Aquatic Macrophyte Survey and Analysis

Spooner Lake WBIC: 2685200

Washburn County, WI

2012

Survey and Analysis Conducted by Ecological Integrity Service, LLC
Sponsored by: Spooner Lake Protection and Rehabilitation District and
Wisconsin Dept. of Natural Resources.

Introduction

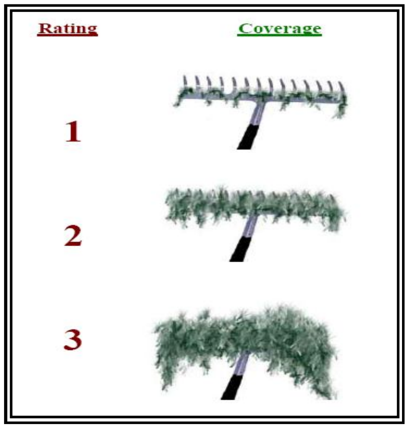
Spooner Lake (WBIC:2685200) is a 1209-acre lake in Washburn County, Wisconsin in the Town of Spooner. It is a drainage lake with the main input from Crystal Creek and outflows into the Yellow River. The Spooner Lake Protection and Rehabilitation District sponsored this aquatic macrophyte survey, with assistance from Wisconsin Department of Natural Resources AIS grant funds.

This report presents a summary and analysis of data collected in a point intercept aquatic macrophyte survey. The primary goal of the survey is to compare this PI survey with one conducted in 2006 for the 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 711 sample points for Spooner Lake. Only points shallower than 25 feet were initially sampled on Spooner Lake until the maximum depth of plants could be established (of which all points are under 25 feet). 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.

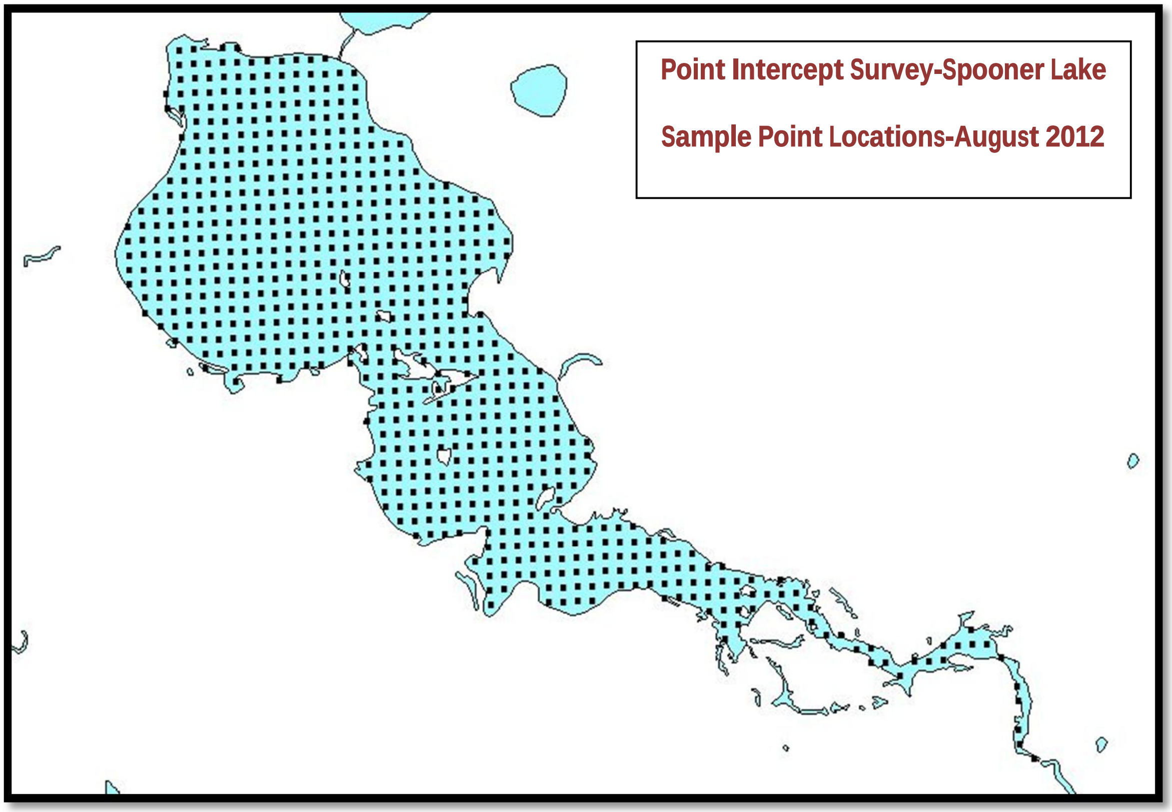


Figure 1: Map of sample points for point intercept survey

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 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 point 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:

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

This point intercept survey involved collecting, identifying and estimating the density of aquatic plants at each of 711 sample points. All points were visited with the exception of points 698 thru 711, which were too shallow and thick with sediment/plants to navigate. These points are located in the very southeastern portion of the lake at the inlet.

The maximum depth with plants was 13.7 feet, which identifies the deepest level of the littoral zone. Within this zone, 96.87% of the depth less than 13.7 feet had plants present. This means that 96.87% of the littoral zone is vegetated. Figure 2 shows the plant community is distributed normally from depth ranging from 0.5 to about 13 feet, with most plants growing in the range of five to nine feet.

