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PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

FINAL REPORT – SECTION 319

Prior Lake – Spring Lake Watershed District
4/5/2022

Section 319 and Clean Water Partnership Projects or Final Progress report for TMDL/WRAPS Development and TMDL/WRAPS Implementation Projects

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Executive Summary

a. Problem

Spring and Upper Prior Lakes are in the Minnesota River Basin, located in the southwestern portion of the Twin Cities metropolitan area. Spring Lake outlets via a natural channel to Upper Prior Lake, which then discharges to Lower Prior Lake; an outlet channel from Lower Prior Lake then leads to the Minnesota River. Both Spring Lake and Upper Prior Lake are important recreational resources for the Twin Cities metro area, receiving intense recreational pressure year-round. Spring and Upper Prior Lakes are considered Priority Lakes by the Metropolitan Council for their high regional recreation value, and their protection and restoration are high priorities for the PLSLWD.

In 2002 Spring Lake and Upper Prior Lake were listed on Minnesota's 303(d) List of Impaired Waters for nutrient/eutrophication biological indicators (Table 1). Aquatic recreation on both lakes is impaired.

	DNR Lake ID	**Size (acres)**	**Year placed on 303(d) impaired waters list**	**TMDL Pollutant**
Spring Lake	70-0054-00	642	2002	Excess nutrients
Upper Prior Lake	70-0072-00	337	2002	Excess nutrients

Table 1. Basic information about Spring Lake and Upper Prior Lake

The 2012 Spring Lake and Upper Prior Lake TMDL Implementation Plan identified internal loading as the source of roughly half of the phosphorus loading to Spring and Upper Prior Lakes (49% and 50%, respectively). Internal loading includes the load from rough fish and curly-leaf pondweed. The plan identified rough fish management as a method of significantly reduce estimated P loading (Table 8. Overall Implementation Plan, p.22). Carp resuspend sediments, making phosphorus available to phytoplankton and increasing the shading effect on native submergent aquatic vegetation, which typically sequesters phosphorus. Carp may also uproot vegetation and feed on them directly, further increasing the level of phosphorus in the water column.

SPRING LAKE: The ten-year average for phosphorus levels on Spring Lake were 118 µg/L when the Spring Lake and Upper Prior Lake TMDL Implementation Plan was first completed in 2012. The plan stated that an 83% reduction in phosphorus was necessary to meet in-lake water quality standards and that an alum treatment would help temporarily reduce the internal loading in the lake. The treatment is intended to buy time until loading from the upper watershed could be better managed. The first phase of an alum treatment was completed in 2014, which helped Spring Lake reduce its total phosphorus levels by approximately 26% to a level of 86.7 µg/L on a ten-year average. However, the TP levels have continued to increase exponentially every year following the treatment, meaning it is not a permanent solution to the nutrient loading and eutrophication of Spring Lake.

In 2016 the updated site-specific standards for Spring Lake were approved by the EPA. The total phosphorus standard increased from 40 µg/L to 60 µg/L and the Chlorophyll-A standard was increased from 14 µg/L to 20 µg/L. However, even after the alum treatment, Spring Lake fails to consistently meet these standards for TP and Chlorophyll-A with a ten-year average of 86.7 µg/L and 45.34 µg/L, respectively.

An estimated 70% of the common carp population was removed from the lake in January of 2017. The summer after the removal, vegetation began to significantly rebound in Spring Lake. Curly-leaf pondweed (CLP) is present and has dramatically increased in the lake, which continues to pose a threat to water quality in Spring Lake. CLP has an earlier growing season than other aquatic plants, dying off in the middle of the summer and adding to the already high level of nutrients at that time of year.

UPPER PRIOR LAKE: Because of the alum treatment of Spring Lake, lower concentrations of phosphorus were reaching Upper Prior Lake. However, past studies have indicated that there was still an internal reservoir of phosphorus in Upper Prior Lake that continued to hinder the improvement of water quality in the Lake. Water quality data collected from 2002 to 2015 shows that average annual surface water phosphorus and Chlorophyll-A concentrations are slowly decreasing; however, annual summertime spikes in phosphorus and Chlorophyll-A concentrations were still occurring prior to this project and were noted annually, which correlated with algal blooms and poor water quality. These seasonal trends are heavily correlated with loads from internal sources including the release of phosphorus from the sediment in areas of the lake that become anoxic during the summer.

From 2016 to 2017, the District investigated how to best address internal phosphorus loads impacting the lake and developed an Upper Prior Lake In-Lake Phosphorus Management Plan. The plan identified three steps to reduce internal phosphorus loading: 1) Carp Management - reduction of common carp population and eliminating migration, 2) Alum Treatment - treat areas with high sediment P concentrations with alum, and 3) Vegetation Management - managing invasive species and encouraging native plant establishment.

The District completed two successful removals of carp prior to this project, but only approximately 20% of the population had been removed at that point. Challenges such as rocks and obstructions on the bottom of the lake and the presence of significant curly leaf vegetation still pose an obstacle to successful seining. This project included the use of an innovative underwater speaker system to herd carp into desired locations that do not have obstructions, making removals more successful.

b. Waterbody Improvement

To address the problem of the excess nutrients and eutrophication, the District implemented a holistic carp management project that was guided by integrated pest management (IPM) principles. These principles include data collection, physical removal, barriers, predator introduction, and movement tracking.

In addition to this project, alum treatments were completed on both Spring and Upper Prior Lakes in 2020 and most likely influenced improvements in water quality in addition to carp biomass removal. Huser (2015) found that carp can increase the mixing depth of sediments by as much as 2.5 times, which can lead to reduced efficacy of alum treatments since more mobile phosphorous is available. Carp biomass reduction may work to increase the effective life of the alum treatment in both lakes, as there is less potential for carp to disturb lake sediments that have been treated with alum.

Improvements to Spring and Upper Prior Lakes can be measured by changes in water quality parameters such as total phosphorus (TP), Chlorophyll-A (Chl-A), and Secchi depth, as well as by an increased abundance of submersed aquatic vegetation (SAV).

The District monitors a variety of qualitative and quantitative metrics on many of the waterbodies within the Prior Lake-Spring Lake Watershed District and maintains a robust dataset dating back to 2004. The District contracts with the Three Rivers Park District to collect water quality samples on a bi-weekly basis throughout the growing season.

To understand changes to water quality, a review of the data was completed utilizing water quality data from 2013 through 2021 for both Upper Prior Lake and Spring Lake. As stated previously, the alum application in both lakes, in addition to other external water quality improvement projects, most likely influenced water quality of both basins in conjunction with carp biomass removal. A comparison of pre- and post-project data for TP, Chl-A, and Secchi depth can be seen in Figure 1 below.

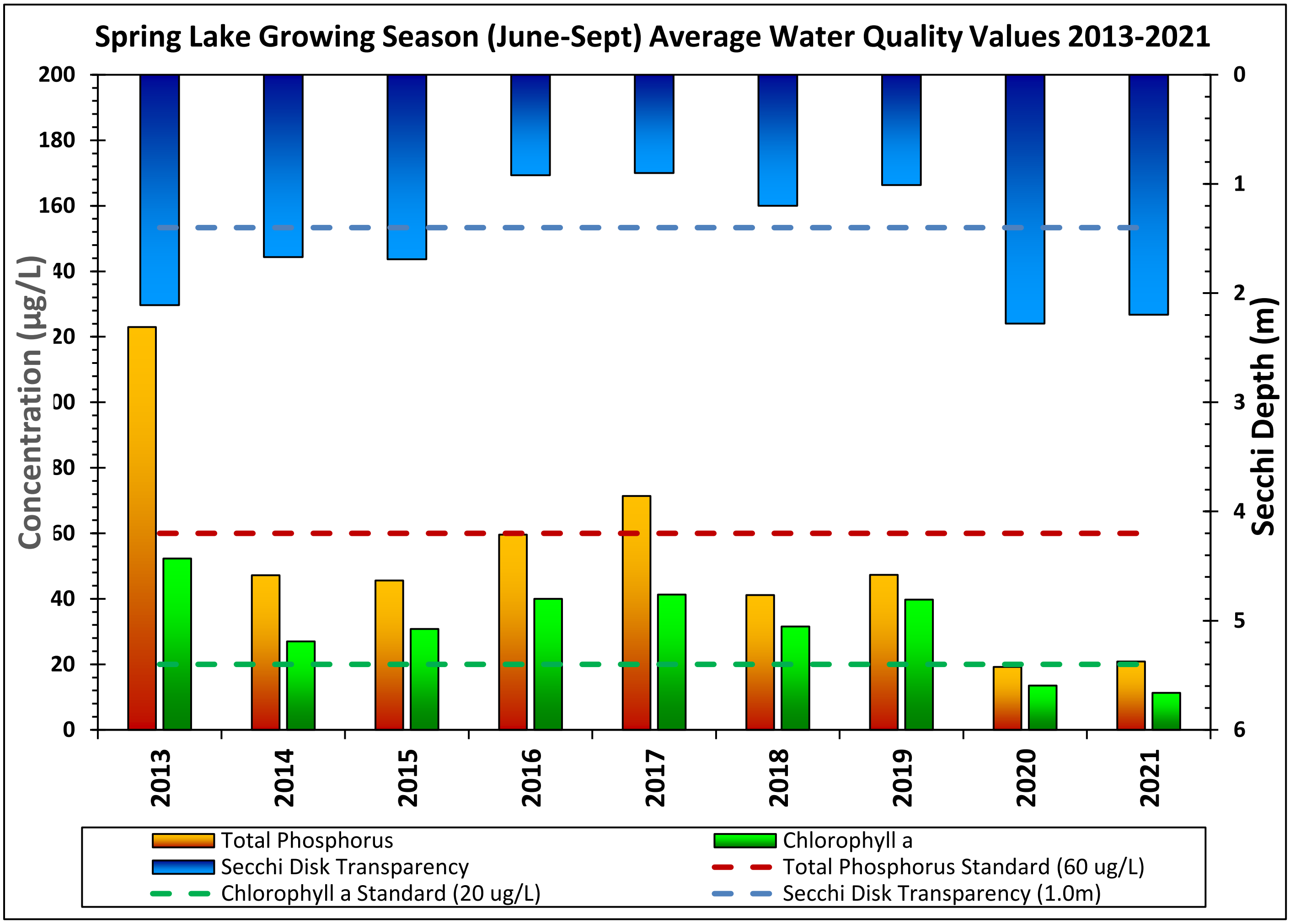


Figure 1. Seasonal average values of total phosphorus, chlorophyll A, and transparency in Spring Lake from 2013 to 2021

Prior to the start of the project, TP was generally high. In 2013 TP concentration was 123 µg/L, which is more than twice the limit. Between 2014 and 2018, TP concentrations ranged from 41 µg/L to 72 µg/L. Chl-A concentrations exceeded the goal of 20 µg/L each year between 2013 and 2018, ranging from 27 µg/L to 52 µg/L. Secchi depth met the goal of 1.4 meters in three of the six years (2013-2015) and exceeded the goal between 2016 and 2018.

At the beginning of the project period in 2019, TP remained above the goal, measuring at 47.23 µg/L for the 2019 growing season, but decreasing significantly in 2020 (19.11 µg/L) and 2021 (20.78 µg/L). These two years represent the lowest measured values since 2013 and show a decreasing trend in TP concentrations.

Chlorophyll-a concentrations remained elevated above the goal in 2019, measured at 39.76 µg/L for the 2019 growing season, but dropped below the goal of 20 µg/L in both 2020 (13.52 µg/L) and 2021 (11.44 µg/L) showing that this metric was meeting the standard (goal) for the first time.

Secchi depth increased from 1.01 meters in 2019, to 2.28 and 2.20 in 2020 and 2021 respectively. As can be seen in Figure 2, Upper Prior Lake had similar results to Spring Lake for the same time period.

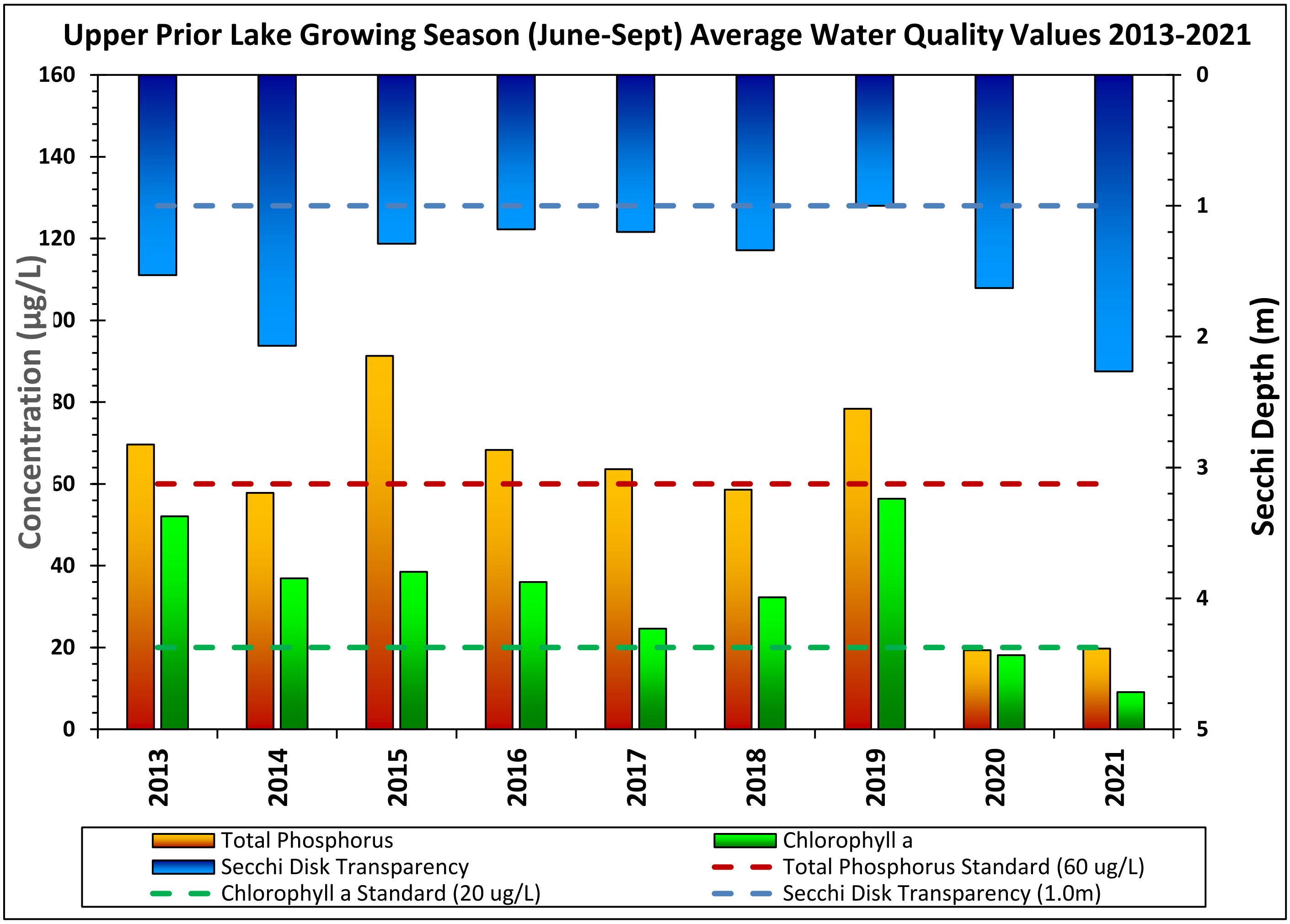


Figure 2. Seasonal average values of total phosphorus, chlorophyll A, and transparency in Upper Prior Lake from 2013 to 2021

Between 2013 and 2018, TP concentrations hovered near the goal of 60 µg/L, exceeding the standard in four of the six years and ranging from 54.79 µg/L to a high of 91 µg/L. Chlorophyll-a concentrations exceeded the standard in all years between 2013 and 2018 ranging from 24.57 µg/L to a high of 52 µg/L in 2013. Secchi depth consistently met the standard of 1 meter in each of the years between 2013 and 2018, ranging from 1.18 meters to 2.97 meters.

In 2019 TP and chlorophyll-a concentrations spiked in Upper Prior Lake with TP concentrations averaging 78.37 µg/L and Chl-A concentrations averaging 56.37 µg/L, the highest average concentration observed between 2013 and 2021. However, both TP and Chl-A concentrations decreased dramatically in 2020 and 2021.

The average growing season concentration for TP in 2020 was 19.22 µg/L, roughly a third of the goal, and remained low in 2021 (19.78 µg/L). Chl-A concentrations showed an even larger decline. In 2020 the average growing season concentration was 18.11 µg/L and in 2021 decreased again to 9.11 µg/L. These two years show the first period where Chl-A concentrations met the standard.

Secchi depth just met the standard in 2019 (1 meter), but showed improvements in 2020 and 2021, increasing to 1.63 meters in 2020 and 2.27 meters in 2021.

c. Aquatic Vegetation

Submergent aquatic vegetation (SAV) abundance can also be utilized to gauge the change and subsequent improvements in lake ecology. As shown in alternative stable state models for lake ecology, typically turbidity and nutrient concentrations decrease as lake ecology shifts from an algal dominated state (high nutrients, high turbidity, benthivourous fish dominant) to a macrophyte dominated state (low nutrients, low turbidity, piscivorous fish dominant).

Macrophytes can act as refugia for juvenile gamefish and panfish and a food source for waterfowl, work to stabilize lake sediments, and take up nutrients rather than nutrients being available to algae.

The district collects data on SAV using both a point-intercept sampling method and BioBase (automated vegetation mapping system utilizing sonar) in both Spring Lake and Upper Prior Lake. Point-intercept data for Spring Lake shows an increase in distribution, density, and species richness for SAV. Between 2015 and 2021, a low of six individual species were documented in 2016 and a high of 15 individual species were documented in 2021. Species richness has been on an increasing trend since 2019 as shown in Figure 3 below.

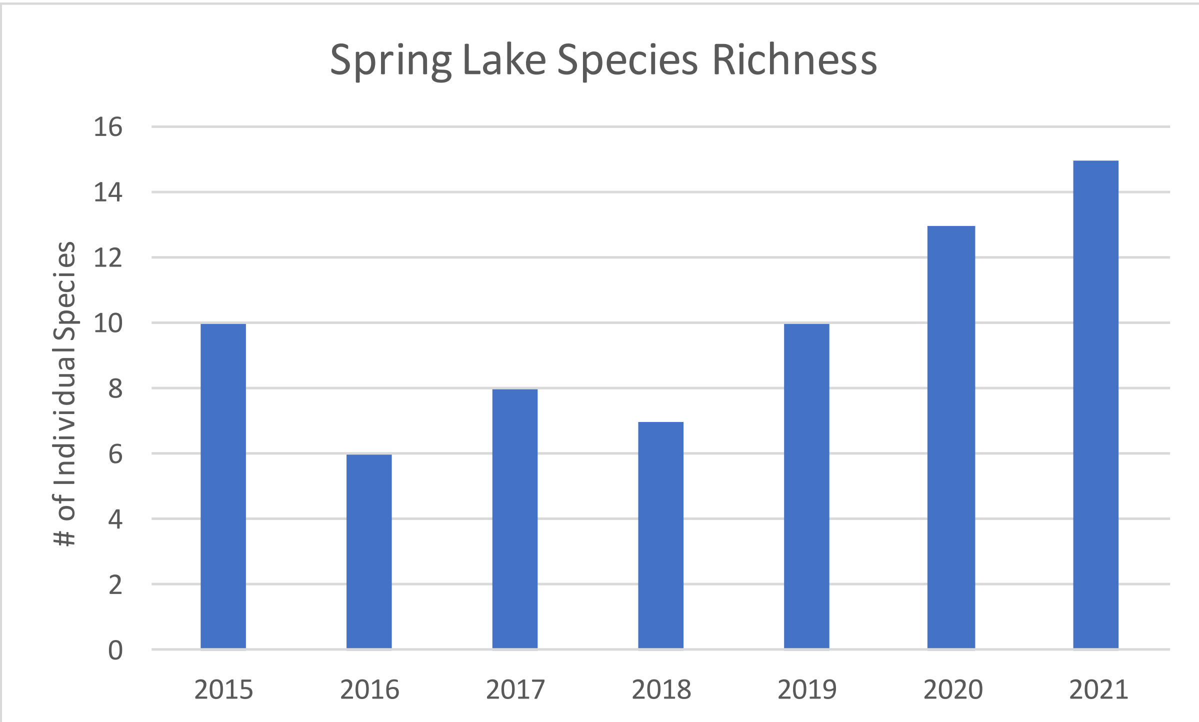


Figure 3. Number of individual aquatic plant species found in Spring Lake from 2015 to 2021

In addition to increases in diversity, distribution also increased for most species, but a minority of SAV species did decrease. The percent occurrence is calculated by determining the percentage of sampling points a particular species is found at a particular sampling point during each survey year. Figure 4 below shows results for percent occurrence for each of the survey periods. A combination of bars and lines have been used to represent the data to make the graph more legible. Values at the Y-intercept are the same for both bars and lines.

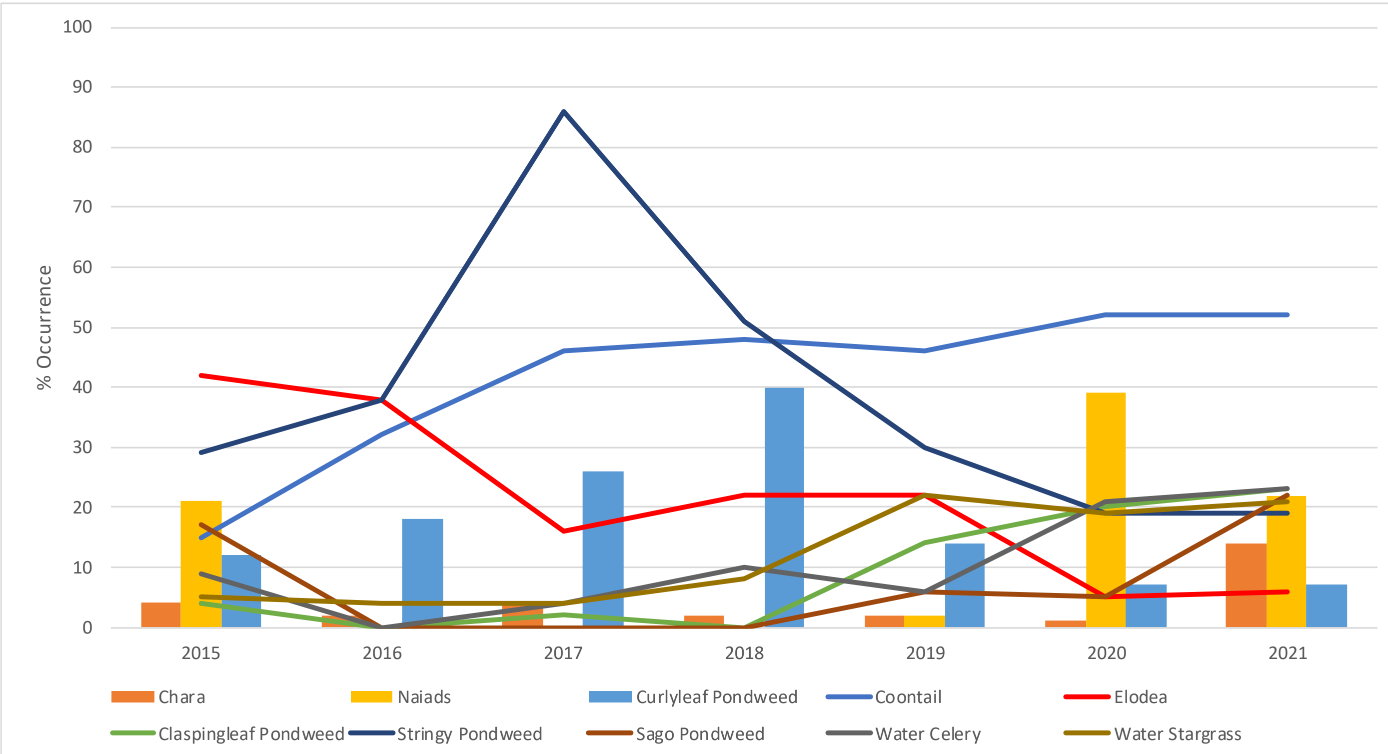


Figure 4. Percent occurrence of aquatic plants in Spring Lake from 2015 to 2021

An examination of SAV density data using BioBase between 2020 and 2021 shows an increase in both density and distribution of all SAV combined as indicated by the point-intercept data.

Figures 5 and 6 below show the percent area coverage for Spring and Upper Prior Lakes delineated from BioBase heat maps.

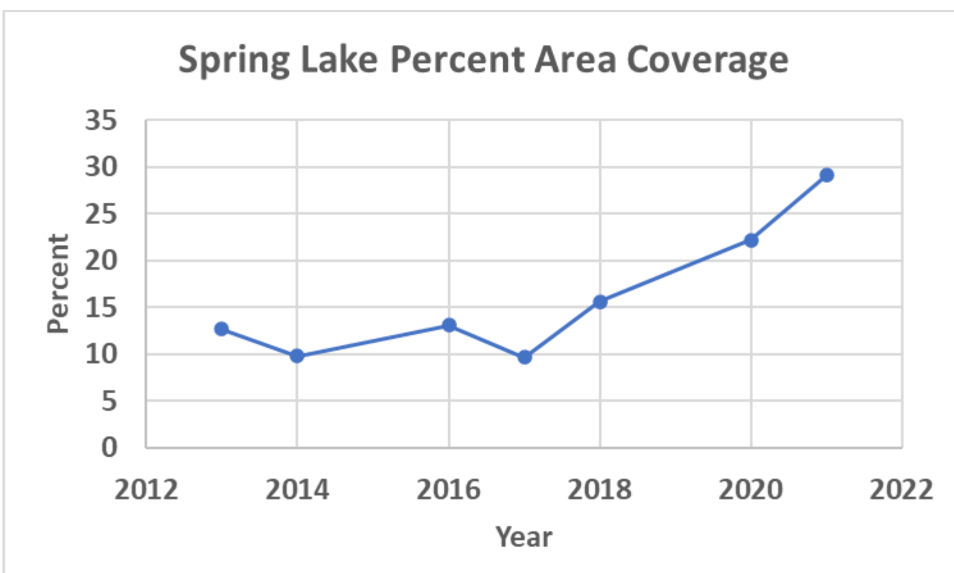


Figure 5. Spring Lake percent area with vegetation

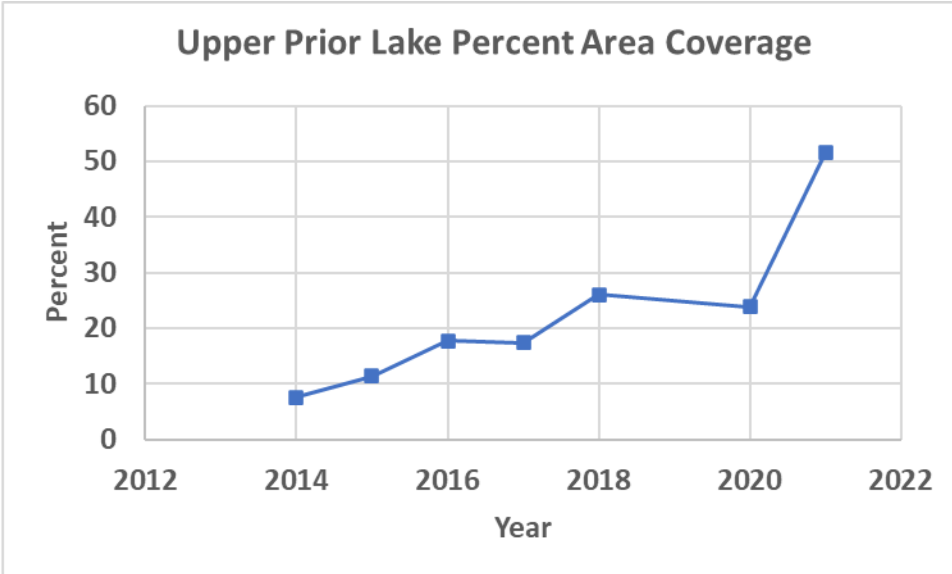


Figure 6. Upper Prior Lake percent area with vegetation

The BioBase heat maps that were used for interpretation of vegetation in Spring Lake are shown below in Figure 7.

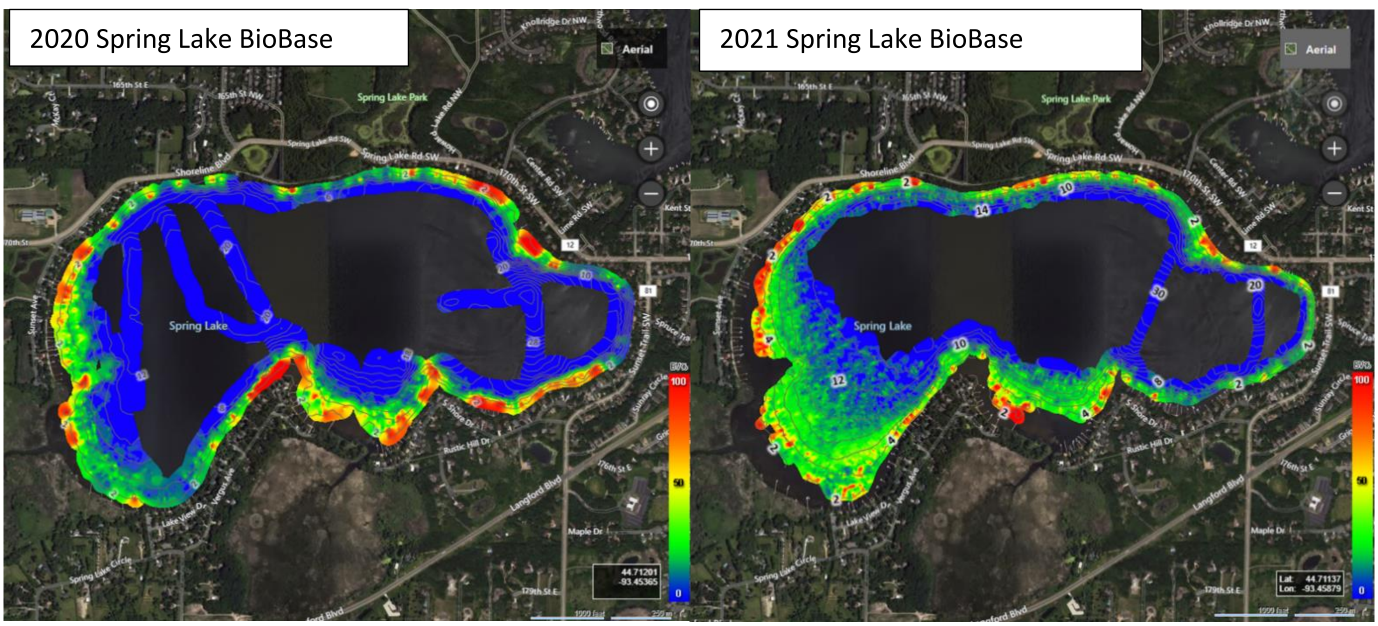


Figure 7. Biobase heat maps of Spring Lake from 2020 (left) and 2021 (right)

As can be seen in Figure 7, SAV rings most of the shoreline of Spring Lake, with some exceptions mostly along the north and east shorelines in 2020, with some locations along the south central and western shoreline (red indicates dense coverage, while blue shades indicate sparse to no coverage of SAV). In 2021 much of the shoreline filled in with SAV and SAV in the southwestern and west central portion of Spring Lake increased in density and distribution.

A more dramatic shift towards increased SAV abundance can be observed in BioBase images in Upper Prior in 2020 and 2021 (Figure 8).

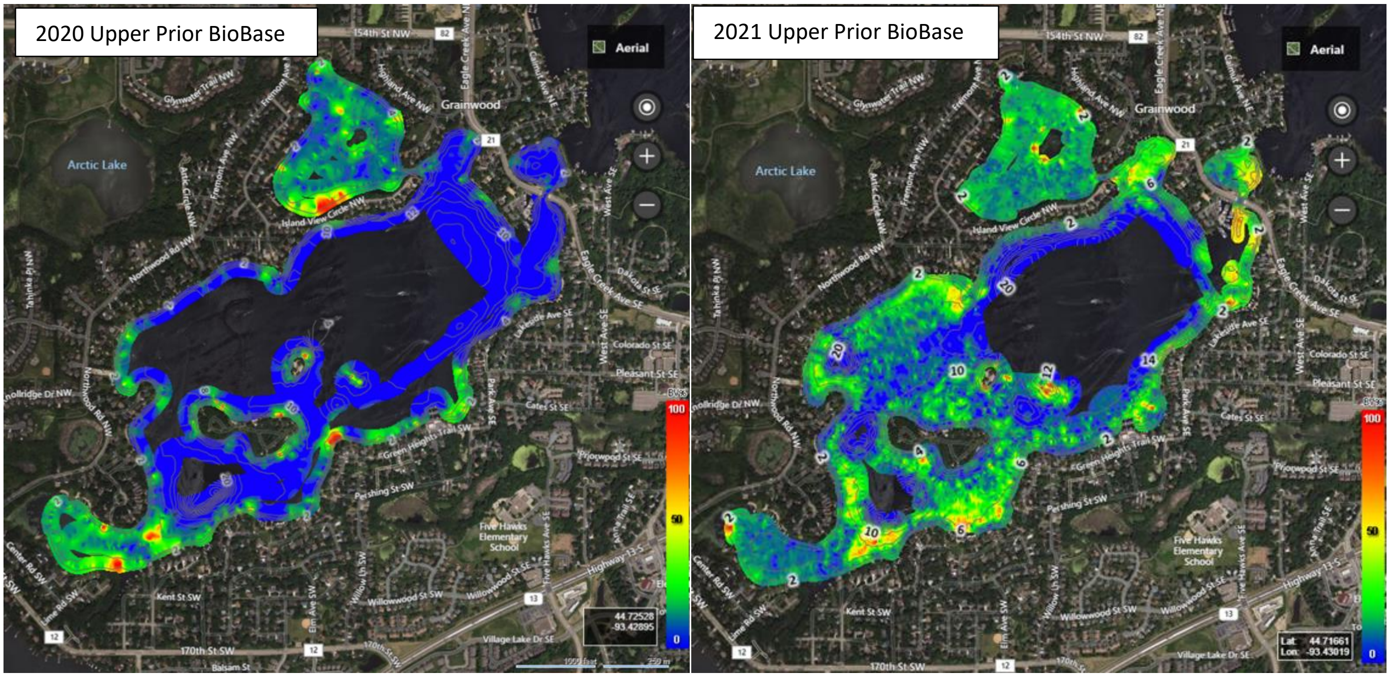


Figure 8. BioBase heat maps of Upper Prior Lake from 2020 (left) and 2021 (right)

Overall, SAV density increased as vegetation began growing in more areas in 2021, primarily the narrows into Lower Prior Lake, the north-central portion of the lake, the south-central portion of the lake, and around the islands in the center of the lake.

The final metric for waterbody improvement is the reduction in carp biomass in both basins. Biomass reduction for both basins is described in more detail in section II.

d. Project Highlights

The major BMP that was implemented was common carp management supported by the tasks listed above and described in detail later in the report. All project activities funded through this grant were completed starting in 2019 and concluding in December 2021. This project and associated activities were completed as part of the District's Integrated Pest Management Plan (IPM Plan) for Common Carp. This plan provides long term guidance for the District to collect critical data for decision making, implement project activities, and monitor ecological changes throughout the District based on implementation. This project was built upon previously collected datasets and implementation activities and provides a baseline for monitoring carp populations throughout the watershed to remain proactive in carp management.

Partners included:

- Shakopee Mdewakanton Sioux Community
- Spring Lake Association
- Prior Lake Association
- City of Prior Lake
- Private Residents (Carp disposal, data collection, and planning efforts)

The District plans to continue management of carp throughout the watershed to further reduce carp biomass and maintain lowered biomass levels so as not to realize water quality impairments in the future.

e. Results

The overarching goal of the project was to improve water quality by reducing TP and Chl-A concentrations and increasing Secchi depth to meet site specific standards through integrated pest management (IPM) of common carp. IPM of carp was guided by the objectives described in Section 1 below. All objectives were completed as carp biomass was reduced on Spring Lake and significantly reduced on Upper Prior Lake. This led to TP, Chl-A, and Secchi depth meeting water quality goals by the conclusion of the project period (end of 2021 growing season).

Internal TP loads were reduced by 198 pounds/year in Spring Lake by reducing the carp biomass by 19,154 pounds and Upper Prior Lake internal TP loads were reduced by 499 pounds/year through the removal of 39,367 pounds of carp in Upper Prior.

Neither Upper Prior Lake nor Spring Lake have been delisted as a result of this project thus far.

MN Statute 97C.815 Subdivision 2 was amended to include Subpart (b) which is described in more detail in Section II of this report.

Body of Main Report

The following outline is structured according to the grant's work plan.

Section I – Work plan review

Goal: *To improve the water quality of Spring and Upper Prior Lakes by decreasing total phosphorus concentrations through the use of integrated pest management to effectively manage the common carp populations and through the encouragement of native aquatic plant establishment.*

Objective 1: *Track movement and population of carp (Complete)*

Task A: *Employ tracking methods on captured carp*

District staff and the consultant will capture and surgically implant 20 adult carp throughout the three lakes with high frequency radio transmitters to track migration routes and identify potential aggregation areas. In addition, up to 200 carp will be implemented with Passive Integrate Transponder (PIT) tags and returned to the lake which will be used to track carp movement through channel connections between waterbodies.

Subtask 1*: Capture/release adult carp in Spring Lake, Upper Prior Lake, and the wetland to the southwest of Spring Lake*
Subtask 2*: Surgically implant 20 carp with radio transmitters*
Subtask 3: *Surgically implant 200 carp with PIT tags*
Subtask 4: *Install seasonal PIT tag receivers in strategic channel connections to track movement*

38 radio-tags have been implanted into carp between 2019 and 2021 in Spring Lake (18) and Upper Prior Lake (20) and locations of these carp have been tracked throughout the project period. These locations have been used to identify migration routes and aggregation areas of carp in the project area and this data was used to target carp for removal.

195 PIT tags have been implanted into carp in Spring Lake (112), Upper Prior Lake (52), and the wetland to the southwest of Spring Lake (31) under this project. These tags have been tracked by a set of PIT tag readers and antennas placed in strategic channel connections to track movement through watershed. Movement detected has guided removal activities as well as the placement of barriers to movement that is associated with springtime spawning migration.

PIT tag receivers were installed in strategic channel connections in 2019, 2020, and 2021 to track movement of PIT tagged carp.

Task B: *Identify migration routes and aggregation areas of carp*

District staff and the consultant will complete multiple site visits to the lake to track the movement and aggregation of the carp population in preparation for seining efforts and to identify effective locations for carp barriers. Carp will be tracked post barrier installation to determine the effectiveness of the barriers and allow us to determine if any modifications may be necessary.

Migration routes and aggregation areas were identified throughout the project period with frequent visits to the lakes to track location of radio-tagged carp. In addition, PIT tag readers were installed in strategic locations throughout the watershed to track migration routes. In the springtime, carp were found to be moving towards three wetland areas adjacent to Spring Lake and Upper Prior Lake. Barriers were placed in these connecting channels to limit carp movement.

Task C: *Estimate carp population & biomass removal amount*

All remaining carp captured as part of the tagging efforts will be fin clipped and released to complete a mark/recapture population estimate during seining efforts.

District staff and the consultant will complete a count of the carp captured during seining and electrofishing efforts to generate a population estimate, combining the information with a weight and length subsample to obtain a biomass estimate.

Subtask 1: *Fin clip adult carp*

Subtask 2: *Calculate population estimate and removal amounts*

All carp that were tagged with a PIT tag were also marked with a fin clip and these marks and tags were monitored throughout the project period as carp were captured. This allowed managers to estimate the population via a mark-recapture method that can be compared to a catch per unit effort (CPUE) survey completed in Spring Lake and Upper Prior Lake in the fall of 2021.

Additionally, population estimates where conducted using boat electrofishing surveys. A Catch Per Unit Effort (CPUE) survey was used to estimate carp. These surveys are completed in the late summer to early fall and over the span of one to two months. Three (3) separate electrofishing surveys in each lake are conducted to establish an average CPUE. Surveys consisted of at least three (3) 20-minute transects that cover shoreline and littoral zones that are suitable habitat for carp. Time spent, number of carp captured, and length and weight data are recorded. A population and biomass estimate of common carp were then calculated using this data in a CPUE model developed for using the protocol and gear described and reflects the population at the time of the survey (Bajer et al., 2012).

Objective 2: *Complete seine (netting) and other removal events to achieve carp population levels at or below water quality goal. (Complete)*

Task A: *Complete carp removal efforts*

District staff and the consultant will coordinate the carp removal utilizing a variety of methods.

Subtask 1: *Coordinate and conduct carp removal efforts*

Subtask 2: *Clear obstructions from removal locations*

Subtask 3: *Employ innovative tools such as underwater speakers for herding to more effectively remove carp populations during seining efforts*

Carp were targeted for removal in Spring Lake, Upper Prior Lake, and Geis Wetland using open water and under ice seine netting, boat electrofishing, in-stream removal, box netting, Push Trap, Newman Trap, and gill netting.

Obstructions were removed from priority seining locations to prevent nets from getting caught up while conducting these operations. Obstructions such as underwater rock points were mapped with greater accuracy allowing greater confidence when deploying equipment.

Underwater speakers were used for herding carp to more effectively capture and remove carp during seine netting efforts effectively called the Modified-Unified-Method (MUM).

Objective 3: *Install carp barriers at strategic locations (Complete)*

Task A: *Identify strategic locations for carp barriers*

Using information gained from Objective 1, District staff and the consultant will identify strategic locations for carp barriers that will inhibit carp recruitment.

Based on carp movement data and trap-net survey data, strategic locations for carp barriers were identified at the Ferric Chloride facility (FeCl), push trap (temp), tadpole, Northwoods Pond, and Freemont (locking the grate and city installing the drop structure and beehive on upstream side).

Task B: *Installation of carp barriers*

District staff and the consultant will install a carp barrier at the upstream wetland to the southwest of Spring Lake where carp have been documented during spawning and up to two more barriers at other strategic locations identified in Task A.

A barrier was installed at the upstream wetland to the southwest of Spring Lake and two other locations were identified and barriers installed. One location is connected to the west of Upper Prior Lake we have called Northwood Pond. The other location is another wetland to the southwest of Spring Lake along the inlet channel, which we have called Tadpole Wetland.

Objective 4: *Aquatic plant surveys and management plans*

In order to monitor and ensure effective native plant establishment following carp removals, aquatic plant point-intercept surveys will be conducted every year. As guided by these surveys, the District will aggressively treat invasive curly-leaf infestations to allow better establishment of native plants and assess the presence of other invasive species. Aquatic plant management plans will be created so that the PLSLWD can remain proactive in establishing native species following the carp removals and increased clarity in the lakes.

Task A: *Aquatic plant point-intercept surveys*

Aquatic plant point-intercept surveys will be conducted each year on Spring Lake and Upper Prior Lake

Aquatic plant point-intercept surveys were conducted each year on both lakes, with the exception of 2019 on Upper Prior Lake.

Curlyleaf Pondweed (CLP) specific surveys were conducted each year on both lakes. Herbicide treatments targeting CLP were administered along with post-treatment surveys each year. During the 2021 survey, Eurasian Watermilfoil was observed in Spring Lake. This led to an initial hand pulling effort followed by an herbicide treatment.

Task B: *Aquatic plant management plans*

Aquatic plant management plans for Spring Lake and Upper Prior Lake will be created in order to help guide the long-term management of aquatic vegetation in response to carp removals and increased water clarity.

Aquatic plant management plants were created giving PLSLWD the ability to better coordinate with the DNR to treat invasive aquatic plants and further management goals.

Objective 5: *Community outreach (Complete)*

Outreach materials were created and distributed to landowners in the carp removal area on Mud Bay of Upper Prior Lake last May 2019. Initial outreach was conducted to schools in fall 2019.

In 2020 we engaged directly with local residents with carp management activities through four volunteer programs (carp tracking, carp espionage https://www.plslwd.org/carp, baited box traps, & training the carp), two school partnership events where high school students tracked carp during ice-on conditions, website updates, 10 social media posts, direct mailings to over 50 shoreline landowners by carp removal locations, and two lake association presentations.

In 2021 presentations were given to both Spring and Prior Lake Associations. A newsletter was sent to 1,112 residents informing them of the water quality implications of common carp, the grant's removal objectives, and the importance of native aquatic plants. The District maintained an interactive carp location map, volunteer carp tracking opportunities, social media posts, and educational materials on the District's website.

Task A: *Outreach mailings*

The PLSLWD will conduct outreach mailings to lakeshore residents about the importance of native aquatic plant establishment for water quality and what they can do as individuals to help the overall project be more successful.

Outreach mailing were sent to lakeshore residents on Spring and Upper Prior Lakes in 2019, 2020, and 2021.

Task B: *Engage the local community*

PLSLWD will have a page on its website that provides information on the project, how integrated pest management is being used to control the carp population, and the water quality goals on Spring and Prior Lakes. The website will also display current locations of radio-tagged carp to keep community engaged/interested.

Presentations will be given at local schools about carp management and the importance of aquatic plants. Classrooms will be invited to name the carp that are tagged, so they can follow their individual fish around the lake on the PLSLWD website. Presentations will also be given to local community groups as opportunities arise.

PLSLWD and the consultant will present information at a Prior Lake Association meeting and a Spring Lake Association meeting about the project's use of integrated pest management, how these activities will improve the water quality of Spring and Prior Lakes, and about the importance of native aquatic plant establishment for water quality.

PLSLWD maintained up to date information on District website about the project including a carp locations map, GIS Story maps detailing carp management processes, social media updates, monthly board meeting updates, educational YouTube videos, training information for volunteers, and carp removal estimates. The District has created two ArcGIS Storymaps that provide a unique look at the carp management and the project success.

- 2020 Carp Management: https://storymaps.arcgis.com/stories/828435c645db478b88649cb8e1df4802
- 2022 Carp Tracking:https://storymaps.arcgis.com/stories/3ab85725c02b4ae9bb7b9f864a2319de

Presentations were given at a local middle school as well as an interactive field trip activities class for the local high school where students were brought out onto Prior Lake during the winter and practiced tracking radio-tags.

Presentations were given each year to both Spring Lake Association and Prior Lake Association annually. Presentations provided annual updates on the project detailing carp removal statistics, barrier installations, carp tracking, water quality improvements, and expectations of greater aquatic plant abundance with clearer water. Special attention was given to the benefits of native aquatic plants and the role they play in maintaining a healthy lake.

Objective 6: *Project Administration & Management (Complete)*

Task A: *Complete and submit semi-annual and final grant reports to MPCA.*

Subtask 1: *Submit semi-annual reports for each year of this project.*

Subtask 2: *A final project report, along with supporting materials.*

Semi-annual reports were submitted for each of the semi-annual reporting deadlines during the grant period. This includes a total of five (5) reports submitted beginning in 2019 and concluding with this report. Copies of all reports are included in Appendix A.

This report constitutes completion of Objective 6. Task A, subtask 2.

Task B: *Project Coordination*

District staff and the consultant will coordinate together and with local partners to complete the objectives of the project and to obtain the required permits.

Subtask 1: *Project coordination*

Subtask 2: *Secure the necessary permits*

Project coordination included obtaining access to private property from residents to install PIT stations and dispose of carp biomass, coordinating with the Minnesota Association of Watershed Districts (MAWD) on legislation to allow for flexibility in licensed commercial fishing areas, formation of a MN Metro Common Carp Working Group, and scheduling carp removal operations with commercial fishing crews.

Permits required for project completion included Minnesota DNR Fisheries Research permit for data collection activities, a Class C commercial fishing permit, MN DNR Fish stocking permit to stock bluegill (carp biocontrol), MN DNR Fish Screen Permit, and a MN DNR Public Waters Work Individual Permit-Intake/Outfall Structure. In 2020, the project team coordinated with the MN DNR to implement a pilot project to utilize gill netting as another tool for carp removal due to carp aggregating where seine nets were not feasible to use. Based on successful implementation on Upper Prior Lake, MN DNR expanded the use of gill nets to Spring Lake and issued the 2021 permit as a non-pilot project. Copies of all permits are included in Appendix B.

Section II – Grant results

In this section of the report, the project workplan will be used again to outline methods, measurements and resulting products produced to accomplish the goals, objectives, tasks, and subtasks.

Objective 1: Track movement and population of carp

***Task A**: Employ tracking methods on captured carp*
***Subtask 1:** Capture/release adult carp in Spring Lake, Upper Prior Lake, and the wetland to the southwest of Spring Lake*
***Subtask 2:** Surgically implant 20 carp with radio transmitters*
***Subtask 3:** Surgically implant 200 carp with PIT tags*
***Subtask 4:** Install seasonal PIT tag receivers in strategic channel connections to track movement*

Tracking Movement and Population of Carp

Determining how carp use the system is critical to the development of the carp IPM plan (Appendix X). Understanding movement patterns allowed project managers to identify potential nursery sites, migration routes, and wintering areas where carp may be vulnerable to large scale biomass removal or blockage to movement to limit recruitment (Bajer, 2011). Radio-tags were surgically implanted into carp that were then released back to the basin they were captured in. A total of 38 carp were implanted in Spring Lake (18) and Upper Prior Lake (20). Tags were then tracked by PLSLWD and WSB staff throughout the project period to help guide capture and removal efforts by identifying aggregations (Figure 9).

Survey frequency was greatest during the spring spawning period (1-2/week) and during the winter aggregation period when ice conditions were safe enough for foot travel. The remainder of the year, radio telemetry surveys were completed on a once per week basis.

Radio-Tags

A radio-tag consists of a 2.5-inch-long cylinder which is surgically inserted inside the body of the carp with a foot long antenna extending outside of its body. Unlike PIT tags, radio-tagged fish can be located manually and tracked in real-time with an antenna from a boat or from on top of the ice in winter. Tracking requires listening for a directional signal and triangulating the vectors from which the sound is coming from. The tone and strength of the signal can also indicate the tag is to the receiver. Radio-tags implanted in the carp last for about two to three years, providing the District with key information about where the carp gather to overwinter and where they go to spawn. Each radio tag has a unique frequency, which can be picked up from up to a mile away with the tracking antenna device.

Passive Integrated Transponder (PIT) Tags

PIT tags act as a lifetime barcode for an individual carp and when scanned are as reliable as a fingerprint (Gibbons & Andrews 2004). The tag is between 10 and 14 mm long and 2 mm in diameter. PIT tags are injected with a needle under the skin of the fish. PIT tags are dormant until activated; they therefore do not require any internal source of power throughout their lifespan. To activate the tag, a low-frequency radio signal is emitted by a scanning device that generates a close-range electromagnetic field. The tag then sends a unique alpha-numeric code back to the reader (Keck 1994). Scanners are available as handheld, portable, battery-powered models and as stationary, automated receiver devices that are used for automated scanning. PIT tag receiver stations were strategically placed in suspected carp migratory routes to determine movement behaviors in those channels and around barriers to determine effectiveness. PIT stations aided in determining location for barriers and once barriers were installed, PIT stations were kept operating to see if tags detected on one side would detect on the other.

Fin Clips / Plastic Tags

To determine population estimates, carp were sometimes marked with a unique fin clip for the waterbody (e.g., right dorsal fin, pectoral fin, etc.) which does not harm the fish but leaves an identifiable marker. In other studies, carp have been marked with plastic tags that are inserted into the body of the fish and are similar looking to retail clothing tags.

Trap Netting

Trap netting was completed using fyke nets as fish traps. A fyke net operates as a long cylindrical net containing wings at one end that guide fish toward a series or cone shaped chambers at the other end of the net. The fyke nets were deployed in waters where information needed was gathered to determine young of year (yoy) carp or bluegill presence. Trap netting occurred in waterbodies where carp were tracked using radio tags, PIT tags, and observed spawning. Tracking of yoy within the connected waterbodies guided management decisions related to biocontrol techniques, and barrier placement for this project.

Carp Espionage

A volunteer carp sighting program was developed to gain information from residents who could identify carp sightings who had the ability to view the waterbodies at all hours of the day. Volunteers were recruited through an outreach campaign on social media. A short form would be filled out and with basic information regarding the sighting along with placing a pin of the location on map. Carp sightings were broken down into spawning, migration, and groups/clusters. The Carp Espionage program can be found here: https://carp-espionage-plslwd.hub.arcgis.com/. Sightings from this program proved valuable when much of the early spawning activity occurred after work hours and into the night. Having the knowledge carp were showing signs of spawning, PLSLWD and WSB were able to take action to perform removal activities.

The District also uses two stationary cameras to be placed at strategic locations to confirm carp migration routes and/or aggregations of carp during spawning season. These cameras are set up wirelessly and transmit real-time information so that staff can move quickly to coordinate carp removals at optimal times.

Task B: *Identify migration routes and aggregation areas of carp*

Winter-time telemetry surveys and past studies have proven that carp tend to aggregate together in large groups during the winter (Johnsen, 1977; Penne, 2008). This phenomenon allows for these aggregations to be targeted for removal using under ice netting techniques, thus the identification of carp wintering areas on Spring Lake and Upper Prior Lake was determined to be a main objective in the 2015 carp management project.

Radio-tagged carp have been periodically monitored in PLSLWD since 2015 to identify winter carp aggregation areas that could be targeted for carp biomass removal. Two (2) distinct sites were identified on Spring Lake (Figure 9). Note: Both sites have historically been commercial fishermen have been able to pull a seine net through.

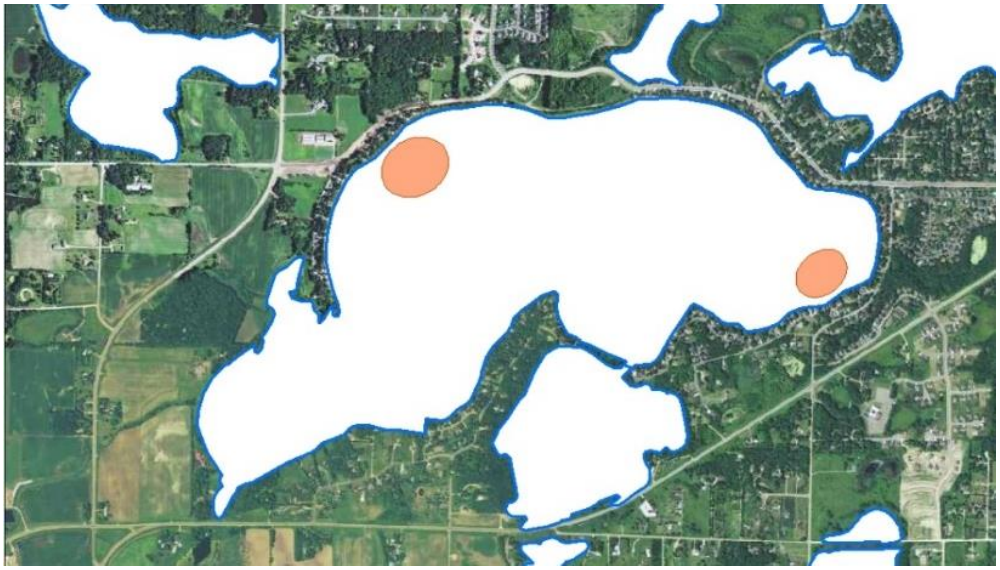


Figure 9. Aggregation areas suitable for seining

Telemetry data from 2015-2021 has identified winter aggregation areas on Upper Prior Lake. Four (4) distinct sites have been identified where carp tend to aggregate, mainly in the winter (Figure 10). Locations 1-3 depicted have been successfully seined in both open water and under ice. Location 4 poses a significant risk of snagging lake bottom rocks and is not suitable for netting. Note: In 2020 and 2021 when carp were located near the rocks at location 4, the district utilized underwater speakers to herd carp from the undesirable seining location. Additionally, all 4 locations have been targeted with gill nets during the Gill Netting Pilot project.

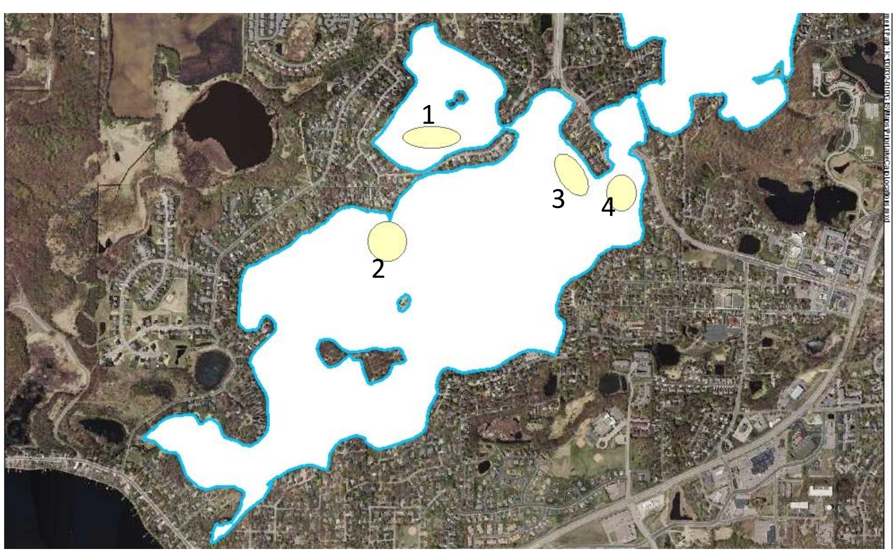


Figure 10. 2016 - 2021 Upper Prior Lake carp aggregation areas suitable to seine

Radio-tags will continue to be tracked, mapped, and documented to identify new and continued areas that carp are congregating on or migrating to in Upper Prior and Spring Lakes.

Identifying aggregations and connections within Spring and Prior Lakes and their connecting ponds, wetland, and other waterbodies is a complex task. Using staff, volunteers, and stationary cameras, the District monitors the that are suitable for small-scale carp removals when fish begin aggregating in the spring. This information was used to coordinate electrofishing, gillnetting, micro-hauls, or seine netting carp removals with consultants and/or commercial netters.

Seasonal maps have been produced that show aggregation areas and migration routes using radio-tag locations. Aggregation areas have been exploited for removal activities and some identified migration routes have been blocked with permanent or temporary barriers.

Radio-tag Mapping Analysis

Radio-tag telemety data from the winter months were compiled from 2015 to 2021. Each purple dot represents the location of a radio-tagged carp during this time period. A density map was created from these points to highlight aggregation areas of Spring and Prior Lakes; areas where radio-tagged carp are most frequently found. The northwest corner and the far eastern bay of Spring Lake are two primary aggregation areas that were identified during the winter season (figure 11). In Upper Prior Lake, the northeast shores and into the narrows that lead to Lower Prior Lake are the primary winter aggreggation locations (figure 12).

Radio-tag telemety data from the spring spawning months were compiled from 2015 to 2021. As in Figures 11 and 12, each purple dot represents the location of a radio-tagged carp during this time period. A density map was created from these points to highlight areas in Spring and Prior Lakes and nearby wetlands that were most used for spawning. The shallow, and highly vegetated southwest corner of Spring Lake was the primary hot spot for carp spawning. Carp were also found in high densities in the Tadpole and Desilt Ponds, which are connected to the west side Spring Lake by county ditch 13. Radio-tags were occasionally found in the farest eastern bay as well (figure 13). During the spawning months in Upper Prior Lake, carp are typically located in the northern most waters of Mud Bay. Carp have aslo been tracked in the southwestern most bay of Upper Prior Lake where the connecting channel to Spring Lake is located. Beginning in 2021, carp multiple radio-tagged carp migrated into Lower Prior Lake. Continued tracking efforts are planned in 2022 to gather enough data to further analyze migration season patterns in Lower Prior Lake (figure 14).

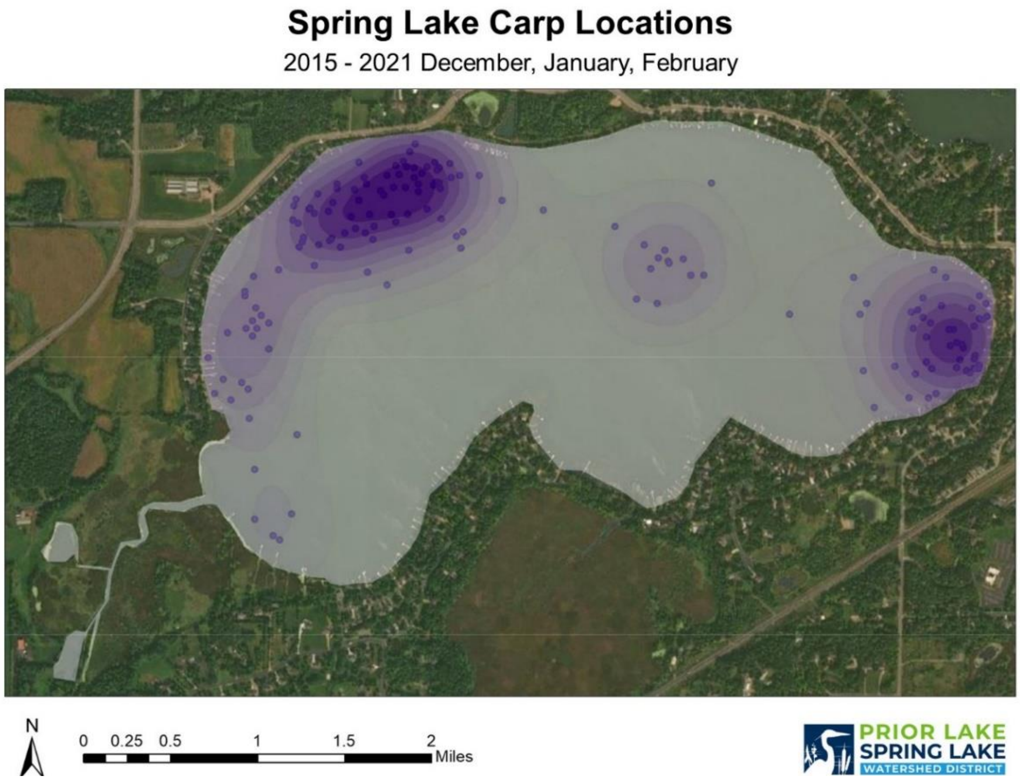


Figure 11. Spring Lake winter months carp locations heat map

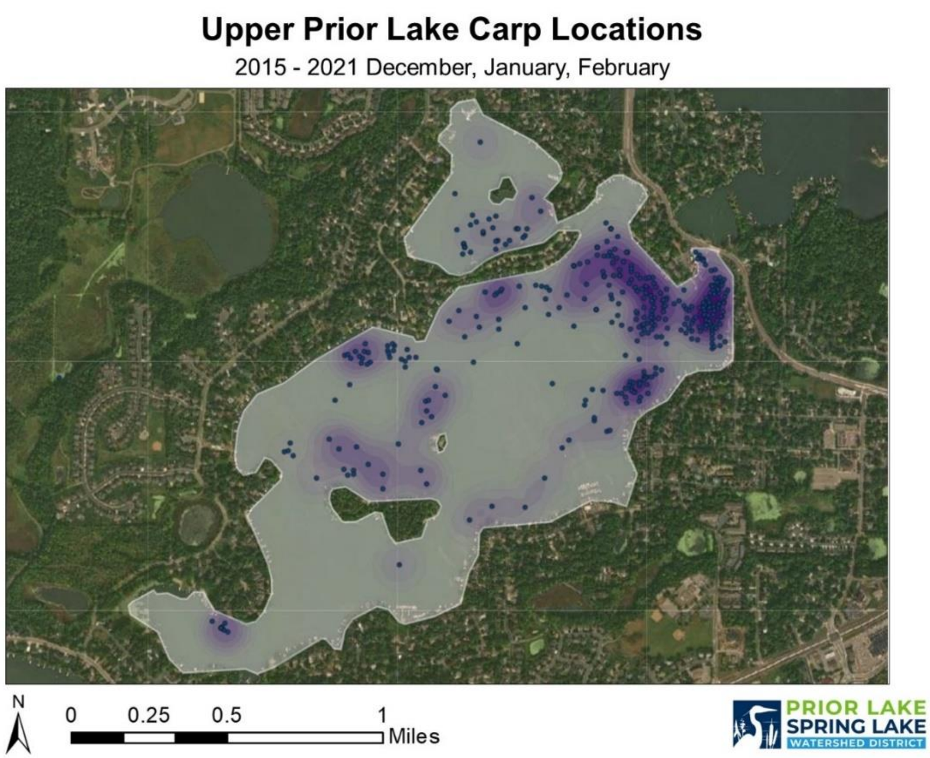


Figure 12. Upper Prior Lake winter months carp locations heat map

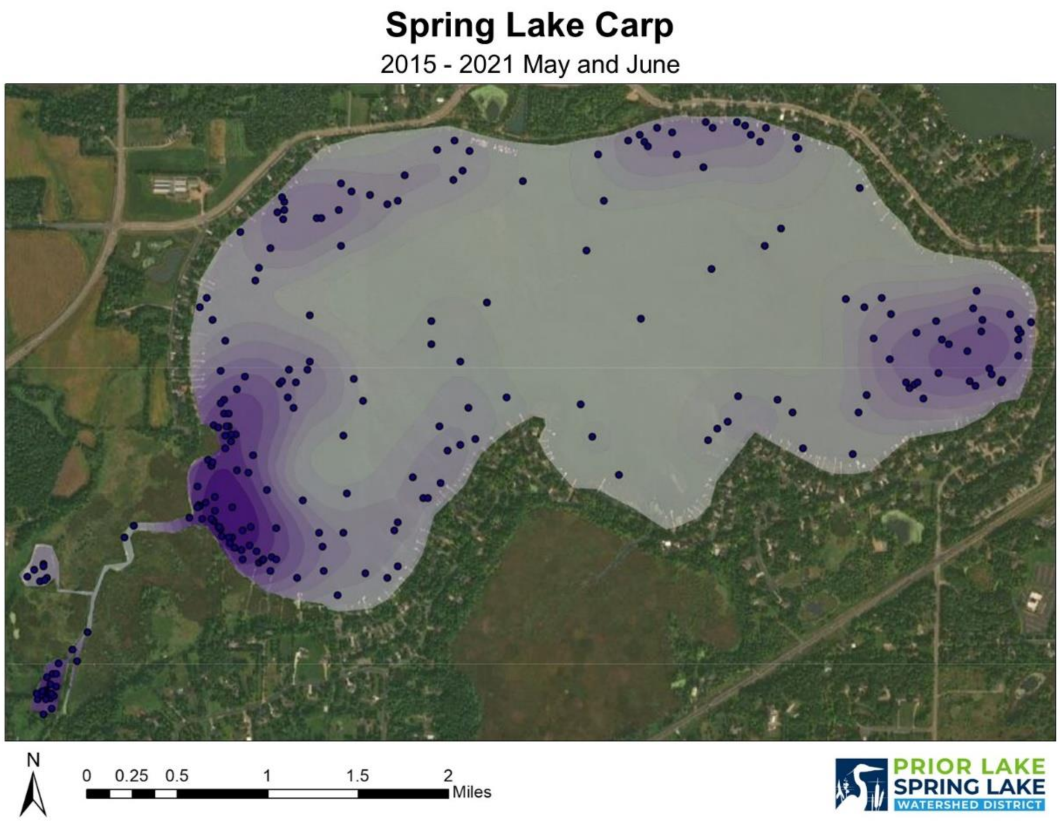


Figure 13. Spring Lake spawning season carp locations heat map

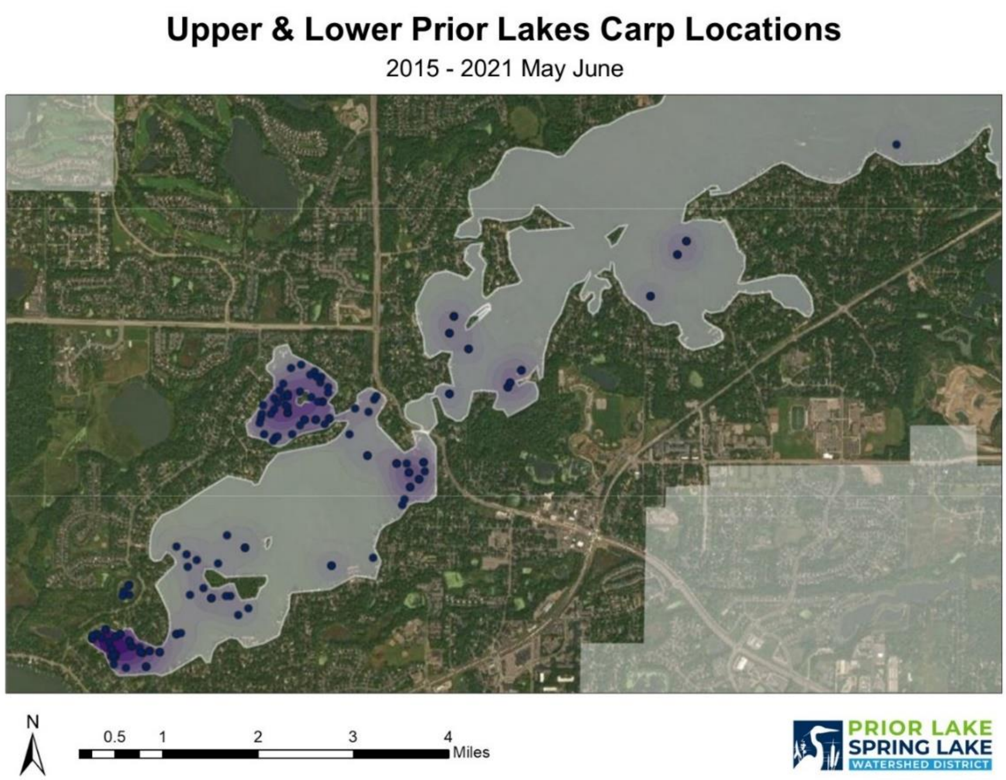


Figure 14. Spring Lake spawning season carp locations heat map

Radio-tag telemety data from the summer growing season months were compiled from 2015 to 2021. As in the previous figures, each purple dot represents the location of a radio-tagged carp during this time period. A density map was created from these points to highlight areas in Spring Lake and nearby wetlands that were most utilized by radio-tagged carp during the growing season. Similar to spawning season, the southwest shoreline of Spring Lake was the primary hot spot for carp during this time. They were also found within county ditch 13. Upper and Lower Prior Lakes growing season data shows that carp tend to spread out (figure 16). There are less datapoints in the summer months as scheduled tracking events get spread out with less opportunities for removals.

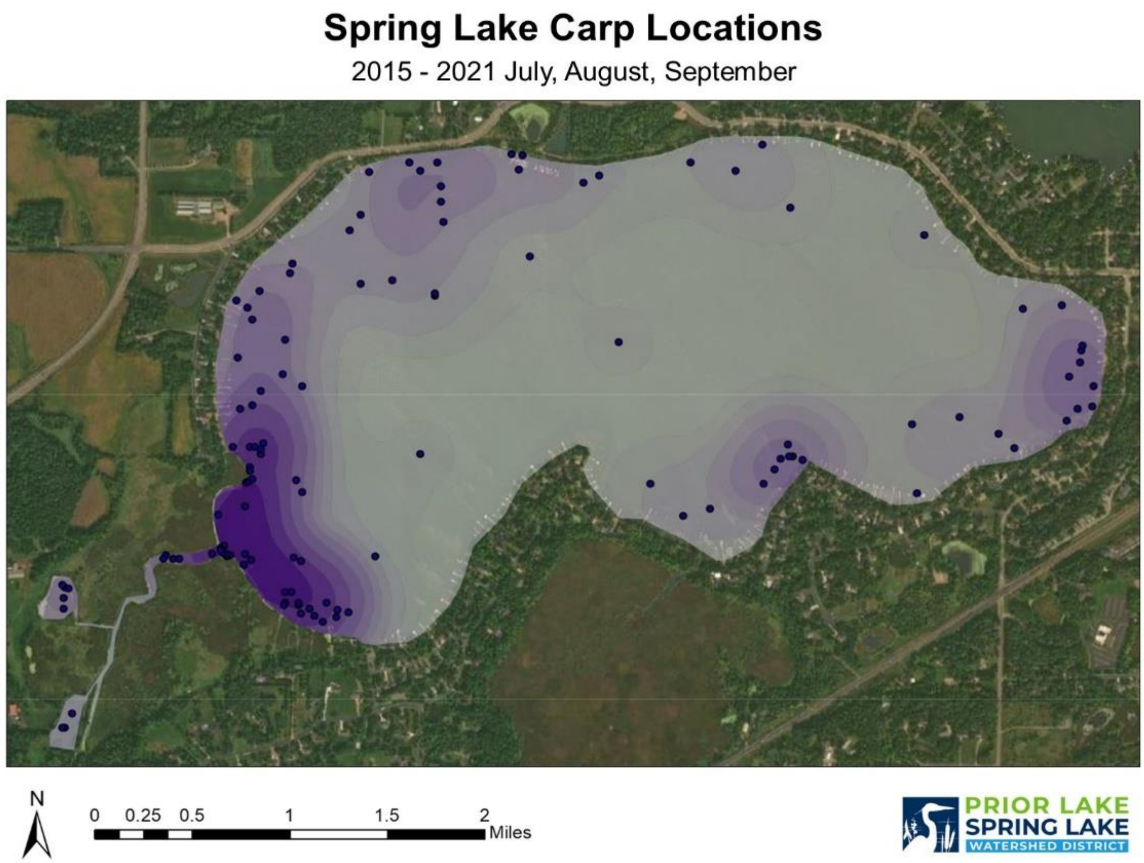


Figure 15. Spring Lake growing season carp locations heat map

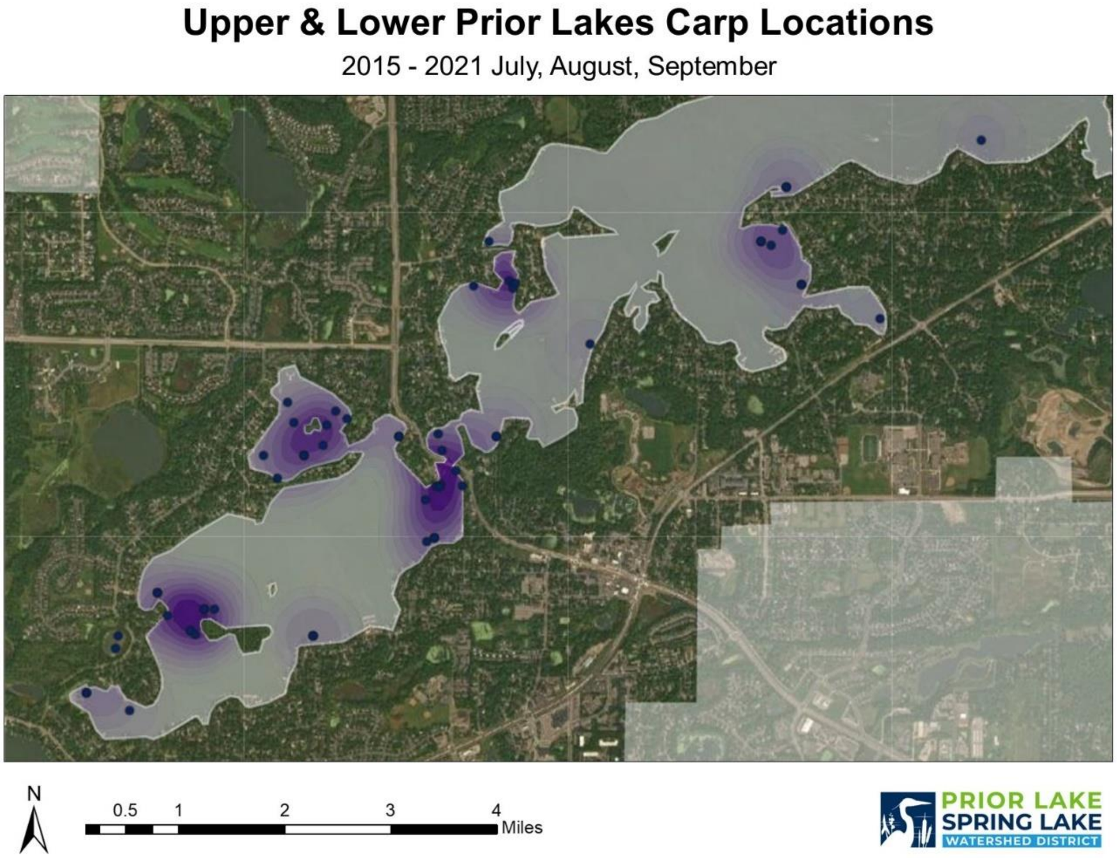


Figure 16. Spring Lake growing season carp locations heat map

Figure 17 below focuses on all radio-tagged carp in Spring Lake from years 2015-2017 and 2020-2021. The map also includes radio-tagged carp from Upper Prior Lake (2016-2021) and Arctic Lake (2017-2018), both of which traveled upstream into Spring Lake. The map also displays PIT tag station locations and barriers. The movement that was seen by radio-tag and PIT tag data helped inform PLSLWD placement of barriers.

Figure 18 highlights all radio-tagged carp in Upper Prior Lake from 2016-2021. The map also includes radio-tagged carp from Spring Lake and Arctic Lake. There is intermixing of carp populations between Upper and Lower Prior Lakes due to the number of radio-tagged carp that found their way to Lower Prior Lake. The map also displays PIT tag station locations and barriers, which were informed by the movement that was seen by radio-tag and PIT tag across the PLSLWD.

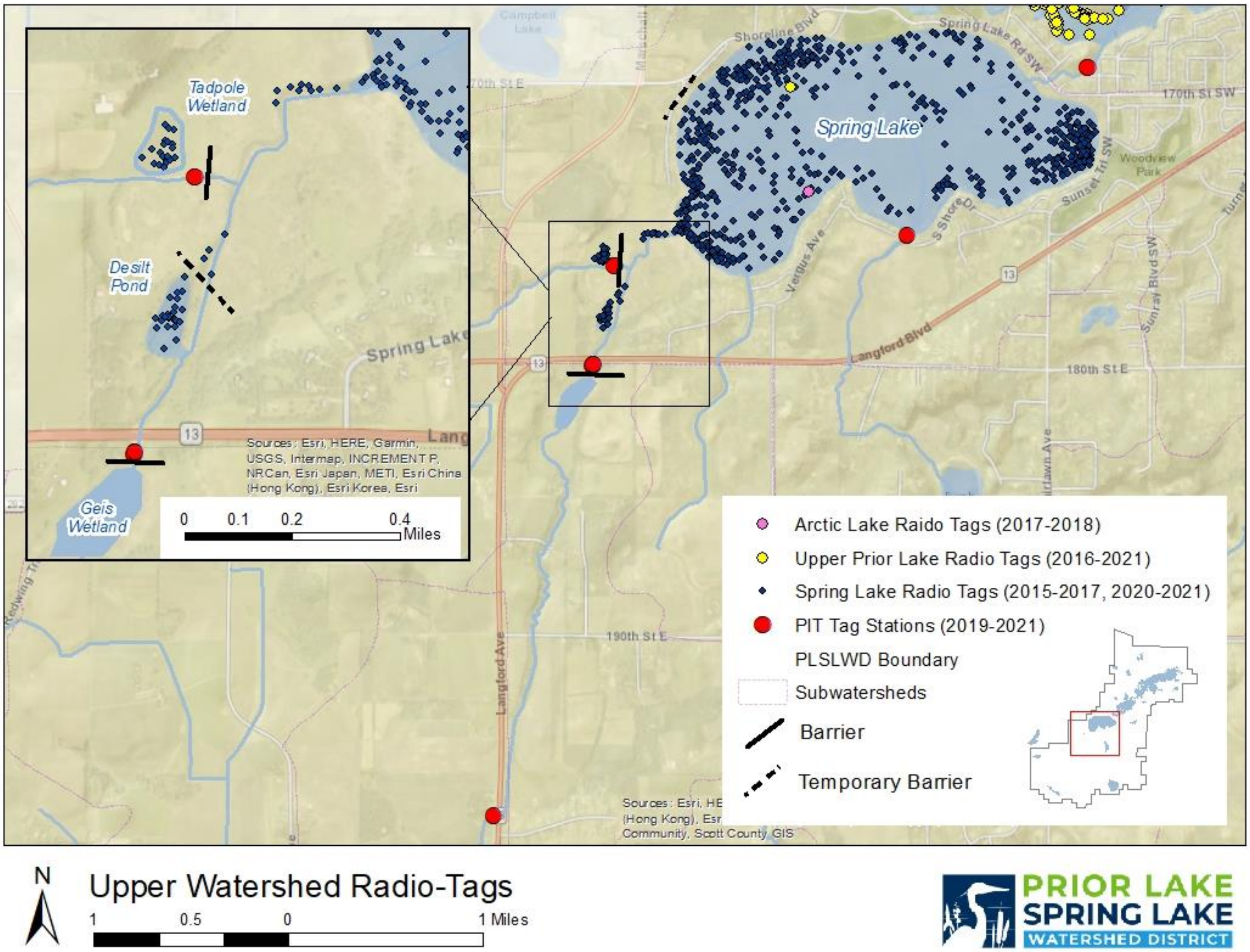


Figure 17. Upper Watershed radio tags

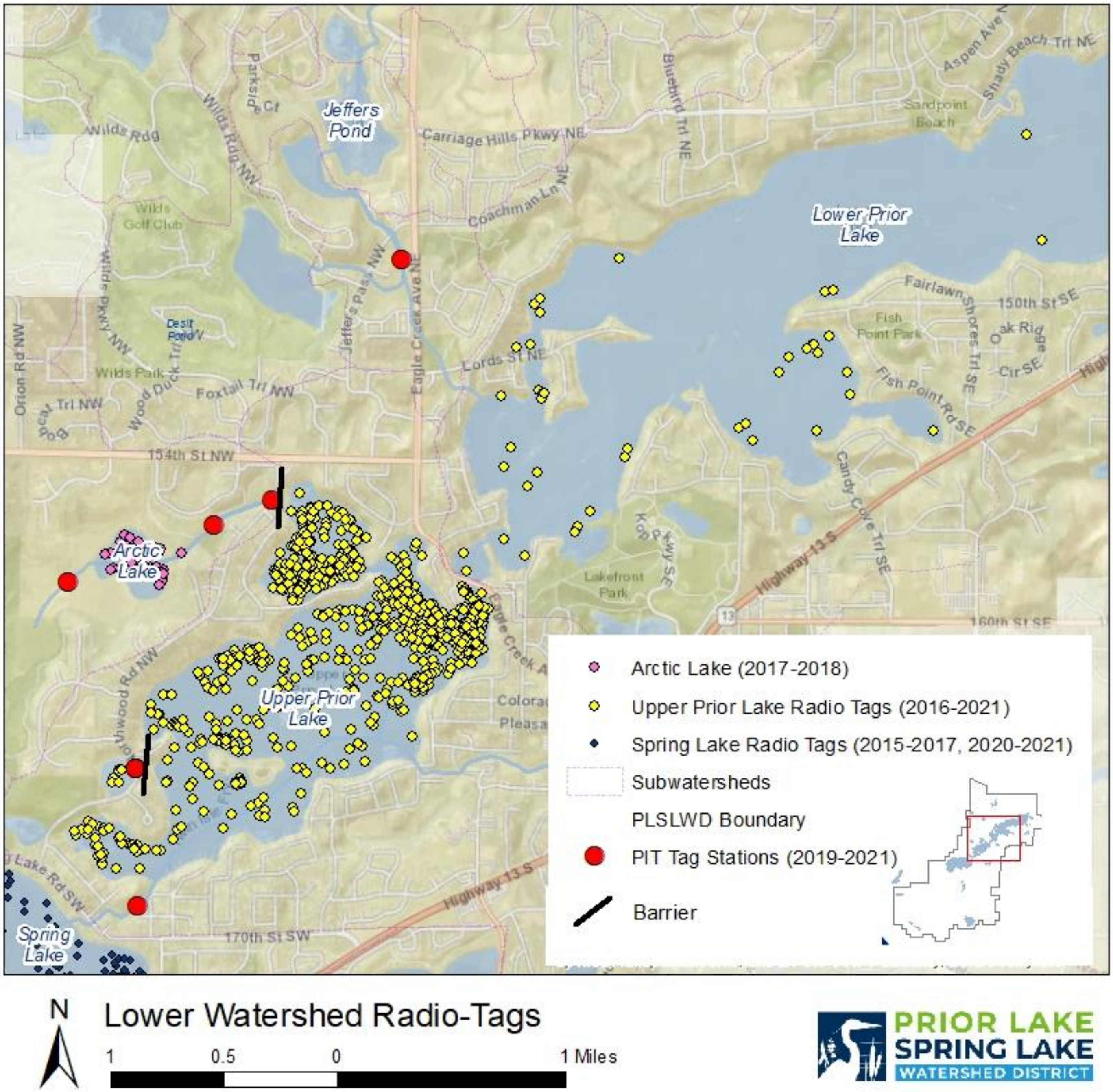


Figure 18. Lower Watershed radio tags

Using PIT Stations to Map Migration Routes and Identifying Connected Nursery Sites

Migration routes that allow access to shallow basins that carp exploit for use as nursery sites are the support mechanism for carp recruitment in those systems where carp spawn outside the main basins. Carp have evolved to seek out these sites since hard winters in Minnesota periodically freeze shallow basins resulting in winterkill of most or all fish species. Absence of predator species, such as bluegill sunfish, greatly increase the chance for survival of carp eggs and larvae. Radio-tags and passive integrated transponder (PIT) tags and stationary receivers are currently being used to track the movement of carp each season (Appendix C).

Carp movement out of the Spring Lake and Upper Prior Lake system is being studied using the same radio-tags used in the Judas fish technique to find carp winter aggregations. Several apparent surface connections exist on Spring Lake and Upper Prior Lake and in some cases, anecdotal information suggests that carp are using a connection even though no radio-tags have been detected moving. In response to this, the PLSLWD initiated a study using Passive Integrated Transponder (PIT) tags and seven (7) unmanned receivers/Loggers placed in streams to detect movement and quantify the extent of movement in locations of highest priority (figure 19). Five of the sites are using solar powered PIT Stations which allows for a more complete data set at remote locations where frequent battery swapping is difficult. The population and physical movement of carp throughout the watershed was tracked under this project work-plan. Two types of tracking technology were used including high frequency radio-tags (ATS model 1850B) and passive integrated transponder (PIT) tags (Oregon RFID). Radio-tags were manually tracked using a handheld receiver and yagi antenna (ATS R410) and PIT tags were tracked via handheld readers or by readers (Oregon RFID) installed in channel connections.

PIT tag antennae and readers power a PIT tag as it travels through the field and the unique number and time of crossing is recorded in the database. This information can be compared with the implant tag list to determine the origin of the fish and length data collected at the time of implant. PIT tags were implanted into carp in Spring Lake (112), Upper Prior Lake (52), and the wetland to the southwest of Spring Lake (31) under this project work-plan (Objective 1: Task A: Subtask 3). These tags, coupled with a fin clip, can serve as a mark that can be used in a mark-recapture estimate of population (Objective 1: Task C).

Data collection for the PIT stations showed significant movement around the watershed. Knowing that only a tiny fraction of the entire carp population is tagged, collecting data with PIT stations in an effective and proven method to determine migration routes and special usage. This means even one tag detected at a station can be representative of a large population. Carp were found to have moved from the wetland southwest of Spring Lake into Spring Lake, from Spring Lake into Tadpole wetland, from Spring Lake into Upper Prior Lake, from Upper Prior Lake into Northwood Pond, from Spring Lake and Upper Prior Lake to Lower Prior Lake and into the outlet structure towards Jeffers Pond.

A map of all the stations can be found below in Figure 19. Brief descriptions of each station are also available in the following section.

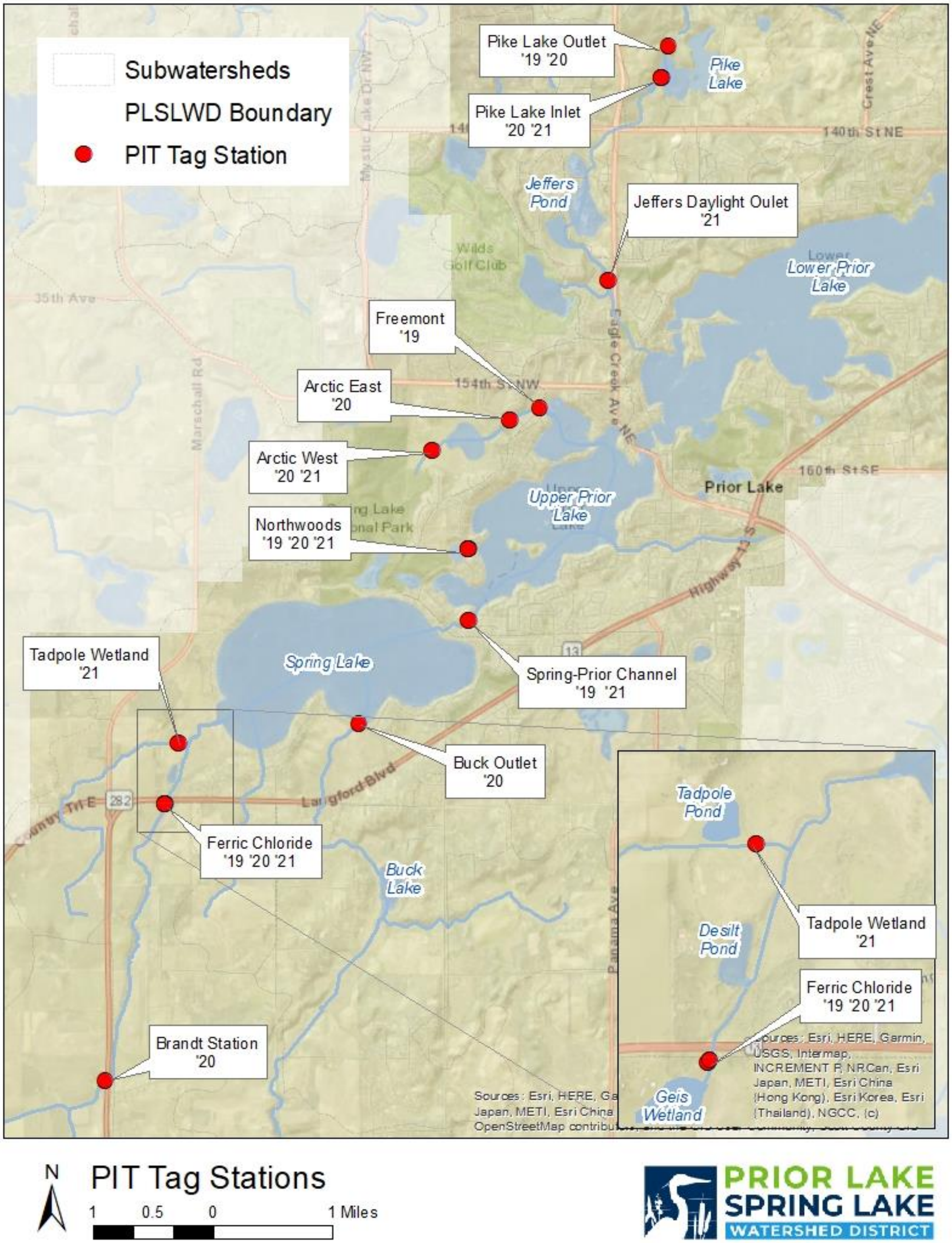


Figure 13. PIT tag stations throughout the watershed

Figure 20. Solar panel mounted on pole to power Brandt PIT station

Brandt 2020

The Brandt station is located along Langford Ave (Hwy 13) just north of Butterfly Ln and is powered by a solar panel (Figure 20). It was installed in 2020 to monitor possible movement from downstream Geis Wetland towards Sutton Pond. PIT tags have been implanted into carp, and white sucker fish in Geis Wetland but not in Sutton Pond.

