Aquatic Vegetation Density Mapping – BioBase 2015 Report

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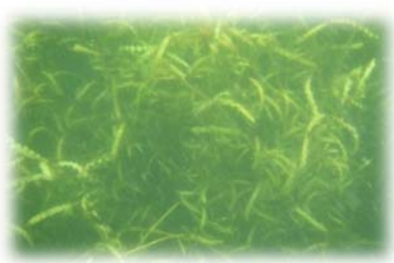
PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT



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Introduction

In 2013 Prior Lake – Spring Lake Watershed District began mapping aquatic vegetation density in local lakes using a software program by Contour Innovations, called BioBase. One of the goals of this program was to locate and determine the trends and quantity of vegetation growth. Some lakes have too little vegetation, some have too many invasive species, and some have very little vegetation data and need baseline data. By locating and monitoring the vegetation, a more holistic approach can be used to analyze a lakes overall health and ecosystem.

Figure 1 BioBase equipment being used by volunteers

BioBase uses sonar to detect and record aquatic vegetation density, lake bottom hardness, and bathymetry (contours of lake bottom). 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.

The relationship between water depth and aquatic plant life is called the Littoral Zone. As described by the DNR "the shallow transition zone between dry land and the open water area of the lake. In Minnesota waters, the littoral zone extends from the shore to a depth of about 15 feet, depending on water clarity. "The width of the littoral zone will vary . . . places where the slope of the lake bottom is steep, the littoral area may be narrow . . . if the lake is shallow and the bottom slopes gradually, the littoral area may extend hundreds of feet into the lake (Where Aquatic Plants Grow)." See Figure 2.

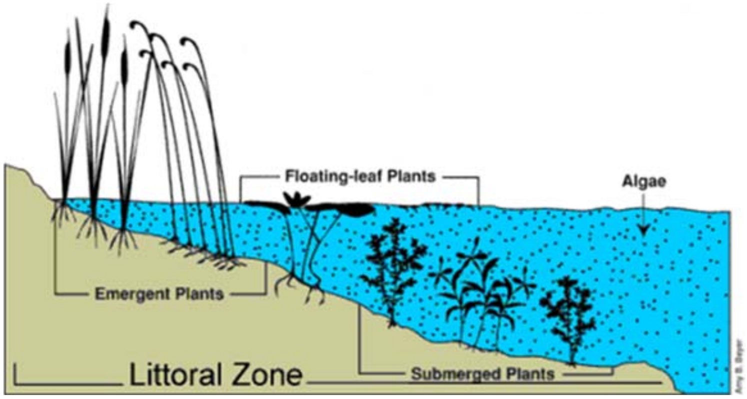


Figure 2 Shows the different areas and plants of the littoral zone.

Data is stored on a memory stick using a depth finder and sonar equipment. The data is then uploaded to the BioBase cloud storage and mapping software system. Contour Innovations, the creators of the BioBase software, processes the collected data/trips and maps are created to illustrate conditions.

The equipment used consists of a Lowrance depth finder, a transducer (sonar), and structure scan (structure scan is optional but used to aid in vegetation identification). When collecting data on the lakes, the staff member drives a boat less than 5mph in order for the sonar to record data. The sonar collects data from about 150ft out from either side of the boat, so driving near the ends of the docks is generally close enough to map the vegetation all the way up to the shoreline. Laps or "tracks" are then made moving farther and farther into deeper water.

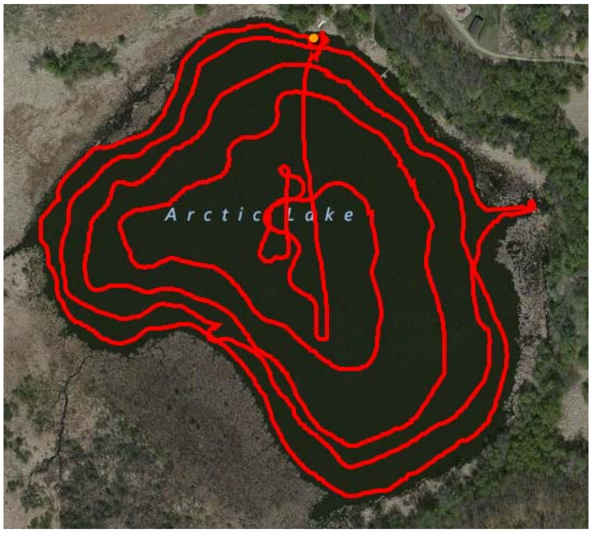


Figure 3 Tracks recorded by Biobase Software

Objectives

Collect Baseline Data

There are many uses for data like this depending on what information is needed and for what reason. To begin with, a baseline is needed to simply have data to compare to. In order to have truly valuable data, information over at least a couple years' time is needed. For example, if there is an unusual occurrence, like the 2014 flood, the vegetation may look different compared to other years when the lake level is at an average height.

Detect Changes

Flooding, drought, algae growth, rough fish abundance, or countless other circumstances may change when and where plants grow. It is important to have numerous years of data in order to determine normal, or baseline, conditions. Once a baseline is collected, one can more easily notice changes which may indicate something has changed. Comparing data from year to year could inform what trends exist or if there are sudden changes (whether due to natural or human interference). It may also help determine how well projects are working, or can be used to justify needs for grant funding. For example; if carp were to be managed and their population numbers decreased, there could be corresponding evidence that more vegetation may be found. Documenting a project as not successful can result in a review of alternatives.

Water quality can also be affected by the amount of vegetation. Spring Lake was treated with Aluminum Sulfate in October 2013, which increased the clarity of the lake. After a few more years of monitoring vegetation density, we should be able to determine if better clarity will lead to more plant growth. 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. It will be interesting to see how the Alum Treatment affects vegetation growth, if at all.

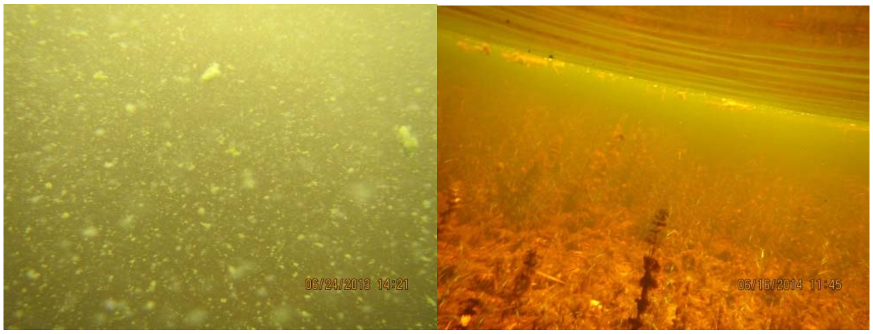


Figure 4 Spring Lake before the Alum treatment on the left (taken 6/24/13) and after the treatment (taken on 6/15/14) on the right

Aquatic Vegetation Management

Comparing vegetation density from each season may help determine what kinds of plants are growing in the lakes, since certain plants have different growing seasons. For instance, if a lake has Curlyleaf pondweed (CLP), it is typically the first aquatic plant to grow and dies off naturally after the 4th of July. By documenting high density in spring and then less density after July, it may be a sign that there is Curlyleaf pondweed present

Monitoring the invasive curly-leaf pondweed treatment effectiveness is another valuable objective. Knowing where it has shown up in the past, finding out where it is growing in the spring, and where it is densest helps in deciding where to focus treatment. Afterward, staff can map the treatment locations to see how effective the treatments were and where to best continue treating.

Figure 5 Blue Water Science recording plant surveys and checking curly-leaf treatments.

In the example in Figure 6, the areas showing presence of vegetation were dominated by CLP. This was confirmed by vegetation surveys conducted by Blue Water Science. CLP was treated in all three areas, however, treatment success varied, as is seen in the maps. The bay (Crystal Bay) in the top of the map was very effective while the two locations on the south central and southwest part of the lake were less effective and CLP flourished. Based upon the evidence created by these maps, the PLSLWD was able to receive a credit from the contractor for inadequate Curlyleaf pondweed treatment in 2015, which was used for 2016 treatments.

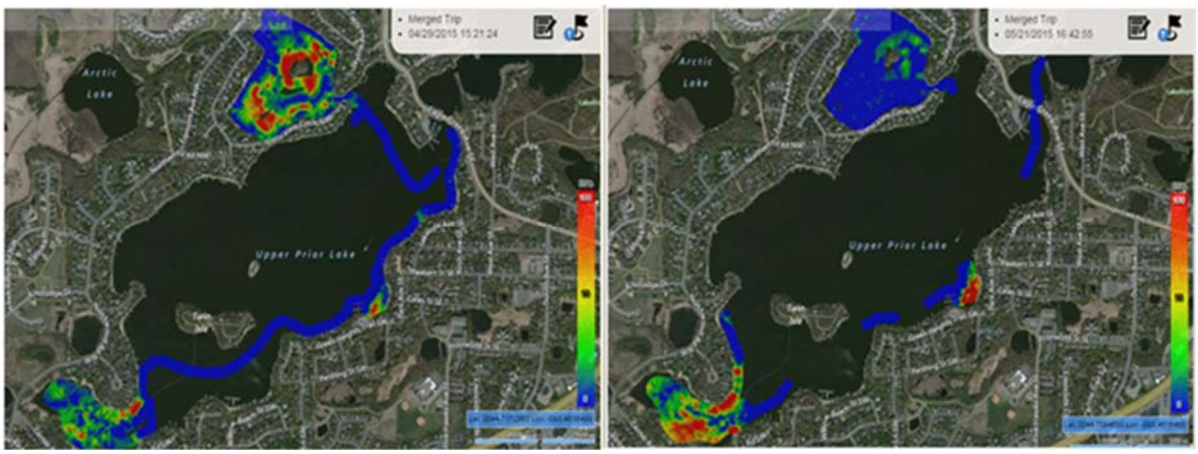


Figure 6 Curlyleaf presence before (4/29/15 - left) and after treatment (5/21/15 - right).

Map Bottom Hardness

Mapping bottom hardness or substrate composition of a lake is also potentially useful as it may help explain part of the water clarity issues in our local lakes. When looking at the bottom hardness of this close up view of a bay in Lower Prior Lake in Figure 7, it is noticeable that where the lake bottom is harder, there is less vegetation. All bottom hardness maps are located in Appendix C *Note: bottom hardness is measured light – dark corresponding as soft – hard, and vegetation is blue – red corresponds as 0 – 100% density.*

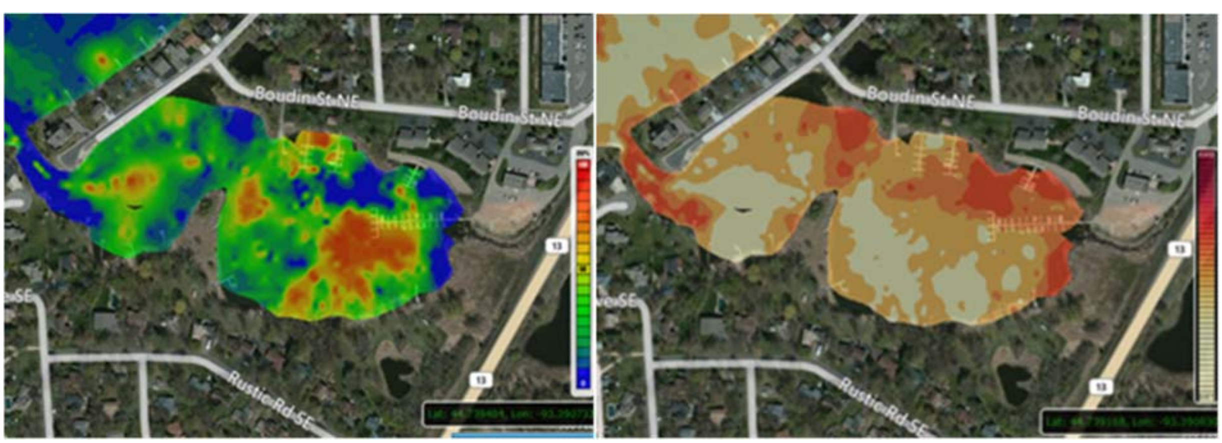


Figure 7 Where there is a lack of vegetation (blue) the bottom of the lake is harder (dark orange/red).

According to Ray Valley's article *Composition Algorithm Improved*, bottom hardness is determined as the sonar send signals out that bounce back to the sonar. The density is dependent on how fast the signal comes back (Valley). Data values range from 0.0 (soft) to 0.5 (very hard). The table below is an example from Valley's article of the soil composition compared to the values recorded by the sonar.

Table 1
Agreement between visually estimated substrate hardness while collecting Lowrance/BioBase composition data.

Back Bay Site ID	Composition (visual)	Estimated Hardness	BioBase Hardness
BC1	muck	Soft	Soft
DW1	sand	Hard	Hard
DC1	sand	Hard	Hard
EW1	sand	Hard	Hard
EC1	silt	Soft	Med
FC1	silt	Soft	Soft
GEW1	sandy silt	Med	Hard
GWE1	muck/sand	Med	Med
GWW1	clay	Med	Med
	Percent Agreement	**0.78**	

Plants have a difficult time growing in lakes with hard bottoms (sandy or rocky). An example of this is found in Mr. Valley's article *Composition Algorithm Improved*, in Figure 8. The bottom hardness is a 0.4 in the data recorded, but an underwater photo was taken at that point during the monitoring to see what the bottom looks like at that point. As can be seen, there is some vegetation there but it is sparse and small due to the lack of soft substrate to grow in.

Figure 8
The lake bottom in the photo has a high hardness value (0.4) and little vegetation.

Create Bathymetric Maps

Another feature of BioBase is the ability to create extremely accurate bathymetric maps. Bathymetric maps show the elevation contours (depth) of the lake bottom. This gives a complete map of the depths in the lake available in 1, 3 and 5 foot contours. On page XIX in Appendix D there are bathymetric maps of each lake. This can be useful for detecting sediment deposition over time.

Plant Area Coverage Calculations

According to Canfield, a lake needs 40% plant area cover (PAC) for optimal water clarity. If a lake has healthy vegetation to filter the water and compete with algae, the clarity will increase along with more plant life, since sunlight will be able to penetrate farther into deeper water levels. However, if there are little favorable conditions for vegetation, this may be difficult to achieve. Lower Prior has achieved the optimal PAC at approximately 44%, Spring Lake is approximately 12.0% and Upper Prior is approximately 10% (these percentages are highly influenced by time of year, but these numbers are averages for summer). More details of PAC in the Analysis section below.

Structure Scan

In addition to the sonar transducer, 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. See Figure 9.

