Aquatic Vegetation Density Mapping
2022 Report

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PRIOR LAKE
SPRING LAKE
WATERSHED DISTRICT

Contents

Introduction

In 2013 the Prior Lake – Spring Lake Watershed District (PLSLWD) began mapping aquatic vegetation density in District lakes by using a software program by Contour Innovations, called BioBase.

One of the goals of this program is to collect baseline data on the trends and quantity of vegetation growth throughout all the watershed's lakes. Baseline data is necessary to make comparisons to future datasets by helping determine the normal, or baseline, conditions of the lake. Data that has been collected over multiple years and at various times of year provide a strong foundation of baseline data to yield reliable results in data analysis.

Another goal of the program is to detect and compare changes in plant distribution and density in District lakes. Plant growth in lakes is expected to change seasonally due to changes in water temperature, sunlight, and nutrient availability. However, the location and density of plant growth can also be affected by other factors such as water clarity, water levels, algae growth, and rough fish abundance. For example, water clarity determines how deep sunlight can reach into the lake. Because plants require sunlight to grow, water clarity, which can be impacted by algae abundance, and water level (flooding/drought) can cause vegetation to grow at different depths. Detecting and comparing changes in plant growth also provides insight on the effectiveness of water quality improvement projects, such as alum treatments, carp management, and aquatic vegetation management. Thus, it is worthwhile for staff to investigate gradual and sudden changes in lake plant area coverage (PAC) to track lake health during various lake conditions.

According to a study done by Canfield, a lake needs around forty percent PAC for optimal water clarity. This is because aquatic vegetation absorbs nutrients in the water and makes it unavailable for algae growth. Therefore, water clarity will increase and allow sunlight to penetrate further into deeper water levels. Clear water supports further plant growth and continues the cycle of long-term lake health. The District actively works to manage its lakes to meet the 40% lake wide plant coverage through its projects and programs.

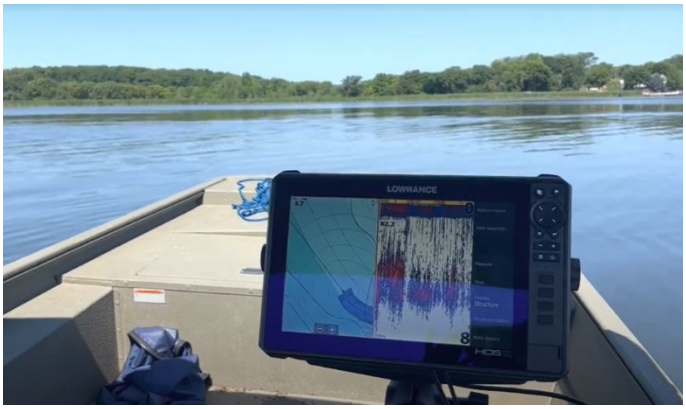


Figure 1. BioBase screen while boating

Methods

PLSLWD uses the recommended equipment for data collection: a Lawrence depth finder, a transducer (sonar), and a structure scan (optional but used to aid in vegetation identification). The structure scan equipment takes "ultra-sound-like" pictures of vegetation that allows for better visual clarity when looking at vegetation images. This can be helpful when determining plant type.

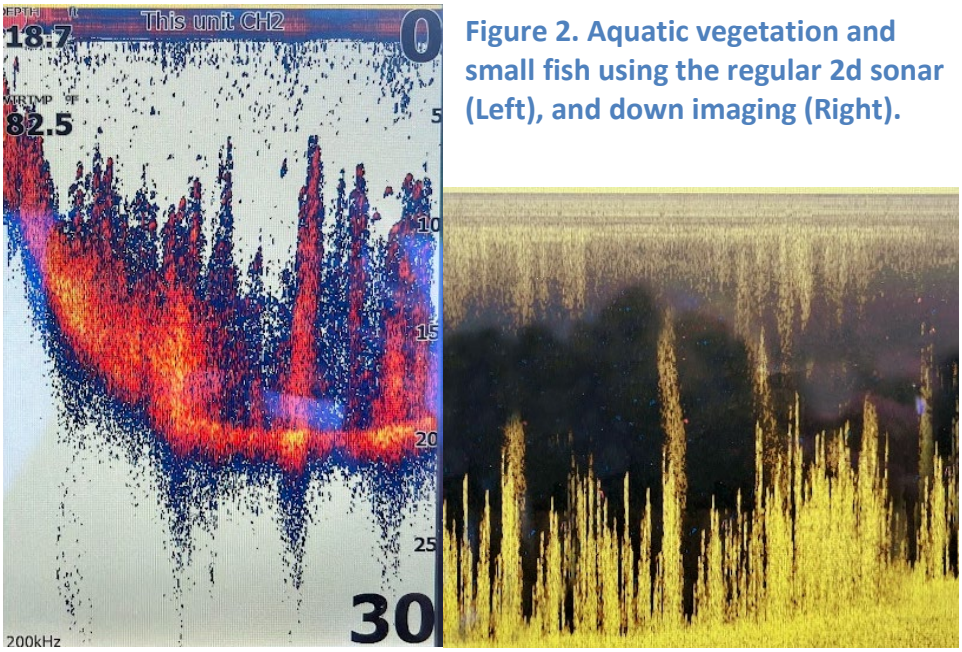


Figure 2. Aquatic vegetation and small fish using the regular 2d sonar (Left), and down imaging (Right).

BioBase sonar detects and records aquatic vegetation density, lake bottom hardness, and bathymetry. Vegetation density is determined by the percent of the water column (the vertical space between the lake bottom and the water surface) that is filled with plants. An area that has plant growth from the lake bottom to the lake surface has 100% vegetation density, while an area of the lake with no vegetation has 0% density.

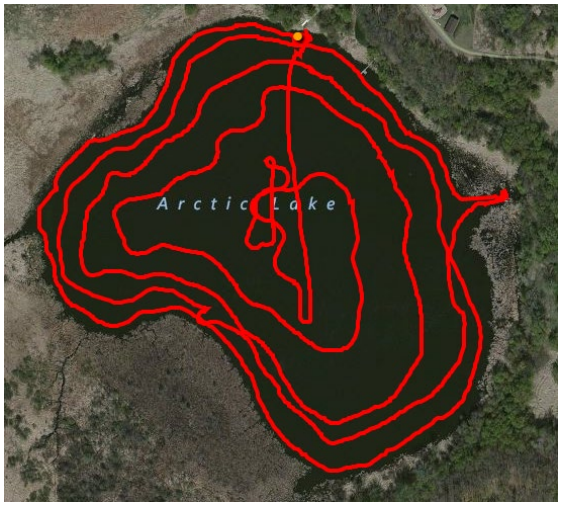


Figure 3. Recorded tracks shown in BioBase software.

To collect data, staff set up the equipment on the boat and drive the below 5mph for the scanner to properly record data. The scanner can collect data about 50 meters out from each side of the boat, but for more accurate measurements, a buffer of 25-40 meters is typically used to map the vegetation all the way up to the shoreline. Laps or "tracks" are then made, starting in the littoral zone, and moving farther into deeper water. To save on time, not all surveys are completed over the entirety of the waterbody. The boat operator will keep an eye on the graphing display which will show depths where vegetation stops growing. Sometimes tracking may vary allowing gaps or slivers to appear in the vegetation map. Surveys on large water bodies can require multiple trips where surveys need to be merged together. Data is then uploaded to the BioBase cloud storage where BioBase staff process the data and populates each complete trip to the District's online account.

A timeframe based on approximate water temperatures and length of day was made to clearly establish time frames for each BioBase season going forward shown in Table 1. The spring season is primarily used to map the aquatic invasive species Curlyleaf Pondweed which begins growth often before spring ice out. The summer

season is representative of when native plants are at their peak growth. The fall season captures the senescence stage and post die-off timeframe.

Table 1. Seasonal categorization timeframe

Spring	May 1 – mid June
Summer	Mid-June – early September
Fall	Early September – Oct 16

The long-term monitoring plan establishes survey frequencies based on lake tiers according to the schedule in Table 2.

Table 2. BioBase annual schedule

Tier 1 lakes	Every year	Upper, Lower, Spring, Fish
Tier 2 lakes	Every 3 years	Pike, Arctic, Buck, Sutton, Haas
Tier 3 lakes	Every 5 years	Crystal, Rice, Cates, Jeffers, Swamp
Non-tier lakes	As needed basis	Little Prior, Desilt, Geis, others

Data Collected

Historical Data

Table 3. All historic BioBase historical data by PLSLWD

Lake	Season	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Lower Prior	Spring		x	x	x	x					
	Summer	x	x	x	xx	xx	x		x	x	x
	Fall			x			x				
Spring	Spring	xx	x	x	x	x	x				
	Summer	x	x	x	xx	x	x		x	x	x
	Fall		x	x							
Upper Prior	Spring		x	x	xx	x	x				
	Summer		x	x	x	x	x		x	x	x
	Fall		x	x	x						
Fish	Spring			x	x		x				
	Summer			x	x	x	x		x		x
	Fall			x							
Pike	Spring										
	Summer				x		x				x
	Fall										
Arctic	Spring				x						
	Summer			x	x			x			x
	Fall			x							
Buck	Spring				x						
	Summer				x						x
	Fall			x			x				
Sutton	Spring										
	Summer										
	Fall										
Haas	Spring										
	Summer										

Cates	Spring										
	Summer				x		x				x
	Fall										
Crystal	Spring										
	Summer				x				x		x
	Fall										
Rice	Spring										
	Summer										
	Fall										
Swamp	Spring										
	Summer										
	Fall										
Jeffers Wildlife Pond	Spring										
	Summer										x
	Fall										
Jeffers Fish Pond	Spring										
	Summer				x				x		
	Fall										
Lower Jeffers	Spring										
	Summer										x
	Fall										
Desilt	Spring										
	Summer				x			x			x
	Fall							x			
Fish Point Park Pond	Spring										
	Summer				x						
	Fall										
Geis Wetland	Spring										
	Summer						x				
	Fall										
Little Prior Lake	Spring										
	Summer				x						
	Fall										

2022 Vegetation Maps

Listed below are the vegetation results from all the BioBase trips that were taken in 2022.

