Aquatic Macrophyte Survey

Rice Lake, Barron County Wisconsin

WBIC: 2103900

July, 2013

Sponsored by: Rice Lake Protection and Rehabilitation District
Wisconsin Department of Natural Resources

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Abstract

An early season point intercept survey was conducted in June 2013 on Rice Lake, Barron County Wisconsin. The survey found 153 sample points with curly leaf pondweed (Potamogeton crispus) present and 8 sample points with curly leaf pondweed viewed. The growing season full lake survey was conducted in late July 2013. There were 41 species sampled, 7 species viewed only and 3 species observed in a boat survey and a Simpson's diversity index of 0.89. The maximum depth of plants was 14.1 feet and a mean depth of plants of 4.68 ft. The littoral zone had 58.29% with plants sampled. The floristic quality index was calculated to be 38.59. In a comparison to a previous point intercept surveyconducted in2008, there was a difference in maximum depth of plants, percent of littoral zone with plants sampled. There was a significant difference in the frequency of occurrence in 10 plant species, which includes a reduction in curly leaf pondweed. The floristic quality index in 2008 and 2013 were nearly identical.

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Introduction

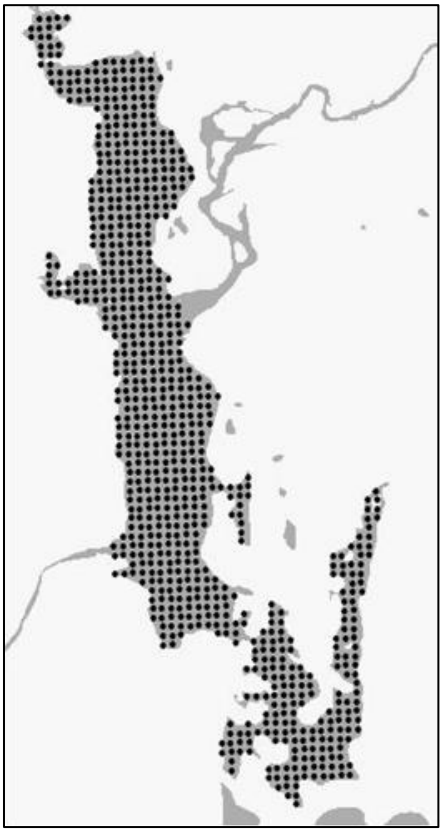
In June and late July 2013, a full lake aquatic macrophyte survey using the point intercept method was conducted on Rice Lake, Barron County Wisconsin (WBIC: 2103900). Rice Lake is 859 acres in size. Rice Lake is a drainage lake mostly resulting from the damming of the Red Cedar River. The trophic status of Rice Lake is recorded as eutrophic with the Wisconsin Department of Natural Resources. The five year average Carlson trophic status reading is 56.3 using secchi disk depths. In 2010, phosphorus and chlorophyll-*a* were measured and were also in the eutrophic range. The maximum depth is 19 ft with a mean depth of nine ft. The water clarity is fair, with a mean growing season secchi disk reading in 2013 of 4.17 ft. A full lake, point intercept survey was conducted in 2008 and will be the baseline that this survey is compared to.

Field Methods

A point intercept method was employed for the aquatic macrophyte sampling. The Wisconsin Department of Natural Resources (Wisconsin DNR) generated the sampling point grid of 843 sample points for Rice Lake. All points were initially sampled for depth only. Once the maximum depth of plants could be established, only sample points at that depth or less were sampled for plants. If no plants were sampled, one sample point beyond

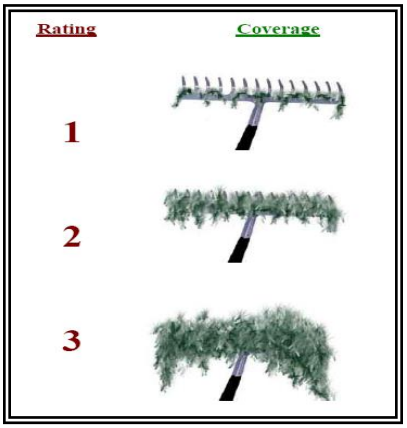
that was sampled for plants. In areas such as bays that appear to be under-sampled, a boat survey was conducted to record plants that may have otherwise been missed. This involved going to the area and surveying that area for plants, recording the species viewed and/or sampled. The type of habitat is also recorded. These data are not used in the statistical analysis nor is the density recorded. Only plants sampled at predetermined sampled points were used in the statistical analysis. In addition, any plant within six feet of the boat was recorded as "viewed." A handheld Global Positioning System (GPS) located the sampling points in the field. The Wisconsin DNR guidelines for point location accuracy were followed with an 80 ft resolution window and the location arrow touching the point.

Figure 1: Point intercept sample point grid as generated by the Wisconsin DNR.



At each sample location, a double-sided fourteen-tine rake was used to rake a 1m tow off the bow of the boat. All plants contained on the rake and those that fell off of rake were identified and rated as to rake fullness. The rake fullness value was used based on the criteria contained in the diagram and table below. Those plants that were within six feet were recorded as "viewed," but no rake fullness rating was given. Any under surveyed areas such as bays and/or areas with unique habitats were monitored. These areas are referred to as a "boat survey."

The rake density criteria used:



Rake fullness rating	Criteria for rake fullness rating
1	Plant present, occupies less than ½ of tine space
2	Plant present, occupies more than ½ tine space
3	Plant present, occupies all or more than tine space
v	Plant not sampled but observed within 6 feet of boat

The depth and predominant bottom type was also recorded for each sample point. Caution must be used in using the sediment type in deeper water as it is difficult to discern between muck and sand with a rope rake. All plants needing verification were bagged and cooled for later examination. Each species was mounted and pressed for a voucher collection and submitted to the Wisconsin DNR for review. On rare occasions a single plant may be needed for verification, not allowing it to be used as a voucher specimen and may be missing from the collection.

An early season, AIS (emphasis on *Potamogeton crispsus*-curly leaf pondweed) is completed to pick up any potential growth before native plants are robust. Curly leaf pondweed grows in the spring, only to senesce in early July before the survey is typically conducted.

Data analysis methods

Data collected was entered into a spreadsheet for analysis. The following statistics were generated from the spreadsheet:

- Frequency of occurrence in sample points with vegetation (littoral zone)
- Relative frequency
- Total points in sample grid
- Total points sampled
- Sample points with vegetation
- Simpson's diversity index
- Maximum plant depth
- Species richness
- Floristic Quality Index

An explanation of each of these data is provided below.

