

Date: October 5, 2016

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Subject: 2016 Vegetation Survey Final Report

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Executive Summary

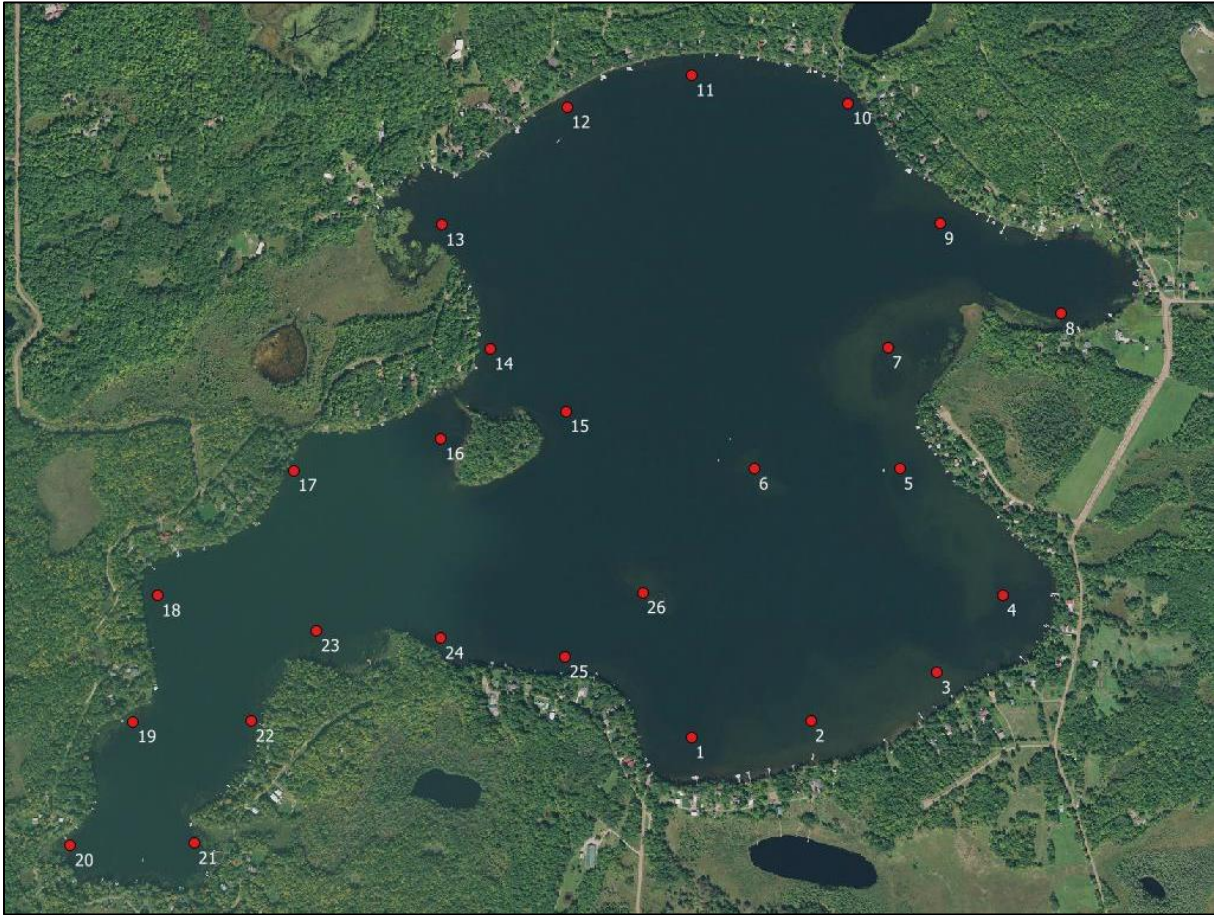
A.W. Research Laboratories, Inc. completed a vegetation survey of Big Pine Lake on July 22, 2016. The purpose of the survey was to monitor the lake for aquatic invasive plants and to gain a basic understanding of the diversity of plants in Big Pine Lake.