Ferric Chloride 2019, 2020, 2021

The Ferric Chloride station was installed in 2019, 2020, and 2021. This station is in the outlet stream of Geis Wetland as it heads towards downstream Spring Lake. In In 2020, a new barrier was installed to prevent movement from Spring Lake into Geis Wetland that replaced an aging one. The antenna is below a weir structure at the outlet of Geis, just south of Hwy 13/Langford Blvd in Prior Lake, MN (Figure 16).

Tadpole Wetland 2021

The Tadpole station was placed in the channel between Spring Lake and an upstream wetland known as Tadpole Wetland. The connection offshoots from the outlet channel north of Hwy 13 (Figure 16). 2021 monitoring was employed to confirm movement of carp through the channel.

In 2022 this station will be redeployed to test the efficacy of the new barrier.

Buck Outlet/Raymond Park 2020

This station is designed to capture movement out of Spring Lake towards Buck Lake (Figure 21). This outlet channel is located south in Spring Lake and flows into a large cattail wetland before going under Hwy 13 and into Buck Lake.

Spring/Prior Connecting Channel 2019, 2021

The stream connection between Spring Lake and Upper Prior Lake was monitored with a PIT station in 2019, and 2021. In the future, a barrier may be considered between Spring Lake and Upper Prior Lake to prevent movement between these basins. Special consideration for a barrier is required in this stream reach as it is a main outlet channel with sometimes high flow conditions. A barrier cannot impede much water flow as it would be a risk to flooding in this highly developed area.

Northwood Pond 2020, 2021

This station is located at the outlet of Northwood Pond before it enters an underground pipe that inlets to Upper Prior Lake in the southwestern portion of Upper Prior Lake. In 2018 radio-tags were tracked in the pond and a barrier design plan was put into place (Figure 19). The site was monitored in 2020 and 2021 to further study movement into the basin before barrier installation and to determine the efficacy of the barrier after it was installed in 2020.

Freemont 2019, 2020

The Freemont Avenue station was in place in 2019 and 2020 and is located along a connecting channel between Arctic Lake and Upper Prior Lake (Figure 16). The antenna was located on the upstream side of a barrier to carp movement that is on a culvert structure as the stream enters Mud Bay in Upper Prior Lake. This station is associated with the Arctic East station.

Arctic East 2020, 2021

The Arctic East site is located in the stream that connects Arctic Lake to Upper Prior Lake and was installed in 2020 and 2021.

Arctic West 2021

The Arctic West station is located upstream of Arctic Lake (Figure 16). This stream reach outlets from a wetland complex into a iron sand filter and eventually flows into Arctic Lake and then towards Upper Prior Lake. PIT tagged fish originating from Arctic Lake have been found in recapture events in Spring Lake and Upper Prior Lake, but the route they used to get there has been unconfirmed. No Arctic Lake tags have been detected at the Spring/Prior Connecting Channel station. In response to this phenomenon, the Arctic West station was employed in 2021.

Jeffers Daylight 2021

The Jeffers Daylight Pond station is located along the Prior Lake Outlet Channel (PLOC) (Figure 16) and was installed in 2021. The PLOC is a seven-mile channel that connects Lower Prior Lake to the Minnesota River through a network of stream and wetland habitat. The outlet leaves Lower Prior Lake through a weir structure into a pipe that daylights 400 feet upstream of the Jeffers Daylight Pond station. Water continues to flow towards Jeffers Pond, to Pike Lake and into Dean's Lake before entering the Minnesota River.

Pike Inlet 2020, 2021

The Pike Inlet station was installed in 2020 and 2021. It is located along the PLOC downstream from Jeffers Pond. Water flows from Lower Prior Lake outlet to Jeffers Pond to Pike Lake and then to Dean's Lake before entering the Minnesota River. Tags had been implanted in Pike Lake in 2019 that are suspected to have expired in a large-scale winterkill event in the winter of 2020-2021.

Pike Outlet 2020

The Pike Lake Outlet site was not fully operational in 2020. The solar station and antenna were installed but the single antenna reader was not tuning correctly and determined through the consultation with Oregon RFID that the reader may be at fault and must be sent back. In July, a replacement receiver was delivered to WSB and it was installed at the Pike Lake Inlet Site and the Pike Lake Outlet Site was removed.

Problems faced

The PIT Tag movement study started in 2017. The stations were powered by 12-volt batteries that would have to be changed every 5-7 days. It was difficult to keep up with the battery exchange, so over the project period, the stations were upgraded with a hardwire to a power source or with solar panels. This has made it possible for the watershed district to employ a greater number of PIT stations and in more remote areas.

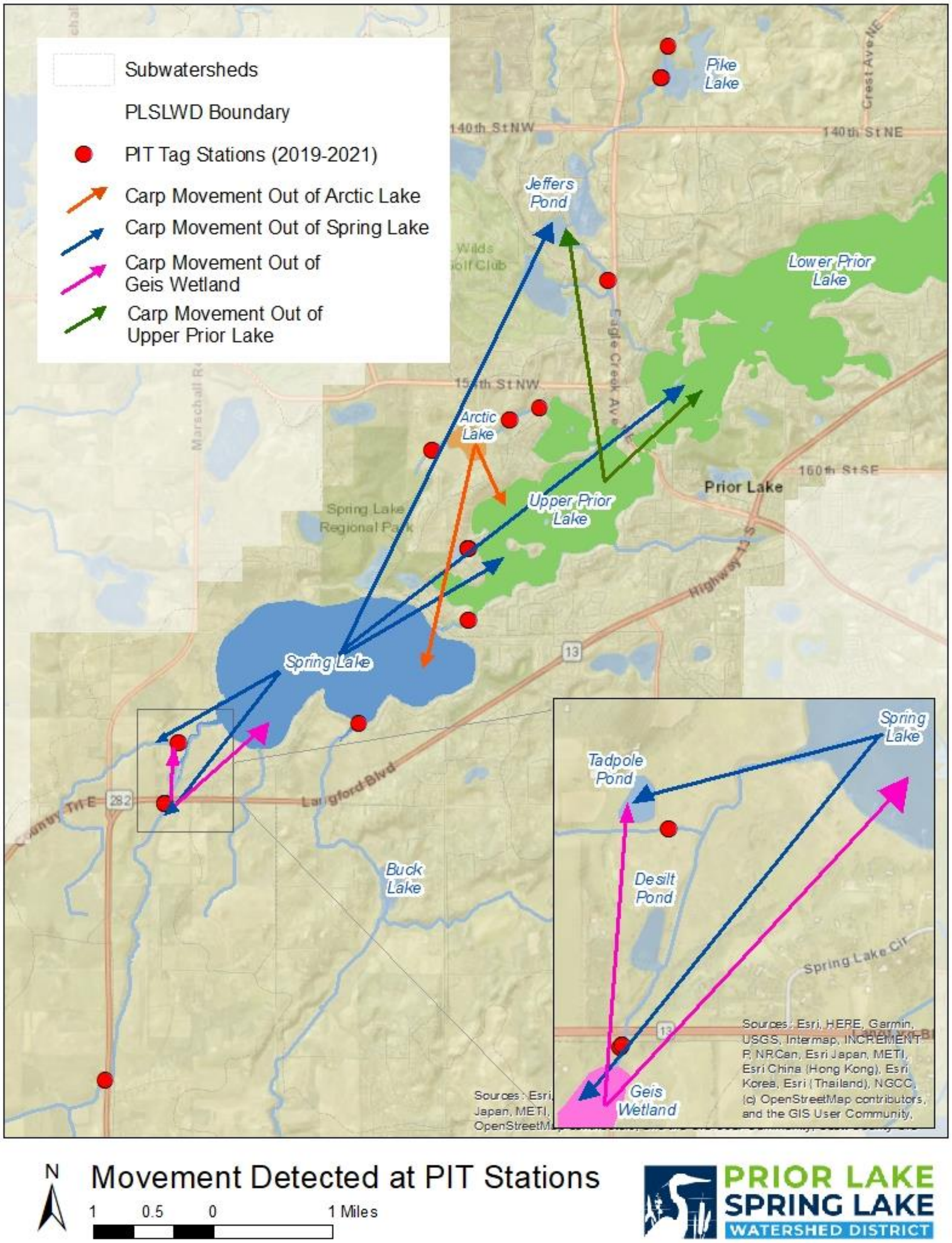


Figure 21. Movement detected at PIT stations

The movement of carp through the PIT tag stations is shown in Figure 21. Many fish were detected moving out of Spring Lake; fish moved upstream to the Geis Wetland and Tadpole Pond, as well as downstream to Upper Prior Lake, Lower Prior Lake, and Jeffers Pond. Carp from Upper Prior Lake also only moved downstream to Lower Prior Lake and Jeffers Pond. Carp that were tagged in Geis Wetland were detected having moved down CD 13 into the Tadpole Pond and into Spring Lake. Tagged fish from Arctic Lake were detected in Upper Prior Lake and Spring Lake.

Trap Netting

Trap net surveys were conducted in each year to detect the presence absence of young of year (YOY) carp and bluegill sunfish. Basins sampled were chosen based on the data collected on carp spawning migration to or from Spring Lake and Upper Prior Lake. In basins where carp young of the year were sampled in trap net surveys, barriers to carp movement or bluegill stocking have been considered (Figure 20. Fish samples and stocked). Trap netting results along with radio-tag and PIT tag carp movement data were used to determine the need for these management tools.

***Task C**: Estimate carp population & biomass removal amount*
***Subtask 1:** Fin clip adult carp*
***Subtask 2:** Calculate population estimate and removal amounts*

Mark-Recapture Estimate

To complete a mark-recapture estimate of abundance, captured carp were marked with a unique mark (e.g. a fin clip, a plastic tag, a PIT tag, or a radio-tag), measured for length and weight, and released back into the basin that they were captured. Subsequent surveys note the ratio of marked to un-marked fish and a population estimate was develop using this method of estimation. This method assumes that marked carp are redistributed with the unmarked population, meaning that sufficient time (upwards of one-week) must be given between the date of marking a carp to the recapture event (Chapman, 1951). It also assumes that no emigration or immigration of the species occurs in the lake during the survey period. Managers evaluated this method throughout the project period in case one or more of these assumptions was being violated.

Catch Per Unit Effort (CPUE) Survey

CPUE boat electrofishing surveys were used to estimate carp abundance and to predict the density of adult common carp in some cases (Bajer, 2012). These surveys are completed in the late summer to early fall and over the span of one to two months. Up to three (3) separate electrofishing surveys in each lake are conducted to establish an average CPUE. Surveys consisted of at least three (3) 20-minute transects that cover shoreline and littoral zones that are suitable habitat for carp. Time spent, number of carp captured, and length and weight data are recorded. A population and biomass estimate of common carp are then calculated using this data in a CPUE model developed for using the protocol and gear described and reflects the population at the time of the survey (Bajer et al., 2012). An average of multiple surveys aims to develop a more robust estimate over a larger span of time.

Mark-recapture Estimate of Population Results

A mark-recapture estimate of population was attempted throughout the project period using PIT tags and fin clips as marks. Carp captured as part of select capture events were marked with a unique PIT tag and fin clipped before being released back to the basin. On subsequent visits to the lake, recaptured fish and their unique PIT tag number was recorded and used to develop a mark-recapture population estimate using the Chapman equation (Equation 1). PIT tagged fish that were recaptured were often removed from the basin as subsequent catches were part of a removal event.

$$N = (((K+1)(n+1))/k+1) - 1$$

Equation 1: Chapman equation where N = Number of animals in the population, n = Number of animals marked on the first visit, K = Number of animals captured on the second visit, k = Number of recaptured animals that were marked.

Table 1. Mark-recapture estimate of population using event where multiple recaptures occurred in final year of project period.

Lake	Date of Estimate	Year	Mark/Recapture Estimate (kg/ha)
Spring Lake	2/18/2021	2021	105.8 +/- 54.3
Upper Prior Lake	5/20/2021	2021	202.4 +/- 110.3

We know that some emigration and immigration occur in these basins and recognize that this occurrence can impact the estimate of population. Under PLSLWD scope for their carp management program, they have employed multiple ways to estimate population including a catch per unit effort (CPUE) survey using a boat electro fisher. This method gives researchers a quick and efficient method of estimating the population that can be compared to the mark-recapture estimate. In 2018 CPUE estimates were first developed for Spring Lake and Upper Prior Lake. These 2018 estimates were used to establish removal amounts needed to reach biomass goals and used to track progress towards that goal as removal events were pursued (Table 1). The boat electrofishing CPUE estimates were updated in 2021 for Spring Lake and Upper Prior Lake and are provided in Table 2 for comparison.

*Table 2. Summary of Catch Per Unite Effort (CPUE) estimates developed over project period. *2019 CPUE estimate for Spring Lake and 2018 CPUE estimate for Upper Prior Lake is reported minus carp removed from the system through Fall 2021*

Lake	Year	CPUE estimate (kg/ha)
Wetland Southwest of Spring Lake (Geis Wetland)	2019	54.3 +/- 12.1
Spring Lake	2019*	227.0 +/- 45.7
	2021	51.0 +/- 19.4
Upper Prior Lake	2018*	211.0 +/- 66.7
	2021	183.4 +/- 161.1
Lower Prior Lake	2018	8.9 +/- 0

We realize that there are limitations to all methods of estimating a population and movement into or out of the basin in question can violate model assumptions. In both Spring Lake and Upper Prior Lake, we have detected both emigration and immigration of PIT tagged carp. Because there is overlap in the confidence interval over multiple years and using a variety of methods, we feel comfortable using the 2018 CPUE minus carp removed as a standard to measure progress towards the district goal of 30 kg/ha in Upper Prior Lake. In Spring Lake, the district will continue to track progress towards biomass goal using the 2019 CPUE estimate minus fish removed. Removal events will continue to inform on the population present in the basin with the ability to run a mark-recapture estimate.

NOTE: In 2021, carp young of the year were captured in the main basin of Spring Lake. A portion of this cohort of fish will recruit to the adult population and may cause a slight rebound in the carp population. This cohort should be monitored with the use of a CPUE survey in Fall of 2022 and additional marking to further refine the population estimate here.

Objective 2: Complete seine (netting) and other removal events to achieve carp populations at or below water quality goal

***Task A**: Complete carp removal efforts*
***Subtask 1:** Coordinate and conduct carp removal efforts*

SEINES

Commercial netters use long mesh nets that hang vertically in the water with floats along the top and weights along the bottom. They are typically used to surround fish in an area and pulled through the water and along the lake bottom to crib up the carp in a shallow area for removal. Both open water and under ice seine netting is very effective but limited to areas where carp aggregate and are snag free. Commercial seines have been a popular event for residents to attend. The District created a video explaining what a carp seine is and how it works showing in link. What is a Carp Seine? https://www.youtube.com/watch?v=1GKxy_I8svM . While seeing is considered the best bang for the buck, there are many factors (figure 22) to consider for completing a successful seining event.

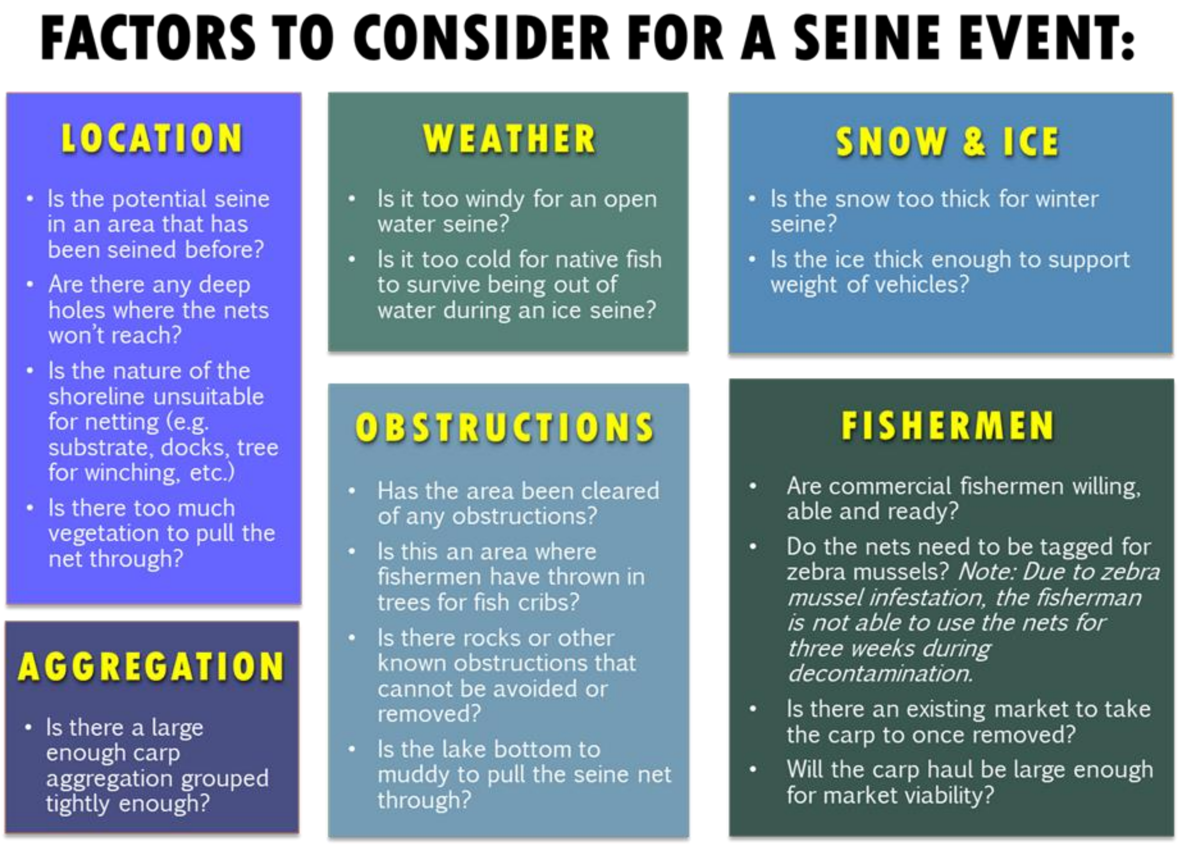


Figure 22. Factors to consider for a seine event

Upper Prior Lake Seine Net

There has been some hesitancy by commercial fishing crews to commit resources to netting Upper Prior Lake due to the presence of aquatic invasive species (Eurasian watermilfoil, curly leaf pondweed, and zebra mussels) and the DNR's requirement to decontaminate nets and associated equipment. Depending on the weather, the decontamination period may be up to 21 days, meaning that commercial crews may not have gear to net other high priority lakes/projects. In 2019, the District purchased a seining net designed for Spring and Prior Lakes seining locations. The PLSLWD's seine net available for use by commercial fishermen in the District should mitigate this obstacle by providing a net that could be properly decontaminated or used repeatedly in the same waterbody while not restricting the fishing crews' ability to continuously net in other waters.

Specialized Traps

Specialized fish traps were designed at attempting to exploit behavioral patterns during spawning migrations. The idea is to guide carp traveling toward spawning habitat into holding compartments. These traps are usually set in shallow water, and style and size can vary. The District has developed two specialized trap nets for capturing carp during spawning season: the Push Trap included a one-way trap door style panel on the opening, and the Newman Trap Net that included multiple-staged guidance walls and openings for enhanced entrapment, both of which can be placed seasonally at carp spawning migratory routes (figure 24).

In 2020, headed by the accelerated carp management initiative set by the PLSLWD board of manager, specialized traps were built and installed. Both traps were successful in capturing carp during the spawning migration. With minor modification, both traps were again installed in the same locations in 2021. The springtime water levels posed a significant challenge as flowing water ceased. Without the flowing water through these traps, they failed to catch carp. The silver lining to this is that while carp were not actively being caught, the traps have a secondary purpose as a barrier. Both traps effectively blocked the movement past their respective sites preventing carp from reaching spawning areas.

Newman Cage

The Newman Cage design is similar to a baited box net. Rather than having to set the net by pulling up the sides to capture the carp, this net provides constant capture of carp when set. Carp swim into the trap and cannot escape. Figure 23 below is an approximate version:

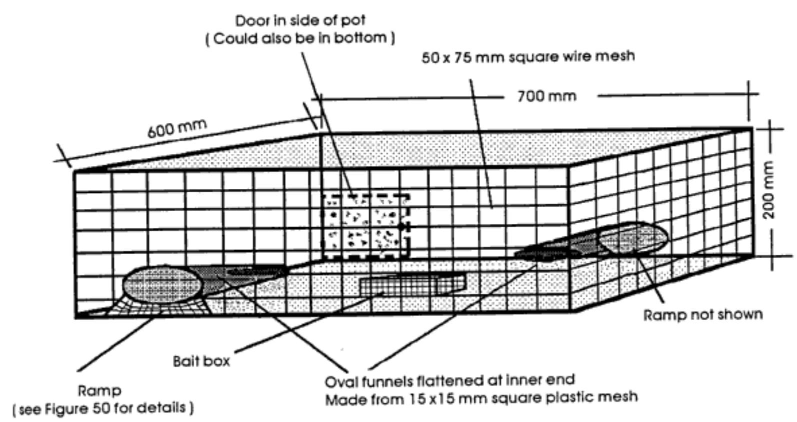


Figure 23. Newman trap design inspiration

Push-Trap

This trap takes advantage of the migratory behavior of carp as well as their propensity to "push" through barriers and is modeled conceptually on a design described in detail by Thwaites (2015). Initial laboratory results indicate that the push trap was successful in capturing 91% of adult carp in the experiment. The design incorporates a row of PVC pipe fingers mounted on a crossbar and set at angles that allow carp to push through and swim upstream into a collection basin. The rotating fingers are similar to those mounted at the ferric chloride weir, which rotate on a fixed cylinder. The fingers are set at a height that allow for the forward or upstream movement of the fingers that "open" the trap, but the fingers cannot swing back to allow carp to exit the trap. The trap itself is composed of economical fencing materials. A cellular wireless camera with motion detection placed on the trap would effectively show carp entering and remaining captured in the trap. The camera was used to detect when carp needed to be removed from the trap.

Figure 24. Push trap at the Desilt Pond (left) and the Newman trap in Mud/Crystal Bay (right)

Baited Box Traps

The baited box trap is a mesh net trap that lays flat on the bottom of the lake, but quickly forms into a box when lifted to trap the carp inside (Figure 25). Eight solid pipes are secured around the box and ropes are run through the net and up the poles to a pulley system. Carp are typically baited with corn at the box trap location for several days with help from volunteers until a large grouping forms. It was important to set baiting stations in advance of the traps to determine if there were carp in the vicinity. When enough bait was consumed during an overnight period, a trap would get set. While a baited box trap catches fewer fish, it holds an advantage over a seine net because the carp are much less likely to escape. An informational video on what a baited box trap is and how it works is available on our YouTube channel at this link: https://www.youtube.com/watch?v=LWLusacT7I0.

Figure 25. Baited box trap (left) and deploying the baited box trap (right)

After the two stationary cameras were used with the specialized traps, they were moved into the centers of baited box traps to coordinate carp removals at optimal times. A lesson learned from the cameras was that we observed ducks consuming the corn during overnight hours. A solution to this problem was to add ribbons and other devices to try and deter birds from using our bait stations for free meals. We found that the effectiveness of a trap at a single location diminished over the course of 4 deployments or about 6-7 weeks. Baited bot trap locations from Spring and Upper Prior Lakes are showing in Figures 26 and 27.

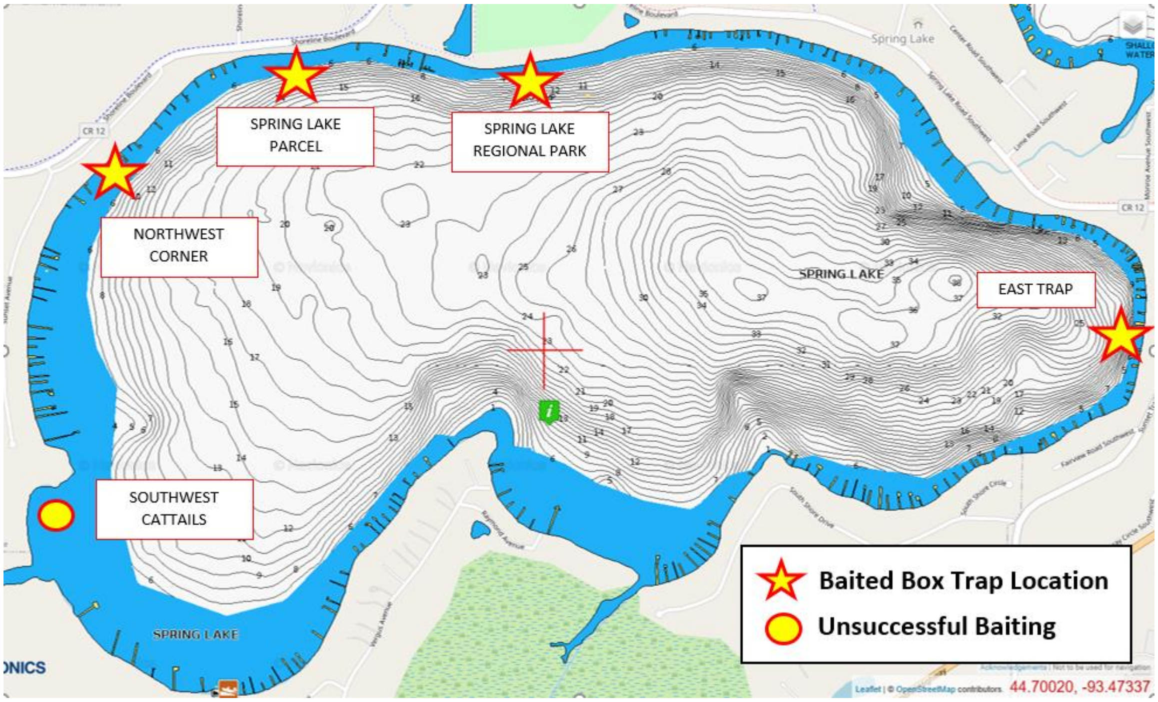


Figure 26. 2020 Spring Lake baited box trap locations

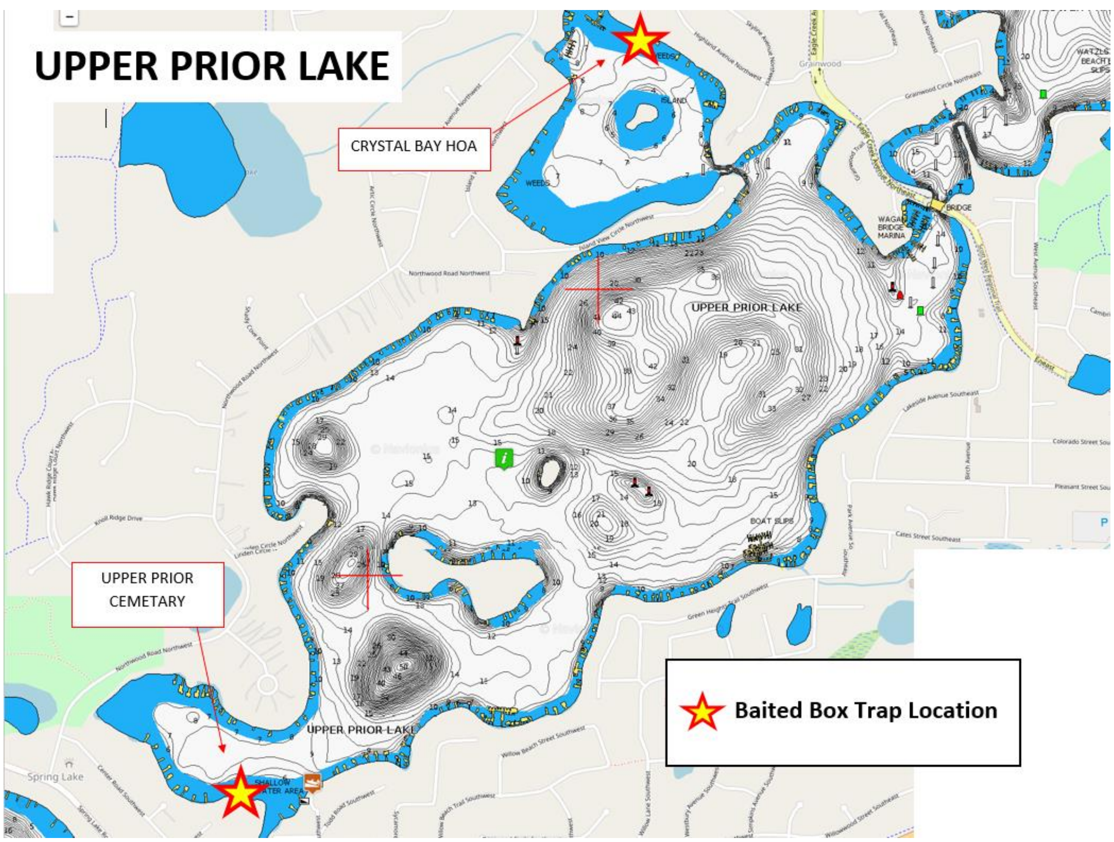


Figure 27. 2020 Upper Prior Lake baited box trap locations

Micro-Hauls

Micro-hauls are simply smaller removals that are completed using a variety of methods as opportunities arise. For example, using a small 500' section of a seine net called a "block net", the PLSLWD is able to complete small micro-haul events when carp group up in small areas unsuitable for seining. The removal is often assisted by electrofishing efforts, small gill nets and/or the unified sound technique to drive carp towards an area. Corn may also be used to bait an area prior to a micro-haul attempt to achieve greater removal numbers.

Electrofishing

An electric field is generated between anodes and cathodes placed in the water. The current causes muscle contraction and temporary paralysis in fish; most species will float to the surface where they can then be netted. Stunned fish usually recover quickly when the power is switched off. Unfortunately, fish in deep water are not often captured, so this technique is best used in shallower areas near the shore. Different electrofishing methods (e.g. backpack, bank-mounted and boat, including electro-seining) are used depending on local site conditions. Electrofishing was found to be an effective removal tool at locations where barrier had already been installed. A video was made from a notable electrofishing removal event at the Arctic Lake carp barrier seen here https://www.youtube.com/watch?v=UvzXH-KjfgA . *Note: This method is also used for conducting CPUE survey (Objective 1: Task C).*

Gill Netting

Mesh net panels are placed vertically in the water to entangle fish. The net has a rope along the top with floats attached and another rope along the bottom with weights attached. The mesh of a gill net is uniform in size and shape and the netting is large enough for a fish to fit its head through, but not its body, trapping them in place. Beginning in 2019, the District was allowed the opportunity through DNR permitting to conduct the Gill Netting Pilot Project for carp removal. Through this special permitting and under the watchful eye of the DNR, the District worked with commercial netters to deploy gill nets for large scale removal. Specific sizing of the gill nets was assigned to reduce the chance of catching non target species. Memos detailing the activities are showing in Appendix D.

Carp Removal Summary

Carp biomass removal efforts focused on Spring Lake and Upper Prior Lake and over the course of the project period, methods for removal were pursued that are described above. The district has set a goal biomass for these main basins at 30 kg/ha, a number below the 100 kg/ha threshold that is accepted by scientists as the biomass where carp are damaging to water quality. Biomass removed in each event has been tracked against CPUE estimates that were gathered early in the project period (Table 3, Table 4). In 2019 thru 2021, 8,688 kg (19,154 lbs.) has been removed from Spring Lake and 19,239 kg (42,414 lbs.) has been removed from Upper Prior Lake.

Table 3. Spring Lake Removal Events and Biomass Estimates

Lake	Date	Method	No. Carp Removed	Kilograms carp removed	Biomass estimate (kg/ha)
Spring Lake	**2019**				
	December 2019	CPUE	n/a	n/a	266.2 +/- 53.7
	2020				
	April 2	REMOVAL: Open Water Seine	4	7	-0.03
	April 3	REMOVAL: Gill Netting	8	15	-0.06
	April 5	REMOVAL: Open Water Seine (district net) Netting	23	43	-0.2
	April 5	REMOVAL: Gill Netting	0	0	0
	April 24	REMOVAL: Open Water Seine Netting	345	1388	-5.8
	May 18	REMOVAL: Push Trap	22	69	-0.3
	May 19	REMOVAL: Push Trap	8	22	-0.1
	May 20	REMOVAL: Push Trap	9	24	-0.1
	May 21	REMOVAL: Push Trap	14	41	-0.2
	May 21	REMOVAL: Boat Electrofishing	64	153	-0.6
	May 22	REMOVAL: Push Trap	0	0	0
	May 22	REMOVAL: Boat Electrofishing	97	259	-1.1
	May 24	REMOVAL: Push Trap	3	8	-0.03
	May 24	REMOVAL: Boat Electrofishing	163	414	-1.7
	May 27	REMOVAL: Push Trap	32	97	-0.9
	May 27	REMOVAL: Boat Electrofishing	142	431	-4.0
	May 28	REMOVAL: Push Trap	1	1.97	0
	May 28	REMOVAL: Boat Electrofishing	29	76	-0.7
	June 1	REMOVAL: Push Trap	9	23	-0.1
	June 1	REMOVAL: Boat Electrofishing	39	106	-0.4
	June 2	REMOVAL: Push Trap	32	69	-0.3
	June 2	REMOVAL: Boat Electrofishing	78	219	-0.9
	June 3	REMOVAL: Push Trap	15	36	-0.2
	June 4	REMOVAL: Boat Electrofishing	7	18	-0.1
	June 8	REMOVAL: Push Trap	9	15	-0.1
	June 16	REMOVAL: Boat Electrofishing	33	167	-0.7
	July 16	REMOVAL: Box Netting (Trap 1)	137	279	-1.2
	July 16	REMOVAL: Box Netting (Trap 2)	113	231	-1.0
	July 23	REMOVAL: Box Netting (Trap 1)	83	169	-0.7
	July 23	REMOVAL: Box Netting (Trap 2)	56	109	-0.5
	August 12	REMOVAL: Box Netting (Trap 1)	8	14	-0.1
	August 20	REMOVAL: Box Netting (Trap 1)	94	205	-0.9
	August 20	REMOVAL: Box Netting (Trap 2)	89	245	-1.0
	December 2020	2018 CPUE minus fish removed	n/a	n/a	242.5 +/- 48.9
	2021				
	February 18	REMOVAL: Under Ice Seine Netting	1238	3402	-14.2

	June 4	REMOVAL: Boat Electrofishing	114	314	-1.3
	June 7	REMOVAL: Boat Electrofishing	1	3	-1.3
	June 10	REMOVAL: Boat Electrofishing	0	0	0
	November 19	REMOVAL: Gill Net (District Gills)	5	14	-0.1
	November 19	REMOVAL: Open Water Seine (District Net)	1	2.8	0
	December 2021	2019 CPUE minus fish removed	n/a	n/a	227 +/- 45.7

Table 4. Upper Prior Lake Removal Events and Biomass Estimate

Lake	Date	Method	No. Carp Removed	Kilograms carp removed	Biomass estimate (kg/ha)
Upper Prior Lake	Nov 2018	CPUE	n/a	n/a	333.3 +/- 105.3
	2019				
	April 2019	REMOVAL: Open Water Seine	530	2471	-15.8
	May 2019	REMOVAL: Freemont Stream	348	1984	-12.7
	June 2019	REMOVAL: Freemont Stream	33	109	-0.7
	Dec 2019	2018 CPUE minus fish removed	n/a	n/a	304.1 +/- 96.1
	2020				
	March 2	REMOVAL: Under Ice Seine	815	4694	-30.0
	March 5	REMOVAL: Under Ice Seine	12	45	-0.3
	April 7	REMOVAL: Gill Netting	50	365	-2.3
	April 21	REMOVAL: Gill Netting	72	447	-2.9
	April 22	REMOVAL: Gill Netting	5	32	-0.2
	April 30	REMOVAL: Gill Netting	30	195	-1.2
	April 30	REMOVAL: Boat Electrofishing	45	119	-0.7
	May 6	REMOVAL: Boat Electrofishing	35	105	-0.7
	May 7	REMOVAL: Northwoods Barrier	50	140	-0.9
	May 18	REMOVAL: Northwoods Barrier	21	59	-0.4
	May 19	REMOVAL: Boat Electrofishing	209	613	-3.9
	May 20	REMOVAL: Boat Electrofishing	53	140	-0.9
	May 21	REMOVAL: Boat Electrofishing (night)	4	14	-0.1
	May 27	REMOVAL: Boat Electrofishing	65	168	-1.1
	May 28	REMOVAL: Newman Trap	25	67	-0.4
	May 28	REMOVAL: Boat Electrofishing	29	74	-0.5
	June 1	REMOVAL: Newman Trap	8	23	-0.1
	June 1	REMOVAL: Boat Electrofishing	71	225	-1.3
	June 2	REMOVAL: Boat Electrofishing	90	348	-2.0
	June 3	REMOVAL: Newman Trap	125	354	-2.0
	June 3	REMOVAL: Boat Electrofishing	18	44	-0.2
	June 4	REMOVAL: Newman Trap	26	62	-0.3
	June 4	REMOVAL: Boat Electrofishing	18	41	-0.2
	June 11	REMOVAL: Boat Electrofishing	5	15	-0.1
	June 15	REMOVAL: Boat Electrofishing	16	43	-0.2
	December 2020	ESTIMATE: 2018 CPUE minus fish removed	n/a	n/a	250.4 +/- 79.1
	2021				
	January 29	REMOVAL: Under Ice Seine + Gill Net	160	1042	-6.6

		+ MUM (speakers)			
	February 23	REMOVAL: Gill Netting	212	1043	-6.6
	March 5	REMOVAL: Gill Netting	19	139	-0.9
	March 30	REMOVAL: Freemont Stream		719	-4.5
	May 13	REMOVAL: Boat Electrofishing		242	-1.5
	May 18	REMOVAL: Boat Electrofishing		836	-5.3
	May 19	REMOVAL: Boat Electrofishing		803	-5.1
	May 21	REMOVAL: Boat Electrofishing		380	-2.4
	May 24	REMOVAL: Boat Electrofishing		503	-3.2
	May 25	REMOVAL: Boat Electrofishing		217	-1.4
	May 26	REMOVAL: Boat Electrofishing		206	-1.3
	June 9	REMOVAL: Boat Electrofishing		79	-0.5
	June 10	REMOVAL: Boat Electrofishing		32	-0.2
	December 2021	ESTIMATE: 2018 CPUE minus fish removed			211.0 +/- 66.7

Table 5: Spring Lake removal summary with phosphorus load remaining based on population estimate at end of year.

Spring Lake Yearly Estimate	Population Estimate Year Beginning (kg/ha)	Population Estimate Year Ending (kg/ha)	Total Weight Removed (kg)	Kilograms per Hectare Removed	Phosphorus loading (kg) per year based on population estimate at year end
2019	266.2	266.2	0	0	610
2020	266.2	242.5	4,953	24	557
2021	242.5	227.0	3,735	16	520

Table 6: Upper Prior Lake removal summary with phosphorus load remaining based on population estimate at end of year.

Upper Prior Lake Yearly Estimate	Population Estimate Year Beginning (kg/ha)	Population Estimate Year Ending (kg/ha)	Total Weight Removed (kg)	Kilograms per Hectare Removed	Phosphorus Loading per year based on population estimate
2019	333.3	304.8	4,564	29	792
2020	304.8	250.4	8,433	54	650
2021	250.4	211.0	6,242	39	548

Bluegills as a Control

Research completed by the Minnesota Aquatic Invasive Species Research Center (MAISRC) showed that bluegill sunfish are the main predator of carp, preying on the eggs and larvae of carp young of year. Carp actively seek out nursery sites that are devoid of these predator fish and proliferate in lakes where bluegill abundance is low. A robust panfish and gamefish population may act as biological control and complements the other IPM strategies (Weber et al., 2012). These predator fish are necessary to prevent carp recruitment after a significant portion of the carp biomass has been removed or to keep carp from establishing in lakes.

In 2017, the PLSLWD partnered with the University of Minnesota as part of a graduate research project to assess the effectiveness of using bluegill sunfish as biocontrol for common carp (Poole, 2018). The eastern basin at the 12/17 wetland restoration site was one of four study basins in the Twin Cities metro area used; it was stocked with both spawning carp and adult bluegill to measure the effective rate of bluegill predation on carp eggs. The results from the study indicate that bluegill predation had a major effect on the abundance of post-larval carp. In the 12/17 wetland study basin, there 0% recruitment of carp during the study period.

As part of the workplan for this project, this District and WSB used trap netting and electrofishing methods to collect data where carp are migrating to and spawning (figure 28). These methods are ideal for sampling young of year carp and bluegills. While bluegills typically have self-sustaining populations, winterkill is common in smaller shallow basins where carp can exploit the lack of predator fish. Project managers analyzed sample data (Table 7) and worked with the DNR to determine where bluegill stocking could be an effective control method.

*Table 7. YOY Carp and Bluegill Trap Netting and Electrofishing Presence Absence Summary***

YOY Carp and Bluegill Trap Netting and Electrofishing Presence Absence Summary					
Key – Presence (P), Absence (A), Trap Netting (TN), Electrofishing (E), Bluegill Stocking (B)					
Waterbody	Year	Common Carp	Bluegill	Sample Method	Stocking
Geis Wetland	2019	P	P	E, TN	
	2020	P	P	E, TN	B
	2021	P	P	TN	B
Tadpole Pond	2019	P	P	TN	
	2020	P	P	TN	
Pike Lake	2019	A	P	TN	
	2020	A	P	TN	
Lower Jeffers Pond	2021	P	P	TN	
Upper Jeffers Pond	2021	A	P	TN	
Arctic Lake	2019	A	P	TN	
Northwoods Pond	2020	A	A	TN	B
	2021	A	A	TN	B
Spring Lake *	2019	A	P	E	
	2020	P	P	E	
	2021	P	P	E	
Upper Prior Lake*	2019	A	P	E	
	2020	A	P	E	
	2021	A	P	E	
12/17 Wetland	2020	P	P	TN	
	2021	A	P	TN	
Desilt Pond	2020	A	P	TN	
	2021	A	P	TN	B
Buck Lake	2019	A	P	TN	

* Spring and Upper Prior Lakes Survey Data include DNR Fisheries data.

** Additional Waterbodies with absence of YOY carp and blue without stocking are not shown in the table.

Recommended by the PLSLWD's Citizen Advisory Committee, the PLSLWD is moved forward in 2020 with its first lake fish stocking event in both Spring and Prior Lakes since 2010. With donations from the Spring Lake Association and the Prior Lake Association, along with a District contribution.

In spring of 2020, the PLSLWD began stocking the existing carp spawning sites at the Geis wetland, Tadpole Pond, and the Northwoods Pond with 2-4" bluegills before carp migration and spawning. These bluegills were marked with fin-clips before releasing them into the wetland to aid in future assessment of stocking success. The 2020 bluegill stocking event was captured in this video https://www.youtube.com/watch?v=IqhaW5ZQeSs .

In spring of 2021 the Geis wetland, Northwoods Pond, Tadpole Pond, and Delist Pond were resurveyed to assess if the stocked bluegills survived. There were no 2020 bluegill recaptures during the 2021 pre-stocking surveys. Based on recommended stocking rates, the Geis wetland was stocked with 2,000 bluegills, Northwoods Pond site was stocked with 700 bluegills, and Desilt Pond was stocked with 700 bluegills to support low recruitment of young carp in these nursery sites in spring of 2022 (Table 8). The 2020 bluegill stocking event was captured in this video https://www.youtube.com/watch?v=Tj4bXWlICqw .

Table 8. Summary of Bluegill Stocking in Nursery Sites

Waterbody	2020 Stocking	2021 Stocking
Geis Wetland	2,000	2,000
Northwoods Pond	900	700
Tadpole Pond	100	0
Desilt Pond	0	700

PLSLWD will continue assessing carp nursery locations for bluegill populations. More bluegills will be stocked in identified nursery locations if deemed necessary to prevent carp recruitment. Additional nursery locations based on spring 2022 spawning observations will be analyzed for potential bluegill stocking 2023.

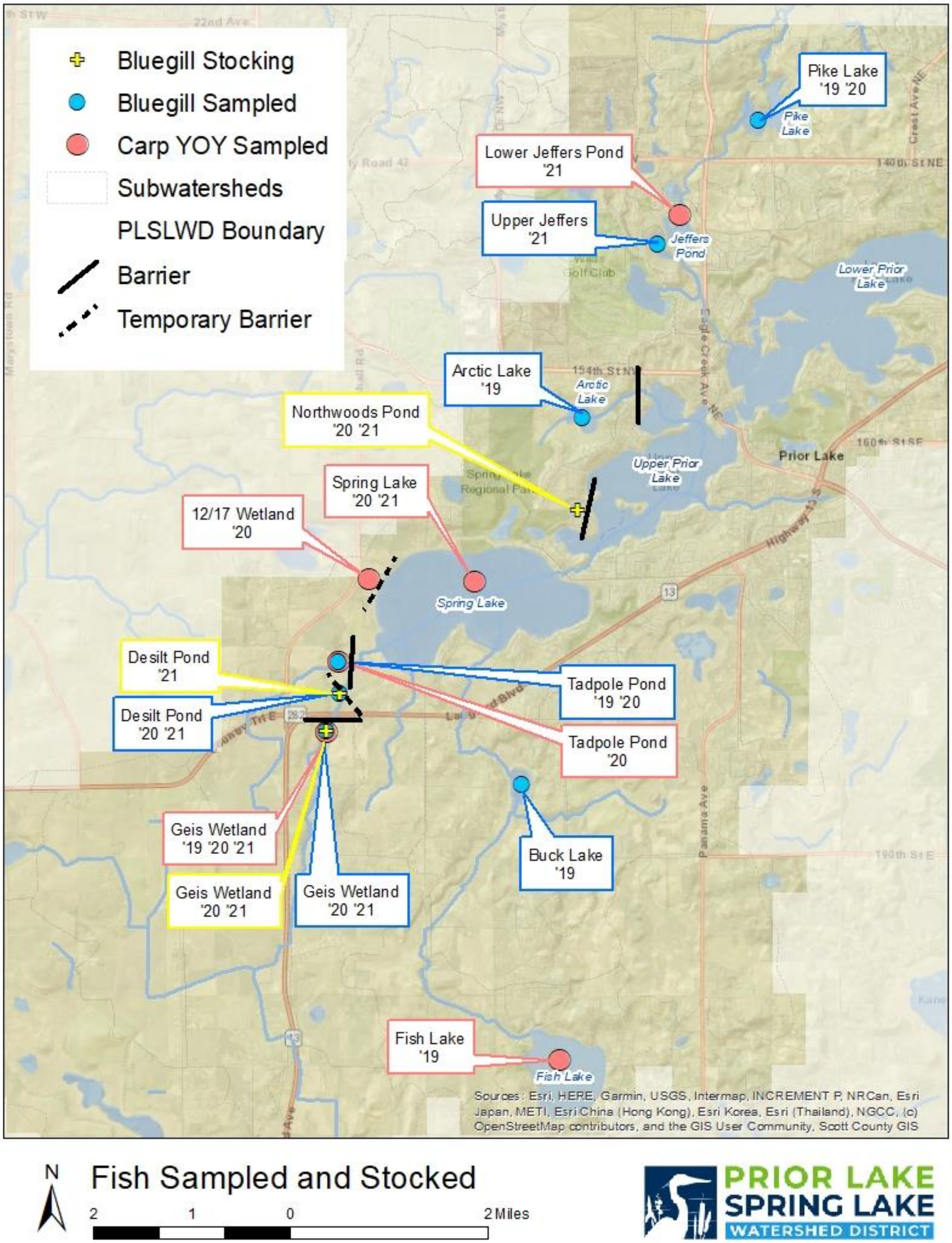


Figure 28. Fish sampled and stocked

Cost Effective Carp Management

At the Board meetings in the summer of 2019, the PLSLWD Board of Managers and staff discussed ways to think outside the box to accelerate carp removal efforts in Spring and Prior Lakes. Staff and WSB consultants explored all potential activities, proven and theoretical, that could increase the probability of success within a year's timeframe through the end of 2020. The yearlong enhanced carp management program (https://www.plslwd.org/projects-and-programs/projects/carp-management/) was introduced as Accelerated Carp Management Strategies (ACMS) and was approved by the Board in August of 2019. These strategies were an addition to the existing carp management program. The Carp management Cost-Benefit Summary is provided below in Appendix E. The goal of ACMS was to quantify an annualized cost per pound of phosphorus removed on a 10-year scale for the overall carp management program to compare its effectiveness to other District projects. Next it was to support the larger components of the carp management program and to keep carp populations from rebounding through innovative approaches to removals. A cost-benefit analysis was on acquiring a District owned seine net, completing an increased number of seining events, stocking bluegills, building specialized traps, and having volunteers assist with baited box traps.

Subtask 2: *Clear obstructions from removal locations*

Clearing Obstructions

Seine netting was the primary carp removal gear for large scale removal; both in the open water and under the ice. Advantages of seine nets are they are large and provide an opportunity to capture large amounts of fish biomass in a single event by fishing the entire water column and from shore to shore. One of the most critical factors to a successful seine is have an area that is clear of obstructions on the lake bottom. However, the lead line (bottom line) of seine nets traverses the bottom of the lake during the netting operation and can become entangled in obstructions such as rocks, man-made objects, and sunken trees resulting in damage to the netting material and ultimately the escape of captured carp. This scenario had played out more than once on both Upper Prior and Spring Lake during previous removal operations. (https://www.youtube.com/watch?v=wDQ8mDv3Yrc)

The PLSLWD helped prepare known aggregation areas prior to seine season (November – April) by engaging commercial netters to run a test seine through areas with their nets, or by running a chain on the bottom of the lake. These obstruction removals may occur on Spring Lake and Upper Prior Lake each October/early November to prep the sites if a seine event is anticipated. Additionally, the project team used side scan sonar to determine if obstructions were present within delineated seine netting areas (identified by radio telemetry). This was done by completing multiple transects over the netting areas (gridding) and marking (with GPS) the location of potential netting obstructions. Figure 29 below shows an example of a pontoon float found in a netting area on Upper Prior Lake in 2020. Note depth on the left side of the image.

Figure 29. Side Scan image of a pontoon float

The next step was to utilize an underwater drone to determine what the obstruction was and the approximate size. This allowed for confirmation that the image was in fact an obstruction and provide us with information as to the feasibility of moving it and how it could be moved. If the object was a verified obstruction, then a float was deployed over the object to make its location easily identifiable for divers.

The last step in this process was to utilize a diver to hook the object with a rope which was attached to an outboard boat. Once the object was securely tethered to the boat, the object was drug out of the netting area to a section of the lake where it would not impact netting operations. This obstruction removal operation was competed on both Spring and Upper Prior Lakes.

Subtask 3: *Employ innovative tools such as underwater speakers for herding to more effectively remove carp populations during seining efforts*

In many instances carp may become aggregated but cannot be removed in the aggregation area due to obstructions on the bottom or along the shoreline. By developing alternative removal methodology, the PLSLWD will be able to expedite carp biomass removal and in some instances, make removal possible. By developing these techniques, the PLSLWD may be able to assist other water resource management entities in addressing carp management; especially in areas where traditional methods are difficult to employ.

The modified unified method (MUM) may provide opportunity to enhance carp removal efforts by concentrating carp using underwater speakers; essentially using sound to herd carp to a specific location or drive them from undesirable removal locations.

Innovative Tools

The underwater sound system for herding carp consists of an MP3 player wired to underwater speakers and an amplifier to "pump" sound near an aggregation to drive them into nets or herd them to an area of the waterbody that is conducive to netting. This is especially effective in an area like the northeast corner of Upper Prior Lake where rock obstructions exist near the Knotty Oar Marina. The underwater speakers were successfully used many times during an under-ice seine on Upper Prior Lake in 2020 and 2021.

Modified Unified Method (MUM) – Herding Carp

A novel approach, the MUM, was implemented to further improve large scale carp removal efforts on both Spring and Upper Prior Lakes. The MUM involves the use of underwater speakers to "herd" fish into an aggregation into an area that is conducive to netting. This technique has been implemented successfully by Illinois DNR and United States Geological Survey (USGS) to remove nearly 90% of carp biomass in a 500-acre lake in Illinois. Another successful example was completed on Creve Coeur Park Lake in Missouri which removed 85% of the Asian carp biomass.

The systems consisted of an underwater speaker (Lubell Labs, Model #LL916C) that was connected to an amplifier (TOA CA-160, 60-watt output) and an MP3 player (Sandisk Clip Sport Plus) (figure 30). The amplifier, MP3 player, and speaker were connected and powered from the deep cycle battery, but a trickle charger (plugged into 110-amp hard wired residential service) was also attached to the battery terminals to provide constant power to both the amplifier and MP3 player continuously.

Figure 30. MUM speaker

The speaker cable (from the amplifier to the speaker) was 70 feet (18/3 AWG) in length. A 100-foot rope was also attached to the frame of the speaker to eliminate tension on the cable when the speaker was deployed in the water column (open water or under ice). The MP3 player was loaded with five (5) distinct sound files downloaded from https://freesound.org/. Sound files varied in duration from 6 to 39 seconds and consisted of ice cracking, feedback, human voices combined with gunshots, and a steel hammer on an anvil. The MP3 player was put in repeat and continuous shuffle mode, so no noise pattern was developed.

This technique was first deployed in winter of 2020. There were two areas of Upper Prior where winter aggregations were observed that are not nettable using seine nets. The first area is referred to as German Bay. German Bay is located along the north shore of Upper Prior Lake. The area is not conducive to seine netting as there is a steep drop off and carp are typically situated along this drop off. Seine netting is not possible as the lead line (bottom line) of the net is not able to fish the bottom of the lake due to the tension on the lead line which leaves a gap under the lead line that fish can escape through.

The second area is known as Knotty Oar. This is area is located near the Prior Lake Narrows as the lake crosses under Eagle Creek Avenue. The Knotty Oar Marina is on the north side of this area. Mush of the bottom of the lake here is composed of rock and boulders with a narrow rock bar that juts out from the northern shore to the southwest. These factors make this portion of the lake unseinable. However, carp aggregations form here annually in the winter as indicated by radio telemetry.

Figure 31. Upper Prior seine hauls and obstruction areas

The MUM was utilized in two (2) specific ways for carp aggregations in German Bay and Knotty Oar. The carp aggregation in German Bay was moved out so as to aggregate carp in German Bay or seine haul 2, and carp in Knotty Oar were targeted with the MUM to move and capture simultaneously (figure31).

The German Bay operation deployed the MUM starting in February of 2020 by installing the speaker systems directly over the aggregation and activating the speakers over the course of a ~ 6-hour period. Radio telemetry was used to monitor carp locations during the course of the deployment. Carp were observed moving away from the speaker array in the first few hours of deployment but would aggregate again in the original location of German Bay overnight. To counteract this, the MUM arrays were deployed overnight which worked to move the aggregation out of this area and into Knotty Oar.

The Knotty Oar operation also began in February of 2020. The first step was to complete a test of the carps' response to the speaker deployment. This was done after an aggregation was identified within Knotty Oar using radio telemetry. The speakers were set up behind (to the east or near the Eagle Creek Avenue Bridge) the aggregation and allowed to run for ~10 minutes (figure 32). After the 10-minute period that the system was operating, radio tag locations where surveyed. We found that all radio-tagged carp had vacated the area and were found well out into the main basin.

Based on this response, a plan was devised to herd and capture carp near this location using the MUM, block nets, and a seine net for final capture and removal. This plan is depicted in Figure 33 below and shows the first phase with the end of the sine "open" towards the block net to allow carp to escape into the seine from Knotty Oar. Figure 34. shows the seine "closed" around the herded carp.

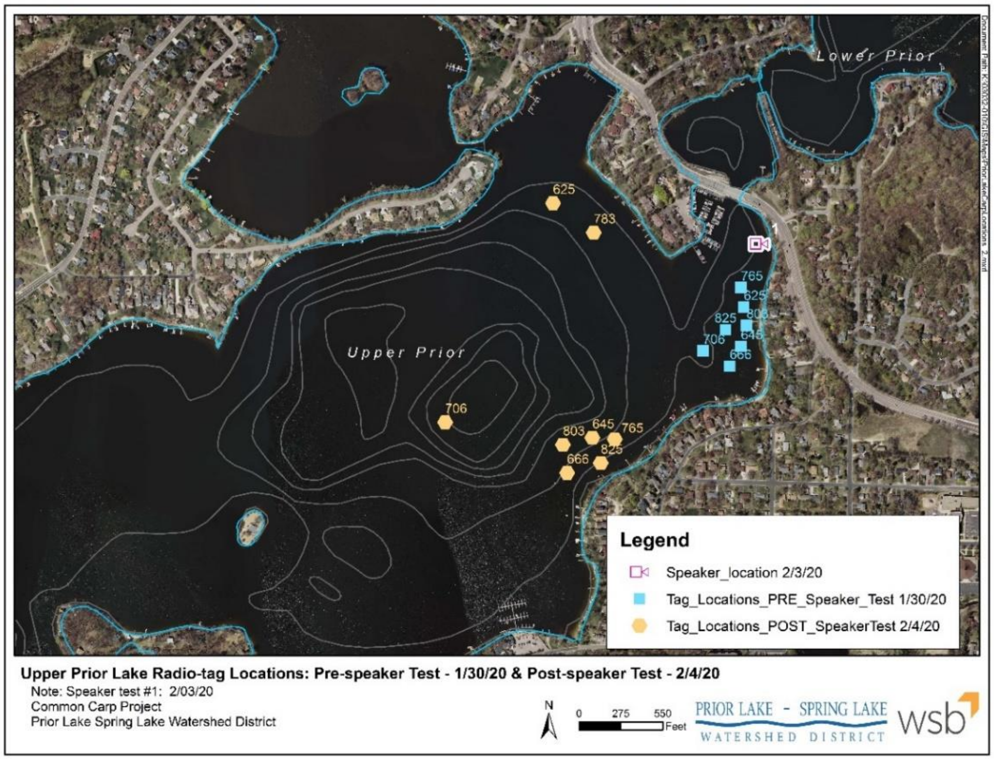


Figure 32. Initial test of MUM on Upper Prior in Knotty Oar

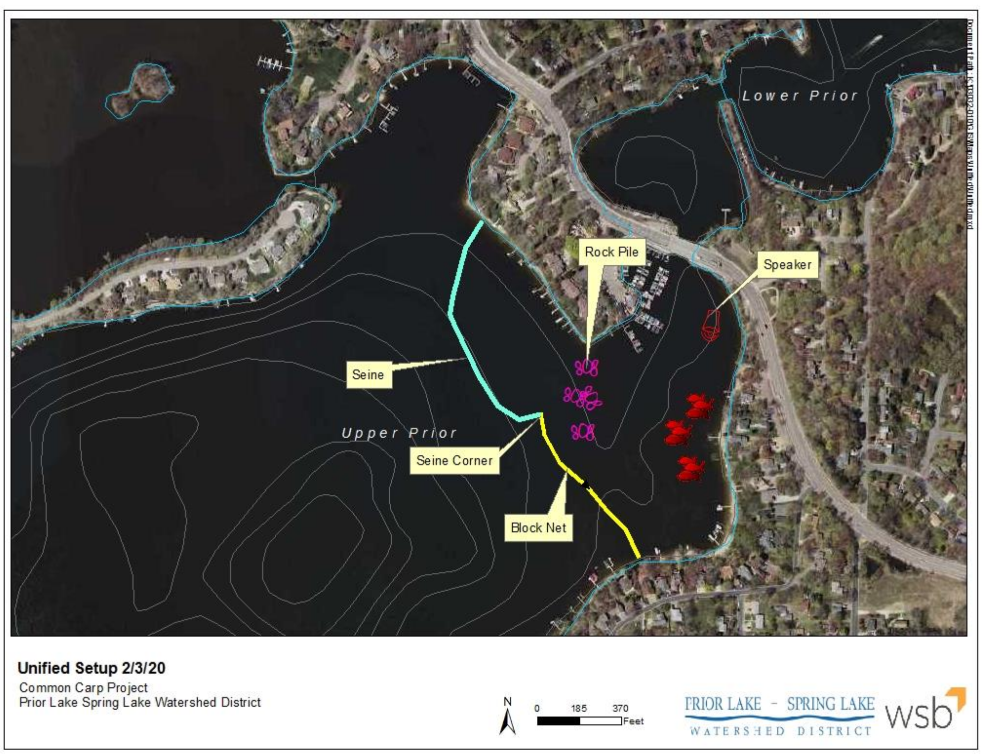


Figure 33. MUM initial deployment

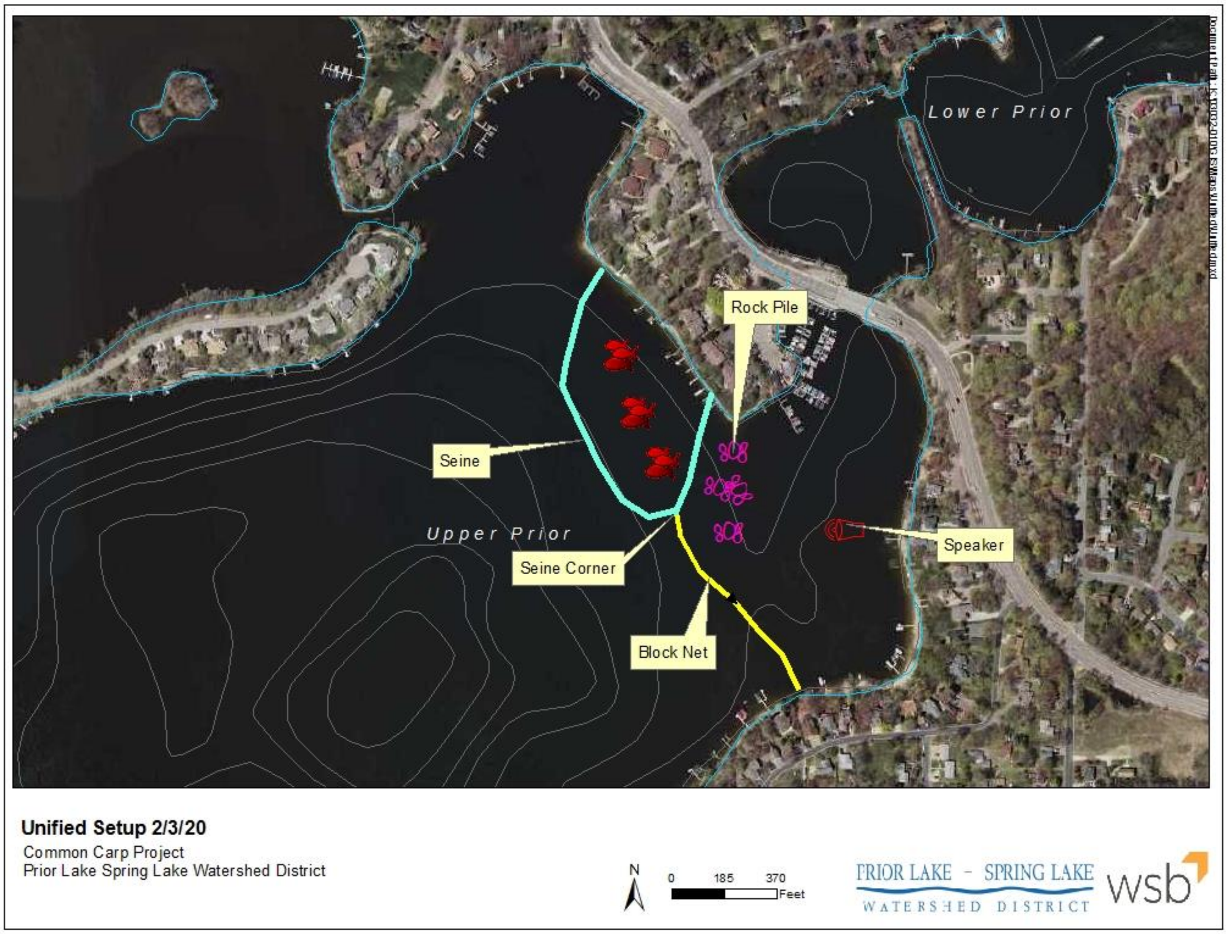


Figure 34. MUM capture

This plan was executed on March 2, 2020 using two (2) commercial fishing crews. The first step was to deploy the seine net around the haul, leaving the southeast side "open" where it connected to the block net. The block net was then deployed to prevent any escape of carp from Knotty Oar into the main basin. The MUM was then activated in the same manner as the test deployment competed earlier in 2020. A forward looking sonar was deployed where the block net and seine net met to observe the movement of carp from Knotty Oar into the seine. Carp movement was also monitored using radio telemetry. The MUM was "leap frogged" as radio-tagged carp began to move in response to the MUM to push carp into the seine haul As carp approached the block net and open side of the seine, they were observed on forward looking sonar. Once it appeared that the radio tags and the mass of carp had moved past the open side of the seine, that end was pulled into shore and carp were captured in the bag of the seine. A total of 815 individual carp were captured on this date, reducing carp biomass in Upper Prior Lake by 30 kg/ha. A video describing the event is available at https://www.youtube.com/watch?v=BzeY4I_PgOw .

The MUM was also deployed in Spring Lake in late March of 2020 to move carp from the east end of the lake to the west end near the boat landing. Carp were observed to be aggregating in the eastern end of Spring Lake in March of 2020. This end of the lake is not as conducive to seine netting and poses a greater risk of an unsuccessful seine removal (prior to obstruction removal). To move the aggregation, District staff deployed the MUM in the open water during a series of days in late March 2020. This deployment worked to move the carp from the east end to the west end (also may have been some influence due to water flow from County Ditch 13 inlet as carp may have been attracted to this). Figures 35 and 36 below show the difference in carp aggregations between early March 2020 and late March 2020 after the MUM deployment.

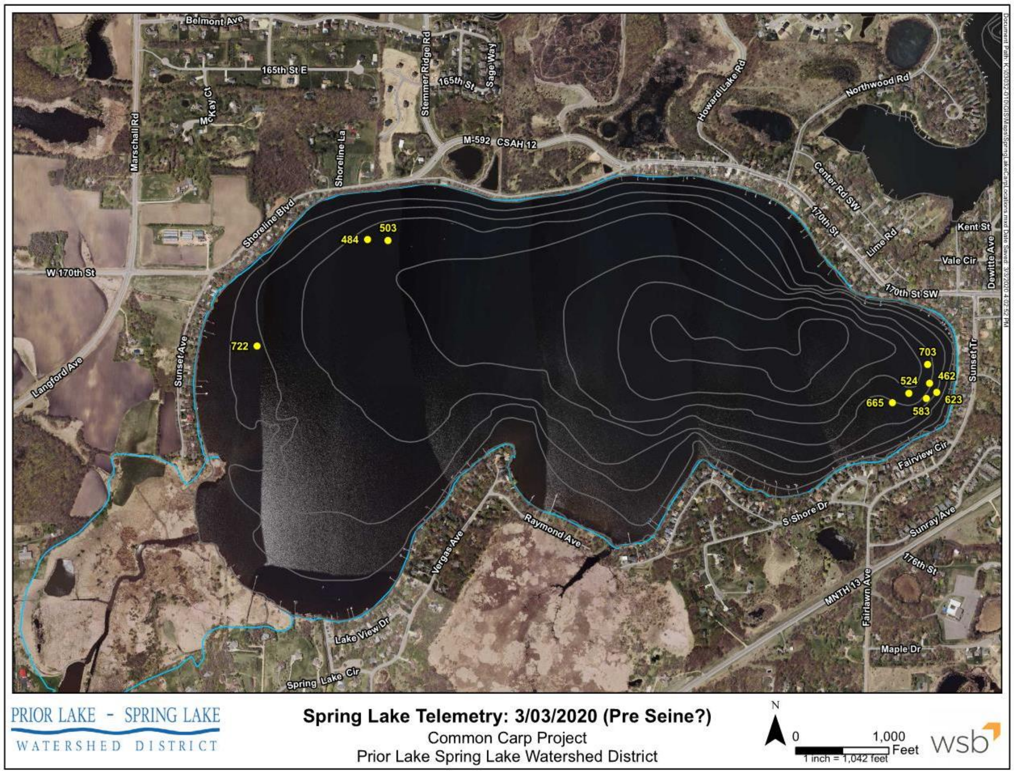


Figure 35. Spring Lake Carp Locations 3/3/2020

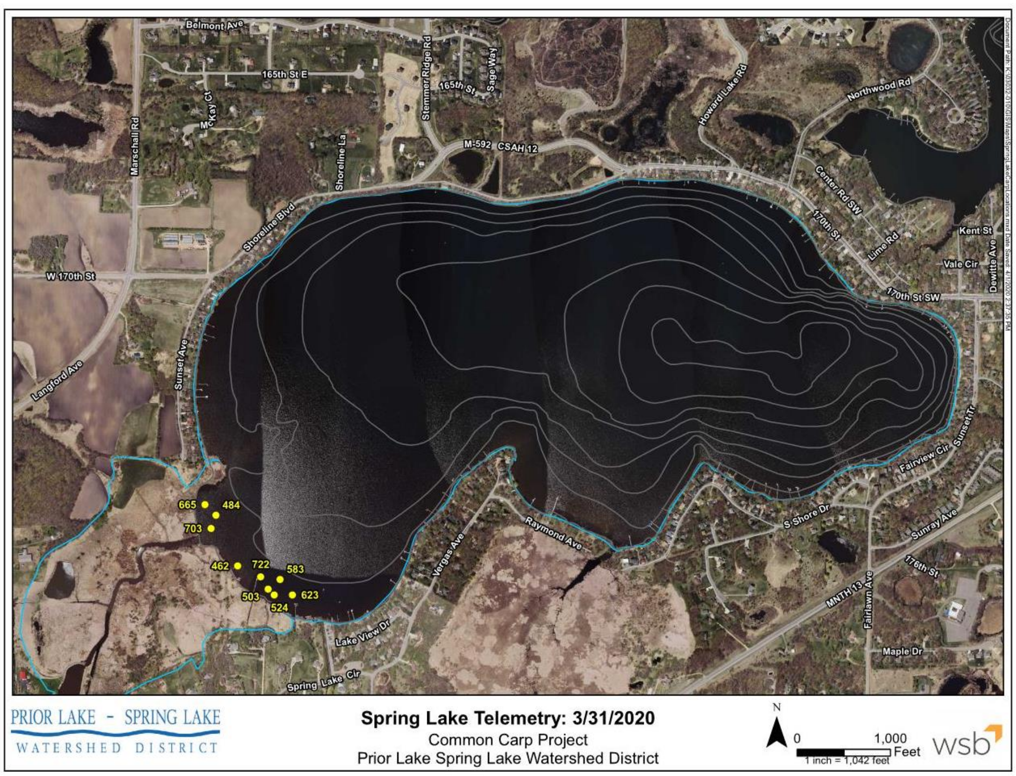


Figure 36. Spring Lake Carp Locations 3/31/2020 Post MUM Deployment

Open water seining was attempted on April 2, 2020 to capture carp found in the aggregation shown above. The sein was deployed from the Spring Lake boat landing to the north and drug towards the wetland edge and back to the landing. Unfortunately, only 4 individual carp were captured in this seine event most likely due to a variety of factors including, vegetation “lifting” the lead line, carp utilizing the cattail edge to escape, and carp “outrunning” the north end of the net and escaping to deep water.

The MUM was used on Upper Prior Lake in a similar fashion as the 2020 deployment in Knotty Oar on January 29, 2021. During this event, only 160 individuals were captured. This is most likely due to a lowered carp biomass volume on Upper Prior since very few carp were observed using forward looking sonar even though there was an aggregation of radio tags.

The MUM has also been deployed to drive carp during small scale gill netting efforts with success.

Objective 3: Install carp barriers at strategic locations

Task A: *Identify strategic locations for carp barriers*

Carp barrier locations have been chosen in response to radio-tag and PIT tag movement that has been monitored throughout the project period. There are many factors that need to be account for when wanting to create a fish barrier. Getting landowner permission, acquiring the required DNR permits, and accessing potential negative impacts are just a few of the considerations needed. Barrier placement was balanced with the potential for fish passage with respect to native gamefish. Barriers also have the benefit of protecting sensitive areas such as the 12/17 wetland reconstruction from the destructive foraging behavior of carp or prevent carp from exploiting migration routes to disrupt recruitment.

Task B: *Installation of carp barriers*

Two permanent barriers along with the seasonal installation of the push-trap have been installed in the PLSLWD to prevent the movement of carp.

Northwoods Barrier

In 2019, the District identified a carp nursery site when radio-tagged carp were documented within Northwood Pond during spring spawning. The potential location for a carp barrier was determined where carp been observed entering wetland on the west side of Upper Prior Lake along Northwood Ave. The Northwood Pond PIT station confirmed movement into this basin from Upper Prior Lake. The District worked with the City of Prior Lake and WSB Consultants on final design for the Northwood carp barrier. As construction had to wait until after fish spawning period, a temporary carp barrier was installed at the Northwood carp barrier location that was made from PVC pipe and 2x4s to prevent carp reaching these spawning grounds. In April of 2020, the temporary PVC carp barrier was removed immediately prior to the permanent barrier installation. The District worked with WSB Consultants to ensure the Northwood carp barrier was properly stabilized with vegetation after completion of the project. In 2021, after the barrier had been installed for one year, zero (0) PIT tags were detected. PIT station data indicates that the Northwood Pond barrier is effective at preventing migration into the basin. A memorandum from the design engineer certifying correct installation of the Northwood barrier is in Appendix O.

Tadpole Pond Barrier

Since 2020, radio-tagged carp have been accurately documented visiting a small, connected waterbody to the southwest of Spring Lake during spawning season named Tadpole Pond. A PIT station installed in 2021 confirmed seasonal movement. PLSLWD and WSB consultants began working together to design a barrier that could meet multiple challenges. The first challenge was to design a barrier knowing it was to be installed in a channel surrounded by wetland. The design idea formed by turning what our hypothetic temporary barrier would look like and use long lasting materials like the Northwood barrier. The second challenge in the design was making sure season fish passage and boat passage when necessary. Building the barriers in four panels allowed for the middle two to swing open. The third challenge was that installation was to be completed by the end of the year and to be done without eh use of heavy equipment. Boat access was also limited from low was level in 2021. Building the barrier panels out of aluminum, using dock anchoring technologies, transporting the fabricated materials to the site with Jon boats, and hard work made the undertaking possible. The installation of this barrier was completed on October 15, 2021. Future PIT monitoring at this site will help to confirm the efficiency of this barrier. A memorandum from the design engineer certifying correct installation of the Tadpole barrier is in Appendix P.

Figure 37 shows operational barriers placed throughout the Upper Prior and Spring Lake connections based on documented carp migratory information:

- Arctic Lake Outlet
- 12/17 Wetland (west side of Spring Lake)
- FeCl Weir (south of Spring Lake on Ditch 13)
    - Rebuild in 2020
- Desilt Pond (south of Spring Lake at Ditch 13 outlet)
- Northwoods Pond (west side of Upper Prior Lake)
    - Installed in 2020
- Tadpole Pond (south of Spring Lake)
    - Installed in 2021

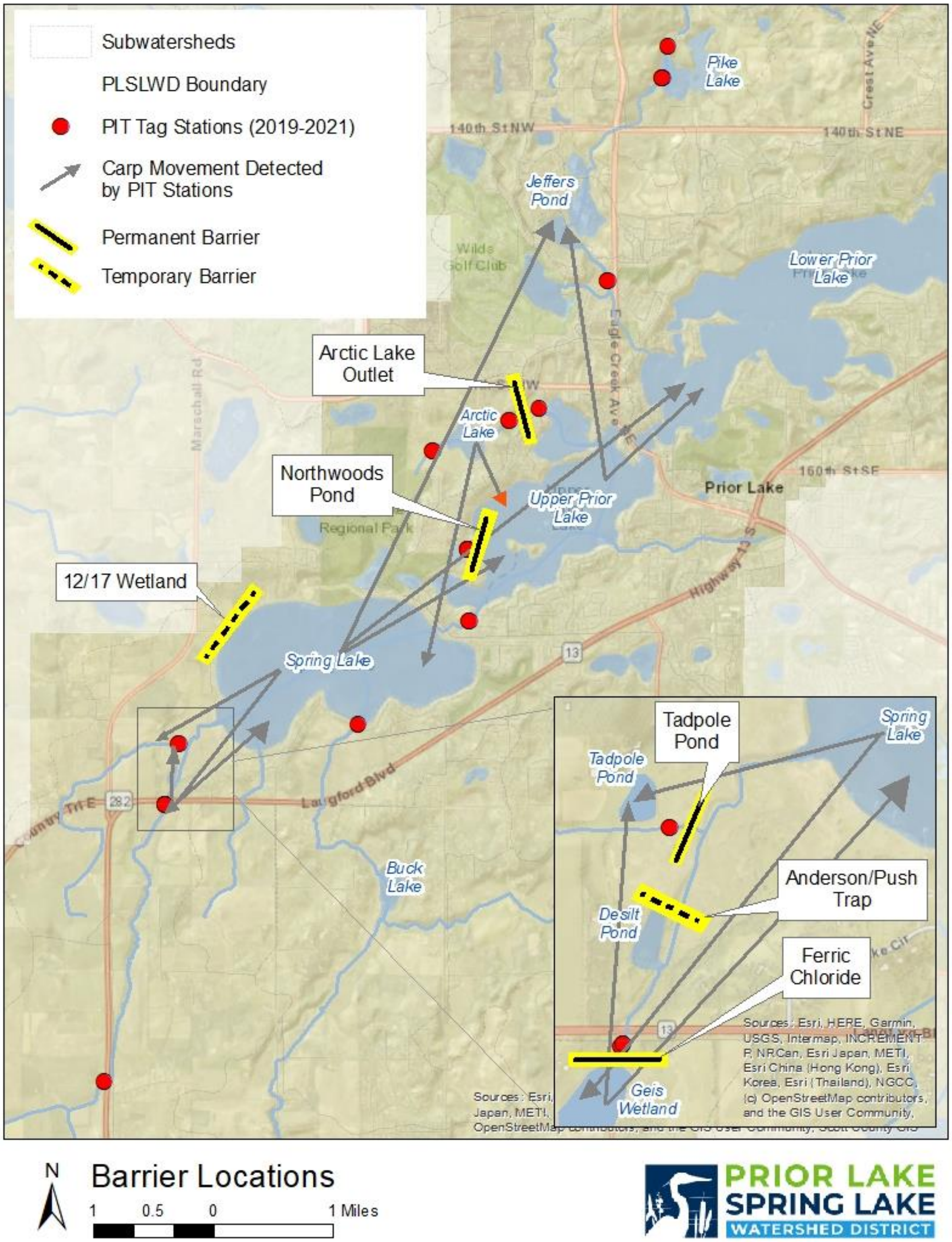


Figure 37. Barrier locations within the PLSLWD

The existing FeCl Weir barrier from 2003 was re-designed and updated in 2020. This barrier system needed repair for nearly a decade. The new system requires less maintenance and is designed to be more effective in high water flood conditions. This barrier was placed in response to PIT tag data collected at the Ferric Chloride PIT station that showed movement out of Geis Wetland towards Spring Lake and movement from Spring Lake towards Geis Wetland in the springtime during spawning migration period.

The PLSLWD plan to continue investigating other potential barrier locations in 2022 and beyond. These locations will be identified using the various tracking methods including PIT tag and radio-tag monitoring. Furthermore, as access to prime spawning habitats are continuously being blocked off, the district will be confirming barrier effectiveness.

Objective 4: Native plant establishment

Task A: *Aquatic plant point-intercept surveys*

The District contracted Blue Water Science to perform aquatic plant point-intercept surveys in both Spring and Upper Prior Lakes each year of the project except Upper Prior Lake in 2019. Appendices (Q, R, S, T, U). The surveys assessed the distribution, type, and growth density of the entire submergent plant community in the lakes. As shown in the executive summary, native vegetation establishment has significantly increased over the span of the project helping to meet the District's water quality goals.

Vegetation Management

Both Lakes have had known nuisance levels of Curlyleaf Pondweed (CLP). Additional CLP specific surveys were completed each year of the project just after ice out to determine the potential need for treatment. When CLP was treated, an assessment was done post-treatment to determine effectiveness of treatment. This data informs the District's Aquatic Plant Management Program including when and where to treat for invasive plant species and the effectiveness of any performed treatments.

BioBase Mapping

In addition to the aquatic plant point-intercept surveys, the District mapped lake plant biomass densities, bathymetry, and bottom hardness using sonar data analyzed by https://biobasemaps.com/ . The goal of the mapping program is to capture a long-term dataset on lake plant density, depth of plant growth. The final maps will be helpful for assessing project effectiveness, planning future projects, assessing the health of the lakes in the District, defining locations needed for Curly-leaf Pondweed (CLP) treatment, and confirming effectiveness of CLP treatments.

Task B: *Aquatic plant management plans*

The aquatic plant management plans for Spring Lake and Upper Prior Lake provide an organized strategy for managing aquatic plants by remaining proactive in establishing native plant populations, providing control of invasive aquatic plants such as Curlyleaf Pondweed, and preventing establishment of new invasive aquatic plant species. The plans review up to date water quality data, previous years point-intercept surveys, frequency of occurrence of target species, past AIS treatment history, discusses management alternatives, and recommends action items. The document builds a history of aquatic plant management for each lake and presents it to the Department of Natural Resources Division of Ecological and Water Resources. A primary action item of having the plans approved by the DNR is the District could treat more that 15% of the littoral area with herbicide or harvest move than 50% to control for invasive aquatic plants. The District will carry out the plans action items and recommended actions. Approval would also require a public participation process with notification to lake shore owners' informing them of the plan. Aquatic plant management plant for Spring and Upper Prior Lakes are in Appendices V and W.

Objective 5: Community outreach

Task A: *Outreach mailings*

The District designed all of its outreach materials in house. In 2019 and 2020, Information fliers were mailed to over 50 shoreline residents adjacent to the removal areas (Appendix F) and specialized traps (Appendix G) placed in and around Upper Prior Lake. The fliers aimed to inform the residents of our unique activies near their shorelines as well as provide information on this project. In 2021 a newsletter (Appendix H) was sent to 1,112 residents informing them of the water quality implications of common carp, the grants removal objectives, and the importance of native aquatic plants.

Task B: *Engage the local community*

Over the span of the project, a total of three articles were published by the Prior Lake American about carp removals on Spring and Prior Lakes found in Appendices (K, L, M). In 2020, two school partnership events were completed whereby WSB and District staff gave presentations to five 12th grade classrooms at Prior Lake High School totaling roughly 150 students on February 4th, 2020. This was followed by a field day on the ice on Upper Prior Lake on February 6th, 2020, where students got an opportunity to track the carp using the Districts' Yagi antennas (figure 38).

Figure 38. Field presentation for high school class.

The District regularly updated its website https://www.plslwd.org/ with carp tracking locations, project news, removal events, volunteer opportunities, educational material, YouTube videos, and social media posts https://www.facebook.com/PLSLWD/ . Appendix Z contains all the website links available in this report. The following materials were created to for volunteers and public outreach:

- Volunteer Carp Tracking Training https://www.youtube.com/watch?v=KPVhS3LF9xs
- Volunteer Baited Box Trap Training https://www.youtube.com/watch?v=fc6FuGmCBvE

- 2020 Carp Management: https://storymaps.arcgis.com/stories/828435c645db478b88649cb8e1df4802
- 2022 Carp Tracking: https://storymaps.arcgis.com/stories/3ab85725c02b4ae9bb7b9f864a2319de
- Comprehensive Carp Management – BWSR October Snapshots Article (Appendix Y)

Presentations were given at community event center for Prior Lake Association 2019-2021. Spring Lake Association annual meetings have been conducted both in person and virtually between 2019 and 2021. A total of six lake associate presentations have been completed all highlighting the negative impact common carp have and water quality and the importance of native plants. The District also wrote articles for the annual Spring and Prior Lake Association Newsletters. See Appendix N for the 2021 Spring Lake Association Newsletter.

Objective 6: Project Administration & Management

Task A: *Complete and submit semi-annual and final grant reports to MPCA.*

Subtask 1*: Submit semi-annual reports for each year of this project.*

All semi-annual reports were submitted and are included in Appendix A.

Subtask 2*: A final project report, along with supporting materials.*

This report serves as the final project report and includes all supporting materials in appendices as required.

Task B*: Project Coordination*

Subtask 1: *Project coordination*

Project coordination included at least quarterly meetings between members of the project team (PLSLWD staff and WSB staff) to review objectives for completeness, evaluate methods (traditional or novel) for removal, and plan field activities that were seasonally dependent.

The project budget was updated and tracked monthly to ensure there were no overages in the budget and that expenses were appropriate for each line item.

Coordination of carp removals required the largest effort in terms of coordination as staff availability, permitting, weather, carp markets or disposal sites, carp aggregations, and safe ice were present or in place.

One of the largest and most holistic efforts was working with the MN Association of Watershed Districts (MAWD) to support and champion and effort to amend state statutes to allow for more flexibility in assigning carp removal permits to governmental subdivisions and subcontractors, regardless of the licensed commercial fishing operator's existing license.

This was done as prior to the statute amendment, it was difficult for government subdivisions, non-profits, or any other entity interested in pursuing carp removal as part of a formal plan to improve water quality, to work with various licensed commercial fishing operators if the operator did not have an interest and would not allow other subcontractors to fish or reduce carp biomass in their respective area.

PLSLWD staff worked with MAWD, state legislators, other watershed and soil and water conservation districts, and state agencies to amend the statute language to allow governmental subdivisions to work with subcontractors other than the licensed commercial fishing operator for a specific area if that operator was uninterested in carp removal or uncooperative. A copy of the amended statute can be found in Appendix I.

The District also created a working group of up to 15 public organizations with programs or goals of carp management. The group has had several meetings virtually and in person with local and international expert speakers. PLSLWD built hosts the meetings and has a website that supports the groups mission. https://www.metrocarp.org/ The mission of the Metro Carp Management Group (MCMG) is to discuss and troubleshoot the many challenges that twin cities lake managers face with carp management. This is a collaborative group that shares carp management techniques and strategies from across the metro area, exchanging information that will help better advance all our carp management efforts.

Subtask 2: *Secure the necessary permits*

As described in section 1, multiple permits were needed for project completion.

Each year, a MN DNR research permit was acquired. These permits allowed for basic fisheries data collection and fish capture for population estimates, radio tagging, and PIT tagging.

A Class C permit was required for large scale carp removal for entities other than the licensed commercial fishing operator. The district successfully obtained this permit in 2020 and 2021 as a result of the work described under the project coordination section. The licensed commercial fishing operators for this inland commercial fishing area of Minnesota (area 21) is Don Geyer. Don obtained his Class B commercial fishing license each year of the project to provide removal services in addition to other commercial fishing entities that the District contracted.

MN DNR Public Waters Work Permits were required for barrier projects. A water control structure permit was issued in 2019 to allow for the construction of the Geis Wetland (Ferric Chloride) carp barrier. Barrier/ Fish Screen permits were issued for the Northwood Barrier prior to 2019, but installation occurred in 2020, and the tadpole pond barrier in 2021.

Two (2) separate fish transportation, importation, and stocking permits were acquired in 2020 to allow for the stocking of Northwoods Pond and Geis Wetland, both of which had been identified as nursery sites. Bluegills were stocked as a form of biocontrol to consume carp larvae and eggs. Similar permits were acquired in 2021.

Project Summary

Waterbody Improved

Improvements to Spring Lake and Upper Prior Lake were measured by positive changes in water quality (TP, Chlorophyll-A, and Secchi depth) and increased abundance of submersed aquatic vegetation (SAV).

Project highlights

To address the problem of excess nutrients/eutrophication, the District implemented a holistic carp management project that was guided by integrated pest management (IPM) principles. These principles include data collection, physical removal, barriers, predator introduction, and movement tracking. In addition to carp management, alum treatments were completed on both Spring and Upper Prior Lakes in 2020, and likely influenced improvements in water quality. Carp biomass reduction may work to increase the effective life of the alum treatment in both lakes. All project activities funded through this grant were completed starting in 2019 and concluding in December 2021.

Results

Internal TP loads were reduced by 198 pounds/year in Spring Lake by reducing the carp biomass by 19,154 pounds and Upper Prior Lake internal TP loads were reduced by 499 pounds/year through the removal of 39,367 pounds of carp in Upper Prior. In addition, aquatic vegetation spatial distribution and species richness increased on both Spring and Prior Lake. This led to TP, Chl-a, and Secchi depth meeting water quality goals by the conclusion of the project period.

Partnerships

Shakopee Mdewakanton Sioux Community (SMSC) – Shared water quality data, provided access to water resources for project activities, provided community garden disposal site of carp for fertilizer.

Spring Lake Association – Provided outlet and support for education and outreach, helped fund bluegill stocking; volunteered for tracking, baited box traps, and carp espionage.