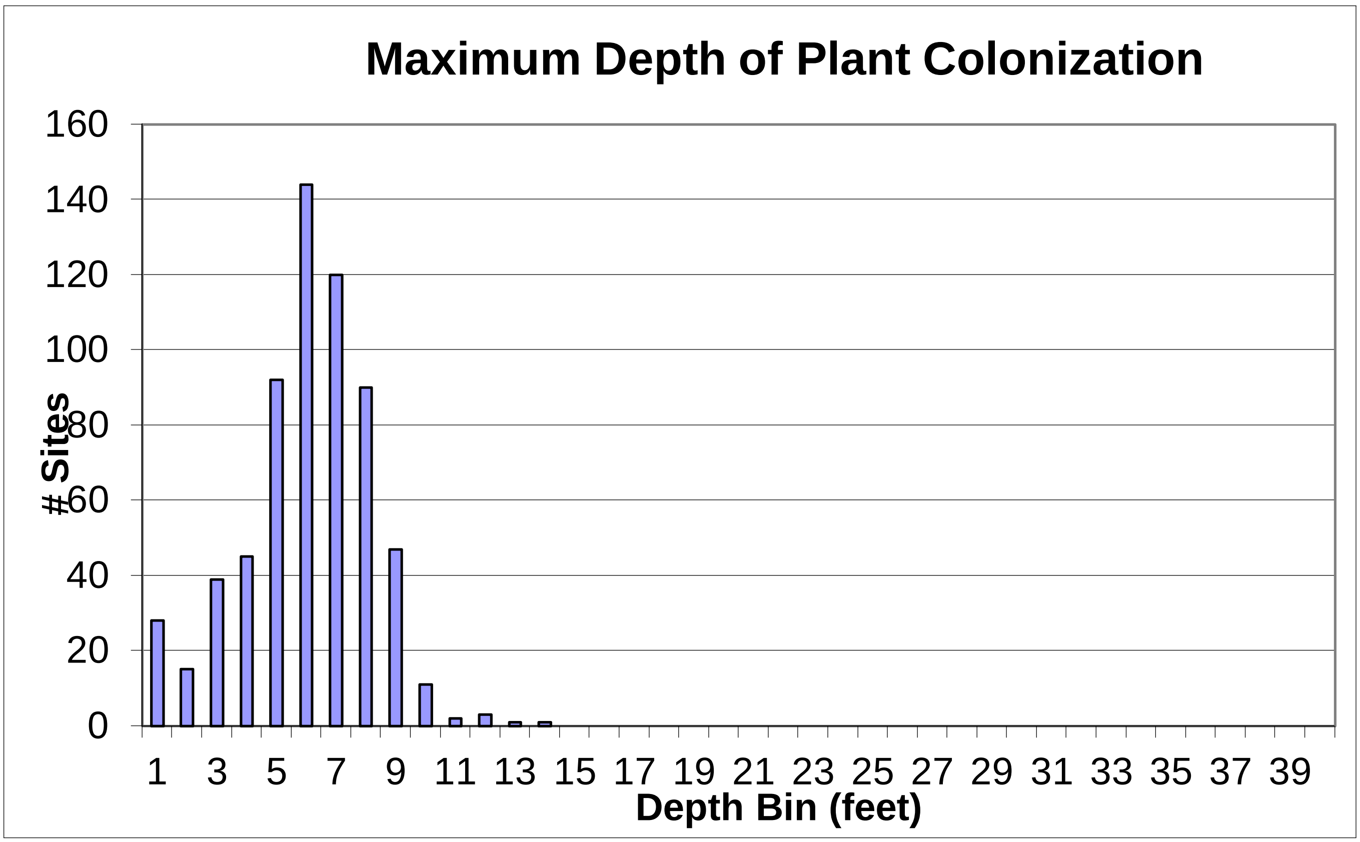


Figure 2: Depth of plant growth distribution analysis.

Spooner Lake Point Intercept Stats:	Value
Total number of sites visited	690*
Total number of sites with vegetation	681*
Total number of sites shallower than maximum depth of plants	703*
Frequency of occurrence at sites shallower than maximum depth of plants	96.87*
Simpson Diversity Index	0.84
Maximum depth of plants (ft)	13.70
Average number of all species per site (shallower than max depth)	2.08
Average number of all species per site (veg. sites only)	2.29
Average number of native species per site (shallower than max depth)	2.08
Average number of native species per site (veg. sites only)	2.29
Species Richness (not including filamentous algae and sponge)	32
Species Richness (including visuals)	38
Species Richness (including boat survey)	44

***Not all sites navigable so sampling not possible, but plants could be viewed so used to calculate frequency.**

Table 1: Summary of survey statistics.

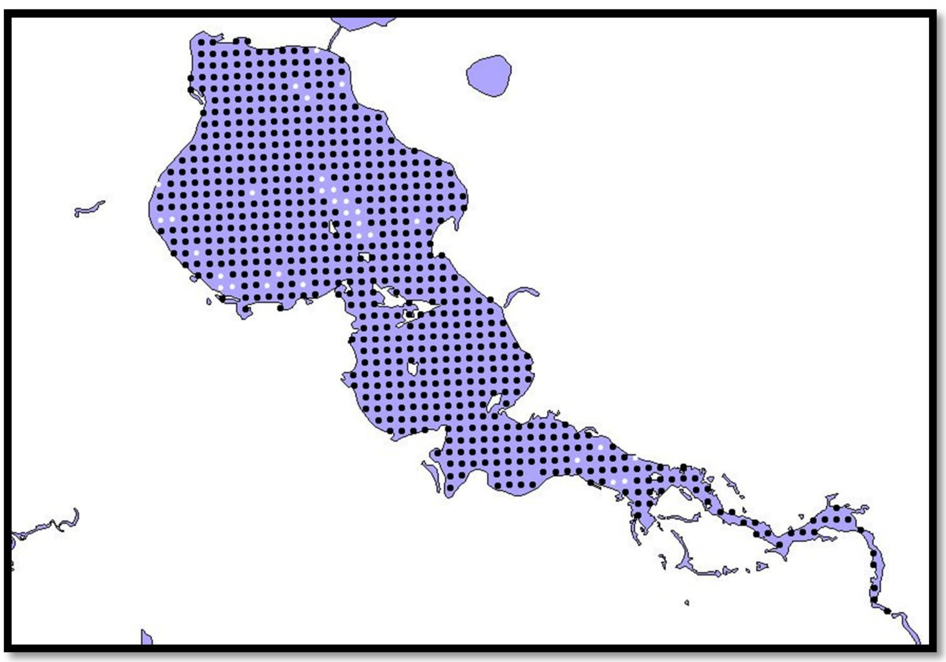


Figure 3: Littoral zone of Spooner Lake; location of plants present and absent.

The density is quite high in Spooner Lake. There were numerous sample points with a rake fullness of 2 and 3. Figure 4 shows the density ratings of the rake sample. This map can be somewhat misleading as in many areas the density was high, but was not near the surface.

There are some areas, mostly bays, that have high density that may tend to impeded navigation.

