Aquatic Plant Management Plan

Spooner Lake, Washburn County Wisconsin
WBIC: 2685200

Final Report-2007

Sponsored by: Spooner Lake Protection and Rehabilitation District

Prepared by: Harmony Environmental

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Introduction

This Aquatic Plant Management Plan is for Spooner Lake. It presents data about the plant community, watershed, and water quality of Spooner Lake. Based on this data and information, this plan provides goals as well as strategies to coordinate sound management of aquatic plants in the lake. This encompasses preservation of native species related to their benefit to the lake ecosystem, managing nuisance aquatic plants, and reducing/preventing the establishment of aquatic invasive species. The plan reviews public input, discusses management options and alternatives, and recommends action items. This plan should guide the Spooner Lakes District and Wisconsin Department of Natural Resources in plant management.

A very important theme of this and any other Aquatic Plant Management Plan is understanding the importance of aquatic plants in a lake. Spooner Lake is no different and much of this plan is based on this idea. Aquatic plants provide immeasurable benefit to the lake ecosystem. Basically this is the base of the food chain and provides the primary habitat for most any aquatic organism. The following list is just a portion of the contributions plants make to the lake:

- Provide habitat for invertebrates, fish and other wildlife.
- Provide important forage areas for fish.
- Many species of fish need plants or plant cover for reproduction.
- Plants are nature's aerators through oxygen release during photosynthesis.
- Plants reduce wave energy, which can reduce erosion.
- Plants in and around the lake stabilize shoreline areas and lake sediments.
- Aquatic plants can absorb nutrients that may otherwise be available for algae to bloom.

Public Input for Development

The Spooner Lake District board members as well as trustees provided the public input. A survey of trustees within the District as well as with visitors to Spooner Lake was conducted. In addition, comments at the 2006 annual meeting as well as the fall meeting provided further input. Both the meeting comments and the survey indicate plant management as a very important issue. The issue largely is based on concerns over nuisance plant growth, filamentous algae, and curly leaf pondweed and their management.

The Plant Management Committee was comprised of members from the Spooner Lake District. This committee reviewed all data provided and developed goals based on that data as well as comments from concerned citizens. Based on public input, the Plant Management Committee recognizes the importance of plant management in Spooner Lake. They also understand the importance of aquatic plants in the lake ecosystem and the need for education about this issue.

Plant management committee members are:

Joe Bannick
Ron Booshon
Frank Gray
John Meacham
Mike Saunders

District members survey

The Spooner Lake District conducted a survey of District trustees in 2004. The survey contained roughly 60 questions about Spooner Lake. Many of the questions pertained to lake use and lake quality concerns. For the purposes of this plan, the questions pertaining to lake ecosystem quality and concerns were focused upon. The following results were received (greatest response in bold):

Weed growth 71.3%
Algae growth 51.7%
Failing private wastewater systems 28.7%
Chemical/fertilizer runoff 27.6%
Chemical runoff from lawns 26.4%
Fish kills 17.2%
Soil erosion/sedimentation 17.2%
Animal wastes 5.7%
Soil erosion/sediment from development 5.7%
Watercraft 4.6%
Household hazardous waste 3.4%
Littering 2.3%

Appearance of lakes compared to last 10 years (greatest response in bold)

Much worse	slightly worse	about the same	slightly better	much better
11.5%	**26.4%**	23%	13.8%	5.7%

There were many comments, which are not reported here, many of which were in relation to plants growth.

Weed growth, algae growth and nutrient sources were of greatest concern, with weed growth being much higher in priority than any other item.

Spooner Lake District 2006 Annual Meeting

The Spooner Lake District voted to carry out Phase III of the four phase plan. Phase III is the completion of an aquatic macrophyte survey. Phase IV is the development of a Comprehensive Lake Management Plan, of which an Aquatic Plant Management Plan is a portion of that plan.

Spooner Lake District 2006 Fall Meeting

The results of the macrophyte survey (Phase III) were discussed with the trustees. The basic structure and components of an Aquatic Plant Management Plan was presented. It was then communicated that Phase IV is the next step, which includes completing the Aquatic Plant

Management Plan. At this time, many questions and comments were fielded. The attendees of the meeting had many valuable concerns and comments about the plan. It was stated to the public that they should also share their concerns with any committee member for representation in the planning meetings.

Public review

This plan was available for approximately one month at the Spooner Public Library for public review. Comments received are contained in the appendix. Also, a public meeting presenting the plan prior to submitting for approval took place on August 11 of 2007.

Lake Management Concerns

The aquatic plant management plan addresses the top concerns of Lake District trustees:

1. Aquatic Plants ("weeds")-Native plant protection, curly leaf pondweed control, invasive species control and nuisance plant growth reducing lake use.

2. Algae growth-Filamentous growth on lake bottom and aquatic plants.

Lake Information

Spooner lake is a 1092 acre lake located in Washburn County, Wisconsin in the Town of Spooner (T39N R12W S27); WBIC: 2685200. The lake is a drainage lake with one main inlet, Crystal Brook and an outlet, the Yellow River which is controlled by a dam. The watershed area is approximately 7811 acres. The maximum depth is 17 feet, with a mean depth of 7 feet.

The Spooner Lake District along with the Wisconsin Department of Natural Resources, sponsored water quality monitoring in 2002, 2003 and 2004. In 2006, they sponsored the completion of a plant survey. In addition, a comprehensive management plan was in progress in 2006.

Figure 1: Spooner Lake Map

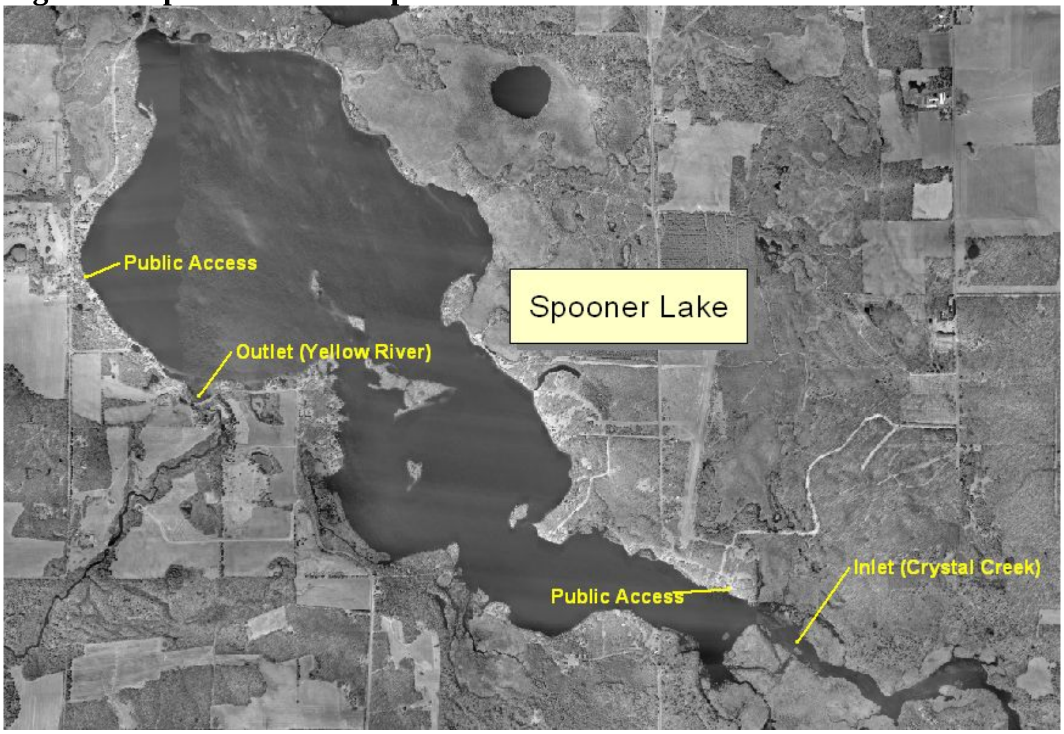
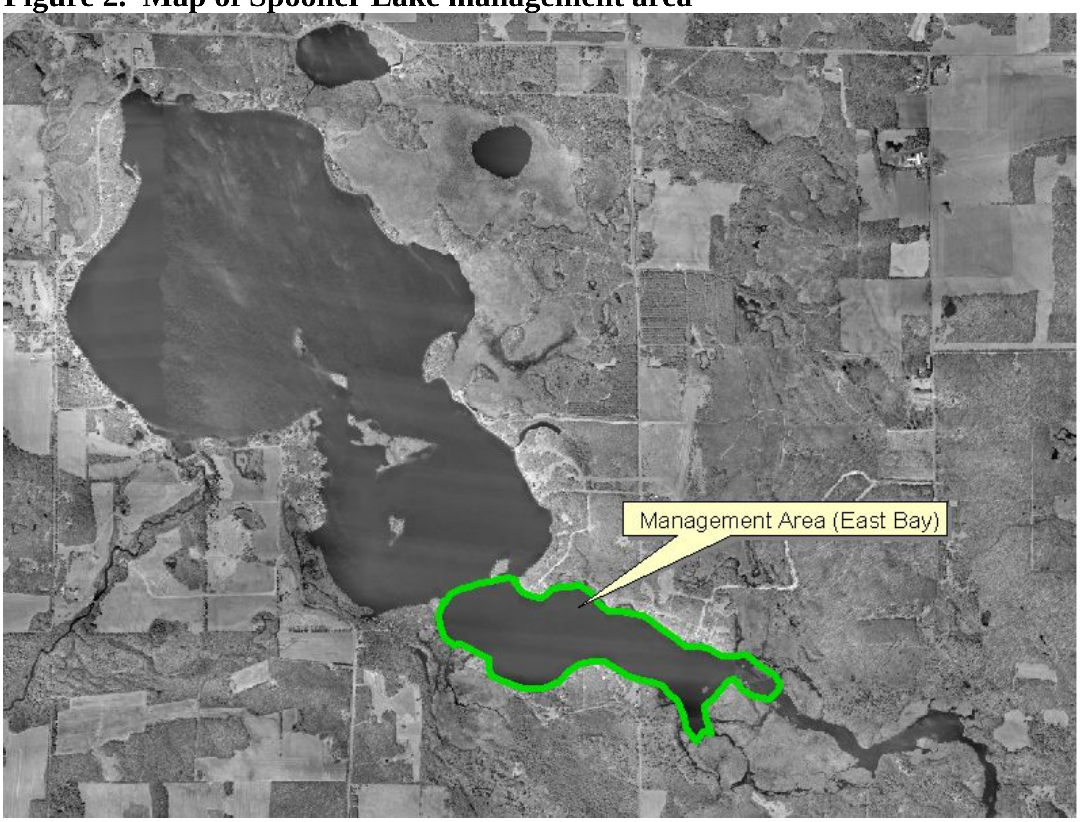


Figure 2. Map of Spooner Lake management area



Fisheries[1]

There are many significant sport species of fish present in Spooner Lake. They are northern pike, largemouth bass, bluegill, black crappie, pumpkinseed sunfish, yellow perch, black bullhead, brown bullhead, and yellow bullhead, as well as white sucker. Brown trout are present from late fall into May before they migrate back up into Crystal Brook. Historically, walleyes have been sampled. However, in a 2001 fish survey, walleyes were not sampled. In a 1991 survey, very few were sampled, and it was stated that walleye will most likely disappear in the near future. The 2001 survey supports this and it is assumed there are no walleye present. If there are, they are not reproducing and probably in very low numbers.

Table 1. Fish Spawning information[2]

Species	Spawning Temp in ^{o}F	Spawning substrate	Comments
Black Crappie	Upper 50's to lower 60's	Nests built in 1-6 feet of water	Build nests
Bluegill/Largemouth Bass and Pumpkinseed	Mid 60's to lower 70's	Nests built in less than 3 feet of water	Build nests
Northern Pike	Upper 30's to mid 40's-soon after ice-out	Emergent vegetation in 6-10 inches of water	Eggs broadcast onto vegetation
Yellow Perch	Mid 40's to lower 50's	Submergent vegetation or large woody debris	Broadcast eggs.
Bullheads[3]	70-77	Muddy bottom for blacks, sandy/rocky for browns, and heavy vegetation for yellows	Make nests in bottom and broadcast eggs into nests protected by vegetation and/or woody debris

Fisheries and Wildlife Habitat[4]

In August of 2000, an integrated sensitive area survey was conducted by the Wisconsin Department of Natural Resources. There were nine areas designated as "sensitive," containing very important habitat for fish and wildlife, as well has documenting important plant species. The map below shows the areas designated.

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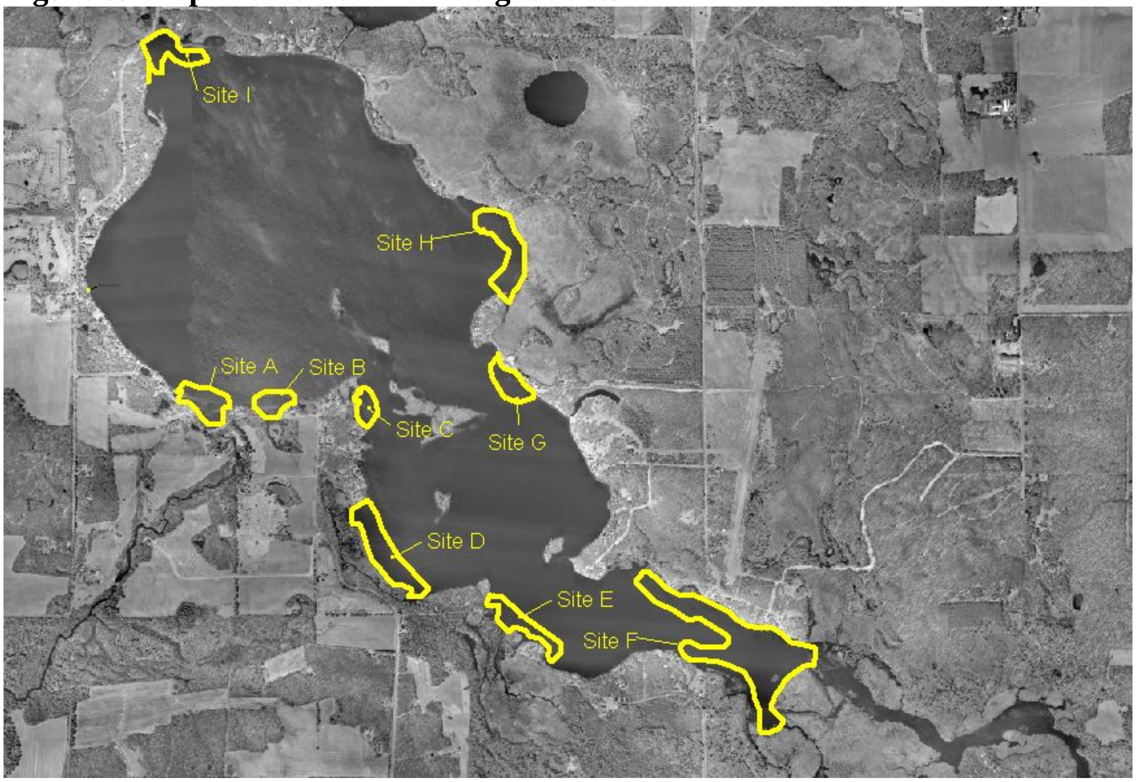
[1] Information from Larry Dammon, fish biologist, Wisconsin DNR. Personal communication.
[2] Information on spawning from Heath Benike, fish biologist. Wisconsin DNR.
[3] Information on bullheads from Mecozzi, Maureen. *Bullheads*. Wisconsin DNR Bureau of Fisheries Management. PUBL-FM-706 89. May 1989.
[4] Sensitive Area Survey. Wisconsin Dept. of Natural Resources. 200?

Figure 3. Map of sensitive area designations.



The following management guidelines are encouraged for these aquatic plant sensitive areas:

1. Limit aquatic vegetation removal to navigational channels no greater than 25 feet wide, where necessary. These channels should be kept as short in length as possible and it is recommended that there is not complete elimination of aquatic vegetation with the navigational channel. Remove only what is necessary to prevent fouling of propellers to provide access to open water areas. Chemical treatments should be discouraged and if a navigational channel must be cleared, pulling by hand is preferable over mechanical harvesters, where practical.
2. Prohibit littoral zone alterations covered by Wisconsin Statutes Chapter 30, unless such alterations clearly benefit the lake's ecosystem. Rock riprap permits should not be approved for areas that already have a healthy native plant community stabilizing the shoreline.
3. Leave large woody debris in the littoral zone to provide habitat for fish, wildlife, and other aquatic organisms.
4. Leave an adequate shoreline buffer of un-mowed natural vegetative cover and keep access corridors as narrow as possible (less than 30 ft or 30% of any developed lot, which ever is less.
5. Prevent erosion, especially at construction sites.
6. Strictly enforce zoning ordinances and support development of new zoning regulations where needed.
7. Eliminate nutrient inputs to the lake caused by lawn fertilizers, failing septic systems, and other sources.

8. Manage for invasive/exotic species.

The following are special mention made about the various sites:

The sensitive areas provide food and habitat for many fish and other aquatic species as well as some terrestrial species. Protection of these areas is strongly encouraged. Chemical treatments and/or mechanical harvesting are strongly discouraged. Historical chemical treatments and mechanical harvesting should be limited to navigational channels only and other chemical treatments/mechanical harvesting should be scrutinized.

<u>Value of Site A:</u>

This area provides important habitat for centrarchid (bass and panfish) and sucker species for spawning, feeding, protection and as nursery for young. Esocid (northern pike) will use this area for spawning, feeding, protection and as a nursery for young. This area also provides important habitat for forage species.

Wildlife is also reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, amphibians and reptiles benefit from this valuable habitat.

<u>Value of Site B</u>:

This area provides habitat for large mouth bass and northern pike. These species will use the area for spawning, feeding, protection and as nursery for young. This area also provides important habitat for forage species.
Wildlife value is the same as Site A.

<u>Value of Site C:</u>

This area provides important habitat for centrarchid (panfish) and esocid (northern pike). These species will use this area for spawning, feeding, protection and as nursery for young. This area also provides important habitat for forage species.
Wildlife values same as Site A.

<u>Value of Site D:</u>

This sensitive area rates as outstanding for natural scenic beauty.

This area provides important habitat for centrachid (panfish and bass) and esocid (northern pike). Northern pike will use this area for spawning. Small mouth bass and panfish will use this area for feeding and protective cover. This area also provides important habitat for forage species.
Wildlife values same as other sites.

<u>Value of Site E:</u>

This sensitive area rates as outstanding for natural scenic beauty.

This area provides important habitat for centrarchid and esocid. Northern pike and panfish will use this area for spawning, feeding, protection, and as nursery for young. Large mouth bass will use this area for feeding, protection and as a nursery for young.
Wildlife values same as other sites.

Value of Site F:

This sensitive area has good natural scenic beauty with no development.
Fish and wildlife value is very similar to other sites.

Value of Sites G, H and I:

These areas were stated to have average natural scenic beauty.
The fish and wildlife values are very similar to other sites.

Water quality[5]

Table 2. Historical water quality data

Date	Total Phosphorus(mg/L)	Chlorophyll a (ug/L)	Secchi depth(m)
6/27/02	0.028	15.3	1.4
7/30/02	0.070	49.3	0.7
8/29/02	0.078	48.4	0.85
3/18/03	0.042	N/A	N/A
4/29/03	0.026	5.68	2.7
Date	**Total Phosphorus(mg/L)**	**Chlorophyll a (ug/L)**	**Secchi depth(m)**
6/9/2004	0.035	9.1	1.9
6/21/2004	0.035	n/a	2.5
7/2/2004	0.024	6.2	1.7
7/12/2004	0.023	8.2	2.2
7/20/2004	0.025	8.1	1.9
7/28/2004	0.033	8.8	1.7
8/12/2004	0.028	8.5	3.0
8/25/2004	0.026	6.7	2.5

The water quality data from 2002 indicates a eutrophic lake, while 2004 data indicates a somewhat eutrophic lake. The total phosphorus values from June until the end of August in 2002 range from 0.028 mg/L to 0.078 mg/L. The first is just below the eutrophic range while the next two readings were well above. In 2004, they ranged from 0.023 mg/L to 0.035 mg/L, which are just below and just above the eutrophic threshold according to the Carlson Trophic Index. The chlorophyll-a values ranged from 15.3 micrograms/L to 49.3 micrograms/L, in 2002. All of these values are eutrophic. In 2004, they ranged from 7 to 9 micrograms/L, which is also just below and just above the eutrophic threshold. The Secchi

[5] Water Quality and Lake-Stage Data for Spooner Lake near Spooner, WI for 2004. Data Summary USGS. April 14, 2005.

depth readings support both of these trophic states. All readings were in the eutrophic range in 2002 and in the mesotrophic/eutrophic range in 2004. From June 2002 to August 2004, the Trophic State Indices calculated were consistently in the eutrophic range, with a few time periods just under the eutrophic threshold. Therefore, it appears Spooner Lake is eutrophic, ranging from slightly to well into the eutrophic range.

Depth profiles of temperature show the lake does not stratify at any point during the summer months. This will allow for water to mix in the water column during storms and wind events. In addition, the dissolved oxygen profiles conducted in 2004 indicate that the lake becomes anoxic in the deep hole during a very short period of time in July. This could allow for a small phosphorus release from the sediments, but should be minimal with the small time it is anoxic.

The historical data is very limited, so it is difficult to discuss any trends. When comparing the 2002 data to the 2004 data, it is very evident the lake responded very differently in these two years. With no more information, it is difficult to even speculate about the causes for these differences. It can be stated that Spooner Lake had rather substantial algae blooms in 2002, and not in 2004. The lake has the potential to have very high nutrient levels and therefore high production. As a result, the presence of macrophytes may play a vital role in absorbing excess nutrients that would otherwise be available for algae to grow excessively.

Watershed description

The Spooner Lake watershed totals 7811 acres. The watershed is large, mainly due to the inlet of Crystal Creek, which has a vast watershed area. Crystal Creek is a cold-water stream that flows continuously throughout the entire year. Its water budget contributions and nutrient load contributions are unknown at this time.

The land use has been determined for the Spooner Lake watershed. The most dominant land use category is forested. It comprises approximately 54% of the watershed land use. Grassland is the next most dominant at 15% followed by wetland at 14%. Agriculture makes up about 6% of the land use. This watershed should have less impact on the lake than it would if agriculture made up a greater portion of the landcover.

There is a fair amount of development on Spooner Lake. The buildings present can be seen on the topographical map as small, black squares (Figures 4 and 5). The percentage of shoreline developed is unknown at this time. Most of the development is on the west shore and on the north and south shore toward the inlet. Much of the east shore is undeveloped and is comprised of a large area of wetlands.

Figure 4. Northern portion topographical map of Spooner Lake.

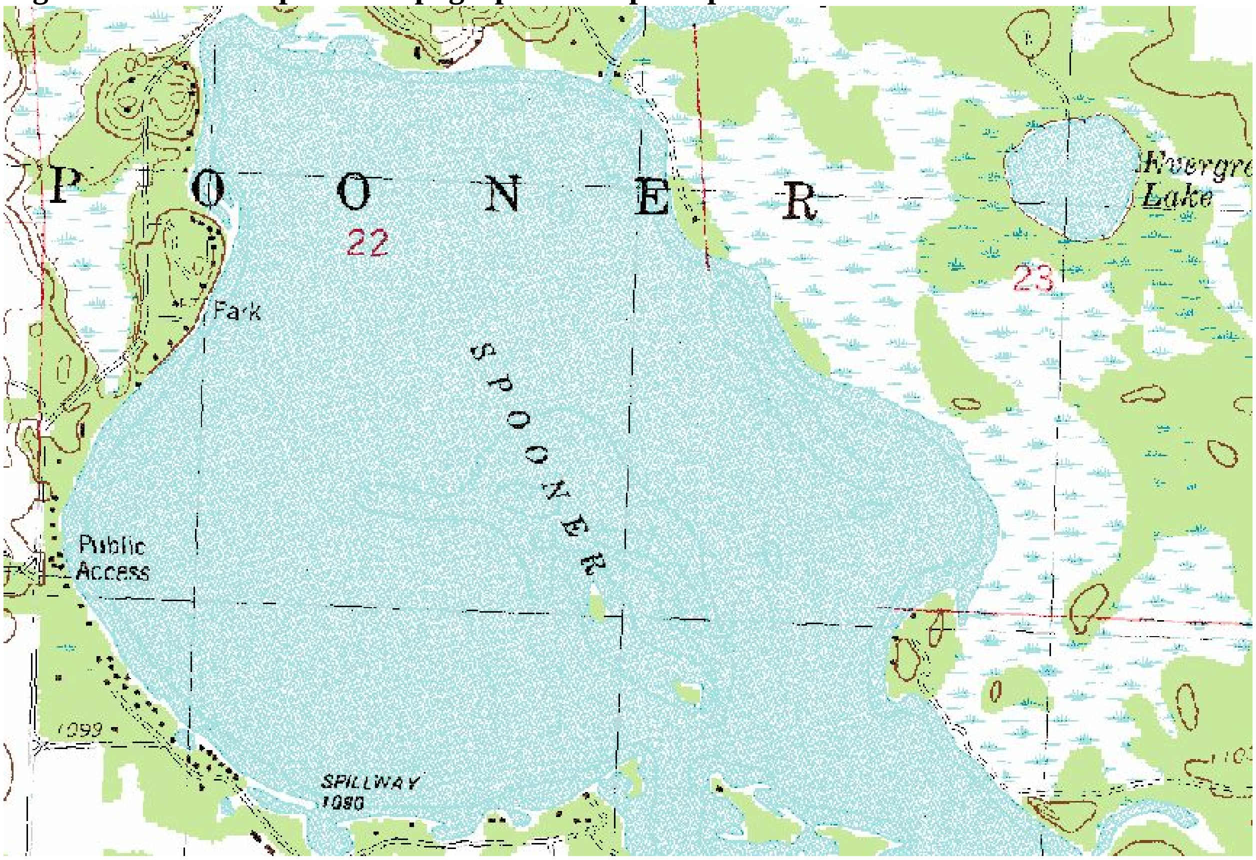


Figure 5. Southern portion topographical map of Spooner Lake.

