

Town of Plum Lake Aquatic Plant Point Intercept Survey Report: Aurora, Nixon, Snyder and Wilson Lakes Summer 2022

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INTRODUCTION

The following report provides the results and analysis of the aquatic vegetation found in four small lakes through point-intercept surveys conducted by the North Lakeland Discovery Center (NLDC) in the Town of Plum Lake. The four lakes included Aurora, Nixon, Snyder, and Wilson Lakes. These surveys were funded by the Town of Plum Lake Lakes Committee. The point-intercept surveys were conducted in July and August of 2022. The purpose of aquatic plant point-intercept surveys is to provide data regarding the species present, abundance, and species richness on each lake.

Aquatic plants are vital to the well-being of a lake ecosystem. They provide functions and services such as breeding habitat, water purification, and soil stabilization. Aquatic plants also provide food and shelter for a variety of different animals like moose, deer, and waterfowl, as well as fish and turtles, and zooplankton and macroinvertebrates. Despite all these functions, many people still consider plants to be a nuisance. While there are few aquatic invasive species that do cause harm, the majority of aquatic plants play a fundamental role in creating a healthy ecosystem (Skawinski 2022).

Aquatic invasive species are organisms that have spread out of their native range and cause harm or have the potential to. The introduction of aquatic invasive species into bodies of water in Wisconsin have been detrimental to the quality of many water bodies. Invasive species found in Northern Wisconsin, like Curly Leaf Pondweed (*Potamogeton crispus*) and Eurasian Water Milfoil (*Myriophyllum spicatum*), outcompete native plant species, which decreases the overall plant diversity and abundance. Point-intercept surveys play an important role in understanding the aquatic plant diversity and density in each lake, as well as, detecting aquatic invasive species.

On Aurora Lake, 45 different species of aquatic plants and algae were found (Table 1). On Nixon Lake, 40 different species of aquatic plants and algae were found (Table 2). On Wilson Lake, 14 different species of aquatic plants and algae were found (Table 3). On Snyder Lake, 11 different species of plants and algae were found (Table 4). Overall, throughout the four point-intercept surveys, 60 different species were found (Table 5). No aquatic invasive species were found on any of the four lakes. Although there was overlap of species between lakes, each lake's diversity of plants created a unique ecosystem different from the rest. The following report provides information on the point-intercept methods, vegetation found on each lake, and summary of the results found.

METHODS

The point-intercept method used on the Aurora, Nixon, Snyder, and Wilson lakes was developed by the Wisconsin Department of Natural Resources (WDNR) named as the "Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications" document. The point-intercept survey was conducted using a geo-referenced sampling grid, developed by the WDNR, input into GPS devices. Using a canoe or small boat and a GPS, each point was sampled. At each site, the plant community is surveyed with a rake sampler to determine species presence and rake fullness rating. The rake is dropped until it touches the lake bottom, then it is pulled up and given a rake fullness rating. This rating is to estimate the total coverage of plants on the rake from 1-3. One is few, two is moderate, and three is abundant. When no plants were on the rake, the rake fullness rating given was zero. Each plant on the rake was identified and given a rake fullness rating based on its prevalence on the rake. The overall rake fullness and individual plant rake fullness were recorded on the data sheet. The plants that were not pulled up on the rake, but were

visual within six feet of the point were recorded as visual sightings on the data sheet. Plants outside of the six-foot range were recorded as boat observations. The depth at each point was determined by a depth finder or by foot markings on the rake and recorded on the data sheet. The feel of the rake on the lake bottom determined the sediment type (mucky, sandy, or rocky) or sediment pulled up in the rake and recorded. The two rakes used were a six-foot pole rake and a 20-foot rope rake. The pole rake was used on depths of six feet or less and the rope rake was used at depths over six feet. Sites that were inaccessible due to various reasons were recorded as non-navigable (plants), terrestrial, shallow, rocks, dock, swim area, temporary obstacle, or no information. Sites skipped due to depth greater than maximum depth of plants were labeled as deep on the data sheet. Visuals within the six feet range were recorded (Hauxwell et al., 2010). Samples that were unidentifiable in the field were collected and were identified using a microscope. Each new species found was collected and pressed to create a herbarium collection.

The WDNR provides an Excel spreadsheet called “The Aquatic Plant Survey Data Workbook” with formulas to generate statistics about the species found. All data collected from the survey on the field sheet is entered into the entry sheet on the Excel spreadsheet. Any boat surveys are input into the boat survey tab on the Excel sheet. Once all data is entered, the statistics are automatically generated. The statistics worksheet is broken down into individual species statistics and summary statistics. Individual species statistics includes the frequency of occurrence of plants, relative frequency, number of sites with vegetation, average rake fullness, and number of visual sightings. The summary statistics include the total number of sites visited, total number of sites with vegetation, sites shallower than the maximum depth of plants, frequency of occurrence, Simpson’s Diversity Index, maximum depth of plants, sites sampled using pole or rope rake, average number of species per site, and species richness, including

visuals. A maximum depth of plant colonization graph is automatically generated from the maximum depth data (Hauxwell et al., 2010).

The Simpson's Diversity Index is an estimator of community diversity. The Index estimates the probability of two different plants that are randomly selected. It is based on the relative frequency of plants on the lake, and it is not impacted by visuals. Simpson's Diversity Index is based on a scale of 0-1. The closer to one, the more diverse the plant community is (Hauxwell et al., 2010).

Finally, the worksheet calculates the Floristic Quality Index (FQI). The FQI metric is used to evaluate sampled plant communities' closeness to an undisturbed plant community. In Wisconsin, there is a demand by the Department of Natural Resources, local governments, and lakeshore riparian for considering the quality of lake plant communities in a variety of planning, zoning, sensitive area designation, and aquatic plant management decisions. Floristic quality provides a standardized analysis technique, which aids in the development of regional and temporal trends of plant community "health". The floristic quality (I) = the average coefficient of conservatism (C) multiplied by the square root of the number of species in the lake ($\sqrt{N}$). All native species are included in the number of species. Conservatism (C) is the likelihood of a plant to occur in a landscape that is not relatively impacted by settlement. The collection of values ranges from 0-10, 10 being the species that are most sensitive to disturbance. Plants are assigned a C value based on substrate preference, tolerance to turbidity, rooting strength, reproductive means, and water drawdown tolerance (Nichols 1999).

To understand the results, the I , C , and N are compared to state and regional values. Statewide, the median number of species per lake is 13, with ranges from 1-44 species. The C value had a median of six, with ranges from 2-9.5. Finally, the I had a median value of 22.2, with

ranges from 3-44.6. As *C* values can vary region to region, the state is broken up into eight different ecoregions. The four lakes surveyed are all in the Northern Lakes and Forests Ecoregion. The median number of species in this ecoregion is 13. The median *C* value is 6.7 and the median *I* is 24.3 (Nichols 1999). Each lake surveyed will be compared to these values in the following sections of the report.

RESULTS

Aurora Lake Aquatic Vegetation

Aurora Lake had 272 points plotted and of those points, 248 were visited. 23 Points were considered non-navigable due to a high abundance of plants or terrestrial land. All 248 sites visited were sampled with a pole rake. The maximum depth of plants was 4 feet deep and the overall maximum depth was 4 feet. Therefore, 248 sites were shallower than the maximum depth of plants. The total number of sites with vegetation was 238. The average rake fullness rating was 1.5, with 10 sites resulting in a rake fullness of zero. The distribution total rake fullness is shown on Map 1. The frequency of occurrence of plants at sites shallower than maximum depth of plants was 95.97%. The average number of species per site shallower than maximum depth was 2.68. The average number of species per site for all vegetated sites was 2.79. The overall species richness was 27 species, pulled up on the rake during sampling. The species richness including visual sightings was 31 species and the species richness with boat observations was 42 species. The Simpson Diversity Index for Aurora Lake is .87. This value indicates a high diversity for the lake.

The three most relatively frequent plants on Aurora were Common Waterweed (*Elodea canadensis*), Coontail (*Ceratophyllum demersum*), and Common Bladderwort (*Utricularia vulgaris*). Common Waterweed had a relative frequency of 26.7% and its distribution is shown

on Map 2. Coontail had a relative frequency of 17.2% and its distribution is shown on Map 3.

Common Bladderwort had a relative frequency of 7.2% (Figure 1) and its distribution is shown on Map 3.

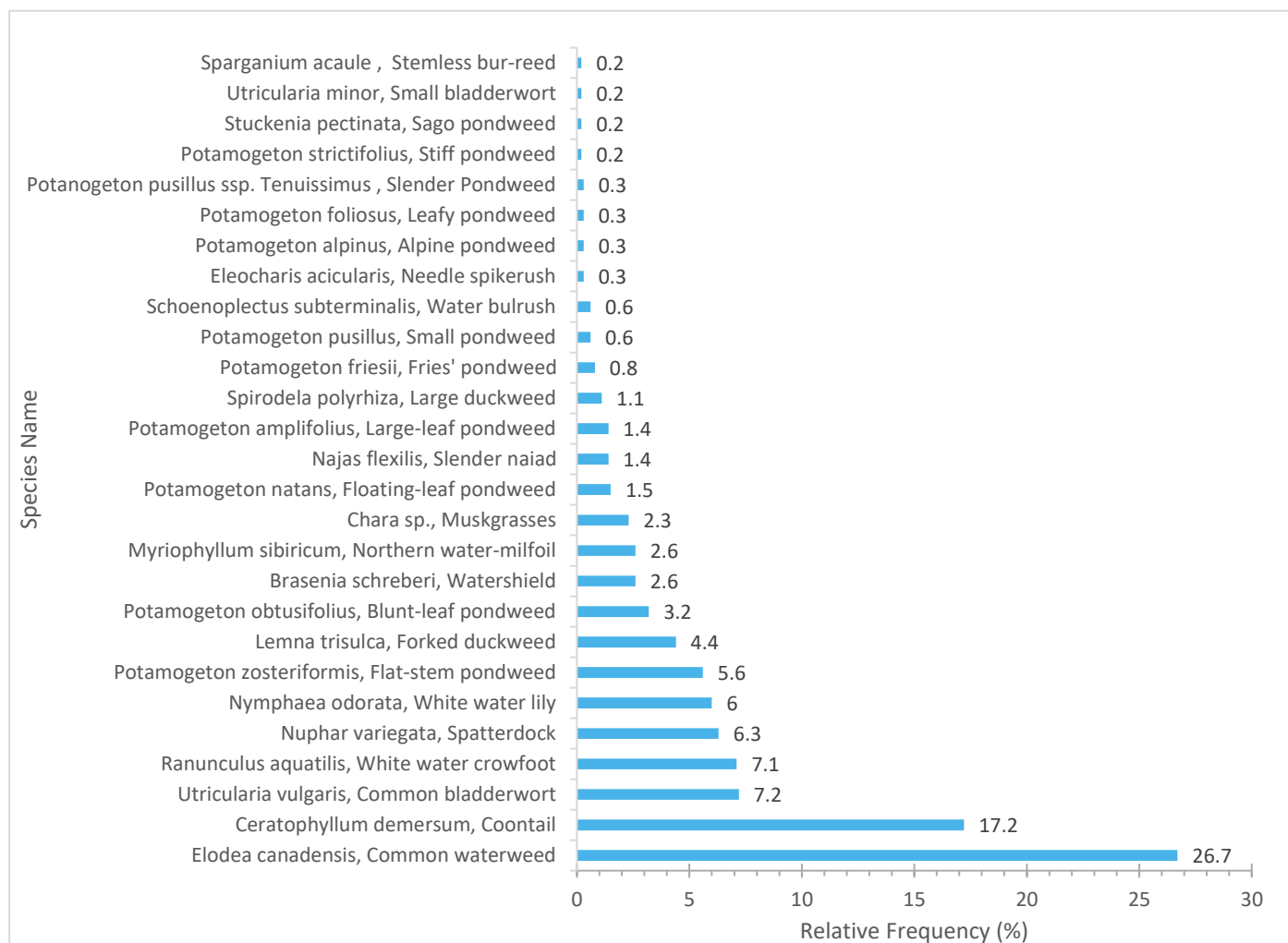


Figure 1. Aurora Lake relative frequency (%) of occurrence of aquatic plant species collected in rake during the 2022 point-intercept survey.

Common Waterweed is a submergent species that has flat, lance-shaped leaves that are pointed, with no leaf stalk (Borman et al., 1997). The leaves whorl in sets of three. It is often bushier near the top of each branch. Tiny white or pink flowers are produced on a long, thread-like stalk that reaches the water's surface. This species prefers soft substrates and is found in shallow and deep water (Skawinski 2022). Coontail is a submergent plant that is often light green

to brown. It can be heavily branched with leaves that whorl with 5-12 at a node. The leaves branch once or twice and have small teeth on the leaf margins. The tips of the plants are often very bushy. The flowers are small and are attached to the leaf axis in early summer. Coontail is a dominant species in nutrient rich waters and can grow in shallow to deep water. Coontail stores its energy as oils and can cause natural “oil slicks” when it decays. It provides great habitat for many aquatic species (Skawinski 2022). Common Bladderwort is a submergent plant that often has very leafy stems. The tops of the plant are often very bushy. It floats either just beneath the surface or sits upright in the sediment. Leaves branch between three to nine times and are alternate, with tiny hairs on the leaflet margins. Bladderworts are carnivorous plants with bladders that swallow prey like zooplankton. Bladders are abundant on leaflets of Common Bladderwort. A small, 5-parted, yellow flower is produced mid-summer with a hook below the lower lip. Common Bladderwort is found in shallow and deep water and is a common species found in lakes (Skawinski 2022). No species listed as special concern, threatened, or endangered were found at Aurora Lake.