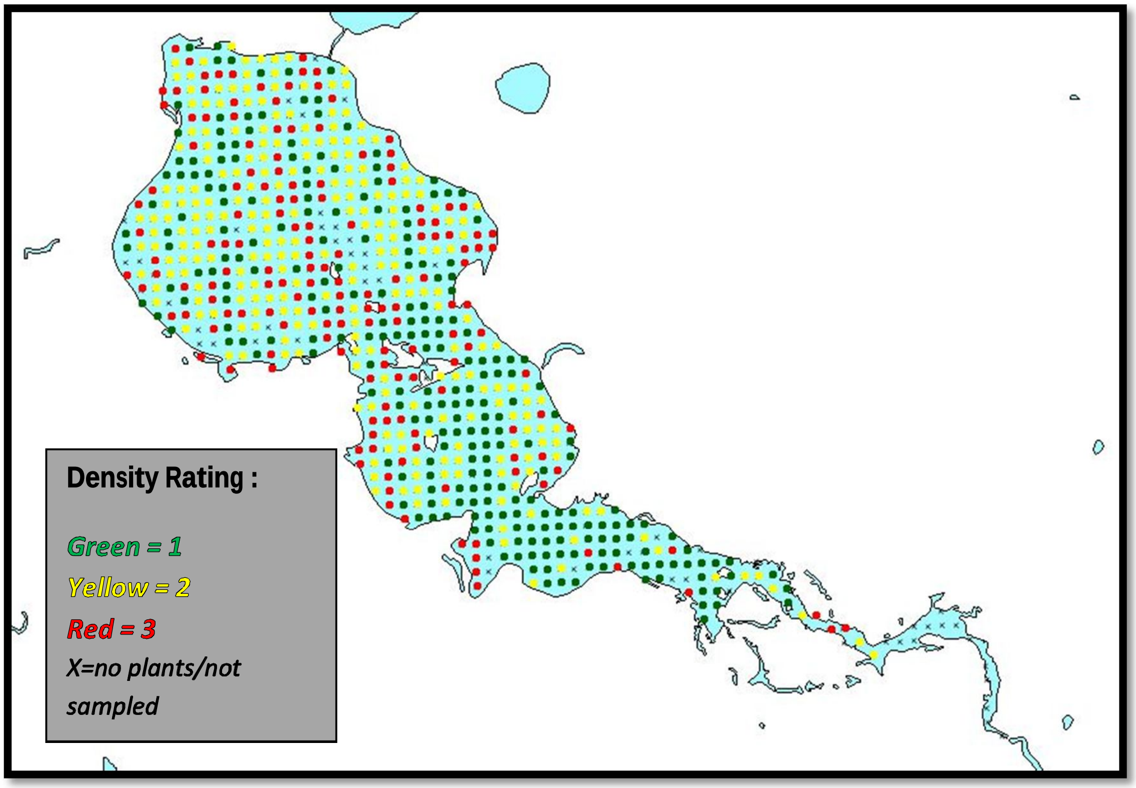


Figure 4: Density rating at each sample point, Spooner Lake 2012.

Diversity of the plant community in Spooner Lake is moderate. Several parameters indicate diversity. The first is the species richness. There were 32 species of aquatic plants sampled on the rake. When viewed species are included (seen within six feet of sample point), the richness increases to 38. Filamentous algae and freshwater sponge are recorded but not included in the species richness as suggested by Wisconsin DNR. The other indicator is the Simpson's diversity Index. The index value for Spooner Lake is 0.84. This means that when two plants are sampled in Spooner Lake, there is an 84% probability they are different. Lastly, there was an average 2.29 species sampled at each sample point.

Species	Frequency of occurrence	Relative Frequency	No of pts sampled	Mean density
Ceratophyllum demersum, Coontail	73.04	31.87	466	1.32
Potamogeton zosteriformis, Flat-stem pondweed	37.50	16.21	237	1.27
Potamogeton robbinsii, Fern pondweed	24.45	10.67	156	1.26
Elodea canadensis, Common waterweed	23.82	10.40	152	1.30
Myriophyllum sibiricum, Northern water-milfoil	11.44	4.99	73	1.03
Najas flexilis, Slender naiad	8.93	3.90	58	1.39
Potamogeton richardsonii, Clasping-leaf pondweed	6.90	3.01	44	1.20
Vallisneria americana, Wild celery	6.74	2.90	36	1.17
Potamogeton praelongus, White-stem pondweed	6.58	2.87	42	1.05
Chara sp., Muskgrasses	4.39	1.92	28	1.50
Stuckenia pectinata, Sago pondweed	3.76	1.64	24	1.00
Potamogeton amplifolius, Large-leaf pondweed	3.61	1.57	23	1.00
Heteranthera dubia, Water star-grass	2.98	1.30	19	1.00
Nymphaea odorata, White water lily	2.35	1.03	15	1.07
Lemna minor, Small duckweed	1.88	0.82	12	1.00
Potamogeton friesii, Fries' pondweed	1.25	0.55	8	1.00
Spirodela polyrhiza, Large duckweed	0.94	0.41	6	1.00
Wolffia columbiana, Common watermeal	0.81	0.35	5	1.00
Nuphar variegata, Spatterdock	0.63	0.27	4	1.00
Pontederia cordata, Pickerelweed	0.63	0.27	4	1.00
Sagittaria rigida, Sessile-fruited arrowhead	0.63	0.27	4	1.00
Potamogeton foliosus, Leafy pondweed	0.47	0.21	3	1.00
Potamogeton natans, Floating-leaf pondweed	0.47	0.21	3	1.00
Schoenoplectus acutus, Hardstem bulrush	0.31	0.14	2	1.00
Carex comosa, Bottle brush sedge	0.16	0.07	1	1.00
Eleocharis erythropoda, Bald spikerush	0.16	0.07	1	1.00
Isoetes sp., Quillwort	0.16	0.07	1	1.00
Ranunculus aquatilis, White water crowfoot	0.16	0.07	1	1.00
Sagittaria latifolia, Common arrowhead	0.16	0.07	1	1.00
Schoenoplectus tabernaemontani, Softstem bulrush	0.16	0.07	1	1.00
Typha angustifolia, Narrow-leaved cattail	0.16	0.07	1	1.00
Typha latifolia, Broad-leaf cattail	0.16	0.07	1	1.00
Freshwater sponge	0.47	Not used	3	1.00
Filamentous algae	22.26	Not used	142	1.06

Table 2: Species richness with frequency and density data.

Species Viewed only (near sample points)

Calla palustris, Wild calla

Decodon verticillatus, Swamp loosestrife

Eleocharis acicularis, Needle spikerush

Sparganium eurycarpum , Common bur-reed

Myosotis scirpoides-Aquatic for get me not

Sagittaria sp. (rosette)

Species from boat survey only

Carex sp.-Sedge

Phragmites australis-Giant reed

Phalaris arundinacea-Reed canary grass

Rumex orbiculatus-Aquatic dock

Sagittaria gramineus-Grass leaved arrowhead

Lythrum salicaria-Purple loosestrife

All of the plants sampled on the rake were native species. Two algae species were sampled, those being *Chara sp*. and filamentous algae. All of the rest were native vascular plants.[1] Any non-native plants are discussed in that section of this report.

The most abundant plant surveyed was coontail (Ceratophyllum demersum) with a relative frequency of 31.87%. This is a very high relative frequency, indicating the coontail is dominating the plant community significantly. Whatever conditions present in Spooner Lake, it is allowing for the domination of coontail. It is common to see this plant dominate in nutrient rich lakes. Coontail is a common aquatic plant in Wisconsin lakes and is desirable, although it can sometimes reach nuisance levels.

