2015 Lake Ripley Aquatic Plant Inventory

Methods

Lake Ripley's 2015 aquatic plant (macrophyte) inventory employed the point-intercept sampling method in accordance with protocols approved by the Wisconsin Department of Natural Resources.[1] Sample points are provided to analyze the entire lake. Investigators locate sample points using a hand held GPS. Once at a monitoring location, a rake is lowered into the water to collect a sample and measure the water depth. The density of plant cover on the rake and sediment composition is determined. The plants are identified and each species is given a density rating based on the amount plants collected on the rake. The collected data are used for statistical analysis. Plants that are identified in close proximity to the sample site, but not collected within the rake sample are termed "visuals". Plants identified outside of the sample site or within the lake boundary are noted as "boat survey". Visuals and boat survey results are provided where applicable.

The inventory was conducted between August 11 and August 20, 2015, with actual sampling dates dictated by weather conditions and field crew scheduling. Jeanne Scherer (Water Resources Management Specialist, Wisconsin Department of Natural Resources (DNR)), Katrina Gilbank (Water Resources Management Specialist, DNR), Lisa Griffin (Lake Manager, Lake Ripley Management District), Patricia Cicero (Water Resource Management Specialist, Jefferson County Land and Water Conservation Department (LWCD)), Lianna Spencer (Intern, Lake Ripley Management District), and Lindsey Schreiner (Volunteer) performed the plant inventory, specimen preparation, and data analysis. Yearly comparison maps were prepared by David Winston (GIS specialist, DNR). Plant-distribution maps were prepared by Gerry Kokkonen (GIS Specialist, Jefferson County LWCD).

During the 2015 inventory, investigators were able to differentiate between two *Chara* species commonly referred to as muskgrass or stoneworts. This inventory catalogs two separate entries for *Chara; Chara contraria* (fetid stonewort) and *Chara globularis* (globular stonewort). Prior inventories used the term muskgrass for *Chara vulgaris (common stonewort).* A sample of *Chara globularis* was pressed, dried and submitted to the Wisconsin State Herbarium in Madison. Watermilfoil species were sampled and differentiated between northern watermilfoil, Eurasian watermilfoil and hybrid watermilfoil based on physical characteristics in the field.

[1] Hauxwell, J., S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky and S. Chase. 2010. *Recommended baseline monitoring of aquatic plants in Wisconsin: sampling design, field and laboratory procedures, data entry and analysis, and applications. Wisconsin DNR Bureau of Science Services, PUB-SS-1068 2010. Madison, Wisconsin, USA.*

Possible hybrid species may display overlapping characteristics of northern and Eurasian watermilfoils and were documented during both 2006 and 2011 inventories. The most accurate method to differentiate watermilfoil species when a hybrid is known within a waterbody is through genetic analysis, which is cost prohibitive. An analysis of the frequency of occurrence combines all three species and is provided within the results of this document. This was done for the benefit of future inventories if it is decided that all three species should be combined. Factors which may influence results of inventories include variations in sampling technique and inter-annual variability in plant growth.

Results

Total plant species found using point-intercept, visual, and boat survey methods was 34. A total of 24 aquatic plant species were found through point-intercept rake sampling. This number increases to 27 species if three visuals are included (bulrush, small duckweed, and arum-leaved arrowhead) (Table 2). Plants were found at water depths extending to 15 feet. The six most dominant species documented, in descending order, were: sago pondweed (*Stuckenia pectinata*), fetid stonewort (*Chara contraria.)*, spiny naiad (*Najas marina*), coontail (*Ceratophyllum demersum*), and eel grass or wild celery *(Vallisneria americana)* (Table 1). Maps showing plant distributions and densities are shown in Figures 5-13.

Total plant density for the entire lake, based on rake fullness values, has increased to 2.36 compared to a density of 1.61 found in 2011 (Table 2) (Figure 5). Data for total plant rake density for all plant species was not calculated in the 2006 survey. The timing of the 2015 inventory which occurred in August may contribute to an increase in density compared to the 2006 and 2011 June studies as plant growth peaks later in the season for a majority of species.

In prior inventories conducted in 2006 and 2011, a hybrid species of milfoil was recorded though not confirmed. Positive identification by the Wisconsin DNR of a hybrid species using genetic analysis occurred in 2014. It is the case that it is not reliable to visually distinguish between the 3 watermilfoil species in the lake. Therefore, to compare all watermilfoil species found in the lake, all 3 species have been combined. This may benefit future inventories if it is determined that differentiation between species is impossible in a field setting. The frequency of occurrence is the number of occurrences of a species divided by the number of sampling points where plants were collected. The frequency of occurrence of Eurasian watermilfoil, northern watermilfoil, and the hybrid watermilfoil was 10.6% in 2006, 40.6% in 2011, and 13.3% in 2015 when all species are combined. Frequency of occurrence for each watermilfoil species identified based on field observations is found in Table 3. It should be noted that these number may not be precise as it is difficult to distinguish visually between the three watermilfoil species (Table 3).

Curly-leaf pondweed, an invasive species, had a frequency of occurrence of 1.4% in 2006, 8.9% in 2011, and 1.4% in 2015. The 2006 and 2011 surveys were performed in June when the curly-leaf pondweed is actively growing. The 2015 inventory was conducted in August when most curly-leaf pondweed plants would have died back and would not be as prevalent as in inventories conducted earlier in the year. One thing is certain with the curly-leaf pondweed coverage in the lake – it increased in coverage in 2011 compared to 2006.

Discussion

Lake Ripley aquatic plant community diversity has remained fairly consistent since the 2006 inventory. The total number of species documented (on the rake, visual observation near sample points, and a general boat survey) for each year are 31 for 2006, 28 for 2011, and 34 for 2015 (Table 2). The most dominant species in the lake in terms of frequency of occurrence in 2015 were sago pondweed (*Stuckenia pectinata*), fetid stonewort (*Chara contraria.)*, spiny naiad (*Najas marina*), coontail (*Ceratophyllum demersum,* and eel grass *(Vallisneria americana)*(Figure2). Comparing the 2011 and 2015 frequency of occurrence, 4 native plant species have increased, 3 have decreased, and 9 have no statistically significant change. However, when comparing the frequency of occurrences of the 2006 data with the 2015 data, they are very similar. The exceptions are that frequency of occurrence for sago pondweed, water celery, bushy pondweed, and coontail have increased with each subsequent survey (Figure 3). The 2006, 2011 and 2015 species diversity was significantly higher compared to inventories conducted prior to 2006. Data comparisons with inventories prior to 2006 is limited given the change from transect-based (less sample points) to point-intercept-based (more sample points) methods. The similarity between the 2006 and 2015 data and their differences with the 2011 data illustrate that plant growth in lakes can be variable and is related to weather and other factors including plant management.

The relative frequency of occurrence is the frequency of a species divided by the total frequency of all species (Table 1). The sum of the relative frequencies should equal 100 percent. This statistic presents an indication of how plants occur throughout the lake in relation to each other. The relative frequency of occurrence is also used to calculate importance values and the Simpson's diversity index (Table 1). Sago pondweed makes up 22% of the plant community in 2015, can increase from 14% shown in the 2011 inventory.

The importance value is the product of the relative frequency and the average density and is expressed as a percent for each species. This number provides an indication of the dominance of a species within a community based upon both frequency and density (Table 1). Sago pondweed has the highest importance value of 43.1 as is a considerable increase from the value of 14.3 in the 2011 survey.

The coefficient of conservatism is a number on a scale from 0 to 10 that represents an estimated probability that a plant species is likely to occur in a lake unaltered from what is believed to be pre-settlement conditions. A coefficient of 10 indicates the plant is almost certain to be found only in an un-degraded natural community, and a coefficient of 0 indicates the probability is almost 0. Introduced plants were not part of the pre-settlement flora, so no coefficient is assigned to them. Higher coefficients of conservatism are indicative of native plants that are more intolerant of habitat modification or impaired water quality. The data for the eco-region that includes Lake Ripley is for 68 lakes: the average coefficient of conservatism ranges from 6.87 to 2.12 with an average of 5.21. The 2015 mean coefficient of conservatism for Lake Ripley is 5.95 and has basically been stable since 2006 (Table 2). This average takes into account plants that are documented on the rake and not observed during the boat survey.