The Floristic Quality Index for Aurora is 32.2; this is higher than both the state and ecoregional median values of 22.2 and 24.3 respectively. The mean conservatism is 6.44, which is higher than the state median value of six, but slightly lower than the ecoregional value of 6.7. This indicates that the species on Aurora have an average sensitivity to disturbance. The number of species is 25 (not including moss or algae), which is much higher than the state and ecoregional medians of 13 (Figure 2).

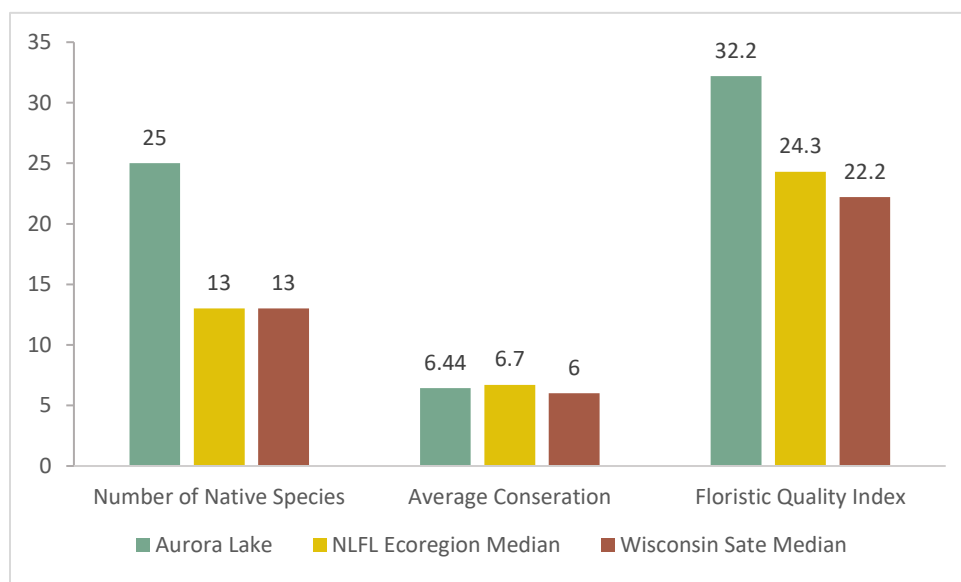


Figure 2. Floristic Quality Assessment of Aurora Lake. Created using data from 2022 point intercept survey. Analysis follows Nichols (1999).

Table 1. Aurora Lake aquatic species list. Recorded during the 2022 aquatic plant survey on Aurora Lake, Vilas County, WI.

Species	Common Name	Presence
<i>Brasenia schreberi</i>	Watershield	x
<i>Carex comosa</i>	Bristly Sedge	BO
<i>Ceratophyllum demersum</i>	Coontail	x
<i>Chara</i> sp.	Muskgrasses	x
<i>Comarum palustre</i>	Marsh Cinqufoil	BO
<i>Dulichium arundinaceum</i>	Three-way Sedge	BO
<i>Juncus</i> sp.	Rush sp.	x
<i>Eleocharis palustris</i>	Creeping Spikerush	V
<i>Elodea canadensis</i>	Common Waterweed	x
Filamentous algae	Algae	BO
<i>Iris versicolor</i>	Blue Flag Iris	BO
<i>Lemna minor</i>	Small Duckweed	V
<i>Lemna trisulca</i>	Forked Duckweed	x
<i>Myriophyllum sibiricum</i>	Northern Watermilfoil	x
<i>Najas flexilis</i>	Slender Naiad	x
<i>Nuphar variegata</i>	Spatterdock	x
<i>Nymphaea odorata</i>	White Water Lily	x

Table 1 (Cont.). Aurora Lake aquatic species list. Recorded during the 2022 aquatic plant survey on Aurora Lake, Vilas County, WI.

Species	Common Name	Presence
<i>Potamogeton alpinus</i>	Alpine Pondweed	x
<i>Potamogeton amplifolius</i>	Large-Leaf Pondweed	x
<i>Potamogeton foliosus</i>	Leafy Pondweed	x
<i>Potamogeton friesii</i>	Fries' Pondweed	x
<i>Potamogeton natans</i>	Floating-Leaf Pondweed	x
<i>Potamogeton obtusifolius</i>	Blunt-Leaf Pondweed	x
<i>Potamogeton pusillus</i>	Small Pondweed	x
<i>Potamogeton strictifolius</i>	Stiff Pondweed	x
<i>Potamogeton zosteriformis</i>	Flat-Stem Pondweed	x
<i>Potamogeton pusillus</i> ssp. <i>Tenuissimus</i>	Slender Pondweed	x
<i>Ranunculus aquatilis</i>	White Water Crowfoot	x
<i>Rumex</i> sp.	Dock sp.	BO
<i>Schoenoplectus subterminalis</i>	Water Bulrush	x
<i>Schoenoplectus tabernaemontani</i>	Soft-Stemmed Clubrush	BO
<i>Nitella</i> sp.	Nitella	BO
<i>Sparganium acaule</i>	Stemless Bur-Reed	x
<i>Sparganium angustifolium</i>	Narrow-Leaved Bur-Reed	V
<i>Spirodela polyrhiza</i>	Large Duckweed	x
<i>Spongilla lacustris</i>	Freshwater Sponge	BO
<i>Stuckenia pectinata</i>	Sago Pondweed	x
<i>Syngonium podophyllum</i>	Arrowhead	BO
<i>Triadenum fraseri</i>	Fraser's Marsh St. Johnswort	BO
<i>Utricularia minor</i>	Small Bladderwort	x
<i>Utricularia vulgaris</i>	Common Bladderwort	x
<i>Zizania palustris</i>	Northern Wild Rice	V

X = LOCATED ON RAKE DURING POINT INTERCEPT SURVEY

V = VISUAL; SEEN DURING SURVEY, BUT NEVER PICKED UP ON RAKE

BO = BOAT OBSERVATIONS; LOCALIZED OCCURANCES OF SPECIES OUTSIDE THE POINT-INTERCEPT GRID OR IN BETWEEN SAMPLING SITES.

Nixon Lake Aquatic Vegetation

Nixon Lake had 229-plotted points, 224 of which were visited. Five sites were non-navigable due to high plant concentration or the point was terrestrial. All sites were sampled with a pole rake. The maximum depth on Nixon was 6 feet and the maximum depth of plants was 6 feet. All 224 sites were shallower than the maximum depth of plants. The total number of sites

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with vegetation were 186. Therefore, the frequency of occurrence of plants at all visited sites was 83.04%. The average rake fullness was 1.45, with 35 sites with a rake fullness of zero. The distribution of total rake fullness is shown on Map 5. The average number of species per site shallower than the maximum depth of plants was 2.42. The average number of species per site at vegetated sites was 2.92. The species richness for plants pulled up on the rake was 27. The species richness including visuals was 31. The total number of species including boat observations was 36. The Simpson's Diversity Index for Nixon Lake is .91. This indicates a high diversity of plants.

The three most relatively frequent plants observed on Nixon were White Water Lily (*Nymphaea odorata*), Watershield (*Brasenia schreberi*), and Coontail (*Ceratophyllum demersum*). White Water Lily had a relative frequency of 14.90% and its distribution is shown on Map 6. Watershield had a relative frequency of 13.44% and its distribution is shown on Map 7. Coontail had a relative frequency of 12.52% (Figure 3) and its distribution is shown on Map 8.

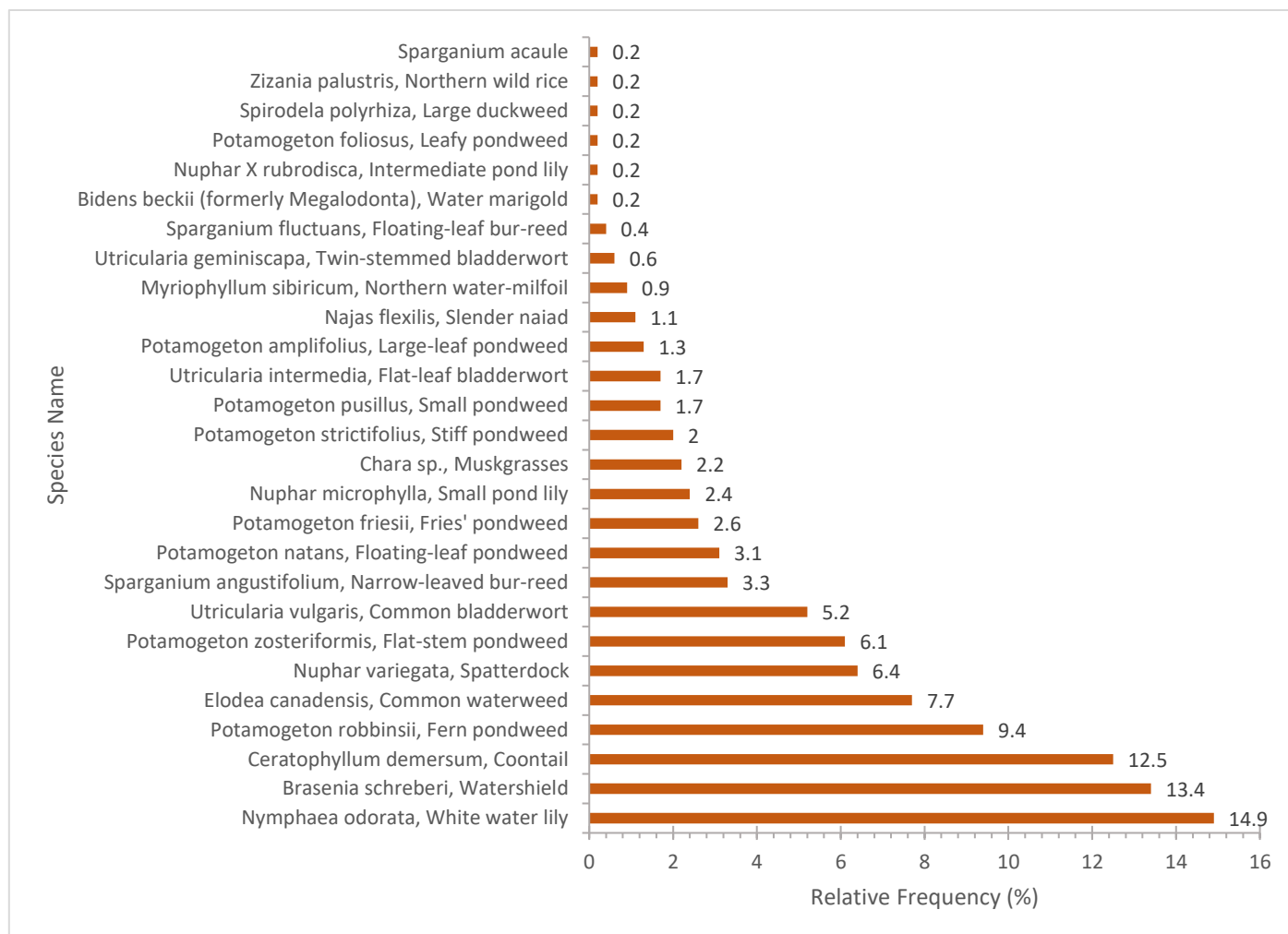


Figure 3. Nixon Lake relative frequency (%) of occurrence of aquatic plant species collected in rake during the 2022 point-intercept survey.

White Water Lily is a floating plant with very large round leaves, up to 30 cm in diameter. They are green to purple in color and have a notch from the center of the leaf to the edge. The outer edge of the notch comes to a slight point; 6-27 veins radiate from the petiole. In mid-summer, white flowers are produced with a yellow center. The flower is up to 19 cm across and has 17-43 petals. White water lilies spread by spongy rhizomes that can be very large. It is a common species found in mucky sediments, ranging from shallow water to a few meters deep (Skawinski 2022). Watershield is another floating species that has a stem upwards of two meters long. The stem is attached to the center on the underside of the leaf with a clear mucus that

covers the stem and underside of the leaf. Veins radiate from the center of the leaf and leaves are often 5-15 cm long and can be submergent in early stages. The flower is produced in mid-summer. The flower is a red-purple color that is emergent and about 2 cm wide. Watershield is a common species found in mucky sediment of lakes and streams (Skawinski 2022). Coontail is a common species found in lakes and streams in shallow to deep water. The description of Coontail has been mentioned previously in the Aurora Lake section.

One species of special concern was found on Nixon Lake. Dwarf Yellow Pond Lily (*Nuphar microphylla*) was found at 60 sites. It was found at 47 sites visually and 13 sites on the rake. Dwarf yellow pond lily is a floating leaved plant that is usually less than 10 cm long. It is oval shaped with a notch that reaches from the center to the leaf edge. The leaf ranges in color from green to purple. Veins are parallel and converge at the midvein. A yellow flower is produced with a red center; it is usually less than 3 cm wide. The stem is flattened on one side, with no wings. Dwarf Yellow Pond Lily is found in mucky soils and soft water lakes (Skawinski 2022).

The Floristic Quality Index for Nixon Lake is 35.5 which is higher than both the state and ecoregional median values. The mean value of conservatism is 7.0, which is higher than both the state and ecoregional median values. Therefore, it is more sensitive to disturbance. The number of species is 26 (excluding aquatic moss), which is greater than the state and ecoregional medians (Figure 4).