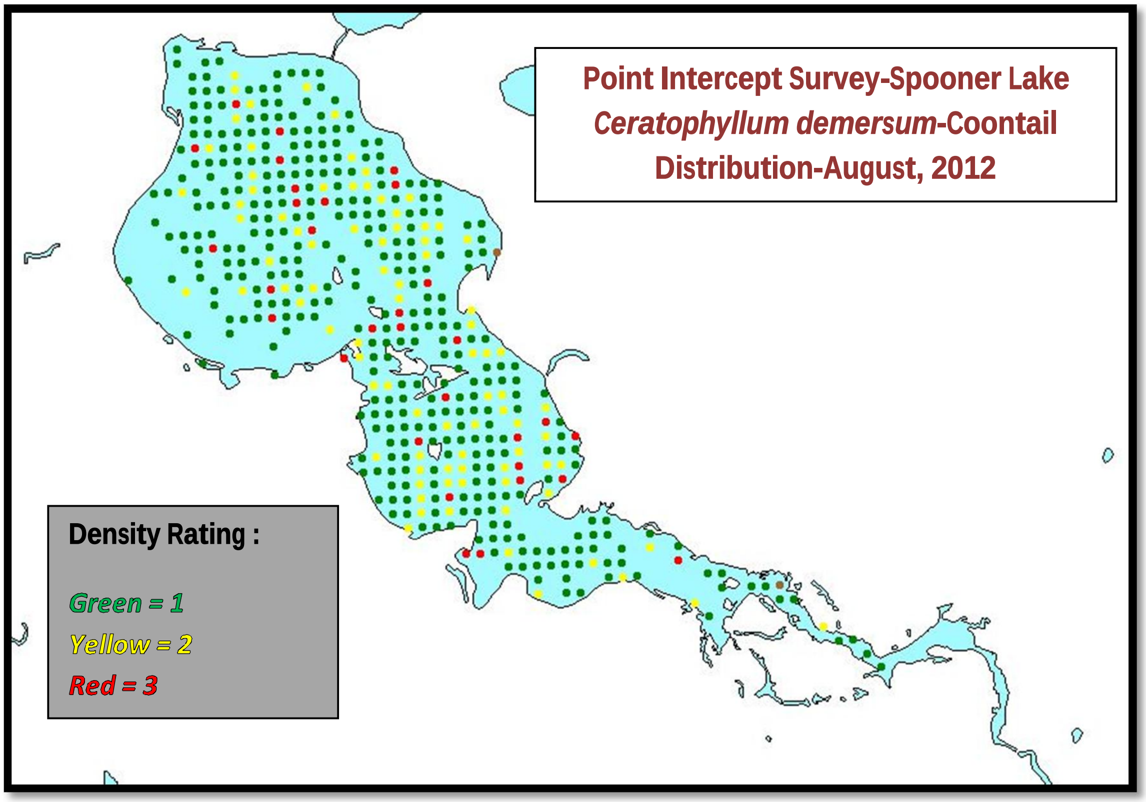


Figure 5: Distribution of Ceratophyllum demersum-coontail.

The second and third most dominate plants are flat-stem pondweed (*Potamogeton zosteriformis*) and Robbin's pondweed (*Potamogeton robbinsii*). Both of these plants are common aquatic plants in Wisconsin lakes and are desirable to have present.

[1] *Potamogeton crispus* was sampled in the early season (June) survey, but none in the August survey,

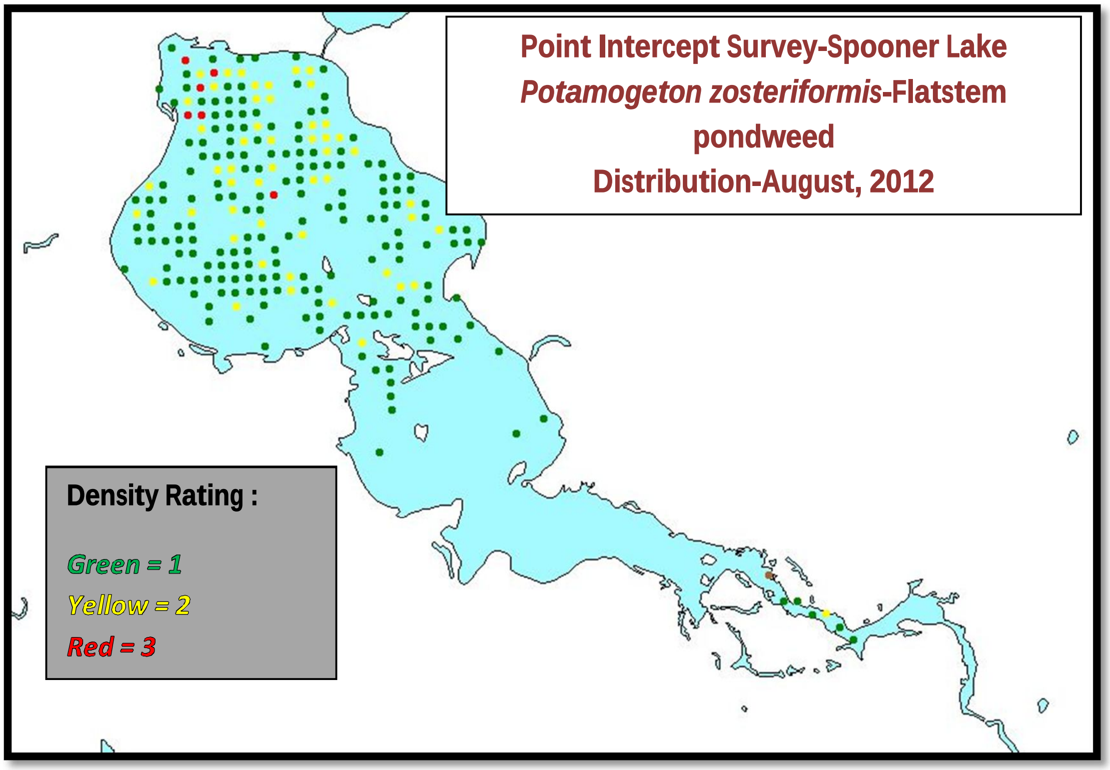


Figure 6: Distribution of <u>Potamogeton zosteriformis</u>-flatstem pondweed.

