Lake Keesus Aquatic Plant Survey

Lake and Pond Solutions Co.

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Lake Keesus Aquatic Plant Survey Results August 2017

Goal Statement

Development of the Lake Keesus aquatic plant management plan and revision intends to continue to balance the long-term recreational use and ecological diversity that Lake Keesus has maintained in its history. Consideration of various recreational users and the ability of the system to sustain a healthy biological community have been analyzed to accomplish conceivable goals.

The Lake Keesus Aquatic Plant Management Plan was a cumulative planning effort. Information and recommendations provided are based on public input from concerned adjacent lake residents, ecological data, and the guidelines provided by the Wisconsin Department of Natural Resources for aquatic plant management planning.

Three public meetings were held in 2008-2009 to provide information and education to adjacent lake residents regarding current ecological status of Lake Keesus, management options, and threats posed by aquatic invasive species. The objectives of the meetings were to gather local input on acceptable management techniques and to obtain overall goals for Lake Keesus in the future which are provided below.

Lake Keesus APM Goals

1. Maintain a variety of water-oriented recreational opportunities for lake users while promoting lake access in an environmentally sound way. Recreational opportunities are of the utmost importance to the residents of Lake Keesus.
2. Protect and restore valuable and sensitive fish and wildlife habitats.
3. Minimize impacts of existing aquatic invasive species to the lake ecosystem and prevent the addition of new aquatic invasive species.
4. Educate district landowners and lake users about the benefits of aquatic vegetation and the threats posed of aquatic invasive species to the lake ecosystem.

Introduction

Lake Keesus is located within the town of Merton, Waukesha county, WI. The lake is 235 acres and has a shoreline length of approximately 5.3 miles with a maximum depth of 46.5 feet. This body of water is spring fed and is drained by an unnamed tributary of the Oconomowoc River. The substrate consists of approximately 30% sand, 20% gravel and 50% muck according to the Wisconsin DNR website (dnr.wi.gov). Due to the steep shoreline in the main portion of the lake, most of the plant growth was found within the three bays to the South.

The Lake Keesus Management Plan was originally developed by Hey and Associates, Inc. in 2009 and distributed to the Lake Keesus Management District and the Wisconsin Department of Natural Resources. The following, updated aquatic plant survey will assist the District and state aquatic plant managers when implementing future management programs.

Comprehensive Point Intercept Survey Methods

An aquatic plant point-intercept survey was conducted in august 2017 using 471 predetermined sample locations, as was previously done in 2007, and 2012. Sample locations were provided by the WDNR (Figure 8) and were systematically organized to produce homogenous sampling analysis from previous data. Each sample site was downloaded onto a Delorme Earthmate GPS PN-20 for ease of navigation from site to site, as well as a *Humminbird 899 Ci HD* to determine depth at each sample location where depth was greater than seven feet. At locations seven feet and shallower a PVC measuring pole was used, and sediment type determined.

Each location generated one of five designations:

1) **Non-navigable Sites** were designated to indicate sample locations with shallow water and dense vegetation. Visual identification was recorded in these sites.

2) **Terrestrial** indicates sample sites that are located on terrestrial habitat.

3) **Pole Rake Sites** include points that were in less than 7 feet of water. A long-handled, double-headed sampling rake was lowered to the sediment and rotated twice to accurately represent the aquatic vegetation found at these sites.

4) **Rake-on-a-Rope Sites** were points that had a depth greater than 7 feet and a double headed rake-head was attached to a rope and dragged along the bottom to capture plants at deeper depths.

5) **Deep Sites:** Aquatic plant growth was consistently found no deeper than 22 feet. Sample points beyond 22 feet were designated as "deep sites" and did not merit sampling after numerous attempts at plant retrieval. However, two sites that exceeded this depth were found to have coontail and/ or Nitella *flexilis* during random rake throws.

The ***Density*** of a specie is indicated using a scale of 1-3 to describe rake fullness, 3 being the most-dense.

Frequency describes the number of times a species was found, divided by the total number of vegetated sites. The ***Relative Frequency*** of a plant species collected describes each species contributing a certain percentage of the whole plant community (totaling 100%).

Floristic Quality Index
Since each lake possesses unique ecological characteristics, comparing lake biological health can be difficult. The Floristic Quality Index (FQI) attempts to identify natural conditions within the system, monitor long-term floristic trends, and to monitor restoration efforts[1].
The FQI for any area is represented as: the floristic quality (I) equals the average coefficient of conservatism (C-value) times the square root of the number of native species (√N).

I = "C-Value" x √N

Results

Of the 471 sites 426 were visited due to navigational limitation (non-navigable sites and terrestrial sites). More specifically, 77 sites were sampled with the pole rake, 150 sites were sampled with the rake-on-a-rope, 35 sites were non-navigable, 10 sites were on land and 200 sites were deeper than the 22 feet (the maximum depth at which growth was sampled). 72.26% of sites shallower than 22 feet contained growth.

There were 31 total species identified, which includes the two exotic, invasive species, Eurasian water-milfoil (EWM) and curly-leaf pondweed (CLP). These species were also discovered in both the 2007 and 2012 point-intercept surveys.

EWM was found at 53.4% in 2007 and then 61.3% in 2012 within the vegetated sample sites. CLP was found at 31.6% in 2007 and 0.5% in 2012. The current survey in 2017 found EWM at 41.92% of vegetated sites and CLP at 12.63%

Some of the most dominant aquatic plants identified other than EWM and CLP in the 2017 survey were muskgrass (*chara sp.*), coontail (*Ceratophyllum demersum*), wild celery (*Vallisneria Americana*, Illinois pondweed (*Potamogeton illinoensis*), and filamentous algae). All of which are comparable, besides filamentous algae, to the previous surveys. Density rating maps are provided for the top five most abundant plants, and all invasive species. These maps can be seen in Figures 3-9.

Many of the surveyed aquatic plant species of Lake Keesus can be seen with a short description in Appendix C where plant presses of each species are also provided from previous surveys.

Floristic Quality Index
According to the survey completed in 2017, the Lake Keesus FQI is 27.6, far above the Swink and Wilhelm[2] Wisconsin average of 20.9 for this area. Comparatively in 2012 the FQI was 20.2 and 24.6 in 2007. The shift towards a higher floristic quality is likely due to the identification of several high-quality species not previously sampled. Though it is encouraging that the FQI has increased so drastically within the past five years it should be mentioned that many of these species are not abundant, being sampled typically only a handful of times.

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[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.

[2] Swink, F. and Wilhelm, G. 1994. *Plants of the Chicago Region*, 4th ed, 921 Indianapolis: Indiana Academy of Science.

Discussion

Relative to other lakes in southeast Wisconsin, the Lake Keesus aquatic plant diversity is slightly above average. Invasive species do exist within Lake Keesus and with persistent management they can be kept in check. Without proper management, it is possible for species like Eurasian Water-Milfoil (EWM) and Curly-Leaf Pondweed (CLP) to create a mono-culture due to their advantageous growth habits and characteristics.

CLP was found at 25 sites; this seems predictable based on previous surveys and the time of year the 2017 survey was conducted. This is because CLP is a cold-water species and can germinate before ice-out. The current survey was taken in August of 2017, several months after typical CLP resurgence. Its early growth is advantageous and creates a canopy that prevents sunlight penetration to native plants. Ultimately, navigation and recreation suffer due to the high biomass and an early senescence period.

EWM reflected a noteworthy 19.38% decrease within vegetated sites from the 2012 survey. Like CLP, EWM can threaten navigational/recreational use, water quality, and biodiversity within lake ecosystems. EWM has gained recognition through its unique ability to invade a body of water. The germination period is much earlier than our native plants, creating a sunlight barrier to bottom sediments and potential native growth. EWM also persists throughout the entire growing season and can spread through fragmentation (see harvesting section for additional warnings).

Coontail is a native plant that was surveyed abundantly in all surveys. Although it can grow in high densities, it should be managed to reduce populations, not to eradicate. Coontail is an effective nutritional buffer, storing nutrients like phosphorus and nitrogen. Nitrogen and phosphorus are an important consideration as these nutrients will fuel nuisance algae and cyanobacteria blooms.

Wild celery is an important macrophyte for wildlife and was surveyed frequently during the 2017 sampling. It serves as a valuable food for waterfowl, other marsh birds, and muskrats. It is currently listed as a “high-value” species by the WDNR. Wild celery is typically protected and seldom creates navigational or recreational issues. On occasion wild celery may become a hinderance to lake usage during its cycle of “auto-release” in the late summer season, an unavoidable characteristic of its reproductive cycle.

An important abundant species surveyed in Lake Keesus is *chara sp*. Although an alga, it is often mistakenly identified as an aquatic plant. *Chara* is valued for its ability to absorb nutrients and clarify the water. *Chara* can grow in thick mats across the substrate and occasionally becomes an issue for navigation and recreation in shallow water. It seldom requires control and should never be completely eradicated. *Chara* is an important food source for waterfowl and serves as habitat for fish, especially bass and pan-fish.

Filamentous alga is quite common within Lake Keesus. It was sampled at 45 of the 426 sites visited. This type of algae is associated with higher levels of nutrients and more stagnant conditions. During the 2017 survey this alga was found mainly in the middle bay, covering much of the lake bottom.

Harvesting Information

On-going harvesting should target areas of non-native growth with the intent to reduce surface growth and encourage native species. Based on our 2017 sample, there is no evidence to support a significant change or deviation from the 2009 aquatic plant management strategy. Harvesting lanes and depths have been defined within the harvesting recommendation section below.

Harvesting equipment used throughout Lake Keesus:

- Aquatic Harvester HM-420
- Shore Conveyer S/C-23
- 2003 GMC C5500 Dump Truck

Figure 1: Aquatic Weed Disposal Site

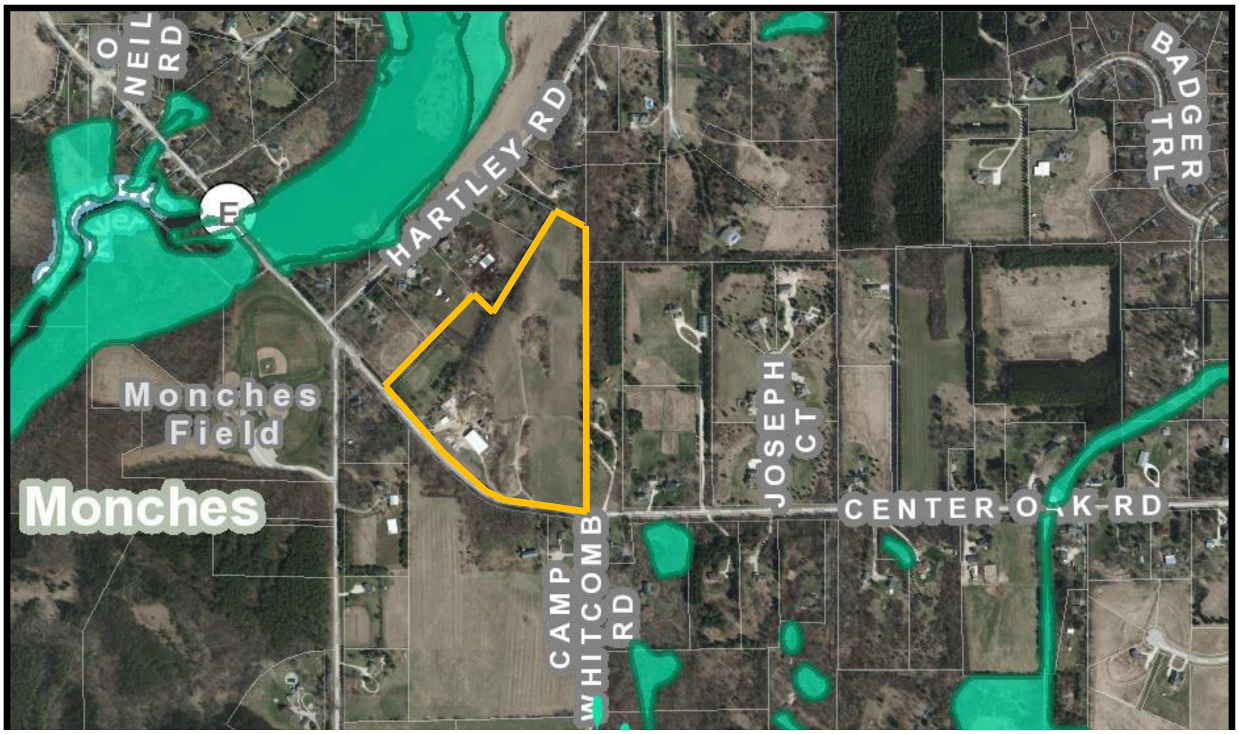

Figure 1: Weeds disposed at the property of Don Cull, W294 N9248 Center Oak Road, Hartland, WI 53029

*Green areas are designated wetlands. This property is not within a WDNR designated wetland.

