Aquatic Plant Management Plan

Lake Wapogasset/Bear Trap Lake
Polk County Wisconsin
2009

Sponsored by: Lake Wapogasset/Bear Trap Lake Sanitary District

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Introduction

This Aquatic Plant Management Plan is being developed for Bear Trap Lake and Lake Wapogasset. It presents data about the plant community, fisheries, watershed, and water quality of Bear Trap Lake and Lake Wapogasset. Based on this data and public input, this plan provides goals as well as strategies for the sound management of aquatic plants in the lakes. The plan reviews public input, summarizes data, discusses management options and alternatives, and recommends action items. This plan will guide the Lake Wapogasset/Bear Trap Lake Sanitary District, the Lake Wapogasset/Bear Trap Lake Association, Polk County, and the Wisconsin Department of Natural Resources in aquatic plant management over the next five years (2009-2014). After 2014, this plan will be evaluated and revamped as needed.

Both Bear Trap Lake and Lake Wapogasset are drainage lakes that are connected by a channel that is locally referred to as the "narrows". Lake Wapogasset has two inlets, Balsam Branch and Friday Creek. Balsam Branch contributes a very large portion of the water budget with Friday Creek having substantially less flow. A single outlet with substantial flow leaves Lake Wapogasset at the west shoreline. There are no tributaries that flow continuously into Bear Trap Lake.

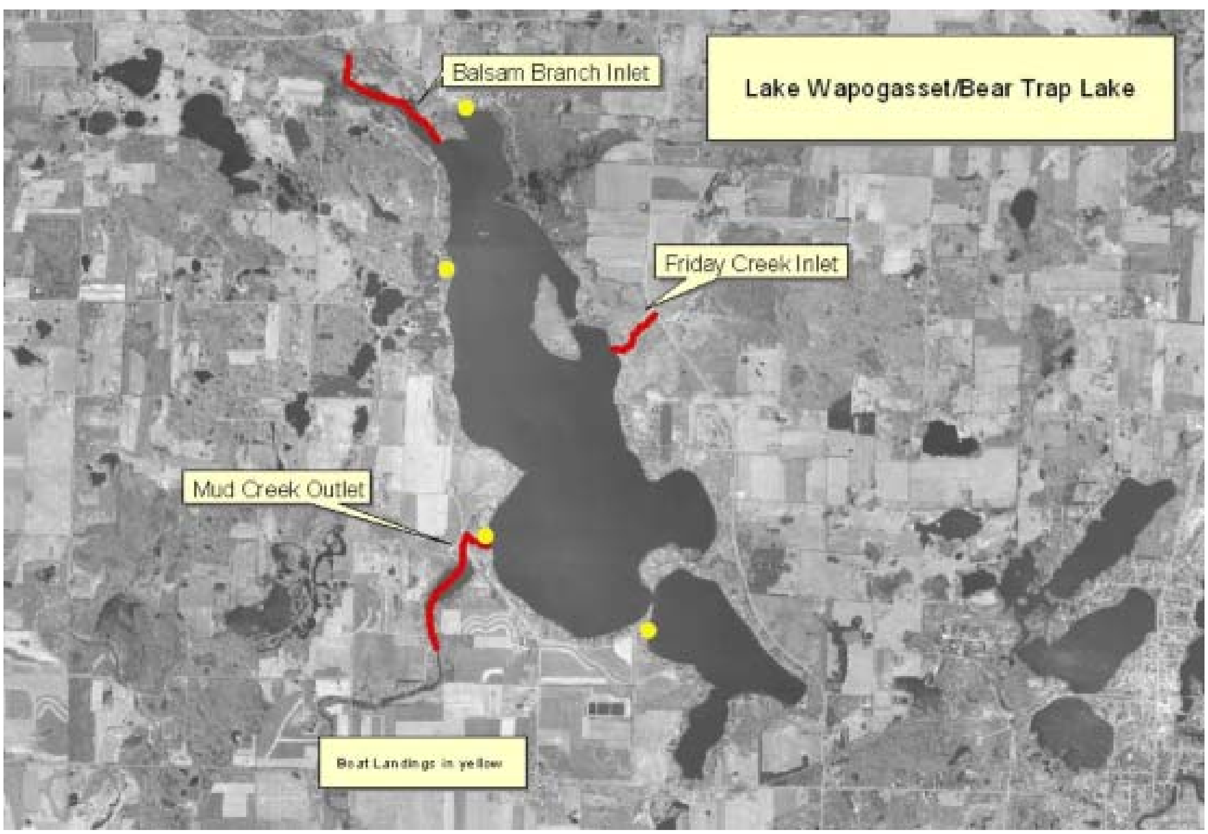


Figure 1: Aerial photo of Lake Wapogasset and Bear Trap Lake with tributaries and boat landings.

Bear Trap Lake

WBIC: 2618100
Location: T33N R17W S25
Area: 241 acres
Maximum depth: 25 feet
Mean depth: 10.9 feet

Figure 2: Topographical map of Bear Trap Lake.

Lake Wapogasset

WBIC: 2618000
Location: T33N R17N S26
Area: 1186 acres
Maximum depth: 32 feet
Mean depth: 9.8 feet

Figure 3: Topographical map of Lake Wapogasset.

Public Involvement

In spring 2009, a public survey was conducted to determine lake shore property owner's concern about the lakes. Approximately 650 surveys were distributed and 350 (54%) were returned. The results of the survey indicate that water quality is the greatest concern of lakeshore property owners.

Summary of results:

Respondents were asked to rate various problems in and around the lake on a scale from 0 to 4 (0 not at all and 4 a great deal). The results of their response is as follows (mean scale for each category listed):
:

Lack of water clarity in middle of lake = 1.9
Lack of water clarity at the end of dock = 2.5
Excessive invasive aquatic plant growth in lake = 2.4
Excessive native aquatic plant growth in lake = 2.3
Potentially toxic algae blooms = 2.6

Respondents were asked a question about how much a particular issue may negatively impact their use of the lakes. The scale ranged from 0 (definitely no) to 4 (definitely yes) with the results as follows:

	Lake Wapogasset	**Bear Trap**
Algae growth	3.1	3.0
Native aquatic plant growth	2.5	2.4
Invasive aquatic plant growth	3.2	3.0

When asked whether or not various activities should be pursued by the Sanitary District and/or Lake Association, the following results were received (0 definitely no to 4 definitely yes):

Spray native aquatic plants = 2.4
Harvest native aquatic plants = 2.5
Spray invasive aquatic plants = 2.6
Harvest invasive aquatic plants = 3.1
Prevent aquatic invasive species introduction = 3.7
Monitor for aquatic invasive species = 3.7
Protect sensitive habitat areas = 3.2

Responses when asked to rate the level of aquatic plants was as follows (1 too few; 2 right amount; 3 too many):

Lake Wapogasset = 2.6
Bear Trap Lake = 2.3

When asked what affect aquatic plants have on participation in various activities around the lakes the following mean values (0 not at all; 4 a great deal):

Activity	Lake Wapogasset	Bear Trap Lake
Swimming	2.5	2.2
Fishing	1.8	1.7
Boating	2.1	2.0
Enjoying the view	1.6	1.3

When property owners were asked about reducing growth of curly leaf pondweed (CLP), the following mean response was received:

Response	Lake Wapogasset	Bear Trap Lake
Definitely no	2%	1%
Maybe no	0%	0%
Not sure	3%	5%
Maybe yes	10%	9%
Definitely yes	71%	55%
No answer	13%	30%

In terms of water quality practices, 44% are familiar with shoreline buffer zones and 35% have them present on their property, although the definition may vary by owner. Of the 350 respondents, 41% are either "fairly" or "very interested" in water quality practice being installed at their property (no designation of which of many listed) and 13% "not" or "not very" interested.

Based on the overall results of the survey, the residents of Lake Wapogasset and Bear Trap Lake are concerned about water quality and aquatic plants. There seems to be little distinction between invasive and native plants but consistent response to reduce their growth. The respondents are very concerned about CLP and want to do something about it. Property owners are also very concerned about new introductions of aquatic invasive species. It is apparent that there needs be some educational components about the native versus invasive aquatic plants. Since harvesting of CLP is not a suggested management method for these lakes, education about the pros and cons of various management methods is needed.

Lake Wapogasset and Bear Trap Lake have two lake organizations. One is the Lake Wapogasset/Bear Trap Lake Sanitary District, which is a taxing entity. The other is the Lake

Wapogasset/Bear Trap Lake Association. Both of these organizations are very active in protection and management of the two lakes. Both have representatives on the committee that was formed in June of 2008 to develop this plan. The members of this committee that are representing their respective organization have been reporting back to those organizations about the components of the plant management plan.

Plant management committee members:

- Dave Anderson – Lake Resident
- Paul Elbing - Lake Wapogasset/Bear Trap Lake Sanitary District
- Ron Flatten – Lake Resident
- John Kugler – Lake Wapogasset/Bear Trap Lake Association
- Mike McBrayer – Lake Resident
- Mort Mortenson – Lake Resident
- Dave Nelson – Lake Wapogasset/Bear Trap Lake Association
- Mark Tryggestad – Lake Wapogasset/Bear Trap Lake Sanitary District

Upon the completion of the first draft, the plan will be available for public review in hard copy at the public library and electronically on the Lake Wapogasset/Bear Trap Lake website. Any public comments will be examined and considered for improvements in the plan. A public meeting will also be conducted presenting the plan and taking comments.

Importance of Aquatic Plants

The lake ecosystem relies extensively on the littoral zone, which is the area of the lake where the water is shallow enough to hold plants. As a result, the aquatic plant community plays a very important role in maintaining a healthy lake ecosystem.

Emergent plants (the ones sticking above the water surface) can help filter runoff that enters the lake from the watershed area. Their extensive root networks can stabilize sediments on the lake bottom. Wave energy can be reduced by emergent plants, thus reducing shoreline erosion. Many of these beds provide important fish habitat and spawning areas, as well as key wildlife habitat. Many birds, waterfowl, and some mammals rely on these plants for nesting materials as well as food.

Floating-leaf plants such as water lily provide shade and cover for invertebrates and fish. Although they appear thick on the surface, the underwater area beneath them is more open. This allows fish and other animals to move about hidden by the leaves above.

Submergent plants provide many benefits to the lake ecosystem. These plants are nature's aerators, producing the essential oxygen byproduct from photosynthesis. Submersed plants absorb nutrients through their roots and in some cases through their leaves, decreasing the nutrients that would otherwise be available for nuisance algae growth. Roots stabilize bottom sediments thus reducing re-suspended sediments. As a result, these plants help maintain water clarity.

Aquatic plants take on many shapes and sizes and provide excellent habitat. Many of the plants, such as the milfoils or water marigold, have fine leaves that provide key invertebrate habitat. These invertebrates comprise a very important level in the food chain and result in excellent forage opportunities for fish. Other plants are adapted to grow in low nutrient substrates such as sand and gravel. These plants maintain important fish and wildlife cover for areas that would otherwise be devoid of plants.

Many fish rely on aquatic plants for reproduction. *Esox sp.* often spawn amongst submergent plants. The Northern Pike even has eggs that are adapted for attachment to the plants themselves. Once fish emerge from their eggs, the plants provide important cover and foraging areas.

Lake Information

Fisheries

Both Lake Wapogasset and Bear Trap Lake have abundant, diverse fish populations. In a population survey conducted in 2008, it was reported that the following fish are present in the two lakes (the fish biologist combined both lake results in the report)[1]:

Walleye
Northern Pike
Muskellunge
Largemouth Bass
Smallmouth bass
White bass
Bluegill
Black crappie
Pumpkinseed
Yellow perch
Green sunfish
Warmouth
White sucker
Common carp
Redhorse
Bullheads.

[1] Heath Benike. Wisconsin DNR Fisheries Biologist. Draft Report on 2008 fish survey. Feburary 2008.

The management of fish in these two lakes has involved a large amount stocking of walleye fry and small fingerlings. The walleye stocking program dates back to 1938. The most recent stocking occurred in 2006 when 41,485 walleyes (35 fish/acre) less than 3" in length were stocked (combined in both lakes). In 2005, a low-level muskellunge stocking program was initiated (<0.5 fish/acre). This was initiated to maintain a low-density fishable population that has been present in the past several decades. Historically muskellunge emigrated from upstream, which has had the stocking reduced.

The most abundant managed game fish in Lake Wapogasset/Bear Trap Lake is largemouth bass at 8.7 fish per acre. A concern was raised by the fish biologist about this population being too dense, leading to a stunted largemouth bass population.

The fish survey management recommendations discussed the importance of maintaining an adult walleye population between 1-2 fish/acre through increased walleye stocking (70 fish/acre) in Lake Wapogasset. Walleye appear to be an integral part of the overall fish management of Bear Trap Lake and Lake Wapogasset.

The survey also recommends that muskellunge stocking continue at a rate of 0.5 fish/acre on alternating years. It is also suggested that the lakes be upgraded to a Class B, 3 muskellunge classification. This reflects priority of the muskellunge in the overall fish management of the two lakes.

The final suggestion is that largemouth bass and smallmouth bass populations be monitored. The largemouth bass population appears to be increasing and may lead to the development of a high density, sub-optimal size population. A very small population of smallmouth bass is present in the lakes. A pulse-stocking event is suggested for a 3-5 year period to increase several year class strength in smallmouth bass.

When considering fish in the management of plants in Lake Wapogasset and Bear Trap Lake, the following should be considered:

1. Although it appears the natural walleye reproduction is minimal, it may be occurring. Walleye spawn on clean gravel beds. Sedimentation of these beds can render them useless as spawning beds. It is therefore important to keep sedimentation to a minimum by maintaining native shorelines and restoring developed shorelines to native vegatation.

2. Muskellunge reproduce in the spring at water temperatures in the mid-50's F. They also spawn amongst aquatic vegetation and/or woody debris. As a result, the loss of early plant growth such as CLP could affect the limited muskellunge reproduction. In addition, CLP may be used by muskellunge for cover and forage areas early in the spring. As a result, early season treatment of CLP needs to be delayed until after spawning occurs (by water temperature). It is also

important to target the CLP so native plants can replace the CLP and limit the potential habitat reduction.

3. Black crappie also spawn when the water temperature is the same as the recommended CLP treatment. This treatment would need to be timed accordingly, either prior to or after crappie spawning.

4. Northern Pike rely on aquatic plants for spawning. However they spawn when water temperatures are in the 40's F, so treatment of herbicides in the mid 50's F should not coincide with the northern pike spawning activity.

Fish species[2]	**Spawning Temp in °F**	**Spawning substrates**
Black crappie	Upper 50's to lower 60's	Build nests in 1-6 feet on hard bottom
Bluegill, Largemouth bass and Pumpkin seed	Mid 60's to lower 70's	Build nests in less than 3 feet on hard bottom
Muskellunge[3]	Mid 50's to near 60.	Broadcast eggs over organic sediment, woody debris and submerged vegetation.
Northern Pike	Upper 30's to mid 40's soon after ice-out	Broadcast eggs onto vegetation (eggs attach)
Smallmouth Bass	Usually between 62 and 64 but recorded as low as 53	Nests in circular, clean gravel
Walleye	Low 40's to 50 degrees	Gravel/rocky shoals with moving or windswept water 1-6 feet deep
Yellow perch	Mid 40's to lower 50's	Broadcast eggs in submergent vegetation or large woody debris

Table 1: Summary of game fish species spawning temperatures and substrate needs.

[2] Information from Heath Benike. Wisconsin DNR Fisheries Biologist. 2006

[3] Information from: Rust, Ashely J., James Diana, Terry L. Margenau, and Clayton J. Edwards. Lake Characteristics Influencing Spawning Success of Muskellunge in Northern Wisconsin Lakes. *North American Journal of Fisheries Management.* 2002. p834.

Sensitive Habitats and Species

A sensitive area survey was conducted on Lake Wapogasset in 1989. There were seven locations around the lake that were recorded as "sensitive area" based upon their importance as habitat in the lake ecosystem. The table below summarizes the seven areas in terms of location, importance and protection.

Lake Wapogasset Sensitive Area	Location/description	Importance	Protection
A	3000 feet of shoreline extending from Friday Creek to YMCA camp	Habitat for centrachid and esocid species of fish; important wildlife habitat	Chemical and mechanical treatments should not be allowed.
B	2000 feet of shoreline out 200 ft on East shore of Wapogasset	Rock and gravel bottom with no silt that provides walleye spawning	No dredging, structures or deposits should occur.
C	1500 feet of shoreline out 200 ft near bible camp.	Rock and gravel bottom with no silt that provides walleye spawning.	No dredging, structures or deposits should occur
D	2000 ft of shoreline out 200 ft on western shore of Wapogasset	Rock and gravel bottom with no silt that provides walleye spawning	No dredging, structures or deposits should occur
E	Entrance of Balsam Branch into Wapogasset and surrounding wetlands/approx. 3500 ft of shoreline	Habitat for centrachid and esocid species of fish for spawning and nursing; important wildlife habitat; wild rice in the area	Chemical and mechanical treatments should not be allowed
F	A small bay on north end of Wapogasset/approx. 800 ft of shoreline	Habitat for centrachid and esocid species of fish for spawning and nursing; important wildlife habitat	Chemical and mechanical treatments should not be allowed
G	Located along YMCA camp out 200 ft covering approx. 900 ft of shoreline	Rock and gravel bottom with no silt that provides walleye spawning	No dredging, structures or deposits should occur

Table 2: Sensitive area information for Lake Wapogasset.

Bear Trap Sensitive Area	Location/description	Importance	Protection
A	Southern bay of Bear Trap Lake near County F	Habitat for centrachid and esocid species of fish for spawning and nursing; important wildlife habitat	Chemical and mechanical treatments should be limited to navigation channels
B	Along northwest shoreline of Bear Trap Lake including narrows leading to Lake Wapogasset.	Habitat for centrachid and esocid species of fish for spawning and nursing; important habitat forage species; important wildlife habitat	Chemical and mechanical treatments should be limited to 80 feet from shoreline

Table 3: Sensitive area information for Bear Trap Lake

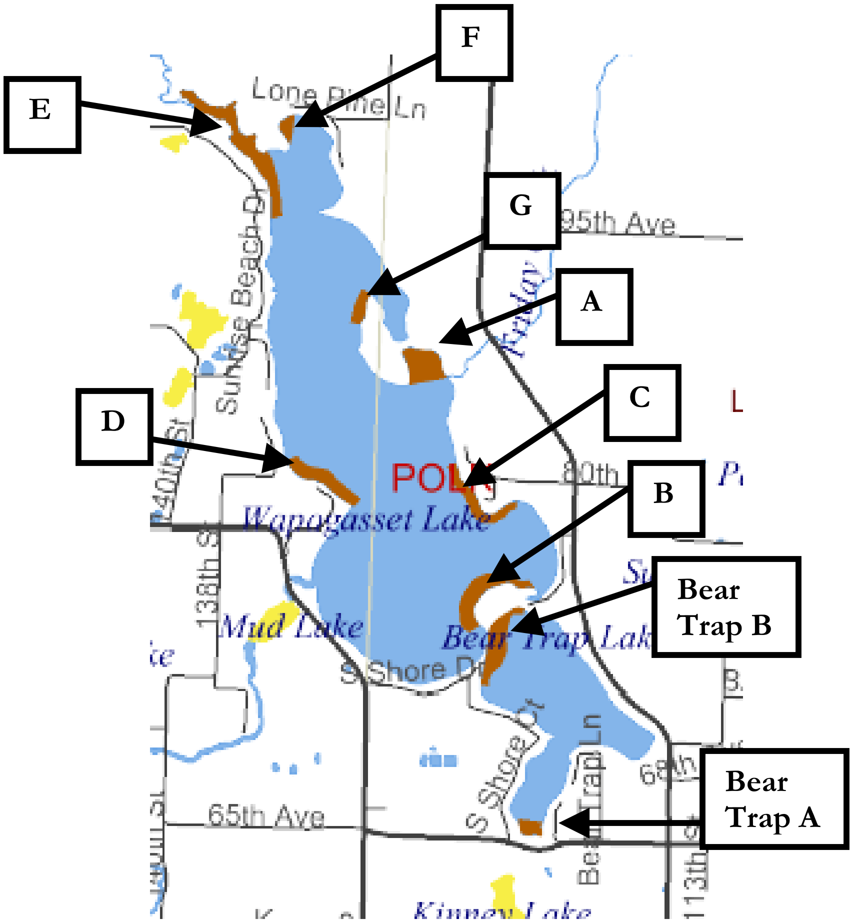


Figure 4: Estimated location of sensitive areas on Lake Wapogasse and Bear Trap Lake.