The floristic quality index (FQI) is used to assess a lake's quality using the aquatic plants that live in it. FQIs range from 3.0 to 44.6 in Wisconsin. The higher the value, the more likely the plant is negatively influenced by human activities that affect water quality or habitat. Plants with low values are tolerant of human disturbances, and often exploit these impacts to the point where they may crowd out other species. The floristic quality index is the average coefficient of conservatism multiplied by the square root of the number of plants in the lake. Generally, higher FQI numbers mean a healthier plant community. Lake Ripley's floristic quality index of 25.92 continues to rank above the median (21.10) and average (20.00) values for the Southeast Wisconsin Till Plains ecoregion (Table 2).[2] In terms of its Aquatic Plant Community Biotic Index, a measure of biological quality of the aquatic plant community, Lake Ripley scored similar to the regional mean with a value of 48.[3]

The Simpson Diversity index was 0.86 and has remained consistent over the past 3 surveys (Table 2). This index is calculated as one minus the sum of each of the relative frequencies squared. The closer the SDI value is to one, the greater the diversity is between communities being compared. The index allows the plant community at one location to be compared to the plant community at another location. It also allows a single location's plant community to be compared over time. The index value (on a scale of 0-1) represents the probability that two

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[2] Median and average FQI for Wisconsin lakes sampled in the SWTP eco-region (updated: August 2011). Statistics provided by Michelle Nault, Wisconsin DNR.

[3] Nichols, Stanley, Weber, Steven and Shaw, Byron. (2000) *A Proposed Aquatic Plant Community Biotic Index for Wisconsin Lakes*. Journal of Environmental Management. Volume 26, Number 5, pages 491-502.

individuals (randomly selected) will be different species. The greater the index value, the higher the diversity in a given location. Plant communities with high diversity are usually representative of healthier lakes, and also tend to be more resistant to invasion by exotic species.

Plant depth will fluctuate from year to year depending on changes in water clarity conditions. Plants may be found at depths of over 20 ft. in clear lakes, but only in a few feet of water in stained or turbid lakes. While some species can tolerate very low light conditions, others are only found near the surface. In general, the diversity of the plant community decreases with increased depth. During the 2015 survey, plants were not found in depths greater than 15 feet. However the 2006 survey documented plants at 17 ft. and 2011 documented plants at 21 feet (Table 2). Depths at which plants are growing also impact the number of sites sampled (Table 2). Other factors that restrict access to sampling points include pier placement, boaters, and other obstructions.

Hybrid watermilfoil was reported as early as the 2006 inventory in different areas throughout the lake but were not officially documented as a hybrid species until 2014. Current scientific knowledge on hybrid watermilfoils and their physical and environmental characteristics is emerging. Physical traits of hybrid plants can vary based on local ecological conditions and can mimic either parent plant.[4] It is unknown whether Lake Ripley's hybrid watermilfoil populations will display invasive characteristics of its non-native parent.

When considering all three watermilfoil species together, it shows that the watermilfoil species has similar abundance in 2006 and 2015 compared to a higher abundance in 2011. It is important to continue to survey the amount of the watermilfoils in the lake to determine if they are a cause for concern. The 2006 and 2015 abundances are considered maintenance levels in which harvesting can keep the Eurasian and hybrid watermilfoils in check (Figure 1, Tables 3 &4).

Curly-leaf pondweed was documented but may not represent true population densities due to the time of year the inventory was conducted. Comparisons of 2006 and 2011 data (both surveys were done during the time with curly-leaf pondweed are expected to grow in the lake) show an increase in curly-leaf pondweed populations (Tables 3 & 4). Any increase or decrease in plant populations may be due to a variety of factors, including changes in annual weather that might favor early-season plants. Attention should be paid to curly-leaf pondweed in future inventories

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[4] Moody, M.L., Les, D.H. (2007) *Geographic distribution and genotypic composition of invasive hybrid watermilfoil (Myriophyllum spicatum x M. sibiricum populations in North America.* Biol Invasions. Volume 9, pages 559-570.

to verify growth trends with respect to the seasonal variability of curly-leaf pondweed populations.

Table 1: Statistical summary for all plant species documented in the 2015 inventory

Aquatic Plant	Number of Sites Found	FREQ[a] [0-15'] (%)	RFREQ[b] (%)	ADEN[c] (1-3 scale)	IV[d]	C[e]
Stuckenia pectinata (Sago pondweed)	174	48.5	22.1	2.0	43.1	3.0
Chara contraria (2015*) (fetid stonewort)	155	43.2	19.7	1.9	37.8	7.0
Najas marina (spiny naiad)	127	35.4	16.1	2.1	33.6	
Ceratophyllum demersum (coontail)	98	27.3	12.4	1.9	23.8	3.0
Vallisneria americana (Eel grass)	79	22.0	10.0	1.4	13.8	6.0
Myriophyllum sibiricum (northern watermilfoil)	26	7.2	3.3	1.4	4.5	6.0
Najas flexilis (bushy pondweed)	25	7.0	3.2	1.4	4.5	6.0
Chara globularis (2015*) (globular stonewort)	21	5.9	2.7	1.3	3.6	7.0
Potamogeton friesii (Fries' pondweed)	20	5.6	2.5	1.0	2.5	8.0
Myriophyllum spicatum (Eurasian watermilfoil)	12	3.3	1.5	1.8	2.6	
Myriophyllum spp. (hybrid watermilfoil)	10	2.8	1.3	1.4	1.8	
Utricularia vulgaris (bladderwort)	6	1.7	0.8	1.3	1.1	7.0
Heteranthera dubia (water stargrass)	5	1.4	0.6	1.2	0.7	6.0
Nuphar variegata (spatterdock)	5	1.4	0.6	1.2	0.7	6.0
Potamogeton crispus (curly-leaf pondweed)	5	1.4	0.6	1.0	0.6	
Potamogeton gramineus (variable pondweed)	4	1.1	0.5	1.0	0.5	7.0
Nymphaea odorata (white water lily)	3	0.8	0.4	1.0	0.4	6.0
Potamogeton illinoensis (Illinois pondweed)	3	0.8	0.4	1.3	0.5	6.0
Potamogeton pusillus (small pondweed)	3	0.8	0.4	1.0	0.4	7.0
Elodea canadensis (waterweed)	2	0.6	0.3	1.5	0.5	3.0
Potamogeton natans (floating-leaf pondweed)	2	0.6	0.3	1.0	0.3	5.0
Potamogeton strictfolius	1	0.3	0.1	1.0	0.1	8.0

(stiff pondweed)						
Potamogeton zosteriformis (flat-stem pondweed)	1	0.3	0.1	1.0	0.1	6.0
Zannichellia palustris (horned pondweed)	1	0.3	0.1	1.0	0.1	7.0
Decodon verticillatus (water willow, swamp loosestrife)	B	B	B	B	B	B
Lemna minor (small duckweed)	V	V	V	V	V	V
Sagittaria cuneata (arum-leaved arrowhead)	V	V	V	V	V	V
Cicuta maculata (water hemlock)	B	B	B	B	B	B
Typha sp. (cattils)	B	B	B	B	B	B
Phragmites australis (phragmites)	B	B	B	B	B	B
Asclepias incarnata (swamp milkweed)	B	B	B	B	B	B
Scripus acutus (hardstem bulrush)	V	V	V	V	V	V
freshwater sponge	6	1.7	NA	1.0	NA	NA
filamentous algae	6	1.7	NA	1.3	NA	NA

B = species observed during general boat survey

V = found within 6 ft. of sample site during point intercept method

[a]FREQ [0-15'] = Frequency of Occurrence within depth zone defining extent of plant growth. For the 2015 survey, this is the number of occurrences of a species divided by the number of sampling points in the 0-15' depth range.

[b]RFREQ = Relative Frequency of Occurrence.

[c]ADEN = Average Density. The sum of the density ratings for a species (1-3 rake fullness scale) divided by the number of sampling points containing that species.

[d]IV = Importance Value. The product of the relative frequency (RFREQ) and the average density, expressed as a percentage.

[e]C = Coefficient of Conservatism.

Table 2: Statistics for the 2006, 2011, and 2015 plant surveys

	2006	**2011**	**2015**
Total Number of Points Sampled	398	421	369
Number of Points Sampled Shallower than Maximum Depth of Plants	369	407	359
Number of Points with Vegetation	318	366	330
Maximum Depth of Plant Growth	17 ft	21 ft	15 ft
Total Number of Species in Lake (includes visuals and boat survey)	31	28	34
[a]Species Documented on the Rake	20	21	24
Frequency of Occurrence at sites shallower than maximum depth of	86	90	91

plants			
Average Rake fullness for all vegetation	--	1.61	2.36
Simpson Diversity Index	0.85	0.89	0.86
Floristic Quality Index (FQI)	22.75	23.77	25.92
Mean Coefficient of Conservatism (C)	5.69	5.76	5.95
Average Number of Species Sampled Per Site	1.76	2.33	2.19
Average Number of Species Sampled at Sites with Vegetation	2.05	2.60	2.39
Average Number of Native Species Sampled Per Site	1.52	2.02	1.79
Average Number of Native Species Sampled at Sites with Vegetation	2.00	2.34	1.97

[a]Includes filamentous algae and freshwater sponge.