Prior Lake Association - Provided outlet for and support f of education and outreach, helped fund bluegill stocking; volunteered for tracking, baited box traps, and carp espionage.

City of Prior Lake - Provided access to water resources for project activities and barrier installations, provided storage for equipment.

Private Residents - Provided access to water resources for project activities and barrier installations, provided farm fields for disposal of carp for fertilizer; volunteers supporting tracking, baited box traps, and data collection during seining events.

Appendices

**Some appendices not included*

A. *MPCA 319 Semi-annual reports 2019-2021**

B. *PM Project Permits**

C. Track MEMO 2019 2020 2021 PIT Station Summary PLSLWD

D. *Carp Removals MEMO Upper Prior Gillnetting**

E. 2019 Carp Management Cost Benefit Summary

F. E&O 2019 04 13 Lit Drop Fact Sheet Mud Bay

G. E&O 2020-05 Newman Trap Lit Drop Prior Lake

H. E&O 2021 Aquatic Plant Outreach Newsletter

I. Carp Removals MN Statue Amendment

J. *Carp Removals MUM MEMOS**

K. E&O Prior Lake American 2019-04-27

L. E&O Prior Lake American 2021-02-02

M. E&O Prior Lake American 2021-02-24

N. E&O 2021 Spring Lake Association Newsletter

O. *Barrier Installation Memo Northwooods**

P. *Barrier Installation Memo Tadpole**

Q. Aquatic Plants_2019 Spring CLP and PI Surveys

R. Aquatic Plants_2020 Prior - CLP and PI Surveys

S. Aquatic Plants_2020 Spring – CLP and PI surveys

T. Aquatic Plants_2021 Spring – CLP and PI Surveys

U. Aquatic Plants_2021 UPL LPL - CLP and PI Surveys

V. *Aquatic Plants_Spring LVMP 2021**

W. *Aquatic Plants_Upper Prior LVMP 2021**

X. 2021-2022_PLSLWD_Carp IPM_Plan

Y. E&O_BWSR Snapshots-story 2021-10-03 Carp-management

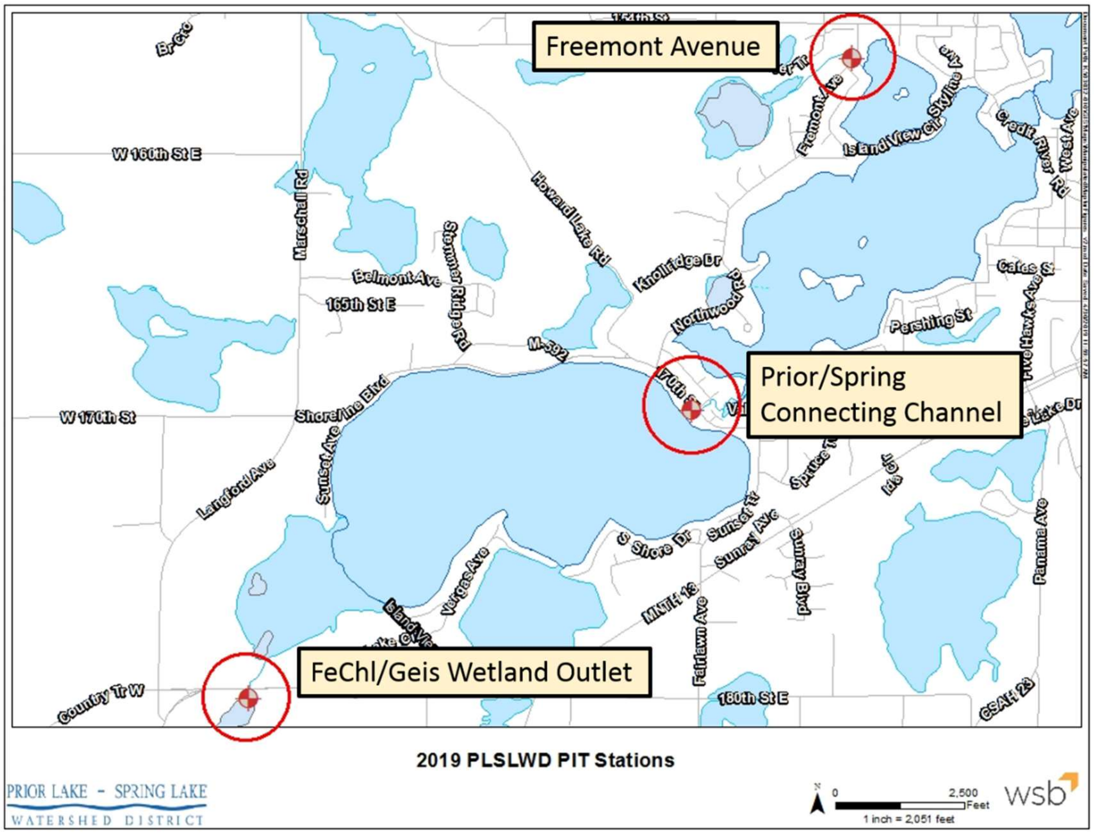
Z. *319 Final Report_PLSLWD Hyperlinks**

2019 PIT Station Summary - PLSLWD

2019 PIT Implants Summary:

	2019 Active **PIT Tags**
Spring Lake	93
Upper Prior Lake	231
Arctic Lake	26
Geis Wetland (Carp)	119
Geis Wetland (White Sucker)	9

2019 PIT Station Locations:



FeChl/Geis Outlet Site

2019 PIT tag hits

In 2019, 46 uniquely numbered PIT tags crossed over the antennae at the outlet of FeChl site/Geis Wetland on the downstream side of the weir between April 18 and August 6th. These tags were originally implanted into Carp and White Suckers in Geis Wetland and Spring Lake between 2017 and 2019 (Table 1).

Basin Marked	Date Marked	Species	Length	Weight	Tag #	# Days Detected in 2019
Geis Wetland	5/22/2019	CARP	12.4	0.95	228000656997	1
Geis Wetland	5/22/2019	CARP	13.9	1.31	228000656996	2
Geis Wetland	5/22/2019	CARP	12.4	0.86	228000656986	1
Geis Wetland	5/22/2019	CARP	15.1	1.72	228000656985	1
Geis Wetland	5/22/2019	CARP	28.2	9.11	228000656982	1
Geis Wetland	5/22/2019	CARP	10.3	0.58	228000656981	2
Geis Wetland	5/22/2019	CARP	27.7	8.54	228000656971	3
Geis Wetland	5/22/2019	CARP	13.4	1.46	228000656966	1
Geis Wetland	5/22/2019	CARP	11	0.73	228000656961	20
Geis Wetland	5/17/2018	CARP	10.3		228000557293	1
Spring Lake	5/28/2018	CARP	17.8	3.2	228000557211	3
Spring Lake	5/28/2018	CARP	18.8	5.45	228000557181	1
Spring Lake	5/28/2018	CARP	17.8	3.2	228000557177	2
Geis Wetland	5/17/2018	CARP	16.4	3.5	228000557169	1
Geis Wetland	5/17/2018	CARP	27	10.25	228000557164	3
Geis Wetland	10/4/2018	CARP	11.3	0.65	226000074710	2
Geis Wetland	8/15/2018	CARP	27.4	8.7	226000074700	1
Geis Wetland	10/4/2018	CARP	11.7	0.65	226000074692	1
Geis Wetland	10/4/2018	CARP	10.9	0.65	226000074682	2
Geis Wetland	10/4/2018	CARP	11.1	0.65	226000074668	4
Geis Wetland	8/15/2018	CARP	12.7	0.69	226000074662	1
Geis Wetland	10/4/2018	CARP	27.8	9.45	226000074661	4
Geis Wetland	10/4/2018	CARP	10	0.63	226000074654	27
Geis Wetland	10/4/2018	CARP	10.9	0.65	226000074653	1
Geis Wetland	10/4/2018	CARP	10.8	0.63	226000074651	5
Geis Wetland	10/4/2018	CARP	10.8	0.65	226000074646	1
Geis Wetland	8/15/2018	CARP	11.6	0.59	226000074630	1
Geis Wetland	10/4/2018	CARP	10.9	0.63	226000074621	1
Geis Wetland	10/4/2018	CARP	11.3	0.65	226000074619	1
Geis Wetland	8/15/2018	CARP	11.4		226000074618	1
Geis Wetland	8/15/2018	CARP	16.5	2.2	226000074617	1
Geis Wetland	10/4/2018	CARP	10.6	0.65	226000074658	1
Geis Wetland	8/15/2018	CARP	11.3	0.73	226000074679	1
Spring Lake	5/28/2018	CARP	31.2	14.45	228000557219	5
Spring Lake	5/28/2018	CARP	18.2	3.45	228000557222	1
Spring Lake	5/28/2018	CARP	27.2	10.7	228000557226	9
Geis Wetland	5/17/2018	CARP	27	9.5	228000557294	3
Geis Wetland	5/17/2018	CARP	27.2	10.25	228000557297	5
Geis Wetland	5/22/2019	CARP	11.3	0.75	228000656964	1
Geis Wetland	5/22/2019	CARP	17.2	2.76	228000656988	1
Geis Wetland	5/22/2019	CARP	12.6	1.02	228000656995	1
Spring Lake	5/25/2017	CARP	26.5		228000557154	1
Geis Wetland	5/22/2019	White Sucker	16.9	1.94	228000656969	1
Geis Wetland	5/22/2019	White Sucker	16.8	1.81	228000656972	1
Geis Wetland	5/22/2019	White Sucker	17.7	2.32	228000656973	1
Geis Wetland	5/22/2019	White Sucker	17.4	2.3	228000656991	1

Table 1: PIT tags detected at FeChl/Geis Wetland PIT station in 2019 and the record of original capture and PIT implant date along with length and weight data at time of implant.

At the outlet of Geis Wetland movement was first detected on May 12th with the majority of hits occurring on June 16, 2019 (16) and June 20, 2019 (13) (Figure 1). All but one of the tags detected between these two dates had originally been tagged in Geis Wetland between 2016 and 2019 and this movement is suspected to be movement out of the Geis Wetland Basin back towards Spring Lake. There is not a strong correlation at the Geis Wetland site for movement occurring with an increase in water levels within the district.

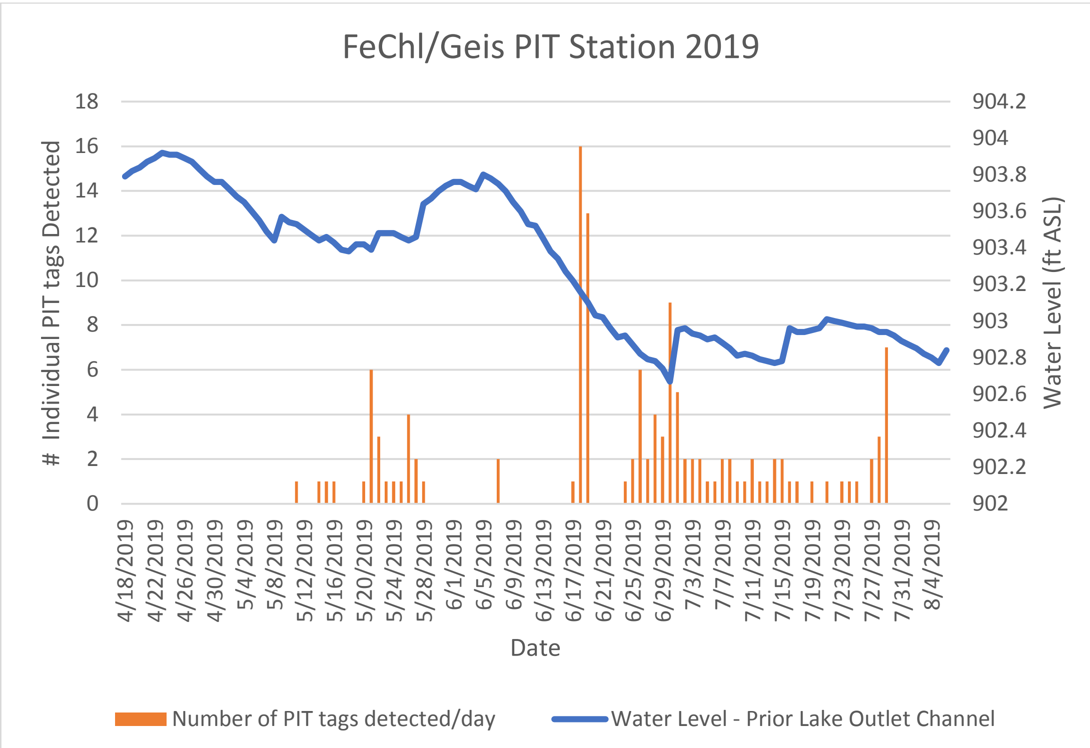


Figure 1: Number of uniquely numbered PIT tags detected at the FeChl/Geis Wetland outlet site by day in 2019 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Prior/Spring Connecting Channel Site

2019 PIT tag hits

In 2019, 6 uniquely numbered PIT tags crossed over the antennae through the channel that connects Upper Prior Lake to Spring Lake between the date of install on April 29th and the final download on August 6th. Tags that were detected in 2019 had been originally tagged in either Upper Prior Lake or Spring Lake between 2016 and 2018 (Table 2).

Basin Marked	Date Marked	Species	Length (in)	Weight (lbs)	Tag #
Upper Prior Lake	11/30/2016	CARP	32	9.14	228000557007
Spring Lake	5/28/2018	CARP	22.80	6.2	228000557194
Spring Lake	5/25/2017	CARP	26		228000557153
Upper Prior Lake	11/30/2016	CARP		8.95	228000557034
Spring Lake	5/28/2018	CARP	24.40	6.95	228000557225

Table 2: PIT tags detected at Prior/Spring Connecting Channel PIT station in 2019 and the record of original capture and PIT implant date along with length and weight data at time of implant.

At the connecting channel between Spring Lake and Upper Prior Lake movement was first detected on May 14, 2019 with the majority of detections occurring on May 23 (2) and May 28, 2019 (Figure 2). Movement between May 23-28 is correlated with a rise in water levels within the district. The tags detected on these dates were from four different tags: 228000557194, 228000557153, 228000557034, and 228000557225 that were originally tagged in Upper Prior Lake or Spring Lake. It is unclear if these fish were moving upstream or downstream.

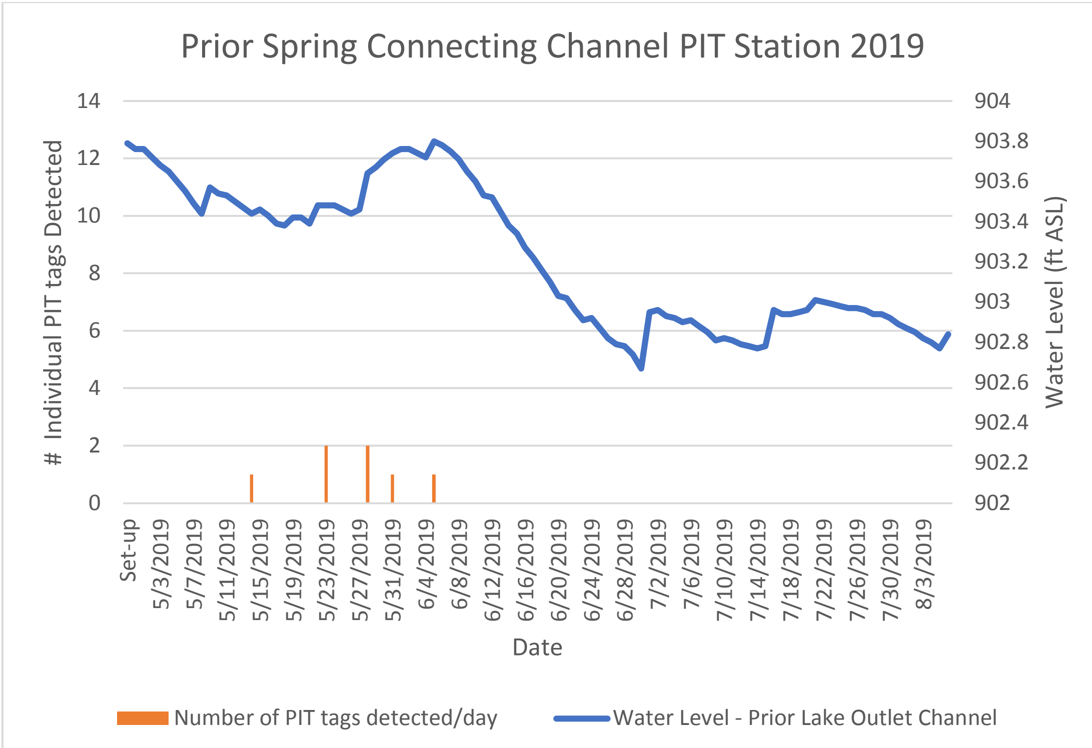


Figure 2: Number of uniquely numbered PIT tags detected at the Prior/Spring Connecting Channel by day in 2019 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Freemont Avenue Site

2019 PIT tag hits

In 2019, 11 uniquely numbered PIT tags crossed over the antennae through the channel that connects Upper Prior Lake to Spring Lake between the date of install on May 13th and the final download on August 6th. Tags that were detected in 2019 had been originally tagged in Upper Prior Lake 2016 and 2019 (Table 3).

Basin Marked	Date Marked	Species	Length (in)	Weight (lbs)	Tag #	# Days Detected 2019
Upper Prior Lake	5/28/2019	CARP	20.8	5.16	228000656923	4
Upper Prior Lake	5/28/2019	CARP	21.5	4.5	228000656928	4
Upper Prior Lake	9/6/2018	CARP	19.1	4.25	228000630703	3
Upper Prior Lake	11/30/2016	CARP	26.8	8.9	228000557120	5
Upper Prior Lake	9/17/2018	CARP	19	5	228000557281	3
Upper Prior Lake	9/17/2018	CARP	18.5	3.75	228000557286	3
Upper Prior Lake	9/17/2018	CARP	17.6	4	228000557287	2
Upper Prior Lake	9/6/2018	CARP	17.60	3.75	228000630706	3
Upper Prior Lake	9/6/2018	CARP	17.90	3.75	228000630708	3
Upper Prior Lake	5/28/2019	CARP	19.8	3.88	228000656921	1
Upper Prior Lake	5/28/2019	CARP	26.6	8.65	228000656954	1

Table 3: PIT tags detected at Freemont Avenue PIT station in 2019 and the record of original capture and PIT implant date along with length and weight data at time of implant.

At the Freemont Avenue PIT Station, movement was first detected on May 23 with the majority of hits on May 31, 2019 (10) (Figure 3). The surge in movement is correlated with a rise in water levels within the watershed district. All of the tags detected at the Freemont Avenue Station were originally tagged in Upper Prior Lake. A barrier is in place on the downstream side of the site in Upper Prior's Mud Bay. It is suspected that fish are being let through the barrier by people and efforts are ongoing to get a lock installed on the grate system to prevent further movement from Upper Prior Lake into the wetland complex and possibly into Arctic Lake that is located upstream from this site.

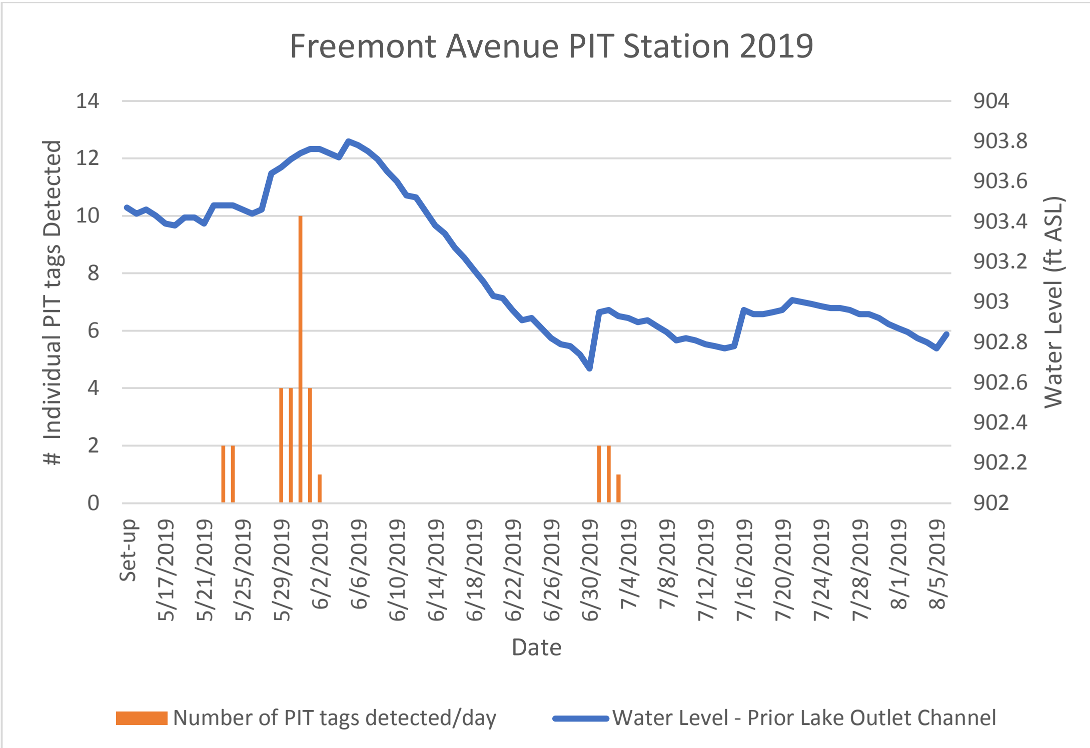


Figure 3: Number of uniquely numbered PIT tags detected at the Freemont Avenue site by day in 2019 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

2020 PIT Station Summary - PLSLWD

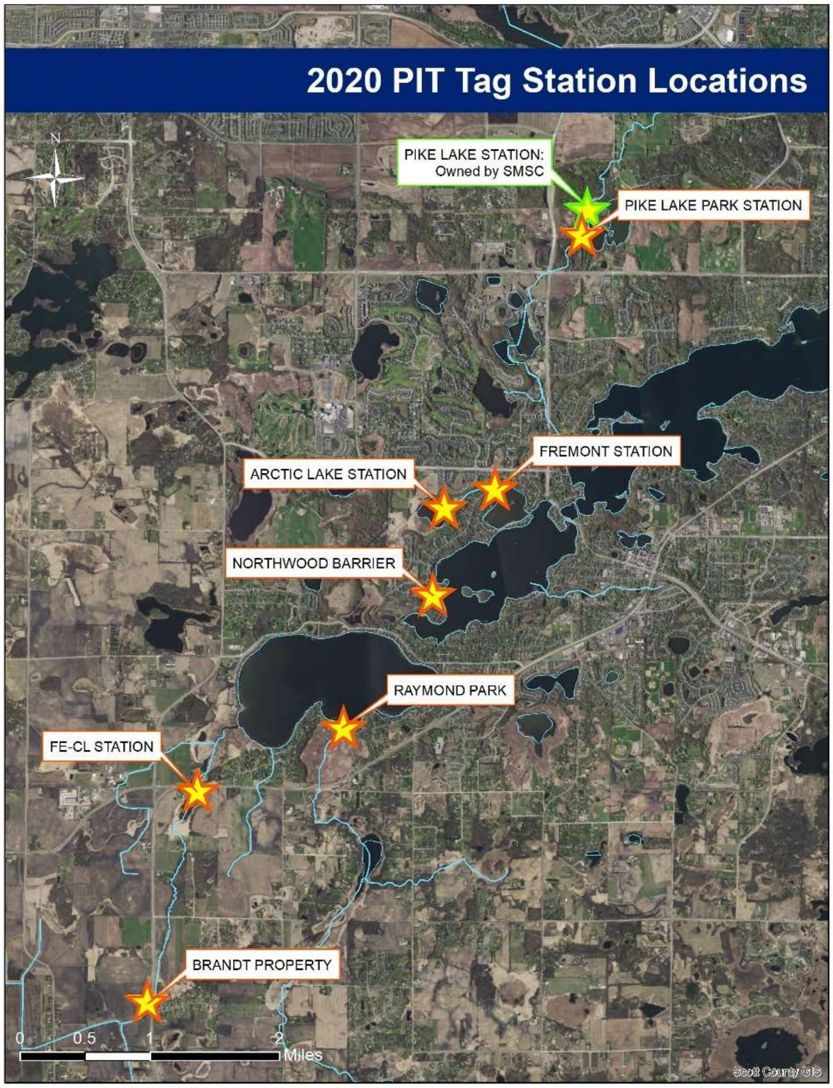
2020 PIT Implants Summary:

Passive Integrated Transponder (PIT) Tags have been implanted into common carp in the Prior Lake Spring Lake Watershed District since 2016. Efforts have been made in a number of basins to mark fish during a variety of capture events to increase numbers (Table A.). Table A represents the number of tags present at the beginning of the 2020 monitoring season. As efforts are ongoing to remove fish from the system, these numbers of PIT tags have varied throughout the 2020 season as a total of 65 PIT tagged carp have been removed via these removal activities. PIT tags removed are reported by lake in Table A and reflect numbers removed as of August 25, 2020.

	Current Active PIT Tags	2020 Removed PIT Tags	*Tags Remaining December 2020
Spring Lake	156	-37	119
Upper Prior Lake	237	-16	221
Arctic Lake	26	0	26
Geis Wetland (Carp)	119	-12	107
Geis Wetland (White Sucker)	9	0	9
Fish Lake	0	0	0
Pike Lake	50	0	50

*Table A: PIT tagged fish in the PLSLWD at the beginning of 2020 and PIT tags removed over the 2020 PIT monitoring season. * This number is approximate since all fish that were removed from the system were not checked for tags and mortality is not accounted for.*

2020 PIT Station Locations:



Brandt Site

The Brandt Site is located in the Upper Watershed Southwest carp management zone. The stream reach being monitored connects Geis Wetland to Sutton Pond along Langford Ave (Hwy 13) just north of Butterfly Ln (GPS Coordinates: 44.664996, -93.501337). PIT tags have been implanted into carp, and white sucker fish in Geis Wetland. In the summer of 2020, a barrier was placed at the outlet of Geis Wetland towards Spring Lake to the north. This barrier may not prevent the movement out of Geis Wetland to Spring Lake but is thought to prevent the immigration of fish from Spring Lake to Geis and further upstream.

2020 PIT tag hits

In 2020, zero PIT tags crossed over the antennae at the Brandt station between the set-up date of May 12, 2020 and the latest download date of November 4, 2020 (Table 1).

Lake Originally Tagged	Date Tagged	Fish	Length (in)	Weight (lbs)	Tag #	# Days Detected in 2020
na	na	na	na	na	228000557150 (TEST TAG)	na
*na	na	na	na	na	226001166058 (Test Tag?)	na
*na	na	na	na	na	226000659690 (Test Tag?)	na

Table 1: PIT tags detected at Brandt site PIT station in 2020. The reader was tested with a tag but no new tags were detected at the site.

The station at this site powered down for six days between May 29 - June 3 due to a miswiring between the solar panel and the charge controller (Figure 1). Water level data is from the Prior Lake Outlet Channel through 2020 PIT monitoring dates. The site was checked periodically through 2020 and the read range of the antenna was approximately 2 feet from the plane of the antennae. This gave full read coverage of the stream in the 2020 monitoring season.

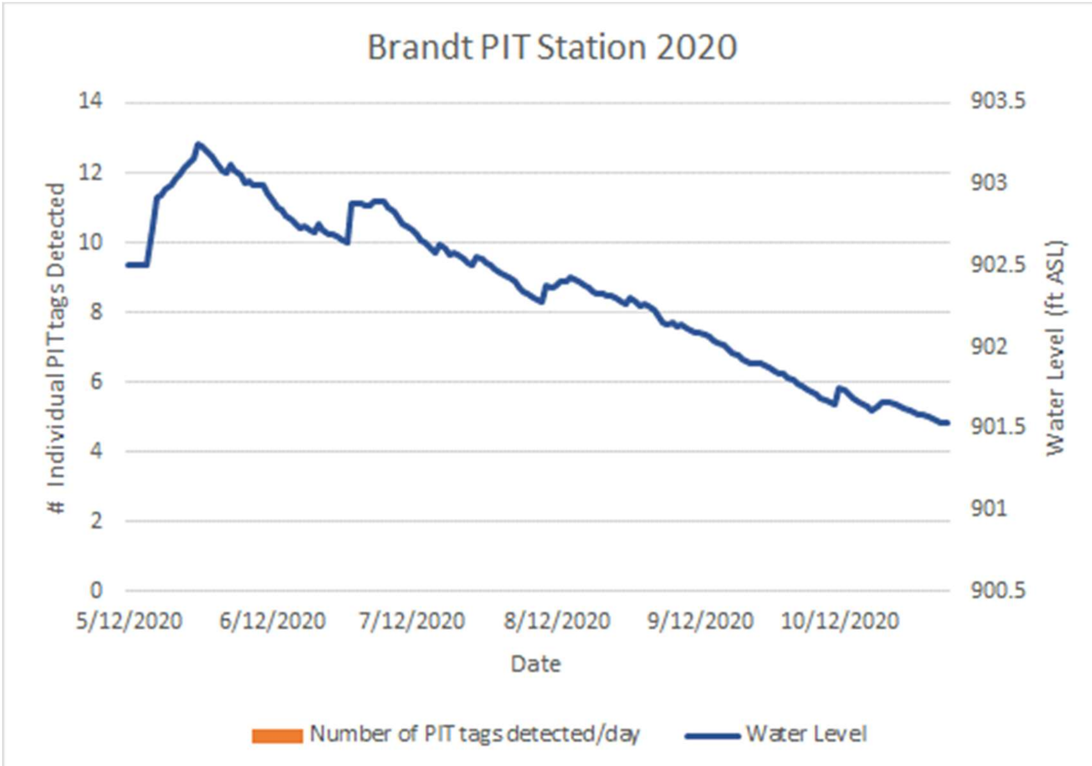


Figure 1: Number of uniquely numbered PIT tags detected at the Brandt Site Station by day in 2020 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

FeChl/Geis Outlet Site

2020 PIT tag hits

In 2020, 26 uniquely numbered PIT tags crossed over the antennae at the outlet of FeChl/Geis Wetland on the downstream side of the weir between the installation date of May 8th and the latest download date of November 4, 2020. Fish detected at the site were Carp and White Sucker fish that had been tagged in Geis Wetland and Spring Lake between 2018 and 2019 (Table 2). A number of these fish were also detected at the site in 2019. A number of the tags detected at the FeChl/Geis Wetland site were recorded as passing the antenna more than one day and up to 49 days throughout this period. This observation suggests that fish were not able to pass by the temporary barrier that was installed in early spring of 2020. Additionally, this barrier site may provide an opportunity for removal of these fish in the future with use of a trap or active physical removal by district employees and carp consultants.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	Weight (lbs)	Previous Detection	Tag #	# Days Detected in 2020
Geis Wetland	8/15/2018	CARP	11.4		FeChl/Geis 2019	226000074618	11
Geis Wetland	10/4/2018	CARP	11.4	0.63		226000074634	1
Geis Wetland	10/4/2018	CARP	10.9	0.65	FeChl/Geis 2019	226000074653	9
Geis Wetland	10/4/2018	CARP	10	0.63	FeChl/Geis 2019	226000074654	50
Geis Wetland	5/17/2018	CARP	27.00	10.25	FeChl/Geis 2019	228000557164	19
Geis Wetland	5/17/2018	CARP	27.80	10.25	FeChl/Geis 2019	228000557170	10
Spring Lake	5/28/2018	CARP	8.70			228000557180	2
					FeChl/Geis 2019	228000557297	1
Geis Wetland	5/22/2019	CARP	11	0.73	FeChl/Geis 2019	228000656961	30
Geis Wetland	5/22/2019	CARP	27.7	8.54	FeChl/Geis 2019	228000656971	6
Geis Wetland	5/22/2019	WHS	16.8	1.81	FeChl/Geis 2019	228000656972	1
Geis Wetland	5/22/2019	WHS	17.8	2.34		228000656975	5
Geis Wetland	5/22/2019	CARP	28.2	9.11	FeChl/Geis 2019	228000656982	4
Geis Wetland	5/22/2019	CARP	15.1	1.72	FeChl/Geis 2019	228000656985	3
Geis Wetland	5/22/2019	CARP	12.4	0.86	FeChl/Geis 2019	228000656986	5
Spring Lake	8/16/2019	CARP	24.5	6.55		228000659622	5
Spring Lake	8/16/2019	CARP	16.3	2.27		228000659670	2
Spring Lake	8/16/2019	CARP	20.4	4.03		228000659683	7
Geis Wetland	10/4/2018	CARP	10.8	0.65	FeChl/Geis 2019	226000074646	1
Geis Wetland	10/4/2018	CARP	10.6	0.65	FeChl/Geis 2019	226000074658	2
Geis Wetland	8/15/2018	CARP	27.4	8.7	FeChl/Geis 2019	226000074700	2
Spring Lake	5/28/2018	CARP	17.80	3.2	FeChl/Geis 2019	228000557177	1
Spring Lake	5/28/2018	CARP	19.70	3.7		228000557213	2
Spring Lake	5/28/2018	CARP	18.80	3.7		228000557227	2
Spring Lake	5/28/2018	CARP	19.20	4.2		228000557233	1
Geis Wetland	5/22/2019	CARP	13.9	1.31	FeChl/Geis 2019	228000656996	1

Table 2: PIT tags detected at FeChl/Geis Wetland site PIT station in 2020 and the record of original capture and PIT implant date along with length and weight data at time of implant and previous detection locations and year.

In 2020, there were no power interruptions at the FeChl/Geis Wetland site. Detection range at the antennae provided full coverage of the stream, even with a rise in water levels. The antennae is placed on the downstream side of the barrier on the Spring Lake side to detect attempted movements into Geis Wetland and to capture movement out of the wetland.

At the outlet of FeChl/Geis Wetland movement was first detected on May 11, 2020 with the majority of hits occurring on June 29, 2020 (Figure 2). This movement on June 29 is associated with an increase in water level in the district as is a spike in movement between May 18 – 21.

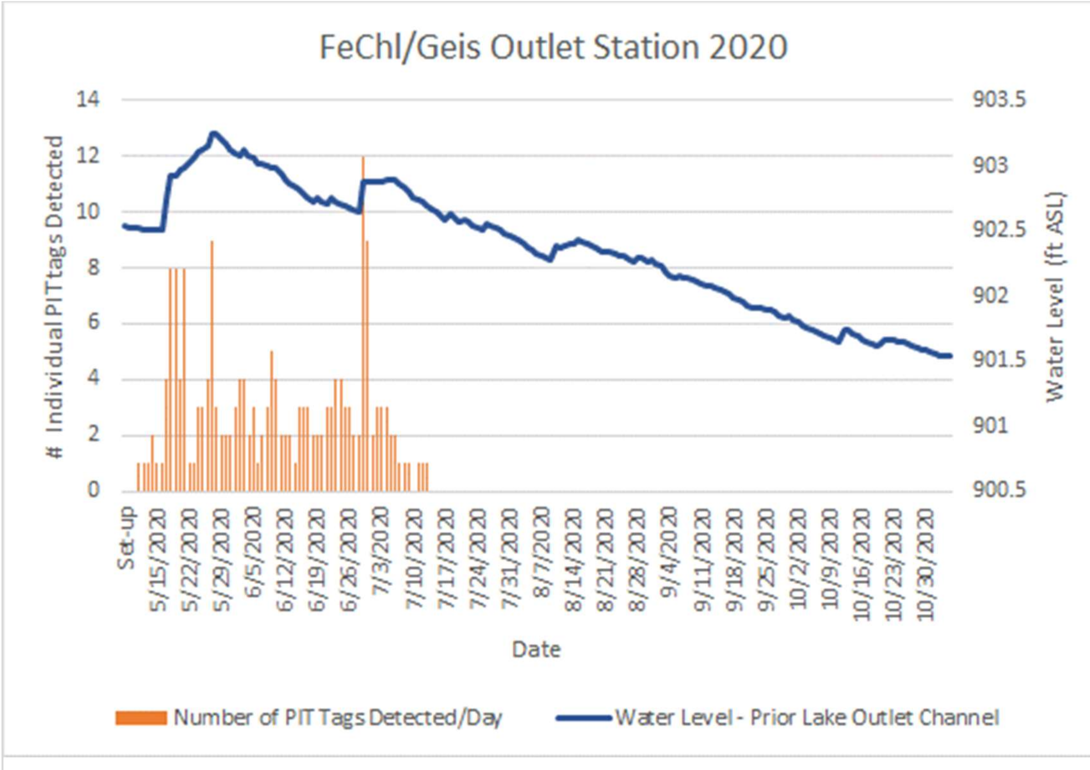


Figure 2: Number of uniquely numbered PIT tags detected at the FeChl/Geis Wetland Outlet Station by day in 2020 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Raymond Park Site

2020 PIT tag hits

In 2020, zero PIT tags crossed over the antennae at the Raymond Park Site between the set-up date of June 5, 2020 and the latest download date of November 4, 2020 (Table 3). The unit was powered on throughout the monitoring period in 2020. Detection range was 6-8 inches from the antennae and did not provide full coverage of the stream at the deepest section of the stream if fish moved at the surface of the water.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	Weight (lbs)	Tag #	# Days Detected in 2020
na	na	na	na	na	228000557150 (TEST TAG)	na
na	na	na	na	na	228000557290 (TEST TAG?)	na

Table 3: PIT tags detected at Raymond Park site PIT station in 2020. The reader was tested with a tag but no new tags were detected at the site.

The station was not installed at the time of a spike in water level within the watershed that occurred between May 17 – 21 (Figure 3).

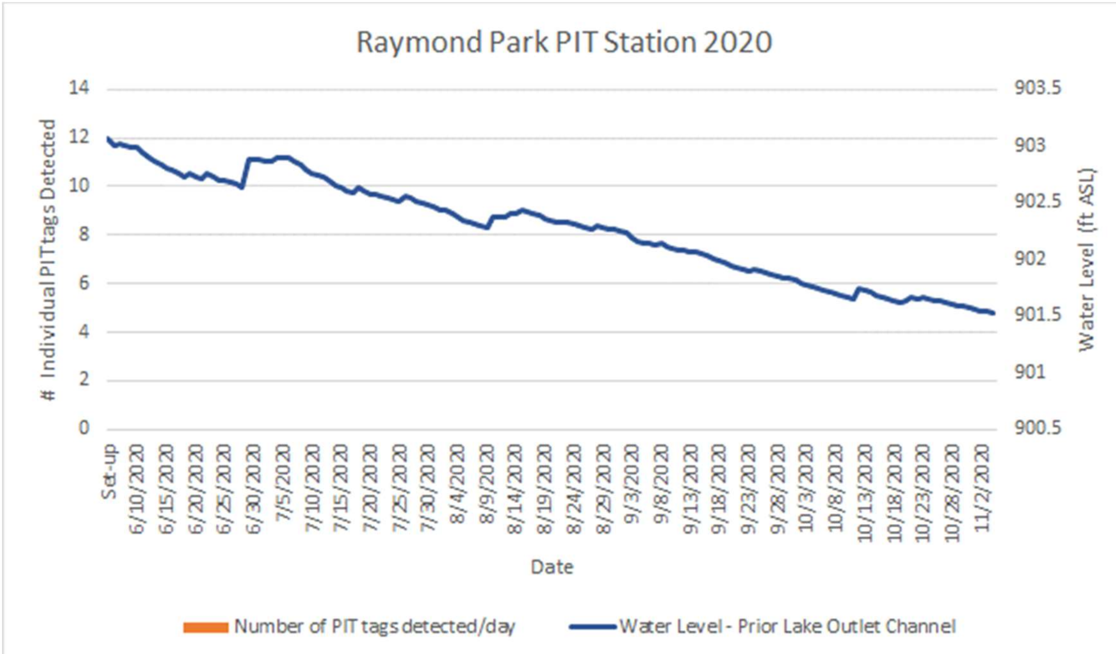


Figure 3: Number of uniquely numbered PIT tags detected at the Raymond Park Station by day in 2020 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Northwoods Pond Site

2020 PIT tag hits

In 2020, six (6) uniquely numbered PIT tags crossed over the antennae at the Northwoods pond site between the installation date of May 14, 2020 and the latest download date of June 26, 2020 (Table 4). All of the tags detected were originally implanted in Upper Prior Lake between 2016 and 2019. It is unclear from this data whether or not these fish over-wintered in the basin or moved into the basin from Upper Prior in this time period.

A barrier was installed at this site in early spring 2020 that is meant to prevent movement into or out of the basin. Additional tagging of carp in Upper Prior Lake and Northwoods Pond would help to decipher direction of movement. Multiple years of monitoring data at this site will also help to determine if movement into this basin is occurring.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	Weight (lbs)	Previous Detection	Tag #	# Days detected in 2020
Upper Prior Lake	11/30/2016	CARP	24.6	7.61	none	228000557106	11
Upper Prior Lake	9/6/2018	CARP	25.6	10.25	none	228000557276	1
Upper Prior Lake	9/6/2018	CARP	23.2	6.5	none	228000557277	2
Upper Prior Lake	9/17/2018	CARP	19.3	5.25	none	228000557283	2
Upper Prior Lake	9/17/2018	CARP	18.5	3.75	none	228000557286	11
Upper Prior Lake	9/19/2019	CARP	22.4		none	228000659684	3
na	na	na	na	na	na	228000557150 (Test tag)	na

Table 4: PIT tags detected at Northwoods Pond site PIT station in 2020 and the record of original capture and PIT implant date along with length and weight data at time of implant and previous detection locations and year.

After the installation date at Northwoods Pond, movement was first detected on May 17, 2020 with most hits occurring on May 21, 2020 (Figure 4). Movement is correlated with a rise in water levels in the district.

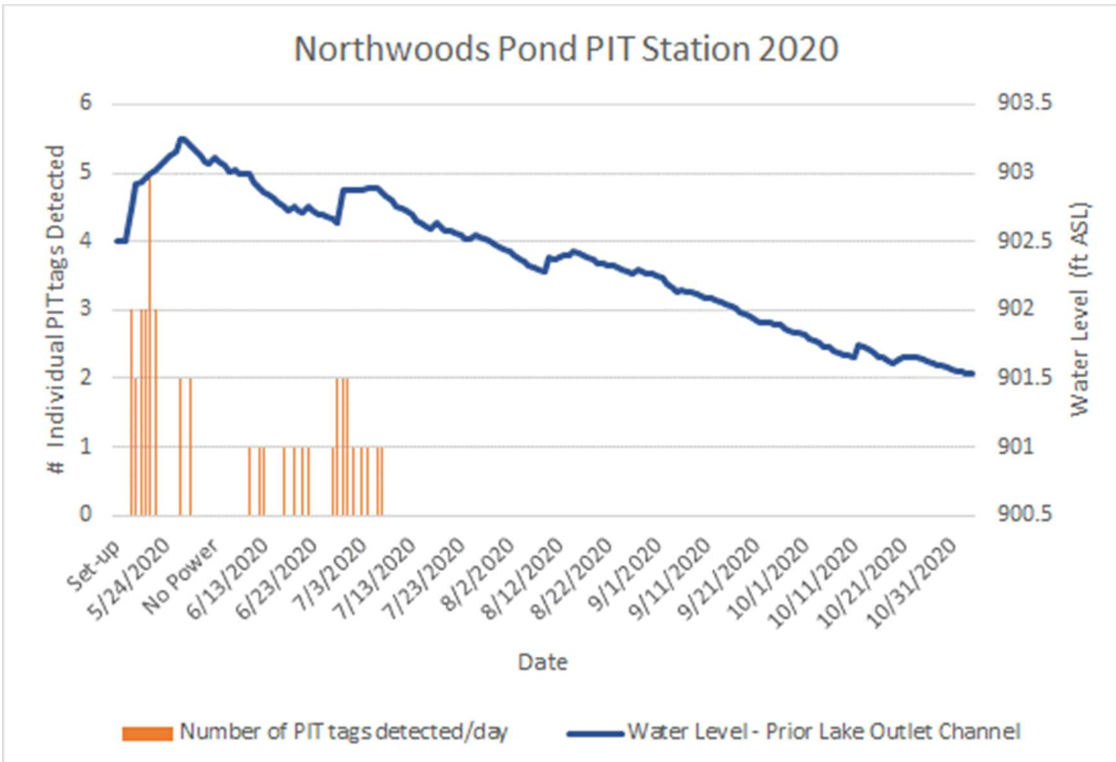


Figure 4: Number of uniquely numbered PIT tags detected at the Northwoods Pond Station by day in 2020 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Carp were removed from the cement structure at the outlet of Northwoods Pond near the barrier site in 2020 (Table 5). These removals occurred on May 7 and 18, and October 8, 2020. Fish were removed from the system and disposed of properly. Fish were not checked for PIT tags as they were removed. Monitoring in the 2021 field season at this site will help to monitor the efficacy of the barrier at this site. The district is planning a drawdown in the basin in the winter of 2020-21 in hopes to induce winterkill. If this effort is successful, no tags will be present in the basin at the beginning of the PIT tag monitoring season in the springtime of 2021.

Date	# Carp Removed	PIT tags Removed
5/7/2020	50	NA
5/18/2020	21	NA
10/8/2020	7	NA

Table 5: Removal from the outlet structure in 2020. Fish were not checked for PIT tags that were removed from the stream.

Freemont Avenue Site

2020 PIT tag hits

In 2020, seven (7) uniquely numbered PIT tags crossed over the antennae at the outlet of Arctic Lake to Mud Bay at the Freemont Avenue PIT station between the date of installation on May 7 and the latest download date of November 4, 2020. The tags were originally implanted into carp in Upper Prior Lake or Arctic Lake between 2016 and 2019 (Table 6). Carp that were originally tagged in Upper Prior Lake were also detected at the site in 2019 and it is suspected that these tags stayed upstream of the barrier at Freemont barrier since the last detection date and may have overwintered in Arctic Lake.

A barrier is in place on the downstream side of Freemont Avenue that is designed to prevent movement towards Arctic Lake from Upper Prior Lake's Mud Bay. In late 2019, a lock was placed on this barrier so that human activity could not influence the potential for movement through this section of the stream. Based on tag data in 2020, it appears that this effort has proven successful. The Arctic Stream site is located approximately 1,100 feet upstream of the Freemont Avenue Site and was installed on June 4, 2020.

Capture and removal activities on the downstream side of the barrier (Mud Bay) in spring 2020 may have also contributed to the decrease in movement towards Arctic Lake.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	Weight (lbs)	Previous Detection	Tag #	# Days Detected 2020
Upper Prior Lake	11/30/2016	CARP	26.8	8.9	Freemont 2019	228000557120	5
na	na	na	na	na	na	228000557151 (TEST TAG)	1
Upper Prior Lake	9/6/2018	CARP	19.1	4.25	Freemont 2019	228000630703	1
na	na	na	na	na	na	228000630718 (TEST TAG)	2
Upper Prior Lake	5/28/2019	CARP	21.5	4.5	Freemont 2019	228000656928	3
Arctic	5/28/2019	Carp	17.2	2.25	none	228000656932	1
Arctic	5/28/2019	CARP	15.4	1.79	none	228000656951	2
Arctic	5/28/2019	CARP	16.8	2.21	none	228000656952	2
Upper Prior Lake	5/28/2019	CARP	26.6	8.65	Freemont 2019	228000656954	4

Table 6: PIT tags detected at Freemont Avenue site PIT station in 2020 and the record of original capture and PIT implant date along with length and weight data at time of implant and previous detection locations and year.

At the Freemont Avenue site, movement was first detected on May 8, 2020 with the majority of hits occurring between the 9-10 of May. The spike in movement was not correlated with a spike in water levels within the watershed.

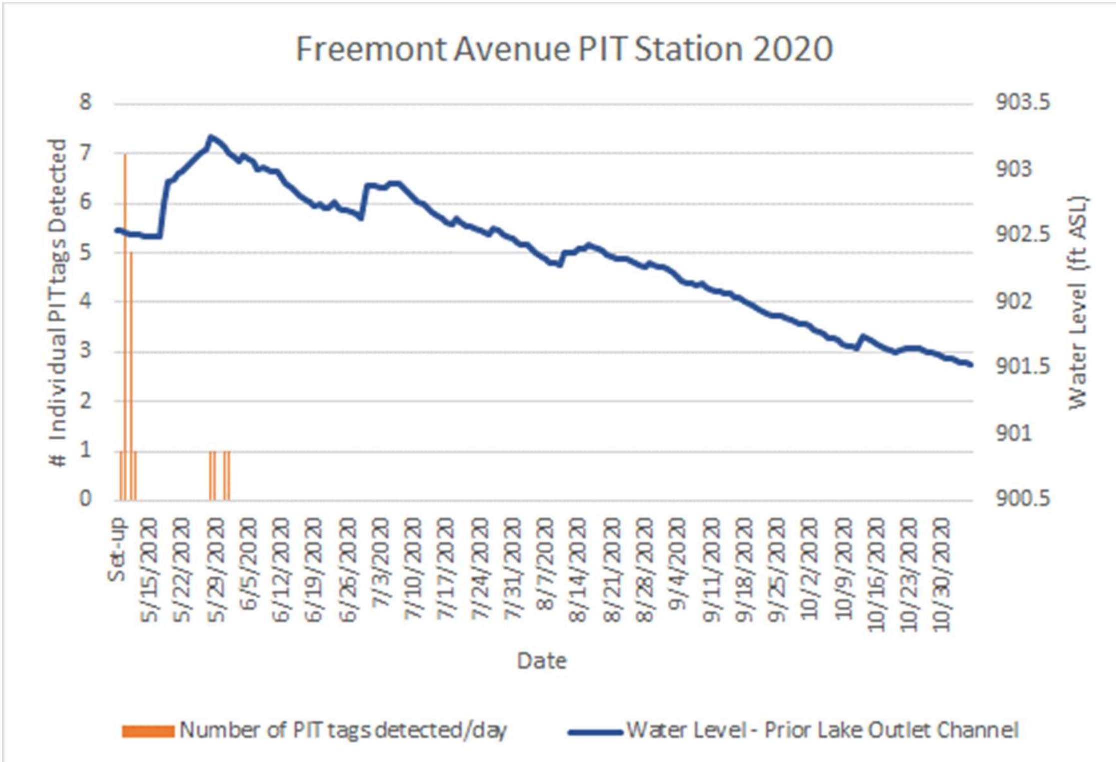


Figure 5: Number of uniquely numbered PIT tags detected at the Freemont Avenue Station by day in 2020 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Arctic Stream Site

2020 PIT tag hits

In 2020, two (2) uniquely numbered PIT tags were detected in the Arctic Stream site between Arctic Lake and Upper Prior Lake (Table 7). Both of these tags were also detected at the Freemont Avenue site in 2020 and suggest that movement of these fish was to or from Arctic Lake. The two tags were originally implanted in Upper Prior Lake and also detected in 2019 at the Freemont Avenue site. Because of the previous detection in 2019, we might assume that these fish moved in 2019 from Upper Prior Lake/Mud Bay and overwintered in Arctic Lake 2019-2020.

As mentioned above, the barrier on the downstream side of Freemont Avenue has been locked since “new” movement was last detected and it is suspected that this has prevented further movement towards Arctic Lake from Upper Prior Lake.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	Weight (lbs)	Previous Detection	Tag #	# Days Detected in 2020
Upper Prior Lake	11/30/2016	CAP	26.8	8.91	Freemont 2019	228000557120	4
na	na	na	na	na	na	228000557150 (TEST TAG)	na
Upper Prior Lake	5/28/2019	CARP	26.6	8.65	Freemont 2019	228000656954	2
na	na	na	na	na	na	226001166045 (Test Tag?)	na
na	na	na	na	na	na	226001166010 (Test Tag?)	na
na	na	na	na	na	na	226001166080 (Test Tag?)	na

Table 7: PIT tags detected at Arctic Stream PIT station in 2020 and the record of original capture and PIT implant date along with length and weight data at time of implant and previous detection locations and year.

At the Arctic Stream Site, movement was first detected on June 6, 2020 and continued through June 9. At the time of installation, it was noted that a beaver dam is located just upstream of the PIT tag detection site in a culvert that is located there. This may be impeding some movement or stalling the movement back upstream towards Arctic Lake but is not a permanent feature as it expected that the City of Prior Lake will remove this blockage. Movement is correlated with a slight increase in water levels within the district.

Tags were detected at the Arctic Stream station and were also detected at the Freemont Ave Barrier. These two (2) tags were first detected at the Freemont barrier on May 18-20, before the installation of the Arctic station. Tag ending in 7120 was detected at the Freemont station on June 5-6 and at the Arctic Station on June 5-8. Tag ending in 6954 was detected at the Freemont station on June 8-9 and at the Arctic station on these same dates in June. The last detection for both tags was at the Arctic Station, indicating these fish may have continued upstream to Arctic Lake.

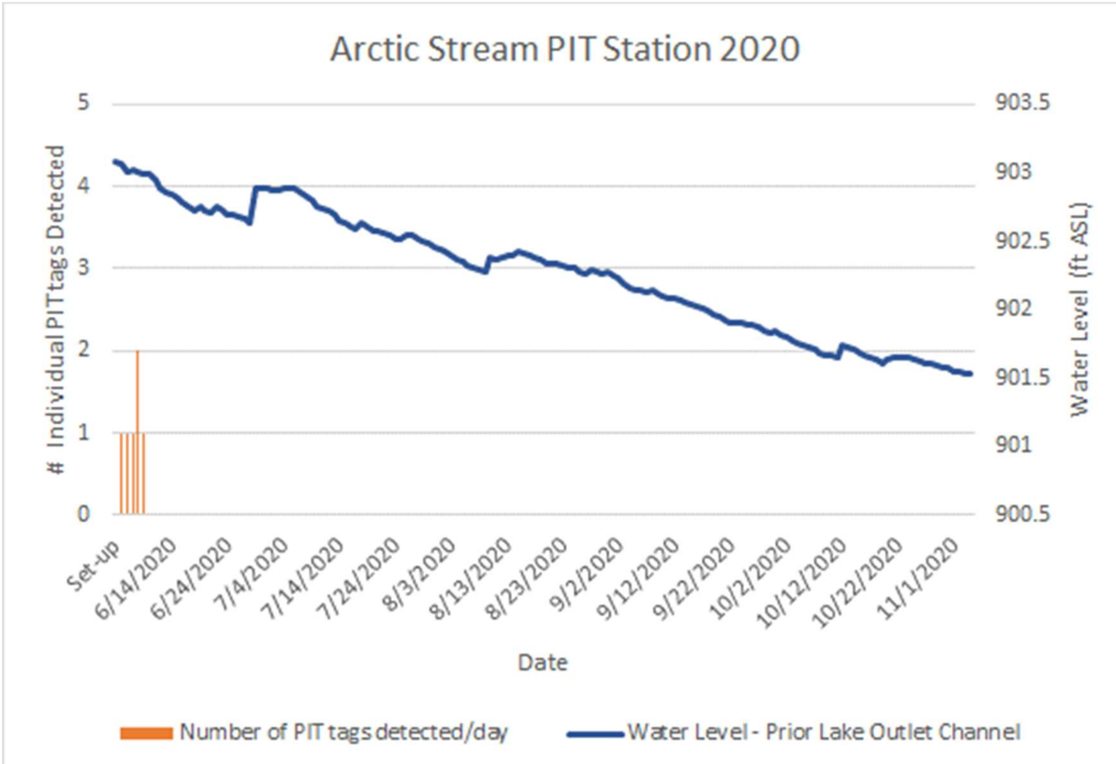


Figure 6: Number of uniquely numbered PIT tags detected at the Arctic Stream Station by day in 2020 and water level as measured at the Prior Lake Outlet Channel and collected by the PLSLWD.

Pike Lake Inlet Site

2020 PIT tag hits

The Pike Lake Inlet Site was not fully operational until the end of July 2020. A multi-antennae reader was sent back to the manufacturer for repairs in spring 2020 after it had been damaged when in use at the FeChl Site in 2019. A replacement receiver was sent for the Pike Outlet Site in July 2020 and it was decided that it would be installed at the Pike Lake Inlet. On July 30, 2020 WSB and PLSLWD staff installed the single antennae reader and antennae in this stream reach. Zero tags were detected between the install date and final download date of November 4, 2020.

On November 4, 2020 it was discovered that the solar panel had been stolen from the Pike Lake Inlet Site. It is unknown for how many days the solar panel had been missing and the site was inoperable. The cord was severed from the solar panel to the charge controller. A new cord is needed before this station can be re-installed. The station was at least logging until August 22, 2020.

Pike Lake Outlet Site

2020 PIT tag hits

The Pike Lake Outlet site in not fully operational in 2020. The solar station and antennae were installed but the single antennae reader was not tuning correctly and determined through the consultation with Oregon RFID that the reader may be at fault and must be sent back. In July, a replacement receiver was delivered to WSB and it was installed at the Pike Lake Inlet Site and the Pike Lake Outlet Site was removed. This equipment can be re-installed in the springtime of 2021 to capture any movement into or out of the basin at that time.

2021 PIT Station Summary - PLSLWD

Several apparent surface connections exist on Spring Lake and Upper Prior Lake and in some cases, anecdotal information suggests that carp are using a connection even though no radio-tags have been detected moving. In response to this, the PLSLWD initiated a study using Passive Integrated Transponder (PIT) tags in 2016. In 2021, seven (7) unmanned receivers/loggers placed in streams to detect movement and quantify the extent of movement in locations of highest priority (Figure 1). Five of the sites are using solar powered PIT Stations which allows for a more complete data set at remote locations where frequent battery swapping is difficult.

Over the course of the PIT tag study, extensive movement has been detected throughout the watershed. Movement includes between the main basins of Spring Lake and Upper Prior Lake, Spring Lake and connected shallow basins (Tadpole Wetland, Geis Wetland), Upper Prior Lake and connected shallow basins (Northwood Pond) and Arctic Lake, Upper Prior Lake and Spring Lake to Lower Prior Lake and through Prior Lake Outlet Channel (PLOC) towards Jeffers Pond. This data has been used to recommend and implement barriers in multiple locations to help prevent spawning migration that could lead to recruitment of young carp to the main basins.

In all years, PIT tag movement and water levels have been plotted and a correlation exists between the two. This finding can help managers to plan for removal events to exploit the aggregations that develop as a part of these movement patterns.

2021 PIT Station Locations:

Figure 1: Map of 2021 PIT Tag station locations.

2021 PIT Implants Summary:

Passive Integrated Transponder (PIT) Tags have been implanted into common carp in the Prior Lake Spring Lake Watershed District since 2016. Efforts have been made in a number of basins to mark fish during a variety of capture events to increase numbers (Table 1.). Table 1 represents the number of tags present at the beginning of the 2021 monitoring season in each basin. PIT tags removed are reported by lake and reflect numbers removed as of December, 2021.

Lake	***2020 PIT Tags***	***2021 Removed***	**2021 Implant**	***Tags Remaining December 2021***
Spring Lake	119	19**	22	122
Upper Prior Lake	221	20	20	221
Arctic Lake	26	1**	0	25
Geis Wetland (Carp)	107	4**	0	103
Geis Wetland (White Sucker)	9	0	0	9
Fish Lake	0	0	0	0
*Pike Lake**	50	0	0	0

*Table 1: PIT tagged fish in the PLSLWD at the beginning of 2021 and PIT tags removed over the 2021 PIT monitoring season. * Pike Lake experienced a large scale winterkill in 2020-21 and all PIT tags are assumed to be expired. ** Two (2) Spring Lake tags were removed from recapture event in Upper Prior Lake in 2021. One (1) Arctic Lake tag was removed from recapture event in Upper Prior Lake. Four (4) Geis Wetland tags were removed from recapture event in Spring Lake in 2021.*

Pike Inlet

No Detections
Setup: 4/7/2021
Takedown: 7/23/2021

The Pike Inlet station is located along the Prior Lake Outlet Channel (PLOC) downstream from Jeffers Pond and the station at the Jeffers Daylight Pond station. Water flows from Lower Prior Lake outlet to Jeffers Pond to Pike Lake and then to Dean's Lake before entering the Minnesota River.

In 2021, zero (0) PIT tags crossed over the antennae at the Pike Inlet station between the set-up date of April 7, 2021 and the uninstall date of July 23, 2021. Low water levels left the stream reach at this station dry for much of 2021.

Jeffers Daylight Outlet

DETECTIONS
Setup: 6/8/2021
Takedown: 7/27/2021

The Jeffers Daylight Pond station is located along the Prior Lake Outlet Channel (PLOC), a seven mile channel that connects Lower Prior Lake to the Minnesota River through a network of stream and wetland habitat. The outlet leaves Lower Prior Lake through a weir and baffle structure into a over 2,000 foot long pipe that daylights approximately 400 feet upstream of the Jeffers Daylight Pond station. Water continues to flow towards Jeffers Pond, Pike Inlet and into Dean's Lake before entering the Minnesota River. 2021 was the first year a station has been placed in this location.

Five (5) tags were detected at the Jeffers Daylight Pond station in 2021. Tags originated from Upper Prior Lake or Spring Lake that were implanted in 2016-2019 (Table 2). It is unknown when these fish may have moved through the outlet structure as low flows likely prevented much movement along the PLOC in 2021.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	PIT tag # (new)
Upper Prior Lake	9/6/2018	Carp	18.00	228000630702
Upper Prior Lake	5/28/2019	Carp	23.6	228000656925
Upper Prior Lake	11/30/2016	Carp	24.6	228000557071
Upper Prior Lake	11/30/2016	Carp	16	228000557075
Spring Lake	7/2/2019	Carp	23	228000659600

Table 2: PIT tags detected at the Jeffers Daylight Outlet station in 2021.

The antennae at the Jeffers Daylight Outlet station is near a small pond at the end of the outlet channel that outlets towards Jeffers Pond. In 2021 low water levels may have prevented movement further downstream and the culvert upstream is suspected to prevent movement in that direction. The fish that were detected at this station moved freely through the antennae location and movement seems to be random and not always correlated with a change in water level or precipitation events (Figure 2).

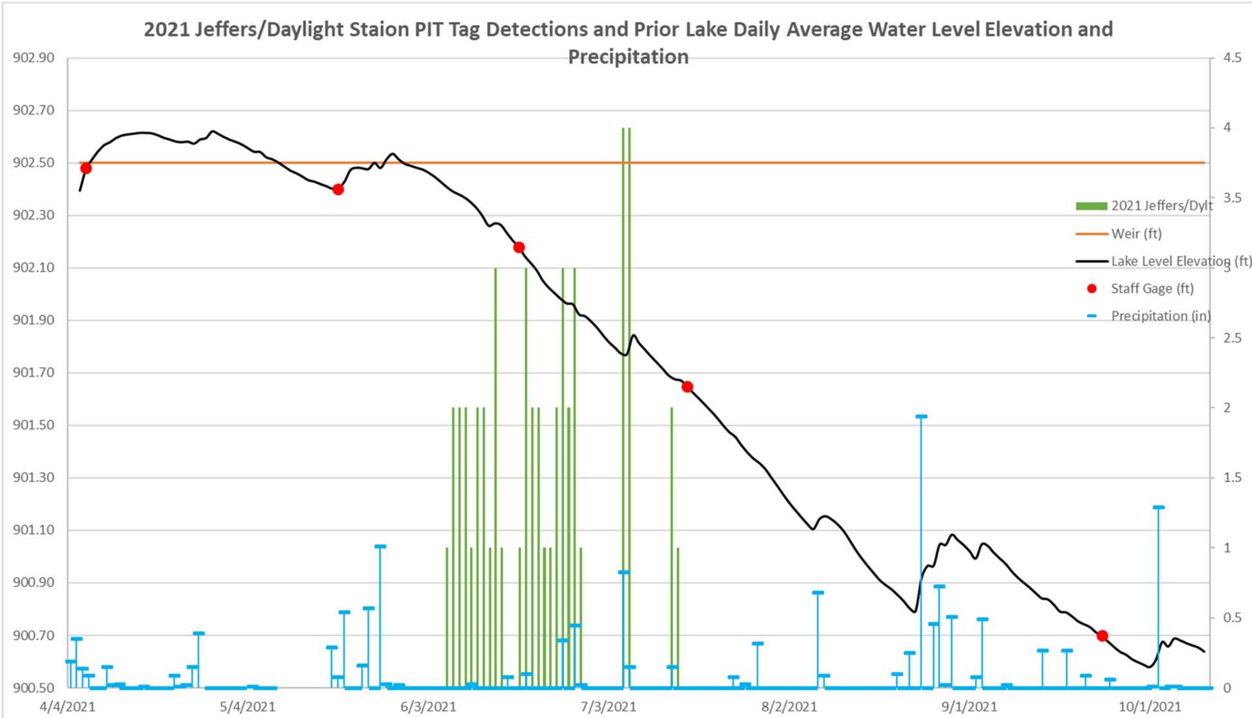


Figure 2: 2021 Jeffers Daylight Outlet station PIT tag detections and Prior Lake Daily Average Water Level Elevation and Precipitation.

Arctic East

No detections
Set-up on: 4/7/2021
Take-down date: 6/7/2021

The Arctic East site is located in the stream that connects Arctic Lake to Upper Prior Lake and was installed first in 2020. In 2021, zero PIT tags crossed over the antennae at the Arctic East station between the set-up date of April 7, 2021 and the uninstall date of June 6, 2021.

This station was monitored in 2020 and 2021 and detected tags originating from Upper Prior Lake and Arctic Lake. Two (2) tags were detected in the 2020 monitoring season at this station that were also detected in 2019 in this stream reach. Since 2019, the barrier at the outlet of the arctic channel to Upper Prior Lake has been outfitted with a locking grate system and it is assumed that fish can no longer emigrate from Upper Prior Lake towards Arctic Lake via this channel. This assumption is strengthened by the PIT station data from 2021 that shows no detections.

It should be noted that water levels were low in 2021 and the stream reach between Arctic and Upper Prior Lake was sometimes not flowing. Continued monitoring in this stream reach can help to determine efficacy of the barrier.

Arctic West

No detections
Set-up on: 4/18/2021
Take down: 10/22/2021

The Arctic West site is located in the stream reach upstream of Arctic Lake and was first installed in 2021. This stream reach inlets to Arctic Lake from a wetland complex that lays to the north of Spring Lake (Figure x). This stream reach is being monitored to detect potential movement from Arctic Lake to Spring Lake since Arctic PIT Tags have been detected in Spring Lake but the route is currently unknown. Managers suspect that this route is unpassable in most years due to the inclusion of an iron sand filter between the wetland and Arctic Lake.

In 2021, zero (0) PIT tags were detected at the Arctic West station. Since 2021 was a low water year, it could still stand that movement occurs here but only in high water years. It is recommended that a PIT station continue to monitor at this location to capture data from a high-water year. More tags in Arctic Lake carp could help in this effort to detect potential movement through this wetland complex to Spring Lake.

Ferric Chloride

DETECTIONS
Set up: 4/15/2021
Take down: 10/2021

Two (2) tags were detected at the Ferric Chloride site in 2021. Both of these tags were originally implanted into White Sucker in Geis Wetland in 2019 (Table 3). Both of these tags have previous detection records at the Ferric Chloride site. Tag # …656969 was last detected at the Ferric Chloride site in 2019 and tag # 656975 was detected at the Ferric Chloride site in 2020.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	PIT tag # (new)
Geis Wetland	5/22/2019	WHS	17.8	228000656975
Geis Wetland	5/22/2019	WHS	16.9	228000656969*

*Table 3: Unique tag numbers detected at the Ferric Chloride PIT station in 2021. *This tag was also detected at the Spring/Prior Connecting Channel PIT station in 2021.*

In 2021, tag # …656969 was detected at the Ferric Chloride site and also detected at the station in the Prior/Spring connecting channel eight days after it was detected at the Ferric Chloride site. This could indicate that the attempted to move into Geis wetland and was stopped by the barrier in place there and then traveled towards upper Prior Lake as part of a spawning migration.

Low water levels in the district in 2021 might explain the low number of PIT tag detections at this site (Figure 3). This is suspected since in 2019 fourty-six (46) and 2020, twenty-six (26) tags were detected at the site that were originally tagged in Carp or White Suckerfish in Geis or Spring Lake. A permanent barrier is in place at this site in 2021 that is designed to prevent movement into the basin from downstream. However, the barrier would not impact the movement downstream from Geis Wetland or detections of attempted movement upstream as the antennae is downstream of the barrier structure.

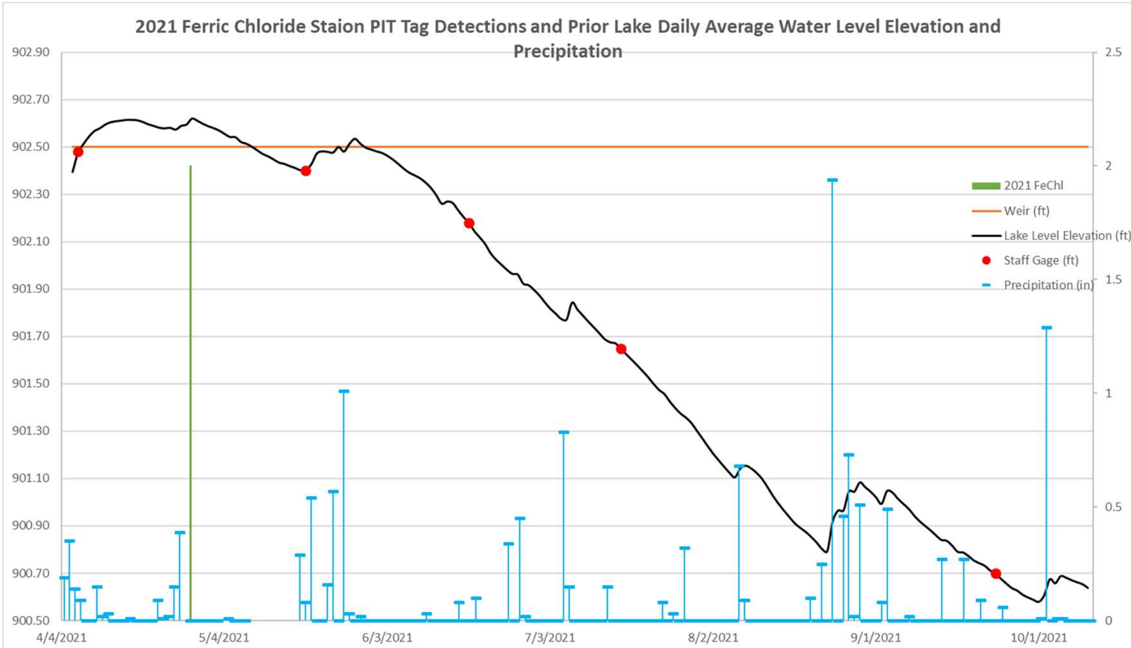


Figure 3: 2021 Ferric Chloride station PIT tag detections and Prior Lake Daily Average Water Level Elevation and Precipitation.

In 2022 it is recommended to continue to monitor at this location and to monitor upstream of the barrier with another antennae to help prove the efficacy of the barrier.

Northwood Pond

No Detections
Setup: 5/19/21
Takedown:10/22/2021

In 2021, zero PIT tags crossed over the antennae at the Northwood Pond station between the set-up date of May 19, 2021 and the uninstall date of October 22, 2021. It is believed that the barrier at the inlet to Northwood Pond was effective at keeping carp from migrating into this basin in 2021.

In 2020, six (6) uniquely numbered PIT tags crossed over the antennae at the Northwoods pond site. All of the tags detected were originally implanted in Upper Prior Lake between 2016 and 2019. It is suspected that these fish over-wintered in the Northwood Pond basin in 2019-2020 as a barrier was installed at this site in early spring 2020 to prevent further movement. Additional years of monitoring data at this site can help to prove the efficacy of this barrier.

Spring/Prior Connecting Channel

DETECTIONS
Setup: 4/15/2021
Takedown: 7/27/2021

A total of seven (7) tags were detected at the Spring Prior Connecting Channel station in 2021. Tags that were detected on this station originated from Geis Wetland (3), Spring Lake (3), and Upper Prior Lake (1) (Table 4). Tags detected from Geis Wetland were implanted into white sucker fish and tag numbers were detected at the FeChl station at the outlet of Geis in 2019 and 2020. One tag from Upper Prior Lake was also detected at the Spring Prior Connecting Channel station in 2019.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	PIT tag # (new)
Geis Wetland	5/22/2019	WHS	17.4	228000656991
Geis Wetland	5/22/2019	WHS	16.9	228000656969*
Geis Wetland	5/22/2019	WHS	16.8	228000656972
Spring Lake	5/28/2018	CAP	19.00	228000557197
Spring Lake	8/16/2019	CAP	21.1	228000659679
Spring Lake	8/16/2019	CAP	24.4	228000659627
Upper Prior Lake	11/30/2016	CAP		228000557034

*Table 4: Unique tag numbers detected at the Spring/Prior Connecting Channel PIT station in 2021. *This tag # was also detected at the Ferric Chloride PIT station in 2021.*

The Spring/Prior connecting channel has been monitored with the use of PIT stations annually since 2017. Spring Lake, Geis Wetland, and Upper Prior Lake tags have been detected on this station. However, it has not been confirmed with the use of these stations that Upper Prior Lake tags can move through the channel in high flow conditions. We suspect if movement occurs, that this movement does not occur often, and that assumption is based on recapture rates in these basins.

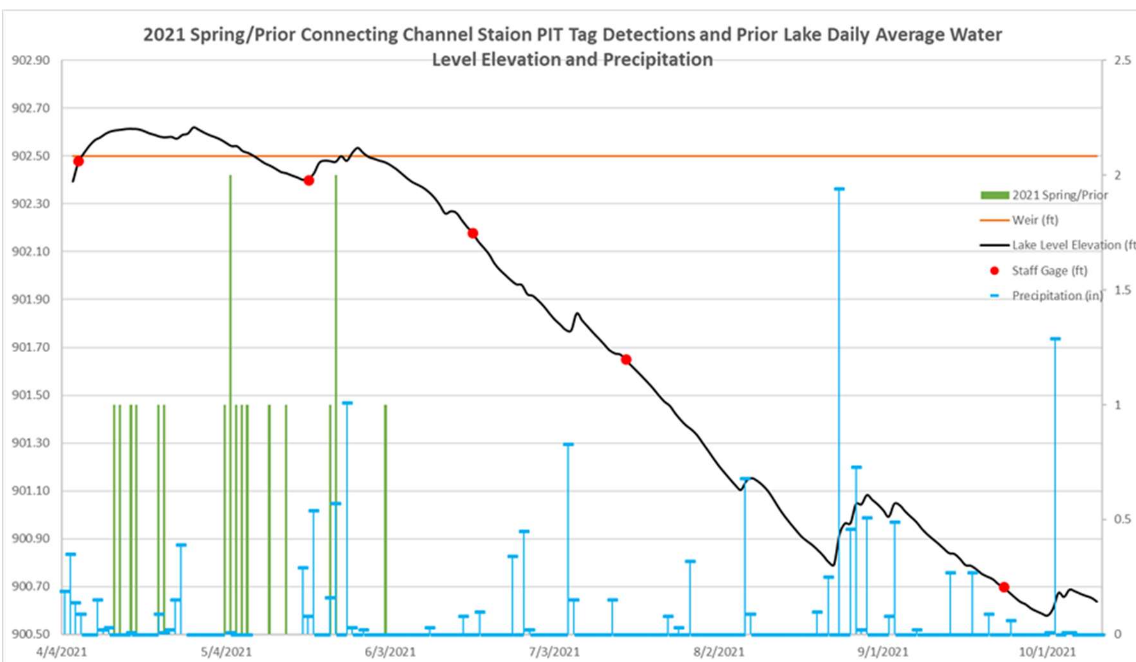


Figure 4: 2021 Spring/Prior Connecting Channel station PIT tag detections and Prior Lake Daily Average Water Level Elevation and Precipitation.

Sampling events have recaptured carp from both Spring Lake and Geis Wetland in Upper Prior Lake. It makes sense that fish can freely move downstream between these two basins, even in high flow conditions and is confirmed by this recapture data. Over the course of the PIT tag and movement study, there has been no recaptured Upper Prior Lake fish in Spring Lake or Geis Wetland, leading us to believe that Upper Prior Lake do not migrate through to Spring Lake. Continued monitoring of fish that are captured for the presence of PIT tag is important to answering the question about movement between Upper Prior Lake and upstream Spring Lake.

Tadpole Wetland

Tadpole Wetland
DETECTIONS
Setup: 4/6/2021
Takedown: 10/13/2021

The Tadpole Wetland station was located in a channel connected to the Spring Lake inlet channel to the southwest. In 2021, this stream reach was uninhibited to fish movement and a total of 27 tags were detected at the Tadpole Wetland station. 23 tags were originally implanted into Spring Lake carp and 4 tags were originally implanted into Geis Wetland Carp (Table 5). This movement occurred during the springtime spawning migration and coincided with rain events (Figure 5). A barrier was installed at this location on October 13, 2021 to prevent movement of carp into this wetland basin in future years.

Lake Originally Tagged	Date Tagged	Fish	Length (in)	PIT tag # (new)
Geis Wetland	5/17/2018	Carp	13.90	228000557176
Geis Wetland	5/17/2018	Carp	27.20	228000557297
Geis Wetland	8/15/2018	Carp	9	226000074644
Geis Wetland	5/22/2019	Carp	11.3	228000656964
Spring Lake	5/28/2018	Carp	18.00	228000557205
Spring Lake	5/28/2018	Carp	18.20	228000557210
Spring Lake	5/28/2018	Carp	18.20	228000557212
Spring Lake	5/28/2018	Carp	18.70	228000557215
Spring Lake	5/28/2018	Carp	18.70	228000557190
Spring Lake	5/28/2018	Carp	18.80	228000557201
Spring Lake	5/28/2018	Carp	19.10	228000557184
Spring Lake	5/28/2018	Carp	19.70	228000557213
Spring Lake	5/28/2018	Carp	23.30	228000557198
Spring Lake	5/28/2018	Carp	26.70	228000557178
Spring Lake	7/2/2019	Carp	12.1	228000659616
Spring Lake	7/2/2019	Carp	18.8	228000659607
Spring Lake	8/16/2019	Carp	18.5	228000659660
Spring Lake	8/16/2019	Carp	18.6	228000659656
Spring Lake	8/16/2019	Carp	18.7	228000659677
Spring Lake	8/16/2019	Carp	19	228000659646

Spring Lake	8/16/2019	Carp	19	228000659664
Spring Lake	8/16/2019	Carp	19.1	228000659681
Spring Lake	8/16/2019	Carp	19.3	228000659633
Spring Lake	8/16/2019	Carp	20	228000659678
Spring Lake	8/16/2019	Carp	20	228000659619
Spring Lake	8/16/2019	Carp	20.4	228000659628
Spring Lake	8/16/2019	CAP	21.7	228000659642

*Table 5: Unique tag numbers detected at the Spring/Prior Connecting Channel PIT station in 2021. *This tag # was also detected at the Ferric Chloride PIT station in 2021.*

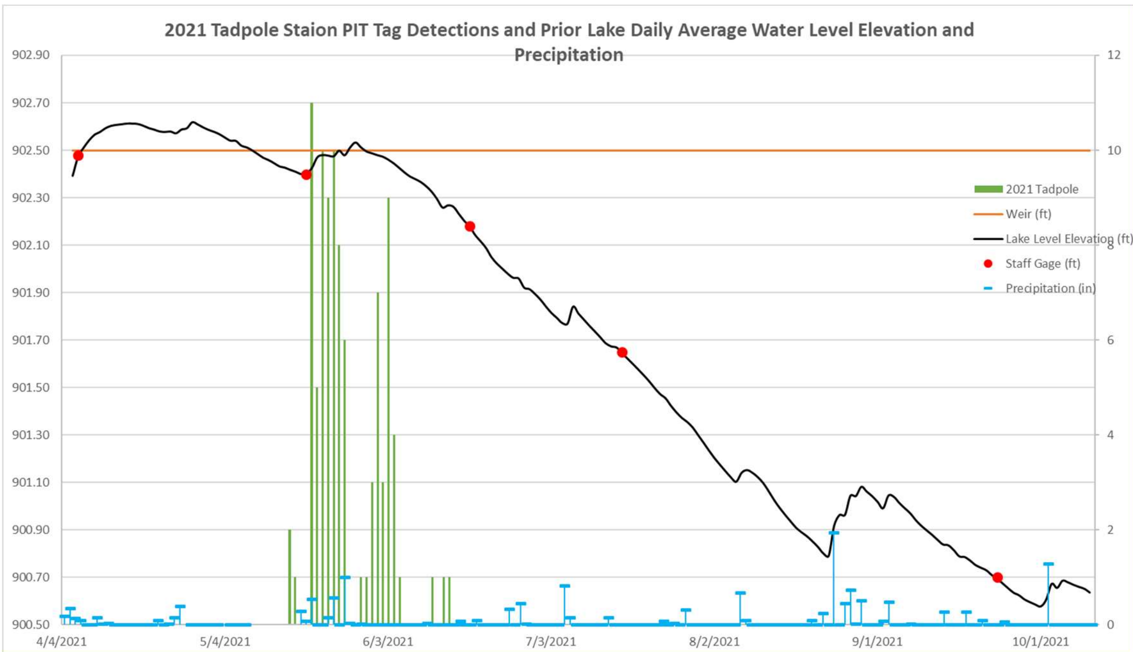


Figure 5: 2021 Tadpole station PIT tag detections and Prior Lake Daily Average Water Level Elevation and Precipitation.

It is recommended that this station monitor in this location in 2022 with an antennae upstream of the barrier. This will help to prove the efficacy of the barrier in this location.

Prior Lake-Spring Lake Watershed
Carp Management Cost-Benefit Summary

Prepared for
Prior Lake-Spring Lake Watershed District

June 2020

Carp Management Cost-Benefit Summary

Maggie Karschnia, PLSLWD

Tony Havranek, WSB

Mary Newman, WSB

June 4, 2020

1.0 Introduction

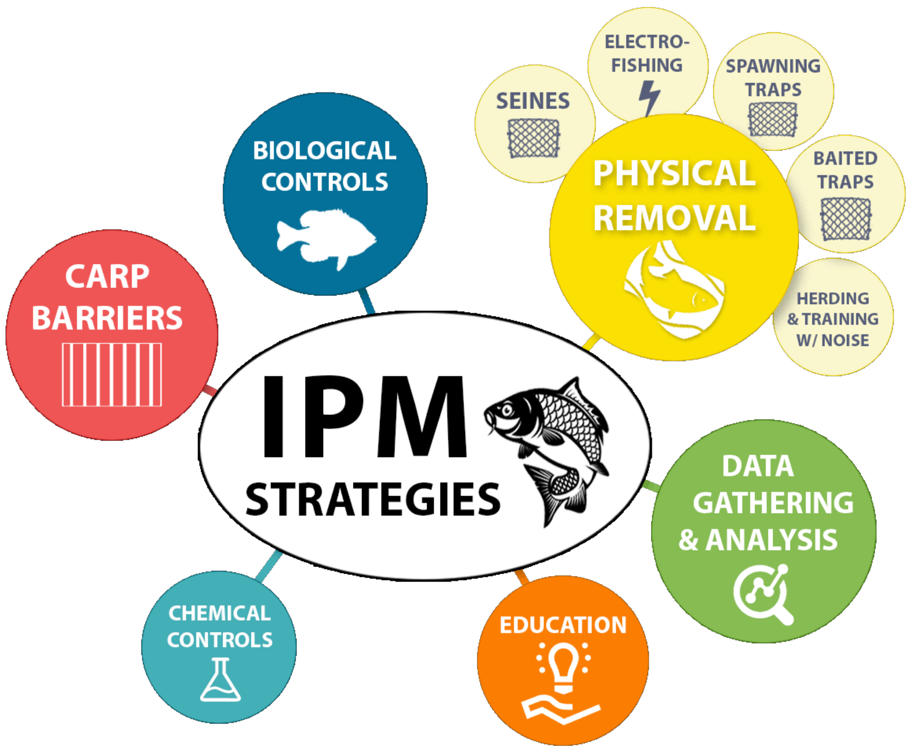
The Board of Managers set an ambitious goal for staff in August of 2019 to try and reduce carp biomass in Upper Prior and Spring Lakes to the water quality level goal of 30 kg/ha by the end of 2020. Extra funding and resources were provided to try new and innovative tools for carp management (a.k.a. Accelerated Carp Management Strategies, ACMS). While it has not quite been a year since this target was established, this summary is intended to provide the Board with a cost-benefit assessment to determine if the investment into the program is paying back with measurable results.

2.0 Background

2.1 Integrated Pest Management Plan for Common Carp

As part of its wholistic approach to carp management, the District developed an Integrated Pest Management (IPM) Plan for Common Carp which involves using adaptive management (a management process involving step-wise evolution of a flexible management system in response to feedback information actively collected to check or test its performance). This approach uses data that is collected on the carp population with respect to biomass estimates as well as migration routes and winter aggregation locations to determine whether or not it should change/update its strategies and tools.

The IPM Plan was first created and approved by the Board in 2017. The District continues to make updates to the plan as carp populations change and as new information and tools become available for management.



The IPM Plan has five major components that are mimicked in the state and federal grants the District has received for its carp management program:

1) **Data Gathering & Analysis:** Tracking carp locations and populations by using a variety of tools, including radio-tags, PIT tags, fin-clipping, and electrofishing. This information is used to identify migration routes for potential barrier sites, to locate aggregation areas of carp for removals, and to estimate carp population & biomass removal amounts.
2) **Physical Removal:** Reduce and sustainable manage carp biomass by using a variety of tools including seines and electrofishing.
3) **Biological Controls:** Manage lakes to support a robust gamefish/panfish population that preys on carp eggs and larvae. (Note: not initiated until Accelerated Carp Management Strategies were approved).
4) **Carp Barriers:** Install carp barriers at strategic locations to block carp access to spawning areas.
5) **Education:** Provide information and opportunities to the public on the carp program and ways they can assist.

2.1.1 Accelerated Carp Management Strategies

At the Board meetings in the summer of 2019, the Board of Managers and staff discussed ways to think outside the box to accelerate carp removal efforts in Spring and Prior Lakes. Staff and WSB consultants explored all potential activities, proven and theoretical, that could increase the probability of success within a year's timeframe through the end of 2020.

The following accelerated carp management strategies were approved by the Board in August of 2019. These strategies were *an addition to the existing carp management program*. A summary of the status of each is also provided below:

2019 – 2020 Approved ACMS Strategies:

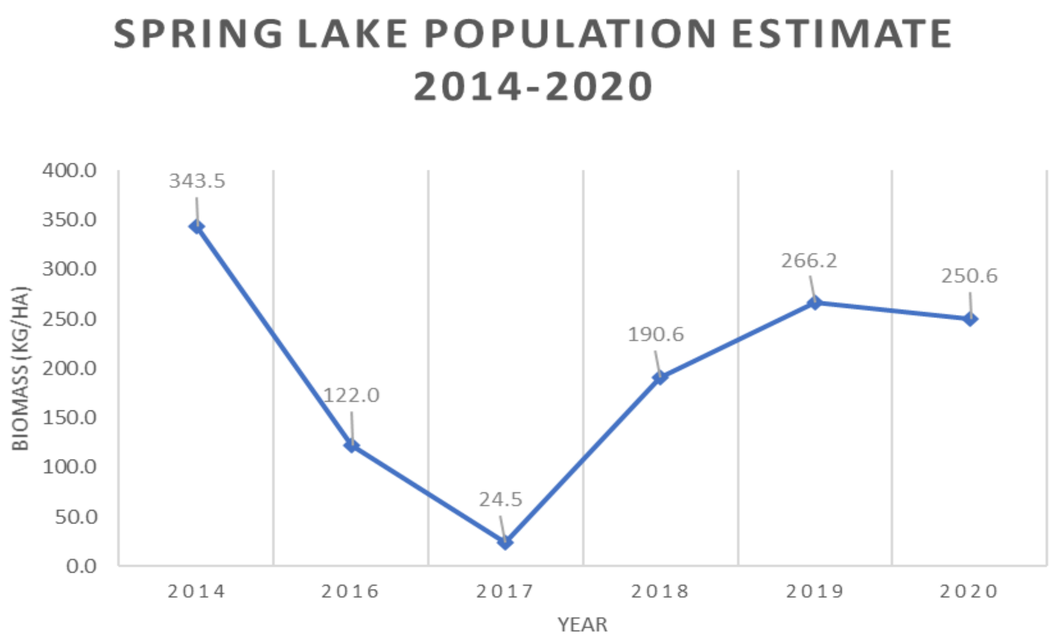
Strategy	District Levy	Grant Funding	Total Estimated Cost	*2020 Updates: Status & Next Steps*
Cameras	$4,180		$4,180	*Purchased underwater camera; installed two stationary cameras at carp traps; one additional camera will be purchased for FeCl site.*
Identify Alternate Disposal Locations	$1,600		$1,600	*Identified new locations to dispose of carp; staff and WSB continue to find new recipients for small removals.*
Purchase Seine Net	$6,500	$10,000	$16,500	*Completed; seine net is used on Upper Prior Lake only so that fishermen do not have to worry about zebra mussel decontamination.*

(Continued from previous page)

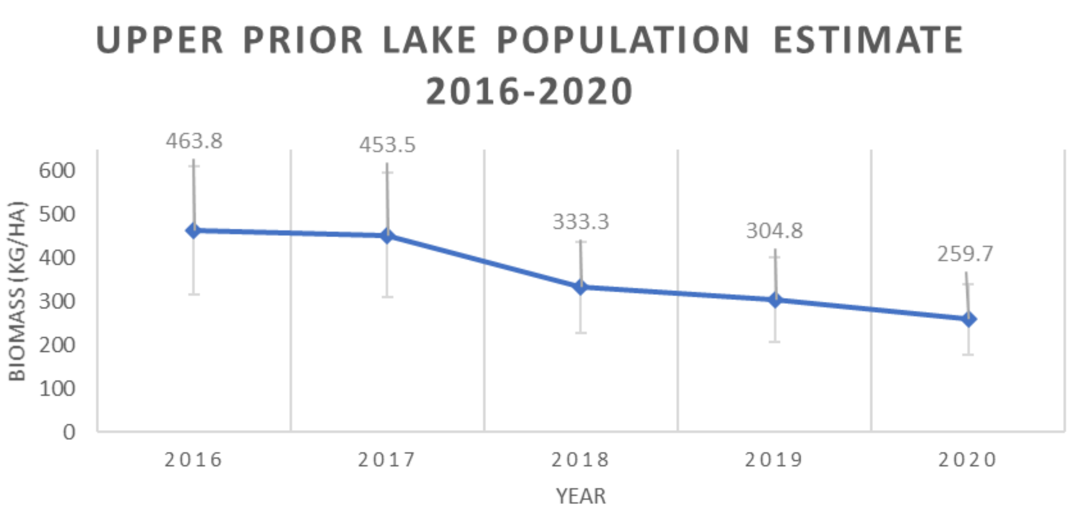
Strategy	District Levy	Grant Funding	Total Estimated Cost	*2020 Updates: Status & Next Steps*
Newman Cage	$27,125	$7,000	$34,125	*Installed at Arctic Lake outlet; as of June 1st, 560 pounds had been captured and removed; will remain active until mid-June for additional removals.*
Push Trap	$29,400	$8,000	$37,400	*Installed at desilt pond; an initial removal resulted in 148 pounds, but additional amounts will be removed.*
Multiple Seine Efforts	$22,275	$9,000	$31,275	*Engaged three commercial fishermen for multiple removal efforts. In 2020 alone, fishermen have attempted a seine on six separate occasions on Upper Prior & Spring Lakes.*
Stocking Bluegills	$5,812		$5,812	*Stocked bluegills at Northwood pond and Geis wetland. Additional bluegills will be stocked at the Geis wetland later this fall.*
Purchase Boat	$18,000		$18,000	*Completed; have used the boat for micro-hauls, tracking carp on Spring Lake, installing carp cribs, transporting carp during removals, etc.*
Engaging Volunteers	$20,724	$7,000	$27,724	*Purchased box traps, will begin Baited Box Trap Program and Carp Training Program in mid-June*
Herding Carp	$6,898		$6,898	*Used speakers to successfully herd carp for removals on both Spring and Upper Prior Lakes during under ice and open water conditions.*
TOTAL	**$142,514**	**$41,000**	**$183,514**	

2.2 Population Estimates

There are many different methods used to determine a population estimate. For carp, these typically include a catch per unit effort method (CPUE) or a mark-recapture method. Through the use of these different sampling techniques and estimation methods, we can track carp populations over time. These estimates will help use determine the effectiveness of the program and the benefits received to Prior and Spring Lakes.