Frequency of occurrence for each species- Frequency is expressed as a percentage by dividing the number of sites the plant is sampled by the number of sites. There can be two values calculated for this. The first is the percentage of all sample points that this plant was sampled at depths less then maximum depth plants were found (littoral zone), regardless if vegetation was present. The second is the percentage of sample points that the plant was sampled at only points containing vegetation. The first value shows how often the plant would be encountered in the defined littoral zone (by depth), while the second value shows if considered where points contain plants. In either case, the greater this value, the more frequent the plant is in the lake. If one wants to compare how frequent in the littoral zone, we look at the frequency of all points below maximum depth with plants. This frequency value allows the analysis of how common plants are where they could grow based upon depth. If one wants to focus only where plants are actually present, then one would look at frequency at points in which plants were found. Frequency of occurrence is usually reported using sample points where vegetation was present.

Frequency of occurrence example:

Plant A sampled at 35 of 150 littoral points = 35/150 = 0.23 = 23%

Plant A's frequency of occurrence = 23% considering littoral zone depths.

Plant A sampled at 12 of 40 vegetated points = 12/40 = 0.3 = 30%

Plant A's frequency of occurrence = 30% in vegetated areas

Relative frequency-This value shows, as a percentage, the frequency of a particular plant relative to other plants. This is not dependent on the number of points sampled. The relative frequency of all plants will add to 100%. This means that if plant A had a relative frequency of 30%, it occurred 30% of the time compared to all plants sampled or makes up 30% of all plants sampled. This value allows us to see which of the plants the dominant species in the lake are. The higher the relative frequency the more common the plant is compared to the other plants and therefore the more frequent in the plant community.

Relative frequency example:

Suppose we were sampling 10 points in a very small lake and got the following results:

	Frequency sampled
Plant A present at 3 sites	3 of 10 sites
Plant B present at 5 sites	5 of 10 sites
Plant C present at 2 sites	2 of 10 sites
Plant D present at 6 sites	6 of 10 sites

So one can see that Plant D is the most frequent sampled at all points with 60% (6/10) of the sites having plant D. However, the relative frequency allows us to see what the frequency is compared the other plants, without taking into account the number of sites. It is calculated by dividing the number of times a plant is sampled by the total of all plants sampled. If we add all frequencies (3+5+2+6), we get a sum of 16. We can calculate the relative frequency by dividing by the individual frequency.

Total points in sample grid- The Wisconsin DNR establishes a sample point grid that covers the entire lake. Each GPS coordinate is given and used to locate the points.

Number of points sampled- This may not be the same as the total points in the sample grid. When doing a survey, we don't sample at depths outside of the littoral zone (the area where plants can grow). Once the maximum depth of plants is established, many of the points deeper than this are eliminated to save time and effort.

Sample sites with vegetation- The number of sites where plants were actually sampled. This gives a good idea of the plant coverage of the lake. If 10% of all sample points had vegetation, it implies about 10% coverage of plants in the whole lake, assuming an adequate number of sample points have been established. We also look at the number of sample sites with vegetation in the littoral zone. If 10% of the littoral zone had sample points with vegetation, then the plant coverage in the littoral zone would be estimated at 10%.

Simpson's diversity index-To measure how diverse the plant community is, Simpson's diversity index is calculated. This value can run from 0 to 1.0. The greater the value, the more diverse the plant community is in a particular lake. In theory, the value is the chance that two species sampled are different. An index of "1" means that the two will always be different (very diverse) and a "0" would indicate that they will never be different (only one species found). The higher the diversity in the native plant community, the healthier the lake ecosystem.

Simpson's diversity example:

If one sampled a lake and found just one plant, the Simpson's diversity would be "0." This is because if we randomly sampled two plants, there would be a 0% chance of them being different, since there is only one plant.

If every plant sampled were different, then the Simpson's diversity would be "1." This is because if two plants were randomly sampled, there would be a 100% chance they would be different since every plant is different.

Maximum depth of plants-This depth indicates the deepest that plants were sampled. Generally more clear lakes have a greater depth of plants while lower water clarity limits light penetration and reduces the depth at which plants are found.

Species richness-The number of different individual species found in the lake. There is a number for the species richness of plants sampled, and another number that takes into account plants viewed but not actually sampled during the survey.

Floristic Quality Index-The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. This index is a measure of the plant community in response to development (and human influence) on the lake. It takes into account the species of aquatic plants sampled and their tolerance for changing water quality and habitat quality. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A high conservatism value indicates that a plant is intolerant while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes, largely due to human influence (Nichols, 1999). The FQI is calculated using the number of species and the average conservatism value of all species used in the index.

The formula is: $\mathbf{FQI = Mean\ C \cdot \sqrt{N}}$

Where C is the conservatism value and N is the number of species (only species sampled on rake).

Therefore, a higher FQI indicates a healthier aquatic plant community, which is an indication of better plant habitat. This value can then be compared to the median for other lakes in the assigned eco-region. There are four eco-regions used throughout Wisconsin. These are Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. The 2006 and 2008 values from past aquatic plant surveys will also be compared in this analysis.

Summary of Northern Lakes and Forests-Flowages Median Values for Floristic Quality Index:

(Nichols, 1999)

Mean species richness = 23.5

Mean conservatism = 6.2

Mean Floristic Quality = 28.3*

*Floristic Quality has a correlation with area of lake (+), alkalinity(-), conductivity(-), pH(-) and Secchi depth (+). In a positive correlation, as that value rises so will FQI, while with a negative correlation, as a value rises, the FQI will decrease.

Results

The 2013 point intercept survey conducted in July 2013 resulted in a species richness of 41 plant species sampled, seven species viewed only and three more different species observed in a boat survey. Of the 41 species sampled, only one is an invasive species, curly-leaf pondweed (*Potamogeton crispus*). One of the species viewed only is non-native, but not generally regarded as invasive, aquatic for-get-me-not (*Myosotis scorpioides*).

Table 1: Summary of aquatic plant survey results.

