Aquatic Plant Management Plan

Lake Beulah, Walworth County, Wisconsin

January 2017

-Update for Harvesting Permit Renewal

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Statement of Intent

The Lake Beulah Management District (LBMD) wishes to pursue aquatic plant harvesting for the conditional control of *Eurasian Watermilfoil* (EWM).

Timing

Harvesting operations typically begin in late May. Harvesting during this period is typical due to the emergence of the target species that hinders lake usage. Listed below is a table that depicts the previous start dates.

Historical Harvesting Start Dates

2016	2015	2014	2013	2012
12-Jun	28-May	24-May	27-May	14-May

Table 1: Historical Harvesting Start Dates for past 5 years.

Cutting Procedures

All harvesting operations will be limited to depths that are greater than three feet. Disturbance of the bottom sediment can disrupt spawning activity and beneficial benthic organisms. Furthurmore, the suspension of solids reduces visibility of sight-feeding predators, as well as, the posibility of increasing available nutrients throughout the water column.

By targeting and removing EWM only, it is the operator's intent to promote native species. Top-cutting is a preferred method where native plants are present while still reducing the canopy of the target species.

In stands where the target species dominates, deep harvesting may be implemented. Bottom sediment must remain undisturbed with a minimum buffer of one foot between blades and top of sediment. Lake Beulah's harvesting program is consistent with these methods. It's understood that the district has been harvesting to a depth of 4 feet while staying one foot above the sediment in all shallow areas.

Concerns

Care should be taken to eliminate damage to spawning habitat and the conveyer must be monitored for the removal of young-of-the-year fish. All harvester operators must be proficient in basic aquatic plant identification. The harvester supervisor must train all seasonal employees prior to operation.

Harvesting Equipment

Equipment currently used for the harvesting of aquatic plants on Beulah are listed below: one aquatic plant harvester: Aquarius HM-420, with the associated trailer, Aquarius T-23, one aquatic plant transport barge: Aquarius T-12S, with the associated trailer AquariusTR-12, and one aquatic conveyor that is made by Aquarius.

Shoreline Pick-Up Schedule

Aquatic plants that are removed from the waterfront property owners are collected daily on an "as need" basis. Total cubic yards of aquatic plants from shoreline pick-ups are not measured at the time of removal but are estimated to range from 10 to 20 cubic yards per year.

Disposal Sites

The disposal sight for the aquatic plants removed via harvester are transported to and dumped at 2716 Friemoth Road, East Troy, WI 53120.

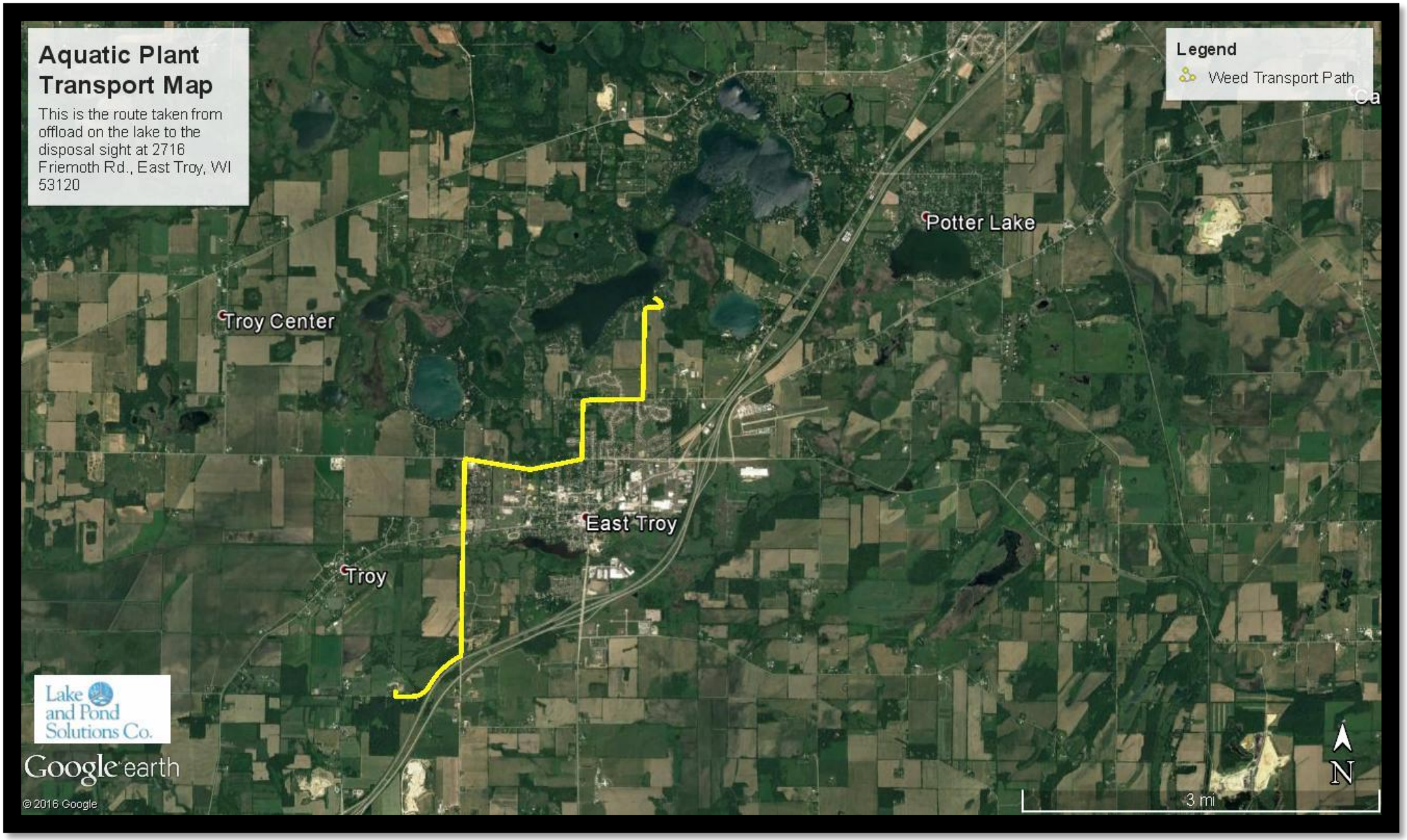

Figure 1: Current Aquatic Plant Transport Map.