Rare and endangered species

Wild rice is the only species that has been observed that is considered highly sensitive and is a species of concern. This was located in the area where Balsam Branch comes into Lake Wapogasset. No rare or endangered plant species were viewed, sampled or observed elsewhere on either lake.

According to the Natural History Survey, the following flora and fauna that are listed as endangered, threatened, rare or of special concern in the township Lake Wapogasset and Bear Trap Lake are located:

Cypripedium parviflorum var. m-Northern yellow lady's slipper
Fondulus diaphams-Banded killifish
Haliaectus leucocephalus-Bald eagle

Watersheds

During the summer of 2007, the land use in the Bear Trap Lake and Lake Wapogasset watersheds was updated. The watershed was divided to sub-watersheds. In addition, the nutrient and water loading from each sub-watershed was updated. This updated nutrient budget used field data from the tributaries and modeling the watershed using BathTub with the corrected land use information.

Tributaries

As mentioned in the methods, the daily flow was weighted for phosphorus load. The daily load vs flow was graphed and a regression analysis was conducted. In Balsam Branch the daily load vs flow was used to give a strong correlation. In Friday Creek, the best correlation came from graphing the log of daily load vs log of flow.

In the case of Total Suspended Solids (TSS), the daily averages and the average loads were used to calculate the total load during the sampling period.
The results of all calculated loads are in table 5.

Test	Balsam Branch	Friday Creek
Mean Total Phosphorus	0.066 mg/L	0.292 mg/L
Mean Ortho Phosphate	0.061 mg/L	0.226 mg/L
Mean TSS	6.18 mg/L	111.73 mg/L
Mean TVSS	2.0 mg/L	45.36 mg/L

Table 4. Averages for water quality analysis (includes base flow and storm events).

Stream	Inflow in hm3	Total P load	TSS load	Peak flow	Low flow	Mean flow
Balsam Branch	10.77	1578 kg	66 586 kg	69.95 cfs	10.2 cfs	25.39 cfs
Friday Creek	0.34	166 kg	37 821 kg	3.17 cfs	0.205 cfs	0.68 cfs

Table 5. Calculated loads and flows of tributaries.

A=Balsam Branch watershed

B=Northeast wapogasset

C=Friday Creek watershed

D=Northwest Wapogasset

E=Southeast Wapogasset

F=Northeast Bear Trap

G=Southwest Wapogasset

H=Northwest Bear Trap

I=Southwest Bear Trap

J=Southeast Bear Trap

K=Lake Wapogasset and Bear Trap Lake

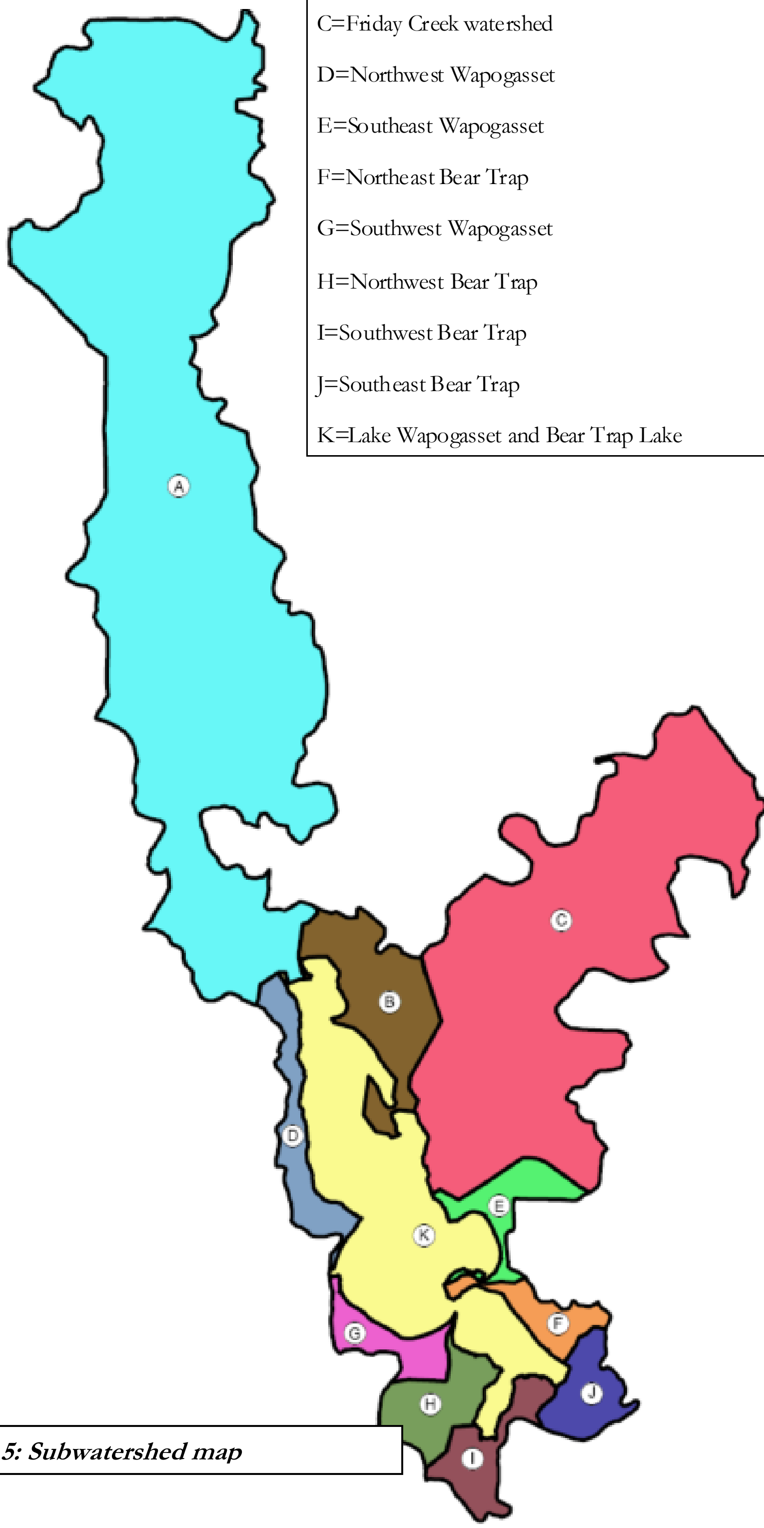


Figure 5: Subwatershed map

Name	Barren	Forage	Forest	Grassland	Open water	Residential	Row crop	Wetland
A - Balsam Branch	0.2	0.68	11.44	4.46	0.44	0.02	0.92	3.56
B - NE wapo	0	0.35	1.11	0.2	0	0.18	0.07	0
C - Friday Creek	0	2.59	2.11	2.29	0.02	0.03	1.68	2.03
D - NW wapo	0	0.15	0.39	0.05	0.01	0.3	0.11	0.04
E - SE wapo	0	0.09	0.23	0.3	0.01	0.16	0.01	0.01
F - NE Bear	0	0.02	0.37	0.04	0	0.14	0.04	0.02
G - SW wapo	0	0.11	0.14	0.11	0	0.19	0.14	0
H - NW bear	0	0.05	0.19	0.41	0.02	0.12	0.26	0
I - SW bear	0	0.02	0.33	0.25	0.09	0.13	0.01	0.07
J - SE Bear	0	0.05	0.32	0.29	0	0.01	0.1	0.04
Percent of Total Land cover	0.5	10.19	41.25	20.83	1.46	3.17	8.28	14.31

Table 6. Land use area for various sub watersheds. Values are in km^2.

Wapogasset Sub-watershed	Annual Load	Inflow (hm3/yr)	Mean daily load	Max daily load	Min daily load	Mean daily flow
A (Balsam Branch)	1577.1 kg/y	23.31	4.32 kg/day	16.96 kg/day	0.11 kg/day	26.10 cfs
B (NE Wapo)	66.9 kg/y	0.17				
C (Friday Creek)	160.1 kg/y	0.68	0.44 kg/day	2.47 kg/day	0.04 kg/day	0.8075 cfs
D (NW Wapo)	85.4 kg/y	0.15				
E (SE Wapo)	33.1 kg/y	0.09				
F (SW Wapo)	85.4 kg/y	0.12				
Precipitation	267.21 kg/y	3.85				
Total external load	2145.21 kg/y	28.37				

Table 7. Nutrient and water budget loads

Bear Trap Sub-watershed	Annual Load	Inflow(hm3/yr)
F (NE Bear Trap)	28.9 kg/y	0.07
H (NW Bear Trap)	141.9 kg/y	0.20
I (SW Bear Trap)	54.0 kg/y	0.15
J (SE Bear Trap)	55.8 kg/y	0.10
Precipitation	56.48 kg/y	0.82
Total external load	337.08 kg/y	1.33

Table 8: Bear Trap Lake subwatershed phosphorus load and water load.

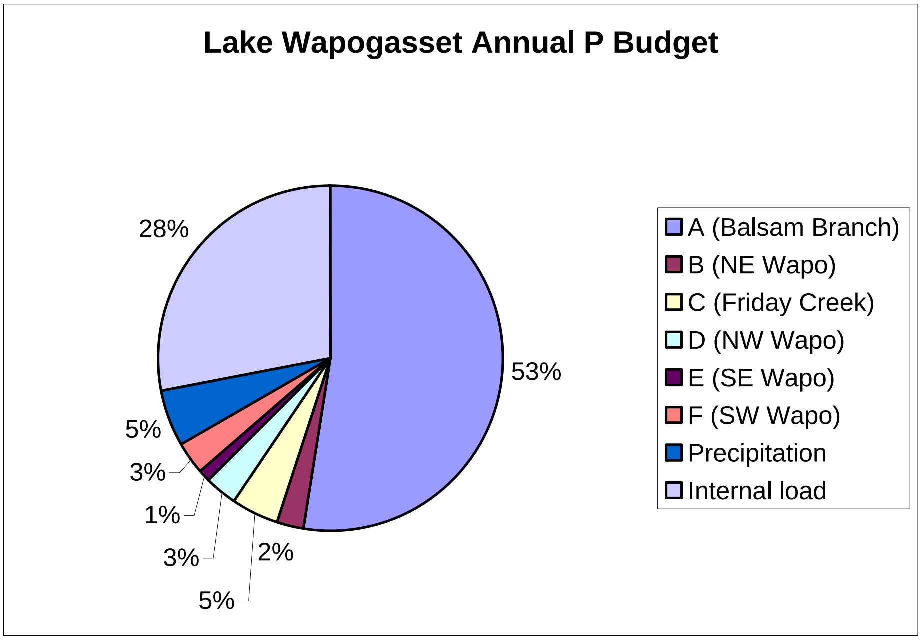


Figure 6: Percent of phosphorus budget (annual) on Lake Wapogasset by source.

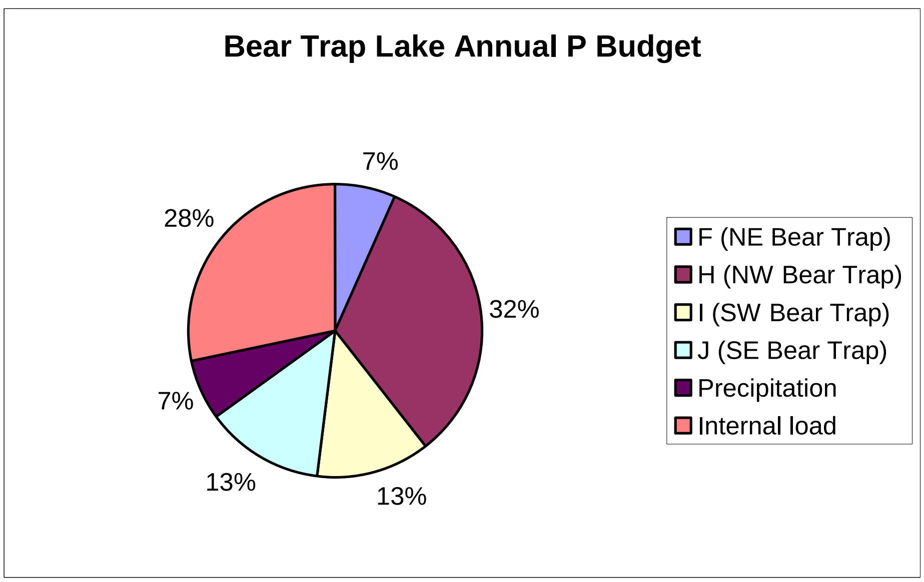


Figure 7: Percent of phosphorus load (annual) Bear Trap Lake by source

Nutrient Loading

External loading

The largest percentage of phosphorus loading into Lake Wapogasset is the Balsam Branch. This tributary accounts for about 74% of the entire phosphorus load annually. The summer of 2006 was extremely dry; therefore the flow was lower than an average year (speculation as no baseline data available). As a result, increased flow in a more normal precipitation year would increase the phosphorus load. In addition, Friday Creek contributes only 6% of the phosphorus to Lake Wapogasset. This could also change immensely with an average year of precipitation. In comparing the two tributaries, Balsam Branch has a rather low phosphorus concentration during base flow. It did increase significantly during rain events, but was still not extremely high. However, its flow is extensive and provides a high flow, low concentration scenario. In some cases, the concentration of phosphorus in Balsam Branch is actually lower than the lake phosphorus concentration. During rain events in mid to late summer, high volumes of water could help contribute to mixing the lake, allowing the release of high phosphorus concentration hypolimnetic water.

Friday Creek has very low flow by comparison to Balsam Branch. However, the phosphorus concentration is higher at base flow, and increases dramatically even with relatively minor rain events. This stream also had less loading based on field data than the model calculated based on land cover. This may be due to the fact that there are many wetlands in the Friday Creek watershed immediately adjacent to the creek. These wetlands appeared to be mostly dry throughout most of the sampling period. During rain events, the runoff may have been absorbed by the wetlands, never reaching the stream. It is for this reason that the drought year may reduce the significance of Friday Creek in the nutrient load and this should be considered when evaluating the load from Friday Creek in the future.

In terms of sediment contributions, Balsam Branch and Friday Creek differ significantly. The mean total suspended solids (TSS) is much lower for Balsam Branch than for Friday Creek (6 mg/L and 111 mg/L). As a result, the total suspended solids flowing toward the lake is higher in Balsam Branch due to much higher flow, but when comparing flows, Friday Creek has a much higher load. In both cases, the stream flow decreases immensely before reaching the lake, which can allow for settling of the solids. This is evident when observing the outlets of both tributaries, with extensive sediment buildup at both locations. The total volatile suspended solids (TVSS) is used to help determine the amount of the suspended solids that may be organic as opposed to inorganic. In Balsam Branch, the mean TVSS is about one third of the mean TSS with the value being so low (6 mg/L and 2 mg/L) that is rather insignificant. In Friday Creek, the mean TVSS is a little less than half of the TSS (111 mg/L and 45 mg/L). This indicates that a large portion of the suspended solids could be organic in nature as opposed to inorganic sediments.

When comparing the total phosphorus values to the dissolved-reactive phosphorus values, some interesting points could be made. Because total phosphorus includes dissolved-reactive phosphorus, one can calculate the percentage of total phosphorus that is dissolved-reactive. In Balsam Branch, the mean dissolved-reactive phosphorus was 92.4 % of the mean total phosphorus. This indicates that most all of the phosphorus in Balsam Branch is dissolved and available for absorption by plant material (algae and macrophytes). In Friday Creek, the mean dissolved-reactive phosphorus was 77% of the mean total phosphorus. Again, the majority of the phosphorus is dissolved and available for absorption, although much lower than Balsam Branch. This would be consistent with the TSS values, since Balsam Branch has such little TSS and Friday Creek has much higher TSS values. This would represent more phosphorus potentially tied up in sediments in the tributary water in Friday Creek.

The remaining watershed has some impact on the phosphorus and water budgets too. In Lake Wapogasset, this impact is much less than the tributaries. Balsam Branch and Friday Creek, according to the field data, accounted for about 75% of the external phosphorus budget. With precipitation accounting for 12% of the phosphorus, the remaining watershed contributed about 13% of the total external phosphorus load. The total mass contributed from the remaining watershed was rather evenly distributed between the various sub watersheds in Lake Wapogasset.

For Bear Trap Lake, there are no major tributaries. A small stream was identified in the southeastern portion of the lake, which locals refer to as Bear Trap Creek. One phosphorus sample was analyzed and it was much lower than the concentration of Bear Trap Lake (0.086 mg/L vs 0.104 mg/L) This does not mean that this stream contributes nothing to the lake. A value of 0.086 mg/L could cause loading. However, in evaluation of the watershed of this stream, it is mostly wetlands and the model does not suggest any significant impact. The flow of the stream is unknown. Further evaluation may be warranted.

The direct watershed of Bear Trap Lake is therefore the major contributor of the external phosphorus with 83% of the external load (17% from precipitation). Comparing the sub-watersheds, the northwest Bear Trap sub watershed contributes 41%. This may be due to the extensive row cropland use, which has one of the highest export coefficients of any land cover type. The phosphorus loading of this sub watershed is much greater than any other sub watershed. Southeast Bear Trap watershed (J), is the next highest with 17%, followed by southwest Bear Trap (I) at 16%.

Upon evaluation of the data for the sewage treatment test wells, as well as the groundwater flow by the engineer in this project, it is inconclusive if the seepage ponds are contributing phosphorus. The well elevations indicate groundwater movement to the southwest, away from the lake. Also, the chloride data supports this conclusion. However, the East well had a very high phosphorus value, which would indicate sewage possible moving that direction. Whether it reaches the lake is unknown. There was positive groundwater pressure at all locations except two in region of concern. This does not necessarily mean that the groundwater below the seepage ponds is flowing into the lake. There is a break in the topography between the ponds and the lake, which could account for the positive flow into the lake and yet flow away from the lake at the pond locations. The overall conclusion is that it doesn't appear the seepage ponds are leeching into the lake, but this is not certain. If the load is occurring as Barr Engineering indicated (20 kg/yr) in 1995, it is less than the precipitation and rather small in comparison to the whole phosphorus load. However, considering the rationalization for a sewage treatment facility, this issue should be resolved through increased monitoring.

Internal loading

The internal loading was not analyzed in this study. This loading has been analyzed extensively due to the alum treatment failure. Based on the data collected, it is significant in both lakes. Also, there are two deep holes in Lake Wapogasset. One of the two deep holes does not appear to stratify based on data collected previously. This makes for an unstable water column potentially allowing mixing of the hypolimnion with the epilimnion prior to fall turnover. The southern most portion of Lake Wapogasset does appear to stratify, limiting hypolimnetic phosphorus loading to overturn events (fall). In Bear Trap Lake, the lake does seem to stratify earlier, but appears to lose stratification in late summer, which could allow mixing prior to fall turnover. The potential phosphorus load internally in both lakes is extensive.

In 1995, the internal loading of Lake Wapogasset and Bear Trap Lake were determined from a model by Barr Engineering. The results indicated an internal load for Lake Wapogasset of 1058 kg/yr, and for Bear Trap Lake an internal load of 242 kg/yr.[1] In 2004, more extensive data was collected through sediment core sampling. In this study, release rates and area of sediments with those release rates were determined. Taking into consideration the length of anoxic conditions, the calculated internal loads were approximately 792 kg/y and 122 kg/y in Lake Wapogasset and Bear Trap Lake respectively.[2] In either lake, the amount is significant.

Since the sampling season of 2006 was very dry, it is recommended that another year of tributary monitoring be carried out. This would allow for data collected over a longer period of time, giving a better reflection of the contributions each tributary makes to Lake Wapogasset. Furthermore, the spring melt was missed in this sample period and can have a big impact on the load calculations.

The sewage treatment ponds do not appear to be contributing phosphorus. In addition, if they are, it makes up a very small percentage of the total load. The data is rather inconclusive so it is not certain if the sewage pond load is occurring. However, since the Sanitary District oversees the operation of the sewage treatment facility, and this was installed to reduce nutrient loading from private systems, it would be prudent to further study this issue.