A point-intercept survey procedure was used in which a large rake was dragged along the lake bottom at each of 26 pre-selected sites on Big Pine Lake (Figure 1). The sites were located within the littoral zone, all having a depth less than 15 feet, and were spaced approximately 250 meters apart. At each site we identified and documented each unique species present in addition to the abundance (as percent cover) of each species on the sampling rake.

No invasive species were identified in Big Pine Lake as a result of this survey. A total of 20 plant and algae species were identified: 15 submerged plants, 1 emergent plant, 1 floating leaf plant, and 3 algae species. The most commonly found species was Northern milfoil, which was found at 73% of sites surveyed. Flat stem pondweed was the next most common species, found at 66% of the sites. Big Pine Lake supports a large and diverse aquatic plant community that provides many benefits to the lake. Fish and other wildlife rely on aquatic plants to provide food and shelter. Residents of the lake benefit from an abundance of fish and better water clarity which translates to higher property values.

We recommend completing this survey procedure every 3-5 years to monitor any changes in the aquatic plant communities in Big Pine Lake. Quick AIS surveys, during which only aquatic invasive species would be identified, could be completed on an annual basis at selected locations.

Figure 1: Survey Points Map

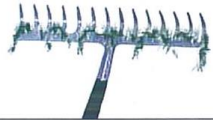




Survey Procedure

The following procedure was used to complete the field survey¹:

1. A large metal rake (3.5 ft in width) was dropped behind the boat at each site. The rake was dragged along the lake bottom for approximately 5-6 feet and then carefully pulled to the surface.
2. All plant material on the rake was collected in a bag and numbered by site for species verification and identification at the lab following the field survey. At the lab, each individual species identified and the percent cover for each species in the sample was recorded.
3. The following information was recorded at each site:
 - a. Site Depth
 - b. Dominant sediment type (M=mucky, S=sandy, R=rocky)
 - c. Rake Fullness (1=few, 2=moderate, 3=abundant; see Figure 2)
 - d. Any species identified visually within 6 feet of the sample site, but not collected on the rake, was recorded and the visual identification was noted.

Figure 2: Rake Fullness

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

¹Procedure and Rake Fullness Diagram (Figure 2) were referenced from: *Hauxwell, et al. Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications; Wisconsin DNR and University of Wisconsin Madison, March 2010.*