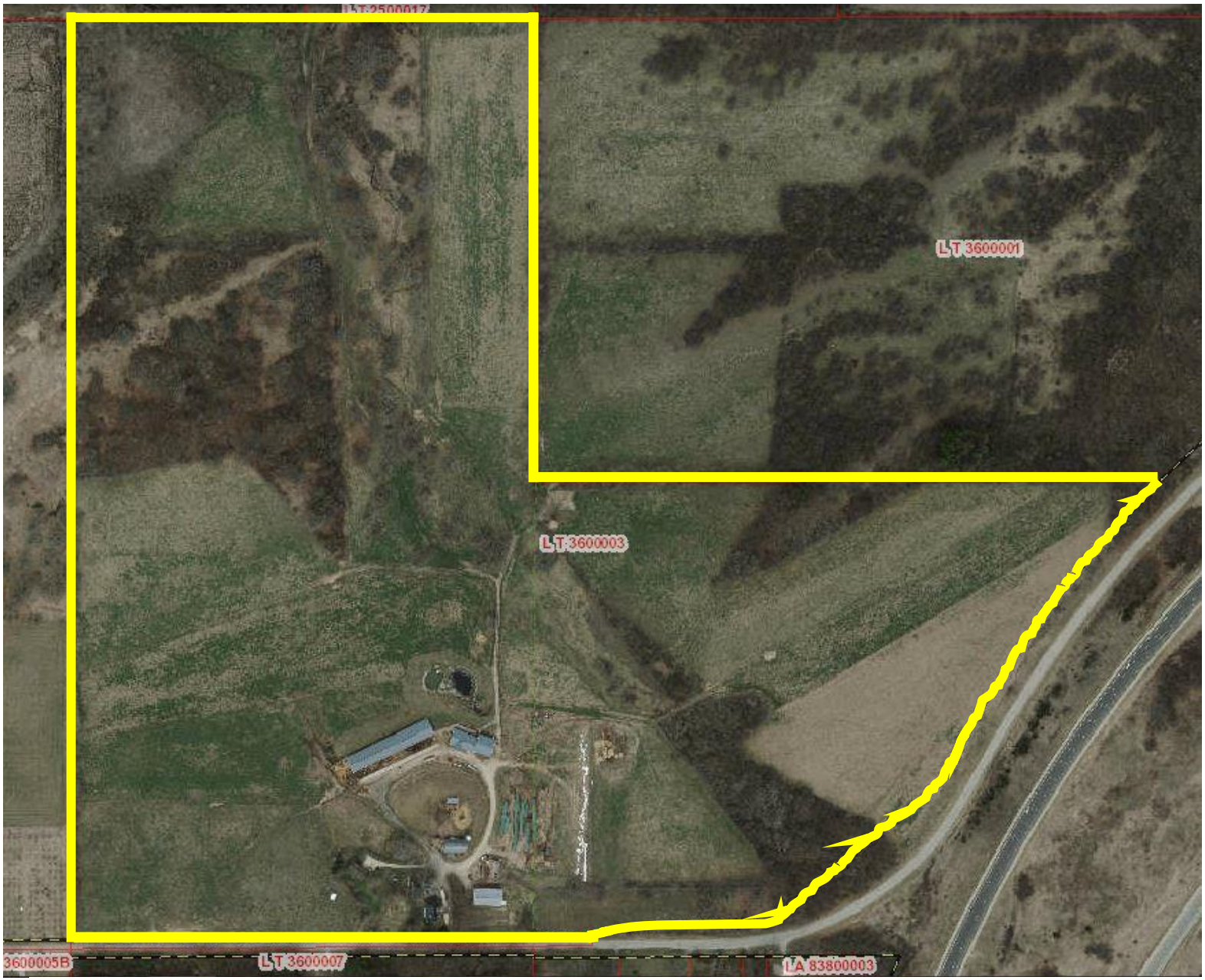

Figure 2: Aerial Image of Disposal Sight. From Walworth County GIS website. www.gisinfo.co.walworth.wi.us.

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Discussion

Methods

Study Area – Lake Beulah lies in Southeastern Wisconsin in the Kettle Moraine region. The lake is 834 square acres with a mean depth of 23 feet and a maximum depth of 62 feet based on the most recent survey (2016).

Field Sampling – 996 sample points, spaced 57 meters apart as specified by the WDNR were sampled. Depths were recorded at each point using a measuring stick in areas 7 feet or less in depth and a *Zebco zf200* (a digital, portable depth finder) at points deeper than 7 feet. At each point plants were identified and recorded based on the WDNR approved plant survey methods. A pole rake and a rake-on-a-rope were used to sample plants at each point. Recording density was based on a number scale. A value of (1) showed that the plant was present but with low density, (2) consisted of moderate density or covering about ½ of the pole rake while (3) showed high density or a rake completely covered with plants.

Results

Areas within the lake are not always accessible or some points are on land, this was the case for Lake Beulah as well, with 71 of the 996 points being recorded as either Non-navigable or Terrestrial, resulting in 922 sampled points.

A species richness (total number of species, including visuals) of 42 was found in Lake Beulah with a Simpson diversity index of 0.886. Simpson diversity index is used to quantify the biodiversity of a habitat. It considers the number of species present, as well as the relative abundance of each species. The index assumes a value between 0 and 1, with 1 having complete evenness.

Out of the 996 sampling points 624 were found to have plants (67.7%). No plants were found at a depth greater than 38 feet. 90.7 % of the points shallower than 38’ contained vegetation. There were 2.19 species recorded on average at sites shallower than 38 feet. Points that recorded vegetation had an average of 2.44 species, with 2.1 being native. Data described here is also listed in *Table 2*.

Table 2: Key Values from Sampling Data

Summary of Statistics	August 2016 Survey
Total Number of Sites with Vegetation/ All Sites Sampled	624/922 (67.7%)
Maximum depth of Plants	38
Species Richness (including Visuals)	42
Average Number of Species per Vegetated Site (including Exotics)	2.44
Average Number of Native Species Only per Vegetated Site	2.10
Simpson Diversity Index	0.886
Average C-Value	6.32
Floristic Quality	36.87

Table 2: Key values for 2016 sampling data.

To understand how the plant community in the lake has changed since the original APM plan was written C-values and the FQI will be assessed. The C-value is a measure of plant conservatism, which in short, means the value assigned to each plant indicates how sensitive that species is to disturbance. The more disturbed an area is the lower the C-value. C-value can range from 0-10. Per the most recent survey the calculated C-value has increased from 6.05 in 2008, to 6.15 in 2016. This change is mainly attributed to the presence of twenty species not found in the earlier survey. The floristic quality indicator (FQI), which evaluates how close an area is to its undisturbed counterpart [1], was 25.69 in 2008, and is now calculated to be 36.2 in the 2016 survey. High FQI values indicates less disturbance. The overall picture of the lake is that the plant community appears to becoming more undisturbed and higher value.

[1] Nichols, SA. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management, 15(2):133-141.

Table 3: Summary of Lake Beulah's 2016 PI Survey Plant Data

Common Name	Scientific Name	Frequency of occurrence within vegetated areas (%)	Average Rake Fullness	Number of sites where species found (Does not include visuals)	# of visual sightings
Eurasian water-milfoil (or Hybrid)	*Myriophyllum spicatum*	17.28	1.55	108	6
Watershield	*Brasenia schreberi*	0	0	0	1
Coontail	*Ceratophyllum demersum*	10.08	1.62	63	0
Muskgrasses	*Chara sp .*	64.16	1.89	401	2
Swamp loosestrife	*Decodon verticillatus*	0.16	1	1	4
Common waterweed	*Elodea canadensis*	0.8	1.20	5	1
Water star-grass	*Heteranthera dubia*	0.64	1	4	0
Small duckweed	*Lemna minor*	1.76	1.18	11	1
Alternate-flowered water-milfoil	*Myriophyllum alterniflorum*	0.64	1	4	0
Various-leaved water-milfoil	*Myriophyllum heterophyllum*	1.44	1.44	9	0
Northern water-milfoil	*Myriophyllum sibiricum*	3.04	1.42	19	0
Whorled water-milfoil	*Myriophyllum verticillatum*	9.92	1.66	62	16
Slender naiad	*Najas flexilis*	4.96	1.32	31	2
Spiny naiad	*Najas marina*	18.4	1.17	115	4
Spatterdock	*Nuphar variegata*	4.32	2.19	27	8
White water lily	*Nymphaea odorata*	6.88	2.49	43	11
Large-leaf pondweed	*Potamogeton amplifolius*	0.48	1.33	3	3
Leafy pondweed	*Potamogeton foliosus*	0.16	1	1	0
Fries' pondweed	*Potamogeton friesii*	4	1.04	25	0
Variable pondweed	*Potamogeton gramineus*	3.04	1.16	19	11
Illinois pondweed	*Potamogeton illinoensis*	5.44	1.12	34	23
Floating-leaf pondweed	*Potamogeton natans*	3.68	1.26	23	28
Blunt-leaf pondweed	*Potamogeton obtusifolius*	0.16	1	1	0
White-stem pondweed	*Potamogeton praelongus*	0.8	1	5	0
Small pondweed	*Potamogeton pusillus*	1.28	1	8	0
Clasping-leaf pondweed	*Potamogeton richardsonii*	0.96	1.17	6	1
Flat-stem pondweed	*Potamogeton zosteriformis*	1.44	1	9	2
White water crowfoot	*Ranunculus aquatilis*	0.32	1.50	2	0
Arrowhead	*Sagittaria sp.*	0.16	1	1	0
Water bulrush	*Schoenoplectus subterminalis*	0.96	2	6	0
Softstem bulrush	*Schoenoplectus tabernaemontani*	0.16	3	1	5
Narrow-leaved bur-reed	*Sparganium angustifolium*	0.16	3	1	0
Sago pondweed	*Stuckenia pectinata*	15.36	1.19	96	20
Cattail	*Typha sp .*	0.16	3	1	2
Common bladderwort	*Utricularia vulgaris*	28.48	1.05	178	11
Small bladderwort	*Utricularia minor*	0.16	1	1	0
Wild celery	*Vallisneria americana*	9.6	1.18	60	10
Common watermeal	*Wolffia columbiana*	0.32	2	2	0
Aquatic moss	-	0.32	1	2	0
Filamentous algae	-	0.64	1	4	1
Nitella flexilis	*Nitella flexilis*	21.92	1.53	137	0
Unknown Pondweed 1	-	0.16	1	1	1
Overall totals for vegetation		5.83	1.97	625	174

Table 3: Summary of Lake Beulah's 2016 PI Survey Plant Data

The 2016 survey resulted in 42 species being present (*Table 3*). Eurasian water-milfoil (EWM) was found and represented the 5th most frequent species found and an average density of 1.55 when found. EWM is not given a C-value because it is listed as an exotic species, which means that it is not included in average C-value or FQI calculations. EWM does provide some habitat to the aquatic life in a lake, but it is not native and should be considered a negative impact to local lakes. EWM can be considered a burden that indirectly drives down C-values and FQI because it limits the range and distribution of beneficial native species. Muskgrass was the most frequently sampled species found during this survey, with common bladderwort and *Nitella flexilis* also being the most sampled species in terms of frequency and density. These species have moderate to high C-values associated with them (7). Listed below are maps of each of the aquatic plants that were found in the august 2016 survey showing the distribution and the density of each sample point where that specie was found. Rake fullness indicates density. The maps are arranged in order from the most frequently found species to the least, apart from the first map (EWM) which is not the most frequent or dense, but is placed there due to it being classified as invasive.