[1] Amount taken directly from Barr Engineering. *Wisconsin Lake Planning Grant Final Report. Lake Wapogasset and Bear Trap Lake, Polk County, Wisconsin.* June 1996.

[2] Amount calculated from release rate data from Barr Engineering. *Investigation of Alum in Lake Wapogasset and Bear Trap Lake.* December 2004.

The most valid method to determine if this load is occurring would be to install more monitoring wells between the lake and the sewage treatment ponds. This can become very costly. Therefore, we recommend first testing shallows wells that are already present on properties adjacent to the lake. This would maybe give more insight into the possible loading due to the ponds. If this data would indicate such a load, further study could be included, possibly more monitoring wells.

Bear Trap Lake appears to have all of its phosphorus coming in internally and from the direct runoff of the watershed. The management practices available for controlling internal loading are being reviewed, which is important. Potential land purchases and/or conservation easements should be explored to try and implement best management practices on some key properties that have potentially large nutrient loads into Bear Trap Lake. As an example, by changing a parcel from row crop to native grassland could reduce phosphorus loading by approximately 80% per acre. This could be a very large reduction in kilograms of phosphorus reaching Bear Trap Lake. Furthermore, reducing residential influence through buffer installations and infiltration devices could reduce runoff enough to make a difference in nutrient loading from these areas.

Reducing Lake Wapogasset external loading is more complicated since much of the phosphorus is coming from Balsam Branch. During the past several years, the Balsam Branch has had many best management practices implemented as a priority watershed. This has most definitely reduced the phosphorus concentrations in Balsam Branch, reflected by low average total phosphorus values. However, this stream has a large flow and will always contribute a large total load as a result. Better management along Friday Creek would help reduce its loading, but it is a relatively small percentage of the total load. There are a couple of key subwatersheds that could reduce nutrient loading due to large amounts of row crop acreage. These are NW and SW Wapogasset subwatersheds. Reducing the row crop influx, or changing the land use to forage crops could reduce loading from those areas immensely.

Lake Phosphorus Trends

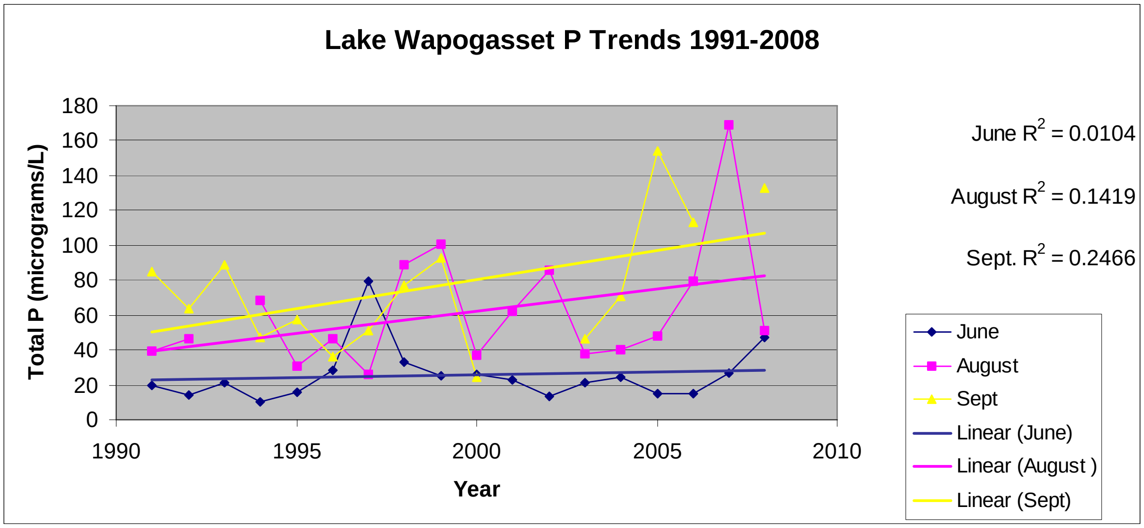


Figure 8: Lake Wapogasset phosphorus trends from 1991-2008.

Figure 8 shows that the total phosphorus increases as the summer progresses. This would support a large internal load. It also shows that there seems to be a slight increase from 1991 to 2006 in the September phosphorus readings. The correlation factor is 0.25, which doesn't really make the predicted trend significant. As a result, the data should be used with caution.

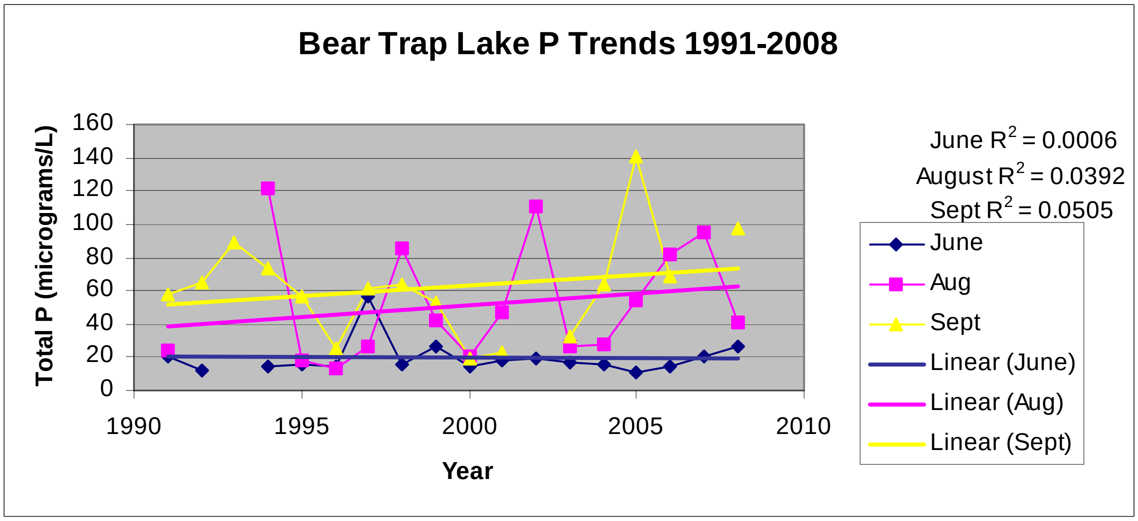
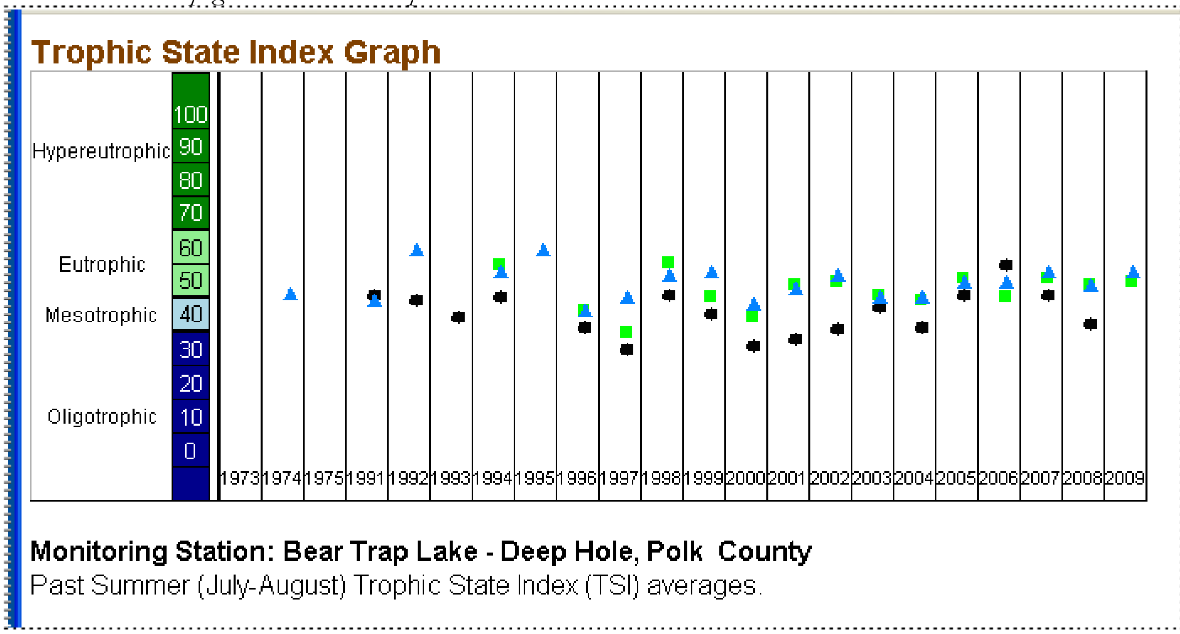


Figure 9: Bear Trap Lake phosphorus trends during summer from 1991-2008.

In Lake Wapogasset, Figure 9 shows a higher September phosphorus value most years. Again this would support a large internal load. There appears to be a slight increase from 1991 to 2006, but the correlation (0.05) makes this prediction insignificant and does not allow us to make this prediction.

Trophic status

The trophic status of a lake describes the productivity. Oligotrophic lakes have very little nutrients and as a result very little production. The algae growth and macrophyte growth in these lakes is very low (low production). Eutrophic lakes have very high productivity. These lakes have ample macrophyte growth and can have nuisance algae blooms. Mesotrophic lakes fall between oligotrophic and eutrophic lakes. Wisconsin uses the Carlson Trophic Status. The value obtained is used to classify the category as to the trophic status. The higher the number the more eutrophic the lake.



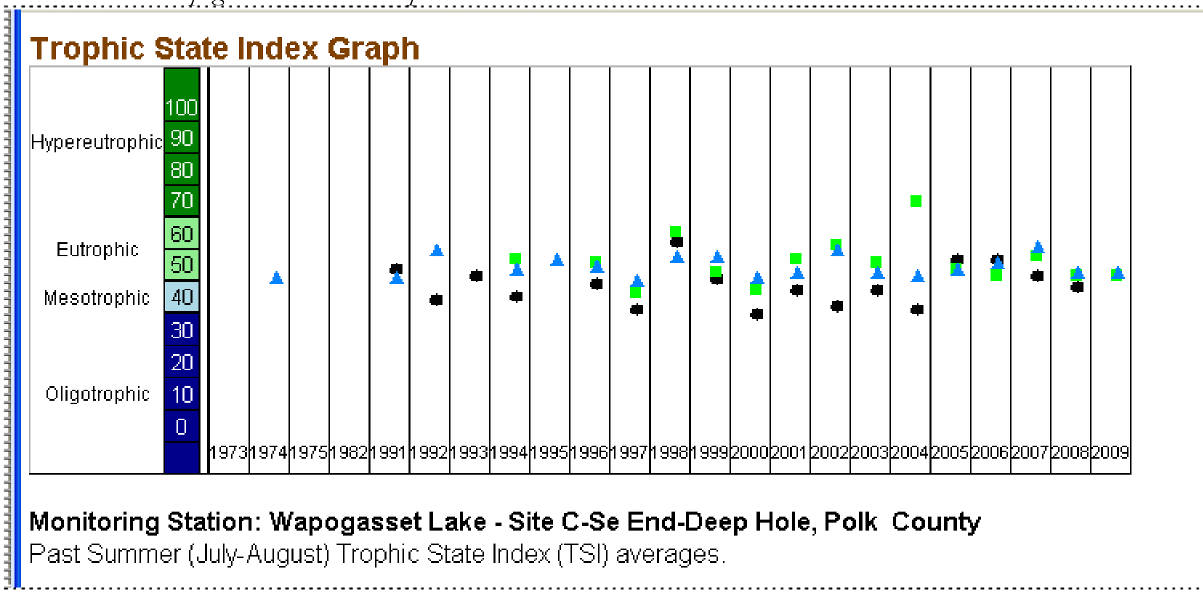
■ =Chlorophyll a

● = Secchi disc

▲ =Total Phosphorus

Figure 10: Trophic status of Bear Trap Lake using chlorophyll a, Secchi disk, and total phosphorus.

Figure 10 shows the trophic status of Bear Trap Lake from 1974 to 2009, with a decade missing. Most values fall within the eutrophic and some in the mesotrophic range. The chlorophyll a and the total phosphorus are usually very similar, but the Secchi disk mean is often times lower (the water clarity indicates less productivity). This is somewhat unusual as more chlorophyll a indicates more algae, which should lower the Secchi depth. However, the type of algae (larger) could allow for more clarity but more chlorophyll at same time.



■=Chlorophyll a

● = Secchi disc

▲ =Total Phosphorus

Figure 11: Lake Wapogasset trophic status graph from 1974 (missing decade of 1980's) to 2009.

Most all of Lake Wapogasset's values fall within the eutrophic level, with some Secchi depth readings in the mesotrophic level. There doesn't appear to be any trends with rather consistent fluctuations up and down of all TSI values.

The data over many years supports the fact that Bear Trap Lake and Lake Wapogasset are both eutrophic lakes. They have water clarity issues most years with severe algae blooms occurring in late July and early August. It is evident that excess nutrients are an issue. As a result, plant management schemes in these lakes should consider this fact. One approach would be to preserve as much plant growth (native) as possible to help reduce excess nutrients. In addition, management of a non-native such as curly leaf pondweed could have nutrient reduction ramifications.

Plant Community

Aquatic macrophyte surveys were conducted on both Bear Trap Lake and Lake Wapogasset in the summer of 2007. Both surveys were using the point intercept method with the sample grid generated by the Wisconsin DNR. The data and analysis are presented and reviewed in this section.

Bear Trap Lake

The sample grid created by the Wisconsin DNR was comprised of 396 sample points. The maps below (Figure 13) show the sample grid and the locations plants were actually sampled. The green dots are sample points with no plants while the blue dots are sample points where plants were present. The statistics representing the amount of plants coverage based on these locations is contained in Table 9.

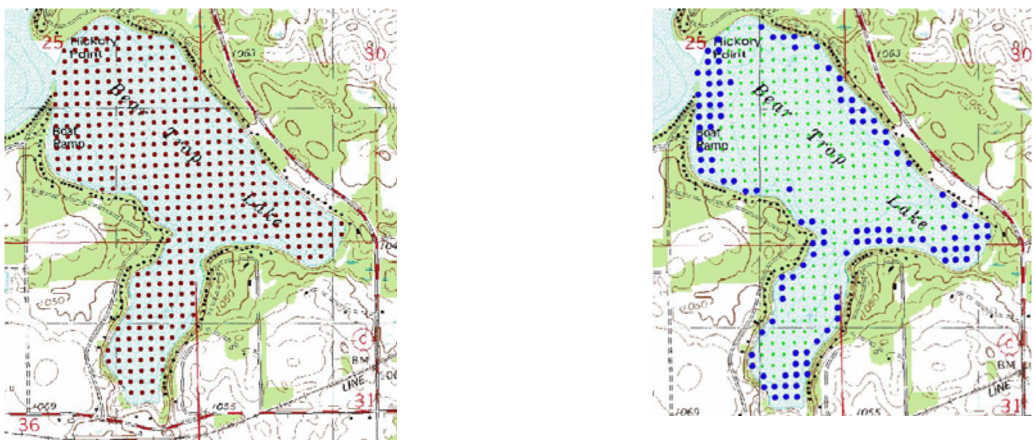


Figure 12: Maps of sample points for PI survey and points with vegetation (littoral zone)-Bear Trap Lake.

The littoral zone is the area of the lake that is shallow enough to accommodate plant growth. For Bear Trap Lake, this area includes 265 of the 396 total sample points (66.9%). Plants were found growing at 118 of these points, which is 29.8% of the total lake area and 44.5% of the littoral zone. As these values demonstrate, plant coverage is Bear Trap Lake is not very extensive. The littoral zone is very narrow, with the exception of Bear Trap Lake's two large bays and the narrows near Lake Wapogasset. This is largely due to the contour of the lake, since a large percentage of Bear Trap Lake is too deep to support plant growth.

Parameter	Value
Number of sample points	**396**
Number of points in littoral zone	**265**
Number of sample points with plants	**118**
Maximum depth with plants	**17.6 ft**
Percentage of lake with plants	**29.80%**
Percentage of littoral zone with plants	**44.50%**
Simpson's diversity index	**0.91**
Species richness	**24**
Species richness with viewed	**28**

Table 9: Plant survey statistics Bear Trap Lake.

Bear Trap Lake Species	Freq of occur.	Relative Freq	Number of sites
Ceratophyllum demersum, Coontail	**75.42**	**19.6**	**89**
Potamogeton zosteriformis, Flat-stem pondweed	**46.61**	**12.11**	**55**
Vallisneria americana, Wild celery	**44.07**	**11.45**	**52**
Ranunculus aquatilis, Stiff water crowfoot	**27.12**	**7.05**	**32**
Potamogeton richardsonii, Clasping pondweed	**24.58**	**6.39**	**29**
Najas flexilis, Bushy pondweed	**23.73**	**6.17**	**28**
Potamogeton pusillus,Small pondweed	**22.88**	**5.95**	**27**
Potamogeton illinoensis, Illinois pondweed	**21.19**	**5.51**	**25**
Heteranthera dubia, Water stargrass	**19.49**	**5.07**	**23**
Elodea canadensis, Common waterweed	**17.8**	**4.63**	**21**
Chara sp., Muskgrass	**11.86**	**3.08**	**14**
Filamentous algae	**11.01**	**2.86**	**13**
Potamogeton crispus, Curly leaf pondweed	**9.32**	**2.42**	**11**
Potamogeton friesii, Fries pondweed	**7.63**	**1.98**	**9**
Stuckenia pectinata, Sago pondweed	**7.63**	**1.98**	**9**
Myriophyllum sibiricum, Northern watermilfoil	**3.39**	**0.88**	**4**
Lemna triscula, Forked duckweed	**2.54**	**0.66**	**3**
Potamogeton foliosus, Leafy pondweed	**2.54**	**0.66**	**3**
Lemna minor, Small pondweed	**1.69**	**0.44**	**2**
Nymphaea odorata, White water lily	**1.69**	**0.44**	**2**
Myriophyllum tenellum, Dwarf watermilfoil	**0.85**	**0.22**	**1**
Potamogeton amplifolius, Large-leaf pondweed	**0.85**	**0.22**	**1**
Potamogeton praelongus, White-stem pondweed	**0.85**	**0.22**	**1**
Iris versicolor, Blue flag iris	**viewed**		
Nuphar variegata, Spatterdock	**viewed**		
Sagittaria graminea, Grass leaved arrowhead	**viewed**		
Sagittaria rigida, Stiff arrowhead	**viewed**		
Sparangium eurycarpum, Common burreed	**viewed**		

Table 10: Bear Trap Lake species richness

Bear Trap Lake has a diverse plant community. There were 24 different species of macrophytes (22 plants and 2 algae species) sampled. By including the plants that were viewed but not sampled, the species richness increases to 28 species. The lake's Simpson's diversity index is 0.91 also supports the notion of a diverse plant community.

Table 10 lists the species sampled and the statistics associated with each, the number of sites at which the plant was sampled, the frequency of occurrence, and the relative frequency. Plants that were merely viewed and not sampled do not have statistical values associated with them.

The most dominant plant is *Ceratophyllum demersum (*coontail). With a relative frequency of 19.6%, coontail is populous but is not dominating the lake. Nor does selection for coontail appear to be occurring. Coontail is effective at absorbing nutrients from the water column, and its dominance can indicate high nutrients, especially if it reaches nuisance levels. There are a number of areas that coontail had a density rating of three, which is supported by the high nutrient content of Bear Trap Lake. Coontail if followed in relative frequency by *Potamogeton zosteriformis* (flatstem pondweed) and *Vallisneria americana* (wild celery). Figures 13 and 14 map the distribution of the two most common plants sampled in Bear Trap Lake and their density. All of the plants that dominate the lake are desirable plants.