LOWER PRIOR LAKE

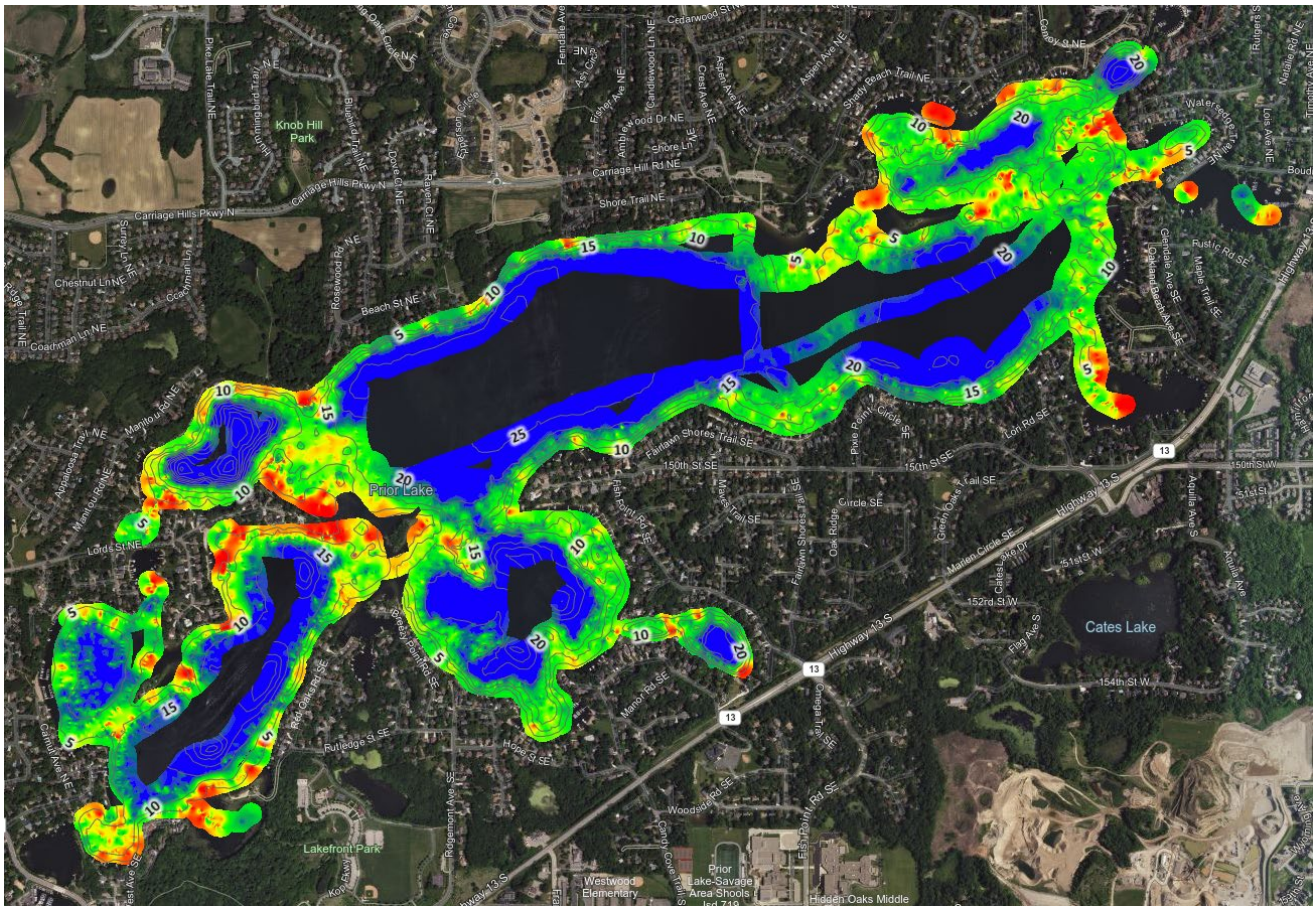


Figure 4. Lower Prior Lake - Summer 2022

PAC: 41.7%
Surface Area: 956 acres
Average Depth: 13 feet
Maximum Depth: 56 feet
Watershed Area: 18,904 acres
Impairment Status: Impaired for mercury & biota
2017-2019 Lower Prior Lake Report Card

Lower Prior Lake has historically met water quality standards. The percent area coverage has consistently tracked around the goal of 40%. From the first BioBase trip in 2013 to 2022, the average summer PAC for Lower Prior Lake is 46.2%. This lake is a great example of how adequate aquatic vegetation helps sustain long-term lake health.

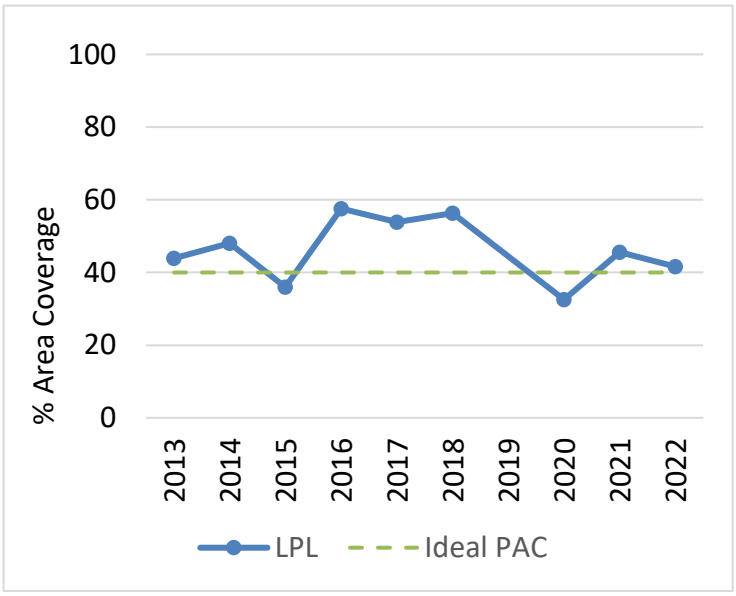


Figure 5. Lower Prior Historic PAC

UPPER PRIOR LAKE

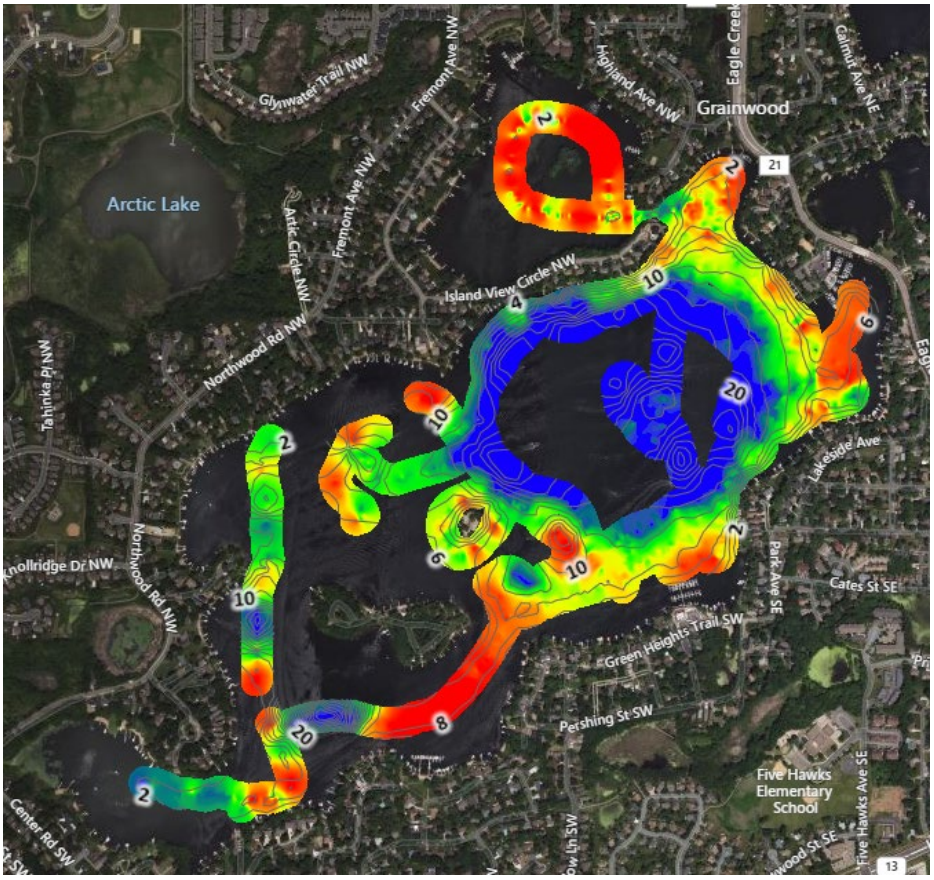


Figure 7. Upper Prior Lake – Summer 2022

PAC: 36% *
Surface Area: 416 acres
Average Depth: 10 feet
Maximum Depth: 43 feet
Watershed Area: 16,038 acres
Impairment Status: Impaired for excess nutrients
[Upper Prior Lake Report Card]

Upper Prior Lake has historically had trouble meeting water quality standards. Consequently, summer PAC before 2020 averaged only 12%. In recent years (2020 – 2022), water quality standards have begun to drastically improve through intensive carp management efforts and an alum treatment. See more about lake improvement projects on page 7.