Figure 2: Haul Route Map

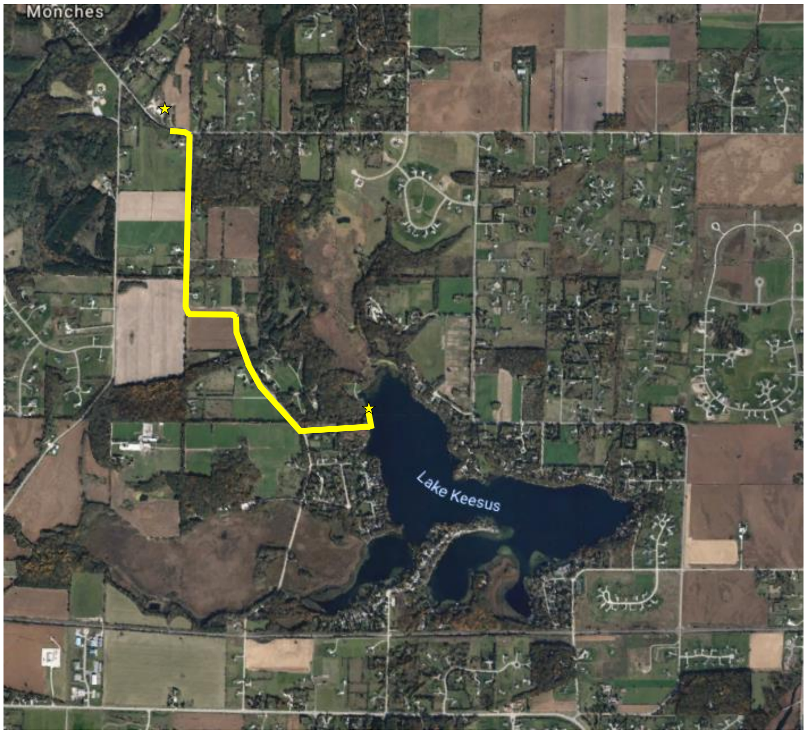

Figure 2: Haul route map from Lake Keesus to the disposal sight.

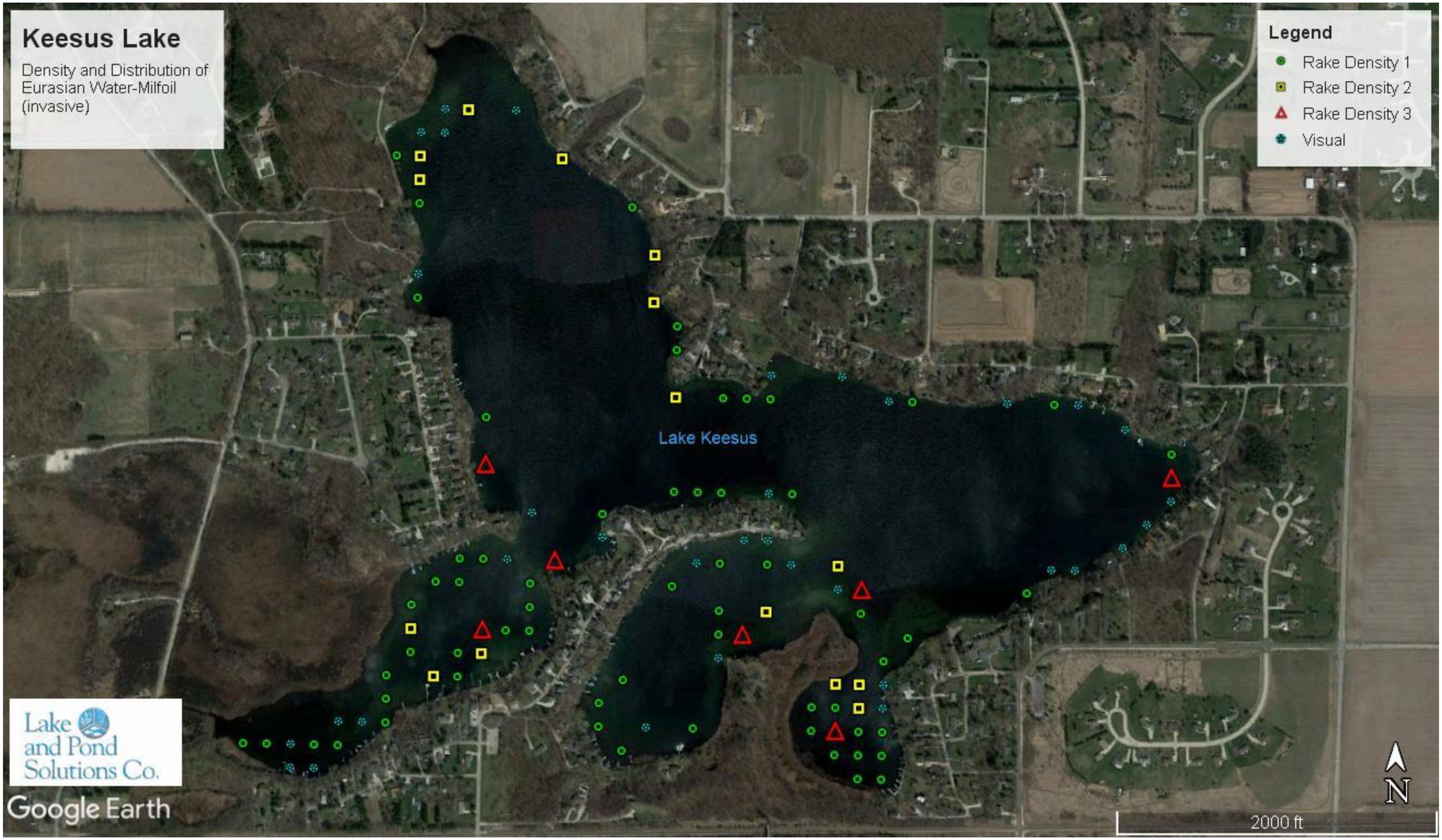

Figure 3: Eurasian Water-Milfoil (invasive) densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

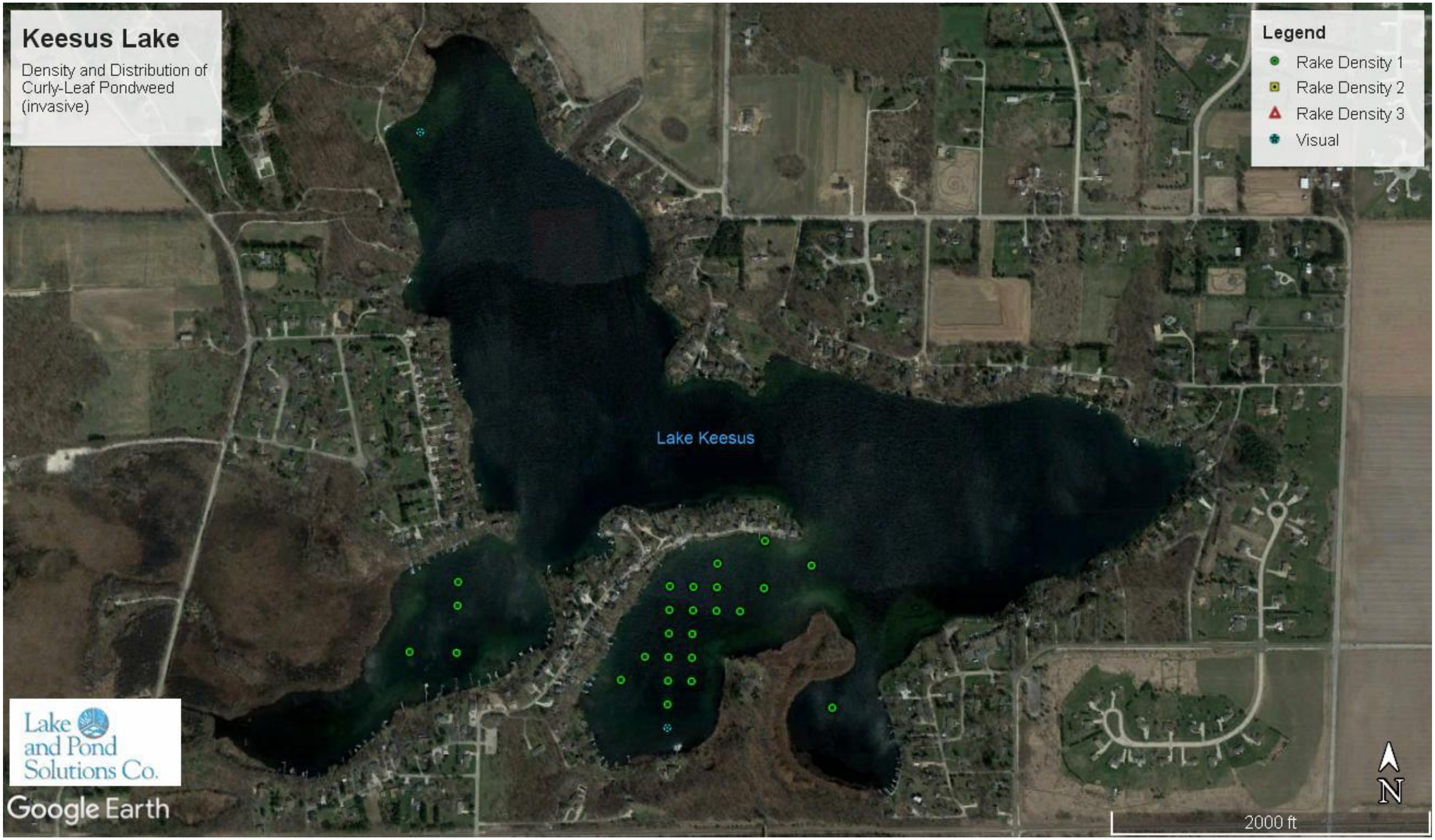

Figure 4: Curly-Leaf Pondweed (invasive) densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

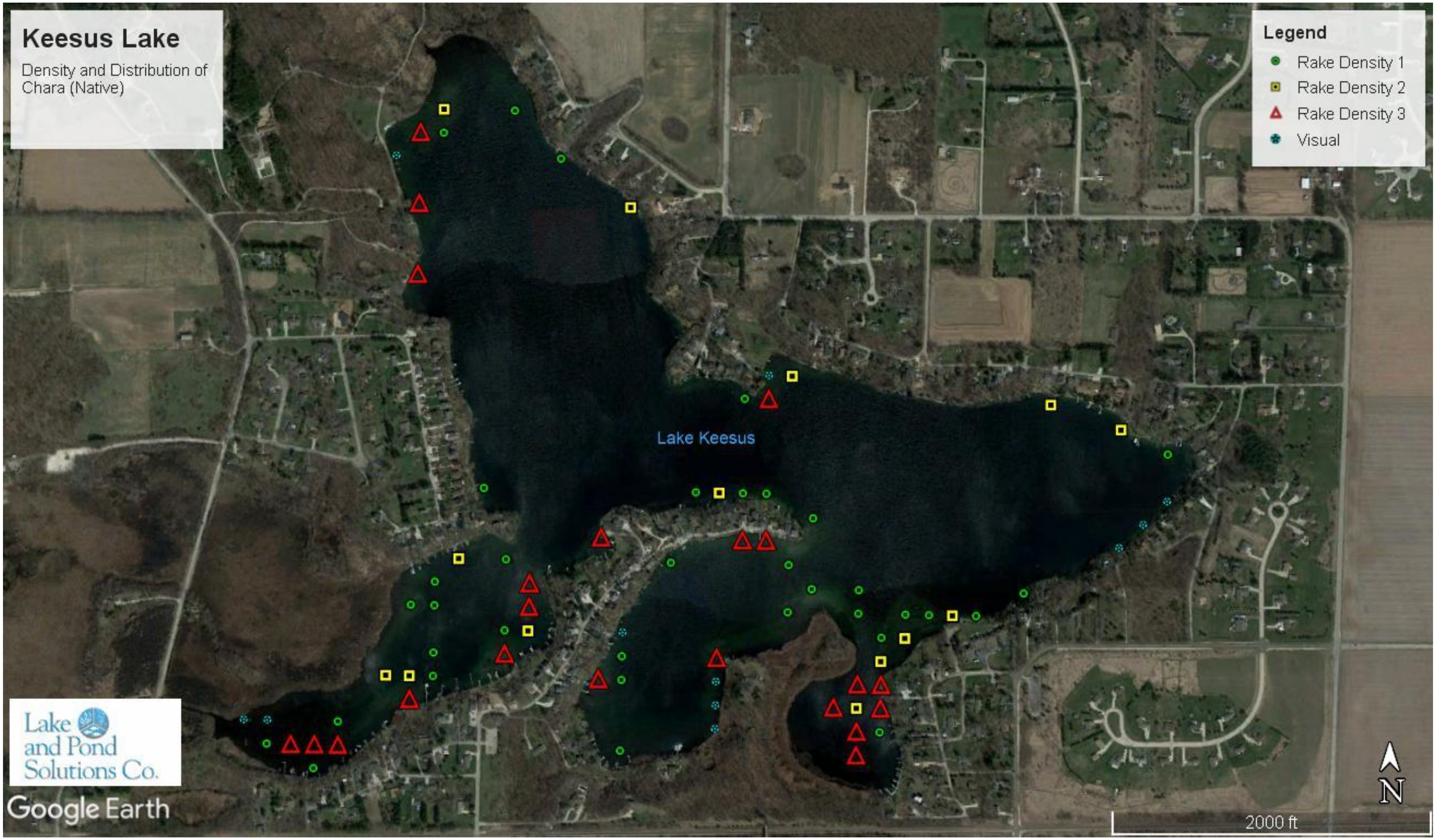

Figure 5: Chara (native) densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