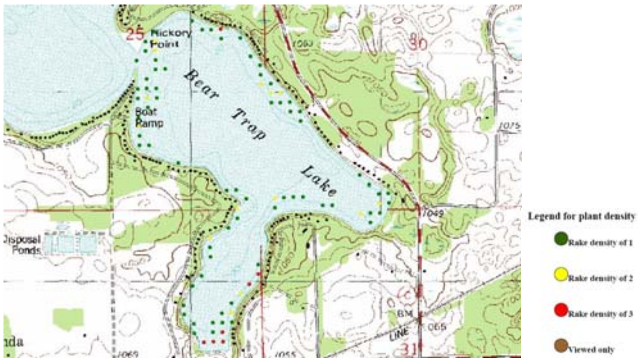


Figure 13: Ceratophyllum demersum-Coontail distribution

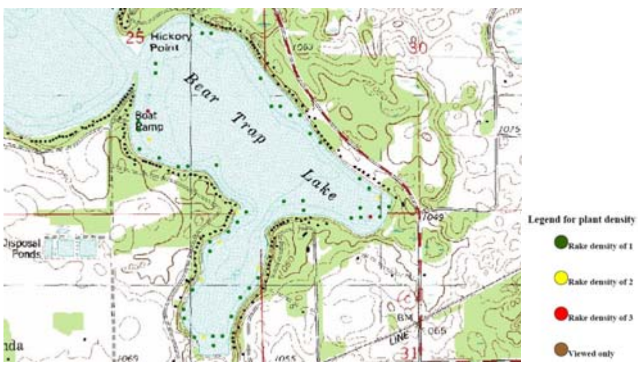


Figure 14: Potamogeton zosteriformis-Flat-stem pondweed distribution

Figure 15 shows the number of native species per sampling point. The points with the highest plant diversity appear to be evenly dispersed around the lake. There are no visible habitat quality issues that could lead to a lack of diversity in certain areas of the lake. Most of the high diversity areas are most likely related to the substrate type.

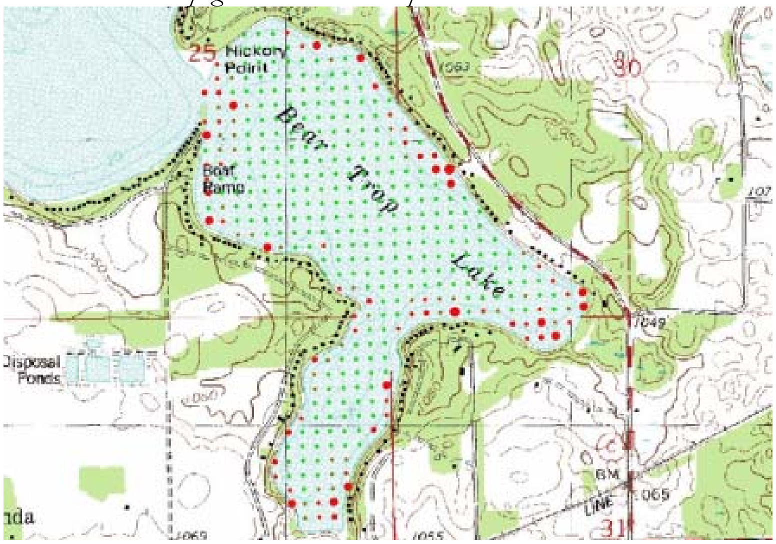


Figure 15: Number of species per sample point. Green dots show no plants while the red dot of larger size indicates more species.

The Floristic Quality Index (FQI) is a measure of the plant community response to development and human influence on the lake. It takes into account the species of aquatic plants present, and their tolerance for changing water quality and habitat characteristics. A plant's tolerance is expressed as a coefficient of conservatism (C). Native plants in Wisconsin are assigned a conservatism value between 0 and 10. A plant with a high conservatism value has more specialized habitat requirements and is less tolerant of disturbance and/or water quality changes. Those with lower values are more able to adapt to disturbed or changing conditions and can be found ina wider range of habitats.

The FQI is calculated using the number of species present and these plants' species conservatism values. A higher FQI generally indicates a heathier aquatic plant community.

There were 27 species of plants sampled that could be used in the floristic quality index calculation. These species ranged from a low conservatism value of 3 (common waterweed and sago pondweed) to a high conservatism value of 10 (dwarf watermilfoil). The number of species (N), the average conservatism(C), and the FQI were all higher than the median for the eco-region (see Figure 16). Table 11 lists the species and their conservatism values.

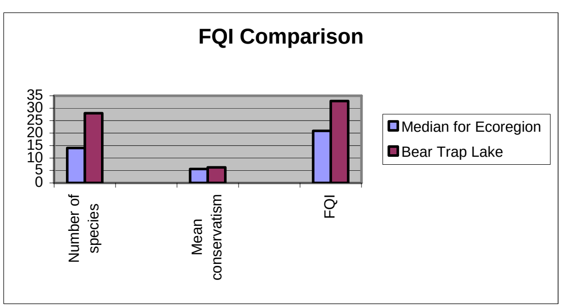


Figure 16: Comparison of FQI for Bear Trap Lake and Ecoregion lakes.

Species	Common Name	C
Ceratophyllum demersum	**Coontail**	**3**
Chara	**Muskgrasses**	**7**
Elodea canadensis	**Common waterweed**	**3**
Eriocaulon aquaticum	**Pipewort**	**9**
Isoetes echinospora	**Spiny-spored quillwort**	**8**
Lemna minor	**Small duckweed**	**5**
Lemna trisulca	**Forked Duckweed**	**6**
Myriophyllum sibericum	**Northern water-milfoil**	**7**
Myriophyllum tenellum	**Dwarf water-milfoil**	**10**
Najas flexilis	**Bushy pondweed**	**6**
Nuphar variegata	**Spatterdock**	**6**
Nymphaea odorata	**White water lily**	**6**
Potamogeton amplifolius	**Large-leaf pondweed**	**7**
Potamogeton foliosus	**Leafy pondweed**	**6**
Potamogeton friesii	**Frie's pondweed**	**8**
Potamogeton illinoensis	**Illinois pondweed**	**6**
Potamogeton praelongis	**White-stem pondweed**	**8**
Potamogeton pusillus	**Small pondweed**	**7**
Potamogeton richardsonii	**Clasping-leaf pondweed**	**5**
Potamogeton zosteriformis	**Flat-stem pondweed**	**6**
Ranunculus aquatilis	**Stiff water crowfoot**	**7**
Sagittaria graminea	**Grass-leaved**	**9**
Sagittaria rigida	**Stiff arrowhead**	**8**
Sparganium eurycarpum	**Common bur-reed**	**5**
Stuckenia pectinata	**Sago pondweed**	**3**
Vallisneria americana	**Wild celery**	**6**
Zosterella dubia	**Water star-grass**	**6**
N (number of species used)		27
mean C (conservatism)		6.21
FQI		32.88

Table 11: Floristic Quality Index for Bear Trap Lake.

Lake Wapogasset

The sample grid created by the Wisconsin DNR was comprised of 750 sample points. The maps below (Figure 17) show the sample grid and the locations at which plants were actually sampled. The statistics representing the plants coverage based in these locations is contained in Table 12.

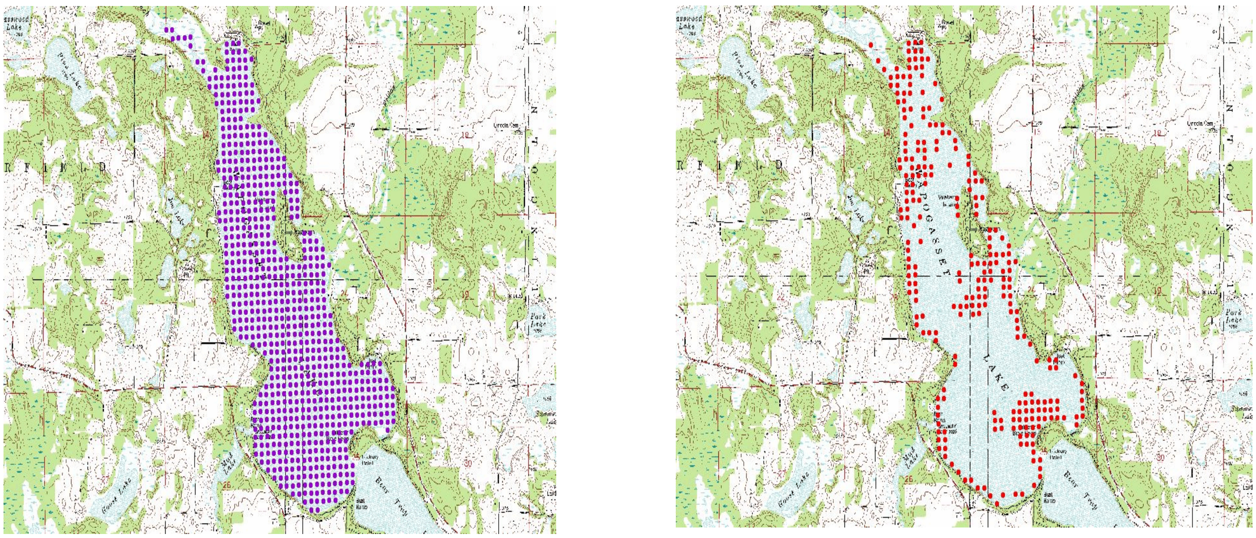


Figure 17: Sample points and points with plants in Lake Wapogasset

Parameter	Value
Number of sample points	**750**
Number of points in littoral zone	**402**
Number of sample points with plants	**265**
Maximum depth with plants	**21 ft**
Percentage of lake with plants	**35.30%**
Percentage of littoral zone with plants	**65.90%**
Simpson's diversity index	**0.91**
Species richness	**31**
Species richness with viewed	**42**

Table 12: Lake Wapogasset survey statistics

The LakeWapogasset littoral zone includes 402 of the lake's 750 total points (53.6%). Plants were found growing at 265 of these points, which is 35.3% of the total lake area and 65.9% of the littoral zone. As these values demonstrate, plant coverage in Lake Wapogasset is high enough to provide a wide array of habitat throughout the lake without "choking" it with plants.

Lake Wapogasset has a very diverse plant community. There were 31 different species of macrophytes (27 plants and 4 algae species) sampled. By including the plants that were viewed but not sampled, the species richness increases to 42 species. The lake's Simpson's diversity index of 0.91 also supports the notion of a highly diverse plant community.

Table 13 lists the species sampled and the statistics associated with each, the number of sites the plant was sampled, the frequency of occurrence, and the relative frequency. Plants that were merely viewed and not sampled do not have statistical values associated with them.

The most dominant plant is *Ceratophyllum demersum (*coontail). With a relative frequency of 18.1%, coontail is populous but is not dominating the lake. Nor does selection for coontail appear to be occurring. Coontail is effective at absorbing nutrients from the water column, and its dominance can indicate high nutrients, especially if it reaches nuisance levels. There are a number of locations that coontail had a density rating of 3, which is supported by the high nutrient content of Lake Wapogasset. Coontail if followed in relative frequency by *Potamogeton zosteriformis* (flatstem pondweed) and *Vallisneria Americana* (wild celery). All of the species that dominate the lake are desirable plants (with the except of curly leaf pondweed in spring). Figures 18 and 19 map the distribution of the two most common plants sampled and their density.

Species	Freq. of occurrence	Relative Freq.	Sites
Ceratophyllum demersum,Coontail	**63.40**	**18.06**	**168**
Potamogeton zosteriformis,Flat-stem pondweed	**38.11**	**10.86**	**101**
*Vallisneria americana,*Wild celery	**35.85**	**10.22**	**95**
Potamogeton pusillus,Small pondweed	**33.96**	**9.68**	**90**
Filamentous algae	**30.94**	**8.82**	**82**
Najas flexilis,Bushy pondweed	**24.53**	**6.99**	**65**
Potamogeton crispus,Curly-leaf pondweed	**17.74**	**5.05**	**47**
Potamogeton richardsonii,Clasping-leaf pondweed	**16.98**	**4.84**	**45**
Potamogeton friesii,Frie's pondweed	**15.47**	**4.41**	**41**
Elodea canadensis,Common waterweed	**14.34**	**4.09**	**38**
Ranunculus aquatilis,Stiff water crowfoot	**12.45**	**3.55**	**33**
Chara sp. ,Muskgrasses	**10.57**	**3.01**	**28**
Myriophyllum sibiricum,Northern water milfoil	**5.66**	**1.61**	**15**
Lemna trisulca,Forked duckweed	**4.53**	**1.29**	**12**
Stuckenia pectinata,Sago pondweed	**3.77**	**1.08**	**10**
Lemna minor,Small duckweed	**3.40**	**0.97**	**9**
Hydrodictyon reticulatum-Waternet	**2.64**	**0.75**	**7**
Spirodela polyrhiza,Large Duckweed	**2.64**	**0.75**	**7**
Potamogeton foliosus,Leafy pondweed	**2.26**	**0.65**	**6**
Heteranthera dubia,Water star-grass	**2.26**	**0.65**	**6**
*Wolffia columbiana,*Common watermeal	**1.89**	**0.54**	**5**
Potamogeton praelongis,White-stem pondweed	**1.89**	**0.54**	**5**

Species	Freq. of occurrence	Relative Freq.	Sites
Potamogeton illinoensis,Illinois pondweed	**1.89**	**0.54**	**5**
Potamogeton amplifolius,Large-leaf pondweed	**0.75**	**0.22**	**2**
Nymphaea odorata,White water lily	**0.75**	**0.22**	**2**
Sparganium eurycarpum,Common bur-reed	**0.38**	**0.11**	**1**
Potamogeton alpinus,Alpine pondweed	**0.38**	**0.11**	**1**
Nuphar variegata,Spatterdock	**0.38**	**0.11**	**1**
Nitella sp.,Nitella	**0.38**	**0.11**	**1**
Eleocharis palustris,creeping spikerush	**0.38**	**0.11**	**1**
*Brasenia schreberi,*Watershield	**0.38**	**0.11**	**1**
Calla palustris, Wild cala	**viewed**		
Carex comosa,bottle brush sedge	**viewed**		
Eleocharis acicularis,needle spikerush	**viewed**		
Justica Americana-Water willow	**viewed**		
Myosotis scorpoides-Aquatic forgetmenot	**viewed**		
Sagittaria graminea,Grass-leaved arrowhead	**viewed**		
*Sagittaria latifolia,*Common arrowhead	**viewed**		
Sagittaria rigida	**viewed**		
Sparganium fluctuans ,Floating-leaved bur-reed	**viewed**		
Typha latifolia,Broad-leaved cattail	**viewed**		
Zizania palustris,Northern wild rice	**viewed**		

Table 13: Species richness Lake Wapogasset

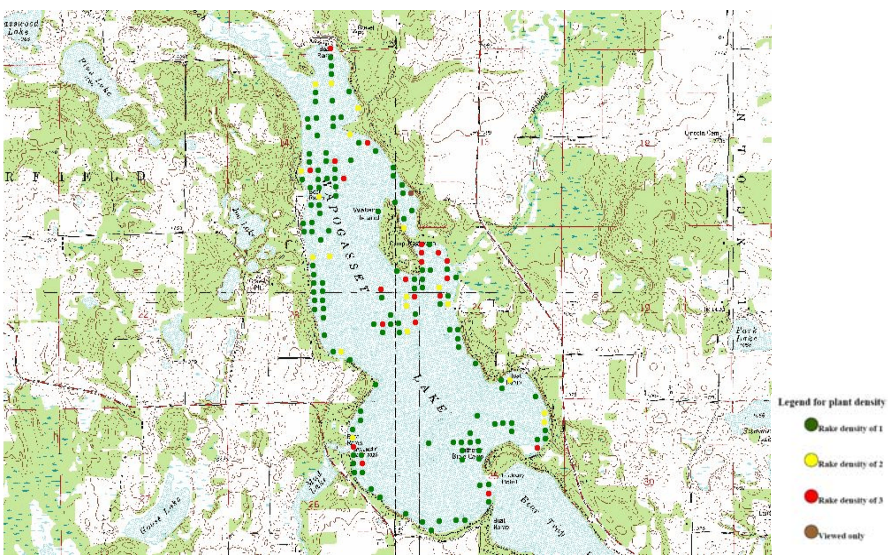


Figure 18: Ceratophyllum demersum-Coontail distribution

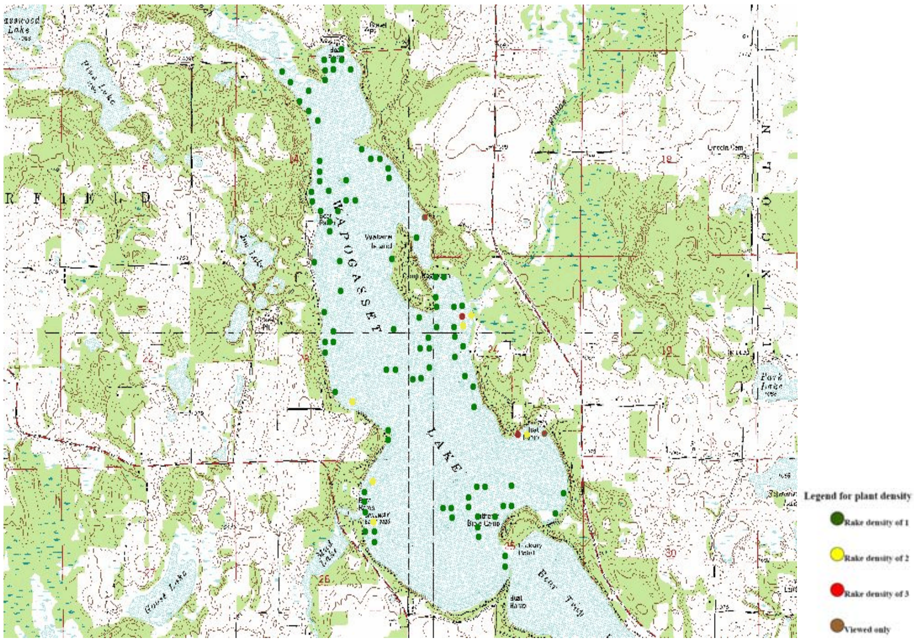


Figure 19: Potamogeton zosteriformis-Flatstem pondweed distribution

As Figure 20 indicates, there are many points where several macrophyte species were sampled. This high diversity seems relatively dispersed around the lake. Therefore, there is no strong indication of adverse habitat changes leading to more limited diversity in certain areas of the lake.

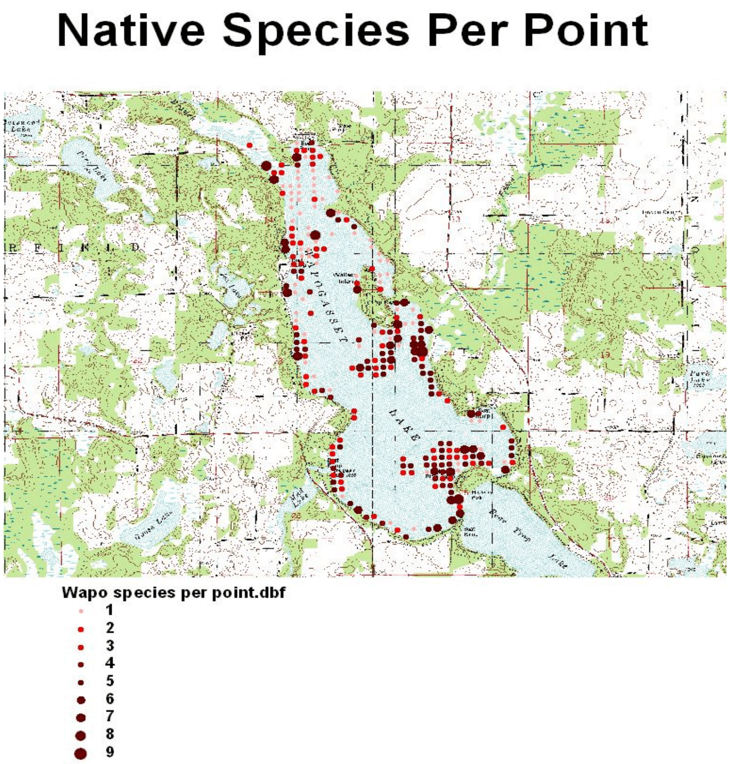


Figure 20: Lake Wapogasset number of natives per sample point

Floristic quality

There were 37 species of plants sampled that could be used in the floristic quality index (FQI) calculation. These species ranged from a low conservatism value of 1 (broad leaf cattail) to a high conservatism value of 10 (floating leaf bur-reed). The number of species (N), the average conservatism f(C), and the FQI value were higher than the median for the eco-region (see Figure 21). Table 14 lists the species used and their conservatism values.