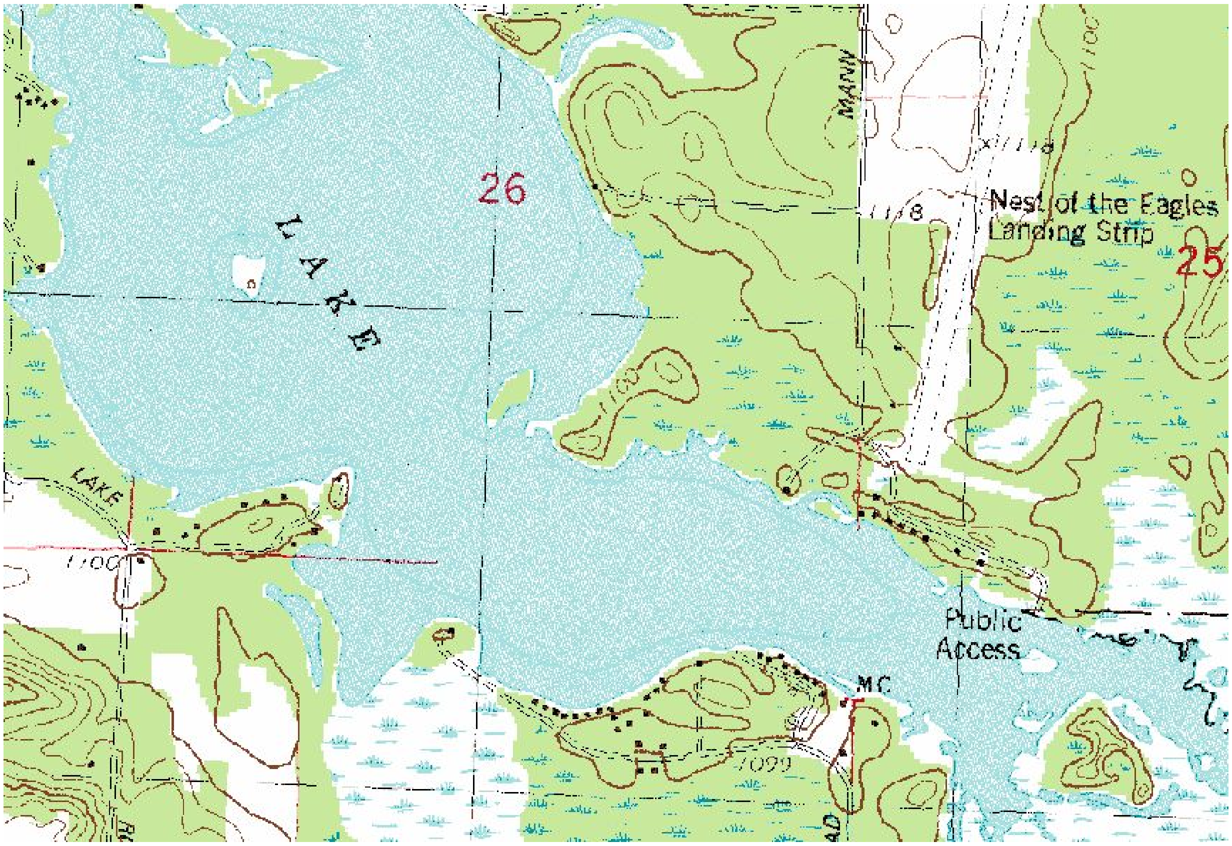
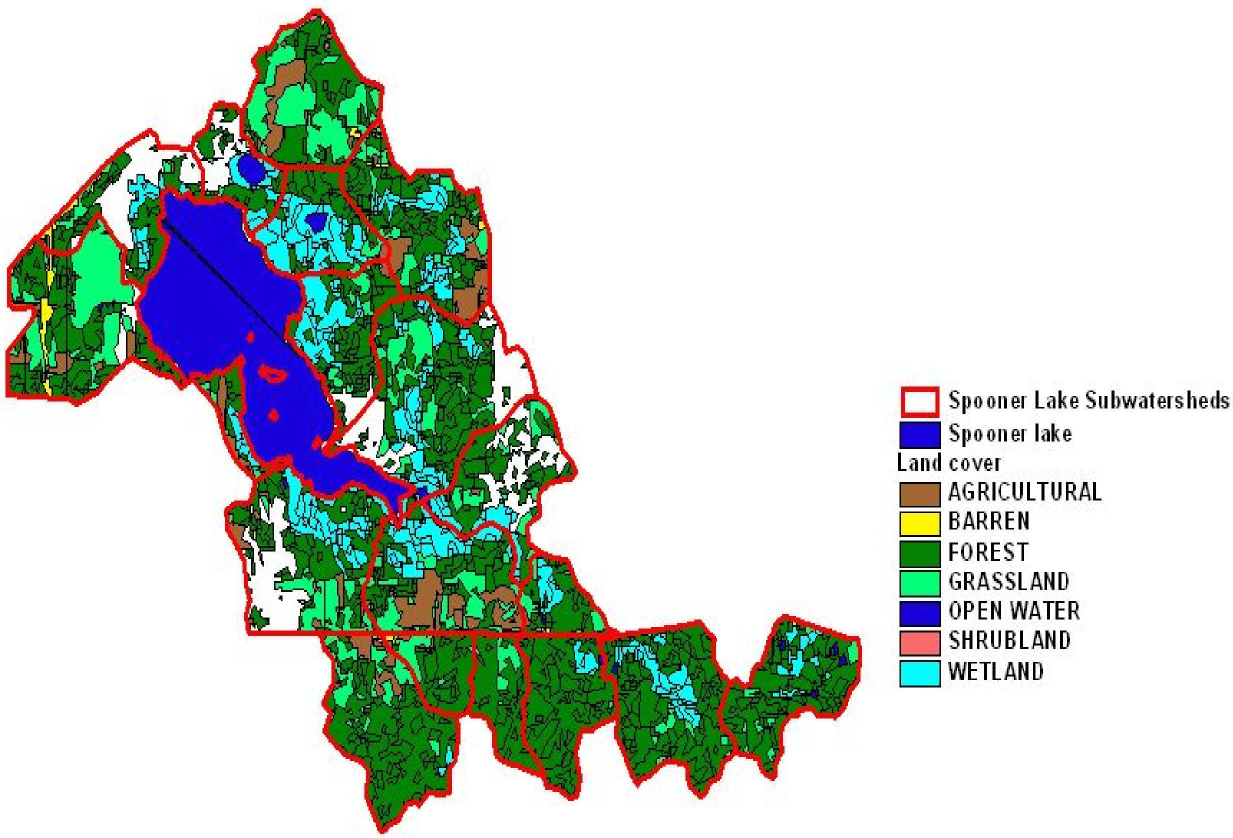


Figure 6. Watershed map of Spooner Lake[6].



[6] Map provided by Cedar Corp. Menomonie, Wisconsin. 2006

Table 3. Current and predicted land use acreage[7].

Current **Acres**

AGRICULTURAL Total	748.66
COMMERCIAL Total	2.52
FOREST Total	4,457.28
GRASSLAND Total	1,059.45
OPEN WATER Total	59.07
RECREATION Total	136.36
RURAL RESIDENTIAL Total	41.04
SINGLE FAMILY Total	168.70
WETLAND Total	1,138.07
Grand Total	7,811.15

Future

AGRICULTURAL Total	615.01
COMMERCIAL Total	317.82
FOREST Total	4,135.74
GRASSLAND Total	945.34
OPEN WATER Total	58.77
RECREATION Total	136.36
RURAL RESIDENTIAL Total	68.02
SINGLE FAMILY Total	396.02
WETLAND Total	1,138.07
Grand Total	7,811.15

As noted in the percent breakdown of the watershed land cover, the present situation shows forested the most land cover in the watershed. The highest two land uses that could have significant impact are agriculture and single family residential, which are both a small percentage of the total watershed. In the future agriculture is predicted to decrease while commercial and single-family residential are predicted to increase significantly. Commercial can also tend to have a high contribution of runoff and nutrient loads. Again, maintaining the native plant community may be very beneficial to the lake in light of these increased nutrient loads since they can absorb excess nutrients.

[7] This data provided by Cedar Corp., Menomonie, Wisconsin. 2006

Table 4. Modeled loads of current watershed and predicted future watershed land uses[8].

Current Land Use

WATER SHED ID	AREA (Acres)	TSS (lb/yr)	P (lb/yr)	N (lb/yr)
A	388.48	4,931.26	23.18	70.06
B	525.91	5,587.60	31.00	79.38
C	353.82	4,254.39	18.06	60.39
D	199.57	2,720.14	14.87	47.90
E	168.18	10,230.94	19.75	84.93
F	544.15	41,801.87	70.00	332.94
G	664.93	64,935.41	117.87	500.91
H	538.02	109,117.95	153.19	775.71
I	167.76	6,233.29	18.16	55.23
J	416.41	6,107.32	33.93	74.95
K	787.53	28,653.67	84.31	271.28
L	362.15	15,813.87	39.51	139.88
M	104.29	27,240.85	47.41	250.38
N	626.57	159,150.99	199.38	1,243.00
O	378.87	58,009.18	107.85	511.89
P	219.28	3,793.71	16.63	50.76
Q	321.09	7,664.21	74.34	88.49
R	543.68	104,748.69	120.78	750.90
S	500.46	107,922.86	134.82	780.31
TOTALS	1,894.12	768,918.21	1,325.05	6,169.31

Future Land Use

WATER SHED ID	AREA (Acres)	TSS (lb/yr)	P (lb/yr)	N (lb/yr)
A	388.48	4,931.26	23.18	70.06
B	525.91	5,587.60	31.00	79.38
C	353.82	4,254.39	18.06	60.39
D	199.57	2,720.14	14.87	47.90
E	168.18	10,230.94	19.75	84.93
F	544.15	41,801.87	70.00	332.94
G	664.93	71,255.31	138.07	598.65
H	538.02	109,117.95	153.19	775.71
I	167.76	6,233.29	18.16	55.23
J	416.41	12,560.45	50.64	166.61
K	787.53	34,570.96	102.98	355.32
L	362.15	23,177.00	62.49	244.46
M	104.29	27,553.13	48.40	254.82
N	626.57	190,938.85	497.68	2,341.24
O	378.87	89,135.80	257.31	1,140.10
P	219.28	7,926.06	29.66	109.45
Q	321.09	7,664.21	74.34	88.49
R	543.68	104,748.69	120.78	750.90
S	500.46	107,922.86	134.82	780.31
TOTALS	1,894.12	854,089.92	1,839.38	8,219.84

Due to the predicted land use changes, the resultant loading that is predicted is over 500 lbs of phosphorus per year. This represents a 38.8% increase in phosphorus loading per year. This is a very large increase, which could result in large increases in unicellular algae, filamentous algae, and plant growth. The control of filamentous algae and unicellular algae may depend on reducing the potential increase in nutrient loading into Spooner Lake.

[8] This data provided by Cedar Corp. Menomonie, Wisconsin. 2006

Plant community

In July 2006 a whole lake macrophyte survey was conducted. The survey showed a very diverse plant community with 29 species of native, vascular plants being sampled or observed visually within six feet of the boat. Two algae species were sampled, filamentous algae and *Chara sp.* Please refer to Table 5, which lists the species sampled and visually observed. One species of non-native vascular plant was sampled, *Potamogeton crispus* (curly leaf pondweed).

Below is a map of the points sampled (Figure 7) on Spooner Lake, followed by a map (Figure 8) of the few points that had no plants present. Of the 696 sampled points, only seven were lacking plants. This indicates a plant coverage of 99% of the entire lake.

As can be observed in Table 5, the most dominant plant is *Potamogeton zosteriformis,* with a relative frequency of 23.4% and a frequency of occurrence of 75.66%. *Potamogeton zosteriformis* is a native pondweed that is very common in Wisconsin lakes. This plant over-winters by rhizomes and winter buds. There is limited reproduction by seeds. Flat-stem pondweed is an important food source for various waterfowl as well as mammals that frequent aquatic areas such as muskrat and beaver. It also provides a food source and cover for invertebrates and fish.

Other common species were *Myriophyllum sibiricum* (Northern water milfoil) and *Certaphyllum demersum* (Coontail). Northern milfoil is a native milfoil commonly found in Wisconsin Lakes. It closely resembles Eurasian water milfoil, which is non-native. Northern water milfoil mainly reproduces vegetative with winter bud production, while seed reproduction is limited. It provides key habitat for invertebrates and provides important forage and cover areas for fish. Coontail is also a common plant. It can live in very deep water and its dominance can indicate high nutrients and grow to nuisance levels. This is not the case in Spooner Lake as it is not the dominant plant throughout the entire lake. There are areas that coontail is fairly dense, namely in the management area. Coontail is not rooted and can live in low light conditions, allowing it to over winter as an evergreen. Most new plants come primarily from stem fragments. As with other plants, Coontail provides great habitat for fish and invertebrates.

Figure 7: Map of aquatic plant sample points in Spooner Lake

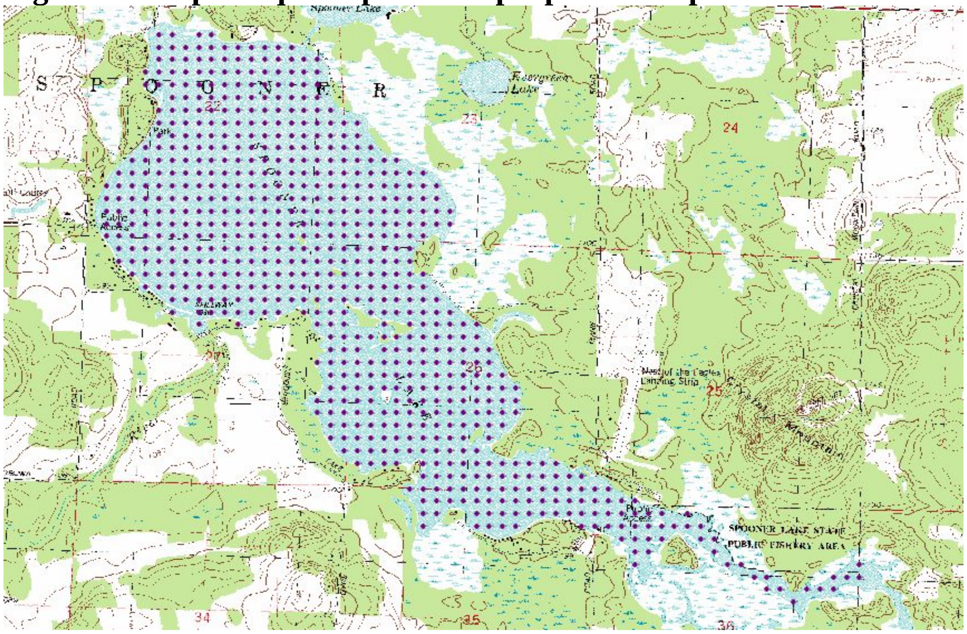


Figure 8: Map of sample points lacking plants in Spooner Lake

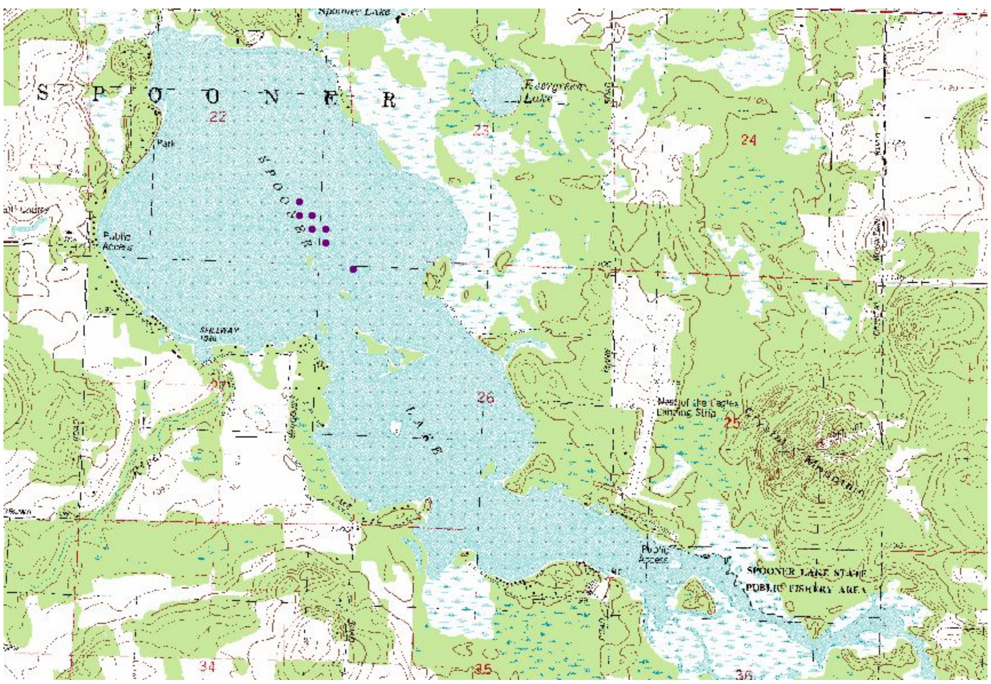


Table 5. Species list from aquatic plant survey

Species	Common name	Relative Freq.(%)
Potamogeton zosteriformis	Flat stem pondweed	23.4
Myiophyllum sibiricum	Northern milfiol	17.6
Ceratophyllum demersum	Coontail	15.2
Potamogeton friesii	Fries pondweed	13.6
Potamogeton robbinsii	Fern pondweed	9.9
Filamentous algae		4.7
Elodea canadensis	Common waterweed	3.7
Potamogeton crispus	curly leaf pondweed	3
Vallisnaria americana	Wild celery	2.2
Najas flexilis	Bushy pondweed	1.7
Potamogeton pectinatus	Sago pondweed	1.5
Potamogeton pusillus	Small pondweed	1.3
Potamogeton amplifolius	Large leaf pondweed	1.1
Zosterella dubia	Water stargrass	0.6
Potamogeton praelongus	White-stem pondweed	0.5
Chara sp.	Muskgrass	0.3
Potamogeton richardsonii	Clasping leaf pondweed	0.3
Lemna minor	small duckweed	0.2
Nymphaea odorata	white water-lily	0.1
Ranunculus aquatilis	white water crowfoot	0.1

Species of aquatic plant observed	Common name
Megalodonta beckii	Buttercup
Carex comosa	Bottle brush sedge
Iris versicolor	Blue flag iris
Nuphar variegata	Spatterdock
Phragmites australis	Giant reed
Pontederia cordata	Pickerelweed
Sagittaria graminea	Grass leaved arrowhead
Schoenoplectus acutus	Hardstem bulrush
Schoenoplectus tabernaemontani	Softsem bulrush
Schoenoplectus fluviatilis	River bullrush
Sparangium sp.	Burreed
Typha latifolia	Broad leaf cattail

Non-native species

Spooner Lake contains a vast, diverse plant community. The plants do reach what could be constituted as nuisance levels in the southeast region near the inlet (management area). During both the early and late season survey, it was very difficult to navigate through these areas. The rest of the lake has extensive plant coverage, but does not seem to impede navigation. This plant coverage may be advantageous beyond the basic need for plants through the absorption of excess nutrients. Spooner Lake has a very large watershed and based on the plant community observed and the historical water quality; there are abundant nutrients available. However, in 2004 the lake had a rather high water clarity and relatively low phosphorus level. It may be that the extensive macrophyte growth is reducing the phosphorus and other nutrients that would otherwise be available to unicellular algae. This increase in algae growth results in lower water clarity.

This picture represents some of the nuisance levels of growth in the east bay.

Other important statistics are as follows:

Species richness (including visual observation): 32
Average number of species per sample site: 3.23
Simpson's Diversity Index: 0.86 (1.0 is the highest possible)
Frequency of sites sampled with vegetation: 99.56%

The above statistics indicate that the plant community is very diverse. The closer to 1.0 the Simpson's Index the more diverse. The value for Spooner Lake is 0.86 which is rather high. Also, the species richness is high. The average rake fullness and the percentage of sampled sites with vegetation indicate extensive plant coverage and biomass. This can also indicate the potential for nuisance levels of aquatic plants.

There were numerous sites with filamentous algae. During the plant survey, many areas were found to have very dense mats of filamentous algae blanketing plants and the lake bottom. Please see Figure 7, which is a map of filamentous algae sites. In the east bay management area the density of filamentous algae was very high with consistent rake densities of 2 or 3.

Floristic Quality Index:

The Floristic Quality Index (FQI) 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 . 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 (which can lead to lower water quality and sediment composition changes). This in turn will give a higher FQI. By comparing the lake in question to other lakes in the ecoregion, an understanding of the health of the plant community can be determined.

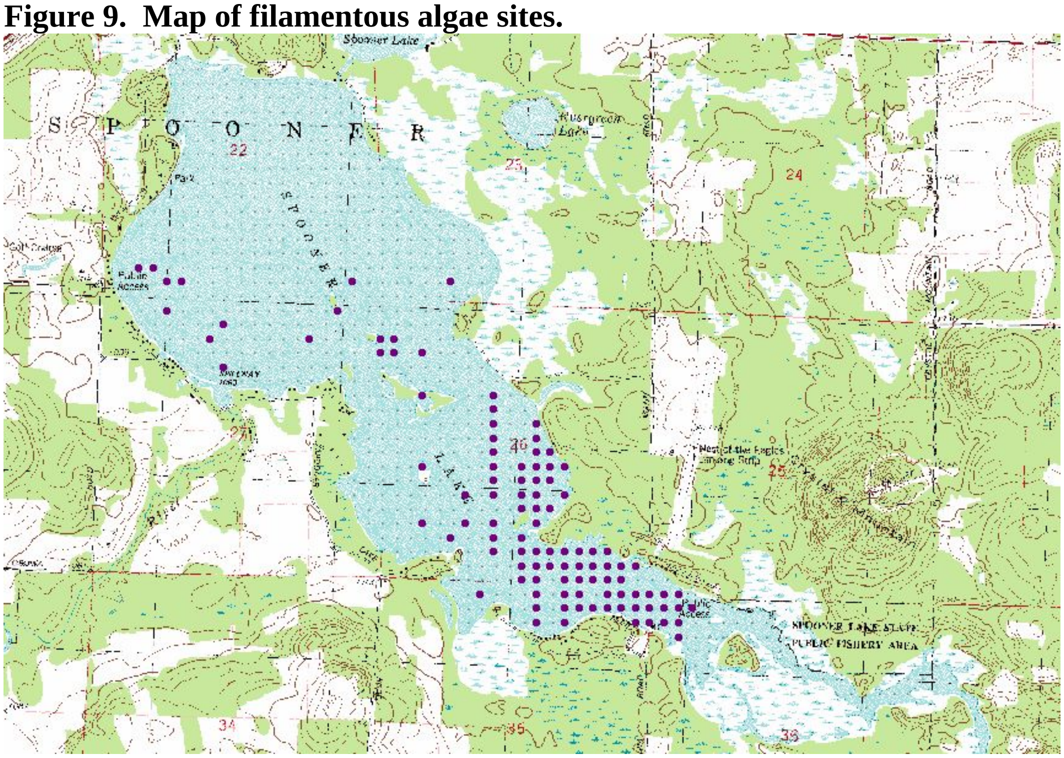
Table 6. Floristic Quality Index data.

Ecoregion of Spooner Lake =Northern Lakes and Forests, flowages

	Spooner Lake	Median for ecoregion
Number of species	28	23.5
Mean conservatism	6.0	6.2
FQI	31.75	28.3

The only segment that Spooner Lake was less than median lakes in the ecoregion was for mean conservatism. However, with such a diverse community, the FQI value is higher than the median for lakes (flowages) studied in the ecoregion. For this reason, we may conclude that the plant community indicates one of good health, diversity and demonstrates few disturbances.

Figure 9. Map of filamentous algae sites.

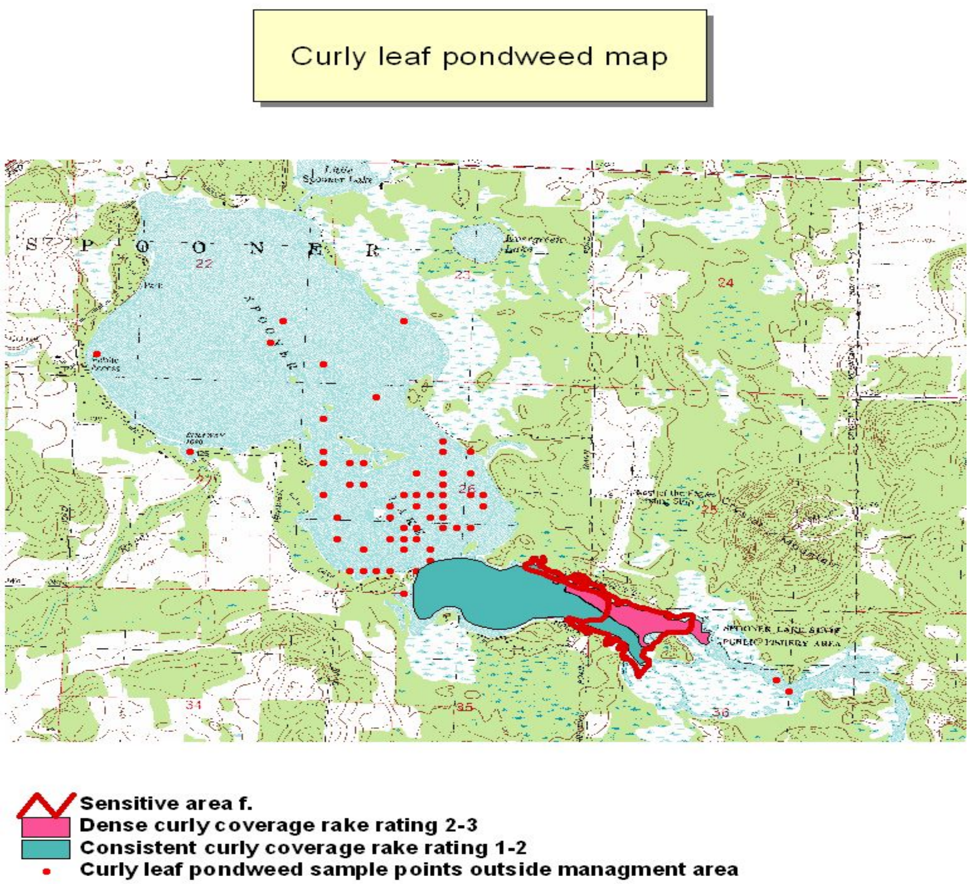


The only non-native plant sampled was *Potamogeton crispus* (curly leaf pondweed). Its relative abundance was low (3%) in the later full survey, but it was very frequent in the early summer survey, which was completed prior to the time curly leaf pondweed tends to die back. Curly leaf pondweed is non-native, cold-water loving plant. It tends to grow in highly nutritive sediments. It reproduces mainly by the production of turions. These turions settle into the sediment in July when the plants tend to die. In late summer to early fall, the turions germinate into new plants. These plants will continue to grow throughout the winter and then grow very quickly in the spring. Sometimes they can reach nuisance levels and reach the surface, appearing to be the only plant present. Later in July, these plants will began to die, releasing the turions they produced in the spring and summer.

In areas of development, the near shore vegetation is mostly lawn. In areas without development, the shoreline vegetation is a mostly shrub, leading to a tree layer. There are some large areas of wetlands that border the lake that appear to have a rather diverse collection of wetland plants growing. These include *Typha sp. Sagittaria sp., Schoenoplectus sp.* and *Phragmites sp.*

Curly leaf pondweed was the one non-native plant located in both the June and July survey. Extensive coverage of curly leaf pondweed was observed and mapped during the June survey.

Figure 10. Map of curly leaf pondweed (*Potamogeton crispus*)



Invasive Species of Concern

Curly leaf pondweed

The seriousness of curly leaf pondweed infestation is somewhat unclear. The lack of clarity on the issue rests on the likelihood of further spread of curly leaf pondweed throughout Spooner Lake, and the resultant impacts on native plants and fish and wildlife habitat. A related question is whether treatment in the form of herbicide application is likely to be effective for long-term, whole lake control and if the result will cause more harm than good to native plant populations. Clear answers regarding these potential impacts are not available. However, it is unlikely that herbicide application will result in complete elimination of curly leaf pondweed. It is possible that management can reduce the spreading of the non-native plant, especially in the main portion of the lake. In the management area (east bay), the growth of curly leaf pondweed is so extensive that treatment would probably have minimal impact and would have adverse affects on the native plant community.

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c)."

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly-leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly-leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly-leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[9]

The state of Minnesota DNR web site explains that curly leaf pondweed often causes problems due to excessive growth. At the same time, the plant provides some cover for fish and some waterfowl species feed on the seeds and winter buds.[10]

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[9] Wisconsin's Comprehensive Management Plan To Prevent Introductions and Control Existing Populatins of Aquatic Invasive Species. Prepared by: Wisconsin Department of Natural Resource. September 2003.

[10] Information from Minnesota DNR (www.dnr.state.mn.us/aquatic_plants).