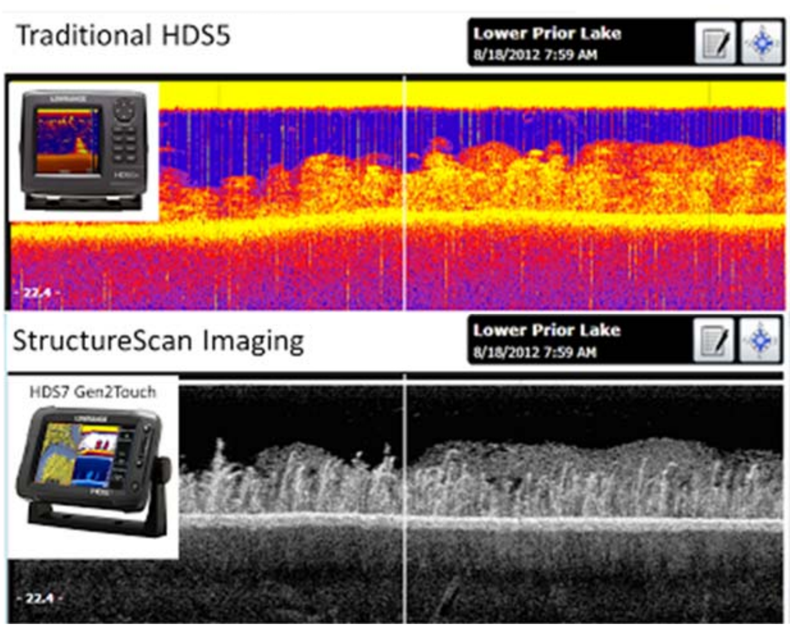


Figure 9 Eurasian Water Milfoil and a school of fish using the regular transducer image (above) and the structure scan image (below). Images courtesy of Ray Valley.

Analysis

PLSLWD staff and volunteers have been mapping Spring Lake, Upper Prior and Lower Prior Lakes since 2013. In 2015, Fish, Buck, and Arctic Lake were added. Maps of all the mapped lakes can be found in Appendix A.

Table 2
Comparison of Plant Area Coverage (PAC) to lake size.

Lake	Year-Month	Lake Size (ac)	Littoral Zone (ac)	Littoral Zone (% of Lake Size)	Plant Area Coverage (Ac)	Plant Area Coverage (% of lake size)
Spring	2013-06	587	283	48	72	12
Spring*	2014-05	587	283	48	65	11
Spring*	2015-06	587	283	48	86	15
Upper Prior	2013-05-08	416	352	85	N/A	N/A
Upper Prior	2014-07	416	352	85	3	1
Upper Prior	2015-09	416	352	85	50	12
Lower Prior	2013-07/22-8/26	940	590	63	409	44
Lower Prior	2014-07/8-8/25	940	590	63	389	41
Lower Prior	2015-09	940	590	63	385	41
Fish	2015-06	171	72	42	54	31
Arctic	2015-08	33	23	70	14	42
Buck	2015-10/20	23	23	100	N/A	N/A

*Asterisk or "N/A" indicates that not enough data was collected to give an accurate analysis.

Lower Prior

Surface Area: 940 acres
Average Depth: 13 feet
Maximum Depth: 56 feet
Ordinary High Water Level: 904.0 feet above sea level
Watershed Area: 18,904 acres

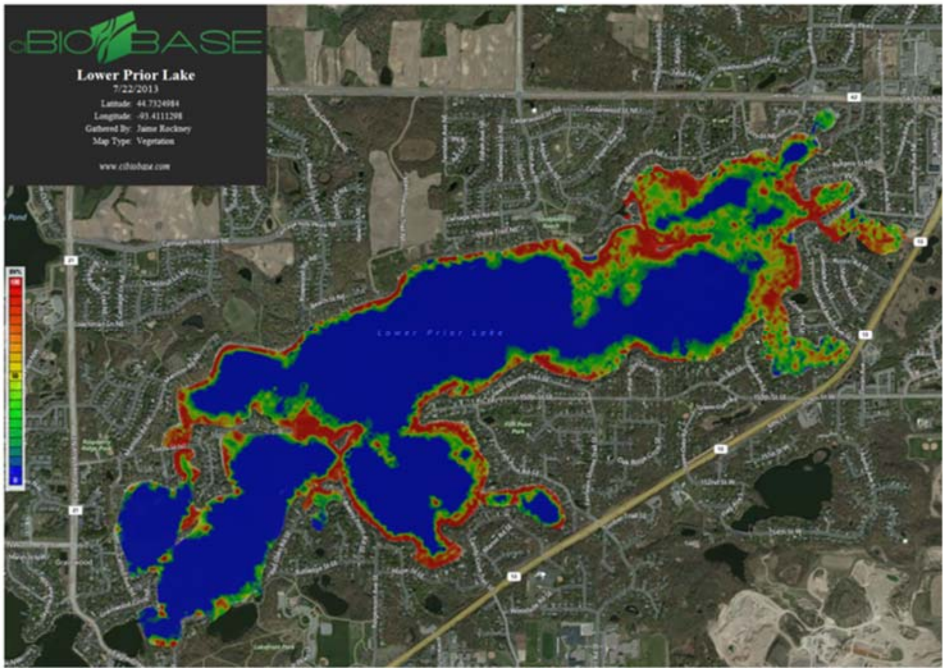


Figure 10 Lower Prior Lake – Summer 2013

Lower Prior is a good example of having a consistent baseline. Looking at the year-to-year data, there is roughly the same amount of vegetation during each season each year (keeping in mind that nature draws outside of the lines and is never precisely the same each year). This consistency will make it easier to catch any significant changes in the future. In any given year, the trend is that the density and location of vegetation is less developed in early spring and grows and spreads as the year goes on, remaining well established through late September. It is still possible the species of plants are changing at this time, but the presence of vegetation is long-standing. One of the likely reasons Lower Prior is healthier may be due to the fact that water runs through Spring Lake and Upper Prior Lakes first, becoming cleaner and nutrients are filtered out along the way. However, retaining a PAC of 43% may have a big effect on water quality and clarity as well.

Upper Prior

Surface Area: 416 acres
Average Depth: 10 feet
Maximum Depth: 43 feet
Ordinary High Water Level: 904.0 feet above sea level
Watershed Area: 16,038 acres

Figure 11 Upper Prior Lake – Summer 2015

By comparison to Lower Prior, Upper Prior's vegetation is not nearly as abundant. Out of Upper Prior's 416 acres, 352 acres (85%) are within the littoral zone. Looking at maps from 2015, only 12-19% PAC was observed in the entire lake, when the whole lake was mapped (summer map did miss the island shoreline). Based upon Blue Water Science vegetation surveys (McComas Upper & Lower Prior Lake, located in Appendix B), Upper Prior lake is dominated by Curlyleaf Pondweed in the Spring. After Curlyleaf pondweed dies-off midsummer, coontail and milfoil were the dominant species in August, however in relatively low abundance.

The most dramatic mapping for Upper Prior was summer of 2014 when nearly the whole lake was devoid of vegetation (see Figure 30). Vegetation was only observed in Crystal Bay after that and almost nothing in Upper Prior itself. 2014 was a flood year, so that could have a lot to do with it. More mapping will determine if this was an anomaly, or common for this lake.

Spring Lake

Surface Area: 587 acres
Average Depth: 18 feet
Maximum Depth: 34 feet
Ordinary High Water Level: 912.8 feet above sea level
Watershed Area: 12,430 acres

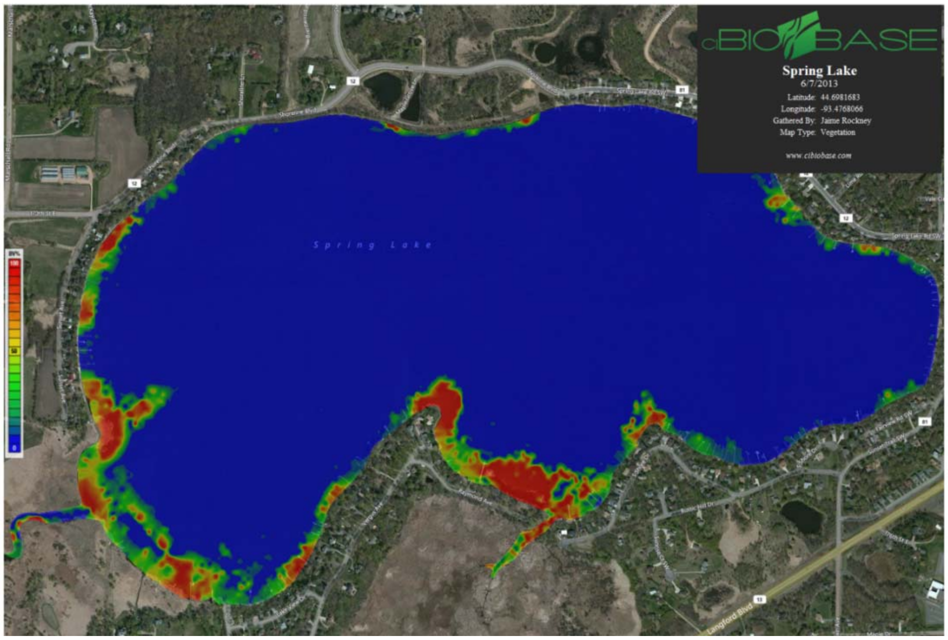


Figure 12 Spring Lake – Summer 2013

Spring Lake appears to have a much more consistent presence of vegetation throughout the monitoring season and each year the areas are mostly the same (See Appendix A). The interesting thing about Spring Lake is that it does not have a lot of vegetation as compared to how much littoral zone or shallow area it possesses. Looking at the bathymetric map of Spring Lake (Figure 13, contours in 5ft.), it would appear there is potential for plants to inhabit more shallow areas. The bottom hardness in Figure 14 shows that the littoral zone consists of a hard lake bottom. Combined with poor water clarity, this most likely contributes to the lack of vegetation in the lake.

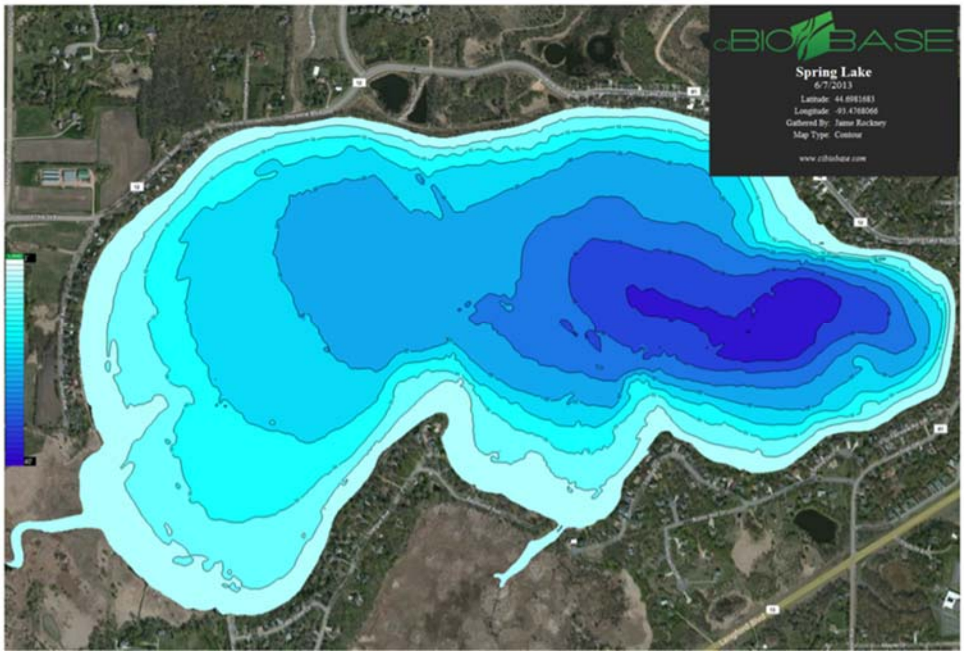


Figure 13 - Bathymetric Map

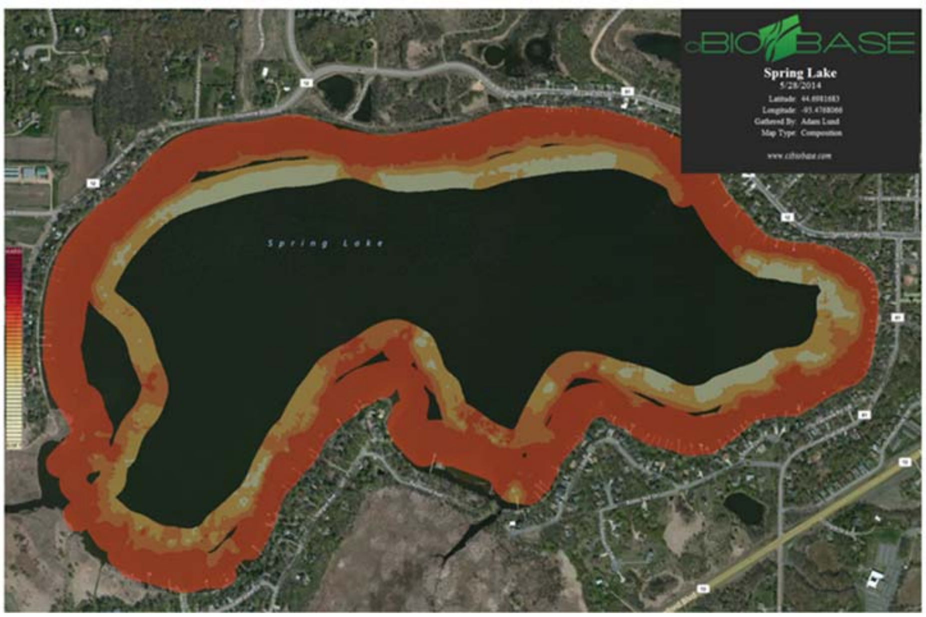


Figure 14 – Bottom Hardness

Projects like the Alum treatment conducted in October 2013 could possibly give plants a chance to grow in deeper areas if sunlight can now penetrate farther into the water. By comparing the summer season between 2013 and 2015, Figure 15, it is easy to see that the vegetation has started growing in deeper water and showing up in places it was absent before. PLSLWD will continue to observe how deep the vegetation grows, with hopes that it will continue to grow deeper. The Alum treatment may help kick-start the process of vegetation growing in enough density to restore the natural process of plants filtering out nutrients in the water for better clarity.