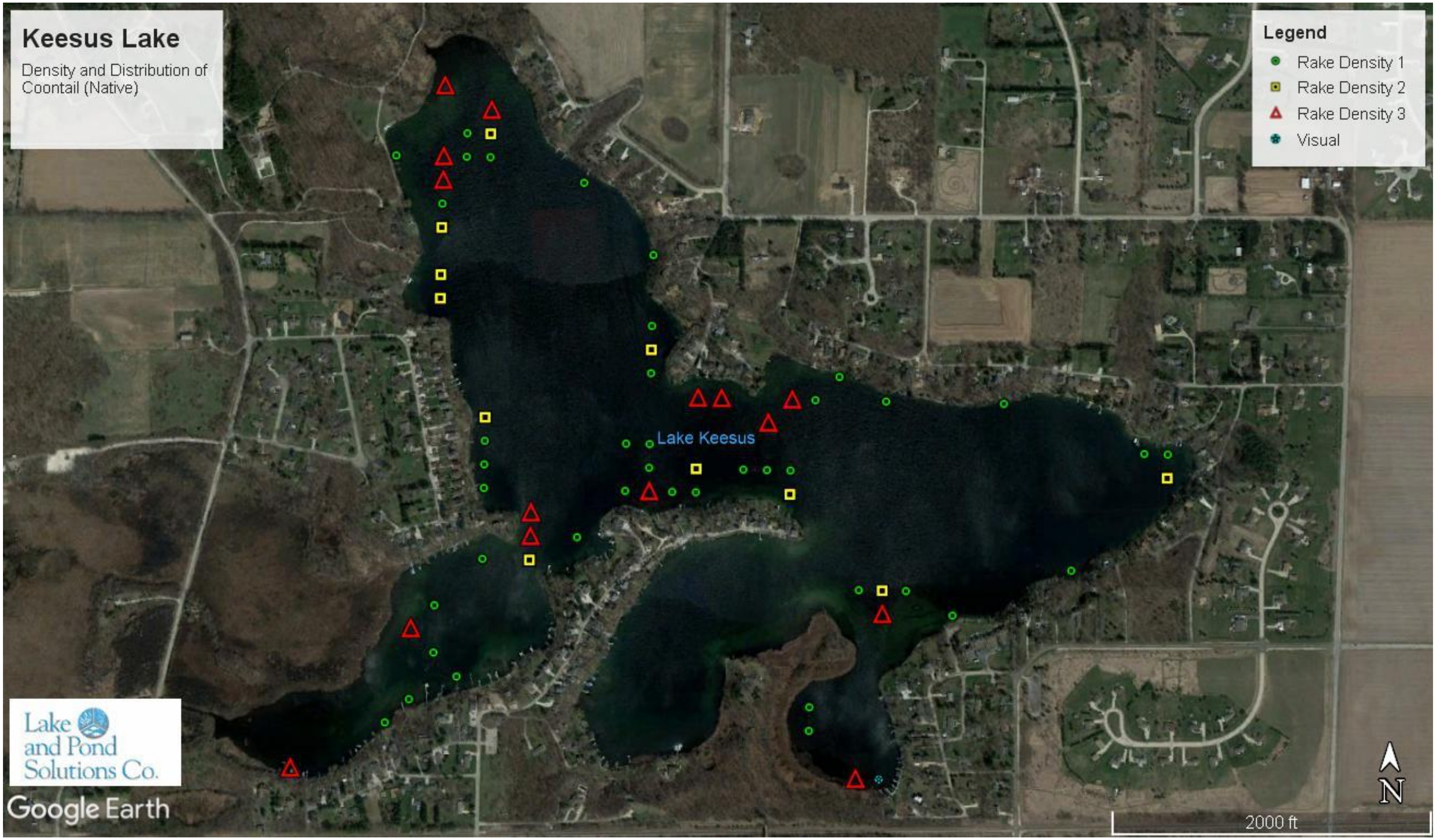

Figure 6: Coontail (native) densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

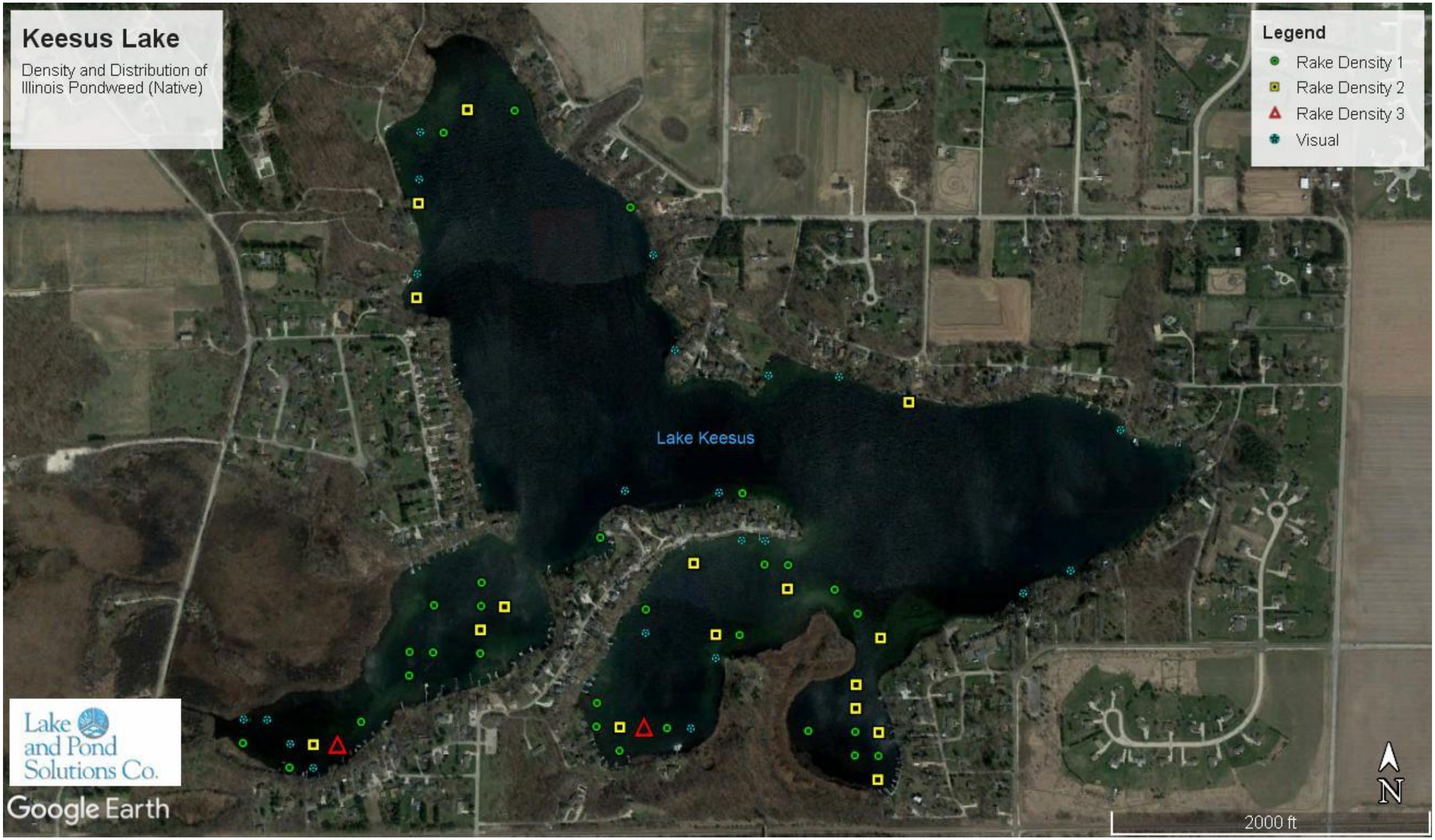

Figure 7: Illinois Pondweed (native) densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

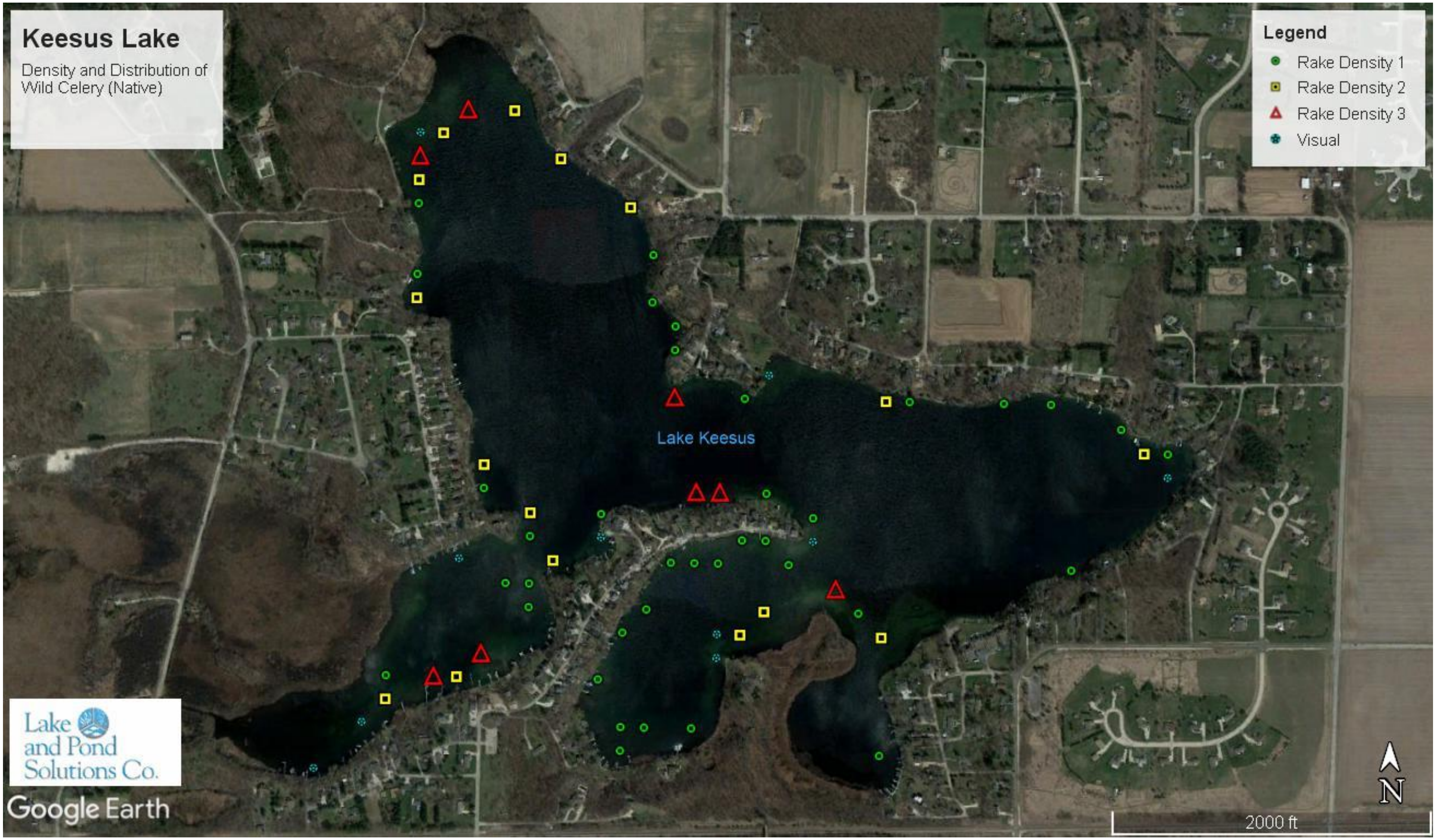

Figure 8: Wild Celery (native) densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