The following description is taken from a Great Lakes Indian Fish and Wildlife Commission handout.

Curly leaf pondweed (*Potamogeton crispus*)[11]

Identification:

Curly leaf pondweed is an invasive aquatic species found in a variety of aquatic habitats, including permanently flooded ditches and pools, rivers, ponds, inland lakes, and even the Great Lakes. Curly leaf pondweed prefers alkaline or high nutrient waters 1 to 3 meters deep. Its leaves are strap-shaped with rounded tips and undulating and finely toothed edges. Leaves are not modified for floating, and are generally alternate on the stem. Stems are somewhat flattened and grow to as long as 2 meters. The stems are dark reddish-green to reddish-brown, with the mid-vein typically tinged with red. Curly leaf pondweed is native to Eurasia, Africa and Australia and is now spread throughout most of the United States and southern Canada.

Characteristics:

New plants typically establish in the fall from freed turions (branch tips). The winter form is short, with narrow, flat, relatively limp, bluish-green leaves. This winter form can grow beneath the ice and is highly shade-tolerant. Rapid growth begins with warming water temperatures in early spring – well ahead of native aquatic plants.

Reproduction and dispersal:

Curly leaf pondweed reproduces primarily vegetatively. Numerous turions are produced in the spring. These turions consist of modified, hardened, thorny leaf bases interspersed with a few to several dormant buds. The turions are typically 1.0 – 1.7 cm long and 0.8 to 1.4 cm in diameter. Turions separate from the plant by midsummer, and may be carried in the water column supported by several leaves. Humans and waterfowl may also disperse turions. Stimulated by cooler water temperatures, they germinate in the fall, over-wintering as a small plant. The next summer they mature, producing reproductive tips of their own. Curly leaf pondweed rarely produces flowers.

Ecological impacts:

Rapid early season growth may form large, dense patches at the surface. This canopy overtops most native aquatic plants, shading them and significantly slowing their growth. The canopy lowers water temperature and restricts absorption of atmospheric oxygen into the water. The dense canopy formed often interferes with recreational activities such as swimming and boating.

In late spring, curly leaf pondweed dies back, releasing nutrients that may lead to algae blooms. Resulting high oxygen demand caused by decaying vegetation can adversely affect fish populations. The foliage of curly leaf pondweed is relatively high in alkaloid compounds possibly making it unpalatable to insects and other herbivores.

[11] Information from GLIFWC Plant Information Center (http://www.glifwc.org/epicenter).

Curly leaf pondweed control:
Small populations of curly leaf pondweed in otherwise un-infested water bodies should be attacked aggressively. Hand pulling, suction dredging, or spot treatments with contact herbicides are recommended. Cutting should be avoided because fragmentation of plants may encourage their re-establishment. In all cases, care should be taken to remove all roots and plant fragments, to keep them from re-establishing.

Control of large populations (such as those found in Spooner Lake) requires a long-term commitment that may not be successful. A prudent strategy includes a multi-year effort aimed at killing the plant before it produces turions, thereby depleting the seed back over time. It is also important to maintain, and perhaps augment, native populations to retard the spread of curly leaf and other invasive plants. Invasive plants will aggressively infest disturbed areas of the lake, such as those where native plant nuisances have been controlled through chemical applications. Due to the extensive coverage and density of this plant in Spooner Lake, it may be prudent to "contain" its spread outside of the management area.

Eurasian watermilfoil[12]
The ecological risks associated with an infestation of Eurasian water milfoil appear to surpass those associated with curly leaf pondweed. This plant is also not present in Spooner Lake. However, there is a risk that Eurasian water milfoil may become established in Spooner Lake.

Public boat landings are located at the west side of the lake and the southeast corner of the Lake . Many fishermen may travel from the Twin Cities, Minnesota metropolitan area, and access the lake at this boat landing. With Eurasian water milfoil present in many urban Twin Cities lakes, such as White Bear Lake and Lake Minnetonka, the danger of transporting plant fragments on boats and motors is very real. The lake is also situated near a major highway, providing easy access to the Twin Cities. According to the Minnesota Sea Grant Office:

> *Eurasian water milfoil can form dense mats of vegetation and crowd out native aquatic plants, clog boat propellers and make water recreation difficult. Eurasian water milfoil has spread to over 150 lakes [in Minnesota], primarily in the Twin Cities area.*

Department of Natural Resource scientists have also found Eurasian water milfoil in the nearby counties of Burnett (Ham Lake and Round Lake) Washburn (Nancy Lake, Totagatic River and the Minong Flowage), Barron (Beaver Dam, Sand, Kidney, Shallow, Duck, and Echo Lakes), Sawyer (Callahan, Clear, Conners, Little Round, Mud, Osprey, Round Lakes and Lake Chippewa, Raddison flowage) and Polk (Long Trade) in Wisconsin.

The following Eurasian water milfoil information is taken from a Wisconsin DNR fact sheet. Both Northern milfoil and coontail, mentioned below as frequently mistaken for Eurasian water milfoil are present in Spooner Lake.

[12] Wisconsin DNR Invasive Species Factsheets from www.dnr.state.wi.us.

Identification

Eurasian water milfoil is a submersed aquatic plant native to Europe, Asia, and northern Africa. It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, Eurasian water milfoil is nearly impossible to distinguish from Northern water milfoil. Eurasian water milfoil has 9-21 pairs of leaflets per leaf, while Northern milfoil typically has 7-11 pairs of leaflets. Coontail is often mistaken for the milfoils, but does not have individual leaflets.

Characteristics

Eurasian water milfoil grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is usually restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lakebeds, lakes receiving nitrogen and phosphorous-laden, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Reproduction and dispersal:

Unlike many other plants, Eurasian water milfoil does not normally rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. Milfoil is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, Eurasian water milfoil is adapted for rapid growth early in spring.

Ecological impacts:

Eurasian water milfoil's ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of Eurasian milfoil provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes.

Control methods:
Preventing a Eurasian water milfoil invasion requires various efforts. The first component is public awareness of the necessity to remove weed fragments at boat landings. Inspection programs should provide physical inspections as well as a direct educational message. Native plant beds must be protected from disturbance caused by boaters and indiscriminate plant control that disturbs these beds. The watershed management program will keep nutrients from reaching the lake and reduce the likelihood that Eurasian milfoil colonies will establish and spread.

Monitoring is also important, so that introduced plants can be controlled immediately. The lake association and lakeshore owners should check for new colonies and control them before they spread. The plants can be hand pulled or raked. It is imperative that all fragments be removed from the water and the shore.

If Eurasian water milfoil is introduced, additional control methods should be considered including mechanical control, chemical control, and biological control. As always, prevention is the best approach to invasive species management.

Because Eurasian water milfoil is found in nearby lakes, it is prudent to provide a contingency plan to be best prepared to control milfoil, should it be found in the lake. A contingency plan should include a systematic monitoring program and a fund to provide timely treatments.

Aquatic Plant Management

This section presents aquatic plant management goals for Spooner Lake, the potential management methods available to reach these goals, and selection of action items for plant management. These goals were developed by the plant committee and reflect the concerns resulting from public involvement, the District board of directors, and suggestions from the Wisconsin Department of Natural Resources.

Spooner Lake's Goals for Aquatic Plant Management

1. Maintain present native plant community and preserve important floating and emergent beds at a non-nuisance level.

2. Restore native shoreline vegetation.

3. Preserve and/or enhance water quality.

4. Contain and reduce curly leaf pondweed in East Bay (inflow) and stop/monitor potential spreading to other areas of lake.

5. Reduce nuisance levels of macrophytes (native and non-native) in East Bay (near inflow).

6. Reduce filamentous algae in East Bay while monitoring remaining lake.

7. Prevent introduction of new invasive species such as Eurasian Water Milfoil (EWM).

8. Establish a rapid response plan to a new introduction of invasive species.

Discussion of Management Methods

Techniques to control the growth and distribution of aquatic plants are discussed in following text. In most cases, a combination of techniques must be used to reach plan goals. The application, location, timing and combination of techniques must be considered carefully.

Permitting requirements

The Wisconsin Department of Natural Resources regulates the removal of aquatic plants when chemicals are used and when plants are removed mechanically, or when plants are removed manually from an area greater than thirty feet in width along the shore. The requirements for chemical plant removal are described in Administrative Rule NR 107-Aquatic Plant Management. A permit is required for any aquatic chemical application in Wisconsin.

The requirements for manual and mechanical plant removal are described in NR 109-Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations. A permit is required for manual and mechanical removal except for when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants, (with the exception of wild rice) from his/her shoreline limited to a 30-foot corridor. A riparian landowner may also manually remove the invasive plants Eurasian watermilfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal means the control of aquatic plants by hand or hand-held devices without the use or aid of external or auxiliary power.

Biological control

Biological control is the purposeful introduction of parasites, predators, and/or pathogenic microorganisms to reduce or suppress populations of plant or animal pests. Biological control counteracts the problems that occur when a species is introduced into a new region of the world without a complex or assemblage of organisms that feed directly upon it, attack its seeds or progeny through predation or parasitism, or cause severe or debilitating diseases (i.e., pathogenic microorganisms). With the introduction of native pests to the target invasive organism, the exotic invasive species may be maintained at lower densities.

While this theory has worked in application for control of some non-native aquatic plants, results have been varied (Madsen, 2000). Beetles are commonly used to control purple loosestrife populations in Wisconsin with good success. Weevils are used as an experimental control for Eurasian watermilfoil once the plant is established. Tilapia and carp are used to control the growth of filamentous algae in ponds. Grass carp, and herbivorous fish are sometimes used to feed on pest plant populations. Grass carp introduction is not allowed in Wisconsin.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control relative to other technologies, lower overall costs, as well as plant-specific control. On the other hand, there are several disadvantages to consider, including control times of years instead of weeks, lack of available agents for particular target species, and relatively strict environmental conditions for success.

Biological control is not without risks; new non-native species introduced to control a pest population may cause problem of its own. Biological control is not going to be a management tool in Spooner Lake. There are no species present that warrant this method and would most likely not be effective.

Re-vegetation with native plants

Another aspect to biological control is native plant restoration. The rationale for re-vegetation is that restoring a native plant community should be the end goal of most aquatic plant management programs (Nichols, 1991; Smart and Doyle, 1995). However, in communities that have only recently been invaded by non-native species, a propagule bank probably exists that will restore the community after non-native plants is controlled (Madsen, Getsinger, and Turner, 1994). Re-vegetation following plant removal is probably not necessary in Spooner Lake because it has a very diverse and healthy plant community present.

Physical control

In physical management, the environment of the plant is manipulated, which in turn acts upon the plants. Several physical techniques are commonly used: dredging, draw down, benthic (lake bottom) barriers, and shading or light attenuation. Because they involve placing a structure on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 DNR permit is required.

Dredging removes accumulated bottom sediments that support plant growth. Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, need deepening, or require removal of toxic substances (Peterson, 1982). Dredging is not a viable option for Spooner Lake as isn't recognized as an aquatic plant management tool alone.

Drawdown, or significantly decreasing lake water levels can be used to control nuisance plant populations. Essentially, the water body has all of the water removed to a given depth. It is best if this depth includes the entire depth range of the target species. Drawdowns, to be effective, need to be at least 1 month long to ensure thorough drying (Cooke 1980a). In northern areas, a draw down in the winter that will ensure freezing of sediments is also effective. Although draw down may be effective for control of hydrilla for 1 to 2 years (Ludlow 1995), it is most commonly applied to Eurasian watermilfoil (Geiger 1983; Siver et al. 1986) and other milfoils or submersed evergreen perennials (Tarver 1980). Drawdown requires that there be a mechanism to lower water levels.

Although it is inexpensive and has long-term effects (2 or more years), it also has significant environmental effects and may interfere with use and intended function (e.g., power generation or drinking water supply) of the water body during the drawdown period. Lastly, species respond in very different manners to draw down and often not in a consistent fashion (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy or adventive species, particularly annuals.

There have been two drawdowns performed in Spooner Lake. One was for the sole purpose of reducing aquatic plants. The results were viewed as relatively positive on a short-term basis. There is no scientific data to verify the result. Draw down is not being proposed for Spooner Lake for many reasons. If draw down were used as a management tool, it would have to occur often. This would make plant management more difficult since it would eventually select species that are resistant draw down, making it less effective through time. Another is the fact that draw down potentially has a very dramatic affect on the lake ecosystem beyond the plant community. When this is weighed against the benefits, other options appear better for Spooner Lake as the primary management tool.

In the future, if drawdown is necessary for dam maintenance, it may also be considered for aiding in plant management. This may affect the amount of water level reduction and can be evaluated at that time.

Benthic barriers or other bottom-covering approaches are another physical management technique. The basic idea is that the plants are covered over with a layer of a growthinhibiting substance. Many materials have been used, including sheets or screens of organic, inorganic and synthetic materials, sediments such as dredge sediment, sand, silt or clay, fly ash, and combinations of the above (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984). The problem with synthetic sheeting is that the gasses evolved from decomposition of plants and sediment decomposition collects under and lifts the barrier (Gunnison and Barko 1992). Benthic barriers will typically kill plants under them within 1 to 2 months, after which they maybe removed (Engel 1984). Sheet color is relatively unimportant; opaque (particularly black) barriers work best, but even clear plastic barriers will work effectively (Carter et al. 1994). Sites from which barriers are removed will be rapidly re-colonized (Eichler et al. 1995). In addition, synthetic barriers may be left in place for multi-year control but will eventually become sediment-covered and will allow colonization by plants. Benthic barriers, effective and fairly low-cost control techniques for limited areas (e.g., <1 acre), may be best suited to high-intensity use areas such as docks, boat launch areas, and swimming areas. However, they are too expensive to use over widespread areas, and heavily affect benthic communities by removing fish and invertebrate habitat. A Department of Natural Resources permit would be required.

Although a benthic barrier may be a potential option for riparian owners, there is no plan to use this as a management tool by the Spooner Lake District. Since the main use of management tools will be to create navigational channels, benthic barriers are not prudent as the coverage is too extensive and would be too labor intensive.

Shading or light attenuation reduces the light plants need to grow. Shading has been achieved by fertilization to produce algal growth, by application of natural or synthetic dyes, shading fabric, or covers, and by establishing shade trees (Dawson 1981, 1986; Dawson and Hallows 1983; Dawson and Kern-Hansen 1978; Jorga et al. 1982; Martin and Martin 1992; Nichols 1974). During natural or cultural eutrophication, algae growth alone can shade aquatic plants (Jones et al. 1983). Although light manipulation techniques may be useful for narrow streams or small ponds, in general these techniques are of only limited applicability. As a result, Spooner Lake will not use this management tool.

Manual removal

Manual removal involving hand pulling, cutting, or raking plants will remove plants from small areas. It is likely that plant removal will need to be repeated during the growing season. Best timing for hand removal of herbaceous plant species is after flowering but before seed head production. For plants that possess rhizomatous (underground stem) growth, pulling roots is not generally recommended since it may stimulate new shoot production. Hand pulling is a strategy recommended for rapid response to a Eurasian water milfoil infestation. If curly leaf pondweed is present at near shore locations in low density, hand pulling by residents may be effective.

Mechanical control

Larger-scale control efforts require more mechanization. Mechanical cutting, mechanical harvesting, diver-operated suction harvesting, and rotovating (tilling) are the most common forms available. Department of Natural Resources permits under Chapter NR 109 are required for mechanical plant removal.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water. The cutter head uses sickles similar to those found on farm equipment, and generally cuts from one to six feet deep. A conveyor belt on the cutter head is always in motion, bringing the clippings onboard the machine for storage. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

Harvesters come in a variety of sizes, with cutting swaths ranging from four to twelve feet in width. The onboard storage capacity varies as well, and is measured in both volume and weight. Harvester storage capacities generally range from 100 to 1000 cubic feet of vegetation by volume, or from one to eight tons. They are usually propelled by two paddle wheels that provide excellent maneuverability and will not foul in dense plant growth.

Because large-scale mechanical control tends to be nonselective and leaves plant fragments in the lake, this method is not recommended for Spooner Lake. Also, this method has been used in the past with variable results on Spooner Lake. Most recently it caused extensive accumulation of uprooted and cut plants in many areas of the lake, leading to many complaints. Also, for curly leaf pondweed control, mechanical harvesting would be largely aesthetic in nature as turions can remain and spreading of the plant is likely thereby reducing plant density for a brief time as the plant dies off in mid summer anyway.

If chemical treatment for a navigational channel should be ineffective upon evaluation, further consideration of mechanical harvesting may be prudent. However, this method would need to be used after curly leaf pondweed has undergone senescence (later in summer). In addition, total control of the harvesting would be necessary for successful implementation such as purchasing a harvester.

Diver dredging operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The dredge hoses are from 3 to 5 inches in diameter and are handled by one diver. The hoses normally extend about 50 feet in front of the vessel. Diver dredging is especially effective against pioneering infestations of submersed invasive plant species. When a weed is discovered in a pioneering state, this methodology should be considered. To be effective, the entire plant, including the subsurface portions, should be removed.

Plant fragments can be formed from this type of operation. Fragmentation is not as great a problem when infestations are small. Diver dredging operations can be an ongoing mission. When applied toward a pioneering infestation, control can be complete. However, periodic inspections of the lake should be performed to ensure that all the plants have been found and collected.

Lake substrates can play an important part in the effectiveness of the operation. Soft substrates are very easy to work in. Divers can remove the plant and root crowns with little problem. Hard substrates, however, pose more of a problem. Divers may need hand tools to help dig the root crowns out of hardened sediment. The areas of Spooner Lake that need management are far to large for this method.

Rotovation involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of 20 feet. Rotovating may significantly affect non-target organisms and water quality as bottom sediments are disturbed. However, the suspended sediments and resulting turbidity produced by rotovation settles fairly rapidly once the tiller has passed. Tilling sediments that are contaminated could possibly release toxins to the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. There may be a need to collect the plant material that is tilled from the bottom. If operations are releasing large amounts of plant material, harvesting equipment should be on hand to collect this material and transport it to shore for disposal.

For Spooner Lake, rotovation would release too much sediment and plant fragments to such a large extent, it would not be a good result. Also, potential treatment of any stands of plants would largely be non-native of which rotovation is not a good option as it could increase spreading of non-native plants such as curly leaf pondweed.

Herbicide and algaecide treatments

Herbicides are chemicals used to kill plant tissue. Currently, no product can be labeled for aquatic use if it poses more than a one in a million chance of causing significant damage to human health, the environment, or wildlife resources. In addition, it may not show evidence of biomagnification, bioavailability, or persistence in the environment (Joyce, 1991). Thus, there are a limited number of active ingredients that are assured to be safe for aquatic use (when used according to the label) (Madsen, 2000).

An important caveat is that these products are safe when used according to the label. The U.S. Environmental Protection Agency (EPA)-approved label gives guidelines protecting the health of the environment, the humans using that environment, and the applicators of the herbicide. In most states, additional permitting or regulatory restrictions on the use of these herbicides also apply. Most states require these herbicides be applied only by licensed applicators. Wisconsin Department of Natural Resources permits under Chapter NR 107 are required for herbicide application.

Herbicide use will likely be the main management tool for Spooner Lake. Considering the potential treatment areas, costs, location and time of season, this option is most viable.

General descriptions of chemical control are included below.

Contact Herbicides

Contact herbicides act quickly and are generally lethal to all plant cells that they contact. Because of this rapid action, or other physiological reasons, they do not move extensively within the plant and are effective only where they contact plants. For this reason, they are generally more effective on annual (plants that complete their life cycle in a single year). Perennial plants (plants that persist from year to year) can be defoliated by contact herbicides but they quickly resprout from unaffected plant parts. Submersed aquatic plants that are in contact with sufficient concentrations of the herbicide in the water for long enough periods of time are affected but regrowth occurs from unaffected plant parts, especially plant parts that are protected beneath the sediment. Because the entire plant is not killed by contact herbicides, retreatment is necessary, sometimes two or three times per year. **Endothall, diquat** and **copper** are contact aquatic herbicides.

Systemic Herbicides

Systemic herbicides are absorbed into the living portion of the plant and move within the plant. Different systemic herbicides are absorbed to varying degrees by different plant parts. Systemic herbicides that are absorbed by plant roots are referred to as soil active herbicides and those that are absorbed by leaves are referred to as foliar active herbicides. Some soil active herbicides are absorbed only by plant roots. Other systemic herbicides, such as glyphosate, are only active when applied to and absorbed by the foliage. **2,4-D, dichlobenil, fluridone, and glyphosate** are systemic aquatic herbicides. When applied correctly, systemic herbicides act slowly in comparison to contact herbicides. They must move to the part of the plant where their site of action is. Systemic herbicides are generally more effective for controlling perennial and woody plants than contact herbicides. Systemic herbicides also generally have more selectivity than contact herbicides.

Broad spectrum herbicides

Broad spectrum (sometimes referred to as nonselective) herbicides are those that are used to control all or most vegetation. This type of herbicide is often used for total vegetation control in areas such as equipment yards and substations where bare ground is preferred. **Glyphosate** is an example of a broad spectrum aquatic herbicide. **Diquat, Endothall, and fluridone** are used as broad spectrum aquatic herbicides, but can also be used selectively under certain circumstances. While glyphosate, diquat and endothall are considered broad spectrum herbicides, they can also be considered selective in that they only kill the plants that they contact. Thus, you can use them to selectively kill an individual plant or plants in a limited area such as a swimming zone.

Selective herbicides

Selective herbicides are those that are used to control certain plants but not others. A good example of selective aquatic herbicide is 2,4-D, which can be used to control water hyacinth with minimum impact on eel grass. Herbicide selectivity is based upon the relative susceptibility or response of a plant to an herbicide. Many related physical and biological factors can contribute to a plant's susceptibility to an herbicide. Physical factors that contribute to selectivity include herbicide placement, formulation, and rate of application. Biological factors that affect herbicide selectivity include physiological factors, morphological factors, and stage of plant growth.

Environmental Considerations

Aquatic communities consist of aquatic plants including macrophytes (large plants) and phytoplankton (free floating algae), invertebrate animals (such as insects and clams), fish, birds, and mammals (such as muskrats, otters, and manatees). All of these organisms are interrelated in the community. Organisms in the community require a certain set of physical and chemical conditions to exist such as nutrient requirements, oxygen, light, and space. Aquatic weed control operations can affect one or more of the organisms in the community that can in turn affect other organisms or it can affect water chemistry that in turn affects organisms. The effects of aquatic plant control on the aquatic community can be separated into direct effects of the herbicides or indirect effects.

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[13]

Copper

Copper is a naturally occurring element that is essential at low concentrations for plant growth. It does not break down in the environment, but it forms insoluble compounds with other elements and is bound to charged particles in the water. It rapidly disappears from water after application as an herbicide. Because it is not broken down, it can accumulate in bottom sediments after repeated high application rates. Accumulation rarely reaches levels that are toxic to organisms or significantly above background concentrations in the sediment.

2,4-D

2,4-D photodegrades on leaf surfaces after applied to leaves and is broken down by microbial degradation in water and sediments. Complete decomposition usually takes about 3 weeks in water and can be as short as 1 week. 2,4-D breaks down into naturally occurring compounds.

Diquat

When applied to enclosed ponds for submersed weed control, diquat is rarely found longer than 10 days after application and is often below detection 3 days after application. The most important reason for the rapid disappearance of diquat from water is that it is rapidly taken up by aquatic vegetation and bound tightly to particles in the water and bottom sediments. When bound to certain types of clay particles diquat is not biologically available. When it is bound to organic matter, it can be slowly degraded by microorganisms. When diquat is applied foliarly it is degraded to some extent on the leaf surfaces by photodegradation, and because it is bound in the plant tissue a proportion is probably degraded by microorganisms as the plant tissue decays. Diquat will be the chemical of choice for navigational channel treatments (see section on management recommendations).

Endothall

Like 2,4-D, endothall is rapidly and completely broken down into naturally occurring compounds by microorganisms. The by-products of endothall dissipation are carbon dioxide and water. Complete breakdown usually occurs in about 2 weeks in water and 1 week in bottom sediments. This will be the chemical of choice for early season CLP treatments.

Fluridone

Dissipation of fluridone from water occurs mainly by photodegradation. Metabolism by tolerant organisms and microbial breakdown also occurs, and microbial breakdown is probably the most important method of breakdown in bottom sediments. The rate of breakdown of fluridone is variable and may be related to time of application. Applications made in the fall or winter when the sun's rays are less direct and days are shorter result in

[13]These descriptions are taken from Hoyer/Canfield: Aquatic Plant Management. North American Lake Management Society. 1997.

longer half-lives. Fluridone usually disappears from pond water after about 3 months but can remain up to 9 months. It may remain in bottom sediment between 4 months and 1 year.

Glyphosate

Glyphosate is not applied directly to water for weed control, but when it does enter the water it is bound tightly to dissolved and suspended particles and to bottom sediments and becomes inactive. Glyphosate is broken down into carbon dioxide, water, nitrogen, and phosphorus over a period of several months.

Algaecide treatments for filamentous algae

Copper-based compounds are generally used to treat filamentous algae. Common chemicals used are copper sulfate and Cutrine Plus, a chelated copper herbicide, has been used on Spooner Lake in the past

Herbicide use to manage invasive species

Curly leaf pondweed

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies three herbicides for control of curly leaf pondweed: Diquat, Endothall, and Fluridone. Fluridone requires exposure of 30 to 60 days making it infeasible to target a discreet area in a lake system. The other herbicides act more rapidly. Herbicide labels provide water use restriction following treatment. Diquat (Reward) has the following use restrictions: drinking water 1-3 days, swimming and fish consumption 0 days. Endothall (Aquathol K) has the following use restrictions: drinking water 7 – 25 days, swimming 0 days, fish consumption 3 days.

Early season herbicide treatment:[14]

Studies have demonstrated that curly leaf can be controlled with Aquathol K (a formulation of Endothall) in 55 - 60 degree F water, and that treatments of curly leaf this early in its life cycle can prevent turion formation. Staff from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center is conducting further trials of this method. Balsam Lake (Polk County, Wisconsin) treated two sites totaling 13 acres in early June of 2004, and will follow up with ongoing treatment and monitoring of the effectiveness of this method.

Because the dosage is at lower rates than dosage recommended on the label, a greater herbicide residence time is necessary. To prevent drift of herbicide and allow greater contact time, application in shallow bays is likely to be most effective. Herbicide applied to a narrow band of vegetation along the shoreline is likely to drift, rapidly decrease in concentration, and be rendered ineffective.[15]

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[14] Research in Minnesota Control of Curly Leaf Pondweed. Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.

[15] Personal communication, Frank Koshere. Wisconsin DNR. March 2005.

Eurasian water milfoil

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian water milfoil:Complexed Copper, 2,4-D, Diquat, Endothall, Fluridone and Triclopyr. Herbicide use may be necessary to rapidly respond to an infestation if discovered in Spooner Lake.

Historical Plant Management Practices[16]

Draw down

In the fall of 1984, Spooner Lake went through a draw down to try and reduce what was recognized as extensive aquatic plant growth that had been occurring for the past 20 years. The lake was refilled in spring, 1985. Informal reports from various interested parties were that the draw down was a success. There is virtually no plant data available pre and post draw down, therefore there is no data to validate this claim[17]. The Wisconsin DNR did state that the plant community was largely made up of species susceptible to draw down techniques and that the plants were growing less the following year. The fisheries did seem to respond positively to the draw down. It was reported that the largemouth bass fishing was outstanding. A fish survey was conducted in 1989 (five years after draw down). The report contained the following significant points:

- More large northern pike in 1989 than in 1984.
- Twice as many largemouth bass were sampled in 1989 vs 1984.
- Walleye appear to be almost gone.
- Panfish growth is less than the average in lakes of northwest Wisconsin.