Figures

Figure 3: Exotic Species (EWM) Densities and Distribution

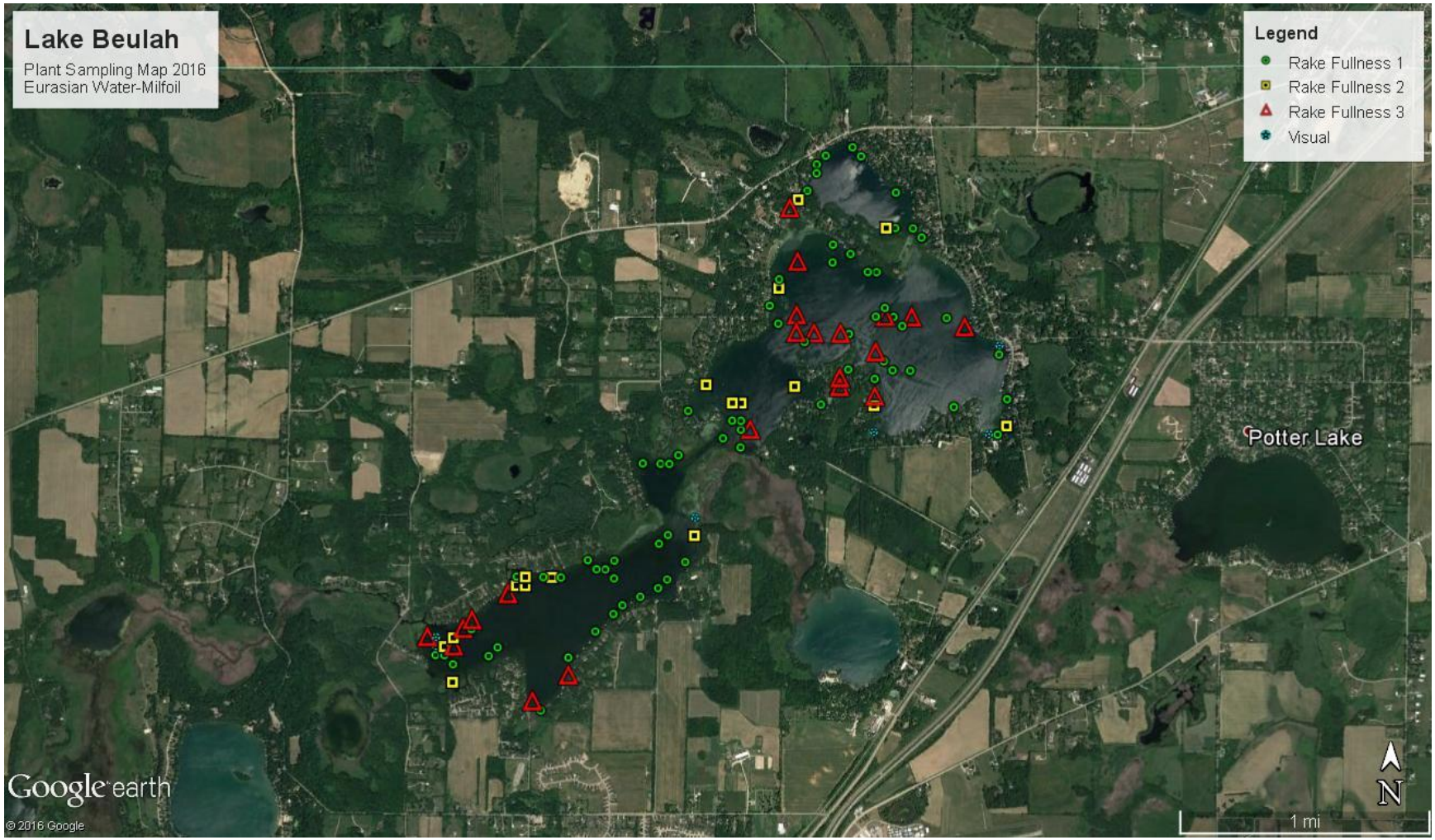


Figure 3: Distribution and density map of EWM.

Figure 4: Most Common Native Plant Species (Chara) Densities and Distribution

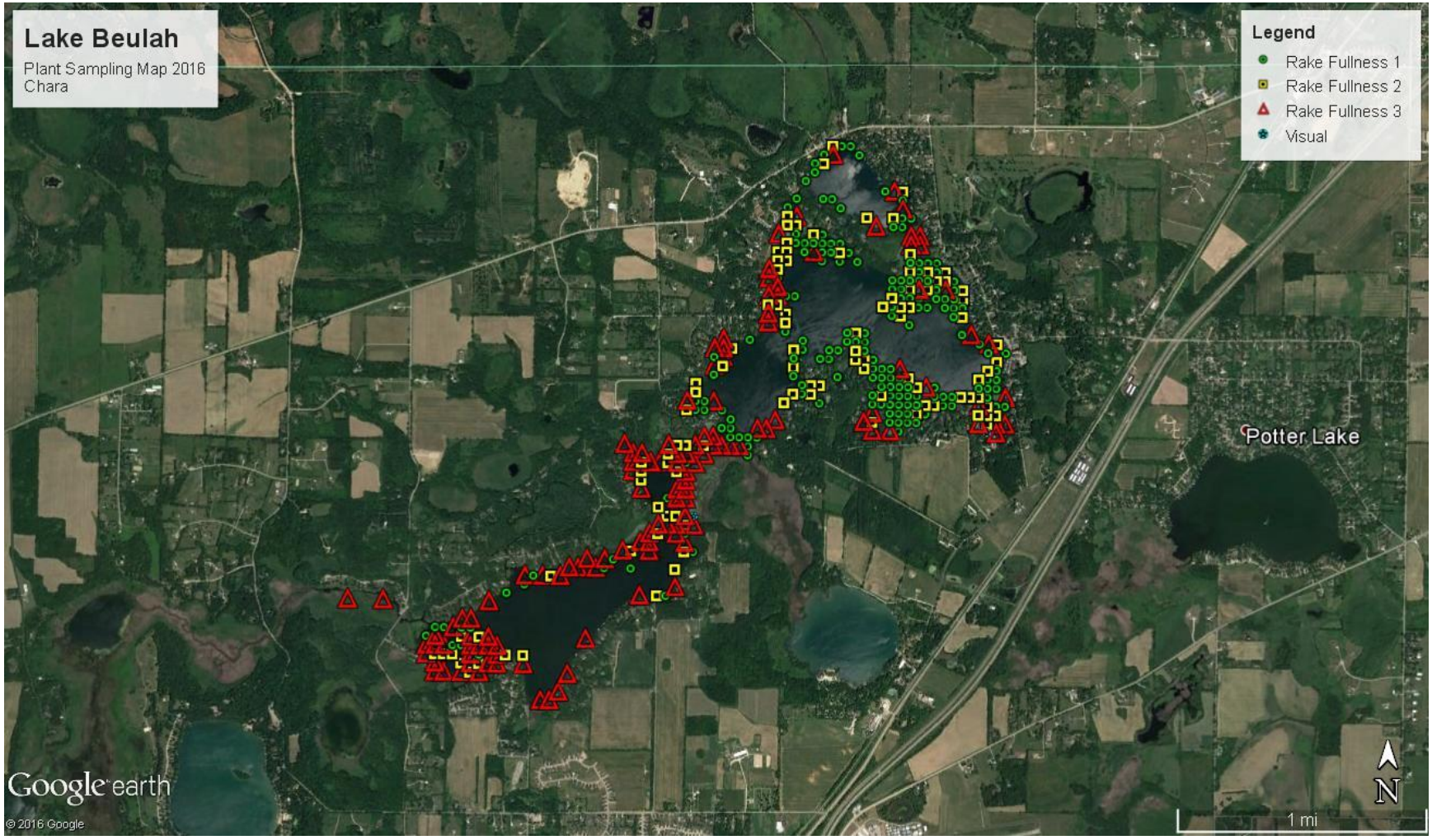


Figure 4: Distribution and density map of Chara.

