Aquatic Macrophyte Point-Intercept Survey

Cranberry Lake

Douglas County, Wisconsin

WBIC: 2693100

July/August 2019

Survey sponsored by: Cranberry Lake Association and Wisconsin DNR

Survey completed by: Ecological Integrity Service, LLC

Amery, Wisconsin

Abstract

A full lake aquatic macrophyte survey using a point intercept method in late July/early August 2019 on Cranberry Lake, Douglas County Wisconsin. The survey resulted in a species richness of 32 species sampled and 33 species if included viewed only species. One species of the 33 is a non-native, invasive species in Wisconsin *Myriophyllum spicatum*. The most frequent species was *Potamogeton robbinsii*. The Simpson's diversity index was 0.88. Within the littoral zone, plants were sampled at 77.55% of the sample locations with the maximum depth of plants 16.7%. The mean conservatism value for plants sampled was 6.7 with a floristic quality index of 36.7. There was one species of special concern sampled, *Potamogeton vaseyi*. In comparing to a previous survey from 2007, a chi-square analysis resulted in a statistically significant reduction in frequency of occurrence in 11 native species. There was a statistically significant increase in frequency of occurrence in three native species and the invasive species *Myriophyllum spicatum*. There were no major changes in any other parameters determined in survey.

Introduction

In August 2019, an aquatic macrophyte survey was conducted on Cranberry Lake (WBIC: 2693100), in Douglas County Wisconsin (T42N R13W S33 NE SW) using the point intercept method developed by the Wisconsin Department of Natural Resources. Lake Nancy is a 169-acre lake with a maximum depth of 19 feet and a mean depth of 11 feet. The lake is designated as a drainage lake and has a mesotrophic trophic status. Development around the lakes is moderate to high with much of the lakeshore developed and/or disturbed from an original native riparian zone.

This report presents a summary and analysis of data collected in 2019 and allows for the comparison to the 2007 baseline aquatic macrophyte survey. The primary goal of the survey is to conduct long-term monitoring of aquatic plant populations and allow for the evaluation of any changes that may potentially occur from human impact. In addition, invasive species presence and locations are key components to a survey of this type. This survey is acceptable for aquatic plant management purposes.

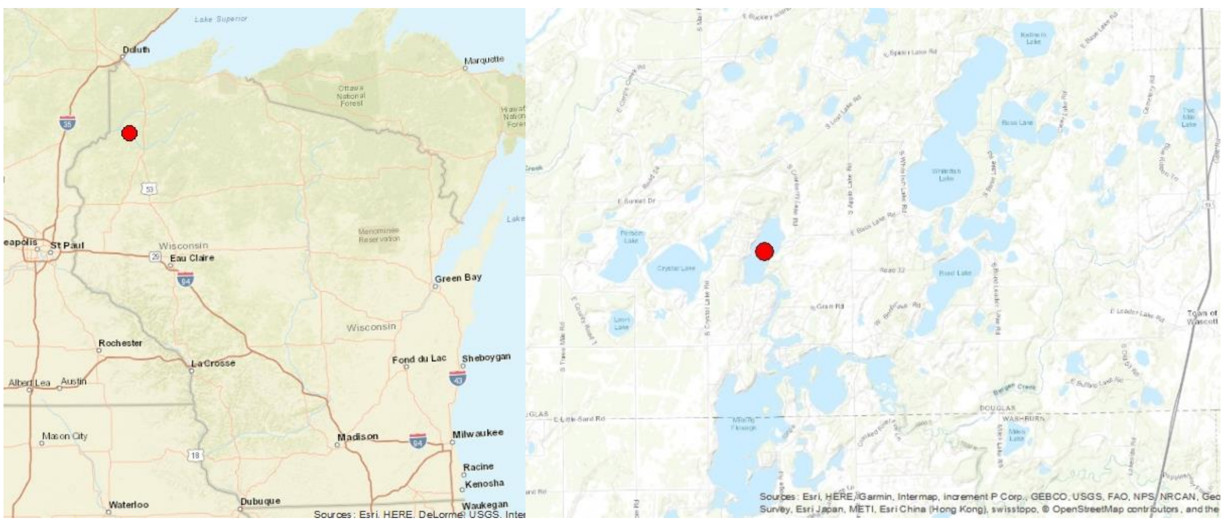


Figure 1: Map of Cranberry Lake location in Wisconsin and closer surrounding area.