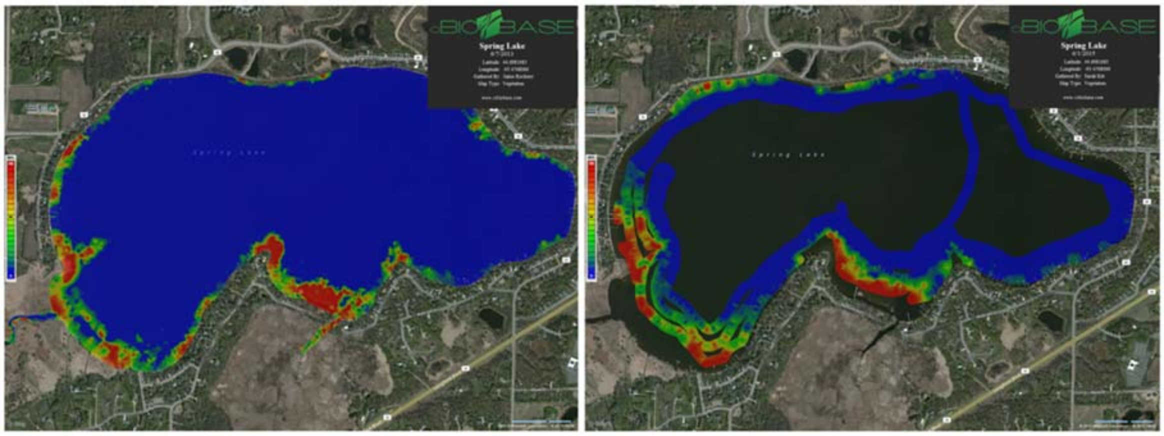
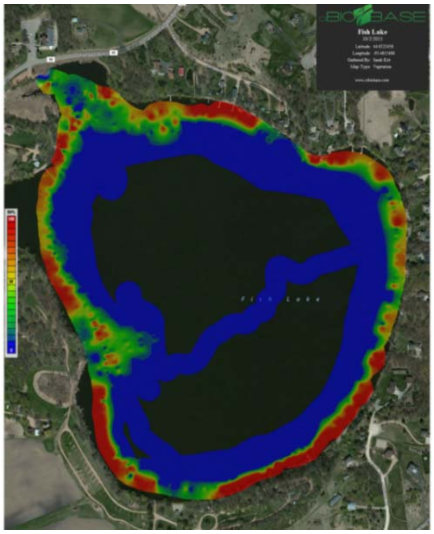


Figure 15 Summer 2013 on the left and summer 2015 on the right.

Fish Lake

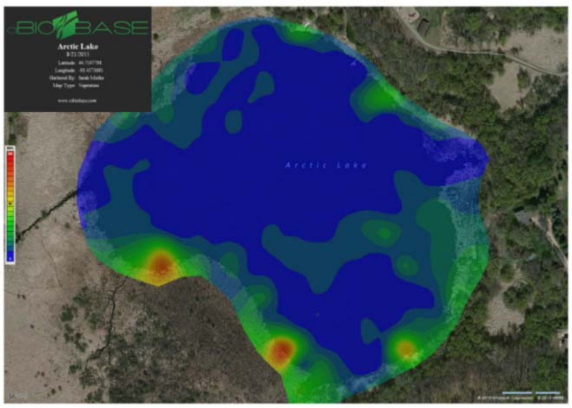


Surface Area: 171 acres
Average Depth: 14 feet
Maximum Depth: 28 feet
Ordinary High Water Level:
946.9 feet above sea level
Watershed Area: 699 acres

Figure 16 Fish Lake Fall 2015

PLSLWD completed summer and fall maps of Fish Lake with help from a volunteer.

Arctic Lake



Surface Area: 33 acres
Average Depth: 9.5 feet
Maximum Depth: 30 feet
Watershed Area: 507 acres

Figure 17 Artic Lake – Summer 2015

Artic lake was accomplished with the help of Shakopee Mdewakanton Sioux Community to create summer and fall maps.

Buck Lake

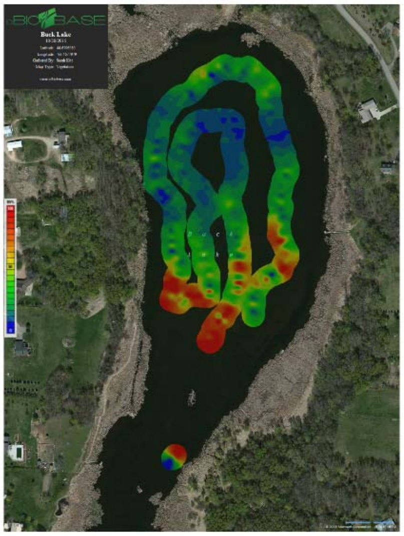


Figure 18 Buck Lake - Fall 2015

Surface Area: 23 acres
Average Depth: shallow
Maximum Depth: 9 feet
Watershed Area: 3350 acres

Buck Lake was challenging to map as there was no public access or motorized boats allowed on the lake. Lakeshore owners supplied a canoe and the sonar equipment was attached to the canoe in order to complete this task, making the first attempt at mapping by canoe in 2015. The strategy proved fairly successful and will be used again in the future (see Figure 19). As more data is collected, PLSLWD will be able to better interpret the health of Buck Lake.

Figure 19 Canoe set up

Developments

Now that a couple years of data have been collected, PLSLWD staff has recognized ways to improve the quality and quantity of data collected for the District's lakes. In order to have very accurate comparisons for each season, a time frame has been established for preferred mapping dates during each season. This will create better quality control.

Spring – First day possible (depending on ice-out) until May 31st. (this timeframe helps in identifying Curlyleaf pondweed locations)

Summer – July 15th to August 15th (peak of native growing season).

Fall – September 1st to October 1st.

To take a closer look at the lake vegetation demographics, PLSLWD will add more plant surveys to help analyze theories on what is happening below the surface of the lakes. One of the questions that staff hopes to examine is whether or not the reason Upper Prior experiences such a lack in vegetation is due to the type of plants growing there poor water clarity, or other variables.

Conclusion

Overall, this project has already given the PLSLWD some insight as to what is happening in the lakes as well as how to improve procedure to be more effective and accurate. Given the data from Upper Prior and Spring Lake, it can be significantly supported that there is valuable information to be gathered that may assist with addressing concerns in the lakes. BioBase also gives the ability to monitor the progress of other projects which would help evaluate their effectiveness. With steady baselines created, it could be possible to catch minor problems before they become larger ones in the future. In conclusion, this is a worthwhile program to continue to be supported by the Watershed District and local community.

Sponsors and Volunteers

PLSLWD is very grateful for all the help and support it has received from the local area. Its sponsors include:

- Your Boat Club: providing boats for staff to map on Upper and Lower Prior
- City of Prior Lake: providing their boat for staff to use on Spring Lake
- Shakopee Mdewakanton Sioux Community: providing a boat and staff to help map Arctic Lake
- Our many volunteers: those who have shown enough care and concern to take it upon themselves to donate their time and boats for mapping Spring, Fish and Buck Lake