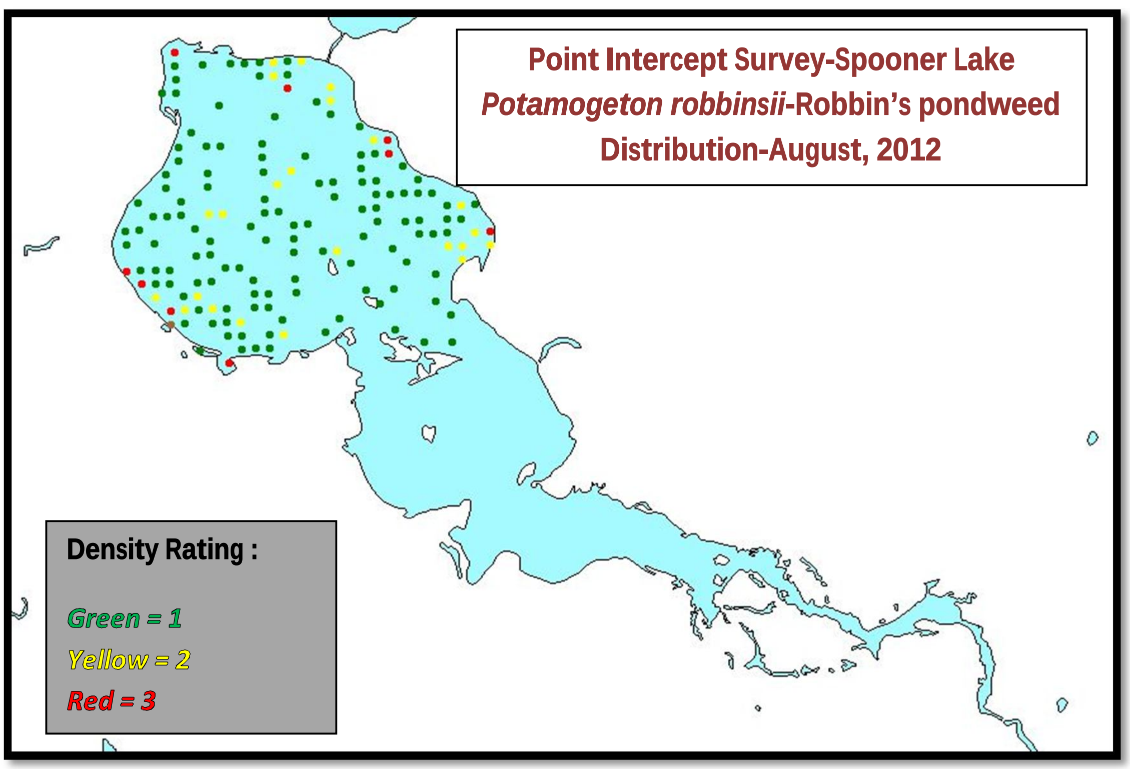


Figure 7: Distribution of <u>Potamogeton robbinsii</u>-Robbin's pondweed.

Floristic Quality Index

The Floristic Quality Index is an analysis of the plant species observed in relation to the response a lake has to development and other human practices. The higher the index value the more healthy the plant community is. The plants used in the FQI represent a "C" value which is a conservatism value ranging from 1 to 10. The higher the conservatism the less tolerant the plant is to disturbances in the lake. If a lake has a very high average conservatism value, it demonstrates that the lake has many species that are intolerant of disturbances. This in turn will give a higher FQI. By comparing the lake in question to other lakes in the Eco-region, an understanding of the health of the plant community can be determined.

FQI Value	Spooner Lake-2012	Median of Ecoregion Lakes
Number of species	32	23.5
Mean conservatism	5.44	6.2
Floristic Quality Index	30.76	28.3

Table 3: Floristic Quality Index statistics.

Spooner Lake has a higher FQI for 2012 than the median for other eco-region lakes. This appears to be due to a higher diversity (more species) since the mean conservatism is lower than the median. This indicates that Spooner Lake has less sensitive plants present even though the diversity is higher.

Non-native and invasive species

The early season (June) survey was conducted to locate the invasive species curly leaf pondweed (CLP) (*Potamogeton crispus*). Spooner Lake has been managing CLP for several years with the growth ranging extensively from year to year. In 2011 the map of CLP coverage was updated with a June survey. A June survey was also conducted in 2012, with another updated map. The CLP coverage in 2012 was significantly less than in 2011. Part of this is due to the reduction that was the result of treatment in May. The areal coverage of CLP in 2011 was 10.3 acres and in 2012 it was about 1 acre.

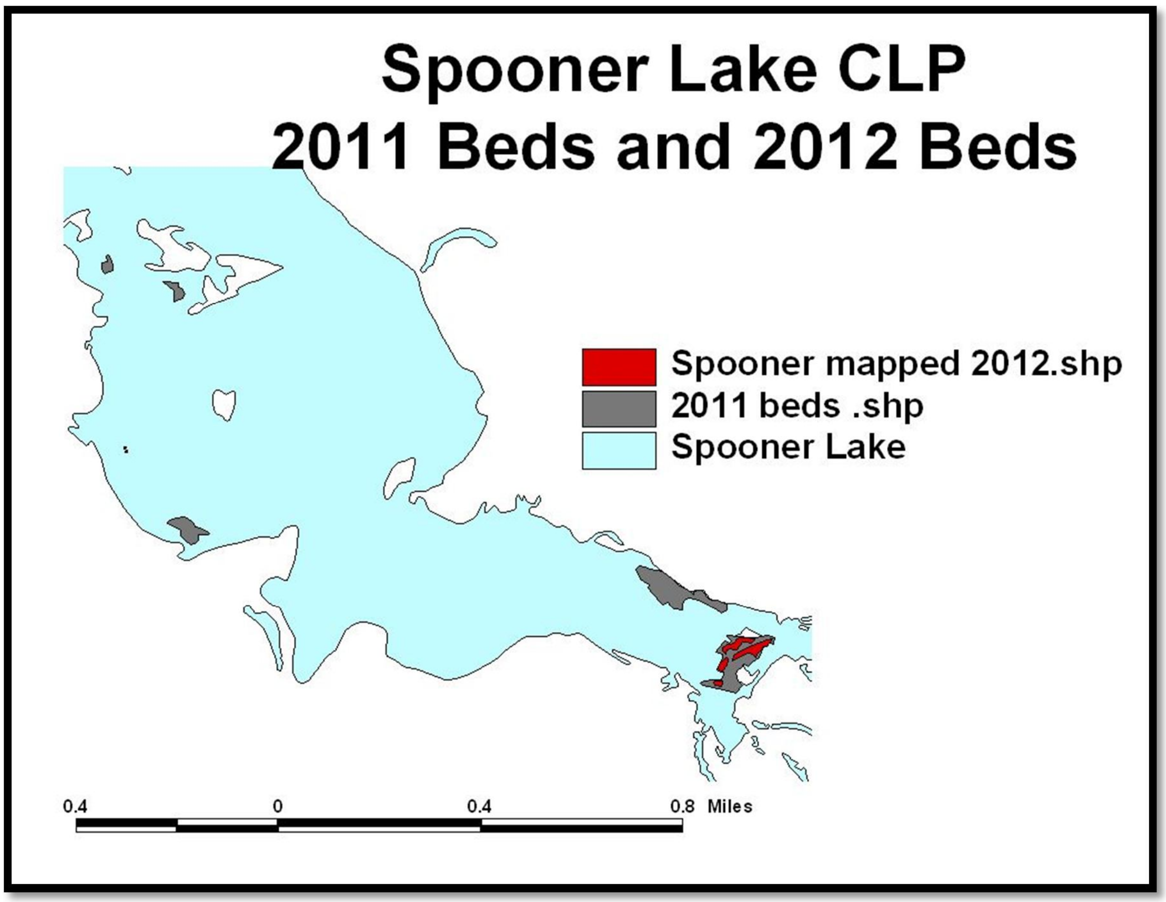


Figure 8: Curly leaf pondweed mapping-2011 and 2012.