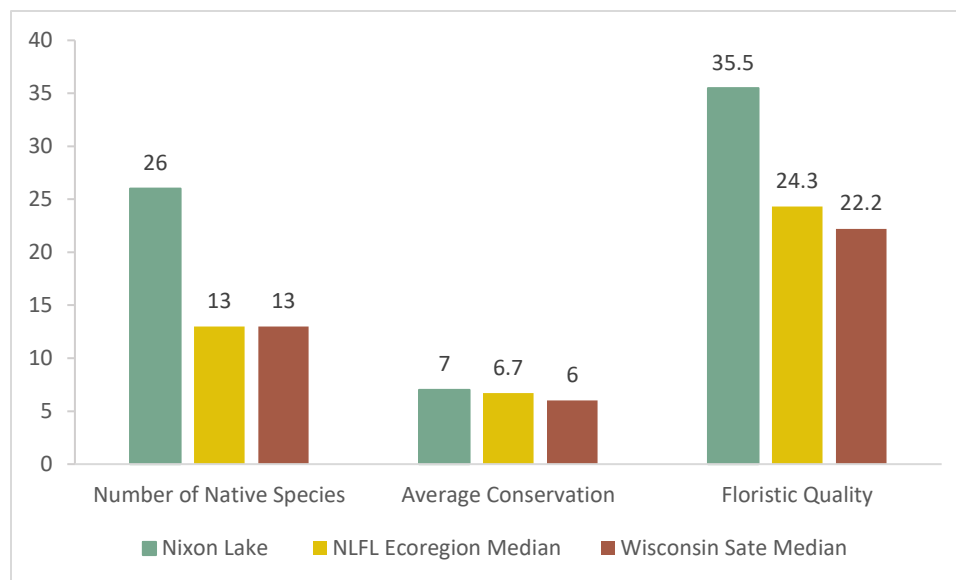


Figure 4. Floristic Quality Assessment of Nixon Lake. Created using data from 2022 point intercept survey. Analysis follows Nichols (1999).

Table 2. Nixon Lake aquatic species list. Recorded during the 2022 aquatic plant survey on Nixon Lake, Vilas County, WI.

Species	Common Name	Presence
<i>Dulichium arundinaceum</i>	Three-Way Sedge	BO
<i>Myrica gale</i>	Sweet Gale	V
<i>Bidens beckii</i> (formerly <i>Megalodonta</i>)	Water Marigold	x
<i>Brasenia schreberi</i>	Watershield	x
<i>Carex comos</i>	Bristly Sedge	BO
<i>Ceratophyllum demersum</i>	Coontail	x
<i>Chara</i> sp.	Muskgrasses	x
<i>Eleocharis palustris</i>	Creeping Spikerush	BO
<i>Elodea canadensis</i>	Common Waterweed	x
<i>Myriophyllum sibiricum</i>	Northern Watermilfoil	x
<i>Najas flexilis</i>	Slender Naiad	x
<i>Nuphar microphylla</i>	Dwarf Yellow Pond Lily	x
<i>Nuphar variegata</i>	Spatterdock	x
<i>Nuphar X rubrodisca</i>	Intermediate Pond Lily	x
<i>Nymphaea odorata</i>	White Water Lily	x
<i>Pontederia cordat</i>	Pickeralweed	BO
<i>Potamogeton amplifolius</i>	Large-Leaf Pondweed	x
<i>Potamogeton epihydrus</i>	Ribbon-Leaf Pondweed	V
<i>Potamogeton foliosus</i>	Leafy Pondweed	x
<i>Potamogeton friesii</i>	Fries' Pondweed	x
<i>Potamogeton natans</i>	Floating-Leaf Pondweed	x

Table 2. Nixon Lake aquatic species list. Recorded during the 2022 aquatic plant survey on Nixon Lake, Vilas County, WI.

Species	Common Name	Presence
<i>Potamogeton pusillus</i>	Small Pondweed	x
<i>Potamogeton richardsonii</i>	Clasping-Leaf Pondweed	V
<i>Potamogeton robbinsii</i>	Fern Pondweed	x
<i>Potamogeton strictifolius</i>	Stiff Pondweed	x
<i>Potamogeton zosteriformis</i>	Flat-Stem Pondweed	x
<i>Schoenoplectus tabernaemontani</i>	Softstem Bulrush	BO
<i>Sparganium acaul</i>	Narrow Bur-Reed	BO
<i>Sparganium angustifolium</i>	Narrow-Leaved Bur-Reed	x
<i>Sparganium fluctuans</i>	Floating-Leaf Bur-Reed	x
<i>Spirodela polyrhiza</i>	Large Duckweed	x
<i>Typha latifoli</i>	Cattail	BO
	Twin-Stemmed	
<i>Utricularia geminiscapa</i>	Bladderwort	x
<i>Utricularia intermedia</i>	Flat-Leaf Bladderwort	x
<i>Utricularia vulgaris</i>	Common Bladderwort	x
<i>Zizania palustris</i>	Northern Wild Rice	x

X = LOCATED ON RAKE DURING POINT INTERCEPT SURVEY

V = VISUAL; SEEN DURING SURVEY, BUT NEVER PICKED UP ON RAKE

BO = BOAT OBSERVATIONS; LOCALIZED OCCURANCES OF SPECIES OUTSIDE THE POINT-INTERCEPT GRID OR IN BETWEEN SAMPLING SITES

Snyder Lake Aquatic Vegetation

Snyder Lake had 102-plotted points, 92 of which were visited. 10 sites were non-navigable due to high plant density or terrestrial landscape. 73 Sites were sampled with the rope rake and 19 sites were sampled with the pole rake. The maximum depth of Snyder Lake is 18 feet. The maximum depth of plants was at 16 feet. Only one site at 16 feet contained plants in the rake. The species found was Fries' Pondweed (*Potamogeton freisii*). Besides this outlier sample site, the maximum depth of vegetation was at 14 feet. Of the 92 sites visited, 85 sites were shallower than the maximum depth of plants. The total number of sites with vegetation was 65 sites. The frequency of occurrence of sites shallower than the maximum depth of plants was

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76.47%. The average rake fullness was 1.25, with 27 sites with a rake fullness of zero. The distribution of total rake fullness is shown on Map 9. The average number of all species per site at depths shallower than the maximum depth of vegetation was .96. The average number of all species per site at vegetated sites was 1.26. The species richness for all sites with plants on the rakes was four. The species richness including visuals was 10. The total number of species including boat observations was 12. The Simpson's Diversity Index for Snyder was .66; this indicates slightly above average plant diversity in the lake.

The top three most frequent plants observed on Snyder were Fries' Pondweed (*Potamogeton friesii*), Watershield (*Brasenia schreberi*), and Nitella (*Nitella sp.*). Fries' Pondweed had a relative frequency of 45.1% and its distribution is shown on Map 10. Watershield had a relative frequency of 29.3% and its distribution is shown on Map 11. Nitella had a relative frequency of 23.2% (Figure 5) and its distribution is shown on Map 12.

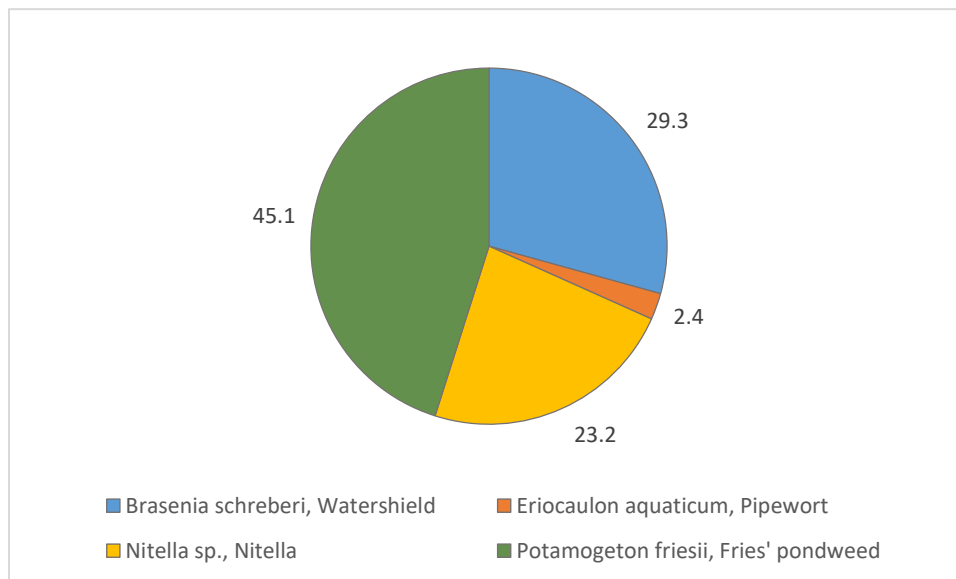


Figure 5. Snyder Lake relative frequency (%) of occurrence of aquatic plant species collected in rake during the 2022 point-intercept survey.

Fries' Pondweed is a submergent species that has delicate, flattened stems that originate from a rhizome. The leaves are alternate with no petiole and 5-7 veins per leaf. There is a row of

lacunar cells along the midvein. The tip of the leaf is rounded with a short beak. Fries' Pondweed has glands present at leaf nodes and white stipules that are wrapped around the stem. This is a common species often found in shallow to deep lakes (Skawinski 2022). Watershield is a very common species that is found in mucky soils. Species characteristics are described in the Nixon lake description. Nitella is a type of green algae (Borman et al., 1997). There are many species of Nitella but for the sake of this report, Nitella will be discussed on the genus level. Within recent years, the Nitella genus has been broken up into multiple different species. This is a new field of study, and it is often very difficult to differentiate Nitella species from one another without the help of specialists. Generally, Nitella have branchlets that often whorl around the main axis. The main axis is smooth and branchlets often fork at least once, ending in dactyls. There are male and female reproductive structures, antheridium and oogonium, that can often be seen along the base of branchlets. Nitella species are found in soft sediment lakes, in zones that can be deeper than 10 meters (Skawinski 2022).

One species of special concern was found on Snyder Lake. Dwarf Yellow Pond Lily (*Nuphar microphylla*) was found visually at one site. The species description for Dwarf Yellow Pond Lily is above in the Nixon Lake Aquatic Vegetation section.

The Floristic Quality Index for Snyder Lake is 15; it is lower than both the state and ecoregional median values. The mean value of conservatism is 7.5, which is higher than both the state and ecoregional median values. This indicates that the lake is sensitive to disturbance. The number of species found is four (excluding visuals and boat surveys), which is much lower than the state and ecoregional number of species of 13 (Figure 6).

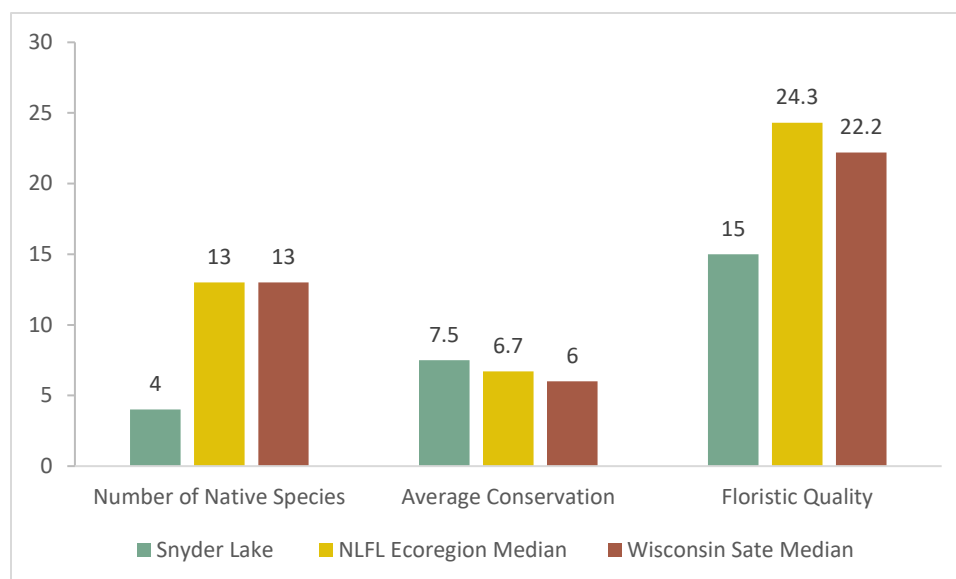


Figure 6. Floristic Quality Assessment of Snyder Lake. Created using data from 2022 point intercept survey. Analysis follows Nichols (1999).

Table 3. Snyder Lake aquatic species list. Recorded during the 2022 aquatic plant survey on Snyder Lake, Vilas County, WI.

Species	Common Name	Presence
<i>Brasenia schreberi</i>	Watershield	x
<i>Eriocaulon aquaticum</i>	Pipewort	x
<i>Iris versicolor</i>	Blue Flag Iris	BO
<i>Myrica gal</i>	Sweet Gale	v
<i>Nitella</i> sp.	Nitella	x
<i>Nuphar microphylla</i>	Dwarf Yellow Pond Lily	v
<i>Nuphar variegata</i>	Spatterdock	BO
<i>Nuphar X rubrodisca</i>	Intermediate Pond Lily	v
<i>Nymphaea odorata</i>	White Water Lily	v
<i>Polygonum amphibium</i>	Water Smartweed	v
<i>Potamogeton epihydrus</i>	Ribbon-Leaf Pondweed	v
<i>Potamogeton friesii</i>	Fries' Pondweed	x

X = LOCATED ON RAKE DURING POINT INTERCEPT SURVEY

V = VISUAL; SEEN DURING SURVEY, BUT NEVER PICKED UP ON RAKE

BO = BOAT OBSERVATIONS; LOCALIZED OCCURANCES OF SPECIES OUTSIDE THE POINT-INTERCEPT GRID OR IN BETWEEN SAMPLING SITES.

