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Lac Courte Oreilles & Little Lac Courte Oreilles 2018 Aquatic Plant Survey Report

Prepared for:
Courte Oreilles Lakes Association

Prepared by:

James Scharl

Toll Free: 866-208-0724
www.wisconsinlpr.com

N7828 Town Hall Rd.
Eldorado, WI 54932
Phone: (920) 872-2032
Fax: (920) 872-2036

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INTRODUCTION / SUMMARY

The Courte Oreilles Lakes Association (COLA) is a State recognized lake association responsible for the management of Lac Courte Oreilles Lakes. Management activities include; aquatic invasive species (AIS), with the species of particular concern being curly-leaf (*Potamogeton crispus* – CLP) and Myriophyllum spicatum (*Eurasian water-milfoil* – EWM) on Lac Courte Oreilles and Little Lac Courte Oreilles (Lakes). Wisconsin Lake & Pond Resource, LLC (WLPR) was contacted by COLA to provide an aquatic plant survey for each lake. WLPR furnished all labor, materials, tools and equipment necessary to perform all operations in connection with the full aquatic plant survey of the Lakes. This report provides a summary of observations and conclusions of the 2018 surveys and recommendations for the management of AIS for the upcoming 2019 season.

This Aquatic Plant Survey Report was produced as part of the aquatic plant management activities for the Lakes and COLA. The goal of the project was to document the entire aquatic plant communities of the Lakes and stands of invasive aquatic plant growth for management. This report reviews existing and historical data for the Lakes.

Lakes Morphology

Lac Courte Oreilles is a 5,139-acre lake located in the Towns of Bass Lake and Sand Lake, Sawyer County, Wisconsin near the City of Hayward. Lac Courte Oreilles has a maximum depth of 90 feet and a mean depth of 33 feet. Little Lac Courte Oreilles is a 221-acre lake located in the Town of Bass Lake, Sawyer County, Wisconsin with a maximum depth of 46 feet and mean depth of 12 feet. COLA is an active lake association that has been managing aquatic plants on the Lakes through surveys and chemical treatments. Curly-leaf pondweed has been chemically treated on Lac Courte Oreilles since 2009. Eurasian water-milfoil was first identified in Little LCO in 2015 and LCO in 2017 with only occasional small-scale management taking place. Morphological characteristics of all lakes are found in Table 1 below.

Table 1: Lac Courte Oreilles Lakes Morphology, Sawyer County, WI.

	Entire System	Lac Courte Oreilles	Little Lac Courte Oreilles
Surface Area (ac)	5,363	5,139	224
Volume (ac-ft)	164512	160,840	3,672
Shoreline Length (mi)	28.9	25.4	3.5
Maximum Depth (ft)	136	90	46
Mean Depth (ft)	49	34	15

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Aquatic Plants

Aquatic plants are vital to the health of a water body. Unfortunately, they are often negatively referred to as "weeds". The misconceptions this type of attitude brings must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants are extremely important for the well-being of a lake community and possess many positive attributes. Despite their importance, they sometimes grow to nuisance levels that hamper recreational activities and are common in degraded ecosystems. The introduction of AIS, such as EWM, often can increase nuisance conditions, particularly when they successfully out-compete native vegetation and occupy large portions of a lake.

To assess the state of the current plant communities, full point-intercept surveys were completed by WLPR on July 23-25, 2018 for Lac Courte Oreilles and on from July 25-26, 2018 for Little Lac Courte Oreilles. All surveys followed WDNR survey protocol and included sampling pre-determined locations to document the following at each site:

- Individual species present and their density
- Water depth
- Bottom substrate

Each location was assigned coordinates and loaded into a GPS unit, which was used to navigate to each point. Data collected at each point was then entered into a DNR spreadsheet, which outputs various aquatic plant community indexes and data, allowing for a comparison to past data to monitor changes over time. Information on methods and all referenced tables, figures or charts is included in Appendices A-C.

Past management plans for the Lakes have included aquatic plant surveys, providing historical background to document potential changes in the communities over time. While portions of LCO have been surveyed at an almost annual basis since 2010, a full point-intercept survey for the entire lake has not been completed since 2010. Only one whole-lake aquatic plant survey has been completed for Little LCO in 2015.

To better document aquatic communities, the WDNR adopted the point-intercept survey method above. This method allows for repetition of past surveys by reusing pre-established sample locations. Because past surveys of LCO focused only on select bays within the lake a complete comparison between the 2018 survey and those used prior is difficult.

To compare changes in the plant community over time within the Lakes and to similar lakes in Wisconsin, the Floristic Quality Index (FQI) can be used. FQI provides the ability to compare aquatic plant communities based on species presence. This value varies throughout Wisconsin, ranging from 3.0 to 44.6 with a statewide average of 22.2. To achieve this, each plant species, except for AIS, is assigned a coefficient of conservatism value (C values). A plant's C value relates to a plant species' ability to tolerate disturbance. Low C values (0-3) indicate that a species is very tolerant of disturbance, while high C values (7-10) indicate species with a low tolerance of

disturbance. Intermediate C values (4-6) indicate plant species that can tolerate moderate disturbance.

Not only does this track changes over time within the Lauderdale Lakes, but allows for comparison of the Lakes to lakes with similar environmental conditions within a delineated area, called an eco-region, to be compared.

The Lac Courte Oreilles Lakes are located in the western portion of the Northern Lakes and Forests eco-region. Lakes within the Northern Lakes and Forest region are typically natural lakes created by glaciation with low shoreline development. Lessened development around the lake and overall use of these lakes leads to fewer disturbances and nearer undisturbed, natural conditions when compared to lakes in southern Wisconsin. Low disturbance leads to increased plant community metrics like FQI and coefficient of conservatism.

2018 Point-Intercept Surveys

In 2018, the aquatic plant surveys identified very diverse communities in both Lakes. Total species identified was nearly equal with 39 in LCO and 38 in Little LCO. Two AIS – Eurasian water-milfoil and curly-leaf pondweed were found in both lakes (Table 2, Figures 1.1, 1.2, 2.1, & 2.2).

Species sampled in the Lakes were present in four categories: emergent, near shore species which are rooted below the water's surface, but their growth extends above the water (bur-reed - *Sparganium sp.*), submersed species which root on the lake bottom and remain below the water's surface (coontail – *Ceratophyllum demersum*), free-floating species which are not rooted to the lake bottom an freely float on the surface (forked duckweed – *Lemna trisulca*), and floating-leaf species which root on the lake bottom with vegetation growing to and floating on the surface (white water lily – *Nymphaea odorata*).

The photic zone, depth to which sunlight reaches the bottom allowing plants to grow, ranged from a depth of 21-ft on LCO to 17.5-ft on Little LCO. However, the amount of photic zone vegetated varied between the lakes, with the lowest amount (67.5%) in LCO, which had many areas of steep dropping shoreline that, though shallow enough for light to penetrate to the bottom, did not provide ideal growing conditions. Native species richness exhibited good diversity per sample point and peaked in Little LCO at 3.28 species per site within the photic zone. Distribution of aquatic plant species was excellent throughout the system, as exhibited by a Simpson Diversity Index (SDI) varying only slightly from 0.91-0.93 throughout. An SDI value closer to 1.0 indicates a healthier, more evenly spread plant community (Table 3).

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Survey Results - Lac Courte Oreilles

The aquatic plant community of Lac Courte Oreilles was sampled on July 23-25, 2018 by WLPR. A full point-intercept survey was completed and included sampling at 2,254 locations. Vegetation within LCO was limited to mainly to shallow flats and bays because of the steep-dropping bottom in many areas. There were many locations that, though within the photic zone, did not provide ideal growing conditions due to nutrient limitation with sandy sediments.

The aquatic macrophyte community of the Lake included 39 floating-leaf, emergent, and submerged aquatic plant species during 2018 (Table 4). Figures 1.1 – 1.7 illustrate the locations of each AIS found and the five most common species identified.

Plants were found growing to a maximum depth of 21 feet, with only 763 of the 2,254 locations shallower than this and 67.5% of locations within the photic zone were vegetated. Slender naiad (*Najas flexilis* – Figure 1.3) was the most dominant species sampled in 2018, found at 20.6% of photic-zone locations. This species is commonly found in Wisconsin and has no substrate preference, growing in many different habitats. The variability of lake substrates within LCO allow for a wide range of species. Common waterweed (*Elodea canadensis* – Figure 1.4) and wild celery (*Vallisneria Americana* – Figure 1.5), are both native plants, valuable for near-shore sediment stabilization and are important food sources for waterfowl and were the next most common species sampled (Table 4).

Two AIS were found; Eurasian water-milfoil and curly-leaf pondweed. These species can grow rapidly and dense, reaching the surface and forming a canopy that shades out native species and hampers recreational opportunities. The life cycle of curly-leaf pondweed is different from all other aquatic plants in Wisconsin. CLP dies back during mid to late summer, typically in July. Because of this, early-season surveys typically completed in April-May are required to accurately document distribution of CLP within a lake. It is likely that CLP is under represented in the surveys completed due to this. EWM is a new invader into LCO being first identified in 2017. During the 2018 survey it was found primarily in scattered locations with one dense bed mapped at 0.5 acres. This location was subsequently chemically managed following the survey with results unknown at this time.

Curly-leaf pondweed has been actively managed in LCO since 2009. Initially, large-scale applications were completed in Musky Bay to control a very dense population of the AIS. As the population of CLP in Musky Bay has been managed areas of direct control have lessened, showing positive results. Control actions have been completed in Barbertown and Stucky Bays at a smaller scale at times as well. Though historically dense in some locations within LCO, there were no locations of dense CLP growth noted.

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www.wisconsinlpr.com

N7828 Town Hall Rd.
Eldorado, WI 54932
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Fax: (920) 872-2036

Past surveys on LCO since the 2010 full survey have been limited to the bays above where active CLP control actions took place and provide a chance to assess changes over time. All surveys were completed using the point intercept method. Near annual surveys of Musky Bay were completed using a modified point-intercept sample approach that increased sample point density four-fold over the grid set for LCO as a whole. The 2010 and 2018 whole-lake point intercept surveys were done using standard spacing between sample points, decreasing the number of points within the bays when compared to past surveys. As such, only Musky Bay had enough sample points during the 2018 survey to selectively perform a statistical comparison.

To compare between years, statistical analysis was completed using a Chi-square test with a 5% Type-I error rate. This error rate is standard in ecological studies and equals that there is a 5% chance of claiming a statistically significant change when no real change has occurred. Only those species that display a p-value of 0.05 or lower changed significantly population-wise between years and the closer to 0 a p-value becomes, the more significant the change. To calculate these values, the total number of sample locations each species was found at is compared between years. For Musky Bay, CLP data from 2007 was absent, so 2008 data was used in its place. Table 6 displays statistical changes, if any, for each species sampled within Lac Courte Oreilles since 2010. Table 7 displays these same changes for only Musky Bay during 2018 versus the most recent 2016 survey, 2010 survey prior to large-scale management, and historical 2007 pre-management data.

Lac Courte Oreilles – 2010 to 2018

The 2018 repeated the original, 2010 survey and used the same sampling grid and points. This allows for a direct comparison of the aquatic plant community and changes of individual species between events. For comparison only the 2010 whole-lake survey data was used. A second survey of only Musky Bay was completed at a separate time with results included in the discussion for Musky Bay only.

Overall, Lac Courte Oreilles was very comparable between surveys with excellent diversity and aquatic plant community health indicators. From 2010 to 2018 the total aquatic plant community remained extremely diverse and healthy. During both surveys over 30 species were sampled, SDI was high nearly identical at 0.93 and 0.94, average coefficient of conservatism slightly increased, and the FQI was within the upper quartile for lakes State-wide and within the ecoregion (Table 8). Additional species found during a special survey of Musky Bay only are not included in this discussion.

Table 8: Comparative Aquatic Plant Community Statistics, Lac Courte Oreilles Lakes, WI.		
	2010	2018
Date Sampled	---	7/23-25/2018
Points Sampled	820	2254
Points with vegetation	626	515
Points shallower than maximum depth of plants	810	763
Frequency of occurrence	77.28%	67.50%
Simpson Diversity Index	0.94	0.93
Maximum depth of plants (ft)	24	21
Average number of species per site (shallower than max depth)	2.26	1.67
Average number of species per site (veg. sites only)	2.93	2.48
Average number of native species per sire (shallower than max depth)	2.1	1.67
Average number of native species per site (veg. sites only)	2.88	2.47
Species Richness	30	39
Floristic Quality Index	32.05	40
Average Coefficient of Conservatism	6.54	6.67

A few notable, positive changes were noted from the 2010 to 2018 surveys; total species sampled and FQI increased significantly from 30 to 39 and 32.05 to 40.0, respectively. Both of these community indicators show an increasingly healthy and diverse aquatic plant population. An increase in FQI is directly related to the increased number of species sampled. This is especially the case as 11 species sampled in 2018 were not present in the 2010 survey. These include high quality, uncommon species with raised coefficients of conservatism.

High quality species newly identified in 2018 and their coefficients of conservatism include; small waterwort (*Elatine minima* – 9), brown-fruited rush (*Juncus pelocarpus* – 8), alternate-flowered water-milfoil (*Myriophyllum alterniflorum* – 10), pickerelweed (8), creeping spearwort (*Ranunculus flammula* – 9), and narrow-leaved bur-reed (*Sparganium angustifolium* – 9). Interestingly, all of these species are commonly found in near-shore areas and, outside of narrow-leaved bur-reed, small in stature and can be easily overlooked. It is likely that these species were present in 2010, but simply missed due to difficulty collecting a sample with a rake and variance in direct sampling locations due to GPS accuracy, among other factors.