In 1995 another draw down was performed for repairing the dam. Information is sketchy, but it appears it was only a one-foot level reduction. There was no information as to the plant response or fisheries response.

In past years, some mechanical harvesting has been done. One summer, the mechanical harvest was reported as a success, with noticeable reduction in aquatic plants. On another occasion, the harvest was reported as a failure with many plant fragments floating around in the lake. The actual data of these treatments were not available.

[16] From Wisconsin DNR files on Spooner Lake. Viewed January 11, 2007.
[17] Larry Dammon, Wisconsin DNR Fish Biologist stated he was unable to locate this information.

Chemical treatments[18]

Table 7. Chemical treatment history

Date	Treatment	Acres treated
6/06-8/06	Private riparian owners: Aquathol K, Cultrine Plus, Reward	0.69
6/05	Private riparian owners: chemical not noted	0.52
6/04	Private riparian owners: Aqualthol K, Cultrine Plus, Reward	0.69
6/03	Private riparian owners: Aquathol K, Cultrine Plus, Reward	0.34
7/02	Private riparian owners: Aquathol K, Copper Sulfate, Reward	1.26
7/02	Navigational channel for Spooner Lake District: Copper Sulfate, Reward	5.85
6/01	Navigational channel for Spooner Lake District: Aqualthol K, Copper Sulfate	5.85
7/01	Private riparian owners Hydrothol Gran, Copper Sulfate, Reward, 2-4 D LVG Ester	3.76
8/01	Navigational channel for Spooner Lake District: Reward	5.85
7/00	Navigational channel for Spooner LakeDistrict: Aquathol K, Reward, Copper Sulfate	6.9
6/00	Navigational channel for Spooner Lake District: Aquathol K, Copper Sulfate, Reward	6.9
6/00	Private riparian owners: Aquathol K, Hydrothol, Copper Sulfate, Reward	2.15
6/00	Private riparian owners: Aquathol K, Hydrothol, Copper Sulfate, Reward	1.47
6/99	Private riparian owners: chemicals not noted	0.64
6/98	Private riparian: owners Aquathol K, Hydrothol, 2-4 D, Cutrine T, Copper Sulfate, Aquakleen[19]	0.64
7/97	Private riparian owners: chemical not noted	0.64

As Table 4 indicates, there is quite an extensive list of chemical treatments that have been carried out in recent years. However, the treatment has been limited in acres and with the exception of private riparian owners, only the navigational channel has been treated by Spooner Lake District, the last year being 2002. In addition, the navigational channel has been marked with bouys every year since beginning this management. Although no plant surveys have been conducted in the past to establish any changes, the present data does not

[18] From files provided by Wisconsin DNR, Spooner Office, January 2007.
[19] This chemical was recorded in the treatment files from June 8, 1998 in a hand written note. This chemical name was not very legible and is written here as it appears.

indicate any major changes in the plant community as a result of these applications. The area where a navigational channel will be proposed is very dense with plants, indicating that the past navigational channel is still too dense for navigation at this time.

Management Recommendations

Outreach through techniques identified in an Education and Information Plan will be critical for many of the plan goals. One of the first tasks is to raise awareness about the plan itself.

Educational and Information Plan

Aquatic Plant Management Plan Outreach

> **Plan Action Item**
> Spooner Lake residents will be aware of this aquatic plant management plan and its recommendations through newsletter articles and handouts and presentations at annual meetings, facilitated by the Spooner Lake District.

Goal 1: Maintain present native plant community and preserve important floating and emergent beds at a non-nuisance level.

The plant community in Spooner Lake is very diverse and extensive. Approximately 99% of the lake area is covered with aquatic plants. Based on water quality monitoring and the water clarity readings, it is speculated that these plants are helping to keep the water clarity in Spooner Lake, much higher than it would otherwise be.

Aquatic plants in Spooner Lake provide key habitat for a diverse fish population. They also provide a reduction in shoreline erosion in some key areas. Although many have expressed interest in significantly reducing the plant density in Spooner Lake, it is important to understand that these plants play an important role in the lake ecosystem. If the reduction of aquatic plants should occur, it is important that this is done in a systematic approach. Residents who believe they have nuisance levels of plant calling for management should consult the Spooner Lake District about this issue. Reducing the plant community too much could lead to very adverse affects in Spooner Lake. These could include algae blooms, reduced fish reproduction and increased sedimentation.

Waterfront activities
Another important message will be to discourage boating disturbance within 200 feet of the shoreline. Although this is a no-wake zone according to state regulation, many boaters still travel close to the shoreline. This activity is strongly discouraged for the following reasons:

- Boats may uproot native plants and break aquatic plants into fragments
- Bare substrate is more likely to be colonized by non-native species

- Plant fragments contribute phosphorus to the water as they decay
- Curly leaf pondweed fragments broken up by boat propellers may root and encourage further uncontrolled spread of this invasive plant.

Waterfront residences can also negatively affect native plant communities by causing disturbance of existing plant beds and altering sediment characteristics. Regular waterfront use like boating, swimming, and clearing removes native aquatic plants. Healthy native plant populations prevent colonization by invasive plants. Erosion and runoff from waterfront property may alter sediment characteristics encouraging spread of invasive plants.

Goal 2: Protect native shoreline vegetation.

Native shoreline restoration

It is recognized by the Plant Management committee that native shoreline vegetation is very important to protecting the lake ecosystem. Due to fairly high development and the large number of residences that have disturbed native shorelines, it is important to work to restore these shoreline areas to native vegetation. This can be done through education discussing the importance of native vegetation shorelines and encouraging the implementation of restoration practices.

Plan Action Item

Education will be provided to riparian owners about shoreline restoration. The Spooner Lake District will work with Washburn County and riparian owners in restoration implementation through cost sharing and technical assistance to restore a maximum number of developed lots. The District may secure financing through grants to help facilitate restoration projects.

Goal 3: Enhance and/or protect water quality.

Nutrient loading

Spooner Lake is a eutrophic lake. However, the water clarity has been fairly high considering the nutrients available to the lake. This may be due to the fact that there is extensive aquatic plant growth in the lake, removing many nutrients. Therefore, the plant community may be contributing to this higher water clarity[20]. Furthermore, if natural shoreline vegetation is restored in areas where there are lawns and infiltration practices are implemented, the runoff quantity and nutrient loading can be reduced.

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[20] Personal communication with Frank Koshere, October 2006.

For these reasons, it is recommended that the plant community in the main part of Spooner Lake (where there are no nuisance stands of plants) left intact. In addition, it is recommended that infiltration practices and native shoreline restoration be encouraged. Lastly, the sensitive areas designated include many emergent plant stands that can reduce erosion. These areas should be protected.

Historically Spooner Lake has been part of the Self-Help Monitoring program. This has been largely through Secchi depth readings and appearance of lake recordings. It is recommended that Spooner Lake District increase this effort through the Expanded Self-Help program. This will allow for annual phosphorus and chlorophyll-a readings to maintain a data set to evaluate long-term trends.

Spooner Lake is an impoundment system (dammed flowing water to create a lake). As a result, nutrients are generally an issue. This is due to the fact that the watershed area is so large and nutrient levels in the inlet stream can get relatively high. When the water is slowed and forms a lake, the result is higher nutrients than other lakes. For this reason, it is very important that nutrients from the immediate watershed be held to a minimum. It must also be understood that the large amount of nutrients has, and could continue to lead to increased plant growth. Decreasing nutrient loading could reduce future increases in macrophyte density and coverage, including the non-native curly leaf pondweed.

Plan Action Item

Maintain the present native plant community in the main portion of Spooner Lake. There will be no chemical application or harvesting except for treatment of invasive species in these areas or should nuisance levels occur and require management. In addition, the District will encourage riparian owners leave native plant stands undisturbed through education efforts.

Plan Action Item

Expanded self-help monitoring, including measurements of chlorophyll-a, total phosphorus, and Secchi depth during growing season months will be implemented.

Goal 4: Contain and reduce curly leaf pondweed (*Potamogeton crispus*) in East Bay (near inflow) and stop potential spreading into other areas of the lake.

Curly leaf pondweed is very extensive in certain areas of Spooner Lake. Near the inlet, the plant reaches the water surface during peak growth and is very dense in areas. This density is high enough to impede navigation with watercraft. According to some residents on the plant committee, this density has become worse over the past 10 years. This change is a possible reflection of increased nutrients coming into Spooner Lake. It was stated that this area of the lake gets used very little, while in past years many people would fish the area. This indicates that it could also affect fishing in some areas due to inability to reach the areas or use hook and line effectively. As one moves toward the main portion of the lake, the density and coverage slowly reduces. Outside of the management area, the curly leaf pondweed is still present, but is rather sporadic in coverage and not nearly as dense.

Large-scale reduction of curly leaf pondweed may seem warranted to protect native communities. However, while identified as an invasive species of concern, its ecological impacts and likelihood of continued spread are uncertain. A large-scale treatment such as herbicide application my damage native plant communities, opening the lake up to a Eurasian watermilfoil infestation. In addition, the low-dose early season herbicide must occur in areas where there is little drift and/or water flow. The areas of curly leaf with the highest density occur in an area where the water flows. The degree of flow is unknown. Also the areas with the highest density occur within a designated sensitive area.

Rather than treating all areas, targeted treatments at identified nuisance areas or areas of concern and a close surveillance of remaining curly leaf populations is recommended. Whole lake surveys every three years will assess if new populations of curly leaf pondweed are becoming established. Annual measurements in June will monitor the extent and density of existing curly leaf pondweed beds.

Definitions of nuisance and areas of concern

Nuisance defined as a consistent rake density of 3, aerial coverage greater than 80%, plants reaching surface of water and impedes navigation during some time interval of the growing season.

Areas of concern would be defined as small, potentially new populations approaching nuisance levels.

Upon evaluation of curly leaf occurrence, it appears the most prudent management is to treat small areas in the main portion of Spooner Lake, to potentially stop the spreading from newly established stands of curly leaf pondweed. This would involve choosing one or two small curly leaf stands. After establishing precise area boundaries, an early season chemical treatment using Endothall can be carried out. This would follow up with a post treatment analysis. The success of the treatment would then be evaluated, thereby determining if any subsequent treatments should be performed in any other small stands. If successful, it may be possible to reduce spreading of curly leaf pondweed into the largest portions of the lake.

The small-scale treatment would be for the containment of curly leaf pondweed. Since this plant is so well established, eradication is not possible. However, it may be possible to "contain" the curly leaf in the management area through reduction in the other portions of Spooner Lake. The goal of the treatments will be to reduce the coverage and density of small areas of dense curly leaf beds. The goal is to reduce the coverage and density by 50% and reduce turion production if possible at any bed of curly leaf pondweed in main part of the lake. This will then lower the possibilities of the increase in size of any particular bed or the spreading of the bed. Again, the goal is to keep any areas in the larger lake area from becoming large, dense, unmanageable beds of curly leaf pondweed.

The strategy of management is one of containment. Since the curly leaf pondweed is limited in the main part of Spooner Lake, the containment could reduce the abundance of this plant. Through this strategy, it could contain large scale spreading and increased density. These increases could lead to a increase in nutrients during the mid-summer when curly leaf pondweed dies. A reduction in water clarity and more dense algae blooms could result. Therefore, this containment strategy could effectively slow or even stop this progression for the future. As a result, the main part of Spooner Lake could maintain a healthy, native plant population.

The curly leaf pondweed is so established in the management area, it is unlikely that eradication or even substantial reduction could be accomplished. It would take a very large-scale treatment that would most certainly adversely affect the native plant community with no guarantee of elimination of curly leaf pondweed. A large portion of the highest density falls within a designated sensitive area and treatment in this area should be avoided or remain extremely limited. The cold water flowing in from Crystal Creek and the high nutrient sediments make for prime habitat for curly leaf pondweed. This coverage should be monitored however as this non-native plant could adversely affect the native community with in the sensitive area.

Private riparian owners should monitor for curly leaf pondweed. If they should locate this plant, they should contact the Spooner Lake District. If the plant appears to reach nuisance levels or appears to be a new infestation due to small, localized coverage, Spooner Lake District will review the location of the curly leaf pondweed. If this bed meets the definition(s) contained within this plan, then treatment may be an option for the riparian owner. If the bed is a small number of plants, hand pulling may be an option. Otherwise chemical treatment would be the best option, with early season Endothall application. Presently the Wisconsin DNR is developing informational materials for riparian owners to guide in regulated control activities. When these materials become available, they will be recognized in this plan as guidance.

Curly leaf pondweed should be monitored annually. This monitoring will allow for evaluation as to the changes in curly leaf pondweed coverage and density. It is not known as to the extent of this plant spreading into the main part of the lake where it is not as nearly established in the management area. Furthermore, within the management area, the density ratings are averages and with the exception of the large, dense bed near the inlet, the individual beds have not been mapped.

Plan Action Item

Chemically treat small stands of curly leaf pondweed that are less than 5 acres in total and fulfill the density definition and area of concern outside of the management area. This treatment will then be evaluated on its effectiveness. If effective, similar treatments may be considered in areas that qualify based on density/nuisance definitions. The treatment(s) will be **early season** (based on water temperature) and reoccurring up to 3 years to account for turion production. The chemical used will be **Endothall and will be applied with water temperatures at or near 55-59 degrees F** (or based on other recommendations if necessary).

In June 2007, the potential beds of curly leaf pondweed for early season treatment were established and the polygon boundaries are mapped in GIS. These will then be the plots identified in any potential permits applied for in 2007 and beyond. Further evaluation of these plots and other potential plots will occur in subsequent years.

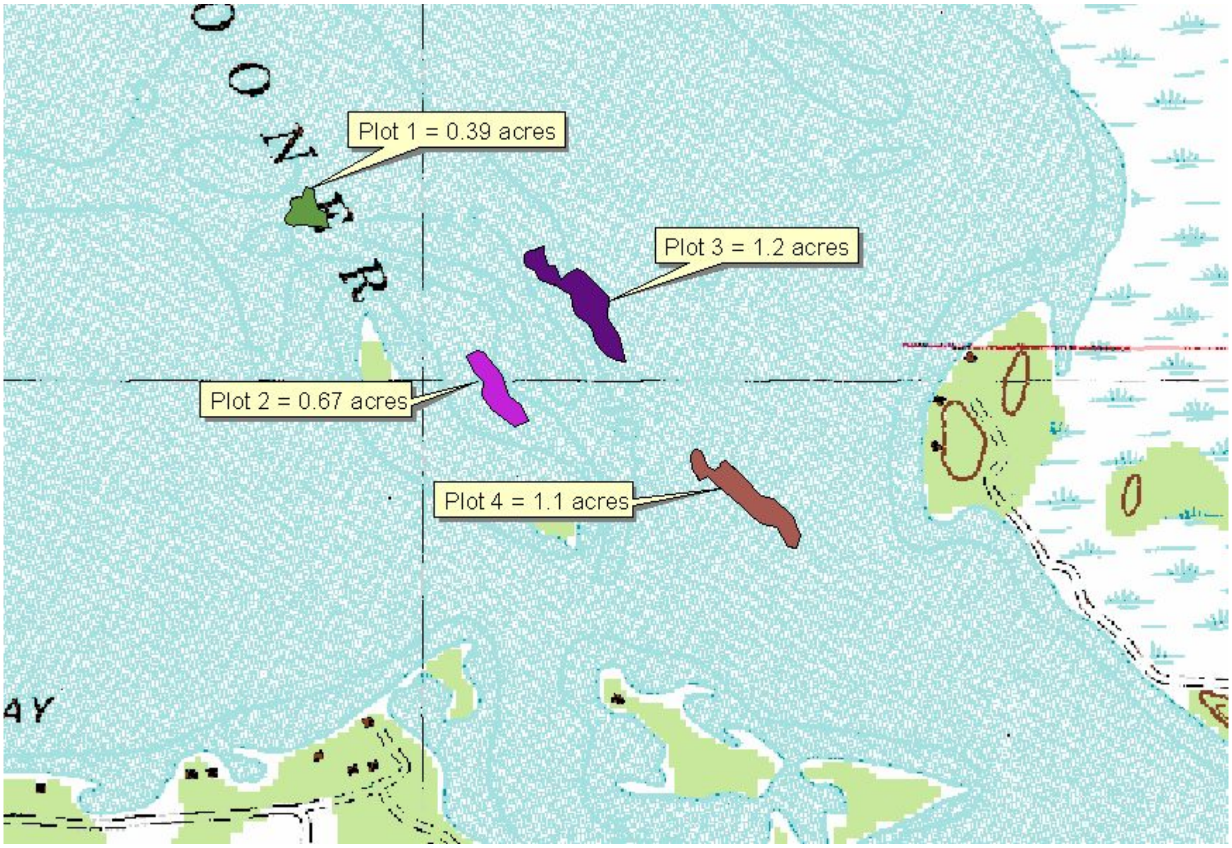
Plan Action Item

The management of curly leaf pondweed stands will be clearly communicated to Spooner Lake residents through meetings and written communication. Proper notification as required by the Wisconsin DNR will be carried out.

Plan Action Item

Curly leaf pondweed will be monitored annually. This monitoring can establish changes in the coverage and density of curly throughout Spooner Lake. It will also help evaluate the effectiveness of any curly leaf pondweed management.

Figure 11. Proposed sites for small-scale curly leaf management.



The stands being proposed are isolated and small dense areas of curly leaf pondweed in early June. This could make these sites good candidate areas to treat since they are dominated by CLP and are in the main lake where CLP coverage is limited and falls in the area where CLP management is sought. A survey of this area will have to be completed to verify it meets the criteria for treatment at the time of treatment. These boundaries were determined in June 2007. All boundaries were determined and GPS coordinates were recorded with stands mapped as GIS shapefiles.

In each year of treatment the following survey information will be collected in order to determine the effectiveness of the treatment[21].

Pretreatment:

1. Using the polygons established, verification of target plant will be verified.
2. Treatment is carried out.

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[21] This protocol was established by the Wisconsin DNR and released in April, 2007. The year one season before treatment was not conducted as this information was not made available to us at the time of this plan and therefore the survey was not scheduled. The post-season analysis will be used each year without this base survey still allowing for evaluation of effectiveness.

Post-treatment:

1. Up to four weeks after treatment (but before CLP dies off), several sample points within the polygons will be sampled for plants. Each plant will be identified and given a rake density rating of 1-3. This method will allow the evaluation of both the effectiveness the treatment has on the target species (CLP) and the potential negative impact on the native plants. The following sample points will be used in each polygon based on size:
    a. 0.5 acres=1 sample point
    b. 1.00 acres=4 sample points
    c. 2.00 acres=8 sample points
    d. 3.00 acres=12 sample points

2. Compare the post-treatment survey each year to evaluate effects on target and native species.
3. Conduct a visual survey to look for new colonies each summer during the peak growth of CLP.

Treatment of curly leaf

The treatment of curly leaf pondweed will be an early season application of Endothall. The application will take place when the water temperatures are 55-60 degrees F. This will reduce adverse effects on the native plant community as most of those plants will still be in, or just coming out of, dormancy. This timing is also based on protection of fish spawning activities, which may cause adjustment by the Wisconsin DNR. Crappies, which are present in Spooner Lake, are a fish spawning at this temperature and could be an issue.

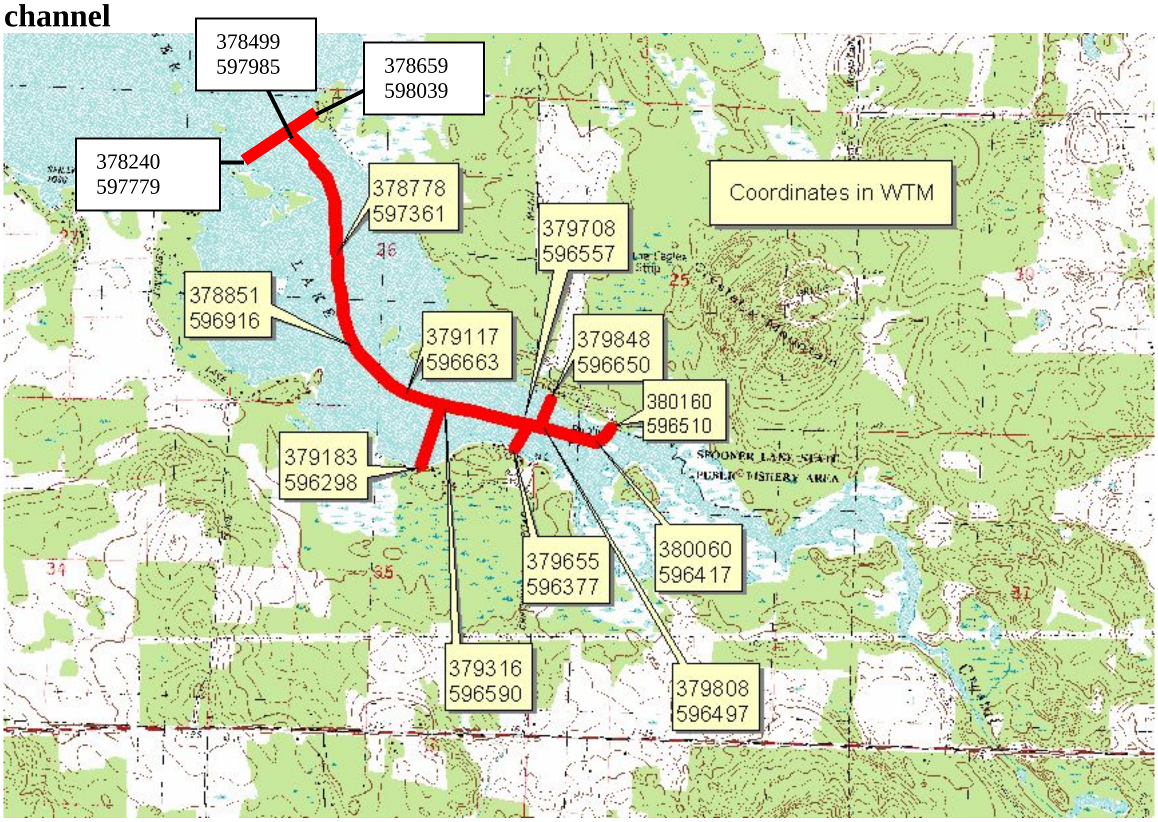
Goal 5: Reduce nuisance levels of macrophytes (native and non-native) in East Bay (near inflow).

Aquatic plants can create nuisances for residents attempting to swim and boat from the shoreline. It is important that riparian owners are aware of importance of native aquatic plants and complete removal can be a high risk. Important habitat can be lost as well as increased chance of colonization by invasive, non-native species.

Plan Action Item

The management of nuisance area referred to, as the "management area" will be clearly communicated to the Spooner Lake residents through meetings and written communication. This will include time of chemical treatment (if used), locations, and the type of chemical used.

Figure 12 . Navigation channel map. Red line indicates location of proposed channel



Plan Action Item

Create a navigational channel through the East Bay management area. The channel may be up to 50 feet wide and may follow established map of a main channel and three secondary channels only. Less treatment is an option. Please refer to figure to view map. Treatment may be done up to two times each summer, depending on status of the channel. The channel will be marked with buoys

There will be no need for pre and post treatment analysis. Since this is a navigational channel, the need for knowledge about changes in the plant community is not necessary as the goal is to eliminate plant growth in the channel. However, pre-treatment dissolved oxygen levels should be monitored leading up to a potential later season treatment. As the water warms and plants die off, oxygen levels can become depleted. If these oxygen levels should lower and plants are treated causing decomposition, the treatment could possibly reduce oxygen even more. **If the dissolved oxygen prior to a later season (July or August) treatment in the navigational channel should be lower than 6 mg/L (ppm)**

in any one of several sample points along the entire channel treatment area, the Wisconsin DNR will be consulted for advice on treatment.

Pre and Post Treatment Evaluations

There will be a need for annual evaluation to determine if the navigational channel needs to be treated in any year. During any given year, the channel may be treated up to two times. Early in the growing season, the non-native aquatic plant curly leaf pondweed is a large contributor to impeding navigation. This may cause for an early season treatment, followed by a later season treatment, depending on density of what would now be native plants later in the summer. If the channel is deemed to impede navigation, treatment is then an option. At the end of the growing season, the effectiveness of navigational channel treatment will be evaluated. If the treatment has been ineffective, the Plant Committee shall meet and review optional and/or alternative treatments if available.

It is recommended that dissolved oxygen be monitored in the navigational channel after treatment as stated above.

Treatment and proposed control actions

The chemical treatment for the navigational channel will be a broad spectrum herbicide such as Diquat. An early season treatment may be necessary due to curly leaf pondweed nuisance. Chemical use will be based on effectiveness, environmental concerns, and biological considerations of Spooner Lake such as fish species and native plant species present.

All chemical treatments can have adverse affects that result. In the case of curly leaf pondweed treatment, non-native plants that are not being targeted could be affected, especially those bordering the application plot. In the navigational channel, all species are targeted, however over-spray and drift may cause adverse affects in areas somewhat wider than the fifty feet plan. The channel does go near a designated sensitive area. Precaution will be taken to reduce any affect on this area. No rare plants were found in the survey conducted in the summer 2006. There is also a period of time after application where fishing warnings will be posted, affecting fishing activities for a short period of time. The amount of chemical application should not affect any drinking water supplies. However, it should be noted that any lake ecosystem is tied to the adjoining water table, and a potential of adverse affects to that water table is possible.

Goal 6: Reduce filamentous algae in East bay and monitor remaining lake.

The long-term strategy for filamentous algae management should be to reduce watershed inputs of phosphorus. This can be difficult considering the size of the Spooner Lake watershed. This plan recommends evaluating treatment options and utilizing the most effective available to manage nuisance levels in the East bay.

The filamentous algae species should be identified in 2007 and monitored in the remaining portions of the lake annually. A density rating will be established to determine any changed in coverage and density:

The main option to reduce filamentous algae would be the use of a chelating copper compound such as Cutrine Plus. However, this treatment would be largely aesthetic due to the extensive coverage of filamentous algae. After reduction the algae will return as nutrients will still be available. Keeping the available phosphorus as low as possible will be the key to reduction of filamentous algae. If filamentous algae should continue increase in density and need be managed, the best option for control will be evaluated at that time.
It is natural to have filamentous algae in lakes. The excessive growth is a response to increased nutrients, namely phosphorus, in the lake. Since they do not root, they absorb these nutrients directly from the water. If filamentous algae did not absorb these nutrients, the nutrients would be available for unicellular algae, leading to decreased water clarity. Therefore, nutrient reduction is important for management.

One of the larger issues with the filamentous algae is that later in the summer it floats to the surface and becomes a substantial nuisance recreationally and aesthetically. For this reason, the Spooner Lake District will make part of their management the option for "skimming" the lake surface to remove the algae.

Plan Action Item

During late summer (late July/August), the Spooner Lake District may remove dead/dyeing filamentous algae from the lake surface as it accumulates in various bays. **This removal will not involve removing any plants/algae below the surface nor will it involve cutting or pulling any plants or plant parts in the lake.**

Plan Action Item

Conduct an annual survey of the filamentous algae to establish any changes in growth. The species of filamentous algae will be determined.

"1"-Sample of algae on rake, less than ½ of tine space.
"2"-Sample of algae on rake, more than ½ of tine space, but less than entire tine space.
"3"-Sample of algae on rake, all tine space filled with algae.

Nuisance algae will be defined as a density of "3", in an area at least 10 square meters, visually present on aquatic vascular plants or at least 10 square meters of floating/decaying filamentous mats. The worst areas can then be mapped in GIS.