Total number of sample points	843
Total number of sites with vegetation	342(362)*
Total number of sites shallower than maximum depth of plants	621
Frequency of occurrence at sites shallower than maximum depth of plants	58.29
Simpson Diversity Index	0.89
Maximum depth of plants (ft)	14.10
Mean depth of plants (ft)	4.68
Average number of all species per site (shallower than max depth)	1.71
Average number of all species per site (veg. sites only)	3.03
Average number of native species per site (shallower than max depth)	1.46
Average number of native species per site (veg. sites only)	2.88
Species Richness	41
Species Richness (including visuals)	47
Boat survey species	3

The maximum depth of plants was 14.1 feet, which is shows relatively deep light penetration considering low secchi readings in 2013. The only plant found this deep was curly-leaf pondweed, which was in June. Most plants were found in less than 10 feet during the July survey. The mean depth of plants was 4.68 feet. The coverage of plants is moderate with 58.59% of the sample sites shallower than 14.1 feet (maximum depth of plants) having plants sampled.

Figure 2: Map showing the littoral zone, as defined by plants sampled.

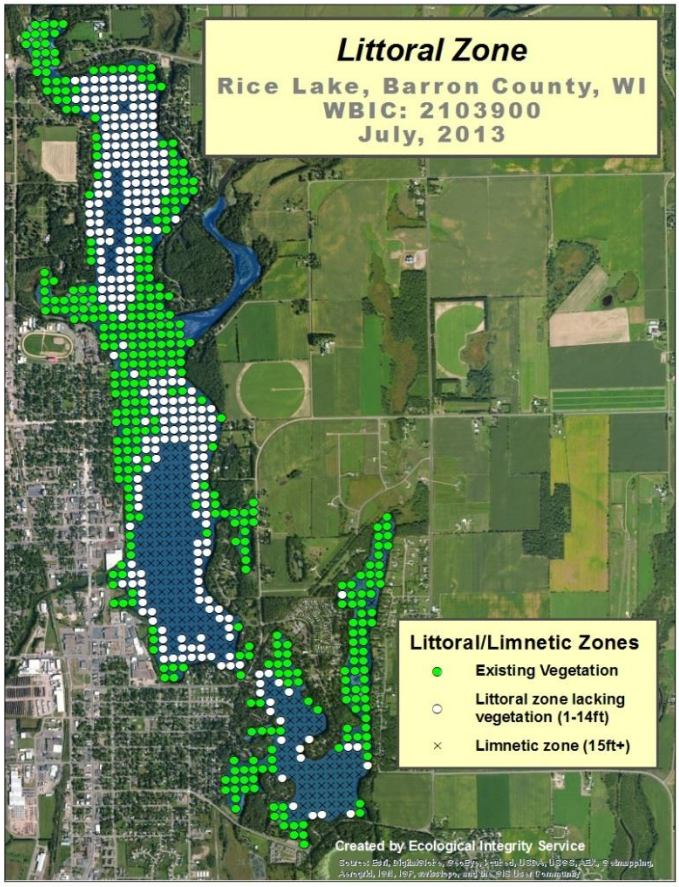


Figure 2 shows the littoral zone of Rice Lake as defined by plant growth. The white areas are areas that are less than 14.1 feet (maximum depth of plants) but no plants were sampled. The green areas are where plants were sampled or at least viewed. Figure 3 is a graph showing the depth distribution. As this graph shows, most points in the 3-4 foot depth have plants, and again at about 8 feet.

Figure 3: Graph showing the depth distribution of plant growth.

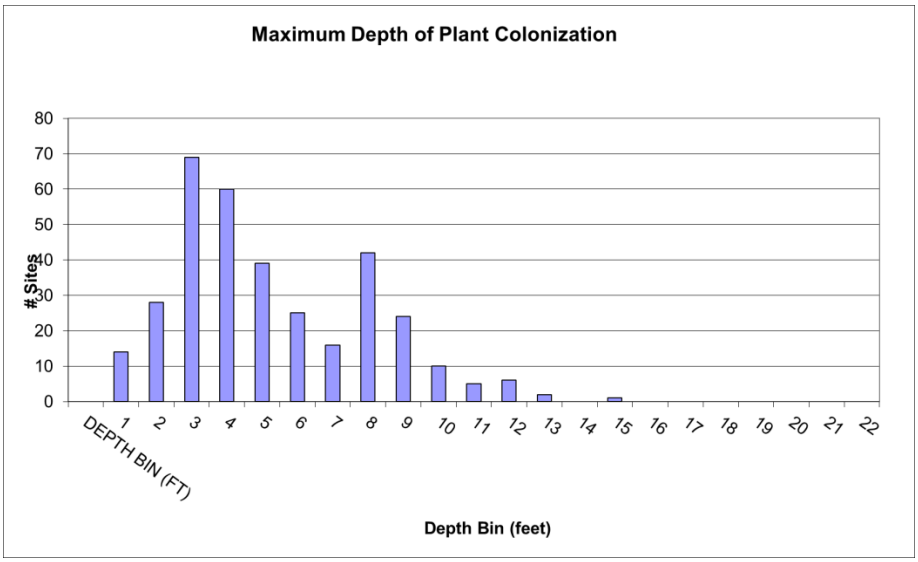
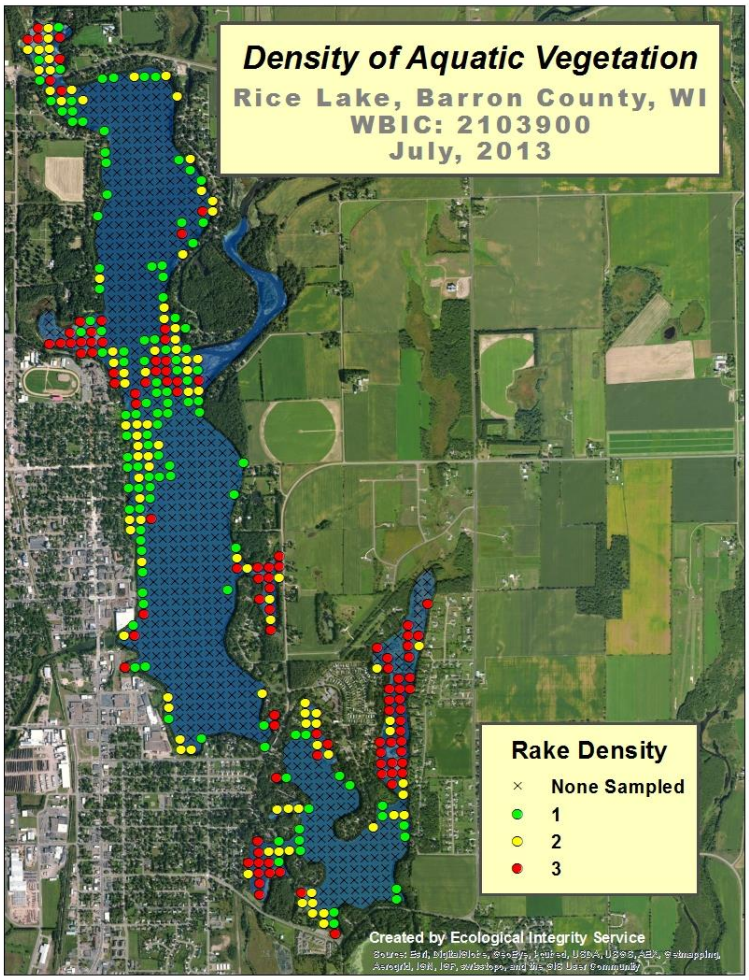


Figure 4: Map of the density rating at each sample point.



