Aquatic Macrophyte Survey

~Point Intercept Method~

Mercer Lake, Iron County Wisconsin

August, 2010

Survey and mapping conducted by Ecological Integrity Service, LLC
Amery, Wisconsin

Introduction

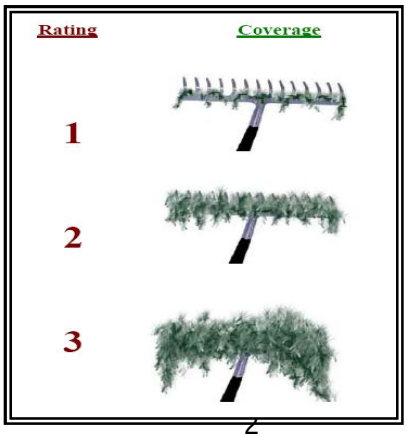
On June 15-16 and July 28-30 2010, an aquatic macrophyte survey was conducted on Mercer Lake (WBIC: 2313600) in Iron County Wisconsin. Mercer Lake is a 181-acre lake with a maximum depth of 24 feet and a mean depth of 11 ft. Development around the lakes is moderate with an estimated 50% of the lakeshore developed and/or disturbed from an original native riparian zone.

This report presents a summary and analysis of data collected in a point intercept, baseline aquatic macrophyte survey. The primary goal of the survey is to establish a baseline for long-term monitoring of aquatic plant populations and allow for the evaluation of any changes that may occur long-term. 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.

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 423 points for Mercer Lake. Only points shallower than 25 feet were initially sampled on Mercer Lake until the maximum depth of plants could be established. 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. 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.

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.



	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.

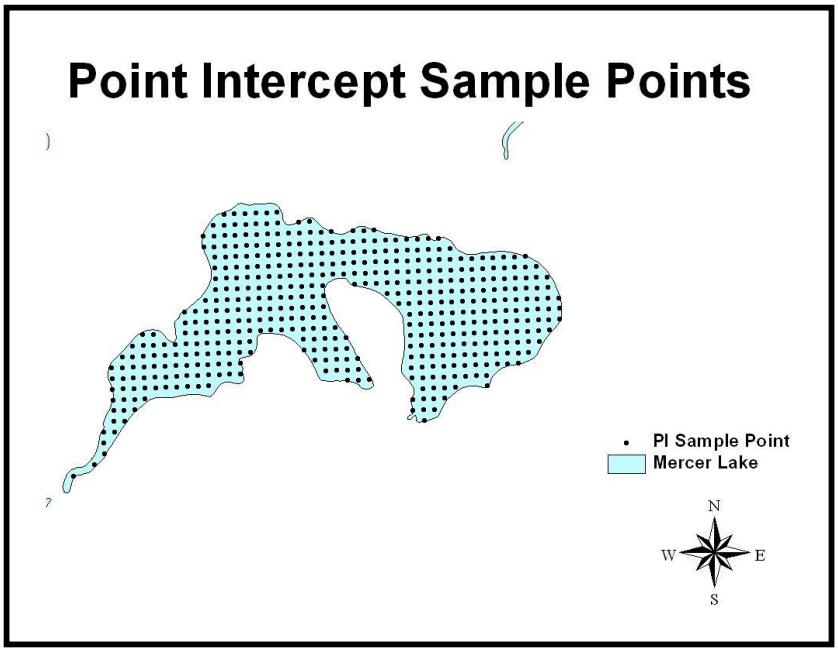


Figure 1: Map of sample points for point intercept survey.

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%

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 are the dominant species in the lake. 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 a 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 more diverse the plant community, the better 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:

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.

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

(Nichols, 1999)

Mean species richness = 14

Mean conservatism = 5.6

Mean Floristic Quality = 20.9*

Results

The full lake PI survey for Mercer Lake in 2010 reveals a diverse and healthy plant community within the lake ecosystem. There were 37 species of plants sampled on the rake in 345 locations, with a mean number of different species at each sample point of 3.71. This indicates a diverse plant community. In addition, the Simpson Diversity Index is high at 0.93, which means that any two plants sampled have a 93% probability they are different. This shows that no one plant is dominating the plant community, with the highest relative frequency being 15.25%. If viewed plants are included (observed within 6 feet of sample point), the richness increases to 43 plants.

The maximum depth of plants is 22 feet, however the majority of the plants were found in less than 15 feet of water. The water in Mercer Lake is brown (due to tannins) and therefore light penetration may be reduced. However, 22 foot depth for plants is quite deep for plant growth and indicates good water clarity regardless of the brown colored water.