At this point, the available chemical treatments for filamentous algae are not very effective. In small areas of dense growth, chemical treatments may be effective but are short-term. In the future, small areas of nuisance may be looked at for potential treatment with Cutrine, or an alternative that is more effective and acceptable for use.

Goal 7: Prevent introduction of new invasive species such as Eurasian watermilfoil (EWM).

Like any other lake in Wisconsin with a public landing, Spooner Lake has a threat of invasion by exotic species. However, no coordinated prevention effort is in place. Lakeshore resident and lake user education will help reduce the risk of an invasive species introduction. Furthermore, pubic access inspections and education would help alleviate this risk too. There are many educational materials available from public sources. Eurasian watermilfoil prevention signs are in place, but identification signs should also be considered.

The Clean Boats/Clean Waters program, developed by the University of Wisconsin Extension, should be implemented. This program involves education as well as periodic access inspections. The goal is to educate all lake users about the importance of keeping invasive species out of the lake.

Plan Action Item

Gather and assemble public information materials about Eurasian watermilfoil prevention for distribution to Spooner Lake residents. Information will be provided and presented at annual meetings and newsletters.

Plan Action Item

Implement a Clean Boats/ Clean Waters program for Spooner Lake. This will include public access education and inspection.

Plan Action Item

Monitor for the presence of Eurasian watermilfoil and other aquatic invasive species. The areas around public boat landings will be the focal points for monitoring, as these are the most likely introduction sites. The area near the inflow will be a third focal point as this could be another introduction site. Areas where northern watermilfoil has been sampled should also be monitored as Eurasian watermilfoil tends to grow in similar habitats. Lake residents will be encouraged to learn to identify Eurasian watermilfoil and, and purple loosestrife and establish a contact for verification of identification.

Plan Action Item

Conduct a whole lake macrophyte survey every 3-5 years. This survey will follow the DNR guidelines and use the point intercept method of data collection.

Goal 8: Establish a rapid response plan to a new introduction of invasive, non-native species.

If a new introduction of a non-native invasive species should occur, the response action contained in this plan should be used as presented.

Plan Action Item

A Eurasian watermilfoil monitoring program will be implemented for detection and rapid response if an invasion is discovered. The Spooner Lake District will maintain a reserve budget (or a plan to secure funds) to respond to a Eurasian watermilfoil infestation quickly. A file with rapid response steps and AIS rapid response grant application materials will be created and held by the District's president.

Plan Action Item

The rapid response action plan will consist of the following steps:

1. Positive identification of invasive species (contact designated local plant identification expert and DNR).
2. Notify DNR aquatic plant management specialists of positive identification.
3. Carry out response plan using one or more of the following methods:
    a. Hand pulling (with diver if needed)
    b. Herbicide use (permits required)
4. Notify residents of positive invasive species identification and location.
5. Carefully monitor infested area and nearby for effectiveness of control methods.
6. Repeat controls as needed.

The following tables outline the activities to be implemented, the dates to be completed, and the responsible party. The cost table is based on estimates only.

Table 8. Implementation activities and timeline.

Activity	Time	Responsible entity
Public education on aquatic plants	Spring 2007, Annual meetings and ongoing	Spooner Lake District, Consultant
Navigational channel through management area	Summer 2007 (two applications); annual	Spooner Lake District, Consultant, Applicator
Filamentous algae monitoring	Summer 2007; ongoing	Spooner Lake District volunteers
Expanded self help	Summer 2007, ongoing	Spooner Lake District volunteers; Wisconsin DNR
Clean Boats/Clean Waters Program	Spring 2007	Spooner Lake District volunteers; UW Extension
Curly leaf pondweed management	April/May 2008; annually assessed	Spooner Lake District, consultant, applicator
Whole lake plant survey	June/July 2010-2012	Consultant

A review of the control actions proposed

1. Treatment of the navigational channel in the management area will be with Reward® (Diquat). This will involve the application of a broad-spectrum herbicide. The application will occur in early summer (June) and be repeated if warranted by re-vegetation within the channel.
2. A treatment of small curly leaf pondweed plots (less than 5 acres) to contain the spread and increase density of curly leaf pondweed in the main lake. This application will be a selective early season application of Endothall.

Potential adverse affects of chemicals proposed

1. Endothall can kill non-target species (curly leaf pondweed is the target). This chemical can be toxic to fauna and should not be used in water supplies. There should be post treatment restrictions on irragation.
2. Reward (Diquat) has limited direct toxicity to fish and other animals. It is toxic to aquatic invertebrates.

Table 6 contains the estimated cost for management activities. All of the items are chemical treatments. Since chemical treatment is the main focus for management, alternatives are not discussed here. Alternatives are discussed in the discussion of management methods and why they are or are not recommended options for Spooner Lake.

Table 9. Estimated cost of management activities.

Activity	Estimated cost
Navigational channel	$2290 to $4880 ($4580 to $9760 for 2 applications)[22] or $539-$689/acre.
Curly leaf pondweed management/treatment	$295/acre for 2-5 acres ($590-$1475)
Curly leaf pondweed monitoring	$1200/season
Water analysis for expanded self-help	Approximately $300 per year.
Aquatic plant survey (point intercept)-711 points	$3900

[22] The lower cost is assuming the use of Reward only on a 30 ft wide channel. The higher cost is assuming the use of Aquathol K and Reward on a 50 ft wide channel. Aquathol K and Reward is $689/acre and Reward only is $539/acre. Estimate is from Lake Restoration, Inc., Rogers Minnesota.

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Appendix A-Points and GPS coordinates of curly leaf pondweed outside of high density management area.

Includes early and late survey samples.

SAMPLING_P	LATITIUDE_	LONGITUDE_
3	376800	598375
125	377360	597655
250	377840	598455
270	377920	598615
336	378160	598295
341	378160	597895
344	378160	597655
345	378160	597575
348	378160	597335
376	378240	597175
378	378240	597015
396	378320	597575
398	378320	597415
406	378320	596775
421	378400	597575
422	378400	597415
428	378400	596935
430	378400	596775
439	378480	598055
454	378480	596775
472	378560	597255
473	378560	597175
475	378560	597015
478	378560	596775
479	378640	598615
495	378640	597335
498	378640	597095
499	378640	597015
500	378640	596935
502	378640	596615
515	378720	597495
517	378720	597335
518	378720	597255
520	378720	597095
521	378720	597015
524	378720	596775
540	378800	597335
542	378800	597175
545	378800	596935
546	378800	596855
547	378800	596775

554	378880	597735
555	378880	597655
557	378880	597495
558	378880	597415
559	378880	597335
560	378880	597255
561	378880	597175
562	378880	597095
577	378960	597095
580	378960	596855
581	378960	596775
582	378960	596695
583	378960	596615
585	379040	597655
587	379040	597495
589	379040	597335
592	379040	597095
598	379040	596535
603	379120	597335
604	379120	597255
609	379120	596775
610	379120	596695
613	379120	596455
622	379200	596615
630	379280	596695
634	379280	596375
637	379360	596615
644	379440	596455
649	379520	596455
656	379680	596535
675	380000	596215
696	380880	595975
697	380960	595895

Appendix B-Filamentous algae points and GPS coordinates.

Sampling_Point	Latitude	Longitude
9	376880	598375
18	376960	598375
32	377040	598295
34	377040	598135
52	377120	598295
99	377280	597975
120	377360	598055
123	377360	597815
165	377520	598135
256	377840	597975
296	378000	598135
315	378080	598295
366	378240	597975
367	378240	597895
393	378320	597975
394	378320	597895
441	378480	597895
444	378480	597655
449	378480	597255
452	378480	596935
483	378640	598295
501	378640	596855
520	378720	597095
522	378720	596935
550	378800	596535
555	378880	597655
556	378880	597575
557	378880	597495
558	378880	597415
559	378880	597335
560	378880	597255
561	378880	597175
562	378880	597095
564	378880	596935
565	378880	596855
566	378880	596775
590	379040	597255
591	379040	597175
592	379040	597095
593	379040	597015
594	379040	596855

595	379040	596775
596	379040	596695
597	379040	596615
601	379120	597495
602	379120	597415
603	379120	597335
604	379120	597255
605	379120	597175
606	379120	597095
607	379120	597015
608	379120	596935
609	379120	596775
610	379120	596695
611	379120	596615
612	379120	596535
613	379120	596455
614	379120	596375
615	379200	597335
616	379200	597255
617	379200	597175
619	379200	597015
620	379200	596775
621	379200	596695
626	379280	597255
628	379280	597095
629	379280	596775
630	379280	596695
631	379280	596615
632	379280	596535
633	379280	596455
634	379280	596375
635	379360	596775
636	379360	596695
637	379360	596615
638	379360	596535
639	379360	596455
640	379440	596775
641	379440	596695
642	379440	596615
644	379440	596455
645	379520	596775
646	379520	596695
647	379520	596615
648	379520	596535
649	379520	596455
650	379600	596695
651	379600	596615
652	379600	596535

653	379600	596455
654	379680	596695
656	379680	596535
657	379680	596455
658	379680	596375
660	379760	596535
661	379760	596455
662	379760	596375
664	379840	596535
665	379840	596455
666	379840	596375
667	379920	596535
668	379920	596455
669	379920	596375
670	379920	596295
672	380000	596455

Appendix C-Funding sources

Potential Funding Sources for Aquatic Invasive Species Monitoring, Planning, etc.

Grant Program: AIS Grant
Wisconsin Department of Natural Resources
Program Goals/Objectives: control aquatic invasive species
Eligible Applicants: Qualified lake and river management organizations and qualified school districts
Eligible Project Elements: education, prevention, and planning; early detection and response; controlling established infestations
Funding limits and rate: 50% of project costs up to $75,000 for education, prevention, planning and controlling established infestations; 50% of project costs up to $10,000 for early detection and rapid response
Application Deadline: February 1st of each year
Contact: Pamela Toschner 715.635.4073

Grant Program: Lake Planning
Wisconsin Department of Natural Resources
Program Goals/Objectives: collect information in order to manage lakes
Eligible Applicants: Qualified lake and local government organizations; qualified school districts
Eligible Project Elements: Monitoring and education; organization development; studies or assessments.
Funding limits and rate: Small scale-75% share costs with a cap of $3000; large scale-75% share costs with a cap of $10,000.
Application Deadline: Feb 1st and August 1st of each year.
Contact: Pamila Toschner 715.635.4073

Potential Funding Sources for Watershed Practices

SHORELINE BUFFERS AND INFILTRATION PRACTICES

Grant Program: Lake Protection
Wisconsin Department of Natural Resources
Program Goals/Objectives: lake protection and restoration
Eligible Applicants: Qualified lake and conservation organizations
Eligible Project Elements: plans and specifications, earth moving and structure removal, native plants and seeds, monitoring costs
Funding Limits and Rates: 75 % of project costs up to $100,000
Application Deadline: May 1st each year
Contact: Pamela Toschner 715.635.4073

Appendix D-Aquatic macrophyte survey

Introduction

This report presents a summary and analysis of data collected in a baseline macrophyte survey completed in July of 2006 on Spooner Lake, Washburn County Wisconsin. A June 2006 survey was completed in order to account for the early season non-native curly leaf pondweed, *Potomageton crispus*. The main survey was conducted in mid-July of 2006. All data presented here is available in spreadsheet format upon request and will be forwarded to the Wisconsin Department of Natural Resources. The primary goals of the project are to establish a baseline for long-term monitoring of aquatic plant populations and to document and map the locations of non-native invasive aquatic plant species such as *Potomageton crispus* (curly leaf pondweed) and *Myriophyllum spicatum* (Eurasian water milfoil).

Spooner Lake (WBIC: 2391200) is a 1092-acre lake in Washburn County, Wisconsin in the Town of Spooner (T40N R08W S29). 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 planning grant funds.

Field methods

A point intercept method was employed for the macrophyte sampling. The Wisconsin Department of Natural Resources (Wisconsin DNR) generated the sampling point grid of 1585 points. The littoral zone was initially defined as any depth less than 25 feet, leading to approximately 580 points to sample. For the early season sampling, random points within the littoral zone were sampled looking specifically for non-natives, *Potomageton crispus* in particular. The entire littoral zone was also monitored visually from shoreline to depths allowing visual observation. In the main survey, most all points within the littoral zone were sampled, and a minimum of one point deeper than a sample with no plants was collected to verify maximum plant depth. In any areas where it appeared the grid caused under-sampling, a boat survey was conducted to monitor these areas. A handheld Global Positioning System (GPS) located the sampling points in the field. The Wisconsin DNR guidelines for point location accuracy were followed.

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 when removing from lake were identified and rated as to rake fullness. The rake fullness value was used based on the criteria contained in the table below.

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. All plants needing verification were bagged and cooled for later examination. Two plants from each species were also collected for creation of a voucher or herbarium collection.

Data analysis methods

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

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

An explanation of each of these data are 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 total sites. There can be two values calculated for this. The first is the percentage of all sample points that this plant was sampled. The second is the percentage of littoral sample points that the plant was sampled. The first value shows how often the plant would be encountered everywhere in the lake, while the second value shows if only within the depths plants are potentially present. In either case, the greater this value, the more frequent the plant is in the lake. If one wants to compare to the whole lake, we look at the frequency of all points and if one wants to focus only where plants are more probable, then one would look at frequency at depths less than maximum at which plants were found.

Frequency of occurrence example:

Plant A sampled at 35 of 150 total points = 35/150 = 0.23 = 23%
Plant A's frequency of occurrence = 23% considering whole lake sample.

Plant A sampled at 12 of 40 littoral points = 12/40 = 0.3 = 30%
Plant A's frequency of occurrence in littoral zone = 30%

These two frequencies can tell us how common the plant was sampled in the entire lake or how common the plant was sampled at depths where plants can grow (littoral zone). Generally the second (littoral zone) will have a higher frequency since that is where plants grow. We need the first (whole lake) value to determine degree of coverage by plants in the entire lake.

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.

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 this sum into the individual frequency.

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%

Now we can compare the plants to one another. 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 we sampled Plant D at 6 of 10 sites, we were sampling many other plants too, thereby giving a lower frequency when compared to those other plants. This then gives a true measure of the dominant plants present.

Total sample points-This is the total number of points created for sampling on the lake. This may not be the same as the actual points sampled. 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 went into a lake and found just one plant, the Simpson's diversity would be "0." This is because if we went and sampled randomly 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 sampled randomly, there would be a 100% chance they would be different since every plant is different.
>
> These are extreme and theoretical scenarios, but they do make the point. The greater the Simpson's index is for a lake, the greater the diversity since it represents a greater chance of two randomly sampled plants being 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 found 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. The FQI is calculated using the number of species and the average conservatism value of all species used in the index. Therefore, a higher FQI, indicates a healthier aquatic plant community. This value can then be compared to the mean for other lakes in the assigned eco-region. There are four ecoregions used throughout Wisconsin. These are Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. Grindstone Lake is in the Northern Lakes and Forest eco-region.

Summary of Northern Lakes and Forest Mean Values for Floristic Quality Index:

Mean species richness = 13

Mean average conservatism = 6.7

Mean Floristic Quality = 24.3*

*Floristic Quality has a significant 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

Figure 1. Early season curly leaf pondweed samples

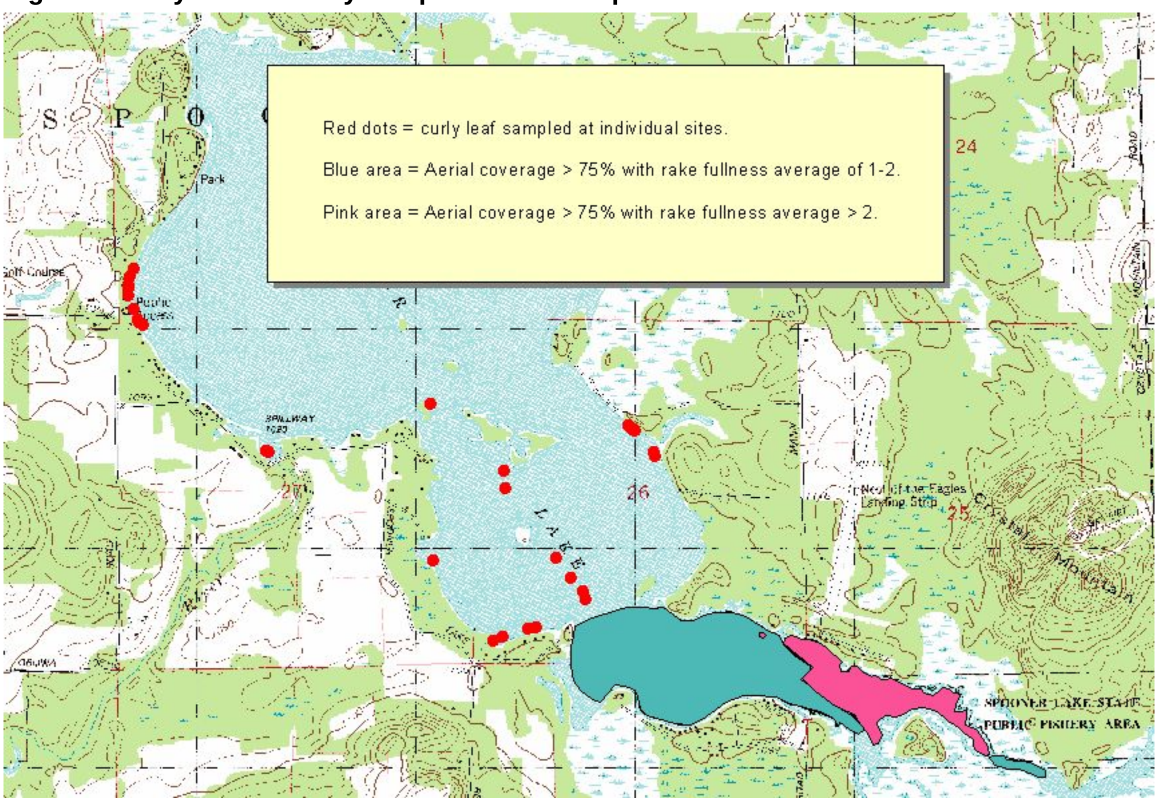
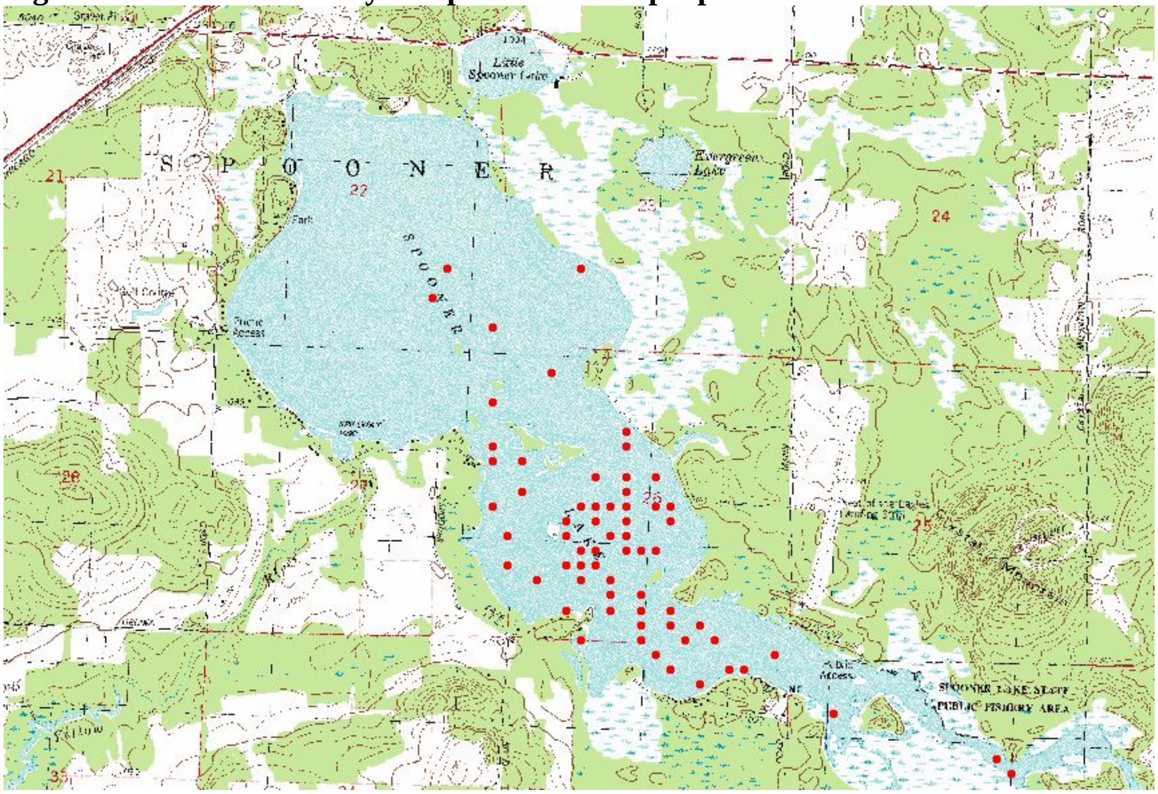


Figure 2. Late season curly leaf pondweed sample points



Species Richness

Species	Common name	Relative Freq.(%)	Freq. of occurrence
Potamogeton zosteriformis	Flat stem pondweed	23.4	75.66
Myiophyllum sibiricum	Northern milfiol	17.6	56.78
Ceratophyllum demersum	Coontail	15.2	49.26
Potamogeton friesii	Fries pondweed	13.6	38.64
Potamogeton robbinsii	Fern pondweed	9.9	31.86
Filamentous algae		4.7	15.34
Elodea canadensis	Common waterweed	3.7	11.95
Potamogeton crispus	curly leaf pondweed	3	9.59
Vallisnaria americana	Wild celery	2.2	7.08
Najas flexilis	Bushy pondweed	1.7	5.46
Stuckenia pectinatus	Sago pondweed	1.5	4.87
Potamogeton pusillus	Small pondweed	1.3	4.13
Potamogeton amplifolius	Large leaf pondweed	1.1	3.69
Heteranthera dubia	Water stargrass	0.6	2.06
Potamogeton praelongus	White-stem pondweed	0.5	1.77
Chara sp.	Muskgrass	0.3	1.03
Potamogeton richardsonii	Clasping leaf pondweed	0.3	0.88
Lemna minor	small duckweed	0.2	0.74
Nymphaea odorata	white water-lily	0.1	0.15
Ranunculus aquatilis	white water crowfoot	0.1	0.15

Species of aquatic plant observed	**Common name**		
Megalodonta beckii	**Buttercup**		
Carex comosa	**Bottle brush sedge**		
Iris versicolor	**Blue flag iris**		
Nuphar variegata	**Spatterdock**		
Phragmites australis	**Giant reed**		
Pontederia cordata	**Pickerelweed**		
Sagittaria graminea	**Grass leaved arrowhead**		
Schoenoplectus acutus	**Hardstem bulrush**		
Schoenoplectus tabernaemontani	**Softsem bulrush**		
Schoenoplectus fluviatilis	**River bullrush**		
Sparangium sp.	**Burreed**		
Typha latifolia	**Broad leaf cattail**		

As one can see the most frequent plant of those sampled is flat stem pondweed (*Potamogeton zosteriformis*). Although it is the most frequent, it is less than 25% showing that no one plant completely dominates the lake plant population. This lake contains many highly desirable native plants. This helps provide a healthy, diverse plant community for the lake ecosystem.

Although curly leaf pondweed was sampled, its frequency should be taken lightly since this is a late season survey. Curly leaf pondweed was surveyed in June and the map is attached with those results. Curly leaf pondweed is the only non-native plant sampled or observed visually at Spooner Lake.

Other important statistics are as follows:

Species richness (plants actually sampled)	**20**
Species richness (including visual observation)	**32**
Average number of species per sample site	**3.23**
Simpson's Diversity Index (1.0 is the highest possible)	**0.86**
Frequency of sites sampled with vegetation	**99.56%**

The above statistics indicate that the plant community is very diverse. The closer to 1.0 the Simpson's Index the more diverse and 0.86 is high. Also, the species richness is very high. The average rake fullness and the percentage of sampled sites with vegetation indicate a very high amount of plant coverage and biomass. This can also indicate the potential for nuisance levels of aquatic plants.

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.

Eco-region of Spooner Lake is Northern Lakes and Forests-flowages	**Spooner Lake Value**	**Median for Eco-region**
Number of species used in FQI	**28**	**23.5**
Average C	**6**	**6.2**
FQI	**31.75**	**28.3**

The only segment that Spooner Lake was less than average was the average conservatism. However, with such a diverse community, the FQI value is higher than the average for lakes (flowages) studied in the ecoregion. For this reason, we may conclude that the plant community indicates one of good health, diversity and demonstrates fewer disturbances.

Discussion of Results

Spooner Lake has a very diverse and extensive plant community. The lake is 99+% covered with plants. All of the plants are native with the exception of one, *Potamogeton crispus* (curly leaf pondweed). This non-native plant is very extensive in Spooner Lake. When viewing the curly leaf pondweed map, it is evident that the southeast portion of the lake near the inlet has a very large aerial covereage and high density. During the peak growth of the curly leaf pondweed, the plants were growing to the water surface and dense enough to impede navigation. In the rest of the lake, curly leaf pondweed is sporadic in coverage and more limited to deeper water areas.

In the native plant community, there were 28 species of vascular plants and 2 species of algae either sampled or visually observed within 6 feet of the boat. No one plant completely dominated as shown in the relative frequency table. Although plants such as *Potamogeton zosteriformes* were very common and sampled at numerous locations, the relative frequency was less than 25% in all cases. Some species with high conservatism values were also present. These were *Potamogeton praelongus, Potamogeton robbinsii, Megalodonta beckii, Potamogeton freisii*, and *Sagittaria graminea.* The FQI value reflects this and represents good habitat and a reflection of less disturbance to the plant community.

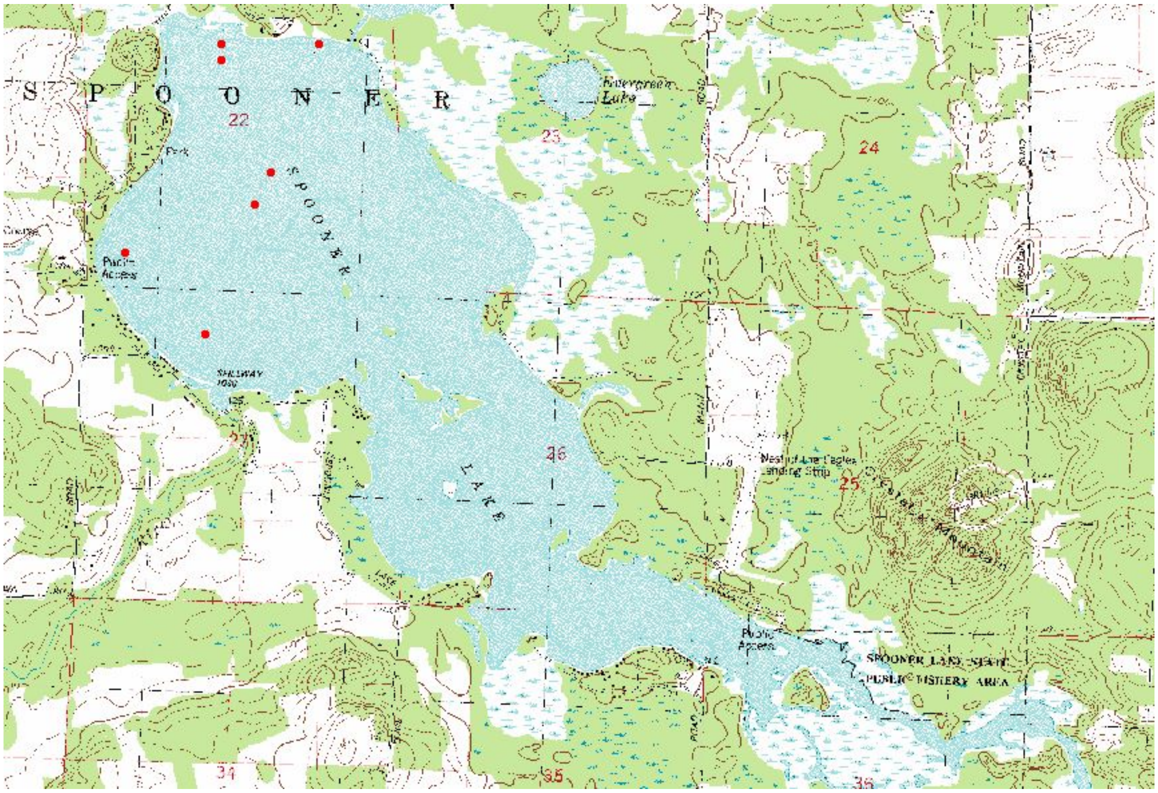
Most of the native plants were in the submergent form. A few floating and emergent stands, such as bulrush do exist. Where there was development, lawns with non-native grasses were quiet common. In undeveloped areas the shoreline vegetation consisted of numerous varieties of native herbaceous plants along with native trees and shrubs. A fair amount of the undeveloped shoreline consists of wetland bordering the lake. These wetlands appeared to contain a high diversity of native emergent and/or wetland plants. The survey of these plants was not conducted in this project.