Data and Discussion

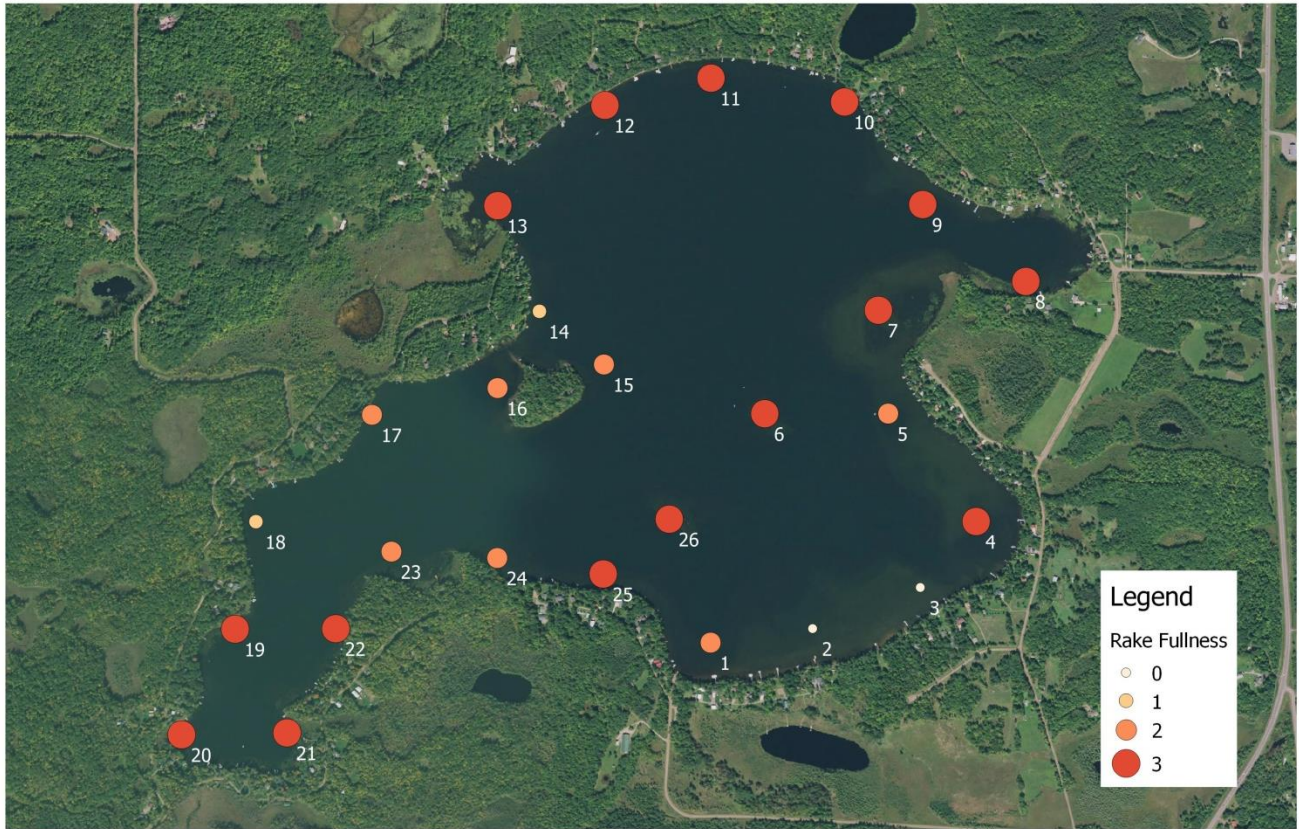
Survey Site Information

Table 1 displays the data collected at each site. Fifteen of the 26 sites (58%) had a rake fullness rating of three, while seven of the sites (27%) had a fullness rating of two. Two of the survey sites (8%) had a rake fullness rating of one, and two of the 26 sites (8%) had a rake fullness rating of zero. Figure 3 displays the rake fullness by site.

Table 1: Site Data

Site	Depth (ft)	Sediment Type	Rake Fullness	# Species
1	4.8	Muck	2	6
2	3.9	Sand/Rocky	0	1
3	3.5	Sand/Rocky	0	1
4	3.2	Muck	3	7
5	4.2	Muck	2	3
6	4.1	Muck	3	5
7	7.8	Muck	3	4
8	6.6	Muck	3	3
9	3.8	Muck	3	5
10	4.4	Muck	3	5
11	5.3	Muck	3	6
12	5.5	Muck	3	6
13	3.2	Muck	3	5
14	4.2	Sand	1	4
15	4.7	Muck	2	6
16	11.8	Muck	2	1
17	14.1	Muck	2	5
18	8.4	Muck	1	5
19	4.3	Muck	3	5
20	4.8	Muck	3	6
21	6.2	Muck	3	7
22	4.2	Muck	3	9
23	4.8	Sand	2	5
24	3.9	Sand	2	7
25	4.5	Muck	3	6
26	4.2	Rocky/Muck	3	6