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 grids for each lake. All points were initially sampled for depth only. Once the maximum depth of plant growth was established, only points at that depth (or less) were sampled. If no plants were sampled, one point beyond that was sampled. In areas such as bays that appear to be under-sampled, a boat or shoreline survey was conducted to record plants that may have otherwise been missed. This involved surveying that area for plants and 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 points were used in the statistical analysis. In addition, any plant within 6 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 50-foot resolution window and the location arrow touching the point.

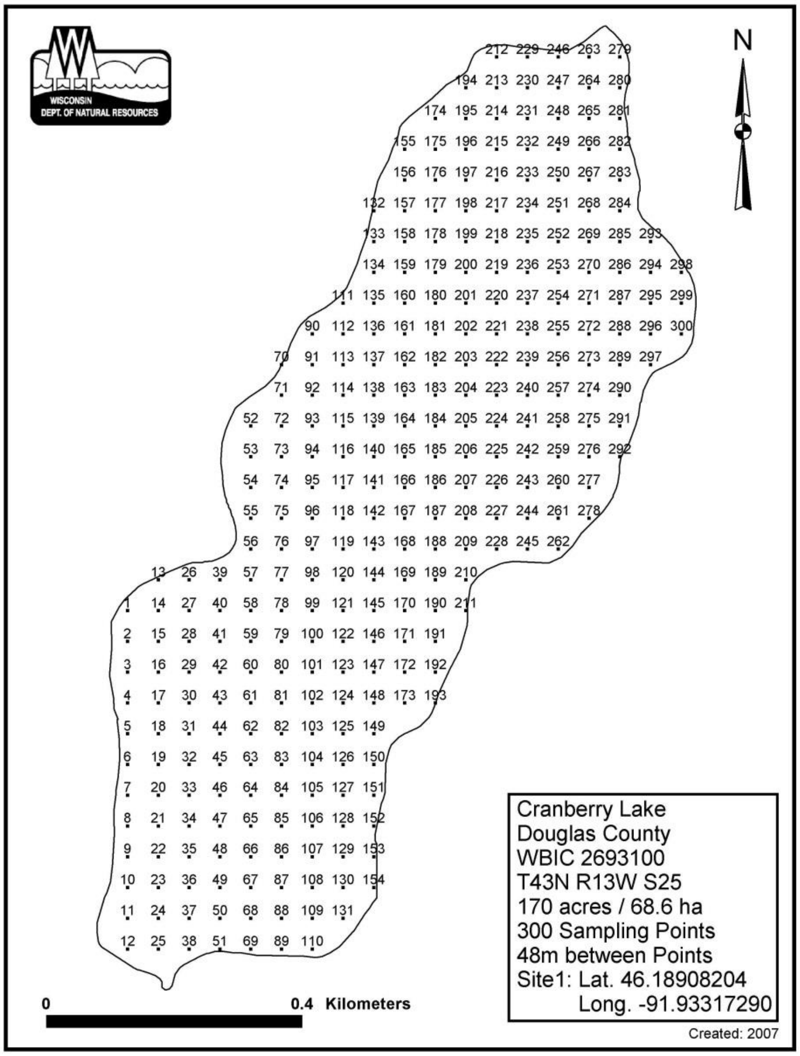
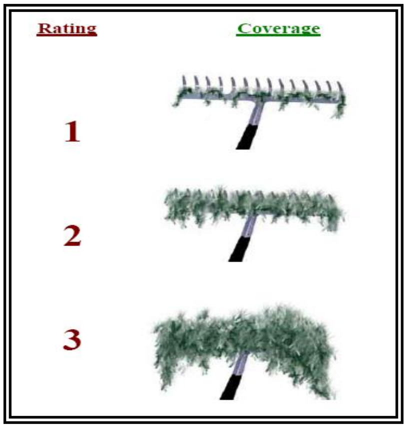


Figure 2: Point intercept sample grid for Cranberry Lake.

At each sample location, a double-sided fourteen-tine rake was used to rake a 1-meter tow off the bow of the boat. All plants present on the rake and those that fell off the rake were identified and rated for rake fullness. The rake fullness value was used based on the criteria contained in the diagram and table below. Those plants that were within 6 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 or shoreline 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 sediment type was also recorded for each sample point. Caution must be used in using the sediment type data since 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 Freckmann Herbarium (UW-Stevens Point) 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.

Data analysis methods

Data collected and analyzed resulting in the following information:

- Frequency of occurrence (FOO) 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.