Appendix A – Vegetation Maps

Lower Prior Lake Vegetation Maps

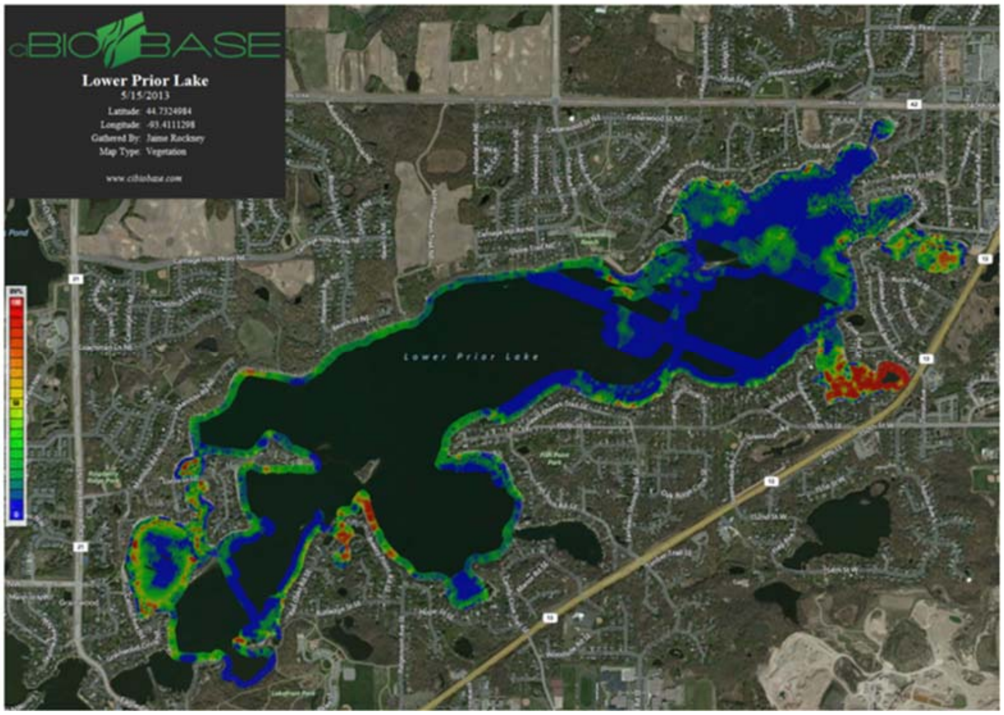


Figure 20 Lower Prior Lake - Spring 2013

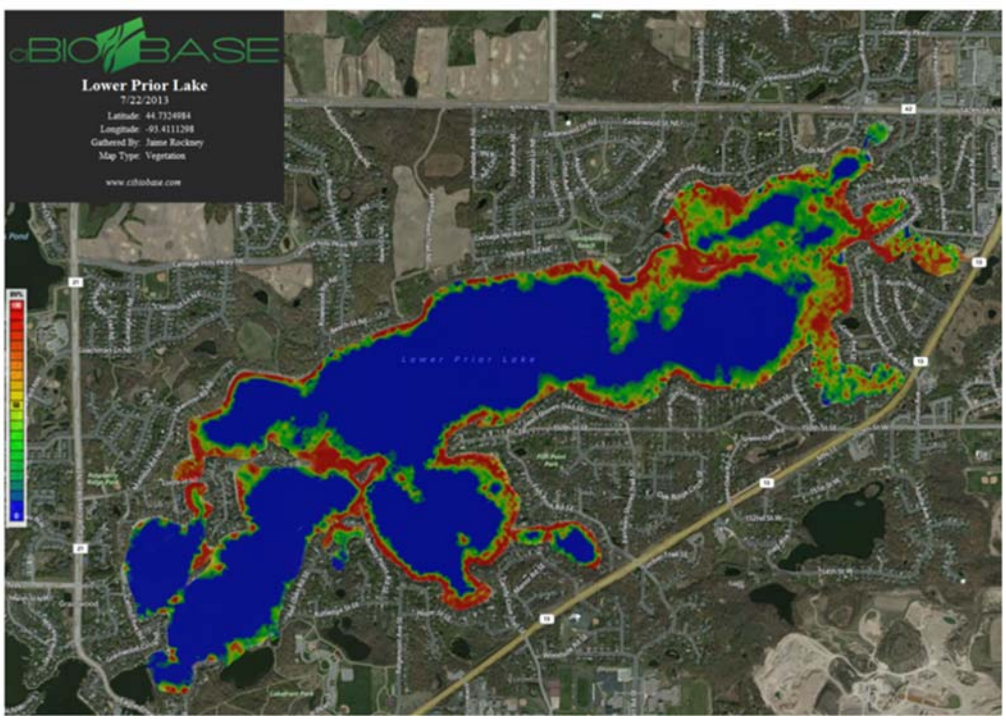


Figure 21 Lower Prior Lak e – Summer 2013

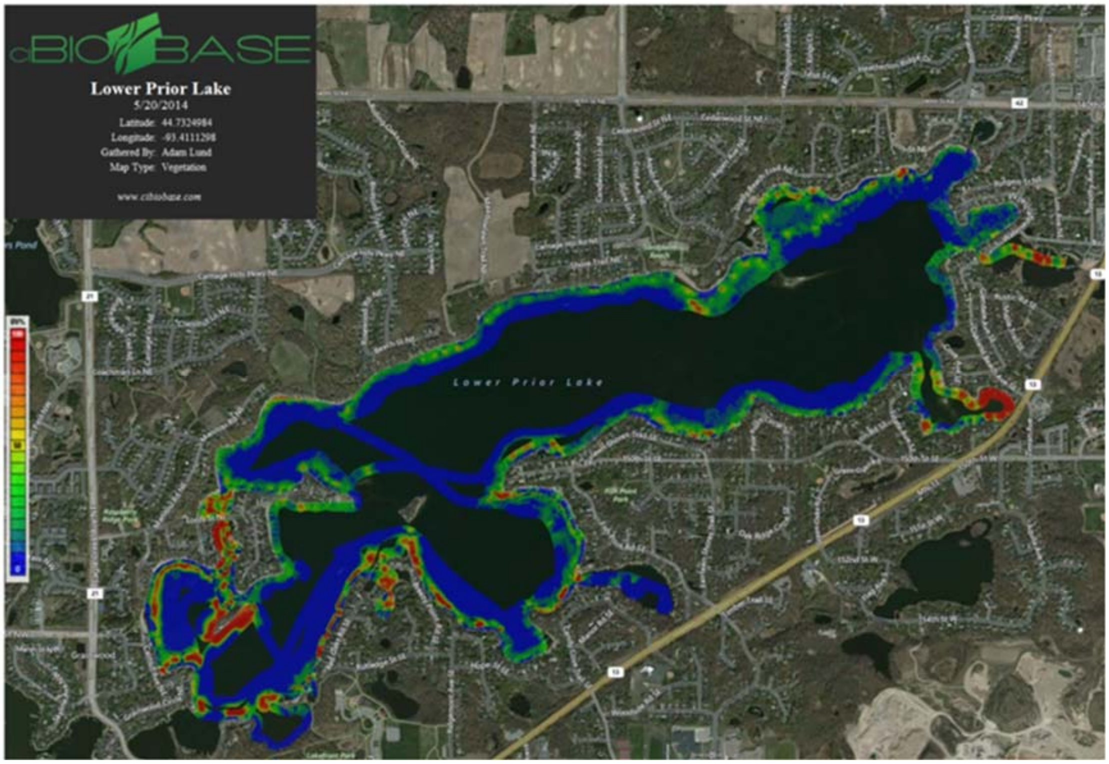


Figure 22 Lower Prior Lake - Spring 2014

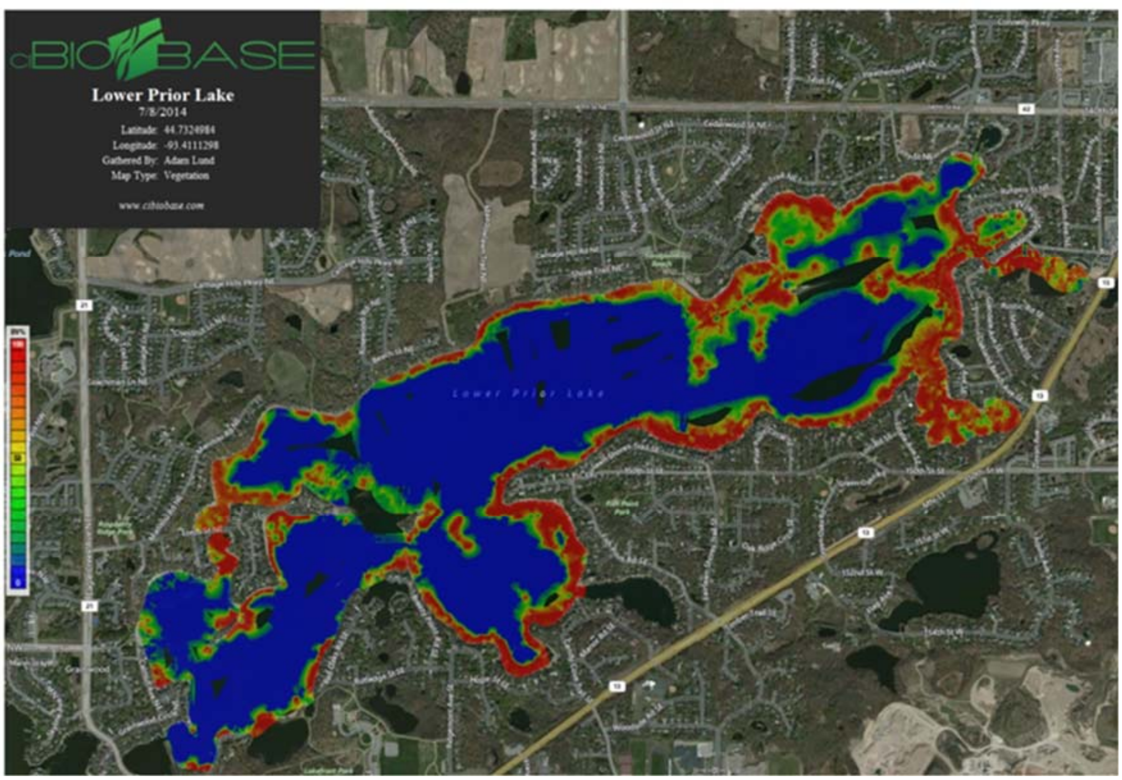


Figure 23 Lower Prior Lake - Summer 2014

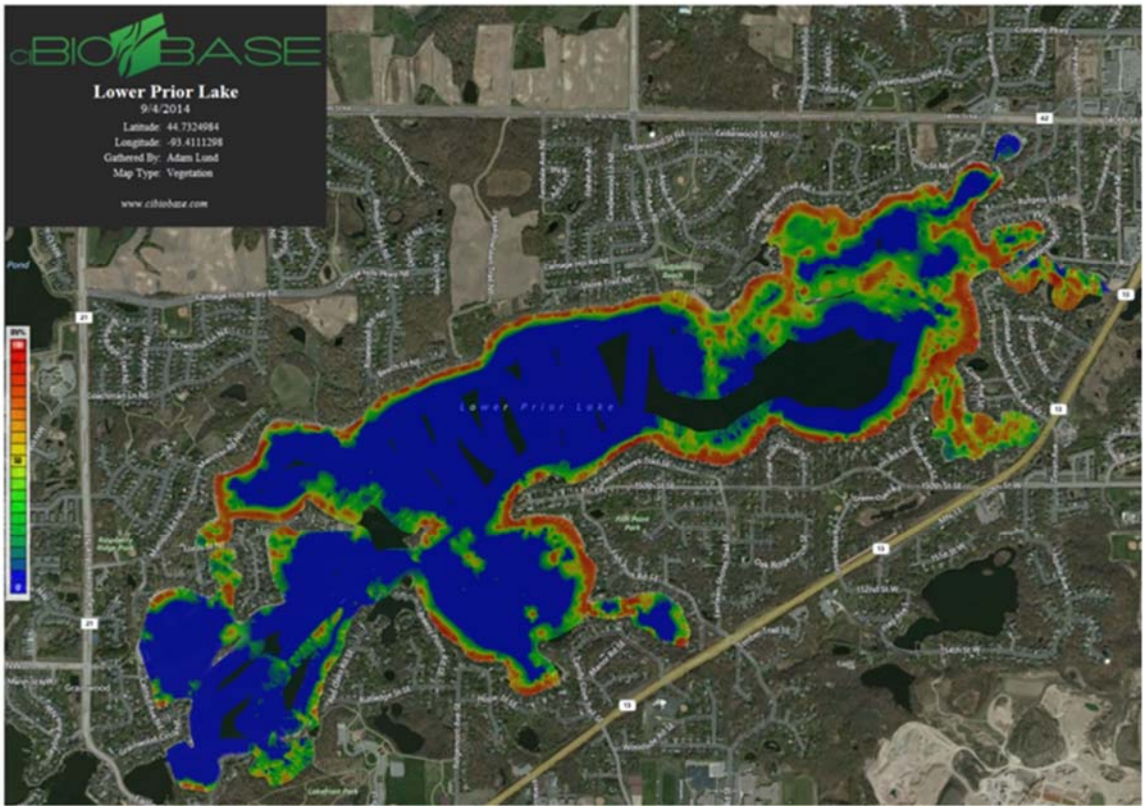


Figure 24 Lower Prior Lake - Fall 2014

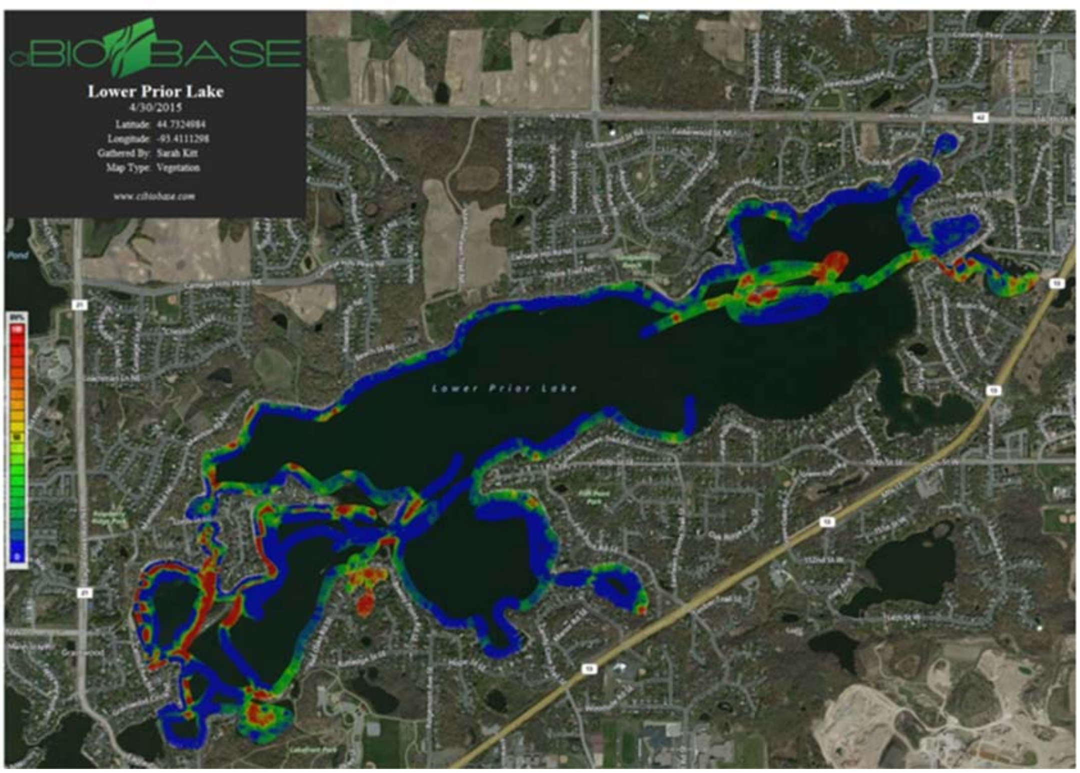


Figure 25 Lower Prior Lake - Spring 2015

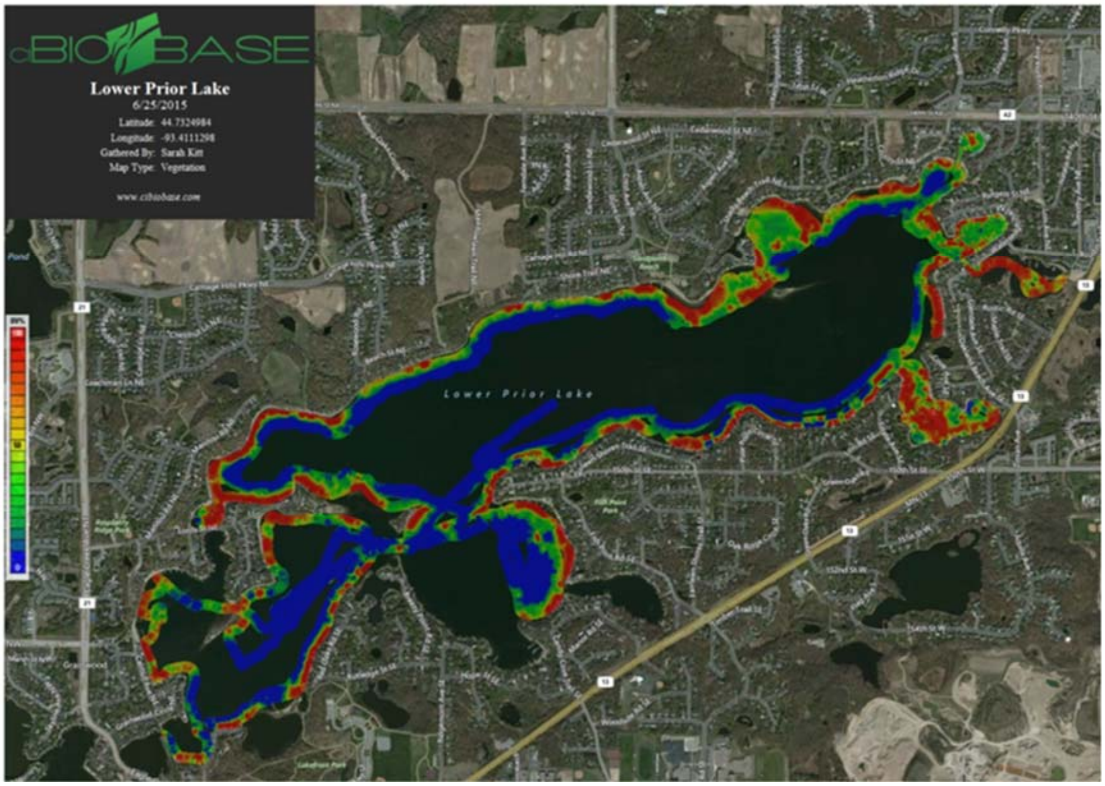