Continuing presence – absence comparison there were three aquatic plant species identified in 2010 that were not sampled in 2018: pipewort (*Eriocaulon aquaticum*), water lobelia (*Lobelia dortmanna*), and common reed (*Phragmites austris*). Similar to the new species sampled in 2018, these "missing" species are mainly small, near shore species and still present in the Lake. Lobelia was visually noted outside of direct sample areas in 2018 and directly sampled in Little Lac Courte Oreilles.

To further assess changes of individual species a statistical comparison using a Chi-square test was completed. Statistical changes were noted from 2010 to 2018 as both increases and decreases for 21 individual species (Table 6). In total, 13 species were noted to have declined and eight increased significantly. Changes in the makeup of an aquatic plant community are expected over time and not an immediate cause for concern as environmental conditions vary. However, significant management of CLP in Musky Bay has taken place between surveys and is a localized, direct impact to a large area of LCO. Changes of the aquatic community to Musky Bay are discussed in detail in the following section.

To better assess changes in LCO independent from a concentrated AIS management regime the Musky Bay sample points were removed from the data pool. Remaining sample points were then re-assessed following the same protocol used above. This allows pinpointing of the data and potential reason for statistical changes. Curly-leaf pondweed, for example, significantly reduced from 2010 to 2018 when using the entire lake's data. But, when removing the Musky Bay sample points, there was nearly no change in abundance in the rest of LCO. This shows the change was only in Musky Bay. The same is true for coontail, common waterweed, and white water crowfoot (*Ranunculus aquatillus*) where the statistical decline was limited to Musky Bay and due to targeted management.

In using data for LCO without Musky Bay there were statistically significant changes in 15 species; 9 decreased and 6 increases (Table 6). All species that increased significantly between surveys were also noted to increase when using the entire lake's data, showing the change was outside of Musky Bay. Two species of note, water star-grass and white-stem pondweed (*Potamogeton praelongus*), provide important habitat for fish and aquatic organisms. Similarly, the species that declined significantly also did so when including the Musky Bay data. This shows that management practices in Musky Bay were not the driving cause for that location and non-target impact from management practices had a lessened effect than initially assessed.

Again, changes in individual species will occur over time. With 8 years passing between surveys some change is expected on a small scale due to environmental factors. More importantly, the indicators of the aquatic plant community as a whole remained excellent and slightly increased, showing continued health and diversity of Lac Courte Oreilles.

Musky Bay – Historical Comparison

Reduction of CLP, the main goal of the treatments, has been largely successful in Musky Bay since 2009. Originally, over 90 acres were managed which, over time, has been drastically reduced. However, due to a large accumulation of turions, reproductive structures for CLP, within the sediment, patches of CLP growth pop up each year. These patches vary in location and density between years and, until exhausted, may continue to cause nuisance within Musky Bay. In 2018 areas of CLP growth requiring management was reduced to only 5.0 acres, showing excellent control since 2009.

Native species restoration and limiting non-target impact is also an important goal of all AIS management. Though successful, CLP control within Musky Bay has not been without impact to non-target native species, which peaked in 2012 following consecutive years of aggressive herbicide applications of endothall at bay-wide rates. Endothall is not only active on curly-leaf pondweed, but also native species of pondweeds. Since 2007, there have been 11 different native pondweeds sampled within Musky Bay with up to 10 of them present per year (2007 and 2016).

When comparing the 2018 survey data to historical, 2007 & 2010 pre large-scale management data, it would appear at first glance that management has had a profound, negative affect on native species, as 10 are indicated to have declined significantly. However, some of the indicated declines of native species are exaggerated due to the conditions inferred in the statistical comparison.

In 2007 and 2018, the sample set of points was much smaller compared to 2010 and 2016, where a denser survey grid introduced many more sample points. When increasing sample points, the statistical comparison assumes the same conditions would apply to all components in Musky Bay. However, the habitat requirements some species (shallow, sandy areas) may occupy only make up a small portion of Musky Bay. Though the sample points increase, the area of suitable habitat remained the same.

From 2016 to 2018 the plant community remained relatively stable under small scale management of CLP. Only two species, wild celery and chara, were noted to have a significant decline in population. Conversely, five species increased significantly; water star-grass, northern water-milfoil, slender naiad, clasping-leaf pondweed, and flat-stem pondweed. Changes between these surveys should be noted as natural variance of the community and not a cause for alarm. Clasping-leaf pondweed, for example, has been documented to fluctuate dramatically on a two-year cycle within Musky Bay. Its presence varies from high to low every other year with 2018 being a year of high distribution. Chara, on the other hand, is still above historical 2007 levels and has significantly increased from 2010. The downturn of chara in 2018 is not a cause for concern.

When digging deeper into the initial 2007 pre-management data, more changes are evident and it is clear that CLP management has had an effect on some species of Musky Bay. Of particular concern are the decreases of large-leaf pondweed, fern pondweed, and flat-stem pondweed. All of these species are susceptible to the active ingredient endothall used for herbicide control of CLP in Musky Bay. The early whole-bay treatments for CLP management significantly reduced populations of these native species. All, however, are beginning an upward trend since. Fern pondweed and flat-stem pondweed were both absent for periods from surveys after 2010. Both have become re-established since.

Survey Results – Little Lac Courte Oreilles

The aquatic plant community of Little Lac Courte Oreilles was sampled on July 25-26, 2018 by WLPR. A full point-intercept survey was completed and included sampling at 529 locations. Little Lac Courte Oreilles has a deep basin, but also a large, shallow soft-sediment flat that creates ideal growing conditions for aquatic vegetation. This area is a high-value habitat area with a diverse aquatic plant community. The aquatic macrophyte community of the Lake included 38 floating-leaf, free-floating, emergent, and submerged aquatic plant species during 2018 (Table 9). Figures 2.1 – 2.7 illustrate the locations of each AIS found and the five most common species identified.

In Little LCO, the photic zone extended to a maximum depth of 17.5 feet, with 288 of the 529 locations shallower than this. Much of the photic zone was vegetated, due to better habitat, with 93.1% of locations within the photic zone vegetated. Fern pondweed (*Potamogeton robbinsii* – Figure 2.3) was the most dominant species, sampled in at 56.3% of photic-zone locations. Fern pondwed is a high-quality native species that provides important fisheries habitat and is also an indicator species. Indicator species are often the first to have their populations reduced from disturbance caused by the introduction of invasive species or through human activity. A decrease in an indicator species population can be used to identify a change in the health of a Lake.

Common waterweed was the next most common species at 53.4% of photic locations (Figure 2.4). Though native to Wisconsin and commonly found, this species can grow dense and become a nuisance. Coontail, another very common species in Wisconsin, was the next most common species sampled (Figure 2.5). Coontail can grow in deeper locations and remain green under ice cover, offering good fisheries habitat year-round (Table 9).

Both EWM and CLP were found within Little LCO, though neither of them was reported as dense (Figures 2.1 & 2.2). The past survey is comparable to the current one. Though Lac Courte Oreilles is many times large than Little LCO, the species diversity in Little LCO is greatly enhanced by a larger percentage of the lake having ideal aquatic plant growing conditions. Many high-quality species uncommon in Wisconsin lakes are present in Little LCO, including; water lobelia, alternate-flowered water-milfoil, dwarf water-milfoil (*Myriophyllum tenellum*), and a State Species of Concern - Vasey's pondweed (*Potamogeton vaseyii*).

Little Lac Courte Oreilles – 2015 to 2018

The 2018 survey was an exact repeat of the initial, 2015 whole-lake survey of Little Lac Courte Oreilles and offers a chance to statistically compare changes between them. The same Chi-square test as outlined for LCO and Musky Bay above was applied to these surveys (Table 11). Five native species identified in 2018 were new compared to historical records; alternate-flowered water-milfoil – a high-quality native milfoil rarely found in Wisconsin, water smartweed, Fries' pondweed, hardstem bulrush, and common bladderwort.

Though EWM and CLP, both AIS, were officially recorded as new in 2018 compared to 2015, documentation of the species took place prior. Both species were present in only low, background levels. Conversely there were four species absent in 2018 that were identified in 2015; waterwort, quillwort, brown-fruited rush, and stiff pondweed. Each of these species was found at minimal locations in 2015 with the first three being small, near-shore species that do not sample well. Absence of these species from 2015 to 2018 and vice versa is not a cause for concern and none of their changes were large enough to be statistically significant.

Statistical changes from 2015 to 2018 were also noted in the aquatic plant community. Coontail, common waterweed, small pondweed, and fern pondweed all increased significantly while northern water-milfoil, Illinois pondweed, and arrowhead were noted to decrease significantly. Coontail and common waterweed are the two most common aquatic plants in Wisconsin. Both often grow to dense, nuisance-causing levels and are tolerant of disturbances. An increase in these species may indicate a change in the Lake to a more disturbed condition and of reduced quality. This is not the case for Little LCO, however. Both coontail and common waterweed were primarily at low, background densities (rake fullness of 1) when sampled. In addition, the increase of fern pondweed and continued presence of species with a high coefficient of conservatism, such as alternate-flowered and dwarf water-milfoils, indicate a continued stable and high-quality aquatic plant community. Any changes should be seen as natural.

Survey Results – Comparison of Both Lakes

Though each lake is its own somewhat unique ecosystem, being a connected chain of waterbodies creates a stable system throughout. Both Lac Courte Oreilles Lakes are subject to the same atmospheric, use, and management conditions. Across each lake, the most common species present by lake, though varying slightly, was compromised of largely the same species. Slender naiad, coontail, and common waterweed were all within the five most common species in each lake (Table 12).

Table 12: Aquatic Plant Community Statistics, Lac Courte Oreilles Lakes, Sawyer, WI

	LCO	Little LCO
F.o.o. at sites shallower than maximum depth of plants	67.50%	93.10%
Simpson Diversity Index	0.93	0.91
Most Dominant Species	Slender Naiad	Fern Pondweed
	Common Waterweed	Common Waterweed
	Wild Celery	Coontail
	Coontail	Flat-stem Pondweed
	Chara / Muskgrass	Slender Naiad
Species Richness	39	38
Community FQI	40	39.55
Average Coeffecient of Conservatism	6.67	6.69

Use of FQI and average C can also be extrapolated out to lakes in similar eco-regions of Wisconsin to compare communities. The Lac Courte Oreilles Lakes lie within the Northern Lakes and Forests eco-region and are minimally developed with varying degrees of low disturbance. This impacts the plant communities and is shown by lakes in this eco-region typically having FQI, average C values, and species diversity above those found throughout the State. Both Lakes have C values at the eco-region median. However, due to their diverse communities, the Lakes are exceeding the upper quartile for all lakes in the eco-region for total FQI and species diversity. A complete breakdown of FQI calculation for Lac Courte Oreilles is included in Table 5 and for Little Lac Courte Oreilles in Table 10. For both lakes, all indicators point towards a very healthy community comparative to an undisturbed, natural condition (Table 13).

Table 13: FQI and Average Coefficient of the Lac Courte Oreilles Lakes Compared to Northern Lakes and Forests.

	Average Coefficient			Floristic Quality			Species Diversity		
Quartile*	Lower	Median	Upper	Lower	Median	Upper	Lower	Median	Upper
Wisconsin Lakes	5.5	6	6.9	16.9	22.2	27.5	8	13	20
Northern Lakes & Forests	6.1	6.7	7.7	17.8	24.3	30.2	7	13	20
Lac Courte Oreilles	6.67			40			39		
Little Lac Courte Oreilles	6.69			39.55			38		

* - Values indicate highest value of the lowest quartile, mean, and lowest value of the upper quartile

Management Recommendations

Management of aquatic plants can take many facets, depending on each lake's unique condition and desire by the community. To be successful, a management option must be accepted by its users. Herbicide use has been done in the past within the Lac Courte Oreilles Lakes at varying scales. Herbicides for aquatic plant management can have negative connotations and be misunderstood by some users, making it potentially controversial. However, the combinations of periodic large-scale whole lake type treatments for AIS have shown to reduce the need and frequency of harvesting for several years after treatment. These include periodic triggers based on frequency of occurrence of the AIS, which may be a hybrid, and is a management option that should be further explored by COLA.

To get a more accurate assessment of the amount of CLP growth, a pre-treatment survey is highly recommended before any management action in 2019 and beyond, in conjunction with a post-treatment survey approximately 30-45 days after treatment to assess potential impacts to the surrounding plant community. Timing of the post-treatment survey is extremely important, to be completed prior to CLP dying off naturally on its own. Additionally, as waters cool in the fall, a second growth of CLP may occur. It is recommended that COLA citizen volunteers monitor locations of known CLP growth for this occurrence and map any second growth CLP noted. These areas should then be a focus of the following year's pre-treatment survey. We recommend the following course of action be followed for CLP management:

- January, 2019: Apply for an aquatic herbicide treatment permit for up 25 acres for Lac Courte Oreilles
    - Increased permit acreage allows for wiggle room in a worst-case scenario. It is easier to permit for more acreage up front than after the fact.
    - Any acreage not actively managed is able to have a refund of permit fees
- April/May, 2019: Pre-treatment survey to verify CLP management zones
    - Drill down exact locations. Expected to be less than 25 acres
- April/May, 2019: Chemical treatment of CLP within management zones. Recommended rates and products are as follows:
    - For individual areas <5.0 acres: Aquathol K (endothall) at 4.0 PPM
    - For individual areas >5.0 acres: Aquathol K (endothall) at 2.5-3.0 PPM
    - If a whole-bay treatment is necessary: Aquathol K dosed at 750 PPB for the entire water volume of the Bay
- July/August, 2019: Post-treatment survey of CLP management zone to assess results and plan for future actions.