In the southeast bay region near the inlet, the native plants also reach nuisance levels, which impede navigation. During the survey, there were areas that were very difficult to get through with the use of a motor and using oars. Furthermore, there was rather extensive coverage of plants with filamentous algae.

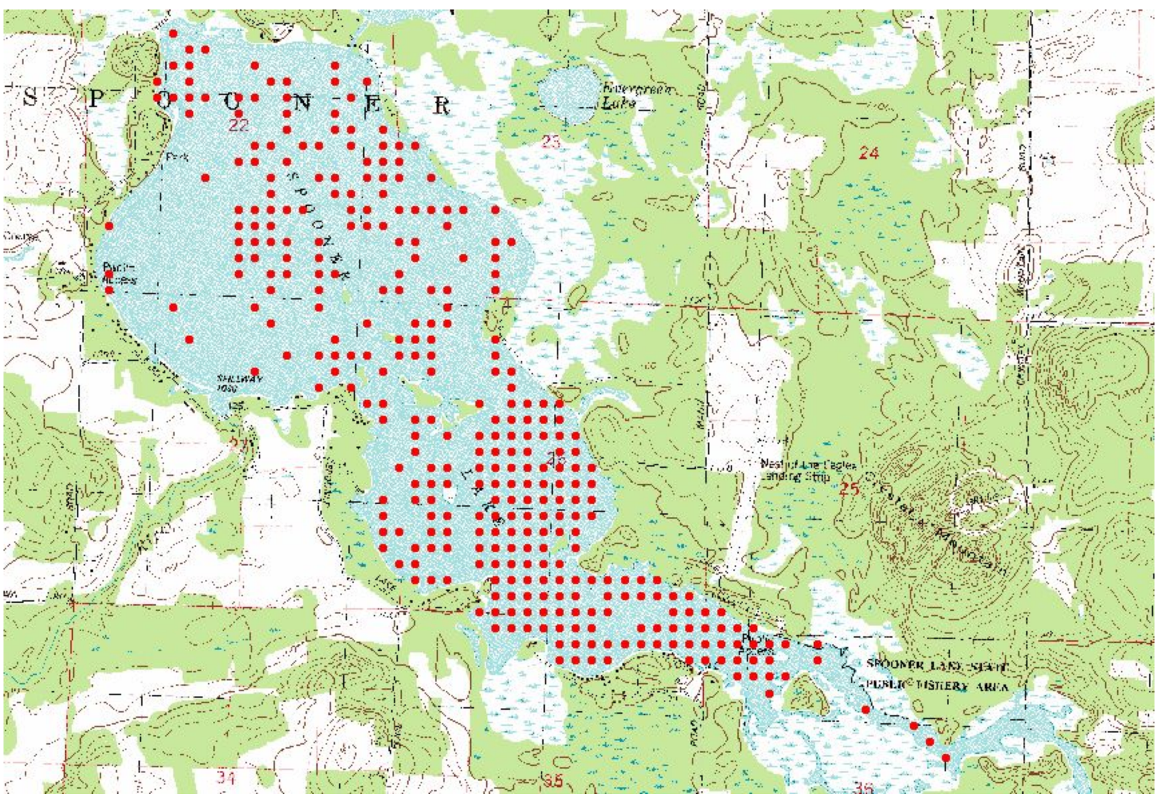
Appendix E

Maps of all species

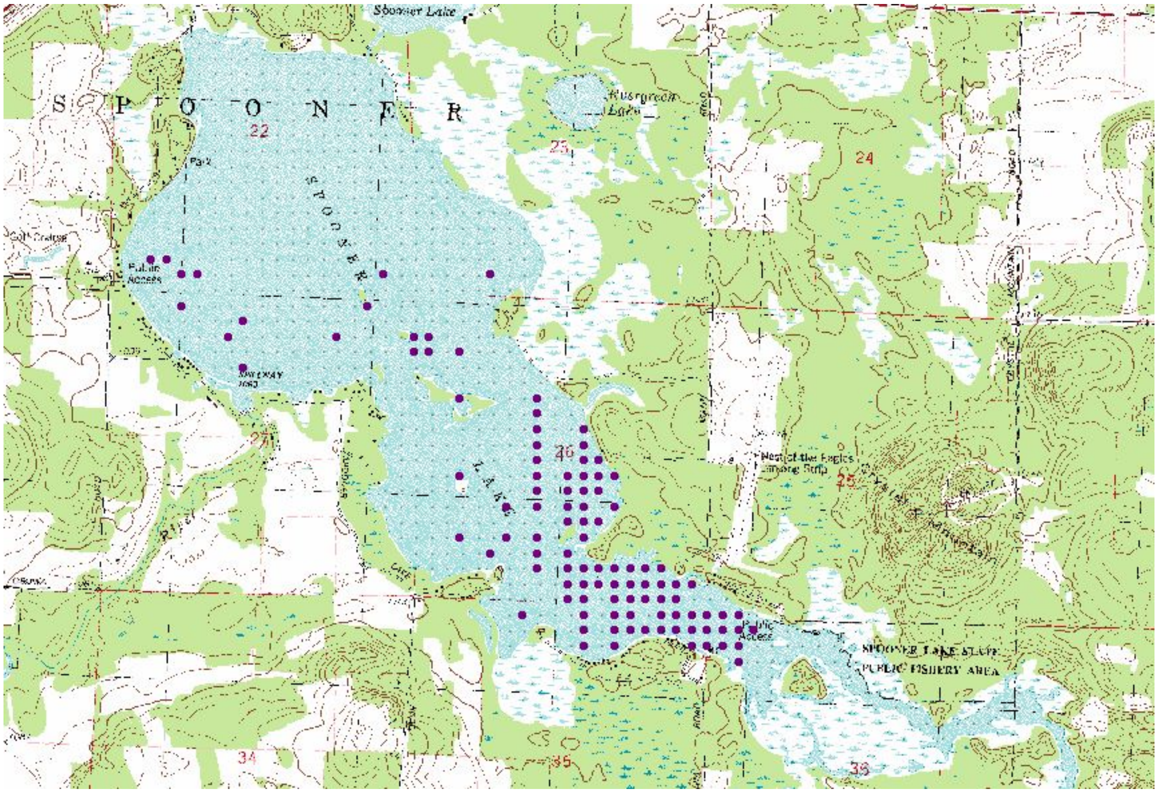
Carex comosa



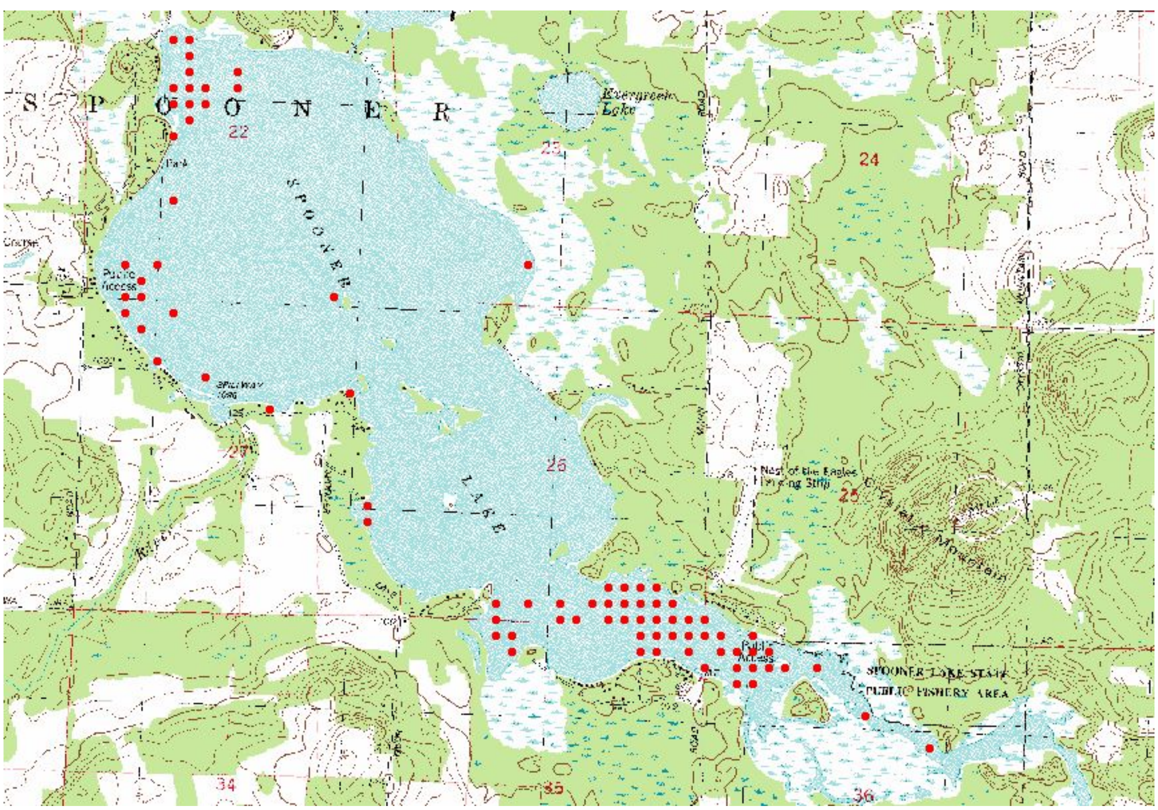
Chara sp.