Total number of sites with vegetation	345
Total number of sites shallower than maximum depth of plants	401
Total number of sites visited	410
Frequency of occurrence at sites shallower than maximum depth of plants	86.03
Simpson Diversity Index	0.93
Maximum depth of plants (ft)**	22
Average number of all species per site (shallower than max depth)	3.19
Average number of all species per site (veg. sites only)	3.71
Average number of native species per site (shallower than max depth)	3.19
Average number of native species per site (veg. sites only)	3.71
Species Richness	37
Species Richness (including visuals)	43

Table 1: Summary of PI survey results and statistics

Species	Frequency	Rel. freq	# of pts	Avg Density	# viewed
***Potamogeton robbinsii*, Fern pondweed**	56.52	15.25	195	1.92	4
***Elodea canadensis*, Common waterweed**	43.19	11.65	149	1.26	
***Potamogeton amplifolius*, Large-leaf pondweed**	30.92	9.70	124	1.44	13
***Ceratophyllum demersum*, Coontail**	29.57	7.97	102	1.05	1
***Vallisneria americana*, Wild celery**	27.25	7.35	94	1.60	
***Myriophyllum sibiricum*, Northern water-milfoil**	23.19	6.25	80	1.43	6
***Lemna trisulca*, Forked duckweed**	22.32	6.02	77	1.08	2
***Potamogeton zosteriformis*, Flat-stem pondweed**	22.03	5.94	76	1.11	3
***Potamogeton praelongus*, White-stem pondweed**	15.65	4.22	54	1.28	7
***Najas flexilis*, Slender naiad**	14.49	3.91	50	1.30	3
***Potamogeton pusillus*, Small pondweed**	11.59	3.13	40	1.08	2
***Potamogeton richardsonii*, Clasping-leaf pondweed**	11.30	3.05	39	1.31	9
***Bidens beckii*, Water marigold**	11.01	2.97	38	1.11	7
***Nymphaea odorata*, White water lily**	8.41	2.27	29	1.10	10
***Brasenia schreberi*, Watershield**	5.22	1.41	18	1.22	9
***Heteranthera dubia*, Water star-grass**	4.64	1.25	16	1.25	6
***Chara sp.*, Muskgrasses**	3.48	0.94	12	1.33	1
***Nuphar variegata*, Spatterdock**	3.48	0.94	12	1.08	5
***Potamogeton friesii*, Fries' pondweed**	2.90	0.78	10	1.00	2
***Utricularia vulgaris*, Common bladderwort**	2.90	0.78	10	1.30	3
***Pontederia cordata*, Pickerelweed**	1.74	0.47	6	1.33	9
***Schoenoplectus acutus*, Hardstem bulrush**	1.74	0.47	6	1.00	1
***Stuckenia pectinata*, Sago pondweed**	1.74	0.47	6	1.00	5
***Utricularia intermedia*, Flat-leaf bladderwort**	1.74	0.47	6	1.00	
***Nitella sp.*, Nitella**	1.45	0.39	5	1.00	
***Sparganium eurycarpum*, Common bur-reed**	1.45	0.39	5	1.00	4
***Eleocharis acicularis*, Needle spikerush**	1.16	0.31	4	1.00	
***Decodon verticillatus*, Swamp loosestrife**	0.87	0.23	3	1.33	3
***Sagittaria sp.*, Arrowhead (rosette)**	0.87	0.23	3	1.00	3
***Potamogeton gramineus*, Variable pondweed**	0.58	0.16	2	1.00	
***Ranunculus aquatilis*, White water crowfoot**	0.58	0.16	2	1.00	1
***Polygonum amphibium*, Water smartweed**	0.25	0.10	1	1.00	1
***Eleocharis palustris*, Creeping spikerush**	0.25	0.10	1	1.00	
***Isoetes lacustris*, Lake quillwort**	0.25	0.10	1	1.00	2
***Potamogeton natans*, Floating-leaf pondweed**	0.25	0.10	1	1.00	2
***Sagittaria rigida*, Sessile-fruited arrowhead**	0.25	0.10	1	1.00	
***Hydrodictyon reticulatum*, waternet**	0.25	0.10	1	1.00	
Aquatic moss	1.45		5	1.00	
Filamentous algae	10.14		35	1.03	

Table 2: Species richness list and frequency/density data.