Table 3: Percent frequency of occurrence of aquatic plant species (2006-2015)

Species	2006	2011	2015
Stuckenia pectinata (Sago pondweed)	16.8	32.7	48.5
Chara contraria * (fetid stonewort)	53.1	49.6	43.2
Najas marina (spiny naiad)	33.3	18.7	35.4
Ceratophyllum demersum (coontail)	12.2	25.3	27.3
Vallisneria americana (Eel grass)	3.0	10.6	22.0
Myriophyllum sibiricum (northern watermilfoil)	3.8	24.6	7.2
Najas flexilis (bushy pondweed)	1.1	2.0	7.0
Chara globularis * (globular stonewort)	--	--	5.9
Potamogeton friesii (Fries' pondweed)	7.3	20.1	5.6
Myriophyllum spicatum (Eurasian watermilfoil)	6.8	3.7	3.3
Myriophyllum spp. (hybrid watermilfoil)	4.61	12.3	2.8
Utricularia vulgaris (bladderwort)	--	2.7	1.7
Heteranthera dubia (water stargrass)	4.3	1.0	1.4
Nuphar variegata (spatterdock)	1.9	1.7	1.4
Potamogeton crispus (curly-leaf pondweed)	1.4	8.9	1.4
Potamogeton gramineus (variable pondweed)	--	0.2	1.1
Nymphaea odorata (white water lily)	1.6	1.2	0.8
Potamogeton illinoensis (Illinois pondweed)	--	7.4	0.8
Potamogeton pusillus (small pondweed)	0.3	0.5	0.8
Elodea canadensis (waterweed)	0.8	9.8	0.6
Potamogeton natans (floating-leaf pondweed)	--	--	0.6
Potamogeton strictfolius (stiff pondweed)	--	--	0.3
Potamogeton zosteriformis (flat-stem pondweed)	--	--	0.3
Zannichellia palustris (horned pondweed)	--	0.2	0.3
Potamogeton foliosus (leafy pondweed)	0.8	--	--
Lemna trisulca (forked duckweed)	0.3	--	--
Lemna minor (small duckweed)	1.1	0.2	V

* 2015 inventory differentiated between *Chara* species

Table 4: Number of sample sites where each species was found (2006-2015)

Species	2006	2011	2015
Stuckenia pectinata (Sago pondweed)	62	133	174
Chara contraria * (fetid stonewort)	196	201	155
Najas marina (spiny naiad)	123	76	127
Ceratophyllum demersum (coontail)	44	103	98

Vallisneria americana (Eel grass)	11	43	79
Myriophyllum sibiricum (northern watermilfoil)	14	100	26
Najas flexilis (bushy pondweed)	4	8	25
Chara globularis * (globular stonewort)	--	--	21
Potamogeton friesii (Fries' pondweed)	27	82	20
Myriophyllum spicatum (Eurasian watermilfoil)	25	15	12
Myriophyllum spp. (hybrid watermilfoil)	--	50	10
Utricularia vulgaris (bladderwort)	--	11	6
Heteranthera dubia (water stargrass)	16	4	5
Nuphar variegata (spatterdock)	7	7	5
Potamogeton crispus (curly-leaf pondweed)	5	36	5
Potamogeton gramineus (variable pondweed)	--	1	4
Nymphaea odorata (white water lily)	6	5	3
Potamogeton illinoensis (Illinois pondweed)	18	30	3
Potamogeton pusillus (small pondweed)	1	2	3
Elodea canadensis (waterweed)	3	40	2
Potamogeton natans (floating-leaf pondweed)	--	1	2
Potamogeton strictfolius (stiff pondweed)	--	--	1
Potamogeton zosteriformis (flat-stem pondweed)	--	--	1
Zannichellia palustris (horned pondweed)	--	1	1
Potamogeton foliosus (leafy pondweed)	3	--	--
Lemna trisulca (forked duckweed)	1	--	--
Lemna minor (small duckweed)	4	1	V

* 2015 inventory differentiated between *Chara* species

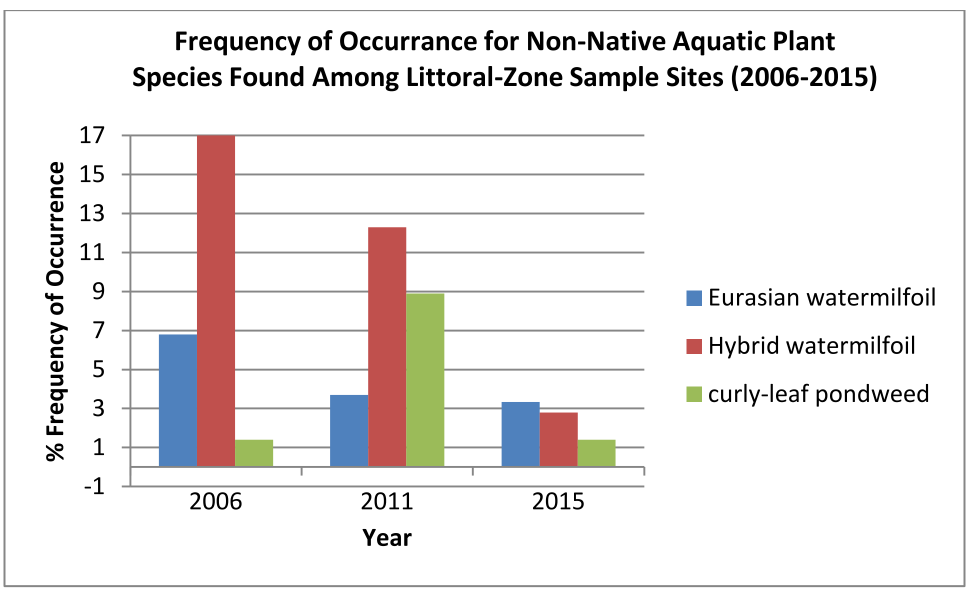

Figure 1: Frequency of Occurrence for Non-Native Aquatic Plant Species Found Among Littoral-Zone Sample Sites (2006-2015)

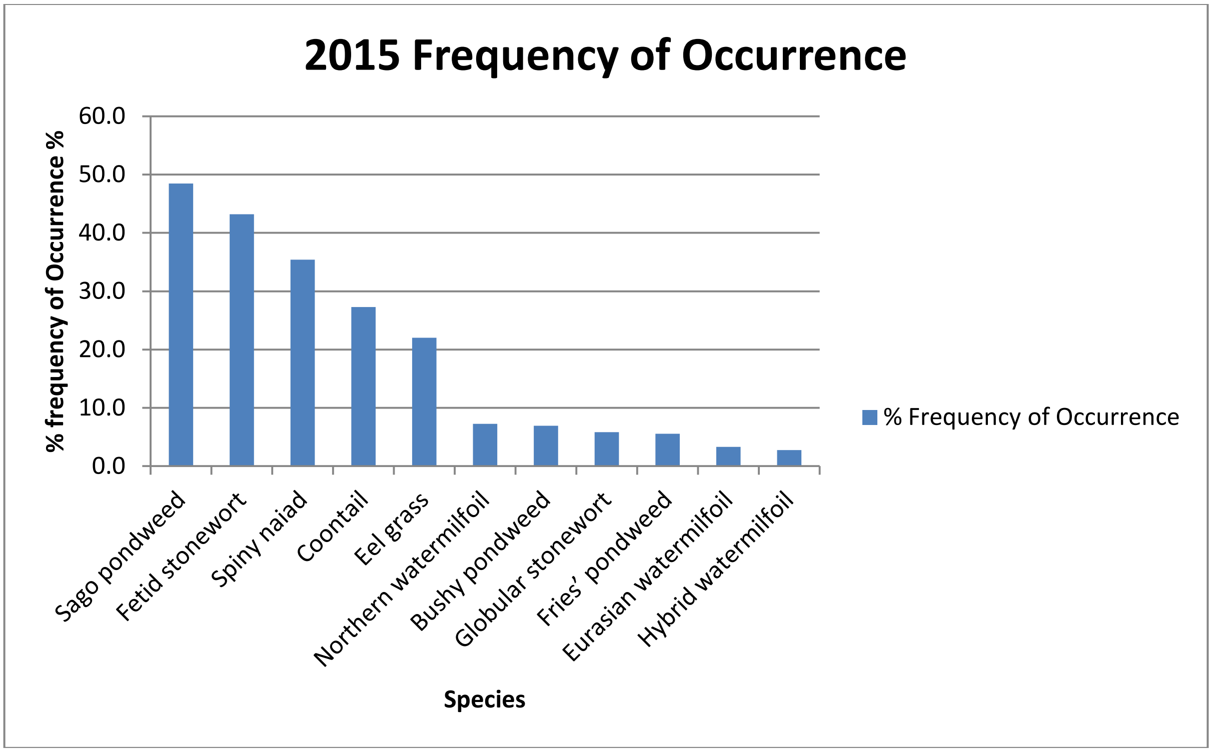

Figure 2: 2015 Species with a Frequency of Occurrence of 1.0% or greater.