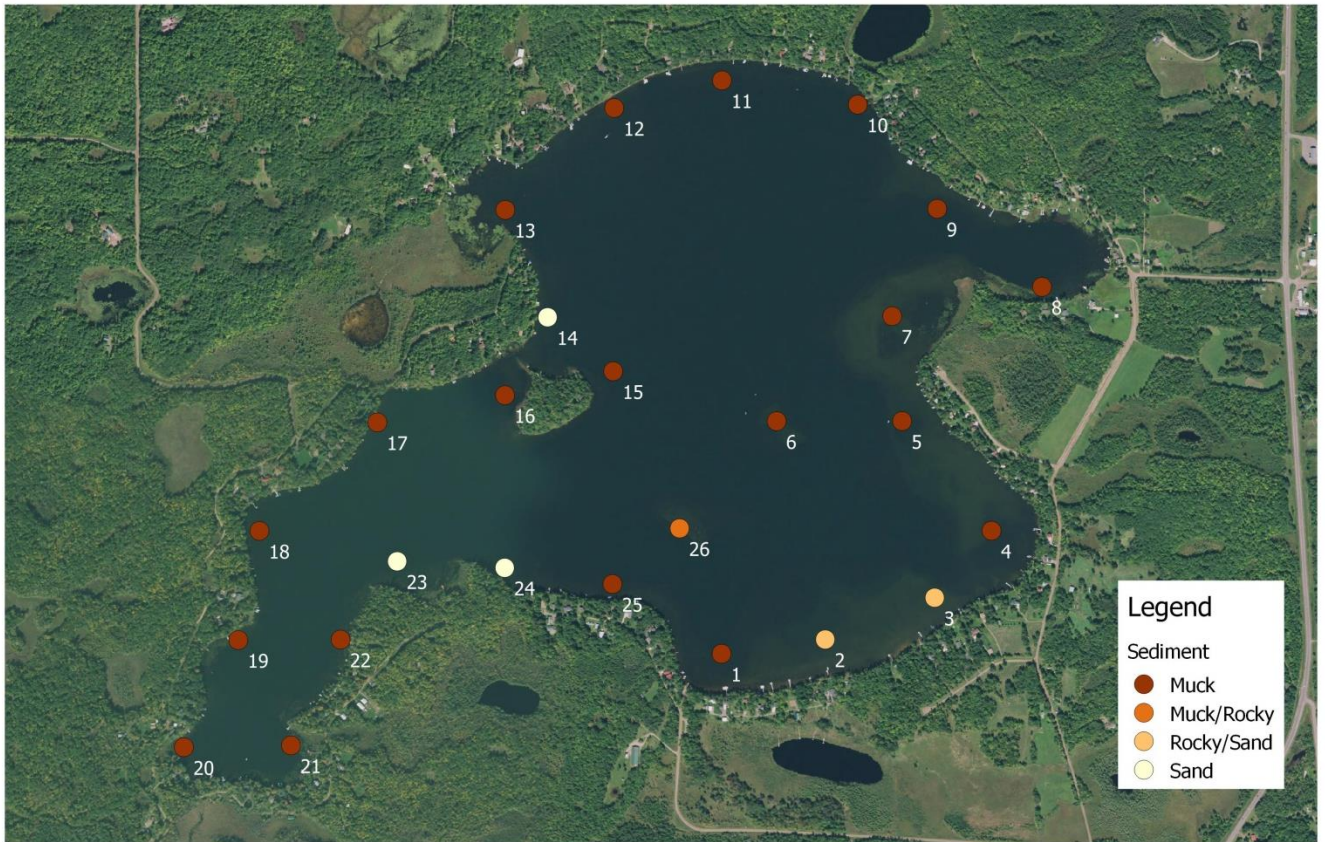
Figure 3: Rake Fullness Map



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Figure 4 displays the sediment type by location. The majority of the lake is mucky sediment with some sandy areas mostly along the southern shoreline of the lake. Sites 2 and 3 both with rocky/sandy sediment were the only two sites where no plants were collected on the rake. In general it appears that sites with mucky sediment had higher rake fullness as well as greater plant diversity (number of species present).