*PAC results on Upper Prior Lake in 2022 may be abnormally low due to the technical difficulties in the field that resulted in an incomplete scan of the lake. The sonar was not able to penetrate through the thick vegetation when water depths reached below about 10'. Manual adjustments were completed to reflect actual conditions using BioBase software. Adjusted datapoints may not be as representative of vegetation density and depth conditions as unadjusted areas.

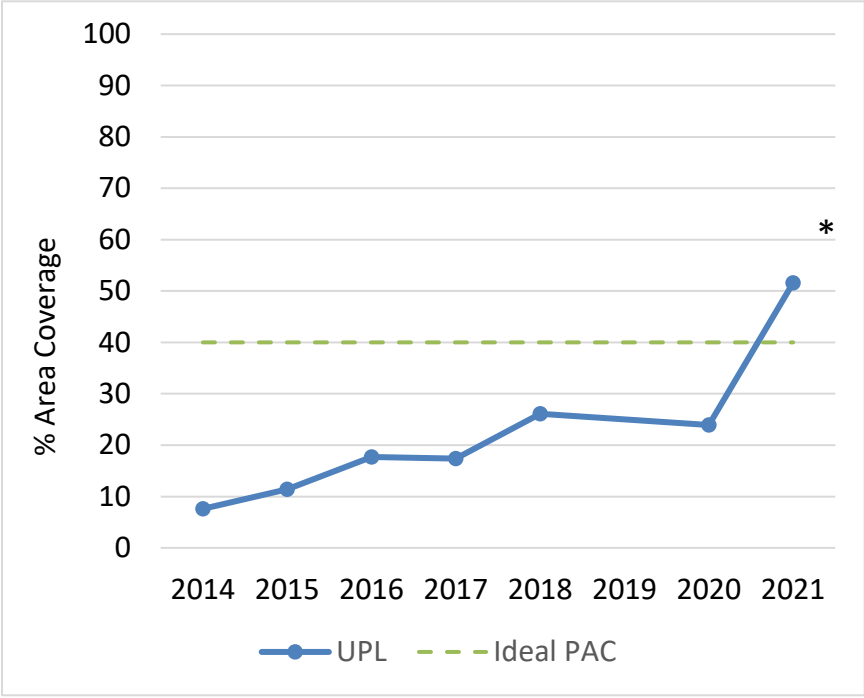


Figure 7. Upper Prior Lake Historic PAC

SPRING LAKE

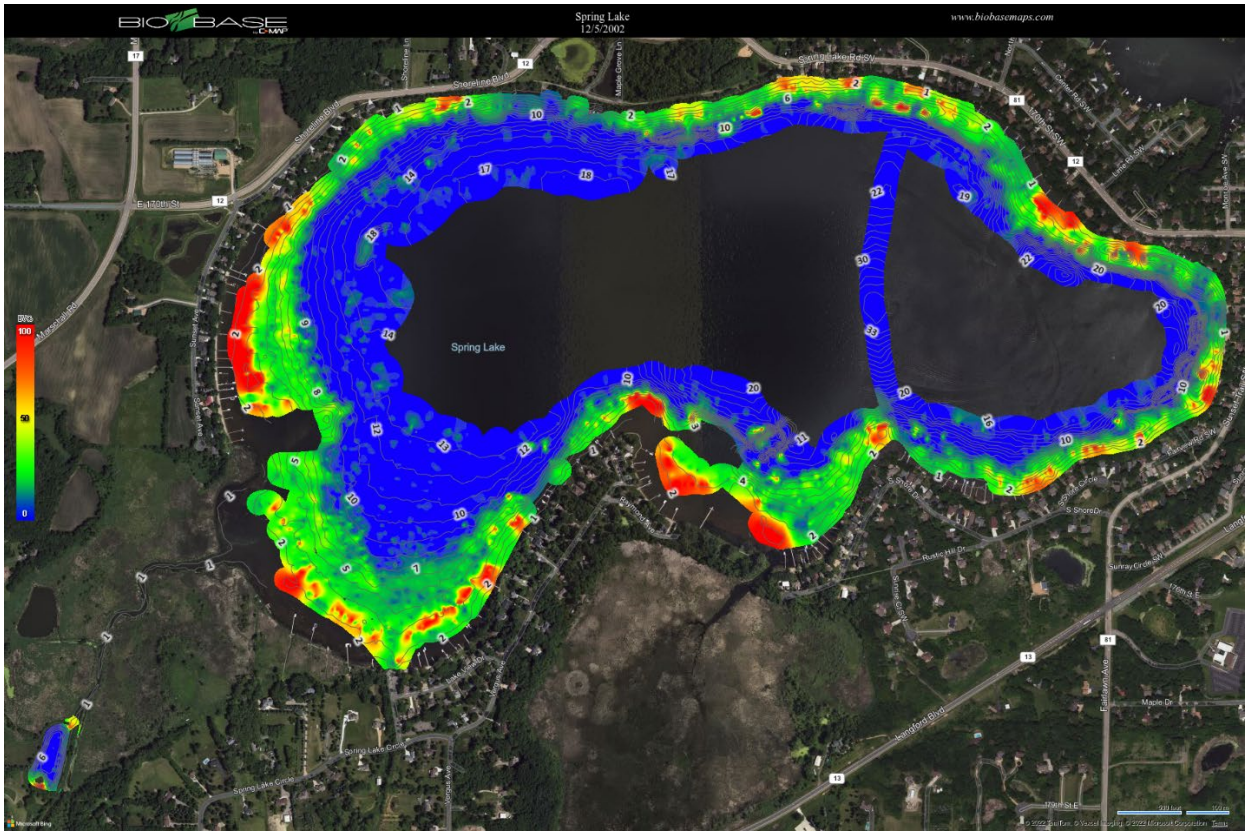


Figure 8. Spring Lake – Summer 2022

PAC: 28.3%
Surface Area: 587 acres
Average Depth: 18 feet
Maximum Depth: 34 feet
Watershed Area: 12,430 acres
Impairment Status: Impaired for excess nutrients
Spring Lake Report Card

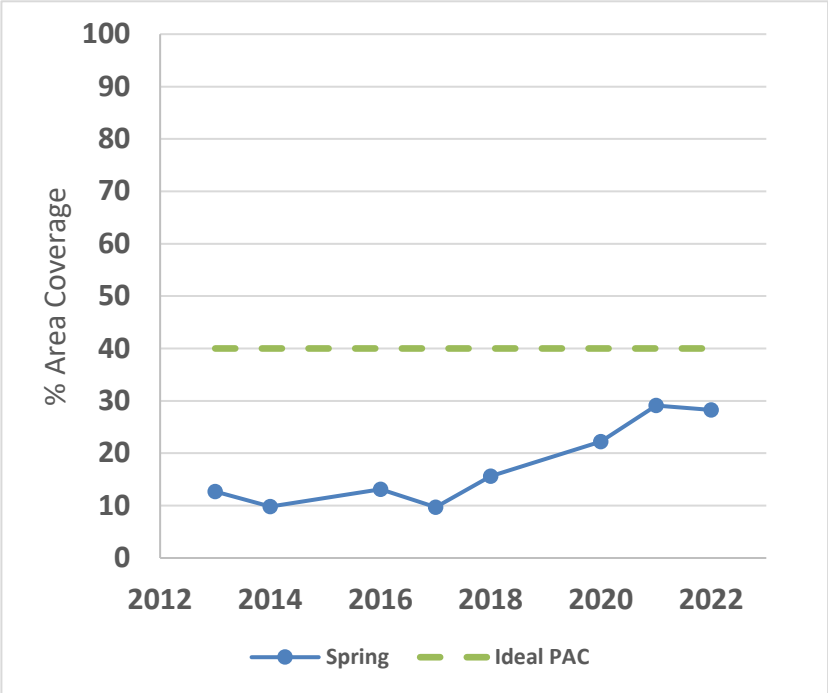


Figure 9. Spring Lake Historic PAC

Similar to Upper Prior Lake, Spring Lake has historically had trouble meeting water quality standards, but it has seen improvements in recent years (2020 – 2022). Consequently, summer PAC before 2020 averaged only 11.7%. The completed of a multi-year phased alum treatment and intensive carp management is beginning to show benefits in aquatic plant coverage and diversity. See more about lake improvement projects on page 7.