Figure 5: Most Common Native Plant Species (Common Bladderwort) Densities and Distribution

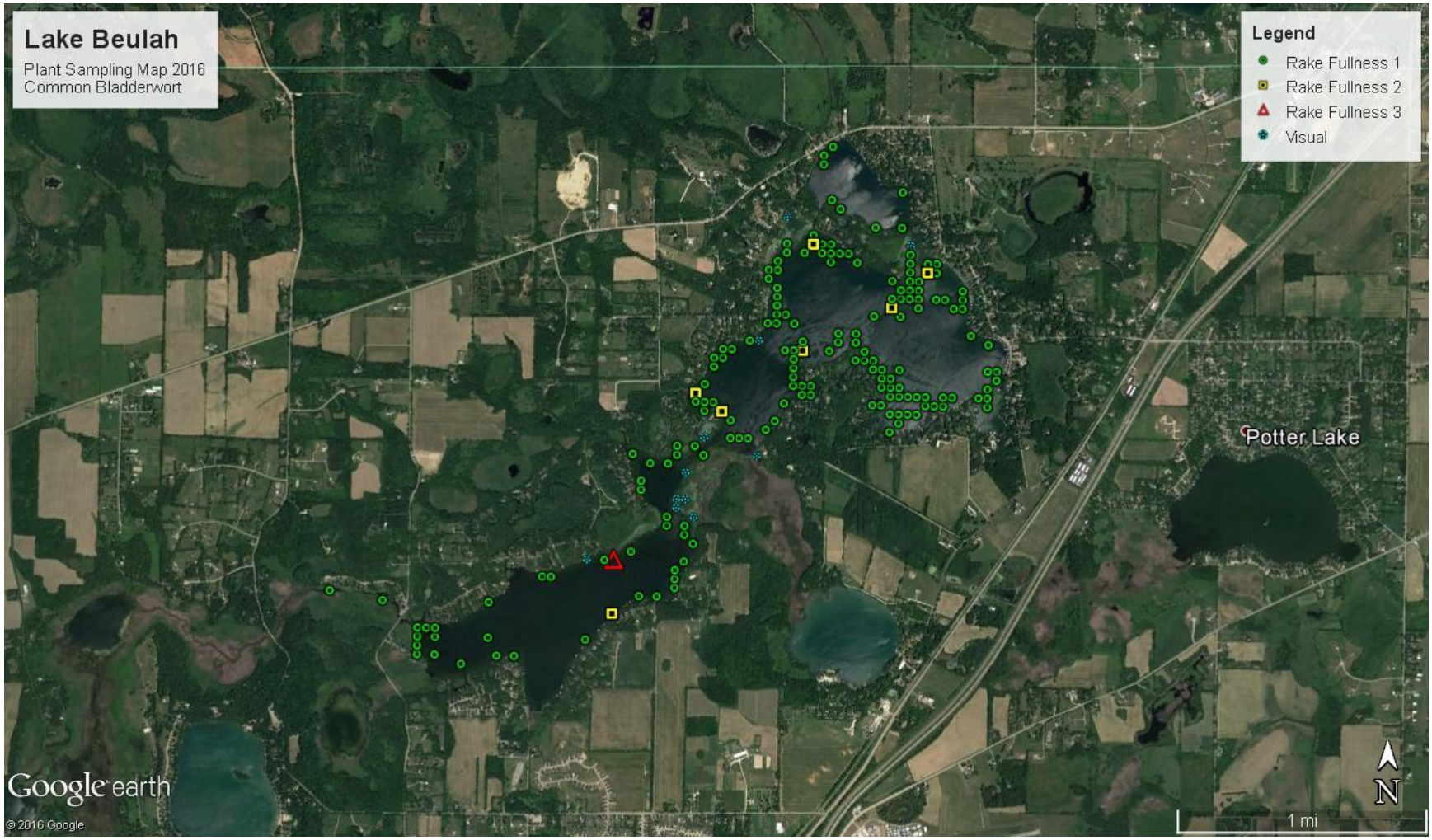


Figure 5: Distribution and density of common bladderwort.

Figure 6: Most Common Native Plant Species (Nitella Flexilis) Densities and Distribution

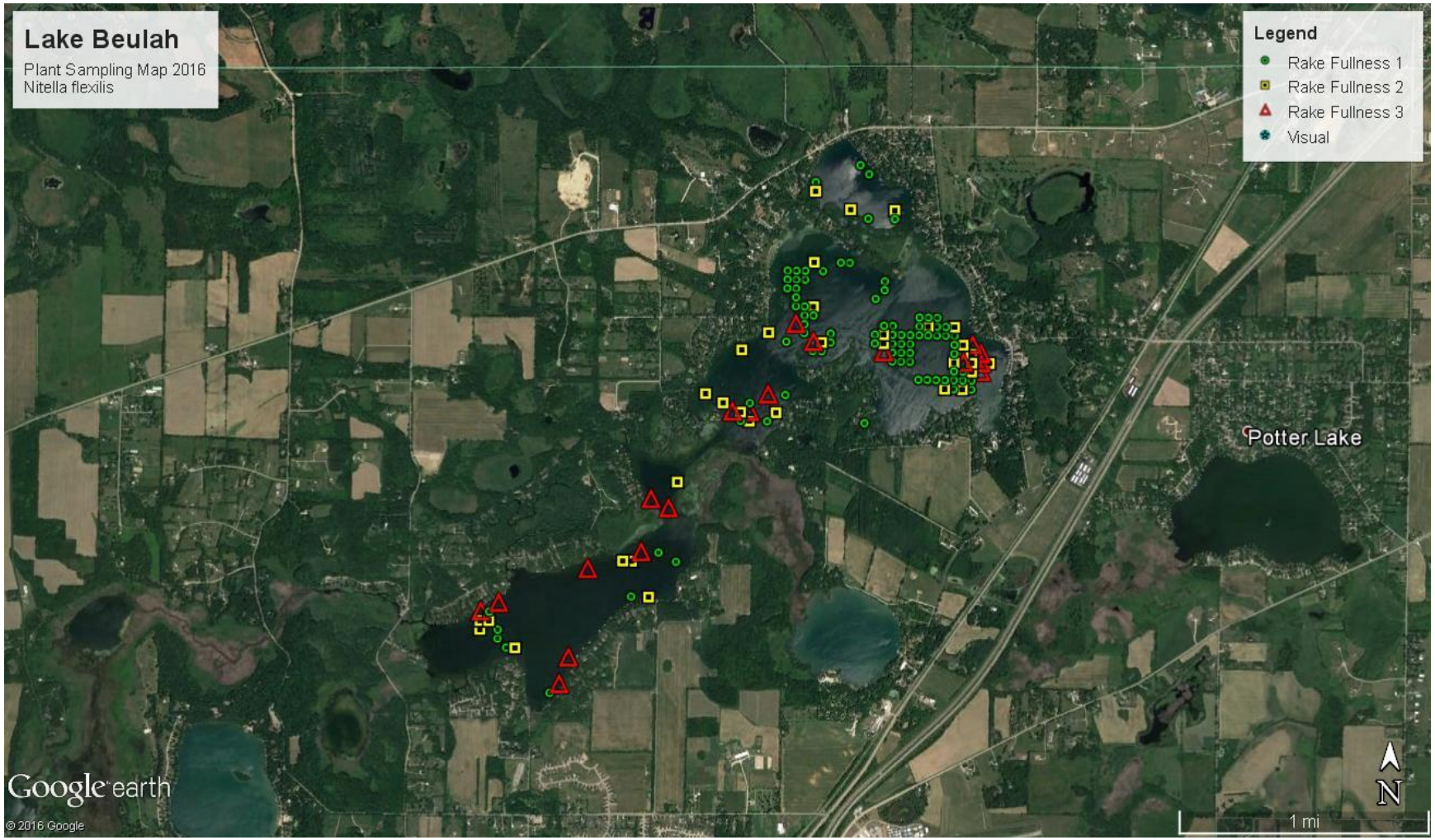


Figure 6: Distribution and density of Nitella flexilis.