Other exotic plants were observed on Spooner Lake in the 2012 survey in areas other than the sample point locations. These species include aquatic for-get-me-not, reed canary grass, one plant of purple loosestrife and giant reed. These locations are shown in the following maps.

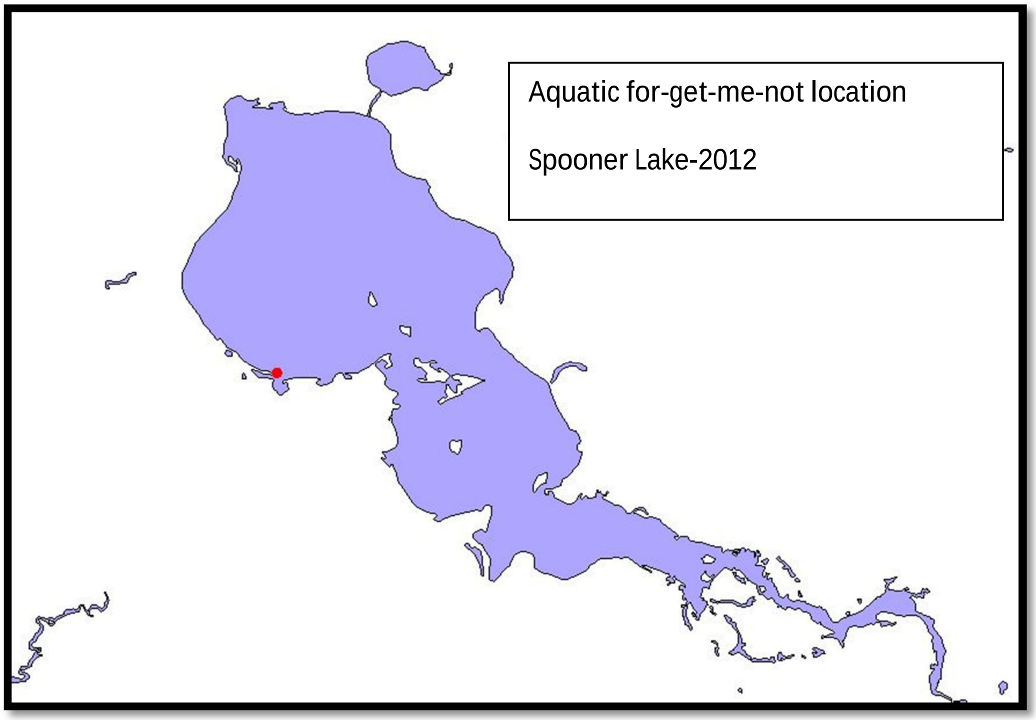


Figure 9: Aquatic for-get-me not locations.

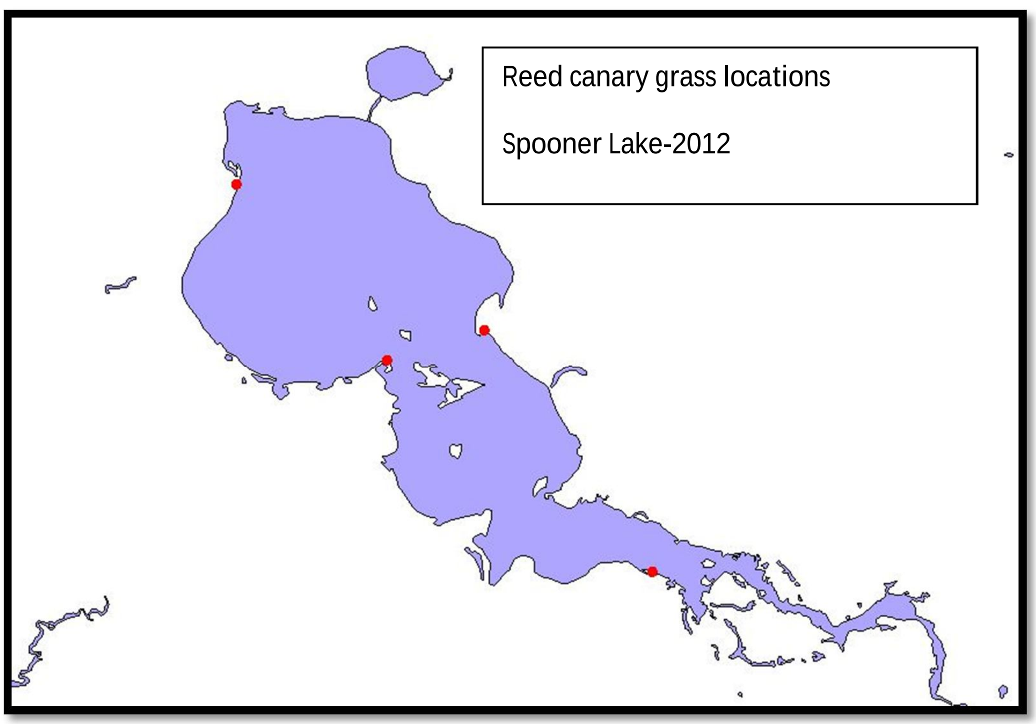


Figure 10: Reed canary grass locations.