FISH LAKE

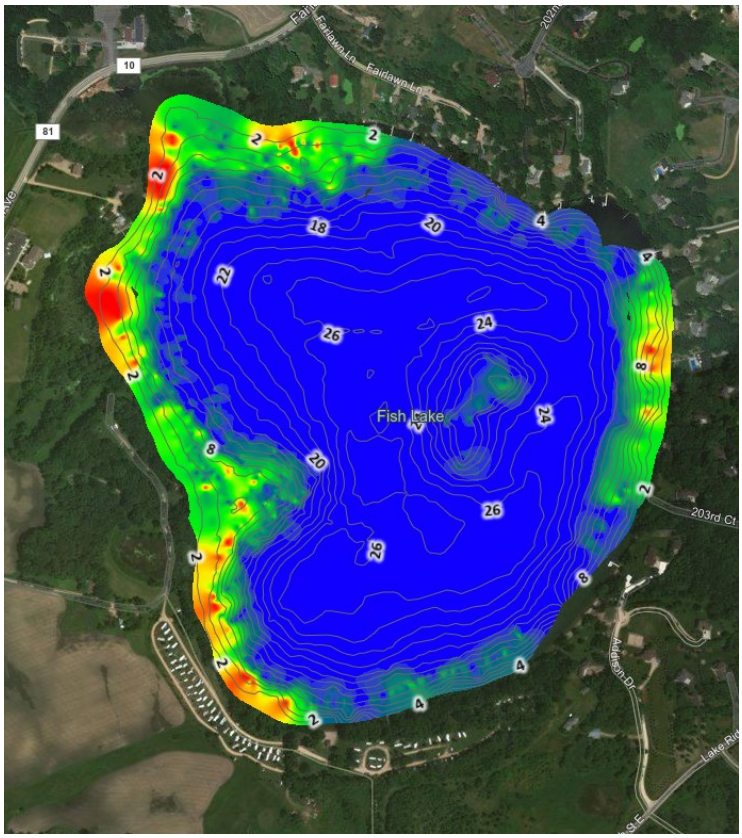


Figure 10. Fish Lake - Summer 2022

PAC: 24.4%
Surface Area: 171 acres
Average Depth: 14 feet
Maximum Depth: 28 feet
Watershed Area: 699 acres
Impairment Status: Impaired for nutrients
Fish Lake Report Card

Water quality results vary in Fish Lake. From the first BioBase trip in 2015 to 2022, the average summer PAC for Fish Lake is 26.1%.

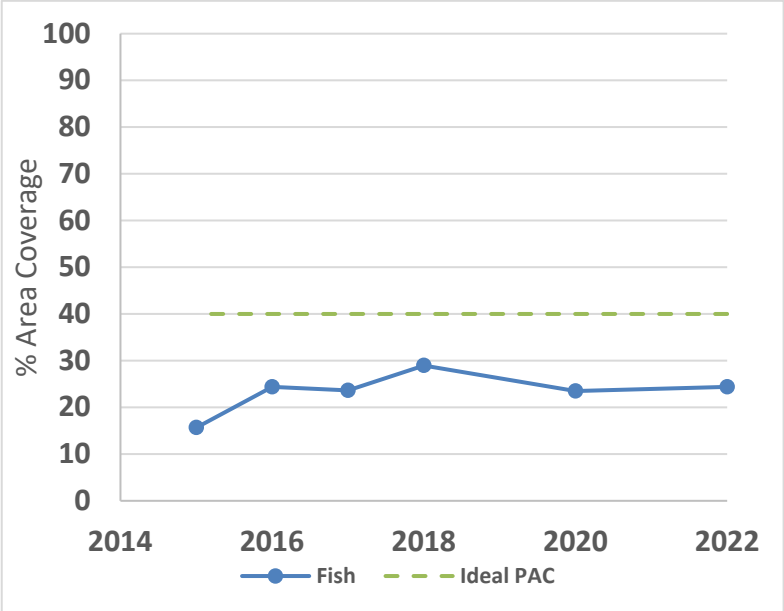


Figure 11. Fish Lake Historic PAC

ARCTIC LAKE

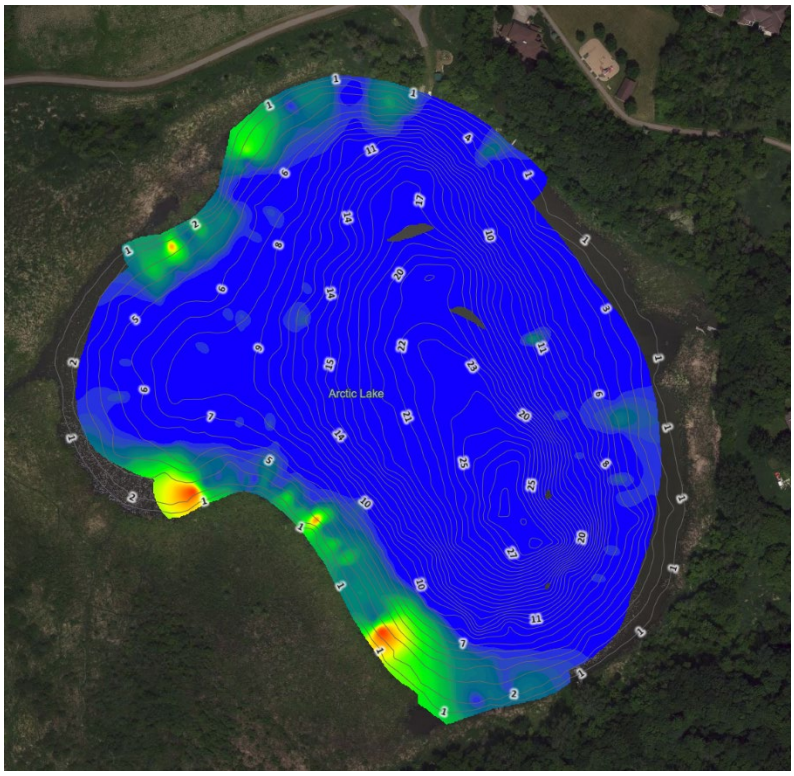


Figure 12. Arctic Lake - Summer 2022

PAC 14.0%
Surface Area: 33 acres
Average Depth: 9.5 feet
Maximum Depth: 30 feet
Watershed Area: 507 acres
Impairment Status: N/A

Arctic Lake has historically been nearly void of aquatic plants. Poor water quality and clarity may be contributing to the lack of plants. A vegetation study[1] was completed in 2020 by the Shakopee Mdewakanton Sioux Community and found that the seed bank in Arctic Lake sediment is very low in quantity and diversity. From 2016 to 2022, the average summer PAC for Arctic Lake is 9.4%.