Species viewed only at sample points:

Comarum palustre, Marsh cinquefoil
Sagittaria graminea, Grass-leaved arrowhead
Sagittaria latifolia, Common arrowhead
Sparganium emersum, Short-stemmed bur-reed
Typha latifolia, Broad-leaved cattail
Carex sp, Sedge

Species observed in boat survey not seen at sample points:

Phalaris arundinacea, Reed canary grass*
Myosotis scorpioides, Aquatic for-get-me-not*
Typha x glauca Hybrid cattail
Carex camosa, Bottle brush sedge
***Not native.**

The amount and frequency of plants is quite extensive. Plants were sampled at 86% of the sample points less than 22 feet (the maximum depth of plants). Since the majority of plants were only found in less than 15 feet of water, the percentage of sample points with plants would increase. Thus the littoral zone (area where plants can grow) makes up a large percentage of Mercer Lake.

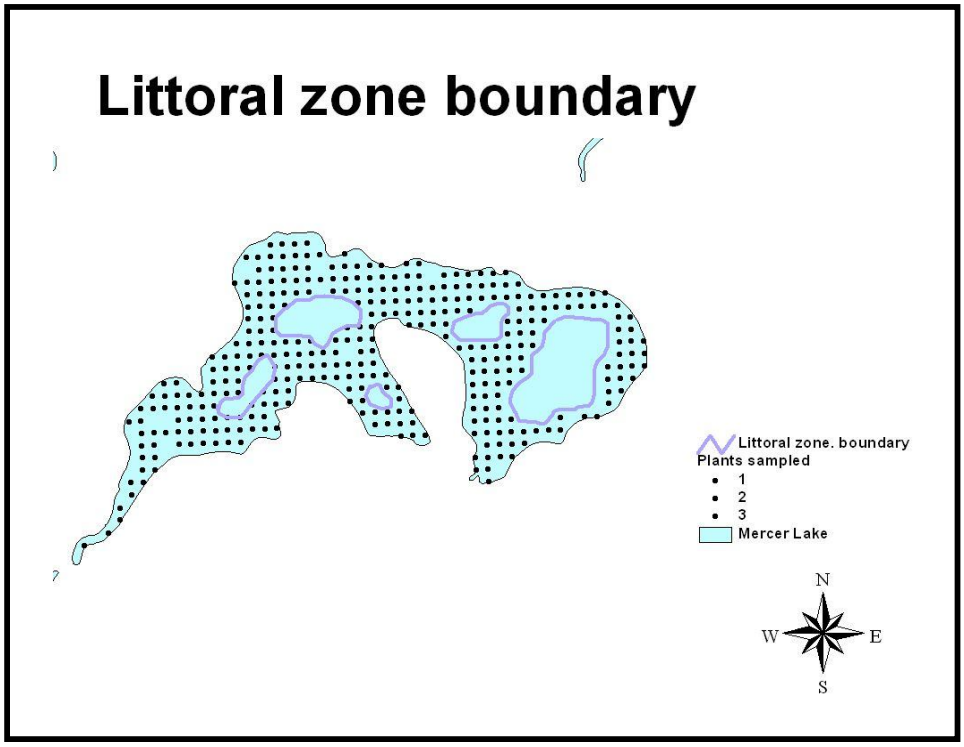


Figure 2: Map showing littoral zone boundary based upon plants sampled.

The results of the rake fullness data reveal that the plant density is high in many areas of Mercer Lake. There are some areas that could impede navigation within the lake due to high density and plants growing at or very near the surface.