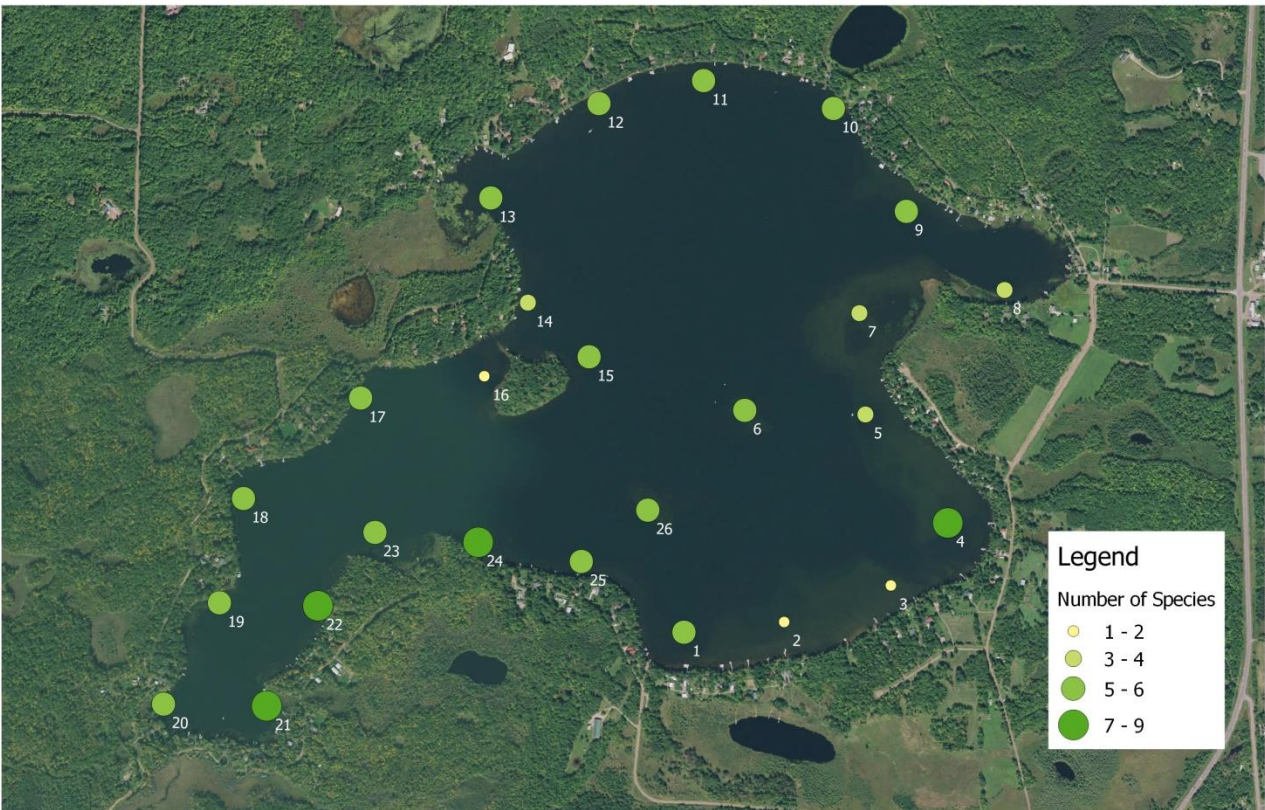
Figure 4: Sediment Type Map



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Figure 5 presents the species diversity for each survey site. Species diversity is defined as the number of unique species found at the site. The mean diversity was 5.96 species. The site with the most diversity (greatest number of species) was Site 22 in the southwest bay of the lake, with 10 different plant and algae species identified. Sites 4, 21, and 24 tied for the second highest diversity with each having 8 different species present. Sites 2, 3, and 16 had the lowest diversity with just 1 species identified at each site. At Sites 2 and 3 there were no plants on the sampling rake, but bulrushes were visually identified near each of the sites resulting in a diversity value of 1 species at these sites.

Figure 5: Species Diversity Map



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Plant Species Information

Table 2 presents the species identified in the July 22, 2016 survey by common name, scientific name, and type. A total of 20 different species of aquatic plant and algae species were found in Big Pine Lake. Thirteen of these are submerged plant species, with 1 emergent and 1 floating leaf plant species. Three of the species identified are algae.