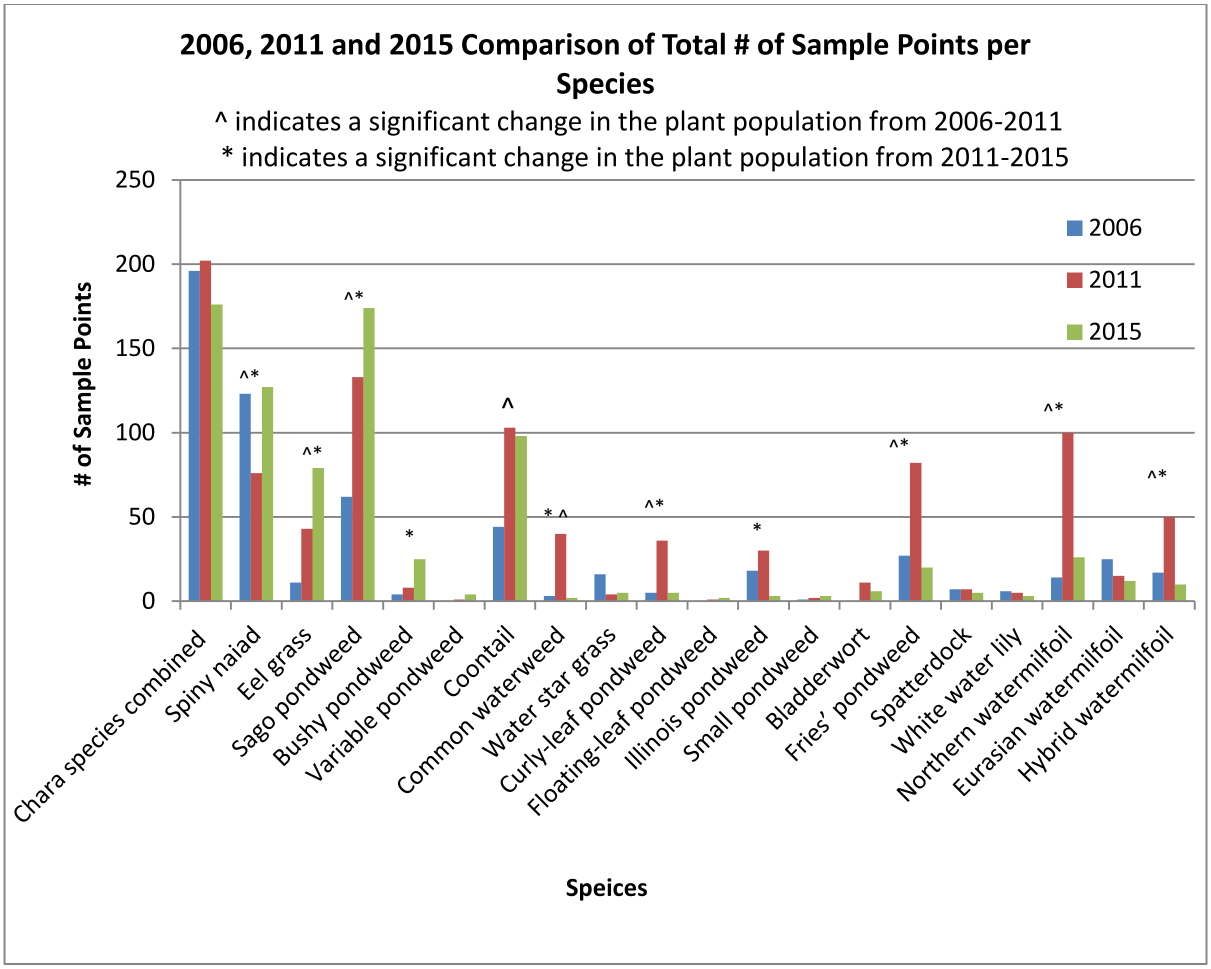

Figure 3: 2006, 2011 and 2015 comparison of total number of sample points where each species was found. Stonewort species combined for analysis. Common watermeal, Horned pondweed and stiff pondweed had low sample points and excluded from the figure.

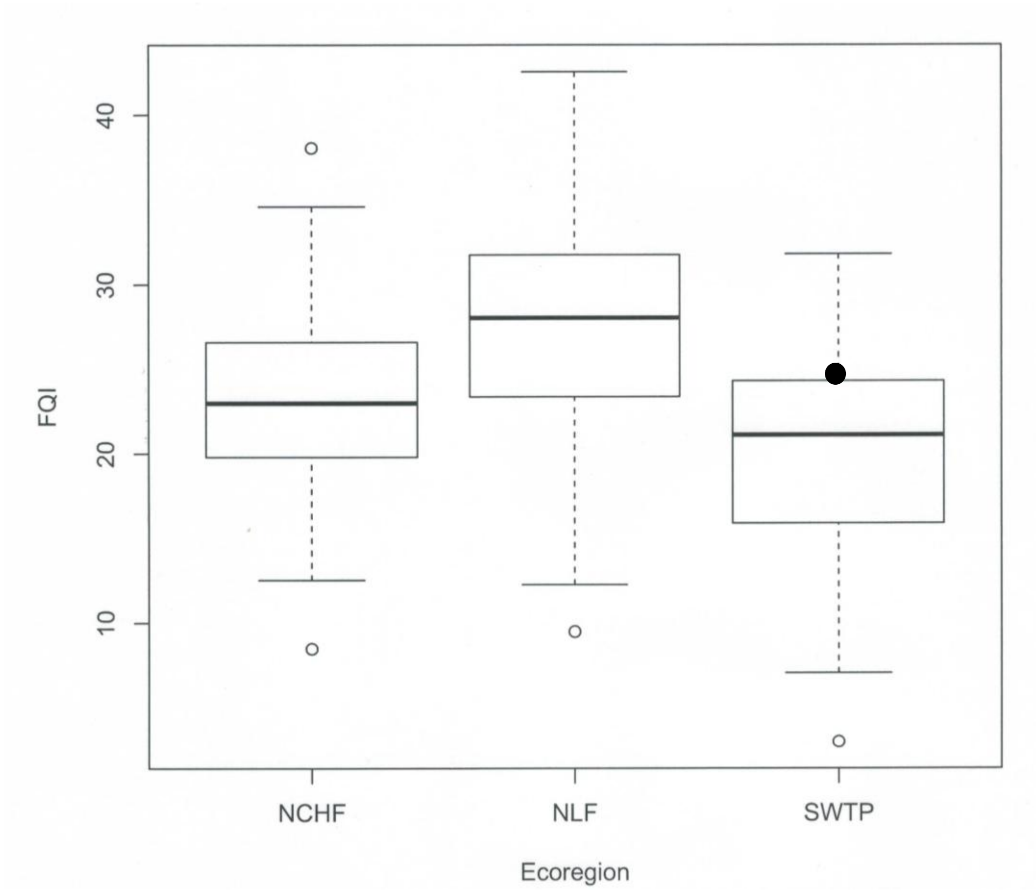

Figure 4: Box plot showing variation in Floristic Quality Index (FQI) by ecoregion across 233 Wisconsin lakes sampled with the Wisconsin standardized baseline aquatic plant monitoring protocol over six years (2005-2011). Mean is center, box covers 50% of the data, whiskers indicate range, circles indicate outliers, solid dot is Lake Ripley. NCHF = North Central Hardwood Forests, NLF = Northern Lakes and Forests, SWTP = Southeastern Wisconsin Till Plains.