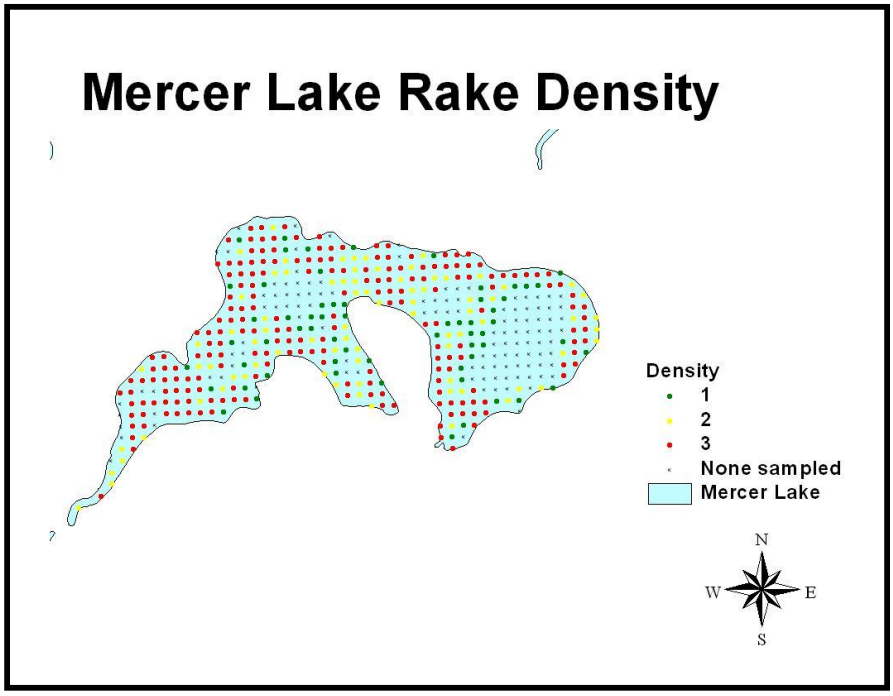


Figure 4: Rake density at each sample point, 1-3.

Depth is a significant factor in plant growth. The graph below indicates that the plants tend to be most diverse under five feet with nearly 200 sites under five feet with plants. This graph also shows that most plants are growing in under 15 feet of water and are relatively evenly distributed from depths of 9 to 15 feet (see figure 4)

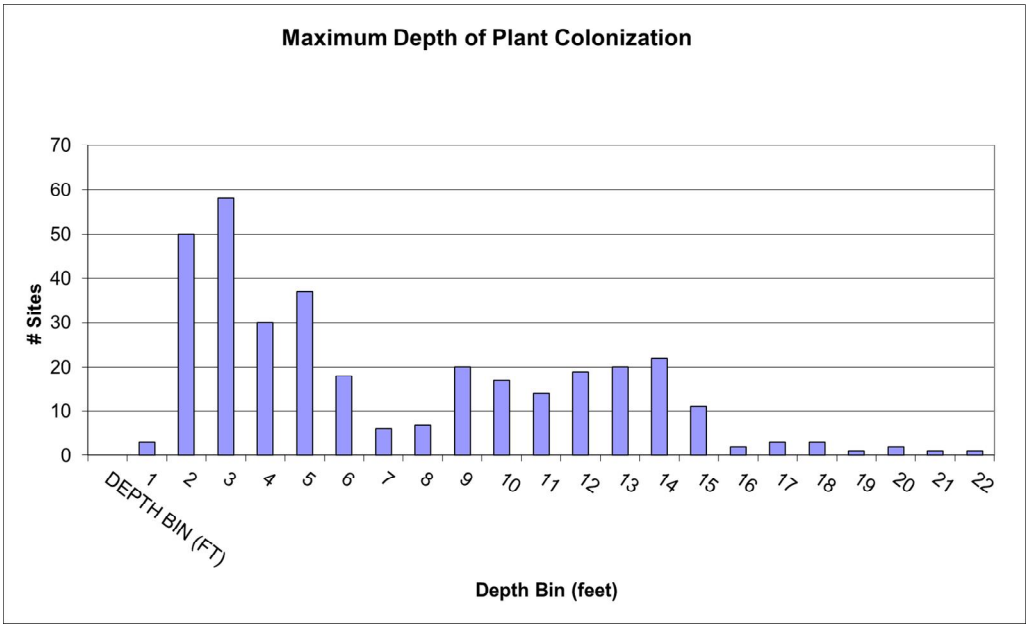


Figure 4: Depth plant analysis graph.

The most common plants in Mercer Lake are determined by observing the relative frequency. The three most common native plants in Mercer Lake (having the highest relative frequency) are Robbin's pondweed (*Potamogeton robbinsii*), waterweed (*Elodea canadensis*), and large-leaf pondweed (*Potamogeton amplifolius*).