Eurasian water-milfoil is a newly found AIS within both lakes. Though 2,4-D is the typical active ingredient used for EWM control its use is not recommended at this time within the Courte Oreille Lakes. 2,4-D requires extended contact time to be successful. The current populations of EWM are widely scattered in small patches. Any product applied for EWM control will rapidly move off site, offering minimal contact and exposure. Currently, the EWM locations are too small to offer adequate contact and exposure of 2,4-D. To prevent further expansion within the Lakes we recommend the following actions for EWM management:

- January, 2019: Apply for an aquatic herbicide treatment permit for up to 5.0 acres for Lac Courte Oreilles and 3 acres for Little Lac Courte Oreilles
- April/May 2019: Pre-treatment survey to verify EWM management zones (congruent with CLP survey above)
- April/May, 2019: Chemical treatment of EWM within management zones. Recommended rates and products are as follows:
    - For individual areas <0.25 acres: Targeted hand-harvesting
    - For individual areas <3.0 acres: ProcellaCOR at 5 PDU/ac-ft*
    - For individual areas >3.0 acres: ProcellaCOR at 5 PDU/ac-ft* or Aquastrike at 1.625 gal/ac-ft.
        - *** Higher rates of ProcellaCOR may be necessary. Any dosing for EWM control should be confirmed with SePro prior to application.**
- July/August, 2019: Post-treatment survey of EWM management zones to assess results and plan future actions (congruent with CLP survey above).

Because of COLA's proactive approach in dealing with AIS, the current populations of CLP within the Lake are decreasing, improving the health and ecosystem overall. However, the Lac Courte Oreilles Lakes Association should continue to be involved in some type of aquatic plant management program to help manage invasive aquatic plant growth. AIS are extremely opportunistic plants and can grow to nuisance levels in a very short period of time. Continued management should occur to ensure that the health, aesthetic and recreational value of the lake is not degraded. This should occur through a two-pronged approach of augmenting the native plant community while targeting reductions in the invasive plants.

The Lac Courte Oreilles Lakes Association must remain proactive in their approach. With COLA's continued commitment to ensuring that the health, aesthetic and recreational values of Lac Courte Oreilles are preserved, with active aquatic plant management, the quantity of exotic species found on Lac Courte Oreilles will be appropriately controlled. Wisconsin Lake & Pond Resource appreciates working for COLA this past season and we look forward to working with you on future projects. Please feel free to contact us if you have any questions regarding the 2018 aquatic plant surveys or with any additional concerns or needs for 2019.

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Appendix A

Supporting Aquatic Plant Survey Methods and Documentation

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

Taxonomic richness (the total number of taxa detected)

- **Maximum depth of plant growth**
- **Community frequency of occurrence** (number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth)
- **Mean intercept point taxonomic richness** (the average number of taxa per intercept point)
- **Mean intercept point native taxonomic richness** (the average number of native taxa per intercept point)
- **Taxonomic frequency of occurrence within vegetated areas** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present)
- **Taxonomic frequency of occurrence at sites within the photic zone** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected, divided by the total number of intercept points which are equal to or shallower than the maximum depth of plant growth)
- **Relative taxonomic frequency of occurrence** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected, divided by the sum of all species' occurrences)
- **Mean density** (the sum of the density values for a particular species divided by the number of sampling sites)
- **Simpson Diversity Index (SDI**) is an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.
-

Floristic Quality Index (FQI) (This method uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present, with a measure of the species richness of the site.

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Appendix B

Tables

Toll Free: 866-208-0724
www.wisconsinlpr.com

N7828 Town Hall Rd.
Eldorado, WI 54932
Phone: (920) 872-2032
Fax: (920) 872-2036

Table 2: Taxa Detected During 2018 Aquatic Plant Surveys, Lac Courte Oreilles Lakes, WI

Genus & species	Common Name	Category	Present in Lake	
			LCO	Little LCO
Myriophyllum spicatum	***Eurasian water milfoil***	**Invasive**	X	X
Potamogeton crispus	***Curly-leaf pondweed***	**Invasive**	X	X
Bidens beckii (formerly Megalodonta)	*Water marigold*	Submersed	X	X
Brasenia schreberi	*Watershield*	Floating-leaf		X
Ceratophyllum demersum	*Coontail*	Submersed	X	X
Chara sp.	*Muskgrasses*	Submersed	X	X
Elatine minima	*Waterwort*	Submersed	X	
Eleocharis acicularis	*Needle spikerush*	Submersed	X	X
Eleocharis palustris	*Creeping spikerush*	Emergent	X	
Elodea canadensis	*Common waterweed*	Submersed	X	X
Heteranthera dubia	*Water star-grass*	Submersed	X	X
Isoetes sp.	*Quillwort*	Submersed	X	
Juncus pelocarpus f. submersus	*Brown-fruited rush*	Submersed	X	
Lemna minor	*Small duckweed*	Free-floating	X	
Lemna trisulca	*Forked duckweed*	Free-floating	X	X
Lobelia dortmanna	*Water lobelia*	Submersed		X
Myriophyllum alterniflorum	*Alternate-flowered water-milfoil*	Submersed	X	X
Myriophyllum sibiricum	*Northern water-milfoil*	Submersed	X	X
Myriophyllum tenellum	*Dwarf water-milfoil*	Submersed	X	X
Najas flexilis	*Slender naiad*	Submersed	X	X
Nitella sp.	*Nitella*	Submersed	X	X
Nuphar variegata	*Spatterdock*	Floating-leaf	X	X
Nymphaea odorata	*White water lily*	Floating-leaf	X	X
Polygonum amphibium	*Water smartweed*	Floating-leaf		X
Pontederia cordata	*Pickerelweed*	Emergent	X	X
Potamogeton amplifolius	*Large-leaf pondweed*	Submersed	X	X
Potamogeton friesii	*Fries' pondweed*	Submersed	X	X
Potamogeton gramineus	*Variable pondweed*	Submersed	X	X
Potamogeton illinoensis	*Illinois pondweed*	Submersed	X	X
Potamogeton natans	*Floating-leaf pondweed*	Floating-leaf	X	X
Potamogeton praelongus	*White-stem pondweed*	Submersed	X	X
Potamogeton pusillus	*Small pondweed*	Submersed	X	X
Potamogeton richardsonii	*Clasping-leaf pondweed*	Submersed	X	X
Potamogeton robbinsii	*Fern pondweed*	Submersed	X	X
Potamogeton vaseyi	*Vasey's pondweed*	Submersed		X
Potamogeton zosteriformis	*Flat-stem pondweed*	Submersed	X	X
Ranunculus aquatilis	*White water crowfoot*	Submersed	X	X
Ranunculus flammula	*Creeping spearwort*	Submersed	X	
Sagittaria sp.	*Arrowhead*	Emergent	X	X
Schoenoplectus acutus	*Hardstem bulrush*	Emergent	X	X
Sparganium angustifolium	*Narrow-leaved bur-reed*	Emergent	X	X
Stuckenia pectinata	*Sago pondweed*	Submersed	X	X
Utricularia vulgaris	*Common bladderwort*	Submersed		X
Vallisneria americana	*Wild celery*	Submersed	X	X

Table 3: 2018 Aquatic Plant Community Statistics, Lac Courte Oreilles Lakes, WI.

	LCO	Little LCO
Date Sampled	7/23-25/2018	7/25-26/2018
Points Sampled	2254	529
Points with vegetation	515	268
Points shallower than maximum depth of plants	763	288
Frequency of occurrence	67.50%	93.10%
Simpson Diversity Index	0.93	0.91
Maximum depth of plants (ft)	21	17.5
Average number of species per site (shallower than max depth)	1.67	3.28
Average number of species per site (veg. sites only)	2.48	3.53
Average number of native species per sire (shallower than max depth)	1.67	3.27
Average number of native species per site (veg. sites only)	2.47	3.51
Species Richness	39	38

Table 4: 2018 Aquatic Plant Taxa-Specific Statistics, Lac Courte Oreilles, Sawyer County, WI

Common Name	Percent Frequency of Occurrence within vegetated areas	Percent Frequency of Occurrence at sites shallower than max depth of plants	Percent Relative Frequency of Occurrence	Number of Intercept Points Where Detected	Average Density
Eurasian water milfoil	**0.39**	**0.26**	**0.16**	**2**	**1.00**
Curly-leaf pondweed	**0.39**	**0.26**	**0.16**	**2**	**1.00**
Water marigold	1.36	0.92	0.55	7	1.00
Coontail	20.19	13.63	8.14	104	1.10
Muskgrasses	17.67	11.93	7.13	91	1.00
Waterwort	0.78	0.52	0.31	4	1.00
Needle spikerush	7.96	5.37	3.21	41	1.00
Creeping spikerush	0.19	0.13	0.08	1	1.00
Common waterweed	25.83	17.43	10.42	133	1.02
Water star-grass	8.16	5.50	3.29	42	1.00
Quillwort	5.44	3.67	2.19	28	1.00
Brown-fruited rush	0.58	0.39	0.23	3	1.00
Small duckweed	0.19	0.13	0.08	1	1.00
Forked duckweed	0.19	0.13	0.08	1	1.00
Alternate-flowered water-milfoil	1.94	1.31	0.78	10	1.00
Northern water-milfoil	15.92	10.75	6.42	82	1.04
Dwarf water-milfoil	4.85	3.28	1.96	25	1.00
Slender naiad	30.49	20.58	12.29	157	1.00
Nitella	4.08	2.75	1.64	21	1.00
Spatterdock	0.97	0.66	0.39	5	1.00
White water lily	0.97	0.66	0.39	5	1.00
Pickerelweed	0.58	0.39	0.23	3	1.00
Large-leaf pondweed	2.72	1.83	1.10	14	1.00
Fries' pondweed	1.36	0.92	0.55	7	1.00
Variable pondweed	13.01	8.78	5.25	67	1.00
Illinois pondweed	0.39	0.26	0.16	2	1.00
Floating-leaf pondweed	0.39	0.26	0.16	2	1.00
White-stem pondweed	2.52	1.70	1.02	13	1.00
Small pondweed	13.59	9.17	5.48	70	1.09
Clasping-leaf pondweed	14.56	9.83	5.87	75	1.05
Fern pondweed	7.77	5.24	3.13	40	1.08
Flat-stem pondweed	16.12	10.88	6.50	83	1.00
White water crowfoot	3.69	2.49	1.49	19	1.00
Creeping spearwort	0.19	0.13	0.08	1	1.00
Arrowhead	0.19	0.13	0.08	1	1.00
Hardstem bulrush	1.17	0.79	0.47	6	1.00
Narrow-leaved bur-reed	0.19	0.13	0.08	1	1.00
Sago pondweed	0.19	0.13	0.08	1	1.00
Wild celery	20.78	14.02	8.38	107	1.00

Table 5: 2018 Floristic Quality Indicies, Lac Courte Oreilles, Sawyer County, WI

Common Name	2018
Water marigold	8
Coontail	3
Muskgrasses	7
Waterwort	9
Needle spikerush	5
Creeping spikerush	6
Common waterweed	3
Water star-grass	6
Quillwort	8
Brown-fruited rush	8
Small duckweed	4
Forked duckweed	6
Alternate-flowered water-milfoil	10
Northern water-milfoil	6
Dwarf water-milfoil	10
Slender naiad	6
Nitella	7
Spatterdock	6
White water lily	6
Pickerelweed	8
Large-leaf pondweed	7
Fries' pondweed	8
Variable pondweed	7
Illinois pondweed	6
Floating-leaf pondweed	5
White-stem pondweed	8
Small pondweed	7
Clasping-leaf pondweed	5
Fern pondweed	8
Flat-stem pondweed	6
White water crowfoot	8
Creeping spearwort	9
Hardstem bulrush	6
Narrow-leaved bur-reed	9
Sago pondweed	3
Wild celery	6
Total Species	36
Mean C	6.67
Floristic Quality Index (FQI)	**40.00**

Please note: There is no Coefficient of Conservatism for exotic species such as Eurasian Water-Milfoil or plants not identified to the species level (*Sagittaria sp.*).

Coefficient of Conservatism C

0-3 taxa found in wide variety of plant communities and very tolerant of disturbance.
4-6 taxa associated with specific plant communities and tolerates moderate disturbance.
7-8 taxa found in narrow range of plant communities and tolerate minor disturbance.
9-10 taxa restricted to a narrow range of conditions with low tolerance of disturbance.

Table 6: Statistical Significance of Species between Sampling Events, Lac Courte Oreilles, Sawyer County, Wisconsin.