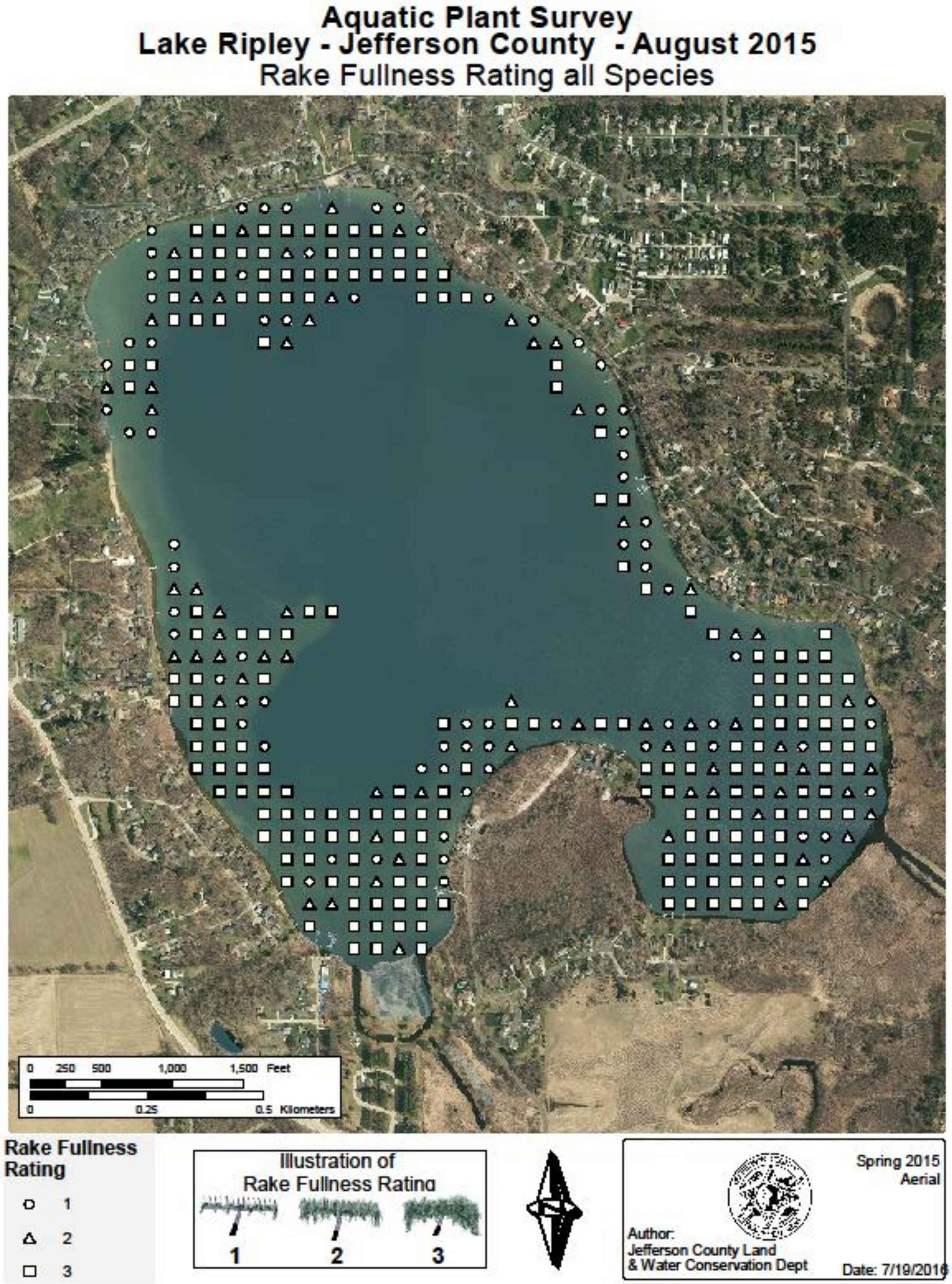

Figure 5: Total Rake Fullness Rating for Each Point Sampled

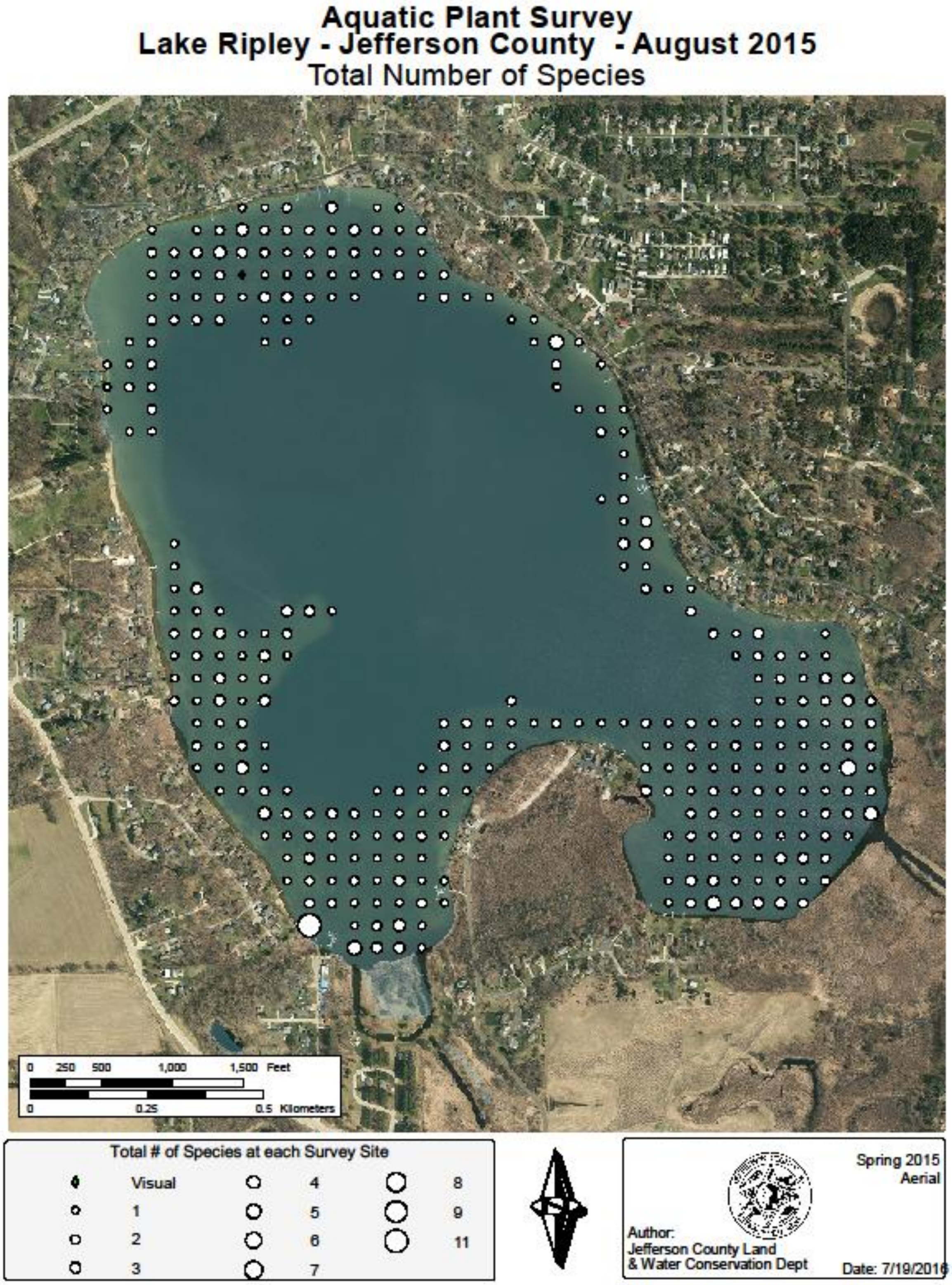

Figure 6: Total Number of Species Found at Each Point Sampled

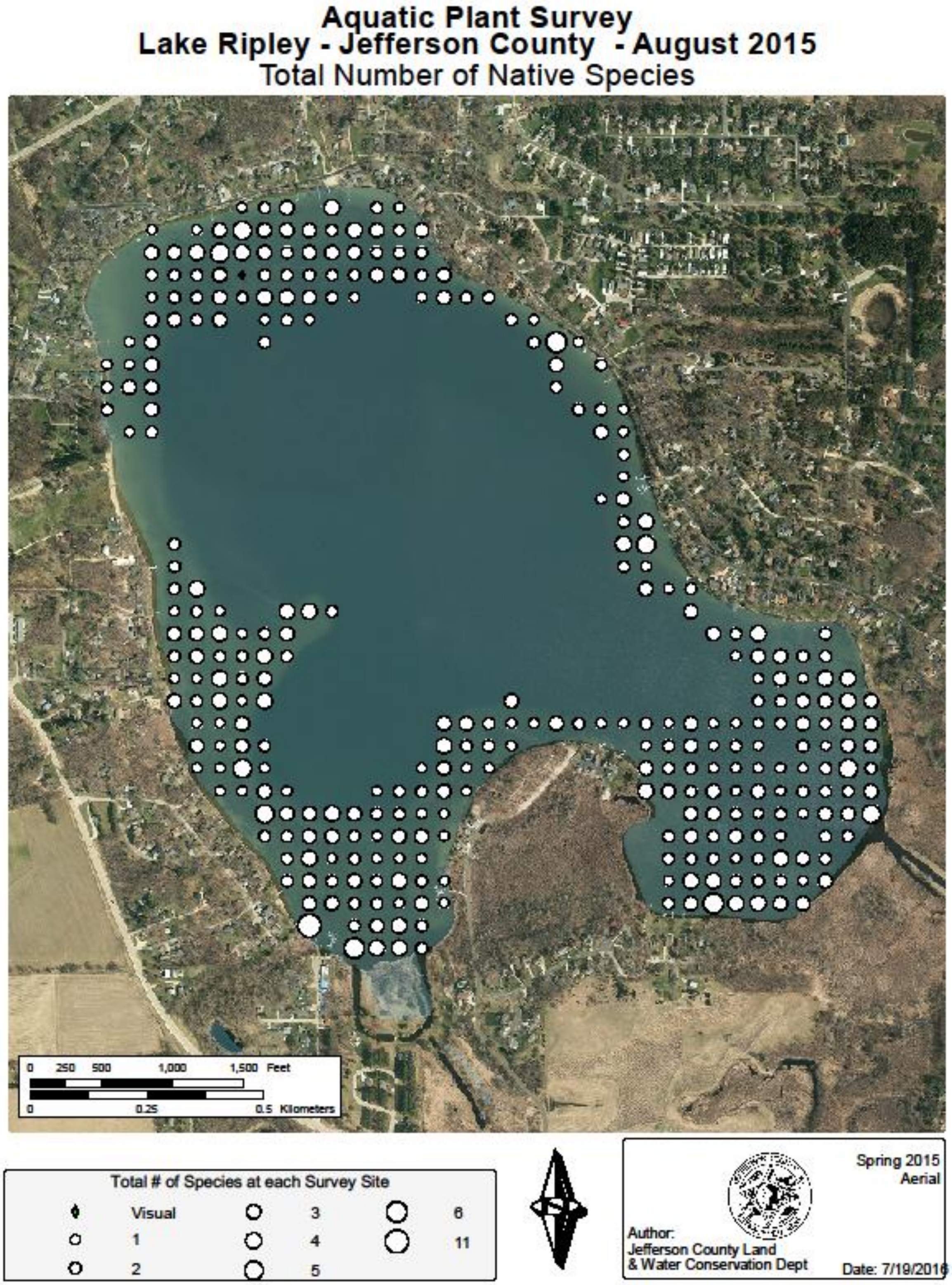

Figure 7: Total Number of Native Species Found at Each Point Sampled