Note that in 2017 there was a large drop in the carp population in Spring Lake after a 32,000 pound seine removal. However, the District was in the process of tracking migration routes to spawning areas and did not yet block off and/or complete active removals in spawning areas. This resulted in a significant rebound in the population the following year. With the updates to the FeCl weir, the push-trap at the desilt pond and consistent electrofishing removals from the County Ditch 13 system, there should be significantly different results following the next removal.



While over 10,000 pounds have been removed from Upper Prior Lake in 2020 alone, the District still has a long way to reach its goal of 30 kg/ha. With the Arctic Lake barrier in place and annual removal events in Mud Bay during spawning season, the District hasn't seen the rebound in carp populations like it did on Spring Lake in 2018. The numbers continue to trend downward over time thanks to the additional strategies in place.

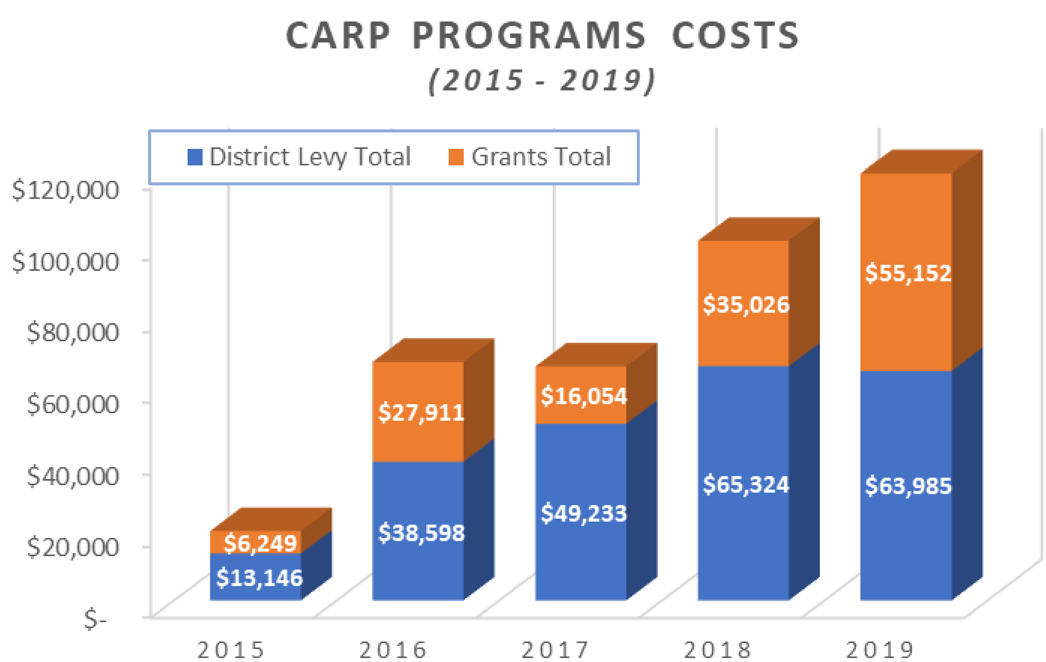
2.3 Program Costs (2015 – present)

Prior to 2015, the District's investment into carp management was minimal and included a carp tournament and sporadic removals as opportunities arose to engage the local commercial fisherman. As the costs and efforts over time were inconsistent, this study will look at only years after 2014 for analysis.

The District received a grant from the MPCA in 2015 to start tracking carp with radio-tags, complete targeted removals, and install barriers to spawning areas. These efforts lead to two large seine events in the three year period, one on Spring Lake and one on Upper Prior Lake. To supplement this grant, the District also received a MnDNR grant to cover the majority of the costs for one of the carp barriers. The MPCA grant concluded in June of 2018, but the District continued with its management program in order to not lose momentum.

In the spring of 2019, the District was awarded two grants for common carp management: BWSR Watershed Based Implementation Funding grant and a 319 federal grant. These grants helped provide funding to not only continue the current program, but to add in additional components to make management more successful such as the enhanced tracking of carp with PIT tags and using underwater speakers to herd carp into seine areas.

The District has two different ways it tracks District levy funds for carp projects; one through the 611 – Rough Fish Management budget line item and one through 750 & 751 – Carp Management/Removal line item to better track grant-eligible activities for reporting. Below is a general summary of carp management expenditures and funding sources from 2015 – 2019:



The following provides a cost summary of carp activities in 2020 up to May 1st of this year.

2020 Carp Management Activities

PROGRAM	PROJECT	DISTRICT LEVY	GRANT FUNDS	TOTAL	LEVY SPENT (1/1 - 5/1)	GRANT SPENT (1/1 - 5/1)	Budget Remaining
611 - O&M	Rough Fish Mgmt	$58,805		**$58,805**	*$ 33,981*		*$ 24,824*
750 & 751	Carp Grant Projects	$150,000	$90,000	**$240,000**	*$ 34,492*	*$ 51,739*	*$ 153,769*
	TOTAL	**$208,805**	**$90,000**	**$298,805**	*$ 68,474*	*$ 51,739*	*$ 178,593*

2020 Carp Management Budget Expended *(1/1 - 5/1)*

PROGRAM	PROJECT	WSB INVOICES	DIRECT COSTS	TOTAL
611 - O&M	Rough Fish Mgmt	$6,199	$27,782	**$33,981**
750 & 751	Carp Grant Projects	$86,231	$0	**$86,231**
	TOTAL	**$92,430**	**$27,782**	**$120,212**

3.0 Cost-effectiveness

While the total pounds of carp removed during seine events can be directly attributed to a reduction in internal loading to the District's lakes, the general nature of many other carp management strategies make it difficult to determine a similar measurable benefit, However, these components, such as carp barriers and bluegill stocking, are very necessary for long-term success in maintaining water quality carp levels. Therefore, in order to determine cost-effectiveness over time, all program components must be looked at as a whole. Individual components can be looked at for their intended purpose to see if they have been effective, but are not able to be compared to each other on similar cost-benefit scales.

3.1 Cost-Benefit Comparison

First we will quantify a annualized cost per pound of phosphorus removed on a 10-year scale for the overall carp management program in order to compare its effectiveness to other District projects. All of the carp management activities that were completed from 2015 to present date total $487,899. Looking at the benefits to Upper Prior Lake *alone*, the District saw a significant reduction in carp resulting in an annual load reduction of phosphorus in the amount of **1,558 lbs/year.**

Similar to other District projects such as the FeCl plant or iron-enhance sand filter, the carp management program requires maintenance and upkeep to sustain the achieved annual load reduction. For example, once a seine is completed, small carp removals and blocking spawning areas with barriers are necessary to ensure carp populations don't rebound. If we assume that carp management on average will require roughly $100,000 per year to maintain the carp population levels at present levels (although our aim is to get the populations significantly lower), then we can annualize the 10-year cost of carp management. We can then use the annual load reduction calculations each year from 2015 – 2020 and assume that the next five years will stay at the same reduction level as 2020 to calculate the total pounds of phosphorus that was reduced from the internal load to Upper Prior Lake. This results in a final estimate of **$97 per pound of phosphorus removed**. *Note this estimate is conservative and includes the load reduction to Upper Prior Lake only.*

With a 10-year annualized cost, we can compare the carp management program results on Upper Prior Lake to other projects in the District:

Cost-Benefit Comparison of District Projects

(Based on 10-Year* Annualized Total Cost of a Project)

$ / lb TP Removed	Project
$81	Upper Prior Lake Alum Treatment *(based off grant information)*
$97	Carp Management Project *(based on 2015-present costs & results)*
$202	Ferric Chloride System *(*Note: based on 25-year annualized cost)*
$252	Fish Point Park Iron-Enhanced Sand Filter
$1,131	Indian Ridge Biofiltration Basin
$1,136	Fairlawn Shores Biofiltration Basin

3.2 ACMS Cost-Effectiveness

As noted previously, many of the Accelerated Carp Management Strategies (ACMS) are intended to support the larger components of the program and to keep carp populations from rebounding. Examples of this would be stocking bluegills or purchasing the Jon boat. While these activities are important tools, they won't have a measurable benefit that can be used for a cost-benefit analysis.

However, many ACMS components could be further discussed by the Board to either support the continuation of funding in 2021 or to provide direction to District staff to discontinue the efforts. Some of these will require more time to complete in order to determine its effectiveness. Below is a summary list of ACMS components that could be discussed:

1) **Upper Prior Lake Seine Net:** While a consistent argument fishermen from fishermen in the past of why they cannot seine in Upper Prior Lake has been that they have to decontaminate their nets, it did not prevent the fishermen from attempting two seines in 2020 with their own nets rather than using the District's. While this does not mean it might be critical in the future for the District to have a seine net tagged for zebra mussels and ready to use by fishermen, the Board could discuss selling this net and using the funds for other purposes if they prefer.
2) **Multiple Seine Efforts:** The District completed six separate seine efforts in 2020 on Upper Prior and Spring Lakes, resulting in roughly 15,000 pounds of carp removed. The commercial fishermen charge between $0 - $5,000 for each attempt, depending on the amount of time, any damage to nets, and if the haul resulted in a commercially viable catch. The total amount provided to the commercial fishermen in 2020 for the six hauls was $16,000. This equates to roughly $1 per pound of carp removed, or an approximate 300 lb/year reduction to annual phosphorous loading between the two lakes. While this annual loading number is significant, the

Board should discuss whether it is better to wait for conditions to be right for a seine (which sometimes takes a few years) or if the District should continue to push for multiple seine attempts at every opportunity, not missing out on any potential gain towards its goal.

3) **Stocking Bluegills:** The bluegills that have been stocked in the Geis wetland have been fin-clipped in order to determine relative mortality during a follow-up survey later this year. Based on these results and results of additional surveys after the winter freeze in both the Geis wetland and the Northwood pond, the Board should discuss in the spring of 2021 whether or not stocking bluegills was worth the effort, and if aeration might be a necessary as a supplement.
4) **Specialized Traps & Volunteer Baited Box Traps:** These should all be assessed in the fall for effectiveness. If they are not resulting in desired removal amounts for the amount of effort, alternatives/updates to the traps should be considered.

4.0 Carp Management Schedule

The attached table shows the completed (in grey) and recommended schedule for carp management activities from August 2019 – December 2021 when the two current grants come to a close. This is intended to provide a frame of reference for the many different components of carp management that are referenced.

CARP MANAGEMENT SCHEDULE

2019-2021

PRIOR LAKE-SPRING LAKE WATERSHED DISTRICT

Summer 2019 (J A S) · Fall 2019 (O N D) · Winter 2020 (J F M) · Spring 2020 (A M J) · Summer 2020 (J A S) · Fall 2020 (O N D) · Winter 2021 (J F M) · Spring 2021 (A M J) · Summer 2021 (J A S) · Fall 2021 (O N D)

TASK	START	END
Carp Tracking & Project Development		
Implant carp with PIT tags & Radiotags	*Mar 2010*	*May 2021*
Install/monitor PIT tag reader stations	*Apr 2019*	*Sep 2021*
Track PIT & Radio tags across waterbodies	*Apr 2019*	*Dec 2021*
Update GIS location information & online maps	*Apr 2019*	*Dec 2021*
Install stationary cameras at strategic locations	*Sep 2019*	*Dec 2021*
Use underwater camera for tracking/training carp	*Sep 2019*	*Dec 2021*
Purchase/use boat for tracking and removing carp	*Oct 2020*	*Oct 2020*
Analysis: *identify aggregation areas, migration routes and population status*	*Jun 2019*	*Dec 2021*
Carp Barriers		
Identify strategic locations for carp barriers	*Oct 2019*	*Oct 2021*
Site analysis & design of barriers	*Dec 2019*	*Mar 2021*
Install Northwood Barrier	*Sep 2019*	*Nov 2019*
Install FeCl Barrier Redesign	*Sep 2019*	*Nov 2019*
Install Barriers #2 & 3 (Location TBD)	*Apr 2020*	*May 2021*
Install temporary barrier at Spring Lake Outlet	*Apr 2020*	*Jul 2020*
Carp Removals		
Spring Lake carp seines	*Nov 2019*	*Apr 2021*
Upper Prior Lake carp seines	*Mar 2019*	*Apr 2021*
Electrofishing removals / micro-hauls	*Apr 2020*	*Apr 2021*
Geis wetland carp removals	*Apr 2019*	*Oct 2021*
Pike Lake carp removals	*Apr 2020*	*Oct 2021*
Purchase/use seine net for Upper Prior Lake	*Oct 2020*	*Nov 2020*
Deploy Newman Cage in Geis wetland	*Apr 2020*	*Jun 2021*
Deploy Push Trap in desilt pond	*Apr 2020*	*Jun 2021*
Stock bluegills in Geis wetland	*Apr 2020*	*May 2021*
Box Trap removals with volunteers	*Apr 2020*	*Sep 2021*
Purchase additional speaker for herding/training carp	*Jan 2020*	*Jan 2020*
Carp removals in other waterbodies (TBD)	*Nov 2020*	*Dec 2021*

What's happening on Upper Prior Lake?

Find out more about the

Carp Management Project

Questions or concerns about the project?

Please contact us at 447-4166.

Prior Lake-Spring Lake Watershed District's contractor, WSB, has located a group of carp on Upper Prior Lake in Crystal Cove (a.k.a. Mud Bay). If the carp continue to stay grouped together, the District hopes to **complete a seine (netting and removal of carp) sometime within the next couple of weeks**, possibly as early as Tuesday.

In order to ensure a successful seine***, please refrain from boating or recreating in Crystal Cove as much as possible.*** Any loud activities could scare the carp from the area, making the seine less successful or preventing it from happening entirely.

Residents are welcome to join us at the public boat landing to see the carp that are removed during the event. For updates, please contact us at 447-4166 or visit our website at www.plslwd.org and click on "Carp Management" under the Projects & Programs tab.

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

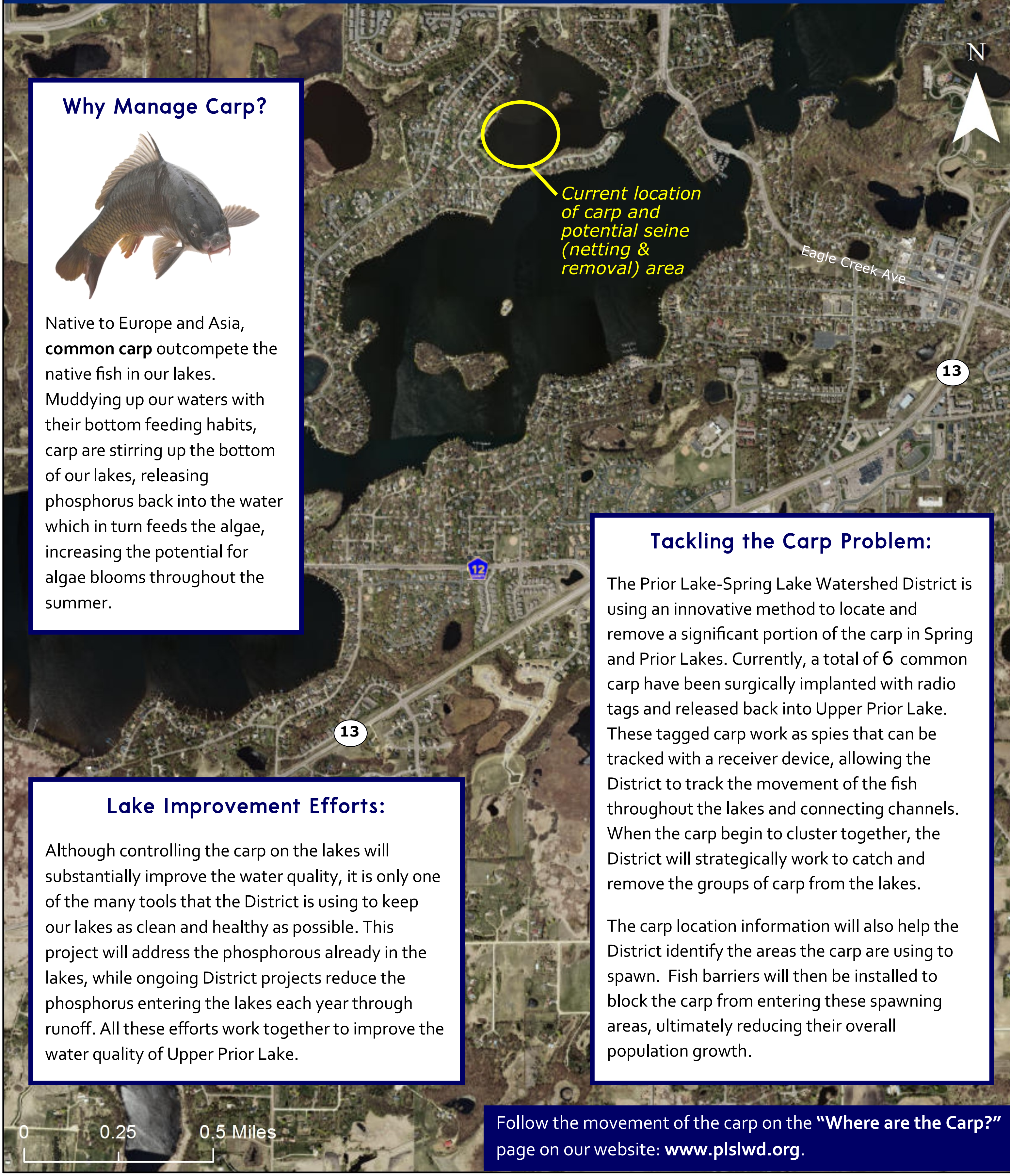
WSB & Associates, Inc.

Funding for this project provided in part by a grant from the Federal 319 Grant Program managed by the Minnesota Pollution Control Agency.

Carp Management Project

Spring and Prior Lakes

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT



Why Manage Carp?

Native to Europe and Asia, **common carp** outcompete the native fish in our lakes. Muddying up our waters with their bottom feeding habits, carp are stirring up the bottom of our lakes, releasing phosphorus back into the water which in turn feeds the algae, increasing the potential for algae blooms throughout the summer.

Tackling the Carp Problem:

The Prior Lake-Spring Lake Watershed District is using an innovative method to locate and remove a significant portion of the carp in Spring and Prior Lakes. Currently, a total of 6 common carp have been surgically implanted with radio tags and released back into Upper Prior Lake. These tagged carp work as spies that can be tracked with a receiver device, allowing the District to track the movement of the fish throughout the lakes and connecting channels. When the carp begin to cluster together, the District will strategically work to catch and remove the groups of carp from the lakes.

The carp location information will also help the District identify the areas the carp are using to spawn. Fish barriers will then be installed to block the carp from entering these spawning areas, ultimately reducing their overall population growth.

Lake Improvement Efforts:

Although controlling the carp on the lakes will substantially improve the water quality, it is only one of the many tools that the District is using to keep our lakes as clean and healthy as possible. This project will address the phosphorous already in the lakes, while ongoing District projects reduce the phosphorus entering the lakes each year through runoff. All these efforts work together to improve the water quality of Upper Prior Lake.

Follow the movement of the carp on the **"Where are the Carp?"** page on our website: **www.plslwd.org**.

What's happening in Crystal/Mud Bay?

Find out more about the

Carp Management Project

Questions or concerns about the project?

Please contact us at 447-4166.

Prior Lake-Spring Lake Watershed District has initiated an Accelerated Carp Management Program that includes innovative, new traps to capture carp. One of these traps has been set up by the Arctic Lake outlet in Crystal/Mud Bay. If you've been down there recently, you might have noticed a large netted area. This new trap design takes advantage of carp's behavior to move upstream to spawn, allowing them to find their way into the trap as they try to reach Arctic Lake, but leaving them unable to find their way out to escape.

The trap will stay deployed at the Arctic Lake outlet until mid-June when carp spawning has ended. You may see activity in the meantime, as carp are periodically removed. The carp that are captured will be removed from Upper Prior Lake as part of the PLSLWD's lake improvement efforts.

For more information, please visit us online at **www.plslwd.org/carp.**

We need carp VOLUNTEERS!

Volunteers needed for help with Baited Box Traps and our Carp Training Program! Training will be done mostly remotely and will be following all COVID-19 safety protocols. If you're interested in helping out, please contact Kathryn at **(952) 440-0069 or kkeller-miller@plslwd.org**

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

Funding for this project is provided in part by a state grant from the BWSR's Watershed-Based Metro Fund, as well as a federal 319 grant.

Preserving and Protecting Our Water Resources

VOLUNTEERS NEEDED!

We need your help! Looking for volunteers to help bait carp with corn for trapping. For more information, contact Kathryn at:

952-440-0069

kkeller-miller@plslwd.org

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

4646 Dakota Street SE
Prior Lake, MN 55372

Office: 952-447-4166
www.plslwd.org

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

Carp Management Project

Spring and Prior Lakes

Why Manage Carp?

Native to Europe and Asia, common carp outcompete the native fish in our lakes. Muddying up our waters with their bottom feeding habits, carp are stirring up the bottom of our lakes, releasing phosphorus back into the water which in turn feeds the algae, increasing the potential for algae blooms throughout the summer.

Lake Improvement Efforts:

Although controlling the carp on the lakes will substantially improve the water quality, it is only one of the many tools that the District is using to keep our lakes as clean and healthy as possible. This project will address the phosphorous already in the lakes, while ongoing District projects reduce the phosphorus entering the lakes each year through runoff. All these efforts work together to improve the water quality of Upper Prior Lake.

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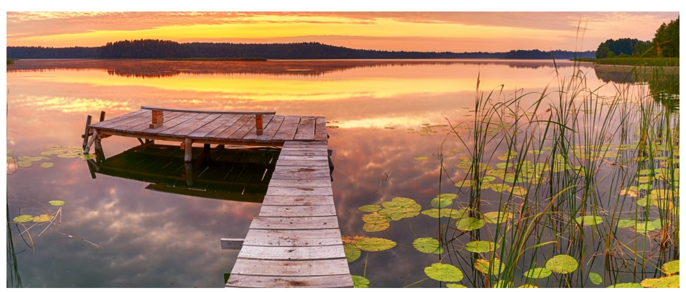
Email: info@plslwd.org
plslwd.org

PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

PRESERVING AND PROTECTING OUR WATER RESOURCES.

Please visit us at our website:
www.plslwd.org

How YOU can make a difference on Prior Lake

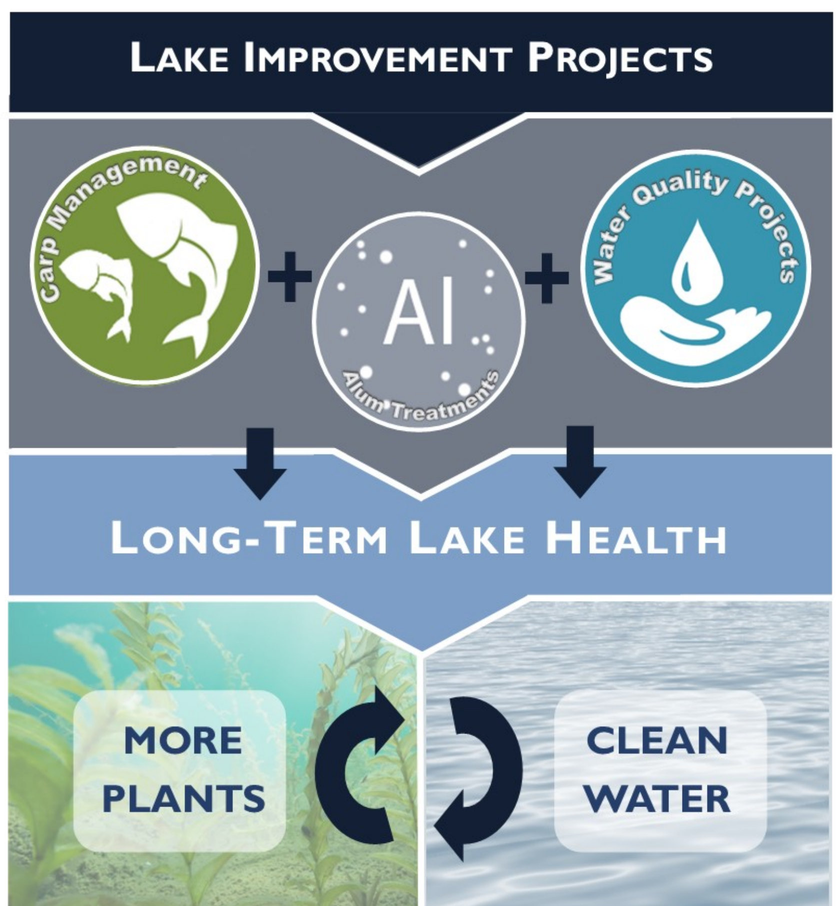


Help maintain a healthy & beautiful lake!

How you can help:

- **Let the water plants on your shoreline grow!**
- **Plant native plants near the edge of the lake.**
- **Only remove the lake plants needed to maintain access to your lake.**
- **Contact the DNR if you have invasive plants like curly-leaf pondweed at your shore: www.dnr.state.mn.us/invasives.**

More plants in the lake are a sign of good water quality and help keep the lake clear of algae!



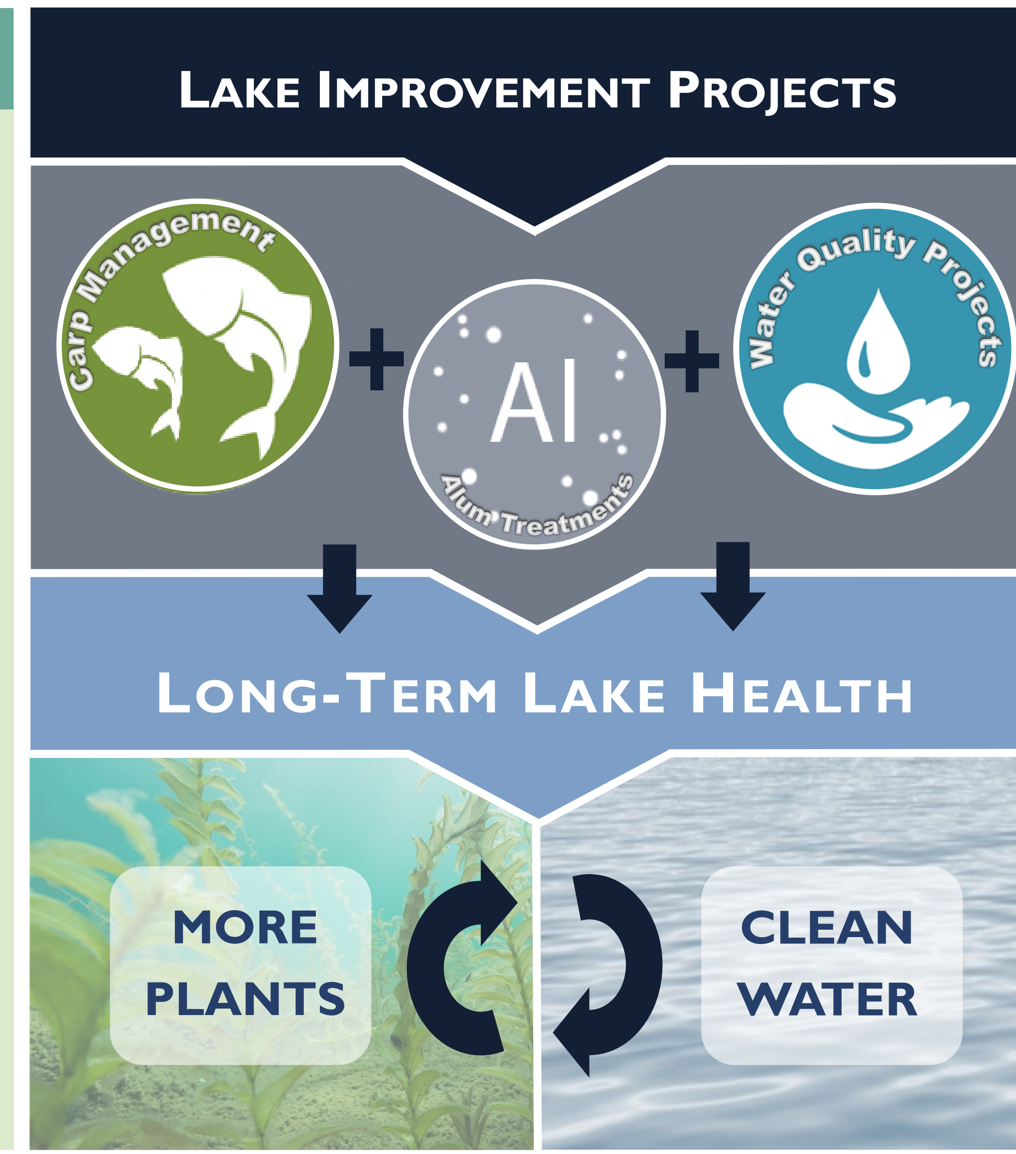
Water Plants at Work!

LET IT GROW!

The Prior Lake-Spring Lake Watershed District has been working hard to remove the invasive carp in Prior Lake in order to improve water quality. As carp populations go down, the lake plants will begin to thrive once again.

Lake plants play a critical role in helping to maintain good water quality in Prior Lake. Without plants to absorb the nutrients in the water that enter the lake from stormwater runoff, the nutrients will instead feed undesirable algae growth.

With warm weather just around the corner, it is tempting to start pulling lake plants. **Be a strong steward for your lake this year and only remove the plants needed to provide lake access along your shore.** *Let it grow!*



Many of the innovative approaches to carp management were funded in part by a federal 319 Grant administered by MPCA and a state Metro Watershed-based Implementation Grant through BWSR.

CLEAN WATER LAND & LEGACY AMENDMENT

BWSR

Clean Water   LONG-TERM LAKE HEALTH   More Plants

CLEAN WATER!

In the graph on the right, notice how water quality projects (such as carp management and alum treatments), work together to create long-term lake health by encouraging plant growth and increasing water clarity.

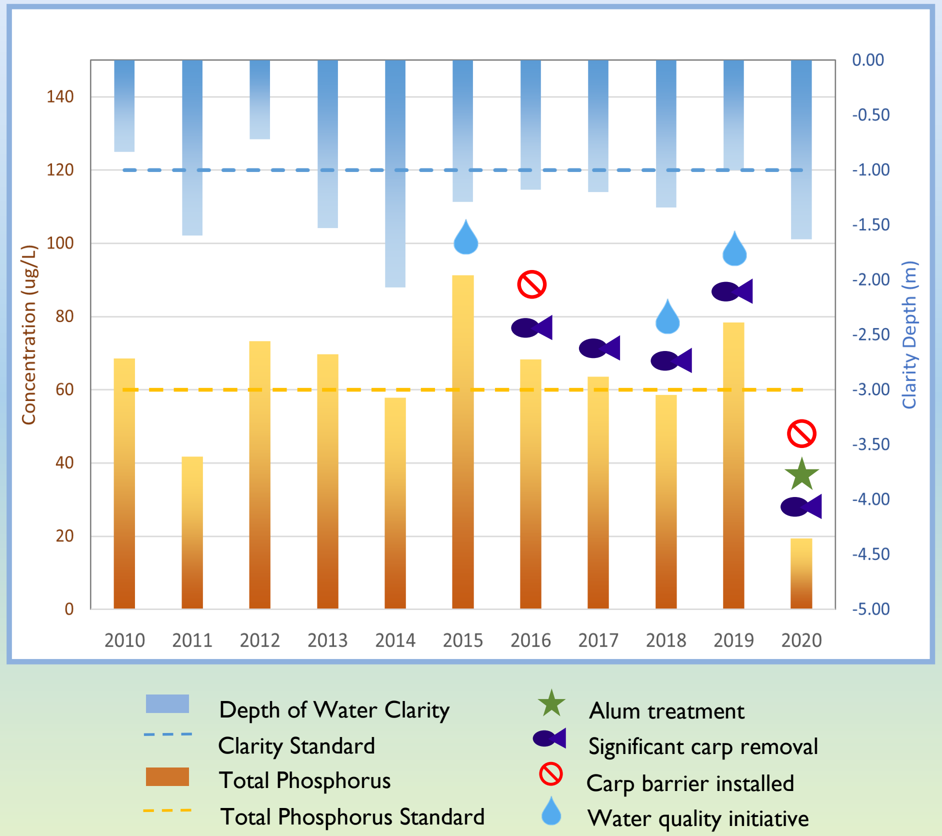
Help maintain a healthy and beautiful lake!

How you can help:

Let the water plants on your shoreline grow!

More plants in the lake are a sign of success for our water quality initiatives. Keep up the good work!

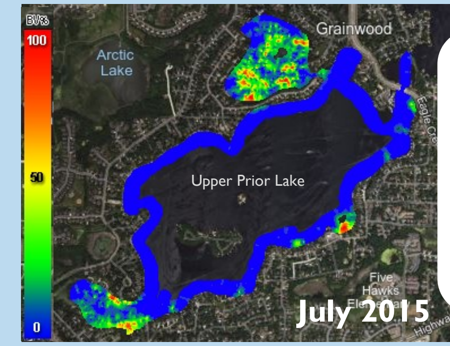
Upper Prior Lake Annual Water Quality Averages



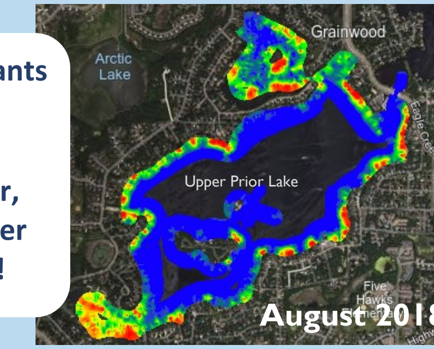
MORE PLANTS!

The District uses an underwater sonar to determine the density of plants at the lake bottom.

As seen in the images on the right, there has been an **increase** in water plant density between 2015 and 2018.



More plants = cleaner, healthier lakes!



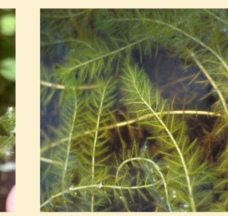
Maintaining Lake Access: What is allowed?

Lake plants are valuable to the lake ecosystem, so the DNR requires a permit to remove them.

However, maintaining your lakeshore for swimming or boat-docking areas is OK! As long as you...

1. Do not remove more than 2,500 square feet of underwater plants
2. Do not modify more than 50 feet along the shoreline or 1/2 the length of your shoreline (whichever is less)

Invasive Plants

Curlyleaf Pondweed (left) and Eurasian Watermilfoil (right) are two common invasive species that may be removed with a DNR permit. Visit **www.dnr.state.mn.us/invasives** for more info.

A few benefits of shoreline and water plants include...

Appendix X. MN Statute Amendment

PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

Carp Removal SOLUTION

What's the Problem with Carp?

Introduced into Minnesota's lakes from Eurasia in the 1880s, common carp have outcompeted our native fish and muddied our waters with their bottom feeding habits which uproot plants and disturb soil. By stirring up the bottom of our lakes, the carp release phosphorus back into the water, a nutrient that feeds harmful algae blooms.

The simple solution? Remove the carp from our lakes. The problem? Getting all **FIVE required factors lined up to net (seine) & remove them:**

1 TEMPS

Outside temps warm enough not to endanger native fish or the carp during sorting.

2 ICE

Ice must be a minimum of 12 inches thick so that it can support trucks & equipment.

3 CARP

Carp must be grouped up together in order to net them. This usually happens in the winter.

4 LOCATION

Carp must be located in an are that is suitable for netting (free of rocks and suitable lake bottom).

5 COMMERCIAL FISHERMAN

The commercial fisherman assigned to the area must be willing, able, and ready to do a seine. A lake manager may not use another fisherman to remove invasive carp without permission from the fisherman assigned to the area.

Challenges in Lining up a Fisherman:

Many lake managers go to great lengths to track carp as they travel under the ice in the winter and being to group together in a suitable spot for a seine (net removal). But patiently waiting and tracking the carp isn't always the most challenging part, it's getting the assigned fisherman lined up to do the work. There is no guarantee how long carp will stay grouped up in a good location, and lake managers need to move quickly to compel their commercial fisherman to seine as soon as possible. However, some typical problems include:

- No response from fisherman after request to seine has been made
- Fisherman does not respond or commit to seining until after the carp have dispersed from their grouping area
- Fisherman is delayed due to a ripped net or problem from previous job
- Fisherman already has multiple jobs lined up and does not have time to complete the seine
- Fisherman will only provide permission to lake managers to use an outside fisherman if they share in the carp haul proceeds.

Carp Removal SOLUTION

Updating legislation to allow lake managers to work with commercial fisherman other than the one assigned will allow for great success in restoring Minnesota's lakes! When the site conditions require immediate action there will be more flexibility to get the job done.

HF 1882
SF 1677

Amending Minnesota Statutes 2018, section 97C.815, subdivision 2:

(b) Area assignments must not restrict permits and contracts that the commissioner issues to governmental subdivisions and their subcontractors for invasive species control.

Prior Lake-Spring Lake Watershed District

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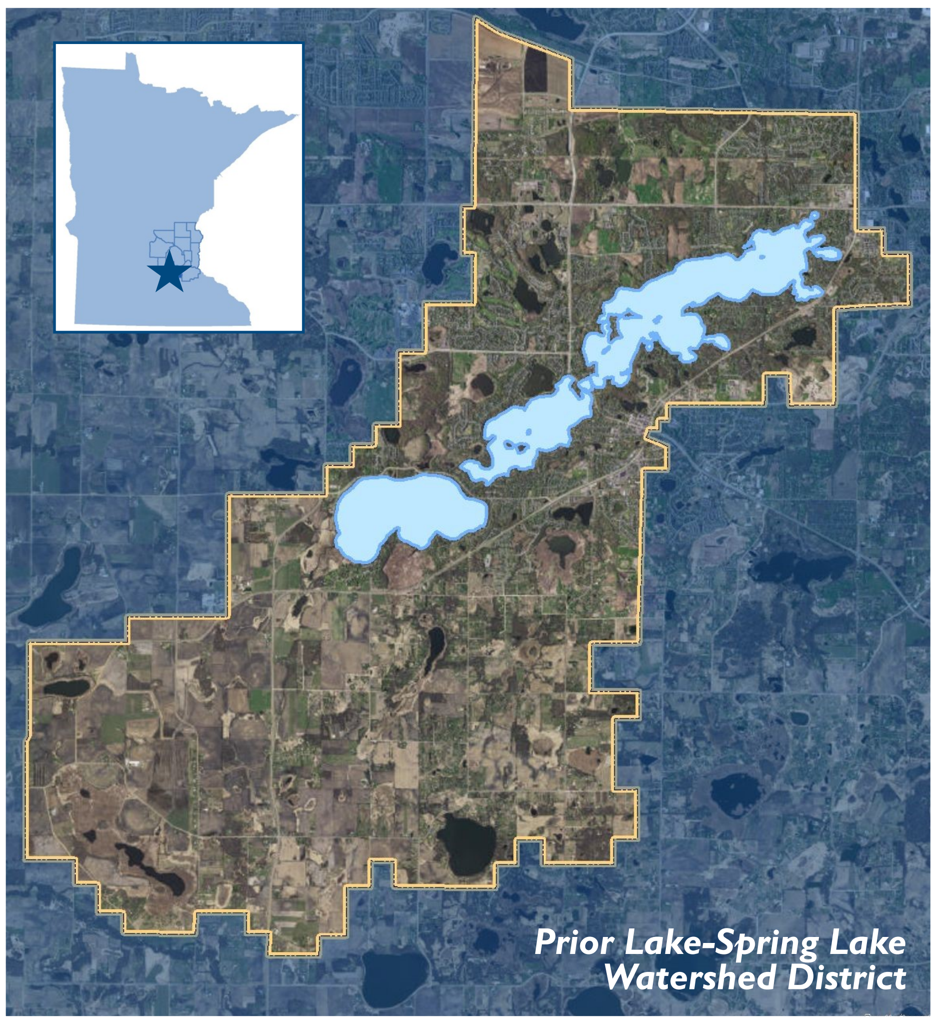
Carp Removal SOLUTION



PRIOR LAKE SPRING LAKE WATERSHED DISTRICT

Please visit us at our website for more information: www.plslwd.org or call us at (952) 447-4166.

97C.815 COMMERCIAL FISHING AREAS.

Subdivision 1. **Designation.** The commissioner shall specify inland commercial fishing areas, taking into account the amount, size, and proximity of waters specified, the species to be removed, and the type and quantity of fishing gear and equipment necessary to provide an adequate removal effort. The commissioner may change inland commercial fishing area boundaries by rule prior to a new licensing period.

Subd. 2. **Assignment.** (a) The commissioner shall assign licensed inland commercial fishing operators to commercial fishing areas and each operator is obligated to fish in the area that the commissioner has assigned to them. The commissioner's assignment is valid as long as the assigned operator continues to purchase a license, continues to provide an adequate removal effort in a good and professional manner, and is not convicted of two or more violations of laws or rules governing inland commercial fishing operations during any one license period. In the operator assignment, the commissioner shall consider the proximity of the operator to the area, the type and quantity of fish gear and equipment possessed, knowledge of the affected waters, and general ability to perform the work well.

(b) Area assignments must not restrict permits and contracts that the commissioner issues to governmental subdivisions and their subcontractors for invasive species control.

Subd. 3. **Unused areas.** If an area is not assigned, or the operator licensed for the area is not fishing that area, the commissioner may issue a special inland commercial fishing permit for the area. The permit may be issued to an individual holding a valid inland commercial fishing license. The permit must describe the specific waters involved, the county, the species to be removed, the equipment to be used, and the time period of the total operation.

Subd. 4. **Inland Commercial Fishing Trade Association; license problems.** The commissioner shall consult with representatives of the Inland Commercial Fishing Trade Association when disagreements arise in the areas of license issuance, problems with performance pursuant to the license, transfers of licenses, area assignments, and the entry of new commercial fishing operators into the inland commercial fishery.

History: *1986 c 386 art 3 s 63; 1991 c 259 s 23; 1996 c 410 s 47; 1Sp2019 c 4 art 3 s 74*

Fishermen seine 5,500 pounds of carp from lakes

Removing the invasive species meant to help water quality

BY JACK HAMMETT
jhammett@swpub.com

SUBMITTED PHOTO
Jeff Anderson of the Prior Lake-Spring Lake Watershed District nets some carp for last week's haul. According to the district, about 8,000 pounds of carp was seined from Prior Lake.

Commercial fishers on Prior Lake hauled about 5,500 pounds of carp out of the water last week, which the Prior Lake-Spring Lake Watershed District is calling a successful seine.

After some weather-related delays, a semi-truck carried off the load Sunday morning to New York, where they will be sold as food.

There are still plenty of carp to be caught in upper Prior Lake before the district's water quality goals are met, however. Mike Myser, president of the district board, said there is an estimated 100,000 pounds of the fish still there.

The fish are an invasive species, according to the Minnesota Department of Natural Resources, and their sheer numbers impact a number of water quality factors.

The species' bottom-feeding stirs up sediment, for example. Phosphorous bound to the sediment particles leads to more algae blooms in the water, which can kill native plants and limit fish habitats.

"The second reason we've been adamant about getting these beasts out of the water is that we want to use an alum treatment," which carp might stir up in the same way, Myser said. "We use alum treatment (to limit phosphorous) because our lake is what is considered quality-impaired. Alum is, to date, the only solution to get a lake off the impaired list."

So far, the district has seen some success. Myser said the lake's phosphorous levels are below the impaired level; however, low phosphorous levels must be demonstrated for several years before a lake is removed from Minnesota's Impaired Waters List.

Addressing rumors of complications due to residents dumping their pet fish in the lake, Myser said such a situation isn't likely.

According to Maggie Karschnia, district project director, the fishermen are momentarily hanging their hats after a successful seine. That's not to say that more seines won't be scheduled soon, however.

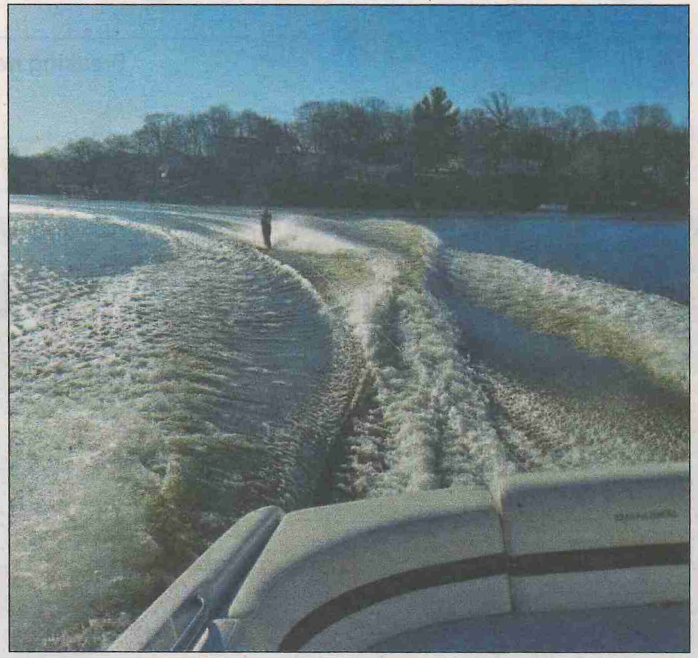
"The Watershed District will be working with the commercial fishermen again later this year to complete additional seines with help from our carp consultants at WSB," a consulting company with several local offices, she said.

Mary Newman, environmental scientist there, said it's uncertain how long the process could take.

"We have so many years of funding left (for removal attempts) for the next three years," Newman said. "It's an ongoing project."

The district's website, plslwd.org, will be regularly updated for future seines.

SEASON'S FIRST WATER SKI



Reader Jane Lorsung shared this snapshot her husband, Jeff, took as she celebrated the ice's clearing from Prior Lake on April 20, shortly before the city announced a no-wake speed restriction because of the lake's level.

SUBMITTED PHOTO

https://www.swnewsmedia.com/prior_lake_american/news/2-300-pounds-of-carp-removed-from-upper-prior-lake/article_c6e7aba5-3fab-5f90-9861-5e96caa2ef5b.html

2,300 pounds of carp removed from Upper Prior Lake

By Trinity Carey tcarey@swpub.com
Feb 2, 2021

Commercial fisherman in the Bloomington District Jeff Morris assisted with the carp seine conducted in Upper Prior La
Jan. 29. Approximately 1,000 pounds of carp were removed during the seine.

Photo by Trinity Carey

Updated 9:40 a.m. Thursday morning

A total of 2,300 pounds of common carp were removed from Upper Prior Lake last week.

The Prior Lake Spring-Spring Lake Watershed District in partnership with consulting company WSB & Associates and area commercial fishermen conducted one of its many carp seines to lower the population of the invasive common carp in the lake on Jan. 29.

Carp feed on bugs and plant material which kicks up sediment and the phosphorus within it. Phosphorus feeds algae and results in more algal blooms in the lake. This prevents aquatic plants from getting sunlight and affects the feeding and hunting of the native fish populations, overall impairing the water quality of the lake.

Pest management

In 2002, Upper Prior Lake and Spring Lake were among those on Minnesota's List of Impaired Waters. In an effort to restore the water quality, the PLSLWD developed an integrated pest management plan to reduce the carp population in the impaired lakes.

"Prior Lake has an abundance of common carp that are detrimental to the water quality," said Jeff Anderson, water resources technician with the PLSLWD. "The watershed has really ramped up efforts in recent years to try and remove common carp here."

These efforts include carp seines which the district has been conducting with partners since 2016.

Seining is the use of seine nets to capture fish. A large hole is first cut in the ice and a net is dropped along with a small remote controlled submarine. The submarine pulls a rope that guides the net to a series of holes augered in the ice. The net forms a circular shape under the ice and around the aggregated carp. The net is then finally pulled through a larger out hole, explained Environmental scientist with WSB Mary Newman.

Finding the carp

Seines are typically more successful in the winter months because carp tend to aggregate in one area making them easier to catch.

"We don't really know the reason but I can tell you that they're not really eating in the wintertime and they're not breeding," Newman said. "They're from the Caspian Region, so it could've been that they had predators there so schooling up would be a way to avoid predators."

Radio tags help the PLSLWD determine where the carp are aggregating in the lakes. Roughly a dozen carp have been tagged in Upper Prior Lake, Anderson said.

Once netted, commercial fishermen sort through the haul to ensure native fish such as walleye and sunfish are released.

The fish are then transported for processing and sold to markets in New York, Iowa and the southeastern U.S. where they will sell for 35 cents to 50 cents a pound in an average year sans pandemic.

“It varies based on how much fish are caught so obviously more fish, the bigger markets they'll go to,” Anderson said.

Measuring success

The number of carp captured during seine events varies and in years past the district has captured between 10,000 and 35,000 pounds during a single event, so this year’s 2,300 pounds wasn’t what it had hoped for.

While the day “wasn’t a great success,” Anderson said, “Anytime we can get partners to come up here and work on getting the fish out of the lake it is a success.”

The commercial fishermen assisting with the seine were a bit somber as they packed empty bins into the beds of their trucks as they expected to have a larger haul for the market.

One reason for the small catch may be that the seine conducted in the narrows near Knotty Oar Marina seemed to spook the carp sending many away from the targeted aggregate, commercial fisherman for the Bloomington District Jeff Morris said.

“We know that there's a good percentage in here. We can see them on our sonar but they kind of snuck out on us a little bit today.”

'Tough lake to seine'

The carp in Upper Prior Lake gather at a depth less than optimal for seining, a gradual shoreline leads to more success, he said.

“It's a tough lake to seine especially where they sit we can't seine, so we try to push them into it with sound, underwater acoustics stuff like that and it works a little bit but sometimes they just swirl around and don't want to come into the trap,” Morris said. “They're hard to move, they're stubborn and don't want to come to where we can see them at.”

To capture the carp sneaking away from the seine nets, gillnets were set up in an adjacent area.

Gillnets are made of monofilament making them hard for fish to see. Fish swim into the net and become trapped in it by the gills when they attempt to back out of it.

While some may be concerned about the harm gillnets could cause native species the nets used had approximately seven-inch gaps, large enough to allow native species to pass through freely, Anderson said.

Gillnet permits were granted by the Minnesota DNR for Prior Lake and Spring Lake. They are the only two lakes permitted for commercial gillnetting in the state, he added.

Morris said there were no native fish caught in the nets during the seine and that the potential harm of the nets is outweighed by the benefit of removing carp from lakes.

After a successful carp seine, fishermen will see a sizable increase in game fish the following season, he said.

Commercial fishing

COVID-19 has “destroyed” the commercial fishing market, he said. “Period, flat out, it’s flatlining” and 2,300 pounds won’t yield a lot of return. But the seine does wonders for the fish population and quality of the lake.

“It improves everything all around for the native fish, for the water clarity, for the weeds,” Morris said.

The PLSLWD hopes to complete two successful seines on both Upper Prior Lake and Spring Lake this year with plans for a seine event on Spring Lake sometime soon.

Clean water, better recreation and better fishing are all results of quality bodies of water, Anderson said.

“The watershed is working hard to help remove all the common carp and improve the water quality in our local lakes,” he said.

Seines are partially funded by a Federal 319 Grant and a Minnesota Board of Water & Soil Resources Watershed Based Funding Grant.

For more information on carp and local carp management efforts, visit plslwd.org.

Trinity Carey

https://www.swnewsmedia.com/prior_lake_american/news/prior-lake-spring-lake-watershed-district-continues-removal-of-invasive-carp-from-local-lakes/article_cf9f7e30-ef2d-5d71-a53f-03f0aea5557e.html

Prior Lake-Spring Lake Watershed District continues removal of invasive carp from local lakes

By Trinity Carey tcarey@swpub.com
Feb 26, 2021

Invasive carp are netted from a lake during a winter seine. The PLSLWD has conducted carp removal events in Prior Lake and Spring Lake this winter to improve the water quality.

Photo courtesy of the Prior Lake-Spring Lake Watershed District

The Prior Lake-Spring Lake Watershed District continued its carp removal efforts with the removal of 7,500 pounds of the invasive species from Spring Lake on Feb. 18 and an additional 3,000 pounds from Upper Prior Lake on Feb. 23.

The removals are carried out by the PLSLWD, consulting company WSB & Associates and area commercial fishermen. The Spring Lake seine, or the netting and removal of carp, was conducted on the northwest corner of the lake near Sailer's Greenhouse, which Water Resources Technician Jeff Anderson said went well.

"We're happy, the fishermen were fairly happy and it really helps with moving towards our goal," Anderson said. That goal being to lower the population of the species in water bodies to improve the overall water quality.

The second carp removal event on Upper Prior Lake this season resulted in the netting of over 200 fish, according to a PLSLWD press release. With a special permit from the DNR, gillnets, nets made of monofilament making them hard for fish to see, were used to remove the group of carp congregating near the Knotty Oar Marina. A seine was conducted in that area in late January and resulted in the removal of 2,300 pounds of carp.

Anderson said population estimates reveal that there are presently more carp in Spring Lake than in Upper Prior.

Using methods like electrofishing surveys, looking for spawning areas and through public input, the watershed tracks the carp populations, but has never found a concerning amount of carp in Lower Prior Lake. Carp tagged by the district have also never been located in that body of water and just why that is isn't exactly known, Anderson said.

The watershed doesn't have any future removal events planned, but they track the carp population in the lakes multiple days a week so seines can be conducted quickly when fish are in the right areas for an event.

"These carp removals will help continue improving water quality in Upper Prior and Spring Lake. They will mutually benefit the other work that we have done on these lakes, with the alum treatments, the stormwater best management practices that we've helped fund and overall health and wellness of the shorelines and the restoration projects that we've worked on," Anderson said. "It's a holistic approach and this is just one of those factors that we're able to complete and really target this time of year."

For more information on the PLSWD’s carp management efforts visit plslwd.org.

Spring Lake Association

Spring 2021

SLA 2020 Photo of the Year | Submitted by Tara Lauren

2021

SLA CALENDAR

Annual Meeting (Zoom)
Sunday, April 18

Paddle Parade
Monday, May 31

NEW - Kids Fishing Contest
Saturday, June 19

NEW - Ice Cream Social
Saturday, July 3

Concert on the Lake
Saturday, August 7

Pick Your Paddle
Monday, September 6

S'mores / Light up the Lake
Saturday, October 16

Visit our website at www.SpringLakeAssociation.org

- Check for updated details regarding our events!
- Pay your 2021 SLA Membership!

2021 Joint Fish Stocking Plan

The following is the fish stocking plan for Spring Lake. This plan is the result of discussions with the Prior Lake-Spring Lake Watershed District (PLSLWD); its Citizen Advisory Committee (CAC); its fisheries consultant, WSB; the Minnesota Department of Natural Resources; and Spring Lake Association.

Walleye
The proposed walleye stocking is planned for fall of 2021 and will include stocking 6-inch walleye fingerlings matching up to the rate that the DNR is planning for. **Funded by:** Spring Lake Association, PLSLWD, Prior Lake Rotary and Edina Realty.

Bluegills
Given the results of the carp assessment of three carp nurseries located in the Tadpole Pond, Desilt Pond and Geis Wetland (located near highway 13), the PLSLWD will stock bluegills there to eat carp eggs. The proposed stocking is planned for Spring of 2021 after initial Bluegill population surveys take place. Carp cause serious damage to native fish populations because they out-compete other fish for food and space. While searching for food, Carp reduce water clarity by uprooting aquatic vegetation and stirring up bottom phosphorus-containing sediments, which contributes to algae blooms. **Funded by:** Spring Lake Association and PLSLWD.

Stocking for Bluegill and/or Walleye is dependent upon a successful permit request. PLSLWD will purchase the bluegill and Walleye from a commercial firm.

Carp Management | Thanks PLSLWD

The Prior Lake-Spring Lake Watershed District (PLSLWD) was recognized and honored to have been awarded the **Best Program of the Year Award for Carp Management** at the 2020 Minnesota Association of Watershed Districts' (MAWD) annual conference.

- PLSLWD conducted multiple Carp Management fishing missions in 2020 which resulted in removing nearly 12,000 pounds from Spring Lake. So far in 2021, PLSLWD has removed 7,500 pounds of carp.
- They use a variety of methods including commercial netting, baited box traps, electrofishing and specialized traps to capture these wily fish.
- In September 2020, the PLSLWD installed an improved carp barrier and maintenance deck at the District's Ferric Chloride Treatment Center near Highway 13 ditch. The new structure will prevent carp from accessing the upstream wetlands for spawning, is safer and will allow easier maintenance.

Carp management activities have been funded in part by a state BWSR Watershed Based Funding Grant as well as a federal 319 grant through the MPCA. Please email us at KKeller-miller@plslwd.org if you would like to volunteer to be a part of the Carp Management Program at PLSLWD?

Spring Lake Water Quality | Abstract Research | By Olaf Morkeberg, Youth Leader & Denver Link

Spring Lake met all three of the water quality standards for a healthy lake in 2020. Water clarity (Secchi disk depth), total phosphorus concentration and chlorophyll-a concentration are the three main standards used to determine water quality.

It is increasingly common for lakes surrounded by agricultural and residential areas to be labeled as hypereutrophic (very low water quality). Several water quality indicators are measured to determine how healthy a lake is including phosphorus, nitrogen, Secchi depth, oxygen, and chlorophyll. Spring Lake was listed as an impaired waterway for recreational use in 2002. Since then, several internal and external lake conservation strategies have been implemented to improve lake quality.

Internal lake strategies include Aluminum (Alum) Sulfate Treatment and removal of invasive species such as carp and curly leaf pondweed. External lake strategies included ferric chloride treatment, lakeshore restoration, conversion of septic systems to city sewer, wetland restorations, agricultural best management practices, and modifying drainage ditch architecture.

We assessed the effectiveness of these strategies by analyzing chemical and physical variables. We found that years with our predicted indicators of low water quality (high temperature, dissolved phosphorus (SRP) and nitrogen) were correlated with higher chlorophyll-a, reduced Secchi depth, and decreased oxygen. We also found that there was improvement in Secchi depth, phosphorus, and chlorophyll numbers during years with Alum Treatment (2013, 2019 & 2020).

We also analyzed trends in fish populations using DNR data. Since 1990, bluegill populations have decreased but are currently stable at a low number. Bluegills are beneficial as they eat carp eggs. Northern pike populations remain stable, and walleye populations are good, most likely due to stocking of walleye by the DNR.

Lakes that have too much phosphorus can have excessive algae growth, that can grow out of control thus creating imbalances which destroys other life forms and produce harmful toxins. Ferric chloride and alum have both been shown to reduce the amount of available phosphorus in the lake. The Prior Lake-Spring Lake Watershed District (PLSLWD) operates a Ferric Chloride Treatment Facility near Highway 13 ditch and is also proud to announce that after a third Alum Treatment in May 2020, Spring Lake and Upper Prior Lake were measured to have the best water quality in many years.

Despite these encouraging data, there is more work to be done in order to sustain these results. Currently the watershed is planning more external projects upstream of Spring Lake to decrease pollution and control flooding. Lake systems serve large ecological and economic roles in local communities. Spring Lake demonstrates the importance in understanding ecological drivers of water quality to promote the sustainability of lake dynamics overtime.

SLA Vergus Avenue Residents Sign up to Help Save the Bees!

By Shelby Roberts Scott SWCD Outreach Specialist

The Scott Soil and Water Conservation District (SWCD), Scott Watershed Management Organization, Prior Lake-Spring Lake Watershed District, and the Lower Minnesota River Watershed District have all partnered together and were awarded funds from the Minnesota Board of Water and Soil Resources (BWSR) for the Lawns to Legumes Program. The program's goal is to make residential pollinator plantings accessible for all Minnesota residents, and to restore habitat for the Rusty Patched Bumblebee.

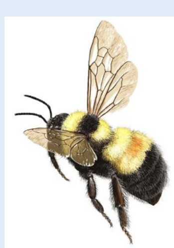
The Rusty Patched is Minnesota's state bee, and the first bumblebee to be placed on the endangered species list. Scott SWCD Natural Resource Specialist, and Lawns to Legumes Coordinator, Meghan Darley elaborates, "the Rusty Patched Bumblebee has seen a remarkable population decline over the last decade, and part of the reason for it is the loss of critical pollinator habitat. Contemporary turf grass lawns are taking away space that previously held wildflowers and prairie grass."

Lawns to Legumes wants to bring habitat back and educate homeowners in the process by means of a "Demonstration Neighborhood," or rather, a series of pollinator plantings in close enough proximity of each other so that each connects and serves a greater reach for pollinators.

"Spring Lake is importantly positioned as an area we want to establish pollinator plantings in first. The bees already want to make their habitat there, we just want to make it a little homier" Darley comments.

Last year, the Scott Soil and Water Conservation District (SWCD) sent out a call for volunteers because they had new grant funds for planting pollinator habitat. The Spring Lake neighbors on Vergus Avenue rose to the occasion, pledging to add beauty, stability, and protection for the habitat. The pollinator plantings will be installed this spring and summer. Keep an eye out for Lawns to Legumes signs and thank your neighbors for helping to protect endangered species and for planting locally.

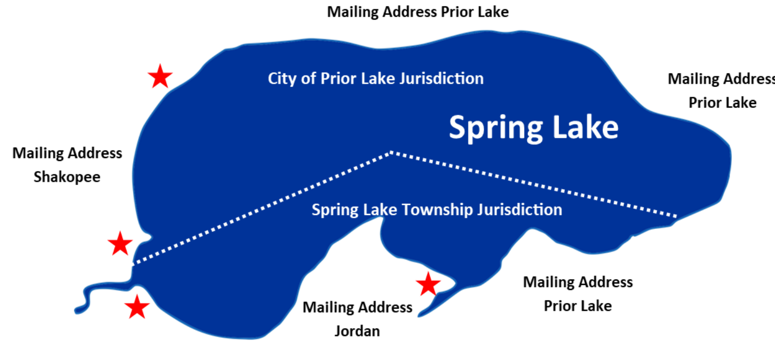
"In a year full of isolation and distancing, it was inspiring to witness the partnership among the Vergus Avenue neighbors. The people around Spring Lake have a strong bond not only with the lake, but with each other," Darley observes.



For more information about different types of pollinator plantings, or for more information on the Lawns to Legumes Program, visit http://bwsr.state.mn.us/l2l. If you are interested in participating in this program and utilizing Lawns to Legumes funds, please contact the Scott SWCD office at 952-492-5425.

Spring Lake | Community & Responsibility

By Maureen Reeder, Resident



There is no doubt, living on Spring Lake has given me a strong feeling of community as well as a sense of responsibility for the health and future of the lake. We all can play an important part to ensure good governance by keeping informed about how laws are passed and enforced for Spring Lake. At times, the process can be tricky because Spring Lake falls under the jurisdiction of two governing bodies: part of the lake lies within Spring Lake Township and part within the City of Prior Lake.

It can be a rather complex process to sync up the governance of Spring Lake but citizens have been attentive to the challenge and have swooped in from time to time to ensure we have consistent rules and regulations for the lake. This is important because what happens on one part of the lake impacts all of the lake and uneven laws may be ineffective and hard to enforce. Staff and elected officials from the city and township have helped coordinate consistency in law changes and the Spring Lake Association has played a role in providing information about public hearings so all perspectives can be heard.

For example, when the City of Prior Lake proposed an ordinance in 2016 to establish a no wake zone on Spring Lake, some township residents took a peek over the fence and said, "we better get involved," knowing that it would be confusing for boaters if half the lake had a no wake zone and the other half did not. Township residents provided input into the development of the city ordinance. They testified at hearings and before the city council. Once an ordinance was passed by the city, city residents stepped up to support township residents who sought passage of a similar ordinance at the township. The result was that no wake is allowed within 150 feet of shore on Spring Lake no matter where you are boating.

More recently, when a new housing development was proposed in 2019 near Spring Lake with a 100-slip marina, township and city residents again joined forces. This time to challenge adding a marina with multiple boats to the lake. The City of Prior Lake considered an ordinance to limit slip rental and moorings facilities; township citizens participated early in the city process knowing that whatever the city passed would likely be brought to their township board. Once the city passed an ordinance, citizens from the city and township worked together successfully to gain support for a similar ordinance in the township. In this case, the goal was to ensure one part of the lake didn't become a zone for unchecked slip rental growth while another part prohibited it. The result is Spring Lake prohibits the rental of personal boat slips.

By working together, Spring Lake residents and officials have navigated these and other important issues in partnership to achieve clear and consistent citizen-driven ordinances for all! This partnership has resulted in an active community with a common vision for being a great place to live and recreate! I am confident that the Spring Lake residents will handle any future issues with the same commitment and passion!

Maintaining a Healthy Shoreline | Contributor: Prior Lake-Spring Lake Watershed District Staff

Water Lily: Because of its value as fish habitat and a decorative plant, the native white-water lily is usually best left along your shore. Removing lilies allows more light to reach the lake bottom and typically results in less desirable plants moving in.

One of the many benefits of living on a lake is the abundance of wildlife; bald eagles soaring above, mallards diving for food, sunfish swimming under your dock and the sound of loons. The goal is to have a lake with enough vegetation for wildlife to thrive while still allowing humans to have fun too.

The carp management activities on Spring Lake, along with the three alum treatments, have made significant improvements to the water quality in recent years. These improvements are anticipated to lead to increased native plant growth along the shoreline which is an indication of a healthy lake!

A healthy lake relies on a healthy community of native aquatic plants to sustain its clear waters. The more native vegetation in the water, the better the water quality. Research has shown that lakes can naturally sustain water clarity when at least 40% of the lake bottom grows vegetation. In June 2019, native aquatic plants were estimated to cover only 17% of Spring Lake, so it is important that we understand what plants are good and what are bad.

What can you do with common aquatic plants near your shoreline?

Cattails: Cattails are native and can only be removed from the water with a DNR permit. Only a small area may be removed to provide boat access to deeper lake water. Floating cattails that land on your shoreline can be moved to an existing cattail colony on the lake or can be left to create a new colony along your shore. **Helpful tip:** cutting cattails below the water surface after first frost provides good control.

Curly-leaf Pondweed: One of the most common undesirable plants present in Spring Lake is curly-leaf pondweed (CLP) *(Potamogeton Crispus)* which is non-native and invasive. It grows quickly early in the season, sometimes smothering native plant growth. The plant releases its seeds and then dies back during mid-summer. The decomposing plants contribute nutrients to the water which then fuels algae growth. The best time to treat for invasive CLP is in the spring before the lake temperature surpasses 60°F and when plants are 1-2' tall because native plants start to grow once the lake temperature reaches 60°F.

Treatments: If you would like to treat other plants along your shoreline, determine if you will hire a company or do it yourself and if you'd like to treat with chemical or manual pulling. There are companies you can hire to do either. Whether you hire a company or do it yourself, chemical treatments require a DNR permit that will allow up to 2 treatments per year. If you choose to do a chemical treatment yourself, Hydrothol 191 Granular is a recommended product that can be used to treat both invasive and native plants. The Prior Lake-Spring Lake Watershed District (PLSLWD or District) treats areas of CLP farther than 150' from the shoreline, when plants are expected to reach nuisance levels. The District cannot manage invasive plants alone and is supportive of landowners taking steps to control CLP along their shoreline. Visit website PLSLWD.org and DNR.State.MN.us for more information regarding native and invasive plants as well as treatment options and required permits.

Dan Kelly

Retiring President

June 2015 - April 2021

As I write my farewell article and look out at the lake and reflect on my 6+ years as the president of the Spring Lake Association (SLA), I feel a lot of different emotions but one that stands out is pride!

I am proud that the SLA membership has grown from only 12 members to over 60% (148) of the lake being active/engaged members and still growing!

I am proud that we have a number of local businesses that support SLA each year!

I am proud that we donate funds each year toward lake efforts and Spring Lake is healthier than ever!

I **am proud** of the partnerships we have created with other organizations that help serve/support Spring Lake Community!

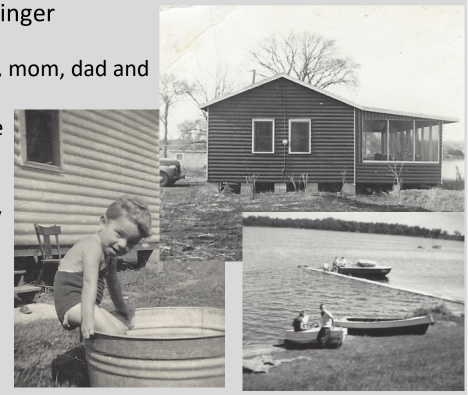
I am proud that we have a driven/passionate/ motivated board that will ensure that SLA will continue to make a difference!

I am proud of the amazing events we hold each year and the growing attendance!

Most of all though I am proud of the community we have helped create on Spring Lake for us to enjoy for years to come!

Spring Lake is a great place to call home | See you on the lake!

My Life on Spring Lake | Reflection by Jim Weninger



I grew up in Highland Park in a home that was shared with my grandfather, mom, dad and 5 siblings with one phone and one bathroom. My family was introduced to Spring Lake in 1947 when my family rented a cabin on Sunset Beach on the east side of the lake. I celebrated my first birthday at the cabin that summer and continued to celebrate almost all of my birthdays on Spring Lake! Traveling to the cabin was an adventurous trip because back then Highway 35E through St Paul didn't exist, Highway 13 was a dirt road in places and the main way for us to cross the Minnesota River was the Mendota Bridge by Ft. Snelling.

Our family enjoyed our summer vacation so much that summer, that the next summer my parents bought lakeshore property on Sunset Avenue on the west side of the lake. They built a pre-fab cabin complete with an outhouse, an outside pump, and a party line phone. For the next 17 years, my family enjoyed our cabin every summer during my father's vacation.

In the early 1950's I remember playing outside with my friend and hearing the sound of the cow bell, which meant it was time to come home. The clouds in the sky were darkening and the winds got stronger. My mother counted all of the kids as they entered the house. My father was waiting for me at the front door and as I arrived, a burst of wind came up and I am told I flew about 10 feet in the air. My father quickly grabbed me and brought me to safety! My family huddled around the radio to hear the tornado warnings! The tornado sent out-houses and trash cans flying and destroyed two houses on our block. We felt fortunate because the only damage our cabin sustained was that it was thrown off the foundation.

Cabin life also included boating to Ed Schmidt's Tavern where they sold ice cream, penny candy, soda pop, burger & fries and had a seasonal fish fry! There was also a tub of live turtles on the patio and the owner would pay kids, mostly in candy, for any turtles that they caught and put in the tub. The turtles were later used for a Turtle Soup Feed that became a yearly treat for cabin owners around the lake!

My rite of passage also occurred at the cabin when my older brother and I were able to take the fishing boat by ourselves and camp overnight on a farmland across the lake.

I enjoyed water skiing and was one of many groups of kids who put a ski jump in and out of the water over the years. I was part of four guys who are remembered for going over the ski jump at the same time and I am also remembered for being able to do hand-stands while water skiing. Things that I certainly am not able to do today!

In 1965, after the death of my grandfather, my parents changed the cabin into a year-round residence and sold their Highland Park home and moved to the lake. I graduated from high school that year and spent the next five years enjoying the lake while attending the University of Minnesota as well as helping to rebuild the cabin. We finished the upgrades to the cabin the year that I was married and moved out.

In the late 1960's Prior Lake Ski Club started using Spring Lake for their ski club. I met my now wife Liz when she was practicing with the Prior Lake Ski Club. Liz and I married in 1972 and rented a duplex on the lake. Three years later, we bought the duplex, moved to the "larger" section and we continue to live there today!

I also have been involved in Spring Lake Association for most of my adult life. I served on the board many times over the years and was the President of the Association in the early 70's when Highway 13 ditch was identified as a problem for Spring Lake.

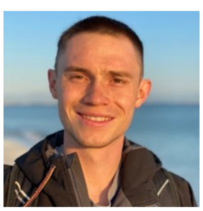
There is no better place than Spring Lake and I feel very fortunate to have lived my life here. My wish for the lake's future is to ensure that our children, grandchildren and their grandchildren are able to have a healthy Spring Lake to enjoy. My advice to Spring Lake residents| Listen, learn and take action to ensure that Spring Lake remains a great place to live and enjoy life!

SLA Youth Leaders

We are excited to highlight a few youth leaders who are making things happen around Spring Lake!

Allie Ketelsen | We are excited that we have found a youth leader who is technical and creative! Allie created the "2020 Year in Review Video" and helped produce the Raymond Park Video that will be shown at this year's Annual Meeting. Allie is in 8th grade and attends Twin Oaks Middle School. She enjoys surfing, ice skating, water skiing and the tree fort her dad built that overlooks the lake. She loves having friends over to go swimming and have bonfires. But one of her favorite things to do is go for sunset boat rides; they are so relaxing and the best way to wind down after a long sunny day on the lake.

Charlie Malecha | Charlie is our Eagle Scout who conducted a zebra mussel test on Spring Lake for his Eagle Scout Project in 2020 which resulted in No Zebra Mussels on Spring Lake! Charlie will be featured at this year's annual meeting with a video of his study! Charlie is a freshman at Prior Lake High School. He enjoys boating and swimming in the summer on Spring Lake.



Olaf Morkeberg | Like his father Christian, Olaf follows the science in an effort to educate us about water quality and preserving this natural resource. See Olaf's great article in this newsletter. Olaf attends St. Olaf College and is majoring in biology and exercise science. He enjoys the outdoors and his best memories include relaxing on his paddle board in the sun in calm blue water enjoying the bird life and the clouds floating by.

Camille Will | Camille has been the SLA's photographer and has worked at the Spring Lake Landing as a Watercraft Inspector. She will be featured at this year's annual meeting with a video of her experience! She attends Gustavus Adolphus College and is majoring in Biology with a minor in English. Her favorite thing about growing up on a lake is the sense of community. Through events like flotillas and the SLA's summer concerts, she has had a blast getting to know other kids and adults around the lake.

Spring Lake Association 2021 Membership Drive

Please visit our website If you haven't paid your 2021 Membership dues. Yearly dues are only $30 per household!

www.SpringLakeAssociation.org

Spring Lake Association
P.O. Box 631
Prior Lake, MN 55372

Connect with us:
www.SpringLakeAssociation.org
Board.SLA@gmail.com

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Area of Previous Heavy CLP in Spring Lake, June 2019

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2019

Curlyleaf Pondweed Meandering Survey: April 29, 2019
CLP Treatment: May 20, 2019, 15.17 ac (diquat)
Curlyleaf Pondweed Assessment Using Meandering and Transect Surveys: June 10, 2019
Summer Point Intercept Plant Survey: August 30, 2019

Prepared for:
Prior Lake/Spring Lake Watershed District
Prior Lake, Minnesota

Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116

March 2020

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2019

Summary

Early Season CLP Delineation and Assessment: Curlyleaf pondweed (CLP) distribution and abundance were delineated in Spring Lake on April 29, 2019 to determine if curlyleaf control was needed. Curlyleaf growth was observed at 29 out of 144 sample sites (Figure S1). Growth ranged from light to heavy. Two areas totaling 15.17 acres were projected to produce abundant growth and were delineated for treatment (Figure S1).

Treatment of 15.17 acres occurred on May 20, 2019 using a diquat herbicide.

A post-treatment assessment survey included a line transect survey and a meandering survey and was conducted on June 10, 2019 to check the status of curlyleaf pondweed and native plant community in Spring Lake. CLP was observed at a few sites of light growth and one site of moderate growth but no nuisance growth. Curlyleaf pondweed was not a navigational or recreational nuisance in June (Figure S1).

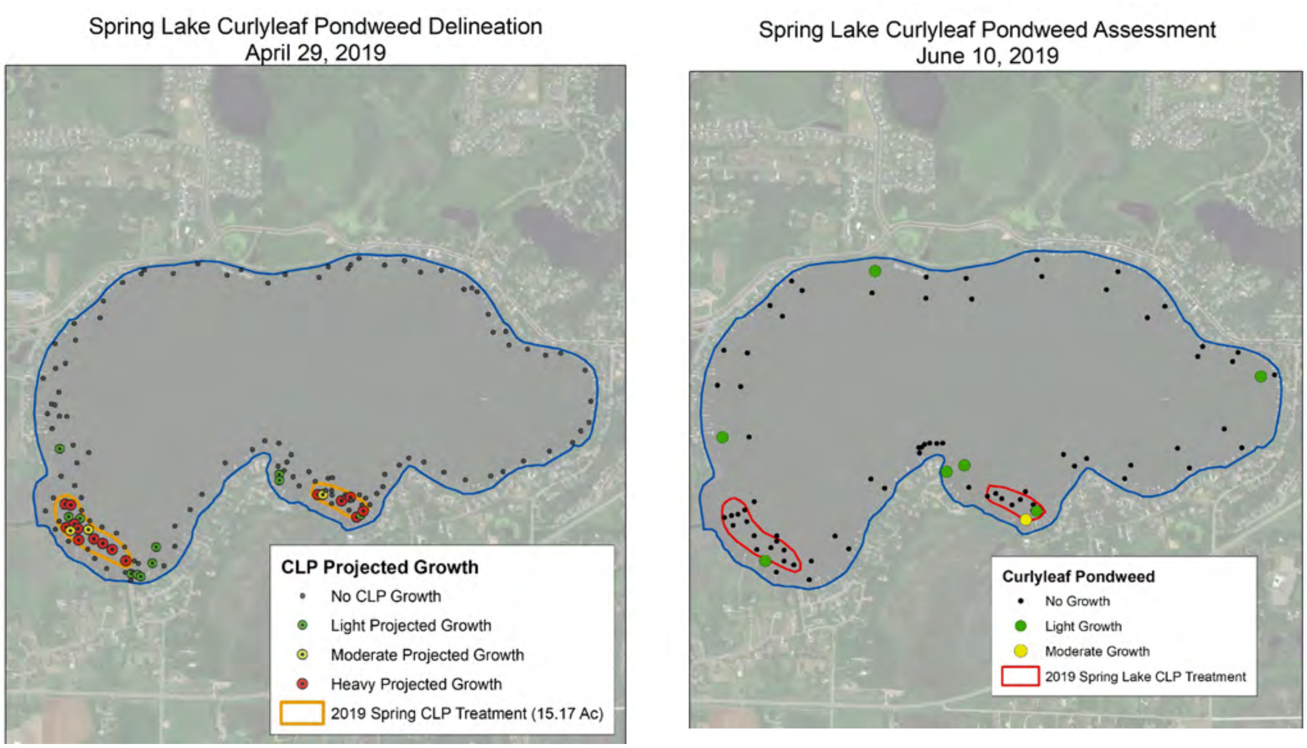
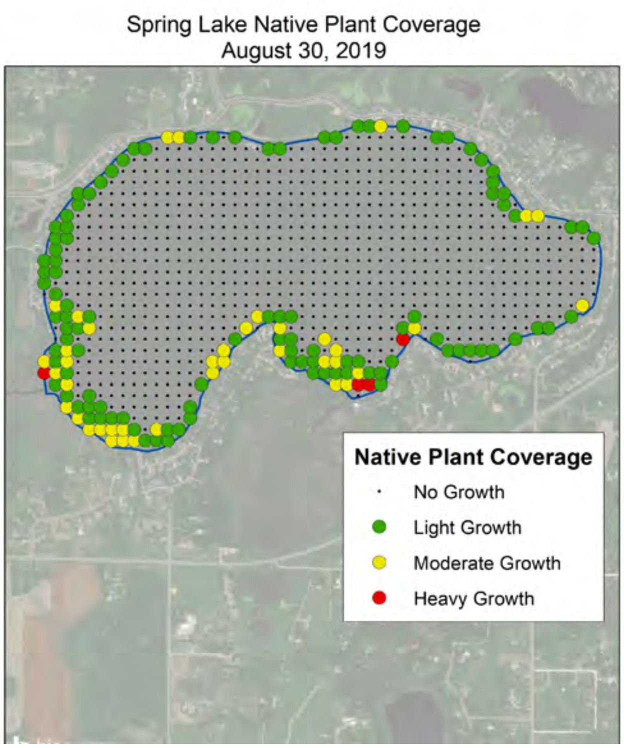


Figure S1. [left] curlyleaf pondweed Delineation. [right] curlyleaf pondweed assessment (post treatment).

Point Intercept Survey: A grid with points spaced 50 meters apart was put over the entire lake and sites were sampled throughout the growing zone. A total of 214 sites were sampled out to a plant growing depth of 8 feet and plants were observed at 150 sites. Results of the summer aquatic plant point intercept survey conducted on August 30, 2019 found 10 submerged aquatic plant species with no CLP or EWM observed in August. Native plants were found around the perimeter of the basin of Spring Lake (Figure S2).

Native aquatic plants were estimated to cover 17% of the lake bottom (98 acres). Coontail was the dominant aquatic plant. The 10 aquatic plant species found in this survey represents a fair to good diversity for Spring Lake in late summer.



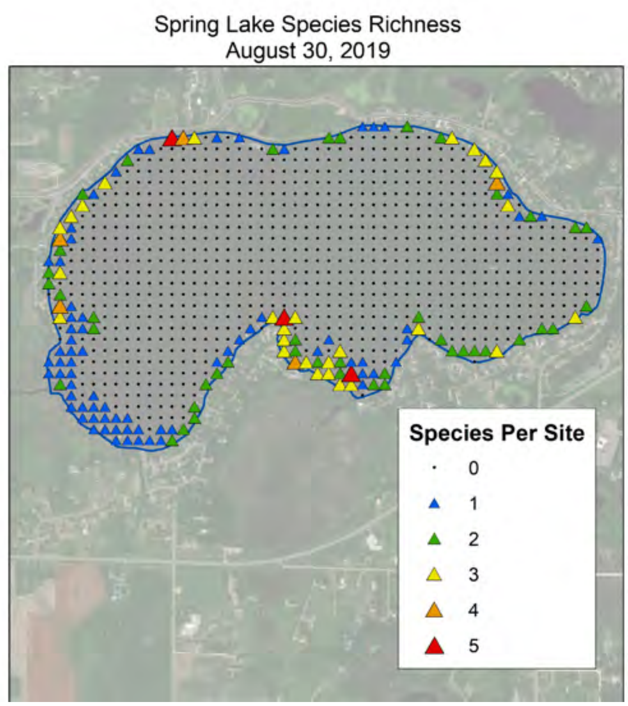


Figure S2. [left] Native plant distribution and abundance for the August 30, 2019 point intercept survey. [right] Species Richness for the August 30, 2019 point intercept survey.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2019

Introduction

Spring Lake has an area of 592 acres with a littoral area of 290 acres (source: MnDNR). The objectives of the plant surveys were to delineate and recommend areas to treat nuisance curlyleaf pondweed and to monitor the non-native and native plants over the summer.

A curlyleaf pondweed delineation survey was conducted on April 29, 2019.

Treatment occurred on May 20, 2019 and covered 15.17 acres.

A curlyleaf pondweed assessment was conducted on June 10, 2019.

A summer aquatic plant point-intercept survey was conducted on August 30, 2019 to check and inspect the native plant community in Spring Lake.

Figure 1. Rake sample of aquatic submerged plants sampled on June 10, 2019 in Spring Lake.

Survey Methods for Meandering and Line Transect Surveys: Determining what areas to treat to control excessive growth of curlyleaf pondweed has been an ongoing challenge. Curlyleaf growth in April and May is just starting to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season. Currently, for Spring Lake, the method has been to use past treatment history combined with early season scouting and then a recheck to evaluate any treatment effects and see if curlyleaf areas were missed. A meandering survey was used to delineate CLP and a meandering survey was combined with a line transect survey to assess the CLP treatment (Figure 2).

Meander Delineation Survey: A meandering survey consists of using a meandering path around the nearshore area of the entire lake. Visual inspection along with plant sampling was conducted. At each sample point, plants were sampled with a rake sampler.

Line Transect Survey: We used 25 line transects with 2 depths per transect. The same transects have been used from 2000 through 2019. Plants were sampled with a rake attached to a pole to characterize species presence and its density. A total of 50 sites were sampled (Figure 1). For the assessment transect survey, plant density was estimated on a scale of 1 to 3 with 3 being the densest.

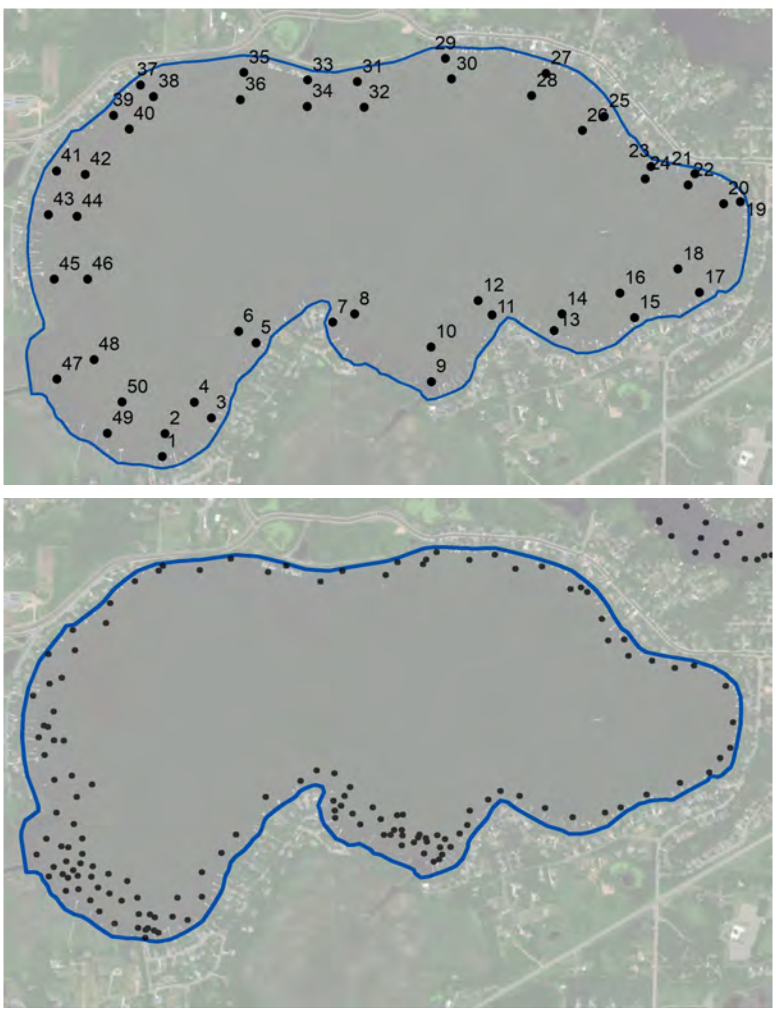


Figure 2. [top] Full lake transect survey sample sites; [bottom] meander GPS sample points. The transect survey can be used for year to year comparisons and the meander GPS surveys help target abundant and nuisance non-native species.

Survey Methods for the Point Intercept Survey: An aquatic plant point-intercept survey of Spring Lake was conducted by Blue Water Science on August 30, 2019. A total 222 points in the growing zone out to 15 feet were sampled. Sample points were spaced 50 meters apart on a grid that covered the lake (Figure 3). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, plant distribution maps were constructed.

Figure 3. Point-intercept sample sites for Spring Lake in 2018. Sample sites were spaced 50 meters apart.

Results of Curlyleaf Pondweed Delineation April 29, 2019: A curlyleaf delineation using a meandered survey collected a total of 144 GPS points around the lake. Curlyleaf was found at 29 out of 144 sites (Table 1 and Figure 4). Curlyleaf was observed growing in water depths of 3- 7 feet. At total of 15. 17 acres were delineated for treatment (Figure 4).