Figure 26 Lower Prior Lake - Summer 2015

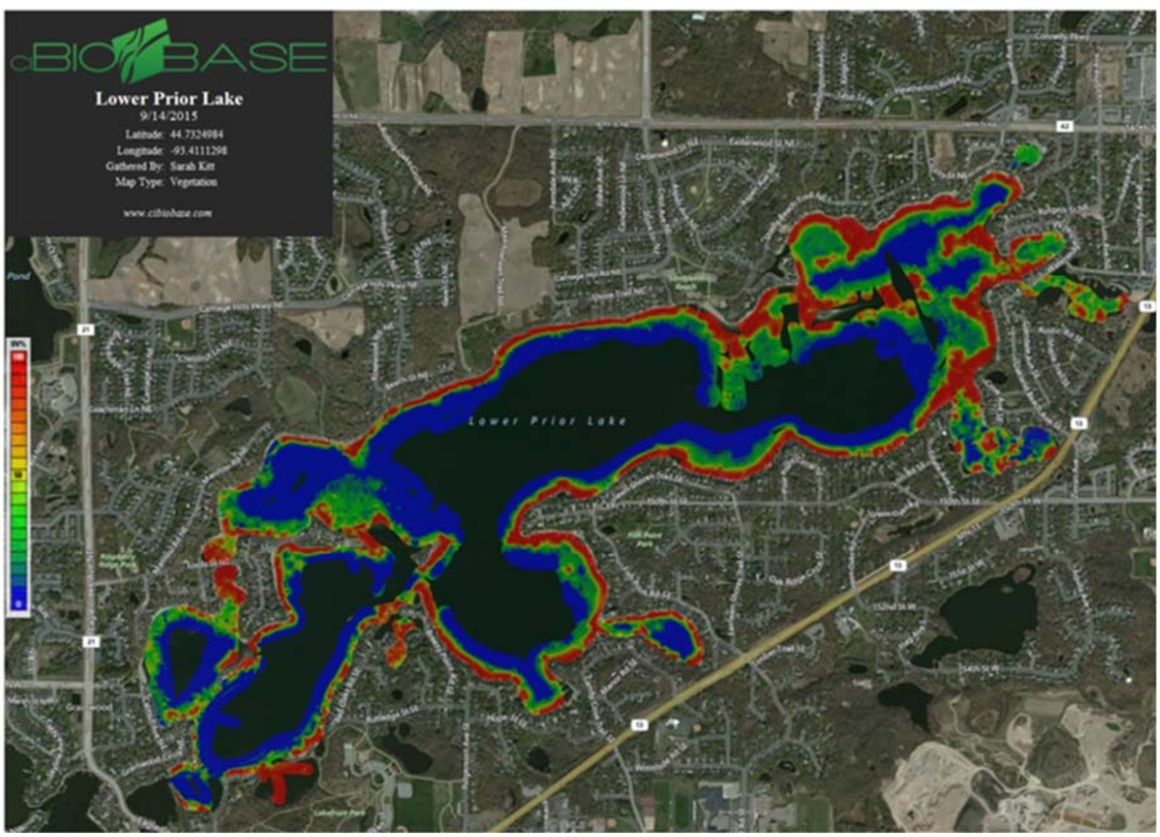


Figure 27 Lower Prior Lake – Summer/Fall 2015

Upper Prior Lake Vegetation Maps

Figure 28 Upper Prior Lake - 2013

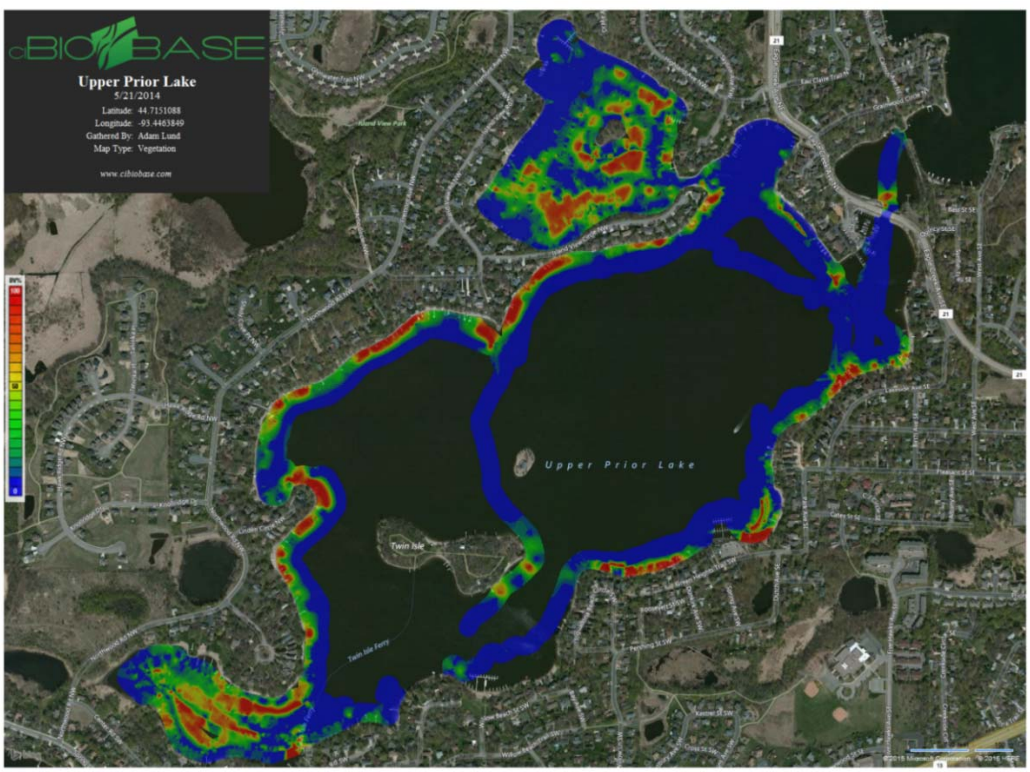


Figure 29 Upper Prior Lake - Spring 2014

Figure 30 Upper Prior Lake – Summer 2014

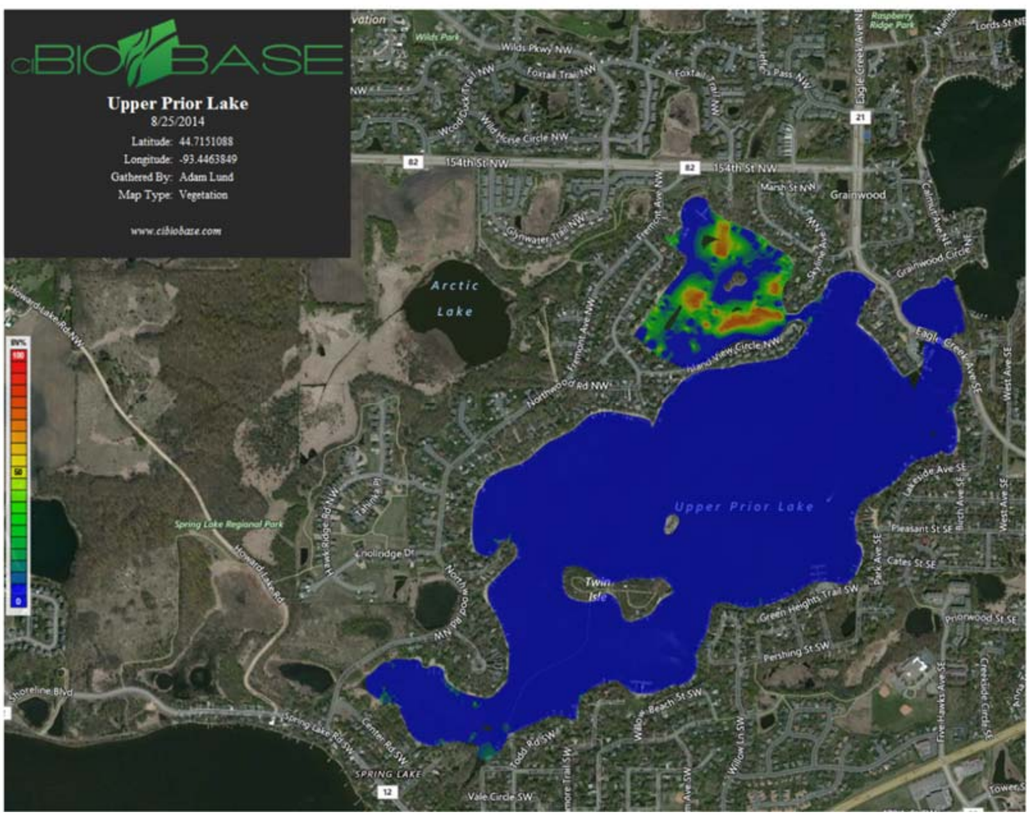


Figure 31 Upper Prior Lake – Fall 2014

Figure 32 Upper Prior Lake – Spring 2015

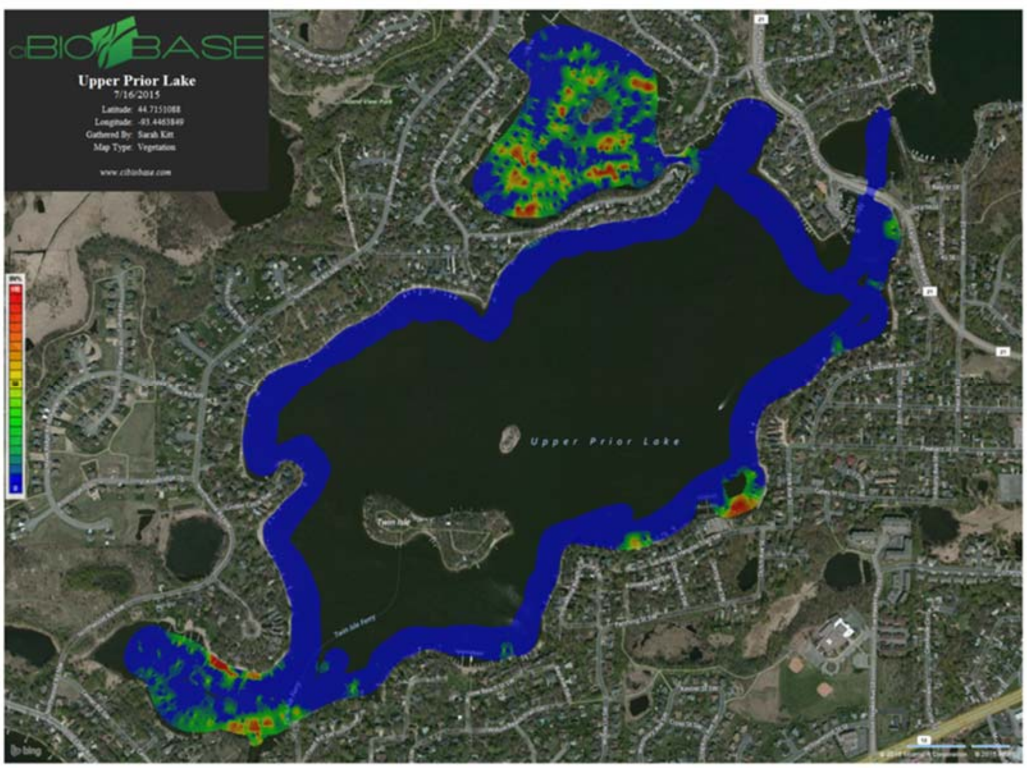


Figure 33 Upper Prior Lake – Summer 2015

Figure 34 Upper Prior Lake – Fall 2015