Figure 7: Most Common Native Plant Species (Spiny Naiad) Densities and Distribution

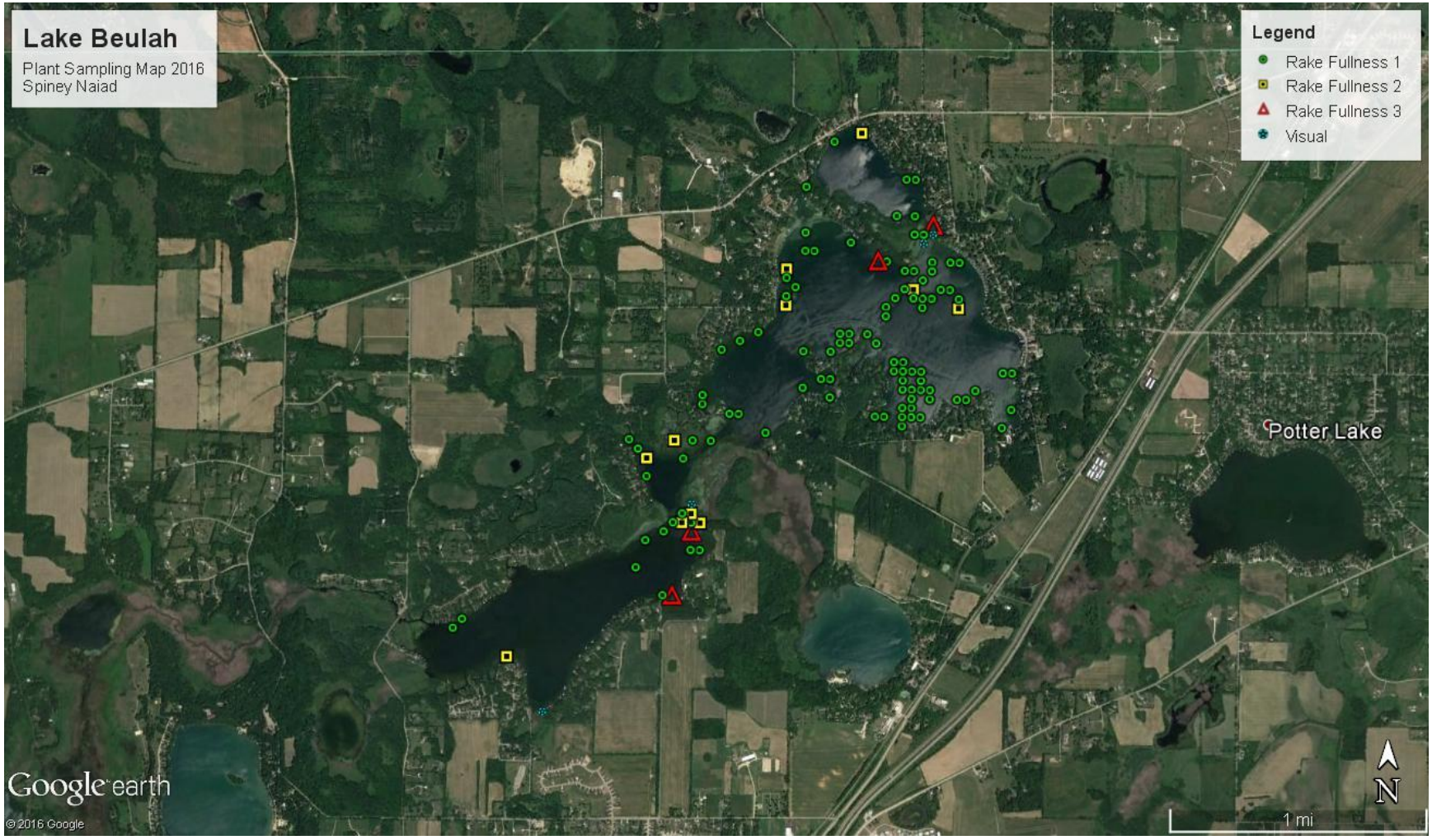


Figure 7: Distribution and density of spiny naiad.

Figure 8: Most Common Native Plant Species (Sago Pondweed) Densities and Distribution

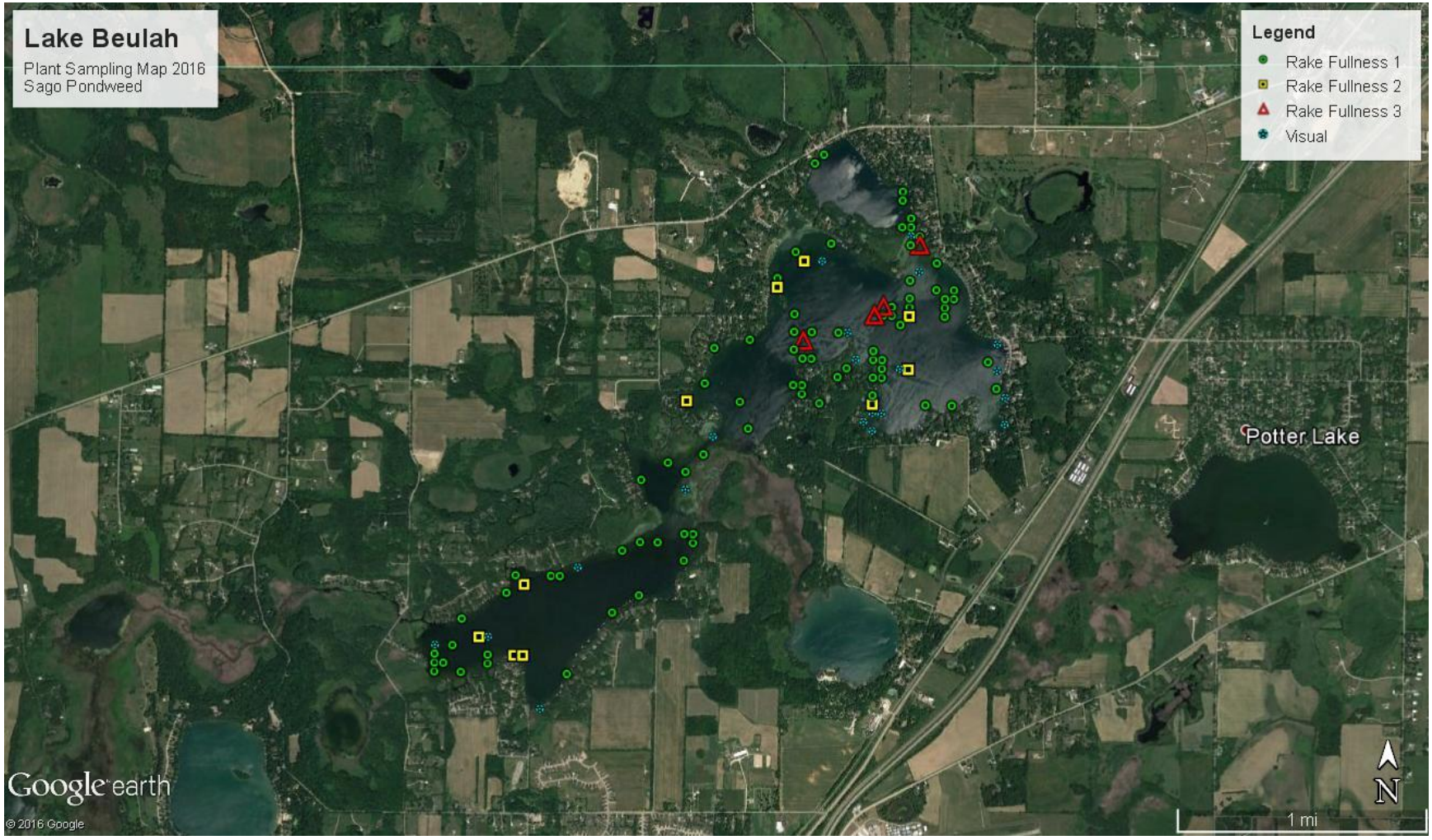


Figure 8: Distribution and density of sago pondweed.