<u>Frequency of occurrence for each species</u>- Frequency is expressed as a percentage by dividing the number of sites the plant is sampled by the total number of sites, which calculates to two possible values. The first value is the percentage of all sample points that a particular plant was sampled at depths less then maximum depth plants (littoral zone), regardless if vegetation was present. The second is the percentage of sample points that a particular 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 how frequent the plant is only where plants grow. In either case, the greater this value, the more frequent the plant is present in the lake. When comparing frequency in the littoral zone, plant frequency is observed at maximum depth. This frequency value is used to analyze the occurrence and location of plant growth based on depth. 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%

These two frequencies will show how common the plant was sampled in the littoral zone or how common the plant was sampled at points plants actually grow. Generally, the second will have a higher frequency since that is where plants are actually growing as opposed to where they could grow. This analysis will consider vegetated sites for frequency of occurrence (FOO) in most cases.

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 totaling100%. 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 demonstrates which plants are the dominant species in the lake. The higher the relative frequency, the more common the plant compared to the other plants and thus more frequent in the plant community.

Relative frequency example:

Suppose 10 points were sampled 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

Results show Plant D is the most frequent sampled plant at all points with 60% (6/10) of the sites having plant D. However, the relative frequency displays 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 all frequencies are added (3+5+2+6), the sum is 16. In this case, the relative frequency calculated by dividing the individual frequencies by 16.

Plant A = 3/16 = 0.1875 or 18.75%
Plant B = 5/16 = 0.3125 or 31.25%
Plant C = 2/16 = 0.125 or 12.5%
Plant D = 6/16 = 0.375 or 37.5%

In comparing plants, Plant D is still the most frequent, but the relative frequency tells us that of all plants sampled at those 10 sites, 37.5% of them are Plant D. This is much lower than the frequency of occurrence (60%) because although Plant D was sampled at 6 of 10 sites, many other plants were sampled too, thereby giving a lower frequency when compared to those other plants. This shows the true value of the dominant plants present.

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

Sample sites less than maximum depth of plants-The maximum depth at which a plant is sampled is recorded. This defines the depth plants can grow (littoral zone). Any sample point with a depth less than, or equal to this depth is recorded as a sample point less than the maximum depth of plants. This depth is used to determine the potential littoral zone and is therefore referred to as the littoral zone.

Sample sites with vegetation- This is the number of sites where plants were actually sampled. This gives a projection of plant coverage on the lake. Vegetation in 10% of all sample points implies about 10%

coverage of plants in the whole lake, assuming an adequate number of sample points have been established. The littoral zone is observed for the number of sample sites with vegetation. If 10% of the littoral zone had sample points with vegetation, then the estimated plant coverage in the littoral zone is 10%.

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

Simpson's diversity example:

If a lake was sampled and observed just one plant, the Simpson's diversity would be "0" because if two plants were randomly sampled, 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.

These are extreme and theoretical scenarios, but they demonstrate how this index works. The greater the Simpson's index for a lake, the more likelihood two plants sampled are different.

Maximum depth of plants-This depth indicates the greatest depth that plants were sampled. Generally, 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 value for the species richness of plants sampled, and another value that documents plants viewed but not 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 considers 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 higher 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: $FQI = \text{Mean } C \cdot \sqrt{N}$

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

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: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area, and Southeastern Wisconsin Till Plain. The 2008 and 2017 values from past aquatic plant surveys will also be compared in this analysis.

Summary of Northern Lakes and Forests for Floristic Quality Index:

(Nichols, 1999)

	Northern Lakes and Forests
Median species richness	14
Median conservatism	5.6
Median Floristic Quality	20.9

*Floristic Quality has a significant correlation with area of lake (+), alkalinity(-),

conductivity(-), pH(-) and Secchi depth(+). In a positive correlation, as that value increases so will FQI, while with a negative correlation, as a value decreases, the FQI will decrease.

Results

The point intercept aquatic macrophyte survey reflects a healthy and diverse native plant community. The species richness was 31 native species sampled on the rake (32 total species including one non-native, invasive species). There was one additional species that was viewed only for a total of 33 species. The Simpson's diversity index indicates fairly high diversity, indicating an 88% probability of any two samples being different species.

Total sample points in full lake sample grid	300
Total number of sites with vegetation	152
Total number of sites shallower than maximum depth of plants	196
Frequency of occurrence at sites shallower than maximum depth of plants	77.55%
Frequency of occurrence of entire lake	50.7%
Simpson Diversity Index	0.88
Maximum depth of plants (feet)	16.70
Mean depth of plants (feet)	4.7
Average number of all species per site (shallower than max depth)	1.83
Average number of all species per site (veg. sites only)	2.36
Average number of native species per site (shallower than max depth)	1.77
Average number of native species per site (veg. sites only)	2.30
Species Richness	32
Species Richness (including visuals)	33

Table 1: Summary of full lake macrophyte survey statistics-2019.