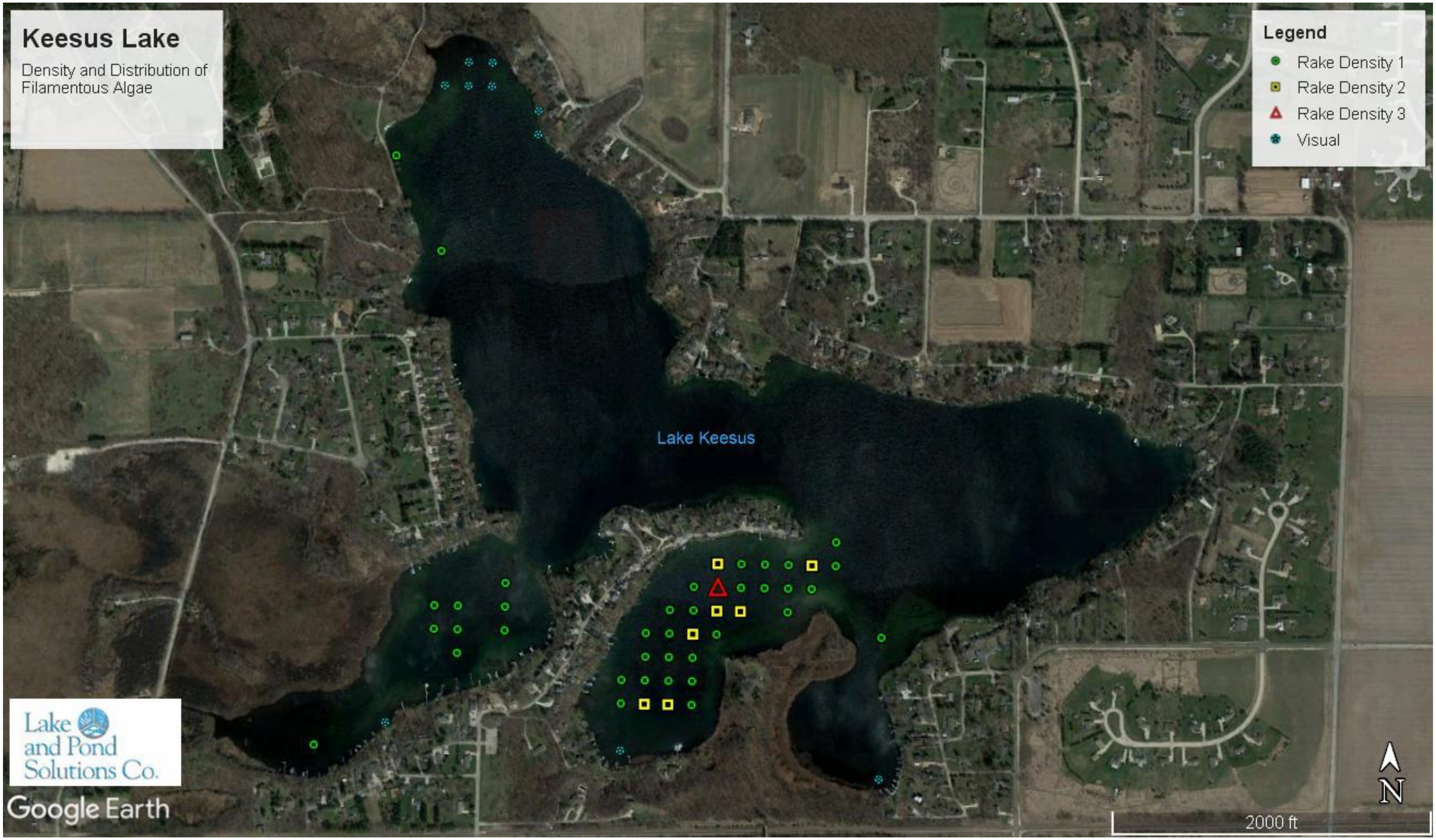

Figure 9: Filamentous Algae densities and distribution within Lake Keesus during the august 2017 point-intercept survey.

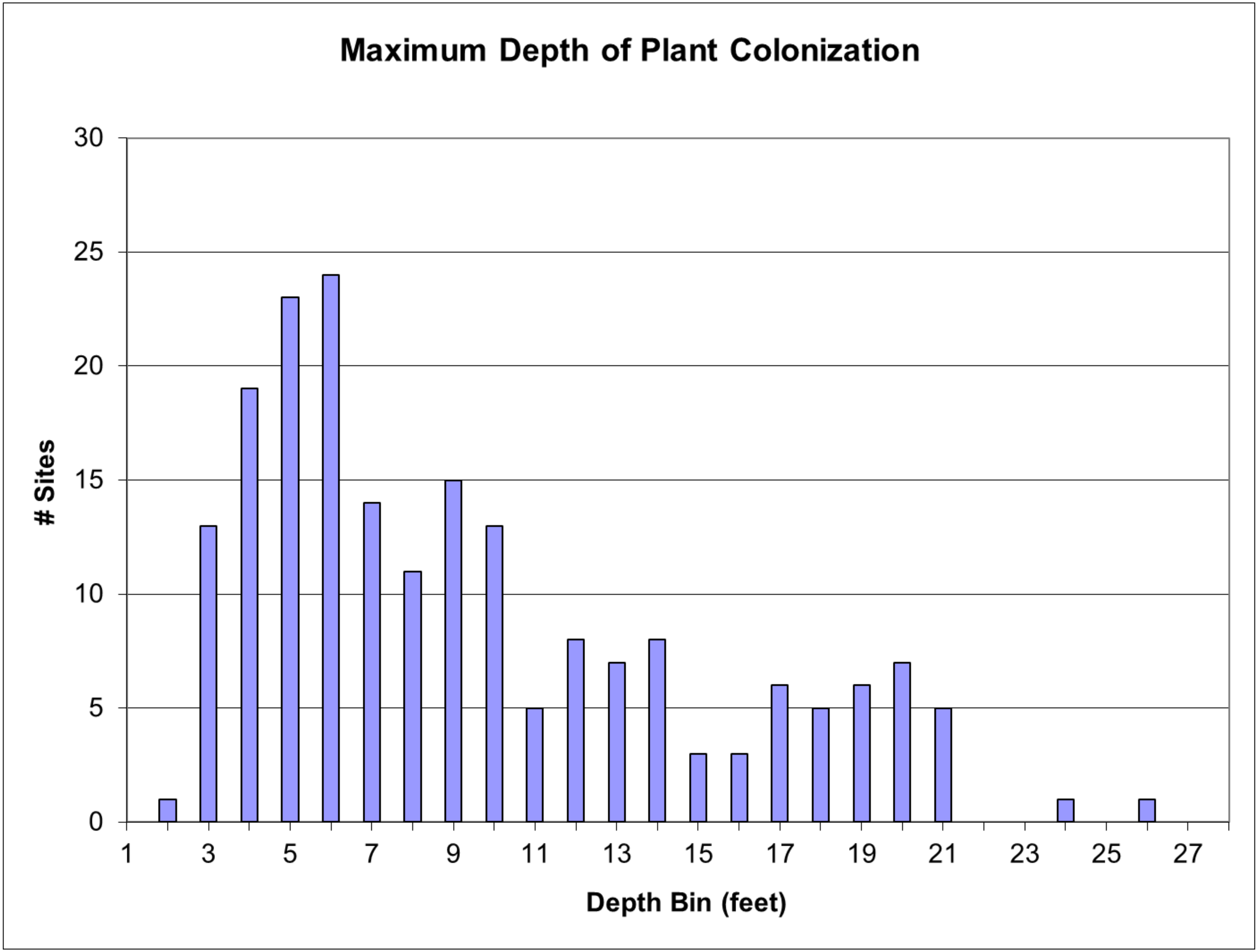

Table 2: Depth of sampled sites containing vegetation.

Lake Keesus Statistics Survey Date: 8/17 - 8/22 2017	Individual Species Stats								
	Frequency of occurance within vegetated areas (%)	Frequency of occurances at sites shallower than maximum of plants	Relative Frequency (%)	Numer of sites where species was found	Average Rake Fullness	# of visual sightings	Present during 2017 survey	Present during 2012 survey	Present during 2007 survey
Myriophyllum spicatum,Eurasian water milfoil	41.9	30.3	17.4	83.0	1.3	34	X	X	X
Potamogeton crispus,Curly-leaf pondweed	12.6	9.1	5.2	25.0	1.0	2	X	X	X
Ceratophyllum demersum, Coontail	33.3	24.1	13.8	66.0	1.6	1	X	X	X
Chara sp., Muskgrasses	35.9	25.9	14.9	71.0	1.8	11	X	X	X
Elodea canadensis, Common waterweed								X	X
Heteranthera dubia, Water star-grass	7.1	5.1	2.9	14.0	1.1	8	X	X	
Lemna minor, Small duckweed						9	X		
Lemna trisulca, Forked duckweed						1	X		
Lythrum salicaria, Purple loosestrife						25	X		
Myriophyllum sibiricum, Northern water-milfoil	1.5	1.1	0.6	3.0	**1.3**		X		
Najas flexilis, Slender naiad	8.6	6.2	3.6	17.0	1.3	2	X	X	X
Najas guadalupensis, Southern naiad	3.0	2.2	1.3	6.0	1.8		X		
Nuphar variegata, Spatterdock	1.5	1.1	0.6	3.0	**1.0**	19	X	X	X
Nymphaea odorata, White water lily	8.1	5.8	3.4	16.0	**1.5**	70	X	X	X
Potamogeton friesii, Fries' pondweed	6.1	4.4	2.5	12.0	**1.0**		X	X	
Potamogeton gramineus, Variable pondweed	2.0	1.5	0.8	4.0	**1.3**	1	X		
Potamogeton illinoensis, Illinois pondweed	23.7	17.2	9.9	47.0	1.4	21	X	X	X
Potamogeton natans, Floating-leaf pondweed						7	X	X	X
Potamogeton nodosus, Long-leaf pondweed						1	X		
Potamogeton praelongus, White-stem pondweed	0.5	0.4	0.2	1.0	1.0		X		
Potamogeton zosteriformis, Flat-stem pondweed	3.5	2.6	1.5	7.0	1.0	1	X		
Ranunculus aquatilis, White water crowfoot	0.5	0.4	0.2	1.0	1.0		X		
Schoenoplectus tabernaemontani, Softstem bulrush						4	X		
Stuckenia pectinata, Sago pondweed	13.1	9.5	5.5	26.0	1.0	10	X	X	X
Typha sp., Cattail						44	X	X	X
Utricularia minor, Small bladderwort	0.5	0.4	0.2	1.0	1.0	1	X		
Utricularia vulgaris, Common bladderwort	2.5	1.8	1.0	5.0	1.2	1	X	X	X
Vallisneria americana, Wild celery	30.8	22.3	12.8	61.0	1.5	10	X	X	X
Wolffia columbiana, Common watermeal						3	X		
Freshwater sponge	2.5	1.8	1.0	5.0	1.0		X		
Filamentous algae	22.7	16.4	9.4	45.0	1.2	10	X	X	X
Nitella Flexilis	3.0	2.2	1.3	6.0	1.3		X	X	
Unkown 1 Stonewort species	0.5	0.4	0.2	1.0	1.0		X		
Unknown 2 Stonewort Species?	0.5	0.4	0.2	1.0	1.0		X		

Table 2: Plant species found during the 2017, 2012 and 2007 Point-Intercept Surveys.