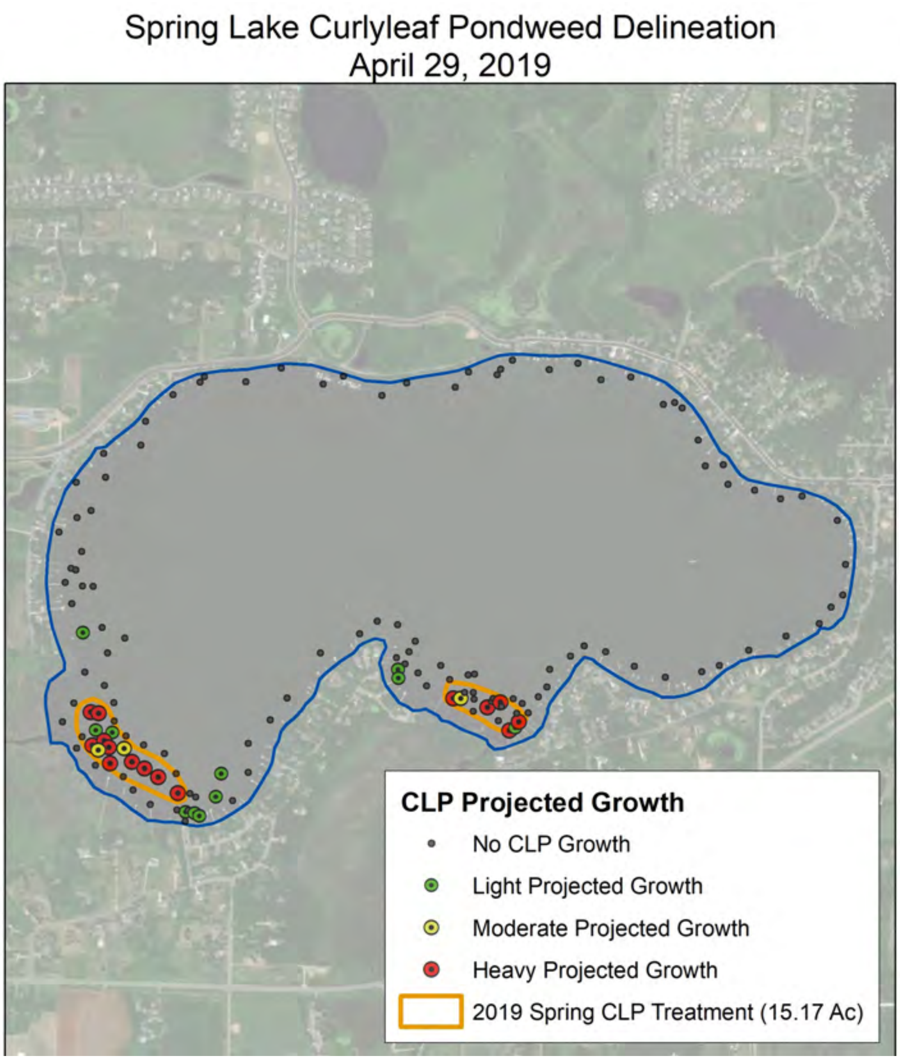


Figure 4. Map of curlyleaf pondweed for April 30, 2019. Colored sample areas indicate the growth in April of 2019 for curlyleaf pondweed. Key: green = light potential growth, yellow = moderate potential growth, red = heavy potential growth, and black dot = no curlyleaf.

Table 1. Aquatic plant densities based on rake sampling for April 29, 2019. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted.

Way point	Depth (ft)	CLP-stems	Chara	Coontail	Elodea	Water stargrass	No plants
1	4				1		
2	4	1					
3	5			1			
4	4	1		1			
5	3	1					
6	6						1
7	6	2		1			
8	3			1	1		
9	7	1					
10	5			1			
11	8						1
12	8						1
13	7						1
14	10						1
15	5						1
16	4						1
17	4					1	
18	8						1
19	7			1			
20	4						1
21	5		1	1			
22	4	2		1			
23	4	1		1			
24	5		1	1			
25	5		2				
26	8						1
27	6						1
28	5	4					
29	3	3					
30	4						1
31	5			1	1		
32	9						1
33	4						1
34	4						1
35	5						1
36	4	4					
37	5			1			
38	6			1			
39	5	6					
40	5			1	1		
41	4						1
42	4	6		2			
43	5	1		1			
44	5	4		1			
45	5			1			
46	7			1			
47	6						1
48	5			1			
49	7						1
50	6			1			
51	8						1
52	5						1
53	4						1
54	8						1
55	7						1
56	6						1
57	8						1
58	5					1	
59	6						1
60	8						1
61	5						1
62	9						1
63	6			1			
64	13						1
65	8						1
66	5						1
67	7						1
68	9					1	
69	6						1
70	4						1
71	7						1
72	5						1
73	4						1
74	5						1
75	7						1
76	5						1
77	12						1
78	5						1
79	7						1
80	5						1
81	7						1
82	10						1
83	7						1
84	10						1
85	4						1
86	8						1
87	4						1
88	9						1
89	5				1		
90	9						1
91	5						1
92	5						1
93	5						1
94	5						1
95	8						1
96	4						1
97	7						1
98	3						1
99	7						1
100	5						1
101	4						1
102	7						1
103	6						1
104	5			1			
105	7						1
106	7			1			
107	7						1
108	5			1			
109	5	1		1			
110	6			1			
111	7						1
112	6						1
113	4				1		
114	8						1
115	5			1	1		
116	4						1
117	6	10		1			
118	6	6		1			
119	8						1
120	8						1
121	7	1		1			
122	6	2					
123	4			1	1		
124	4			1			
125	5	6					
126	6	8					
127	6	6					
128	8						1
129	6	3		2			
130	5	6					
131	5	3					
132	4			1			
133	5			2			
134	6	5		1			
135	8						1
136	6	12					
137	5			2			
138	4			1			
139	6	12					
140	9						1
141	7						1
142	5	5		1	1		
143	4			1			
144	6						1
Average		4.2	1.3	1.1	1.0	1.0	
Occur (144 sites)		29	3	41	9	3	81
% occurrence		20	2	28	6	2	

Curlyleaf Pondweed Assessment, June 10, 2019: A curlyleaf assessment was conducted on June 10, 2019, the survey included meandering survey collecting 30 GPS points and a line-transect survey which collect data on 50 sites. Curlyleaf was found at 8 out of 80 of the total sites (Figure 5). Curlyleaf did not expand and the curlyleaf treatment was good. Results for individual sample sites are found in Table 2.

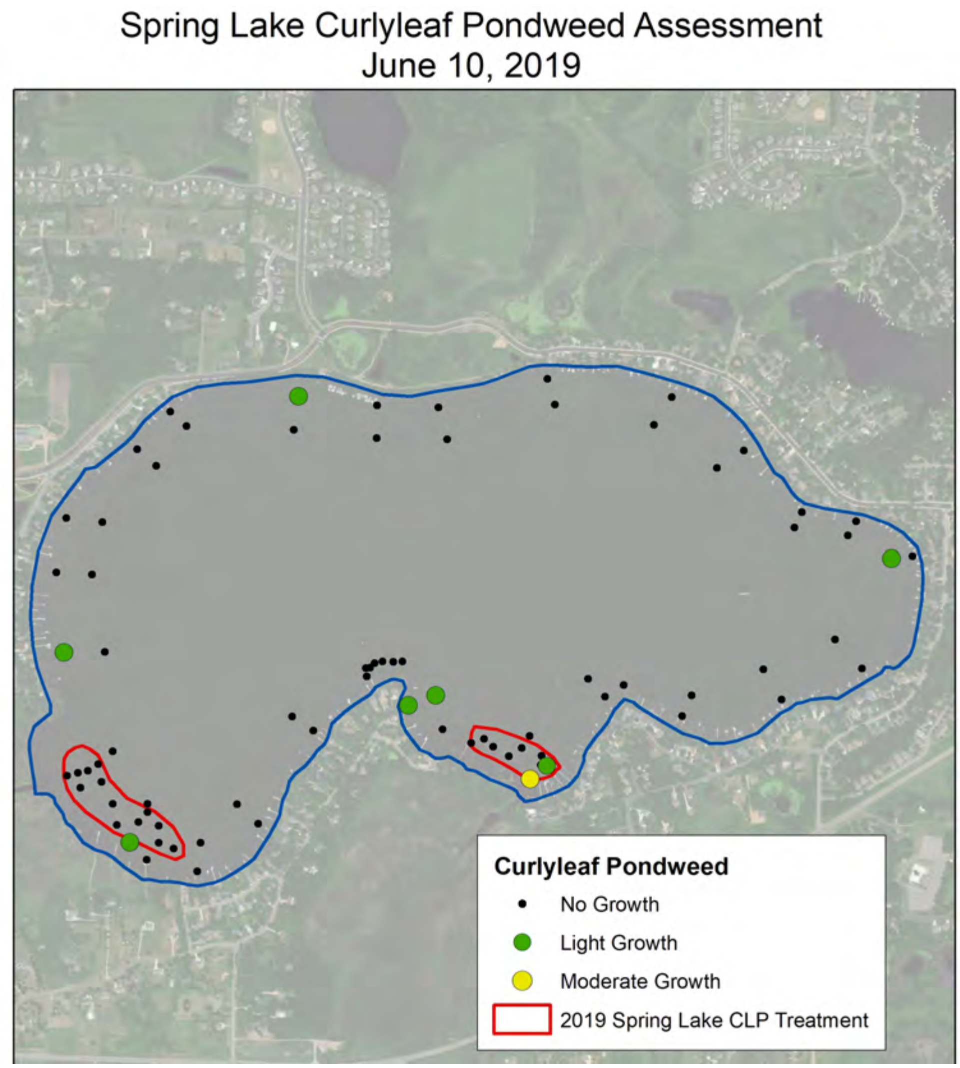


Figure 5. Curlyleaf pondweed assessment on June 10, 2019.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black = no curlyleaf.

Table 2. Aquatic plant densities based on rake sampling for June 10, 2019. Densities are based on a scale from 1 to 3 with 3 being the densest.

Way point	Transect Site	Depth (ft)	Chara	Claspingleaf	Coontail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
	1	5			1				1					
	2	7			1		1				1			
	3	5			1									
	4	7			1									
	5	5			1						1			
	6	7												1
	7	4		1	1	1						1	1	
	8	6			2	1					1		1	
	9	4			2	2								
	10	7			1									
	11	4									1			
	12	7						1						
	13	4			1						1	1		
	14	7											2	
	15	4			1						1	1	1	
	16													1
	17	4						1					1	
	18	8												1
	19	5					1						1	
	20	7				1	1	1			1		1	
	21	3		2				1			1			
	22	8												1
	23	4		1								1	1	
	24	7												1
	25	4	1	2							1		1	
	26	6												1
	27	5		2			1							
	28	7					1							
	29	4			1		2							
	30	7												1
	31	4			1					1			1	
	32	8												1
	33	4			1		1			1	1		1	
	34	7												1
	35	4		1		1	2							
	36	7					1							
	37	5			1						1			
	38	7			1									
	39	5			1						1			
	40	8												1
	41	4		1							1			
	42	7												1
	43	4			1		1				1			
	44	7			1									
	45	4			1	1					1			
	46	7			1		1							
	47	4			1					1				
	48	8												1
	49	5			1	1								
	50	7												1
1		4		2										
2		4		2										
3		5		2										
4		6		2										
5		5		1										
6		4			1									
7		5												1
8		5			1									
9		4		2				1						
10		4		2							1			
11		4		1							1			
12		3			1						2		1	
13		6												1
14		5			3									
15		4			3									
16		5			1	1								
17		4		3										
18		7												1
19		6			1		1							
20		4			1									
21		5			2									
22		6			1									
23		5			2									
24		5			1									
25		6			1									
26		7												1
27		6			1		1							
28		5			1									
29		4			1									
30		6			1									
ALL SITES:	Average		1.0	1.7	1.2						1.1		1.1	
	Occur (80 sites)		1	16	40						18		12	0
SITE: Average			1.0	1.4	1.1	1.1	1.2	1.0	1.0	1.0	1.0	1.0	1.1	
	Occur (50 sites)		1	7	23	7	11	4	1	3	15	4	11	13
	% occur		2	14	46	14	22	8	2	6	30	8	22	
WAYPOINT: Average			0.0	1.9	1.4	1.0	1.0	1.0	0.0	0.0	1.3	0.0	1.0	
	Occur (30 sites)		0	9	17	1	2	1	0	0	3	0	1	4

Curlyleaf Delineations for 2014 Through 2019: Full aquatic plant surveys using transects were combined with additional sampling to delineate areas of predicted heavy growth of curlyleaf in 2014 through 2019 (Figure 6). There appears to be a persistent bed of curlyleaf that grows on the south side of the lake, west of the public access and also on the south side of the mid-lake area. The hot spot map shows all treatment areas from 2014-2019 (Figure 6).

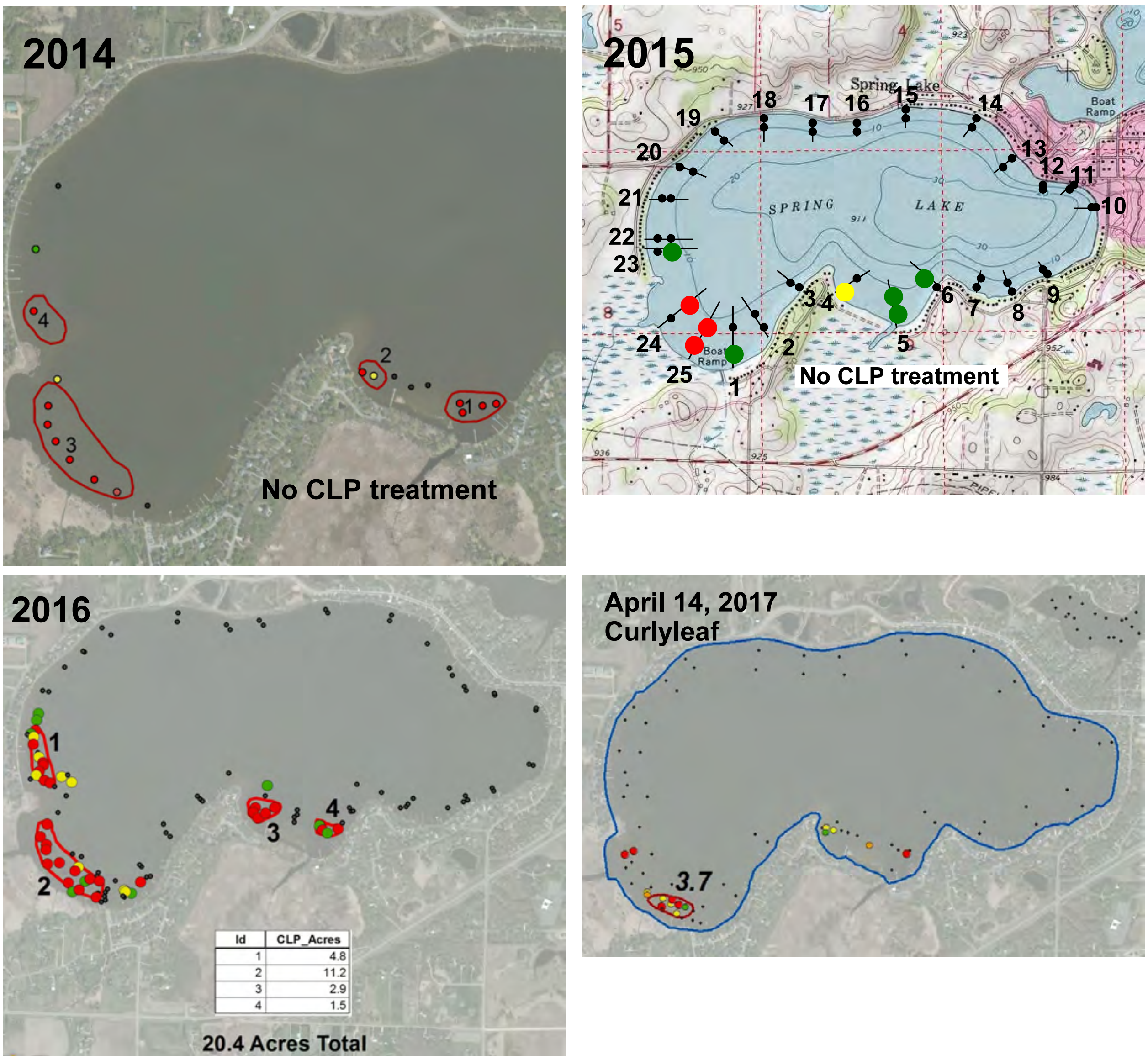
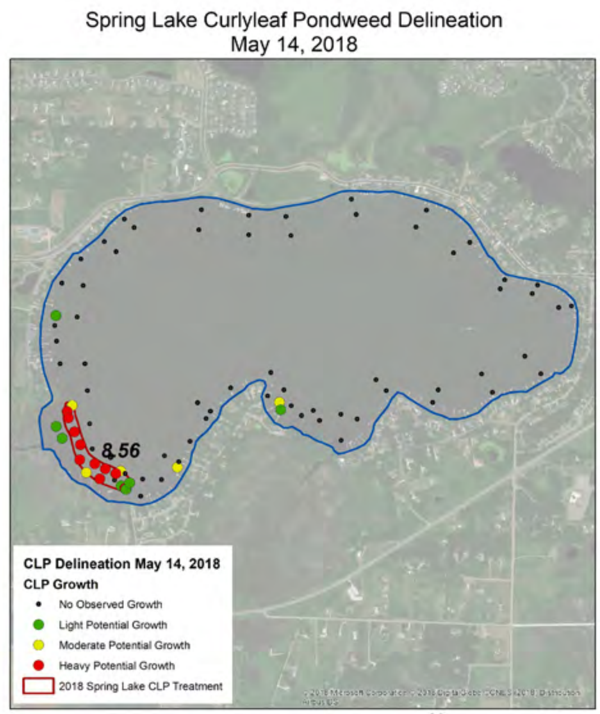
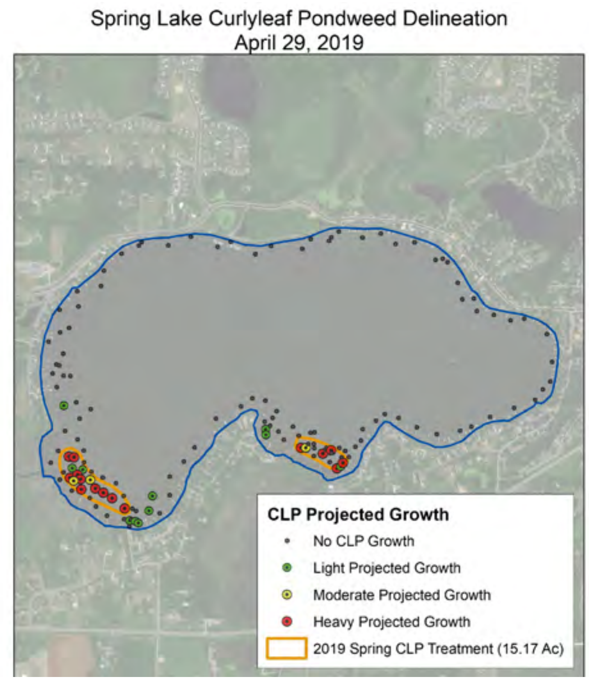


Figure 6. [top-left] Curlyleaf delineation in Spring Lake on May 21, 2014. [top-right] Curlyleaf delineation in Spring Lake on May 28, 2015. [bottom-left] Curlyleaf delineation in Spring Lake on April 20, 2016. [bottom-right] Curlyleaf delineation in Spring Lake on April 14, 2017.
Key: black dot = no curlyleaf, green dot = light curlyleaf growth, yellow dot = moderate growth, red dot = heavy growth, and red outline = treatment area.





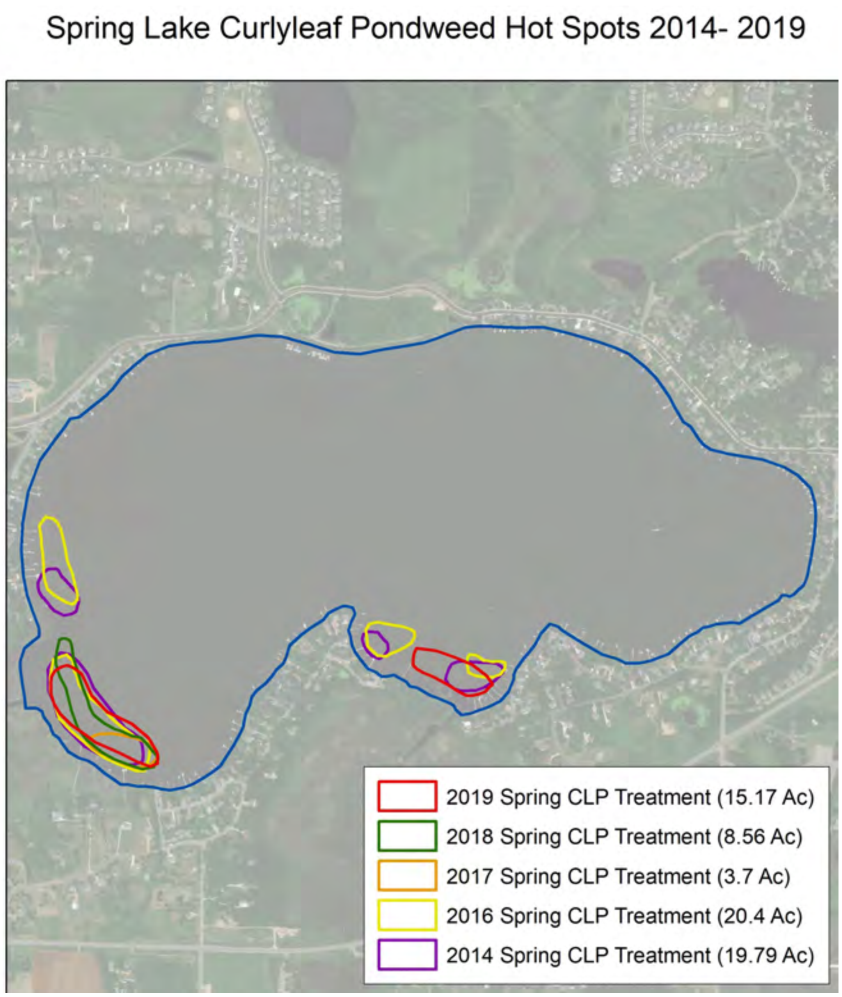


Figure 6. Concluded. [top left] Curlyleaf delineation in Spring Lake on May, 2018. [top right] Curlyleaf delineation on April 29, 2019 [bottom] Spring Lake Curlyleaf Hot Spot map, showing areas of CLP treatment 2014-2019 Key: Green dots = light curlyleaf growth, yellow dots = moderate growth, and red dots = heavy growth. Black dots = no curlyleaf.

Summary of Curlyleaf Pondweed 2000 to 2019

Curlyleaf pondweed growth has been variable from 2000 through 2018 but there has been less curlyleaf from 2007 through 2019 compared to the time frame of 2000 through 2006. There may be a correlation to the use of an iron dosing station on the County 13 ditch where ditch flows eventually enter Spring Lake and a reduction in Spring Lake curlyleaf. The amount of iron dosed is listed in Table 3. Likely only a small percentage of the dosed iron makes its way into Spring Lake. Iron in the water column that may inhibit CLP growth is speculative but heavy CLP growth, as shown in Figure 7, has not occurred since iron dosing has occurred in Spring Lake.

Table 3. Curlyleaf pondweed occurrence and acres either harvested or treated with herbicides from 2000 to 2018.

	Iron (kg)	$FeCl_3$ (gallons)	Curlyleaf Occurrence (based on 50 sites)	Harvesting Acres	Herbicide Treatment Acres	Total Curlyleaf Treatment (acres)
2000	?		49			
2001	?					
2002	?		43	60	14	74
2003	0	0	35	74	14	88
2004	0	0	40		59	59
2005	2,629	4,232	29		59	59
2006	895	1,440	32		59	59
2007	920	1,481	22			
2008	726	1,168	4			
2009	109	176	5			
2010	0	0	25			
2011	1,491	2,390	10			
2012	0	0	6			
2013	1,248 (J-A)	?	3			
2014	?	?	10			
2015	?	?	10			
2016	4,284	6,910	11		20.4	20.4
2017	3,286	5,300	11		3.7	3.7
2018	3,281	5,250	4			
2019					15.7	15.7

Figure 7. Curlyleaf pondweed growth was very heavy in 2000.

Curlyleaf Pondweed Density at Individual Sites from 2000-2019: Curlyleaf growth was found to growing inin 2018 (Table 4). From 2007 through 2015 and 2018 there were no open water herbicide applications except in 2016 and 2017.

Table 4. Summary of Curlyleaf Pondweed Distribution and Abundance from 2000 - 2018. For 2000-2017, curlyleaf density is shown on a scale from 0.5 - 5 (with 5 being most dense) for each depth zone on all 25 transects for each survey. In 2018 the density rating was on a scale of 1 to 3. Colors are coded for density. A sediment survey was conducted on Spring Lake in 2008. Predicted curlyleaf growth (far right column) has been close to actual curlyleaf growth conditions. Purple shading in transect column indicates transect areas that were harvested or treated with herbicides from 2002-2006 and 2016-2017 (blue shading for years of treatment). There has been no treatment from 2007-2015 and 2018.

Transect	Depth	2000 Jun 3	2002	2003	2004		2005		2006		2007		2008		2009		2010		Predicted growth based on lake soils
			Jun 7	May 15	May 2	Jun 14	Apr 20	Jun 1	Apr 26	Jun 2	Apr 15	Jun 5	Apr 29	Jun 13	Apr 23	Jun 10	Apr 27	Jun 2	
1	S	5	0.5	0	0	0	0	0	0	0	0	2	0	0	0.5	2	0	0	
	M	4	2	2	1	0	1	1	0.5	0	0	0	0.7	1	1	0	0	0	Heavy
2	S	4	0.5	0	0.5	0	0	2	1	0	0	0	0	0	0	0	0	0	
	M	5	2	4	0.5	0	0	0.3	0.7	0	0	1.8	0	1	0	0	0	0	Moderate
3	S	2	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0.5	1	Light
	M	4	2	0.5	0.5	0	0.5	1	0.8	0.5	0	1.5	0	0	0	0	0	0	Light
4	S	4	2	0.5	1	0	1	0	0	0	0	0	0.5	0	0	1	0	0	Moderate
	M	5	2.5	4	1	0	2	0.8	1.3	0.7	0	1	0	0.5	0	0	0	0	
5	S	2	2	0.5	1	0	2	1	1	0.5	0	0.7	0	0	0	0.5	1	1	
	M	5	3	2	2.5	0	0.5	0	2	1	0	0	0	0	0	0	1	1.3	Light
6	S	1.8	0	0	0.5	0	0	1	0	0	0	0	0	1	0	0	0	0	
	M	2	2	1	1	0	0.5	0.5	2	0.3	1	0	0	0	0	0	0.5	0	Moderate
7	S	1	0.5	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	
	M	4.5	1.5	1	0	0.5	0.5	1	1.8	1	0.5	1.5	0	0	0	0	0	0	Light
8	S	1	1	0	0.5	0	0.3	1	0	0	0	0	0	0	0	0	0.5	0	
	M	3	1	1	0	0	0.5	1	0	0.3	0	0	0	0	0	0.5	0	0	Moderate
9	S	4	0.5	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0.5	Moderate
	M	4	0.5	0.5	0.5	0	0	1	0.8	0.5	0.5	1.8	0	0	0	0.5	0	0.5	
10	S	2	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	
	M	4	0	0	0.5	0	0	0	0	0	0	1	0	0	0	0	0	0	Light
11	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	3	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
12	S	3	0.5	0	0.5	0	0	0	0	0	0	1	0	0	0	1	1	0	
	M	3	0.5	0	0.5	0	0	0	0	0	0	1	0	0.3	0	0	0	0	
13	S	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	2.7	1	0.5	0.5	0	0.5	0.7	1	1.7	0.8	3.5	0	3	0	0	0	0	Moderate
14	S	3	0.5	0.5	0.5	0	0	1	2	0.5	1	1	0	1	0	0	0.5	1	
	M	4	1.5	2	1	0	2	1.5	2	3	1	2.8	0	1.5	0	0	0.5	1	Moderate
15	S	2	1	0.5	2	0	0.3	1	1	2	0	3.5	0	1	0	2	1	1	
	M	2	0.5	3	1	1	1	1.5	1	2.5	1.3	2.8	0	2	0	0.3	1	1	Moderate
16	S	2	0	0.5	0.5	0	0.5	1	1.3	0	0	1	0	0	0	0	1	1	
	M	4	4	1	1	1	1	1	0.5	1.5	0.5	1.8	0	0	0	0	1	1	Moderate
17	S	2	1	0.5	1	0	1.5	1	1.5	2	0.5	0	0	0	0	0	1	0	Light
	M	4	2	2	1	0	1	0	1.5	1.7	0.3	2	0.3	0	0	0.3	1	1	
18	S	2	0	0.5	0.5	0	1	1	0	2	0.5	0	0	1	0	0	1	0	
	M	4	3	2	1	0	2	1.8	0.8	2.5	0.5	1	0.3	0	0	0	1	0	Light
19	S	3	1	3	0.5	0	0.5	1	0	3	0	1	0	0	0	0.5	1	1	
	M	5	1.5	2	0.5	0	0.3	0.3	0	0	0	0	0	0	0	0	0	1	Moderate
20	S	3	1	0.5	0.5	0	0	2	1.5	3	0.5	2.8	0	0	0	0	0.5	1	Moderate
	M	5	1.5	2	0.5	0	1.5	2	0.3	3	0.5	0	0	1	0.3	0	0.5	0.5	
21	S	2.5	0.5	0.5	0.5	0	0	1	0.5	3	0	1.5	0	0	0	1	1	0.5	Moderate
	M	5	2.5	3.5	0.5	0	2	0.5	1.3	3	0	4	0	0	0	0	0	0	
22	S	3	0.5	0	0	0	0	0	0.5	2	1	1	0	1	0	0	1	0	
	M	5	2	3	1	0	1	1	0.2	1	1	0	0	0	0	0	0.5	0	Moderate
23	S	2	1	0	0.5	0	0	0	0	1	1	0	0	0	0	1	0	1	
	M	4.7	4.5	3	0.5	0	1	1	0.8	1.3	0.5	1	0	0.5	0	0	0	0	Moderate
24	S	3	1	0.5	0.5	0	0	4	0.5	0	1	0	0	1	1	2	0	1	
	M	5	1.5	4	2	0	1.5	0.5	0.5	1.3	0.5	0	0	1	0	0	1	1	Moderate
25	S	2	1	0.5	0.5	0	1	2	1.8	2	1	0.5	0	1	1	1	0	2	
	M	4.7	3	4	0	0	1	1	1.7	0.5	0	0	0	1	0	0	1	0	Moderate
Number of Reds		23	2	4	0	0	0	1	0	0	0	1	0	0	0	0	0	0	
Number of Sites		49	43	35	40	3	29	37	32	32	22	29	4	19	5	14	25	21	

Depth Zones: S = 0 - 4 feet; M = 5 - 8 feet

Table 4. Concluded.

Transect	Depth	2011		2012		2013		2014		2015		2016		2017		2018		2019	Predicted growth based on lake soils
		May 12	Jun 10	Apr 17	Jun 5	May 29	Jun 24	May 21	June 19	May 28	Jul 30	Apr 20	June 1	Apr 14	Jun 1	May 14	Jun 18	June 10	
1	S	0	0	0	0	1	1	0	1	2	0	1	1	0	0	0	1	0	
	M	0	0.5	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	Heavy
2	S	0.5	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	
	M	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
3	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Light
	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	Light
4	S	0	0.5	0	0	0	0	2	1	3	0	4	0	0	1	0	2	1	Moderate
	M	0	0.5	0	0	0	1	0	0	0	1	1	0	0	0	0	2	1	
5	S	0	2.5	0	0	0	0	2	2	2	0	0	0	0	0	0	1	2	
	M	0	0.3	0	1	0	3	2	0	2	1	0	0	0	0	0	1	0	Light
6	S	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
	M	0	0	0.5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	Moderate
7	S	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	Light
8	S	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
9	S	0	2	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	Moderate
	M	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
10	S	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	
	M	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	Light
11	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
12	S	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	
	M	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	
13	S	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
	M	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	Moderate
14	S	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
15	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	0.5	0.5	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	Moderate
16	S	0	0.8	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	
	M	0	0.5	0	0.5	0	0	0	0	0	1	0	0	0	0	0	0	0	Moderate
17	S	0	0.5	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	Light
	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
18	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	M	0.5	0.5	0.3	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	Light
19	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	0	0	0.5	0	0	1	0	0	0	1	0	0	0	0	0	0	0	Moderate
20	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	Moderate
	M	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	
21	S	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	Moderate
	M	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	S	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	
	M	0	0	0	0	0	0	1	1	0	0	3	1	0	0	0	1	0	Moderate
23	S	0.5	0	0	0	0	0	2	1	0	0	1	0	0	1	0	1	1	
	M	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	1	0	Moderate
24	S	0	0	0	0	0	0	2	1	4	0	3	0	0	0	1	1	0	
	M	0	0	0	0	1	1	3	1	4	1	3	0	0	1	0	0	0	Moderate
25	S	0.5	1	0	0	0	2	1	1	5	1	2	0	1	2	3	3	0	
	M	0	0.8	0	0	1	3	1	3	5	1	0	0	0	2	0	0	1	Moderate
Number of Reds		0	0	0	0	0	0	0	0	4	0	1	0	0	0	1	1	0	
Number of Sites		10	18	6	8	3	12	10	18	10	12	11	9	1	11	4	13		

Depth Zones: S = 0 - 4 feet; M = 5 - 8 feet

Peak Curlyleaf Abundance from 2007 Through 2019-Typically June

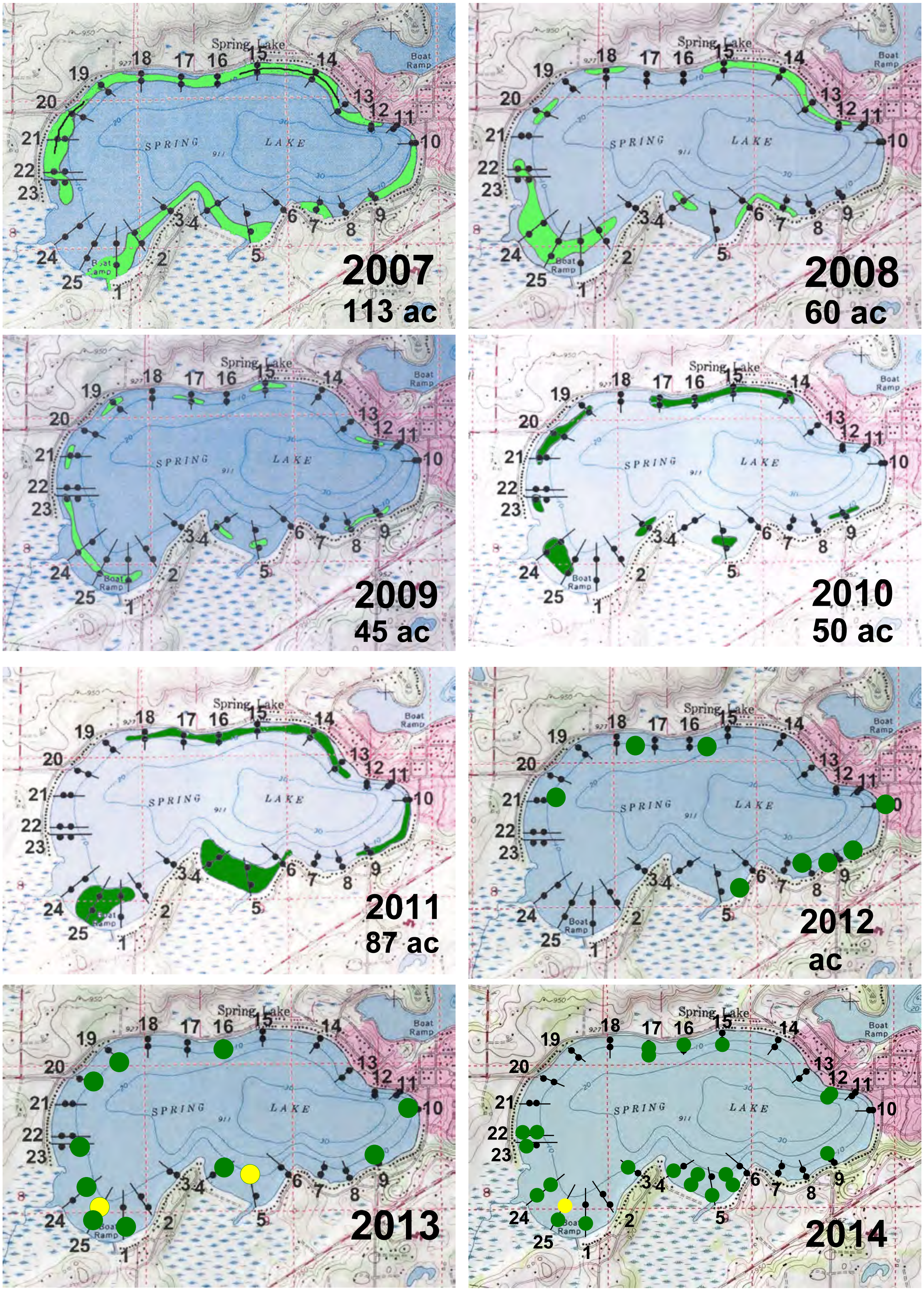


Figure 8. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2017.

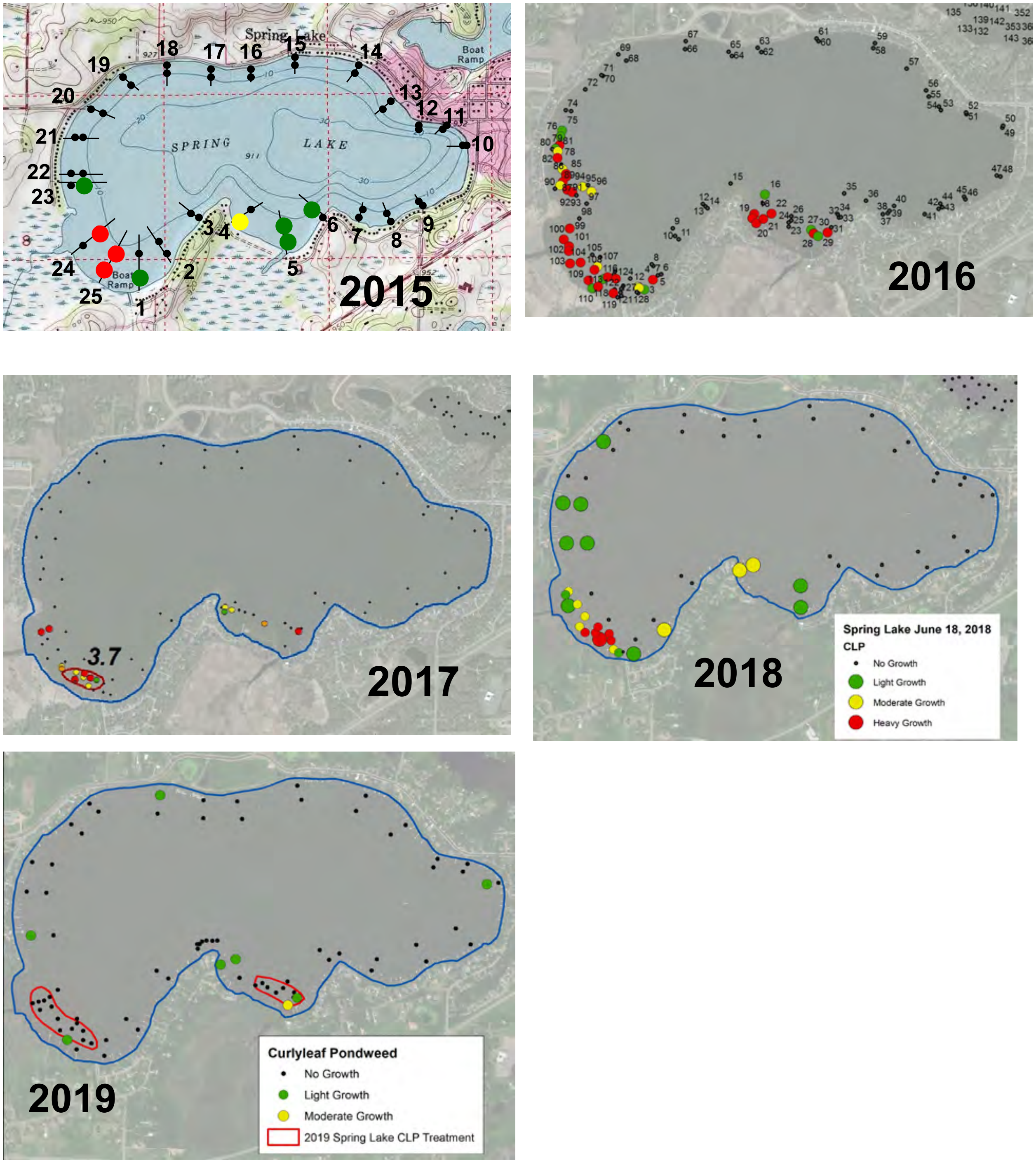


Figure 8. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2019.

Results - Point Intercept Aquatic Plant Survey on August 30, 2019:

Results of the summer aquatic plant survey conducted on August 30, 2019found 10 submerged aquatic plant species, CLP was not present in August. Plant growth was restricted to water depths of 8 feet or less in Spring Lake (Table 5). Native plants were found around the perimeter of the basin of Spring Lake. Plant distribution and abundance are shown in Table 5.

Table 5. Spring Lake aquatic plant occurrence and density for the August 30, 2019 survey based on 214 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

Spring Lake August 30, 2019	All Stations (n=214)		
	Occur	% Occur	Average Density
White water lilies (*Nymphaea ordata*)	10	5	1.0
Coontail (*Ceratophyllum demersum*)	104	47	1.3
Chara (*Chara sp*)	4	2	1.3
Moss (*Drepanocladus sp*)	5	2	1.0
Elodea (*Elodea canadensis*)	7	3	1.0
Naiads (*Najas flexilis*)	21	9	1.1
Curlyleaf pondweed (*Potamogeton crispus*)	--	--	--
Claspingleaf pondweed (*P. Richardsonii*)	22	10	1.1
Stringy pondweed (*P. sp*)	8	4	1.0
Sago pondweed (*Stuckenia pectinata*)	20	9	1.1
Water celery (*Vallisneria americana*)	50	23	1.3
Water stargrass (*Zosterella dubia)*	23	10	1.0

Spring Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 6 and 7 and Figure 9. A total of 214 points were sampled and plants were found out to 8 feet of water. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 6. MnDNR Template Statistics

Total # Points Sampled	214
Depth Range of Rooted Veg	1-8 feet
Maximum Depth of Growth (95%) in feet	5.0
# Points in Max Depth Range	214
# Points in Littoral Zone (0-15 feet)	222
% Points w/ Submersed Native Taxa	68%
Mean Submersed Native Taxa/Point	0.89
Mean Density of Submersed Native Taxa	1.1
# Submersed Native Taxa	10

Table 7. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled	% Sampling points with submersed species observed
0		
1	5	80%
2	30	97%
3	59	98%
4	36	89%
5	34	80%
6	31	3%
7	10	10%
8	9	11%
9	3	0%
10	1	0%
11	0	0%
12	1	0%
13	1	0%
Sites with Plants	214	

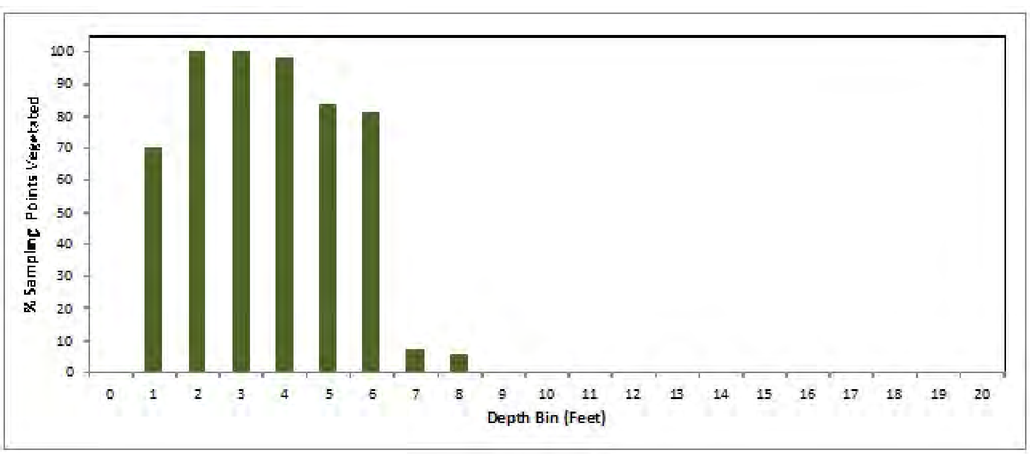
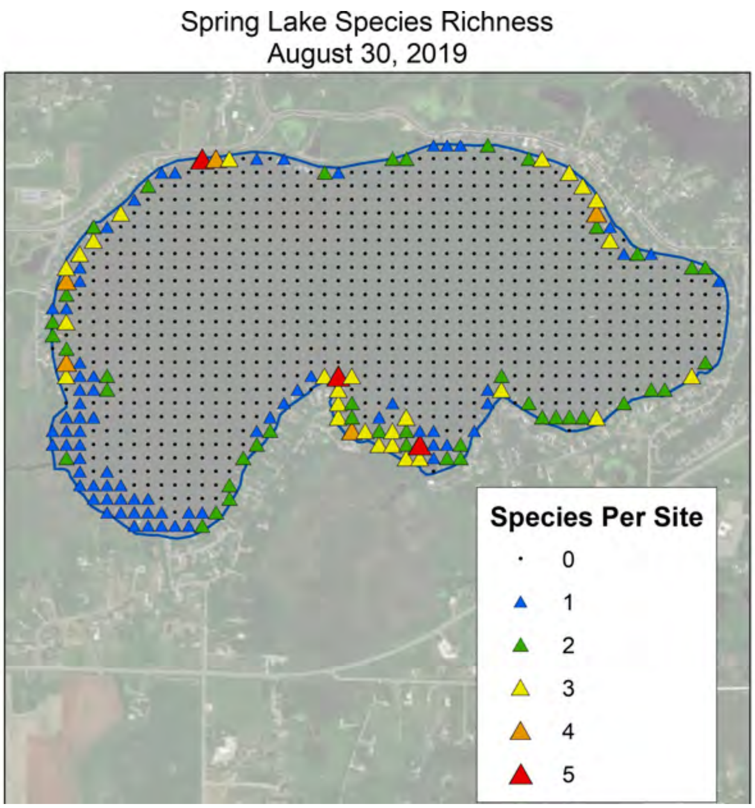


Figure 9. Depth of plant colonization (in feet).

Aquatic Plant Maps: Coverage of the select native plants species found in the August survey are shown in Figures 10 and 11. Native plant coverage was estimated at of the lake area in 2019 (Figure 10).



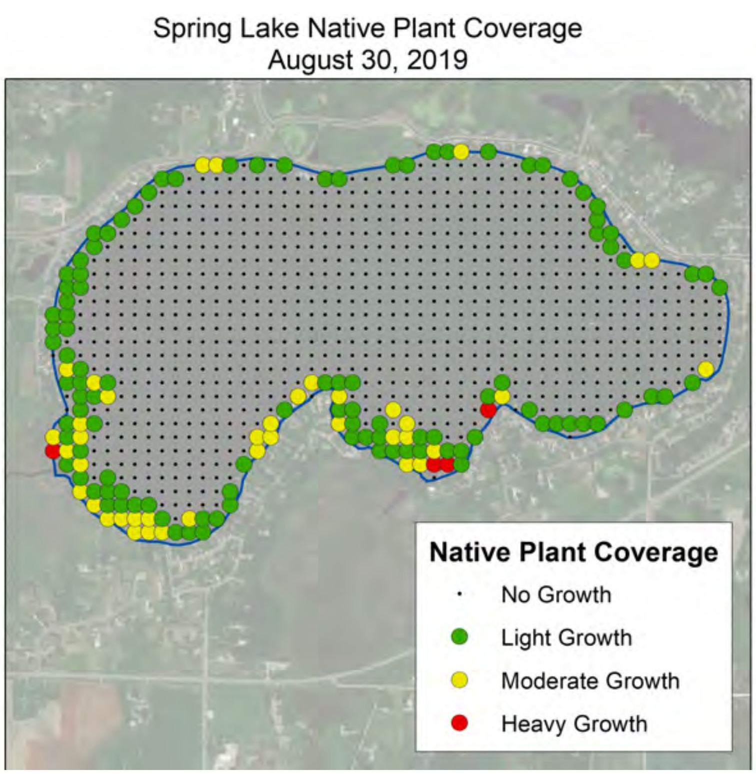


Figure 10. Distribution and abundance maps for native submerged aquatic plant species. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

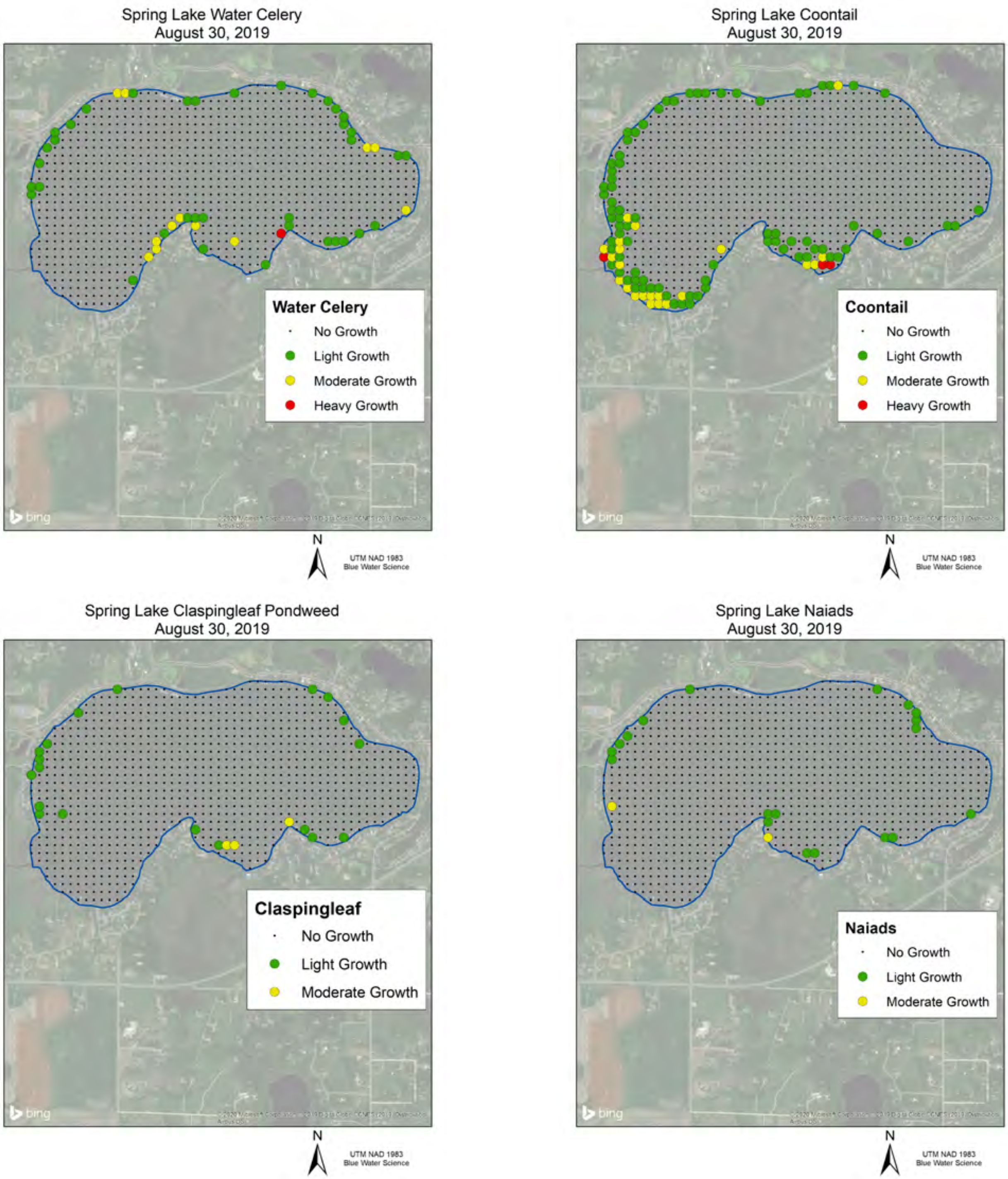


Figure 11. Distribution and abundance maps for select submerged aquatic plant species. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Comparison of 2015, 2018, and 2019 Point Intercept Surveys

Point intercept surveys were conducted in 2015 and 2018 and results are shown in Table 8. In 2015, elodea was the dominant plant and in 2018 it was coontail. Several species decreased in occurrence from 2015 to 2018 including stringy pondweed and sago pondweed. Several species increased including coontail, claspingleaf pondweed, water celery, and water stargrass. Also the number of submerged plant species increased from 10 in 2015 to 13 in 2018 (Table 8).

Table 8. Spring Lake aquatic plant occurrence for the point intercept surveys conducted in 2015 and 2018.

	2015 % Occur (113 sites)	2018 % Occur (248 sites)	2019 % Occur (214 sites)
Cattails (*Typha sp*)		1	
Duckweed (*Lemna sp*)		1	
White water lilies (*Nymphaea ordata*)		1	5
Coontail (*Ceratophyllum demersum*)	15	56	47
Chara (*Chara sp*)	4	2	2
Chara - 2 (*Chara sp*)		1	
Moss (*Drepanocladus sp*)		1	2
Elodea (*Elodea canadensis*)	42	36	3
Naiads (*Najas flexilis*)	21	23	9
Curlyleaf pondweed (*Potamogeton crispus*)	12	6	0
Claspingleaf pondweed (*P. Richardsonii*)	4	10	10
Stringy pondweed (*P. sp*)	29	7	4
Sago pondweed (*Stuckenia pectinata*)	17	11	9
Bladderwort (*Utricularia vulgaris*)		1	
Water celery (*Vallisneria americana*)	9	20	23
Water stargrass (*Zosterella dubia)*	5	12	10
Number of submerged species	10	13	10

Native Plant Coverage Comparisons : Native aquatic plant distribution may have decreased slightly from 2015 to 2019 based on point intercept survey results (Figure 12). In 2015, plants grew to a depth of 9 feet and covered an estimated 175 acres of the lake (29%). In 2018, plants were found out to a depth of 8 feet and covered an estimated 122 acres of the lake (198 sites with plants 21%). In 2019, plant coverage was estimated at 98 acres or about 17% of the lake area (150 sites with plants).

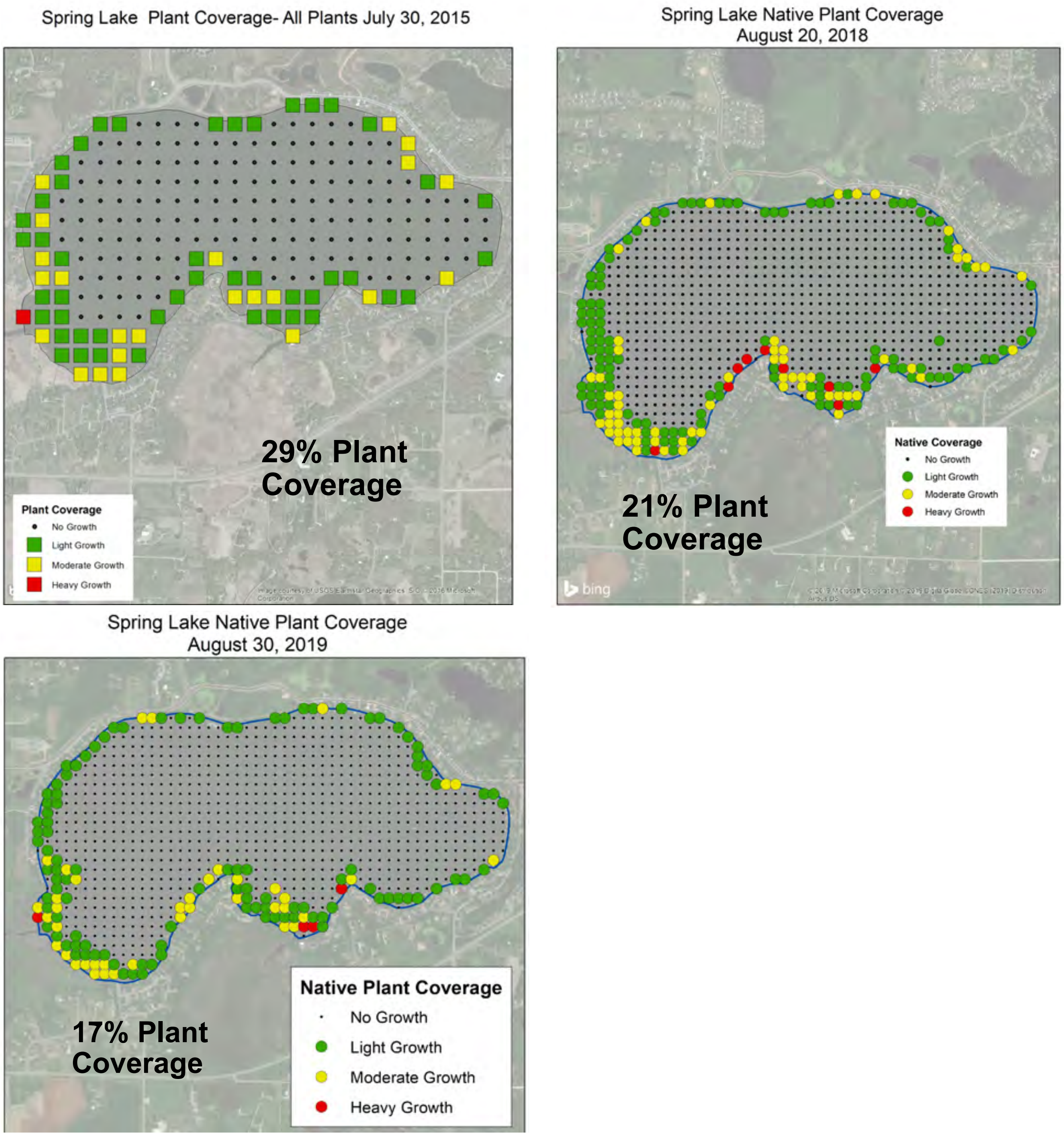


Figure 12. [top left] All plants distribution and abundance for the point intercept survey July 30, 2015. [top right] Native plant distribution and abundance for the August 20, 2018 point intercept survey. [bottom left] Native Plant distribution and abundance for the August 30, 2019 point intercept survey. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Summary of Aquatic Plant Surveys from 1948 - 2018

Since 1948, specific plant species in Spring Lake have appeared and disappeared (Table 9). For a number of years, stringy pondweed, likely a *P. pusillus*, was the dominant plant species. However, in 2018, coontail was the dominant plant (Table 9).

The number of aquatic plant species has range from a low of 5 to a peak of 13 which was recorded in 2018 (Table 9).

A summary of the percent occurrence of aquatic plant species for surveys from 1948 through 2018 is shown in Table 10.

Table 9. Aquatic plant status for 1948 to 2018.

	Dominant Plant Occurrence (% occurrence based on transect surveys, except for 2015 and 2018)	Dominant Species in Mid Summer Survey	Number of Plant Species
1948	Rare (MnDNR)	All rare	7
1973	Rare-Common (MnDNR)	5 - common	8
1982	Rare-Common (MnDNR)	Coontail	8
1986	Present (MnDNR)	3 species	5
1988	Present-Occasional (MnDNR)	Sago + water stargrass	8
2000	40	Curlyleaf	9
2002	36	Sago	9
2004	68	Elodea	9
2005	76	Elodea	9
2006	48	Coontail	8
2007	30	Coontail	6
2008	24	Stringy	9
2009	66	Stringy	9
2010	34	Stringy	7
2011	64	Stringy	6
2012	72	Stringy	4
2013	19	Stringy	5
2014	48	Stringy	5
2015	42 (PI survey)	Elodea	10
2016	38	Elodea	6
2017	86	Stringy	8
2018	56 (PI survey)	Coontail	13
2019	47 (PI survey)	Coontail	10

Table 10. List of aquatic plants found in past surveys. Surveys from 1948 to 1988 were conducted by MnDNR. Surveys in 2000 and 2002 through 2019 were conducted by Blue Water Science. Numbers for plant species in 2000 and 2002 through 2019 represent percent occurrence. Key: A = Abundant, C = Common, O = Occasional, P = Present, R = Rare, and X = Present

Year	1948	1973	1982	1986	1988	2000		2002		2003	2004			2005			2006		
Date (month.day)	9.18	7.9	8.16	7.2	8.15	6.3	9.3	6.7	9.3	5.15	5.2	6.14	8.27	4.20	6.1	8.18	4.26	6.2	9.1
Secchi disc (ft)	2.6	3.0	3.3	--	2.5	7.0					7.1	7.2	3.5	16.7	6.9	2.0	4.7	5.0	2.0
Lesser duckweed (*Lemna minor*)				X	R														
Duckweed (*Lemna sp*)			O													6			
White waterlilies (*Nymphaea sp*)																			
Greater duckweed (*Spirodela polyrhiza*)				X									2						
Coontail (*Ceratophyllum demersum*)	R	O	A	X	O		29	4	22		13	28	40	8	14	58	16	26	50
Chara (*Chara sp*)							4		2			4							
Elodea (*Elodea canadensis*)			O		O		25	8	18	6	25	48	68	22	54	76	64	68	48
Moss (*Drepanocladus sp*)																			
Star duckweed (*Lemna trisulca*)		C																	
Naiads (*Najas flexilis*)																			
Berchtold's pondweed (*Potamogeton berchtoldi*)	R	O																	
Curlyleaf pondweed (*P. crispus*)			R	X		98	40	86	4	72	78	6	10	58	72	12	64	64	2
Variable pondweed (*P. gramineus*)	R	C	O																
Floatingleaf (*P. natans*)	R	C			P														
Stringy pondweed (*P. pusillus*)							2	6	8	2			4		6	8		20	
Claspingleaf (*P. Richardsonii*)	R	C			O				10				6		2	4		2	4
Stringy pondweed (*P. strictifolius*)																			2
Narrowleaf pondweed (*P. sp*)			O	X															
Sago* (*Stuckenia pectinata*)	R	C			C	40	15		36	2		24	6		6	14			6
Bladderwort (*Utricularia sp*)																			
Wild celery (*Vallisneria americana*)			O		P		6		16			2	22		2	32		2	18
Mud plantain* (*Zosterella dubia*)	R	R	C		C		17		22				24			30			4
Number of submerged species	7	8	7	3	7	2	8	4	9	4	3	6	9	3	7	9	3	6	8

* Stuckenia pectinata = Potamogeton pectinatus   Mud plantain = water stargrass   Zosterella dubia = Heteranthera dubia

Table 10. Continued.

Year	**2007**			**2008**			**2009**			**2010**		**2011**		**2012**		**2013**		**2014**	
Date (month.day)	4.15	6.5	7.13	4.29	6.12	8.13	4.23	6.10	8.19	4.27	6.2	5.12	6.10	4.17	6.5	5.29	6.24	5.21	6.19
Secchi disc (ft)				2.3	3.9		3.5	6.2	2.9		2.2		5.6					15.5	
Lesser duckweed (*Lemna minor*)			2																
Duckweed (*Lemna sp*)																			
White waterlilies (*Nymphaea sp*)																			
Greater duckweed (*Spirodela polyrhiza*)																			
Coontail (*Ceratophyllum demersum*)	22	28	30	8	30	16	4	8	24	18	26	16	22	4	30	3	6		16
Chara (*Chara sp*)		2				8		2		12									
Elodea (*Elodea canadensis*)	20	6	2			4			4	2	2	2	4	2			2		
Moss (*Drepanocladus sp*)				1															
Star duckweed (*Lemna trisulca*)																			
Naiads (*Najas flexilis*)									6										
Berchtold's pondweed (*Potamogeton berchtoldi*)																			
Curlyleaf pondweed (*P. crispus*)	44	58		5	38	8	10	28	18	50	42	20	36	14	16	5	23	20	36
Variable pondweed (*P. gramineus*)																			
Floatingleaf (*P. natans*)																			
Stringy pondweed (*P. pusillus*)		26																	
Claspingleaf (*P. Richardsonii*)		2	2		2	2		2	6		4		2			2			
Stringy pondweed (*P. sp*)	2		2			24		14	66	52	34		64	36	92	5	16		48
Narrowleaf pondweed (*P. sp*)								2											
Sago* (*Stuckenia pectinata*)		8	2	1	24	8		24	20		26						16		6
Bladderwort (*Utricularia sp*)																			
Wild celery (*Vallisneria americana*)		6	12			18		2	18		4		2		6				10
Mud plantain* (*Zosterella dubia*)						8			24										
Number of submerged species	4	8	6	4	4	9	2	8	9	5	7	3	6	4	4	4	5	1	5

* Stuckenia pectinata = Potamogeton pectinatus   Mud plantain = water stargrass   Zosterella dubia = Heteranthera dubia

Table 10. Concluded.

Year	2015		2016		2017		2018			2019		
Date (month.day)	5.28	7.30	4.20	6.1	4.14	6.5	5.14	6.18	8.20	4.29	6.10	8.30[1]
Secchi disc (ft)		4.5										
Lesser duckweed (*Lemna minor*)												
Duckweed (*Lemna sp*)								2	1			
White waterlilies (*Nymphaea sp*)									1			5
Greater duckweed (*Spirodela polyrhiza*)												
Coontail (*Ceratophyllum demersum*)		15		32	8	46	8	38	56	41	46	49
Chara (*Chara sp*)		4		2	6	4	2		2	3	2	2
Chara - 2 (*Chara sp*)	6	42		38					1			
Elodea (*Elodea canadensis*)					12	16	10	18	36	9	22	3
Moss (*Drepanocladus sp*)					2				1		8	2
Star duckweed (*Lemna trisulca*)		21						2				
Naiads (*Najas flexilis*)									23		2	10
Berchtold's pondweed (*Potamogeton berchtoldi*)	22	12	50	18								
Curlyleaf pondweed (*P. crispus*)					2	26	8	26	6	29	14	
Variable pondweed (*P. gramineus*)												
Floatingleaf (*P. natans*)												
Stringy pondweed (*P. pusillus*)		5										
Claspingleaf (*P. Richardsonii*)	12	29		38		2			10		14	10
Stringy pondweed (*P. sp*)						86		62	7		30	4
Narrowleaf pondweed (*P. sp*)		17										
Sago* (*Stuckenia pectinata*)									11		6	9
Bladderwort (*Utricularia sp*)		9							1			
Wild celery (*Vallisneria americana*)		5		4		4		12	20		8	23
Mud plantain* (*Zosterella dubia*)	3	10		6		4		10	12	3	22	11
Number of submerged species	4	11	1	7	5	8	4	8	13	5	11	10

* Stuckenia pectinata = Potamogeton pectinatus   Mud plantain = water stargrass   Zosterella dubia = Heteranthera dubia

[1]Point Intercept Survey

APPENDIX

Individual sample site data for sites sample in Spring Lake point intercept surv ey on August 30, 2019.

Site	Depth (ft)	White lilies	Chara	Claspingleaf	Coontail	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
1	2				2								
2	3				2								
3	3				2								
4	3				1								
5	4				1								
6	3				1				1				
7	2				2								
8	3				2								
9	3				2								
10	4				2								
11	5				1								
12	5												1
13	5				2								
14	5				1								
15	3				1					1			
16	3				2								
17	3				1								
18	4				1								
19	5				1								
20	5				1								
21	6												1
23	6												1
24	6												1
25	5												1
26	2				1					1			
27	2				2								
28	2				1								
29	4				1								
30	5				1								
31	6												1
32	6												1
34	6												1
35	7												1
36	7												1
37	6												1
38	4				1						1		
39	3				1								
40	4												1
41	5				1								
46	9												1
49	7												1
50	6												1
52	2				1	1							
53	3				2								
54	5												1
55	6												1
64	7												1
65	4				1							1	
66	1	1			2				1				
67	1	1			2	1							
68	3				3								
69	3				3	1							
70	2	1									1		
71	2				3								
72	3				2								
73	4				1								
74	6												1
84	9												1
85	6												1
86	3								2		2		
87	1	1	1						1				
88	2	1			1				1				
89	1.5				1			1					
90	2	1				1		1	1			1	
91	4				2								
92	5				1								
93	3	1			1								
94	2				2								
95	2				1								
96	4				2								
97	6												1
109	5				2								
110	3								1		2		

Site	Depth (ft)	White lilies	Chara	Claspingleaf	Coontail	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
111	2	1							1		1	1	
112	3	1			1	1							
113	2			1					1				
114	3			2					1			1	
115	3			2								1	
116	5				1								
117	5				1								
118	6												1
119	6												1
120	2				1								
122	2				1								
123	3				2								
124	5				1								
137	4										2		
138	3				1			2	1				
139	3				1				1				
140	5												1
141	5				1								
142	4												1
143	4				1				1		2		
144	7												1
145	8												1
146	8												1
147	8												1
148	6.5												1
149	2			1				1					
150	2							1				1	
151	3										1	1	
152	5				1						1		
153	3			1							1	1	
155	3				1								
156	6												1
170	4										1		
171	3	1		1	1								
172	4				1				1				
173	6												1
174	6												1
175	8		2										
181	8												1
182	3										3		
183	2												1
184	3			1	1								
185	6												1
189	8												1
190	7												1
191	2										1	1	
193	2				1								
194	3				1								
195	4				2					1			
209	4										2		
210	land												1
211	2							1			2	1	
212	4												1
214	8												1
215	9												1
222	5				1								
223	2			2							1	1	
224	7												1
225	8												1
233	7												1
234	5				1						1		
235	5				1							1	
236	2			1	1				1				
237	4				1								
238	5				2								
239	2			1	1								
240	5												1
254	4										2		
255	3		1								1	1	
256	3					1		1	1		1	1	
257	3							1			1	1	
267	8												1
268	6						1				1		
281	6												1
282	3		1				1	1					
283	3			1	1			2		1			
284	5				1								
285	5.5												1
286	6												1
330	4				1						2		
331	1												1

Site	Depth (ft)	White lilies	Chara	Claspingleaf	Coontail	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
332	4				1					1			
333	6												1
335	7												1
380	3												1
381	2				1						1		
382	3												1
393	6												1
430	7												1
431	2				1						1		
432	4				1					1	1		
433	6												1
480	10												1
481	2			1									
482	3				1								
483	6												1
530	13												1
531	3			1	1								
532	6												1
579	12												1
580	3			1	1			1			1		
581	5				1								
628	4						1						
629	2			1				1	1				
630	5				1								
675	5										1	1	
676	3						1				1		
677	3			1				1			1		
717	5			1									
718	4										2	1	
719	3										2		
720	4				1			1			1		
758	4						1		1		1		
759	3												1
760	2				1						1		
761	4				1								
797	5							1				1	
798	3										1		
799	3				1			1			1		
834	3			1				1			1	1	
835	4			1									
860													1
869	3							1			1	1	
870	4				1						1		
901	6												1
902	3							1			1	1	
903	3				1								
904	5				1								
915	4				1						1		
916	4										1		
917	5												1
932	6												1
933	3			1							1	1	
934	3			1	1	1		1			2		
935	3				1				1	1	2		
936	4				1					1	1		
937	6												1
938	5				1								
939	4												1
940	4				1								
941	3				1							1	
942	4				1						1		
950	6												1
951	5							1	1				
952	3			1	1						1		
953	3				1								
954	3				1								
955	3				2								
956	3				1						1		
Average		1.0	1.3	1.1	1.3	1.0	1.0	1.1	1.1	1.0	1.3	1.0	
Occur (214 sites)		10	4	22	104	7	5	21	20	8	50	23	72
% occur		5	2	10	49	3	2	10	9	4	23	11	

Individual sample site data for sites sample in Spring Lake point intercept surv ey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
1	2								2		1								
2	3								1		1								
3	3								3		1								
4	3								2	1	1							1	
5	3								1	1	1								
6	2								1		2								
7	3								2		1								
8	3								2		1								
9	3								2		1								
10	3								1		1								
11	4								2										
12	5								1		1				1				
13	5								1	1	1								
14	4								1	1	2								
15	2							1	1		1			1		1			
16	2								2		1							1	
17	3								2	1	1							1	
18	4								2	1	1								
19	4								2										
20	5								1	1									
21	6								2		1				1				
22	6								1	1					1				
23	5								1										
24	5								1										
25	4								2						1				
26	2								1		2			1					
27	2								2									1	
28	3								2		1								
29	4								2		1								
31	5								1	1									
32	6								1										
33	7																		
37	5																		1
38	3								1		1		1			1			
39	3								1										
40	4								1		2								
41	4								2		1								
42	6										1								
43	7																		1
50	5										1								
51	1			1					2									1	
52	2								1		1								
53	2								1										
54	5								1	1									
55	6								2										
56	7																		1
64	7																		1
65	3												1				2		
66	1							1	1				1						
67	1		2						1					1				1	
68	2		1	2	1				3		1								
69	3								1	1									
70	2		2	1					1		1								
71	2								1		1								
72	2								1		1								
73	3								1	1	1								
74	5								2										
75	6								2										
76	8																		1
85	6									1	1		1						
86	3								1		1		1	1		1			
87	1	3																	
88	2							1	2					1					
89	1							1	1				1						
90	2								2		1			1	1				
91	4								2										

Individual sample site data for sites sample in Spring Lake point intercept surv ey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
92	4								2	1	1						1		
93	2								1				2		1		1		
94	2								1										
95	3								1										
96	4								1										
97	5								1										
98	7																		1
99	8																		1
108	9																		1
109	4								1		1		1	1	1	1			
110	3								1		1		2	1		3	1		
111	3								2									1	
113	3							2											
114	2							1	1					1					
115	3																1	1	
116	4								3										
117	5								1						1			1	
118	6								1										
119	5																		1
120	3								1		1				1		1	1	
122	1								2										
123	2								2										
124	6								1										
125	8																		1
137	4						1		1		2					1			
138	2							1	1									1	
139	3							2	2		1			1					
140	4						2									1			
141	5								2										
142	4						1		2										
143	3										1			1		1			
144	7																		1
145	9																		1
146	9																		1
147	8																		1
148	4															1			
149	2							1			1		1						
150	1										1		2				1		
151	2												1	1		1	1		
152	4								1		1						1	1	
153	4										1		1				1	1	
154	1	3																	
155	2								1		1			1					
156	5								1		1								
157	8																		1
170	3												1	1		3			
171	2							1	1		1								
172	3								3										
173	5																		1
174	7																		1
175	8																		1
176	9																		1
182	2												1			3		1	
183	2								1				1			1			
184	4								1										
185	5								2		1								
186	5												1	1			1		
187	7																		1
188	8																		1
189	9																		1
190	6								1		1								
191	4										1						1	1	
192	1	2																	
193	2								1							1			
194	4							1	1					1		1			
195	4								1										

Individual sample site data for sites sample in Spring Lake point intercept surv ey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
209	3										1		1			3	1		
211	1							1	1							2	1	1	
212	3							2	1										
214	10																		1
218	8																		1
222	4												1	1	1	1		1	
223	3							2					1				1		
224	4								1				1			1			
232	10																		1
233	8																		1
234	5															1			
235	4										1				1	1	1		
236	2								1									1	
237	3								1									1	
238	4								1										
239	2													2	1				
255	2							3			1				1		1		
256	2							2					1	1		2	1		
257	2							1					1			2	1		
267	6											1	1						
268	6																		1
269	8																		1
281	4							1								1	1		
282	3							2								2		1	
283	3								1		1							1	
284	3								1		1								
285	5								1										
286	3							2											
302	4												1				1		
303	2							1				1	1	1		2	1		
321	2								1										
330	5												1			1		1	
332	3								1				1						
333	5								1									1	
334	7																		1
351	8																		1
380	4								1		1		1			1	1	1	
381	2								1		1								
382	3								1		1								
383	5								1									1	
431	3										1							1	
432	4									1	1							1	
433	6										1		1						
434	8																		1
480	8											1							1
481	2								1	1			1						
482	3								1				1						
483	5													1					
489	8																		1
533	8																		1
580	3								1		1								
581	3								1		1							1	
582	9																		1
627	5																	2	
628	3												1	1		1			
629	2								1		1								
630	4								1		1								
632	10																		1
641	7																		1
674	11																		1
676	3							1					1			2		1	
677	2							1	1		1		1			1		1	
678	5																		1
679	9																		1
717	4															1			
718	2												1			2		1	

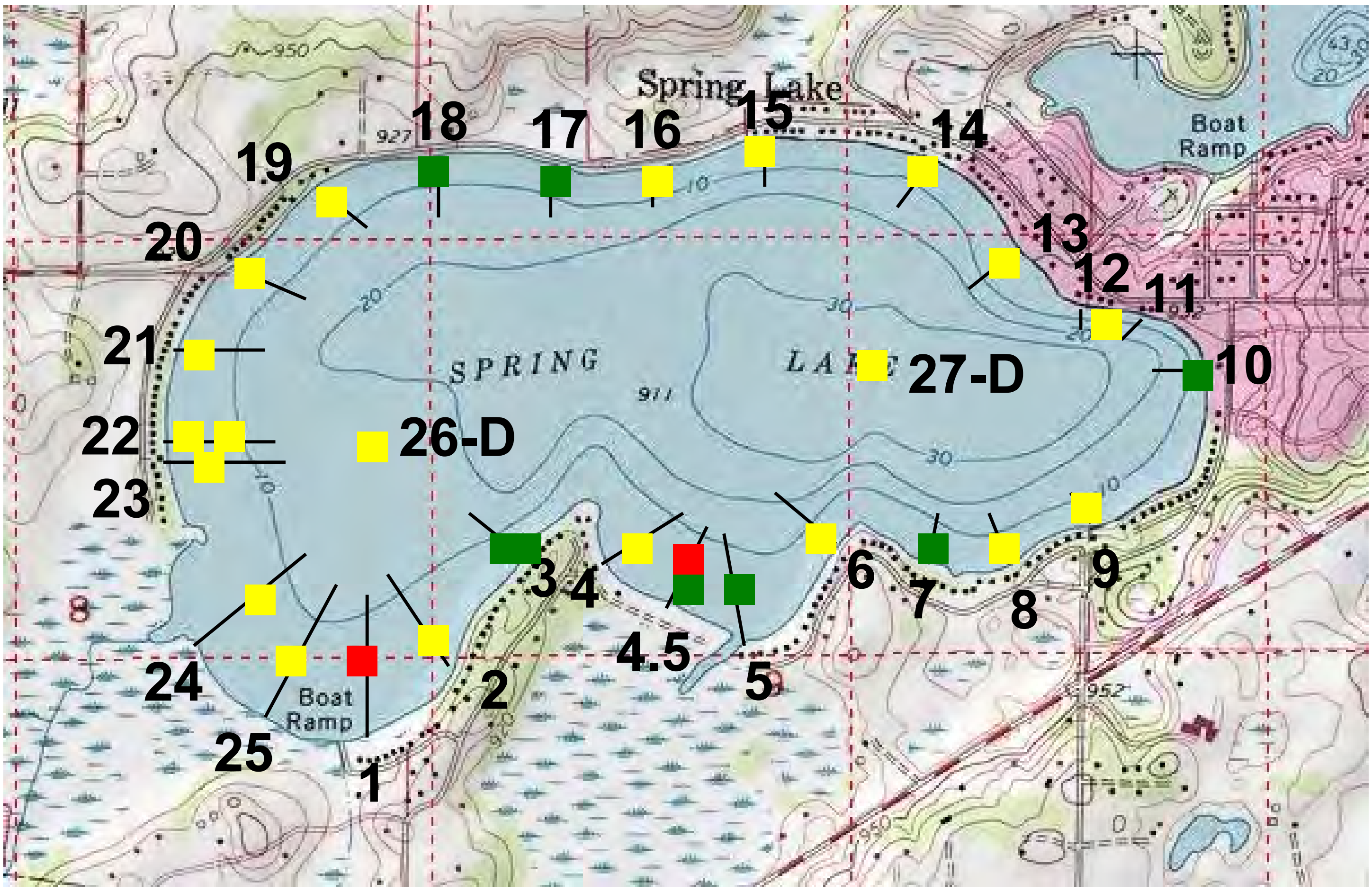
Individual sample site data for sites sample in Spring Lake point intercept surv ey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
719	3												1			2	1		
720	3								1		1			1		1			
721	7																		1
758	3													1		2			
759	2															2			
760	2										1		1		1	1			
761	3								1		1		2						
762	8																		1
797	4												1	1					
798	3							2						1		1			
799	3								1		1							1	
800	7																		1
833	6																		1
834	3												1				1		
835	3								1		1		1					1	
836	7																		1
868	4																	1	
869	3								1				2						
870	5								2		1								
871	6								1										
872	9																		1
901	5							1	1		1		1					2	
902	3												1			1			
903	4								1										
904	4								1									1	
905	6																		1
913	8																		1
914	8																		1
915	4					1							1			1			
916	4					1					1							1	
917	4					1			1										
932	5								1		1		1						
934	3								1		1		1			1			
935	3								1		1			1		1			
936	4								1		1		1		1				
937	4								2		1								
938	4								1		1								
939	4												1			1	1	1	
940	4								1		1		1			1	1		
941	3								1		1			1		1			
942	4					1			1		1		1					1	
943	7								1						1		1		
945	9																		1
950	5								1								1	1	
951	4												1						
952	3												1			1			
953	3					1			1		1		1		1	2			
954	3								1		1					1			
955	3					2			1		1								
956	4								2		1		1						
Average		2.7	1.7	1.3	1.0	1.2	1.3	1.4	1.3	1.0	1.1	1.0	1.1	1.0	1.0	1.4	1.0	1.0	
Occur (248 site)		3	3	3	1	6	3	25	138	16	89	3	56	28	17	49	29	41	50
% occur		1	1	1	0	2	1	10	56	6	36	1	23	11	7	20	12	17	

Spring Lake Curlyleaf Growth Potential Based on Lake Sediment Characteristics

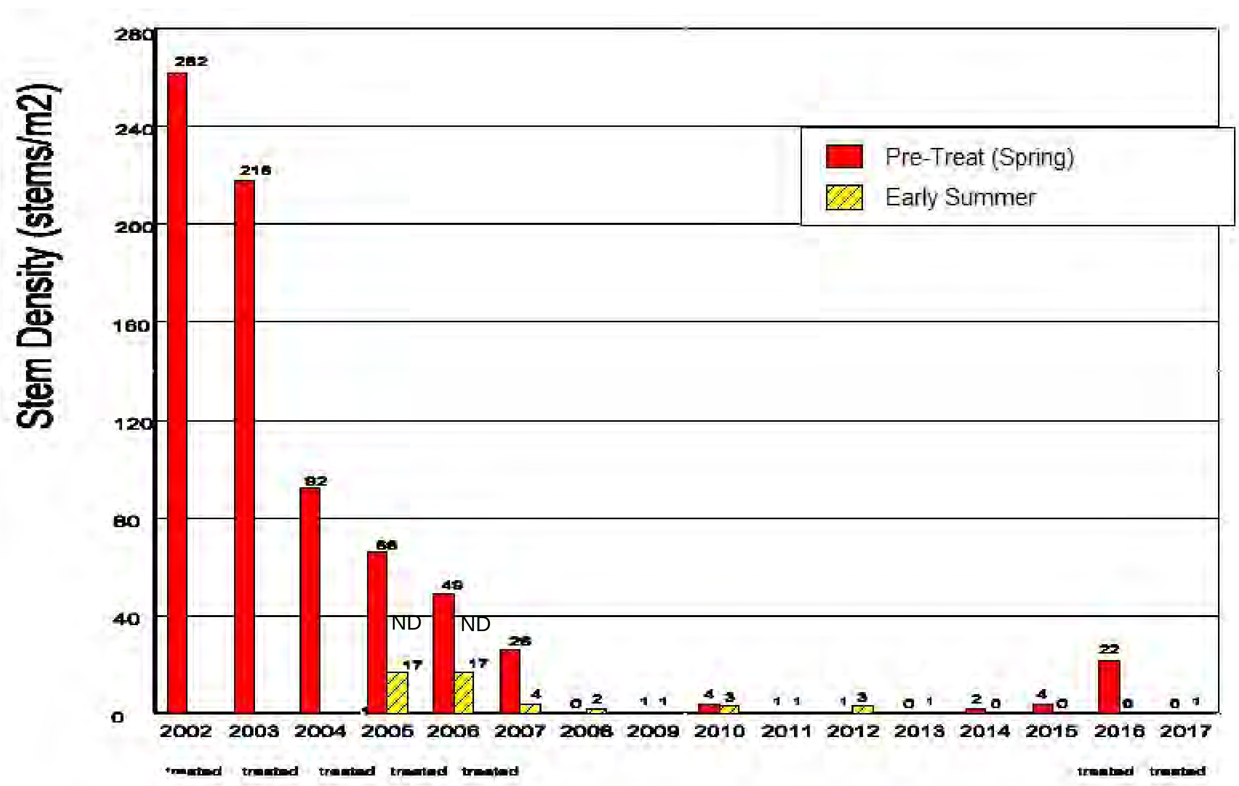
A Spring Lake sediment survey was conducted on August 13, 2008. Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support heavy curlyleaf pondweed plant growth. Based on the key sediment parameters of pH, sediment bulk density, organic matter, and the Fe:Mn ratio (McComas, unpublished), the predicted growth characteristics of curlyleaf pondweed are shown in below.

Except for two sites, curlyleaf pondweed growth is predicted to produce mostly light to moderate growth around the lake based on lake sediment characteristics.



Sediment sample locations are shown with a square. The square color indicates the potential for curlyleaf pondweed growth to occur at that site. Key: green = light; yellow = moderate; red = heavy. A key that illustrates the three types of growth is shown on the next page.

Curlyleaf Plant Density from 2002 - 2017: The 2 established sites (Transects 4.5 and 22) were sampled again in 2017. Rake sampling was used to collect curlyleaf stem densities at 4 feet and 5 feet for 10 sites at each depth at 2 locations in early and late season dates. Data from the two sites (n=40) for each date are shown below. Curlyleaf stem densities have been very low since 2007.



Curlyleaf stem densities (stems/m^2) for early season and late season monitoring (using scuba diving) for 2002-2017 (ND = no data).

Nests In Trees on an Island in Upper Prior Lake, April 30, 2020

Curlyleaf Pondweed Delineation and Assessment Surveys and Summer Point Intercept Survey for Upper and Lower Prior Lake, Scott County, 2020

Curlyleaf Pondweed Delineation: April 30, 2020
Herbicide Treatment: 24.26 acres May 12, 2020
Curlyleaf Pondweed Assessment Date: June 11, 2020
Point Intercept Surveys: August 17, 2020; September 2, 2020

Prepared for:
Prior Lake/Spring Lake Watershed District
Prior Lake, Minnesota

Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116

March 10, 2021

Curlyleaf Pondweed Delineation and Assessment Surveys and Summer Point Intercept Survey for Upper and Lower Prior Lake, Scott County, 2020

Summary

Early Season Curlyleaf Pondweed Delineation: Curlyleaf pondweed (CLP) distribution and abundance were delineated on April 30, 2020. Based on the curlyleaf pondweed densities in both Upper and Lower Prior, several areas were delineated as having the potential for heavy curlyleaf growth by June (Figure S1).

Curlyleaf density was mostly light in April but there was the potential for heavy curlyleaf growth in some areas and 24.26 acres were delineated for a herbicide treatment.

The curlyleaf pondweed treatment was conducted on May 20, 2020 using diquat, a total of 24.26 acres were treated in Upper and Lower Prior Lake.

Post Treatment Assessment: A follow-up curlyleaf assessment was conducted on June 11, 2020. The June 11 curlyleaf assessment found curlyleaf in the treatment areas was mostly well controlled. Outside of the treatment areas, there were a few spots where heavy curlyleaf pondweed growth was present, however most heavy growth was patchy.

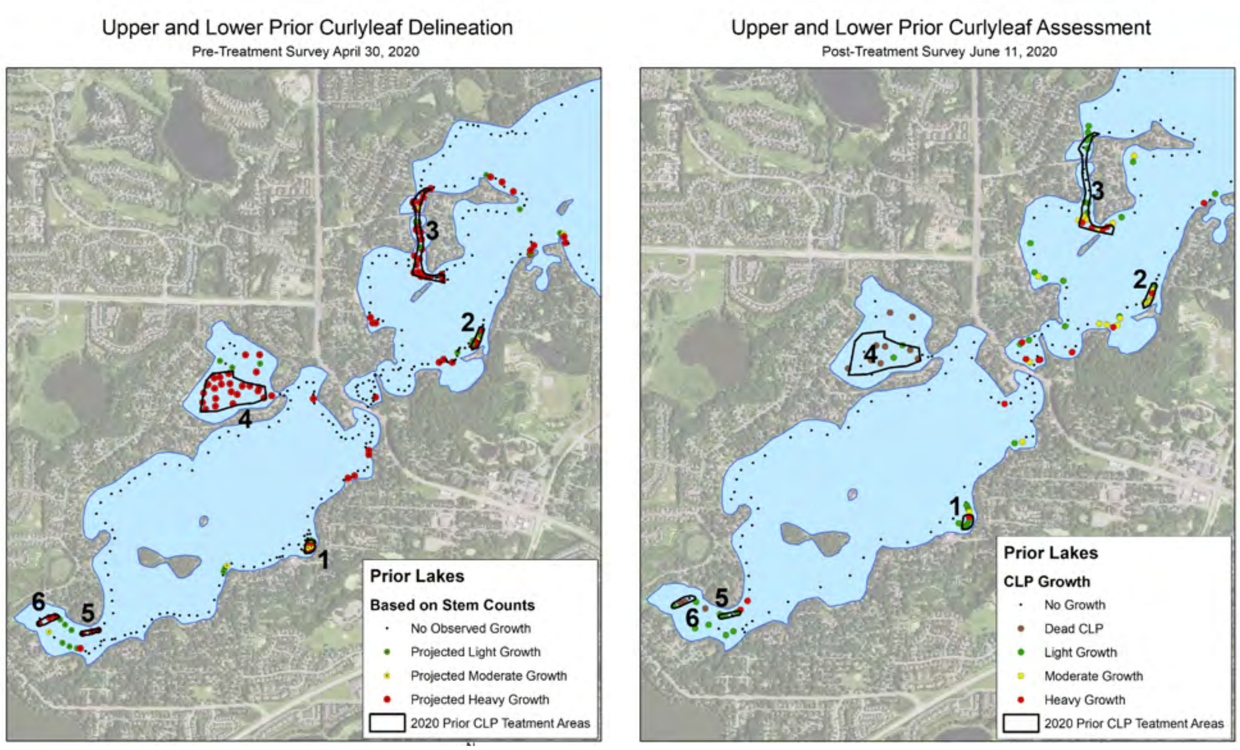


Figure S1. [left] Curlyleaf pondweed delineation survey conducted in Prior Lake on April 30, 2020. [right] Curlyleaf pondweed assessment survey conducted June 11, 2020.