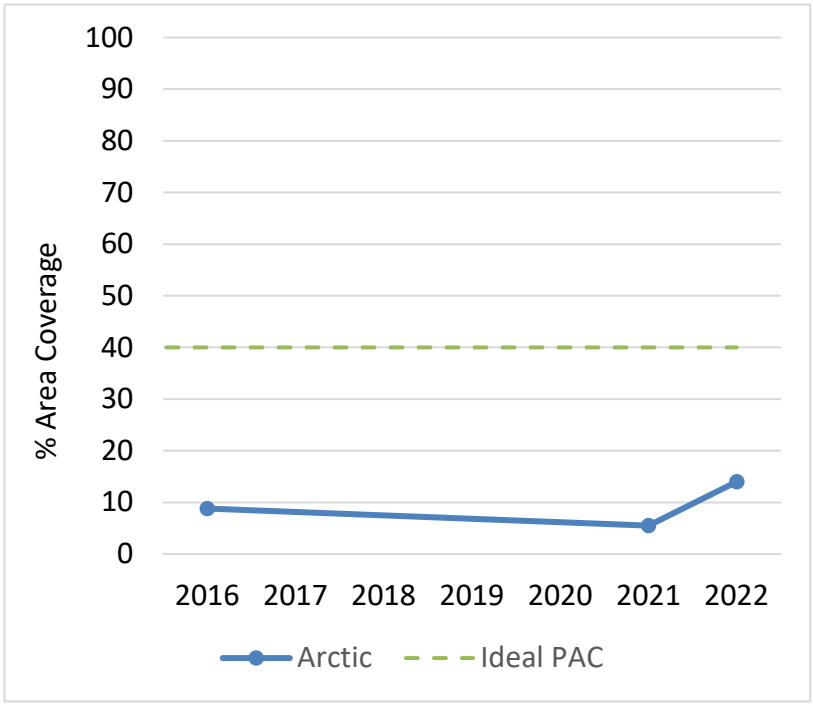


Figure 13. Arctic Lake Historic PAC

[1] https://storymaps.arcgis.com/stories/1398d9ed2ef44e1aa35c27603264b520

BUCK LAKE

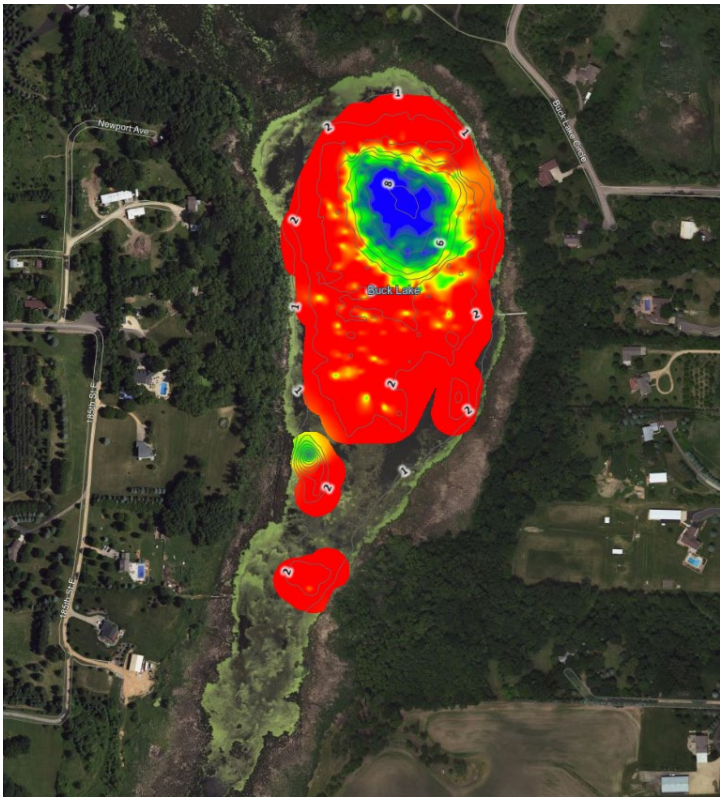


Figure 14. Buck Lake – Summer 2022

PAC: 73.4%
Surface Area: 23 acres
Average Depth: shallow
Maximum Depth: 9 feet
Watershed Area: 3350 acres
Impairment Status: N/A
Buck Lake Report Card

Very little BioBase data is available for Buck Lake at this time. With the two years of summer data that have been collected, Buck Lake appears to have a healthy level of aquatic plant life with an average summer PAC of 60.2%

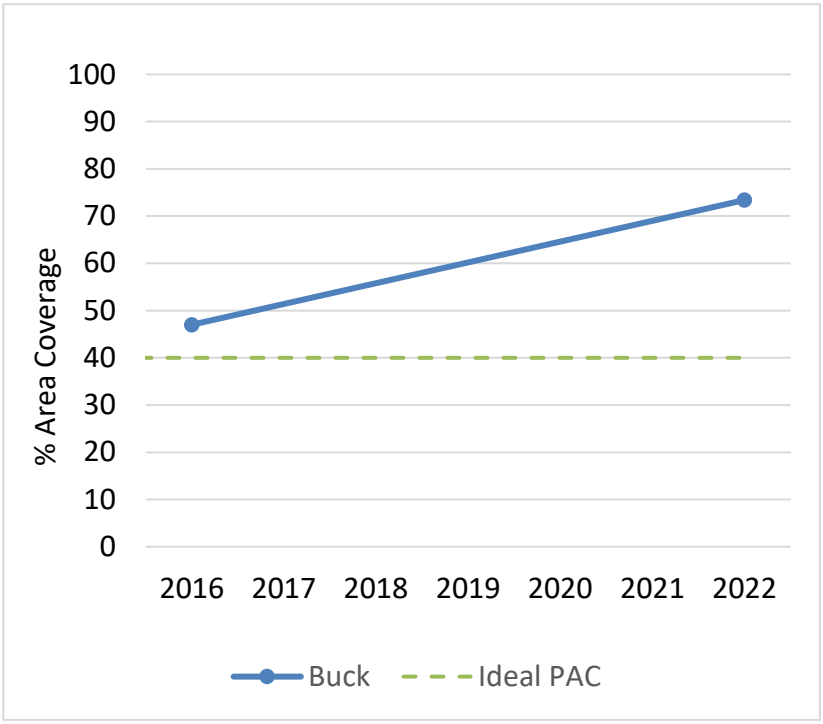


Figure 15. Buck Lake Historic PAC

CATES LAKE

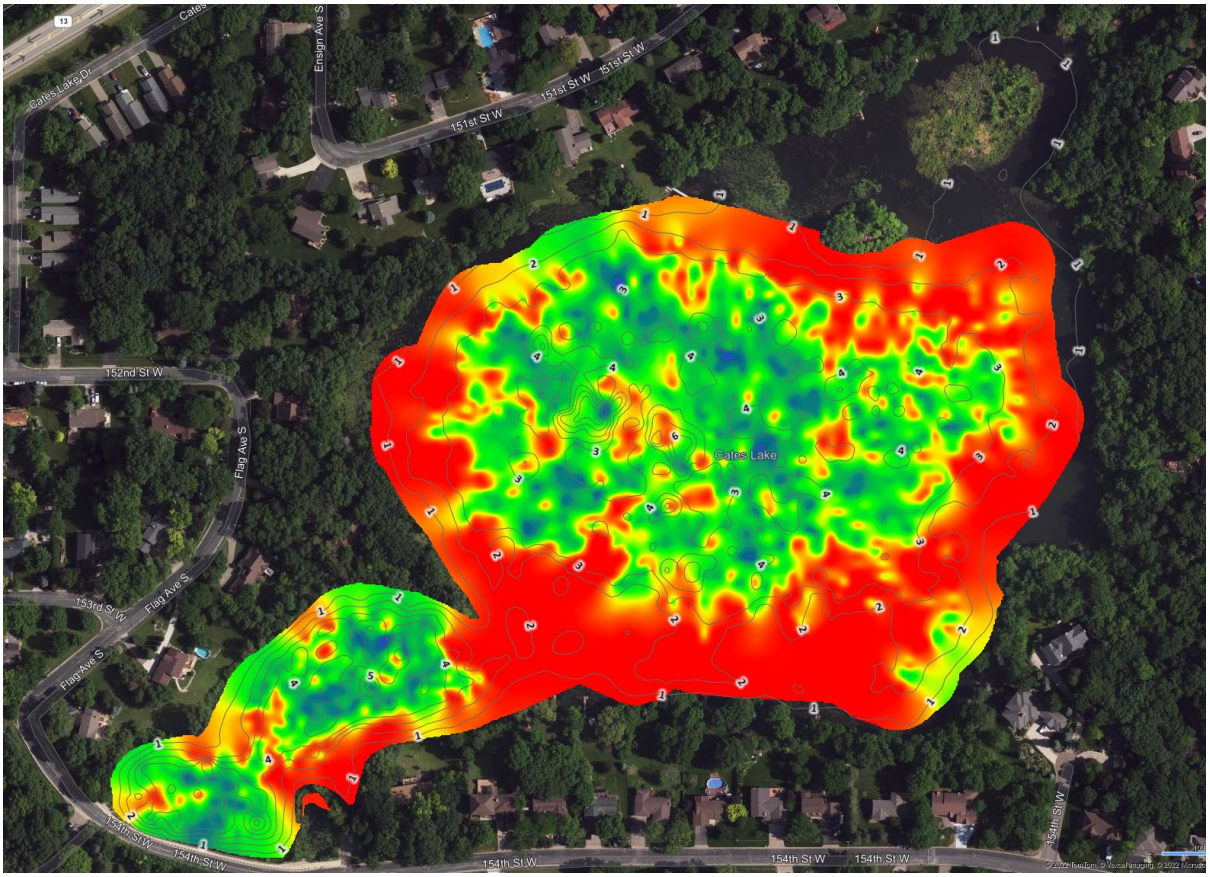


Figure 16. Cates Lake – Summer 2022

PAC: 88.1%
Surface Area: 30 acres
Average Depth: 3 feet
Maximum Depth: 13 feet
Impairment Status: N/A

Cates Lake has historically been a good example of a lake with excellent water quality and plant life. From the first BioBase trip in 2016 to 2022, the average summer PAC for Fish Lake is 91.7%.