Wilson Lake Aquatic Vegetation

Wilson Lake had 101-plotted points; 95 of the points were visited. 6 Points were not navigated to due to a terrestrial landscape or a depth deeper than the maximum depth of plants.

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87 sites were sampled using the rope rake and eight sites were sampled using the pole rake. The maximum depth of Wilson Lake is 19 feet. The maximum depth of plants is 13 feet. Of the 95 points visited, 84 sites were shallower than the maximum depth of plants. The total number of sites with vegetation was 61. The frequency of occurrence at sites shallower than the maximum depth of plants was 72.6%. The average rake fullness was 1.03, with 25 sites with a rake fullness of 0. The distribution of total rake fullness is shown on Map 13. The average number of all species found per site that is shallower than max depth of plants is 1.24. The average number of species per site at vegetated sites only was 1.72. The species richness of plants on the rake was seven species. The species richness including visuals was 12 species. The Simpson's Diversity Index for Wilson was .75; this indicates that Wilson has high plant diversity in the lake.

The three most frequently found plant species were Nitella (*Nitella sp.*), Ribbon-Leaf Pondweed (*Potamogeton epihydrus*), and Common Bladderwort (*Utricularia vulgaris*). Nitella had a relative frequency of 35.2% and its distribution is shown on Map 14. Ribbon-Leaf Pondweed had a relative frequency of 26.7% and its distribution is shown on Map 15. Common Bladderwort had a relative frequency of 19% (Figure 7) and its distribution is shown on Map 16.

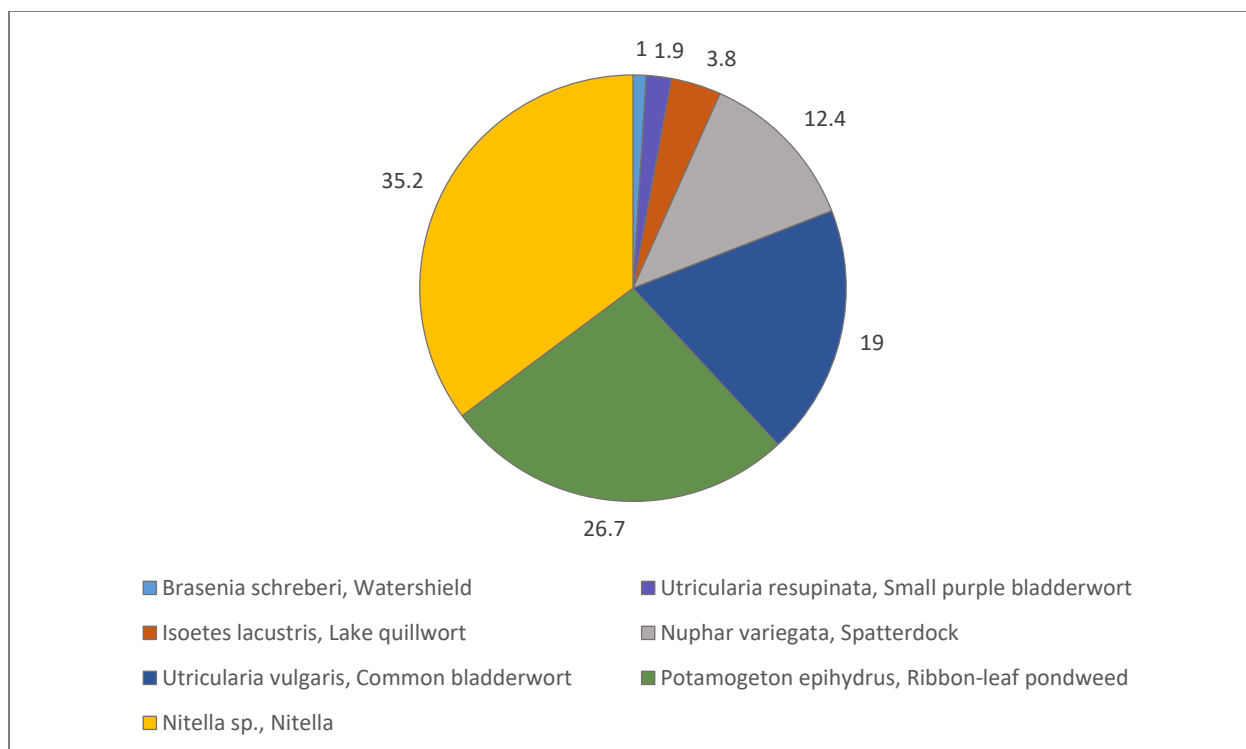


Figure 7. Wilson Lake relative frequency (%) of occurrence of aquatic plant species collected in rake during the 2022 point-intercept survey.

Nitella is an algal genus that is often found in deeper depths of lakes. The description of the Nitella genus is located in the Snyder Lake Aquatic Vegetation section. Ribbon-Leaf Pondweed is a submerged plant that has a slightly flattened stem. It has both submergent and floating leaves. Submergent leaves alternate and are long and ribbon-like. Leaves have a strong midvein with a lacunar band, as well as 5-13 veins, and no petiole. The floating leaves have a long petiole and are elliptical in shape. They have 11-41 veins and the stipules are free from the leaves. This species is common in soft-water lakes, ranging from shallow to deep (Skawinski 2022). Common Bladderwort is a common species found in lakes, in depths from shallow to deep. The description of Common bladderwort is located in the Aurora Lake Aquatic Vegetation section.

One species of special concern was found in Wilson Lake. Small Purple Bladderwort (*Utricularia resupinate*) was found at three sites, one sighting being visual. Small Purple Bladderwort is a submergent plant that also can be found on wet shorelines. The thin stems lay horizontal in the substrate and leaves, up to 7.5 cm tall, reach out of the substrate. Leaves are white below the substrate and green above the substrate. Small bladders are found along the rhizome and on the leaves. A small purple flower is produced on long stalks during mid-summer. Small purple bladderwort is found in shallow waters, sandy shorelines, and bogs (Skawinski 2022).

The Floristic Quality Index for Wilson Lake is 19.3. This value is lower than the state and ecoregional median values. The mean value of conservatism is 7.3, which is higher than the state and ecoregional values. This indicates that the lake is sensitive to disturbance. The number of species found is 7, this is much lower than the state and ecoregional values (Figure 8).

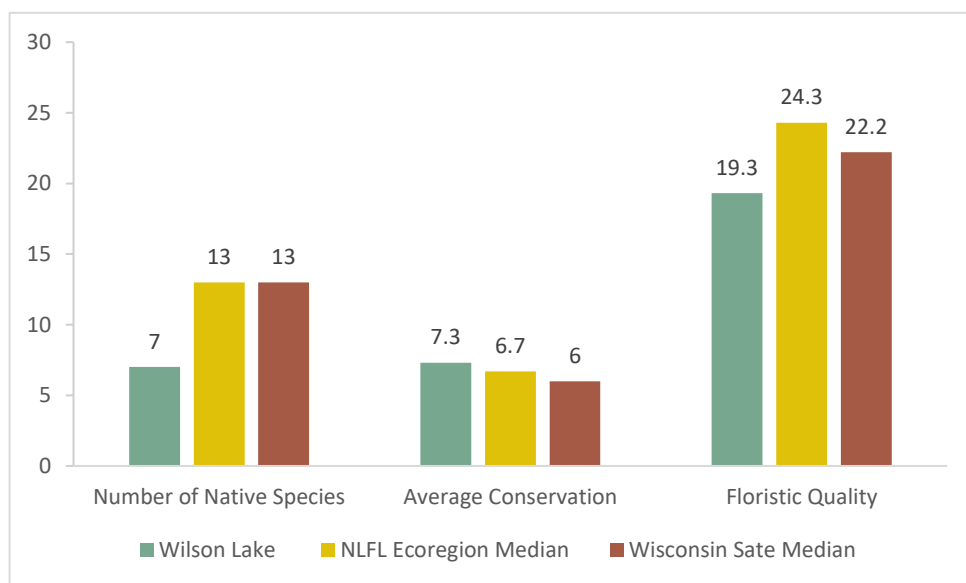


Figure 8. Floristic Quality Assessment of Wilson Lake. Created using data from 2022 point intercept survey. Analysis follows Nichols (1999).

Table 4. Wilson Lake aquatic species list. Recorded during the 2022 aquatic plant survey on Wilson Lake, Vilas County, WI.

Scientific Name	Common Name	Presence
<i>Brasenia schreberi</i>	Watershield	x
<i>Comarum palustre</i>	Marsh Cinquefoil	v
<i>Dulichium arundinaceum</i>	Three-Way Sedge	v
<i>Isoetes lacustris</i>	Lake Quillwort	x
<i>Myrica gale</i>	Sweet Gale	v
<i>Nitella</i> sp.	Nitella	x
<i>Nuphar variegata</i>	Spatterdock	x
<i>Potamogeton epihydrus</i>	Ribbon-Leaf Pondweed	x
<i>Potamogeton foliosus</i>	Leafy Pondweed	v
<i>Sparganium angustifolium</i>	Narrow-Leaved Bur-Reed	v
<i>Utricularia resupinata</i>	Small Purple Bladderwort	x
<i>Utricularia vulgaris</i>	Common Bladderwort	x

X = LOCATED ON RAKE DURING POINT INTERCEPT SURVEY

V = VISUAL; SEEN DURING SURVEY, BUT NEVER PICKED UP ON RAKE

BO = BOAT OBSERVATIONS; LOCALIZED OCCURANCES OF SPECIES OUTSIDE THE POINT-INTERCEPT GRID OR IN BETWEEN SAMPLING SITES.

CONCLUSION

Analysis of the data collected from the plant point-intercept surveys, conducted on the lakes of Aurora, Nixon, Snyder, and Wilson, indicate that all four lakes have a healthy and diverse plant community. A baseline that led to the conclusion that all four lakes are healthy, is that no aquatic invasive species were discovered that would indicate declining lake health or disturbance. Another baseline that led to this conclusion is that of all four lakes surveyed, two out of the four lakes had FQI values greater than the state and region means. This is not surprising, given that northern Wisconsin is largely forested and the least developed out of the other ecoregions. Notably, Nixon Lake had the highest Floristic Quality Index of 35.5, which indicates a higher floristic integrity. The state FQI values ranged from 3-44.6 with a median value of 22.2. Comparing Nixon Lake to the state values indicates that Nixon has a notable high

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quality of plant vegetation and health. Therefore, Nixon, in comparison to the other three lakes surveyed, is undisturbed; however, the plants present are highly sensitive to disturbances, as the conservatism value is 7 out of 10.

On the other hand, Snyder Lake had the lowest FQI value of 15 and a conservatism value of 7.5 out of 10. Which indicates a low florist integrity, and is more sensitive to changes in the proportion and distribution of vegetation. It is important to note that the FQI can be impacted by both the size and the heterogeneity of the lakes (Bernthal 2003). Smaller lakes, such as Snyder and Wilson, can be impacted by this in their calculations and misrepresented due to low *N* values, resulting in low *I* values.

Lastly, the Simpson Diversity index was another vital point of reference supporting the claim the four lakes surveyed are healthy. Nixon had the highest Simpson's Diversity Index of .91, followed by Aurora at .87 Wilson at .75 and Snyder with .66. The closer the diversity index is to one, the more species diversity and even distribution of aquatic plants. Nixon's index indicates that the lake has a very high diversity. Overall, all four lakes surveyed during the 2022 point intercept survey had a Simpson's diversity index of .66 or greater. Concluding, that all four lakes' aquatic plants communities have above average species richness and evenness.

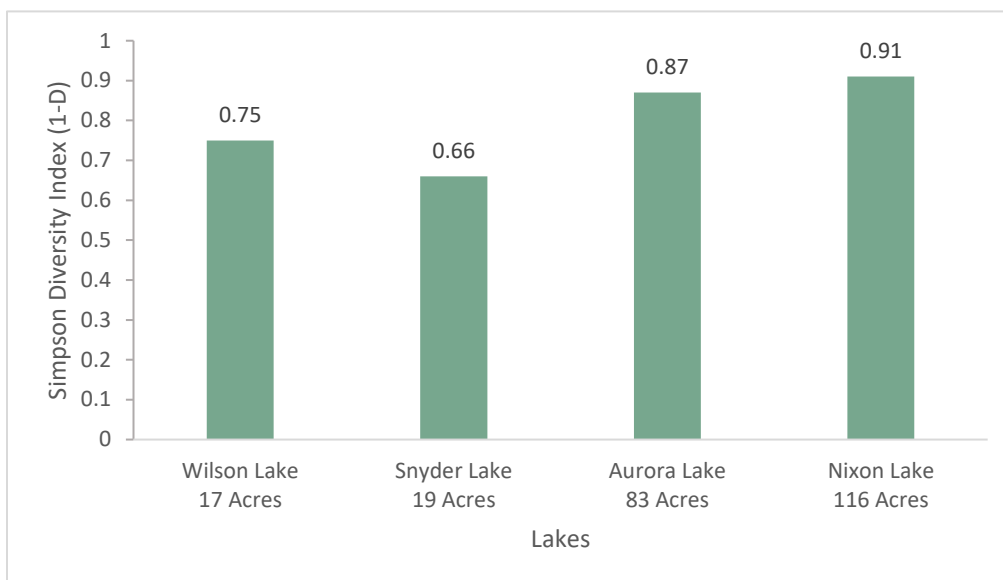


Figure 9. Simpson diversity index comparison of four lakes sampled during the 2022 plant intercept survey in Vilas County, WI.