Figure 9: Most Common Native Plant Species (Coontail) Densities and Distribution

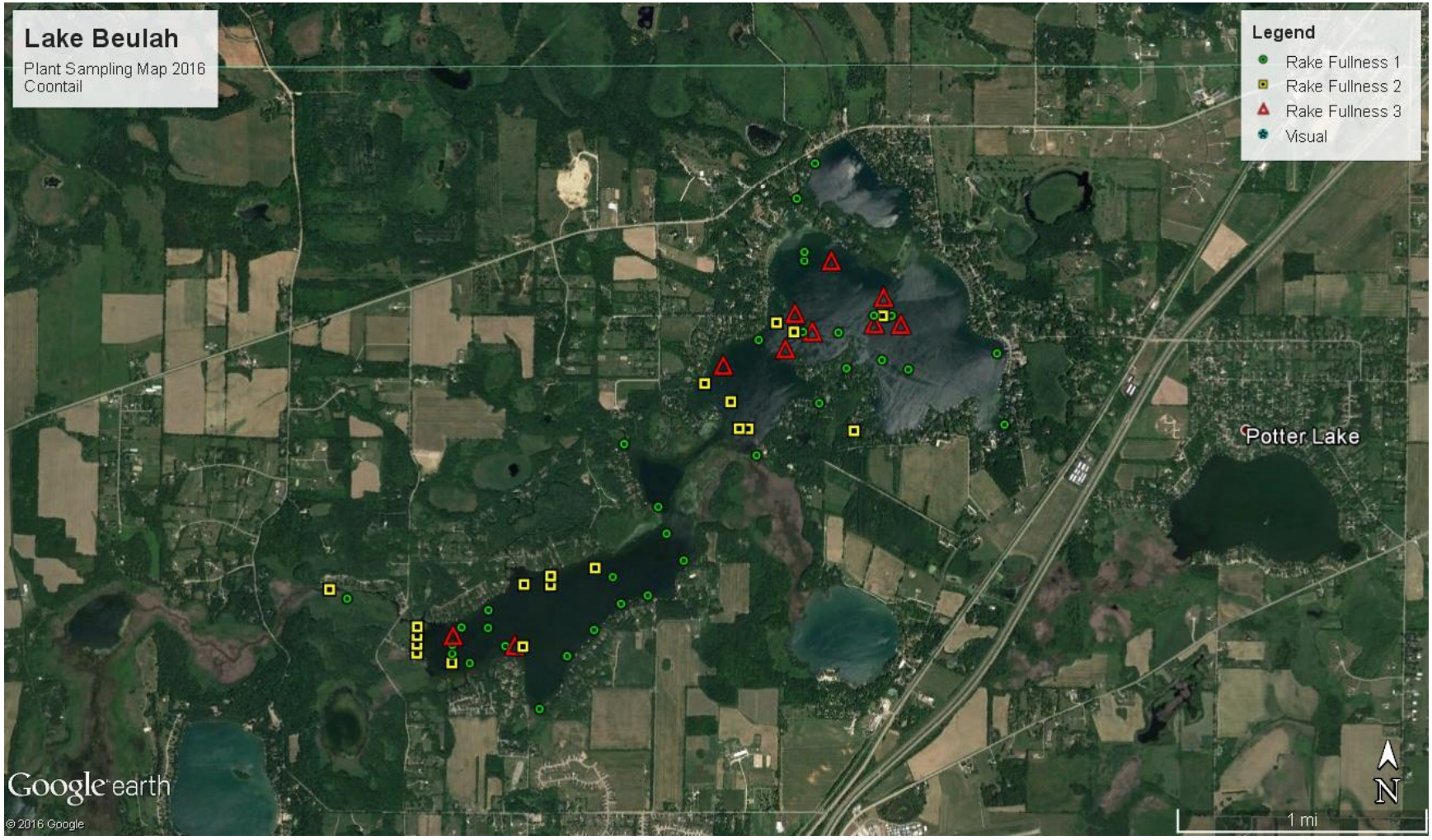


Figure 9: Distribution and density of coontail.

Figure 10: Most Common Native Plant Species (Whorled Water-Milfoil) Densities and Distribution

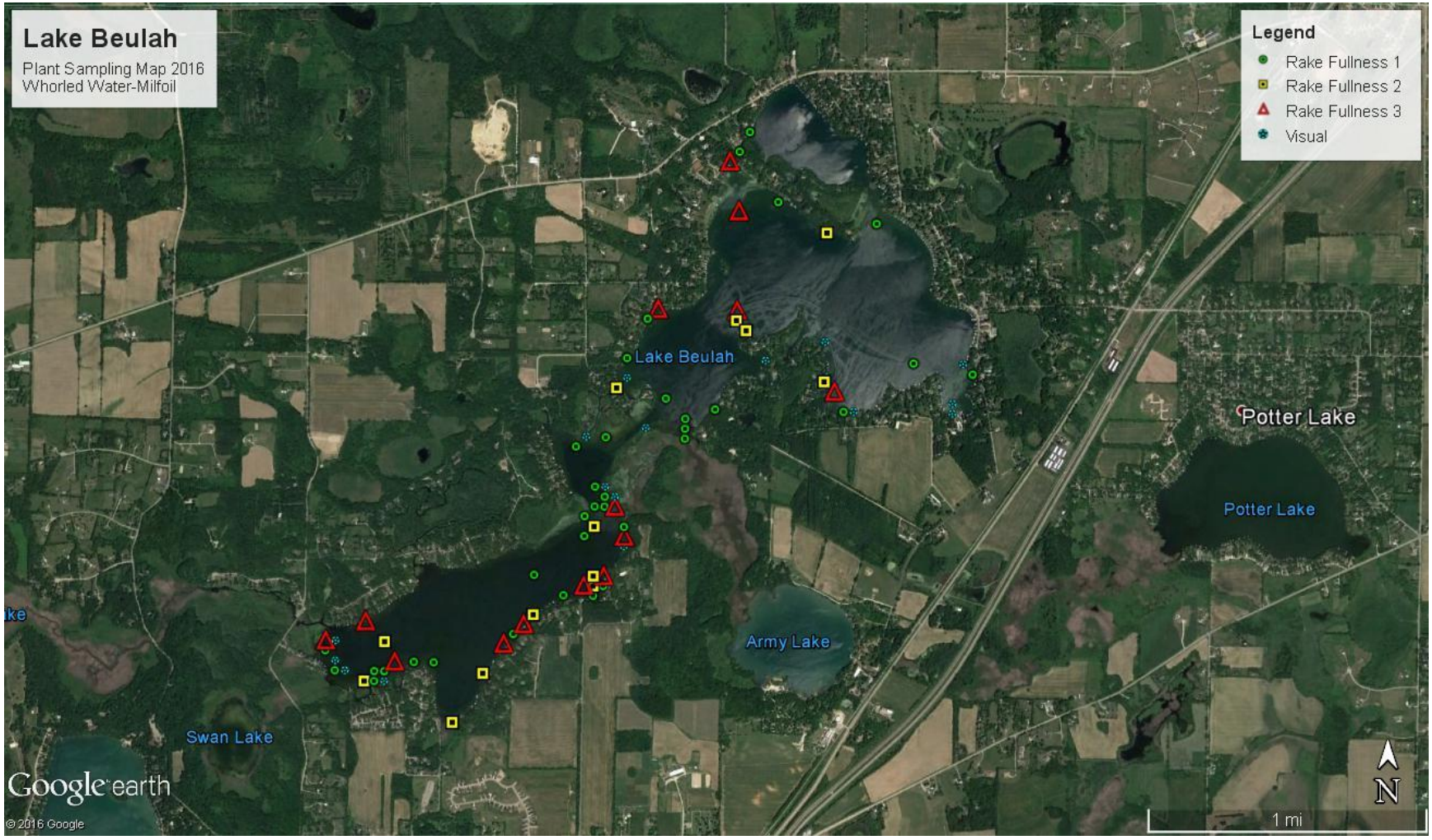


Figure 10: Distribution and density of whorled water-milfoil.

The survey conducted in August of 2016 in comparison to previous surveys show that the aquatic plant life in Lake Beulah is prospering. The 2016 survey resulted in 42 species being present, a large leap from the 23 found in the 2008 survey. The surveys found 19 of the same species, 4 that were found only in 2008 and 23 that were only found in 2016, as shown in *Table 4*: Comparison between 2008 and 2016 Plant Composition and *Table 5*: Comparison of 2008 and 2016 Plant Surveys Continued.

Table 4: Comparison between 2008 and 2016 Plant Composition

2016			
SPECIES	OCCURRENCES	FREQUENCY (%)	AVG. DENSITY
Muskgrasses	401	64.16	1.89
Eurasian water-milfoil (or Hybrid)	108	17.28	1.55
Common bladderwort	178	28.48	1.05
Large-leaf pondweed	3	0.48	1.33
Northern water-milfoil	19	3.04	1.42
Coontail	63	10.08	1.62
White water lily	43	6.88	2.49
Wild celery	60	9.6	1.18
Small pondweed	8	1.28	1
Spatterdock	27	4.32	2.19
Water bulrush	6	0.96	2
Clasping-leaf pondweed	6	0.96	1.17
Floating-leaf pondweed	23	3.68	1.26
Spiny naiad	115	18.4	1.17
Flat-stem pondweed	9	1.44	1
Common waterweed	5	0.8	1.20
Filamentous algae	4	0.64	1
Small duckweed	11	1.76	1.18
Slender naiad	31	4.96	1.32
Alternate-flowered water-milfoil	4	0.64	1
Aquatic moss	2	0.32	1
Arrowhead	1	0.16	1
Blunt-leaf pondweed	1	0.16	1
Cattail	1	0.16	3
Common watermeal	2	0.32	2
Fries' pondweed	25	4	1.04
Illinois pondweed	34	5.44	1.12
Leafy pondweed	1	0.16	1
Narrow-leaved bur-reed	1	0.16	3
Nitella flexilis	137	21.92	1.53
Sago pondweed	96	15.36	1.19
Small bladderwort	1	0.16	1
Softstem bulrush	1	0.16	3
Swamp loosestrife	1	0.16	1
Unknown Pondweed 1	1	0.16	1
Variable pondweed	19	3.04	1.16
Various-leaved water-milfoil	9	1.44	1.44
Water star-grass	4	0.64	1
Watershield	0	0	0
White water crowfoot	2	0.32	1.5
White-stem pondweed	5	0.8	1
Whorled water-milfoil	62	9.92	1.66