Curlyleaf Planning for 2021: Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution is a challenge. Curlyleaf in April and May has just started to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in late May and June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season.

Currently, for Upper and Lower Prior Lake, the method has been to use past CLP growth history (Figure S2) combined with early season scouting. Then if curlyleaf growth has indications of producing potential heavy growth, those areas are delineated and treatment is considered. That is the approach to be considered for 2021.

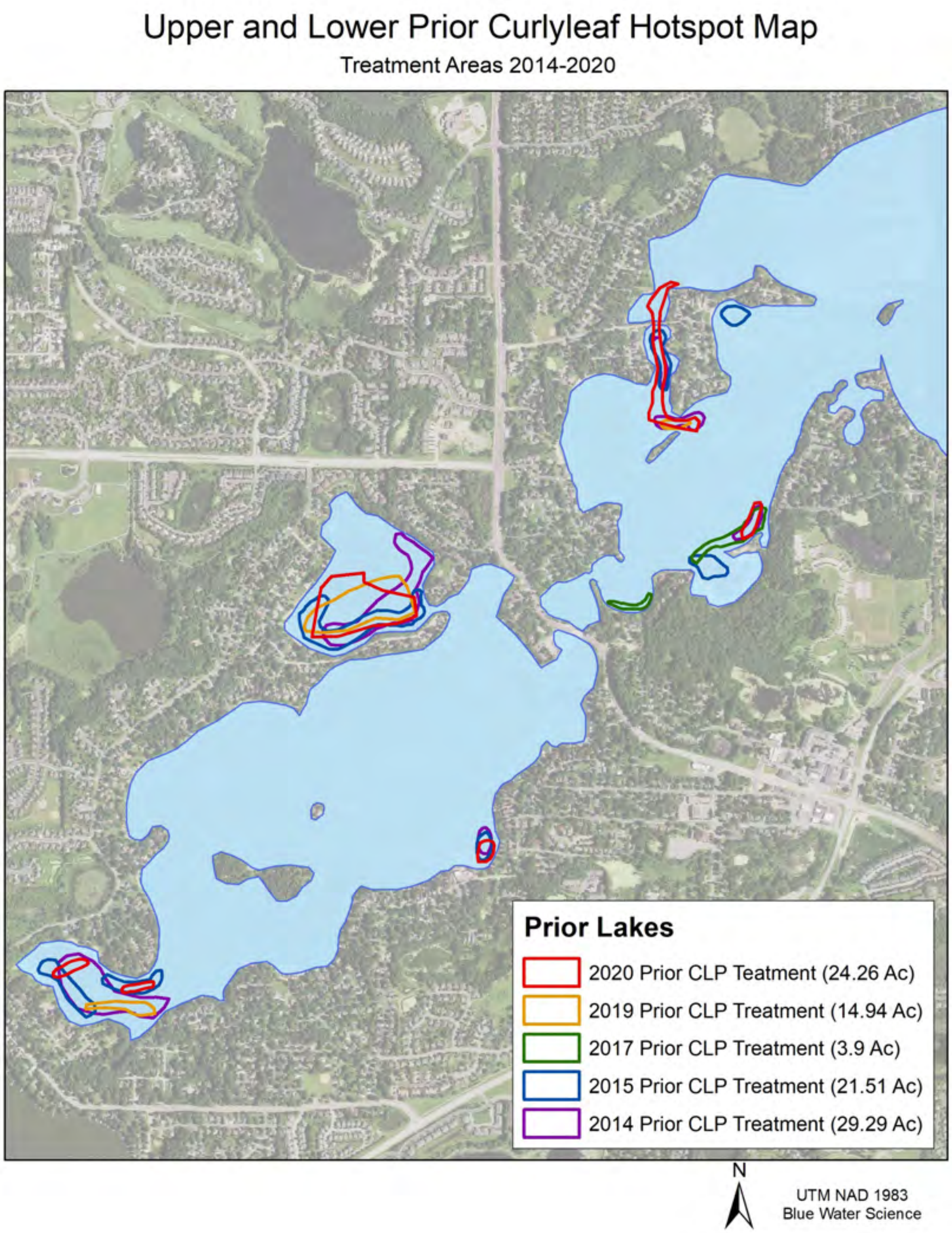


Table S1. Treatment summary from 2009-2020.

Year	Treatment
2009	No treatment
2010	No treatment
2011	No treatment
2012	No treatment
2013	23 acres
2014	29.3 acres
2015	21.5 acres
2016	15.8 acres
2017	2.55 acres
2018	No treatment
2019	14.9 acres
2020	24.3 acres

Figure S2. Prior Lake hot spot map for curlyleaf pondweed treatment areas from 2014-2020.

Point Intercept Survey: A grid with points spaced 100 meters apart was put over the entire lake and sites were sampled throughout the growing zone. A total of 352 sites were sampled, plants were observed growing to a depth of 8 feet. Results of the summer aquatic plant point intercept survey found 15 submerged aquatic plant species in Lower Prior and 6 species in Upper Prior including CLP. Native plants were found around the perimeter of the basin of Prior Lake (Figure S3).

Native aquatic plants were estimated to cover 27% of the lake bottom (358 acres). Coontail was the dominant aquatic plant. The 10 aquatic plant species found in this survey represents a fair to good diversity for Prior Lake in late summer.

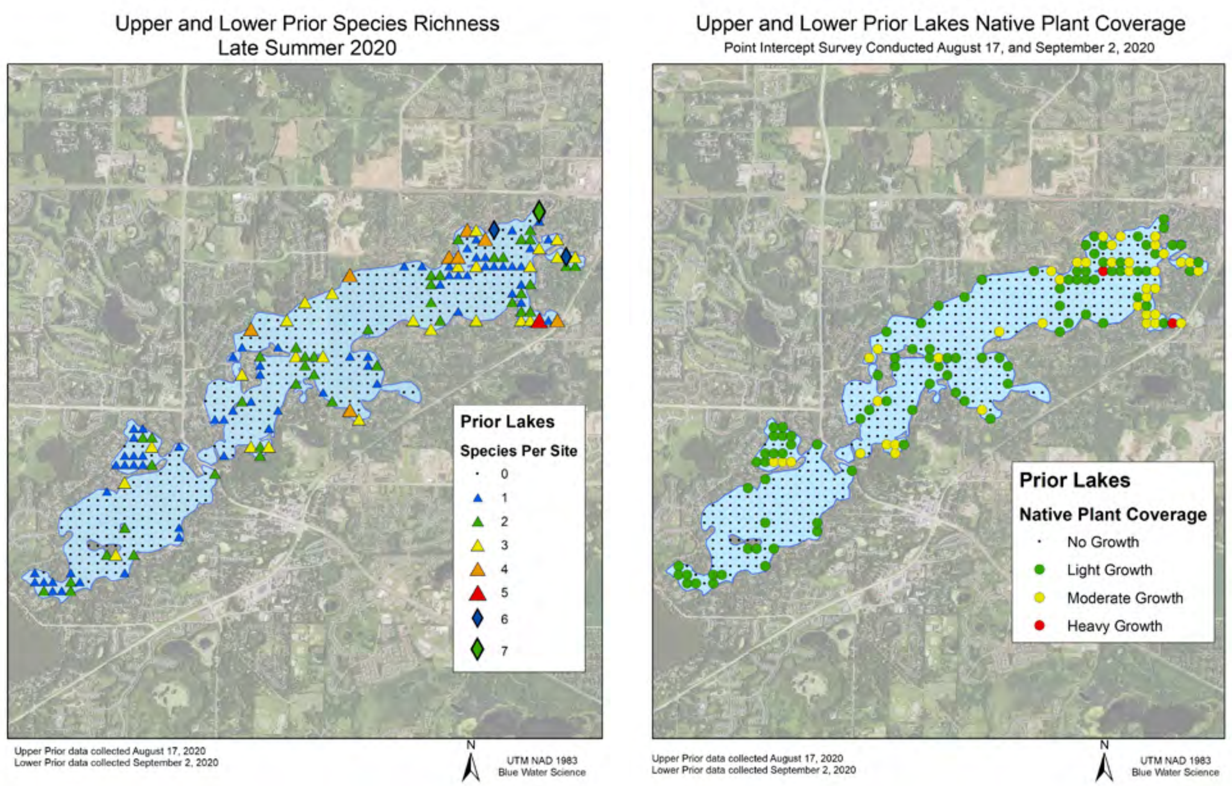


Figure S3. Point intercept survey results for species richness (left) and native plant coverage (right).

Curlyleaf Pondweed Delineation and Assessment Surveys and Summer Point Intercept Survey for Upper and Lower Prior Lake, Scott County, 2020

Introduction

Upper and Lower Prior Lakes combined have an area of 1,343 acres with a total littoral area of 732 acres (MnDNR). An initial curlyleaf pondweed delineation was conducted on April 30, 2020 including both Upper and Lower Prior. Curlyleaf was then treated on May 12, 2020 and a follow-up curlyleaf pondweed assessment was conducted on June 11, 2020 to characterize the status of curlyleaf pondweed at it's peak growing period. Sample sites in the delineation survey are shown in Figure 1. Sample sites were selected based on areas where curlyleaf had been found over the years.

A summer point intercept aquatic plant survey was conducted in August and September to evaluate the entire plant community in Upper and Lower Prior Lake.

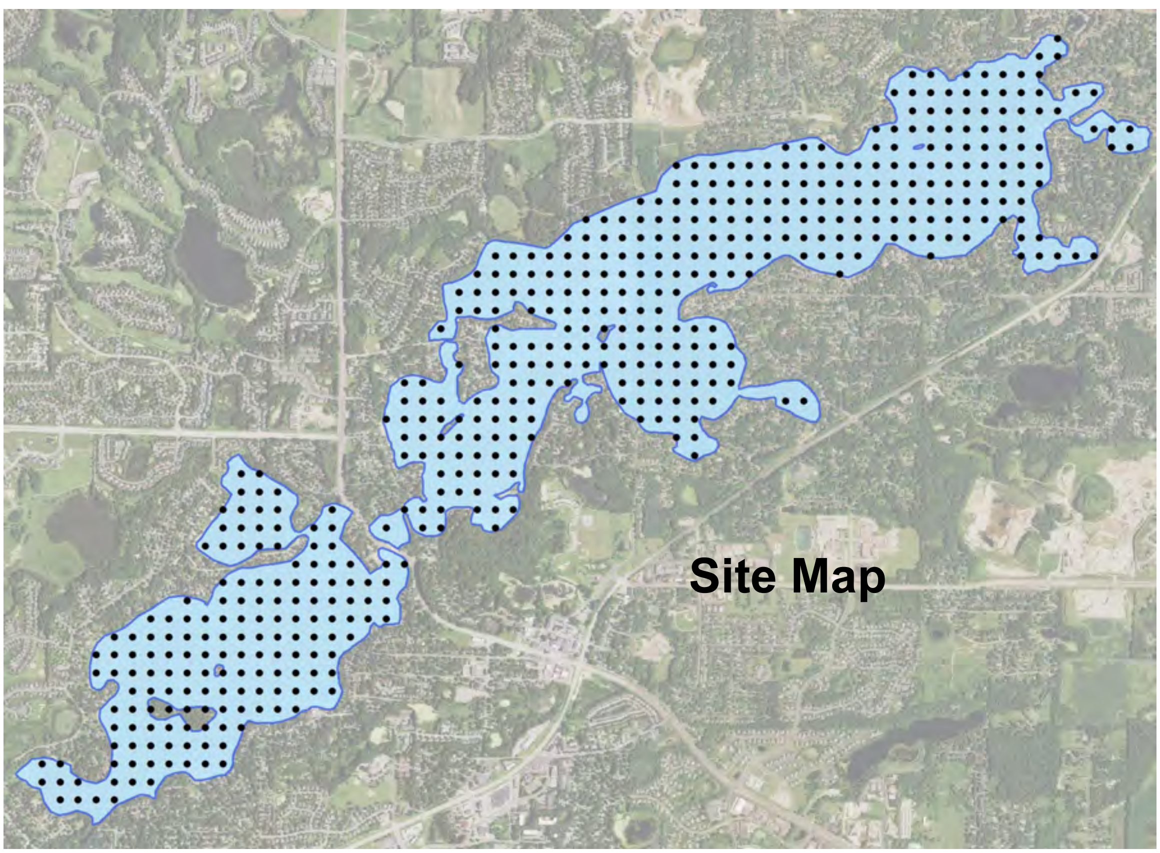


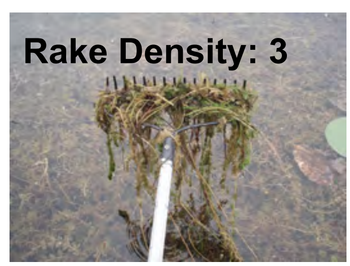
Figure 1. Point intercept 100 meter grid on Upper and Lower Prior Lake.

Methods

Curlyleaf Pondweed Delineation: At the time of the spring CLP delineations, only a fraction of the peak curlyleaf biomass is present. For spot treatments, the areas to be treated should be delineated prior to curlyleaf developing peak biomass. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce dense curlyleaf. After a short sweep of about 1-foot (30 cm), 4 curlyleaf stems or more per rake sample generally indicated some CLP plants had developed runners and would likely produce heavy growth in the next few weeks. Alternatively, sites where 3 stems or less were collected per rake sample were not predicted to produce dense growth at the peak growing period. These areas were not targeted for treatment. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

Curlyleaf Pondweed Assessment: A CLP assessment was conducted by Blue Water Science on June 11, 2020. The assessment is a post-treatment evaluation, it involved surveying the entire lake nearshore area, observing CLP growth, and sampling aquatic plants with rakes. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being a nuisance. Plant density chart is shown on the next page (Figure 2). Based on these sample sites, plant distribution maps were constructed.

Survey Methods for the Point Intercept Survey An aquatic plant point intercept survey of Prior Lake was conducted by Blue Water Science on August 17, 2020 and September 2, 2020. Sample points were spaced 100 meters apart on a grid that covered the lake (Figure 1). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, a plant distribution map was constructed.



**McComas, S.R., Y.E. Christianson, and U. Singh. 2015. Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. Lake and Reservoir Management. 31:109-114.*

Curlyleaf Pondweed Delineation on April 30, 2020 and Assessment on June 11, 2020 in Upper and Lower Prior Lake

A delineation survey on April 30, 2020, sampled a total of 229 sites around Upper and Lower Prior Lake with rake sampling. Curlyleaf was found at 58 out of 229 sample sites including 32 sites with curlyleaf growth projected to be abundant in June. A total of 24.26 acres in Upper and Lower Prior Lake areas were delineated as having the potential to develop moderate to heavy growth conditions by June (Figure 2).

A total area of 24.26 acres of CLP in Prior Lake was permitted for treatment based on criteria where treatment was either 150 feet or more from shore or treatment was in front of public property.

On June 11, 2020, a curlyleaf assessment was conducted. A total of 185 sites were sampled (Figure 2). Control was good in the treated areas. A few spots of moderate to heavy growth were observed in untreated areas (Figure 2). CLP conditions on June 11, 2020 are shown in Figure 2.

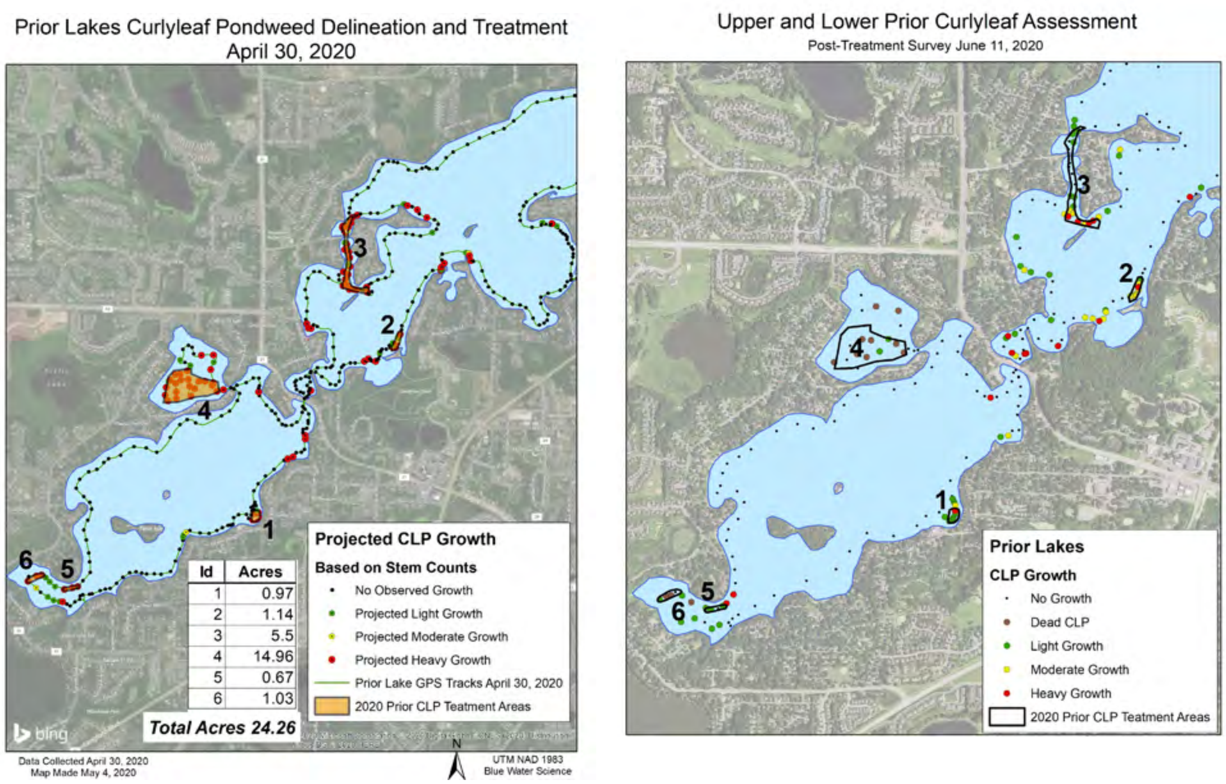


Figure 2. Map of curlyleaf pondweed delineation is shown on the left (April 30, 2020) and the curlyleaf assessment is shown on the right (June 11, 2020).

Point Intercept Aquatic Plant Survey for Upper and Lower Prior Lake

Results: A point intercept aquatic plant survey was conducted on Upper Prior Lake on August 17, 2020 as well as Lower Prior Lake on September 2, 2020. Plant distribution and species richness were greater in Lower Prior compared to Upper Prior (Figure 3). Aquatic plants grew to a water depth of 19 feet in Lower Prior and to 10 feet in Upper Prior. Compared to the 2018 aquatic plant survey, the depth of plant establishment increased by 2 feet in Upper Prior and decreased by 1 foot in Lower prior. Aquatic plants covered approximately 96 acres in upper prior in 2020 compared to approximately 69 acres in 2018. In Lower Prior, aquatic plants covered 262 acres in 2020 compared to 375 in 2018.

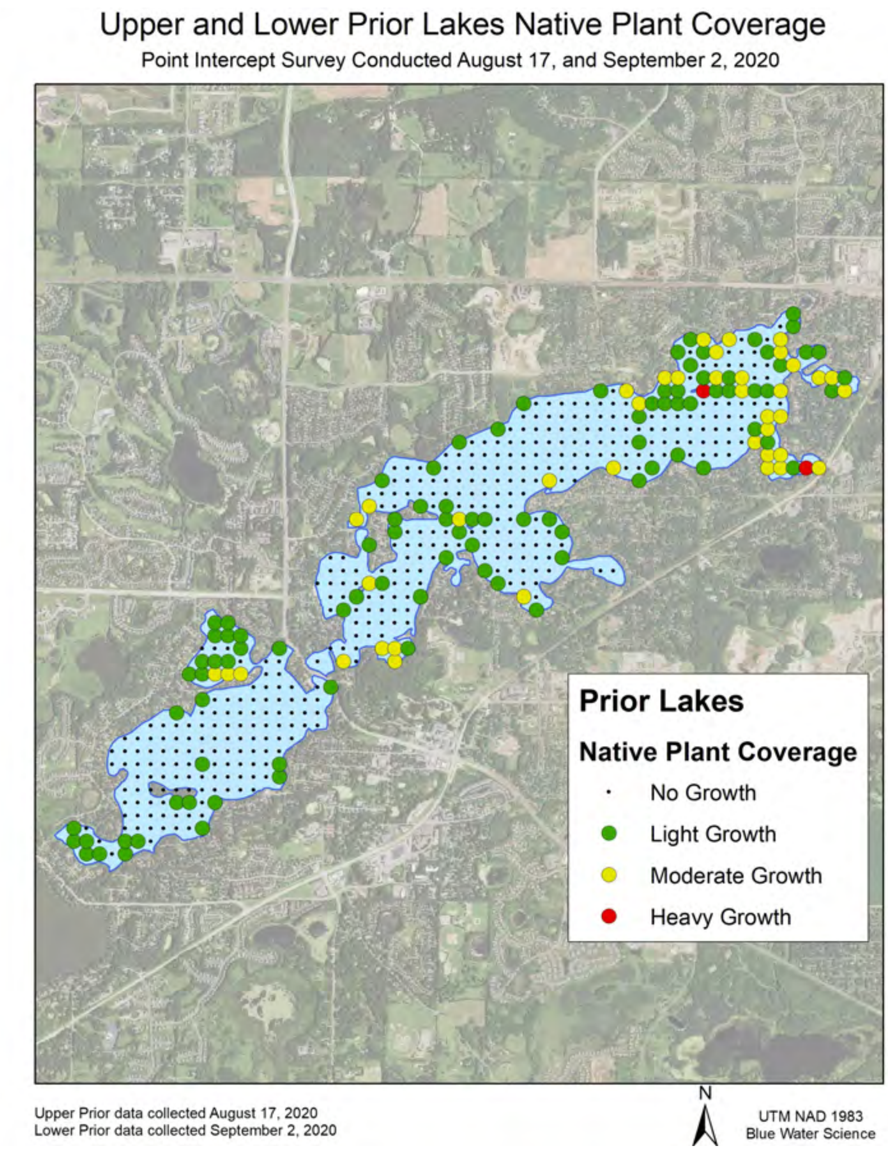


Figure 3. Native Plant Coverage in Prior lakes in late summer 2020.

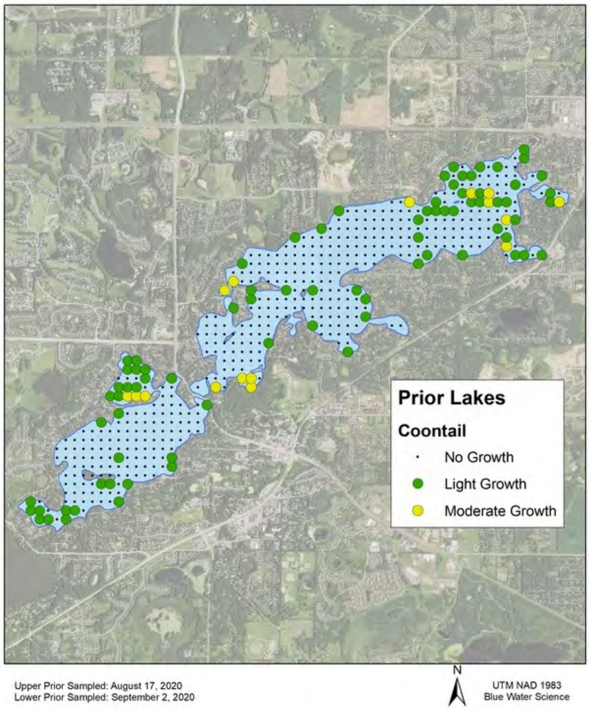
Table 1. Prior Lake aquatic plant data for 2020 point intercept surveys.

Upper Prior August 17, 2020	**All Stations (n=48)(10 feet)**		
	Occur	**% Occur out to 10 ft**	**Average Density**
Coontail (*Ceratophyllum demersum*)	33	69	1.1
Elodea (*Elodea canadensis*)	3	6	1.0
Water stargrass (*Heteranthera dubia*)			
Star duckweed (*Lemna trisulca*)			
Northern watermilfoil *(Myriophyllum sibiricum)*	6	13	1.0
Eurasian watermilfoil (*M. spicatum*)	5	10	1.0
Naiads (*Najas flexilis*)			
Nitella (*Nitella sp*)			
Cabbage (*Potamogeton amplifolius*)			
Curlyleaf pondweed (*P. crispus*)	3	6	1.0
Claspingleaf (*P. Richarsonii*)			
Stringy pondweed (*P. sp*)	2	4	1.0
Flatstem pondweed (*P. zosteriformis*)			
Sago (*Stuckenia pectinata*)			
Water celery (*Vallisneria americana*)			

Lower Prior September 2, 2020	**All Stations (n=162)(19 ft)**		
	Occur	**% Occur out to 19 ft**	**Average Density**
Coontail (*Ceratophyllum demersum*)	63	39	1.2
Elodea (*Elodea canadensis*)	1	1	1.0
Water stargrass (*Heteranthera dubia*)	7	4	1.0
Star duckweed (*Lemna trisulca*)	3	1	1.0
Northern watermilfoil *(Myriophyllum sibiricum)*	4	2	1.0
Eurasian watermilfoil (*M. spicatum*)	32	20	1.2
Naiads (*Najas flexilis*)	2	1	1.0
Nitella (*Nitella sp*)	1	1	1.0
Cabbage (*Potamogeton amplifolius*)	4	2	1.8
Curlyleaf pondweed (*P. crispus*)	7	4	1.0
Claspingleaf (*P. Richarsonii*)	9	6	1.0
Stringy pondweed (*P. sp*)	3	1	1.0
Flatstem pondweed (*P. zosteriformis*)	32	20	1.1
Sago (*Stuckenia pectinata*)	1	1	1.0
Water celery (*Vallisneria americana*)	46	28	1.4

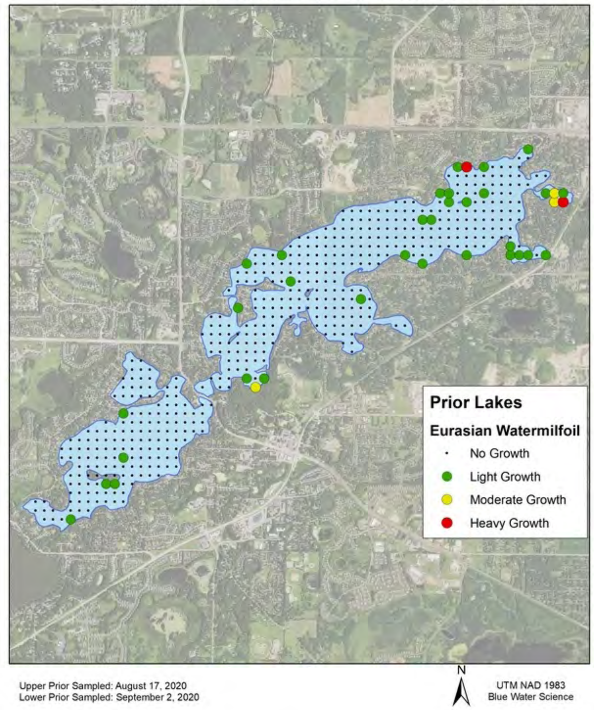
Upper and Lower Prior Coontail Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



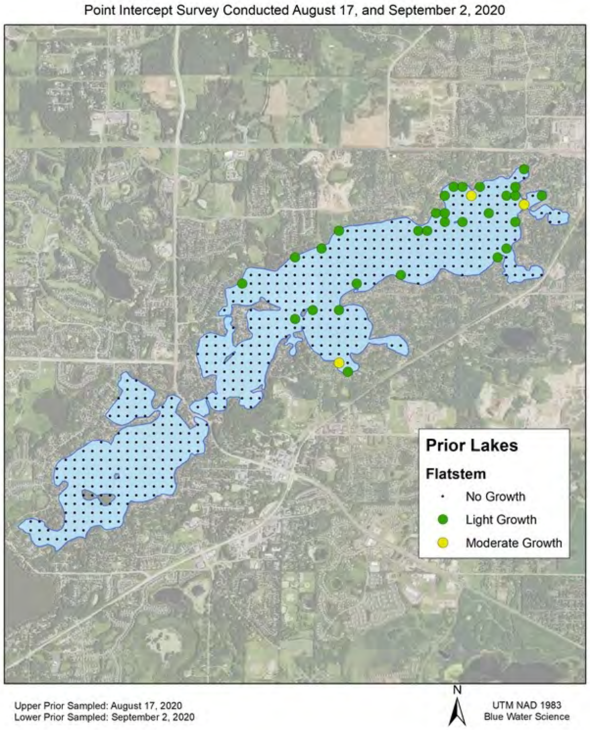
Upper and Lower Prior Eurasian Watermilfoil Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



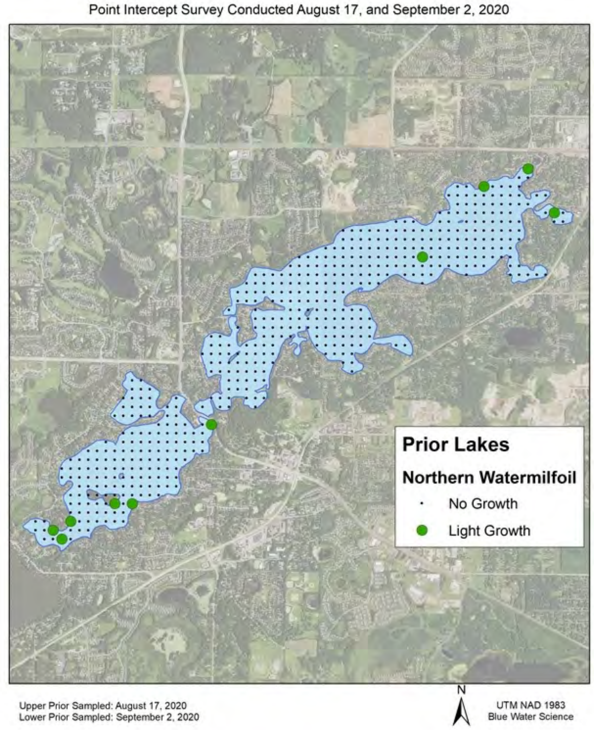
Upper and Lower Prior Flatstem Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



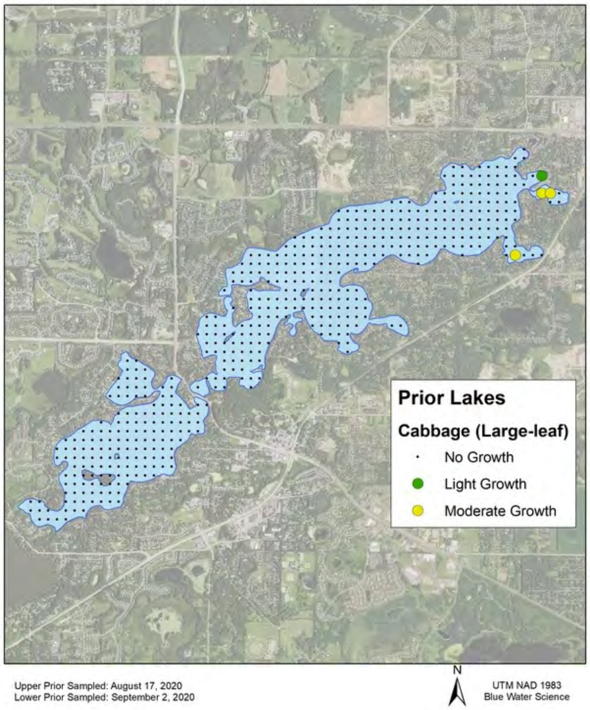
Upper and Lower Prior Northern Watermilfoil Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



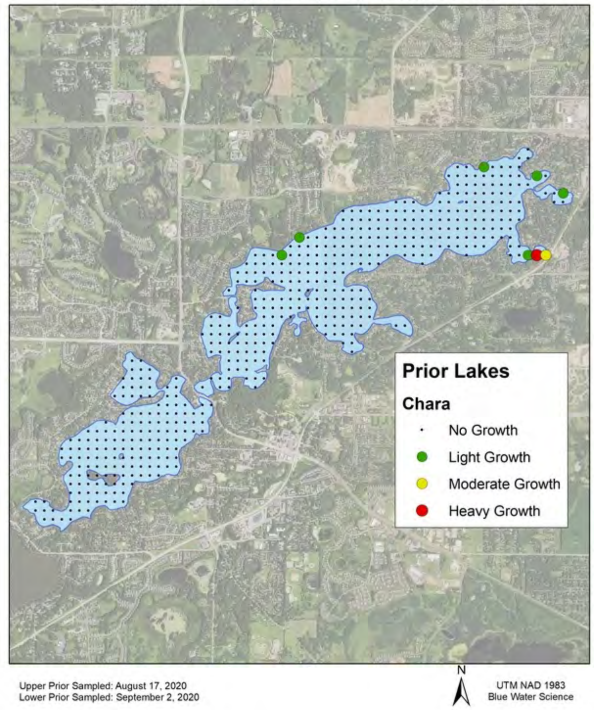
Upper and Lower Prior Cabbage (Large-leaf) Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



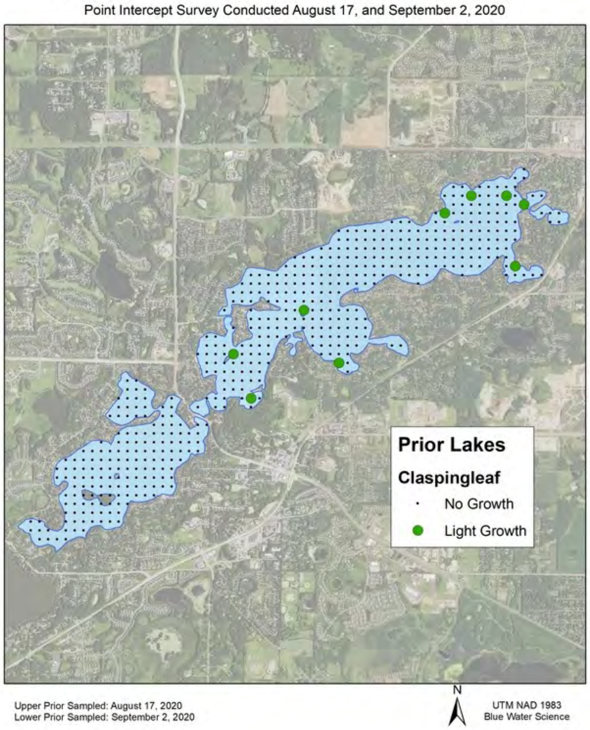
Upper and Lower Prior Chara Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



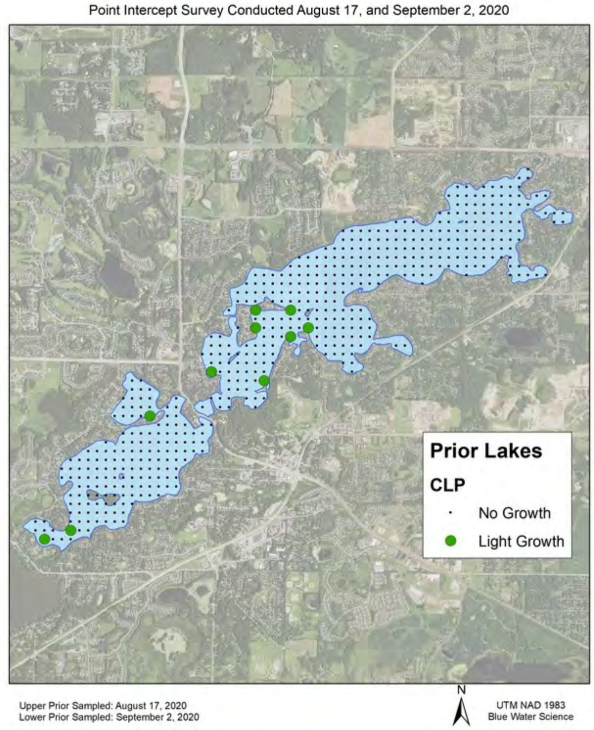
Upper and Lower Prior Claspingleaf Pondweed Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



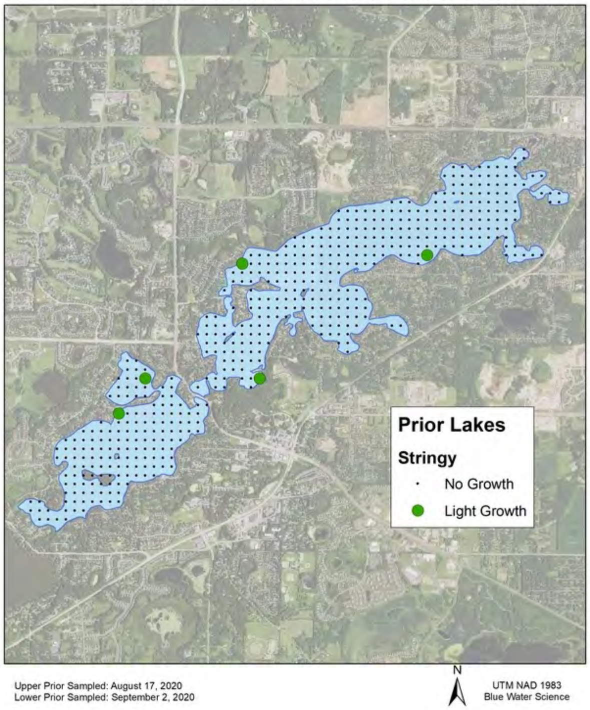
Upper and Lower Prior Curlyleaf Pondweed Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



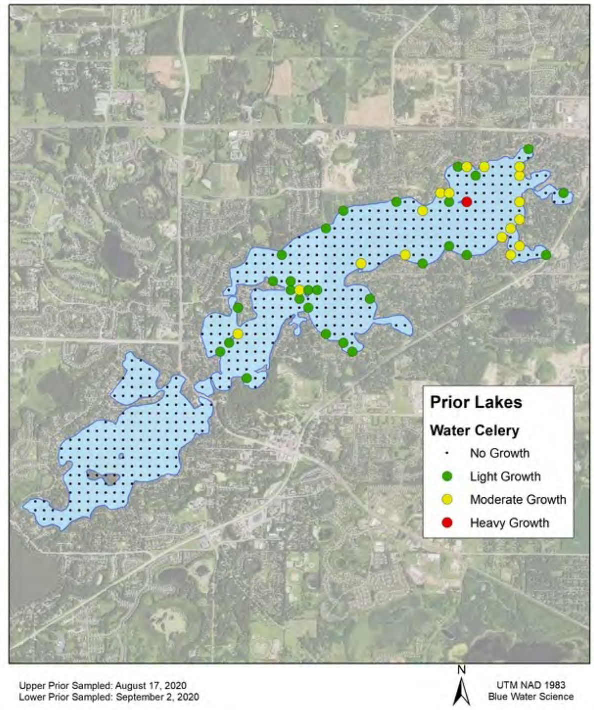
Upper and Lower Prior Stringy Pondweed Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



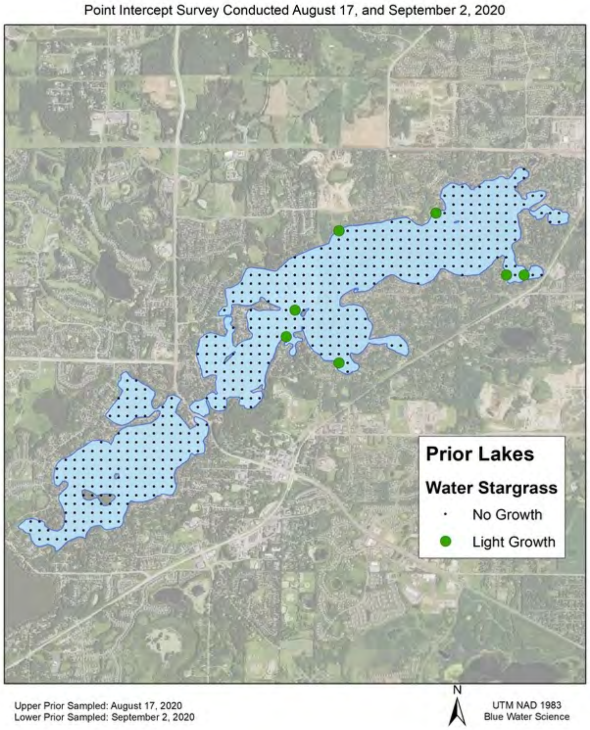
Upper and Lower Prior Water Celery Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



Upper and Lower Prior Water Stargrass Growth

Point Intercept Survey Conducted August 17, and September 2, 2020



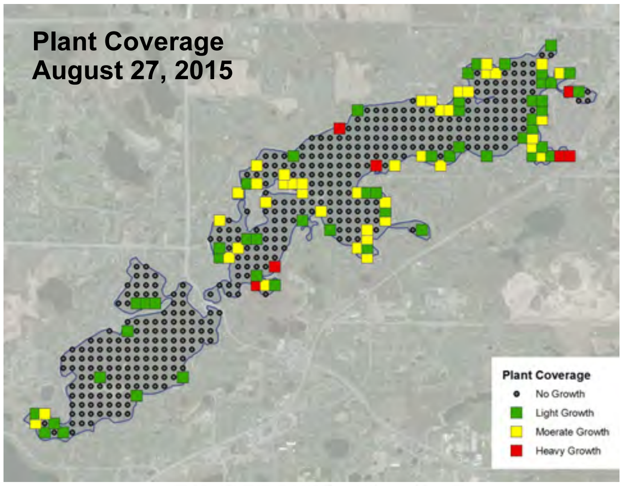
Point Intercept aquatic plant survey comparisons for 2015, 2018, and 2020

Table 2. Prior Lake aquatic plant data for 2015, 2018 and 2020 point intercept surv eys.

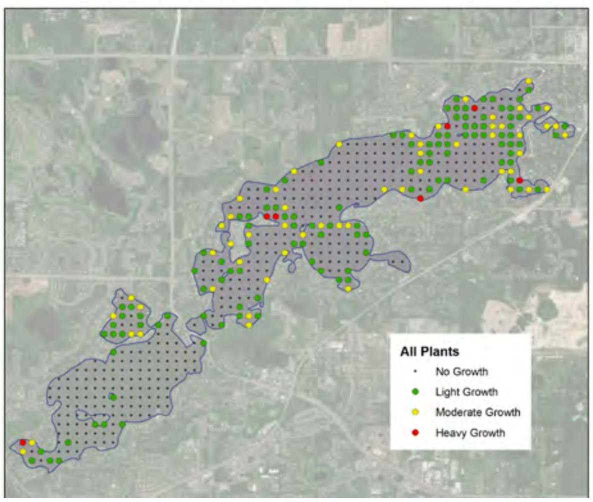
Lower Prior	Occurrence of Plants		
	2015	2018	2020
Estimated aquatic plant coverage (ac)	220 ac	375 ac	262 ac
Max depth of vegetation (ft)	15 ft	20 ft	19 ft
Duckweed (*Lemna sp*)		1	
Coontail (*Ceratophyllum demersum*)	62	129	63
Chara (*Chara sp*)	9		8
Elodea (*Elodea canadensis*)	5	2	1
Star duckweed (*Lemna trisulca*)		4	3
Northern watermilfoil *(Myriophyllum sibiricum)*	10	52	4
hybrid watermilfoil (*M. sp*)		2	
Eurasian watermilfoil (*M. spicatum*)	38	16	32
Naiads (*Najas flexilis*)		4	2
Nitella (*Nitella sp*)		2	1
Cabbage (*Potamogeton amplifolius*)	4	2	4
Curlyleaf pondweed (*P. crispus*)		10	7
Illinois Pondweed *(P. illinoensis)*	6	11	
Whitestem pondweed (*P. praelongus*)	7	4	
Claspingleaf (*P. Richarsonii*)	6	10	9
Stringy pondweed (*P. sp*)		1	3
Flatstem pondweed (*P. zosteriformis*)	10	26	32
Sago (*Stuckenia pectinata*)		1	1
Water celery (*Vallisneria americana*)	37	46	46
Water stargrass (*Zosterella dubia*)	3	22	7

Upper Prior	Occurrence of Plants		
	2015	2018	2020
Estimated aquatic plant coverage (ac)	33 ac	74 ac	82 ac
Max depth of vegetation (ft)	6 ft	8 ft	10 ft
Coontail (*Ceratophyllum demersum*)	5	29	33
Elodea *(Elodea canadensis)*	2	17	3
Eurasian watermilfoil (*Myriophyllum spicatum*)	11	17	5
Northern Watermilfoil *(Myriophyllum sibiricum)*			
Stringy pondweed (*Potamogeton sp*)		2	2
Sago pondweed *(Stuckenia pectinata)*	2	1	
Curlyleaf Pondweed (*P. crispus*)			3

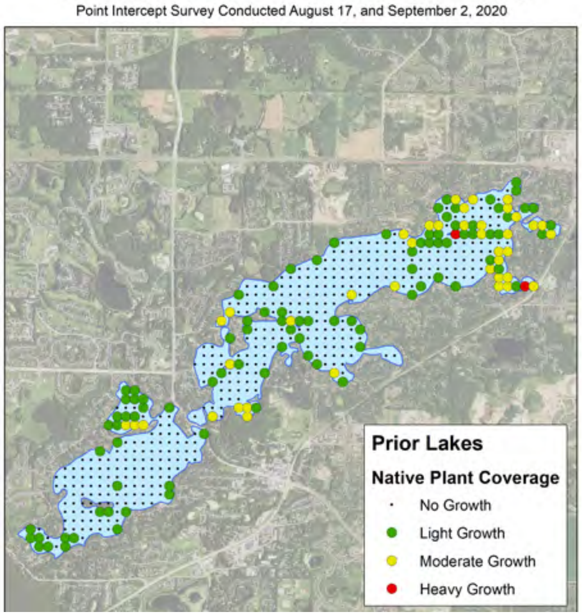
Aquatic Plant Distribution and Abundance for 2015, 2018, and 2020



Prior Lake All Plant Growth
August 17 & 21, 2018



Upper and Lower Prior Lakes Native Plant Coverage
Point Intercept Survey Conducted August 17, and September 2, 2020

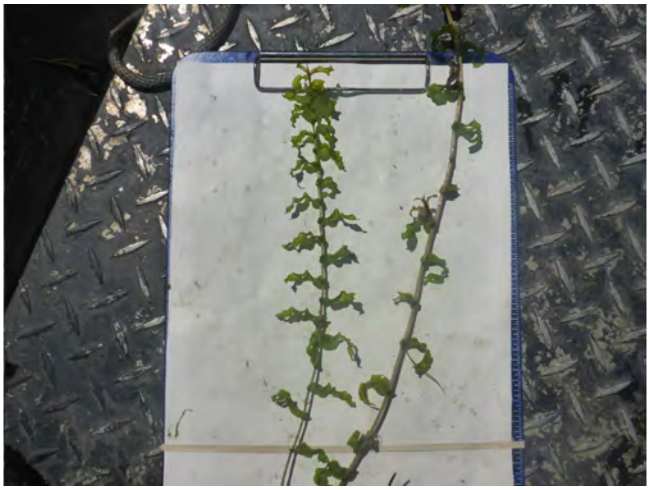


Supplemental Material

Common Aquatic Plants in Prior Lake

Chara (*Chara sp*)

Claspingleaf pondweed (*Potamogeton richardsonii*)



Coontail (*Ceratophyllum demersum*)

Curlyleaf Pondweed (non-native)(*Potamogeton crispus*)

Eurasian watermilfoil (non-native)
(*Myriophyllum spicatum*)

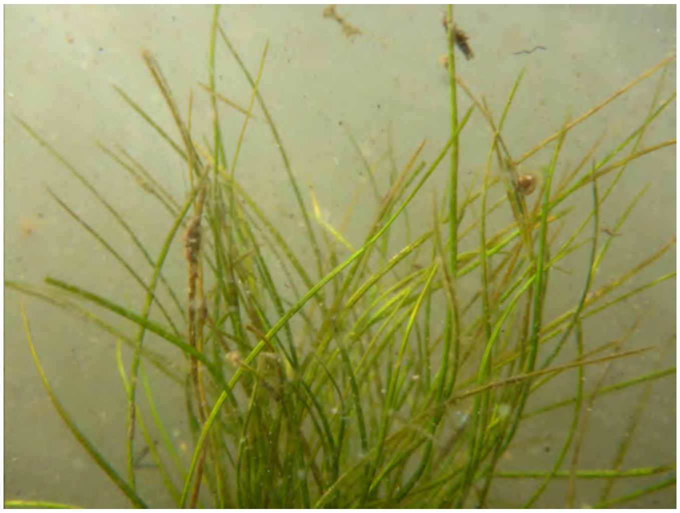
Flatstem pondweed (*Potamogeton zosteriformis*)(WDNR)

Naiad (*Najas sp*)

Northern watermilfoil (*Myriophyllum sibiricum*)

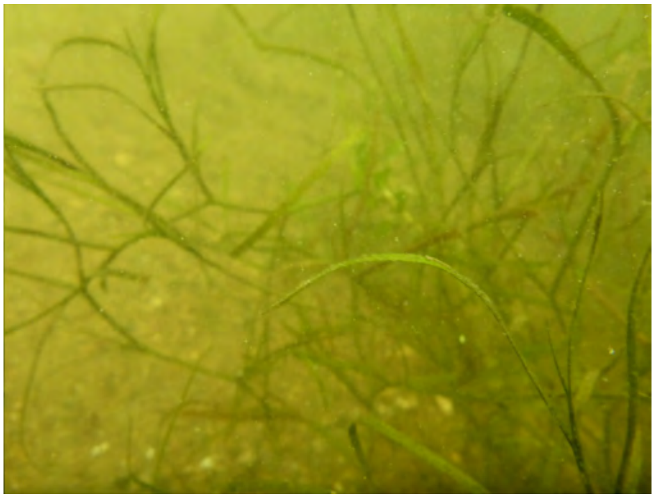
Sago pondweed (*Stuckenia pectinata*)

Stringy pondweed (*Potamogeton pusillus*)

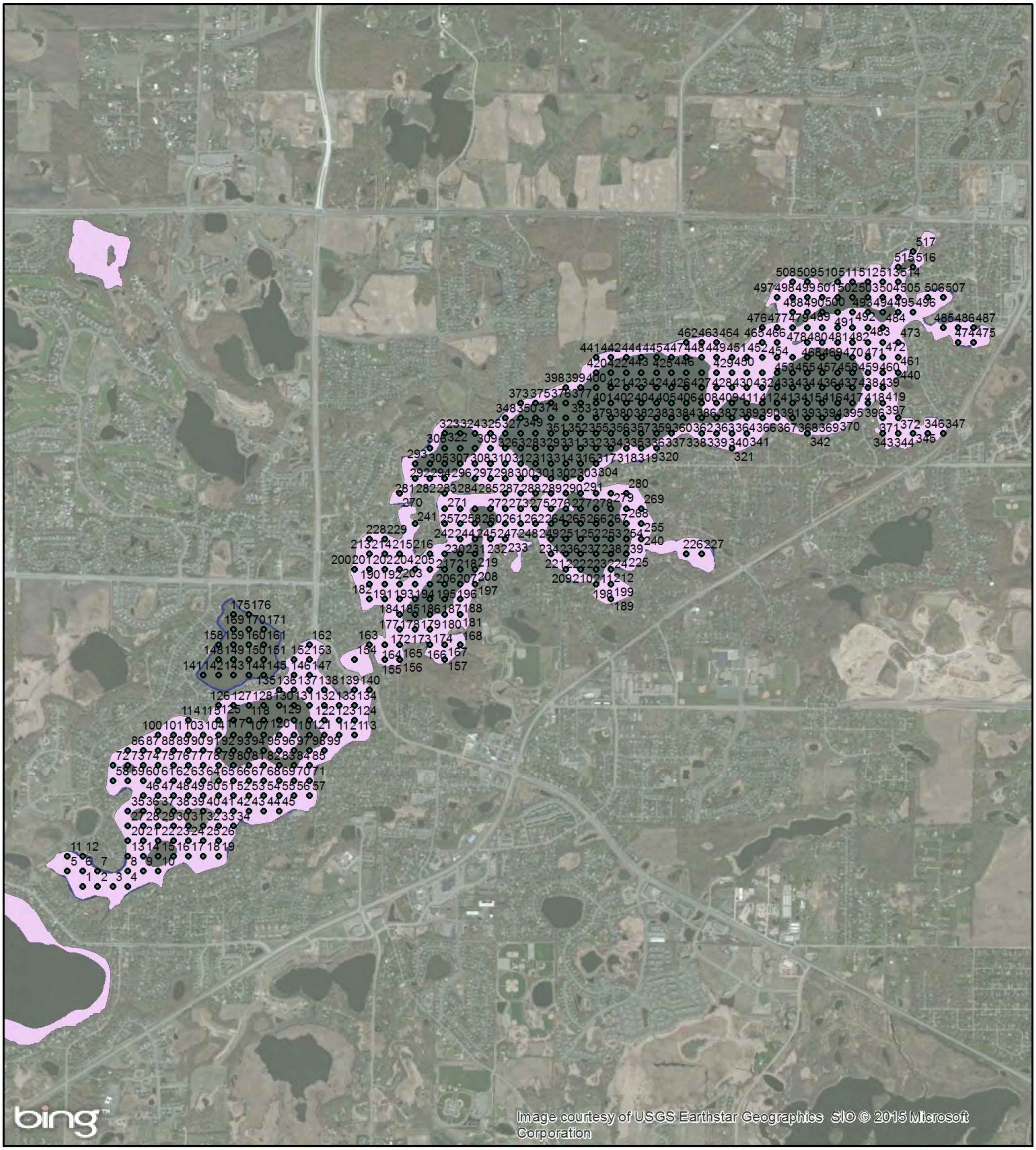


Water celery (*Vallisneria americana*)

Water stargrass (*Heteranthera dubia*)



Prior Lakes Site Map- 516 Points



Point Intercept Site Data for Upper Prior Lake, August 17, 2020

Site	Depth (ft)	Coontail	CLP	Elodea	EWM	NWM	Stringy	Benthic algae	No plants
1	6	1	1					1	
2	6	1						1	
3	5					1		1	
4	7	1			1				
5	5	1						2	
6	6	1						1	
7	5					1		1	
8	8	1	1						
9	10	1							
10	10								1
11	5	1						1	
12	5							1	
13	7					1			
16	13								1
17	11								1
18	12								1
19	9	1							
20	9								1
24	13								1
25	12								1
26	11								1
27	12								1
29	13								1
30	12								1
31	4	1			1				
32	4	1			1	1			
33	12								
34	8	1				1			
35	13								1
41	11								1
42	14								1
43	13								1
44	12								1
45	10								1
46	17								1
47	12								1
48	13								1
49	13								1
50	13								1
55	15								1
56	13								1
57	9	1							
58	10								1
59	12								1
60	14								1
64	10								1
65	7	1			1				
71	8	1							
72	10								1
85	18								1
86	11								1
87	13								1
99	17								1
100	13								1
103	11								1
112	12								1
113	11								1
114	8	1							
124	11								1
125	8	1			1		1		
133	8								1
134	12								1
135	15								1
138	15								1
139	12								1
140	6	1				1			
141	5	1							
142	6	1							
143	5	2							
144	5	2							
145	5	2	1						
147	12								1
148	6	1							
149	6	1							
150	5	1							
151	6								1
152	8								1
153	10								1
161	5	1		1			1		
162	8	1							
169	6	1							
170	6	1		1					
171	5	1		1					
175	5	1							
176	6	1							
Average		1.1	1.0	1.0	1.0	1.0	1.0	1.1	
Occur (85 sites)		33	3	3	5	6	2	8	47
% occur		39	4	4	6	7	2	9	

Point Intercept Site Data for Lower Prior Lake, September 2, 2020

Site	Depth (ft)	Cab-bage	Chara	Chara-stone	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Float-ingleaf	Fries	Naiads	Nitella	NWM/ Hybrid	Sago	Star duck-weed	Stringy	Water celery	Water star-grass	ZM present	No plants
154	15																					1
155	8					2															1	
156	12																					1
157	6					2			2												1	
163	8																					1
165	14																					1
166	7					2			1										1		1	
167	7				1	2															1	
168	7								1							1		1				
172	18																					1
173	17																					1
174	8																					1
177	19																					1
180	18																					1
181	11						1															
182	10						1															
183	9																		1			
188	17																					1
189	11					1				1									1		1	
190	14																					1
192	5																		1		1	
193	17																					1
197	11					1																
198	9				1					2									1	1	1	
199	19																					1
200	10																					1
201	14																					1
203	12																					1
204	4				1														2		1	
205	14											1										1
209	12													1					1		1	
210	24																					1
211	20																					1
212	13																					1
213	16																					1
215	14																					1
216	11																					1
217	18																					1
219	24																					1
220	13					1															1	
221	24																					1
224	20																					1
225	20																					1
226	25																					1
227	24																					1
228	13																					1
229	11																					1
230	16																					1
232	18																					1
233	10						1													1	1	
234	21																					1
240	14					1																
241	7					1			1										1		1	
242	12						1															
246	15																					1
247	15																					1
248	10						1												1		1	
255	16																					1
256	8					1															1	
257	18																					1
258	20																					1
259	23																					1
261	7									1									1		1	
262	18																					1
263	20																					1
264	16																					1
268	9								1													
269	12					1													1		1	
270	8					2															1	
271	9					1	1														1	
272	9					1	1												1		1	
273	6																		2	1	1	
274	7				1														1		1	
275	12					1				1									1		1	
276	17																					1
277	13																					1
278	16									1											1	
279	14																					1
280	13					1															1	
281	13					2															1	
282	17																					1
283	18																					1

Site	Depth (ft)	Cab-bage	Chara	Chara-stone	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Float-ingleaf	Fries	Naiads	Nitella	NWM/ Hybrid	Sago	Star duck-weed	Stringy	Water celery	Water star-grass	ZM present	No plants
284	10																		1		1	
285	14																					1
286	4								1										1		1	
287	17																					1
288	22																					1
289	22																					1
291	22																					1
292	30																					1
295	17																					1
296	16																					1
304	17																					1
305	14					1			1	1								1			1	
317	20																					1
318	7									1									2		1	
319	21																					1
320	15																					1
321	10					1			1										1		1	
324	21																					1
325	7		1						1										1		1	
336	24																					1
337	16																					1
338	8								1	1									2		1	
339	18																					1
340	19																					1
341	15					1												1			1	
342	13					1			1										1		1	
343	7								1										2	1	1	
344	8	2				1			1												1	
345	8		1			1			1				1							1		
346	7			3																		
347	6			2		1			1										1			
348	24																					1
363	23																					1
364	25																					1
365	17																					1
366	13																		1			
367	25																					1
368	24																					1
369	23																					1
370	21																					1
372	5				1														2		1	
373	11		1			1				1											1	
374	22																					1
381	8					2			1												1	
387	13					1									1						1	
395	21																					1
396	10									1									2		1	
397	11					1															1	
398	10					1				1									1		1	
399	20																					1
409	12																					1
410	20																					1
417	25																					1
418	13					1															1	
419	7									1									2		1	
422	24																					1
429	12					1			1												1	
430	11								1												1	
432	20																					1
438	20																					1
439	11					2															1	
440	6					1													2		1	
441	10					1				1									1	1	1	
442	20																					1
443	24																					1
444	25																					1
445	24																					1
446	20																					1
447	25																					1
449	20																					1
450	8									1									2		1	
451	13					1				1											1	
452	13					1															1	
453	16					1															1	
454	16					1															1	
455	24																					1
456	34																					1
458	22																					1
460	19																					1
461	15																					1
462	12																		1		1	
463	15																					1
464	14					2																
465	14					1															1	
466	8								1	1									1		1	

Site	Depth (ft)	Cab-bage	Chara	Chara-stone	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Float-ingleaf	Fries	Naiads	Nitella	NWM/ Hybrid	Sago	Star duck-weed	Stringy	Water celery	Water star-grass	ZM present	No plants
467	6								1	1									3		1	
468	14					1															1	
469	17					1															1	
470	12					2															1	
471	18					1															1	
472	16					1															1	
473	9									1		1							2		1	
474	8					1			2													
475	7					2			3													
476	10								1	1									2	1	1	
477	7				1				1	1									2		1	
478	20																					1
479	14					1															1	
480	14					2															1	
481	11					1			1												1	
482	11					2				1											1	
483	21																					1
484	18																					1
485	6	2							1								1					
486	6	2				1		1	2						1		1					
487	4			1					1										1			
488	16					1															1	
489	20																					1
490	25																					1
491	23																					1
492	19																					1
493	19																					1
494	22																					1
495	16					1															1	
496	9				1					2							1				1	
497	15					1				1											1	
498	19																					1
499	15					1															1	
500	8				1	1				2									1		1	
501	22																					1
502	25																					1
503	21																					1
504	10				1					1											1	
505	10									1									2		1	
506	13			1																	1	
507	14	1				1				1											1	
508	11					1			1	1									1		1	
509	6								3	1									2		1	
510	10		1			1			1	1					1				2		1	
511	22																					1
512	19					1															1	
513	21																					1
514	9									1									2		1	
515	30																					1
516	14					1															1	
517	6					1			1	1	1		1		1				1		1	
Average		1.8	1.0	1.8	1.0	1.2	1.0	1.0	1.2	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.0	1.0	
Occur (218 sites)		4	4	4	9	63	7	1	32	32	1	2	2	1	4	1	3	3	46	7	88	112
% occur		2	2	2	4	29	3	0	15	15	0	1	1	0	2	0	1	1	21	3	40	

Spring Lake, April 2020

Curlyleaf Pondweed Surveys and Aquatic Plant Point Intercept Survey for Spring Lake, Scott County, Minnesota in 2020

Curlyleaf Pondweed Meandering Survey: April 30, 2020
CLP Treatment: May 19, 2020, 14.92 ac (diquat)
Curlyleaf Pondweed Assessment Surveys: June 11, 2020
Summer Point Intercept Plant Survey: August 14, 2020

Prepared for:
Prior Lake/Spring Lake Watershed District
Prior Lake, Minnesota

Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116

March 10, 2021

Curlyleaf Pondweed Surveys and Aquatic Plant Point Intercept Survey for Spring Lake, Scott County, Minnesota in 2020

Summary

Early Season CLP Delineation and Assessment: Curlyleaf pondweed (CLP) distribution and abundance were delineated in Spring Lake on April 30, 2020 to determine if curlyleaf control was needed. Curlyleaf growth was observed at 62 out of 254 sample sites (Figure S1). Growth ranged from light to heavy. Four areas totaling 14.92 acres were projected to produce abundant growth and were delineated for treatment (Figure S1).

Treatment of 14.92 acres occurred on May 19, 2020 using a diquat herbicide.

A post-treatment assessment survey included a line transect survey and a meandering survey and was conducted on June 11, 2020 to check the status of curlyleaf pondweed and native plant community in Spring Lake. CLP was observed at a number of sites with light to heavy growth. Treatment control in 3 of the 4 areas was poor and fair control was observed in the fourth area (Figure S1).

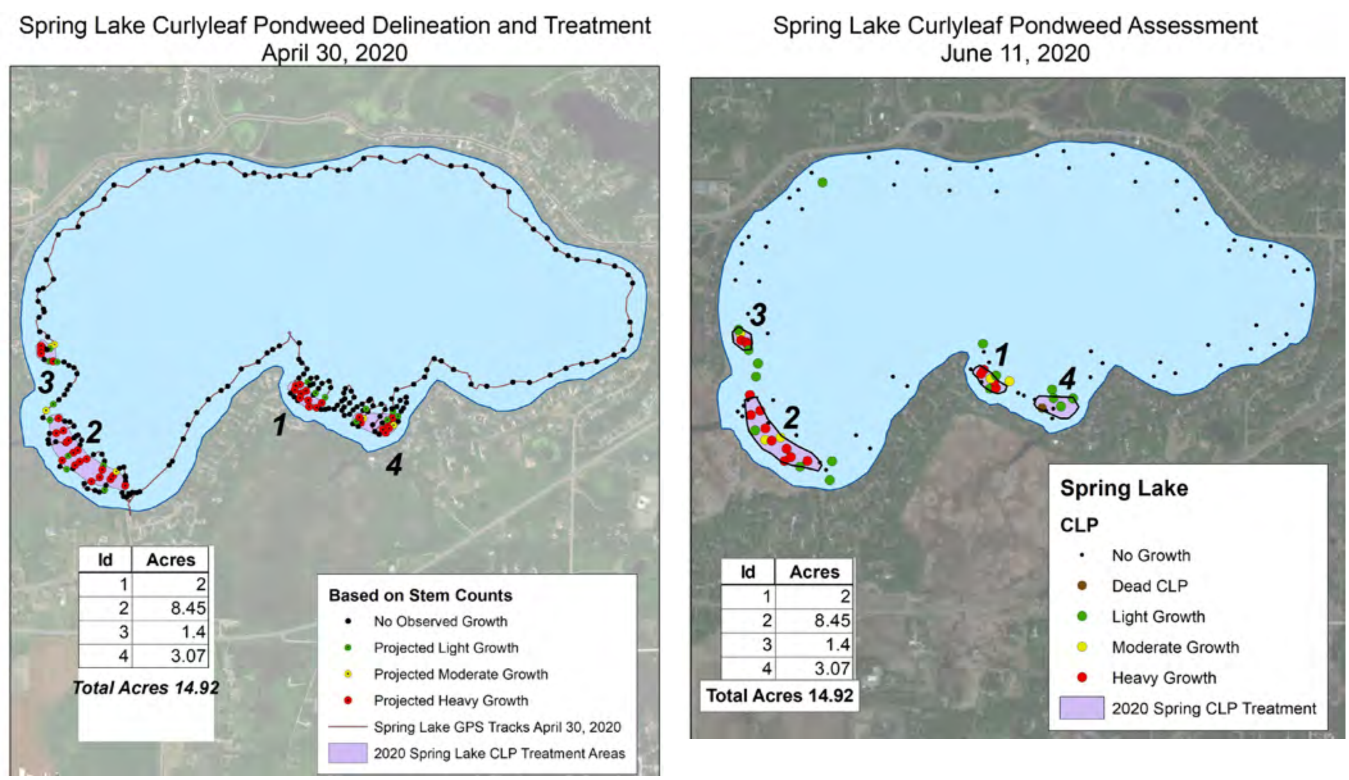


Figure S1. [left] curlyleaf pondweed delineation. [right] curlyleaf pondweed assessment (post treatment).

Point Intercept Survey: A grid with points spaced 50 meters apart was put over the entire lake and sites were sampled throughout the growing zone. A total of 352 sites were sampled, plants were observed growing to a depth of 9 feet. Results of the summer aquatic plant point intercept survey conducted on August 14, 2020 found 14 submerged aquatic plant species with including CLP. Native plants were found around the perimeter of the basin of Spring Lake (Figure S2).

Native aquatic plants were estimated to cover of the lake bottom (98 acres). Coontail was the dominant aquatic plant. The 14 aquatic plant species found in this survey represents a fair to good diversity for Spring Lake in late summer.

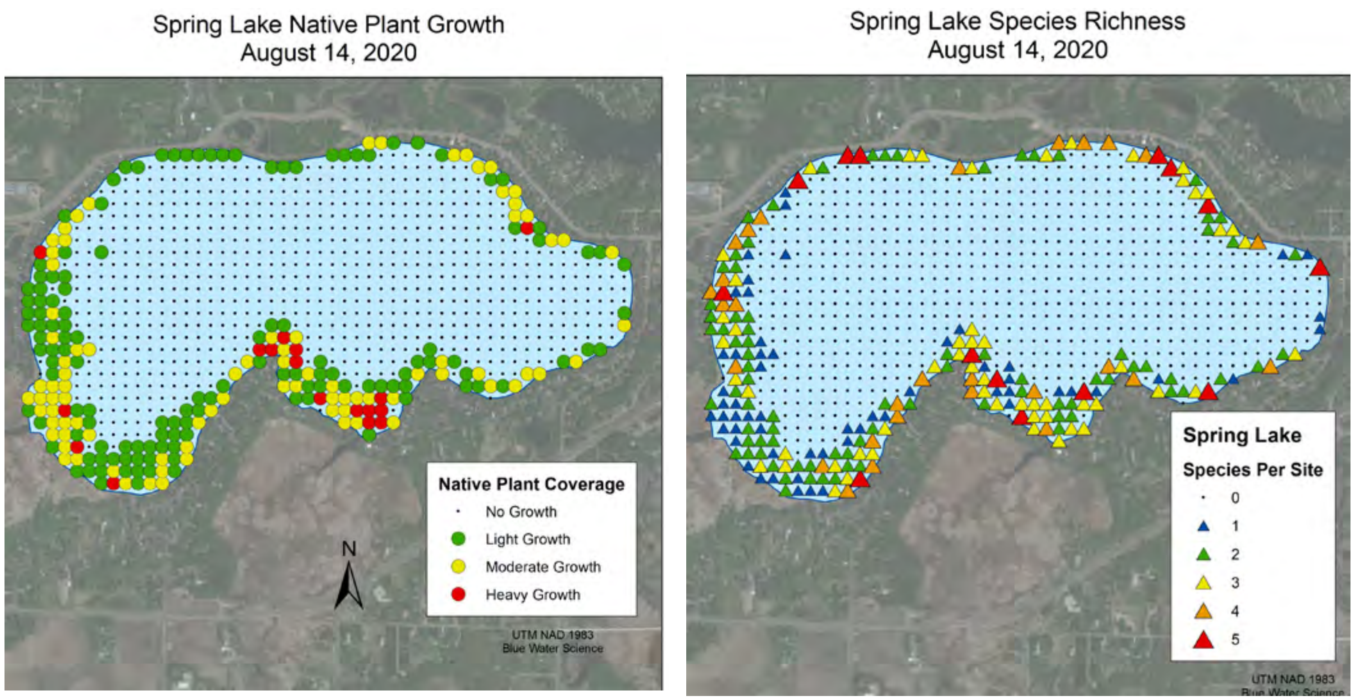


Figure S2. [left] Native plant distribution and abundance for the August 14, 2020 point intercept survey. [right] Species Richness for the August 14, 2020 point intercept survey.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Curlyleaf Pondweed Surveys and Aquatic Plant Point Intercept Survey for Spring Lake, Scott County, Minnesota in 2020

Introduction

Spring Lake has an area of 592 acres with a littoral area of 290 acres (source: MnDNR). The objectives of the plant surveys were to delineate and recommend areas to treat nuisance curlyleaf pondweed and to monitor the non-native and native plants over the summer.

A curlyleaf pondweed delineation survey was conducted on April 30, 2020.

Treatment occurred on May 19, 2020 and covered 14.92 acres.

A curlyleaf pondweed assessment was conducted on June 11, 2020.

A summer aquatic plant point intercept survey was conducted on August 14, 2020 to check and inspect the native plant community in Spring Lake.

Figure 1. Rake sample of aquatic submerged plants sampled on April 30, 2020 in Spring Lake.

Survey Methods for Meandering and Line Transect Surveys: Determining what areas to treat to control excessive growth of curlyleaf pondweed has been an ongoing challenge. Curlyleaf growth in April and May is just starting to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season. Currently, for Spring Lake, the method has been to use past treatment history combined with early season scouting and then a recheck to evaluate any treatment effects and see if curlyleaf areas were missed. A meandering survey was used to delineate CLP and a meandering survey was combined with a line transect survey to assess the CLP treatment (Figure 2).

Meander Delineation Survey: A meandering survey consists of using a meandering path around the nearshore area of the entire lake. Visual inspection along with plant sampling was conducted. At each sample point, plants were sampled with a rake sampler.

Line Transect Survey: We used 25 line transects with 2 depths per transect. The same transects have been used from 2000 through 2020. Plants were sampled with a rake attached to a pole to characterize species presence and its density along a transect. A total of 50 sites were sampled (Figure 2). For the assessment transect survey, plant density was estimated on a scale of 1 to 3 with 3 being the densest.

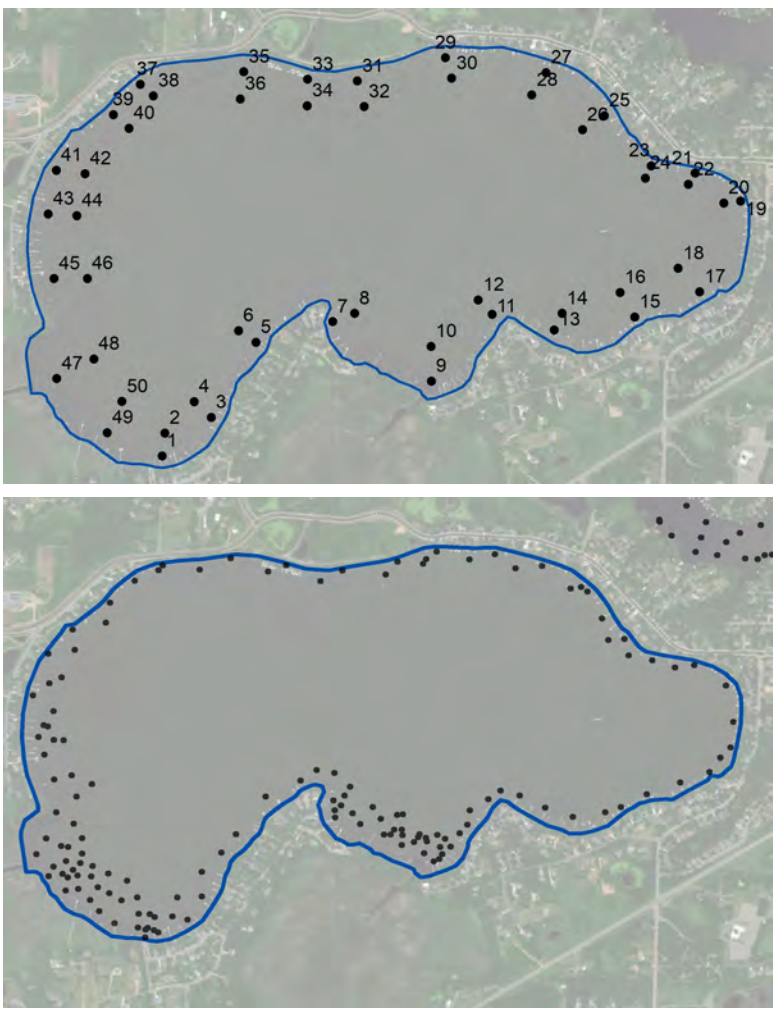


Figure 2. [top] Full lake transect survey sample sites. [bottom] Meander GPS sample points. The transect survey can be used for year to year comparisons and the meander GPS surveys help target abundant and nuisance non-native species.

Methods for the Point Intercept Survey: An aquatic plant point intercept survey of Spring Lake was conducted by Blue Water Science on August 14, 2020. A total 352 points in the growing zone out to 15 feet will be sampled. Sample points were spaced 50 meters apart on a grid that covered the lake (Figure 3). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, plant distribution maps were constructed.

Figure 3. Point intercept sample sites for Spring Lake in 2020. Sample sites were spaced 50 meters apart.

Results of Curlyleaf Pondweed Delineation April 30, 2020: A curlyleaf delineation using a meandered survey collected a total of 254 GPS points around the lake. Curlyleaf was found at 62 out of 254 sites (Figure 4). Curlyleaf was observed growing in water depths of 2-6 feet, notably, no curlyleaf was observed deeper than 6 feet of water depth. Coontail, elodea, and chara were present but rare at this time. At total of 14.92 acres were delineated for treatment (Figure 4).

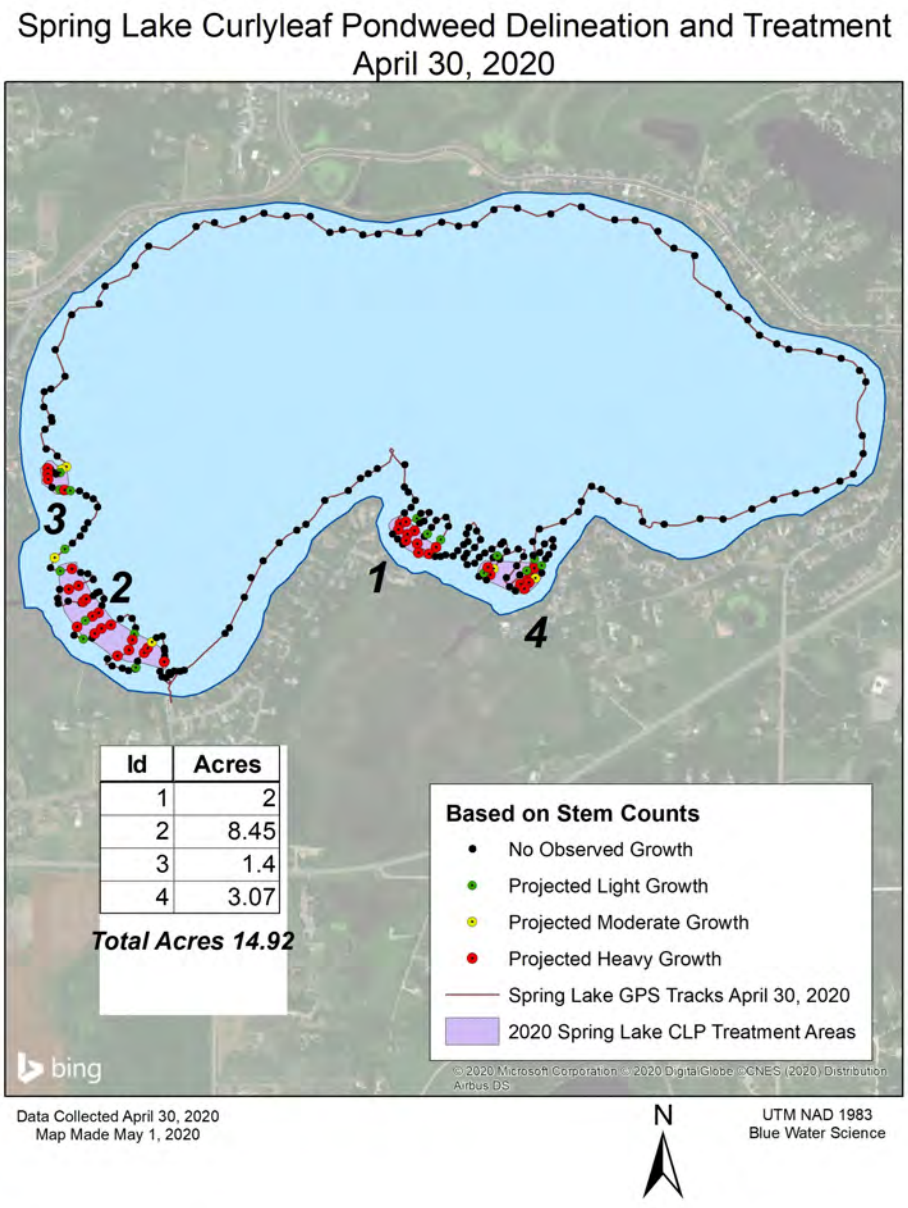


Figure 4. Map of curlyleaf pondweed for April 30, 2020. Colored sample areas indicate the growth in April of 2020 for curlyleaf pondweed. Key: green = light potential growth, yellow = moderate potential growth, red = heavy potential growth, and black dot = no curlyleaf.

Curlyleaf Pondweed Assessment, June 11, 2020: A curlyleaf assessment (post-treatment survey) was conducted on June 11, 2020, the survey included meandering survey collecting 64 GPS points and a line-transect survey which collect data on 50 established sites. Curlyleaf was found at 37 out of 114 of the total sites (Figure 5). Curlyleaf did expand and the curlyleaf treatment was poor to fair.

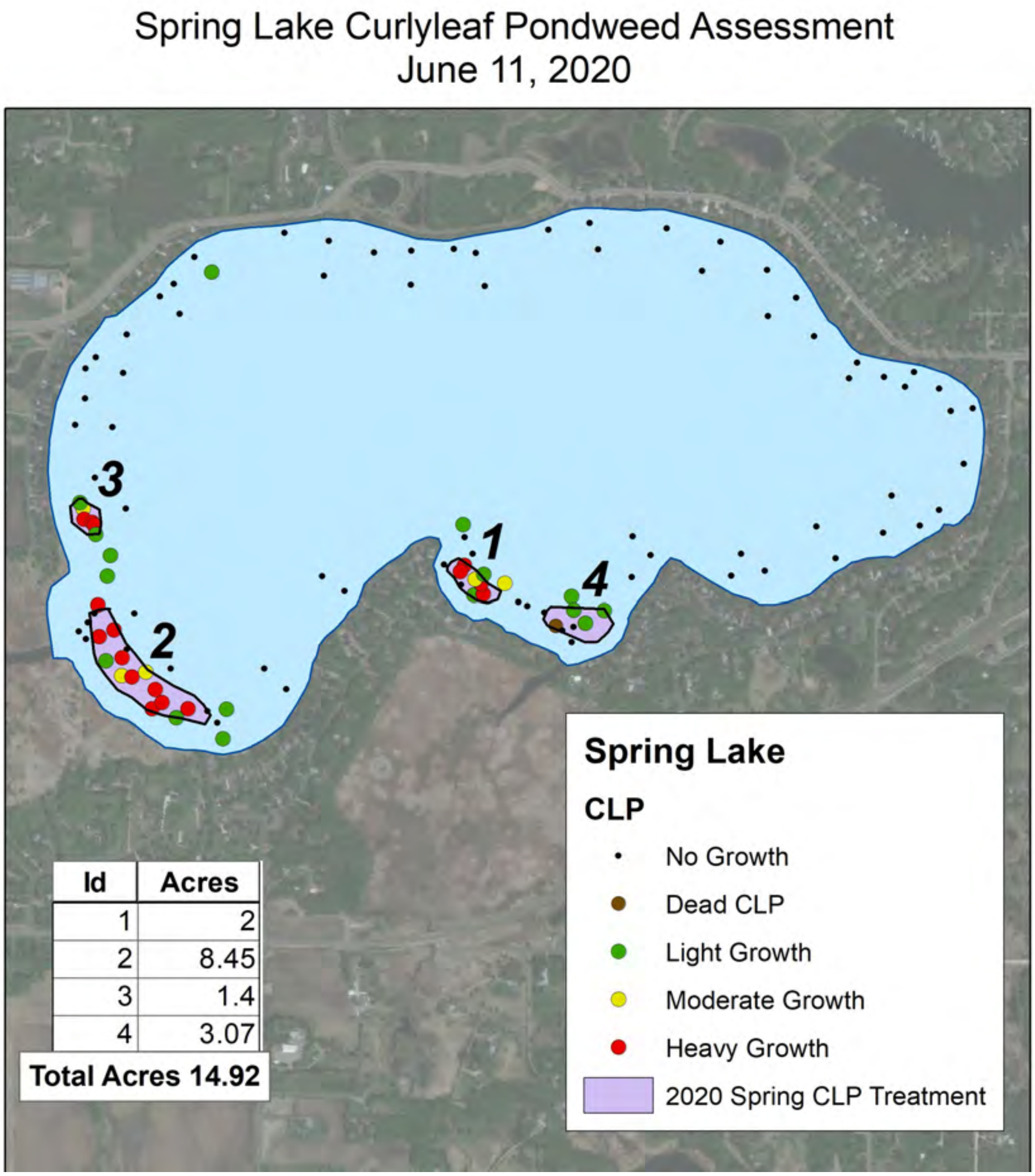


Figure 5. Curlyleaf pondweed assessment on June 11, 2020.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black = no curlyleaf.

Summary of Curlyleaf Pondweed 2000 to 2020

Curlyleaf pondweed growth has been variable from 2000 through 2020. For the years 2007 to 2015 there were no CLP treatments. There may be a correlation to the use of an iron dosing station on the County 13 ditch where flows eventually enter Spring Lake and a reduction in Spring Lake curlyleaf. The amount of iron dosed is listed in Table 1. Likely only a small percentage of the dosed iron makes its way into Spring Lake. Iron in the water column that may inhibit CLP growth is speculative but heavy CLP growth, as shown in Figure 6, did not occur from 2007 through 2015 when some iron from the iron dosing operation may have entered Spring Lake. After a dosing station upgrade, in 2013, it is likely less iron entered Spring Lake and curlyleaf growth may have increased.

Table 1. Curlyleaf pondweed occurrence and acres either harvested or treated with herbicides from 2000 to 2020.

	Iron (kg)	$FeCl_3$ (gallons)	Curlyleaf Occurrence (based on 50 sites unless noted)	Harvesting Acres	Herbicide Treatment Acres	Total Curlyleaf Treatment (acres)
2000	?		49			
2001	?					
2002	?		43	60	14	74
2003	0	0	35	74	14	88
2004	0	0	40		59	59
2005	2,629	4,232	29		59	59
2006	895	1,440	32		59	59
2007	920	1,481	22			
2008	726	1,168	4			
2009	109	176	5			
2010	0	0	25			
2011	1,491	2,390	10			
2012	0	0	6			
2013	1,248 (J-A)	?	3			
2014	>4,547	>7,275	10			
2015	2,800	4,480	10			
2016	4,206	6,730	11		20.4	20.4
2017	4,544	7,270	11		3.7	3.7
2018	3,656	5,850	4			
2019	3,675	5,880	29 (144 sites)		15.7	15.7
2020			62 (254 sites)		14.92	14.92

Figure 6. Curlyleaf pondweed growth was very heavy in 2000.

Results - Point Intercept Aquatic Plant Survey on August 14, 2020

Results of the summer aquatic plant survey conducted on August 14, 2020 found 14 submerged aquatic plant species, CLP was present in August, no Eurasian watermilfoil was observed. Plant growth was restricted to water depths of 8 feet or less in Spring Lake (Table 2). Native plants were found around the perimeter of the basin of Spring Lake. Aquatic abundance and species diversity was greater than previous years. Plant distribution and abundance are shown in Table 2.

Table 2. Spring Lake aquatic plant occurrence and density for the August 14, 2020 survey based on 298 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

Spring Lake August 14, 2020	All Stations (n=298)		
	Occur	% Occur	Average Density
Cattails (*Typha sp*)	3	1	1.7
Duckweed (*Lemna sp*)	3	1	1.7
White water lilies (*Nymphaea ordata*)	5	2	1.2
Coontail (*Ceratophyllum demersum*)	154	52	1.3
Chara (*Chara sp*)	3	1	1.0
Moss (*Drepanocladus sp*)	2	1	1.0
Elodea (*Elodea canadensis*)	14	5	1.0
Water stargrass (*Heteranthera dubia)*	56	19	1.2
Northern watermilfoil (*Myriophyllum sibiricum*)	2	1	1.0
Naiads (*Najas flexilis*)	116	39	1.2
Curlyleaf pondweed (*Potamogeton crispus*)	20	7	1.1
Fries pondweed *(P. friesii)*	1	1	1.0
Claspingleaf pondweed (*P. Richardsonii*)	59	20	1.4
Stringy pondweed (*P. sp*)	57	19	1.0
Flatstem pondweed (*P. zosteriformis*)	1	1	1.0
Sago pondweed (*Stuckenia pectinata*)	14	5	1.0
Water celery (*Vallisneria americana*)	64	21	1.4

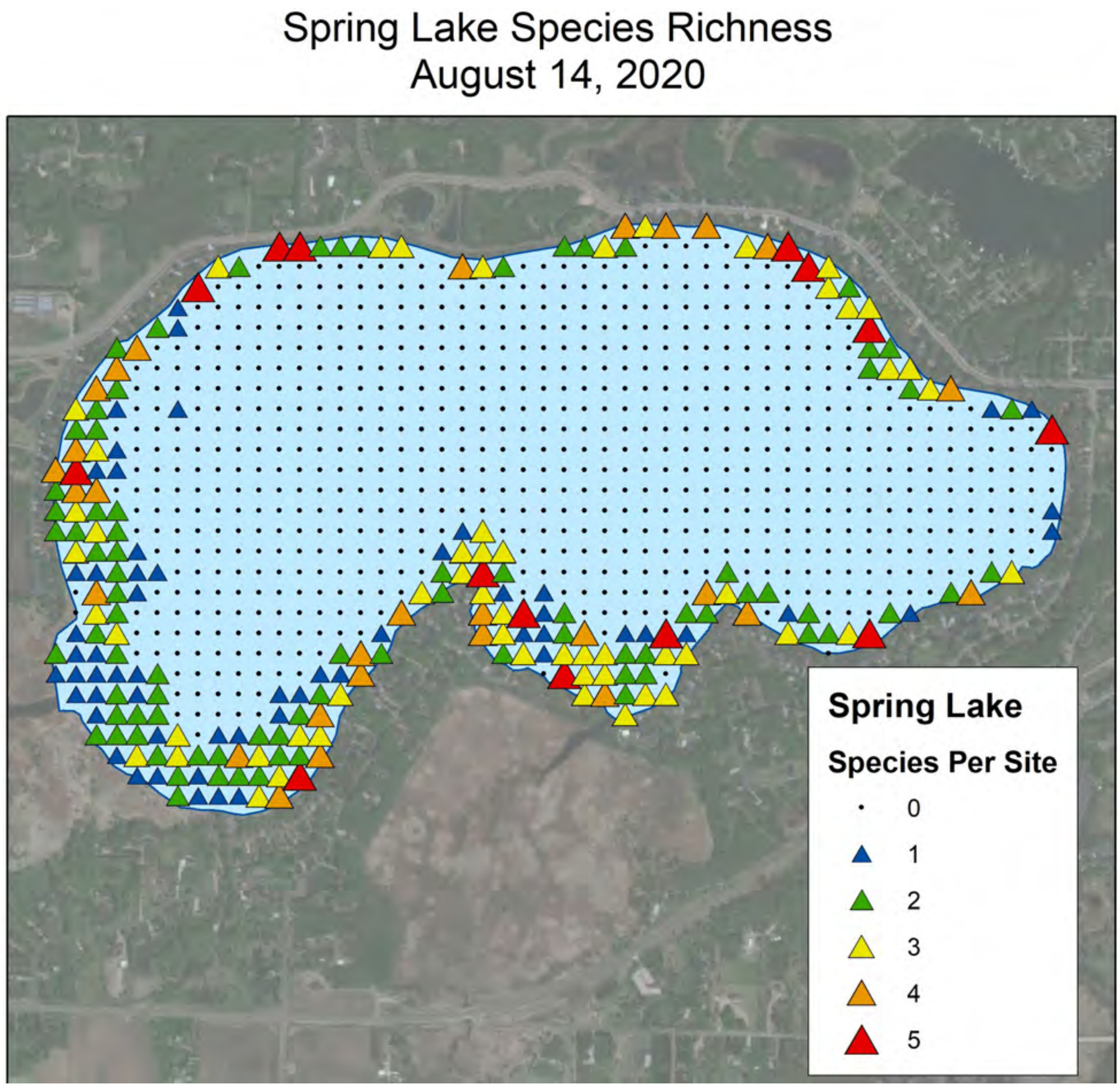


Figure 7. Species Richness or the number of species per site for the point intercept survey on August 14, 2020.