Table 5. Total aquatic species list of all four lakes. Recorded during the 2022 aquatic plant survey in Vilas County, WI at Snyder Lake, Wilson Lake, Nixon Lake, and Aurora Lake.

Growth	Scientific Name	Common Name
Emergent	<i>Juncus sp.</i>	Rush sp.
	<i>Eleocharis palustris</i>	Creeping Spikerush
	<i>Iris versicolor</i>	Blue Flag Iris
	<i>Schoenoplectus tabernaemontani</i>	Soft-Stemmed Clubrush
	<i>Sparganium acaule</i>	Stemless Bur-Reed
	<i>Sparganium angustifolium</i>	Narrow-Leaved Bur-Reed
	<i>Syngonium podophyllum</i>	Arrowhead
	<i>Zizania palustris</i>	Northern Wild Rice
	<i>Schoenoplectus subterminalis</i>	Water Bulrush
	<i>Dulichium arundinaceum</i>	Three-Way Sedge
	<i>Pontederia cordata</i>	Pickerelweed
	<i>Sparganium fluctuans</i>	Floating-Leaf Bur-Reed
	<i>Typha latifolia</i>	Common Cattail
Floating	<i>Brasenia schreberi</i>	Watershield
	<i>Lemna minor</i>	Small Duckweed
	<i>Lemna trisulca</i>	Forked Duckweed
	<i>Nuphar variegata</i>	Spatterdock
	<i>Nymphaea odorata</i>	White Water Lily
	<i>Spirodela polyrhiza</i>	Large Duckweed
	<i>Nuphar microphylla</i>	Small Pond Lily

Table 5. Total aquatic species list of all four lakes. Recorded during the 2022 aquatic plant survey in Vilas County, WI at Snyder Lake, Wilson Lake, Nixon Lake, and Aurora Lake.

Growth	Scientific Name	Common Name
	<i>Nuphar X rubrodisca</i>	Intermediate Pond Lily
	<i>Persicaria amphibia</i>	Water Smartweed
Submergent	<i>Ceratophyllum demersum</i>	Coontail
	<i>Chara sp.</i>	Muskgrasses
	<i>Elodea canadensis</i>	Common Waterweed
	<i>Myriophyllum sibiricum</i>	Northern Watermilfoil
	<i>Najas flexilis</i>	Slender Naiad
	<i>Potamogeton alpinus</i>	Alpine Pondweed
	<i>Potamogeton amplifolius</i>	Large-Leaf Pondweed
	<i>Potamogeton foliosus</i>	Leafy Pondweed
	<i>Potamogeton friesii</i>	Fries' Pondweed
	<i>Potamogeton natans</i>	Floating-Leaf Pondweed
	<i>Potamogeton obtusifolius</i>	Blunt-Leaf Pondweed
	<i>Potamogeton pusillus</i>	Small Pondweed
	<i>Potamogeton strictifolius</i>	Stiff Pondweed
	<i>Potamogeton zosteriformis</i>	Flat-Stem Pondweed
	<i>Potamogeton pusillus ssp. Tenuissimus</i>	Slender Pondweed
	<i>Ranunculus aquatilis</i>	White Water Crowfoot
	<i>Nitella sp.</i>	Nitella
	<i>Spongilla lacustris</i>	Freshwater Sponge
	<i>Stuckenia pectinata</i>	Sago Pondweed
	<i>Utricularia minor</i>	Small Bladderwort
	<i>Utricularia vulgaris</i>	Common Bladderwort
	<i>Vesicularia dubyana</i>	Aquatic Moss
	<i>Megalodonta beckii</i>	Water Marigold
	<i>Potamogeton epihydrus</i>	Ribbon-Leaf Pondweed
	<i>Potamogeton richardsonii</i>	Clasping Pondweed
	<i>Potamogeton robbinsii</i>	Fern Pondweed
	<i>Utricularia geminiscapa</i>	Twin-stem Bladderwort
	<i>Utricularia intermedia</i>	Flat-leaf Bladderwort
	<i>Isoetes lacustris</i>	Lake Quillwort
	<i>Utricularia purpurea</i>	Small Purple Bladderwort
	<i>Eriocaulon sp.</i>	Pipewort

Table 5. Total aquatic species list of all four lakes. Recorded during the 2022 aquatic plant survey in Vilas County, WI at Snyder Lake, Wilson Lake, Nixon Lake, and Aurora Lake.

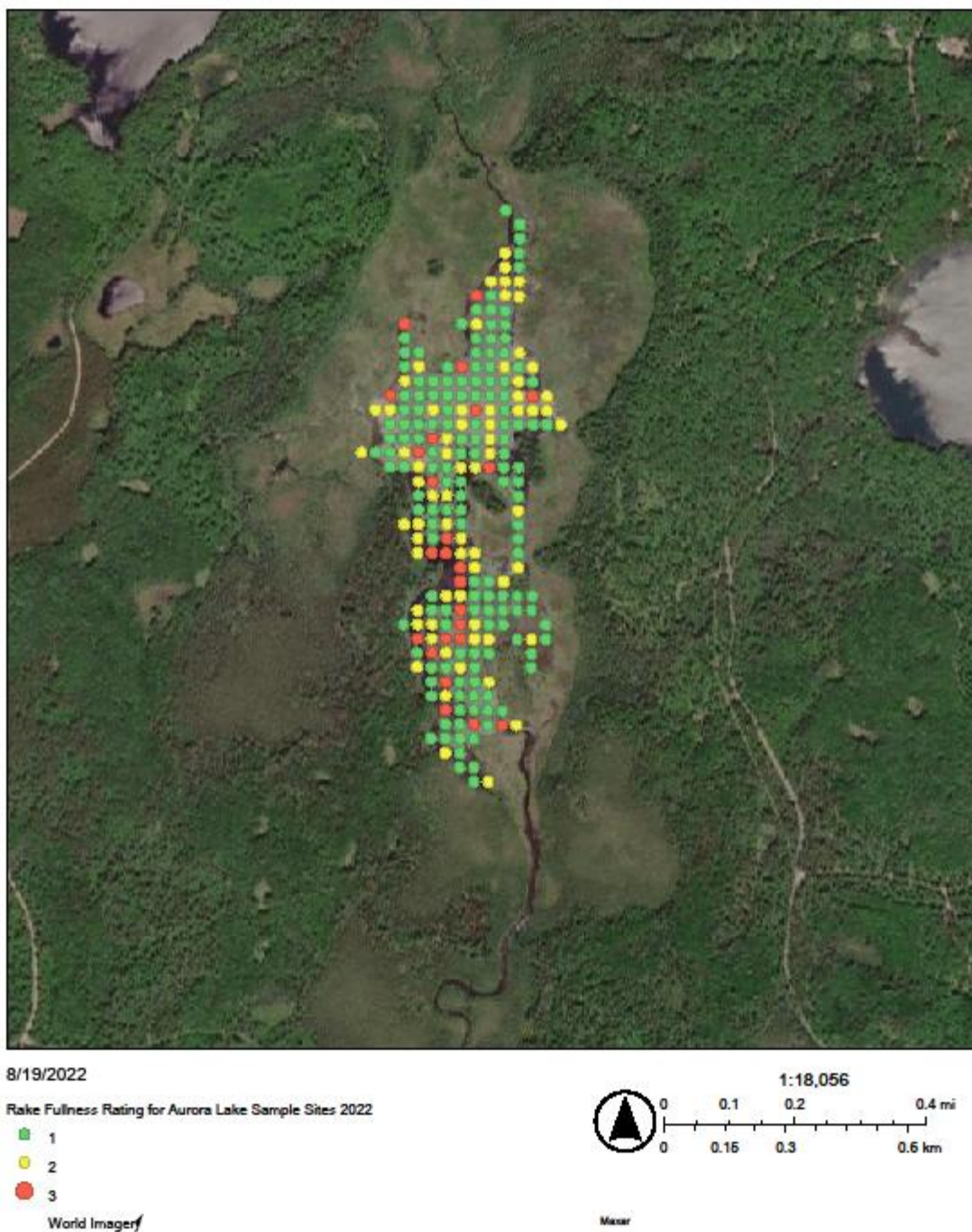
Growth	Scientific Name	Common Name
Terrestrial	<i>Carex comosa</i>	Bristly Sedge
	<i>Comarum palustre</i>	Marsh Cinquefoil
	<i>Rumex sp.</i>	Dock sp.
	<i>Triadenum fraseri</i>	Fraser's Marsh St. Johnswort
	<i>Myrica gale</i>	Sweet Gale
MISC.	<i>Filamentous algae</i>	Algae

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- Nichols, S. A. (1999). Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications, *Lake and Reservoir Management*, 15(2), 133-141. DOI: 10.1080/07438149909353957.
- Skawinski, P. M. (2022). *Aquatic plants of the Upper Midwest: A photographic field guide to our underwater forests* (4th ed.). Wausau, Wis.: P. Skawinski.

MAPS

Aurora Lake Total Rake Fullness 2022

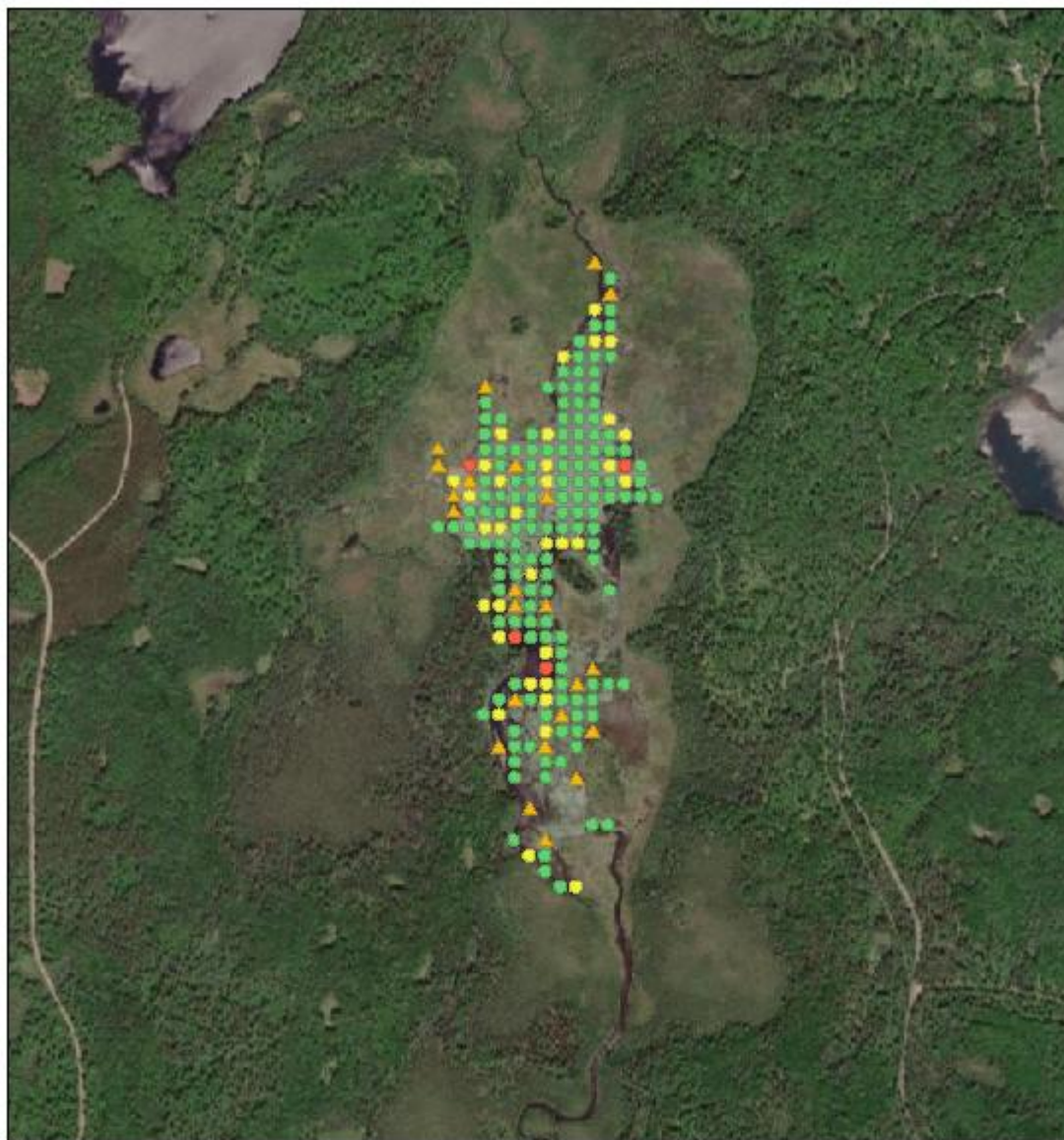


Map 1. Total rake fullness of aquatic vegetation on Aurora Lake, Vilas County, Wisconsin surveyed during 2022 PI survey.