	Littloral Zone Frequency of Occurrence		2018 v 2010			2018 v 2010 - Without Musky Bay		
Species	2010	2018	+/-	P-value	significance	+/-	P-value	significance
Eurasian water milfoil	---	0.26	↑	0.144827604	n.s.	↑	0.142449373	n.s.
Curly-leaf pondweed	3.83	0.26	↓	8.19007E-07	***	↓	0.605536356	n.s.
Water marigold	7.53	0.92	↓	1.15031E-10	***	↓	2.4717E-10	***
Coontail	18.27	13.63	↓	0.012137682	*	↑	0.214287866	n.s.
Muskgrasses	15.56	11.93	↓	0.036989016	*	↓	0.013773683	*
Waterwort	---	0.52	↑	0.039083797	*	↑	0.037907881	*
Needle spikerush	0.12	5.37	↑	1.07947E-10	***	↑	2.80811E-11	***
Creeping spikerush	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Common waterweed	24.69	17.43	↓	0.000427083	***	↓	0.705250975	n.s.
Pipewort	3.09	---	↓	2.19498E-07	***	↓	4.06028E-07	***
Water star-grass	0.12	5.50	↑	6.09947E-11	***	↑	0.014272251	*
Quillwort	5.31	3.67	↓	0.117627128	n.s.	↓	0.157450356	n.s.
Brown-fruited rush	---	0.39	↑	0.074050028	n.s.	↑	0.072327028	n.s.
Small duckweed	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Forked duckweed	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Water lobelia	0.12	---	↓	0.169614291	n.s.	↓	0.172048573	n.s.
Alternate-flowered water-milfoil	---	1.31	↑	0.001080714	**	↑	0.001002831	**
Northern water-milfoil	6.91	10.75	↑	0.007232674	**	↓	0.87099927	n.s.
Dwarf water-milfoil	7.78	3.28	↓	0.000103445	***	↓	0.000237553	***
Slender naiad	12.84	20.58	↑	5.10987E-05	***	↓	0.628235279	n.s.
Nitella	9.63	2.75	↓	1.98433E-08	***	↓	1.02658E-08	***
Spatterdock	0.12	0.66	↑	0.223909772	n.s.	↑	0.942977115	n.s.
White water lily	0.25	0.66	↑	0.223909772	n.s.	↑	0.597254807	n.s.
Common reed	Visual Only	---	↓	0.331616617	n.s.	↓	0.334397563	n.s.
Pickerelweed	---	0.39	↑	0.074050028	n.s.	↑	0.299856586	n.s.
Large-leaf pondweed	2.72	1.83	↓	0.188856989	n.s.	↓	0.050835258	n.s.
Fries' pondweed	---	0.92	↑	0.006293065	**	↑	0.005973487	**
Variable pondweed	14.07	8.78	↓	9.80932E-05	***	↓	0.00016131	***
Illinois pondweed	0.86	0.26	↓	0.113588753	n.s.	↓	0.117358197	n.s.
Floating-leaf pondweed	0.12	0.26	↑	0.528704643	n.s.	↑	0.521978008	n.s.
White-stem pondweed	0.49	1.70	↑	0.020361749	*	↑	0.025716917	*
Small pondweed	10.99	9.17	↓	0.233100437	n.s.	↓	0.190135793	n.s.
Clasping-leaf pondweed	9.14	9.83	↑	0.638611352	n.s.	↓	0.206362689	n.s.
Fern pondweed	13.21	5.24	↓	5.76784E-08	***	↓	1.4212E-05	***
Flat-stem pondweed	15.93	10.88	↓	0.003389046	**	↓	0.000277169	***
White water crowfoot	6.05	2.49	↓	0.000522461	***	↓	0.479978242	n.s.
Creeping spearwort	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Arrowhead	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Hardstem bulrush	0.74	0.79	↑	0.917210524	n.s.	↓	0.853984179	n.s.
Narrow-leaved bur-reed	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Sago pondweed	---	0.13	↑	0.30269705	n.s.	↑	0.299856586	n.s.
Wild celery	22.84	14.02	↓	3.08924E-06	***	↓	6.80719E-05	***

*, **, *** - Levels of significance.

n.s. - Change not significant

--- - Specie was not sampled in both comparison years

Table 7: Statistical Significance of Species between Sampling Events, Musky Bay - Lac Courte Oreilles, Sawyer County, Wisconsin.

	2018 v 2016			2018 v 2010			2018 v 2007		
Species	**+/-**	**P-value**	**significance**	**+/-**	**P-Value**	**significance**	**+/-**	**P-value**	**significance**
Curly-leaf pondweed	↑	0.418852915	n.s.	↓	**6.5E-08**	***	↓	**1.7E-12**	***
Filamentous algae	---	---	---	---	---	---	↓	0.027343	*
Water marigold	↓	0.416270451	n.s.	↓	**0.00898**	**	↑	0.656573	n.s.
Coontail	↓	0.179007062	n.s.	↓	**2.1E-18**	***	↓	**8.9E-08**	***
Chara	↓	**0.005881684**	**	↑	**0.00231**	**	↑	0.172579	n.s.
Needle spikerush	↑	0.982168364	n.s.	↑	0.982168	n.s.	↑	0.305303	n.s.
Elodea	↑	0.321307233	n.s.	↓	**8.8E-22**	***	↓	**2.9E-14**	***
Water horsetail	---	---	---	---	---	---	---	---	---
Water stargrass	↑	**1.41863E-06**	***	↑	**3.7E-26**	***	↑	**1.6E-10**	***
Quillwort	---	---	---	---	---	---	↓	0.088642	n.s.
Small duckweed	↓	0.568322932	n.s.	↓	0.568323	n.s.	---	---	---
Forked duckweed	↓	0.568322932	n.s.	↓	0.568323	n.s.	---	---	---
Watermoss	---	---	---	---	---	---	---	---	---
Northern water-milfoil	↑	**0.00060624**	***	↑	**1E-08**	***	↑	**6.1E-05**	***
Dwarf water-milfoil	↓	0.568322932	n.s.	↓	0.419311	n.s.	↓	0.165291	n.s.
Slender naiad	↑	**2.30861E-26**	***	↑	**3.9E-53**	***	↑	**2E-20**	***
Nitella	↑	0.079064244	n.s.	↑	0.079064	n.s.	↑	0.305303	n.s.
Spatterdock	↑	0.535341554	n.s.	↑	**0.01849**	*	↑	0.614698	n.s.
White water lily	↓	0.871537426	n.s.	↑	0.613804	n.s.	↓	0.17041	n.s.
Pickerelweed	↑	0.088812512	n.s.	↑	**0.01292**	*	↑	0.53477	n.s.
Large-leaf pondweed	↑	0.105973894	n.s.	↑	0.659655	n.s.	↓	**0.00047**	***
Leafy pondweed	↓	0.568322932	n.s.	---	---	---	↓	0.327468	n.s.
Frie's pondweed	↓	0.419311098	n.s.	---	---	---	↓	**0.04886**	*
Variable pondweed	↓	0.419311098	n.s.	↓	0.25248	n.s.	↓	**0.04886**	*
Illinois pondweed	---	---	---	---	---	---	↓	**0.02734**	*
Floating-leaf pondweed	---	---	---	---	---	---	---	---	---
White-stem pondweed	↓	0.068014219	n.s.	↓	0.860613	n.s.	↑	0.472195	n.s.
Small pondweed	↑	0.23442129	n.s.	↑	0.088813	n.s.	↓	**0.0224**	*
Clasping-leaf pondweed	↑	**0.007705372**	**	↑	0.403809	n.s.	↓	0.693102	n.s.
Fern pondweed	↑	0.418852915	n.s.	↓	**3.3E-05**	***	↓	**1.2E-50**	
Flat-stem pondweed	↑	**4.9652E-07**	***	↑	0.134756	n.s.	↓	**0.00056**	***
Stiff water crowfoot	↓	0.229251351	n.s.	↓	**2.7E-06**	***	↓	**0.0122**	*
Grass-leaved arrowhead	---	---	---	---	---	---	↓	0.165291	n.s.
Arrowhead species	↓	0.419311098	n.s.	↓	0.568323	n.s.	↓	0.327468	n.s.
Hard-stem bulrush	↑	0.401376984	n.s.	↑	0.401377	n.s.	↑	0.974058	n.s.
Bur-reed species	---	---	---	---	---	---	---	---	---
Floating-leaved bur-reed	---	---	---	---	---	---	↓	0.165291	n.s.
Narrow-leaved bur-reed	↓	0.568322932	n.s.	---	---	---	---	---	---
Large duckweed	↓	0.568322932	n.s.	↓	0.419311	n.s.	---	---	---
Common bladderwort	↓	0.322136371	n.s.	---	---	---	---	---	---
Wild celery	↓	**0.012384406**	*	↓	**0.01238**	*	↓	0.412633	n.s.

*, **, *** - Levels of significance.

n.s. - Change not significant

--- - Specie was not sampled in both comparison years

Table 9: 2018 Aquatic Plant Taxa-Specific Statistics, Little Lac Courte Oreilles, Sawyer County, WI

Common Name	Percent Frequency of Occurrence within vegetated areas	Percent Frequency of Occurrence at sites shallower than max depth of plants	Percent Relative Frequency of Occurrence	Number of Intercept Points Where Detected	Average Density
Eurasian water milfoil	**1.12**	**1.04**	**0.32**	**3**	**1.00**
Curly-leaf pondweed	**0.37**	**0.35**	**0.11**	**1**	**1.00**
Water marigold	5.97	5.56	1.69	16	1.00
Watershield	4.48	4.17	1.27	12	1.00
Coontail	37.69	35.07	10.69	101	1.03
Muskgrasses	19.78	18.40	5.61	53	1.00
Needle spikerush	4.48	4.17	1.27	12	1.00
Common waterweed	53.36	49.65	15.13	143	1.02
Water star-grass	5.97	5.56	1.69	16	1.00
Forked duckweed	0.75	0.69	0.21	2	1.00
Water lobelia	0.37	0.35	0.11	1	1.00
Alternate-flowered water-milfc	0.37	0.35	0.11	1	1.00
Northern water-milfoil	14.55	13.54	4.13	39	1.05
Dwarf water-milfoil	2.24	2.08	0.63	6	1.00
Slender naiad	24.63	22.92	6.98	66	1.00
Nitella	0.75	0.69	0.21	2	1.00
Spatterdock	4.48	4.17	1.27	12	1.00
White water lily	3.73	3.47	1.06	10	1.00
Water smartweed	0.75	0.69	0.21	2	1.00
Pickerelweed	1.49	1.39	0.42	4	1.00
Large-leaf pondweed	12.69	11.81	3.60	34	1.00
Fries' pondweed	0.37	0.35	0.11	1	1.00
Variable pondweed	14.93	13.89	4.23	40	1.03
Illinois pondweed	0.37	0.35	0.11	1	1.00
Floating-leaf pondweed	0.37	0.35	0.11	1	1.00
White-stem pondweed	3.36	3.13	0.95	9	1.00
Small pondweed	14.55	13.54	4.13	39	1.08
Clasping-leaf pondweed	6.34	5.90	1.80	17	1.00
Fern pondweed	60.45	56.25	17.14	162	1.30
Vasey's pondweed	0.75	0.69	0.21	2	1.00
Flat-stem pondweed	25.75	23.96	7.30	69	1.01
White water crowfoot	3.73	3.47	1.06	10	1.00
Arrowhead	0.75	0.69	0.21	2	1.00
Hardstem bulrush	0.37	0.35	0.11	1	1.00
Narrow-leaved bur-reed	0.75	0.69	0.21	2	1.00
Sago pondweed	0.37	0.35	0.11	1	1.00
Common bladderwort	0.37	0.35	0.11	1	1.00
Wild celery	19.03	17.71	5.40	51	1.00

Table 10: Floristic Quality Indicies, Little Lac Courte Oreilles, WI

Common Name	2018
Water marigold	8
Watershield	6
Coontail	3
Muskgrasses	7
Needle spikerush	5
Common waterweed	3
Water star-grass	6
Forked duckweed	6
Water lobelia	10
Alternate-flowered water-milfoil	10
Northern water-milfoil	6
Dwarf water-milfoil	10
Slender naiad	6
Nitella	7
Spatterdock	6
White water lily	6
Water smartweed	5
Pickerelweed	8
Large-leaf pondweed	7
Fries' pondweed	8
Variable pondweed	7
Illinois pondweed	6
Floating-leaf pondweed	5
White-stem pondweed	8
Small pondweed	7
Clasping-leaf pondweed	5
Fern pondweed	8
Vasey's pondweed	10
Flat-stem pondweed	6
White water crowfoot	8
Hardstem bulrush	6
Narrow-leaved bur-reed	9
Sago pondweed	3
Common bladderwort	7
Wild celery	6
Total Species	35
Mean C	6.69
Floristic Quality Index (FQI)	**39.55**

Please note: There is no Coefficient of Conservatism for exotic species such as Eurasian Water-Milfoil or plants not identified to the species level (*Sagittaria sp.*).

Coefficient of Conservatism C

0-3 taxa found in wide variety of plant communities and very tolerant of disturbance.
4-6 taxa associated with specific plant communities and tolerates moderate disturbance.
7-8 taxa found in narrow range of plant communities and tolerate minor disturbance.
9-10 taxa restricted to a narrow range of conditions with low tolerance of disturbance.

Table 11: Statistical Significance of Species between Sampling Events, Little Lac Courte Oreilles, Sawyer County, Wisconsin.

	Littloral Zone Frequency of Occurrence		2018 v 2015		
Species	**2015**	**2018**	**+/-**	**P-value**	**significance**
Eurasian water milfoil	**---**	**1.04**	↑	0.075374909	n.s.
Curly-leaf pondweed	**---**	**0.35**	↑	0.305416953	n.s.
Water marigold	2.98	5.56	↑	0.120586677	n.s.
Watershield	2.32	4.17	↑	0.203549666	n.s.
Coontail	18.21	35.07	↑	**3.46713E-06**	***
Muskgrasses	17.22	18.40	↑	0.706974721	n.s.
Waterwort	0.33	---	↓	0.328383641	n.s.
Needle spikerush	6.29	4.17	↓	0.247590061	n.s.
Common waterweed	38.41	49.65	↑	**0.009699332**	**
Water star-grass	3.64	5.56	↑	0.266315683	n.s.
Quillwort	0.66	---	↓	0.166544846	n.s.
Brown-fruited rush	1.32	---	↓	0.050025391	n.s.
Forked duckweed	---	0.69	↑	0.146880206	n.s.
Water lobelia	0.33	0.35	↑	0.973176904	n.s.
Alternate-flowered water-milfoil	---	0.35	↑	0.305416953	n.s.
Northern water-milfoil	22.19	13.54	↓	**0.006262451**	**
Dwarf water-milfoil	2.65	2.08	↓	0.651810186	n.s.
Slender naiad	20.53	22.92	↑	0.481982769	n.s.
Nitella	---	0.69	↑	0.146880206	n.s.
Spatterdock	4.64	4.17	↓	0.78139756	n.s.
White water lily	4.64	3.47	↓	0.47452061	n.s.
Water smartweed	---	0.69	↑	0.146880206	n.s.
Pickerelweed	0.66	1.39	↑	0.379212025	n.s.
Large-leaf pondweed	11.26	11.81	↑	0.835161566	n.s.
Fries' pondweed	---	0.35	↑	0.305416953	n.s.
Variable pondweed	14.57	13.89	↓	0.813043883	n.s.
Illinois pondweed	4.64	0.35	↓	**0.000939902**	***
Floating-leaf pondweed	0.33	0.35	↑	0.973176904	n.s.
White-stem pondweed	1.99	3.13	↑	0.379957523	n.s.
Small pondweed	8.28	13.54	↑	**0.039875626**	*
Clasping-leaf pondweed	16.23	5.90	↓	7.00251E-05	***
Fern pondweed	41.06	56.25	↑	**0.00022389**	***
Stiff pondweed	0.33	---	↓	0.328383641	n.s.
Vasey's pondweed	1.32	0.69	↓	0.445777405	n.s.
Flat-stem pondweed	23.18	23.96	↑	0.823513345	n.s.
White water crowfoot	2.65	3.47	↑	0.561124209	n.s.
Arrowhead	2.98	0.69	↓	**0.040201956**	*
Hardstem bulrush	0.33	0.35	↑	0.305416953	n.s.
Narrow-leaved bur-reed	0.66	0.69	↑	0.535124304	n.s.
Sago pondweed	---	0.35	↓	0.590735329	n.s.
Common bladderwort	---	0.35	↑	0.305416953	n.s.
Wild celery	18.21	17.71	↓	0.873458811	n.s.