Table 2: Species List

Common Name	Scientific Name	Type
Chara/Muskgrass	<i>Chara aspera</i>	Algae
Braun's Stonewort	<i>Chara braunii</i>	Algae
Leafy stonewort	<i>Chara foliolosa</i>	Algae
Bulrush	<i>Schoenoplectus sp.</i>	Emergent
White water lily	<i>Nymphaea odorata</i>	Floating Leaf
Variable pondweed	<i>Potamogeton gramineus</i>	Submerged
Northern milfoil	<i>Myriophyllum sibiricum</i>	Submerged
Wild celery	<i>Vallisneria americana</i>	Submerged
Coon tail	<i>Ceratophyllum demersum</i>	Submerged
Ribbon leaf pondweed	<i>Potamogeton epihydrus</i>	Submerged
Slender naid	<i>Najas flexilis</i>	Submerged
Leafy pondweed	<i>Potamogeton foliosus</i>	Submerged
Sago pondweed	<i>Stuckenia pectinata</i>	Submerged
Clasping leaf pondweed	<i>Potamogeton richardsonii</i>	Submerged
Flat stem pondweed	<i>Potamogeton zosteriformis</i>	Submerged
Northern naiad	<i>Najas gracillima</i>	Submerged
Water marigold	<i>Bidens beckii</i>	Submerged
Common Waterweed/Elodea	<i>Elodea canadensis</i>	Submerged
Fern-leaf pondweed	<i>Potamogeton robinsii</i>	Submerged
Large leaf pondweed	<i>Potamogeton amplifolius</i>	Submerged

Submerged plants have stems and leaves that grow entirely underwater, although some may have leaves or flowers that float on the surface. These plants make up the majority of most lake plant communities and provide important habitat for fish and other aquatic species. The growth patterns of submerged plants can range from dense mats along the lake bed to wide spaces between the stems of each individual plant. The majority of species found on Big Pine Lake in this survey are classified as submerged plants.

Emergent plants are rooted in the lake bottom but have stems and leaves that emerge above the surface of the water. These plants, including bulrushes, cattails, and wild rice typically grow along shorelines in water less than 5 feet deep. Emergent plants are important stabilizers of the lake bed in these shallow areas and provide important spawning habitat for many fish species.

In addition, these plants provide cover and food for many songbirds and waterfowl. Only one emergent plant was identified in this survey: bulrush.

Floating leaf plants are rooted in the lake bottom but their leaves and flowers float entirely on the surface of the water. The most well-known example of these plants is water lilies. Floating leaf plants are typically found in sheltered areas with little wave action and provide food for waterfowl and muskrats. Only one floating leaf plant was identified on Big Pine Lake in this survey: white water lily.

Algae are plant-like organisms with no true roots, leaves or stems. They can range from single-celled organisms to complex multi-celled plant-like structures. Three of the 20 species identified in Big Pine Lake are algae.

Table 3 presents the frequency of occurrence and average abundance for each species found in Big Pine Lake. The most common species was Northern milfoil, a native submerged plant that is similar in appearance to the invasive plant Eurasian water milfoil. Northern milfoil provides good cover for fish and invertebrates. Northern milfoil was found at 19 of the 26 survey sites. Flatstem pondweed, Clasp leaf pondweed, and Coontail were the next most common species found at 17, 14, and 14 of the sites respectively.