Greatest depth with plants growing was 16.7 feet and a mean depth of 4.7 ft. The coverage of plants is moderate, with 77.55% of the littoral zone defined by depth of plants had vegetation. In the entire lake, 50.7% of the lake had plants growing (at sample points within grid). The depth of plants indicates the light penetration is moderate, due to average water clarity, leading to plants growing at the depths observed.

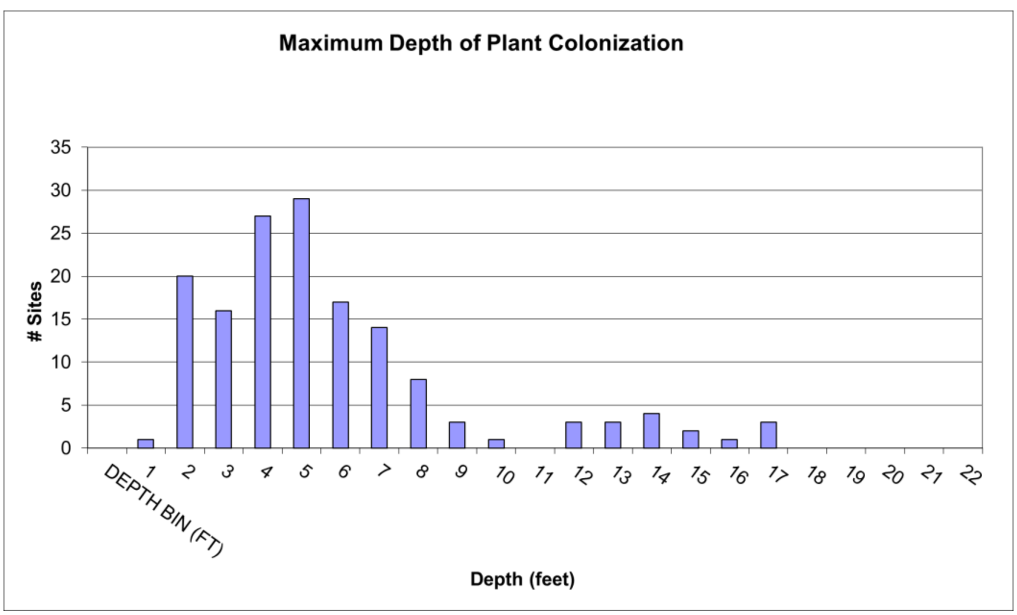


Figure 3: Depth analysis graph for plants growing in Cranberry Lake, 2019.

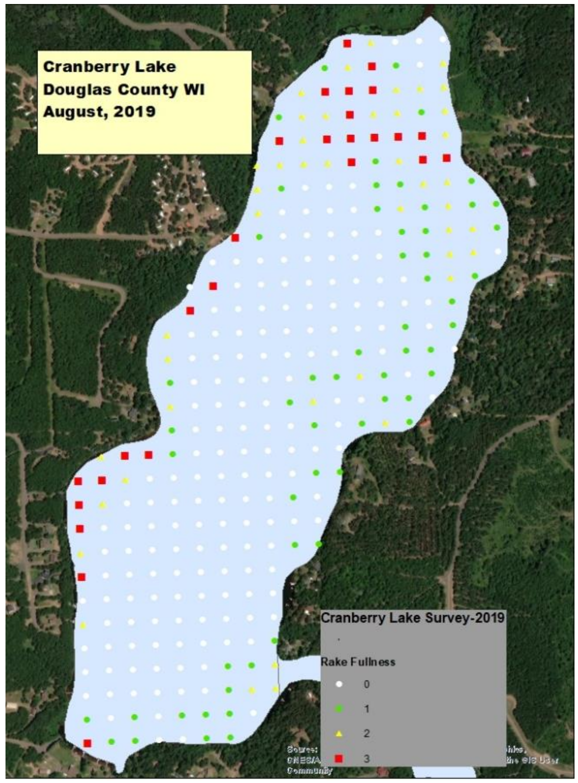


Figure 4: Total rake fullness in Cranberry Lake at each sample site.