*, **, *** - Levels of significance.

n.s. - Change not significant

--- - Specie was not sampled in both comparison years

Appendix C

Figures

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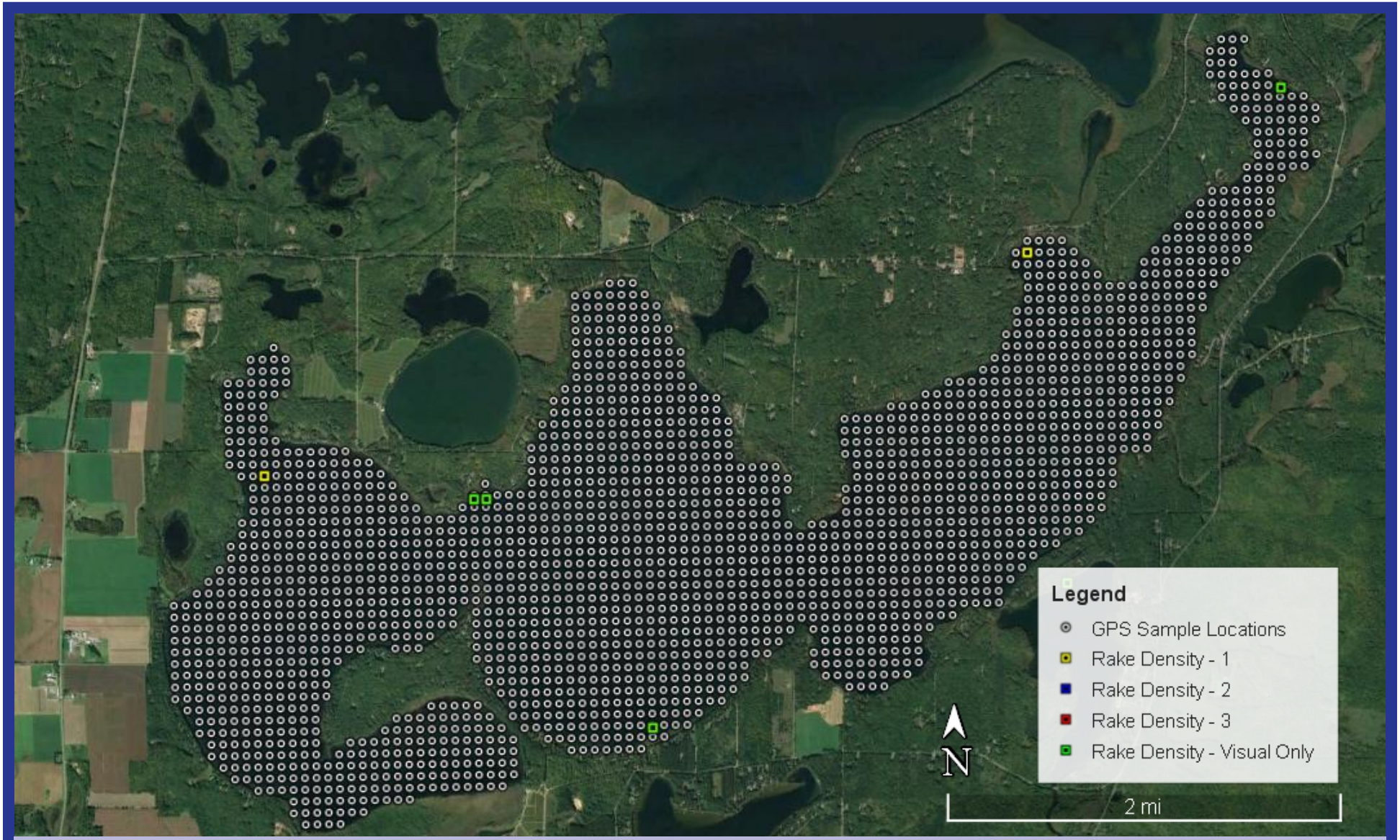
Eldorado, WI 54932
Phone: (920) 872-2032
Fax: (920) 872-2036



2018 Survey - Eurasian Water-milfoil

Lac Courte Oreilles, Saywer County
Surveyed: July 23-25, 2018
Figure 1.1

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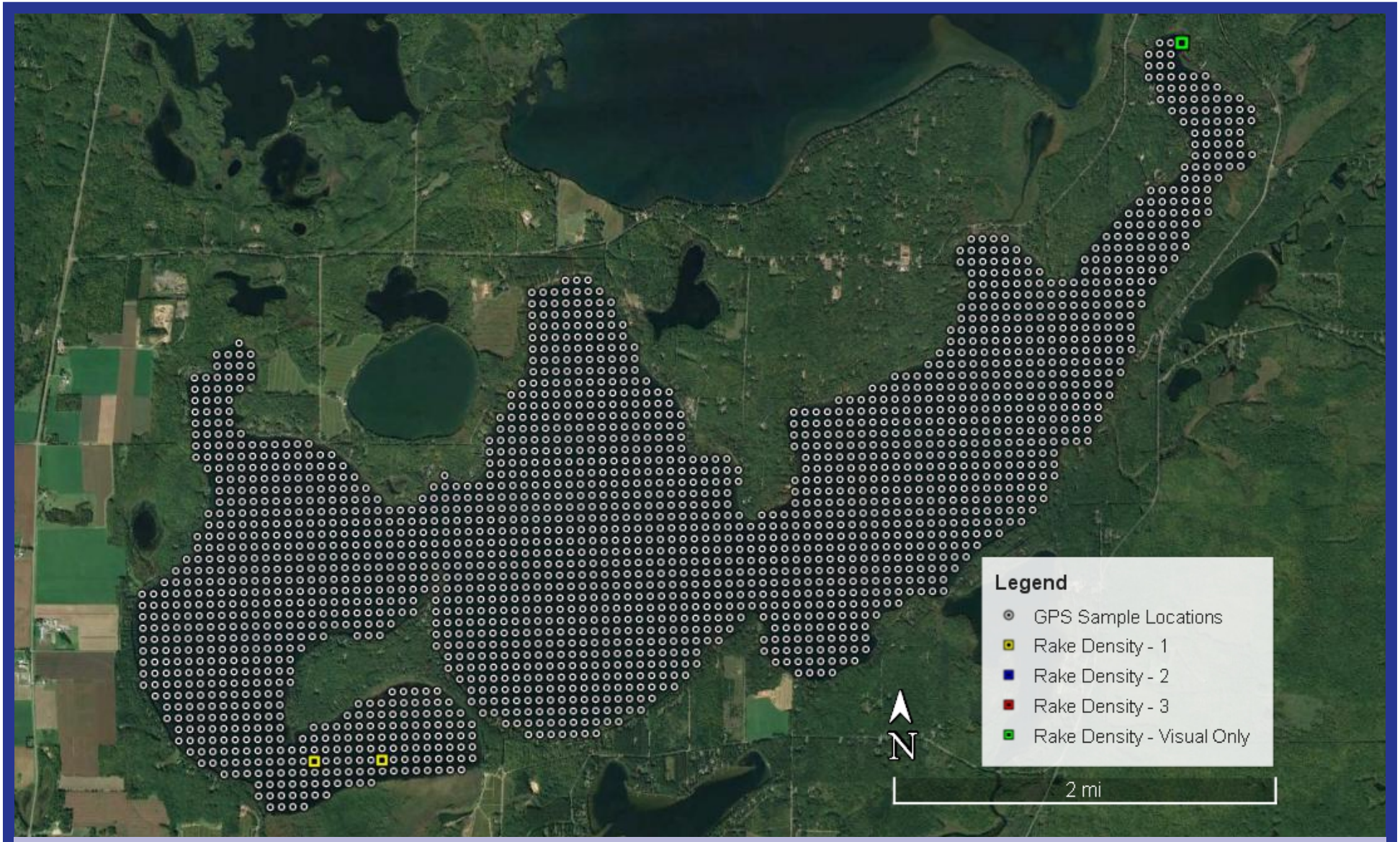

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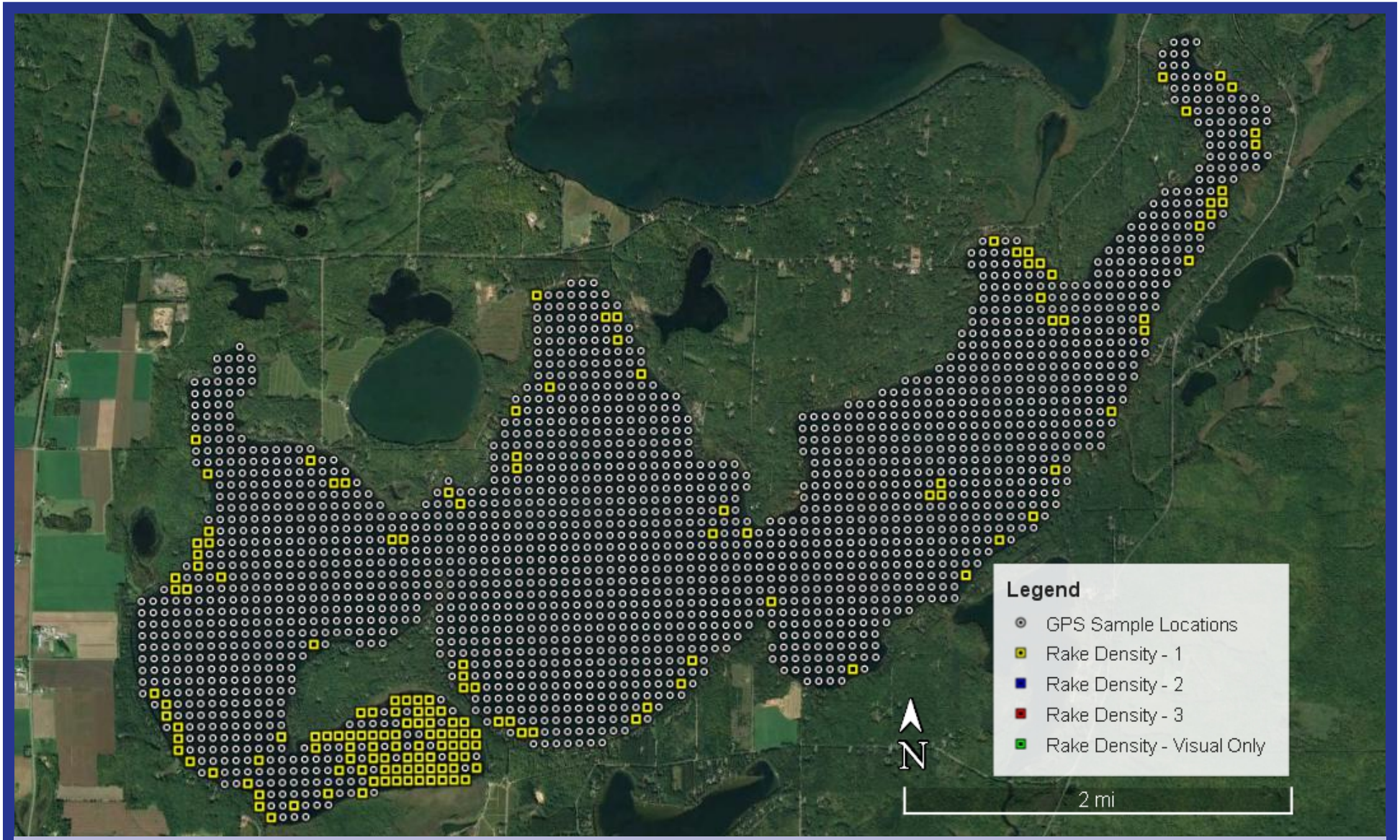
2018 Survey - Curly-leaf Pondweed