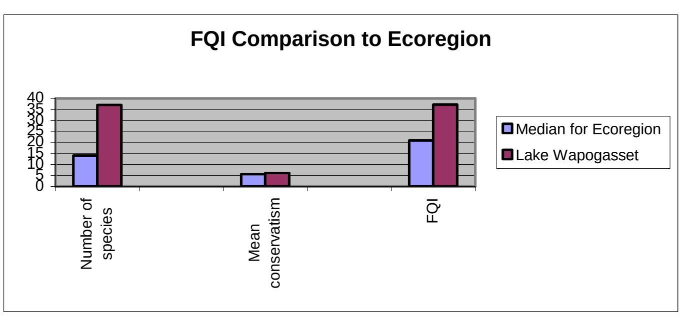


Figure 21: Comparison of FQI Lake Wapogasset and Ecoregion lakes.

Species	Common Name	C
Brasenia schreberi	Watershield	7
Calla palustris	Wild Calla	9
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara	Muskgrasses	7
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Lemna minor	Small duckweed	5
Lemna trisulca	Forked Duckweed	6
Myriophyllum sibericum	Northern water-milfoil	7
Najas flexilis	Bushy pondweed	6
Nitella	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton alpinus	Alpine pondweed	9
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton foliosus	Leafy pondweed	6
Potamogeton friesii	Frie's pondweed	8
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton praelongis	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	Stiff water crowfoot	7
Sagittaria graminea	Grass-leaved	9
Sagittaria latifolia	Common arrowhead	3
Sagittaria rigida	Stiff arrowhead	8
Sparganium eurycarpum	Common bur-reed	5
Sparganium fluctuans	Floating-leaf-bur-reed	10
Spirodela polyrhiza	Large Duckweed	5
Stuckenia pectinata	Sogo pondweed	3
Typha latifolia	Broad-leaved cattail	1
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
Zizania palustris	Northern wild rice	8
Zosterella dubia	Water star-grass	6

N (number of species used)	37
mean C (conservatism)	6.11
FQI	37.15

Table 14: Floristic Quality Index List for Lake Wapogasset.

Exotic (non-native) species

During June 2007, an early season survey was conducted in order to determine the presence of exotic species. During this survey, extensive coverage of *Potamogeton crispus*, also known as curly leaf pondweed (CLP) was observed. The later, full survey did not reflect this coverage as extensively because CLP grows in spring and early summer, and dies back in July. In Figure 22, the coverage of CLP is mapped for both lakes. The map reflects all points CLP was sampled in June, as well as beds that were observed. In the case of larger beds, the perimeter was determined while in smaller beds, the area was estimated.

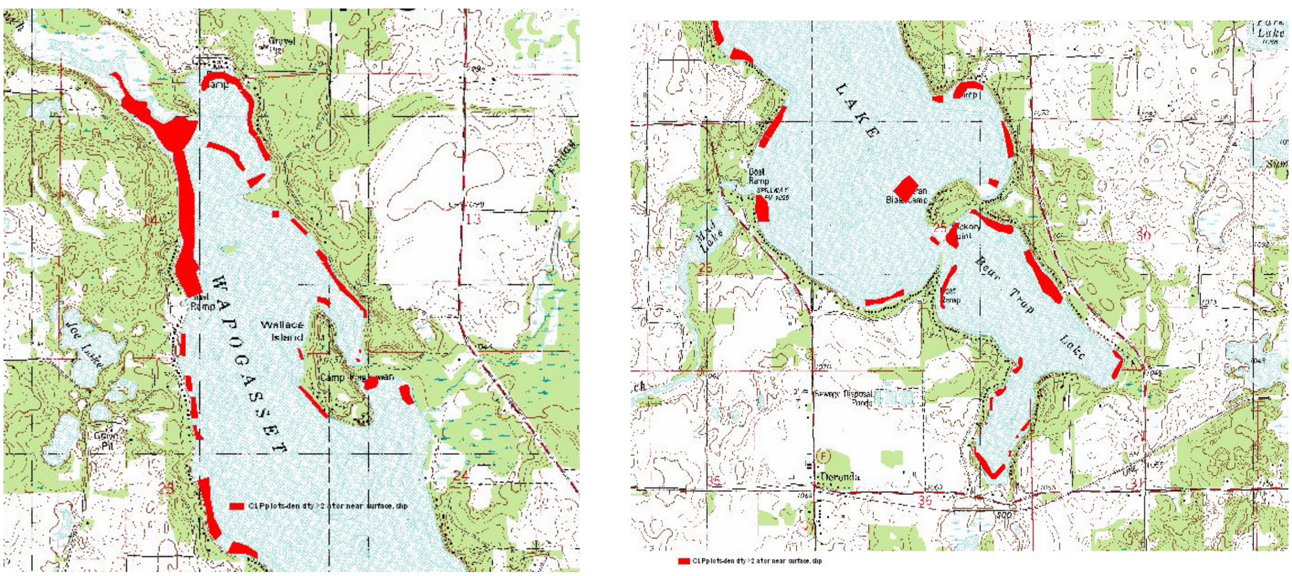


Figure 22: Curly leaf pondweed (Potamogeton crispus) map-early summer 2009

It is estimated that there is approximately 110 acres of CLP coverage on both lakes. This is extensive CLP coverage for a lake. Bear Trap Lake has a higher amount of coverage as compared to the total lake area. Furthermore, many of the beds were very dense with growth in both lakes.

CLP is an exotic aquatic species, but is thought to have been in Wisconsin lakes for many years. As a result, many don't view this plant was being as invasive as Eurasian water milfoil. However, if the CLP grows very dense with high coverage in the lake, it can adversely affect the lake ecosystem. This plant grows during early spring into the early summer when most natives are dormant or just coming out of dormancy. This could result in competition between the native species and CLP. Later in the summer (July) CLP undergoes senescence. When this happens a large amount of phosphorus can be released, leading to a phosphorus load. On rare occasions, they decomposition could lead to lower oxygen levels the lake, but would have to involve very extensive biomass of CLP. The management of this plant needs to be reviewed.

One other non-native plant was viewed. This plant was *Myosotis scorpoides(*Aquatic forget-me-not). This plant does not appear to be invasive as only one single plant was viewed in a bay near the Bible Camp. Its location has been marked and is not well known for becoming a serious problem in Wisconsin lakes.

Discussion

Both Bear Trap Lake and Lake Wapogasset have diverse aquatic macrophyte communities. Lake Wapogasset has higher species richness, but this would be expected as it has more shallow areas for plants to grow. Both lakes have a high Simpson's diversity index of 0.91, representing a high diversity. Furthermore, all floristic quality index values are above the median for the eco-region these lakes are contained within. This demonstrates the habitat for plants has not degraded too drastically over the time of human development.

These lakes have a history of high nutrients. It is very important that a robust native plant community be maintained to help enhance water quality. During algae blooms, the light penetration is reduced and can reduce plant growth. It is important to try and reduce nutrients in both of these lakes to help enhance the plant growth. Plants can help facilitate this as plant growth can absorb excess nutrients that would otherwise be available for nuisance algae growth.

Curly leaf pondweed was the only exotic species sampled. It covers much of both lakes and its management may be warranted. CLP can contribute large phosphorus loads if it grows too extensively and then decomposes rapidly after senescence. These lakes should also be monitored for Eurasian watermilfoil (EWM). The use of the lakes is extensive and the probability of introduction of EWM is high. With the proximity to the Twin Cities area, which has a large number of lakes with EWM, and the increased occurrence in Wisconsin Lakes, both lakes are susceptible from extensive boat launching.

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 Lake Wapogasset and Bear Trap 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.[1]

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.[2]

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

Curly leaf pondweed (*Potamogeton crispus*)[3]

<u>Identification:</u>

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.

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[1] 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.

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

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

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.

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.

Aquatic Plant Management

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.

The Northern Region of the Wisconsin DNR has established a management strategy for future plant management and can affect permitting for management. Their approach is as follows:[4]

1. After January 1, 2009, no individual permits for control of native aquatic plants will be issued. Treatment of native species may be allowed under the auspices of an approved lake management plan, and only if the plan clearly documents “impairment of navigation” and/or “nuisance conditions.” Until January 1, 2009, individual permits will be issued to previous permit holders, only with adequate documentation of “impairment of navigation” and/or “nuisance conditions.” No new individual permits will be issued during the interim.

2. Control of aquatic plants (if allowed) in documented sensitive areas will follow the conditions specified in the report. (Note: Lake Wapogasset and Bear Trap Lake has several documented sensitive areas)

3.Invasive species must be controlled under an approved lake management plan, with two exceptions:

a. Newly discovered infestations: If found on a lake with an approved plan, the invasives can be controlled via an amendment to the approved plan. Without an approved plan, they can be controlled under the WDNR’s Rapid Response protocol.

b. Individuals holding past permits for control of invasive aquatic plants and/or “mixed stands” of native and invasive species will be allowed to treat via

[4] Aquatic Plant Management Strategy. Northern Region of Wisconsin DNR. 2007.

individual Permit until January 1, 2009, if "impairment of navigation," and/or "nuisance conditions" is (are) adequately documented.

4. Control of invasive stands or "mixed stands" of invasive and native plants will follow current best management practices approved by the Department and contain an explanation of the strategy to be used. Established stands of invasive plants will generally use a control strategy based on spring treatment (water temperatures of less than 60 degrees F).

5. Manual removal (by definition) is allowed. However, wild rice may not be removed.

Management Options

Biological control[5]
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 going to be explored for Eurasian watermilfoil control.

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

[5] Information from APIS(Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

probably exists that will restore the community after non-native plants are controlled (Madsen, Getsinger, and Turner, 1994). Re-vegetation following plant management implementation should not be necessary as both lakes have extensive native populations and any management will involve selection for target species only.

Physical control[6]

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 Bear Trap Lake and Lake Wapogasset since this isn't recognized as an aquatic plant management tool alone and is not regarded as an effective tool for these lakes.

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. When drawbacks are weighed against the benefits, other options appear better for Bear Trap Lake and Lake Wapogasset as the primary management tool.

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 growth-inhibiting 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

[6] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

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 for Bear Trap Lake and Lake Wapogasset. Since the main use of management tools will be to reduce CLP, 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, management of Bear Trap Lake and Lake Wapogasset will not use this management tool.

Manual removal[7]

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 or Eurasian watermilfoil is present at near shore locations in low density, hand pulling by residents may be effective. Caution needs to be exercised in removing the entire plant and any fragments to reduce spreading through fragmentation.

[7] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

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 Bear Trap Lake and Lake Wapogasset. Also, for established invasive species control, mechanical harvesting would be largely aesthetic in nature as spreading of the plant is likely, thereby reducing plant density for a brief time only to have the plants return in the near future.

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. Many areas of Bear Trap Lake and Lake Wapogasset that need management are far too large for this method. However, in some sporadic regions, this method may be useful. Since actual dredging calls for other permits for removal of lake basin material, dredging would not be performed. Instead, the use of a suction device to move plants to the surface without removing bottom material would be utilized.

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.

Rotovation would release too much sediment and too many plant fragments and therefore would not be a good method for Bear Trap Lake and Lake Wapogasset. Also, potential treatment of non-native plants by rotovation is not a good option as it could increase spreading of non-native plants while not selecting the target species.

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 Bear Trap Lake and Lake Wapogasset. 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 annuals (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. A combination approach for CLP with contact and systemic may be considered.

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. If used for CLP, an early season broad spectrum herbicide can target the CLP as most other plants are dormant.

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.[8]

Copper compounds

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 binds 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

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

because it is bound in the plant tissue a proportion is probably degraded by microorganisms as the plant tissue decays.

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 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 algaecide.

Herbicide use to manage invasive species of concern

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:[9]
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 are conducting further trials of this method.

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

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.[10]

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

Management Recommendations

The following are goals that the aquatic plant management committee developed based upon review of all data presented and public input from the public survey analysis.

Goals:

1. Preserve a healthy and diverse community of native plants.
2. Stop the introduction of new invasive species into Bear Trap Lake and Lake Wapogasset and develop a rapid response plan to address any introduction that may occur.
3. Reduce external loading of phosphorus by reducing curly leaf pondweed and encouraging the growth of native aquatic plants.
4. Enhance water quality via plant management.
5. Restore developed shorelines to native habitat.
6. Educate lake residents and nonresidents about lake ecology.

Objectives

In order to reach the goals of the aquatic plant management plan, objectives have been outlined. These objectives are specific methods and/or criteria to reach the stated goals. Each objective will be described in further detail in the management section.

Goal 1: Preserve a healthy and diverse native plant community.

Objective 1.1-Management schemes will limit impact on native plants.

The native plant community is very important to the lake ecosystem. As a result, any management of plants, especially invasive species such as curly-leaf pondweed (present at this time) and Eurasian water milfoil (not present at this time) must use management practices that will preserve native plants. Herbicide treatments should be limited to early season and should target the invasive species. Avoid management that may adversely affect floating vegetation such as water lily, and avoid sensitive areas.

Objective 1.2-Encourage preservation of native plant stands.

Education is the key component for preservation of native plant stands. This includes providing information about their importance. Residents should be encouraged to maintain native plants in front of their properties and limit their removal whenever possible. If native plants are a nuisance for recreation such as swimming and boating, a minimum amount may be removed to mitigate the problem. The venues for education are contained in the last goal (goal 7) and in the implementation plan.

Both Lake Wapogasset and Bear Trap Lake have a history of excess nutrients and nuisance algae blooms. Native plants can contribute to better water clarity by absorbing nutrients from the bottom sediment as well as directly from the water column. Coontail (*Ceratophyllum demersum)* is a plant that is very abundant in both lakes. This plant is known to absorb large amounts of phosphorus. Therefore, maintaining a healthy population of this and other native plants could help water clarity and water quality issues.

Objective 1.3-Evaluate native plant communities with whole lake point intercept survey.

A point intercept survey will be completed in 2013. This survey will allow for the evaluation of any changes in the native plant community. A point intercept survey was completed in 2008 and will be the basis for comparison.

Goal 2: Stop the introduction of new aquatic invasive species into Bear Trap Lake and Lake Wapogasset and develop a rapid response plan to address introductions that may occur.

Objective 2.1-Continue the Clean Boats/Clean Waters Program at landings on Wapogasset and Bear Trap Lakes.

Lake Wapogasset/Bear Trap Lake Association volunteers have been trained in the Clean Boats/Clean Waters program. This program will continue and possibly be expanded. The expansion should include the following options:

1. Station volunteers or hired personel at key boat landings during high use times such as opening of fishing season, July 4^{th}, etc.
2. Station volunteers or hired personal at boat landings on weekends and high use weekdays.
3. Hire trained individuals to occupy boat landings for significant portions of spring/summer months.

Regardless of options used, the boat landings will be monitored a minimum total of 400 hours for all landings combined.

Objective 2.2-Use trained volunteers to establish an AIS monitoring program.

Curly leaf pondweed is present in Lake Wapogasset and Bear Trap Lake, as well as aquatic forget-me-not. Eurasian water milfoil is not present at this time. In order to reduce the chance of introducing this and other invasive species and prevent the spread of existing aquatic invasive species in the lakes, a good monitoring program is important. A volunteer group will be trained in the identification of key aquatic invasive species. Once trained, the group will monitor the lakes monthly in pre-determined locations. This protocol is contained in the appendix.

It is recommended that the areas mapped in Figure 23 is emphasized for monitoring purposes. These areas are a minimum and therefore can be expanded. Sample points may be generated for each area to provide for pre-determined sample points. A rake sample will be taken at each sample point. Only invasive species will be monitored and recorded (emphasis on Eurasian water milfoil). If there is a species sampled that is a potential invasive, the plant will be vouchered in a plastic bag forwarded to an aquatic plant specialist (Polk County Land and Water Conservation Dept, Wisconsin DNR, or private consultant).

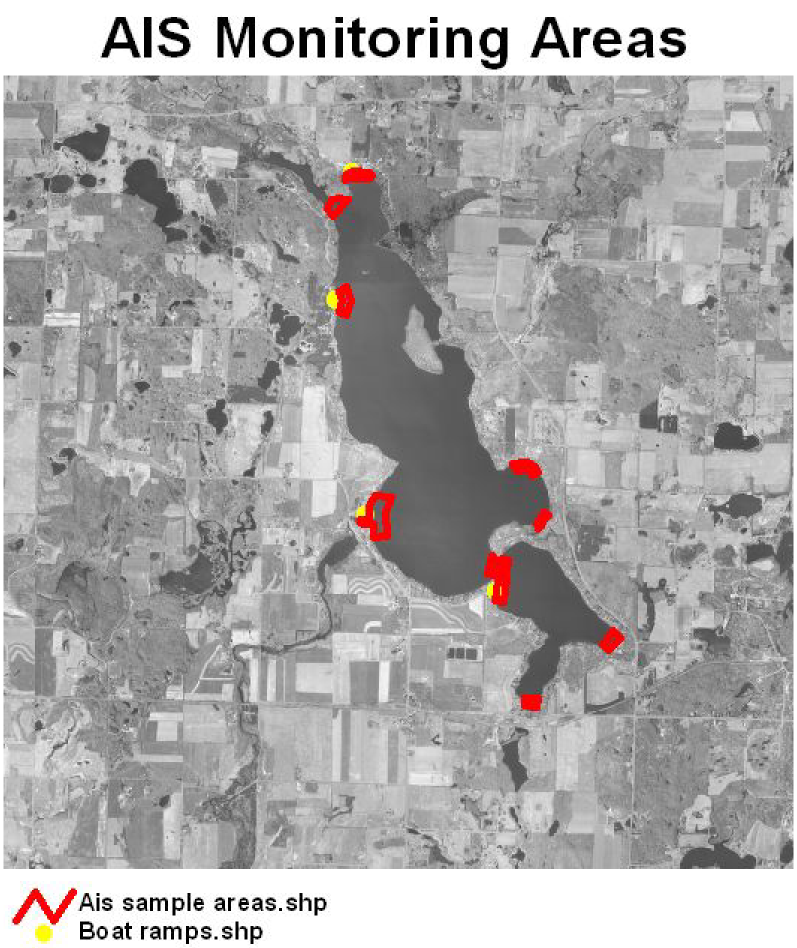

Figure 23: Proposed monitoring locations for AIS.

Objective 2.3-Develop and educate stakeholders about a rapid response plan.

Should other aquatic invasive species be located (or thought to be) in Lake Wapogasset and/or Bear Trap Lake, a rapid response plan will be followed. This rapid response will include:

1. Verification of AIS by Polk County Water Quality Specialist and the Wisconsin DNR.
2. Evaluation of degree of infestation and strategic planning by Polk County Water Quality Specialist (pioneer plants removed, herbicide treatments, etc.).
3. Creation of a reapid response file that contains a copy of the rapid response grant application, the rapid response protocol, and contact information for the Wisconsin DNR.

Goal 3: Reduce CLP coverage and encourage replacement of CLP beds with native species.

Objective 3.1-Chemically treat any CLP beds that reach a nuisance level threshold, which is described as follows:

a. Mean density greater than "2"
b. Aerial coverage greater than 400 square feet.
c. Plants at or near the surface at peak height.
d. Plants impede navigation at peak growth.

CLP has reached nuisance levels in many areas of both lakes. As a result, the management of areas found to be the highest nuisance in nature (of those that meet the criteria for nuisance) will be considered for herbicide treatment. Herbicide treatment for these areas is the best strategy available. A combined total of 15.5 acres will be treated in one area on each lake the first year (2009). The effectiveness of this treatment will be evaluated using the Wisconsin DNR pre and post treatment survey protocol. If the treatment is effective, the nuisance control of CLP may be expanded to larger and more numerous beds.