Species	FOO Vegetated Littoral	FOO Littoral Depth	Relative Freq.	Number Sampled	Mean Density	Number viewed
Potamogeton robbinsii, Fern pondweed	65.79	51.02	27.86	100	1.5	
Potamogeton amplifolius, Large-leaf pondweed	28.95	22.45	12.26	44	1.2	
Vallisneria americana, Wild celery	23.03	17.86	9.75	35	1.0	
Ceratophyllum demersum, Coontail	18.42	14.29	7.80	28	1.1	
Nitella sp., Nitella	15.79	12.24	6.69	24	1.0	
Elodea nuttallii, Slender waterweed	13.16	10.20	5.57	20	1.2	
Najas flexilis, Slender naiad	13.16	10.20	5.57	20	1.0	
Chara sp., Muskgrasses	11.84	9.18	5.01	18	1.2	
Filamentous algae	10.53	8.16		16	1.0	
Nuphar variegata, Spatterdock	9.87	7.65	4.18	15	1.0	
Myriophyllum spicatum,Eurasian water milfoil	7.89	6.12	3.34	12	1.2	
Elodea canadensis, Common waterweed	3.95	3.06	1.67	6	1.0	
Potamogeton friesii, Fries' pondweed	3.29	2.55	1.39	5	1.0	
Potamogeton pusillus, Small pondweed	3.29	2.55	1.39	5	1.2	
Myriophyllum sibiricum, Northern water-milfoil	2.63	2.04	1.11	4	1.0	
Potamogeton richardsonii, Clasping-leaf pondweed	1.97	1.53	0.84	3	1.0	
Utricularia vulgaris, Common bladderwort	1.97	1.53	0.84	3	1.0	

Species	FOO Vegetated Littoral	FOO Littoral Depth	Relative Freq.	Number Sampled	Mean Density	Number viewed
Eleocharis acicularis, Needle spikerush	1.32	1.02	0.56	2	1.0	
Polygonum amphibium, Water smartweed	1.32	1.02	0.56	2	1.0	
Potamogeton praelongus, White-stem pondweed	1.32	1.02	0.56	2	1.0	
Juncus pelocarpus f. submersus, Brown-fruited rush	1.32	1.02	0.56	2	1.0	
Bidens beckii, Water marigold	0.66	0.51	0.28	1	2.0	
Brasenia schreberi, watershield	0.55	0.51	0.28	1	1.0	
Isoetes echinospora, Spiny spored-quillwort	0.66	0.51	0.28	1	1.0	
Nymphaea odorata, White water lily	0.66	0.51	0.28	1	1.0	
Potamogeton epihydrus, Ribbon-leaf pondweed	0.66	0.51	0.28	1	1.0	
Potamogeton gramineus, Variable pondweed	0.66	0.51	0.28	1	1.0	1
Potamogeton illinoensis, Illinois pondweed	0.66	0.51	0.28	1	1.0	
Potamogeton vaseyi, Vasey's pondweed	0.66	0.51	0.28	1	1.0	1
Potamogeton zosteriformis, Flat-stem pondweed	0.66	0.51	0.28	1	1.0	
Sagittaria cristata, Crested arrowhead	0.66	0.51	0.28	1	1.0	
Sagittaria rigida, sessile fruited arrowhead	0.66	0.51	0.28	1	1.0	
Sparganium angustifolium, Narrow-leaved bur-reed	0.66	0.51	0.28	1	1.0	
Aquatic moss	0.66	0.51		1	3.0	
Elatine minima, Waterwort						1

Table 2: Species richness with frequency of occurrence and rake fullness data-2019.

The relative frequency resulted in *Potamogeton robbinsii* (fern pondweed) was the most common plant sampled on the rake (27.86%). This was followed by *Potamogeton amplifolius* (large-leaf pondweed)(12.26%) and *Vallisneria americana* (wild celery)(9.75%) respectively. All three of these aquatic plants are common native species found in Wisconsin lakes. The plants serve important roles in the lake ecosystem, including key habitat for invertebrates and fish.