Lac Courte Oreilles, Saywer County
Surveyed: July 23-25, 2018
Figure 1.2



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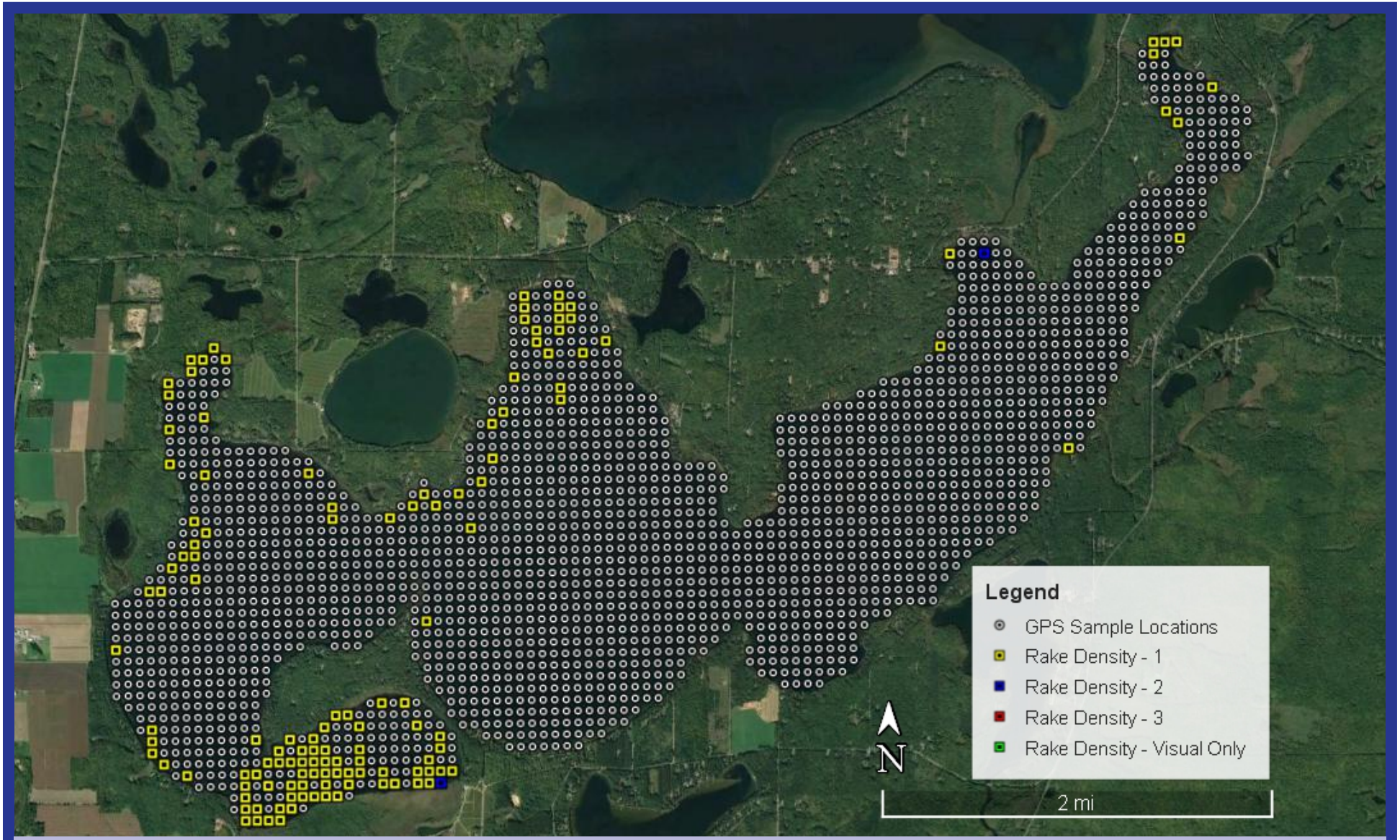
2018 Survey - Slender Naiad

Lac Courte Oreilles, Saywer County
Surveyed: July 23-25, 2018
Figure 1.3



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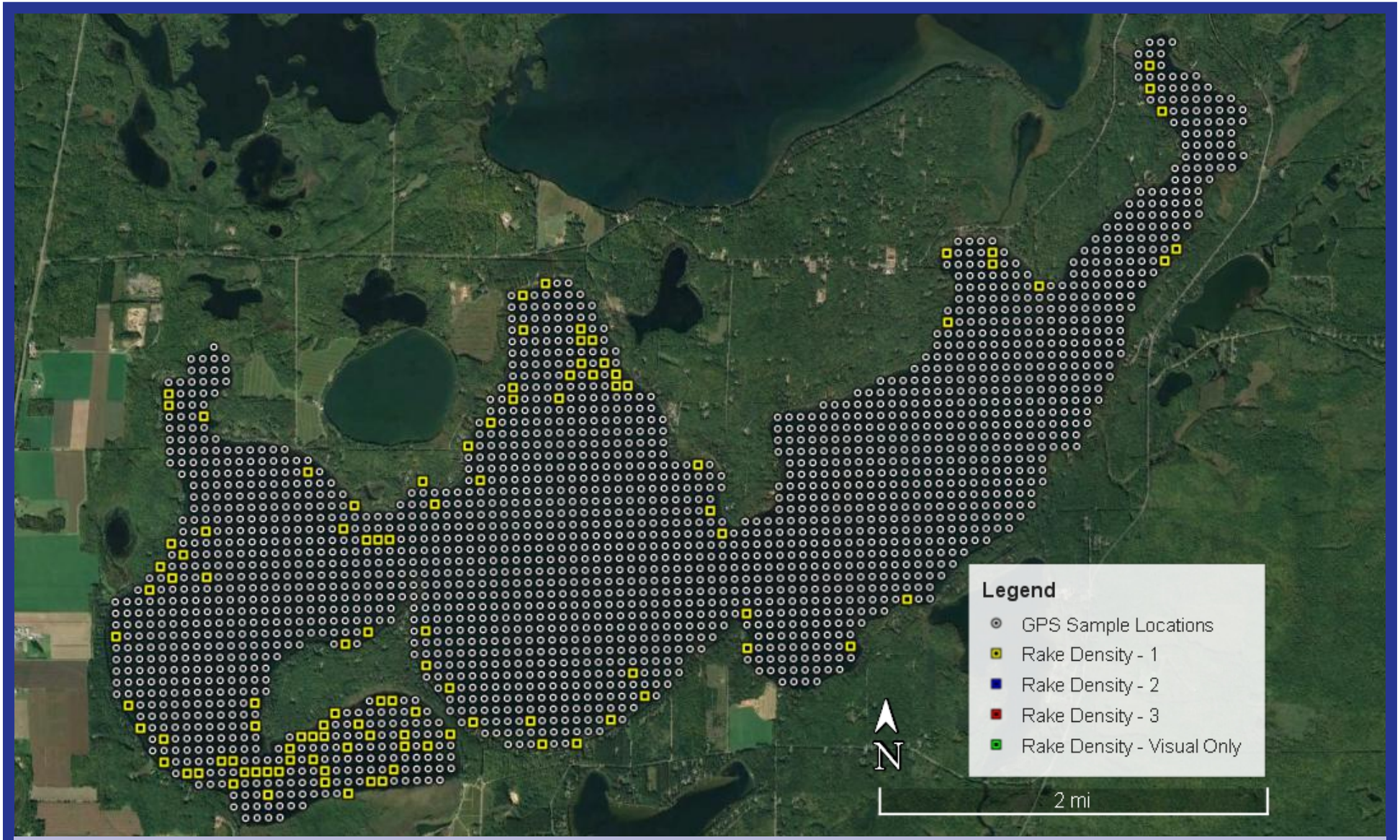
2018 Survey - Common Waterweed

Lac Courte Oreilles, Saywer County
Surveyed: July 23-25, 2018
Figure 1.4



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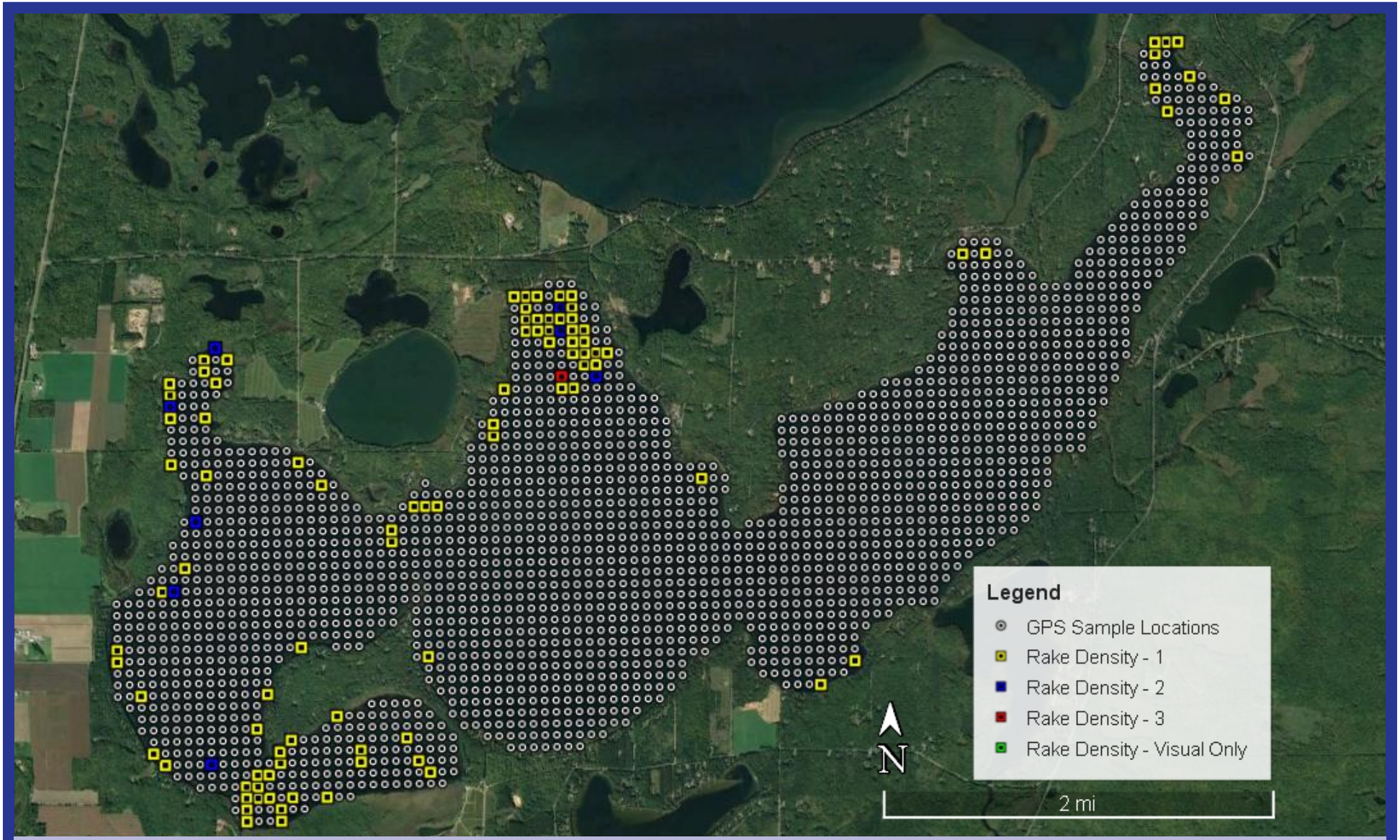
2018 Survey - Wild Celery

Lac Courte Oreilles, Saywer County
Surveyed: July 23-25, 2018
Figure 1.5



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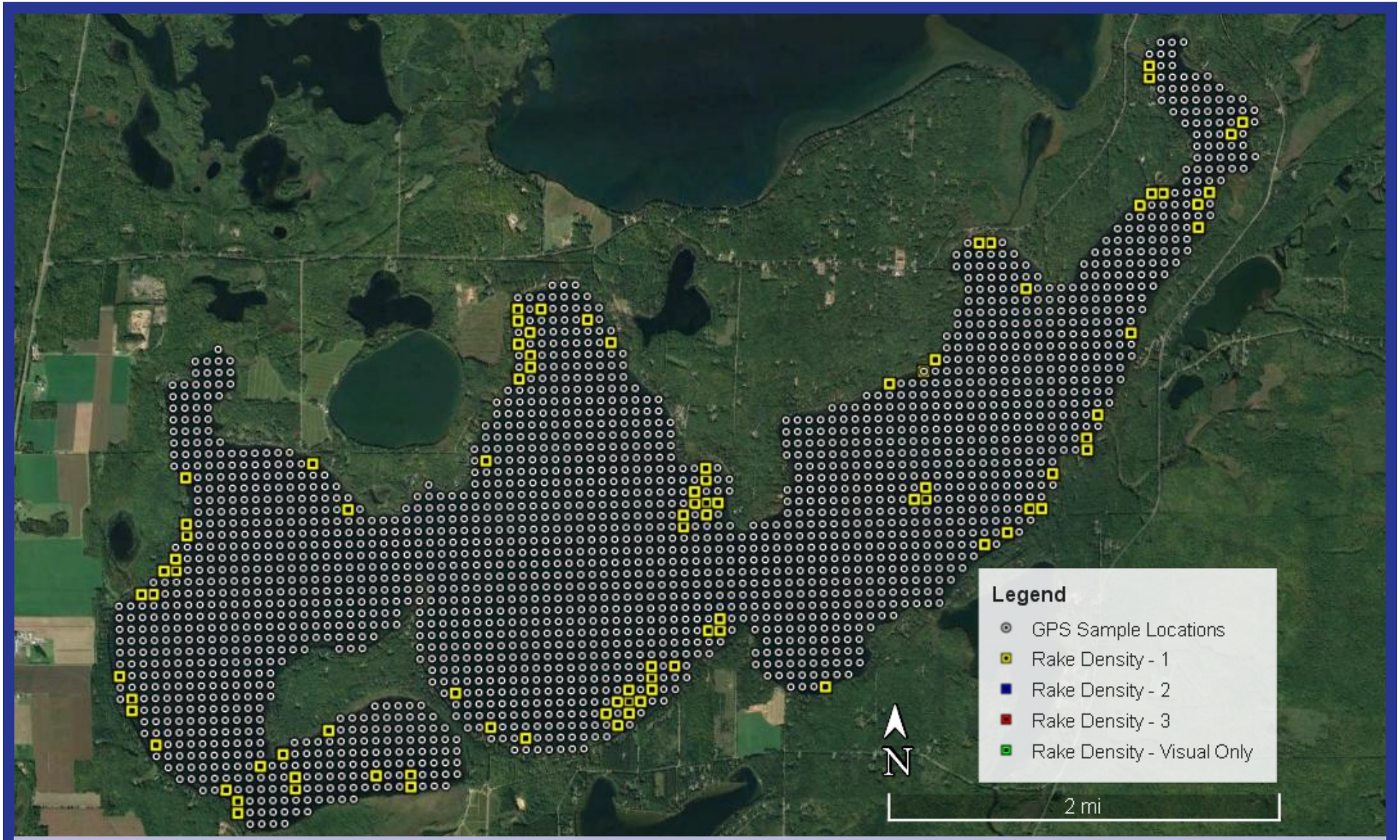
2018 Survey - Coontail