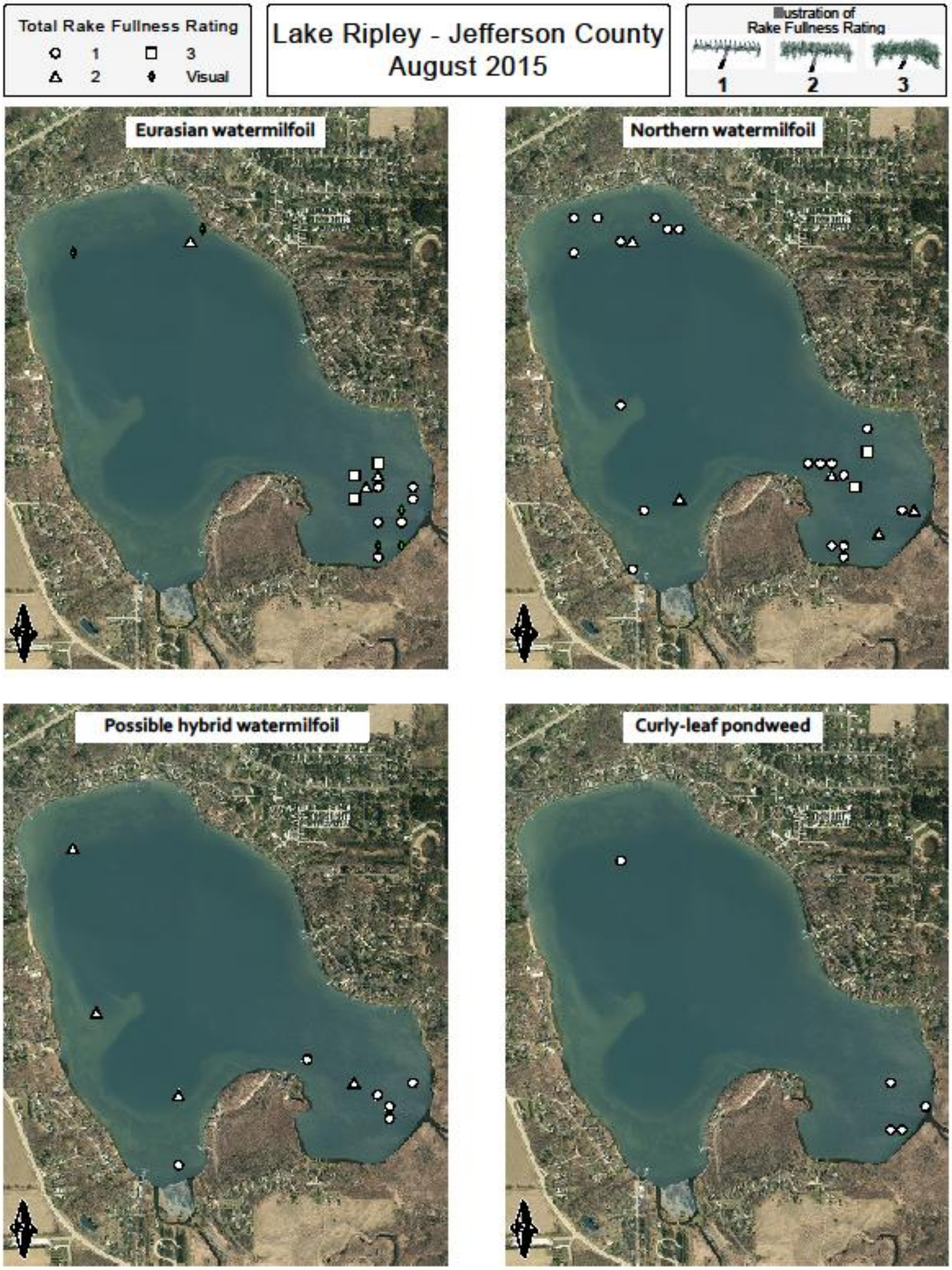

Figure 8: Rake Fullness Ratings for Watermilfoils and Curly-Leaf Pondweed

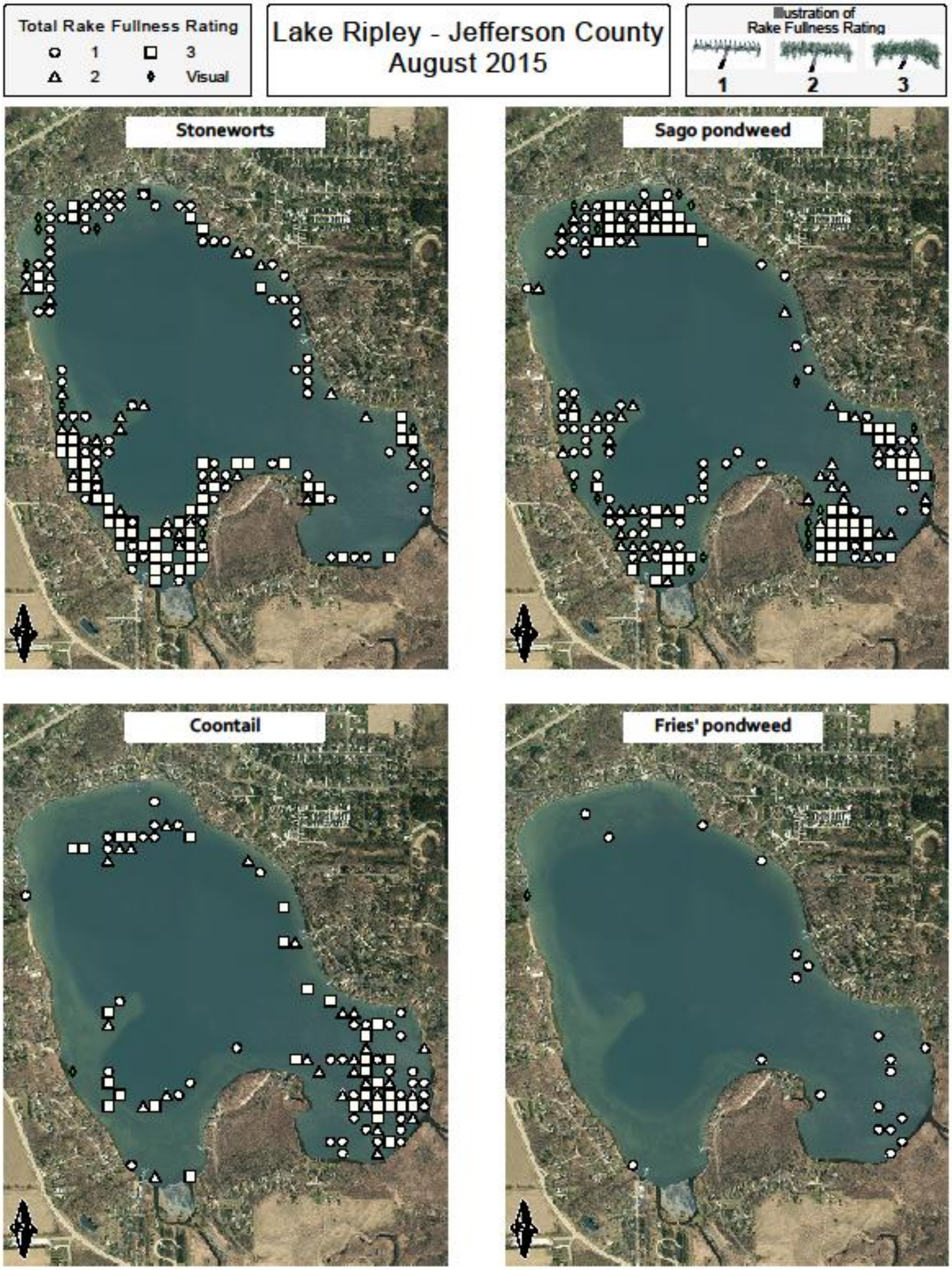

Figure 9: Rake Fullness Ratings for Stoneworts, Sago Pondweed, Coontail, and Fries' Pondweed