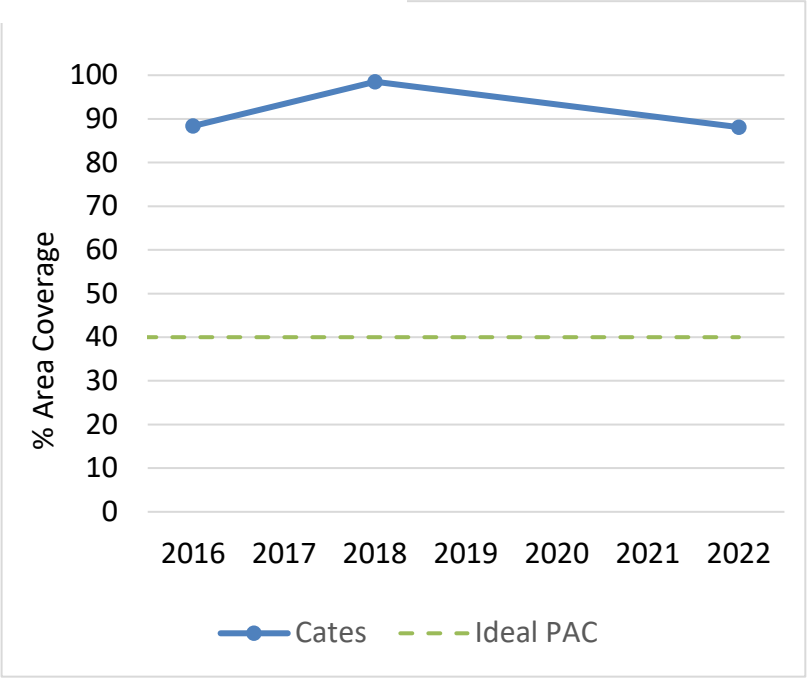


Figure 17. Cates Lake Historic PAC

CRYSTAL LAKE

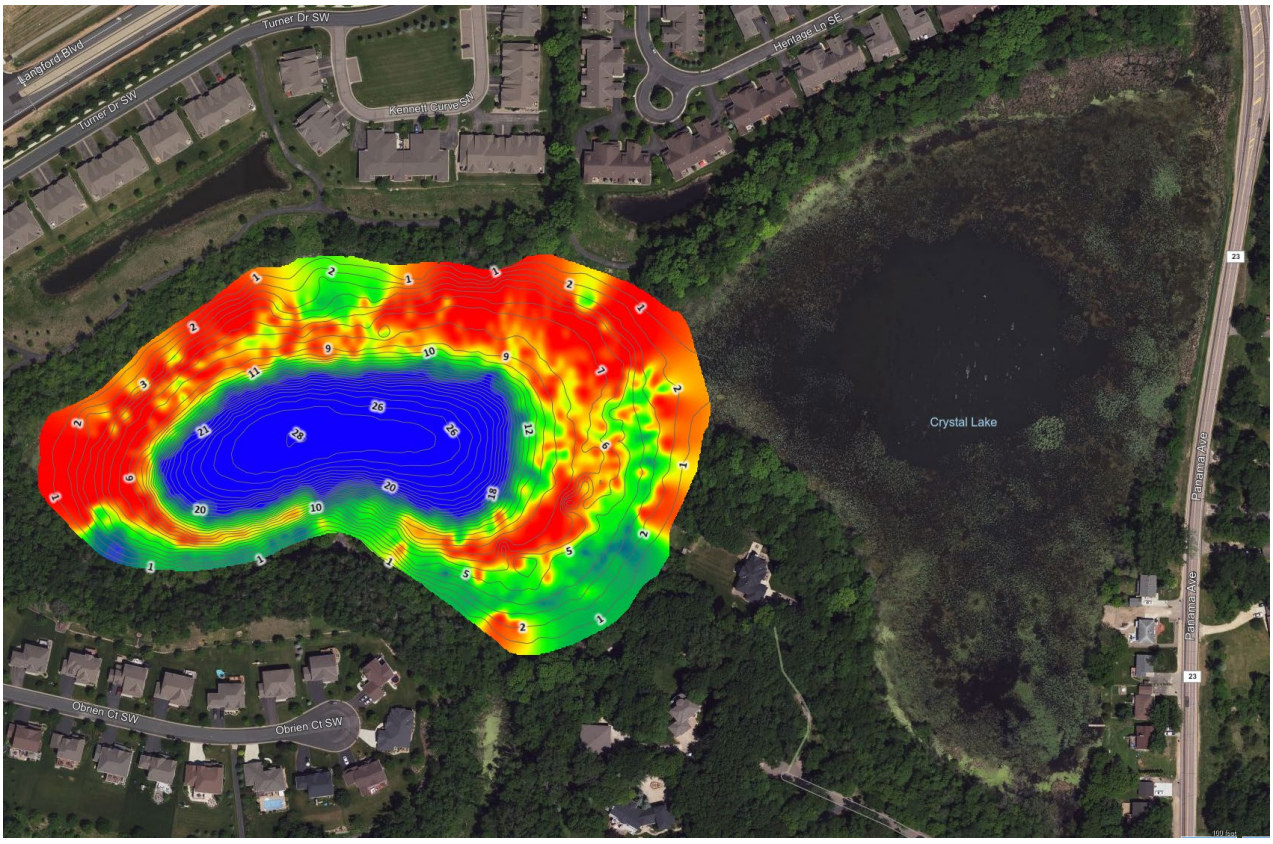


Figure 18. Crystal Lake – Summer 2022

PAC: 33.2%
Surface Area: 30 acres
Average Depth: N/A
Maximum Depth: 26 feet
Watershed Area: 1340 acres
Impairment Status: NA

Very little BioBase data is available for Crystal Lake at this time. Most of the data collected on this lake is only partial due to the thick vegetation that interferes with the sonar. In the future, staff will try to get a BioBase scan of Crystal Lake in the early summer before high vegetation density. With the three years of summer data that have been collected, the eastern half of Crystal Lake appears to an average summer PAC of 29.1%

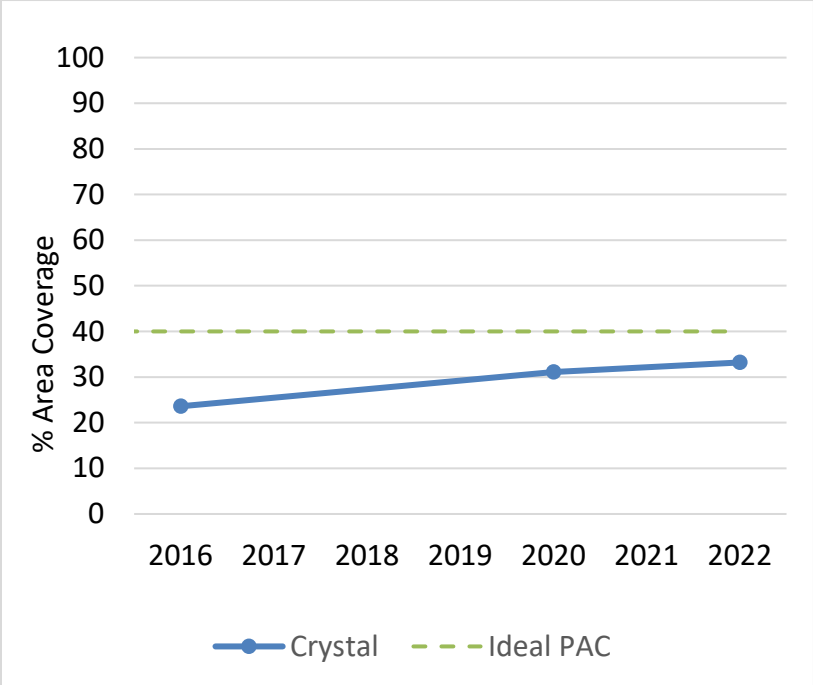
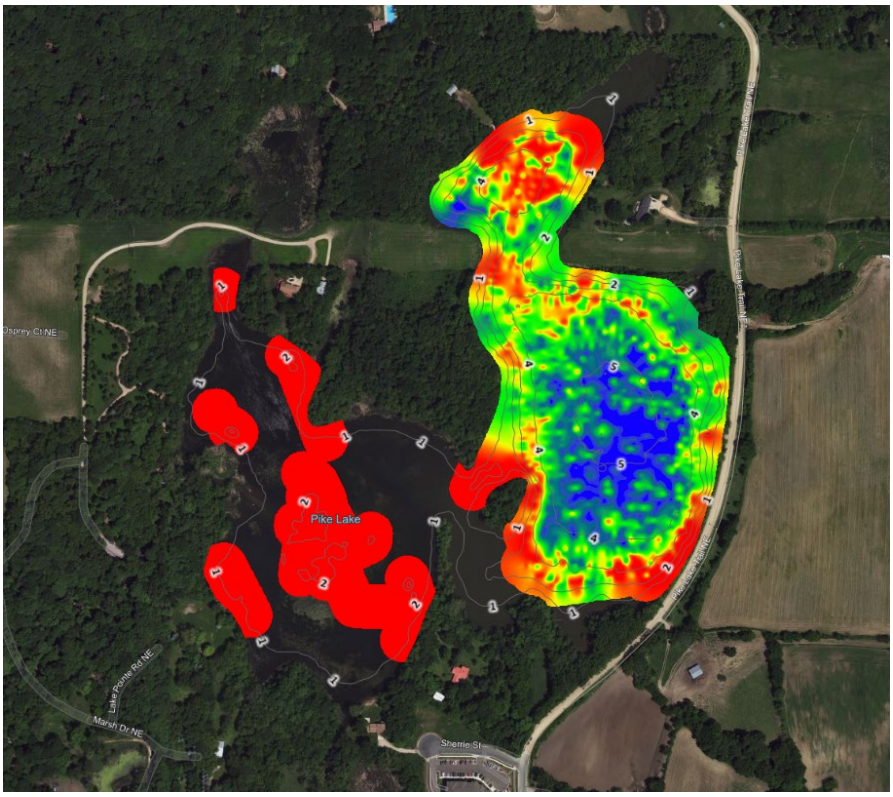


Figure 19. Crystal Lake Historic PAC

PIKE LAKE



PAC: 88.7%
Surface Area: 50 acres
Average Depth: 7 ft
Maximum Depth: 9 ft
Watershed Area: 21,770 acres
Impairment Status: impaired for nutrients

Figure 20. Pike Lake – Summer 2022

Very little BioBase data is available for Pike Lake at this time. Only three BioBase scans have been completed on Pike Lake. However, the western lobe of the lake is shallow and quickly fills with vegetation early in the year. Vegetation mappings from two of the three years is patchy due to using BioBase in highly vegetated, shallow water. Pike Lake has an average summer PAC of 64.4%.