SUMMARY STATS:	2017	2012	2007
Total number of sites visited	426	416	208
Total number of sites with vegetation	198	204	206
Total number of sites shallower than maximum depth of plants	274	293	
Frequency of occurrence at sites shallower than maximum depth of plants	72.26	69.6	
Simpson Diversity Index	0.88	0.84	0.9
Maximum depth of plants (ft)**	26	29	15
Number of sites sampled using rake on Rope (R)	150	0	
Number of sites sampled using rake on Pole (P)	77	166	
Average number of all species per site (shallower than max depth)	1.74	1.5	
Average number of all species per site (veg. sites only)	2.41	2.1	
Average number of native species per site (shallower than max depth)	1.35	1.1	
Average number of native species per site (veg. sites only)	2.03	1.7	
Species Richness	23	15	
Species Richness (including visuals)	31	17	

Table 3: Summary Statistics of the 2017, 2012 and 2007 Point-Intercept surveys.

Management Methods

The figure shown below illustrates the general cost difference between management approaches. These are rough estimates that depend on many project variables. Each method has advantages and disadvantages, as explained in further detail below. Possible methods of control include Herbicide Application, Mechanical Harvesting and Diver Assisted Suction Harvesting (DASH).

Table 4: Contract Work Estimates

	Rough Estimates for Contract Work		
	Dash*	Chemical (2,4-D)	Harvester**
Cost to treat 1 acre / time	$12,000 / 4-7 days	$800 / 1.50 hours	$100-400 / 30 min.
Cost to treat 5 acres	$60,000 / 1 Month	$3,000 / 3 hours	$600-$2,400 / 3 hours
Cost to treat 20 acres	$240,000 / 1 Season	$10,000 / 7.5 Hours	$3,200 - $12,800 / 2 day
Cost to treat 100 acres	$1,200,000 / Several Years	$44,000 / 3 Days	$24,000 - $96,000 / 3+ weeks

* Based on www.aquaticinvasivecontrol.com and local contractors

** Based on www.ecy.wa.gov and local contractors, prices do not include shipping, post cleaning, or other fees.

DASH

Dash is a process where a certified diver maintains control of a hydraulic pump and pulls selected plants by the root, feeding them into the intake hose. The plant is transferred to a collection station that can range from a mesh onion-sack to large on-shore drainage bags. The advantage of DASH includes the ability to select the target plant for removal. The disadvantage is the slow nature of the process and high cost due to specially trained staff and equipment. Also, as operations begin in a DASH location, underwater visibility rapidly diminishes, further reducing the speed of removal. Low visibility and human error also contribute to missed plants or improper removal (not removing the roots). It is also common to do relative damage to non-target species through the tangled nature of aquatic plants and the hydraulic hose flattening areas as the diver(s) are searching for target plants. Mollusks, crustaceans, insects and other species that live in and around the lake bottom, on or within the plants are also inevitable bycatch. DASH should be used in instances of very small and relatively dense patches of invasive plant species that are ideally located on a dense bottom. Deeper patches of target plants on a sand or gravel substrate with few native species is ideal.

Herbicide

Treatments using state-approved herbicides and algaecides are typically applied by injection, spraying or spreading of granular product. Herbicide treatments are relatively inexpensive when compared to other management strategies. Herbicide labels are the law and they indicate target species and whether they are selective or non-selective in the type of plants they affect. The success of an herbicide application is the result of three main components; 1) proper product choice 2) appropriate concentration and 3) timing of application.

The "risk-reward" of herbicide use must be carefully considered. The use of this technology is heavily regulated, requiring knowledgeable, licensed professionals. Many hours, days, even weeks of preparation are necessary. There is always the potential for damage to non-target aquatic plant and the void created by eliminating one species could be filled by another, equally undesirable weed.

Mechanical Harvesting

Mechanical harvesting is a management strategy aimed for the maintenance of plant densities rather than eliminating target species. Mechanical harvesting is costly, with new harvesting boats ranging from $80,000 to well over $200,000; with high operating costs associated with them. Approved disposal sites for the removed weeds are required. These sites are chosen to ensure the species removed and the nutrients they contain are not returned to the lake or wetland. Harvesters can provide short-term relief where plant growth prohibits boating or fishing. Harvesting also helps alleviate competition in areas with high density plant populations. Harvesters will not eliminate the cause of a plant imbalance. Furthermore, harvesters can promote species that spread through fragmentation (i.e. *Eurasian Watermilfoil*).

"By-catch" must also be considered when using mechanical harvesting as a means of weed removal. *"Harvesting removes large numbers of macro-invertebrates, semi-aquatic vertebrates, forage fishes, young-of-the-year fishes, and even adult gamefishes".* [[3]]

[3] Engel, S., 1990. Ecological impacts of harvesting macrophytes in Halverson Lake, Wisconsin. *Journal of Aquatic Plant Management*, 28(1), pp.41-45.

Considerations

All methods described in this section require specific permits, and any equipment entering a waterbody is to be cleaned and sanitized as per NR40.02. The WNDR's Preventative Measures Manual Code #9183.1 further details boat, gear and equipment decontamination and disinfection protocol to prevent the spread of invasive species.

Management Recommendations

Herbicide Application Recommendations

Eurasian Watermilfoil (EWM) should be continuously monitored, and action taken to prevent further infestation. It is recommended to compliment harvesting operations with timely herbicide applications. As an early-grower, spring treatments should be considered to include the use of 2,4-D at low dose (350 – 400PPB) for lake-wide application or by targeting smaller areas using 3.5 – 4PPM. Sonar One© is another whole-lake treatment option that offers partial selectivity when carefully planned. By targeting 4PPB and maintaining a concentration of at least 2PPB for a period of 90 days, Sonar One© will provide 80% control or more for this target species. SePro, the manufacturer of this product, must provide the treatment protocol necessary for this form of application, which may include plant-challenge testing and post-treatment FastTEST monitoring to ensure concentrations are maintained. Up-to-date sonar bathymetry is essential for calculating total volume for any whole-lake application.

Prior to applications targeting small areas, an informal survey of the plant community should be performed to identify, mark (using global positioning systems) and calculate proper treatment concentrations of the targeted stands. Applications should be performed at such a time to minimize damage to all non-target species and does not interfere with lake usage.

Curly Leaf Pondweed (CLP) was identified widely throughout each of the bays, with many small plants having turions in the middle bay. Care should be taken during all future surveys to ensure any infestations are properly managed. The aquatic herbicide Aquathol K is commonly used to treat this species and all such applications should be performed early in the season, prior to turion production. Large scale treatments (>2 acres) should target 0.5-1.5PPM concentration, while smaller spot or margin treatments should use concentrations of 1.5-3.0PPM.

CLP produces turions (a type of bud capable of growing into a complete plant)[4] early in the season and therefore treatments must occur prior to turion production. Turions can remain viable for four or more years. As a result, an ongoing treatment regime should include early-season application and monitoring for several years to exhaust this potential seed-bank.

Always follow NR 107 guidelines, label instructions and manufacturers' recommendations for herbicide use.

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[4] Hickey, M.; King, C. 2001. *The Cambridge Illustrated Glossary of Botanical Terms, Cambridge University Press*, Wikipedia. (accessed on: *1-17-18)*

Figures 3 and 4 on pages 9, 10 (respectively) indicate density and distribution of both EWM and CLP. Four density markers were used within these maps. Red triangles indicate the densest stands (3); yellow squares areas are moderate (2), while the green points are the least dense (1). Blue circles with a star inside are visuals. An informal, spring survey should begin with these known points. Harvesting operations should also concentrate efforts in these areas while monitoring the north shoreline on a regular basis.

*Delineated maps pertaining to chemical and mechanical harvesting are listed in Appendix B.

Harvesting Recommendations

Shallow Bay Navigation Channels – 1st priority: continue cutting at 2-3 foot depth in areas greater than 4 feet deep. While cutting, the blade must remain a minimum of 12" from the lake bottom at all times. Navigation channels must not exceed a maximum of 20 feet wide, and 100 feet wide at bay entrances.

Shallow Bay General Use Areas – 2nd priority: remove surface EWM, cutting at 2-3 foot depth in areas greater than 4 feet deep. While cutting, the blade must remain a minimum of 12" from the lake bottom at all times. Harvesting in the shallow bay (general use areas) may only occur when EWM has exceeded 50% of coverage or frequency of occurrence in the top 2 feet of the water column. The harvesting supervisor must verify the plants that have reached or threaten to reach the surface are 50% EWM. "*Threaten"* as used herein indicate target plants are within 12" of the surface within these general use areas and seasonal temperatures, sunlight and overall conditions indicate continued growth is imminent.

Fishing Area – 3rd priority: to cut a <u>maximum</u> of 20-foot-wide channels at 100-200-foot intervals, only harvesting if vegetation has become or threatens to become a fishing or boating impediment. "*Threaten"* as used herein indicate target plants are within 12" of the surface within the fishing area and seasonal temperatures, sunlight and overall conditions indicate continued growth is imminent.

Natural Shoreline Areas – No harvesting.

Developed Near Shore Areas – Manual removal is primarily recommended 30 feet from the shoreline for invasive species, however the selective removal of aquatic invasive species using selective herbicides is a viable option for these areas. Treatments should occur only when vegetation has become excessive. *"Excessive"* as used herein shall indicate plant biomass within 12" of the surface that either impedes or will impede lake usage to include, but not limited to; swimming, boating and fishing. Follow AIS guidelines, all NR 107 rules, label instructions and manufacturers' recommendations for herbicide use.

*Harvesting CLP is a viable option if growth demands immediate response. Harvesting operations for this species is likely to be limited as growth subsides mid-season and rarely becomes problematic beyond July. A properly timed harvest could remove surface growth and the turions commonly found toward the terminus of the plant. As a result, careful removal could reduce CLP density in future seasons.

DASH

Diver-Assisted-Suction-Harvest is not recommended for this lake. The areas of aquatic invasive species are too wide-spread and numerous to effectively control using this method. DASH should be used only in small (<0.2 acre), dense patches of invasive plant species.

Rapid Response Plan

Wisconsin's Rapid Response Framework for Aquatic Invasive Species
http://dnr.wi.gov/lakes/invasives/WIAISRapidResponseFramework2012.pdf

- Early Detection and Reporting
- Verification of species
- Notification (relavant resource managers, news media, public)
- Rapid Assessment (threats posed by invasion, resources available)
- Planning
- Rapid Response (the action or series of actions taken to contain and control)
- Monitoring & Evaluation (post-action assessments of actions taken for control)
- Restoration (improve disturbed areas when possible)

Rapid response to a new aquatic invasive is imperative. The first step of which is ensuring an invasive species was not previously found within the waterbody. This APM plan shall serve as this record.

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 Coordinator (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 waterbody management entity and current lake consultant should also be notified. Digital photographs may also serve as a faster means of communication. All pictures should be taken within 12" of the plant in question, with care taken to fully illustrate leaf structure, stem and flower (if present).

WIDNR
Attn: Heidi Bunk, AIS Coordinator
141 NW Barstow St., Room 180
Waukesha, WI 53188
262-574-2130 Heidi.Bunk@Wisconsin.gov

If a new invasive species has been verified, a coordinated response plan should be developed in consultation with the WDNR, the governing townships, local lake managing body and lake consultant(s) as needed. Limit or restrict lake access immediately, to include boat landing closures whenever possible. Post signage at all access points with color photographs and species description. Notify all area lake associations and districts immediately.