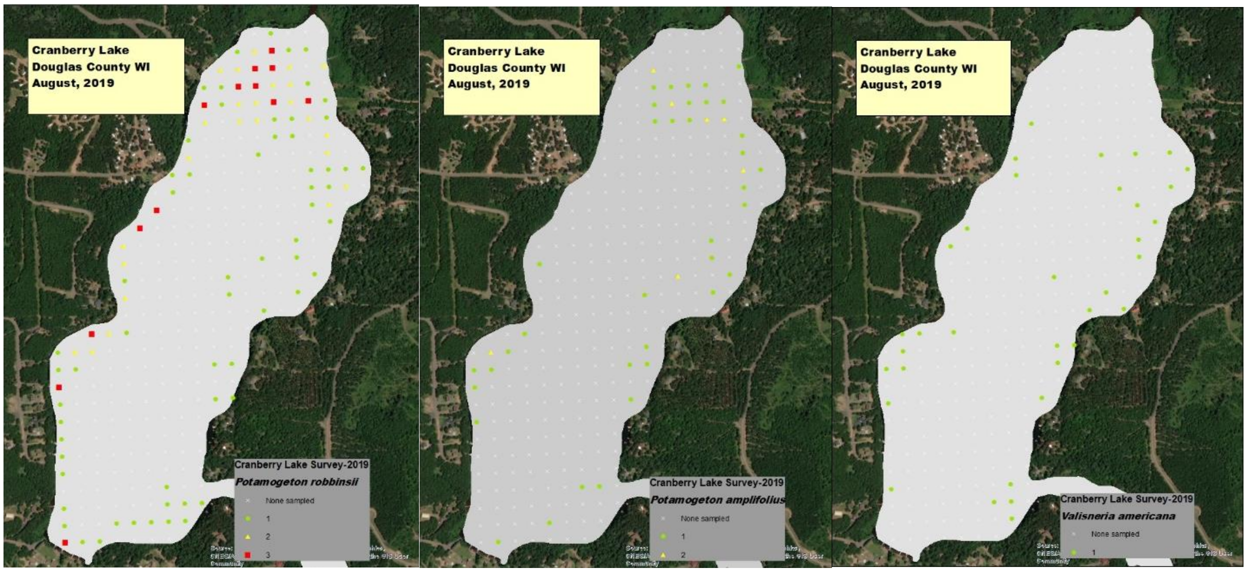


Figure 5: Distribution maps of three most common native plants sampled. Left to right, fern pondweed, large-leaf pondweed, and wild celery.

Invasive species

There was one invasive species sampled in Cranberry Lake, *Myriophyllum spicatum* (Eurasian watermilfoil-EWM). This plant was discovered in Cranberry Lake more than ten years ago and has been managed by use of herbicide. The frequency of EWM has increased since 2007. Figure 6 shows the distribution maps of EWM in 2007 (prior plant survey year) and 2019. In 2007 the frequency of occurrence (FOO) for EWM was 1.9%. In 2019 the EWM FOO was 7.89%. Treatment of EWM with herbicide did occur prior to the point intercept survey taking place in 2019.

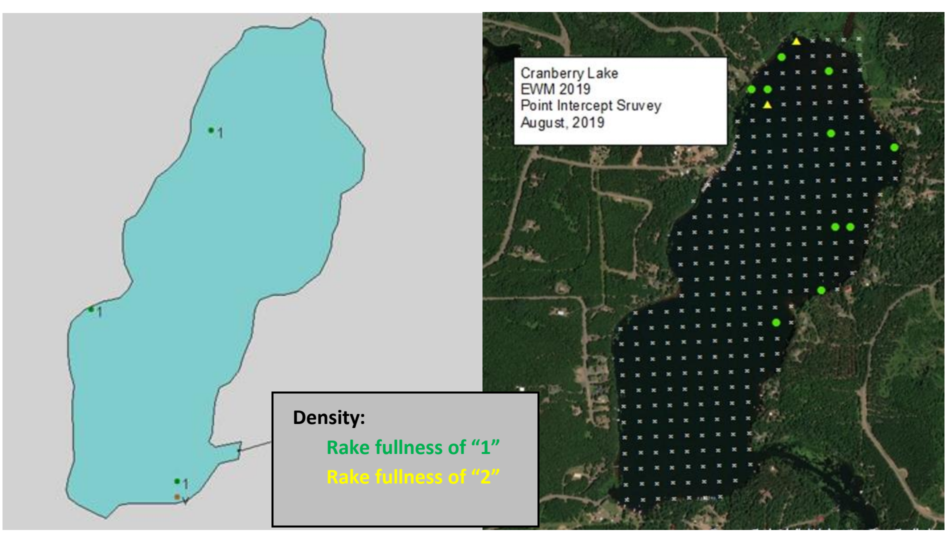


Figure 6: EWM distribution and density in 2007 and 2019.

Bed mapping was completed for EWM in August, 2019. Figure 7 shows the bed that was delineated in Cranberry Lake. This bed covers 2.36 acres.

Figure 7: Bed map of EWM in Cranberry Lake, August 2019.

Species of special concern

Special concern species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Cranberry Lake had two species of special concern observed or sampled. *Potamogeton vaseyi* (Vaseyi's pondweed) was sampled in one location and viewed in a second location. *Najas gracillima* (northern naiad), was observed in boat survey. Table 3 lists the species with frequency.