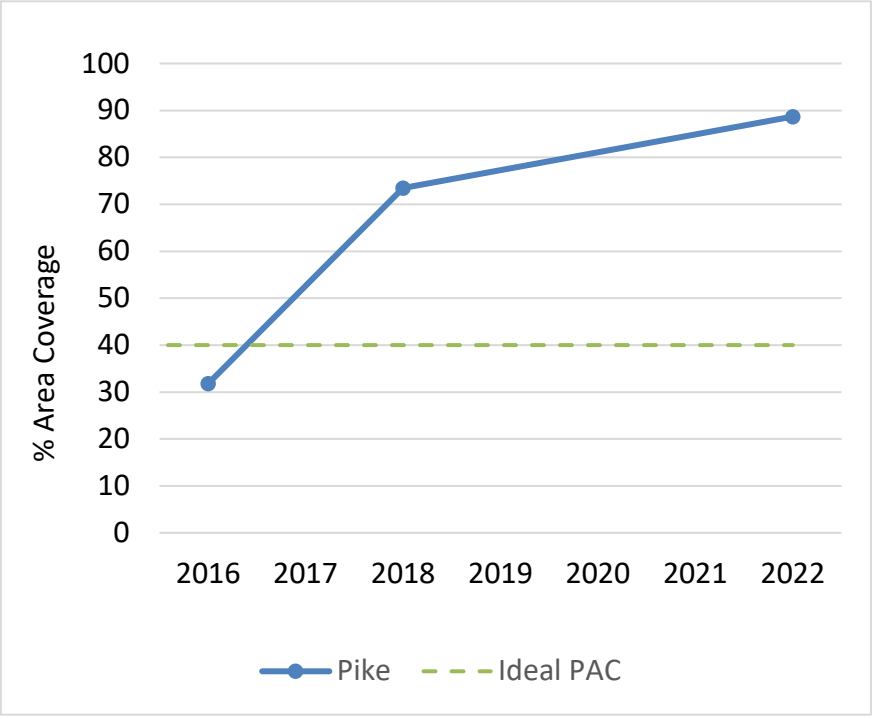


Figure 21. Pike Lake Historic PAC

DESILT POND

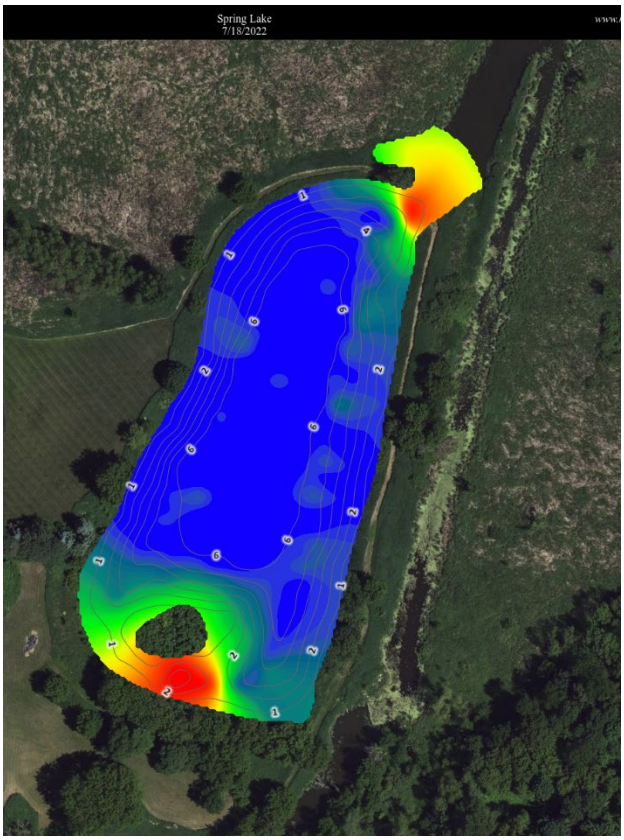


Figure 22. Desiltation Pond - Summer 2022

PAC: 29.5%

The Desilt Pond is connected to Spring Lake via County Ditch 13 and is part of the District's ferric chloride (FeCl) dosing system. This pond allows water to fix with FeCl where phosphorus bonds to the FeCl and precipitates to the bottom before flowing into Spring Lake. The District uses BioBase sonar on this pond primarily to monitor changes in depth over time. As sedimentation occurs, staff will know when to dredge the pond.

Case Studies

2018 – 2021 Upper Prior and Spring Lakes: Carp Grant & Alum Treatments

Before 2018, Spring Lake and Upper Prior Lake historically did not meet water quality standards for phosphorus or water clarity.

The common carp population in Spring Lake hovered around 240-260 kg/ha, and around 530 kg/ha in Upper Prior Lake, which is far above the preferred maintenance level for carp of 100 kg/ha. With frequent algae blooms and murky water, the average summer PAC in Spring Lake was at a bleak 10.8% and 14.9% in Upper Prior. Historically, Spring Lake vegetation did not grow in depths greater than approximately 8 feet. A typical lake with good water clarity could have plant growth as deep as 16 feet.

Between 2018 and 2021, the watershed district coordinated two alum treatments on Spring Lake (2018 and 2020) and one on Upper Prior (2020). The district also removed roughly 17,850 pounds of carp from Spring Lake and 83,825 pounds from Upper Prior. At the same time, water quality results from 2021 show that both lakes have seen an increase in water clarity and have begun meeting phosphorus standards. As a result, Spring Lake's summer PAC as of 2021 has increased dramatically to 26.8% and up to 23% on Upper Prior.

In these two lakes, alum treatments and carp management/removals work in tandem to helped restore water quality and water clarity, which have allowed plants to grow in deeper areas throughout both lakes. Comparing the summer season between 2016 and 2021, Figures 25 and 26, vegetation has started growing farther towards the center of the lake and showing up in places it was absent from before. The district hopes to restore the natural process of plants filtering out nutrients in the water for increased water clarity. This positive feedback loop is the key to long-term lake health.

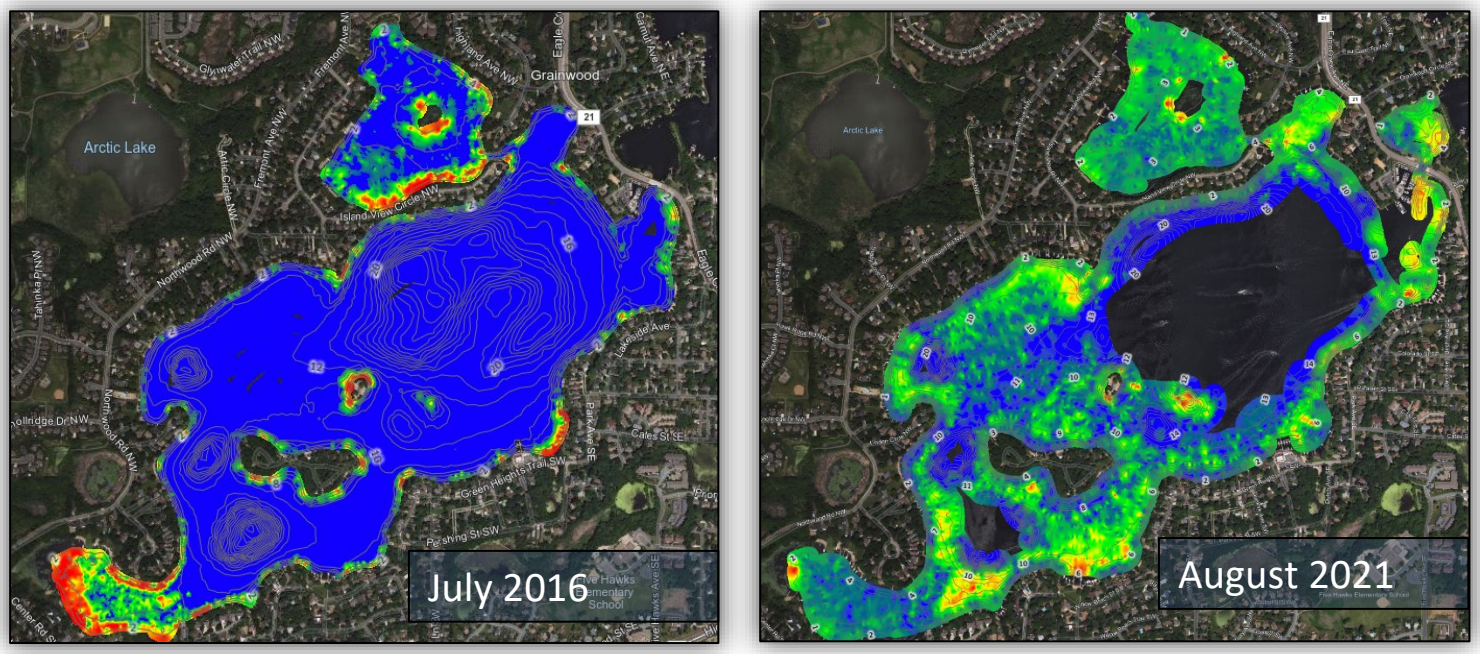
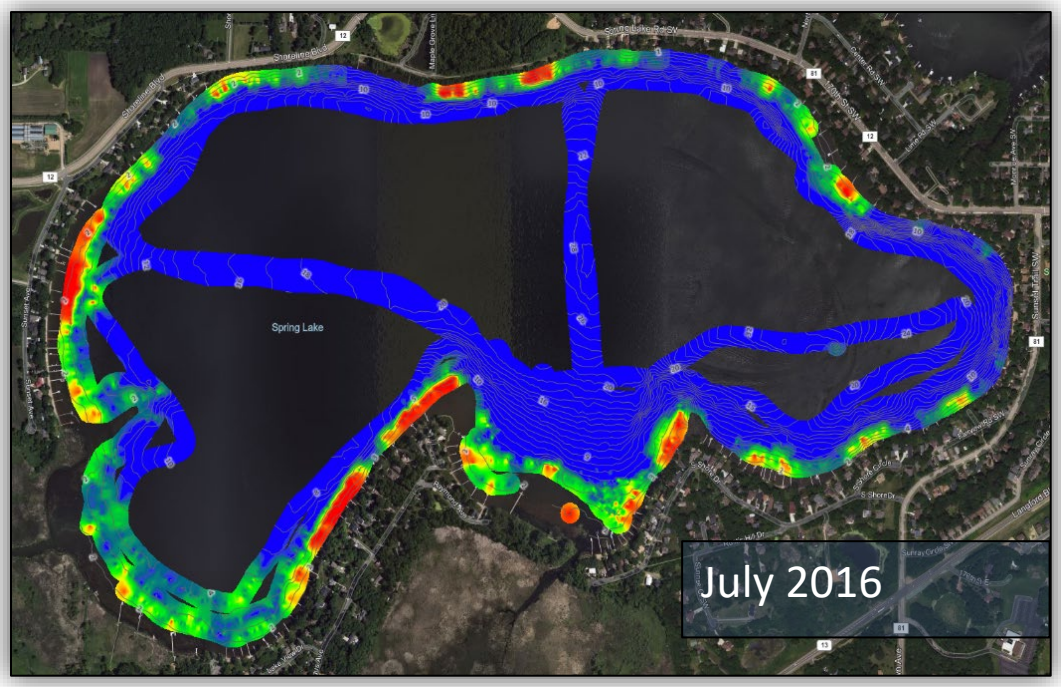