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Aurora Lake Distribution of Plant Species - *Elodea canadensis*



8/19/2022

Aurora Lake Distribution of Plant Species - *Elodea canadensis*

1 (Rake Fullness)

2

3

Visual

World Imagery



1:18,056

0 0.1 0.2 0.4 mi
0 0.15 0.3 0.6 km

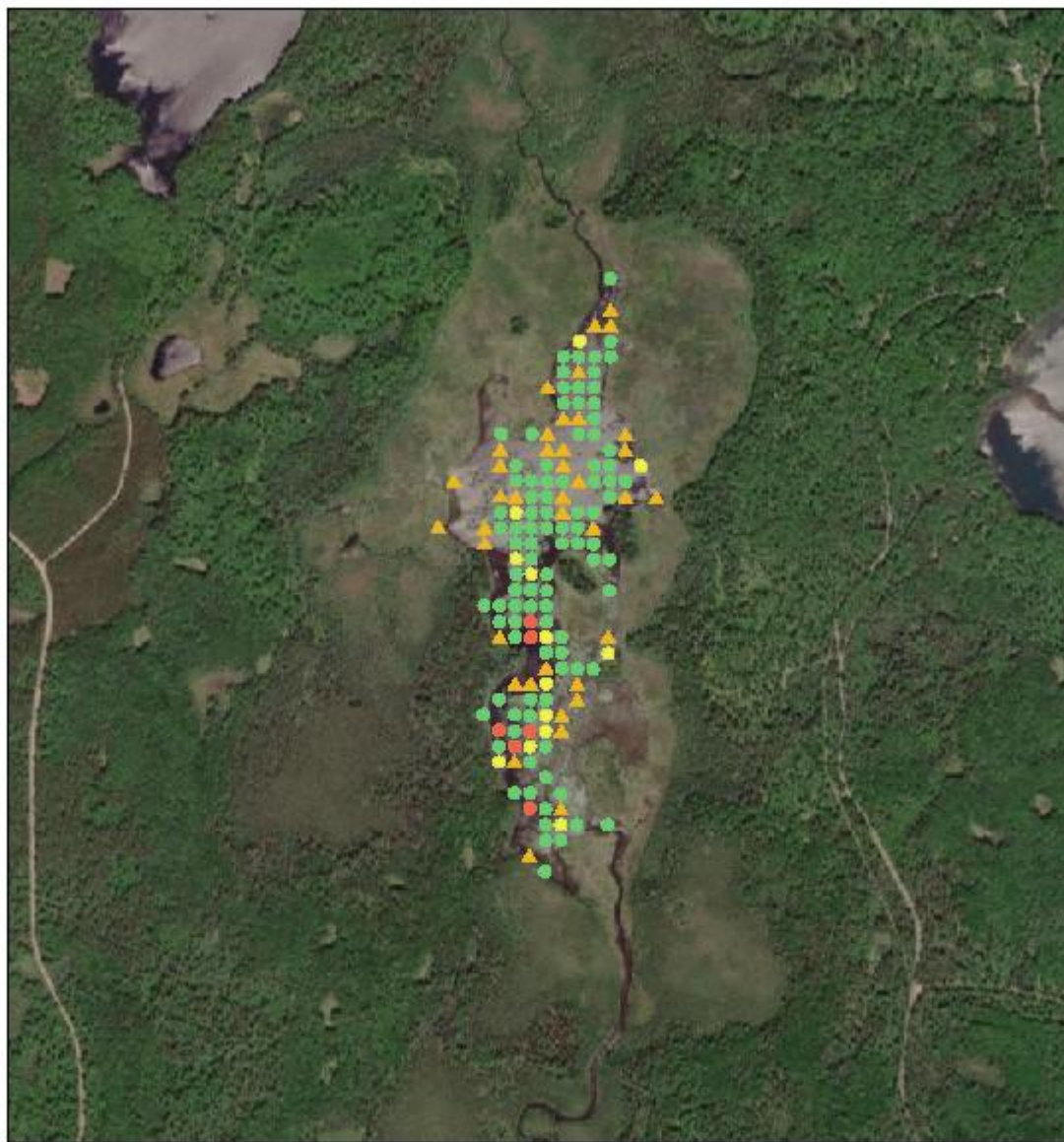
Maxar

Map 2. Relative frequency and rake fullness of Common Waterweed (*Elodea Canadensis*) on Aurora Lake, Vilas County, Wisconsin.

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Aurora Lake Distribution of Plant Species - *Ceratophyllum demersum*



8/19/2022

Aurora Lake Distribution of Plant Species - *Ceratophyllum demersum*

1 (Rake Fullness)

2

3

Visual

World Imagery



1:18,056

0 0.1 0.2 0.4 mi
0 0.15 0.3 0.6 km

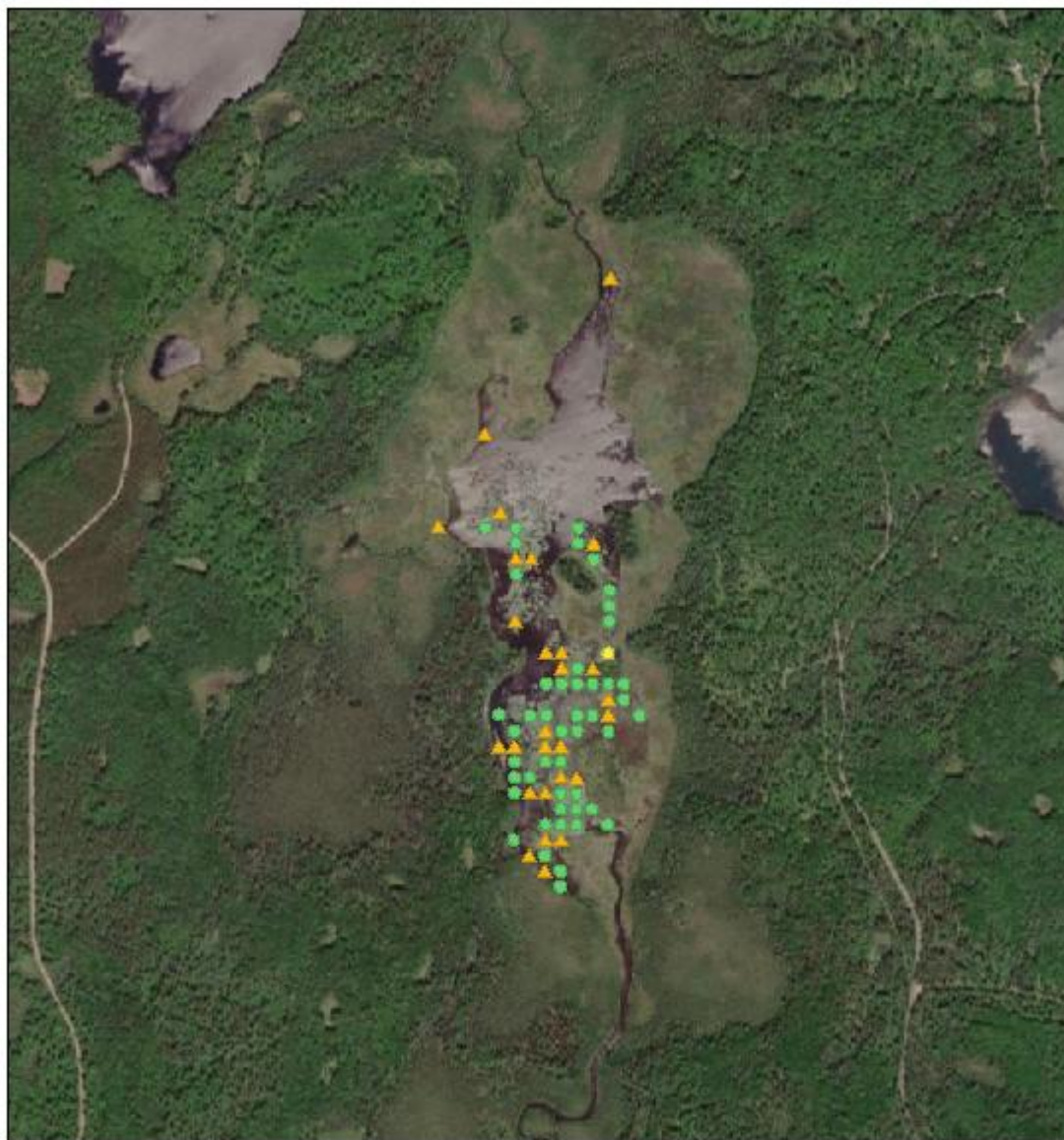
Maxar

Map 3. Relative frequency and rake fullness of Coontail (*Ceratophyllum demersum*) on Aurora Lake, Vilas County, Wisconsin.

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Aurora Lake Distribution of Plant Species - *Utricularia vulgaris*



8/19/2022

Aurora Lake Distribution of Plant Species - *Utricularia vulgaris*

■ 1 (Rake Fullness)

■ 2

▲ Visual

World Imagery



1:18,056

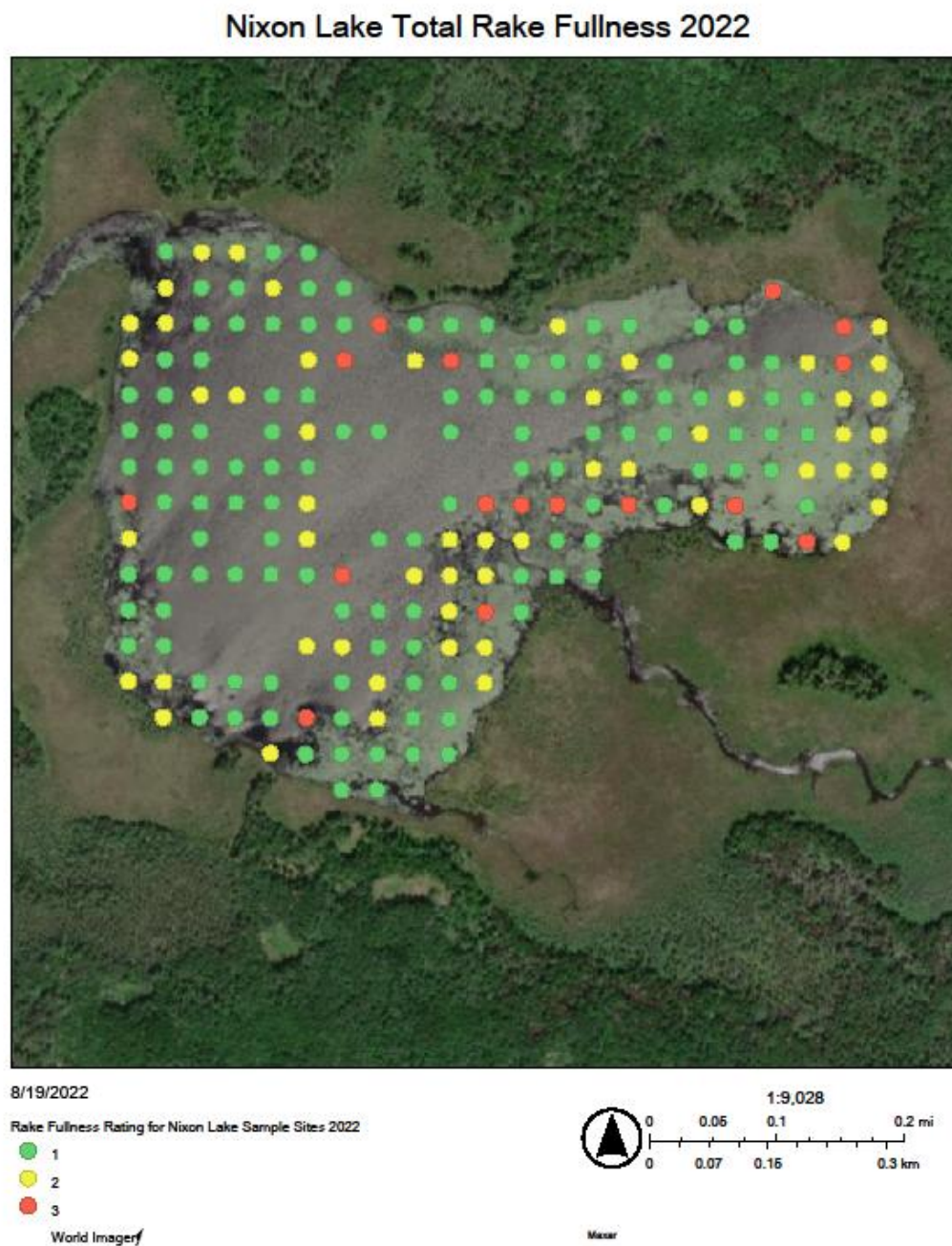
0 0.1 0.2 0.4 mi
0 0.15 0.3 0.6 km

Maxar

Map 4. Relative frequency and rake fullness of Common Bladderwort (*Utricularia vulgaris*) on Aurora Lake, Vilas County, Wisconsin.

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Map 5. Total rake fullness of aquatic vegetation on Nixon Lake, Vilas County, Wisconsin surveyed during 2022 PI survey.