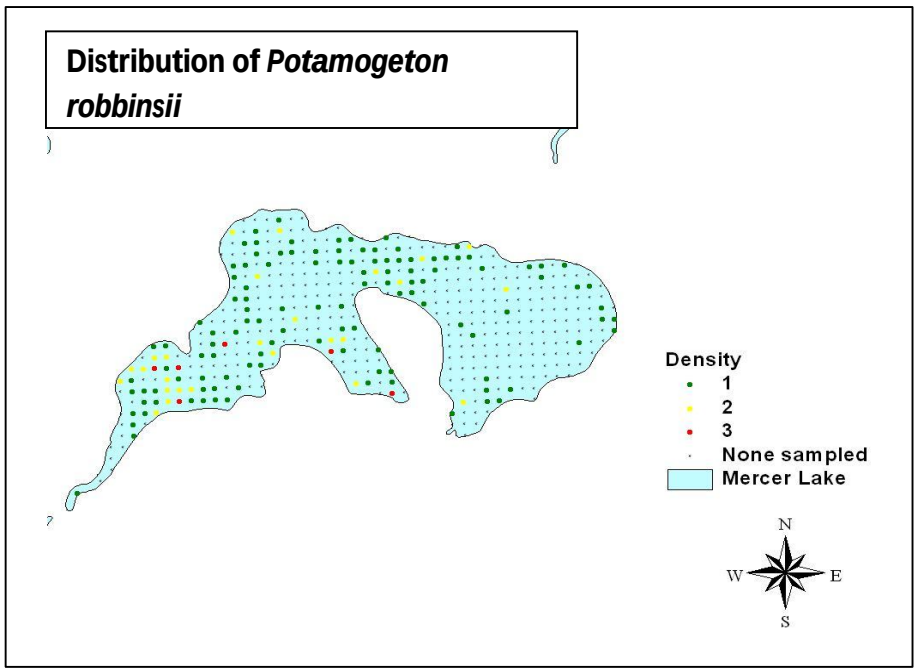


Figure 5: Distribution map of Robbin's pond weed, highest relative frequency of all plants.

All of these native plants are common in Wisconsin Lakes and are desirable to have in the lake ecosystem. These plants provide good habitat for plankton and fish and absorb nutrients.

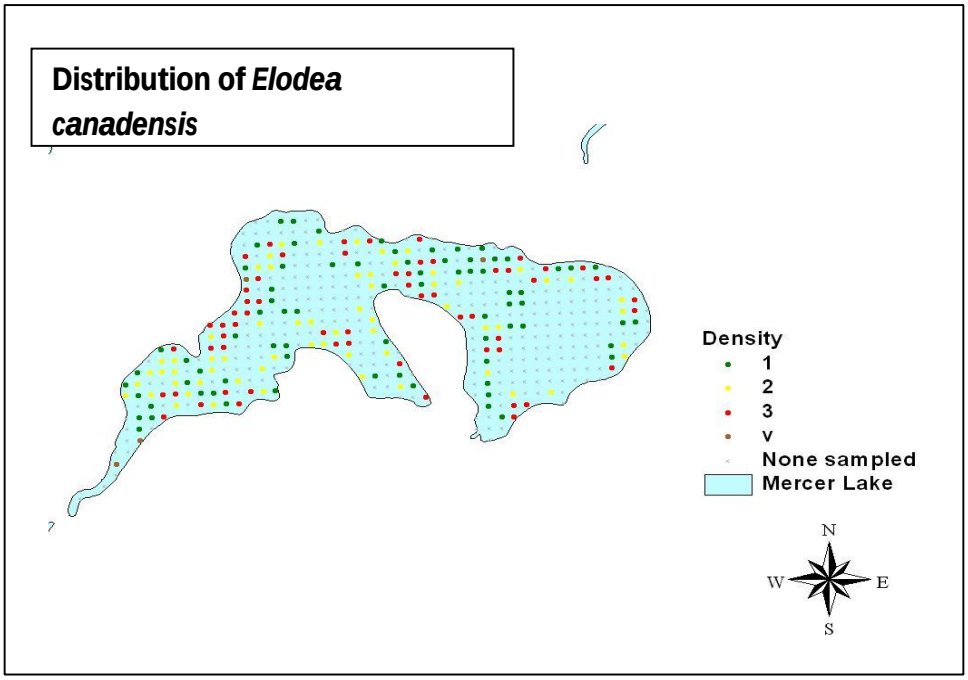


Figure 6: Distribution map of waterweed, second highest relative frequency.