Lac Courte Oreilles, Saywer County
Surveyed: July 23-25, 2018
Figure 1.6



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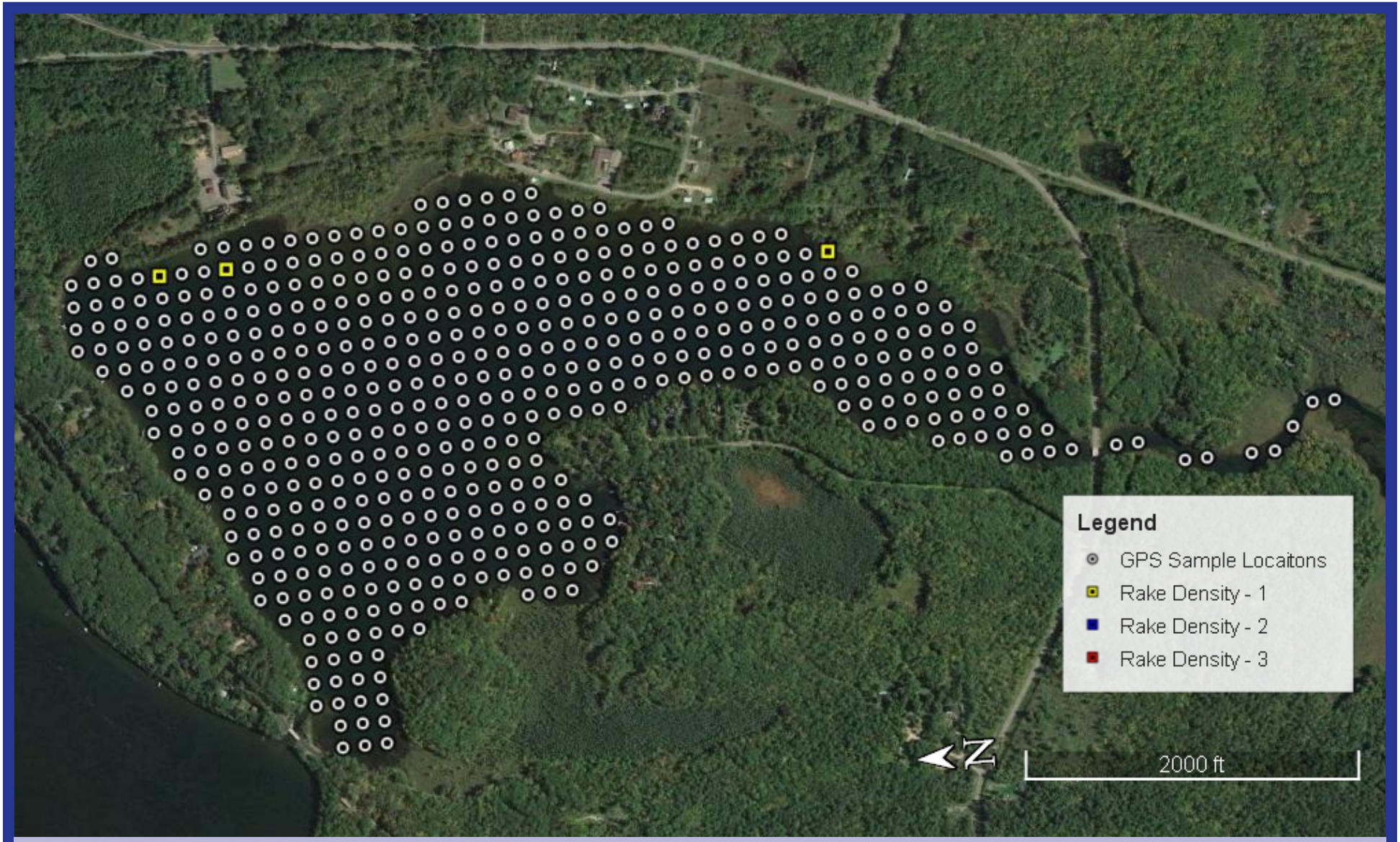
2018 Survey - Muskgrass

Lac Courte Oreilles, Saywer County

Surveyed: July 23-25, 2018

Figure 1.7



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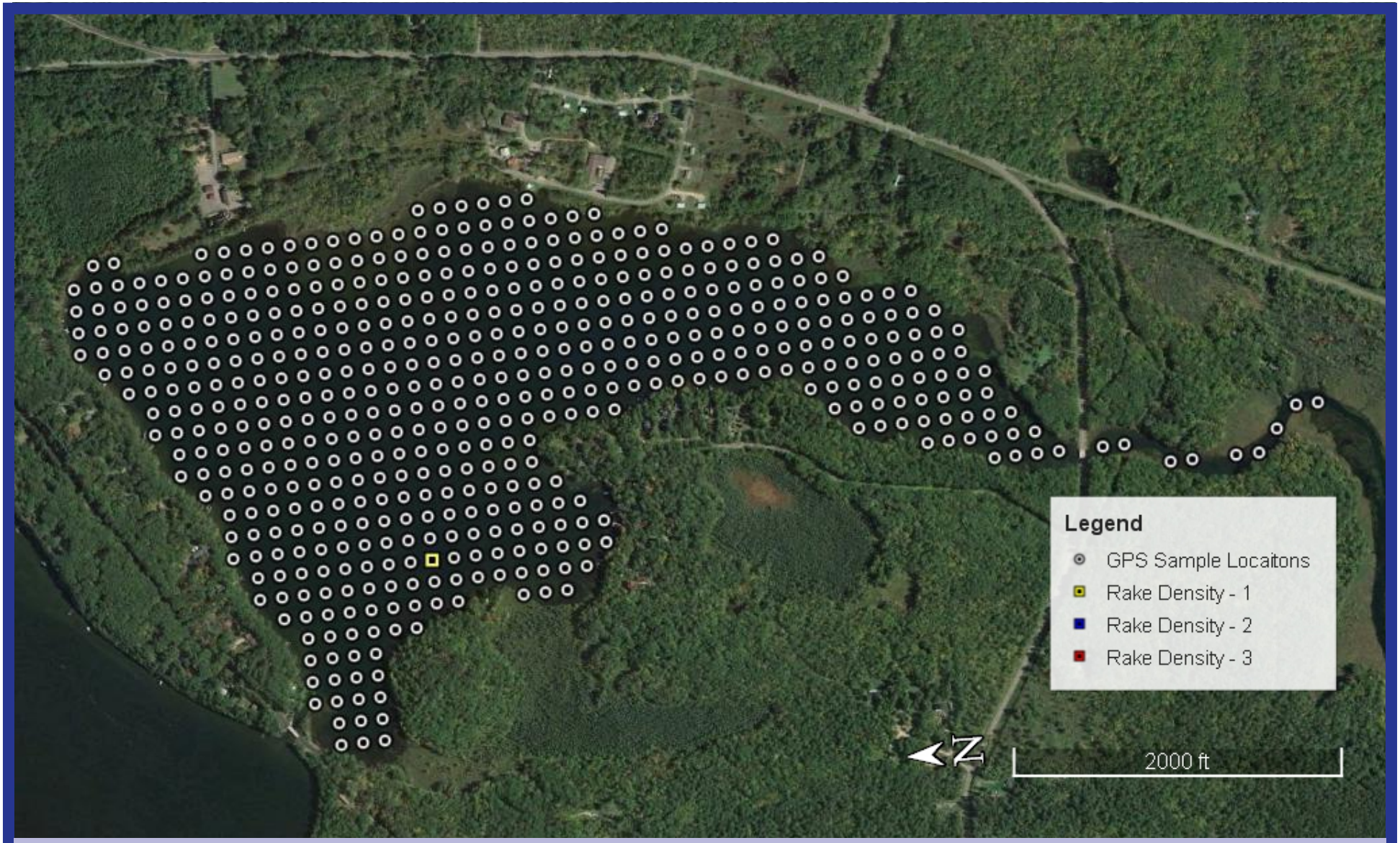
2018 Survey - Eurasian Water-milfoil

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.1



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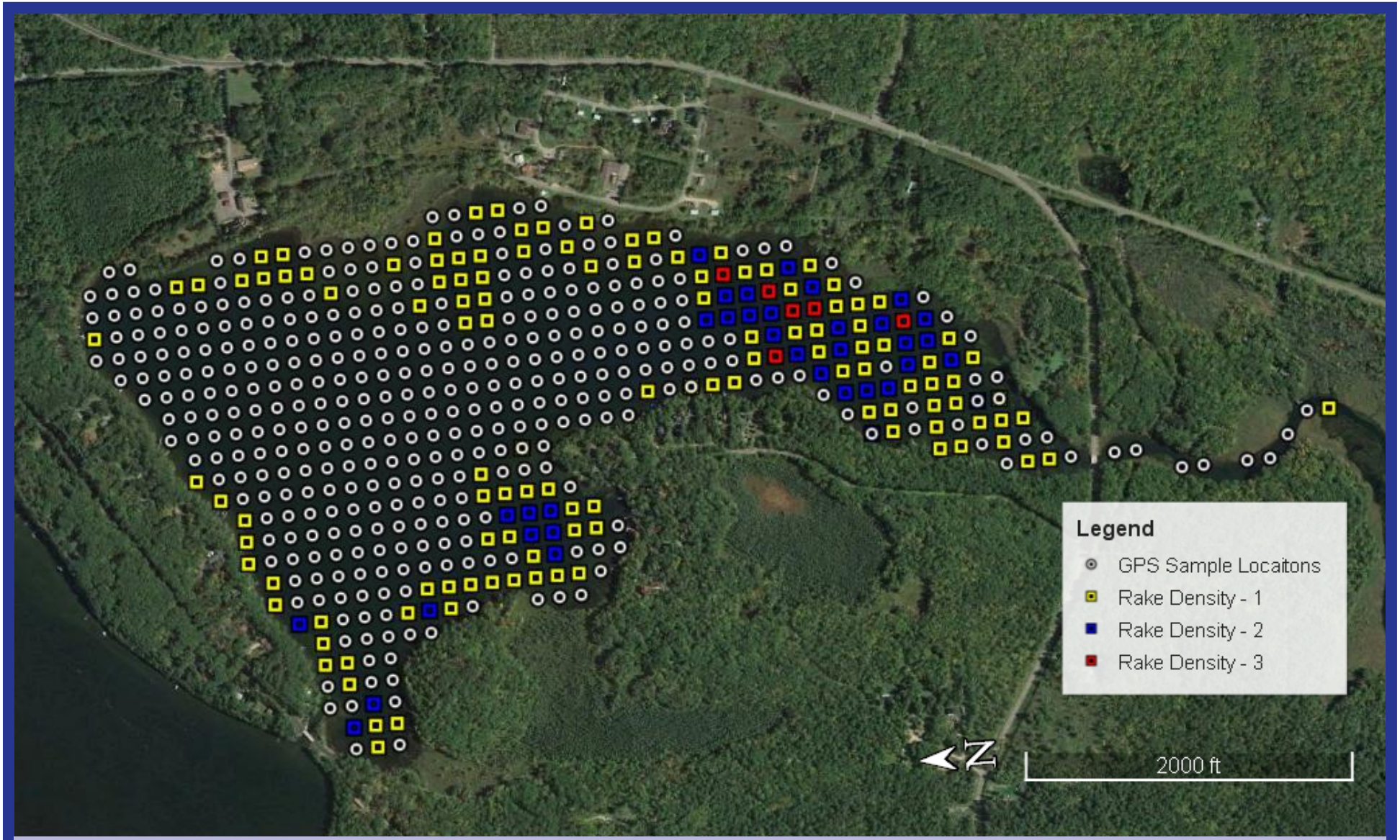
2018 Survey - Curly-leaf Pondweed