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Nixon Lake Distribution of Plant Species - *Nymphaea odorata*



8/19/2022

Nixon Lake Distribution of Plant Species - *Nymphaea odorata*

● 1 (Rake Fullness)

● 2

● 3

▲ Visual

World Imagery



1:9,028

0 0.05 0.1 0.2 mi
0 0.07 0.15 0.3 km

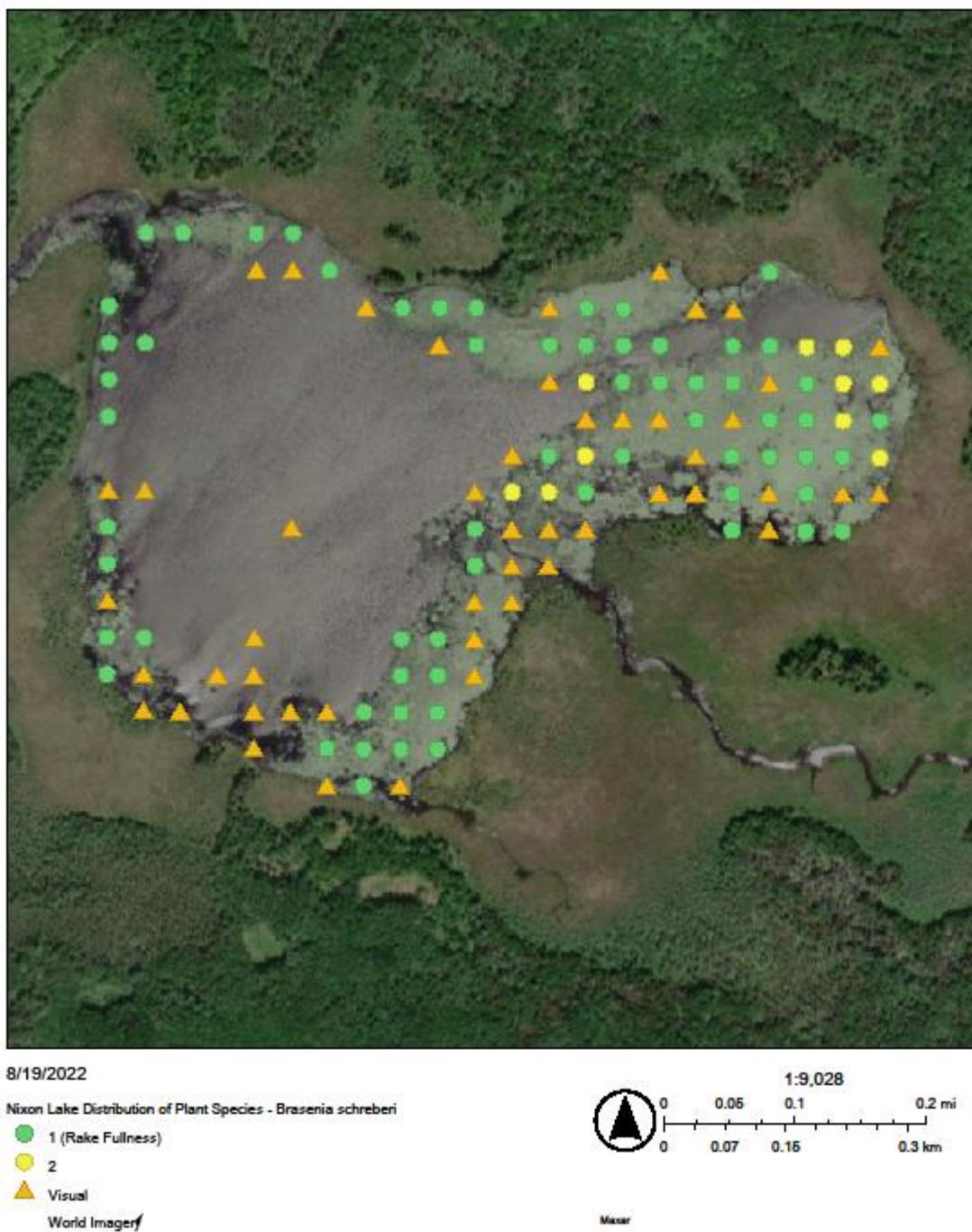
Maxar

Map 6. Relative frequency and rake fullness of White Water Lily (*Nymphaea odorata*) on Nixon Lake, Vilas County, Wisconsin.

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Nixon Lake Distribution of Plant Species - *Brasenia schreberi*

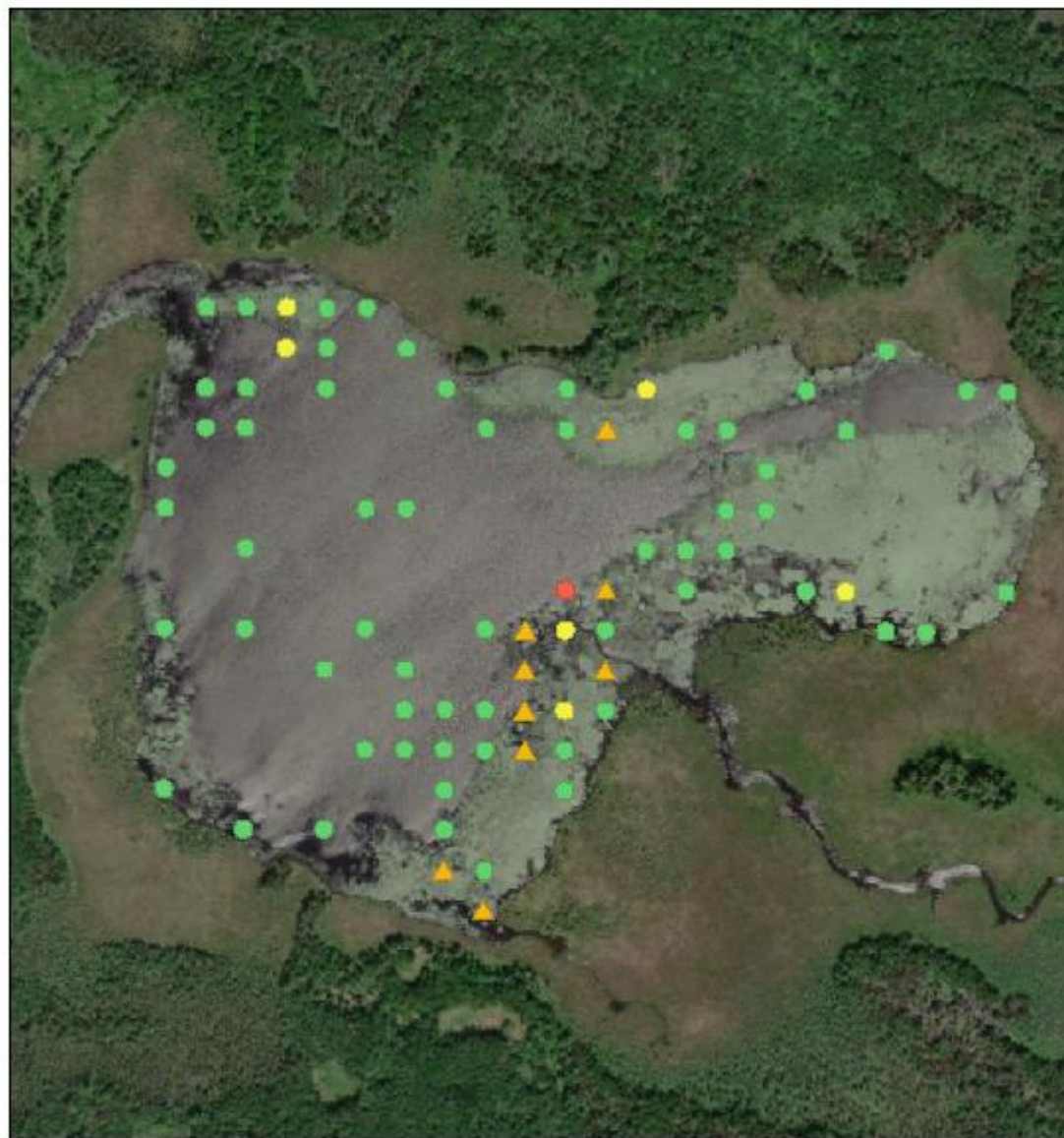


Map 7. Relative frequency and rake fullness of Watershield (*Brasenia schreberi*) on Nixon Lake, Vilas County, Wisconsin.

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Nixon Lake Distribution of Plant Species - *Ceratophyllum demersum*



8/19/2022

Nixon Lake Distribution of Plant Species - *Ceratophyllum demersum*

● 1 (Rake Fullness)

● 2

● 3

▲ Visual

World Imagery



1:9,028

0 0.05 0.1 0.2 mi
0 0.07 0.15 0.3 km

Maxar

Map 8. Relative frequency and rake fullness of Coontail (*Ceratophyllum demersum*) on Nixon Lake, Vilas County, Wisconsin.

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Snyder Lake Total Rake Fullness 2022



8/19/2022

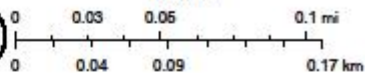
Rake Fullness Rating for Snyder Lake Sample Sites 2022

- 1
- 2
- 3

World Imagery



1:4,514



Maxar

Map 9. Total rake fullness of aquatic vegetation on Snyder Lake, Vilas County, Wisconsin surveyed during 2022 PI survey.

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Snyder Lake Distribution of Plant Species - *Potamogeton friesii*



8/19/2022

Snyder Lake Distribution of Plant Species - *Potamogeton friesii*

● 1 (Rake Fullness)

● 2

▲ Visual

World Imagery



1:4,514

0 0.03 0.05 0.1 mi
0 0.04 0.09 0.17 km

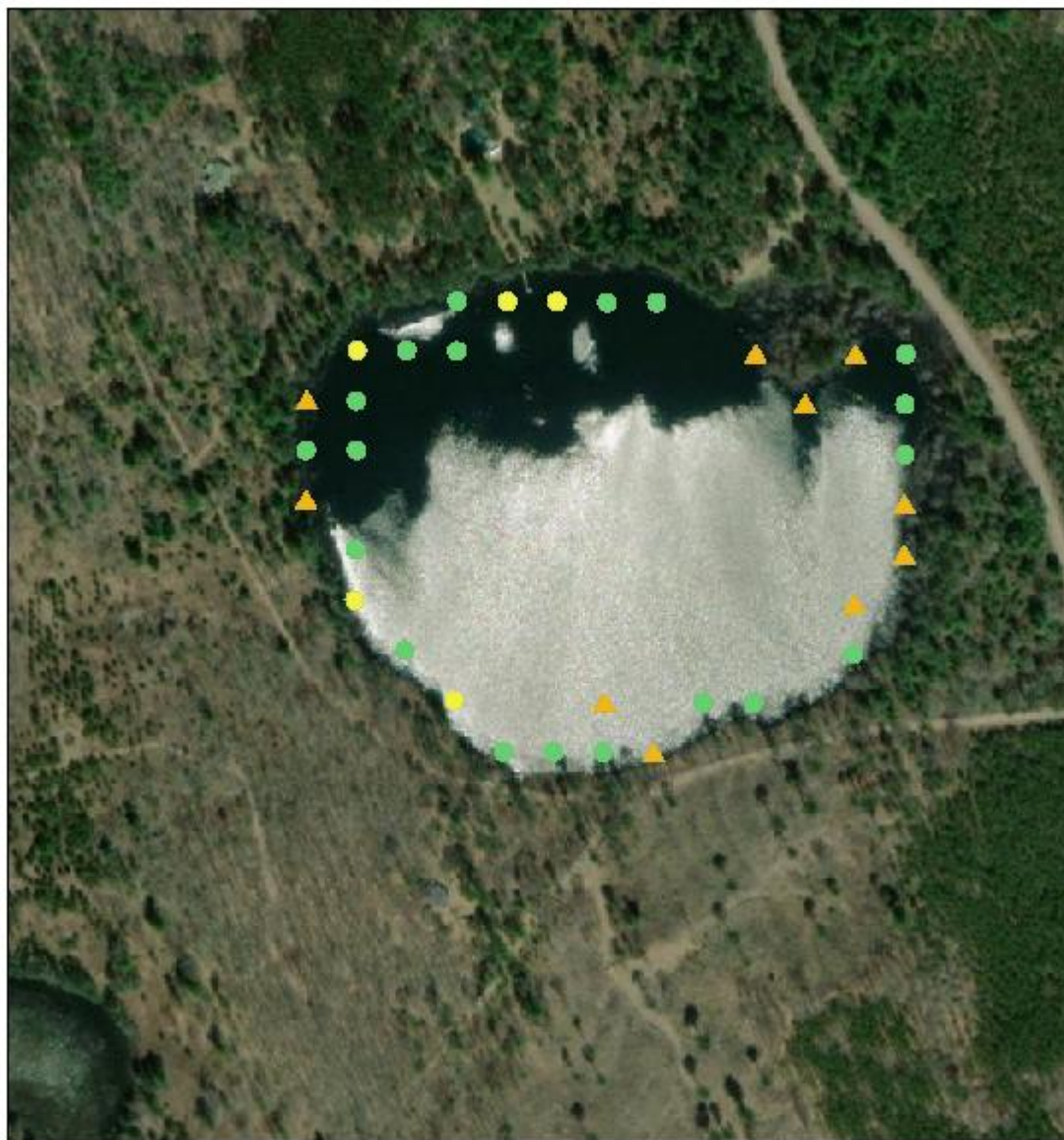
Maxar

Map 10. Relative frequency and rake fullness of Fries' Pondweed (*Potamogeton friesii*) on Snyder Lake, Vilas County, Wisconsin.

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Snyder Lake Distribution of Plant Species - *Brasenia schreberi*



8/19/2022

Snyder Lake Distribution of Plant Species - *Brasenia schreberi*

● 1 (Rake Fullness)

● 2

▲ Visual

World Imagery



1:4,514

0 0.03 0.05 0.1 mi
0 0.04 0.09 0.17 km

Maxar

Map 11. Relative frequency and rake fullness of Watershield (*Brasenia schreberi*) on Snyder Lake, Vilas County, Wisconsin.

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Snyder Lake Distribution of Plant Species - *Nitella* sp.



8/19/2022

Snyder Lake Distribution of Plant Species - *Nitella* sp.