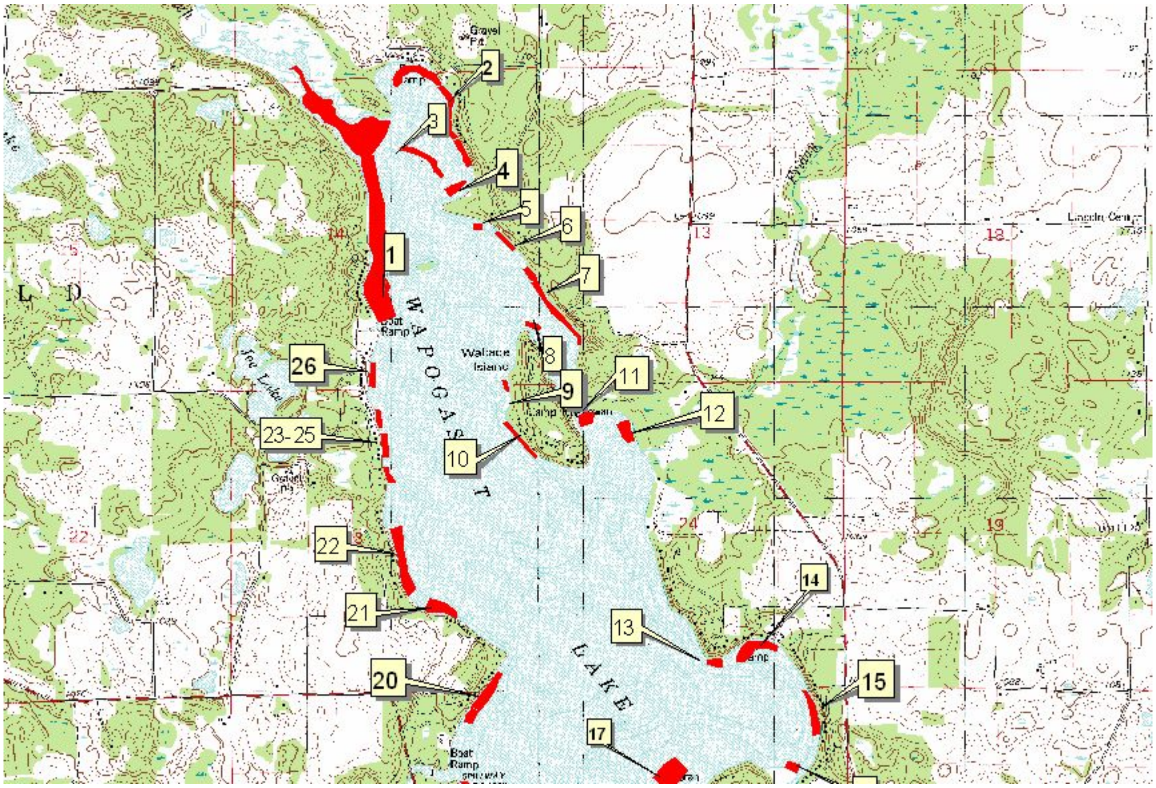

Figure 24: Map of designated CLP beds northern and central Lake Wapogasset.

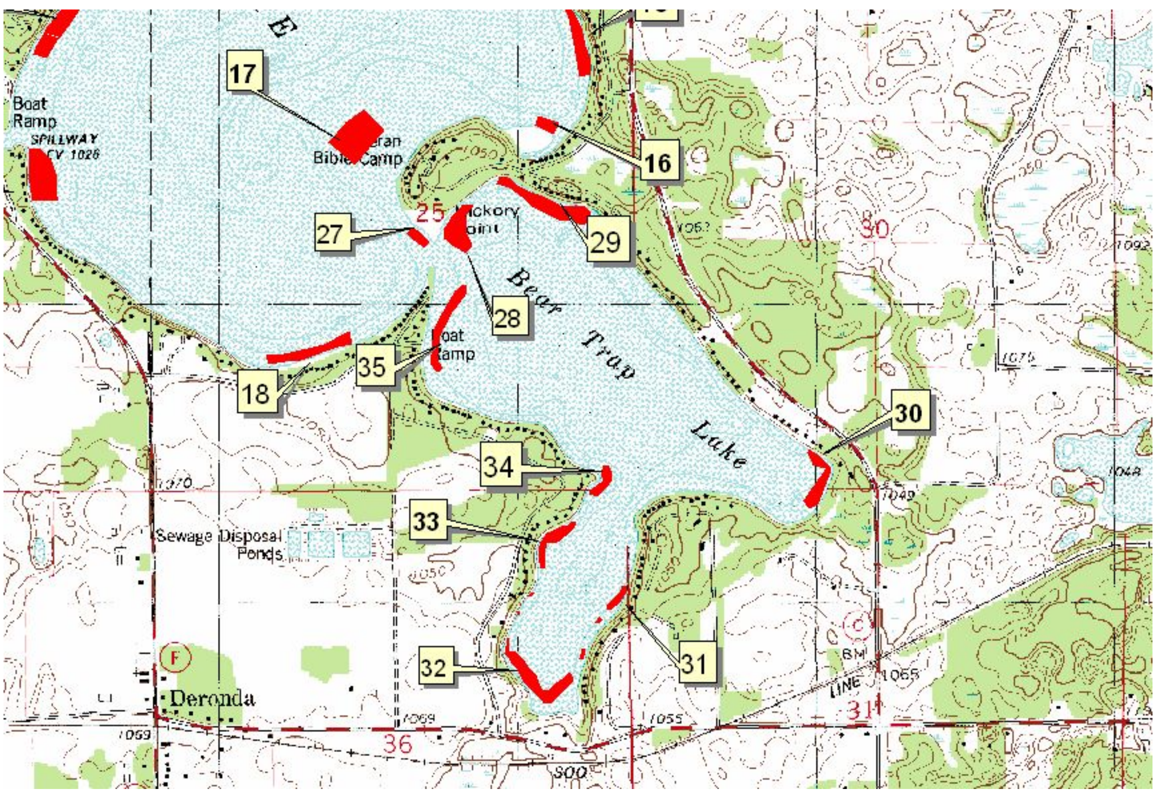

Figure 25: Map of designated CLP beds of southern Lake Wapogasset and Bear Trap Lake.

Plot #	Acres	Plot #	Acres
1	13.5	19	3.53
2	5.6	20	3.93
3	2.2	21	2.38
4	1.08	22	4.54
5	0.42	23	0.76
6	0.84	24	1.13
7	3.5	25	0.65
8	0.67	26	1.05
9	0.37	27	0.57
10	1.45	28	2.35
11	1.35	29	3.45
12	1.65	30	0.57
13	0.76	31	0.47
14	3.58	32	2.69
15	2.2	33	1.2
16	0.73	34	0.89
17	4.4	35	2.1
18	2.18	Wapo 2009 Treat 9.5	
nutrient	nuisance	Bear Trap 2009 Treat 6.0	

Table 15: Area and category of CLP plots on Bear Trap Lake and Lake Wapogasset. Plots in red are those that qualify for "nuisance."

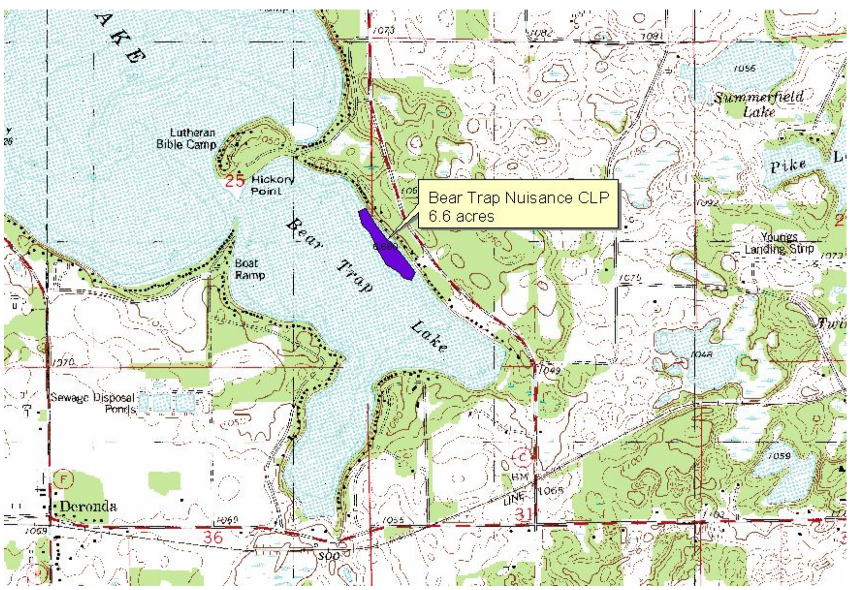

Figure 26: Treatment area for year one (May 2009) Bear Trap Lake.

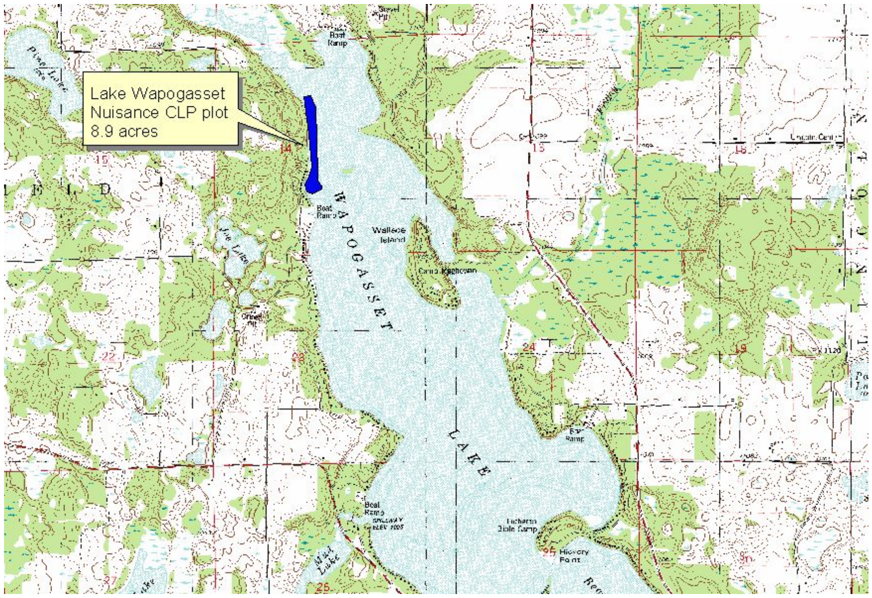

Figure 27: Treatment area for year 1 (May 2009) on Lake Wapogasset.

Objective 3.2-Chemically treat CLP beds that may contribute significant Amounts of phosphorus to the lake during summer senescence of CLP. These beds include those with:

A peak biomass of greater than 150 g/m^2

Aerial coverage greater than 400 sq feet.

Recent analysis have quantified, CLP contributions in phosphorus loading during decomposition in July. Based on calculations in the literature review, peak CLP growth can commonly range from 320-530 g/m2 (dry). The mean phosphorus content in the study was 0.37% during die off and 0.49% during peak growth. There has been approximately 100 acres of highly dense CLP identified in Lake Wapogasset and Bear Trap Lakes. Considering the size and the potential biomass, the CLP could contribute an estimated 634 to 1051 kg of phosphorus to the lakes.

Without collecting actual data from the lakes, it would be invalid to assume that these values represent the actual loading from CLP in these lakes. It does, however, reveal that it is worth pursuing as a management tool. The protocol below will be used to estimate the actual CLP phosphorus loading on Lake Wapogasset and Bear Trap Lake.

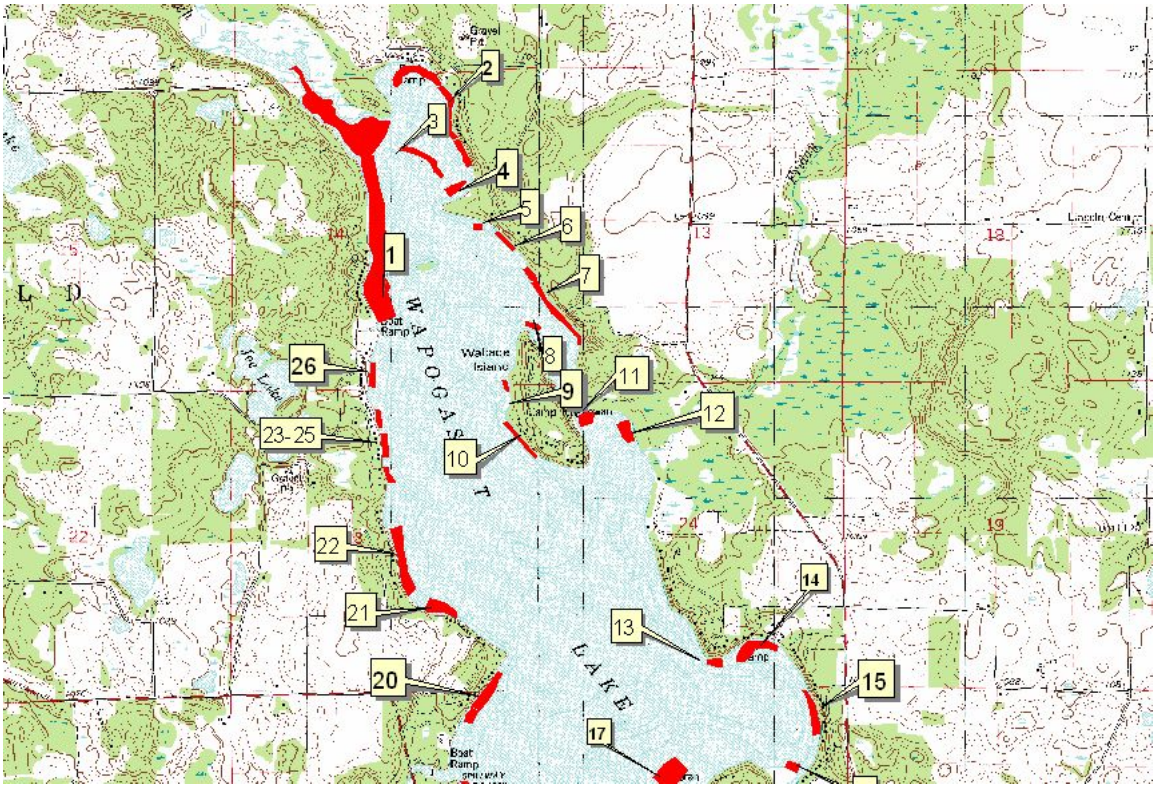

Figure 28: CLP map on northern and central Lake Wapogasset.

Plot #	Acres	Plot #	Acres
1	13.5	19	3.53
2	5.6	20	3.93
3	2.2	21	2.38
4	1.08	22	4.54
5	0.42	23	0.76
6	0.84	24	1.13
7	3.5	25	0.65
8	0.67	26	1.05
9	0.37	27	0.57
10	1.45	28	2.35
11	1.35	29	3.45
12	1.65	30	0.57
13	0.76	31	0.47
14	3.58	32	2.69
15	2.2	33	1.2
16	0.73	34	0.89
17	4.4	35	2.1
18	2.18	Wapo 2009 Treat 8.9	
nutrient	nuisance	Bear Trap 2009 Treat 6.6	

Table 16: Area and category of CLP plots on Bear Trap Lake and Lake Wapogasset. Plots in red qualify for potential nutrient management.

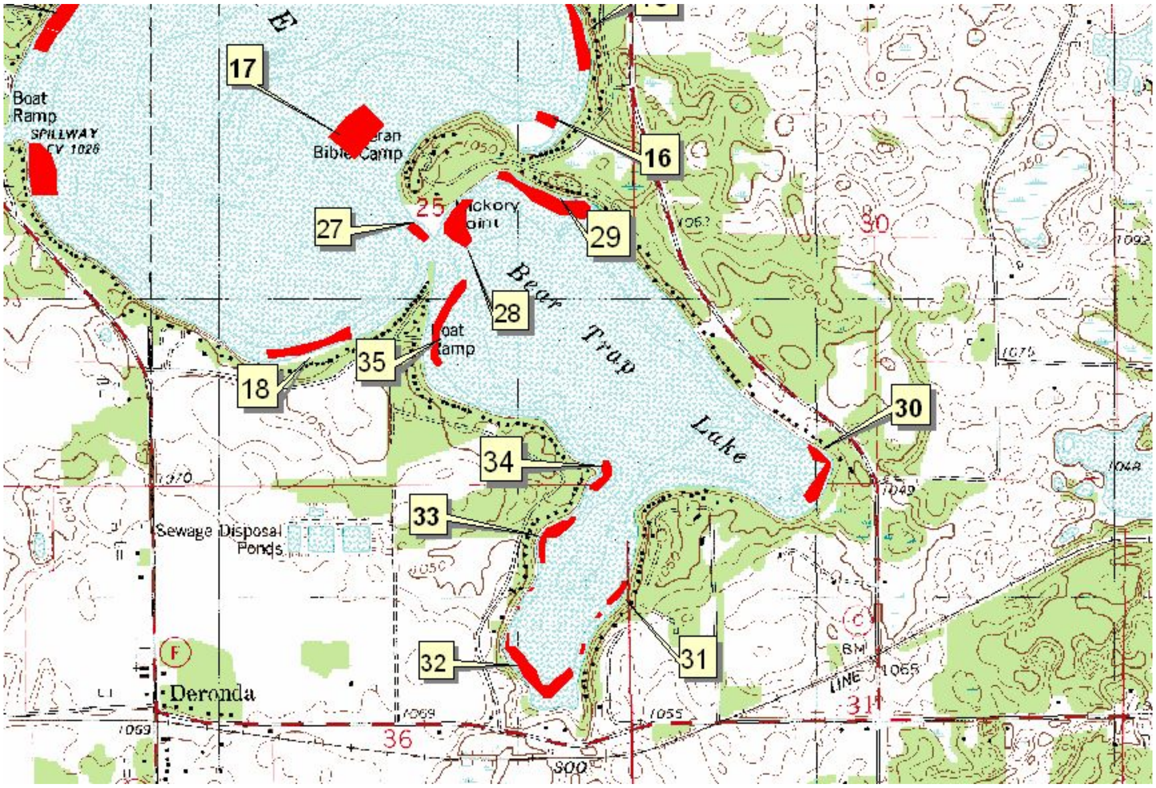

Figure 29: Map of designated CLP beds of southern Lake Wapogasset and Bear Trap Lake.

Both of these lakes have a long history of excess nutrients resulting in dense algae blooms in late July and August. The stakeholders are evaluating all possible strategies to reduce these algae blooms. Management of CLP for the purpose of reducing phosphorus loads in July is one of these strategies.

The first step is to determine the amount of phosphorus that is being loaded into the lake during CLP senescence. The following protocol will be used:

1. Several tissue samples from dense CLP beds around Lake Wapogasset and Bear Trap Lake will be sent to a lab to determine the phosphorus content of the plants. The tissue samples will come from cleaned plants.
2. Several dense beds will be sampled to estimate biomass in g/square meter. Sampling will involve removing all CLP from a 1m^2 quadrant and drying it to determine a dry biomass.
3. The areas meeting or exceeding these density estimates will be used to calculate a total biomass estimate of CLP in the lakes.
4. The mean phosphorus content will be used to calculate the potential phosphorus load from the CLP.
5. This phosphorus load will then be compared to the total phosphorus load of the lake.
6. If the CLP phosphorus load is considered high enough, management of CLP for the reduction of phosphorus loading will be implemented. This management will include herbicide treatment of all areas of CLP that meet the density requirement.

Objective 3.3-Reduce CLP aerial coverage by 90% and reduce mean density to less than "1".

This goal for CLP reduction may seem quite high. However, if this goal should be met, the treatment will be viewed successful and future treatment will be reduced accordingly.

Goal 4: Enhance water quality via plant management.

Objective 4.1-Manage CLP in a manner that can encourage its replacement with native species.

In addition to reducing CLP, the response of native plants to such management must be considered. For CLP management to be successful, the beds need to be replaced with native species. As part of the pre and post treatment protocol, a monitoring program will evaluate the response of the native species. The change in native species frequency will be statistically evaluated. If the native species are not replacing the CLP beds (assuming the CLP is reduced), the management strategies will be evaluated and possibly revised.

Objective 4.2-Educate landowners about the importance of native shoreline vegetation.

Lake Wapogasset and Bear Trap Lake have large residential land use areas. As a result, this c large amounts of phosphorus end up in the lake, contributing to the nuisance algae blooms. One very effective method to reduce this loading is the restoration of developed shorelines. Replacing turf grass and/or infiltration areas will reduce runoff and nutrient loading from their land.

Education activities for this will include newsletters (there are currently 9 per year), postings on the lake website and annual presentations at meetings for the Association and Sanitary District.

Goal 5: Restore developed shorelines to native habitats.

Objective 5.1-Develop a partnership with Polk Land and Water Conservation Department to educate and plan shoreline restoration projects.

Both Lake Wapogasset and Bear Trap Lake have a great deal of developed shorelines and these properties mostly likely contribute large amounts of phosphorus to the lakes. As a result, restoration of these areas could have a tremendous positive impact on lake water clarity.