Species of special concern	Frequency of occurrence	Mean fullness
Najas gracillima-northern naiad	Only observed in boat survey	n/a
Potamogeton vaseyi-Vasey's pondweed	0.66	1.0

Table 3: Species of special concern in Cranberry Lake, 2019.

Floristic quality index

The floristic quality index (FQI) for Cranberry Lake in 2019 resulted all FQI parameters being significantly higher than the eco-region median values. The mean conservatism indicates the susceptibility of plants to habitat changes. This value was 6.77 vs 5.6 for the eco-region median. The overall FQI was 37.06 for Cranberry Lake as compared to 20.7 for the eco-region median. The FQI for Cranberry Lake shows the plant community has several sensitive plants and indicates the habitat in the lake has not changed immensely due to human activity. Table 4 summarizes the FQI data.

FQI Parameter	Cranberry Lake 2019	Eco-region median
Mean conservatism	6.7	5.6
Number of species in FQI	30	14
FQI	36.7	20.9

Table 4: Floristic quality index information for Cranberry Lake, 2019 and eco-region median.

Comparison of 2007 and 2019 surveys

An important aspect of conducting periodic plant surveys on lakes is to compare the results to evaluate changes that may be occurring in the ecosystem. Table 5 outlines some comparison statistics between 2007 and 2019 surveys.

In terms of diversity, the two surveys reflect nearly identical results. The species richness differs by only one species and the Simpson's diversity indexes are different by 0.01. The FQI and mean conservatism values are nearly the same. These parameters show very little change to the plant community over the last 12 years in relationship to plant diversity. The coverage changed by only five sample points as well.

Comparison parameter	2007	2019
Species richness	33	32
Simpson's diversity index	0.89	0.88
Mean conservatism	7.0	6.7
FQI	37.7	36.7
Maximum depth of plant growth	16.0	16.7
Points with plants	157*	152*
**decrease not significant (p=0.68)*		

Table 5: Comparison of various parameters from full lake surveys 2007 and 2019.

To evaluate changes in individual species in Cranberry Lake, the FOO is analyzed using a chi-square statistical analysis. There are various sources for the frequency of occurrence change. Those possible sources are as follows:

1. Management practices such as herbicide treatments can cause reductions. Typically, if herbicide treatments of invasive species are utilized, a pretreatment and post-treatment analysis is conducted in those

specific areas. To determine if this is a cause of a reduction in the full lake survey, the treatment areas would need to be evaluated using the point-intercept sample grid. Furthermore, if herbicide reduces the native species, it is dependent upon the type and concentration of the herbicide. A single species reduction is unlikely and more likely multiple species would be affected.

2. Sample variation can also occur. The sample grid is entered into a GPS unit. The GPS allows the surveyor to get close to the same sample point each time, but there is a possible error of 20 feet or more (the arrow icon is 16 feet in real space). Since the distribution of various plants is not typically uniform but more likely clumped, sampling variation could result in that plant not being sampled in a particular survey. Plants with low frequency could give significantly different values with surveys conducted within the same year.

3. Each year, the timing for aquatic plants coming out of dormancy can vary widely. A late or early ice-out may affect the size of plants during a survey from one year to the next. For example, a lake with a high density of a plant one year could have a very low density another year. The type of plant reproduction can affect this immensely. If the plant grows from seed or a rhizome each year, the timing can be paramount as to the frequency and density are shown in a survey.

4. Identification differences can lead to frequency changes. The small pond weeds such as *Potamogeton pusillus*, *Potamogeton foliosus*, *Potamogeton friesii*, and *Potamogeton strictifolious* can easily be mistaken for one plant or another. It may be best to look at the overall frequency of all of the small pondweeds to determine if a true reduction has occurred. All small pondweeds collected were magnified and closely scrutinized in the 2017 survey.

5. Habitat changes and plant dominance changes can lead to plant declines. If an area received a large amount of sediment from human activity the plant community may respond. For this to occur in 5-7 years may be unlikely. If a plant emerges as a more dominant plant over time, that plant may reduce another plant's frequency and /or density.

6. Large plant coverage reduction that is not species specific can occur from an infestation in the non-native rusty crayfish or common carp.

Management of Eurasian watermilfoil has been taking place for many years. This reason, any reduction in frequency could be due to herbicide use. There is no conclusive evidence that herbicide is the only source of any reductions. Also, there were numerous significant increases as well.