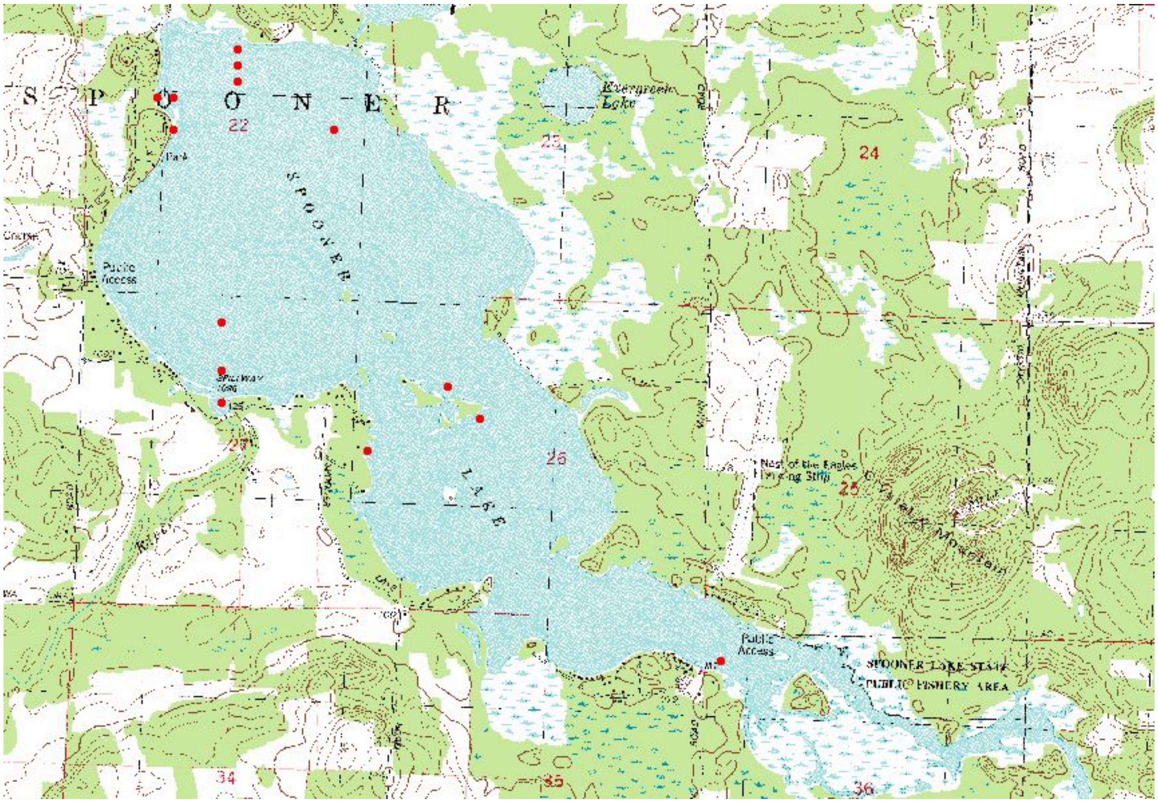
Ceratophyllum demersum



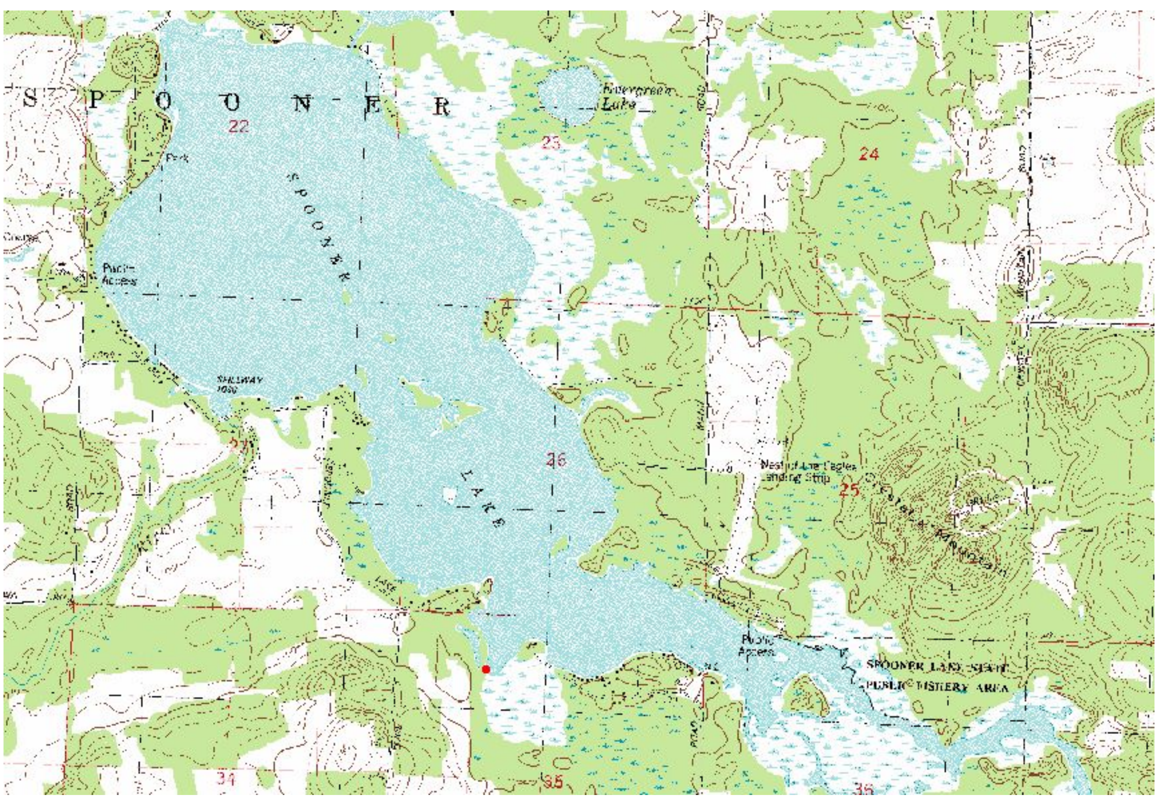
Filamentous algae



Elodea canadensis

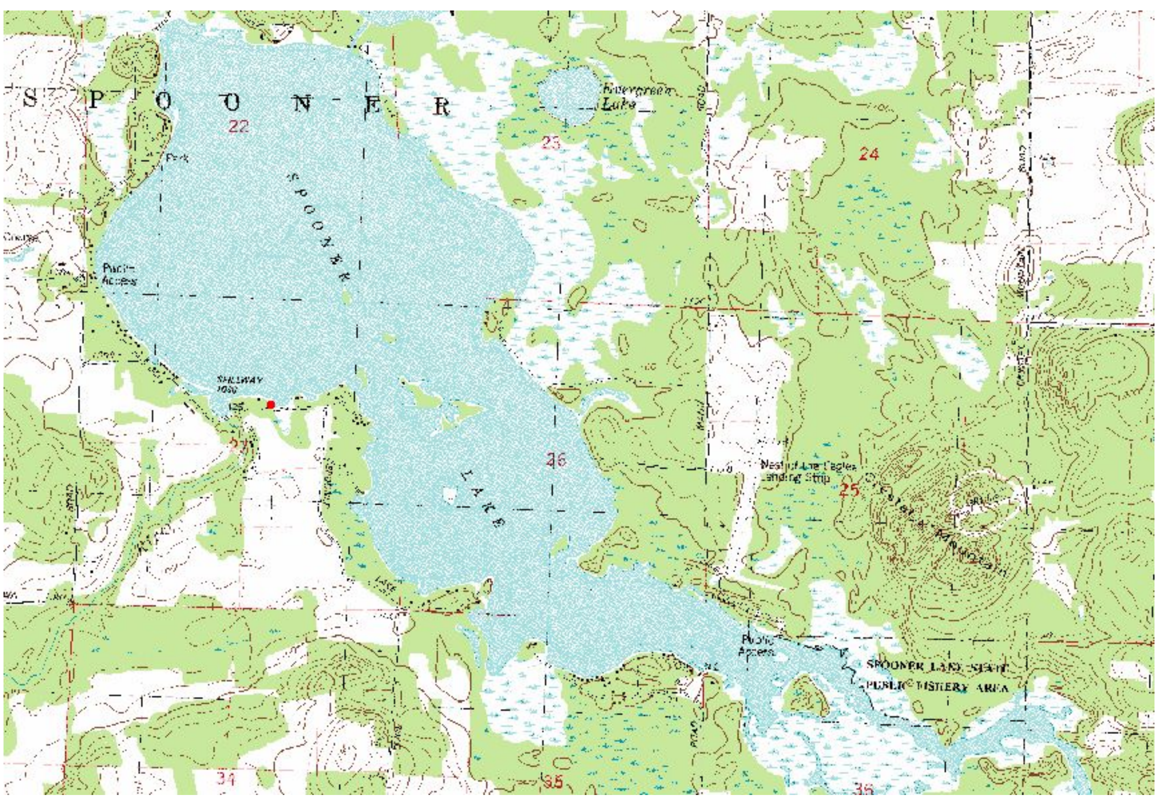


Heteranthera dubia

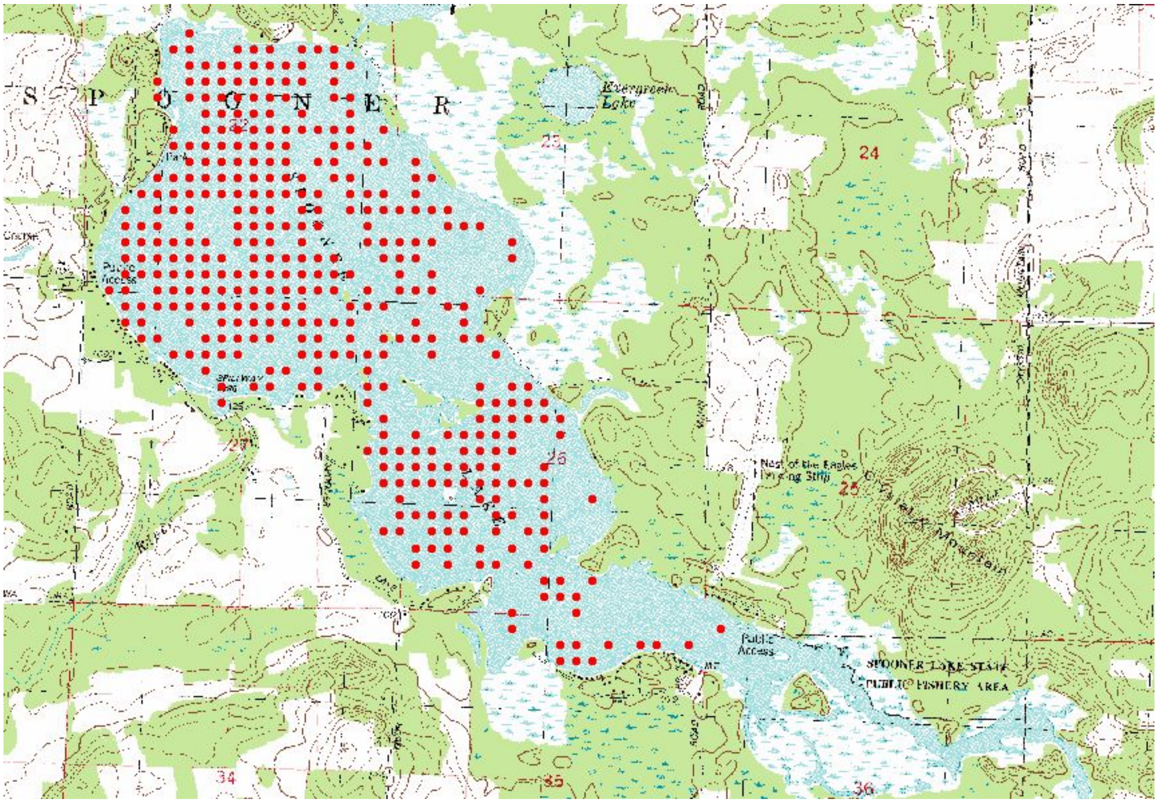


Iris versicolor

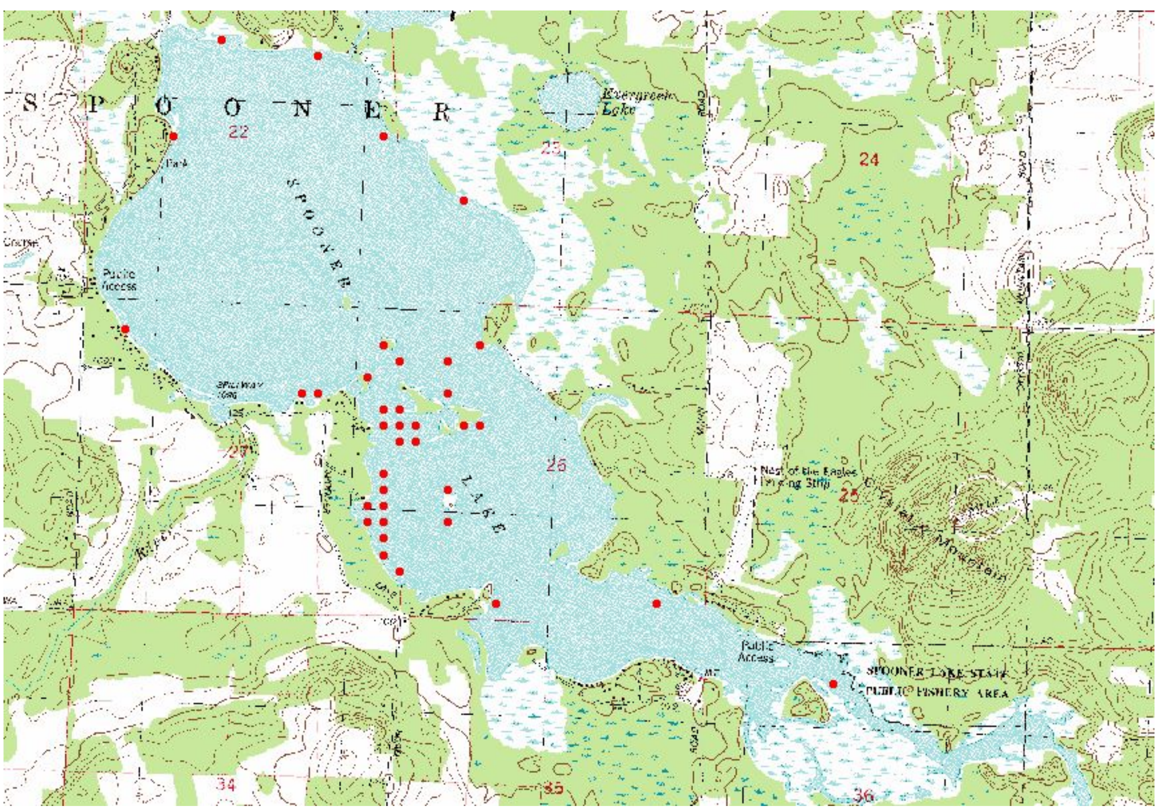
Lemna minor



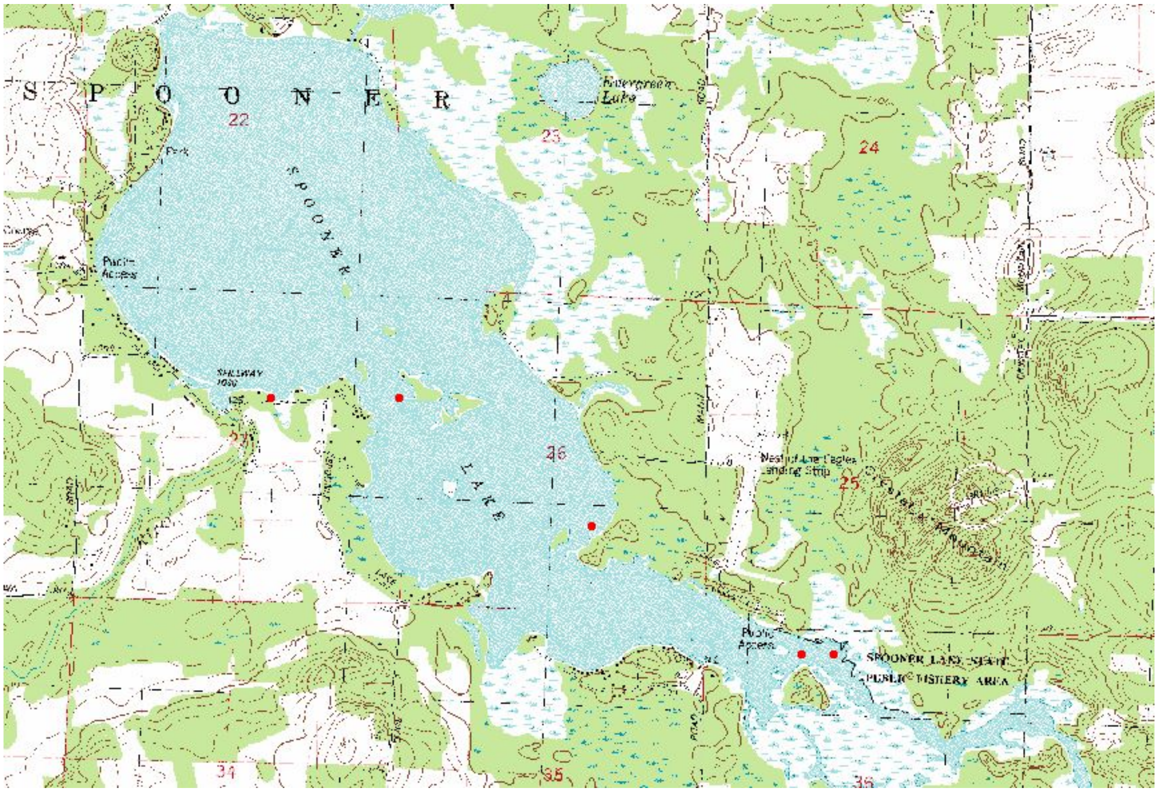
Megalodonta beckii



Myriophyllum sibiricum



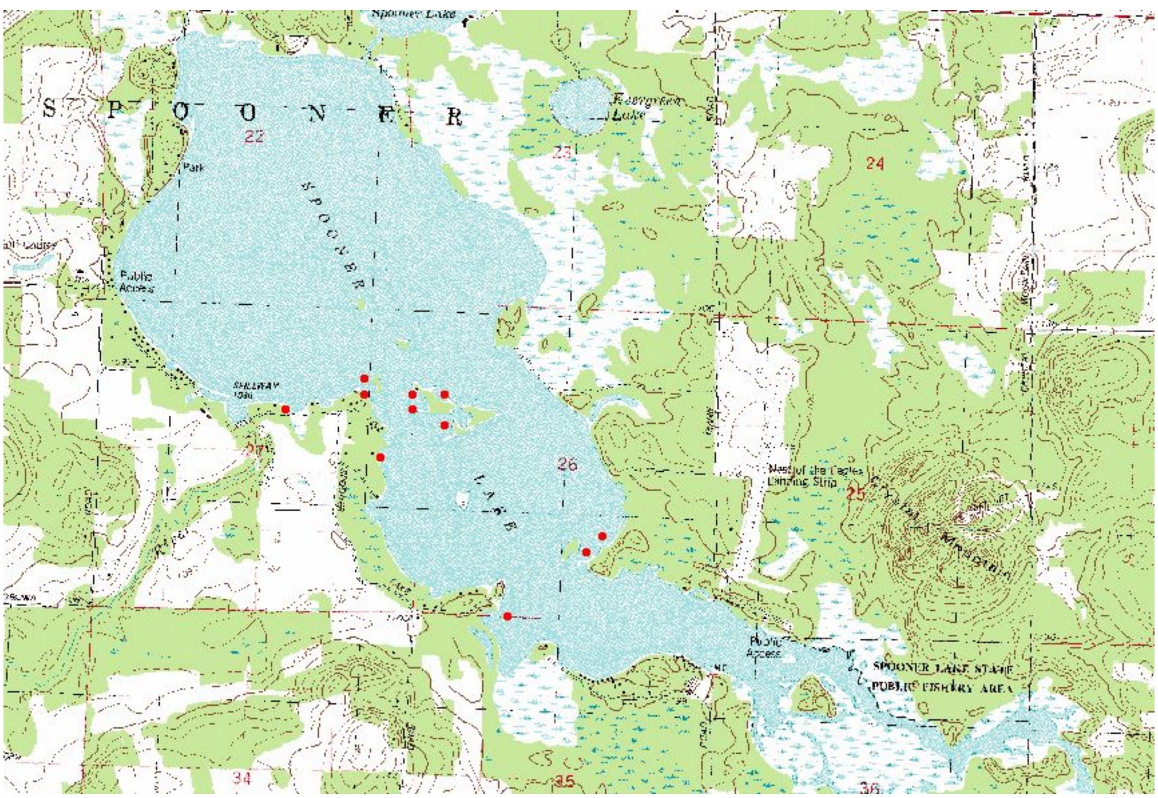
Najas flexillis



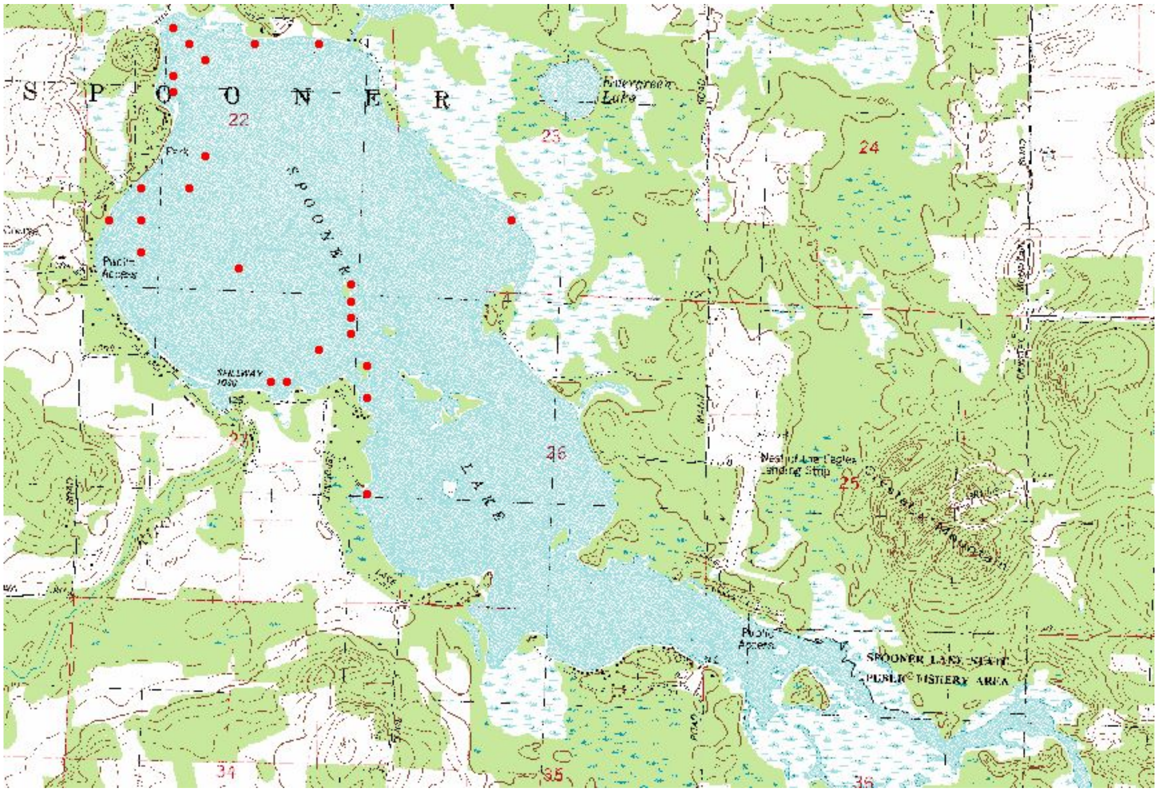
Nuphar variegata Spatterdock

Nymphaea odorata White lily

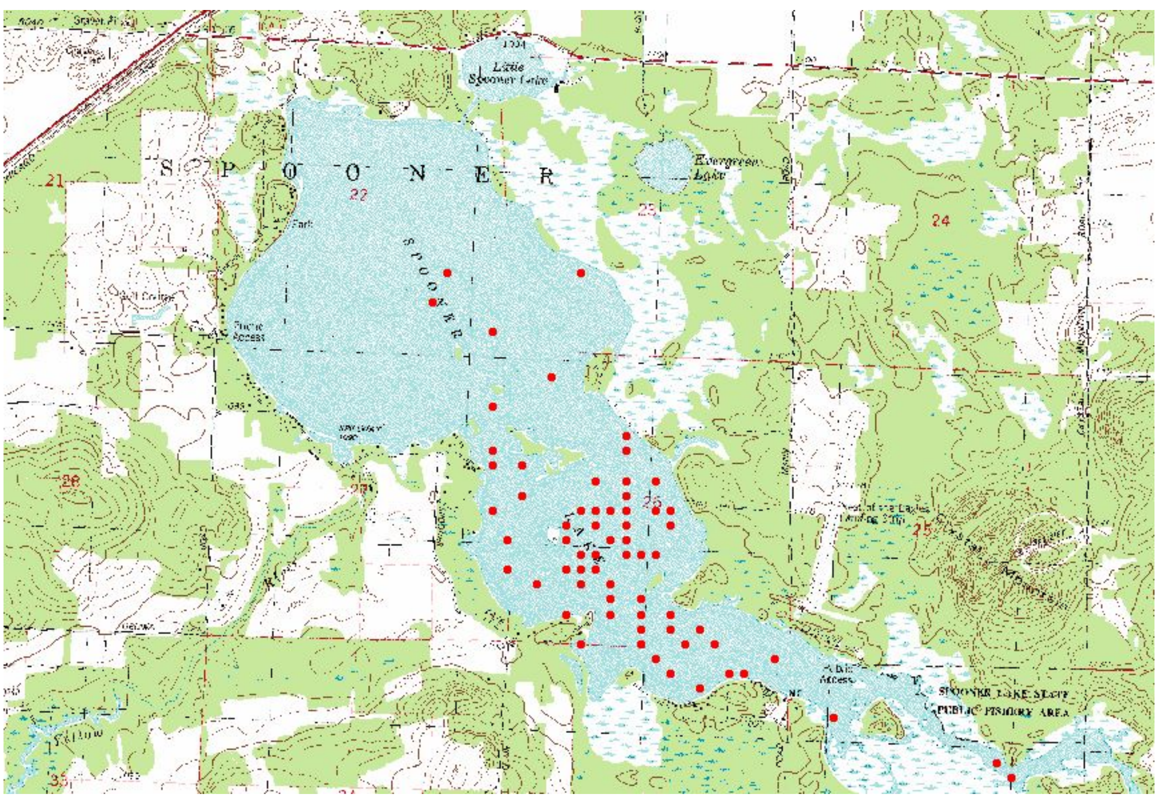
Phragmites australis



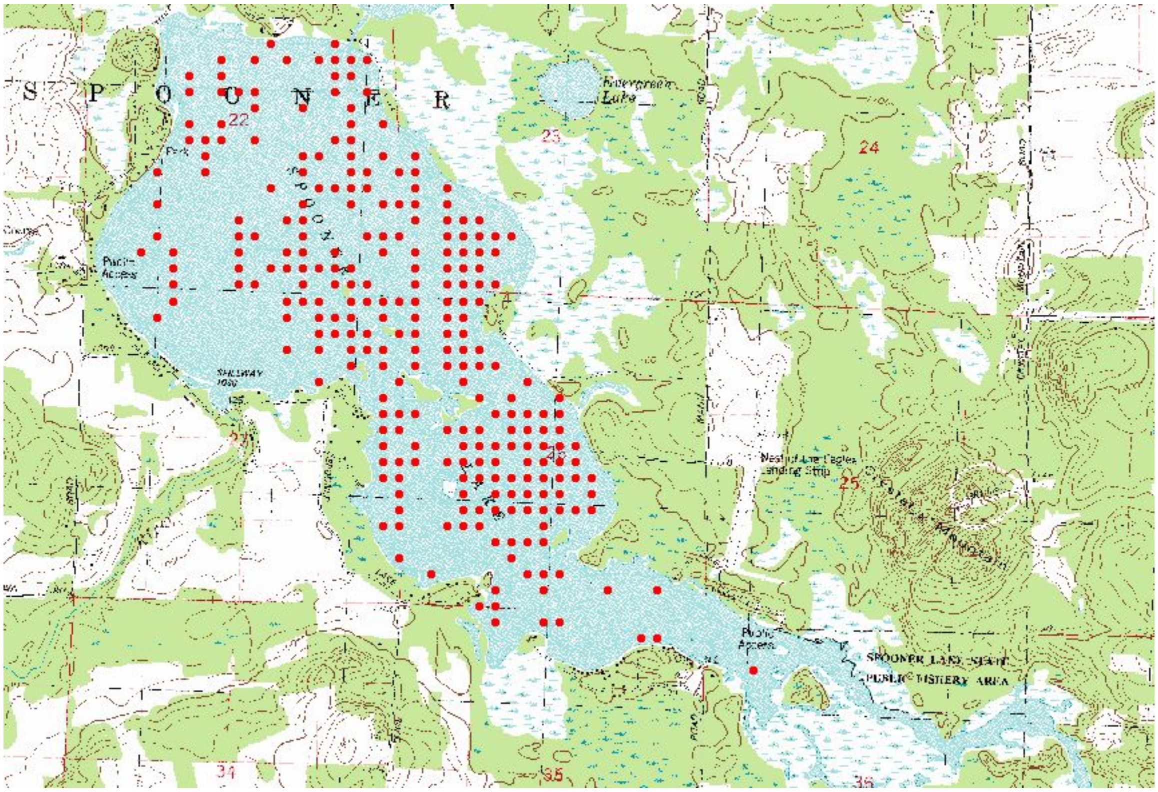
Pontederia cordata



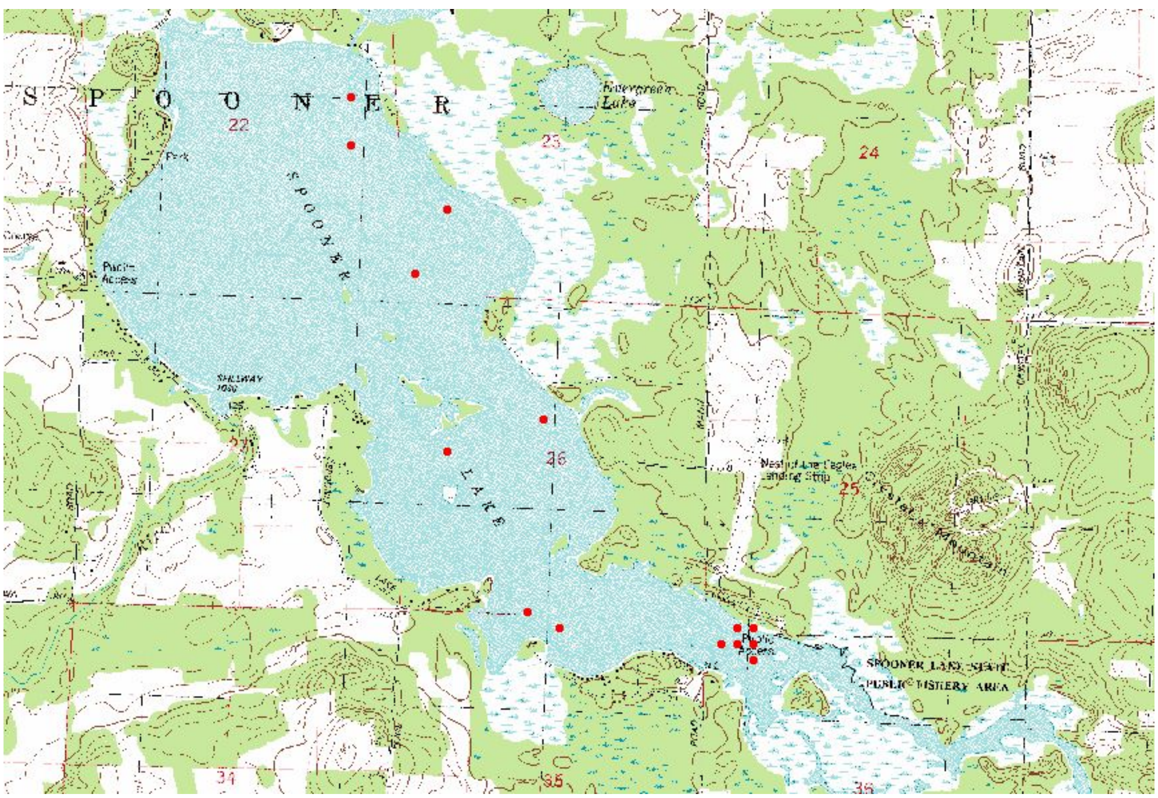
Potamogeton amplifolius



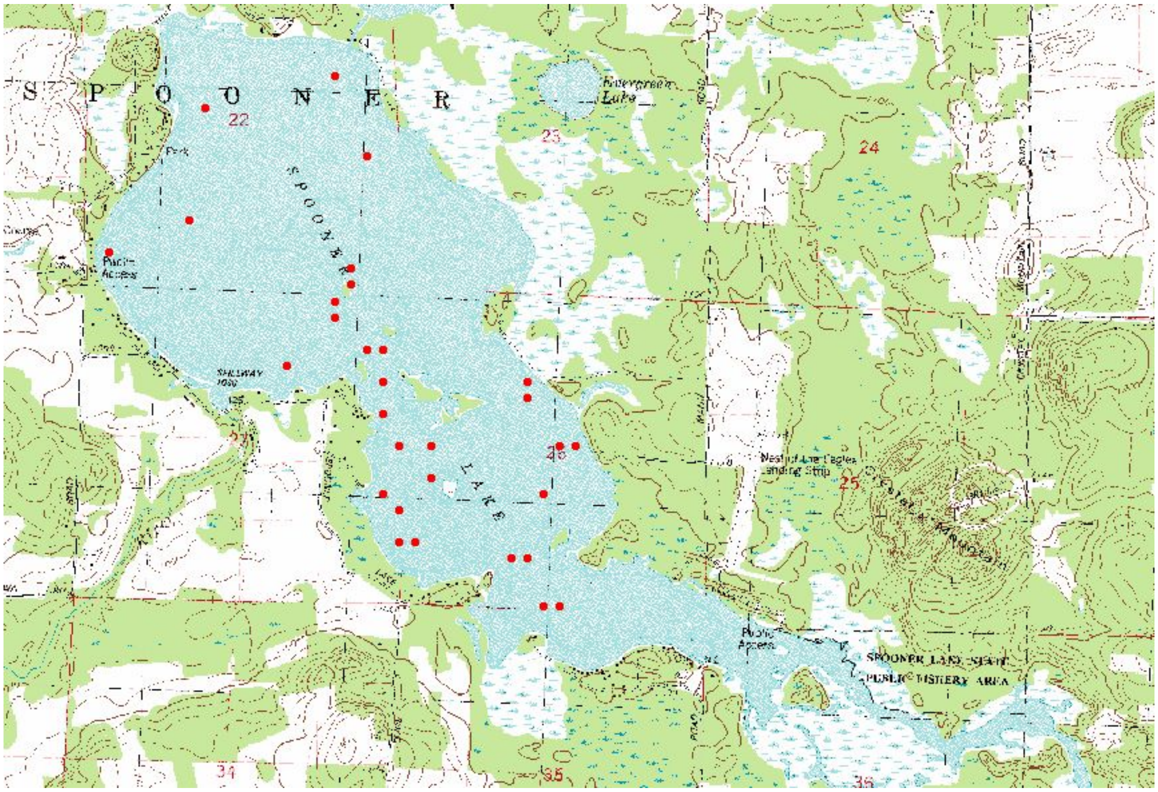
Potamogeton crispus



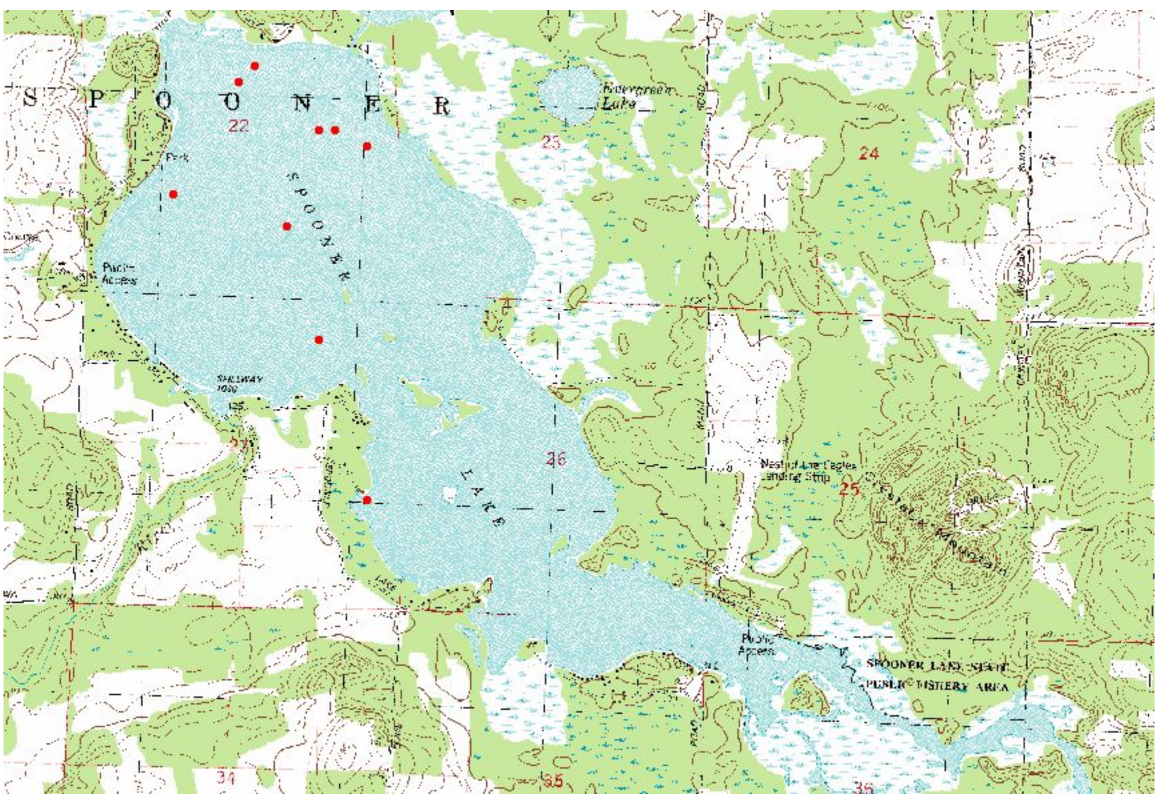
Potamogeton friesii



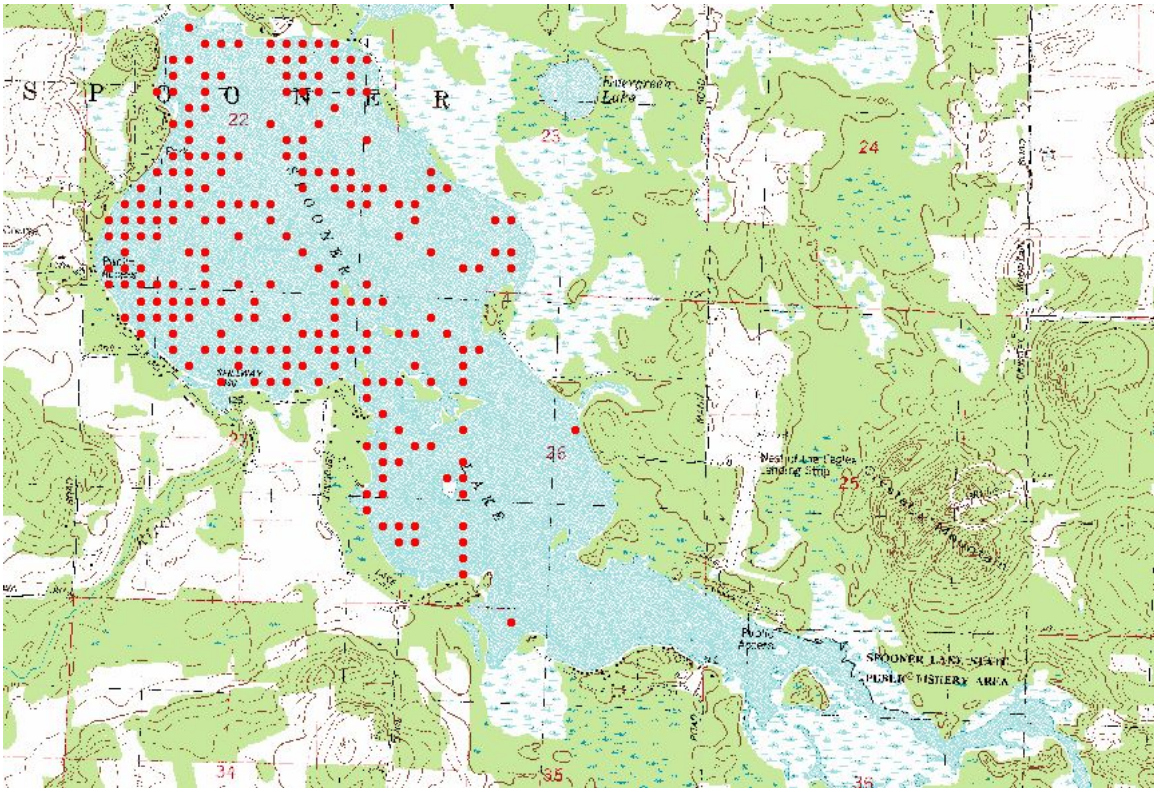
Potamogeton praelongus



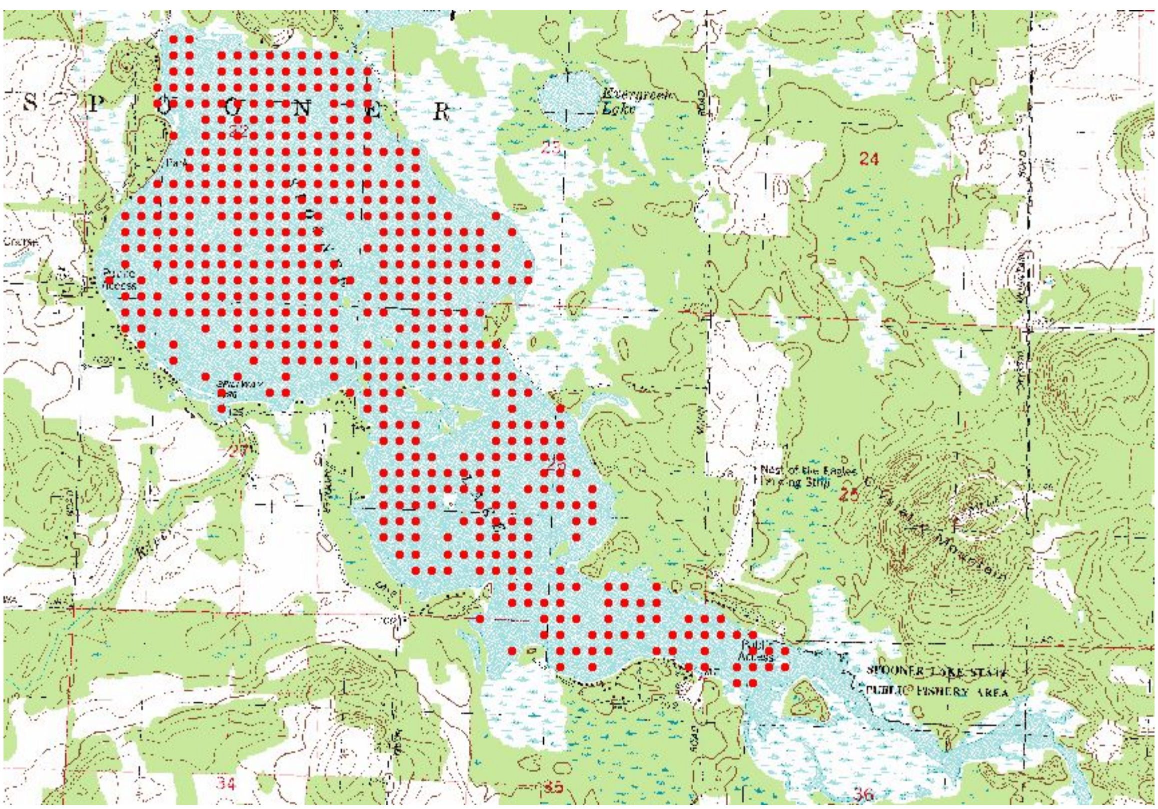
Potamogeton pusillus



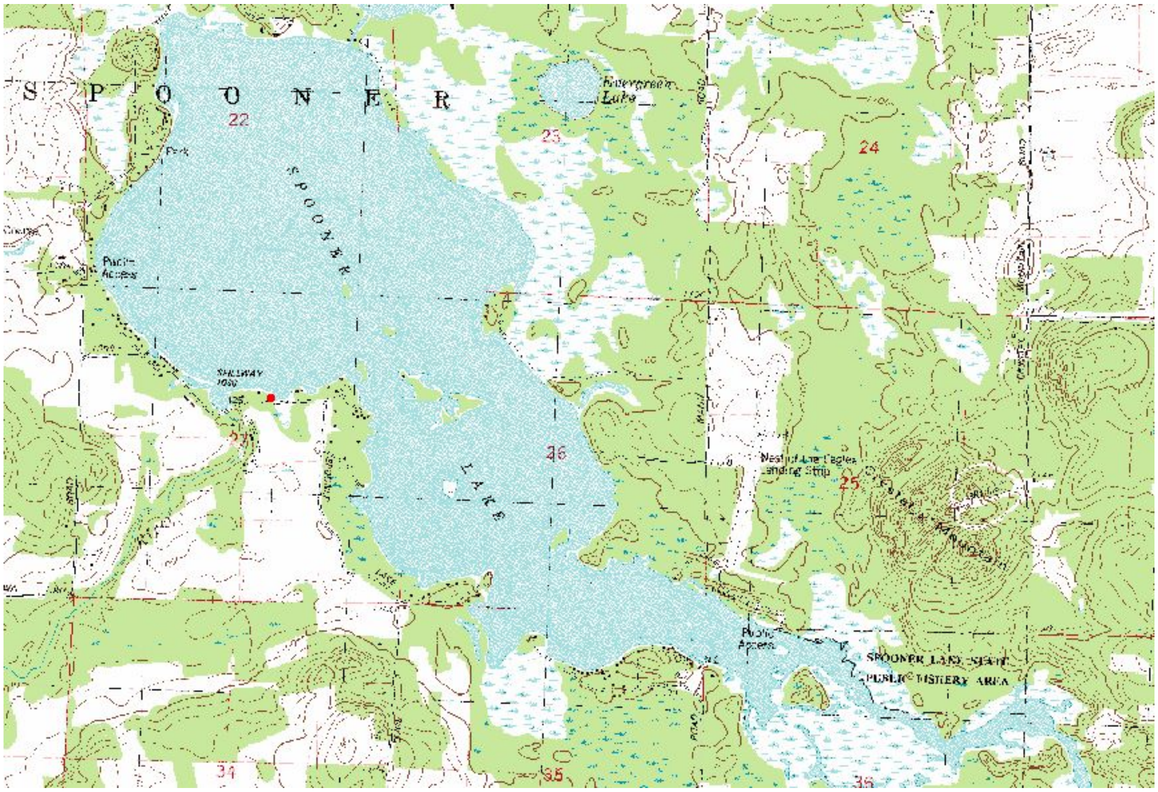
Potamogeton richarsonii



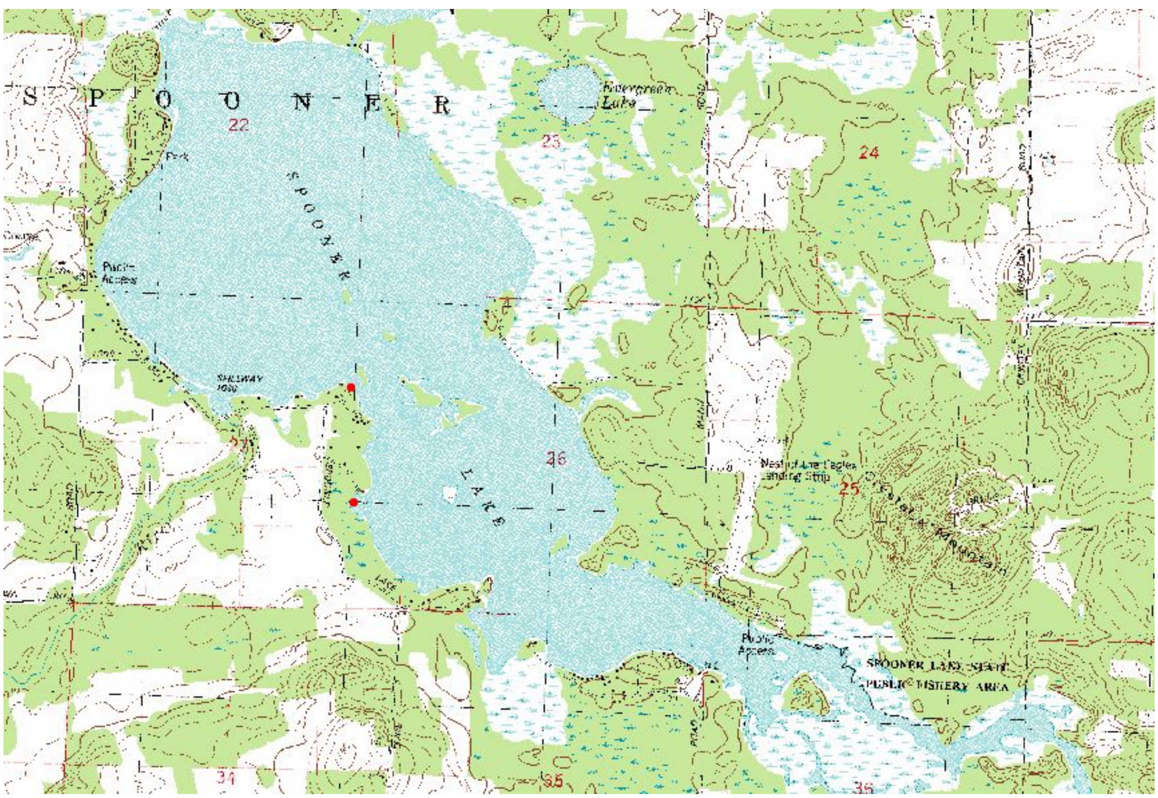
Potamogeton robbinsii



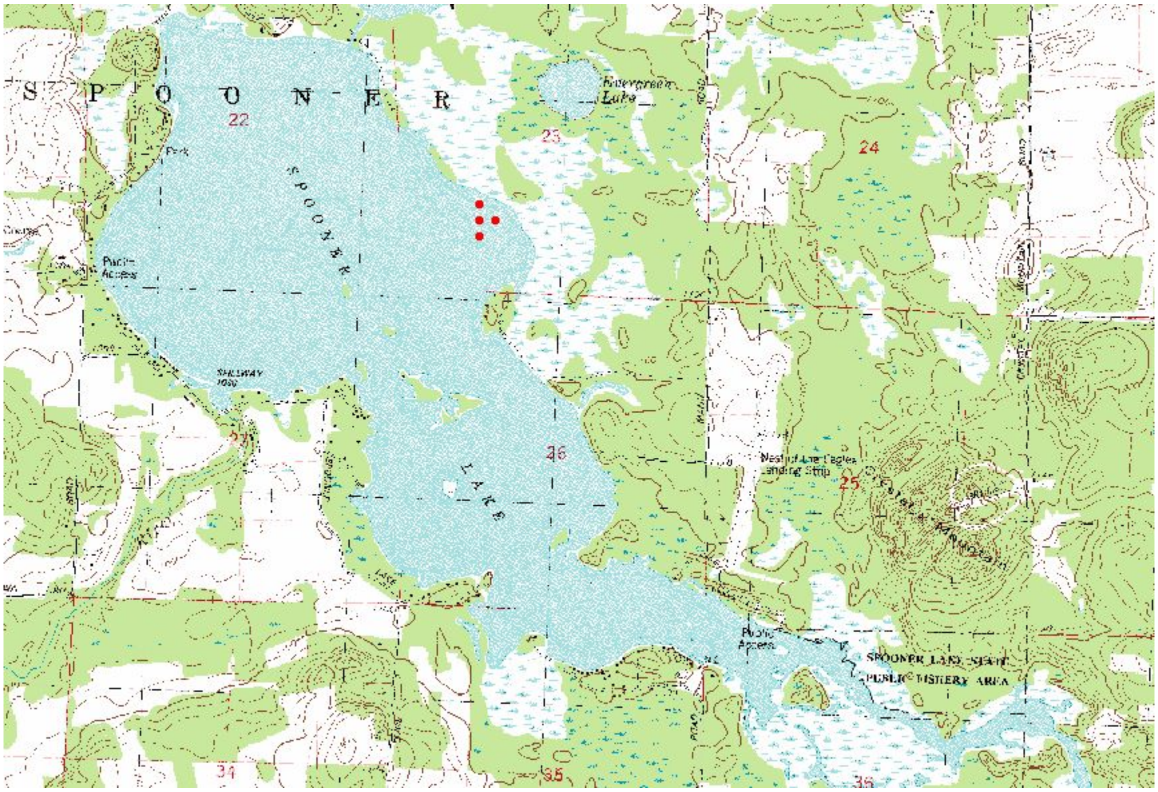
Potamogeton zosteriformis



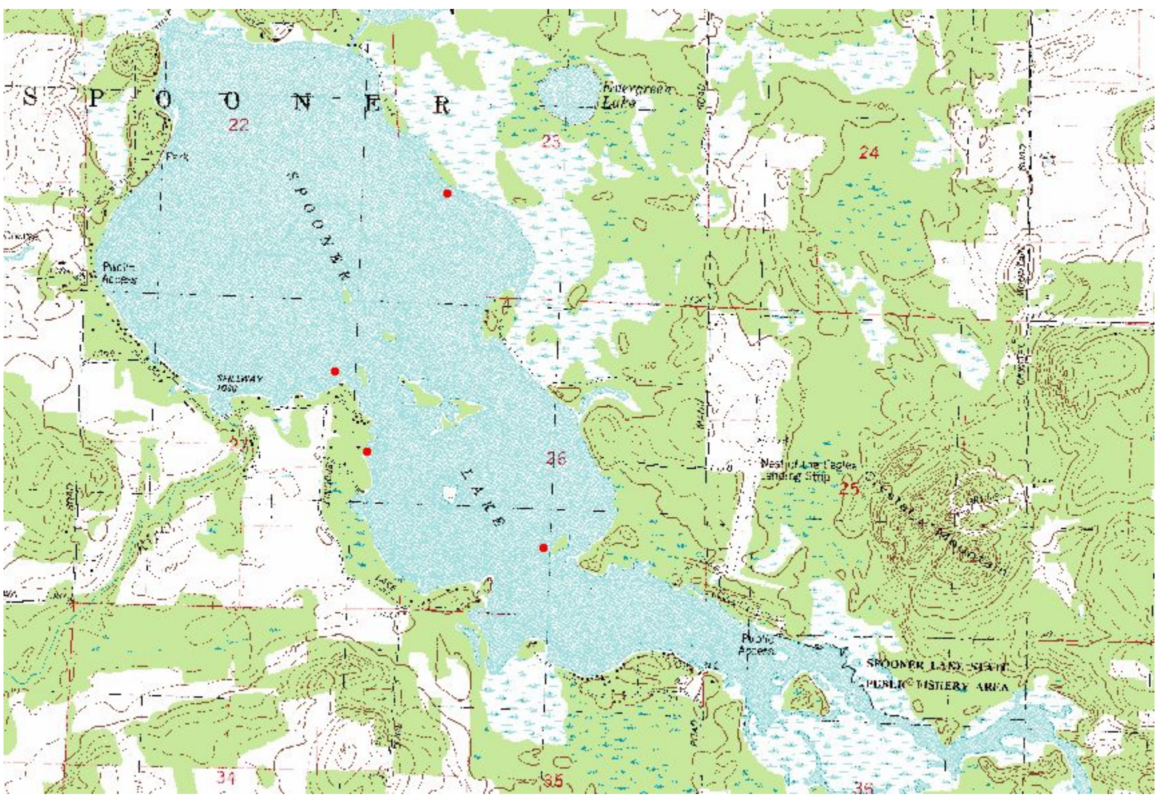
Ranunculus aquaticum



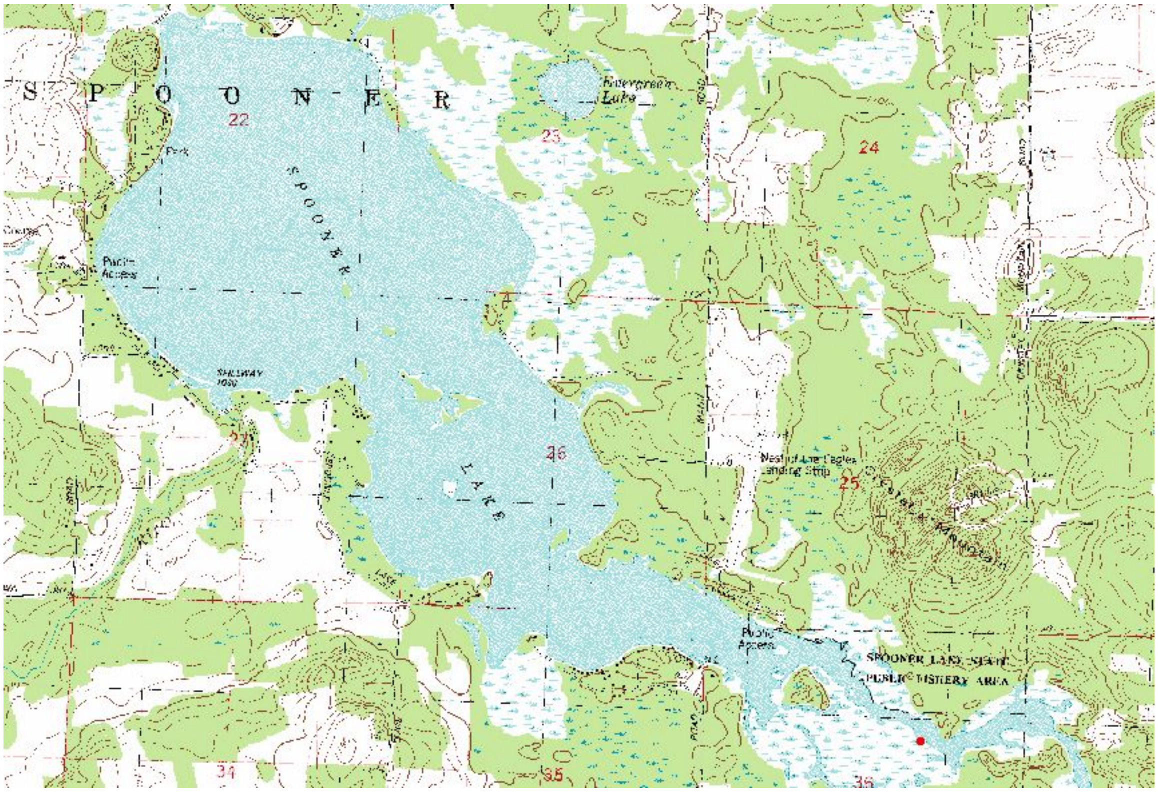
Sagittaria graminea



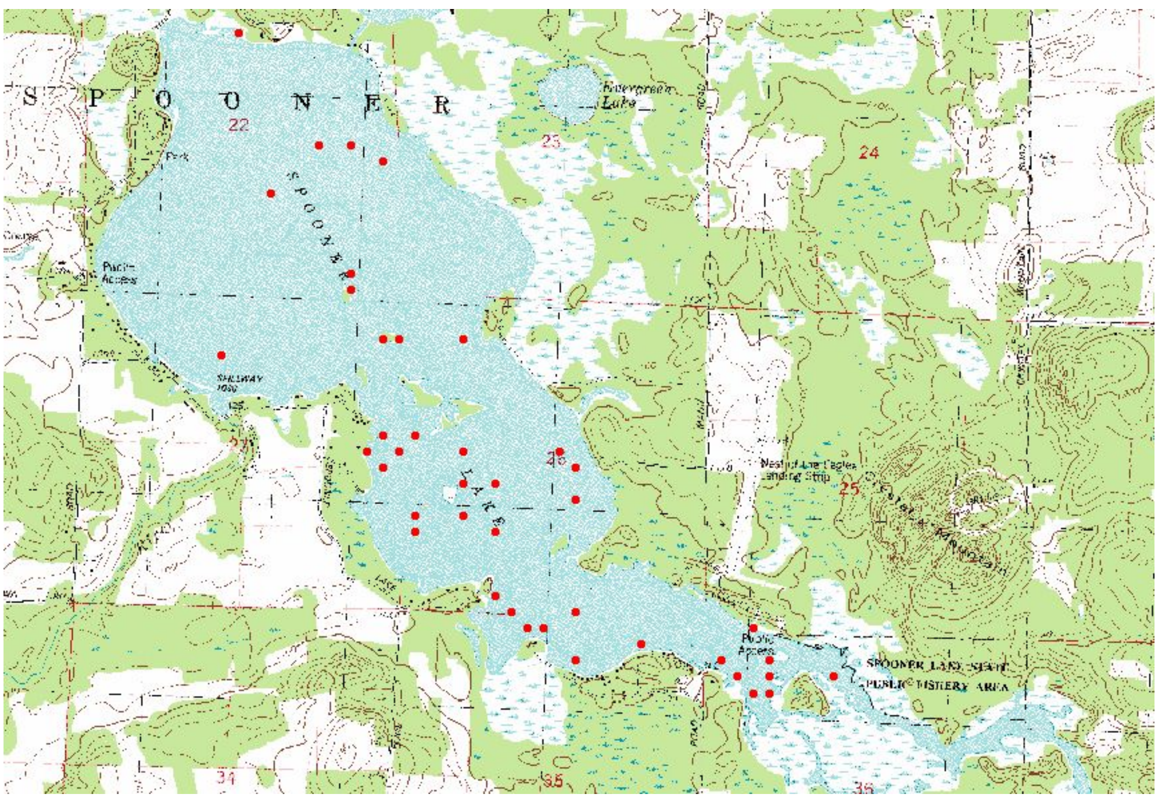
Schoenotplectus acutus



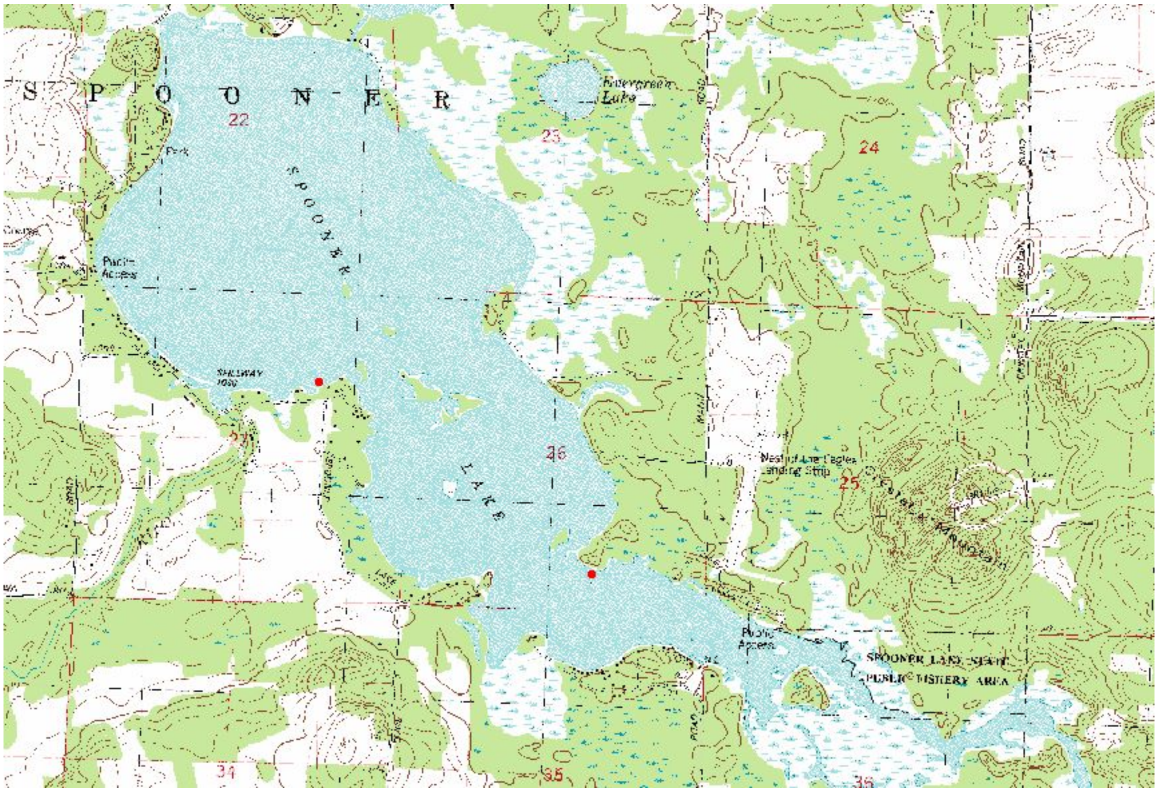
Schoenoplectus tabernaemontani



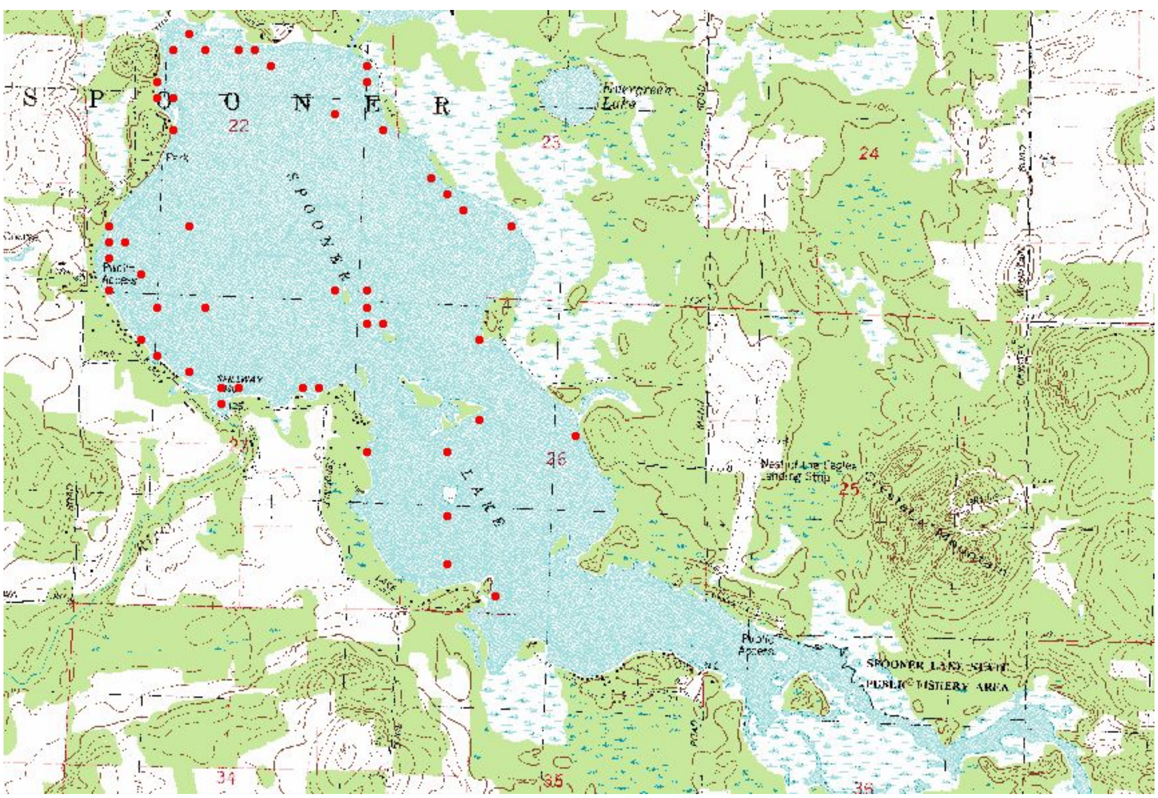
Schoenoplectus fluviatilis



Stuckenia pectinata



Typha latifolia



Vallisnaria americana

Appendix F
Public comments

The following comments were received from one individual during the public review process (plan on display at Spooner Public Library):

I think it's unfortunate that the Spooner Lake District Board didn't give you clear signals to fully explore the pros and cons of plant harvesting in our lake. I'm dismayed when one influential member--who happens to have had an embarrassingly bad experience with a contracted plant cutter which he hired years ago--can stifle full and complete exploration of one particular control strategy. We need to fully explore all options, not just those which one committee member happens to agree with.

To that end, I'd like to do the exploration of the harvesting strategy myself and present an objective report to the Board and to the entire membership before we vote on accepting the recommendations of the APM plan.

You mention above a new study documenting 400+/acre fish kill rates caused by harvesting. Can you cite me a reference so I can find the complete study? I'd be very interested in the methodology the authors used.