The Density of plant growth in Rice Lake varies greatly from area to area. The east most basin (the narrow basin the moves extends north from the southeast basin) has the most density with many "3's" present. The far northern portion of this basin doesn't have density registered since those points were non-navigable, so a density isn't known, but is likely high. The west bay near the old hospital also has extensive plant growth, followed by the north basin that lies north of Hwy 48.

The list of all species sampled with the frequency of occurrence and other sampled data listed after the species is in Table 2. Within these species, coontail dominates the plant community, with a relative frequency of 24.15. This relative frequency is quite high as nearly a quarter of all plants sampled were coontail.

Table 2: Species richness and the frequency statistic, mean density and number viewed.

Species	**Freq. Veg**	**Freq. Litt**	**Rel. Freq.**	**# Sampled**	**Mean Den.**	**# viewed**
Ceratophyllum demersum, Coontail	69.06	40.26	24.15	250	1.57	2
Potamogeton crispus,Curly-leaf pondweed	42.27	24.64	14.78	153	1.54	8
Potamogeton zosteriformis, Flat-stem pondweed	29.01	16.91	10.14	105	1.11	6
Elodea canadensis, Common waterweed	19.34	11.27	6.76	70	1.07	
Vallisneria americana, Wild celery	18.78	10.95	6.57	68	1.09	3
Myriophyllum sibiricum, Northern water-milfoil	12.43	7.25	4.35	45	1.00	4
Potamogeton richardsonii, Clasping-leaf pondweed	12.15	7.09	4.25	44	1.02	5
Nymphaea odorata, White water lily	11.88	6.92	4.15	43	1.09	14
Potamogeton robbinsii, Fern pondweed	10.50	6.12	3.67	38	1.18	5
Lemna minor, Small duckweed	6.91	4.03	2.42	25	1.00	
Lemna trisulca, Forked duckweed	6.08	3.54	2.13	22	1.00	
Najas flexilis, Slender naiad	5.52	3.22	1.93	20	1.05	
Wolffia columbiana, Common watermeal	5.25	3.06	1.84	19	1.00	
Potamogeton pusillus, Small pondweed	4.70	2.74	1.64	17	1.12	2
Spirodela polyrhiza, Large duckweed	4.14	2.42	1.45	15	1.00	
Nuphar variegata, Spatterdock	3.59	2.09	1.26	13	1.00	8
Stuckenia pectinata, Sago pondweed	3.04	1.77	1.06	11	1.00	1
Potamogeton foliosus, Leafy pondweed	2.21	1.29	0.77	8	1.00	
Elodea nuttallii, Slender waterweed	1.93	1.13	0.68	7	1.00	
Nitella sp., Nitella	1.93	1.13	0.68	7	1.29	
Potamogeton amplifolius, Large-leaf pondweed	1.93	1.13	0.68	7	1.00	2
Heteranthera dubia, Water star-grass	1.66	0.97	0.58	6	1.00	1
Brasenia schreberi, Watershield	1.10	0.64	0.39	4	1.00	
Sparganium eurycarpum, Common bur-reed	1.10	0.64	0.39	4	1.00	3
Hydrodictyon sp., Waternet	1.10	0.64	0.39	4	1.00	
Sagittaria rigida, Sessile-fruited arrowhead	0.83	0.48	0.29	3	1.00	2
Utricularia gibba, Creeping bladderwort	0.83	0.48	0.29	3	1.00	1

Species	Freq. Veg	Freq. Litt	Rel. Freq.	# Sampled	Mean Den.	# viewed
Utricularia vulgaris, Common bladderwort	0.83	0.48	0.29	3	1.00	
Bidens beckii , Water marigold	0.55	0.32	0.19	2	1.00	
Chara sp., Muskgrasses	0.55	0.32	0.19	2	1.00	
Pontederia cordata, Pickerelweed	0.55	0.32	0.19	2	1.50	1
Potamogeton friesii, Fries' pondweed	0.55	0.32	0.19	2	1.00	1
Carex comosa, Bottle brush sedge	0.28	0.16	0.10	1	1.00	
Eleocharis palustris, Creeping spikerush	0.28	0.16	0.10	1	1.00	
Najas gracillima, Northern naiad	0.28	0.16	0.10	1	1.00	
Potamogeton natans, Floating leaf pondweed	0.28	0.16	0.10	1	1.00	
Potamogeton praelongus, White-stem pondweed	0.28	0.16	0.10	1	1.00	2
Ranunculus aquatilis, White water crowfoot	0.28	0.16	0.10	1	3.00	
Typha angustifolia, Narrow-leaved cattail	0.28	0.16	0.10	1	3.00	1
Utricularia intermedia, Flat-leaf bladderwort	0.28	0.16	0.10	1	1.00	
Zizania palustris, Northern wild rice	0.28	0.16	0.10	1	1.00	
Aquatic moss	0.28	0.16	n/a	1	1.00	
Freshwater sponge	0.28	0.16	n/a	1	1.00	
Filamentous algae	14.36	8.37	n/a	52	1.10	
Asclepias incarnata, Swamp milkweed						1
Juncus effusus-Soft rush						1
Sagittaria latifolia, Common arrowhead						1
Sagittaria sp., Arrowhead rosette						1
Schoenoplectus acutus, Hardstem bulrush						1
Schoenoplectus tabernaemontani, Softstem bulrush						1
Typha latifolia, Broad-leaved cattail						1