The public survey indicated that 41% of the respondents are very or somewhat interested in implementing a water quality improvement practice. Providing education will be the key to encouraging property owners to implement such a practice. Since there is no cost share money currently available, it would be difficult to establish a specific implementation goal. However, with the public commitment, educational materials, and collaboration of the Sanitary District and the Lake Association, and the Polk County Land and Water Conservation Department, some restorations will hopefully occur.

The Polk County Land and Water Conservation Department can provide planning assistance should residents consider a shoreline restoration.

Objective 5.2-Evaluate funding sources to implement the shoreline restoration plan and secure funding for shoreline restoration if available.

Note: No money appears to be available (according to Polk County) and participation in other lakes is minimal. Also, the phosphorus load as compared to other sources needs to be evaluated by the committee. There may be able a possibility of securing funds through an AIS grant since CLP grows in high nutrient sediment.

Goal 6: Educate lake residents and non-residents about lake ecology.

Lack of understanding about lake ecology is a concern for the committee. They would like to implement strategies for educating lake residents and non-residents about the ecology of these lakes. It is believed that education and understanding of lake ecology is a limiting factor in protection of the lakes.

According to the public survey, respondents don't appear to have a complete understanding of native vs non-native plants and the significance of this distinction. As a result, education about the importance of preserving native species and eliminating invasive species is important.

Objective 6.1-Publish results of lake survey from the spring of 2009 in the summer of 2009.

The committee believes that other people on the lake should be able to see how others responded to the public survey. The results of the survey will be posted on the Lake Association and Sanitary District web sites beginning summer 2009.

Objective 6.2-Publish a lake association newsletter 9 times annually.

A lake association newsletter is currently published 9 times annually. This will continue but a bigger commitment will be made to include information about lake ecology, lake issues, and management schemes. Each newsletter will contain an educational component.

Objective 6.3-Develop a Sanitary District website and post informational brochures on the website as well as the Lake Association web site.

At the development of this plan a website had been started and posted on the web. The information available is presently being expanded.

Lastly, the Sanitary District will publish an annual plant management report each August. This report will discuss the management practices conducted during that spring and summer. This discussion will include areas managed and the results of that management.

Implementation Plan

The objectives outlined in the management recommendations will be implemented over the course of the next five years. Table 17 summarizes the activity, time of implementation and the responsible parties involved. It is important the Sanitary District and the Lake Association work together to assure that these management objectives are implemented. It is also the responsibility of the two organizations to plan for funding the various activities.

Activity	Timeline	Responsible Party
Education about native plants	Begin Summer 2009 Ongoing thereafter	Lake Wapogasset/Bear Trap Association and Sanitary District
Reduction of nuisance CLP	15 acres in Spring 2009 (for 3 years) More acres if effective 2010	Sanitary District
Evaluation of CLP phosphorus loading	Spring/summer 2010	Sanitary District Lake Consultant
Reduction of CLP phosphorus loading	Spring 2011 if determined P reduction significant and warranted	Sanitary District Lake Consultant
Clean Boats/Clean Waters	Spring 2009 Ongoing thereafter	Lake Association
Monitoring AIS	Training Spring 2010 Ongoing thereafter	Lake Association Polk County Land and Water Dept./Lake Consultant
Whole lake plant survey	Spring/summer 2012	Lake Consultant Sanitary District
Education on shoreline restoration	Begin Winter 2009-10 Annually after that	Lake Association Sanitary District
Evaluation of management success	Yearly pre and post treatment surveys. Yearly management reviews	Consultant Plant committee Sanitary District and Lake Association
Evaluation of APMP and revamping of plan	2014-15	Plant committee Sanitary District Lake Assocition Consultant if needed

Table 17: Implementation plan for objectives.

In 2009, the first treatment of CLP took place on two areas (one in Bear Trap Lake and one in Lake Wapogasset) totaling 15.5 acres. These two areas will be treated for two more years to eliminate the possibility of turions germinating new plants (turions are viable for several years). In 2010, additional nuisance areas will be considered for treatment. These areas could add approximately 27 acres to the 15.5 acres. This decision will be made in March, 2010 and will be based upon review of treatment in 2009 as well as financial considerations. The Lake Wapogasset/Bear Trap Lake Sanitary District will be responsible for funding this management portion.

The potential for nutrient management with CLP reduction will be evaluated in 2010. A consultant will be used to collect CLP samples, record biomass and submit CLP samples for phosphorus analysis. These values will then be used to calculate the potential phosphorus load from CLP in July. The Lake Wapgasset/Bear Trap Lake Sanitary District, along with the plant committee and the Lake Wapogasset/Bear Trap Lake Association will determine if the reduction of CLP for nutrient management is worthwhile and feasible.

A monitoring group will be formed and trained in summer 2010. The Polk County Land and Water Conservation Dept. and/or a consultant can lead this training. The monitors will then implement the AIS monitoring program.

Educational programming will be conducted throughout the next 5 years. The Lake Wapogasset/Bear Trap Lake Sanitary District along with the Lake Wapogasset/Bear Trap Lake Association have made a commitment to implementing components discussed in the goal 6 discussion. This will include a shoreline restoration training.

In 2012, another point intercept whole lake aquatic plant survey will be conducted. A qualified aquatic plant professional will complete this. The Wisconsin DNR point intercept method will be used. The same sample grid that was used in 2007 will be utilized. In addition, all plants will be vouchered and verified with the Wisconsin DNR.

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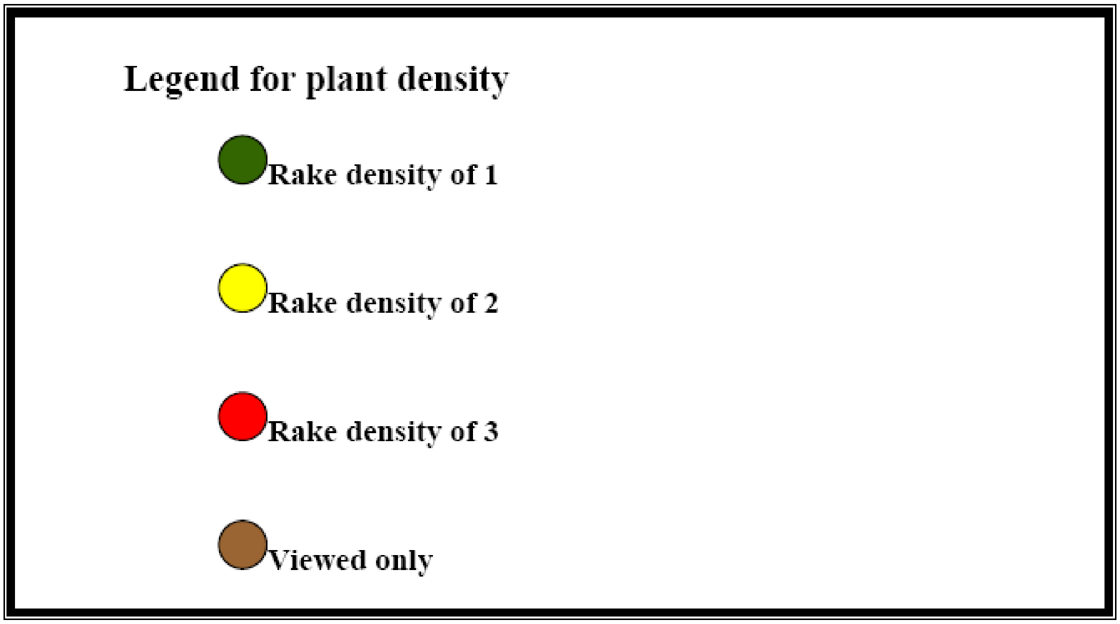
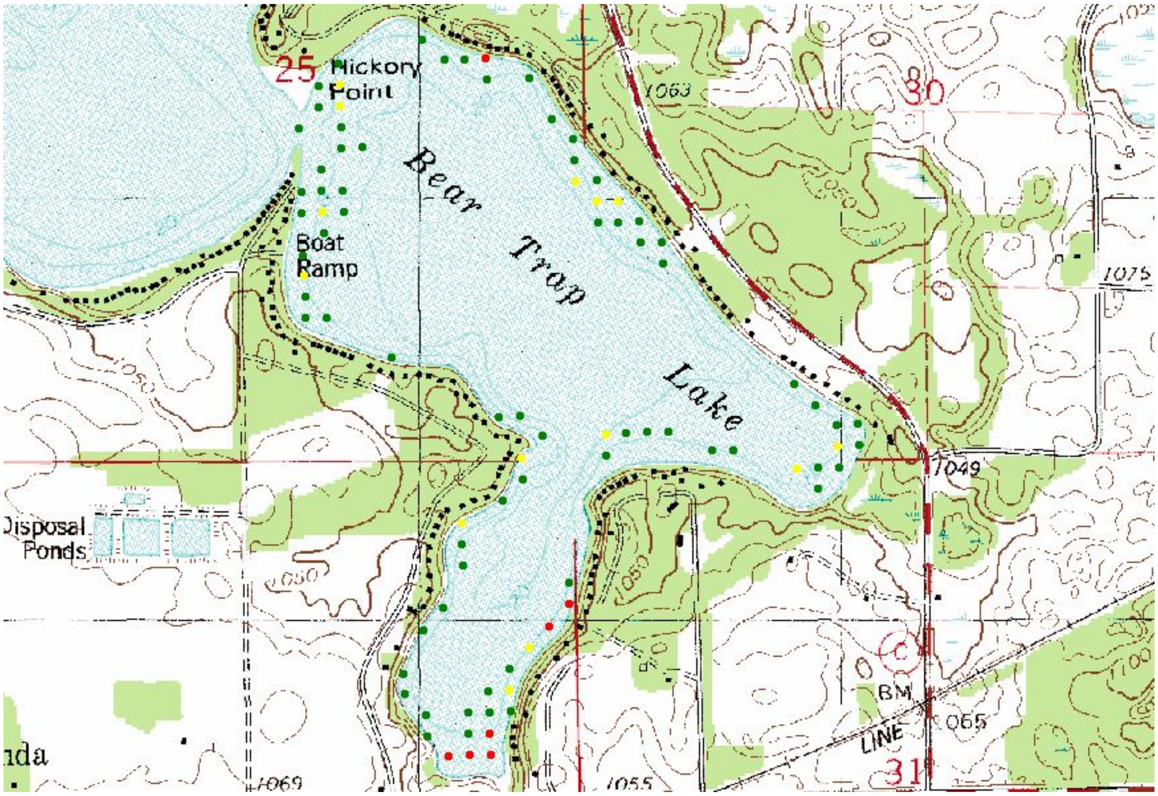
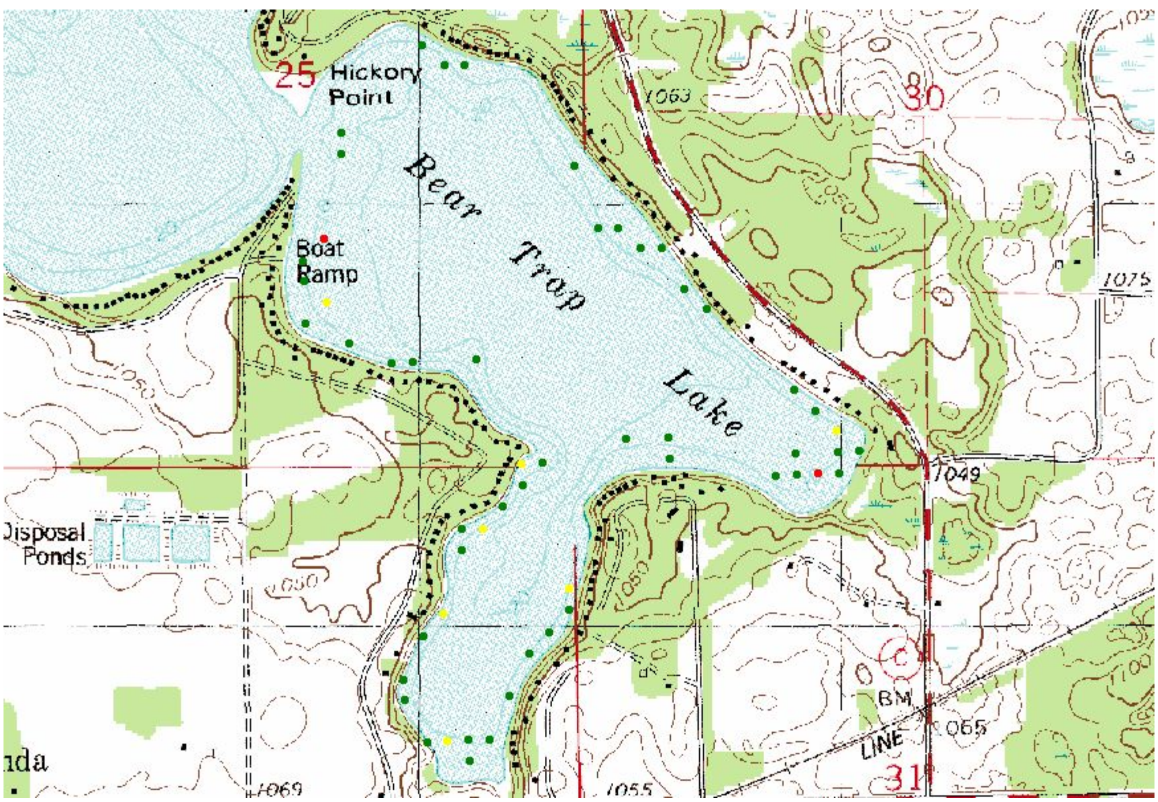
Appendix A-Maps of all plants-Bear Trap Lake

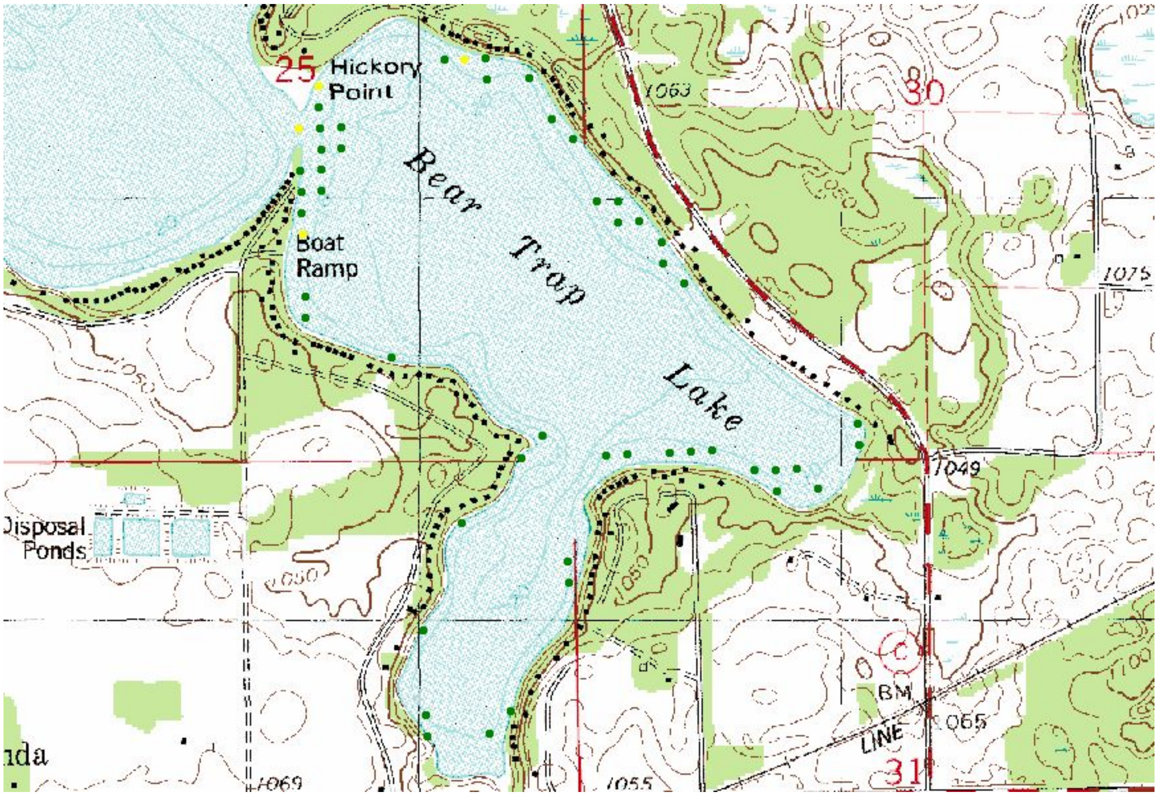




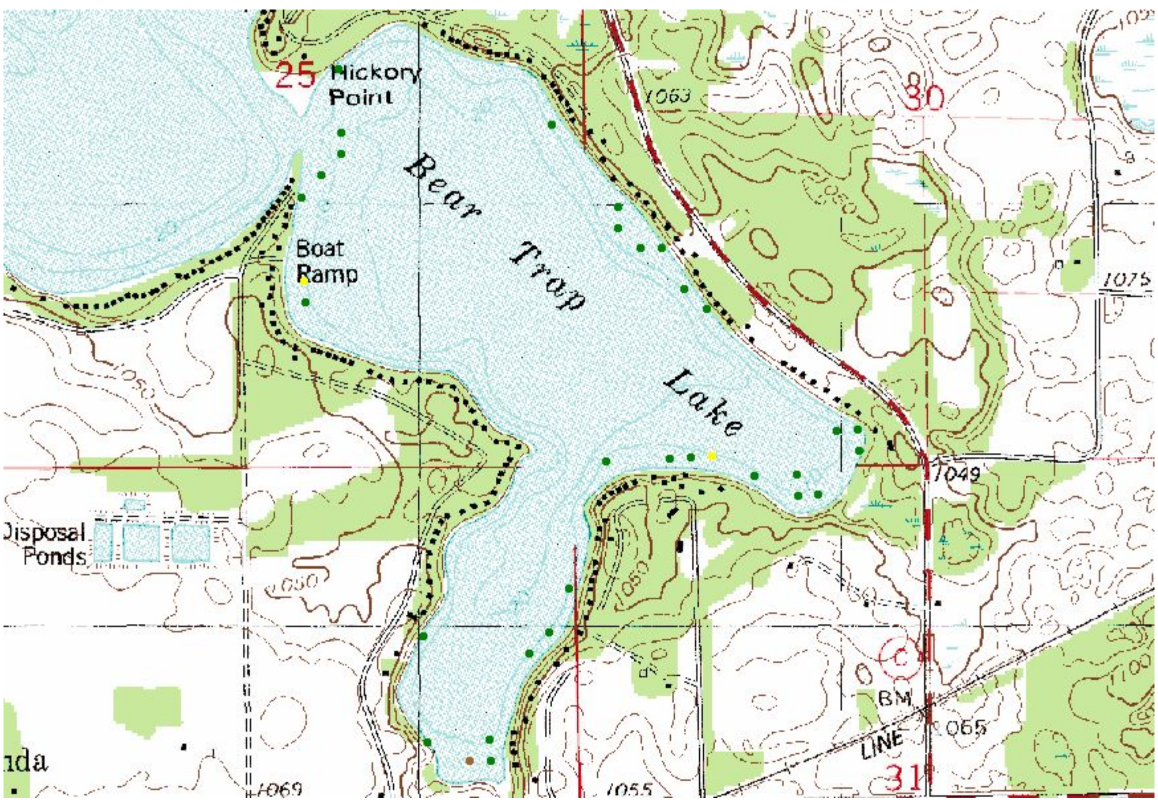
Ceratophyllum demersum-Coontail



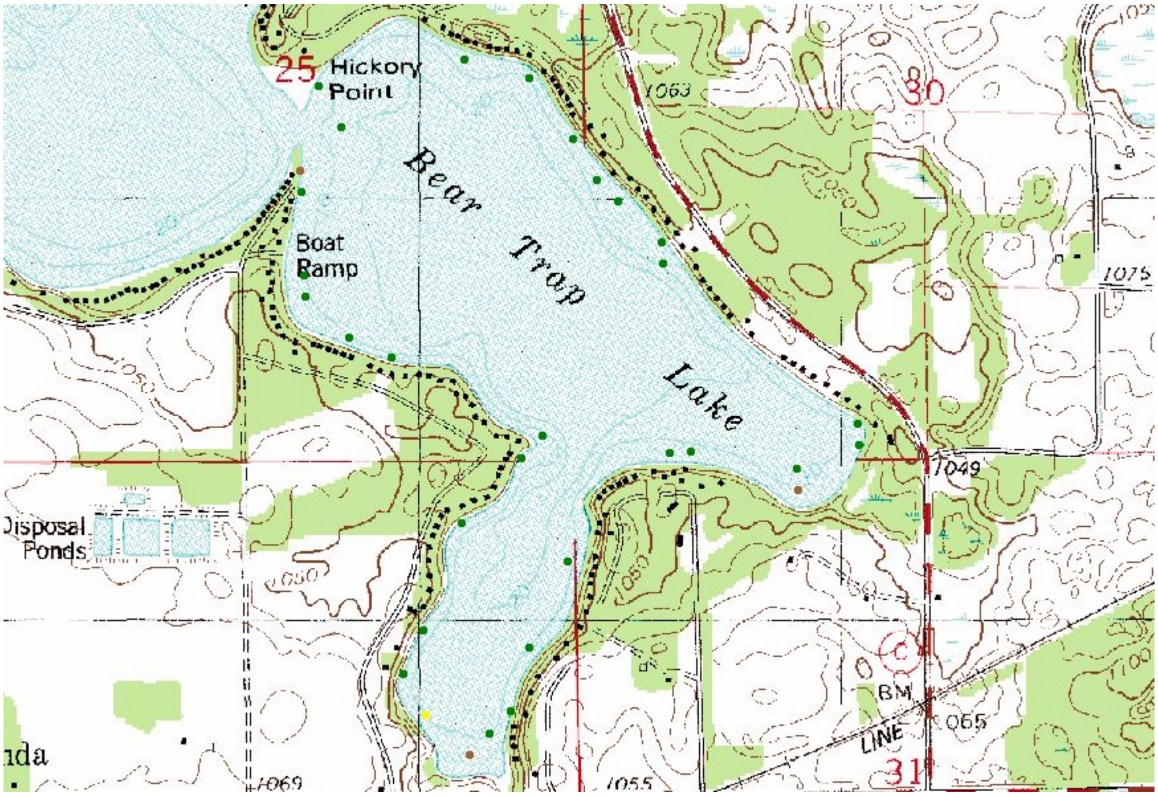
Potamogeton zosteriformis-Flatstem pondweed