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Appendix A

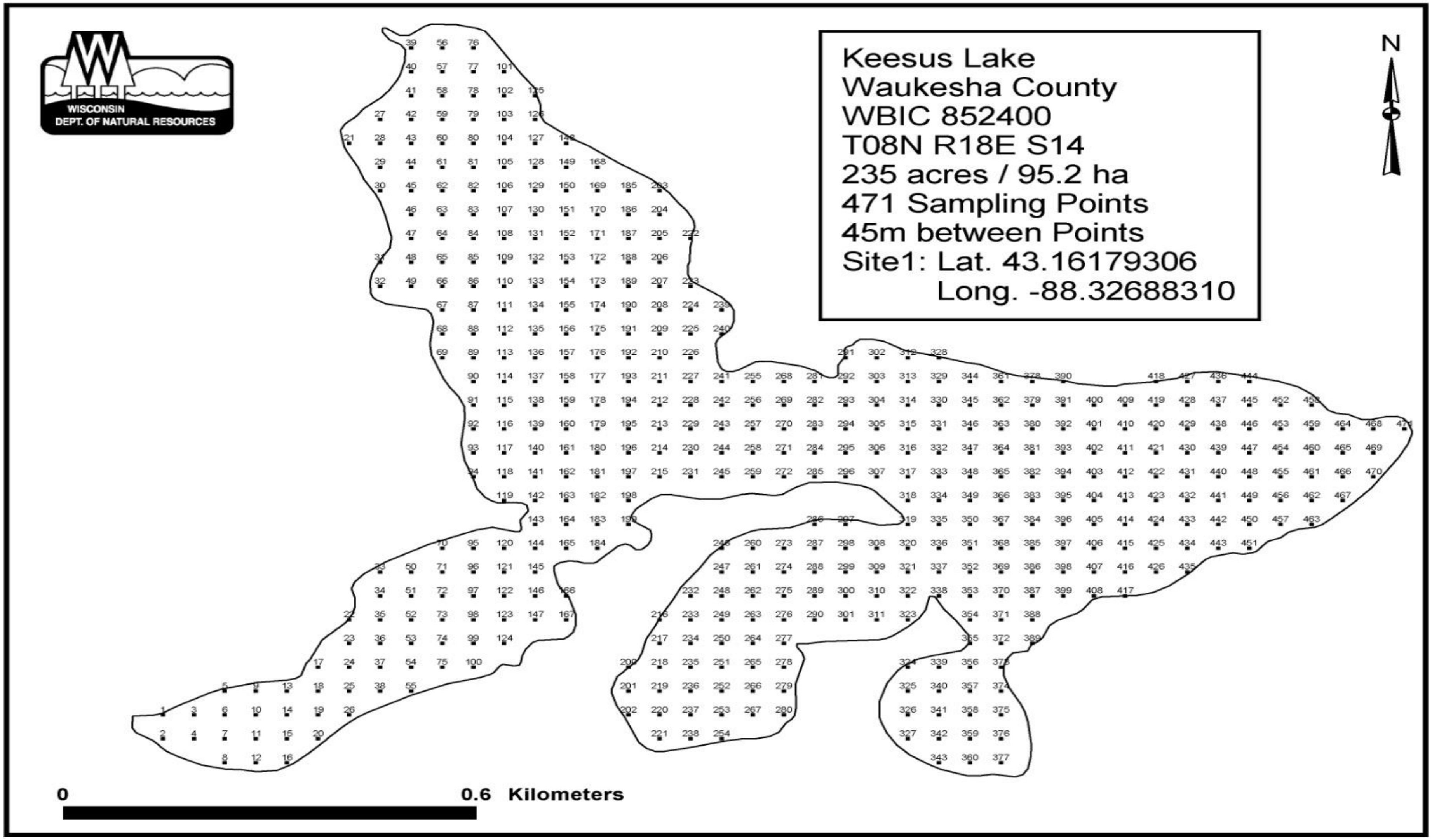


Figure 10: Lake Keesus Point Intercept Map.

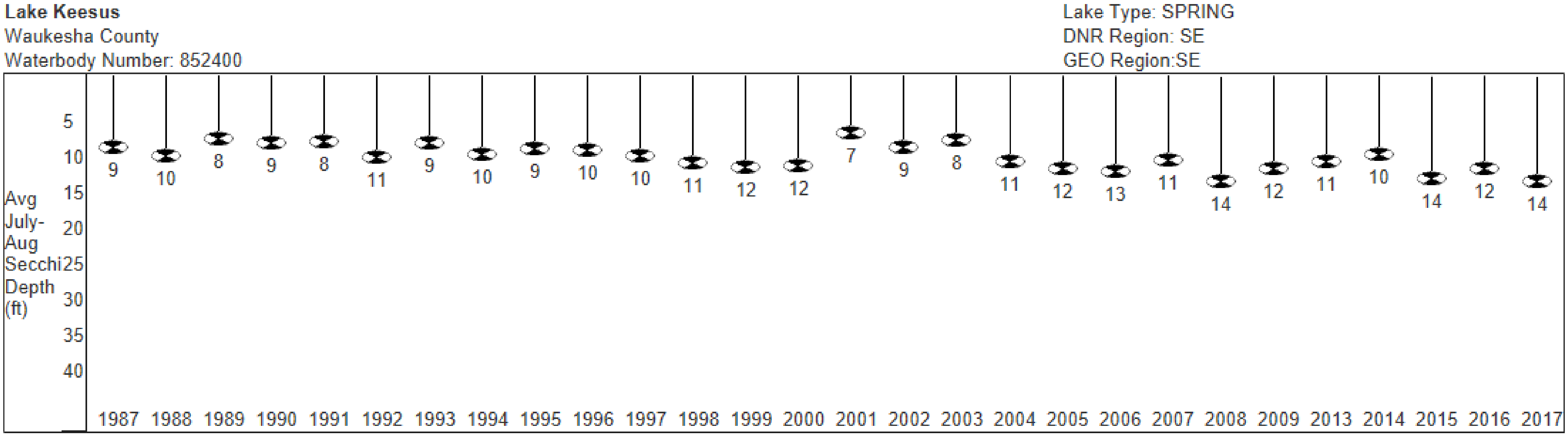


Figure 11: Secchi disk depth data spanning from 1987-2017. Report generated 01/03/2018. www.dnr.wi.gov

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1987	9.25	9	9.5	3
1988	10.33	9.5	11.5	3
1989	8	6.5	9.25	4
1990	8.61	6	12	7
1991	8.45	8	9	5
1992	10.67	10.25	11	3
1993	8.58	8	9.25	3
1994	10.13	7.75	12.25	4
1995	9.38	7.75	10.5	4
1996	9.63	7	13.5	4
1997	10.44	8.75	13.25	4
1998	11.38	10	13	4
1999	12.05	9.5	14	5
2000	11.88	9	13	4
2001	7.2	5.58	8.5	5
2002	9.2	9.2	9.2	1
2003	8.19	7.75	9.2	7
2004	11.15	11.15	11.15	1
2005	12.1	12.1	12.1	1
2006	12.65	12	13.3	2
2007	11	2	17.4	3
2008	13.97	12.8	15	6
2009	12.1	12.1	12.1	1
2010				2
2011				3
2012				1
2013	11.28	9.6	13	4
2014	10.15	9.5	10.8	2
2015	13.5	13.5	13.5	1
2016	12.26	11.81	12.7	2
2017	14.03	13.12	14.93	2

Table 5: Past secchi averages in feet (July and August only). Report generated 01/03/2018.www.dnr.wi.gov

Appendix B

Lake Keesus Harvesting / Proposed Treatment Maps

Figure 12: The four, main treatment / harvesting areas of concern. All mechanical harvesting should be limited to areas less than 3' in depth to prevent disturbance of bottom sediment.

*All aerial photos used for area calculations, density maps and treatment / harvesting maps were taken from DeLorme Earthmate software©.

Area #1

Figure 13: Area #1. North, Northwest end of lake: 8.95 acres, 2,651.6' perimeter. Area encompasses large, surveyed EWM stand.

Area #2

Figure 14: Area #2. Southwest Bay: 31.20 acres, 7,444.8' perimeter. Area encompasses large, surveyed EWM stand.

Area #3

Figure 15: Area #3. South Bay: 18.62 acres, 3,998.0’ perimeter. Area encompasses large, surveyed EWM stand.

Area #4

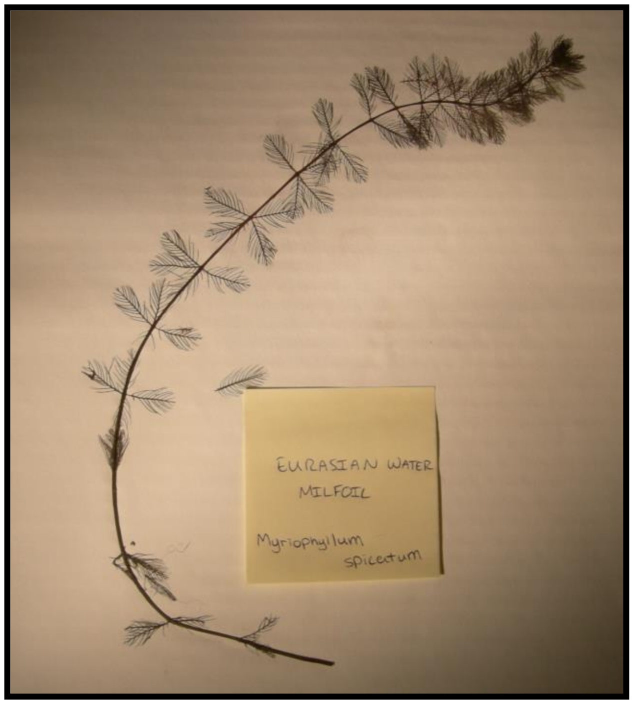
Figure 16: Area #4. Southeast Bay: 4.31 acrea, 2175.8’ perimeter. Area encompasses large, surveyed EWM stand.

Appendix C

Plant Species

All plant descriptions were taken directly from "Through the Looking Glass…", by Susan Borman, Robert Korth, and Jo Temte, third printing 2001, copyright 1997 Wisconsin Lakes Partnership, UWEX-CNR, UWSP.

All photographs provided by Lake and Pond Solutions Co and represent actual plant samples taken during the 2012 point intercept survey.



Common Name: Eurasian water milfoil
Scientific Name: *Myriophyllum spicatum*
Classification: Submergent

<u>Description:</u>

Exotic. Eurasian water-milfoil has long, spaghetti-like stems, sometimes 2 or more meters in length, that emerge from roots and rhizomes. Stems often branch repeatedly at the water's surface, creating a canopy of floating stems and foliage. Leaves are divided like a feather, with a short stalk and about 14-20 pairs of thread like leaflets. The leaf divisions are all about the same length and closely spaced, resembling the bones of a fish spine. Leaves are in whorls of 4-5, and can be widely spaced (1-3 cm or more). The flower spike sticks out of the water with whorls of flowers in the axils of short bracts. The fruit (2-3 mm) has four parts with a smooth to slightly roughened surface.

<u>Distribution:</u>

Exotic, originated in Europe and Asia; distribution in Wisconsin is primarily in the south, but spreading north; range includes most of U.S.

Common Name: Wild Celery
Scientific Name: *Vallisneria americana*
Classification: Submergent

Description:

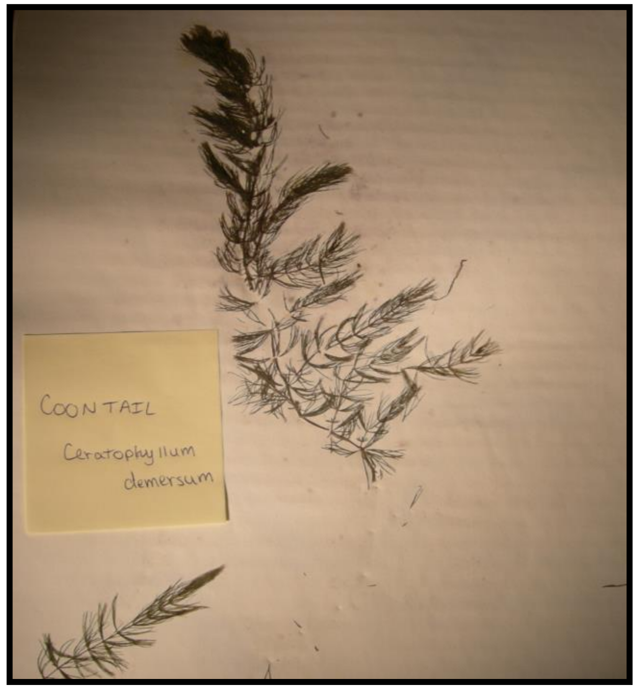
Wild Celery has ribbon-like leaves that emerge in clusters along a creeping rhizome. Leaves (up to 2 m long, 3-10 mm wide) have a prominent central stripe and a cellophane-like consistency. The leaves are mostly submersed, with just the tips trailing on the surface of the water.

Male and female flowers are produced on separate plants. The tiny male flowers (1 mm wide) are clustered in a case that develops underwater. As the flowers mature, they are released from the case. Each male flower is in a closed “floral envelope” that contains and air bubble. This helps lift it to the surface. When it reaches the surface, the floral envelope opens and creates a sail that allows it to skim along the surface.
The femal flowers (3.5-6.5 mm wide) also develop underwater, but then they are raised to the surface by a fast-growing, spiral-coiled stalk. These delicate, white flowers bob at the surface creating a dip in the surface tension. When one of the tiny male flowers sails by, it glides down to meet and pollinate the female flower. After fertilization, the female flower is retracted beneath the surface and a long, capsular fruit (5-12 cm) develops.