Spring Lake Vegetation Maps

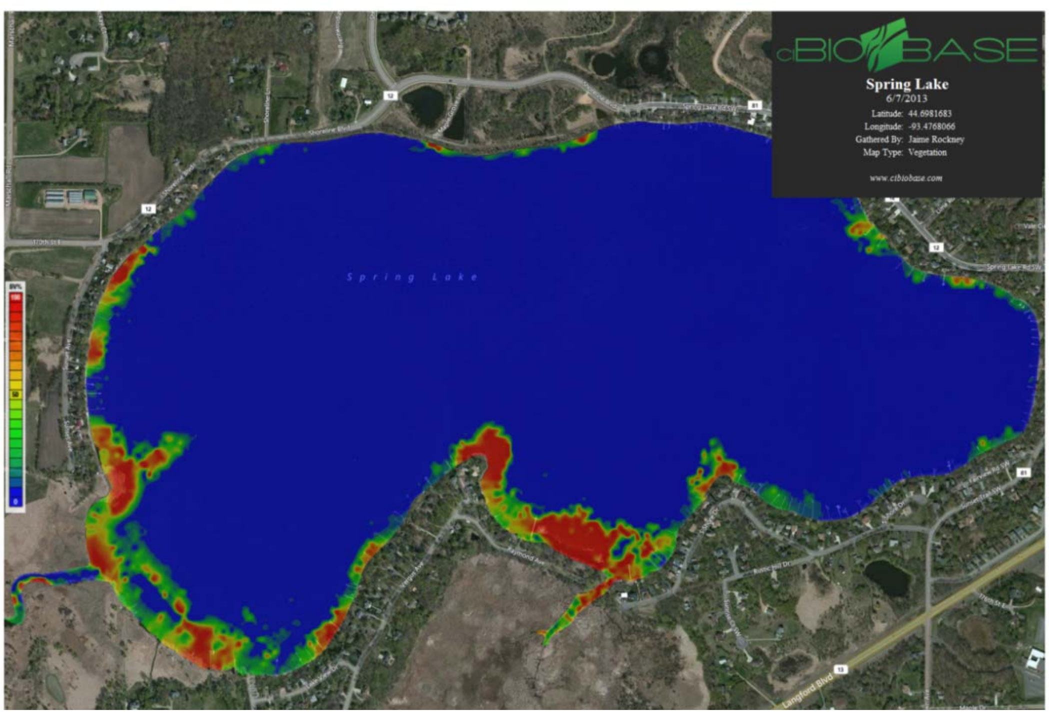


Figure 35 Spring Lake – Summer 2013

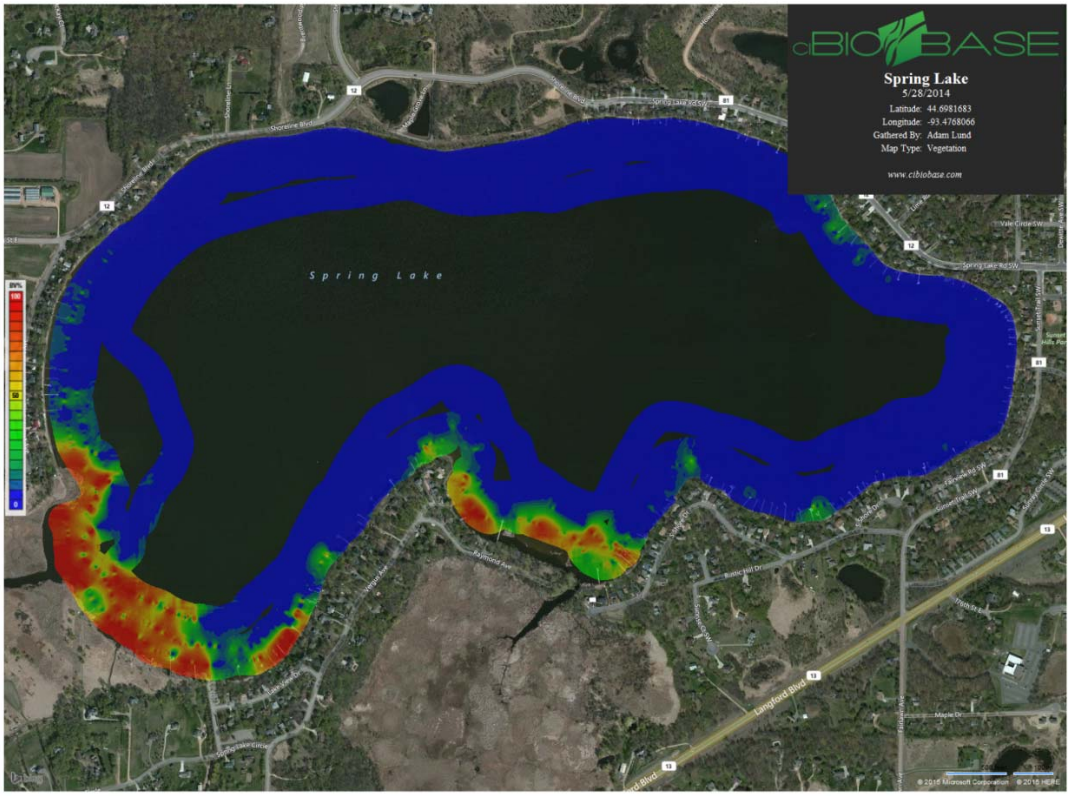


Figure 36 Spring Lake – Spring 2014

Figure 37 Spring Lake – Summer 2014

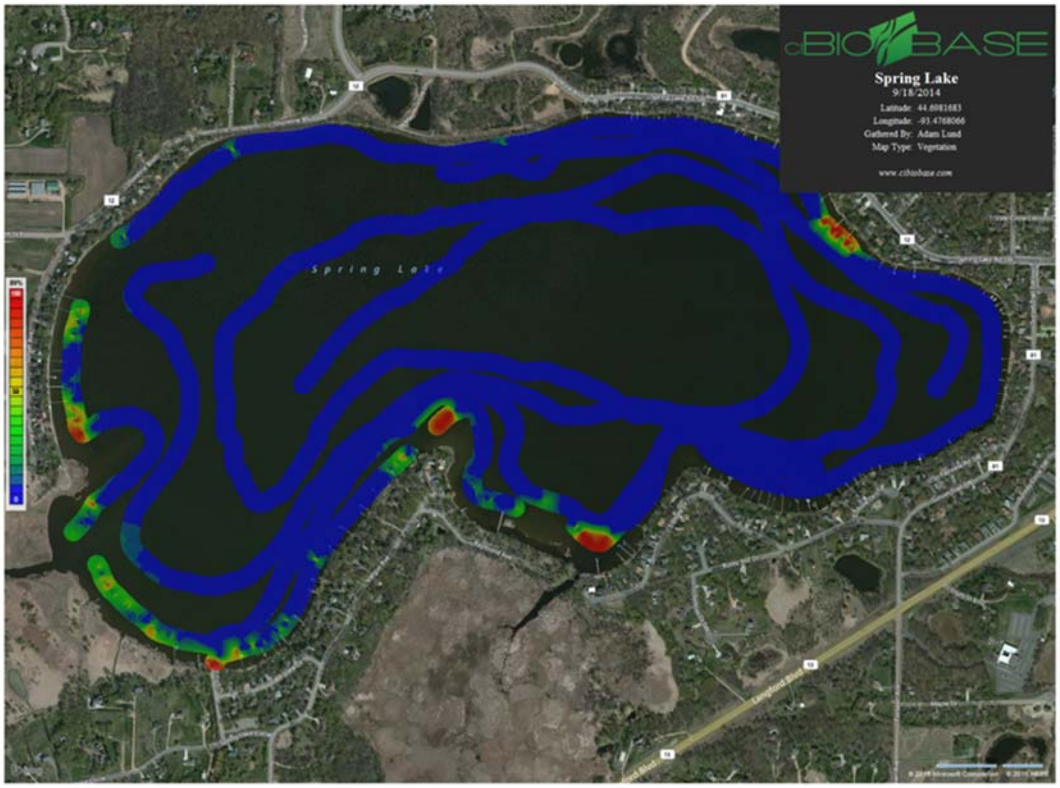


Figure 38 Spring Lake – Fall 2014

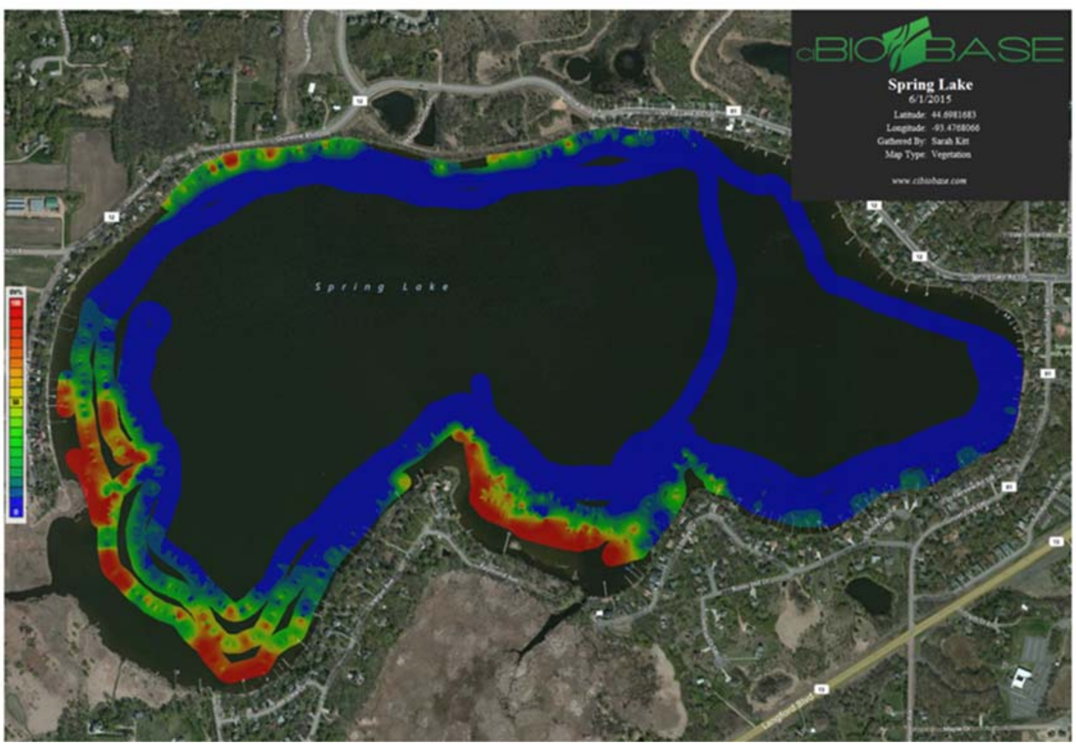


Figure 39 Spring Lake – Summer 2015

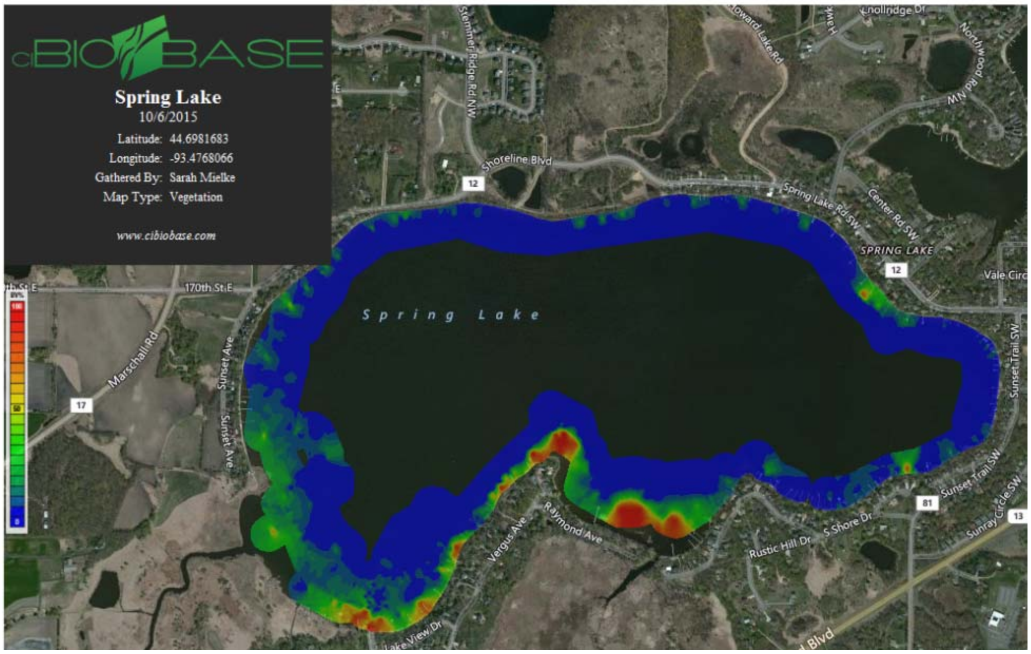


Figure 40 Spring Lake – Fall 2015

Fish Lake Vegetation Maps

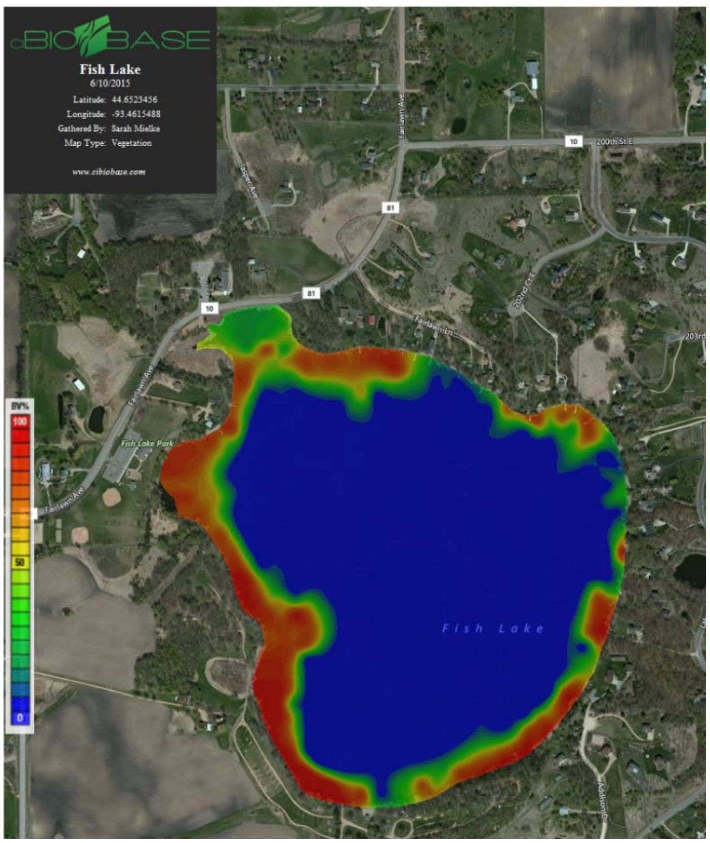


Figure 41 Fish Lake – Summer 2015

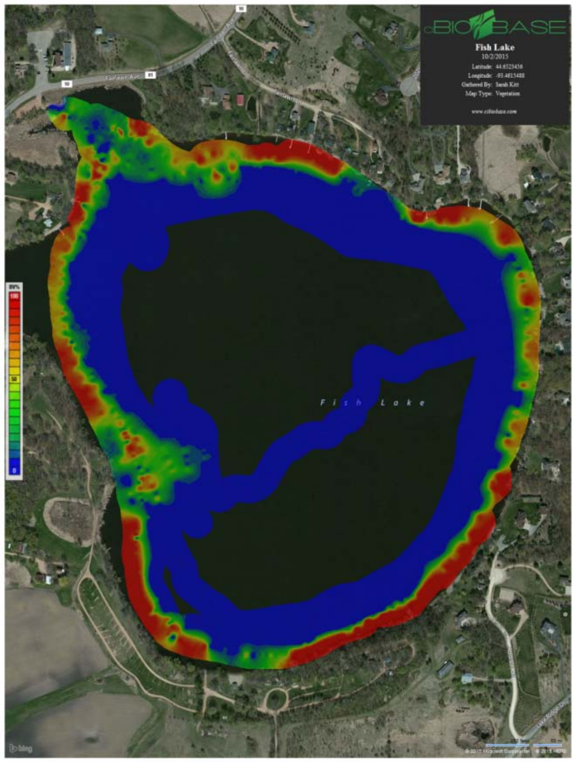