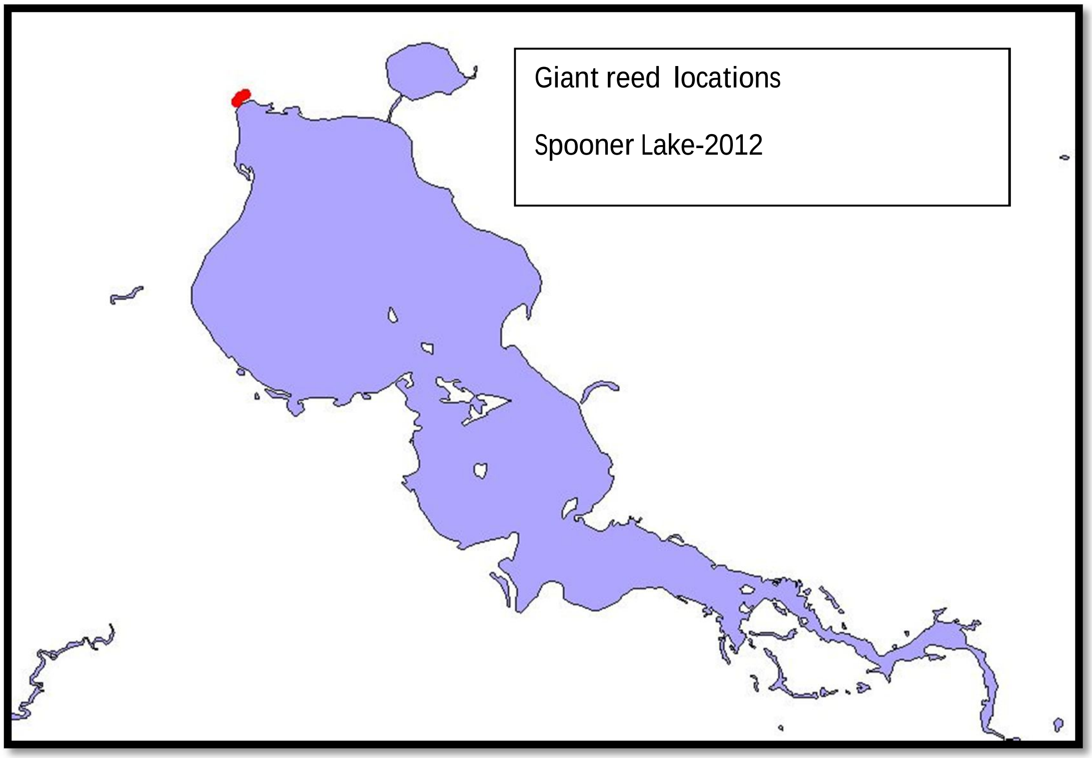


Figure 11: Giant reed (Phragmites) locations.

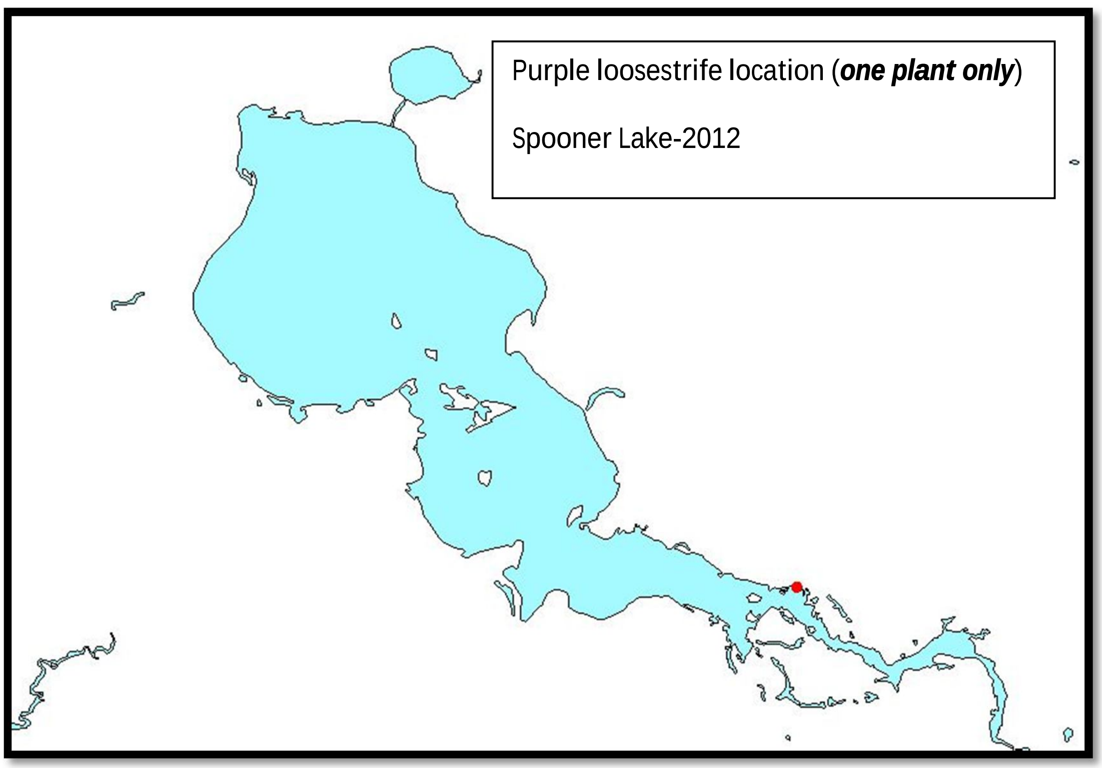


Figure 12: Purple loosestrife location.

2012 PI Survey vs 2006 Survey

In 2006 a point intercept survey using the same sample point locations was conducted. The protocol followed was the same as in 2012. The two surveys resulted in some fairly different data. Table 4 shows the similarities and differences.

Data	2006	2012
Species richness (sampled plants)	20	32
Simpson's diversity index	0.86	0.84
Number of species per sample point	3.14	2.29
Maximum depth with plants	16.50 ft	13.70 ft
% of littoral zone with plants	99.56%	96.72%

Table 4: Comparison of survey statistics of 2006 and 2012.

2006 most abundant plant species:

Potamogeton zosteriformis-flatstem pondweed (23.4%)
Myriophyllum sibiricum-northern water milfoil (17.6%)
Ceratophyllum demersum-coontail (15.2%)

2012 most abundant plant species:

Ceratophyllum demersum-coontail (31.87%)
Potamogeton zosteriformis-flatstem pondweed (16.21%)
Potamogeton robbinsii-Robbin's pondweed (10.87%)

Interestingly, there were more species of plant sampled in 2012, and yet the Simpson's diversity index and number of species per sample were lower in 2012 than in 2006. This may indicate that although there were fewer species in high enough abundance to get randomly sampled in 2006, the species that were present were more widespread allowing for more richness on each rake sample. In 2012, most of the samples were dominated by fewer species, indicating a potential shift in the plant community.