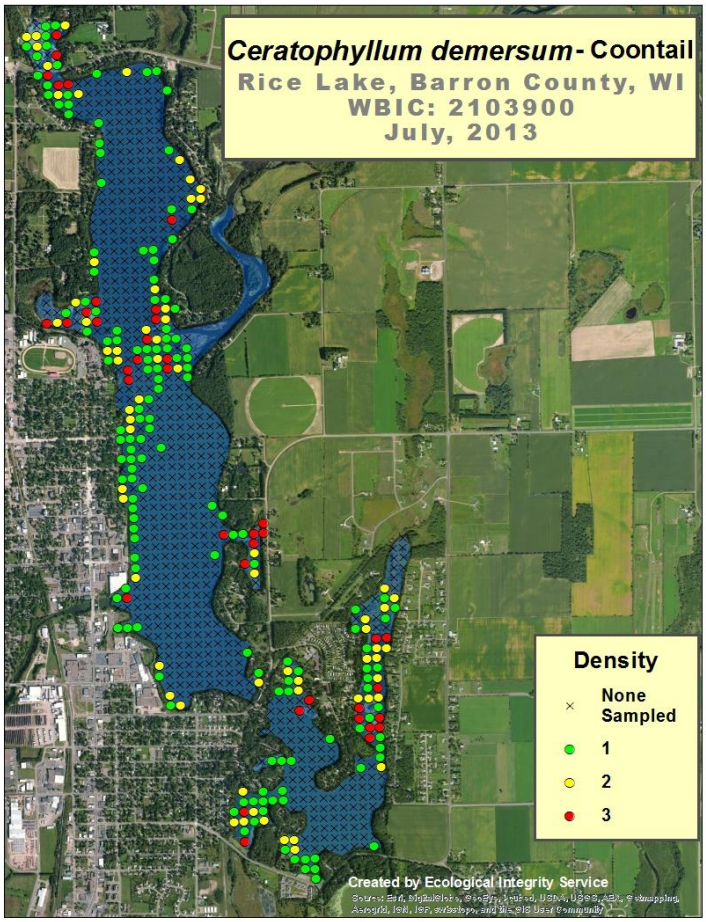
In addition to sampling plants at all sample points that are less than the maximum depth of plants, areas such as bays and other under-sampled areas were surveyed for different plants. Table 3 shows the species observed from the boat survey.

Table 3: List of species observed from boat survey (different from species sampled or viewed).

Boat survey species observed	Nearest sample pt
Dulichium arundinaceum, 3-way sedge	839
Decodon verticillatus, Swamp Loosestrife	648
Comarum palustre, Marsh cinquifoil	660
*Myosotis scorpioides,*Aquatic for-get-me-not	34

The most frequent species sampled in 2013 was *Certophyllum demersum*-coontail. Coontail is a common native plant found in Wisconsin lakes. Coontail can dominate high nutrient lakes as it has an tendency to absorb large amounts of nutrients from the water column. The plant provide good habitat for fish and invertebrates.

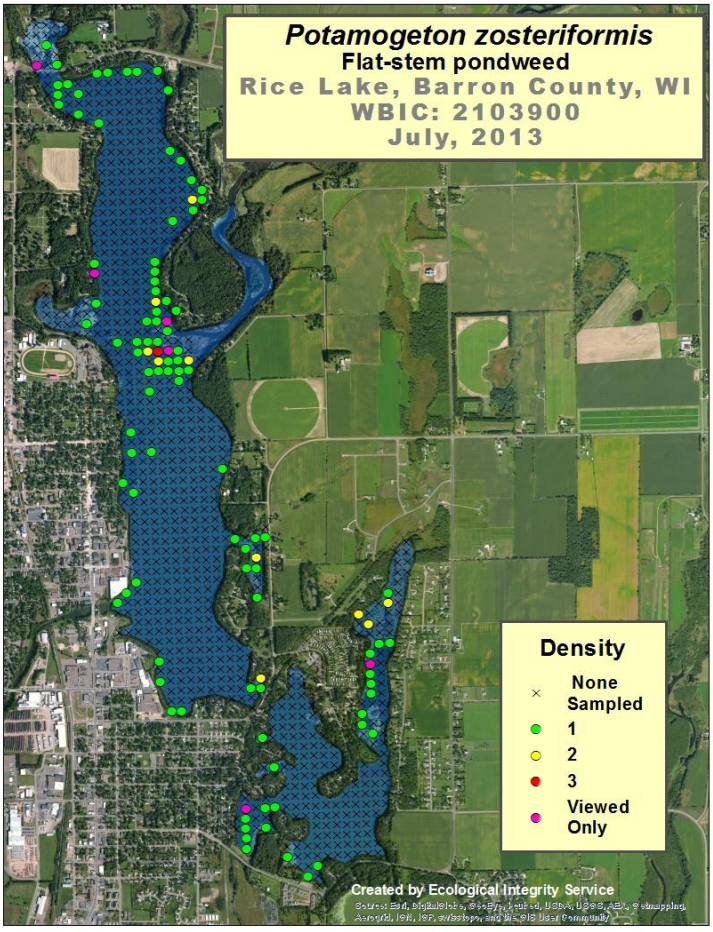
Figure 5: Distribution map of coontail, highest relative frequency plant.



The second most frequent species sampled was *Potamogeton crispus* (during the early season June survey). Curly leaf pondweed is an invasive species common to Wisconsin Lakes. It grows in cold water and typically senesces by early to mid-July. As a result, this plant was sampled at most points in June. See the invasive species section later in this document or Appendix A for the curly leaf pondweed distribution map.

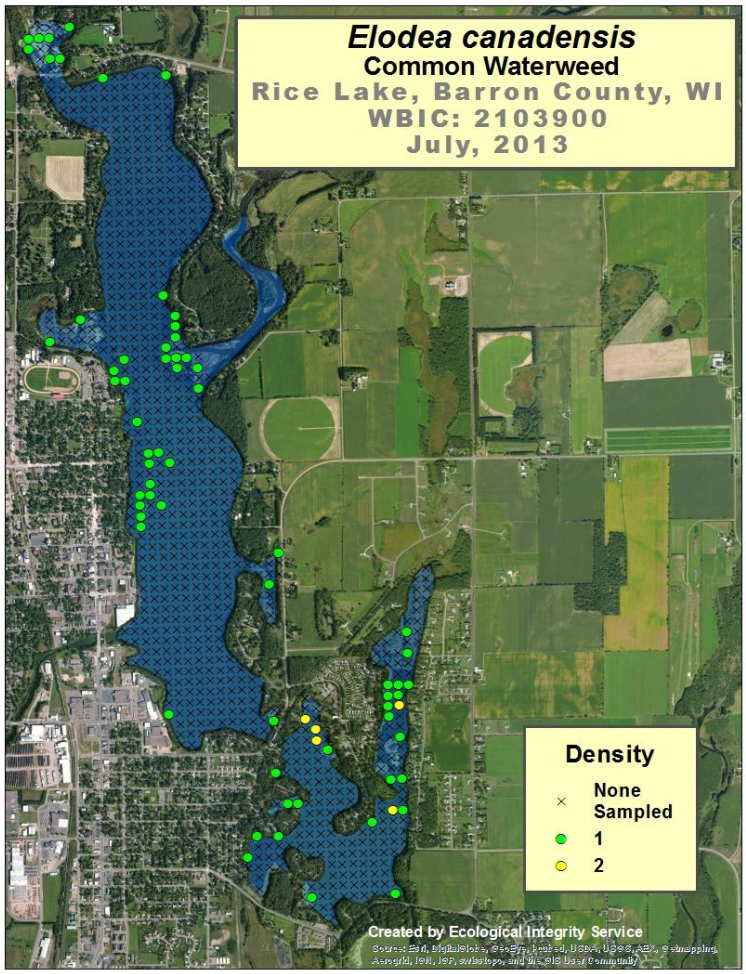
The second most frequent native plant sampled was flat-stem pondweed (*Potamogeton zosteriformis*). This plant is a common aquatic plant in Wisconsin lakes. Flat-stem pondweed provides cover for fish and invertebrates. A variety of waterfowl are provided an important food source by this plant.