Distribution:

Native; found throughout Wisconsin; range includes most of U.S.

Common Name: Coontail
Scientific Name: *Ceratophyllum demersum*
Classification: Submergent



Description:

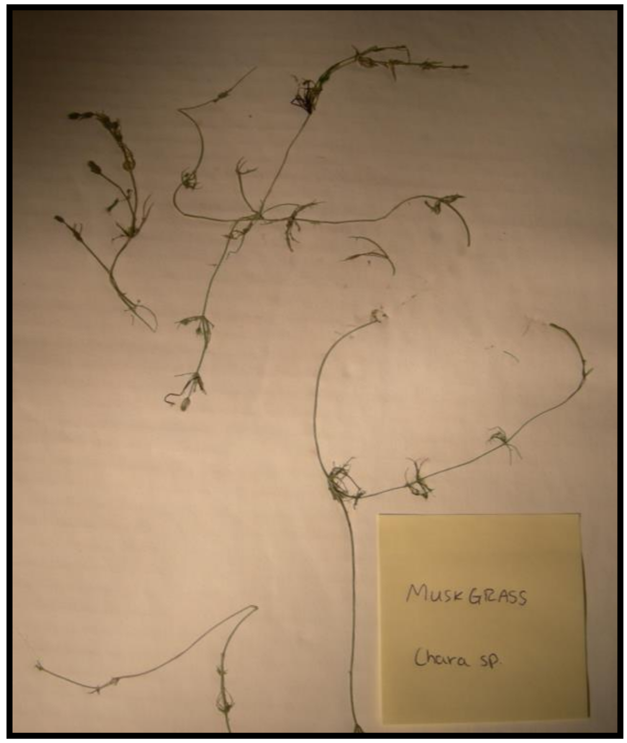
Coontail has long, trailing stems that lack true roots. However, the plant may be loosely anchored to the sediment by pale modified leaves. The leaves are stiff and arranged in whorls of 5-12 at a node. Each Leaf (1-3 cm) is forked once or twice. The leaf divisions have teeth along the margins that are tipped with a small spine. Whorls of leaves are usually more closely spaced near the ends of the branches, creating the raccoon tail appearance.

Flowers are tiny and hidden in the axils of the leaves. Male and femal flowers are on separate plants. The stamen of the male plants floats to the surface at maturity and discharges pollen. The pollen sinks down through the water and may or may not land on tiny female flowers, tucked in the leaf axils. Fruit is rarely produced, partly because of this unpredictable method of pollination. When fruit does develop, it is a nut-like achene with two spines at the base and one on top (the persistent style).

Distribution:

Native; common throughout Wisconsin; range includes most of U.S.

Common Name: Muskgrass
Scientific Name: *Chara sp*.
Classification: Submergent



Description:

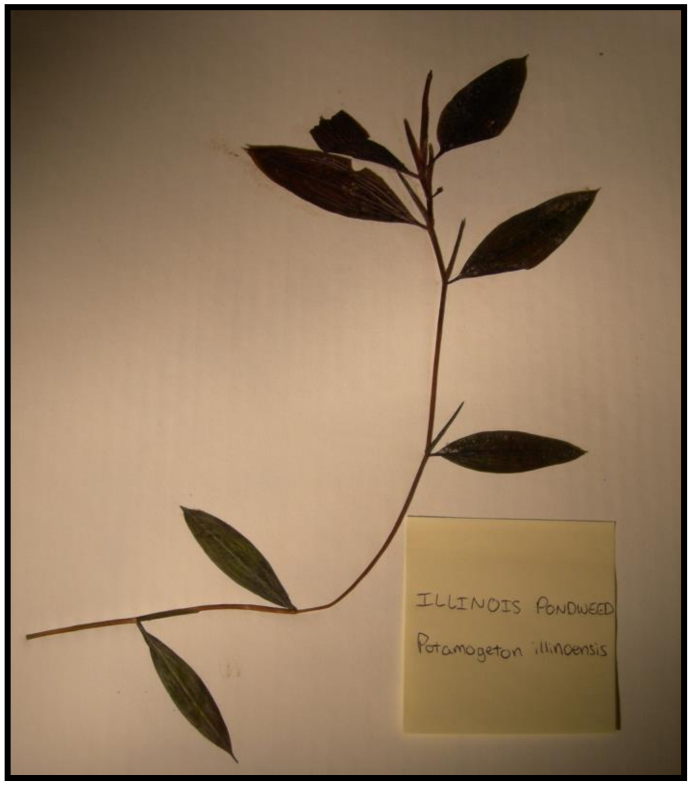
This unusual type of algae has a growth form that resembles a higher plant, but a closer look reveals each join of the stem is a single cell with no conductive tissue. Muskgrass is simple in structure and has rhizoids rather than true roots. These plants range in size from ankle-high to knee-high. The main branches of muskgrass have ridges. They are often encrusted with calcium carbonate, giving the plant a harsh, crusty feel. The side branches develop in whorls like spokes of a wheel.

Muskgrass can reproduce vegetatively by spreading rhizoids as well as sexually. The male reproductive structures, called antheridium, and the female reproductive structure, called oogonium, are located at the base of branches. Each pear-shaped oogonium is capped with five cells.

Distribution:

Native; common throughout Wisconsin; range includes most of U.S.

Common Name: Illinois Pondweed
Scientific Name: *Potamogeton illinoensis*
Classification: Submergent



Description:

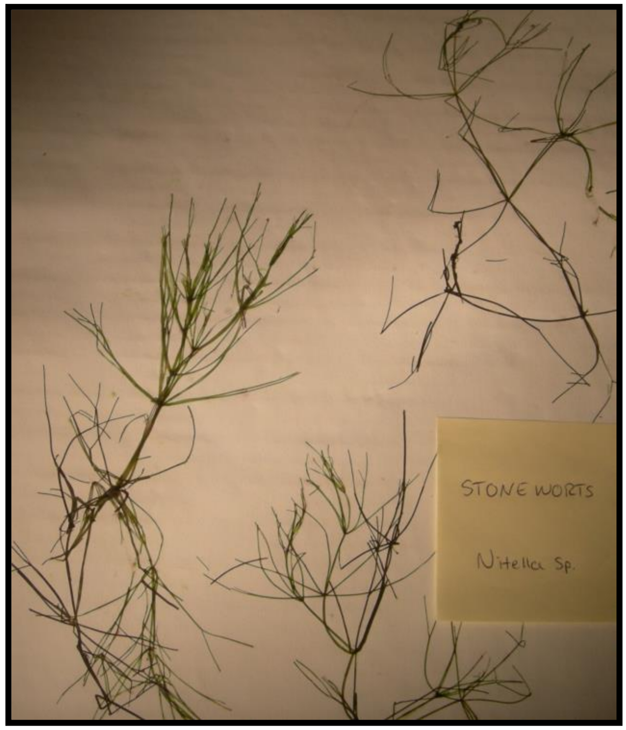
Illinois pondweed has stout stems (up to 2 m long, 1-5 mm wide) that emerge from thick rhizomes. Most submerged leaves (8-20 cm long, 2-5 cm wide) are lance-shaped to oval and either attach directly to the stem or have a short stalk (up to 4 cm). These leaves have 9-19 veins and often have a sharp, needle-like tip. The stipules (4-10 cm) are free in the axils of the leaves and have two prominent ridges called keels. Floating leaves which a have thick stalk and ellipse shaped-blade (7-13 cm long, 2-6 cm wide) are sometimes produced. The stalk is usually shorter than the blade.

Flowers and fruits are produced on a stalk (4-12 cm long) that is usually thicker than the stem. The fruit is arranged in a dense cylindrical spike (2.5-6 cm long). Each fruit (3-4 mm wide) has three low dorsal ridges and a short beak (0.5 mm).

Distribution:

Native; scattered locations in Wisconsin; range includes most of U.S.

Common Name: Stonewort
Scientific Name: *Nitella sp.*
Classification: Submergent



Description:

Nitella is a type of algae that looks like a higher plant. It has no conductive tissue and has simple anchoring structures called rhizoids rather than true roots. Branches are arranged in whorls around the stem. Stems and branches are smooth and translucent green. The overall plant ranges in size. *Nitella* can reproduce vegetatively by spreading rhizoids as well as sexually. The male reproductive structures, called the antheridium, and the female reproductive structure, called the oogonium, are located at the base of the branches. Each pear-shaped oogonium is capped with ten cells.

Distribution:

Native; common throughout Wisconsin; range includes most of U.S.

Common Name: Sago pondweed
Scientific Name: *Stuckenia pectinata*
Classification: Submergent

Description:

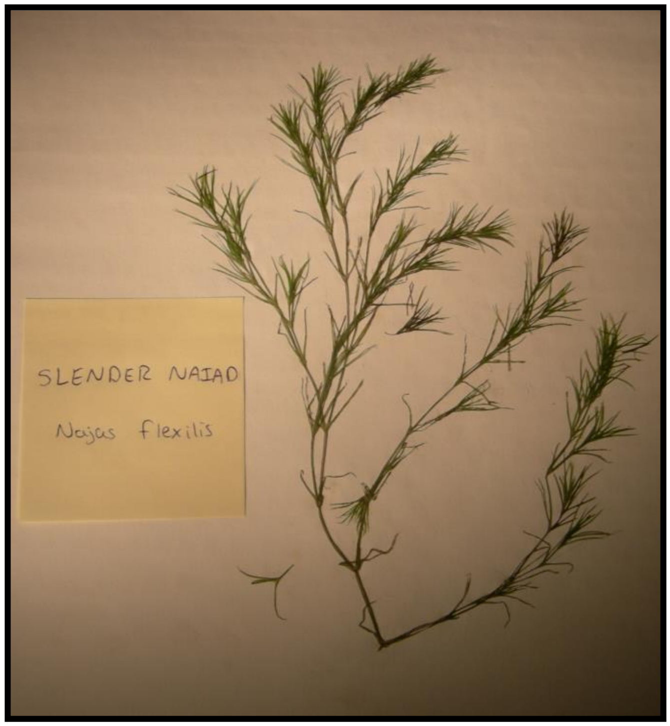
The stems of sago pondweed sprout from slender rhizomes that are peppered with starchy tubers. The leaves are very thin and resemble pine needles, ending in a sharp point. Each branch may be forked several times into a spreading, fan-like arrangement. Stipules are fused to leaves for most of their length, creating a stipular sheath.

Flowers and fruit are produced on a slender stalk that may be submersed or floating on the water surface. The flowers and fruit are arranged in small whorls that are slightly spaced apart on the stalk. This creates the appearance of beads on a string. Each fruit is oval to egg-shaped in outline. The fruit is rounded on the back with a short beak and sometime a low dorsal ridge, two lateral ridges or both.

Distribution:

Native; common in Wisconsin; range includes most of U.S.

Common Name: Slender Naiad
Scientific Name: *Najas flexilis*
Classification: Submergent



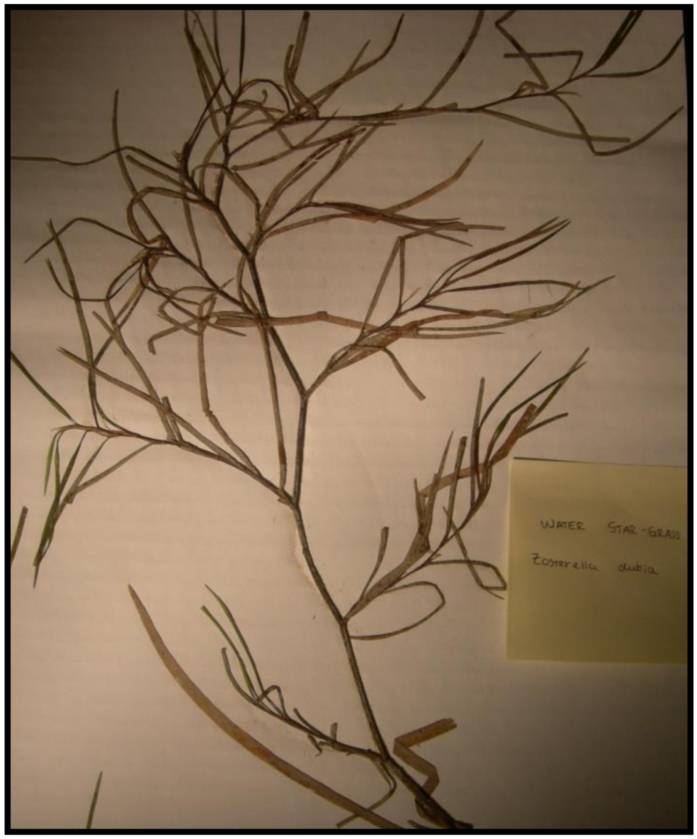
Description:

Slender naiad has fine, branched stems that emerge from a slight rootstalk. The leaves are paired, but there are sometimes there are bunches of smaller leaves crowded in the leaf axils. Size and spacing of the leaves is extremely variable, depending on growing conditions. Sometime, the plant is compact and bushy, and other times trailing and slender. Leaves are narrow with a broad base where they attach to the stem. This base is shaped like sloping shoulders. Each leaf tapers to a point tip. The leaf margin is finely serrated. Tiny flowers develop in the leaf axils and produce fruit with a paper-thin wall. The seed has a glossy surface with 30-50 rows of small, faint pits.