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.2



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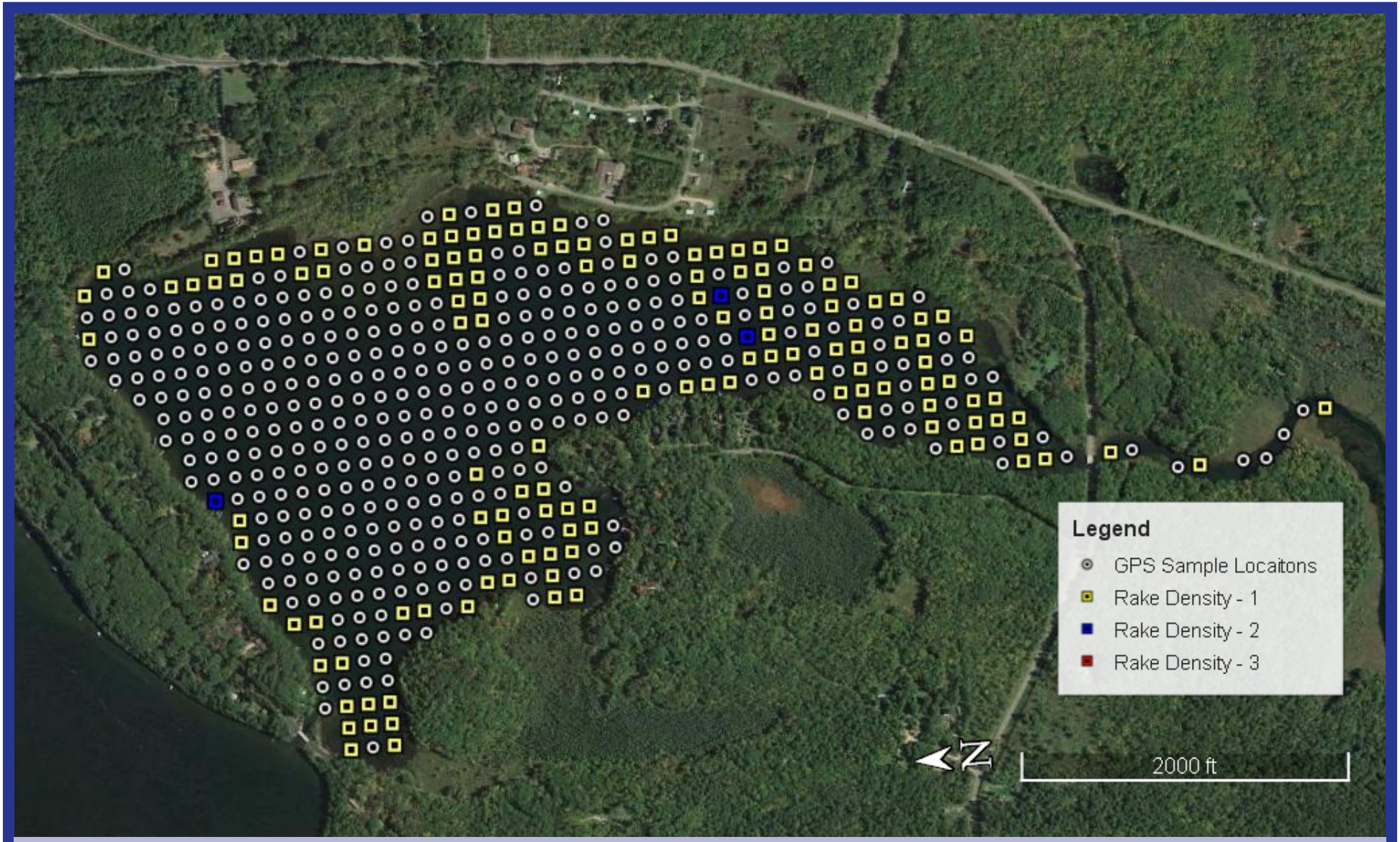
2018 Survey - Fern Pondweed

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.3



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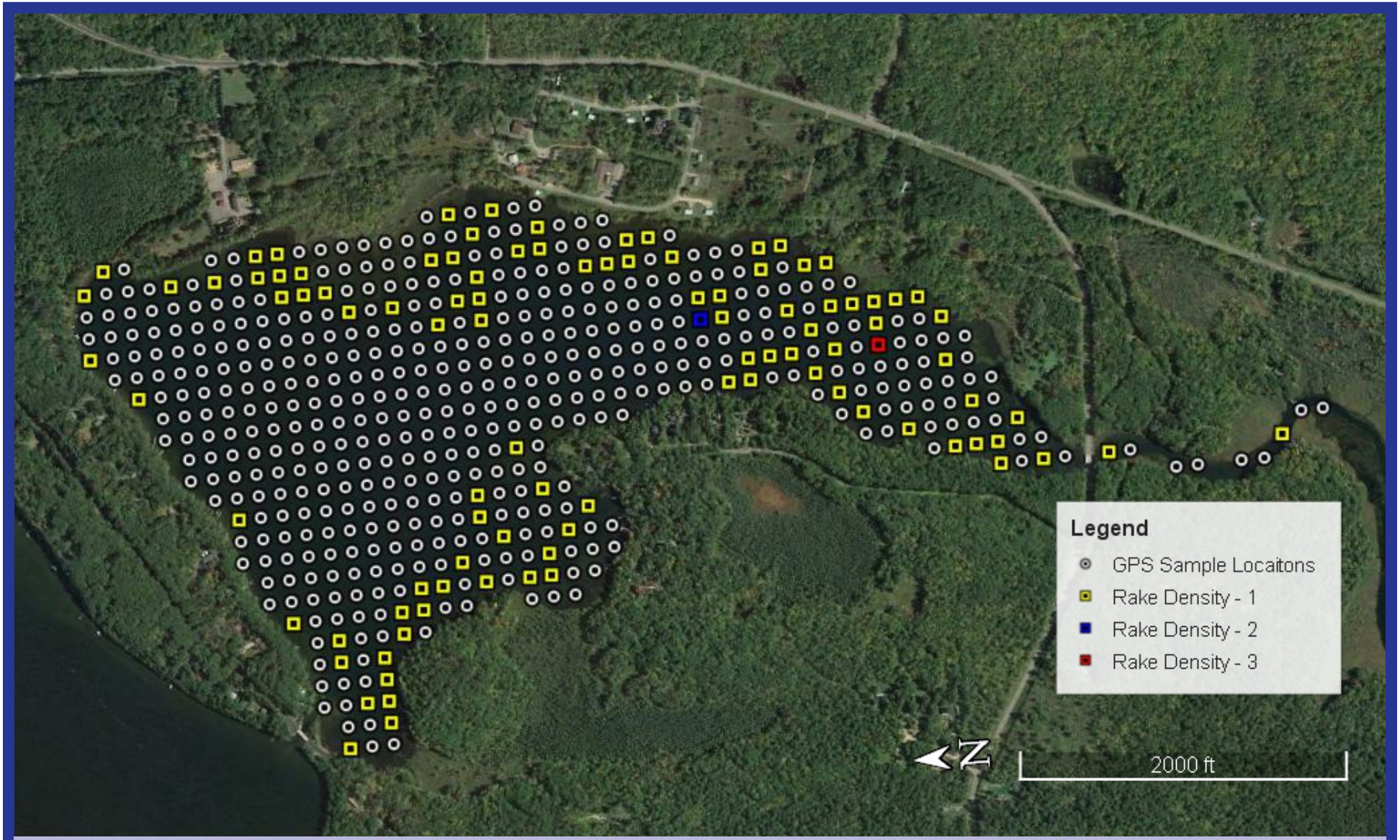
2018 Survey - Common Waterweed

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.4



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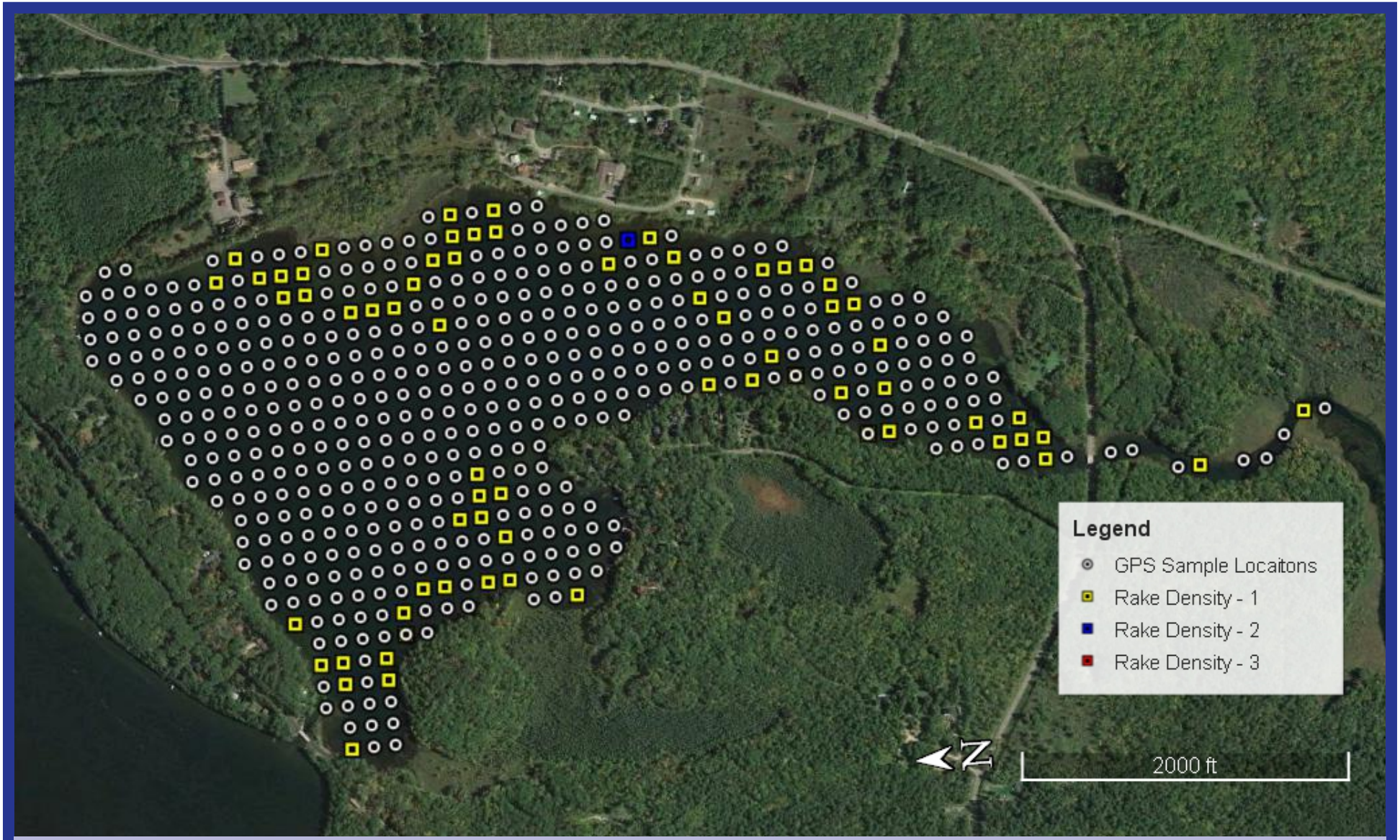
2018 Survey - Coontail

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.5



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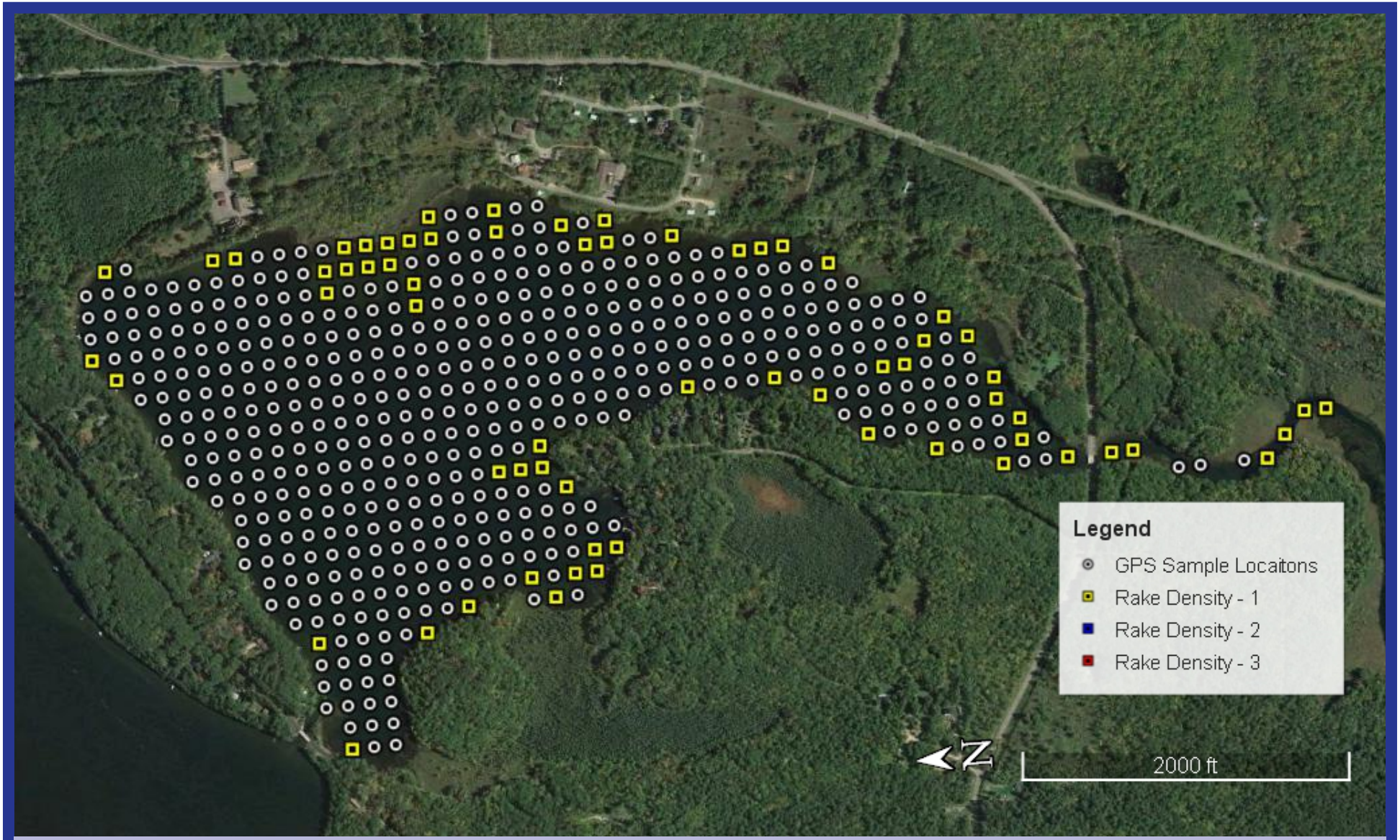
2018 Survey - Flat-stem Pondweed

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.6



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2018 Survey - Slender Naiad

Little Lac Courte Oreilles, Saywer County
Surveyed: July 25-26, 2018
Figure 2.7