- 1 (Rake Fullness)
- 2
- 3

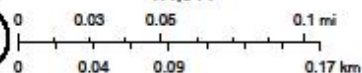
World Imagery

Low Resolution 16m Imagery



Maxar

1:4,514

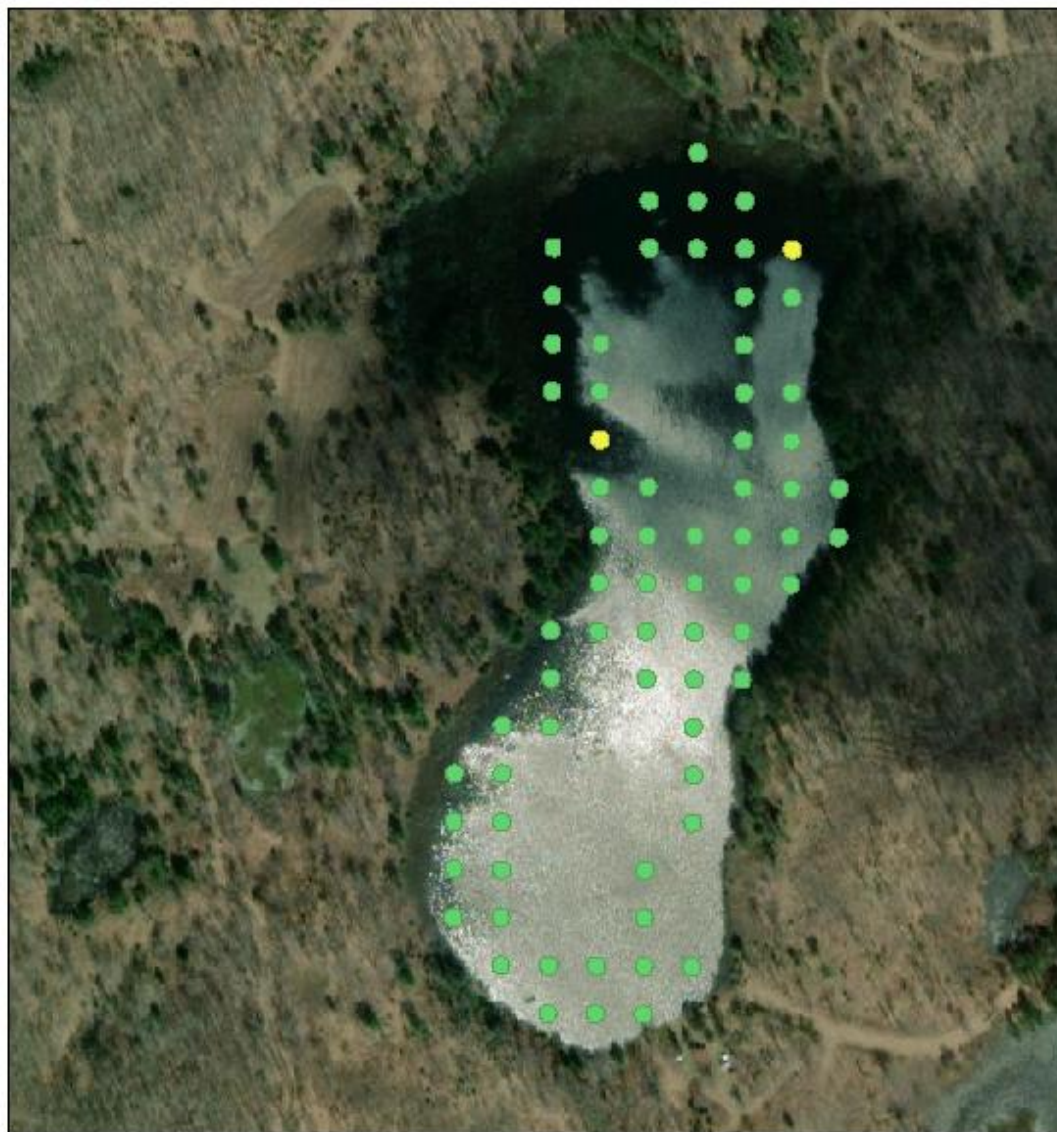


Map 12. Relative frequency and rake fullness of *Nitella* (*Nitella* sp.) on Snyder Lake, Vilas County, Wisconsin.

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Wilson Lake Total Rake Fullness 2022



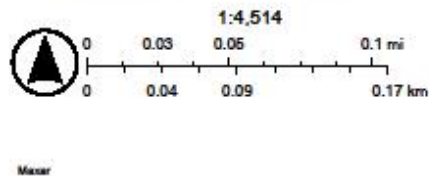
8/19/2022

Wilson Lake Total Rake Fullness 2022

- 1
- 2

World Imagery

Low Resolution 15m Imagery

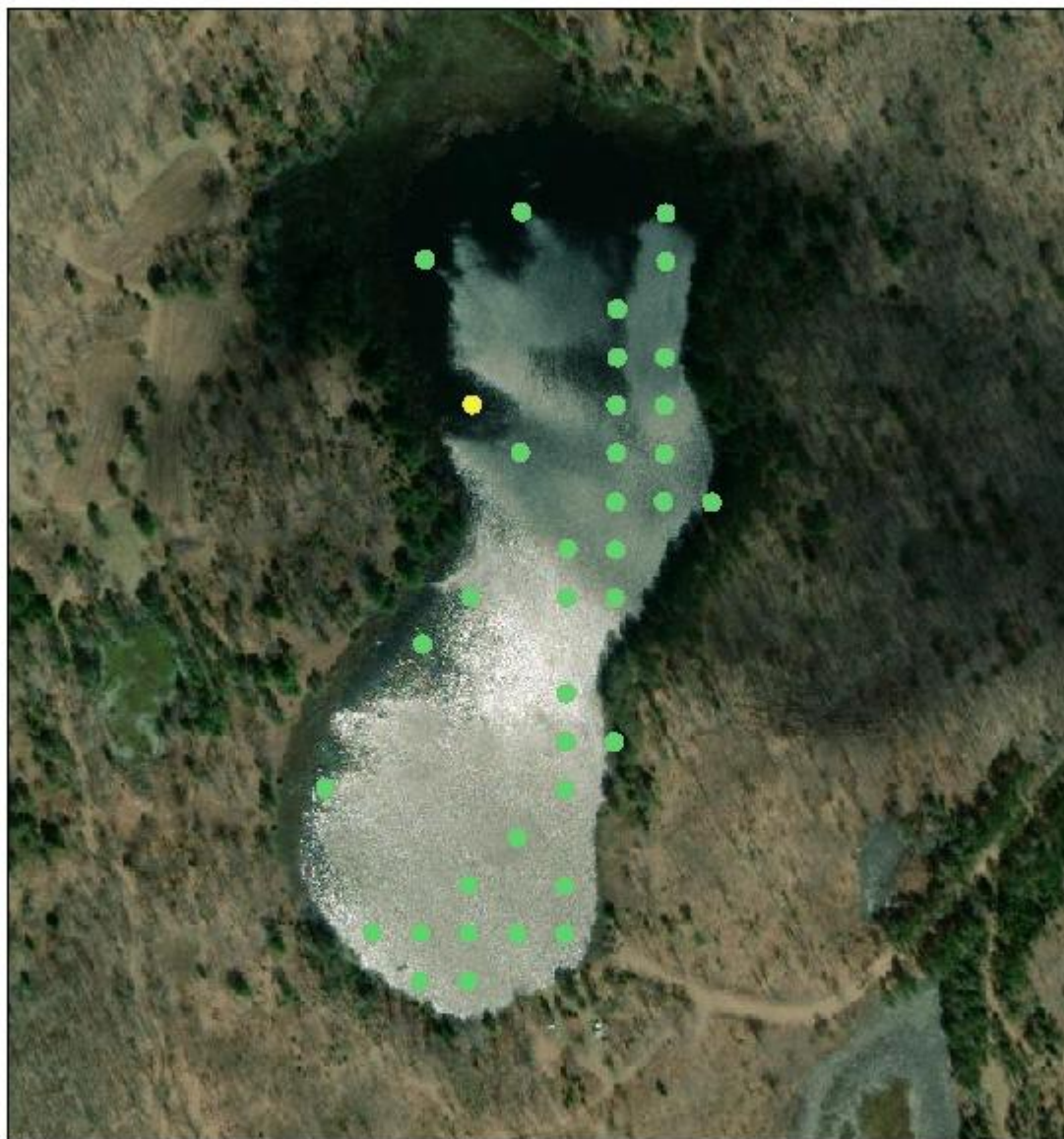


Map 13. Total rake fullness of aquatic vegetation on Wilson Lake, Vilas County, Wisconsin surveyed during 2022 PI survey.

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Wilson Lake Distribution of Plant Species - *Nitella* sp.



8/19/2022

Wilson Lake Distribution of Plant Species - *Nitella* sp.

● 1 (Rake Fullness)

● 2

World Imagery



1:4,514

0 0.03 0.05 0.1 mi
0 0.04 0.09 0.17 km

Maxar

Map 14. Relative frequency and rake fullness of *Nitella* (*Nitella* sp.) on Wilson Lake, Vilas County, Wisconsin.

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Wilson Lake Distribution of Plant Species - *Potamogeton epihydrus*



8/19/2022

Wilson Lake Distribution of Plant Species - *Potamogeton epihydrus*

● 1 (Rake Fullness)

▲ Visual

World Imagery



1:4,514

0 0.03 0.05 0.1 mi
0 0.04 0.09 0.17 km

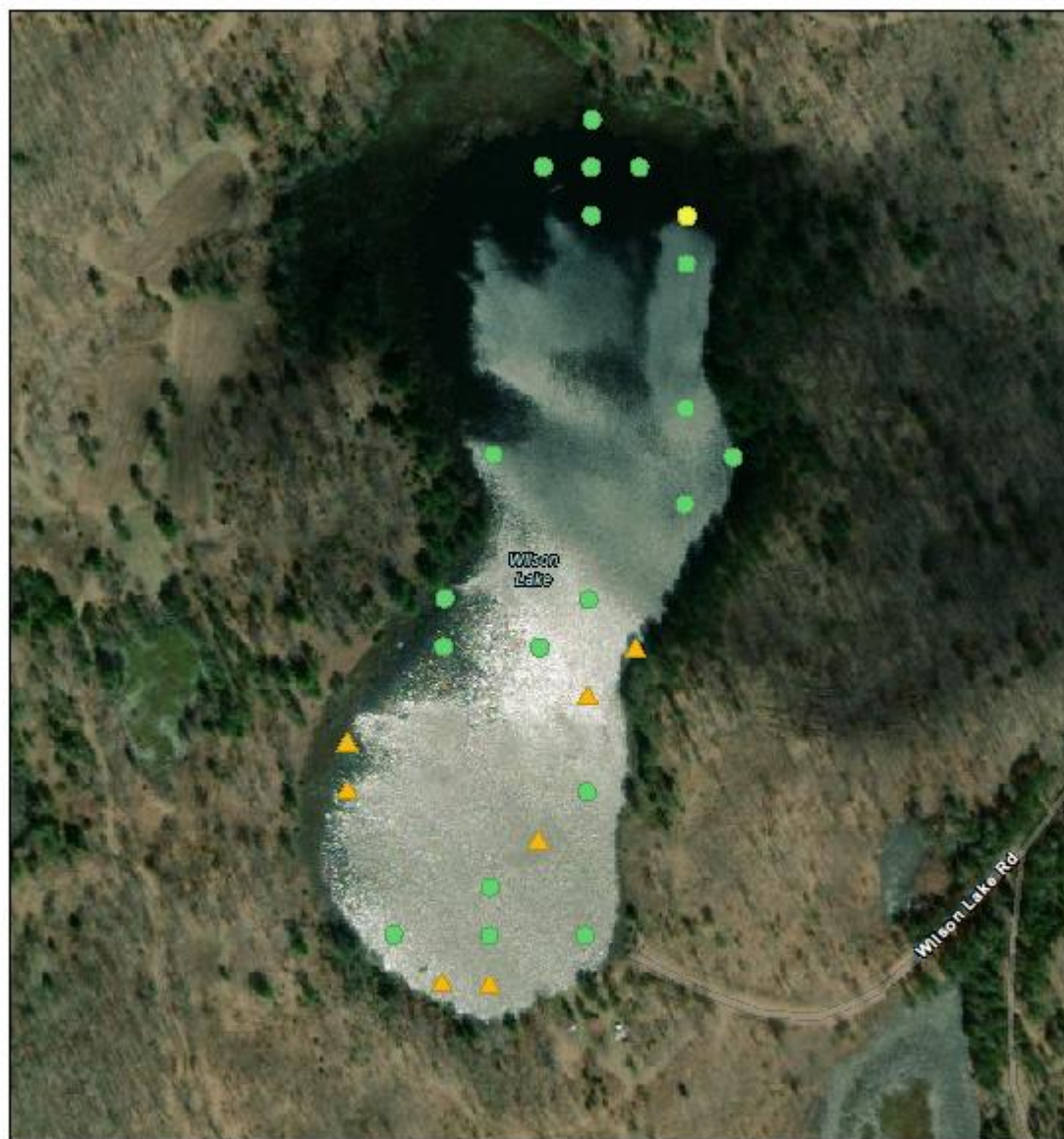
Maxar

Map 15. Relative frequency and rake fullness of Ribbon-Leaf Pondweed (*Potamogeton epihydrus*) on Wilson Lake, Vilas County, Wisconsin.

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Wilson Lake Distribution of Plant Species - *Utricularia vulgaris*



8/19/2022

Wilson Lake Distribution of Plant Species - *Utricularia vulgaris*

● 1 (Rake Fullness)

● 2

▲ Visual

World Imagery



1:4,514

0 0.03 0.05 0.1 mi
0 0.04 0.09 0.17 km

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Map 16. Relative frequency and rake fullness of Common Bladderwort (*Utricularia vulgaris*) on Wilson Lake, Vilas County, Wisconsin.

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