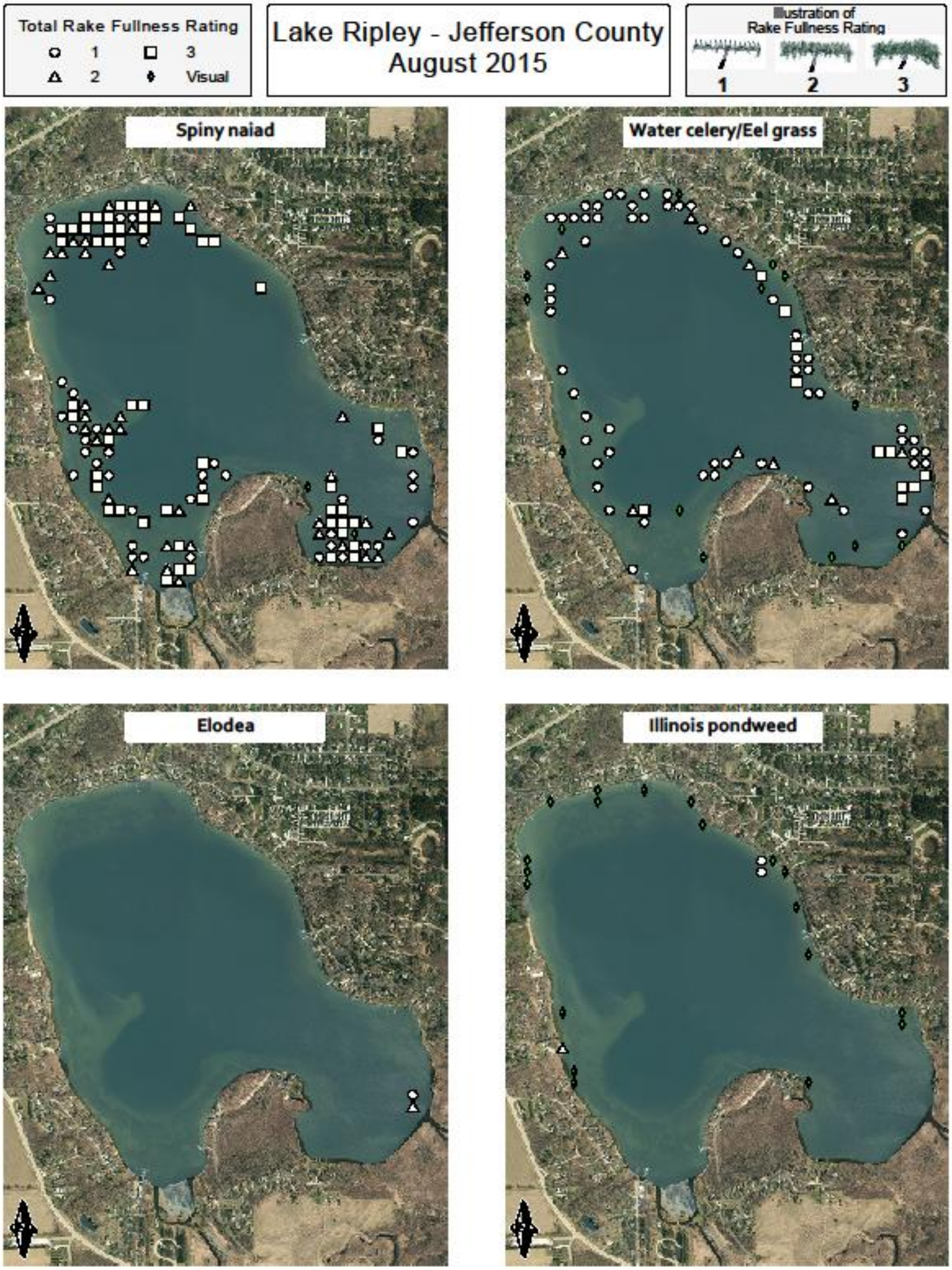

Figure 10: Rake Fullness Ratings for Spiny Naiad, Eel Grass, Elodea, and Illinois Pondweed

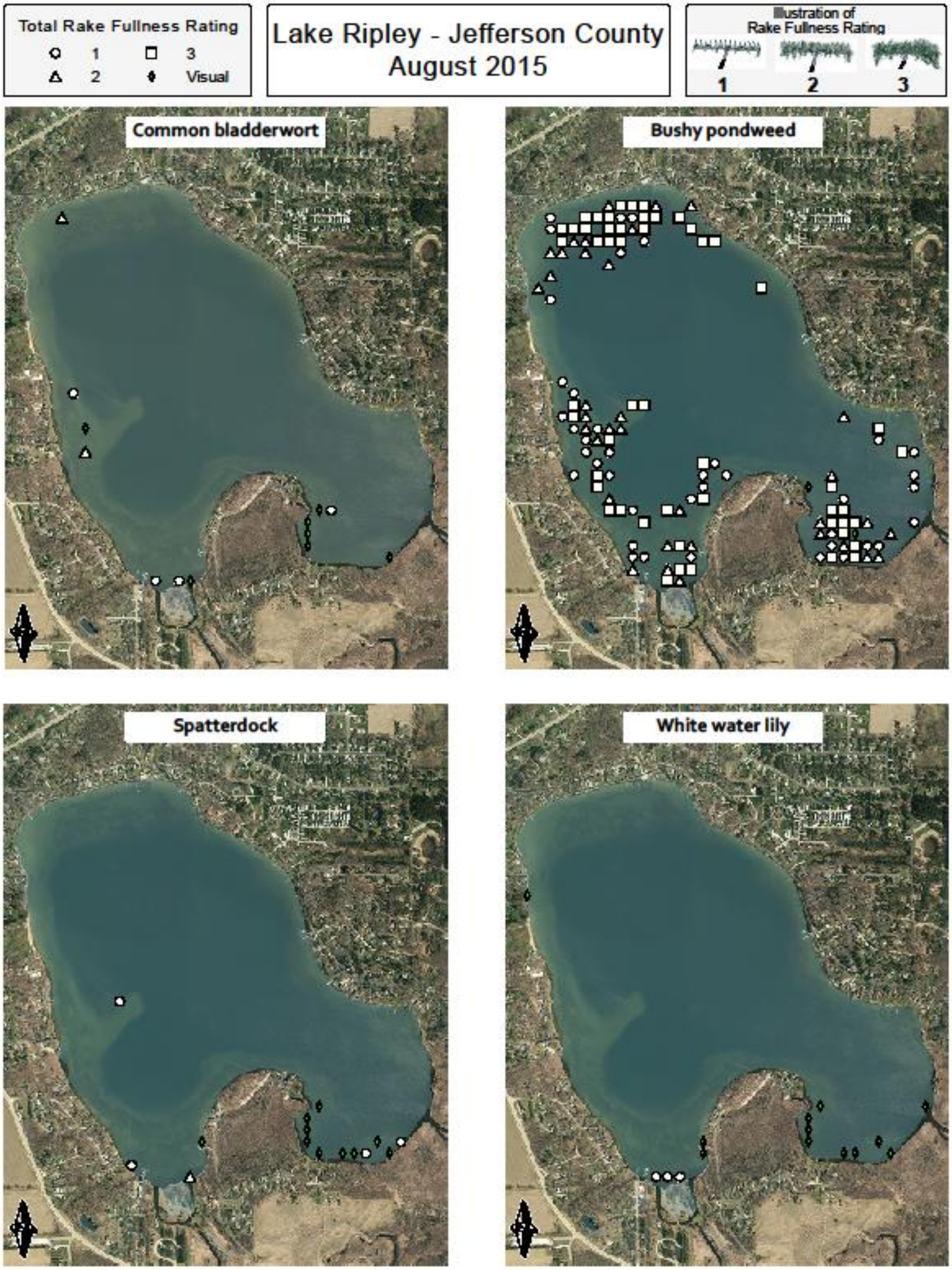

Figure 11: Rake Fullness Ratings for Common Bladderwort, Bushy Pondweed, Spatterdock, and White Water Lily