Spring Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 3 and 4 and Figure 8. A total of 352 points were sampled and plants were found out to 9 feet of water which included 298 sample points out to 9 feet. But 95% of plant growth occurred from 1-8 feet. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 3. MnDNR Template Statistics

Total # Points Sampled	352
Depth Range of Rooted Veg	1-9 feet
Maximum Depth of Growth (95%) in feet	8.0
# Points in Max Depth Range	263
# Points in Littoral Zone (0-9 feet)	298
% Points w/ Submersed Native Taxa	50
Mean Submersed Native Taxa/Point	0.9
Mean Density of Submersed Native Taxa	1.1
# Submersed Native Taxa	14

Table 4. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled (0-9 ft)	% Sampling points with submersed species observed
0	0	0
1	4	100%
2	21	100%
3	64	100%
4	56	100%
5	35	97%
6	26	96%
7	35	63%
8	22	36%
9	35	14%
10	19	0
11	12	0
12	14	0
13	5	0
	298	

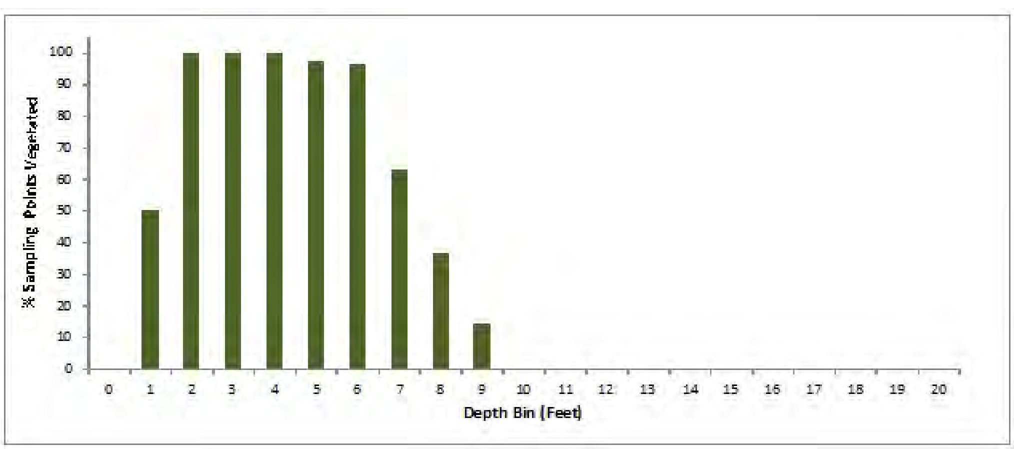


Figure 8. Depth of plant colonization (in feet).

Aquatic Plant Maps: Coverage of the select native plants species found in the August 2020 survey are shown in Figures 9 and 10.

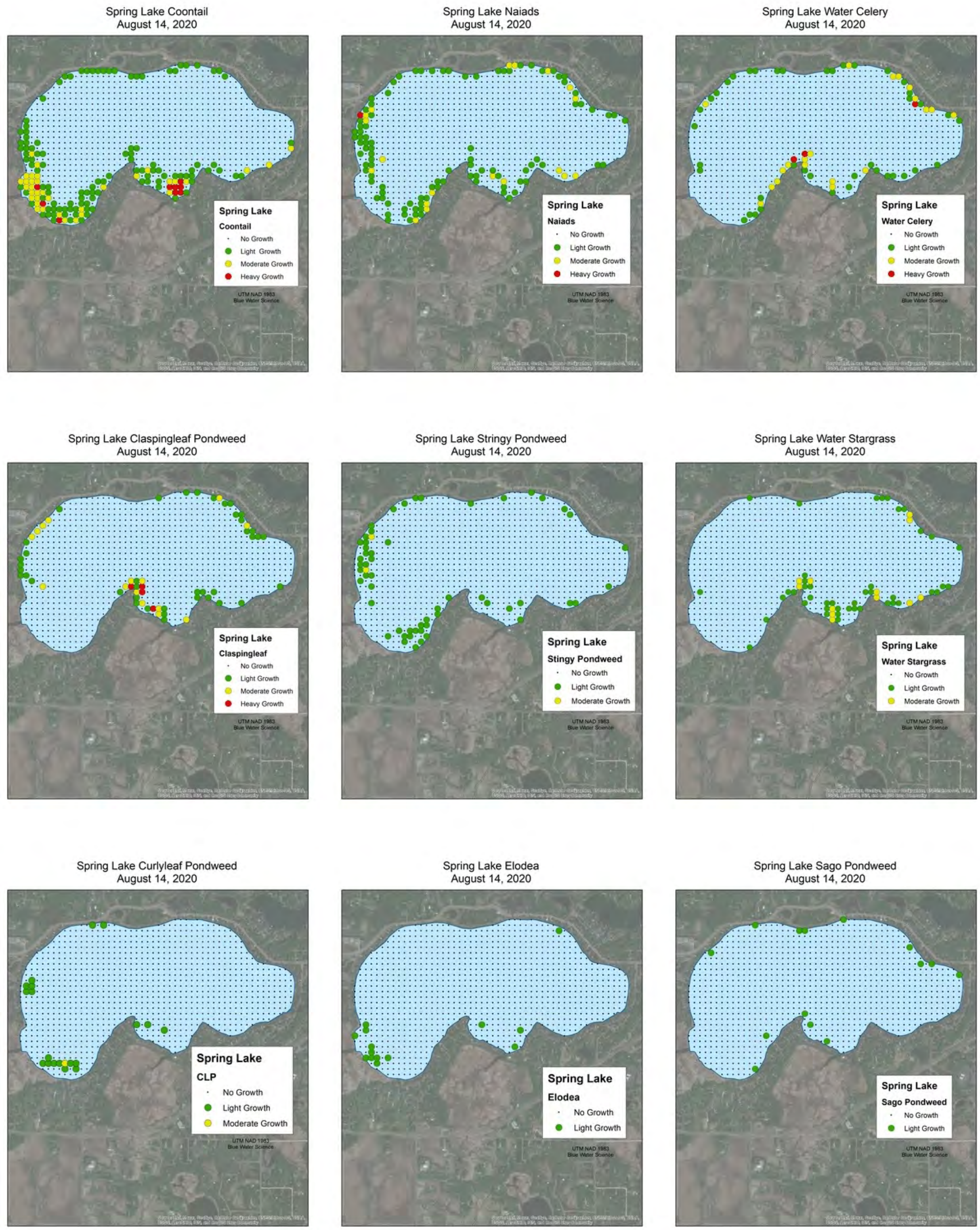


Figure 9. Distribution and abundance maps for common submerged aquatic plant species in Spring Lake on August 14, 2020.

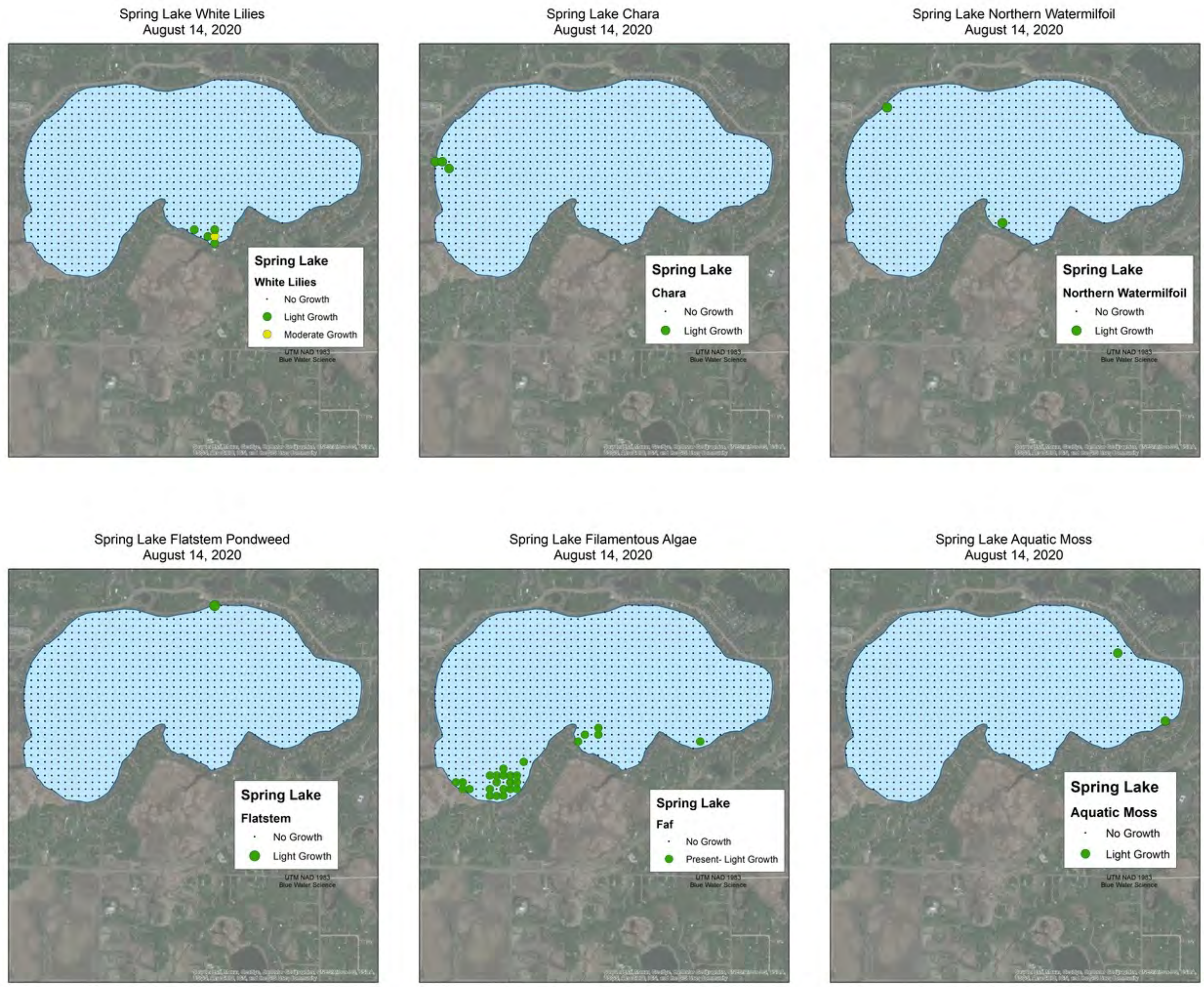


Figure 10. Rare aquatic plant species (Percent occurrence 5% or less) in Spring Lake on August 14. 2020. White lilies, chara, northern watermilfoil, flatstem pondweed, filamentous algae and aquatic moss. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Comparison of 2015, 2018, 2019, 2020 Point Intercept Surveys

Point intercept surveys were conducted on Spring Lake in 2015, 2018, 2019, and 2020, and results are shown in Table 5. In 2015, elodea was the dominant plant but since then coontail has been dominant (Table 5). Several species increased in occurrence since 2015 including coontail, claspingleaf pondweed, water celery, and water stargrass. Elodea and sago pondweed have decreased (Table 5).

Table 5. Spring Lake aquatic plant occurrence for the point intercept surv eys conducted in 2015, 2018, 2019, and 2020.

	2015 % Occur (113 sites)	2018 % Occur (248 sites)	2019 % Occur (214 sites)	2020 % Occur (298 Sites)
Cattails (*Typha sp*)		1		1
Duckweed (*Lemna sp*)		1		1
White water lilies (*Nymphaea ordata*)		1	5	2
Coontail (*Ceratophyllum demersum*)	15	56	47	51
Chara (*Chara sp*)	4	2	2	1
Chara - 2 (*Chara sp*)		1		
Moss (*Drepanocladus sp*)		1	2	1
Elodea (*Elodea canadensis*)	42	36	3	5
Water stargrass (*Heteranthera dubia)*	5	12	10	19
Northern watermilfoil *(Myriophyllum sibiricum)*				1
Naiads (*Najas flexilis*)	21	23	9	39
Curlyleaf pondweed (*Potamogeton crispus*)	12	6		7
Claspingleaf pondweed (*P. Richardsonii*)	4	10	10	20
Stringy pondweed (*P. sp*)	29	7	4	19
Flatstem pondweed *(P. zosteriformis)*				1
Sago pondweed (*Stuckenia pectinata*)	17	11	9	5
Bladderwort (*Utricularia vulgaris*)		1		
Water celery (*Vallisneria americana*)	9	20	23	21
Number of submerged species	10	13	10	14

Native Plant Coverage Comparisons : Native aquatic plant distribution may have decreased slightly from 2015 to 2019 but then increased in 2020 based on point intercept survey results (Figure 11). In 2015, plants grew to a depth of 9 feet and covered an estimated 175 acres of the lake (29%). In 2018, plants were found out to a depth of 8 feet and covered an estimated 122 acres of the lake (198 sites with plants 21%). In 2019, plant coverage was estimated at 98 acres or about 17% of the lake area (150 sites with plants). In 2020, plants grew out to 9 feet and covered approximately 25% of the lake bottom (Figure 11).

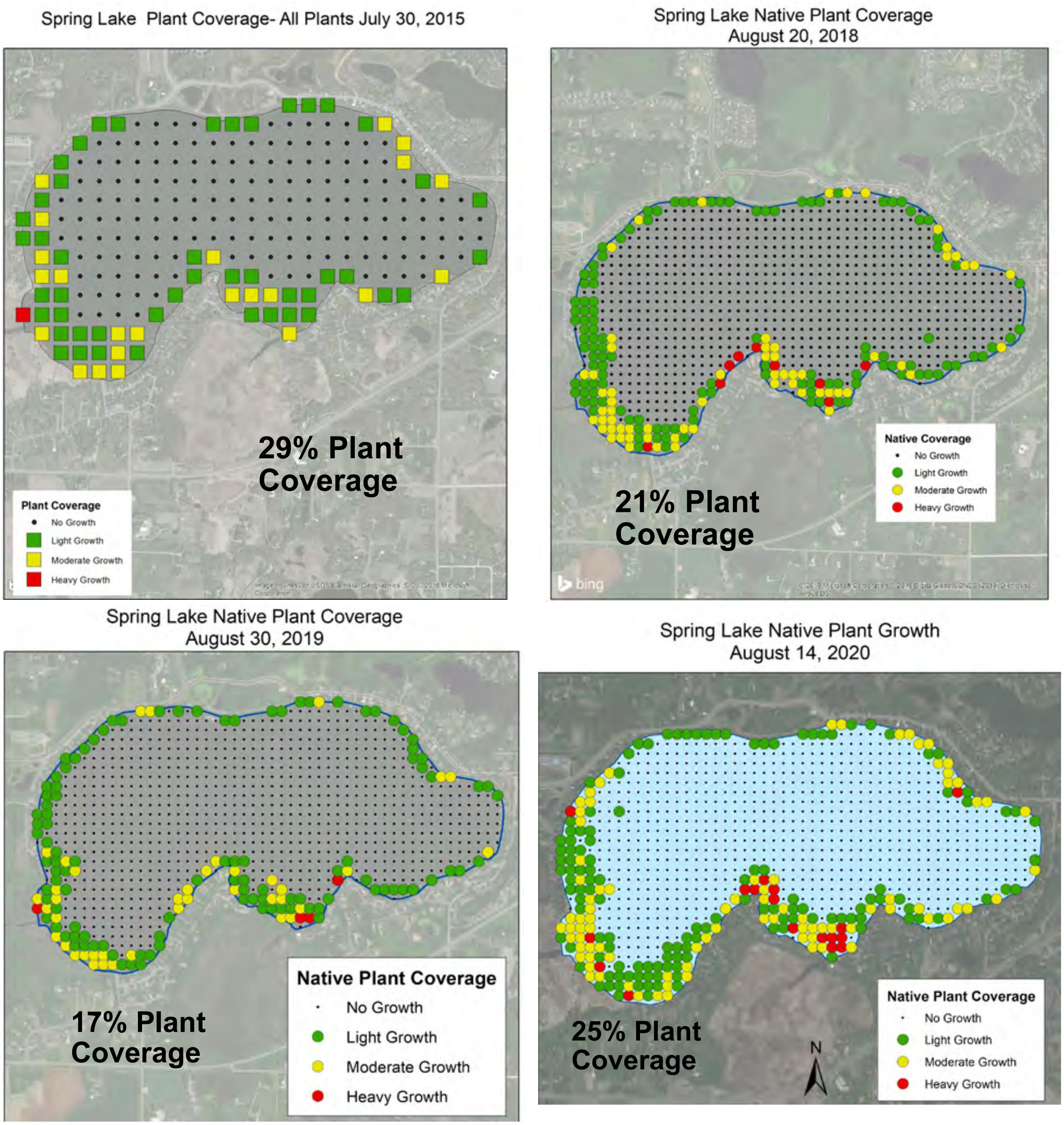


Figure 11. Aquatic plant distribution and abundance for the point intercept surveys in 2015, 2018, 2019, and 2020. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Summary of Aquatic Plant Surveys from 1948 - 2020

Since 1948, specific plant species in Spring Lake have appeared and disappeared (Table 6). For a number of years, stringy pondweed, likely a *P. pusillus*, was the dominant plant species. However, from 2018 through 2020, coontail was the dominant plant (Table 6).

The number of aquatic plant species has range from a low of 5 to a peak of 14 which was recorded in 2020 (Table 6).

Table 6. Aquatic plant status for 1948 to 2020.

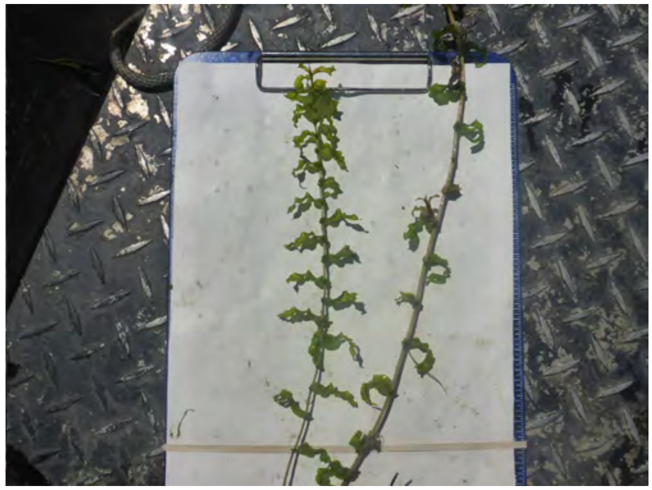
	Dominant Plant Occurrence (% occurrence based surveys)	Dominant Species in Mid Summer Survey	Number of Plant Species
1948	Rare (MnDNR)	All rare	7
1973	Rare-Common (MnDNR)	5 - common	8
1982	Rare-Common (MnDNR)	Coontail	8
1986	Present (MnDNR)	3 species	5
1988	Present-Occasional (MnDNR)	Sago + water stargrass	8
2000	40	Curlyleaf	9
2002	36	Sago	9
2004	68	Elodea	9
2005	76	Elodea	9
2006	48	Coontail	8
2007	30	Coontail	6
2008	24	Stringy	9
2009	66	Stringy	9
2010	34	Stringy	7
2011	64	Stringy	6
2012	72	Stringy	4
2013	19	Stringy	5
2014	48	Stringy	5
2015	42 (PI survey)	Elodea	10
2016	38	Elodea	6
2017	86	Stringy	8
2018	56 (PI survey)	Coontail	13
2019	47 (PI survey)	Coontail	10
2020	52 (PI survey)	Coontail	14

Supplemental Data For Spring Lake

Common Aquatic Plants in Minnesota

Chara (*Chara sp*)

Claspingleaf pondweed (*Potamogeton richardsonii*)



Coontail (*Ceratophyllum demersum*)

Curlyleaf Pondweed (non-native)(*Potamogeton crispus*)

Eurasian watermilfoil (non-native)
(*Myriophyllum spicatum*)

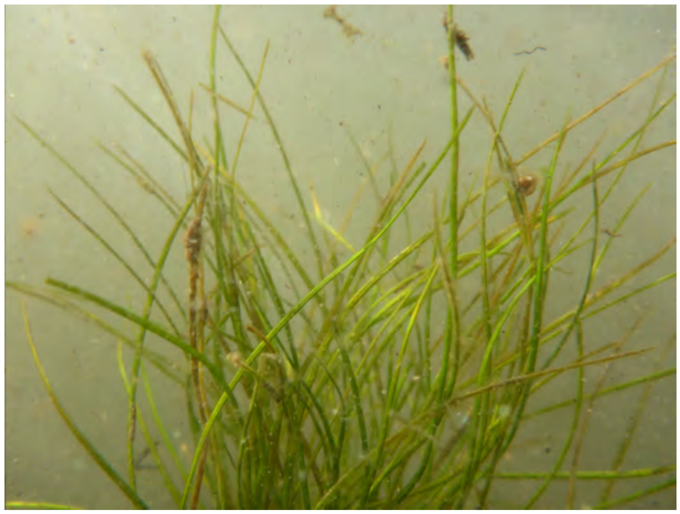
Flatstem pondweed (*Potamogeton zosteriformis*)(WDNR)

Naiad (*Najas sp*)

Northern watermilfoil (*Myriophyllum sibiricum*)

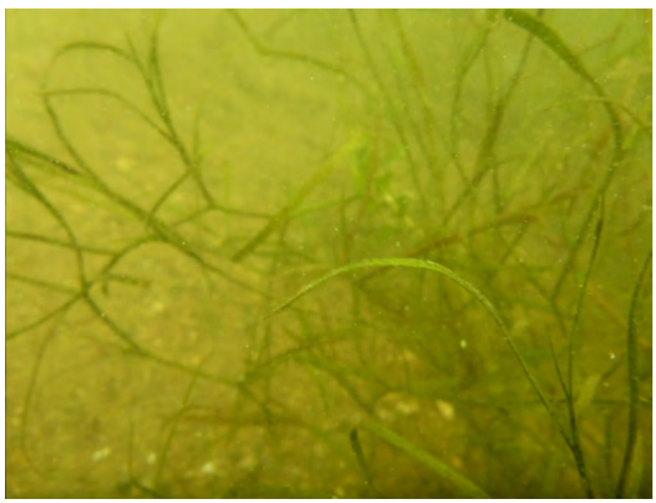
Sago pondweed (*Stuckenia pectinata*)

Stringy pondweed (*Potamogeton pusillus*)



Water celery (*Vallisneria americana*)

Water stargrass (*Heteranthera dubia*)



Spring Lake CLP Delineation, Individual Site Data April 30, 2020

Aquatic plant densities based on rake sampling for April 30, 2020. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted.

Waypoint	Depth (ft)	CLP-stems	Chara	Coontail	Elodea	No plants
1	5					1
2	5					1
21	5			1		
22	5	8	1	1		
23	3	9				
24	6	1				
25	7					1
26	7					1
27	6					1
28	6					1
29	5	6				
30	5	16				
31	4	10		1		
32	3			1		
33	4					1
34	4					1
35	4					1
36	4	6				
37	5	11				
38	5					1
39	5	1				
40	6					1
41	8					1
42	8					1
43	7					1
44	6	2				
45	3	6				
46	4	9				
47	4	7				
48	3					1
49	3					1
50	4					1
51	3					1
52	4					1
53	4					1
54	4					1
55	5					1
56	7					1
57	8					1
58	7					1
59	3					1
60	3					1
61	2					1
63	3					1
64	3					1
65	5					1
66	7					1
68	9					1
69	8					1
70	6					1
71	4	3		1		
72	3	14				
73	2					1
74	2					1
75	2	2		1		
76	3	6		1	1	
77	5					1
78	5	1		1		
79	8					1
80	7					1
81	3			2		
82	4			2		
83	4			1		
84	4	20		1		
85	5	20		1		
86	5	16				
87	5	8				
88	6	2				
89	7					1
90	8			1		
91	7					1
92	6			1		
93	6					1

Waypoint	Depth (ft)	CLP-stems	Chara	Coontail	Elodea	No plants
94	6			1		
95	5	1				
96	4			1		
97	4	3				
98	5	15				
99	4	16		1		
100	3			1		
101	5			1		
102	5	2				
173	6	3				
174	6	3				
175	6	2				
176	6					1
177	6					1
178	6					1
179	6	6				
180	5	8				
181	5	6				
182	4					1
183	5	2				
184	5	5				
185	5	1				
186	5					1
187	3					1
188	4					1
189	8					1
194	5	1				
195	4	3				
197	4	1				
198	5	14				
199	6					1
200	6					1
202	6	5				
203	5	12				
204	4					1
209	5	9				
210	5	7				
211	7					1
216	6	14				
217	5	12				
218	5	2				
219	4	6				
220	3					1
221	4	1				
223	4	5				
224	5	5				
225	5	12				
226	7					1
229	6	2				
230	5	10				
231	5	12				
232	4	8				
233	4					1
238	4	2				
239	4					1
240	5	7				
241	5	6				
242	6	3				
243	7					1
246	6					1
247	6					1
248	5	6				
254						1
Average		6.8	1.0	1.1	1.0	
Occur (254 sites)		62	1	20	1	63

Spring Lake CLP Assessment, Individual Site Data June 11, 2020

Aquatic plant densities based on rake sampling for June 11, 2020. Densities are based on a scale from 1 to 3 w ith 3 being the densest.

Waypoint	Site	Depth ft)	Chara	Claspingleaf	Coontail	CLP	CLP-dead	Moss	Sago	Stringy	Water celery	Water stargrass	No plants
	1	4			1	1							
	2	6			1	1							
	3	5			1								
	4	7											1
	5	4							1		1	1	
	6	10											1
	7	3		1									
	8	5		1									
	9	3			3								
	10	6			1	1							
	11	4		1									
	12	7											1
	13	4		1									
	14	8											1
	15	5			1								
	16	9											1
	17	5		1									
	18	8											1
	19	4						1					
	20	8											1
	21	4		1									
	22	9											1
	23	4		1							1		
	24	9											1
	25	4											1
	26	8											1
	27	4											1
	28	7	1										
	29	5			1								
	30	8											1
	31	4		1									
	32	8											1
	33	4			1						1		
	34	8											1
	35	4											1
	36	6											1
	37	4			1				1	1			
	38	7				1							
	39	5			1								
	40	8											1
	41	4		1	1					1	1		
	42	7											1
	43	4			1				1				
	44	7											1
	45	4			1	2							
	46	7											1
	47	4			1								
	48	7											1
	49	4			1	3							
	50	7			1								
273	3					1							
274	4												1
275	5					3							
276						3							
277					2								
278	4					1							
279	5					3							
280	5					3							
281	5					2							
282	5					1							
283	6					2							
284	3				2								
285	3				1								
286	3				1								
287	3						2						1
288	3			1									
289	4			1									
290	5			1		1							
291	5			3		1							
292	6					1							
293	7												1
294													1
295													1
296													1
297													1
298													1

Aquatic plant densities based on rake sampling for June 11, 2020. Densities are based on a scale from 1 to 3 w ith 3 being the densest.

Waypoint	Site	Depth ft)	Chara	Claspingleaf	Coontail	CLP	CLP-dead	Moss	Sago	Stringy	Water celery	Water stargrass	No plants
299													1
300													1
301													1
302													1
303	5			1									
304													1
305													1
306				1									
307													1
308													1
309													1
310													1
311													1
312	5					1							
313	5					3							
314						3							
315						3							
316	4					1							
317						1							
318						1							
319						3							
320													1
321	4												1
322													1
323						3							
324						3							
325													1
326	5					3							
327	5					1							
328	5					2							
329	5					3							
330	6					2							
331	5					3							
332	5					3							
333	5					1							
334	5					3							
335	6												1
336	6												1
All sites	Average		1.0	1.1	1.2	2.0	2.0	1.0	1.0	1.0	1.0	1.0	
	Occur:	114	1	15	20	37	1	1	3	2	4	1	47
Sites	Average		1.0	1.0	1.1	1.5		1.0	1.0	1.0	1.0	1.0	
	Occur:	50	1	9	16	6		1	3	2	4	1	22
	% occur		2	18	32	12		2	6	4	8	2	
Waypoint	Average			1.3	1.5	2.1	2.0						
	Occur:	64		6	4	31	1						25

August 14, 2020: Individual site data for the point intercept survey.

Site	Depth (ft)	Cattails	Duckweed	White lilies	Chara	Clasping leaf	Coontail	CLP	Elodea	EWM	Flatstem	Fries	Moss	Naiads	NWM	Sago	Stringy	Stringy-Narrow	Water celery	Water stargrass	FA	No plants
1	3						1							1								
2	3						3															
3	3						2														1	
4	4						1														1	
5	3						2							1					1		1	
6	2						1							2			1			1		
7	3						1														1	
8	3						1														1	
9	3						1							1								
10	3		1				2															
11	4						1	1													1	
12	5													1			1					
13	5						1	1													1	
14	4						2							1					1		1	
15	3						1							1		1	1		1		1	
16	3						2														1	
17	4						2	1	1												1	
18	4						1	1														
19	4						1	1									1					
20	5						1	1														
21	5						1	2														
22	6						1	1						1			1				1	
23	6						1	1									1					
24	5						2							1							1	
25	4						1							1							1	
26	2						1							2			1		1			
27	3						1		1													
28	3						2		1													
29	3						3		1													
30	5							1														
31	5						1		1					1								
32	6																					1
33	7																1				1	
34	7						1														1	
35	7													1			1				1	
36	6						1										1				1	
37	6						1							1			1				1	
38	3											1		2					2			
39	3						2															
40	4						2		1													
41	5						1							1								
42	6						2							1								
43	7																					1
44	8																					1
45	9																					1
47	8																				1	1
48	8						1															
49	7													1			1					
50	4						1							1			1		1			
51	2	1		1			1							1								
52	3						1															
53	3						2															
54	4						2		1													
55	6						2															
56	6						1							1								
57	8																					1
58	9																					1
60	10																					1
61	10																					1
62	9						1															
63	8						1															
64	7						1										1				1	
65	4						1							2						1		
66	2					1													1	2		
67	2			1			2							1						1		
68	3			2			3															
69	3						3		1					1								
70	2					2	1										1					
71	1		2				1															
72	3						2															
73	3						2															
74	9						3															
75	6						1															
76	7						1							1								
77	9																					1
78	9																					1
80	11																					1
81	11																					1
82	10																					1
83	10																					1
84	8						1															
85	5													1								
86	4						2							1			1		2			
87	1	1																				
88	2			1		2	1									1				1		
89	2					1													2	2		
90	3						3							1						1		
91	3			1			3															
92	4						3												1			
94	2		2				2		1													
95	3						2															
96	4						2															
97	6						2							1								
103	12																					1
107	11																					1
108	9						1									1						

Site	Depth (ft)	Cattails	Duckweed	White lilies	Chara	Clasping leaf	Coontail	CLP	Elodea	EWM	Flatstem	Fries	Moss	Naiads	NWM	Sago	Stringy	Stringy-Narrow	Water celery	Water stargrass	FA	No plants
109	5						1							1			1	1				
110	3													1					2			
111	3						1							1								
112	3					1	1								1							
113	3					3																
114	2					2	1													1		
115	2					1													2	2		
116	4						2							2						1		
117	6						2										1					
118	5						3													1		
119	5						2							1						1		
120	3						1							1						1		
122	3						2															
123	4						2		1													
124	6						2							1			1					
125	8																					1
126	9																					1
135	12																					1
136	9																					1
137	5						1															
138	3					1	2							1						1	1	
139	3					2								1					1			
140	4						1															
141	5																1					
142	5													2						1		
143	4						1	1						1						1		
144	8																					1
145	7						1															
146	9						1															
147	7						1		1								1		1	1		
148	5						1															
149	3					1													1	1		
150	3																		1	1		
151	4													2						1		
152	4						1										1		1		1	
153	4					1	1							2			1			2		
154	1	3																				
155	2								1					1					1			
156	5						1							2								
157	9																					1
169	10																					
170	4													1			1		2	1		
171	3					1	1	1											1			
172	4						1									1				1	1	
173	5						2	1	1					1			1					
174	7						1														1	
175	6						1							1								
176	9																					1
177	11																					1
178	11																					1
179	11																					1
180	10																					1
181	7						1							1								
182	3					1													2			
183	4					1	1												1	2		
184	5																					1
185	6						1															
186	5													2						1		
187	10																					1
188	9																					1
189	10																					1
190	5						2												1			
191	3																			2		
193	4						1							1					1	1		
194	4						2							1								
195	7						1															
196	8																					1
208	8																					1
209	3					1													2	1		
210	2																		1	1		
211	2					2								1					2			
212	3					3																
213	7																					1
214	8						1														1	
215	10																					1
216	12																					1
217	16																					1
221	9																					1
222	6					1	1							1						1		
223	3					1													1	1		
224	6													1						2		
225	9					1	1															
226	10																					1
227	11																					1
228	12																					1
229	16																					1
231	12																					1
232	9																					1
233	8																					1
234	6													1						1		
235	5						2							1					1	1		
236	3						1															
237	3						1															
238	4													1			1					
239	2					2																
240	6													2								
241	9																					1
252	10																					1
253	7																					1

Site	Depth (ft)	Cattails	Duckweed	White lilies	Chara	Clasping leaf	Coontail	CLP	Elodea	EWM	Flatstem	Fries	Moss	Naiads	NWM	Sago	Stringy	Stringy-Narrow	Water celery	Water stargrass	FA	No plants
254	3					2													3			
255	3					3	1													2		
256	1					1								1		1			2	1		
257	3					3														1		
258	9																					1
259	12																					1
267	7																					1
268	8													1						1		
269	12																					1
270	13																					1
271	12																					1
279	11																					1
280	9																					1
281	7																1			1		
282	3					1							1							1		
283	3						1							1			1					
284	4					1	2															
285	5						1							1								
286	7						1															
300	8																					1
301	6						1															
302	4					2	1													2		
303	2					1													3	1		
304	5					2													2	2		
305	15																					1
314	12																					1
315	13																					1
329	10																					1
330	7																					1
331	2					1	1															
332	3					1	1															
333	5						1							1			1					
334	6													1			1					
335	8																					1
336	9																					1
349	11																					1
350	10																					1
351	8						1															
352	7						1							1						1		
353	12																					1
379	12																					1
380	5						2															
381	3					1	1															
382	4						1							1			1					
383	5													1			2					
384	7						1							1								
385	9																					1
402	16																					1
430	7						1															
431	2					1								1								
432	4						1	1						1			1					
433	6				1			1						1			1					
435	10																					1
480	11																					1
481	2				1	1	1							1								
482	4				1		1	1						1			1					
483	6							1														
484	7																1					
485	10																					1
530	13																					1
531	3					1	1							1					1			
532	5							1						1			1					
533	8																1					
534	10																					1
579	13																					1
580	3						1							1								
581	5													2			1					
582	8																					1
583	10																					1
627	7																					1
628	4													1		1	1		1	1		
629	2					1								3			1					
630	4													2			1					
631	7													1								
632	9																					1
634	7																1					
673	12																					1
674	7													1								
675	4													1					1			
676	3																		2			
677	3					2								1			1		1			
678	6													2			2					
679	9																					1
680	12																					1
712	7																					1
717	5					1										1						
718	3					1								1					2			
719	3					1										1			2	1		
720	3					2								1			1		2			
721	7																					1
722	9																					1
756	9																					1
757	8												1	1								
758	4					1								1					3			
759	3					1													1	1		
760	2													1			1					
761	4					2	1									1			1			
796	10																					1
797	6													2					1			

Site	Depth (ft)	Cattails	Duckweed	White lilies	Chara	Clasping leaf	Coontail	CLP	Elodea	EWM	Flatstem	Fries	Moss	Naiads	NWM	Sago	Stringy	Stringy-Narrow	Water celery	Water stargrass	FA	No plants
798	3					2													2			
799	3					2													1			
800	7													1								
832	13																					1
833	7																					1
834	3					1								1		1			1	2		
835	4									1												
836	8																					1
849	8																					1
867	11																					1
868	4					1								2			1					
869	3					1													2	2		
870	4					1	1							1			1		1			
871	7																					1
872	9																					1
901	6													1			1			1		
902	4																		1	1		
903	3						1							1					1			
904	5						1										1					
905	7																					1
906	9																					1
907	9																					1
908	12																					1
909	11																					1
912	9																					1
913	9																					1
914	7																					1
915	4						1							1		1				1		
916	4						1									1	1					
917	5						1							1								
918	7																					1
919	9																					1
920	9																					1
931	8																					1
932	4					1	1		1					1					2			
933	3					1								1					2			
934	3						1							1			1		1	1		
935	4						1							1		1	1		1			
936	5						1	1														
937	5						1							1								
938	5						1	1														
939	4						1							1					1			
940	4						1							1					1			
941	4					1													1			
942	4													1					1			
943	6						1							1			1					
944	7						1							1								
945	9																					1
946	9																					1
947	9																					1
948	10																					1
950	4													1			1			1		
951	4					1	1							2						1		
952	4					2	1							1					1	1		
953	4										1			2		1			1			
954	4						1							2					2			
955	4					1	1							1					1			
956	4					1	1							1			1					
Average		1.7	1.7	1.2	1.0	1.4	1.3	1.1	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0	1.4	1.2	1.0	
Occur:	352	3	3	5	3	59	154	20	14	1	1	1	2	116	1	14	57	1	64	56	26	112
% occur		1	1	1	1	17	44	6	4	0	0	0	1	33	0	4	16	0	18	16	7	

First Sighting of Eurasian Watermilfoil in Spring Lake, July 12, 2021

Curlyleaf Pondweed Surveys and Aquatic Plant Point Intercept Survey for Spring Lake, Scott County, Minnesota in 2021

Curlyleaf Pondweed Meandering Survey: April 23, 2021
CLP Treatment: May 17, 2021, 22.65 ac (diquat)
Curlyleaf Pondweed Assessment Surveys: June 14, 2021
Summer Point Intercept Plant Survey: July 12, 2021
EWM Hand Removal: August 4, 2021
EWM Herbicide Treatment: September 15, 2021, 8.1 ac

Prepared for:
Prior Lake/Spring Lake Watershed District
Prior Lake, Minnesota

Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116

December 22, 2021

Curlyleaf Pondweed Surveys and Aquatic Plant Point Intercept Survey for Spring Lake, Scott County, Minnesota in 2021

Summary

Early Season CLP Delineation and Assessment: Curlyleaf pondweed (CLP) distribution and abundance were delineated in Spring Lake on April 23, 2021 to determine if curlyleaf control was needed. Curlyleaf growth was observed at 55 out of 142 sample sites (Figure S1). Growth ranged from light to heavy. Four areas totaling 22.65 acres were projected to produce abundant growth and were delineated for treatment (Figure S1).

Treatment of 22.65 acres occurred on May 17, 2021 using a diquat herbicide.

A post-treatment assessment survey included a line transect survey and a meandering survey and was conducted on June 14, 2021 to check the status of curlyleaf pondweed and native plant community in Spring Lake. CLP was observed at 6 locations with light growth. Treatment control in all areas was excellent (Figure S1).

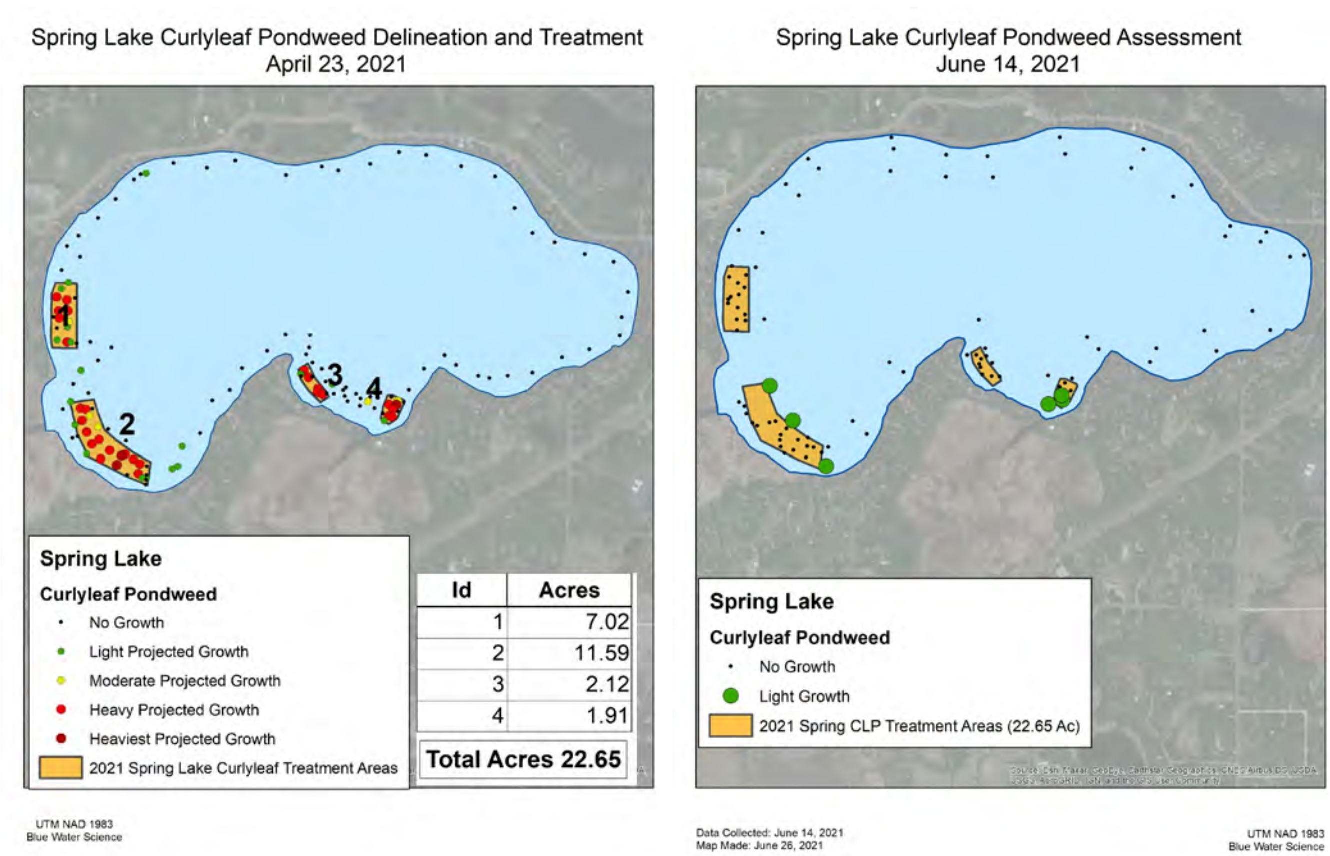


Figure S1. [left] curlyleaf pondweed delineation. [right] curlyleaf pondweed assessment (post treatment).

2021 Point Intercept Survey: A grid with points spaced 50 meters apart was put over the entire lake and sites were sampled throughout the growing zone. A total of 377 sites were sampled, plants were observed growing to a depth of 12 feet. Results of the summer aquatic plant point intercept survey conducted on July 12, 2021 found 15 submerged aquatic plant species with including CLP and Eurasian watermilfoil (EWM). Native plants were found around the perimeter of the basin of Spring Lake (Figure S2) out to a water depth of 12 feet.

Native aquatic plants were estimated to cover of the lake bottom (202 acres). Coontail was the dominant aquatic plant. The 15 aquatic plant species found in this survey represents a fair to good diversity for Spring Lake in late summer.

Eurasian watermilfoil was found for the first time at 3 sites in the point intercept survey and at an additional 9 sites with a meander search (Figure S2). Handpulling occurred on August 4, 2021 and 8 acres were treated on September 15, 2021 (Figure S2).

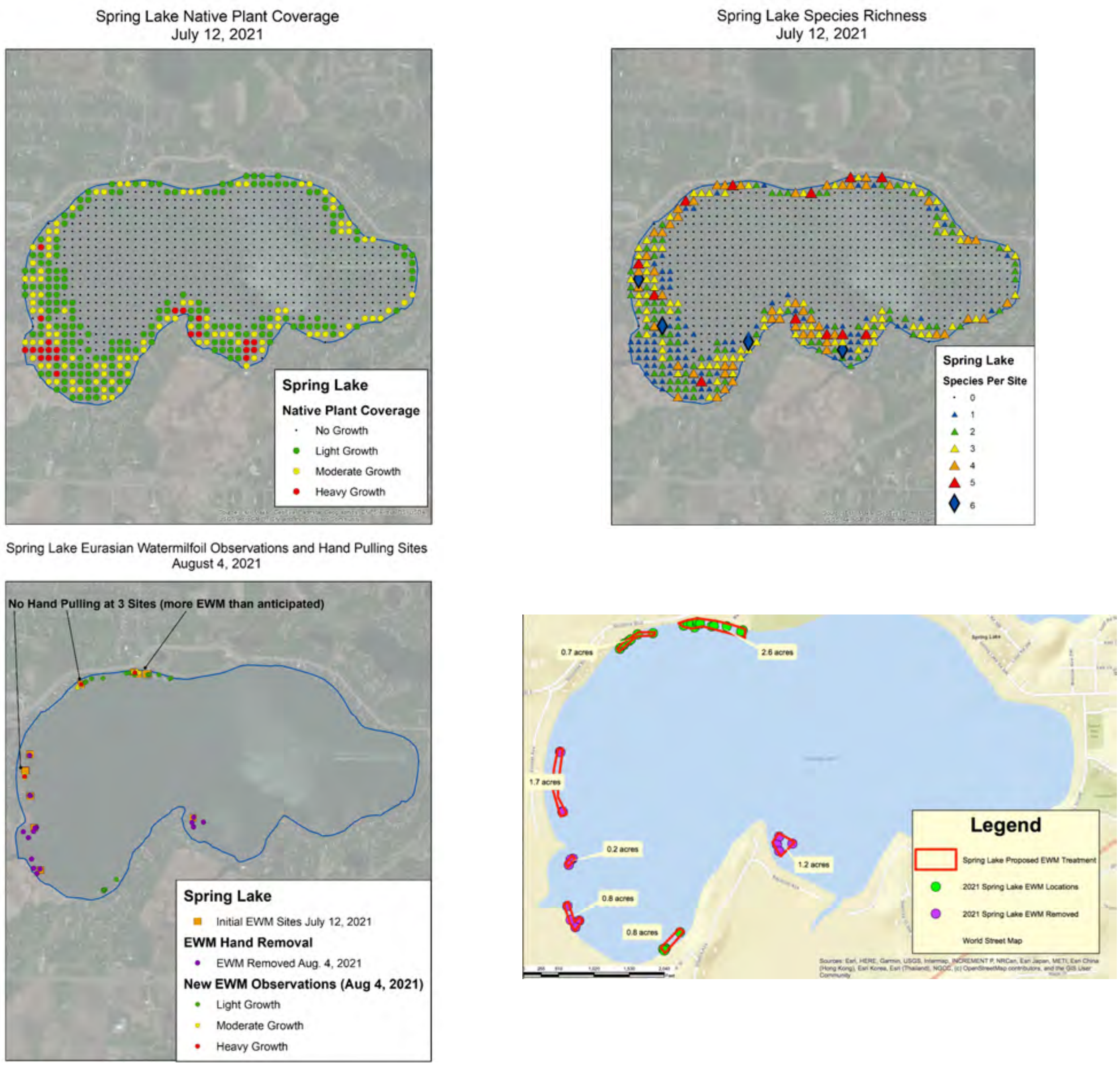


Figure S2. [top-left] Native plant distribution and abundance for the July 12, 2021 point intercept survey.
[top-right] Species richness for the July 12, 2021 point intercept survey.
[bottom-left] EWM observations and handpulling sites for August 4, 2021.
[bottom-right] Treatment sites for 2021.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Comparison of 2015, 2018, 2019, 2020, 2021 Point Intercept Surveys: Point intercept surveys were conducted on Spring Lake in 2015, 2018, 2019, 2020, and 2021 and results are shown in Table S1. In 2015, elodea was the dominant plant but since then coontail has been dominant (Table S1). Several species increased in occurrence since 2015 including coontail, claspingleaf pondweed, water celery, and water stargrass. Elodea and sago pondweed have decreased (Table S1).

Table S1. Spring Lake aquatic plant occurrence for the point intercept surv eys conducted in 2015, 2018, 2019, 2020, and 2021.

	2015 % Occur (113 sites)	**2018** % Occur (248 sites)	**2019** % Occur (214 sites)	**2020** % Occur (298 sites)	**2021** % Occur (377 Sites)
Cattails (*Typha sp*)		1		1	1
Watershield (*Brasenia Schreberi*)					1
Duckweed (*Lemna sp*)		1		1	
White water lilies (*Nymphaea ordata*)		1	5	2	1
Coontail (*Ceratophyllum demersum*)	15	56	47	51	52
Chara (*Chara sp*)	4	2	2	1	14
Chara - 2 (*Chara sp*)		1			
Moss (*Drepanocladus sp*)		1	2	1	
Elodea (*Elodea canadensis*)	42	36	3	5	6
Water stargrass (*Heteranthera dubia)*	5	12	10	19	21
Northern watermilfoil *(Myriophyllum sibiricum)*				1	2
Eurasian watermilfoil (*M. spicatum*)					1
Naiads (*Najas flexilis*)	21	23	9	39	22
Curlyleaf pondweed (*Potamogeton crispus*)	12	6		7	7
Fries pondweed (*P. Friesii*)					1
Claspingleaf pondweed (*P. Richardsonii*)	4	10	10	20	23
Floatingleaf (*P. sp*)					1
Stringy pondweed (*P. sp*)	29	7	4	19	19
Flatstem pondweed *(P. zosteriformis)*				1	1
Sago pondweed (*Stuckenia pectinata*)	17	11	9	5	22
Bladderwort (*Utricularia vulgaris*)		1			
Water celery (*Vallisneria americana*)	9	20	23	21	23
Number of submerged species	10	13	10	14	15
Depth of plant growth (ft)	9	8	8	9	12
Percent coverage of plants (%)	29 (175 ac)	21 (122 ac)	17 (98 ac)	25 (145 ac)	34 (197 ac)

Curlyleaf Pondweed Surveys and Aquatic Plant Point Intercept Survey for Spring Lake, Scott County, Minnesota in 2021

Introduction

Spring Lake has an area of 592 acres with a littoral area of 290 acres (source: MnDNR). The objectives of the plant surveys were to delineate and recommend areas to treat nuisance curlyleaf pondweed and to monitor the non-native and native plants over the summer.

A curlyleaf pondweed delineation survey was conducted on April 23, 2021.

Treatment occurred on May 17, 2021 and covered 22.65 acres.

A curlyleaf pondweed assessment was conducted on June 14, 2021.

A summer aquatic plant point intercept survey was conducted on July 12, 2021 to check and inspect the native plant community in Spring Lake.

Figure 1. Rake sample of coontail sampled on April 23, 2021 in Spring Lake.

Survey Methods for Meandering and Line Transect Surveys: Determining what areas to treat to control excessive growth of curlyleaf pondweed has been an ongoing challenge. Curlyleaf growth in April and May is just starting to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season. Currently, for Spring Lake, the method has been to use past treatment history combined with early season scouting and then a recheck to evaluate any treatment effects and see if curlyleaf areas were missed. A meandering survey was used to delineate CLP and a meandering survey was combined with a line transect survey to assess the CLP treatment (Figure 2).

Meander Delineation Survey: A meandering survey consists of using a meandering path around the nearshore area of the entire lake. Visual inspection along with plant sampling was conducted. At each sample point, plants were sampled with a rake sampler.

Line Transect Survey: We used 25 line transects with 2 depths per transect. The same transects have been used from 2000 through 2020. Plants were sampled with a rake attached to a pole to characterize species presence and its density along a transect. A total of 50 sites were sampled (Figure 2). For the assessment transect survey, plant density was estimated on a scale of 1 to 3 with 3 being the densest.

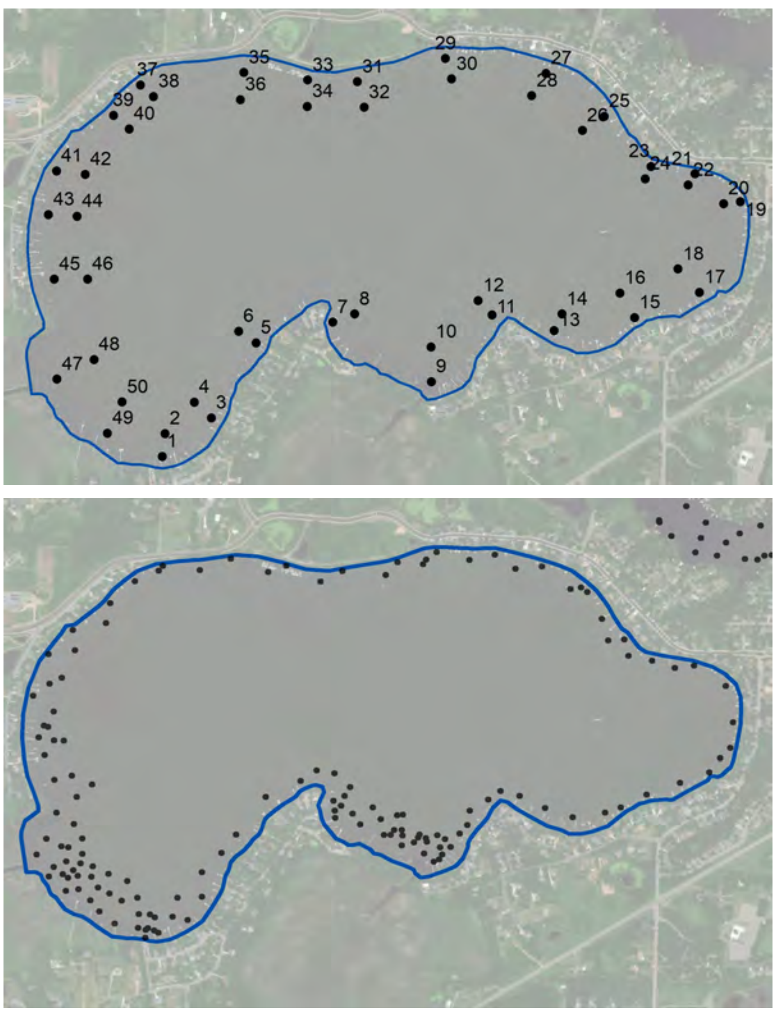


Figure 2. [top] Full lake transect survey sample sites. [bottom] Meander GPS sample points. The transect survey can be used for year to year comparisons and the meander GPS surveys help target abundant and nuisance non-native species.

Methods for the Point Intercept Survey: An aquatic plant point intercept survey of Spring Lake was conducted by Blue Water Science on July 12, 2021. A total 377 points in the growing zone out to 15 feet will be sampled. Sample points were spaced 50 meters apart on a grid that covered the lake (Figure 3). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, plant distribution maps were constructed.

Figure 3. Point intercept sample sites for Spring Lake in 2021. Sample sites were spaced 50 meters apart.

Results of Curlyleaf Pondweed Delineation April 23, 2021: A curlyleaf delineation using a meandered survey collected a total of 142 GPS points around the lake. Curlyleaf was found at 55 out of 142 sites (Figure 4). Curlyleaf was observed growing in water depths of 3-7 feet, notably, no curlyleaf was observed deeper than 7 feet of water depth. At total of 22.65 acres were delineated for treatment (Figure 4).

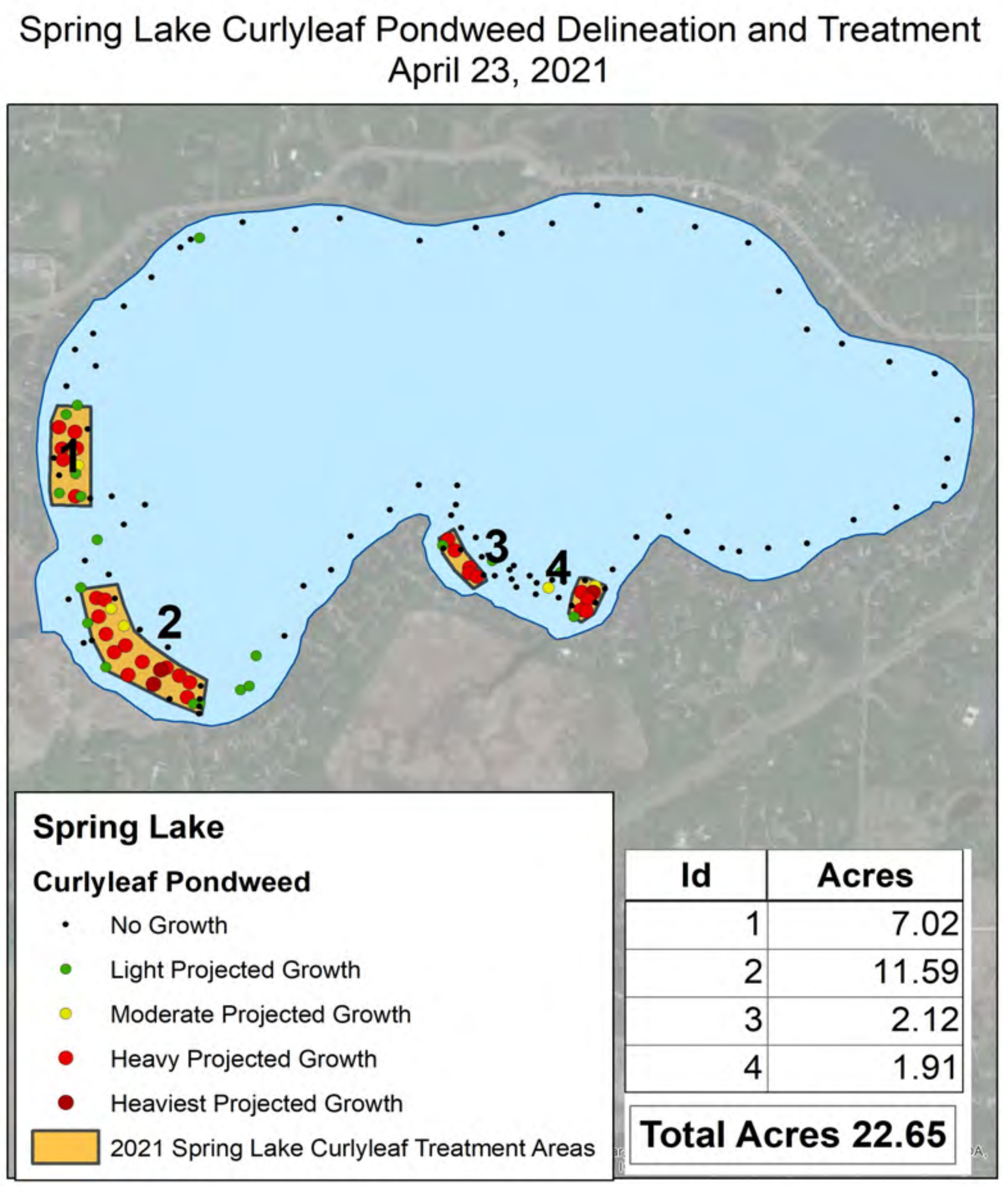


Figure 4. Map of curlyleaf pondweed for April 23, 2021. Colored sample areas indicate the growth in April of 2021 for curlyleaf pondweed. Key: green = light potential growth, yellow = moderate potential growth, red = heavy potential growth, and black dot = no curlyleaf.

Curlyleaf Pondweed Assessment, June 14, 2021: A curlyleaf assessment (post-treatment survey) was conducted on June 14, 2021, the survey included meandering survey collecting 33 GPS points and a line-transect survey which collect data on 50 established sites. Curlyleaf was found at 6 out of 83 of the total sites (Figure 5). Curlyleaf did not expand and the curlyleaf treatment was excellent.

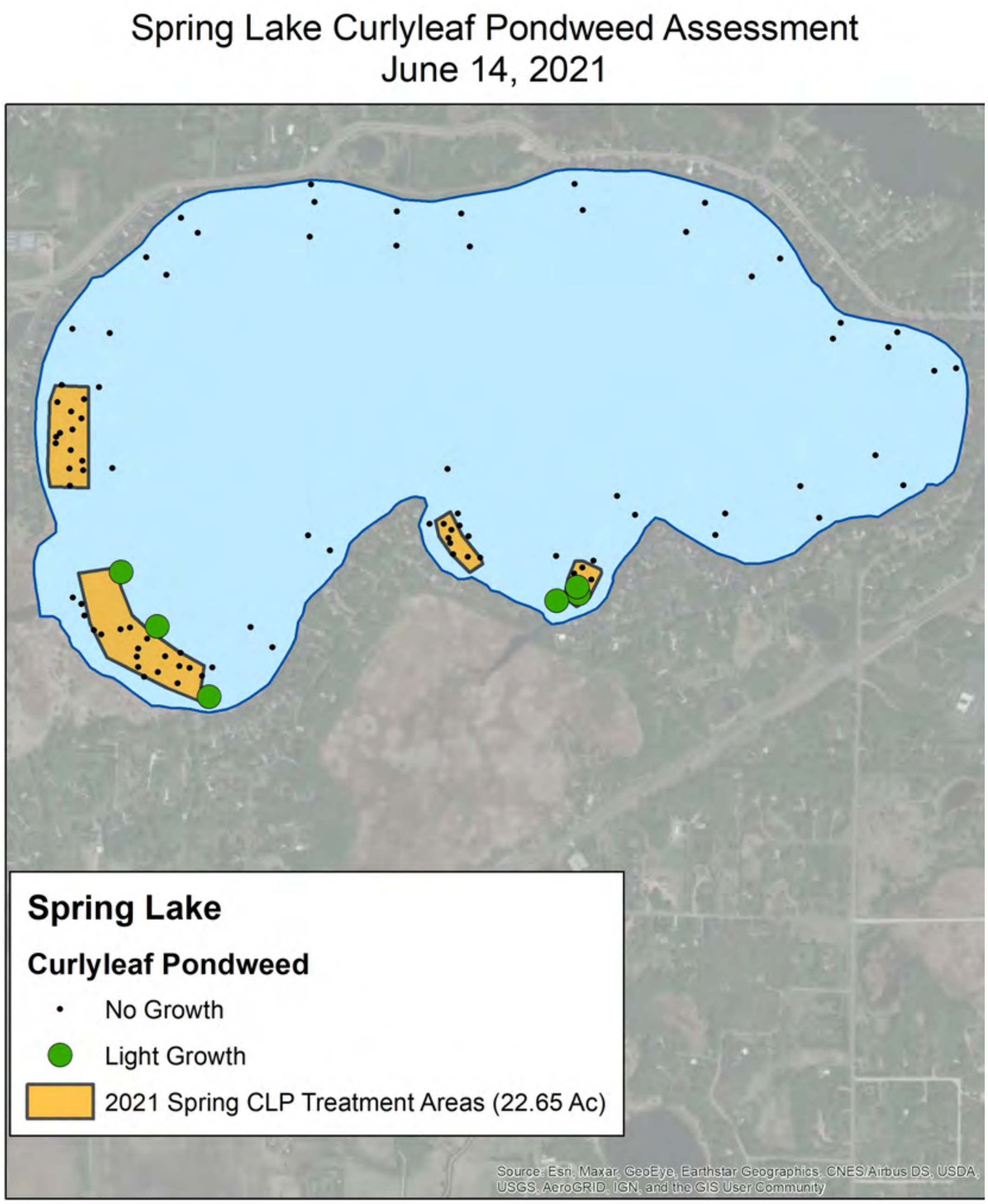


Figure 5. Curlyleaf pondweed assessment on June 14, 2021.
Key: green = light growth, black = no curlyleaf, yellow shading = treatment areas.

Summary of Curlyleaf Pondweed 2000 to 2021

Curlyleaf pondweed growth has been variable from 2000 through 2021. For the years 2007 to 2015 there were no CLP treatments. There may be a correlation to the use of an iron dosing station on the County 13 ditch where flows eventually enter Spring Lake and a reduction in Spring Lake curlyleaf. The amount of iron dosed is listed in Table 1. Likely only a small percentage of the dosed iron makes its way into Spring Lake. Iron in the water column that may inhibit CLP growth is speculative but heavy CLP growth, as shown in Figure 6, did not occur from 2007 through 2015 when some iron from the iron dosing operation may have entered Spring Lake. After a dosing station upgrade, in 2013, it is likely less iron entered Spring Lake and curlyleaf growth may have increased.

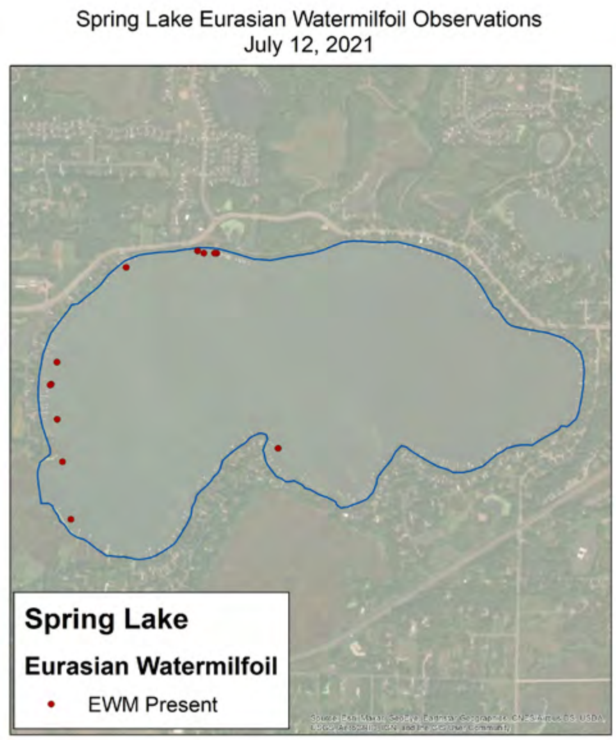
Table 1. Curlyleaf pondweed occurrence and acres either harvested or treated with herbicides from 2000 to 2021.

	Iron (kg)	$FeCl_3$ (gallons)	Curlyleaf Occurrence (based on 50 sites unless noted)	Harvesting Acres	Herbicide Treatment Acres	Total Curlyleaf Treatment (acres)
2000	?		49			
2001	?					
2002	?		43	60	14	74
2003	0	0	35	74	14	88
2004	0	0	40		59	59
2005	2,629	4,232	29		59	59
2006	895	1,440	32		59	59
2007	920	1,481	22			
2008	726	1,168	4			
2009	109	176	5			
2010	0	0	25			
2011	1,491	2,390	10			
2012	0	0	6			
2013	1,248 (J-A)	?	3			
2014	>4,547	>7,275	10			
2015	2,800	4,480	10			
2016	4,206	6,730	11		20.4	20.4
2017	4,544	7,270	11		3.7	3.7
2018	3,656	5,850	4			
2019	3,675	5,880	29 (144 sites)		15.7	15.7
2020			62 (254 sites)		14.92	14.92
2021			55 (142 sites)		22.65	22.65

Figure 6. Curlyleaf pondweed growth was very heavy in 2000.

New Findings of Eurasian Watermilfoil in Spring Lake in 2021

Eurasian watermilfoil was observed in Spring Lake on July 12, 2021. This was the first time EWM had been found in Spring Lake (Figure 7). Handpulling on August 4, 2021 removed some EWM and a herbicide treatment on September 15, 2021 treated 8.1 acres.



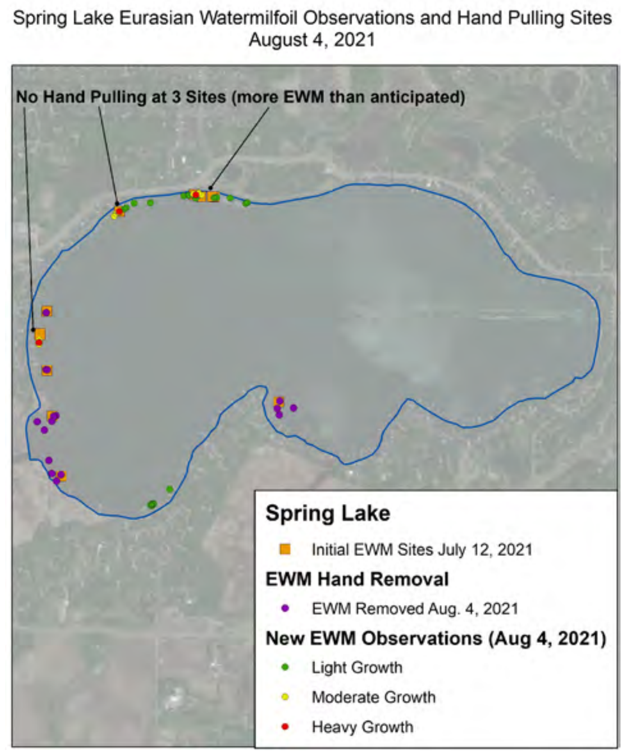


Figure 7. [top-left] Observations of Eurasian watermilfoil for the July 12, 2021 surveys.
[top-right] EWM observations and handpulling sites for August 4, 2021.
[bottom-left] A tub of Eurasian watermilfoil removed on August 4, 2021.
[bottom-right] Treatment on 8.1 ac occurred on September 15, 2021.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Results - Point Intercept Aquatic Plant Survey on July 12, 2021

Results of the summer aquatic plant survey conducted on July 12, 201 found 15 submerged aquatic plant species, CLP was present in August and Eurasian watermilfoil was observed as well. Plant growth was observed to water depths of 12 feet in Spring Lake. A list of species and their percent occurrence is shown in Table 2. Aquatic abundance and species diversity is shown in Figure 8 and plant distribution and abundance for other species are shown in Figure 9. Native plants were estimated to cover 34% of the lake area.

Table 2. Spring Lake aquatic plant occurrence and density for the July 12, 2021 survey based on 377 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

	All Stations (n=377)		
	Occur	**% Occur**	**Average Density**
Cattails (*Typha sp*)	1	1	3.0
Watershield (*Brasenia Schreberi*)	1	1	1.0
White water lilies (*Nymphaea ordata*)	1	1	1.0
Coontail (*Ceratophyllum demersum*)	197	52	1.3
Chara (*Chara sp*)	52	14	1.1
Elodea (*Elodea canadensis*)	23	6	1.0
Water stargrass (*Heteranthera dubia)*	78	21	1.2
Northern watermilfoil (*Myriophyllum sibiricum*)	7	2	1.1
Eurasian watermilfoil (*Myriophyllum spicatum*)	3	1	1.0
Naiads (*Najas flexilis*)	84	22	1.0
Curlyleaf pondweed (*Potamogeton crispus*)	28	7	1.0
Fries pondweed *(P. friesii)*	1	1	1.0
Claspingleaf pondweed (*P. Richardsonii*)	85	23	1.4
Floatingleaf pondweed (*P. spp*)	1	1	1.0
Stringy pondweed (*P. sp*)	72	19	1.1
Flatstem pondweed (*P. zosteriformis*)	1	1	1.0
Sago pondweed (*Stuckenia pectinata*)	83	22	1.2
Water celery (*Vallisneria americana*)	85	23	1.3

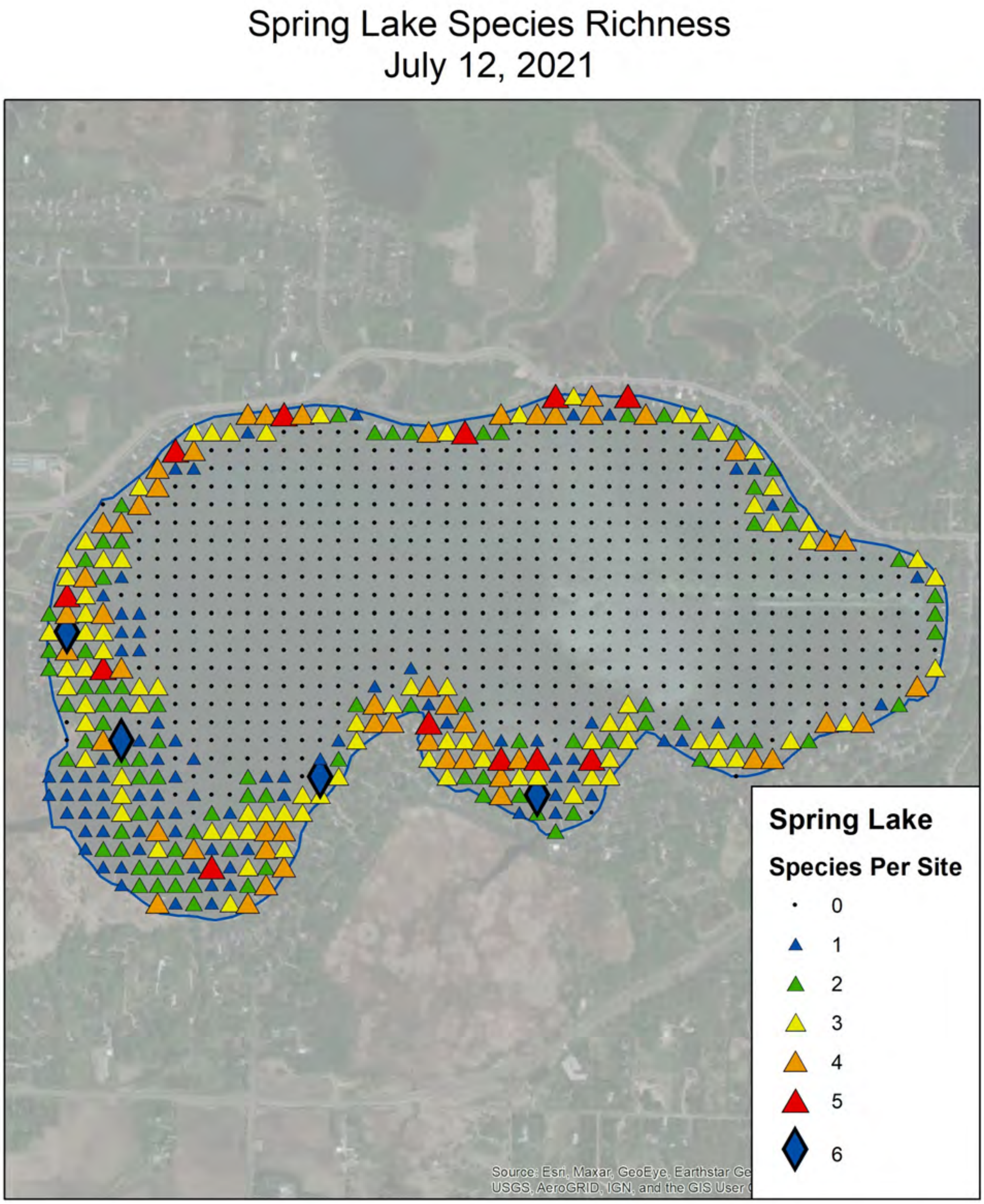


Figure 8. Species Richness or the number of species per site for the point intercept survey on July 12, 2021.

Aquatic Plant Maps: Coverage of the select native plants species found in the July 2021 survey are shown in Figure 9.

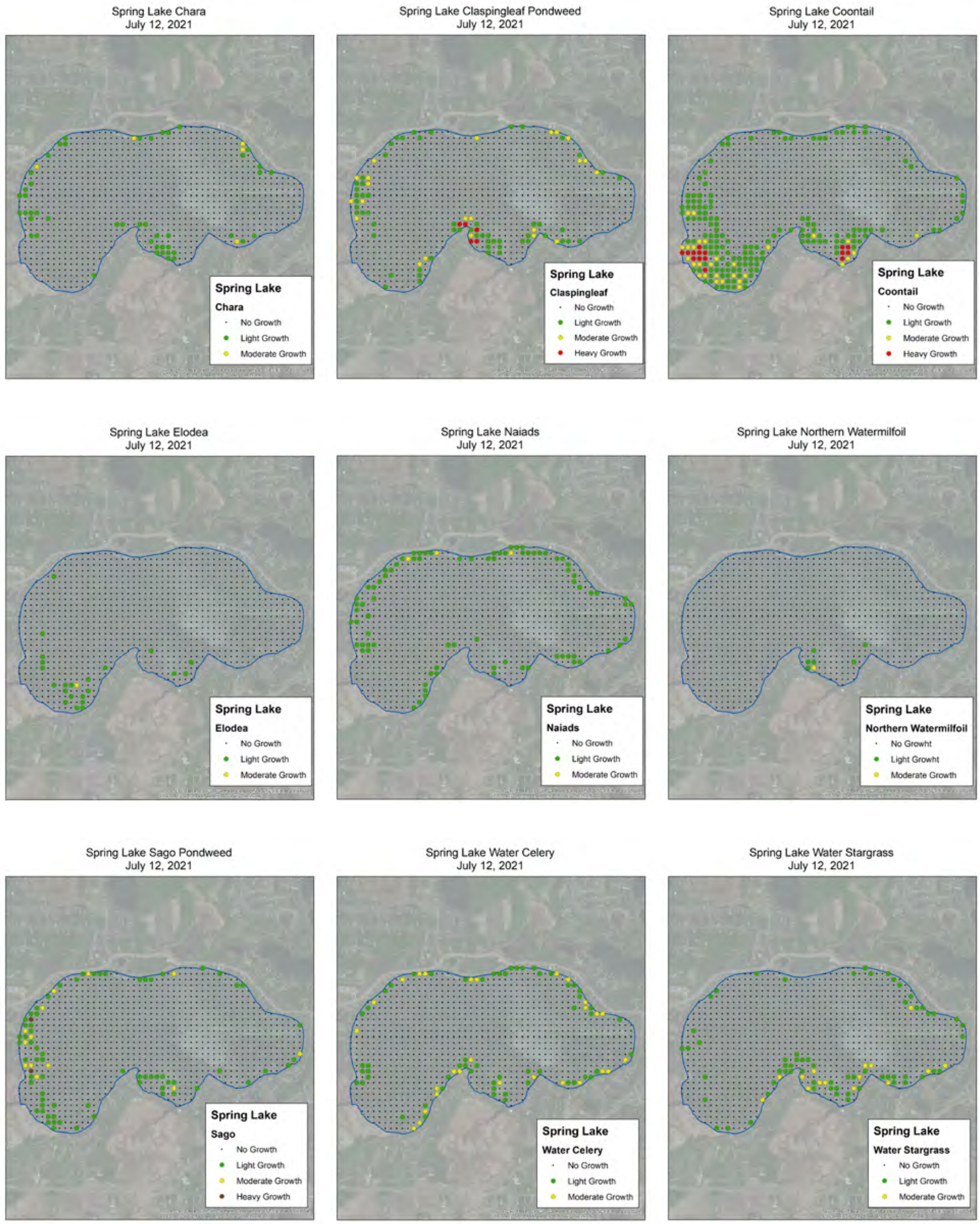


Figure 9. Distribution and abundance maps for common submerged aquatic plant species in Spring Lake on July 12, 2021.

Spring Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 3 and 4 and Figure 10. A total of 364 points were sampled and plants were found out to 12 feet of water which included 358 sample points out to 12 feet. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 3. MnDNR Template Statistics

Total # Points Sampled	374
Depth Range of Rooted Veg	0-12 feet
Maximum Depth of Growth (95%) in feet	10.0
# Points in Max Depth Range	329
# Points in Littoral Zone (0-9 feet)	372
% Points w/ Submersed Native Taxa	63
Mean Submersed Native Taxa/Point	1.2
Mean Density of Submersed Native Taxa	1.1
# Submersed Native Taxa	13

Table 4. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled (0-12 ft)	% Sampling points with submersed species observed
0	0	0
1	21	95%
2	39	100%
3	48	100%
4	50	100%
5	36	97%
6	32	100%
7	20	95%
8	26	92%
9	31	81%
10	26	50%
11	21	48%
12	14	36%
13	6	0
	364	

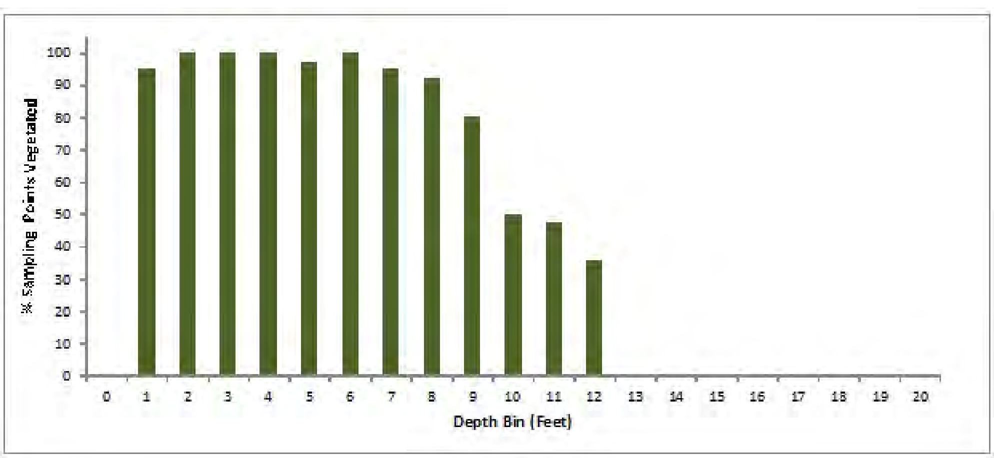


Figure 10. Depth of plant colonization (in feet).

Comparison of 2015, 2018, 2019, 2020, 2021 Point Intercept Surveys

Point intercept surveys were conducted on Spring Lake in 2015, 2018, 2019, 2020, and 2021 and results are shown in Table 5. In 2015, elodea was the dominant plant but since then coontail has been dominant (Table 5). Several species increased in occurrence since 2015 including coontail, claspingleaf pondweed, water celery, and water stargrass. Elodea and sago pondweed have decreased (Table 5).

Table 5. Spring Lake aquatic plant occurrence for the point intercept surv eys conducted in 2015, 2018, 2019, 2020, and 2021.

	2015 % Occur (113 sites)	2018 % Occur (248 sites)	2019 % Occur (214 sites)	2020 % Occur (298 sites)	2021 % Occur (377 Sites)
Cattails (*Typha sp*)		1		1	1
Watershield (*Brasenia Schreberi*)					1
Duckweed (*Lemna sp*)		1		1	
White water lilies (*Nymphaea ordata*)		1	5	2	1
Coontail (*Ceratophyllum demersum*)	15	56	47	51	52
Chara (*Chara sp*)	4	2	2	1	14
Chara - 2 (*Chara sp*)		1			
Moss (*Drepanocladus sp*)		1	2	1	
Elodea (*Elodea canadensis*)	42	36	3	5	6
Water stargrass (*Heteranthera dubia)*	5	12	10	19	21
Northern watermilfoil *(Myriophyllum sibiricum)*				1	2
Eurasian watermilfoil (*M. spicatum*)					1
Naiads (*Najas flexilis*)	21	23	9	39	22
Curlyleaf pondweed (*Potamogeton crispus*)	12	6		7	7
Fries pondweed (*P. Friesii*)					1
Claspingleaf pondweed (*P. Richardsonii*)	4	10	10	20	23
Floatingleaf (*P. sp*)					1
Stringy pondweed (*P. sp*)	29	7	4	19	19
Flatstem pondweed *(P. zosteriformis)*				1	1
Sago pondweed (*Stuckenia pectinata*)	17	11	9	5	22
Bladderwort (*Utricularia vulgaris*)		1			
Water celery (*Vallisneria americana*)	9	20	23	21	23
Number of submerged species	10	13	10	14	15
Depth of plant growth (ft)	9	8	8	9	12
Percent coverage of plants (%)	29 (175 ac)	21 (122 ac)	17 (98 ac)	25 (145 ac)	34 (197 ac)

Native Plant Coverage Comparisons : Native aquatic plant distribution may have decreased slightly from 2015 to 2019 but then increased in 2020 and 2021 based on point intercept survey results (Figure 11). In 2015, plants grew to a depth of 9 feet and covered an estimated 175 acres of the lake (29%). In 2018, plants were found out to a depth of 8 feet and covered an estimated 122 acres of the lake (198 sites with plants 21%). In 2019, plant coverage was estimated at 98 acres or about 17% of the lake area (150 sites with plants). In 2020, plants grew out to 9 feet and covered approximately 25% of the lake bottom (Figure 11). In 2021, plants grew out to 12 feet and covered approximately 34% of the lake bottom (Figure 12).

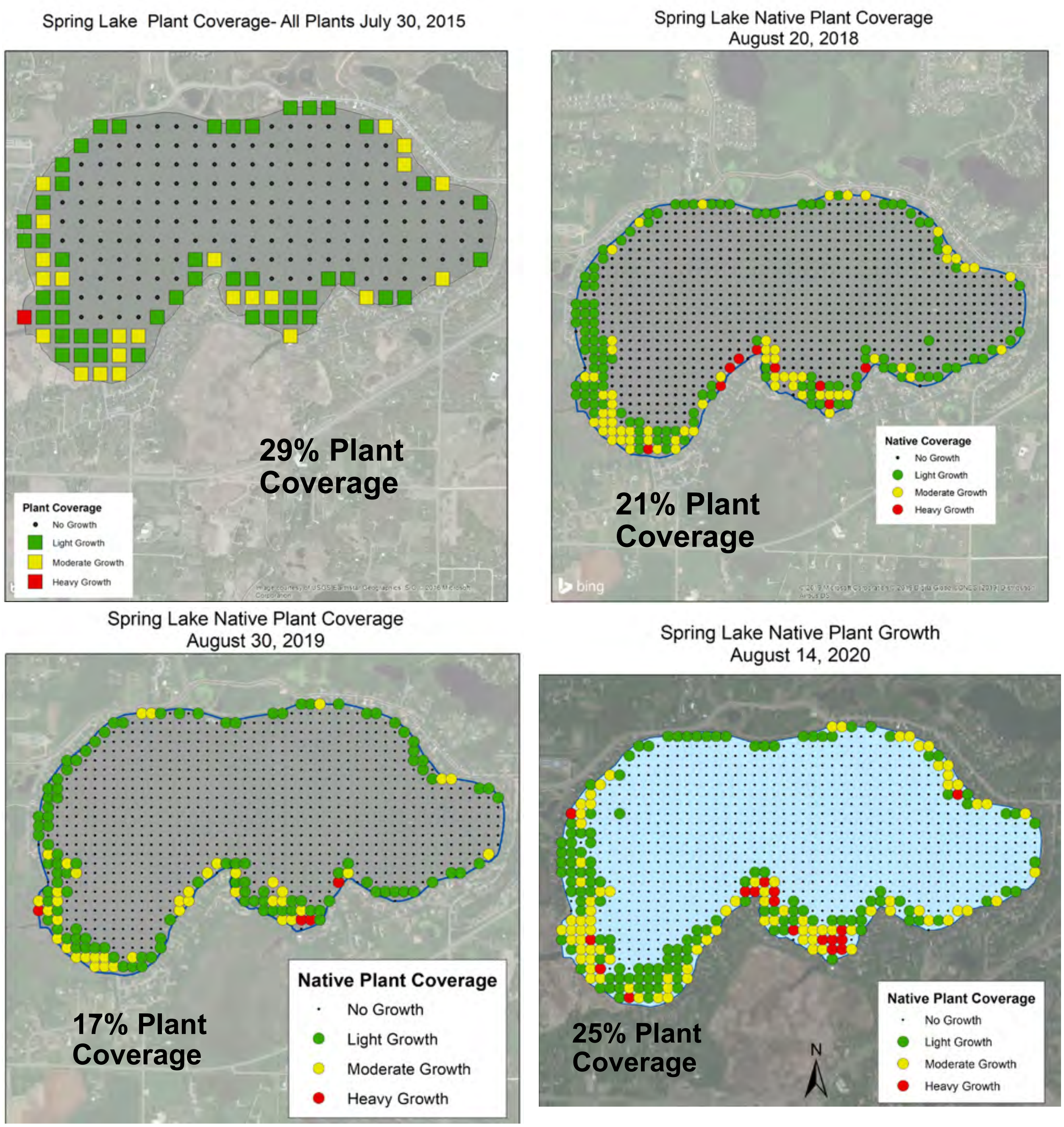


Figure 11. Aquatic plant distribution and abundance for the point intercept surveys in 2015, 2018, 2019, and 2020. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

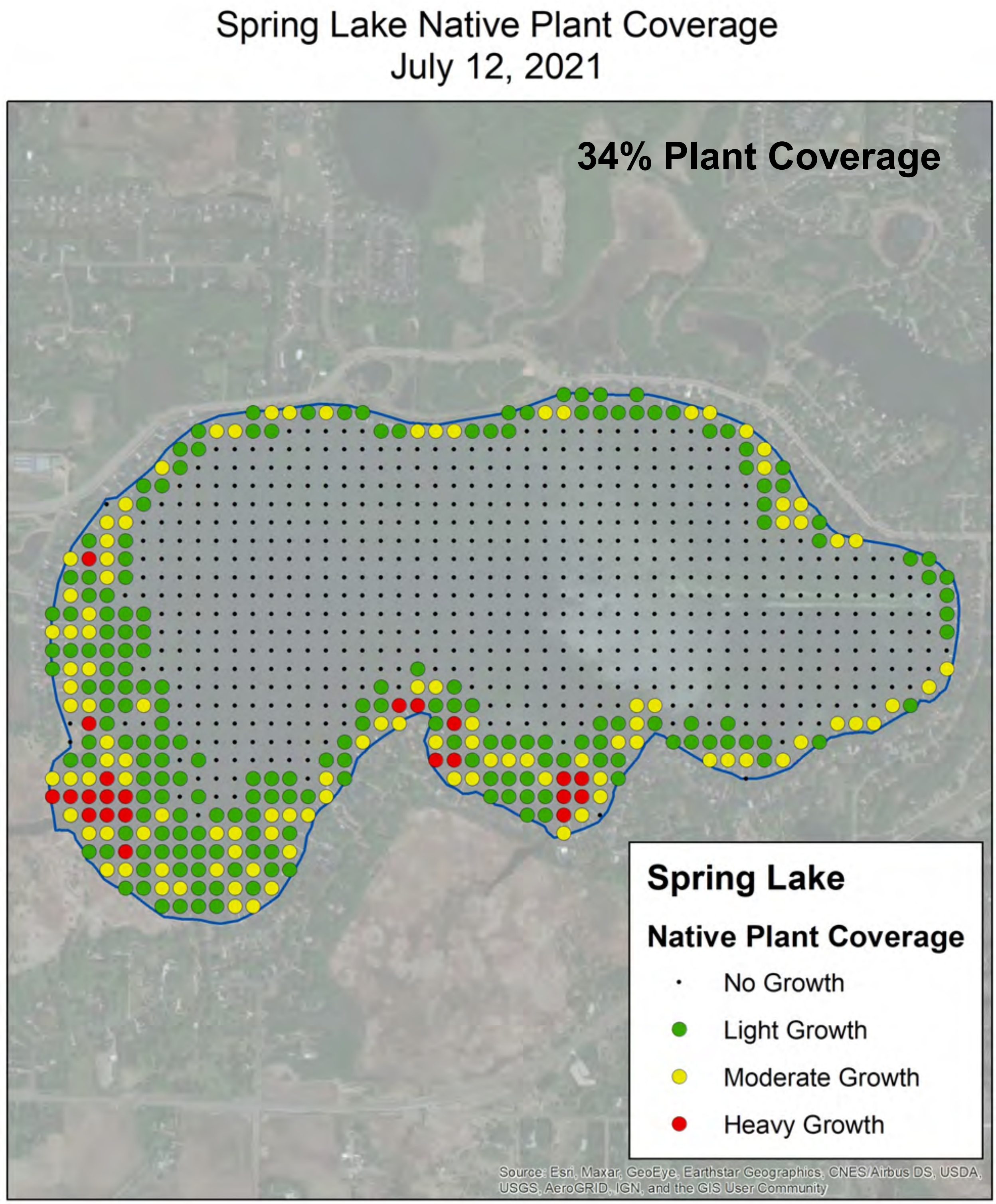


Figure 12. Spring Lake native plant coverage on July 12, 2021.
Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Summary of Aquatic Plant Surveys from 1948 - 2021

Since 1948, specific plant species in Spring Lake have appeared and disappeared (Table 6). For a number of years, stringy pondweed, likely a *P. pusillus*, was the dominant plant species. However, from 2018 through 2021, coontail was the dominant plant (Table 6).