2008			
SPECIES	OCCURRENCES	FREQUENCY (%)	AVG. DENSITY
Muskgrasses	470	77.69	2.32
Eurasian water-milfoil	175	28.93	1.54
Common bladderwort	139	22.98	1.12
Large-leaf pondweed	88	14.55	1.22
Northern water milfoil	67	11.07	1.25
Coontail	65	10.74	1.54
White water lilly	61	10.08	1.36
Wild celery	40	6.61	1.30
Small pondweed	39	6.45	1.41
Spatterdock	15	2.48	1
Water bulrush	15	2.48	1
Clasping-leaf pondweed	7	1.16	1.14
Floating-leaf pondweed	6	0.99	1
Spiny naiad	5	0.83	1
Flat-stem pondweed	5	0.83	1
Common waterweed	4	0.66	1
Filamentous algae	2	0.33	1
Small duckweed	2	0.33	2
Slender naiad	1	0.17	1
Yellow pond lilly	55	9.09	1.33
Curly-leaf pondweed	3	0.50	1
Ditch grass	61	10.08	1.79
Sp1	8	1.32	1.50

Table 4: Comparison between 2008 and 2016 Plant Composition

Table 5: Comparison of 2008 and 2016 Plant Surveys Continued

	2016	2008	2016	2008
SPECIES	FREQUENCY (%)	FREQUENCY (%)	AVG. DENSITY	AVG. DENSITY
Muskgrasses	64.16	77.69	1.89	2.32
Common bladderwort	28.48	22.98	1.05	1.12
Spiny naiad	18.4	0.83	1.17	1
Eurasian water-milfoil (or Hybrid)	17.28	28.93	1.55	1.54
Coontail	10.08	10.74	1.62	1.54
Wild celery	9.6	6.61	1.18	1.30
White water lily	6.88	10.08	2.49	1.36
Slender naiad	4.96	0.17	1.32	1
Spatterdock	4.32	2.48	2.19	1
Floating-leaf pondweed	3.68	0.99	1.26	1
Northern water-milfoil	3.04	11.07	1.42	1.25
Small duckweed	1.76	0.33	1.18	2
Flat-stem pondweed	1.44	0.83	1	1
Small pondweed	1.28	6.45	1	1.41
Water bulrush	0.96	2.48	2	1
Clasping-leaf pondweed	0.96	1.16	1.17	1.14
Common waterweed	0.8	0.66	1.20	1
Filamentous algae	0.64	0.33	1	1
Large-leaf pondweed	0.48	14.55	1.33	1.22

Table 5: Comparison of 2008 and 2016 Plant Surveys Continued

The depth of plants found in the 2016 survey is listed in *Figure 10* which shows that there is a wide range in depth that plants colonize. *Nitella flexilis* is the primary species to be growing in depths greater than 21 feet. EWM was prevalent in water depths ranging from 1 to 18 feet. The deep growing plant community is a positive sign of Beulah's health. This deep community is made up of very few species that can exist under those conditions.

The 10-20 feet of depth range shows a very healthy and diverse plant community. There are 20 different species located within this zone, 18 of which exist in the 10-15-foot range, and 9 species between 16-20 feet of water. Table 6 has the list of plants found between 10-15 and 16-20 feet of water.

Table 6: Deep Plants

	SPECIES
10-15 Feet	Alternate-flowered water-milfoil
	Filamentous algae
	Floating-leaf pondweed
	Fries' pondweed
	Illinois pondweed
	Slender naiad
	Small pondweed
	Spiny naiad
	Variable pondweed
	Whorled water-milfoil
	Nitella flexilis
	Common bladderwort
	Flat-stem pondweed
	Sago pondweed
	Muskgrasses
	Coontail
	Eurasian water-milfoil (or Hybrid)
	Wild celery
16-20 Feet	Nitella flexilis
	Common bladderwort
	Flat-stem pondweed
	Sago pondweed
	Muskgrasses
	Coontail
	Eurasian water-milfoil (or Hybrid)
	Northern water-milfoil
	Unknown Pondweed 1

Table 6: Deep Plants

Looking at the shallow region of the lake there are signs of great plant communities that are diverse and dense. At shallower depth light is more abundant making it easier for plants and algal species to photosynthesize, in turn this creates more competition for space. The number of species found in shallow areas are also a positive aspect to the overall plant community health in Lake Beulah. The number of species found at greater depth are much fewer but add greatly to the diversity and range of flora within the lake.

Figure 11: Plant Depth Graph

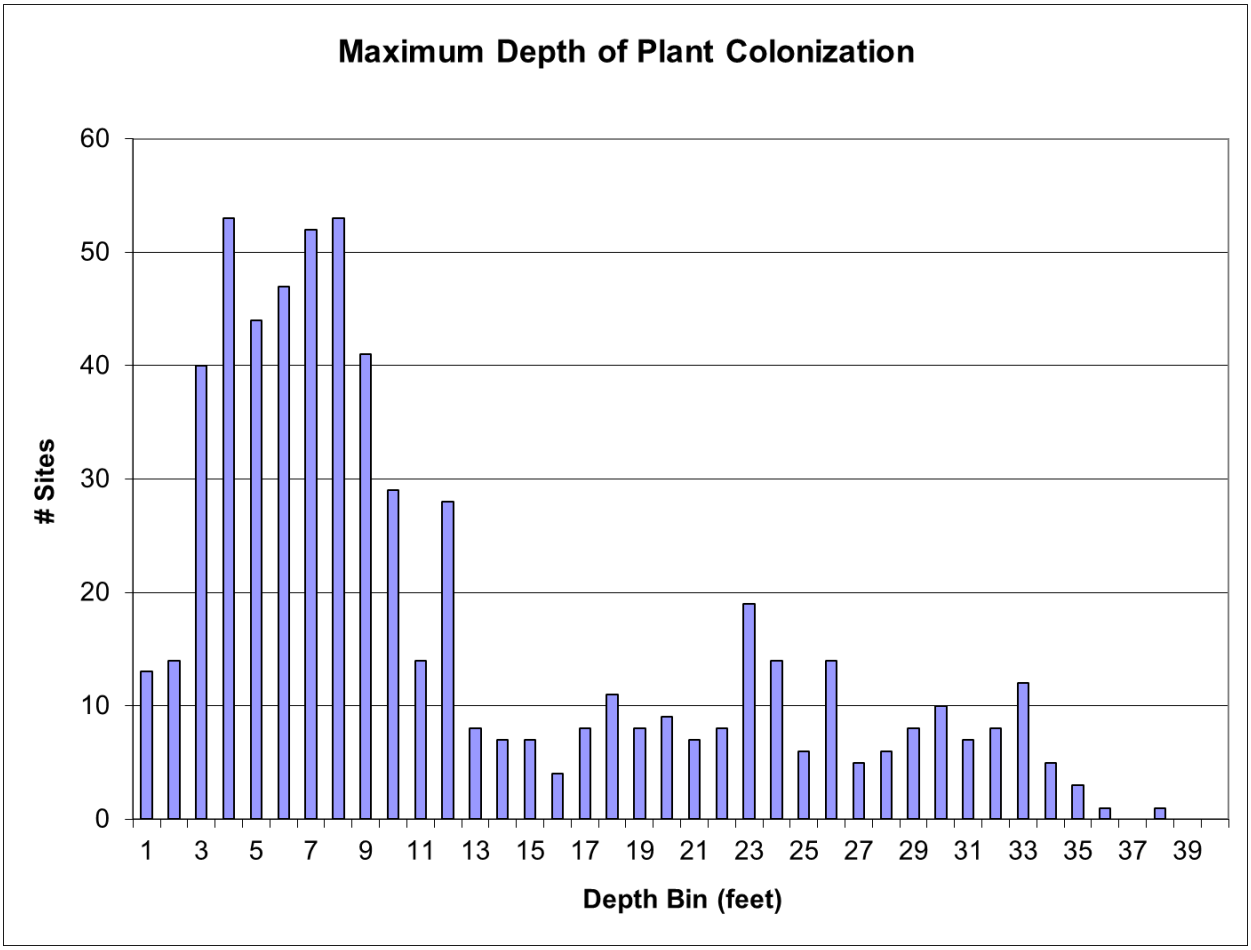


Figure 11: Plant depth graph.

Harvesting Areas

Please note that harvesting areas have changed as per the following statement.

"During our spring 2016 survey, we found the large majority of walleye in the lake congregated for spawning activities in the southern portion of the lake near the seminary (roughly along the shoreline from points 190 through 375). After hatching, larval walleye can be expected to reside in nearby plant beds for shelter and feeding. Restricting the initiation of plant harvest in this area until June 15th would give young walleye time to acclimate to their surroundings and possibly migrate out of the immediate spawning area, thereby likely reducing incidental take during harvest activities. If possible, I would also like to see navigation channels restricted to a 30' width in areas where the plant community is particularly diverse or valuable. Beulah seems to have an excellent plant community that serves the resident fish species very well, providing anglers with a great range of opportunities. These two restrictions should help take advantage of the diversity found in the macrophyte community and further enhance habitat conditions within the lake."