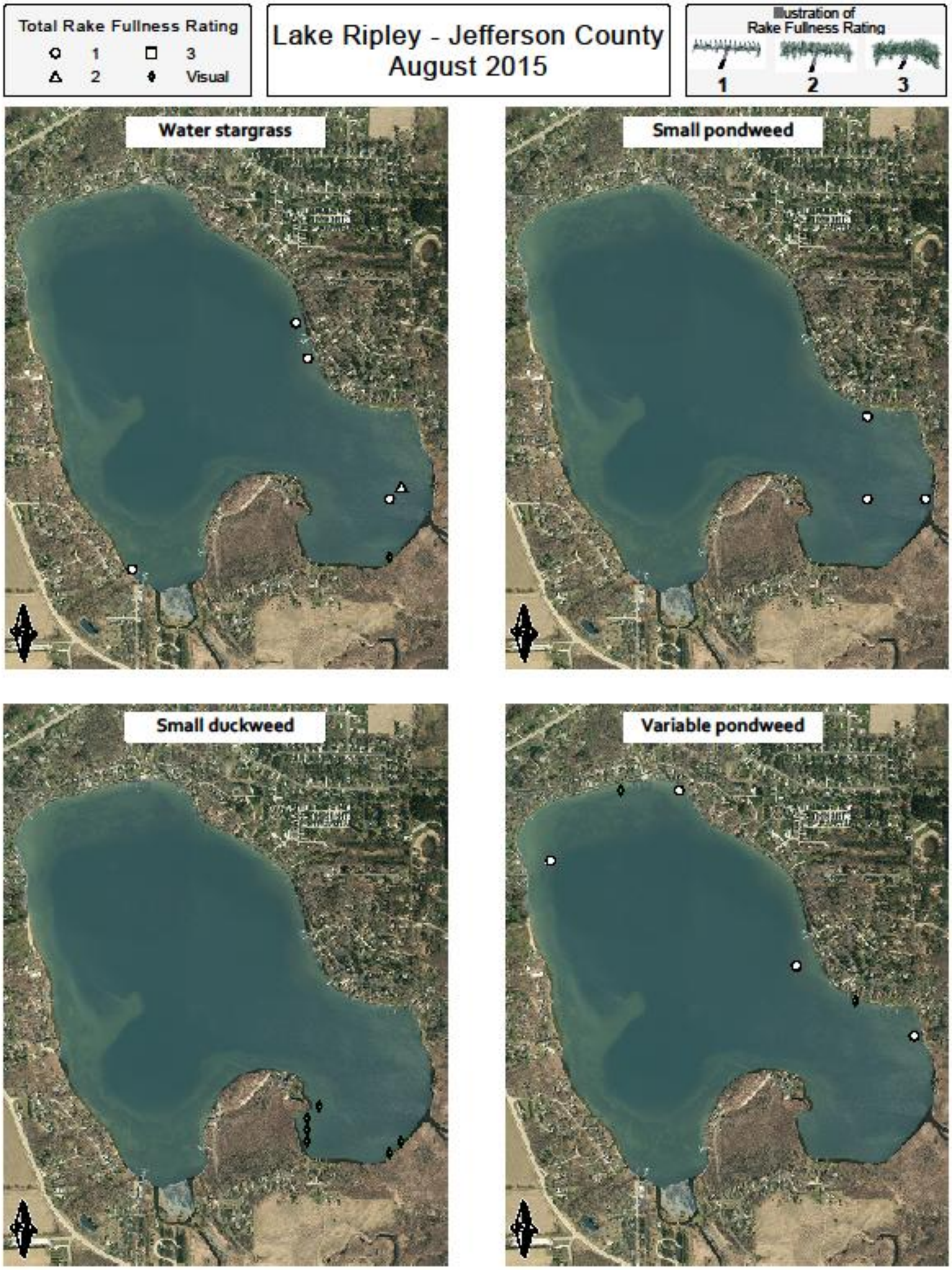

Figure 12: Rake Fullness Ratings for Water Stargrass, Small Pondweed, Small Duckweed, and Variable Pondweed

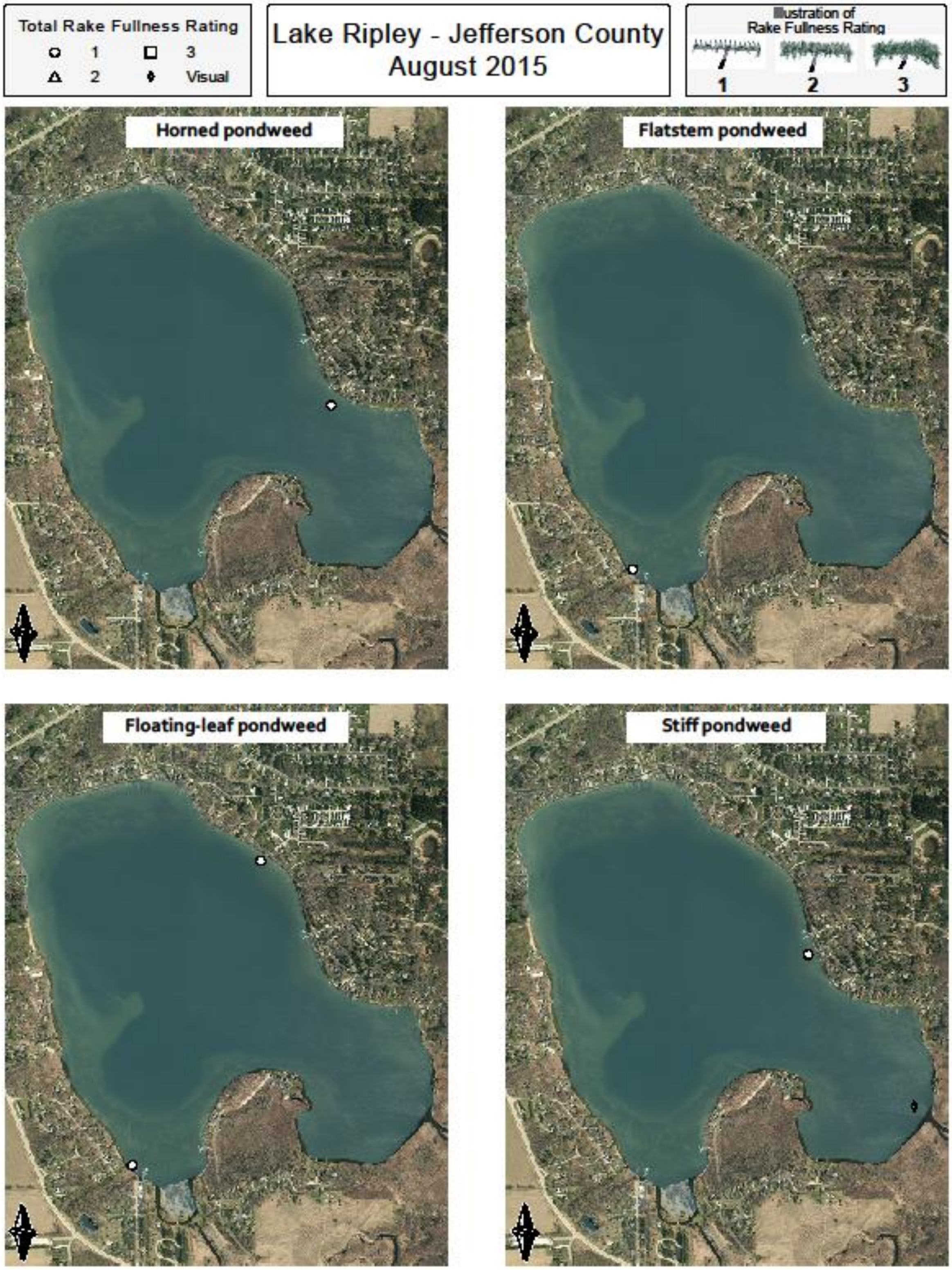

Figure 13: Rake Fullness Ratings for Horned Pondweed, Flatstem Pondweed, Floating Leaf Pondweed and Stiff Pondweed