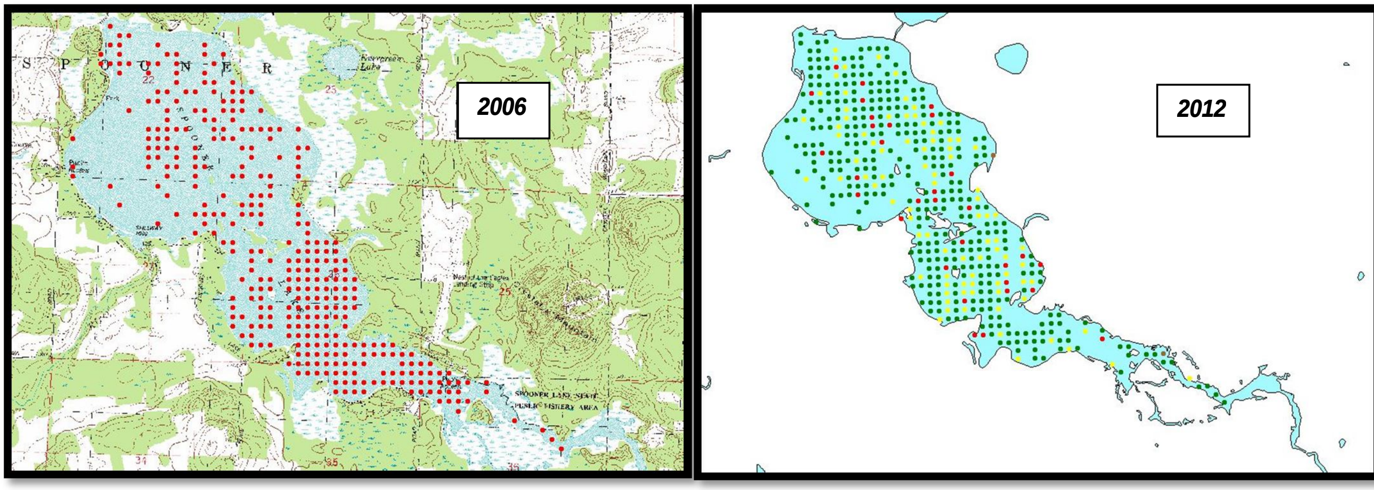


Figure 13: Coontail distribution 2006 vs 2012.

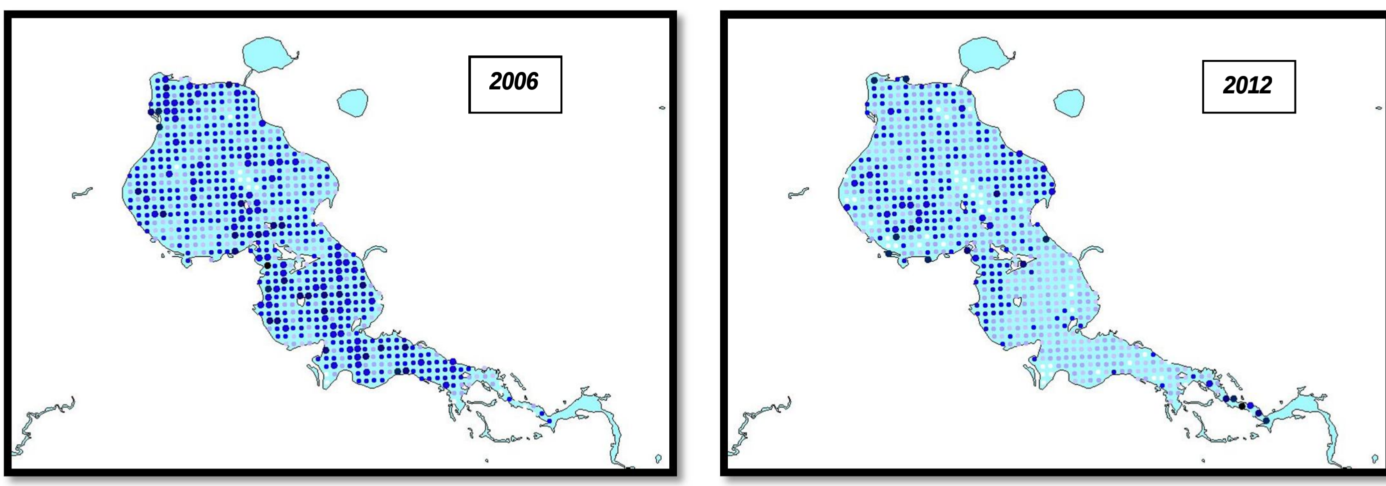


Figure 14: Number of species per point. Darker, bigger dots indicate more species.

The number of species per sample point map shows a significant difference between 2006 and 2012. It appears one area that is quite different is where the navigation channel was treated. This channel was treated in 2012, prior to the survey. Therefore it would be consistent with a plant reduction in that area, which would cause for a diversity reduction as well.

FQI

FQI Parameter	2006[2]	2012
Number of species	19	32
Mean conservatism	5.74	5.44
Floristic Quality Index	25	30.76

Table 5: Comparison of FQI values between 2006 and 2012.

Summary

The 2012 point intercept survey for Spooner Lake revealed a diverse plant community (species richness of 32) that has high density. More than 96% of the depth plants can grow (less than 13.7 ft.) had plants present. The Simpson's diversity index is moderate at 0.84, supported by a high relative frequency of coontail which was 31.87%. This high relative frequency shows that the lake is dominated by coontail. This may reflect high nutrients present throughout the growing season.

The FQI for Spooner Lake was higher than the median for lakes in the Eco-region. This appears to be due to higher diversity rather than more sensitive plants. This is consistent with the Simpson's index and the high relative frequency of the three most dominant plants.

The comparison of the PI survey from 2006 shows some similarities and many differences. The biggest change was the most dominant species. Although two of the three were the same species, the relative frequency of these two changed immensely. The biggest change was coontail, which was the third most common species in 2006 and was found to be the most common species in 2012. The relative frequency doubled from 2006 to 2012.

The differences between the two surveys could be due to several factors other than human activity. First, many of the plants sample on the rake in 2012 were simply viewed in the 2006 survey. This may account for the difference in species richness. Since the plants were viewed in 2006, they were close to the sample points and chance variation resulted in those plants being sampled. Annual variation in plant growth could account for the differences in frequencies and plants sampled in one survey year and not the other. Aquatic plant species can grow very dense one year and then be much less prominent another year due to natural

[2] The FQI for 2006 has been adjusted to match the protocol in place in 2012 (different from 2006 in that the FQI is limited to using only plants sampled on the rake which was not the case in 2006).

variation. Lastly, even though the same GPS coordinates were used, there can be small differences in sample locations due to accuracy of the GPS. The plants that were sample very few times could get missed randomly due to sample location variation from the GPS.

Another apparent difference is the maximum depth of plants. This should be investigated further as it could reflect degradation in water clarity over the past several years. The greatest depth with plants in 2006 was 16.5 feet and curly leaf pondweed was sampled at that location. The greatest depth with plants in 2012 was 13.7 feet, with filamentous algae being sampled. There were other deeper (than 13.7 feet) locations where curly leaf pondweed was sampled in 2006. Since no curly leaf pondweed (CLP) was sampled in the August 2012 survey, it is difficult to determine if the water clarity would allow CLP growth at this depth. Historical secchi depth data should be evaluated.

Since 2006 a navigation channel was established through herbicide application on a couple of occasions, with the most recent being in 2012. This herbicide application could change the frequency and/or density of the more common plant species and could be a source of some difference between 2006 and 2012. If the navigation channel was treated prior to this survey in 2012 (this is probably the case), then this is likely a cause for the differences.

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