Figure 42 Fish Lake – Fall 2015

Buck Lake Vegetation Maps

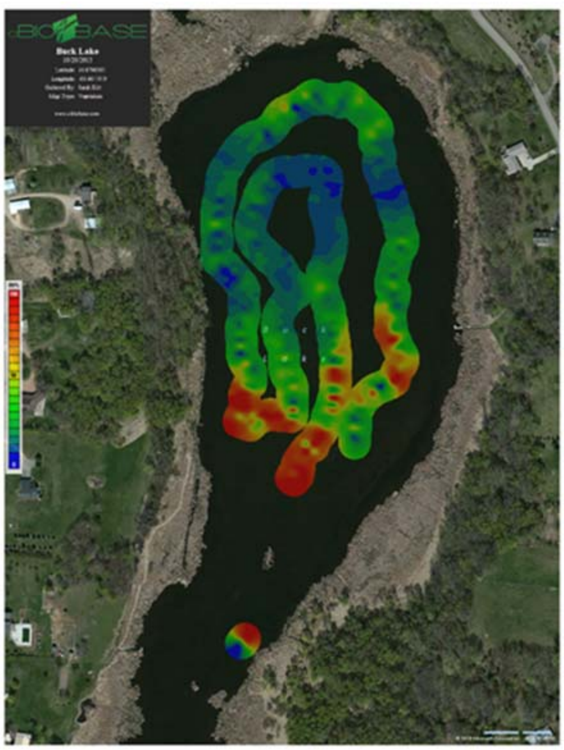


Figure 43 Buck Lake – Fall 2015

Arctic Lake Vegetation Maps

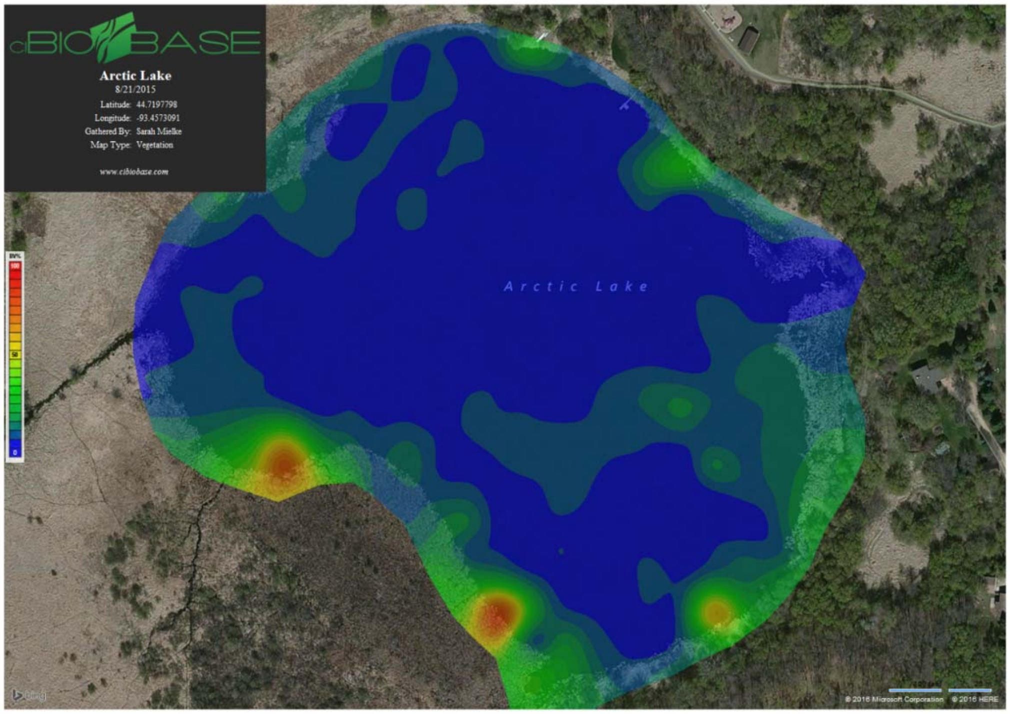


Figure 44 Artic Lake – Summer 2015

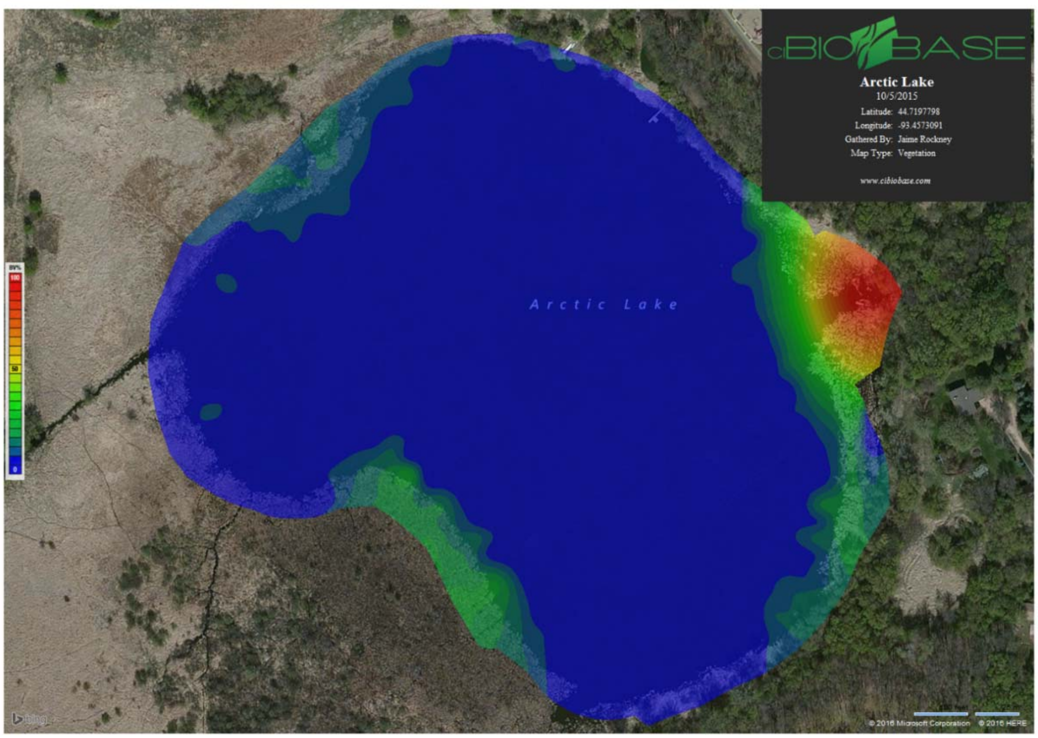


Figure 45 Artic Lake – Fall 2015

Appendix B – Plant Surveys for Upper and Lower Prior Lake

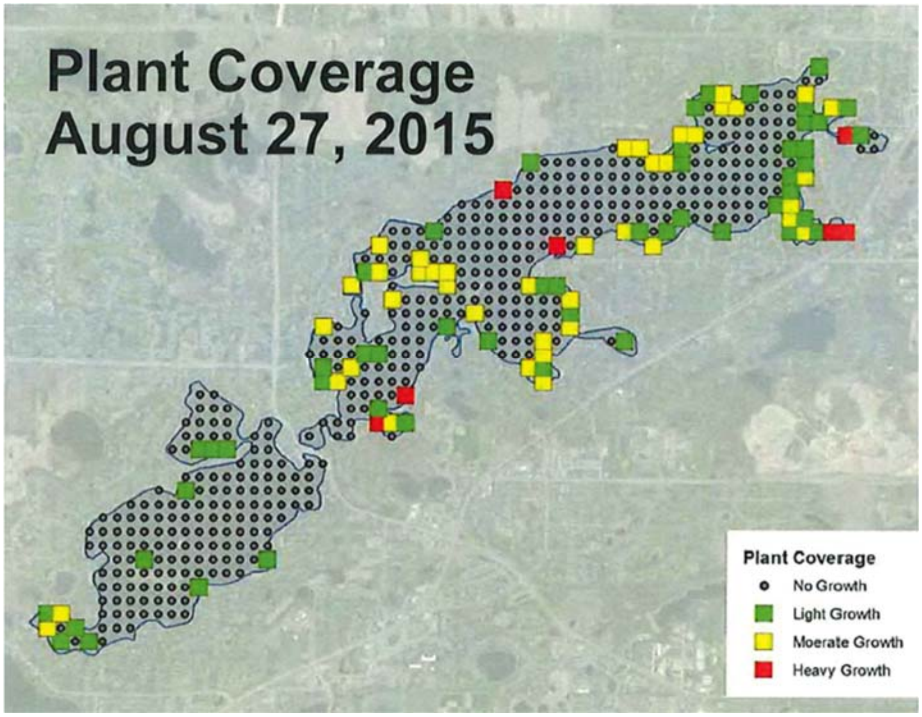


Figure 46 Plant coverage/density at each survey site.

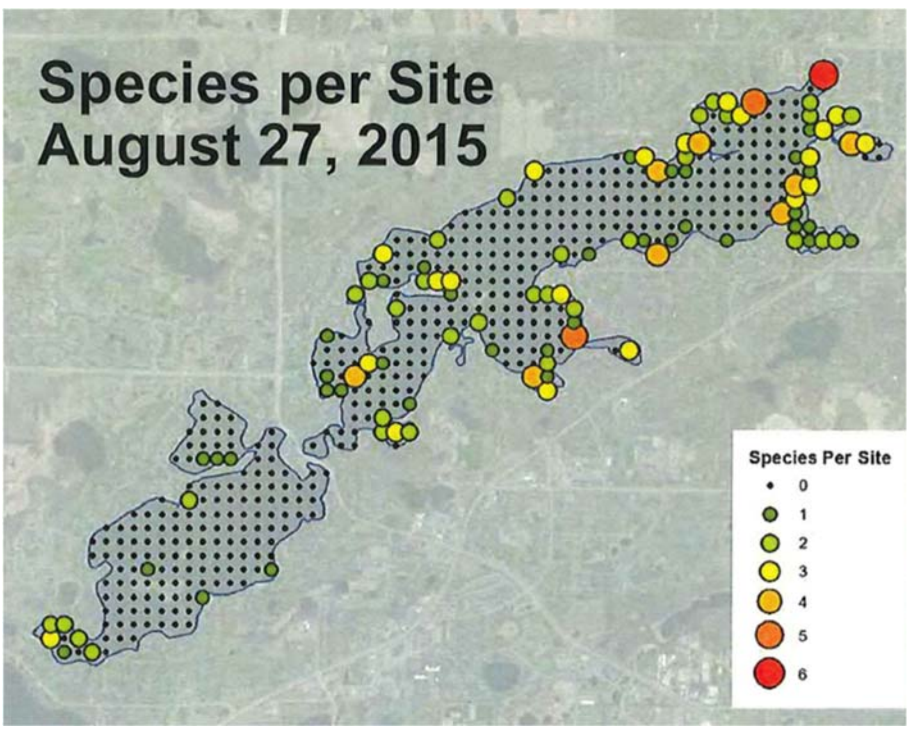


Figure 47 Number of species found at each survey site.