-Luke Roffler, Senior Fisheries Biologist – Racine, Kenosha and Walworth Counties. Wisconsin Department of Natural Resources

The following map indicates areas available for harvesting operations. There are three categories for harvesting, green, yellow and blue. Each harvesting zone will fall into one of these groups. All zones are allowed 30 foot navigational cutting lanes. Green is approved areas, yellow are restricted to EWM and navigational cutting ONLY. Blue is approved for harvesting after June 15th, to allow for young-of -the-year fish species to thrive.

Harvesting operations must consider each of the following while functioning within the lake.

- Avoid dense stands of native species
- Top cut dense stands of Eurasian Water-milfoil
- Fish collected should be returned safely back to the lake
- Maximum cutting depth is ONE-foot above the sediment

Figure 12: Lake Beulah Harvesting Map 2017

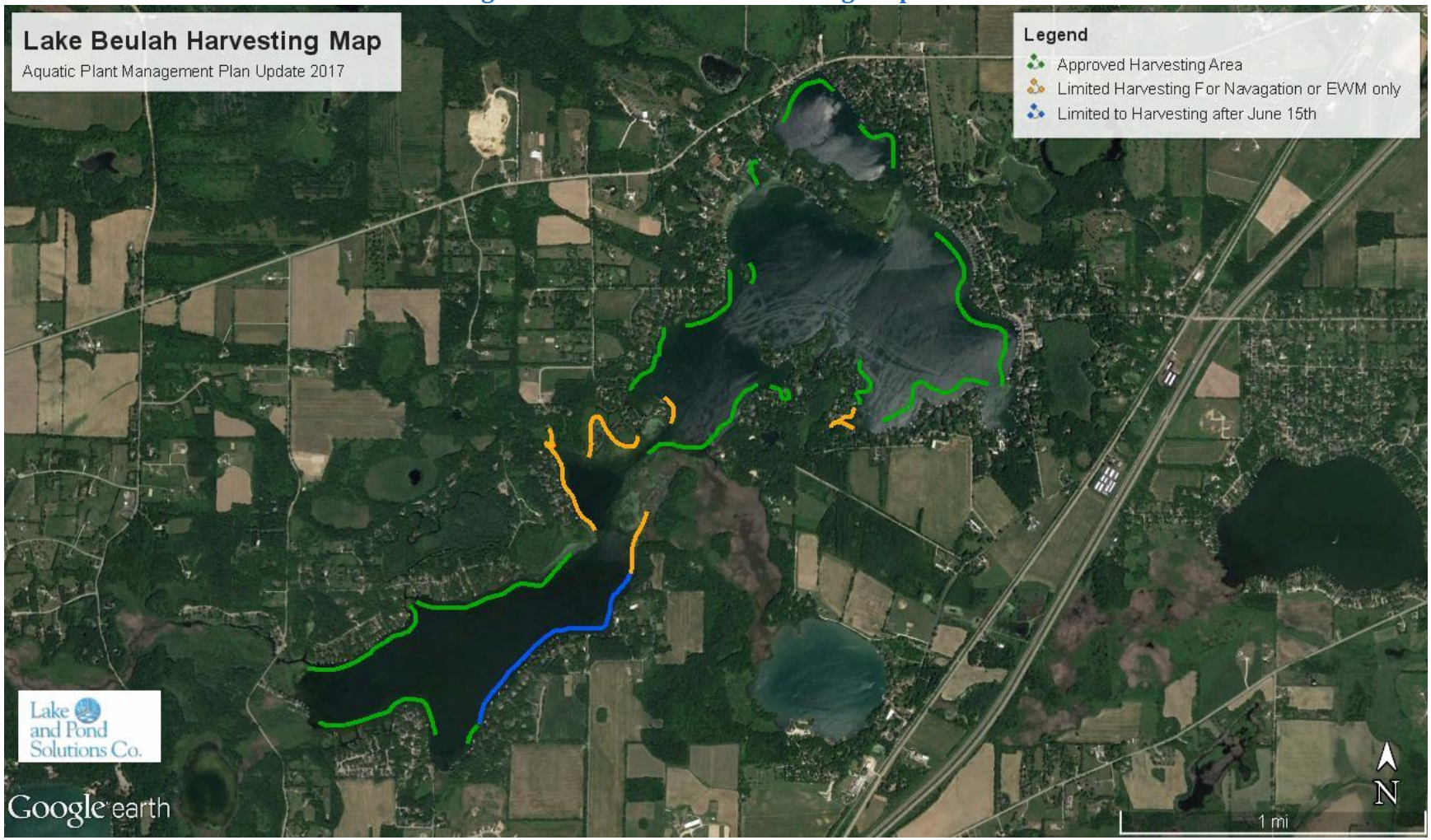


Figure 12: Lake Beulah harvesting map 2017.

Rapid Response Plan

Rapid response to a new aquatic invasive is imperative. But, the first step is ensuring that it is, in fact, an invasive species not previously found on the waterbody.

If a suspected invasive species is found:

- Take a digital photo of the plant in the setting where it was found and mark with a GPS (if possible). Then collect 5 – 10 intact specimens. Try to get the root system, all leaves as well as seed heads and flowers when present. Place in a Ziploc bag with no water. Place on ice and transport to refrigerator.
- Fill out form http://dnr.wi.gov/lakes/forms/3200-125-plantincident.pdf.
- Contact the WDNR Aquatic Invasive Species Contact (currently Heidi Bunk, WDNR Lakes Biologist) and deliver the specimens, report, digital photo and coordinates (if available). Do this as soon as possible; but no later than 4 days after the plant is discovered. The Lake Beulah Management District and current lake consultant should also be notified.

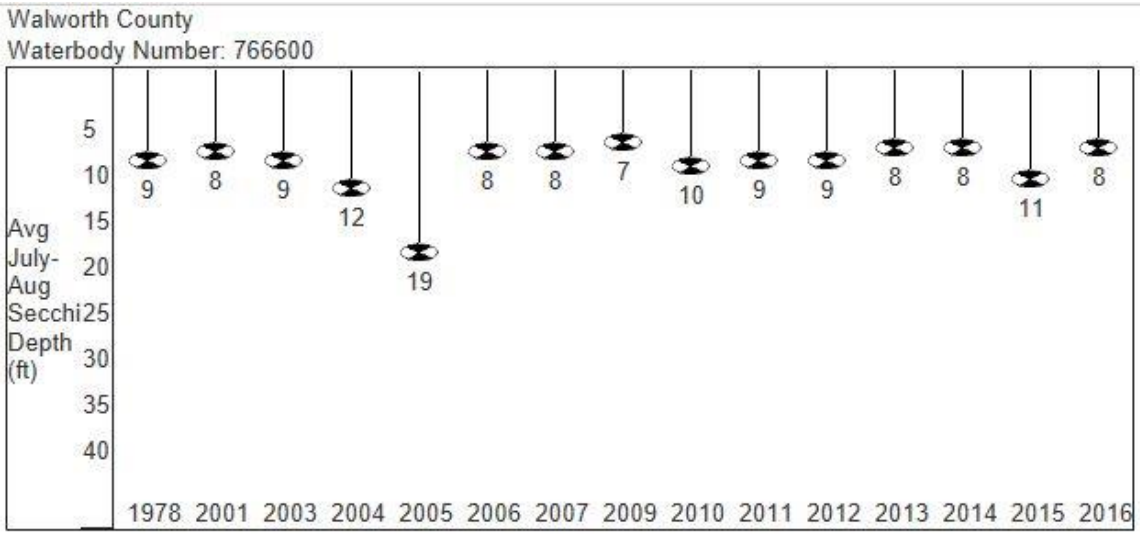
Upon determination of species, a coordinated response plan should be developed in consultation with the WDNR, the governing townships, Lake Beulah Management District and lake consultant(s) as needed.

References

Nichols, SA. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management, 15(2):133-141.

Appendix A

Figure 12: Historical Secchi Disk Data Lake Beulah – Deep Hole



Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1978	9	8	10	2
2001	8	8	8	1
2003	9	8	10	2
2004	12	9	15	2
2005	19	19	19	1
2006	8	8	8	1
2007	8	7	9	2
2009	7	7	7	1
2010	9.5	9.5	9.5	1
2011	8.9	6.5	11.3	2
2012	9	8	10	2
2013	7.5	7	8	2
2014	7.5	7	8	2
2015	11	11	11	2
2016	7.5	7	8	2

Report Generated: 01/30/2017

Figure 13: Historical secchi disk data, Lake Beulah- deep hole.