Figure 25. Upper Prior Lake Vegetation Maps 2016 & 2021



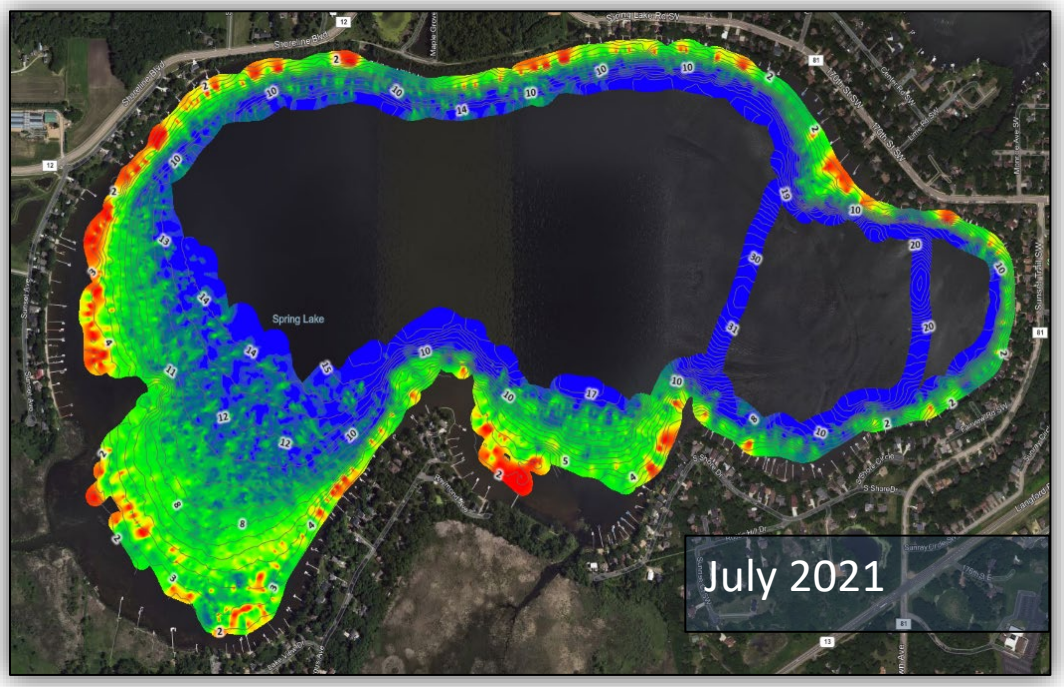


Figure 26. Spring Lake Vegetation Maps 2016 & 2021

Effectiveness of Curlyleaf Pondweed (CLP) Treatments

BioBase also provides insight to the effectiveness of CLP treatments. In the past, staff have used BioBase in combination with aquatic plant surveys to monitor locations of high-density CLP. Knowing these locations helps staff decide where to focus aquatic plant treatments. After a treatment is completed, staff can map the treated locations to see how effective it was, and where to continue future treatments.

Figure 27. CLP on a surveying rake

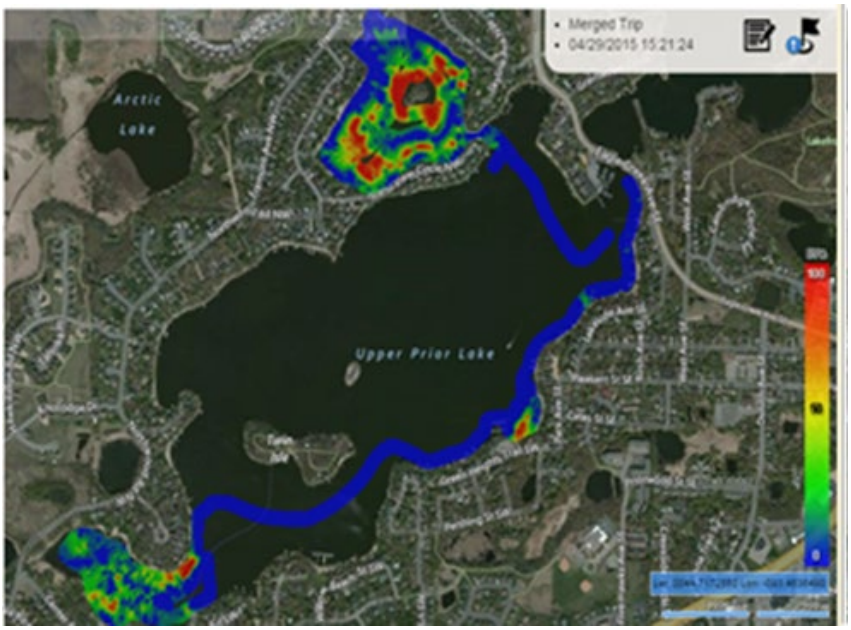


Figure 28. CLP presence before treatment (4/29/15)

For example, in 2015 staff scanned three spots on Upper Prior Lake that were identified to have a high density of plants (the northern-most bay, the southern-most bay, and the small eastern corner). A plant survey helped determine that these spots were dominated by CLP. CLP was then treated in all three areas.

Figure 29. CLP presence after treatment (5/21/15)

After reviewing before and after maps from the treatment, treatment success appeared to be variable. Treatment was very effective in decreasing CLP density in the northern bay, but the two locations on the south and eastern parts of the lake were less effective – in fact, CLP densities increased! Based off the evidence created by these BioBase maps, the PLSLWD was able to receive a credit from the contractor ($1,780) to CLP treatment in 2016.

Improvements

PLSLWD will continue to make efforts to improve the quality and quantity of data collected.

- New BioBase equipment was purchased for use in 2023 to meet both carp management side scanning and lake survey needs. The new equipment is a Lowrance HDS Live 12.
- Improved and formalized training of staff (interns, volunteer, etc).
    - Develop new and improved how-to guides for monitoring, data processing, data analysis, and sharing results.
- Increased education to public about BioBase results.
- Expand baseline data to new lakes and wetlands throughout District.
- Improved timeline for BioBase trips – for example, ensure the kayak and equipment are available early in the year so that lakes/ponds with heavy summer vegetation are scanned early on.
- Pair BioBase scans with aquatic plant surveys to better understand plant identity and density.

Conclusion

Upper Prior and Spring Lakes are a valuable example of how aquatic plant communities can change for the better over time. BioBase has shown that electronically surveying aquatic plants can be an indicator of success for water quality improvement projects. Establishing baseline data for lakes and ponds across the District has helped staff identify changes over time. The District will continue using Biobase to monitor trends and track results as we work to improve our water resources.

Works Cited

Canfield DE Jr. Hoyer MV. 1992. Aquatic macrophytes and their relation to the limnology of Florida Lakes. Bureau of Aquatic Plant Management, Florida Department of Natural Resources, Tallahassee, Florida, 32303.