Was any meaningful exploration done on using occasional winter drawdowns to control undesirable growth in shallow littoral zones of Spooner Lake? A study done in the 1970s by the DNR's Tom Beard on the Murphy Flowage in Rusk County seems very positive for selective species control. And the Murphy Flowage shares many of the characteristics of Spooner Lake.

Thanks for the reference. I'll search out the pub later today.

I didn't mean to imply that you had intentionally given short shrift to the plant harvesting option in your APM plan for Spooner Lake. I can't think of anyone I'd trust more to compile a complete study with a healthy skepticism of chemical control methods.

And, yes, I did jump to conclusions from the Plan about more large-scale chemical spraying again in Spooner Lake. I saw first-hand the side-effects of large-scale, late-season spraying to the lake in 2001 and 2002. I'm encouraged to hear of the rigorous analysis of all control methods done by all parties.

Last weekend, with a stiff wind blowing from the SW, unbelievable quantities of CLP turions were blown into downwind bays near the islands on the lake. I removed floating coontail mats from a 30' beach area at my lot and saw in excess 200 turions in those mats in just that small area.

Email on 7/17/07

I'm glad Frank is willing to consider a historical method to balance out phosphorus in a shallow lake--wild rice.

Wild rice may not turn out to be the phosphorus-reduction tool the lake needs in 2007, but it was certainly one of the native plants that kept Spooner Lake clear and the nutrients in balance for 12,000 years.

Aldo Leopold said that the first rule of intelligent tinkering is to preserve every cog and gear. If we throw out the cog of wild rice, we may be losing a key component of the eventual solution.

If it's easy and no-cost to reintroduce wild rice into the Crystal Brook marsh near where it once grew, why would we not do so?

I am not passing these thoughts onto the board because there is no mechanism to do so. No Board meetings have been this summer held nor are any scheduled to my knowledge. There has been no board discussion of allowing district members to review and comment on the APM Plan prior to the next annual meeting--when I'm assuming we'll be asked to vote it up or down. We have no e-newsletter nor active website on which to view the APM Plan and on which such ideas could be posted.

Note: The APM has been available at the Spooner Public Library for several weeks and this was posted as a public notice.

Presentation of plan at public meeting

On August 11, 2007 a special meeting was conducted to present the Aquatic Plant Management Plan for Spooner Lake District. At this meeting the overall management options were reviewed as well as what is contained within the plan and the rationalization for such schemes. A question and answer/comment session was then carried out. Many questions and comments were over concerns over filamentous algae. An action item of removing dead filamentous algae in late summer was added to the plan as a result.