The chi-square analysis resulted in showing a statistically significant reduction in 11 native plant species. Three of these species had relatively high FOO in 2007 and much lower FOO in 2019 which could be of concern. The other species had more subtle changes or were low frequency in 2007. Table 6 lists the species with significant decreases in FOO.

The largest change was in *Elodea sp.*, with a significant reduction. *Myriophyllum sibiricum* (norther watermilfoil) also had a significant decrease. Both of these plants decreased in after the herbicide treatment in 2019 in the treatment beds. It would seem unlikely the herbicide affected these populations in the whole lake but is possible. Northern watermilfoil is closely related to the AIS Eurasian watermilfoil and is susceptible to the same herbicides, so its decrease is of concern.

Species with significant reduction	FOO 2007	FOO 2019	Significance
Ceratophyllum demersum	35.7	18.4	P=0.0007
Elodea sp.	70.1	17.1	$P=6.9X10^{-21}$
Vallisneria americana	36.3	23.0	P=0.01
Myriophyllum sibiricum	19.7	2.6	$P=2.1X10^{-6}$
Potamogeton zosteriformis	7.0	0.7	P=0.004
Bidens beckii	9.6	0.7	P=0.0004
Heteranthera dubia	4.4	0.0	P=0.008
Potamogeton illinoensis	5.7	0.7	P=0.01
Brasenia schreberi	2.5	0.0	P=0.05
Potamogeton strictifolius	3.2	0.0	P=0.03

Table 6: Native species with statistically significant reduction from 2007 to 2019 (from chi-square analysis).

Figure 7 shows the distribution of *Elodea sp.* (*E. canadensis* and *E. nutalli* combined). The coverage in 2007 was widespread in the lake in 2007. In 2019, the coverage of these plants was much smaller, with most change appearing to be in the north end of the lake.

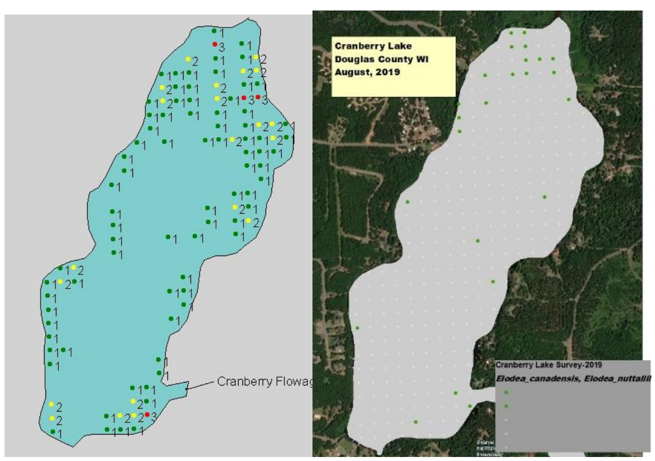


Figure 7: Distribution of *Elodea sp.* In 2007 (left) and 2019 (right) to show the difference in coverage.

There were increases in three native species from 2007 to 2019. All three had a small FOO in 2007 that increased to FOO's between 10% and 20%. There was also a statistically significant increase in the AIS Eurasian watermilfoil from and FOO of 1.9% to 7.9%. Table 7 summarizes the significant increased species.

Species with significant increase	FOO 2007	FOO 2019	Significance
Nitella sp.	3.2	15.79	P=0.0001
Najas flexilis	5.7	13.2	P=0.025
Chara sp.	5.1	11.8	P=0.03
Myriophyllum spicatum (AIS)	1.9	7.9	P=0.014

Table 7: Plant species with statistically significant increase between 2007 and 2019.

Discussion

The 2019 aquatic macrophyte survey reflects a moderately diverse plant community with a high floristic quality index. These data indicate that the aquatic plant community in Cranberry Lake appears healthy. This plant community is paramount to the overall lake ecosystem and it is important to manage Cranberry Lake to maintain a healthy, native plant community.

The comparison of the 2007 and 2019 survey data using chi-square analysis revealed a statistically significant decrease in the frequency of occurrence of 11 native plant species. This is approximately 1/3 of the species sampled in Cranberry Lake. The cause of this decrease is unknown, but since management of EWM using herbicides has been utilized on a near annual basis, it is important to consider this as a possible contributor to native plant reductions and should be considered in future management decisions. Native plants can hopefully compete with AIS such as EWM, reducing their coverage and spread. This needs to be balanced with the reduction sought using herbicide, which can also reduce native plant species. Broad spectrum herbicide such as diquat (which has been used in Cranberry Lake) will reduce any actively growing plant and in theory will have a greater impact than herbicide that target certain types of plants.

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