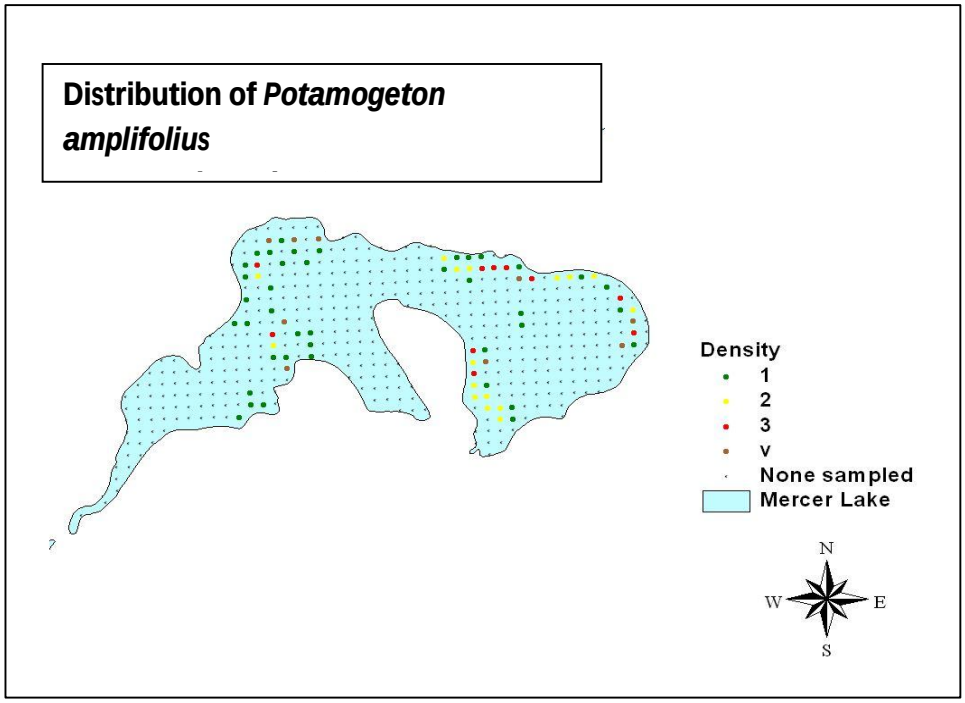


Figure 7: Distribution map of large-leaf pondweed, third highest relative frequency.

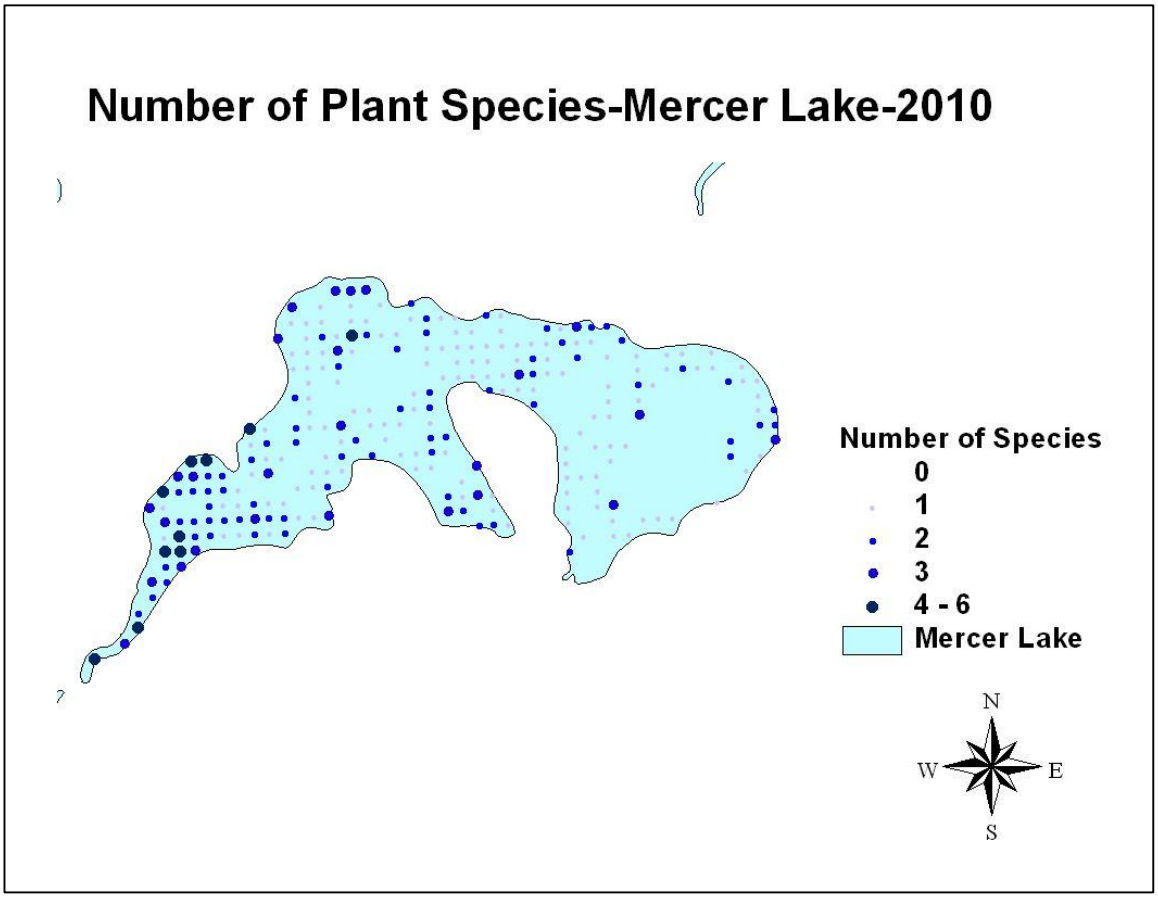


Figure 8: Map showing number of species of aquatic plants sampled at each sample site.