The number of aquatic plant species has range from a low of 5 to a peak of 15 which was recorded in 2021 (Table 6).

Table 6. Aquatic plant status for 1948 to 2021.

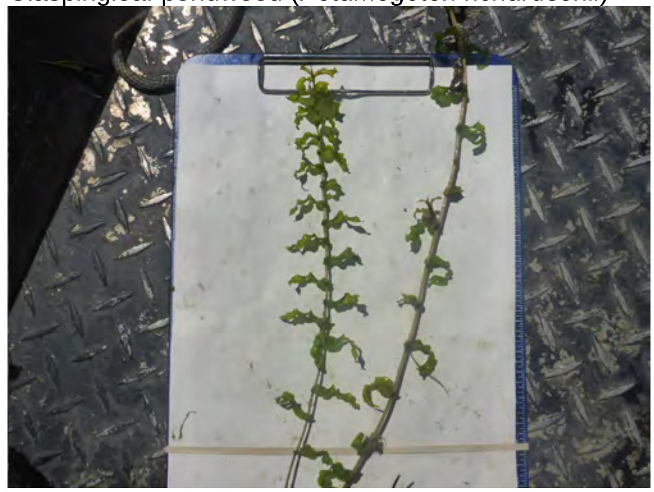
	Dominant Plant Occurrence (% occurrence based surveys)	Dominant Species in Mid Summer Survey	Number of Plant Species
1948	Rare (MnDNR)	All rare	7
1973	Rare-Common (MnDNR)	5 - common	8
1982	Rare-Common (MnDNR)	Coontail	8
1986	Present (MnDNR)	3 species	5
1988	Present-Occasional (MnDNR)	Sago + water stargrass	8
2000	40	Curlyleaf	9
2002	36	Sago	9
2004	68	Elodea	9
2005	76	Elodea	9
2006	48	Coontail	8
2007	30	Coontail	6
2008	24	Stringy	9
2009	66	Stringy	9
2010	34	Stringy	7
2011	64	Stringy	6
2012	72	Stringy	4
2013	19	Stringy	5
2014	48	Stringy	5
2015	42 (PI survey)	Elodea	10
2016	38	Elodea	6
2017	86	Stringy	8
2018	56 (PI survey)	Coontail	13
2019	47 (PI survey)	Coontail	10
2020	52 (PI survey)	Coontail	14
2021	52 (PI survey)	Coontail	15

Supplemental Data For Spring Lake

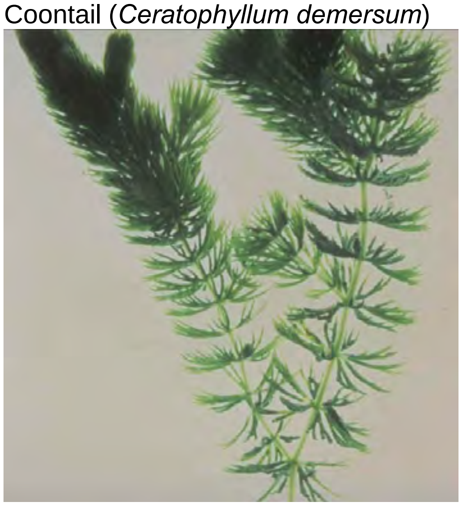
Common Aquatic Plants in Minnesota

Chara (*Chara sp*)

Claspingleaf pondweed (*Potamogeton richardsonii*)



Coontail (*Ceratophyllum demersum*)



Curlyleaf Pondweed (non-native)(*Potamogeton crispus*)

Eurasian watermilfoil (non-native)
(*Myriophyllum spicatum*)

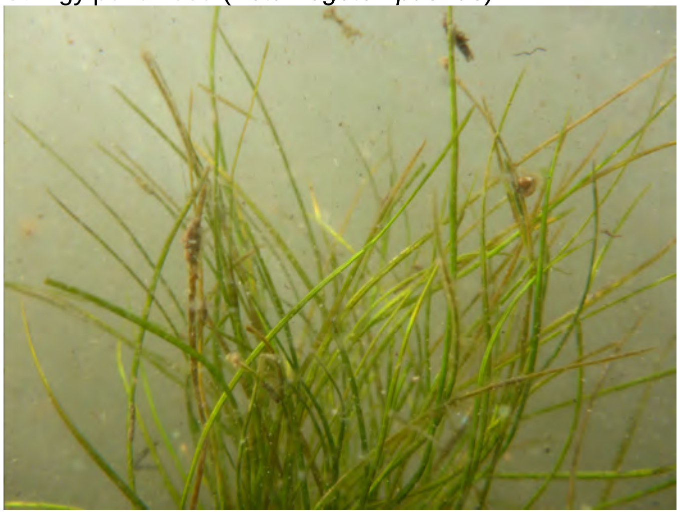
Flatstem pondweed (*Potamogeton zosteriformis*)

Naiad (*Najas sp*)

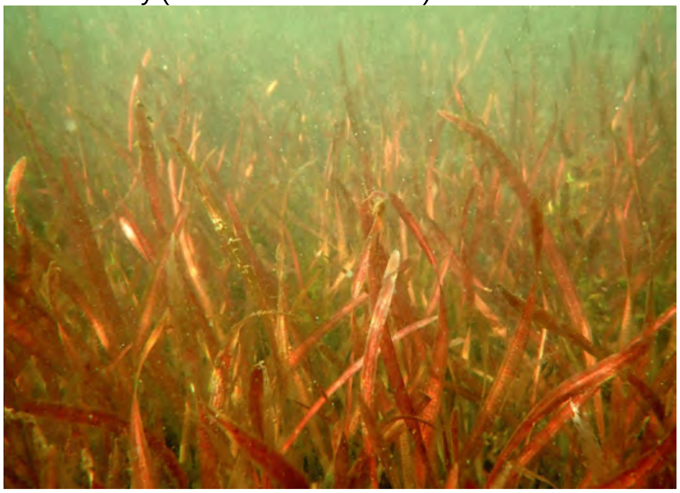
Northern watermilfoil (*Myriophyllum sibiricum*)

Sago pondweed (*Stuckenia pectinata*)

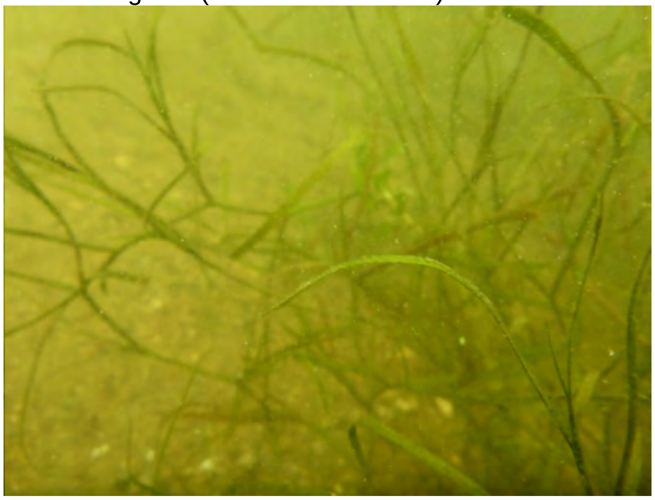
Stringy pondweed (*Potamogeton pusillus*)



Water celery (*Vallisneria americana*)



Water stargrass (*Heteranthera dubia*)



Spring Lake CLP Delineation, Individual Site Data April 23, 2021

Aquatic plant densities based on rake sampling for April 23, 2021. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted.

Site	Depth (ft)	CLP	Natives	no plants
1	4			1
2	5	2		
3	5			1
4	6			1
5	5	1	1	
6	5	1		
7	7	1		
8	5			1
9	8			1
10	6			1
11	8			1
12	3		1	
13	5			1
14	13			1
15	8			1
16	4			1
17	6		2	
18	4	5		
19	5	1		
20	4		1	
21	5	6		
22	5		1	
23	7			1
24	5			1
25	4	10		
26	4	12		
27	4	4		
28	4		1	
29	5	2		
30	3		1	
31	4			1
32	4		1	
33	3			1
34	2			1
35	4			1
36	3		1	
37	2			1
38	5	3		
39	6			1
40	7	1		
41	5		3	
42	4		3	
43	4		3	
44	6	8		
45	7		1	
46	5	3		
47	5	20	1	
48	5	7		
49	4	8		
50	3	2	1	
51	4	10	1	
52	4		1	
53	4			1
54	6			1
55	5			1
56	6			1
57	7			1
58	5			1
59	8			1
60	8			1
61	9			1
62	10			1
63	10			1
64	6			1
65	15			1
66	17			1
67	10			1
68	16			1
69	5			1
70	6			1
71	7			1
72	6			1
73	10			1
74	8			1
75	5			1
76	6			1
77	9			1
78	6			1
79	9			1
80	7			1
81	12			1
82	8			1
83	6	2		
84	5			1
85	5			1
86	5		1	
87	6			1
88	4			1
89	4			1
90	8			1
91	4			1
92	6	2		
93	5	2		
94	5	4		
95	6	6		
96	8			1
97	6	8		
98	6	3		
99	5	7		
100	4			1
101	5	6		
102	6	3		
103	5	2		
104	4		1	
105	3	1		
106	5	4		
107	5	1		
108	5			1
109	6			1
110	8			1
111	9			1
112	5	1		
113	5		1	
114	8			1
115	5	2	1	
116	4		2	
117	6	4	1	
118	6	16		
119	8			1
120	7	3		
121	5	14	1	
122	4	1	1	
123	4		1	
124	4		1	
125	5	9	1	
126	7	3		
127	7			1
128	5	16		
129	4	18		
130	4	1	1	
131	4	8	1	
132	5	15		
133	7			1
134	5	4		
135	5	20		
136	4	20		
137	4		1	
138	5	10		
139	5	14		
140	4	7		
141	5	2		
142	4		1	
Average		6.3	1.3	
Occurrence (142 sites)		55	32	66

Spring Lake CLP Assessment, Individual Site Data June 14, 2021

Aquatic plant densities based on rake sampling for June 14, 2021. Densities are based on a scale from 1 to 3 w ith 3 being the densest.

Way point	Site	Depth (ft)	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Naiads	Sago	Stringy	Water celery	Water star-grass	FA - benthic	No plants
	1	4			1	1	1	1				1			1	
	2	8				1		1				2			1	
	3	3									1	2	1			
	4	7										1	1			
	5	10														1
	6	3											1			
	7	3			1											
	8	6			3											
	9	3	1			3	1								1	
	10	8				1						1				
	11	3			3	1						1	1			
	12	7											1			
	13	3		1											1	
	14	7								1					1	
	15	3											1	1	1	
	16	8		1											1	
	17	3			1									1		
	18	8								1					1	
	19	3		1									1		1	
	20	8														1
	21	3			1								2		1	
	22	6			1										1	
	23	3			2								1		1	
	24	6			2									1	1	
	25	3			1								2	1		
	26	6												1		
	27	3			2								1	1		
	28	7													1	1
	29	4			1											
	30	8				1									1	
	31	4		1	2										1	
	32	6			1	1						1			1	
	33	4									1		2			
	34	9														1
	35	4				1			1				1	1		
	36	6				1										
	37	4			2							1	1			
	38	8				1						1			1	
	39	3			2	1							1			
	40	9														1
	41	3			1	1					1		1			
	42	9										1				
	43	4			3						1	1				
	44	8										1				
	45	4				2										
	46	8				1					1					
	47	4				2										
	48	7				2	1	1								
	49	4				1									1	
	50	7				1	1					1				
1																
2					1											
3					2											
4					1											
5					1											
6					1											
7					3											
8																

Aquatic plant densities based on rake sampling for June 14, 2021. Densities are based on a scale from 1 to 3 w ith 3 being the densest.

Way point	Site	Depth (ft)	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Naiads	Sago	Stringy	Water celery	Water star-grass	FA - benthic	No plants
9																
10					1											
11																
12							1									
13																
14																
15																
16																
17																
18																
19							1									
20																
21									1							
22																
23																
24																
25																
26																
27																
28																
29					1											
30																
31																
32																
33					2											
All sites	Average		1.0	1.0	1.6	1.3	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.0	1.0	
	Occur (83 sites)		1	4	27	18	6	3	2	2	5	13	16	7	19	5
	% occur		1	5	33	22	7	4	2	2	6	16	19	8	23	
Sites	Average		1.0	1.0	1.7	1.3	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.0	1.0	
	Occur (50 sites)		1	4	18	18	4	3	1	2	5	13	16	7	19	5
	% occur		2	8	36	36	8	6	2	4	10	26	32	14	38	
Way point	Average				1.4		1.0		1.0							
	Occur (33 sites)				9		2		1							

Spring Lake Point Intercept Survey, Individual Site Data July 12, 2021

July 12, 2021: Individual site data for the point intercept survey.

Way point	Site	Depth (ft)	Cat-tails	Water-shield	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Floatingleaf Not Natans	Fries	Naiads	NWM	Sago	Stringy	Water celery	Water star-grass	FA	No plants
	1	2					1	1									1			1		
	2	2						1														
	3	2						1												1		
	4	4						1													1	
	5	4						2		1							1					
	6	2						1		1					1				2			
	7	2						1														
	8	3						1									1					
	9	3						2									1					
	10	4						2									1					
	11	4						1		1												
	12	5						1														
	13	5						2														
	14	4						1		1												
	15	3					1								1				2	1		
	16	2						2														
	17	3						2														
	18	3						1									1					
	19	4						2									1					
	20	5					1	1														
	21	5						1														
	22	5						2	1	1								1	1			
	23	5						1														
	24	5						2	1	1												
	25	5					1	1													1	
	26	2				1									1		1		1			
	27	1						1														
	28	1						1									1					
	29	4						3									1					
	30	4						1														
	31	5						1	1									1				
	32	6						1										1				
	33	6						1	1	1								1				
	34	7						1														
	35							1										2				
	36	6																1				
	37	5					1	1		1								1			1	
	38	3						1							1				2			
	39	2						2														
	40	3						2														
	41	4						1									1					
	42	5						2														
	43	6						1	1	1							1					
	44	8																1				
	45	8						1		1											1	
	46	8						2	1	1												
	47	8						1		2								1				
	48	8						1	1									1				
	49	6					2	1									1	1				
	50	5						1							1			1	1			
	51	1			1			2														
	52	2						2														
	53	3						3														
	54	3						3														
	55	5						3									1			1		
	56	7							1									1				
	57	8						2														
	58	9						1														
	59	10																				1
	60	10						1	1													
	61	9						1														
	62	9						1	1									1				
	63	8						1		1								2				
	64	7					2	1										1				
	65	3					1	1												2		
	66	1				1																
	67	1				1													1			
	68	2						3														
	69	2						2												1		
	71	2						3														
	72	2						3														
	73	3						3														
	74	4						3														
	75	6						3									1	1				
	76	7						1														
	77	9						1														
	78	10																				1
	79	11						1														

July 12, 2021: Individual site data for the point intercept survey.

Way point	Site	Depth (ft)	Cat-tails	Water-shield	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Floatingleaf Not Natans	Fries	Naiads	NWM	Sago	Stringy	Water celery	Water star-grass	FA	No plants
	80	11																				1
	81	11																				1
	82	11						1										1				
	83	10						1										1				
	84	8																1				
	85	6						1							1			1				
	86	3													1				2	1		
	87	1				1	1															
	88	1				1									1		1		1			
	89	1				1	1															
	90	1				1		1		1							1		1	1		
	91	3						3														
	92	3						3		1										1		
	93	2						2														
	94	2						2														
	95	2						2														
	96	3						2														
	97	5						3														
	98	6						1		1								2				
	99	8						1										1				
	100	10						1										1				
	101	11						1														
	102	12																				1
	104	12																				1
	105	12						1										1				
	106	11						1														
	107	11						1														
	108	8																				
	109	5						2	1	1					1			1	2			
	110	3										1						1	1			
	111	2							1							1				2		
	112	2														2				1		
	113	2				1	1															
	114	1				1									1		1		1			
	115	1				1	1													1		
	116	4						1									2			1		
	117	4						3														
	118	6						3														
	119	4						1							1					2		
	120	1													1		1			1		
	122	1						1											1			
	123	1						1									1		1			
	124	5						2														
	125	7						2		1												
	126	9*						1										1				
	127	10						1														
	128	11																				1
	129	12						1														
	133	13																				1
	135	11																				1
	136	10						1														
	137	6																1		1		
	138	2					3	1									1					
	139	4					3	1	1							1						
	140	4				1		1								1				1		
	141	4					1	1												2		
	142	5					1	1										2	1	2		
	143	3					1										1		2	1		
	144	7						1	1						1		1	1				
	145	9						1														
	146	8						2														
	147	7					1	1		1						1		1				
	148	4					1	1											1			
	149	2					2													2		
	150	3					1												2	1		
	151	3				2	1												1			
	152	4				1									1				1	1		
	153	4					1								1		1		2			
	154																					1
	155	1				1											1					
	156	3				1											2	1	1			
	157	8					1	1		1							1	1		1		
	158	10						1														
	159	11						1										1				
	160	12						1														
	169	9						1														
	170	4												1					1	2		
	171	2					2	1									1			2		
	172	4					1	1									1					
	173	4					1	2									1					
	174	6				1	1	1									1					
	175	7															1					

July 12, 2021: Individual site data for the point intercept survey.

Way point	Site	Depth (ft)	Cat-tails	Water-shield	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Floatin gleaf Not Natans	Fries	Naiads	NWM	Sago	Stringy	Water celery	Water star-grass	FA	No plants
	176	9				1													1			
	176	11																				1
	177	10						1														
	179	11						1												1		
	180	9						1										1		1		
	181	6					1													2		
	182	3					2	1											2			
	183	1					1															
	184	4																		1		
	185	6							1						1					1		
	186	6				1									1					1		
	187	7													1			1				
	188	9													1					1		
	189	9																				1
	190	5				1		2											1			
	191	4																	1	1		
	192	1	3																			
	193	2													1		3		1			
	194	3													1				1			
	195	7																				1
	196	10																				1
	197	12						1														
	207	12																				1
	208	8						1	1											1		
	209	3					1										1		2	1		
	210	2					1	1											2	1		
	211	1					1	1										1	1	1		
	212	4					3															
	213	6						1		1						1				2		
	214	9																				1
	215	11																				1
	216	12																				1
	220	11						1														
	221	7						1										1	1			
	222	4					2	1												1		
	223	2						1											1			
	224	5																				1
	225	8						1									1					
	226	9																				1
	227	9					1															
	233	6							1								1		1	2		
	234	5						1											2	1		
	235	4						1							1				2	1		
	236	2													1		2					
	237	2													1		2		1			
	238	3													1				1			
	239	3					1								1							
	240	6						1									2	1				
	241	10						1										1				
	242	13																				1
	252	8				1									1							
	253	6				1	1								1					1	1	
	254	4					3												1	1		
	255	1					3												1			
	256	1				1																
	257	2				1	1	1											1			
	258	9						1												1		
	266	12																				1
	267	5					1									1				2		
	268	5					1													2		
	269	10																				1
	270	14																				1
	279	11																				1
	280	9																				1
	281	4																		2		
	282	4													1		1					
	283	2					2	1									1					
	284	4				1		1														
	285	5						1									1					
	286	6						1									1					
	287	6				1		1										1				
	288	9						1	1									1				
	289	13																				1
	300	8																		1		
	301	8																				1
	302	4					2												1	1		
	303	2					2	1											2	1		
	304	9						1							1					1		
	305	13																				1
	314	11																				1
	327	16																				1
	329	9																				1

July 12, 2021: Individual site data for the point intercept survey.

Way point	Site	Depth (ft)	Cat-tails	Water-shield	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Floatingleaf Not Natans	Fries	Naiads	NWM	Sago	Stringy	Water celery	Water star-grass	FA	No plants
	330	5						1							1		1		2			
	331	1				1		1														
	332	3				1	1	2														
	333	5				1	1	2														
	334	6				1	1	1							1			1				
	335	8						1		1							1	1				
	336	10																				1
	349	11																				1
	350	10																				1
	351	8																		1		
	352	10																				1
	353	14																				1
	354	16																				1
	379	10																				1
	380	5						1									2		1			
	381	3						1												1		
	382	4					1	1										1		1		
	383	5						1										1				
	384	6						1									1	1				
	385	8						1														
	386	10						1														
	401	13																				1
	430	9																				1
	431	3					2								1		1					
	432	4					1	1	1		1				1		2					
	433	5					2	1									1					
	434	7						1										1		1		
	435	9																1				
	436	11						1														
	480	9		1				1														
	481	2				1											1					
	482	3				1	1	1									1					
	483	6					1	1									2					
	484	7					1	1							1			1				
	485	9																1				
	486	11						1														
	530	12						1												1		
	531	3				1	1								1		2		2			
	532	6															1	1		1		
	533	7																1				
	534	10																				1
	579	5							1				1									
	580	2					1								1		1					
	581	4				1	1								1		1					
	582	6					2											2				
	583	10						1														
	627	9													1							
	628	3													1		1			1		
	629	2					2								1		1					
	630	3					1										3					
	631	6					2	1										1				
	632	10							1						1			1				
	673	12																				1
	674	10																				1
	675	4					1												1			
	676	4						1							1					1		
	677	2				1											1		1			
	678	4															1	2				
	679	9						1										1				
	680	12																				1
	717	4				1									1				1			
	718	3					2								1				2	1		
	719	2				1	1												2	1		
	720	2				2									1		1		1			
	721	5							1						1		2	1				
	722	12																				1
	747	4					2															
	756	9							1										1			
	757	7						1							1					2		
	758	4																	2	1		
	759	2				1													1	1		
	761	3					2												2			
	762	8						1	1						1			1				
	763	12																				1
	796	6						1							1					1		
	798	3					2												2			
	799	3				1											1			1		
	800	6					1			1					1			1				
	801	10																				1
	833	6				1									1							
	834	4					1												1	1		
	835	4													1		2		1	1		

July 12, 2021: Individual site data for the point intercept survey.

Way point	Site	Depth (ft)	Cat-tails	Water-shield	White lily	Chara	Clasp-ingleaf	Coon-tail	CLP	Elodea	EWM	Flat-stem	Floatin gleaf Not Natans	Fries	Naiads	NWM	Sago	Stringy	Water celery	Water star-grass	FA	No plants
	836	9													1							
	837	9							1													
	867	8													1							
	868	4				2																
	869	3				1													1			
	870	4				1	1	1									1		1			
	871	7				1		1							1			1				
	872	10																				1
	883	11																				1
	901	6													1		1		1	1		
	902	3				2											1		1			
	903	3				1	1	1														
	904	3					1								1				2			
	905	7													2		1	1				
	906	9													1							
	907	10					1	1							1							
	909	13																				1
	912	10																				1
	913	8						1												1		
	914	7						1							1							
	915	4				2													1			
	916	4				1									1		1		2			
	917	3					2										1		2			
	918	7				1		1									1	1	1			
	919	9						1							1							
	920	8						1							1							
	921	11																				1
	931	10						1							1							
	932	6					1								1					1		
	933	3					2												2			
	934	3					1								1		1		1			
	935	3							1						1		2		2			
	936	3													1		1	1	2	1		
	937	3					1								1		1		1			
	938	5									1				2		1					
	939	4						1			1											
	940	5						1														
	941	2				1									1		1		1			
	942	5				1									1				1			
	943	5						1							1		2		1			
	944	7						1	1						2			1				
	945	9																1				
	946	8						1							1			1		1		
	947	9													1							
	948	8						1							1							
	949	6													1			1	1	1		
	950	5							1						1							
	951	4					2										1		1			
	952	5					2												2	1		
	953	2				1	1								1			1	1			
	954	3						1							1				1			
	955	3					1	1							1				1			
	956	4						1									1	1	1	1		
1																						1
2											1											
3																						1
4																						1
5																1						
6																						1
7		3														3						
8											1											
9											1											
10											1											
11											1											
12											1											
13											1											
14											1											
15											1											
All sites	Average		3.0	1.0	1.0	1.1	1.4	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.2	1.1	1.3	1.2	1.0	
	Occur (392 sites)		1	1	1	52	85	197	28	23	12	1	1	1	84	9	83	72	85	78	5	57
Sites	Average		3.0	1.0	1.0	1.1	1.4	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.2	1.1	1.3	1.2	1.0	
	Occur (377 sites)		1	1	1	52	85	197	28	23	3	1	1	1	84	7	83	72	85	78	5	53
	% occur		0	0	0	14	23	52	7	6	1	0	0	0	22	2	22	19	23	21	1	
Way point	Average										1.0					2.0						
	Occur (15 sites)										9					2						4

Underwater Picture of Curlyleaf Pondweed in Prior Lake, June 7, 2021

Curlyleaf Pondweed Delineation and Assessment Surveys for Upper and Lower Prior Lake and Summer Point Intercept Survey for Upper Prior Lake, Scott County, 2021

Curlyleaf Pondweed Delineation: April 20, 2021
Herbicide Treatment: 24.15 acres May 17, 2021
Curlyleaf Pondweed Assessment Date: June 7, 2021
Point Intercept Survey for Upper Prior: August 19, 2021

Prepared for:
Prior Lake/Spring Lake Watershed District
Prior Lake, Minnesota

Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116

December 23, 2021

Curlyleaf Pondweed Delineation and Assessment Surveys for Upper and Lower Prior Lake and Summer Point Intercept Survey for Upper Prior Lake, Scott County, 2021

Summary

Early Season Curlyleaf Pondweed Delineation: Curlyleaf pondweed (CLP) distribution and abundance were delineated in Upper and Lower Prior Lakes on April 20, 2021. Based on the curlyleaf pondweed densities in both Upper and Lower Prior, several areas were delineated as having the potential for heavy curlyleaf growth by June (Figure S1).

Curlyleaf density was mostly light in April but there was the potential for heavy curlyleaf growth in some areas and 43.54 acres were delineated for a herbicide treatment.

The curlyleaf pondweed treatment was conducted on May 17, 2021 using diquat on a total of 24.15 acres in Upper and Lower Prior Lake.

Post Treatment Assessment: A follow-up curlyleaf assessment was conducted on June 7, 2021. The June 7 curlyleaf assessment found curlyleaf in the treatment areas was mostly well controlled. Outside of the treatment areas, there were a few spots where heavy curlyleaf pondweed growth was present, however most heavy growth was patchy.

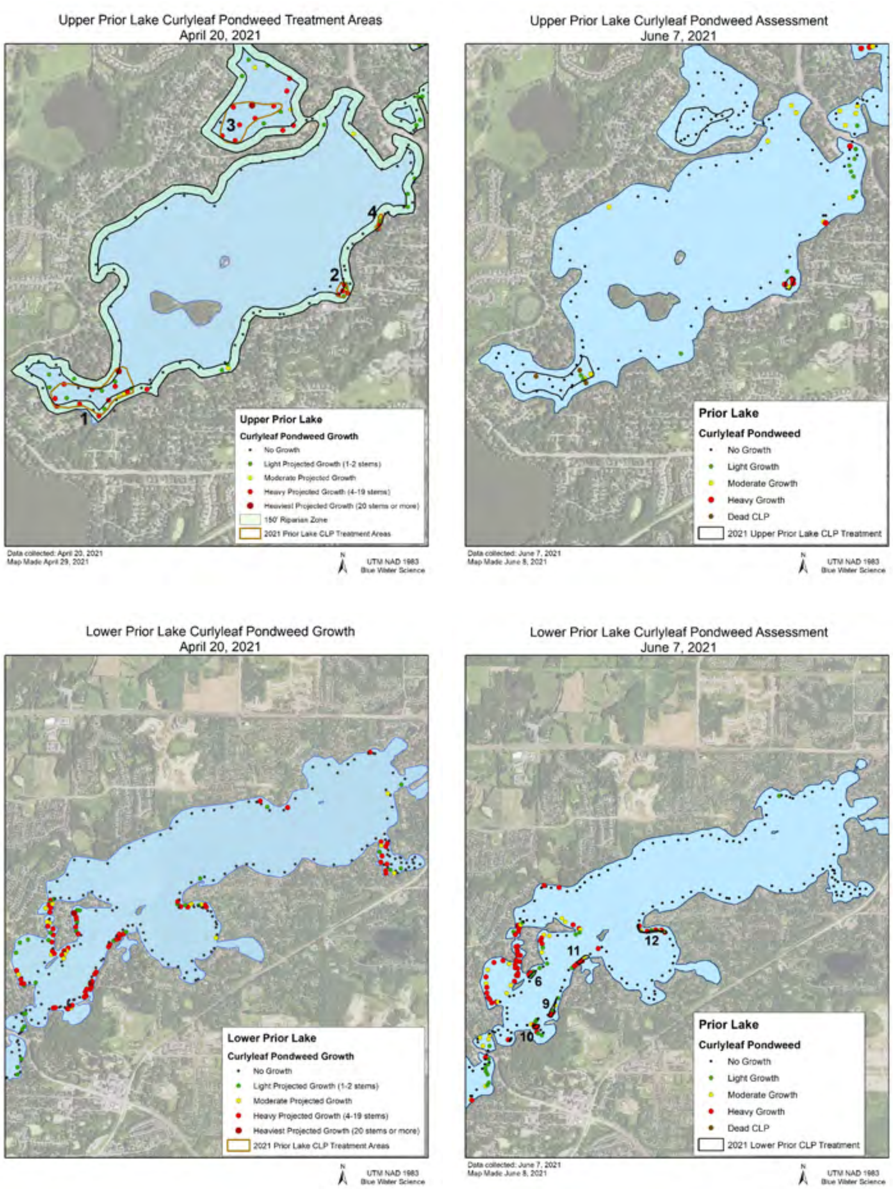


Figure S1. [left-top] Curlyleaf pondweed delineation survey conducted in Upper Prior Lake on April 20, 2021. [right-top] Curlyleaf pondweed assessment survey in Upper Prior Lake on June 7, 2021. [left-bottom] Curlyleaf pondweed delineation survey conducted in Lower Prior Lake on April 20, 2021. [right-bottom] Curlyleaf pondweed assessment survey in Lower Prior Lake on June 7, 2021.

Curlyleaf Planning for 2021: Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution is a challenge. Curlyleaf in April and May has just started to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in late May and June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season.

Currently, for Upper and Lower Prior Lake, the method has been to use past CLP growth history (Figure S2) combined with early season scouting. Then if curlyleaf growth has indications of producing potential heavy growth, those areas are delineated and treatment is considered. That is the approach to be considered for 2022.

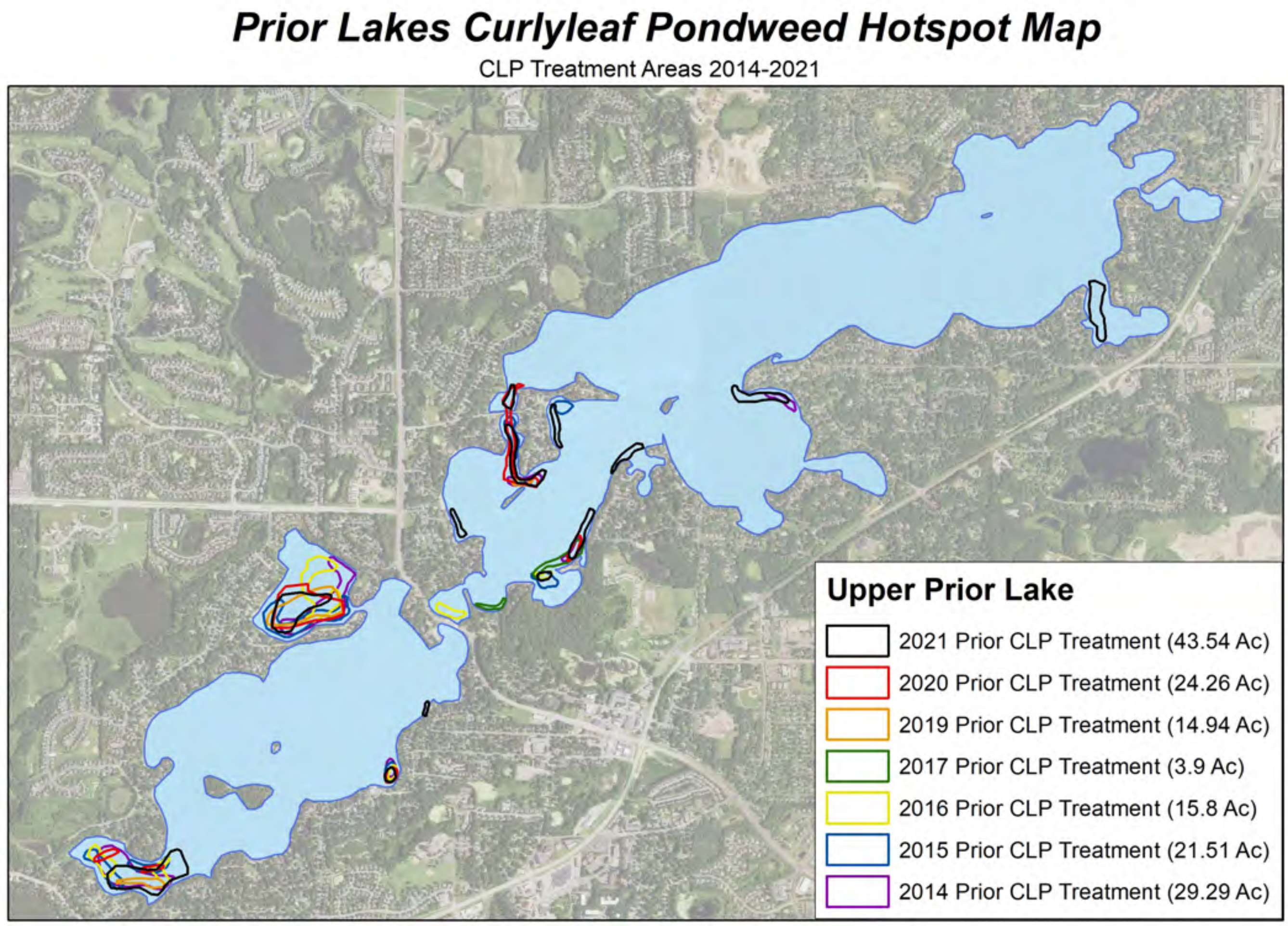


Table S1. Treatment summary from 2009-2021.

Year	Treatment
2009	No treatment
2010	No treatment
2011	No treatment
2012	No treatment
2013	23 acres
2014	29.3 acres
2015	21.5 acres
2016	15.8 acres
2017	2.55 acres
2018	No treatment
2019	14.9 acres
2020	24.3 acres
2021	24.15 acres

Figure S2. Prior Lake hot spot map for curlyleaf pondweed treatment areas from 2014-2021.

Point Intercept Survey: For Upper Prior Lake, a grid with points spaced 100 meters apart were sampled throughout the growing zone. A total of 163 sites were sampled, plants were observed growing to a depth of 8 feet. Results of the summer aquatic plant point intercept survey found 15 submerged aquatic plant species in Lower Prior and 6 species in Upper Prior including CLP. Native plants were found around the perimeter of the basin of Prior Lake (Figure S3).

Native aquatic plants were estimated to cover 27% of the lake bottom (358 acres). Coontail was the dominant aquatic plant. The 10 aquatic plant species found in this survey represents a fair to good diversity for Prior Lake in late summer.

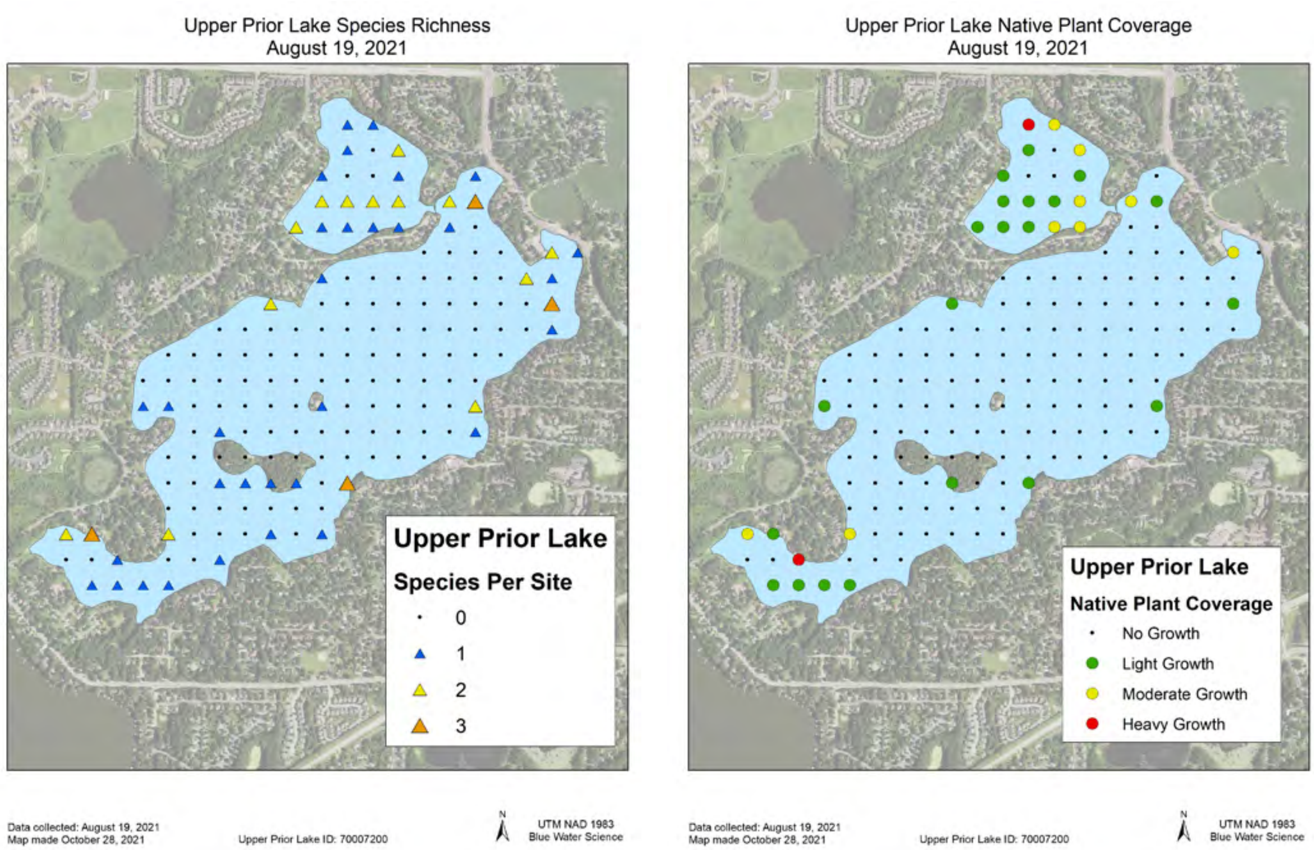


Figure S3. Point intercept survey results for species richness (left) and native plant coverage (right).

Summary of Aquatic Plant Point Intercept Surveys

Three point intercept surveys have been recently conducted in Lower Prior and 4 point intercept surveys have been conducted in Upper Prior Lake (Table S2).

In Upper Prior, the number of aquatic plant species and the coverage have increased since 2015 (Table S2).

Table S2. Prior Lake aquatic plant number of sites where a species was sampled for 2015, 2018, 2020, and 2021 point intercept surveys.

Lower Prior	Occurrence of Plants		
	2015	2018	2020
Duckweed (*Lemna sp*)		1	
Coontail (*Ceratophyllum demersum*)	62	129	63
Chara (*Chara sp*)	9		8
Elodea (*Elodea canadensis*)	5	2	1
Water stargrass (*Heteranthera dubia*)	3	22	7
Star duckweed (*Lemna trisulca*)		4	3
Northern watermilfoil *(Myriophyllum sibiricum)*	10	52	4
hybrid watermilfoil (*M. sp*)		2	
Eurasian watermilfoil (*M. spicatum*)	38	16	32
Naiads (*Najas flexilis*)		4	2
Nitella (*Nitella sp*)		2	1
Cabbage (*Potamogeton amplifolius*)	4	2	4
Curlyleaf pondweed (*P. crispus*)		10	7
Illinois Pondweed *(P. illinoensis)*	6	11	
Whitestem pondweed (*P. praelongus*)	7	4	
Claspingleaf (*P. Richarsonii*)	6	10	9
Stringy pondweed (*P. sp*)		1	3
Flatstem pondweed (*P. zosteriformis*)	10	26	32
Sago (*Stuckenia pectinata*)		1	1
Water celery (*Vallisneria americana*)	37	46	46
Number of submerged species	12	18	16
Estimated aquatic plant coverage (ac)	220 ac	375 ac	262 ac
Max depth of vegetation (ft)	15 ft	20 ft	19 ft
Percent coverage of plants (%)	23%	39%	27%

Upper Prior	Occurrence of Plants			
	2015	2018	2020	2021
Coontail (*Ceratophyllum demersum*)	5	29	33	25
Elodea *(Elodea canadensis)*	2	17	3	2
Bearded stonewort (*Lychnothamnus barbatus*				1
Northern Watermilfoil *(Myriophyllum sibiricum)*			6	1
Eurasian watermilfoil (*M. spicatum*)	11	17	5	25
Naiads (*Najas flexilis*)		4		2
Curlyleaf pondweed (*Potamogeton crispus*)			3	3
Stringy pondweed (*P. filiformis*)				9
Stringy pondweed (*P. sp*)		2	2	
Sago pondweed *(Stuckenia pectinata)*	2	1		2
Number of submerged species	4	6	6	9
Estimated aquatic plant coverage (ac)	33 ac	74 ac	82 ac	116 ac
Max depth of vegetation (ft)	6 ft	8 ft	10 ft	11 ft
Percent coverage of plants (%)	9%	19%	21%	30%

Curlyleaf Pondweed Delineation and Assessment Surveys for Upper and Lower Prior Lake and Summer Point Intercept Survey for Upper Prior Lake, Scott County, 2021

Introduction

Upper and Lower Prior Lakes combined have an area of 1,343 acres with a total littoral area of 732 acres (MnDNR). An initial curlyleaf pondweed delineation was conducted on April 20, 2021 including both Upper and Lower Prior. Curlyleaf was then treated on May 17, 2021 and a follow-up curlyleaf pondweed assessment was conducted on June 7, 2021 to characterize the status of curlyleaf pondweed at it's peak growing period. Sample sites were selected based on areas where curlyleaf had been found over the years.

A summer point intercept aquatic plant survey was conducted in August to evaluate the entire plant community in Upper Prior Lake (Figure 1).

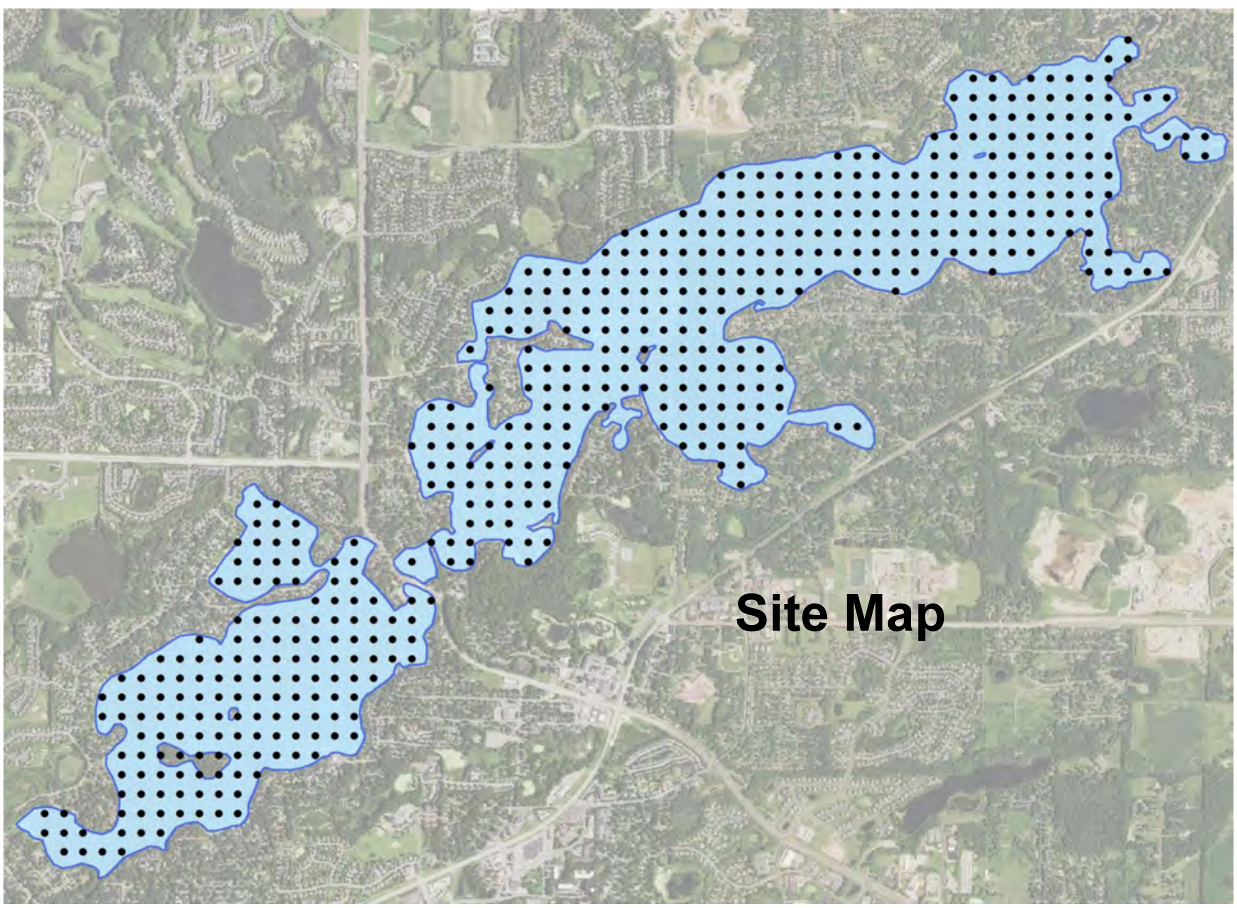


Figure 1. Point intercept 100 meter grid on Upper and Lower Prior Lake.

Methods

Curlyleaf Pondweed Delineation: At the time of the spring CLP delineations, only a fraction of the peak curlyleaf biomass is present. For spot treatments, the areas to be treated should be delineated prior to curlyleaf developing peak biomass. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce dense curlyleaf. After a short sweep of about 1-foot (30 cm), 4 curlyleaf stems or more per rake sample generally indicated some CLP plants had developed runners and would likely produce heavy growth in the next few weeks. Alternatively, sites where 3 stems or less were collected per rake sample were not predicted to produce dense growth at the peak growing period. These areas were not targeted for treatment. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

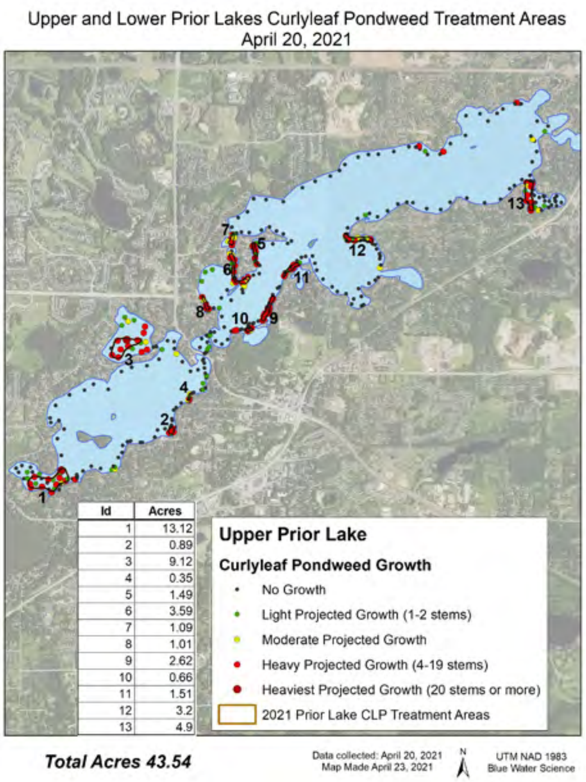
Curlyleaf Pondweed Assessment: A CLP assessment was conducted by Blue Water Science on June 7, 2021. The assessment is a post-treatment evaluation, it involved surveying the entire lake nearshore area, observing CLP growth, and sampling aquatic plants with rakes. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being a nuisance. Plant density chart is shown on the next page (Figure 2). Based on these sample sites, plant distribution maps were constructed.

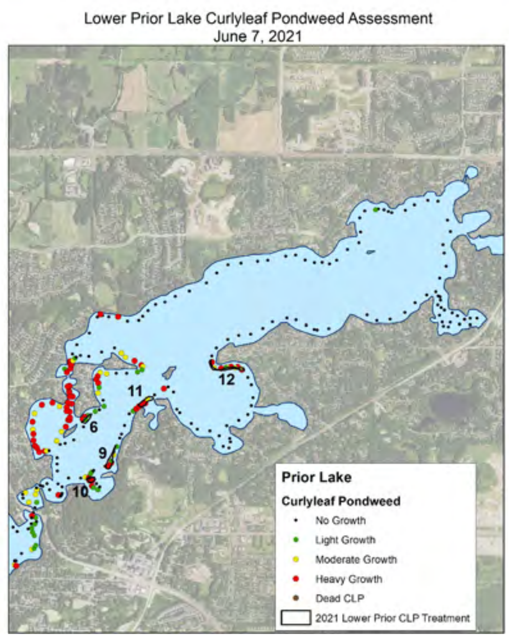
Survey Methods for the Point Intercept Survey An aquatic plant point intercept survey of Upper Prior Lake was conducted by Blue Water Science on August 19, 2021. Sample points were spaced 100 meters apart on a grid that covered the lake (Figure 1). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, a plant distribution map was constructed.

**McComas, S.R., Y.E. Christianson, and U. Singh. 2015. Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. Lake and Reservoir Management. 31:109-114.*

Curlyleaf Pondweed Delineation on April 20, 2021 and Assessment on June 7, 2021 in Upper and Lower Prior Lake

Results: A delineation survey on April 20, 2021, sampled a total of 413 sites around Upper and Lower Prior Lake with rake sampling. Curlyleaf was found at 166 out of 413 sample sites including 88 sites with curlyleaf growth projected to be abundant in June. A total of 43.54 acres in Upper and Lower Prior Lake areas were delineated as having the potential to develop moderate to heavy growth conditions by June (Figure 2). A total area of 24.15 acres of CLP in Prior Lake was permitted for treatment based on criteria where treatment was either 150 feet or more from shore or treatment was in front of public property. On June 7, 2021, a curlyleaf assessment was conducted. A total of 185 sites were sampled (Figure 2). Control was good in the treated areas. A few spots of moderate to heavy growth were observed in untreated areas (Figure 2). CLP conditions on June 7, 2021 are shown in Figure 2.





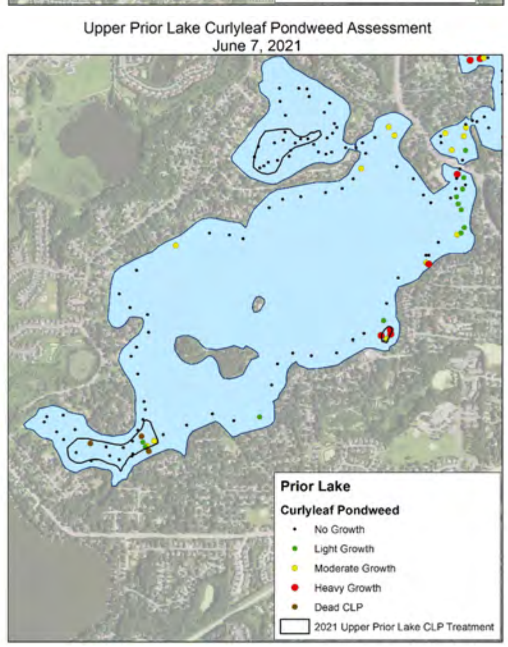


Figure 2. Map of curlyleaf pondweed delineation is shown on the left (April 20, 2021) and the curlyleaf assessment is shown on the right (June 7, 2021).

Point Intercept Aquatic Plant Survey for Upper Prior Lake

Results: A point intercept aquatic plant survey was conducted on Upper Prior Lake on August 19, 2021 (Figure 3). Aquatic plants grew to a water depth of 11 feet in Upper Prior. Aquatic plants covered approximately 116 acres in Upper Prior in 2021 compared to approximately 96 acres in 2020 and to approximately 69 acres in 2018.

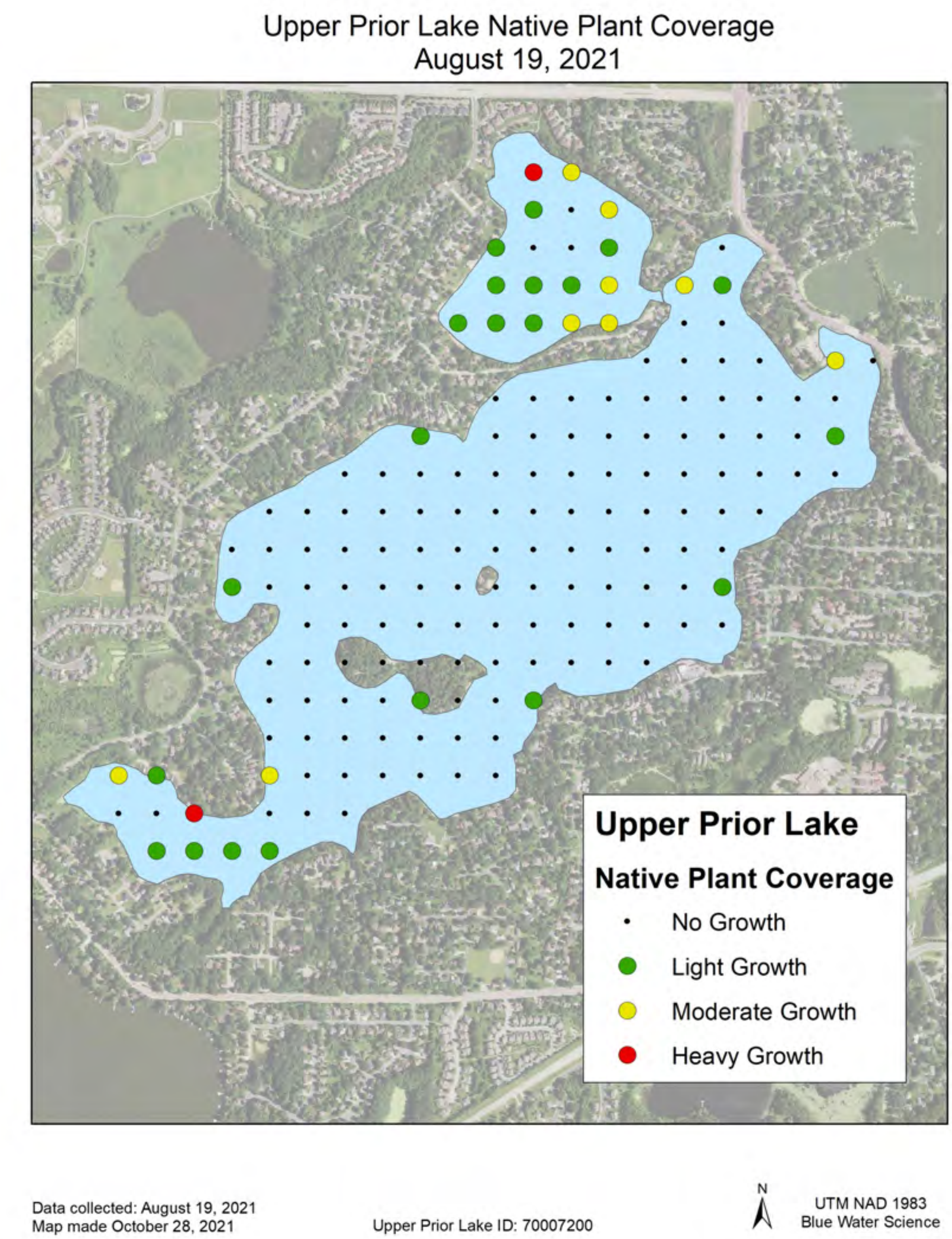


Figure 3. Native Plant Coverage in Prior lakes in late summer 2021.

Table 1. Upper Prior Lake aquatic plant data for August 19, 2021 point intercept survey.

	All Stations (n=77)(11 feet)		
	Occurrence	% Occur out to 11 ft	Average Density
Coontail (*Ceratophyllum demersum*)	25	32%	1.5
Elodea (*Elodea canadensis*)	2	3%	1.0
Bearded stonewort (*Lychnothamnus barbatus*)	1	1%	1.0
Northern watermilfoil *(Myriophyllum sibiricum)*	1	1%	1.0
Eurasian watermilfoil (*M. spicatum*)	25	32%	1.5
Naiads (*Najas flexilis*)	2	3%	1.0
Curlyleaf pondweed (*Potamogeton crispus*)	3	4%	1.0
Stringy pondweed (*P. filiformis*)	9	12%	1.1
Sago (*Stuckenia pectinata*)	2	3%	1.0

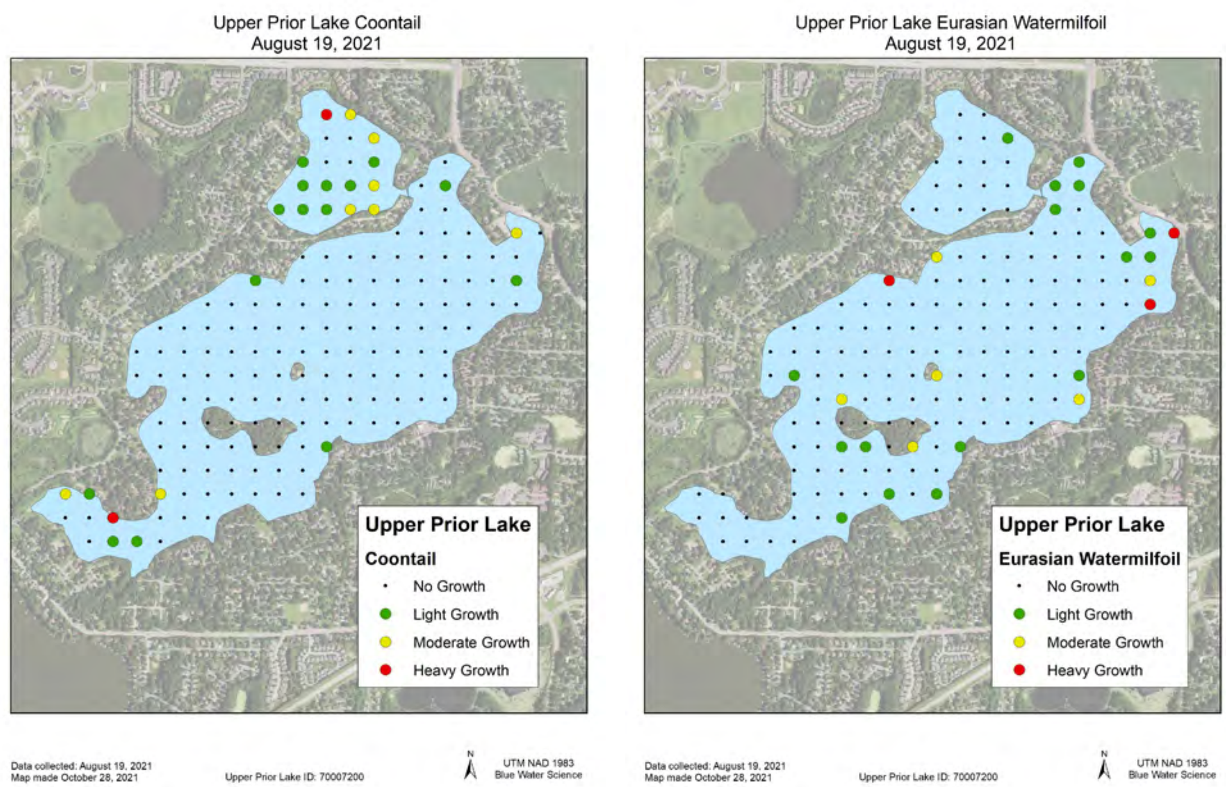


Figure 4. Map of coontail coverage and density is shown on the left (August 19, 2021) and EWM coverage and density is shown on the right (August 19, 2021).

Upper Prior Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 2 and 3 and Figure 5. A total of 102 points were sampled and plants were found out to 11 feet of water which included 77 sample points out to 11 feet. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 2. MnDNR Template Statistics

Total # Points Sampled	102
Depth Range of Rooted Veg	1-11 feet
Maximum Depth of Growth (95%) in feet	11.0
# Points in Max Depth Range	77
# Points in Littoral Zone (0-11 feet)	99
% Points w/ Submersed Native Taxa	32
Mean Submersed Native Taxa/Point	0.4
Mean Density of Submersed Native Taxa	1.1
# Submersed Native Taxa	7

Table 3. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled (0-11 ft)	% Sampling points with submersed species observed
0	0	0
1	2	100%
2	1	100%
3	1	100%
4	17	82%
5	8	100%
6	5	80%
7	5	60%
8	5	40%
9	6	83%
10	12	42%
11	15	27%
	77	

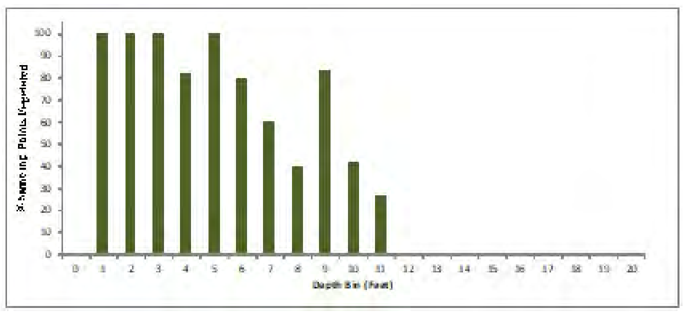


Figure 5. Depth of plant colonization (in feet).

Point Intercept aquatic plant survey comparisons for 2015, 2018, 2020, and 2021

Table 4. Prior Lake aquatic plant number of sites where a species was sampled for 2015, 2018, 2020, and 2021 point intercept surveys.

Lower Prior	Occurrence of Plants		
	2015	2018	2020
Duckweed (*Lemna sp*)		1	
Coontail (*Ceratophyllum demersum*)	62	129	63
Chara (*Chara sp*)	9		8
Elodea (*Elodea canadensis*)	5	2	1
Water stargrass (*Heteranthera dubia*)	3	22	7
Star duckweed (*Lemna trisulca*)		4	3
Northern watermilfoil *(Myriophyllum sibiricum)*	10	52	4
hybrid watermilfoil (*M. sp*)		2	
Eurasian watermilfoil (*M. spicatum*)	38	16	32
Naiads (*Najas flexilis*)		4	2
Nitella (*Nitella sp*)		2	1
Cabbage (*Potamogeton amplifolius*)	4	2	4
Curlyleaf pondweed (*P. crispus*)		10	7
Illinois Pondweed *(P. illinoensis)*	6	11	
Whitestem pondweed (*P. praelongus*)	7	4	
Claspingleaf (*P. Richarsonii*)	6	10	9
Stringy pondweed (*P. sp*)		1	3
Flatstem pondweed (*P. zosteriformis*)	10	26	32
Sago (*Stuckenia pectinata*)		1	1
Water celery (*Vallisneria americana*)	37	46	46
Number of submerged species	12	18	16
Estimated aquatic plant coverage (ac)	220 ac	375 ac	262 ac
Max depth of vegetation (ft)	15 ft	20 ft	19 ft
Percent coverage of plants (%)	23%	39%	27%

Upper Prior	Occurrence of Plants			
	2015	2018	2020	2021
Coontail (*Ceratophyllum demersum*)	5	29	33	25
Elodea *(Elodea canadensis)*	2	17	3	2
Bearded stonewort (*Lychnothamnus barbatus*				1
Northern Watermilfoil *(Myriophyllum sibiricum)*			6	1
Eurasian watermilfoil (*M. spicatum*)	11	17	5	25
Naiads (*Najas flexilis*)		4		2
Curlyleaf pondweed (*Potamogeton crispus*)			3	3
Stringy pondweed (*P. filiformis*)				9
Stringy pondweed (*P. sp*)		2	2	
Sago pondweed *(Stuckenia pectinata)*	2	1		2
Number of submerged species	4	6	6	9
Estimated aquatic plant coverage (ac)	33 ac	74 ac	82 ac	116 ac
Max depth of vegetation (ft)	6 ft	8 ft	10 ft	11 ft
Percent coverage of plants (%)	9%	19%	21%	30%

Aquatic Plant Distribution and Abundance for 2015, 2018, 2020, and 2021

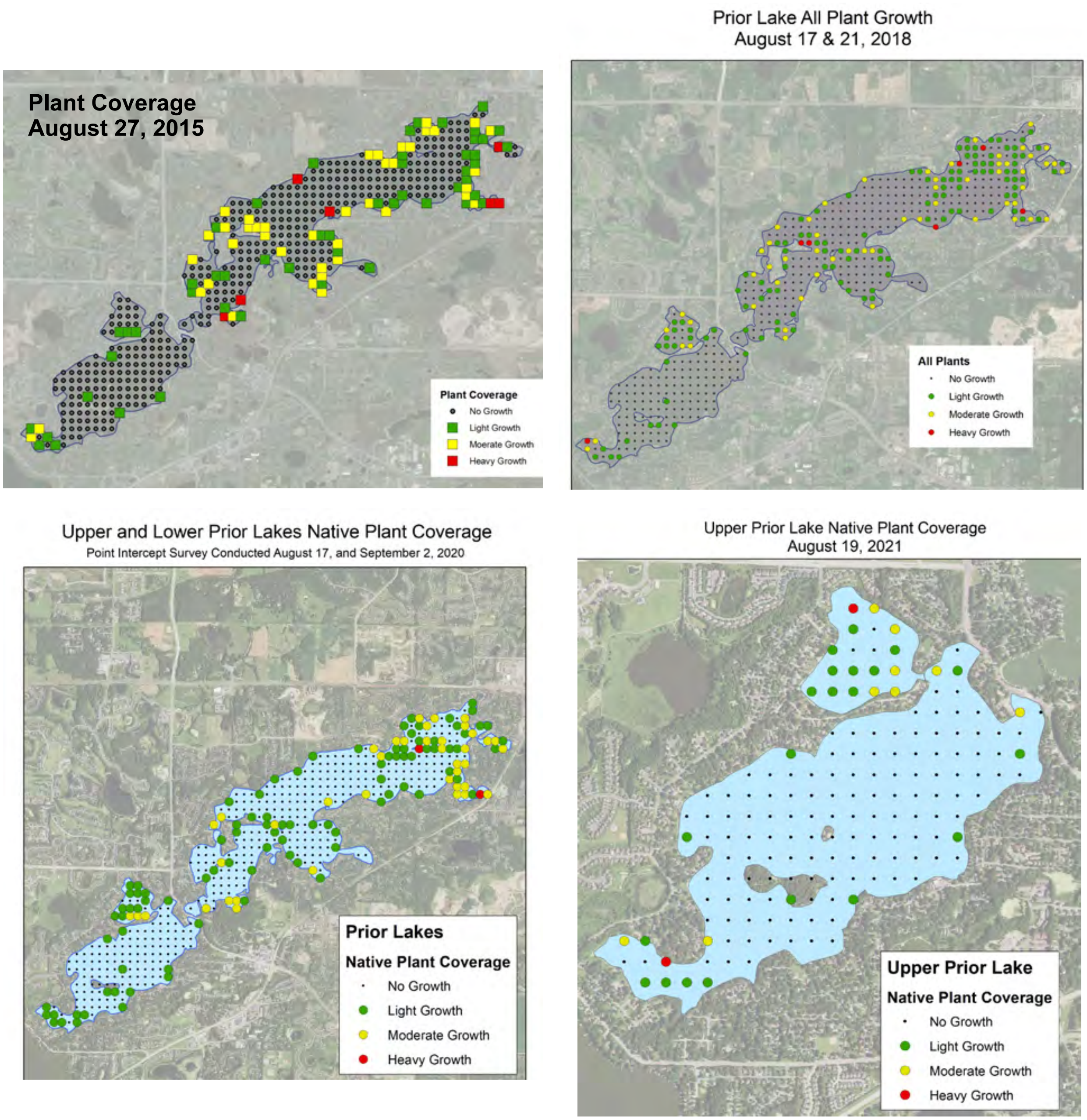


Figure 6. Maps of plant coverage for 2015, 2018, 2020, and 2021.

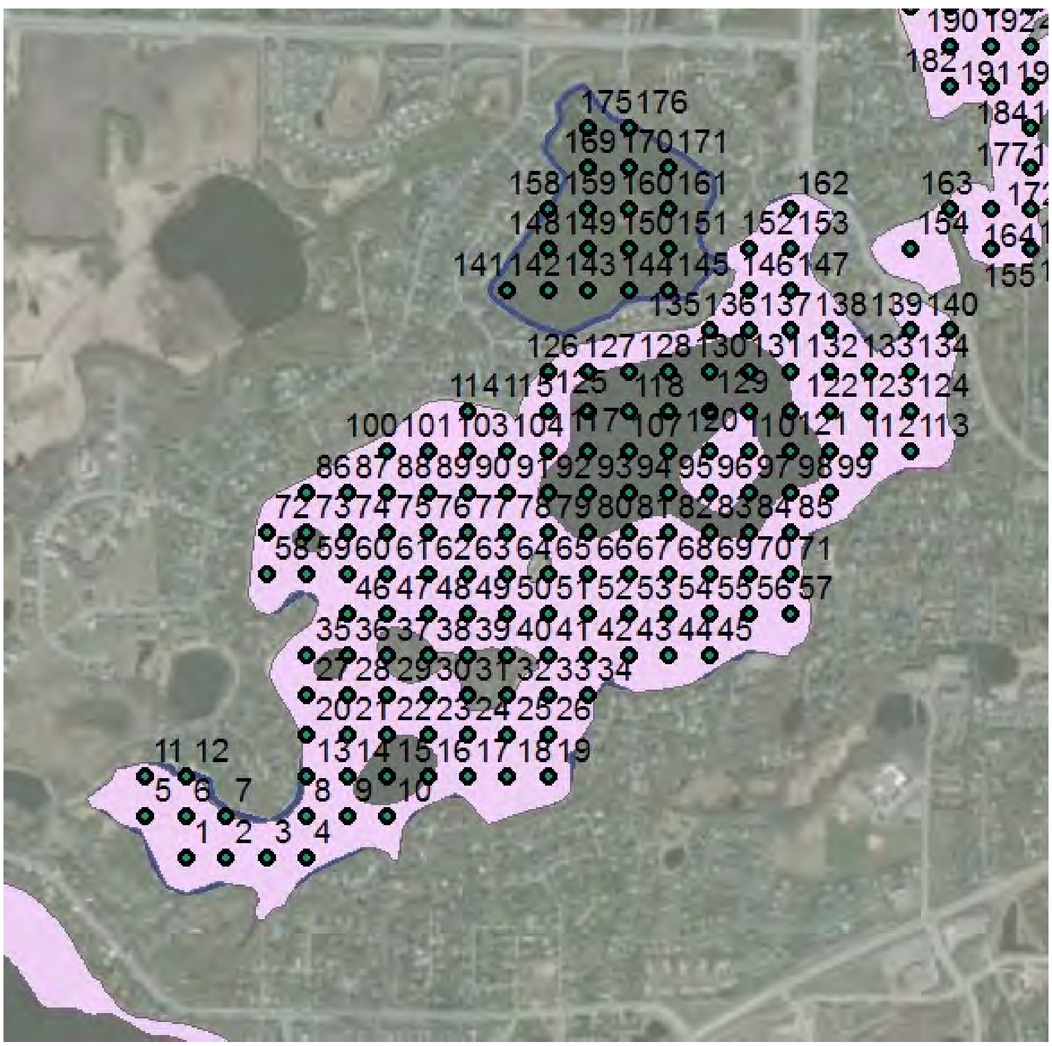
APPENDIX

Upper Prior Lake aquatic plant occurrence for the point intercept survey conducted on August 19, 2021.

Site	Depth (ft)	Coontail	CLP	Elodea	EWM	Filiformis	Naiads	NWM	Sago	Bearded stonewort	Benthic algae	No plants	ZM on plants
1	5							1					
2	5	1									1		
3	4	1									1		
4	6						1						
5	4										1	1	
6	6										1	1	
7	4	3									1		
8	7											1	
9	10											1	
10	9				1								
11	3	2								1			
12	2	1					1		1				
13	5	2	1								1		
14	31											1	
16	14											1	
17	10				1								
18	10											1	
19	9				1								
20	7											1	
24	11											1	
25	12											1	
26	10											1	
27	11											1	
29	11				1								
30	10				1								
31	1								1				
32	1				2								
33	10											1	
34	5	1			1	1							
35	12											1	
41	9										1	1	
42	13											1	
43	14											1	
44	13											1	
45	10											1	
46	13											1	
47	10				2								
48	10											1	
49	11											1	
50	12											1	
51	13											1	
55	16											1	
56	14											1	
57	8				2								
58	9					1							1
59	11				1								
60	11											1	
62	11											1	
63	10											1	
64	8											1	
65	7				2								
70	15											1	
71	9				1	1							
72	8											1	
75	11											1	
76	11											1	
77	13											1	
78	14											1	
79	16											1	
85	14											1	
86	8											1	
87	13											1	
88	13											1	
89	11											1	
99	15											1	
100	11											1	
101	12											1	
102	12											1	
103	11											1	
112	14											1	
113	9				3								
114	6	1			3								
123	14											1	
124	10	1	1		2								
125	6				2								
133	6		1		1								
134	11				1								
138	13											1	
139	11	2			1								

Upper Prior Lake aquatic plant occurrence for the point intercept survey conducted on August 19, 2021.

Site	Depth (ft)	Coontail	CLP	Elodea	EWM	Filiformis	Naiads	NWM	Sago	Bearded stonewort	Benthic algae	No plants	ZM on plants
140	5				3								
141	4	1				1							
142	4	1											
143	4	1											
144	4	2											
145	4	2											
146	10				1								
147	11											1	
148	4	1				1							
149	5	1				1							
150	4	1		1									
151	5	2		1									
152	7				1	2							
153	8	1			1	1							
158	5	1											
159	4											1	
161	4	1											
162	7				1								
169	4					1							
170	4											1	
171	4	2			1								
175	4	3											
176	4	2											
Average		1.5	1.0	1.0	1.5	1.1	1.0	1.0	1.0	1.0	1.0		
Occurrence of plants out to 11 feet (77 sites)		25	3	2	25	9	2	1	2	1	7	53	1
% occurrence		32	4	3	32	12	3	1	3	1	9		

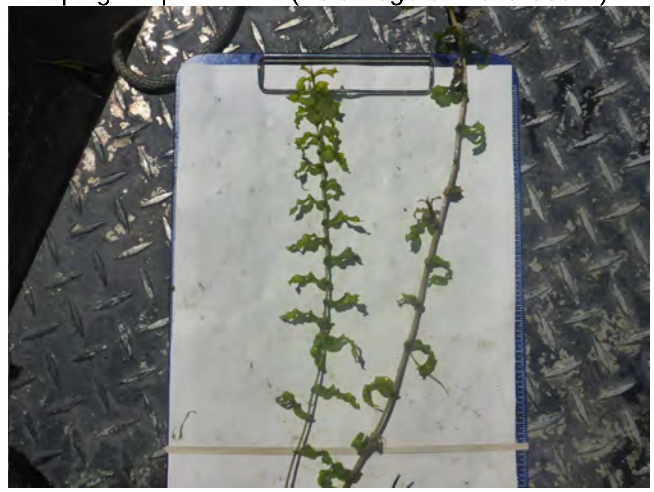


Point intercept sites for Upper Prior Lake, August 19, 2021

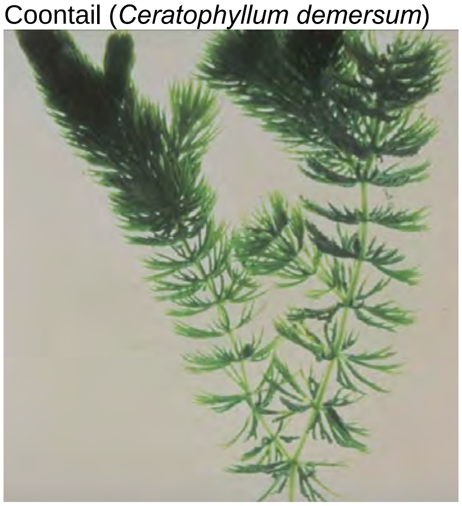
Common Aquatic Plants in Prior Lake

Chara (*Chara sp*)

Claspingleaf pondweed (*Potamogeton richardsonii*)



Coontail (*Ceratophyllum demersum*)



Curlyleaf Pondweed (non-native)(*Potamogeton crispus*)

Eurasian watermilfoil (non-native)(*Myriophyllum spicatum*)

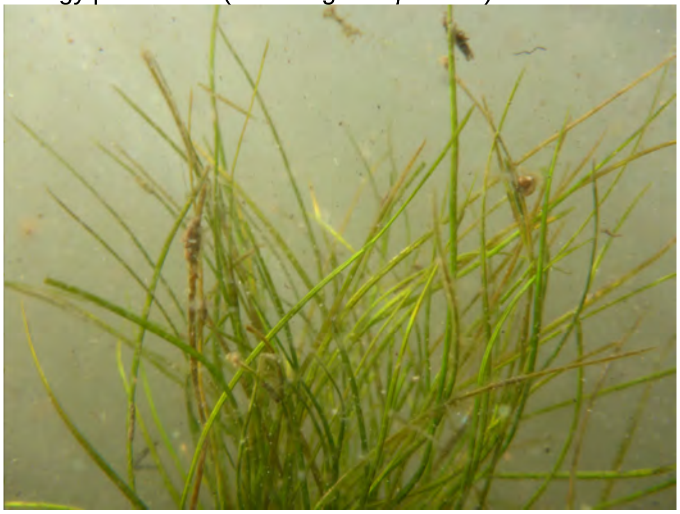
Flatstem pondweed (*Potamogeton zosteriformis*)

Naiad (*Najas sp*)

Northern watermilfoil (*Myriophyllum sibiricum*)

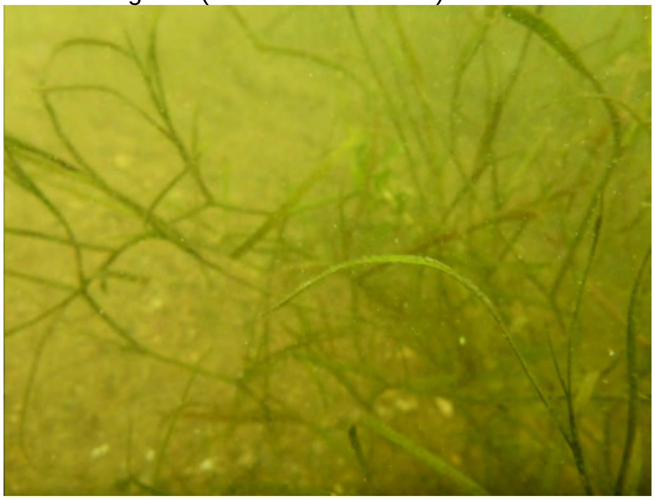
Sago pondweed (*Stuckenia pectinata*)

Stringy pondweed (*Potamogeton pusillus*)



Water celery (*Vallisneria americana*)

Water stargrass (*Heteranthera dubia*)



Comprehensive carp management

Left: *Using electrofishing equipment, Prior Lake-Spring Lake Watershed District staff and consultants captured and removed schooled carp in May at the Arctic Lake outlet in Scott County.*

Below: *Commercial fishermen contracted by the watershed district seined carp in April on Upper Prior Lake's Mud Bay.* **Photo and graphic credits:** PLSLWD

With the University of Minnesota and other partners, the Prior Lake-Spring Lake Watershed District takes an integrated pest management approach to the invasive fish that contributed to four lakes within the district being placed on the impaired waters list

CLEAN WATER LAND & LEGACY AMENDMENT

Sediment-stirring, aquatic plant-uprooting common carp played a major role in landing four of the 12 lakes within Prior Lake-Spring Lake Watershed District (PLSLWD) on Minnesota's impaired waters list. Armed with Clean Water Funds and partners including the University of Minnesota, the district is fighting back. Its multi-pronged, adaptive management approach uses integrated pest management principles to manage the entire lake system instead of individual lakes.

Spring Lake and Prior Lake are among several popular metro-area recreational

water bodies within the PLSLWD that are on the impaired waters list. PLSLWD Board of Managers President Mike Myser said maintaining and improving water quality in watershed lakes is among the district's top priorities.

"Spring and Prior lakes are prized for recreation in the region, however, both are polluted by nutrients that impair fishing and swimming," Myser said. "One of the major reasons is the proliferation of common carp. Managers are committed to do whatever it takes to bring the carp numbers down to a manageable level."

The simple solution? Remove the carp from the lakes.

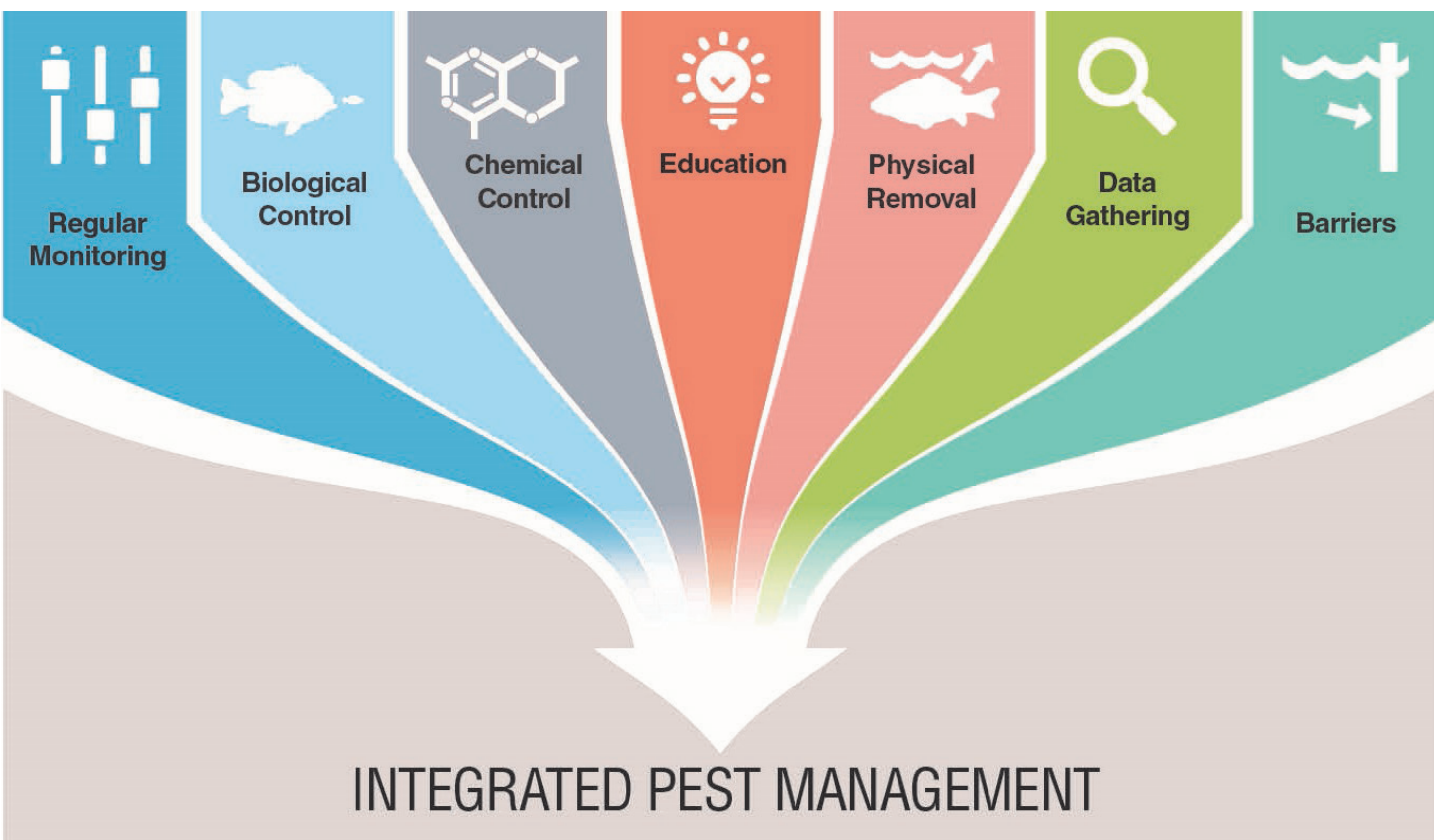
The challenge? Find the fish when and where they're schooling.

Combined, the district's three most heavily used lakes — Spring, Upper Prior and Lower Prior — contain 3 square miles of lakebottom where the carp can hide. Additionally, the carp have access to many upstream lakes and wetlands.

The district's IPM approach involves collecting data and tracking carp to determine migratory routes, aggregation areas and spawning grounds; exploring the feasibility and use of biological controls (such as bluegills); physically removing carp; installing carp barriers; and conducting community outreach.

Commercial fishermen seined 17 tons of carp in winter 2019 on Upper Prior Lake. Physical removal is one of seven tactics the watershed district is using to control carp populations. The graphic below elaborates on the seven methods.

In 2019, the PLSLWD received a $185,000 Clean Water Fund grant through the Minnesota Board of Water and Soil Resources (BWSR) Metro Watershed-based Funding pilot program, with $137,500 of that award dedicated to supporting the district's carp management program. The PLSLWD also leveraged local dollars. Multiple state and federal grants support the district's long-term comprehensive carp management efforts. Those include a Clean Water Partnership Grant for $67,323 awarded in 2015 from the Minnesota Pollution Control Agency (MPCA), federal 319 funding through the MPCA and a DNR Conservation Partners Legacy Grant for $18,160.



A primary management goal: Control the carp population and reduce the internal phosphorous load of Upper Prior Lake by 600 pounds annually.

"We appreciate the support we have received from Clean Water Funds — they have been critical to implementing the district's integrated pest management efforts, such as population monitoring, installation of fish barriers and physical removal," Myser said.

District staff members are trying to understand the system of interconnected lakes and associated channels and wetlands in order to determine where carp are congregating and spawning.

The first step is to track the carp. As many as 250 carp will be implanted with Passive Integrated Transponder (PIT) tags to track their movement as they pass through any of six stationary receivers strategically located throughout the watershed. The PLSLWD is also implanting an additional 30 carp with radio-tags, which allow the fish to be tracked manually with an antenna.

Tracking information will help the PLSLWD determine the best locations to install at least two barriers to spawning grounds and nursery areas. The data also will help determine where and when to place box traps and seine nets. Those will be situated in spots where the carp congregate or school together.

Larger hauls of carp captured by commercial fishermen are sold to markets throughout the United States for consumption. In some cases, carp eggs become caviar. Most often, smaller and mid-size carp are sent to markets on the East Coast while large carp are sent to the South to stock commercial game ponds. Smaller hauls go to the Shakopee Mdewakanton Sioux Community's Organics Recycling Facility which turns the carp into compost.

In 2017, the PLSLWD and the city of Prior Lake allowed the University of Minnesota to study carp at a wetland restoration site. In several ponds, University of Minnesota researchers analyzed the relationship between bluegills and carp.

The goal was to determine appropriate bluegill stocking levels as a potential carp management tool. Some native Minnesota fish species, such as bluegills, control carp populations by consuming their eggs and larvae. The study on the Prior Lake site proved 100 percent effective in eliminating carp recruitment, meaning no new larvae survived, and the overall study will help advance the research on this potential carp management tool.

Myser said the PLSLWD implements its long-term carp management program through key partnerships involving the city of Prior Lake, the University of Minnesota, the Shakopee Mdewakanton Sioux Community, the Spring Lake Association, and the Prior Lake Association.

The PLSLWD produced a video that offers a firsthand look at its carp management program.