Distribution:

Native; common throughout Wisconsin; range includes northern and central U.S.

Common Name: Water star-grass
Scientific Name: *Zosterella dubia*
Classification: Submergent



Description:

Water stargrass has slender, freely branched stems that emerge from buried rhizome. The narrow, alternate leaves attach directly to the stem with no leaf stalk and lack a prominent mid vein. Yellow, star-shaped flowers are produced individually. The capsular fruit contains 7-30 seeds.

Distribution:

Native; common in Wisconsin; range includes most of the U.S.

Common Name: White water lily
Scientific Name: *Nymphaea odorata*
Classification: Floating-Leaf

Description:

The cylindrical leaf stalks of white water lily emerge from a fleshy, buried rhizome. These flexible stalks are round in cross section with four large air passages. The leaves are round with a narrow sinus and a reddish-purple underside. Most of the leaves float on the water's surface. The flowers float on the water's surface and are borne on individual stalks that arise directly from the rhizome. They have four greenish sepals and numerous white petals in a circular arrangement around many yellow stamen attached to a central disc.

Distribution:

Native; widely distributed in Wisconsin; range include most of U.S.

Common Name: Fries’ pondweed
Scientific Name: *Potamogeton friesii*
Classification: Submergent

Description:

Fries’ pondweed has narrow leaves, and each leaf has 5-7 veins and a rounded tip with a short beak. There is a pair of glands at the nodes and white, fibrous stipules. Flowers and fruits are borne on flattened stalk. The fruit is rounded with low ridges or no ridges. Winter buds are a strong characteristic. The inner leaves of each winter bud are compressed and arranged in a fan shape that is at a right angle to the outer leaves.

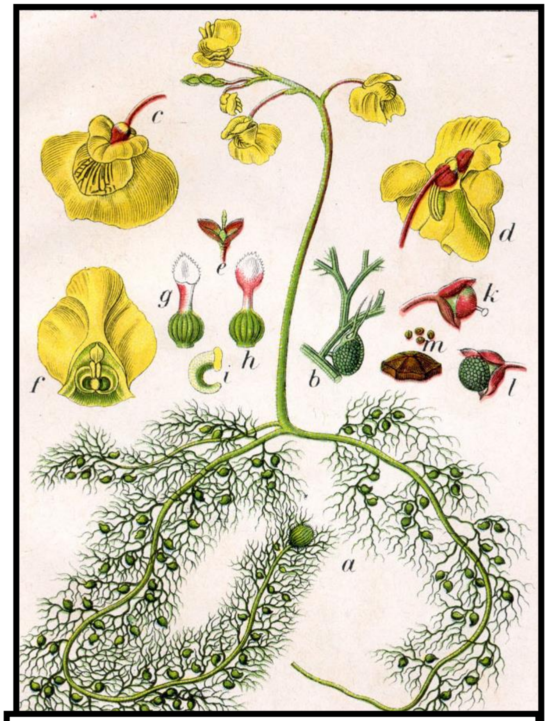
Distribution:

Native; common throughout Wisconsin; rand includes most of U.S.

Common Name: Common bladderwort
Scientific Name: *Utricularia vulgaris*
Classification: Submergent

Description:

Common bladderwort has floating stem that can reach 2-3 meters in length. Along the stem are leaf-like branches that are finely divided. The divisions are filament-like, have no midrib, and fork 3-7 time. Scattered on these branches are bladders that trap prey. Young bladders are transparent and green tinted, but they become dark brown to black as they age. The branches also have fine spines scattered along their margins.



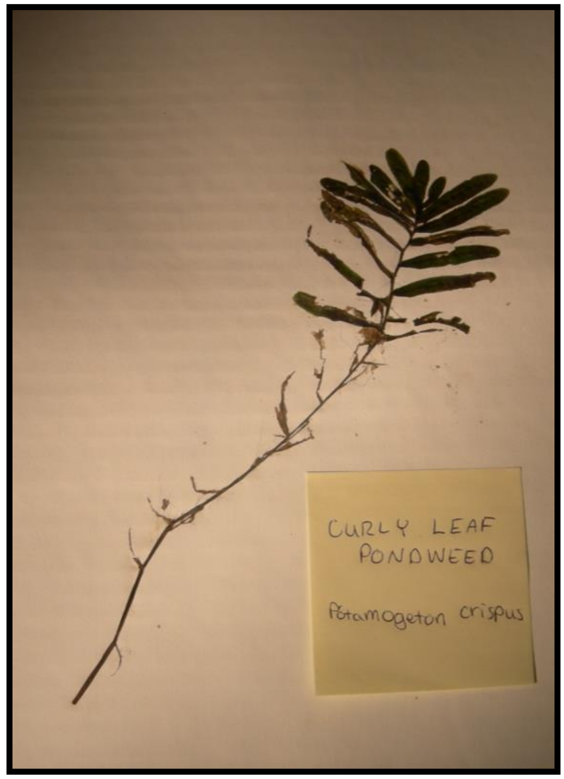
Picture taken from Wikipedia.org

Yellow, two-lipped flowers are produced on stalks that protrude above the water surface. There may be 4-20 flowers per stalk. The upper lip of the flower creates an awning over the sac-like pouch and sickle-shaped spur of the lower lip. The plant is branched in several directions at the base of the flower stalk. This creates a stable base that keeps the top-heavy flower stalk from capsizing.

Distribution:

Native; common in Wisconsin; range includes most of U.S.

Common Name: Curly-leaf pondweed
Scientific Name: *Potamogeton crispus*
Classification: Submergent



Description:

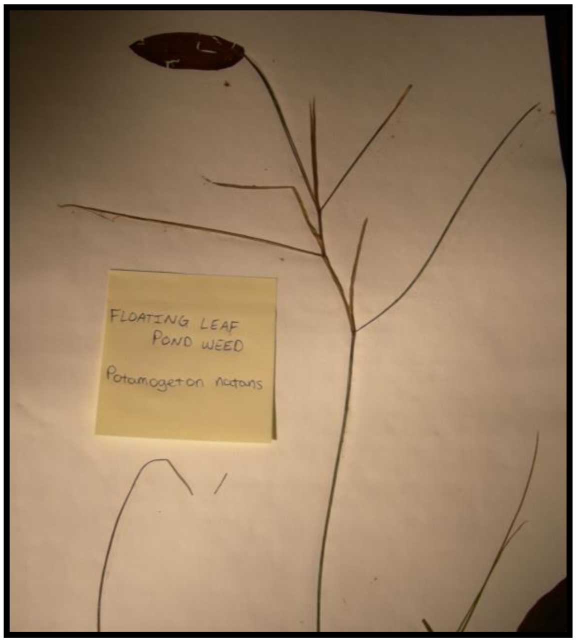
The slightly flattened stems of curly-leaf pondweed grow out of a slender rhizome. Although it is a submersed aquatic plant, the spaghetti-like stems often reach the surface by mid-June. Submersed leaves are oblong and attach directly to the stem in an alternate pattern. Margins of the leaves are wavy and finely serrated, creating an overall leaf texture that is "crispy." The stipules are fused to the base of the leaf and disintegrate as the growing season progresses. No floating leaves are produced.

In the spring, curly-leaf produces flower spikes that stick up above the water surface. The small flowers are arranged in a terminal spike on a curved stalk. Fruits develop that each have three edges and a conical beak. Curly-leaf also produces vegetative buds called turions that look like small, brown pine cones on shortened branches along the stem.

Distribution:

Exotic. The first confirmed specimen of this European exotic in the U.S. was collected in Delaware in the mid-1800s. The first record of curly-leaf in Wisconsin was 1905, and it is now common throughout the state. Range includes most of U.S.

Common Name: Floating-leaf pondweed
Scientific Name: *Potamogeton natans*
Classification: Submergent



Description:

Floating-leaf pondweed has stems that emerge from red-spotted rhizomes. Submersed leaved are stalk-like, with no obvious leaf blade. Floating leaves are heart-shaped at their base. The point where the floating leaf attaches to the stalk is distinctive. It looks like someone pinched the stalk and bent it, so the leaf blade is at a right angle to the stalk and lays flat on the water. This "pinched" portion is usually a lighter color than the rest of the stalk. The fibrous stipules of both the submersed and floating leaves are free in the leaf axils.
Flowers and fruit are produced in a dense cylindrical spike that pokes up above the water surface. Fruit is oval to egg-shaped in outline and rather plump. The surface of the fruit has a wrinkled appearance on the sides, a very low dorsal ridge and a short beak.

Distribution:

Native; common in Wisconsin; range includes northern and western portions of U.S.

Common Name: Spatterdock
Scientific Name: *Nuphar Variegata*
Classification: Floating-leaf

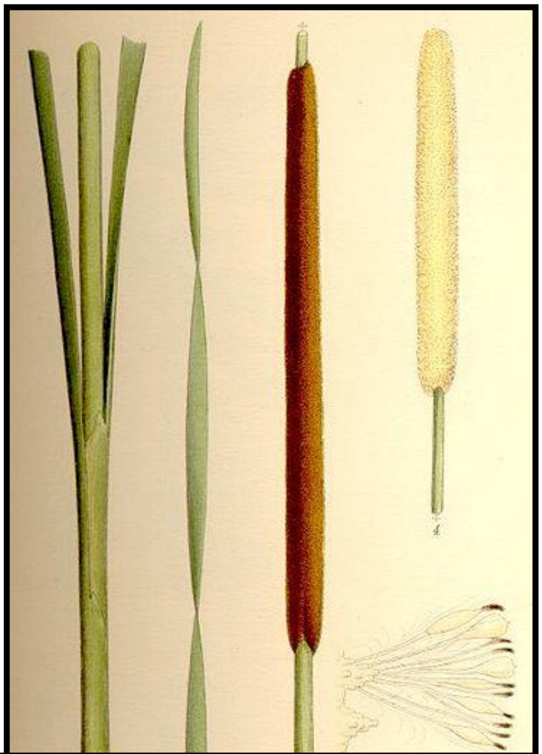
Description:

The leaf and flower stalks of spatterdock emerge directly from a robust, spongy rhizome that is marked with a spiral of scars where old leaf and flower stalks were attached. The sturdy leaf stalks have flattened upper surface with a narrow wing running down each side. Leaves of spatterdock are heart-shaped with rounded lobes that are parallel or overlapping. The leaf notch is usually less than half the length of the midrib. Most of the leaves float on the water's surface. Flowers are globular to saucer-shaped with five to six yellow petals that often have a deep red patch at the base. The sepals curve around numerous small, strap-like petals, stamen and yellowish-green disc with the stigmas. This central disc eventually develops into a seed pod.

Distribution:

Native; widely distributed in Wisconsin; range includes eastern and central U.S.

Common Name: Narrow-leaved cattail
Scientific Name: *Typha angustifolia*
Classification: Emergent


Picture taken from Wikipedia.org

Description:

Narrow-leaved cattail has dark green, sword-like leaves that emerge from a robust, spreading rhizome. The leaves are sheathed around one another at the base. At the junction of the leaf sheath and blade, the sheath has membranous ear-shaped lobes called auricles.

The flower looks like a hotdog on a stick. The lower portion is a cylindrical spike of thousands of tightly-packed female flowers. Each flower has a slender stigma, a fine bract with a spatula –like tip and hairs that are dark on the tips. Some of these female flowers will produce a nutlet and others are sterile. The top of the female spike is separated from the male spike, often by 2 cm or more of bare stem. The male spike has hundreds of anthers that spread pollen to the wind. After the pollen has been released, the male flowers drop off the flower stalk. If you look at the pollen with strong magnification, you can see the pollen grains are individual.

Distribution:

Native; common, particularly in southern Wisconsin but the range is increasing with more disturbances; range includes most of U.S.