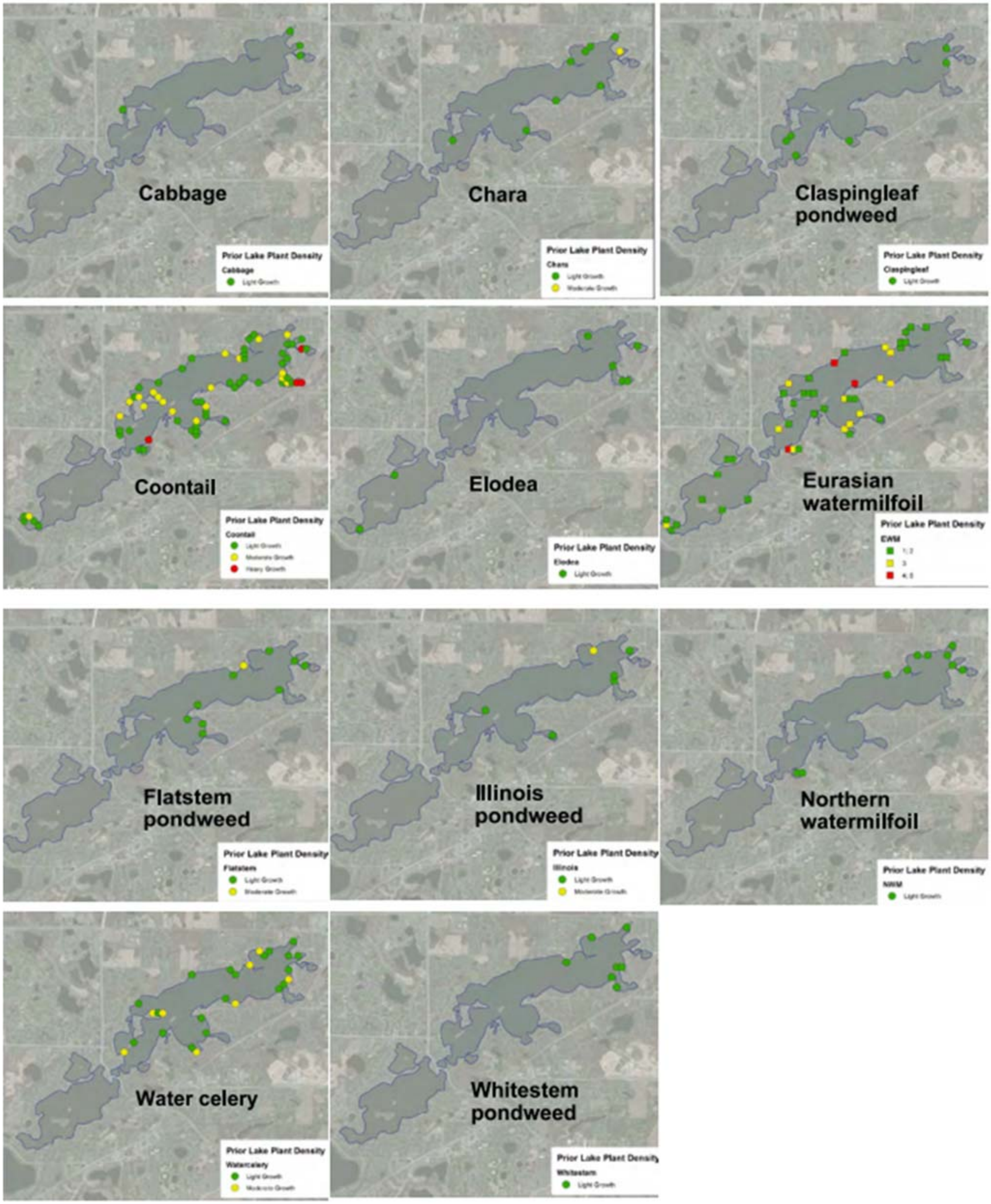


Figure 48 Location of individual species

Appendix C - Bottom Hardness Maps

** Note: sonar for Bottom Hardness is very sensitive and may not always be accurate.*

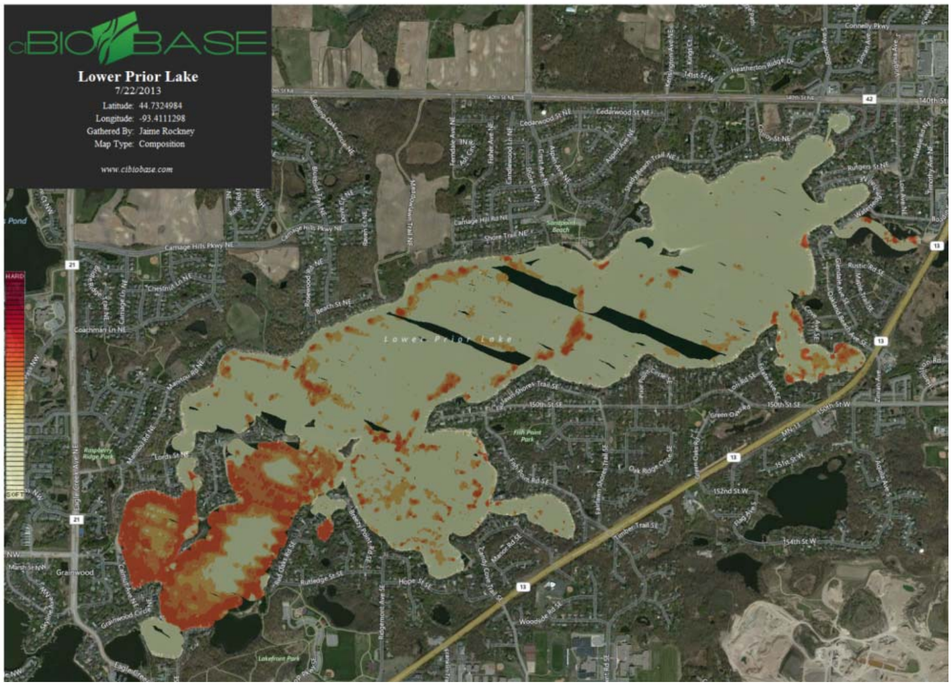


Figure 49 Lower Prior Lake

Figure 50 Upper Prior Lake

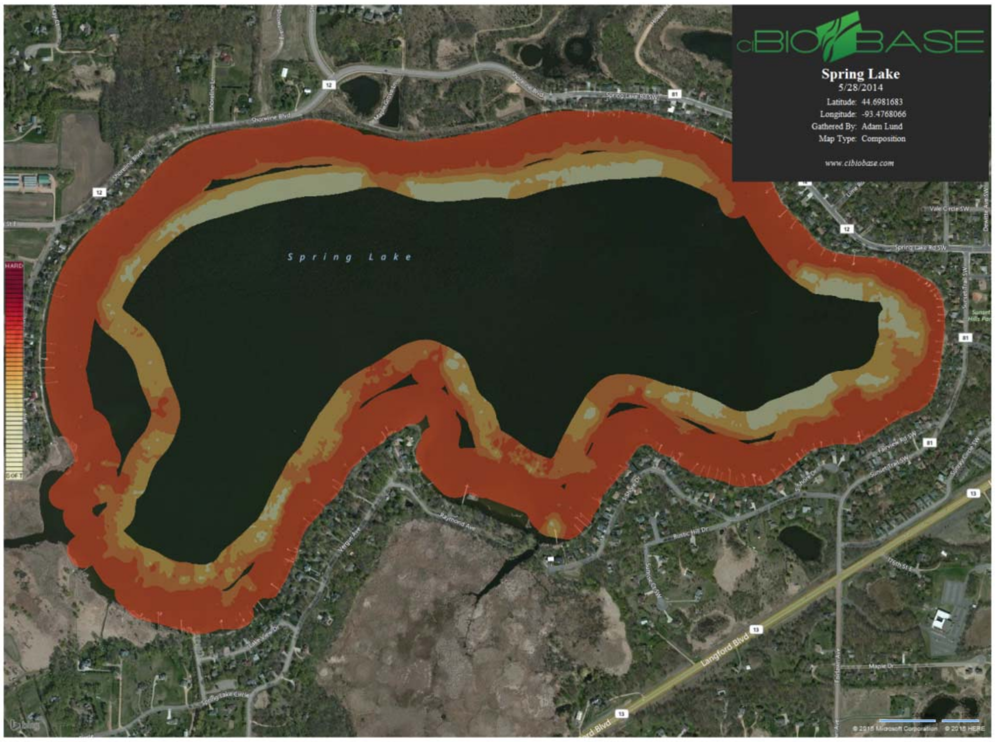


Figure 51 Spring Lake

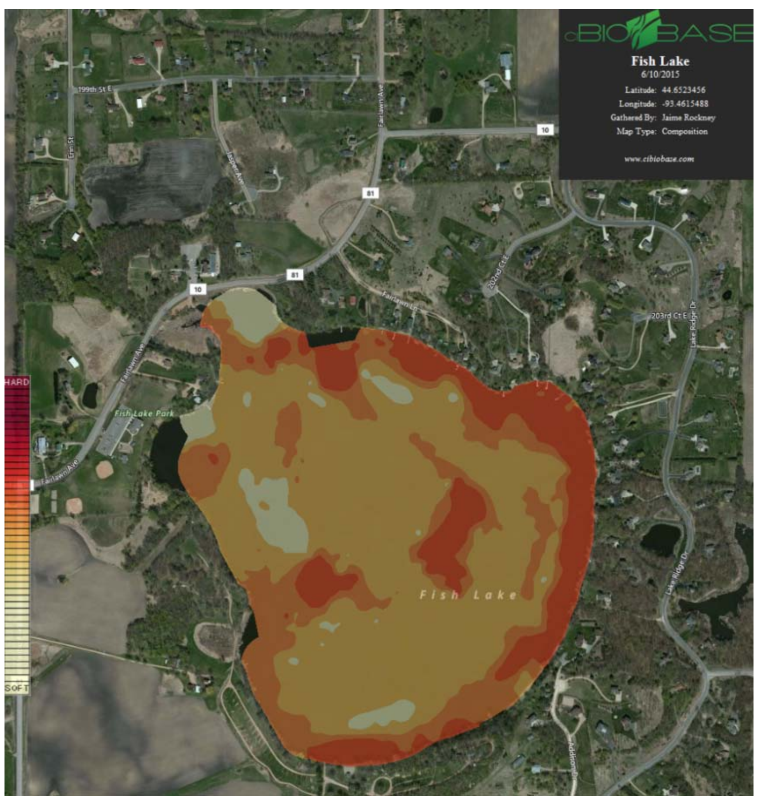


Figure 52 Fish Lake

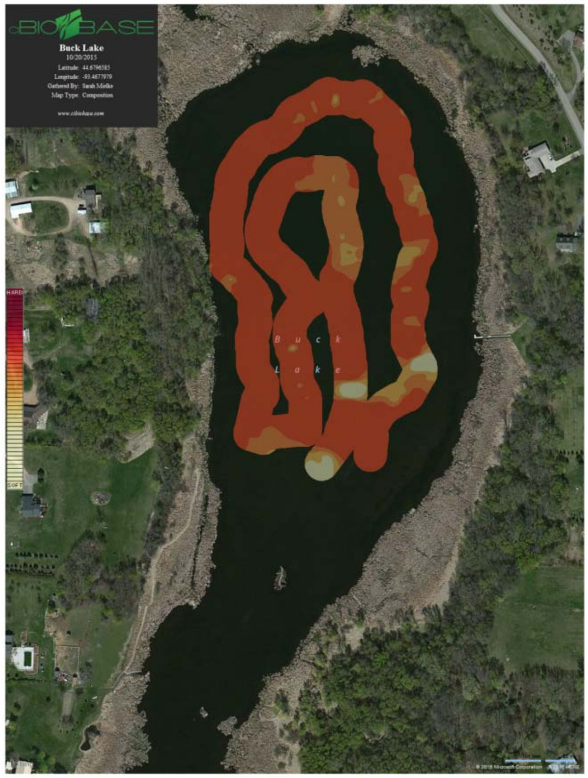


Figure 53 Buck Lake

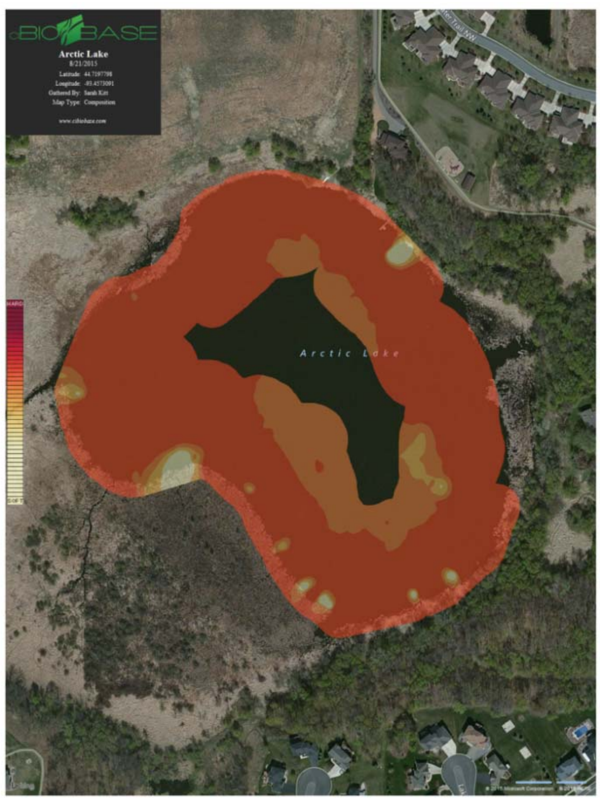


Figure 54 Artic Lake

Appendix D - Bathymetric Maps

*Contour lines change every 3ft.

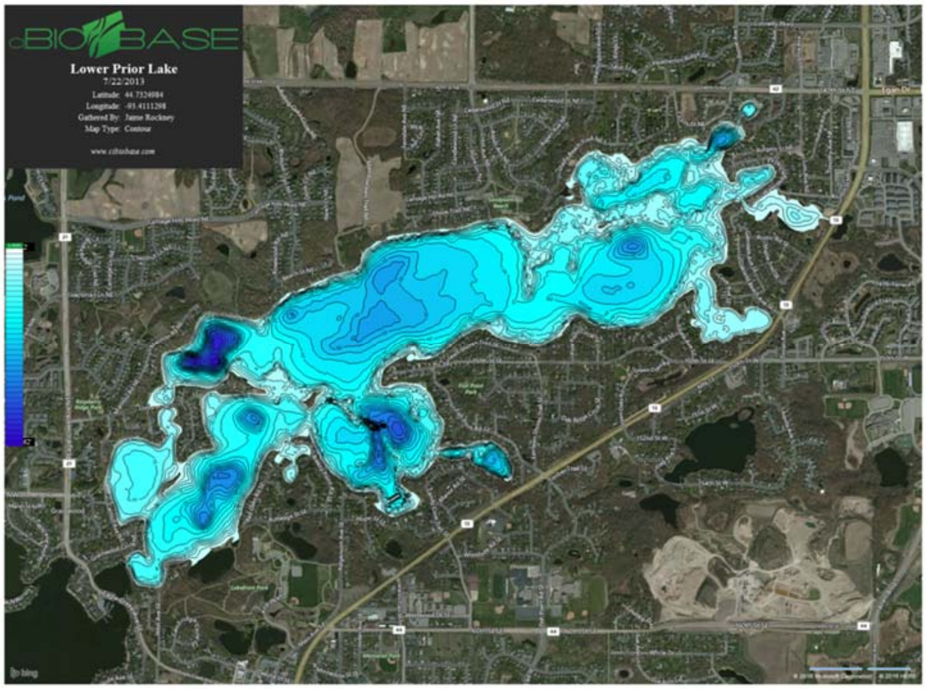


Figure 55 Lower Prior Lake

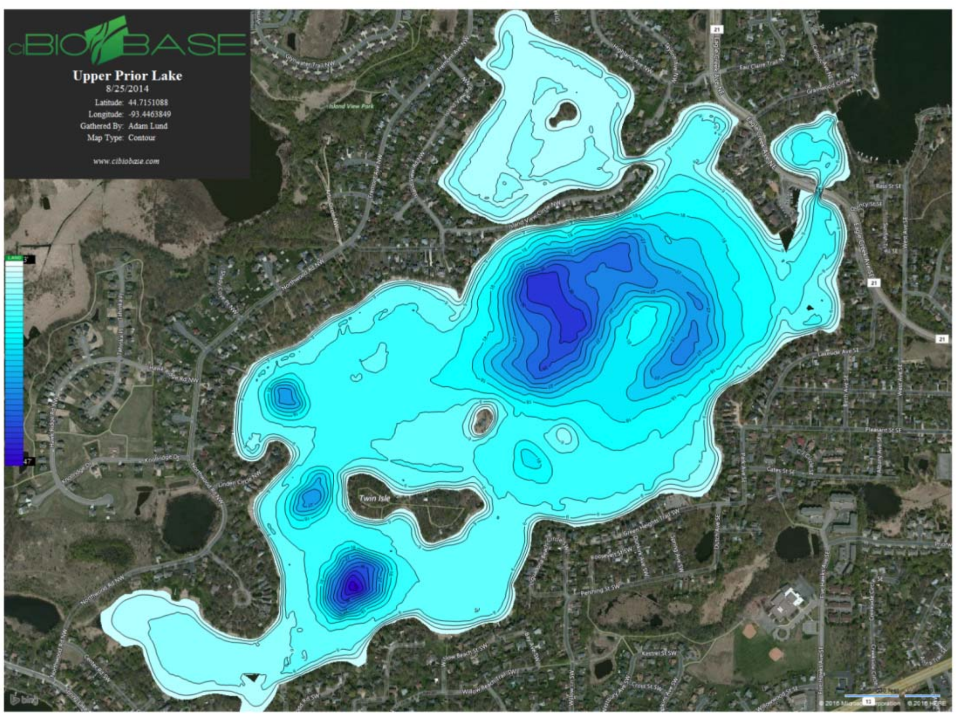


Figure 56 Upper Prior Lake

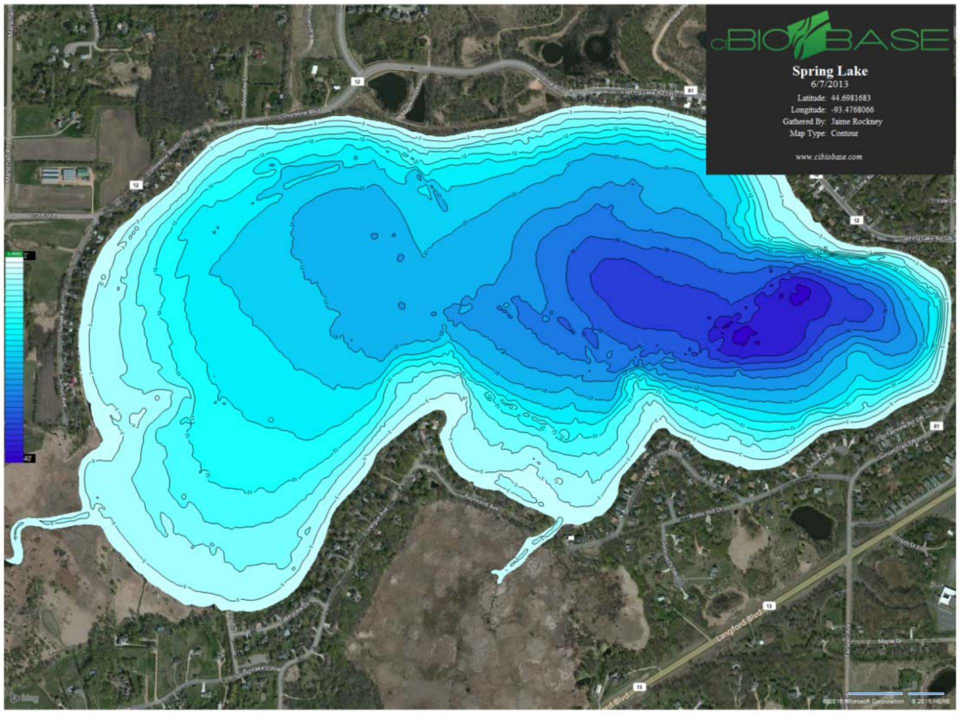


Figure 57 Spring Lake

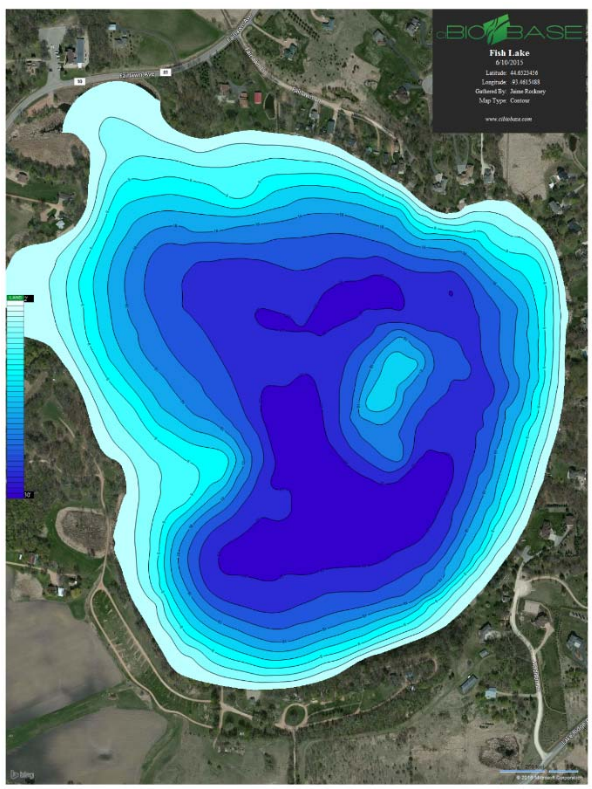


Figure 58 Fish Lake

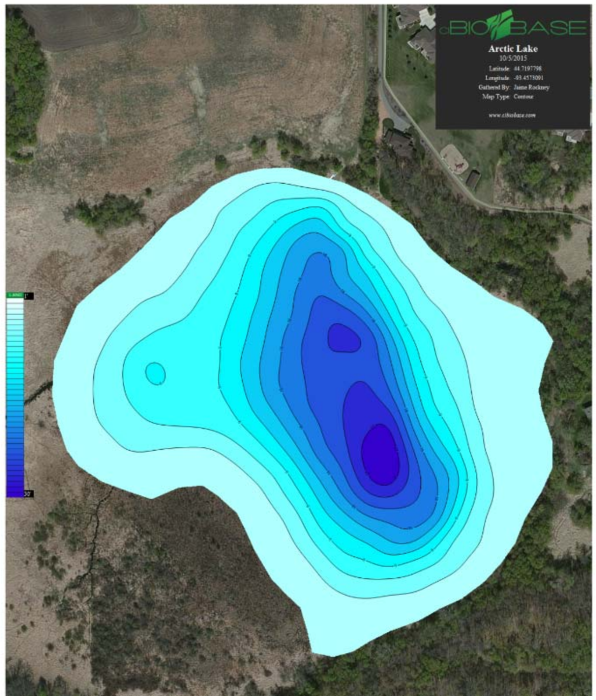


Figure 59 Artic Lake

Buck – N/A

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