Figure 6: Distribution map of flat-stem pondweed, second highest relative frequency.



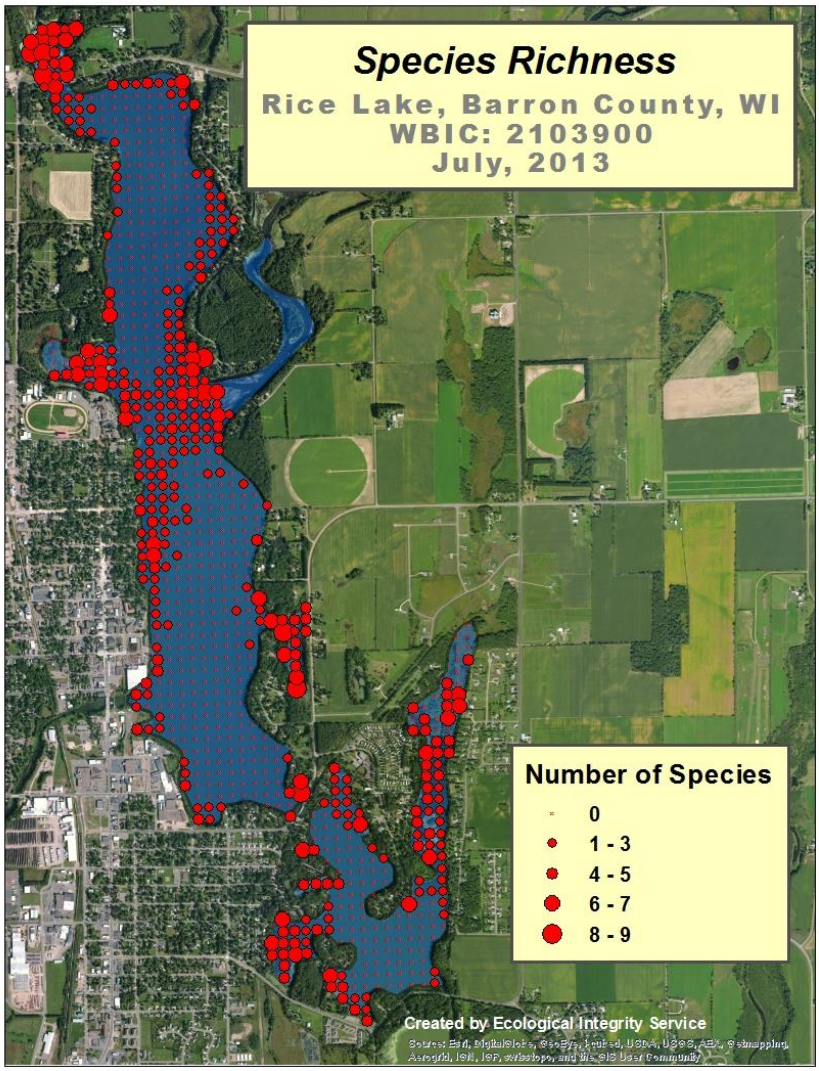
The third most common native aquatic plant present was common waterweed (*Elodea canandensis*). This plant is a very common Wisconsin lake plant that can grow in scattered plants to large, dense clumps. As long as not too dense, common waterweed provides valuable cover and grazing opportunities for fish. Numerous invertebrates use common waterweed for habitat.

Figure 7: Distribution map of common waterweed, third highest relative frequency.



The diversity of aquatic plants varied greatly from one sample point to another. The very north end of Rice Lake, as well as bay by the Red Cedar River inlet and the secluded bay on the east side had the most diversity per sample point. Figure 8 shows the species richness at each sample point.

Figure 8: Map depicting species richness at each sample point.



Floristic quality index

When a plant survey is conducted in Wisconsin, a floristic quality index (FQI) is calculated. This calculation will reflect the health of the plant community based upon habitat and possible habitat changes related to human activities. As human development occurs on lakes, the FQI tends to decrease. The FQI compares the typical plant community in the lake prior to human influences. Table 4 shows the FQI values used for Rice Lake.

Table 4: Floristic quality data

FQI Value	Rice Lake-2013	Median Eco-region
Number of species	39	23.5
mean conservatism	6.2	6.2
FQI	**38.59**	**28.3**

A comparison of the FQI of Rice Lake to the median values for other lakes within the eco-region shows the number of species higher and the mean conservatism the same. This results in a much higher FQI for Rice Lake than the median for the eco-region.

Table 5 lists the species used for the FQI and the conservatism value for each. Only plants sampled on at the rake are used in the FQI.

Table 5: Species list used in floristic quality index.