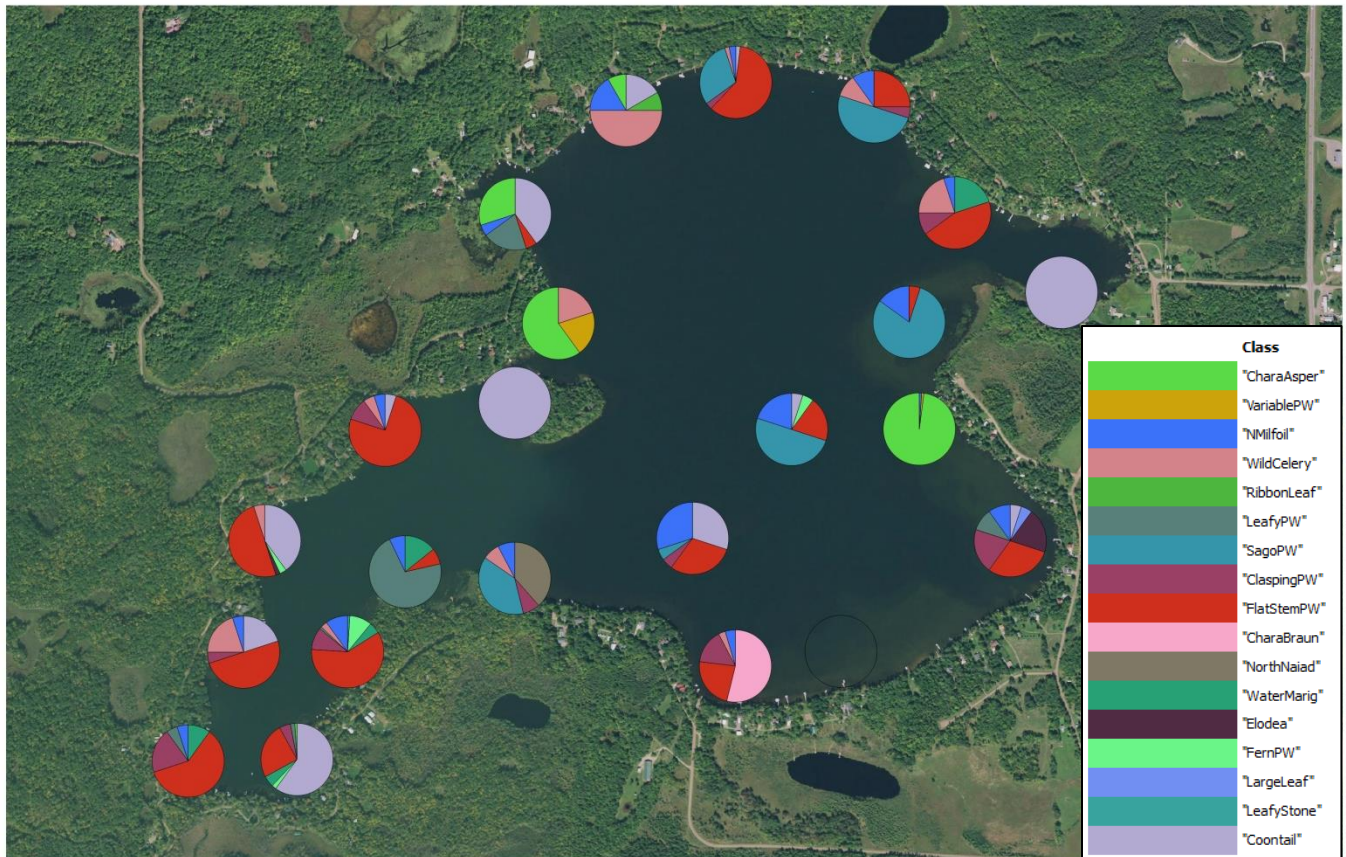
Species abundance was measured as the percentage of the sample composed of each individual species. The percentages measured were based on the total rake fullness. For instance, a species making up ½ of a rake with a fullness of three was rated 50%, as was a species making up ½ of a rake with fullness rating of one. In addition, species abundance can be greatly influenced by the plant structure. Species with full leaves or a bushy structure can be viewed by surveyors as making up a greater percentage of rake cover than more stringy or thinly stemmed species. That being said, our species abundance percentage does give a basic idea of the amount of each species present at each location. Several species had an average abundance ranging between 30-40 percent including: Chara, Braun’s stonewort, Coontail, Slender naiad, Sago pondweed, and Flat stem pondweed. While Northern milfoil was present at 73% of sites, its abundance was relatively low, making up only 11% of the rake fullness on average. Figure 6 presents the species abundance by location.