Figure 8 shows the location of the most diverse plant areas. The southwestern bay of Mercer Lake has the most numerous sample sites with more than 3 species of plants per sample. The mean was 3.71 species per sample (at all sample sites). Many of the sample sites in this area had 4-6 species present on each rake sample. This area of the lake should be considered when making plant management decisions in the future.

There were two species of non-native or exotic species located in the 2010 survey. The two species are reed canary grass and aquatic for-get-me-not. Although both species are exotic, they are not generally regarded as invasive, especially the for-get-me-not. Figure 9 shows the locations that these two species were located. Pictures are included to help in the identification.

Curly leaf pondweed is a very common invasive species found in Wisconsin lakes and Eurasian water milfoil is increasing in Wisconsin. Neither of these species was sample nor observed. Diligent monitoring is recommended.

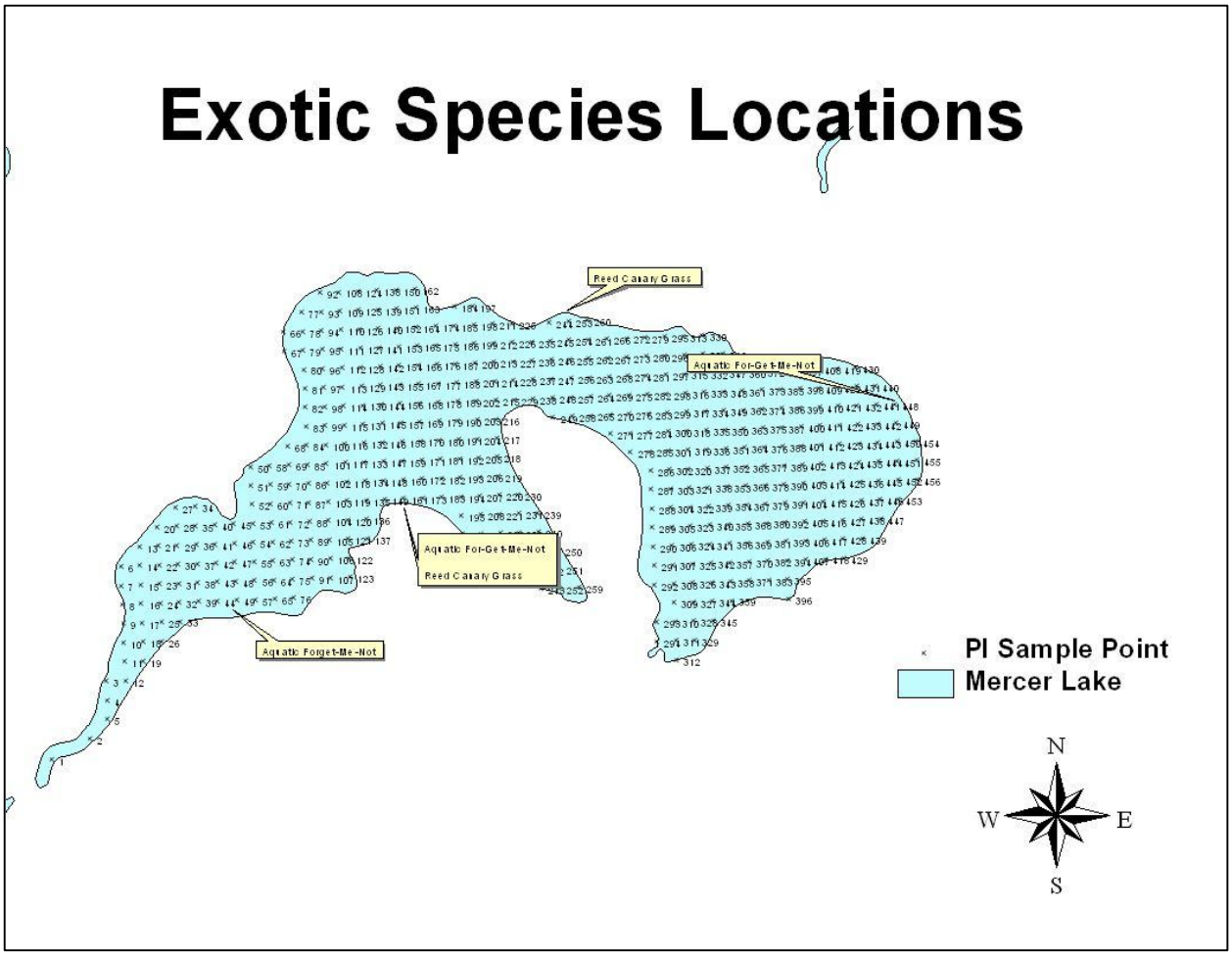


Figure 9: Exotic species locations on Mercer Lake-2010.