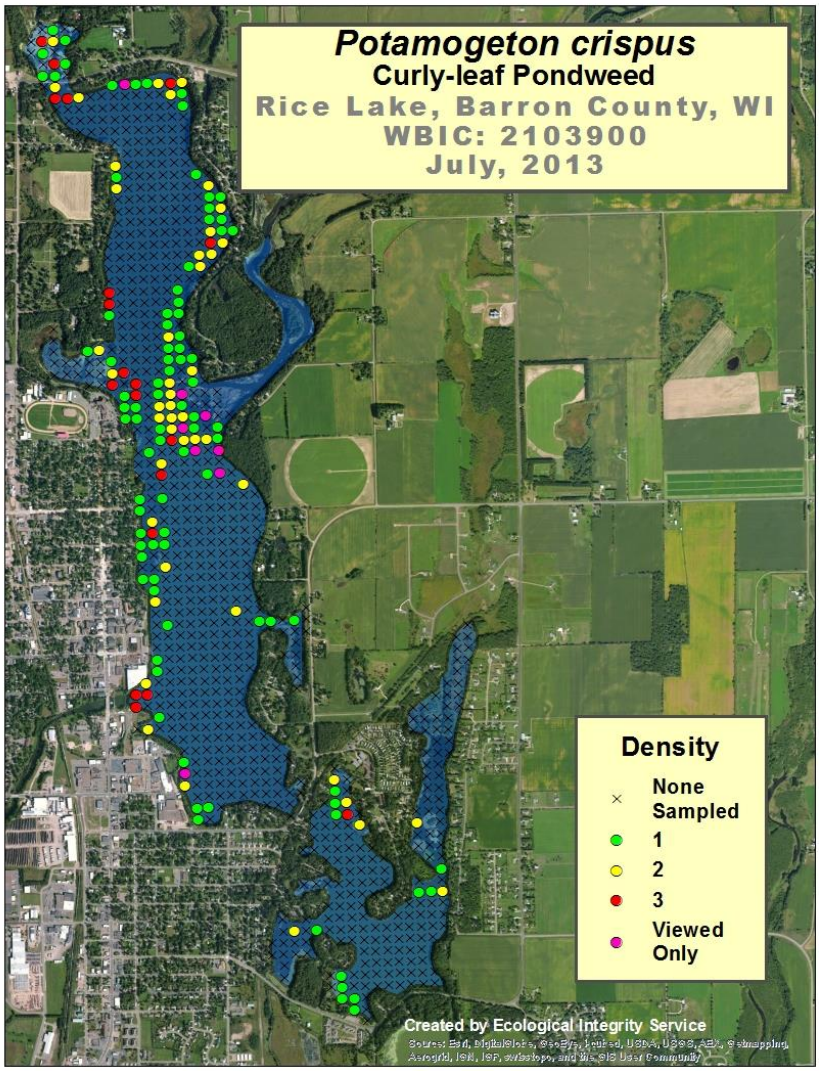
FQI Species	Common name	Conservatism
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara	Muskgrasses	7
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Elodea nuttallii	Slender waterweed	7
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	4
Lemna trisulca	Forked duckweed	6
Myriophyllum sibiricum	Northern water-milfoil	6
Najas flexilis	Slender naiad	6
Najas gracillima	Northern naiad	7
Nitella	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	8

FQI Species	Common name	Conservatism
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton foliosus	Leafy pondweed	6
Potamogeton friesii	Fries' pondweed	8
Potamogeton natans	Floating leaf pondweed	5
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	White water crowfoot	8
Sagittaria rigida	Sessile-fruited arrowhead	8
Sparganium eurycarpum	Common bur-reed	5
Spirodela polyrhiza	Large duckweed	5
Stuckenia pectinata	Sago pondweed	3
Typha angustifolium	Narrow-leaved cattail	1
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
Zizania palustris	Northern wild rice	8

Invasive species

One invasive species was found to be present in Rice Lake, curly-leaf pondweed (CLP)-*Potamogeton crispus*. This plant was widespread in a previous survey (2008) and those comparisons are made later in this document. A point intercept survey was conducted in early June for CLP. This early season survey revealed CLP present in 153 sample points and viewed at 8 locations. The density ranged from 1-3, with 16 points rated a "3", 44 sample points as a "2" and the remaining points either "1" or viewed only.

Figure 9: Distribution map of curly-leaf pondweed, from early season survey.



Comparison of 2008 and 2013 Surveys

There were a number of similarities and difference in the statistics from the 2008 and the 2013 surveys. The exact sample locations used in 2008, were used in 2013. It must be noted that due to GPS location error, sample locations can vary by several feet. The data comparisons are shown in Table 6.

The surveys showed the same or similar values with Simpson's diversity index and species richness. This shows that the plant diversity is basically the same in both surveys.

One difference is the maximum depth of plants. In 2008 this depth was 16.2 feet and in 2013, it was 2+ feet shallower at 14.1 feet. The reason for this is not known. The secchi readings in 2008 averaged XX and in 2013 average 4.1 ft. Since the maximum depth of plants in 2013 is less, the number of sites within the littoral zone was less. So even though there were less sites with vegetation in 2013 (342 vs 368), the frequency of occurrence with in the littoral zone was higher in 2013.

Table 6: Comparison of 2008 and 2013 survey data.

Statistics	2013	2008
Total number of sample points	843	843
Total number of sites with vegetation	342	368
Total number of sites shallower than maximum depth of plants	621	658
Frequency of occurrence at sites shallower than maximum depth of plants	58.29	55.93
Simpson Diversity Index	0.89	0.89
Maximum depth of plants (ft)	14.10	16.20
Average number of all species per site (shallower than max depth)	1.71	1.97
Average number of all species per site (veg. sites only)	3.03	3.52
Average number of native species per site (shallower than max depth)	1.46	1.81
Average number of native species per site (veg. sites only)	2.88	3.42
Species Richness (only sampled on rake)	41	41

The difference in the number of sites with vegetation was not the only big difference found. There were 10 species of plants with a significant frequency change. Coontail, the most common plant in both 2008 and 2013, showed a very significant reduction in frequency comparing 2008 to 2013 (according to a chi-square analysis). This plant was sampled at 317 sites in 2008 and only 153 sites in 2013. See Table 7 for all frequency and chi-square data.

Another native plant that showed a significantly lower frequency was common waterweed. This plant was sampled at 165 sites in 2008 and at only 70 sites in 2013. Other native plants with lower frequencies (that were statistically significant) include: fern pondweed, forked duckweed, small pondweed, water stargrass, and Fries' pondweed.

The cause of these lower frequencies is not known. There have been some plant management practices going on in Rice Lake over the past 5 years. However, it is unknown if these could be impacting these plants. Also, the growing season for lake plants was very short in 2013 with a very late ice-out date in lakes. This could be a factor.

There were also two plant species with higher frequencies in 2013 as compared to 2008. These native species include: white water lily and common watermeal. White water lily more than doubled from 20 to 43 sites.