Table 3: Species Statistics

Common Name	# Sites Present	Average Abundance (% coverage of rake)
Chara/Muskgrass	5	32.8%
Braun's stonewort	1	35.0%
Leafy stonewort	1	1.0%
Bulrush	6	visible
White water lily	1	visible

Common Name	# Sites Present	Average Abundance (% coverage of rake)
Variable pondweed	2	5.5%
Northern milfoil	19	11.7%
Wild celery	13	10.2%
Coontail	14	32.4%
Ribbon leaf pondweed	1	5.0%
Slender naid	5	36.0%
Leafy pondweed	7	7.6%
Sago pondweed	7	36.4%
Clasping leaf pondweed	14	8.2%
Flat stem pondweed	17	35.3%
Northern naiad	1	25.0%
Water marigold	5	10.0%
Common Waterweed/Elodea	3	7.7%
Fern-leaf pondweed	4	5.0%
Large leaf pondweed	3	27.5%

Figure 6: Species Abundance Map



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APPENDIX

Table 4: Raw Data

Site	Depth (feet)	Sediment	Rake Fullness	Chara/Muskgrass	Braun's Stonewort	Leafy Stonewort	Bulrush	White water lily	Variable Pondweed	Northern milfoil	Wild celery	Coon tail	Ribbon-leaf pondweed	Slender naiad	Leafy pondweed	Sago pondweed	Clasping leaf pondweed	Flat stem pondweed	Northern naiad	Water marigold	Common waterweed	Fern leaf pondweed	Large leaf pondweed	TOTAL %	# Species
1	4.8	M	2		35					3	2			35			10	15						100	7
2	3.9	RS	0				V																	0	2
3	3.5	RS	0				V																	0	2
4	3.2	M	3							10		5			10		20	30			20		5	100	8
5	4.2	M	2	98					1	1														100	4
6	4.1	M	3							20		5				50		20				5		100	6
7	7.8	M	3				V			15					80		5							100	5
8	6.6	M	3				V	V				10												100	4
9	3.8	M	3							5	20						10	45		20				100	6
10	4.4	M	3							10	10					50	5	25						100	6
11	5.3	M	3							3	2	2				30	3	60						100	7
12	5.5	M	3	5						10	30	10	5	40										100	7
13	3.2	M	3	30						5		40			20			5						100	6
14	4.2	S	1	30					10		10			50										100	5
15	4.7	M	2							25	15	35			5	15	5							100	7
16	11.8	M	2									10												100	2
17	14.1	M	2							5	5	5					10	75						100	6
18	8.4	M	1								5	40						50			2	3		100	6
19	4.3	M	3							5	20	20					5	50						100	6
20	4.8	M	3				V			5					5		20	60		10				100	7

Vegetation Survey, 7/22/2016
Big Pine Lake, Aitkin County

Site	Depth (feet)	Sediment	Rake Fullness	Chara/Muskgrass	Braun's Stonewort	Leafy Stonewort	Bulrush	White water lily	Variable Pondweed	Northern milfoil	Wild celery	Coon tail	Ribbon-leaf pondweed	Slender naiad	Leafy pondweed	Sago pondweed	Clasping leaf pondweed	Flat stem pondweed	Northern naiad	Water marigold	Common waterweed	Fern leaf pondweed	Large leaf pondweed	TOTAL %	# Species
21	6.2	M	3	1								60			2		5	25		5		2		100	8
22	4.2	M	3			1				10	3				1		10	60		5		10	V	100	10
23	4.8	S	2							5				30				5		10			50	100	6
24	3.9	S	2							5	5			25	10	25	5		25					100	8
25	4.5	M	3							50	5	2					2	40		1				100	7
26	4.2	MR	3				V			30		30				5	5	30						100	7

V=visual id within 6 feet of survey site, not on rake

Sediment Types: M=Muck, S=Sand, RS=Rocky Sand, MR=Muck with Rocks