Reed canary grass

Aquatic for-get-me-not

Floristic Quality Index

The floristic quality index (FQI) measures the quality of the aquatic plant habitat, based upon the plants sampled. If the FQI is high, it indicates that the habitat has changed little from human development around the lake. If the FQI is low, it indicates that the lake has been impacted. The premise is that the more sensitive plants will disappear as the habitat degrades. The FQI is calculated using the number of species sampled and conservatism values that indicate their tolerance.

The FQI can be used to compare from year to year if subsequent surveys are completed. This allows the determination of any changes in the plant community that may be occurring. Since a comparable plant survey has not been conducted on Mercer Lake prior to this survey, the FQI is compared to the median values obtained by Stanley Nichols in an extensive, statewide FQI analysis. In relation to number of species in the FQI sampled and the FQI value itself, Mercer Lake is higher than the eco-region median. The mean conservatism value is essentially the same. This shows that Mercer Lake has comparable species in terms of sensitivity and has a higher diversity than comparable lakes from Nichols' analysis.

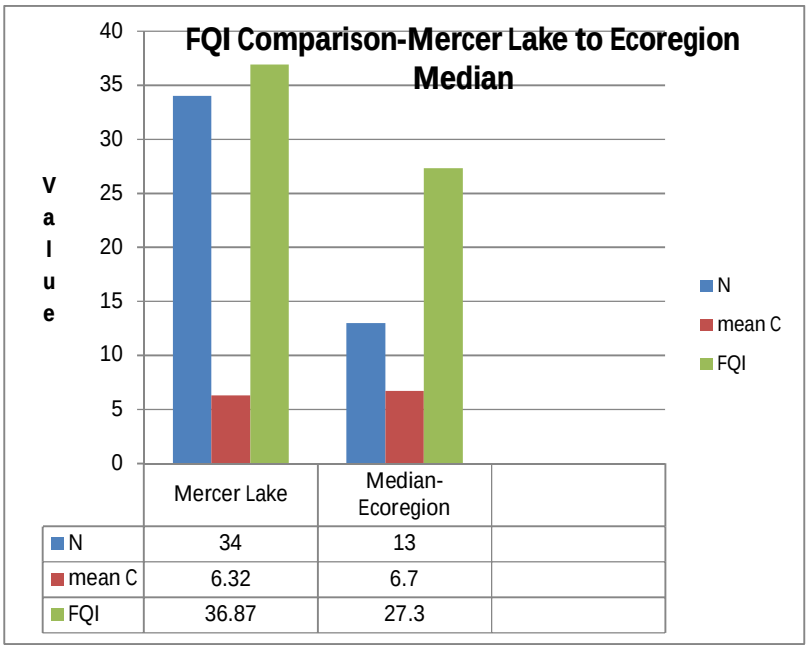


Figure 10: FQI comparison graph and data.

Species	Common Name	Conservatism
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Ceratophyllum demersum	Coontail	3
Chara	Muskgrasses	7
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Isoetes lacustris	Lake quillwort	8
Lemna trisulca	Forked duckweed	6
Myriophyllum sibiricum	Northern water-milfoil	6
Najas flexilis	Slender naiad	6
Nitella	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Polygonum amphibium	Water smartweed	5
Pontederia cordata	Pickerelweed	8
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
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
Schoenoplectus acutus	Hardstem bulrush	6
Sparganium eurycarpum	Common bur-reed	5
Stuckenia pectinata	Sago pondweed	3
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6

Table 3: FQI species list and conservatism value.

The most sensitive plant sampled was *Utricularia intermedia*-flat leaf bladderwort with a conservatism value of "9". There were seven species of plants with an conservatism value of "8".

Summary

Mercer Lake has a healthy and diverse plan community. The plants grow very dense in various areas of the lake. There were two non-native plants observed, but no curly leaf pondweed or Eurasian water milfoil found. The FQI indicates a diverse community with fairly sensitive plants present. It is apparent that the lake has not been adversely affected by human development in terms of the plants sampled. Considering the high urban watershed of Mercer Lake, dense macrophyte growth is not surprising. The aquatic macrophyte community is probably helping contribute to higher water clarity and quality. There are some areas that are approaching nuisance levels and could impede navigation and some recreational use.

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