Another difference that is important to note is the change in curly-leaf pondweed. Although an early season point intercept was not conducted for CLP in 2008, the plant beds were mapped. By overlaying these beds and the sample points, it is estimated that there would be a minimum of 235 sample points with CLP in 2008. An early season point intercept survey was conducted for CLP in 2013 and had only 153 sample points with CLP. This shows a significant reduction. There have been management practices in place for the reduction of CLP the last five years. It may be apparent that this management is reducing the CLP.

Table 7: Chi-square analysis summary comparing 2008 and 2013 species frequencies.

Species	***2008***	***2013***	***P value from chi-square***	***Significant change***	***Change***
Ceratophyllum demersum, Coontail	317	250	0.00001	***	**-**
Potamogeton zosteriformis, Flat-stem pondweed	135	105	0.092	**n.s.**	**-**
Elodea canadensis, Common waterweed	165	70	0.00	***	**-**
Vallisneria americana, Wild celery	74	68	0.94	**n.s.**	**-**
Potamogeton richardsonii, Clasping-leaf pondweed	32	44	0.07	**n.s.**	**+**
Nymphaea odorata, White water lily	20	43	0.00083	***	**+**
Myriophyllum sibiricum, Northern water-milfoil	61	45	0.20	**n.s.**	**-**
Potamogeton robbinsii, Fern pondweed	68	38	0.005	**	**-**
Lemna minor, Small duckweed	25	25	0.79	**n.s.**	**+**
Lemna trisulca, Forked duckweed	79	22	0.00	***	**-**
Najas flexilis, Slender naiad	12	20	0.096	**n.s.**	**+**
Wolffia columbiana, Common watermeal	9	19	0.033	*	**+**
Potamogeton pusillus, Small pondweed	54	17	0.00002	***	**-**
Potamogeton crispus,Curly-leaf pondweed	235(est.)	153	0.00	***	**-**

Species	***2008***	***2013***	***P value from chi-square***	***Significant change***	***Change***
Spirodela polyrhiza, Large duckweed	11	15	0.32	**n.s.**	**+**
Nuphar variegata, Spatterdock	15	13	0.85	**n.s.**	**-**
Stuckenia pectinata, Sago pondweed	7	11	0.26	**n.s.**	**+**
Potamogeton foliosus, Leafy pondweed	11	8	0.59	**n.s.**	**-**
Elodea nuttallii, Slender waterweed	2	7	0.07	**n.s.**	**+**
Nitella sp., Nitella	10	7	0.56	**n.s.**	**-**
Potamogeton amplifolius, Large-leaf pondweed	15	7	0.12	**n.s.**	**-**
Heteranthera dubia, Water star-grass	17	6	0.03	*	**-**
Brasenia schreberi, Watershield	2	4	0.3647	**n.s.**	**+**
Sparganium eurycarpum, Common bur-reed	1	4	0.15	**n.s.**	**+**
Water net	6	4	0.60	**n.s.**	**-**
**Sagittaria rigida*, Sessile-fruited arrowhead	2	3	0.60	**n.s.**	**+**
Utricularia gibba, Creeping bladderwort	1	3	0.28	**n.s.**	**+**
Utricularia vulgaris, Common bladderwort	4	3	0.78	**n.s.**	**-**
Bidens beckii, Water marigold	8	2	0.07	**n.s.**	**-**
Chara sp., Muskgrasses	6	2	0.18	**n.s.**	**-**
Pontederia cordata, Pickerelweed	0	2	0.14	**n.s.**	**+**
Potamogeton friesii, Fries' pondweed	11	2	0.02	*	**-**
Eleocharis palustris, Creeping spikerush	0	1	0.30	**n.s.**	**+**
Najas gracillima, Northern naiad	1	1	0.96	**n.s.**	**+**
Potamogeton praelongus, White-stem pondweed	4	1	0.21	**n.s.**	**-**
Ranunculus aquatilis, White water crowfoot	2	1	0.61	**n.s.**	**-**
Typha angustifolia, Narrow-leaved cattail	2	1	0.61	**n.s.**	**-**
Utricularia intermedia, Flat-leaf bladderwort	0	1	0.30	**n.s.**	**+**
Zizania palustris, Northern wild rice	0	1	0.30	**n.s.**	**+**
Potamogeton natans, Floating leaf pondweed	1	0	0.33	**n.s.**	**-**
Potamogeton epihydrous, Ribbon leaf pondweed	2	0	0.17	**n.s.**	**-**
Schoenoplectus acutus, Hardstem bulrush	1	0	0.33	**n.s.**	**-**

A comparison of the floristic quality index is summarized in Table 8. As the data shows, there is virtually no difference in the FQI values obtained in 2008 and 2013. Although there were some significant changes in the frequencies of some plants between 2008 and 2013, the FQI does not reflect any significant differences in the quality of the plant community.

Table 8: Floristic quality index comparison, 2008 and 2013.

FQI Comparison	Number of species	Mean conservatism	FQI
2008*	38	6.2	38.21
2013	39	6.2	38.59

*Note: The FQI for Rice Lake was adjusted for the protocol used at this time. In 2008 all plants viewed were also included.

Discussion

The 2013 full lake macrophyte survey on Rice Lake shows a very diverse and robust plant community. The coverage of plants in the lake varies greatly. There are some areas in the lake (main, central basin) where the plant coverage is limited. In some bays, the plants are so dense that navigation is very difficult. Figure 10 shows two locations that reflect this density.

Figure 10: Two areas showing high density of plants. The left is the north east basin and the right photo is the bay near the old hospital.

When comparing the 2013 survey to a previous survey from 2008, several differences were evident. Amongst these were significant changes in the frequencies of various plants. Most of the differences were reduced frequencies from 2008 to 2013. The cause of these reductions is unknown. It could be related to management, largely harvesting of plants, which occurs extensive on Rice Lake. It could also be due to natural variation. The Wisconsin DNR started implementing the point intercept method less than 10 years ago and therefore there is limited data available where two subsequent point intercept surveys

are compared. As more data is gathered, natural fluctuations in plant coverage will be better reflected.

One positive reduction is the difference in CLP coverage. It was very evident that the CLP is less than in 2008 and this is reflected by the data.

One other interesting difference was the observation of a few wild rice plants. In the 2008 survey, no wild rice was sampled, viewed or observed in a boat survey. In 2013, a few rice plants were viewed near the Red Cedar River inlet. Figure 11 shows two pictures of single wild rice plants. These pictures depict on the presence was limited to some single plants that didn't look very robust and had been fed upon. It does show that rice has been present on Rice Lake.

Figure 11: Wild rice plants observed near the Red Cedar River inlet.

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