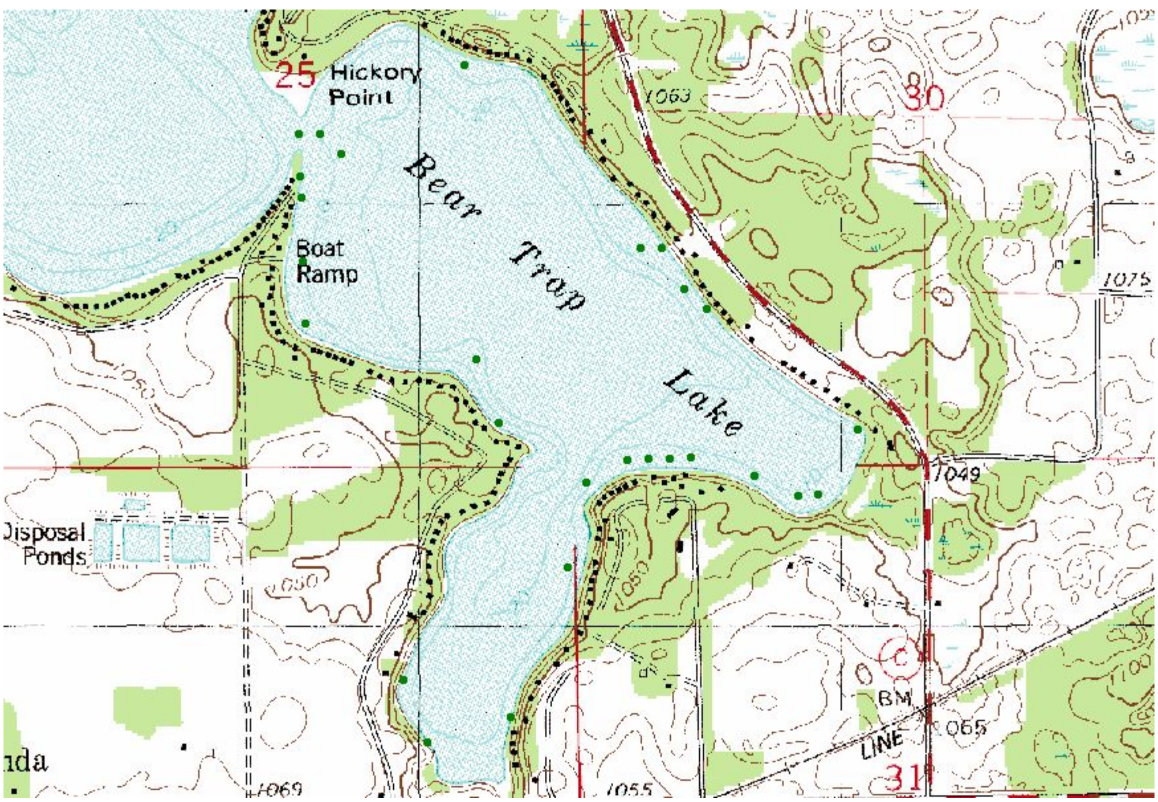
Vallisneria Americana-Wild celery



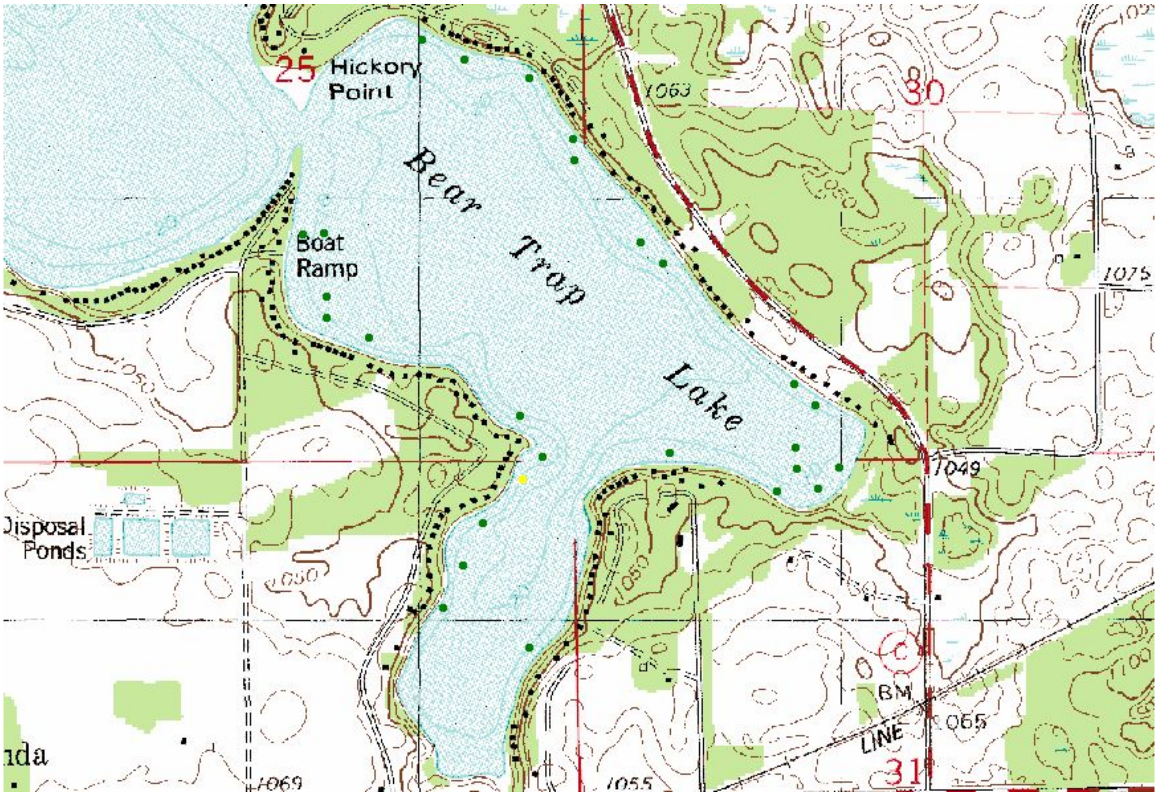
Ranunculus aquatilis-Stiff water crowfoot



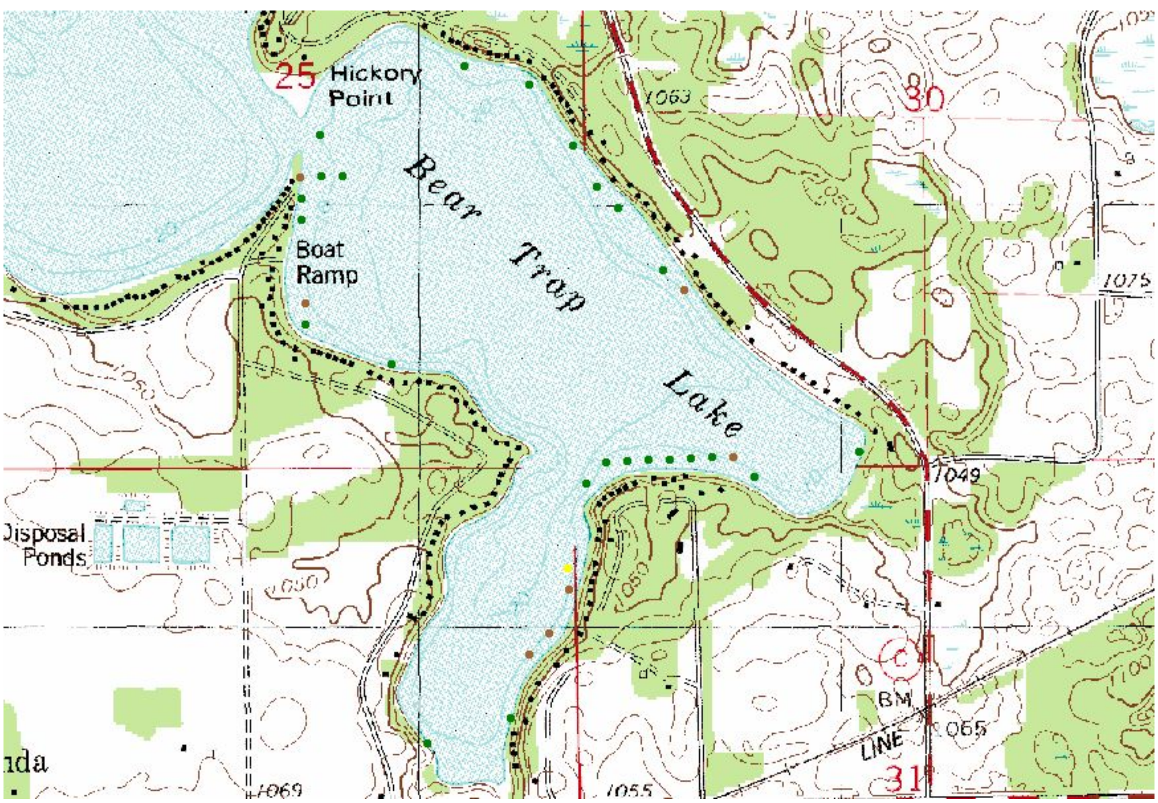
Potamogeton richarsonii-Clasping pondweed



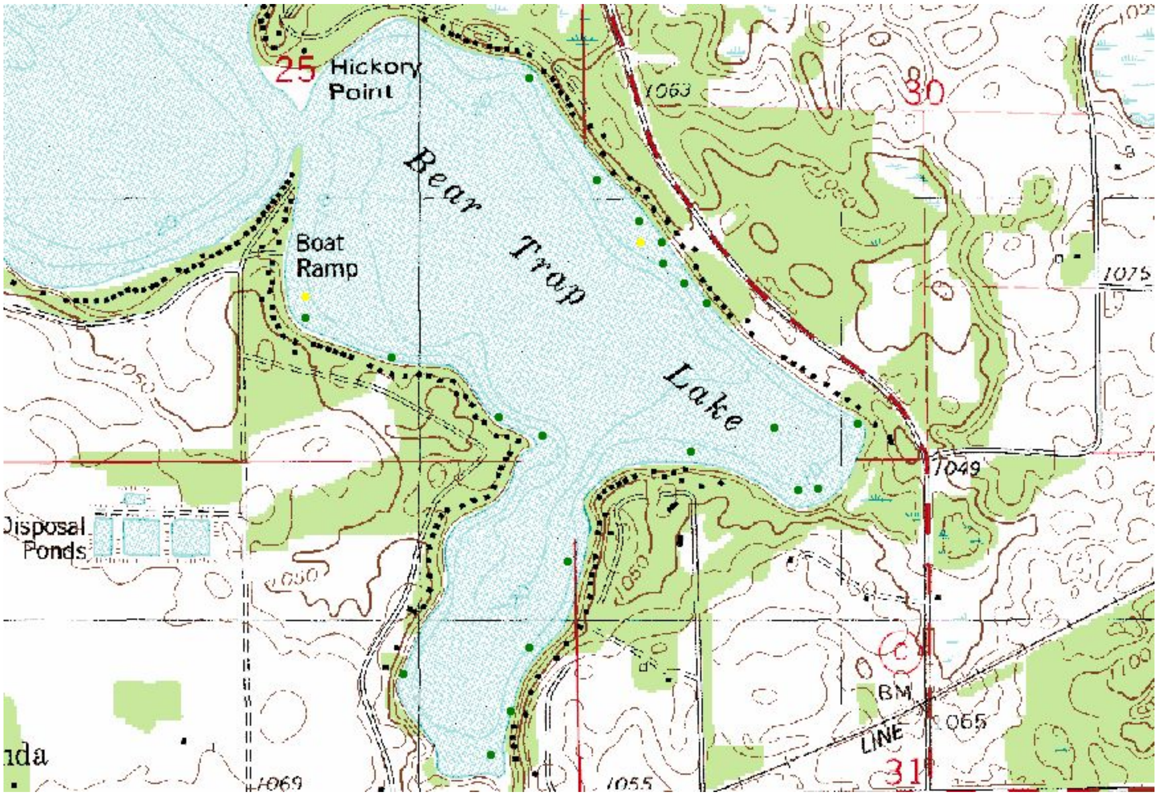
Najas flexilis-Bushy pondweed



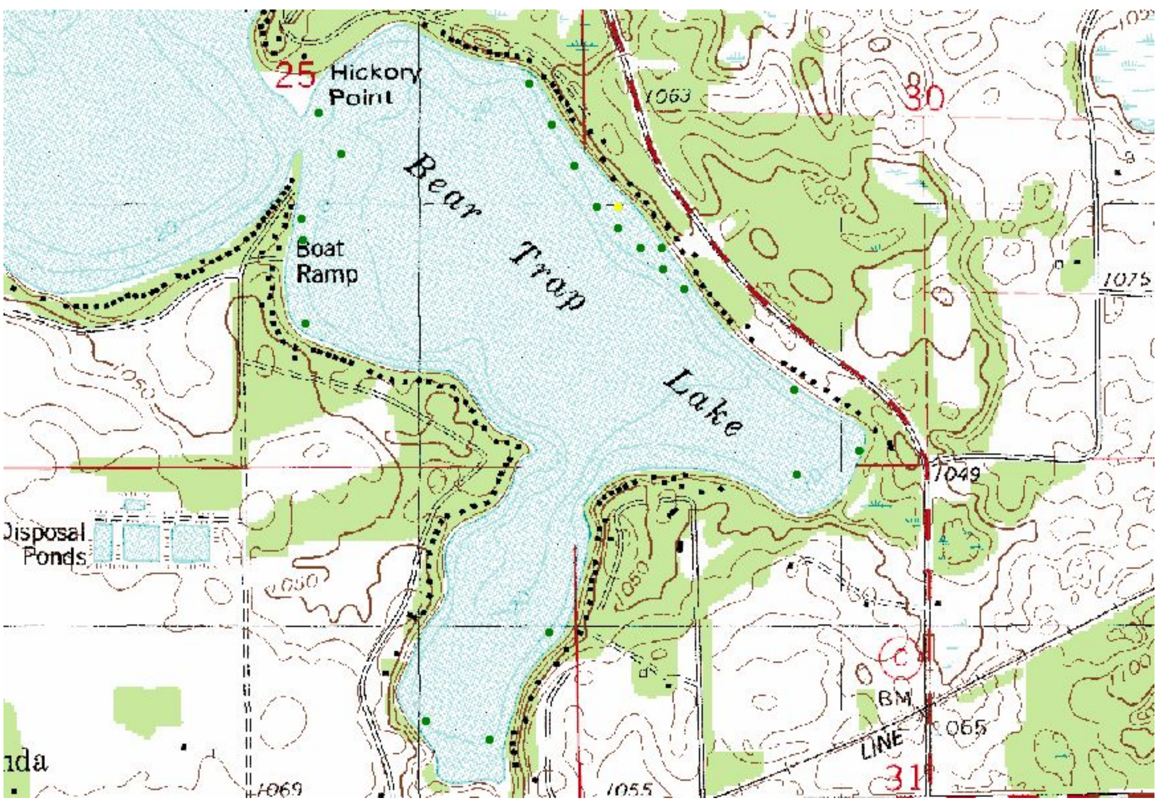
Potamogeton pusillus-small pondweed



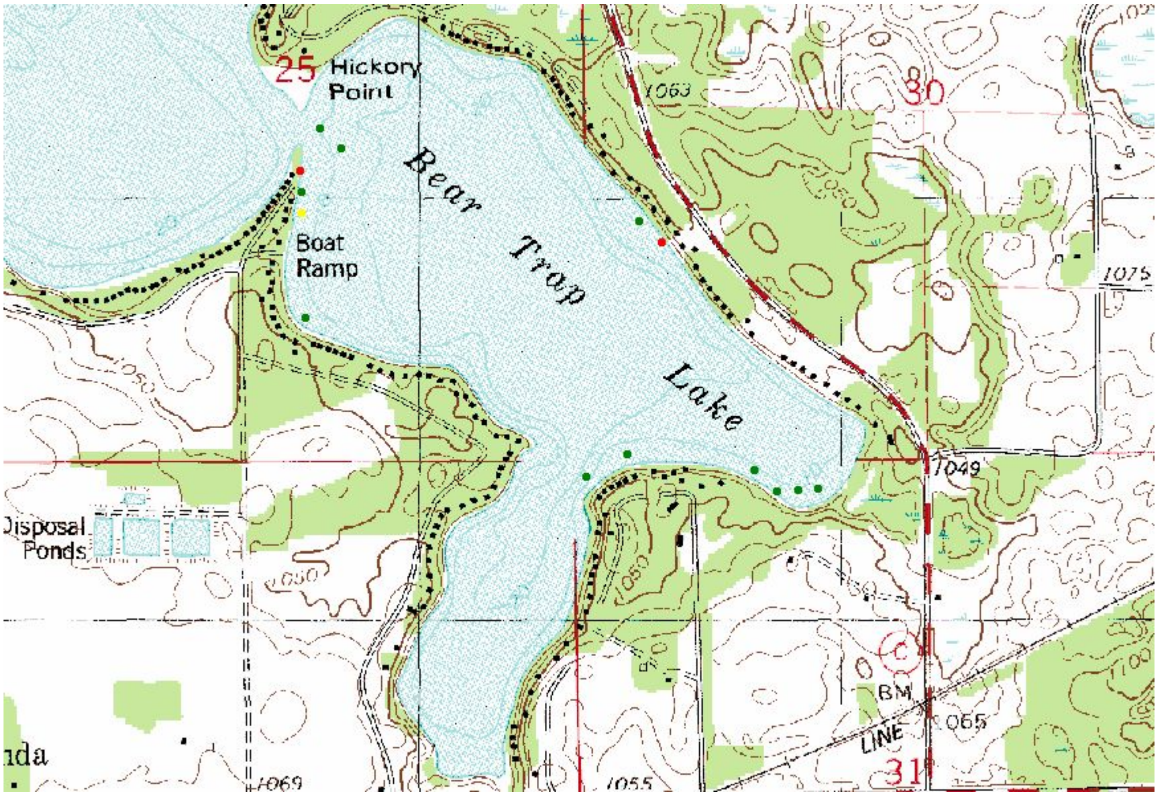
Potamogeton illinoensis-Illinois pondweed



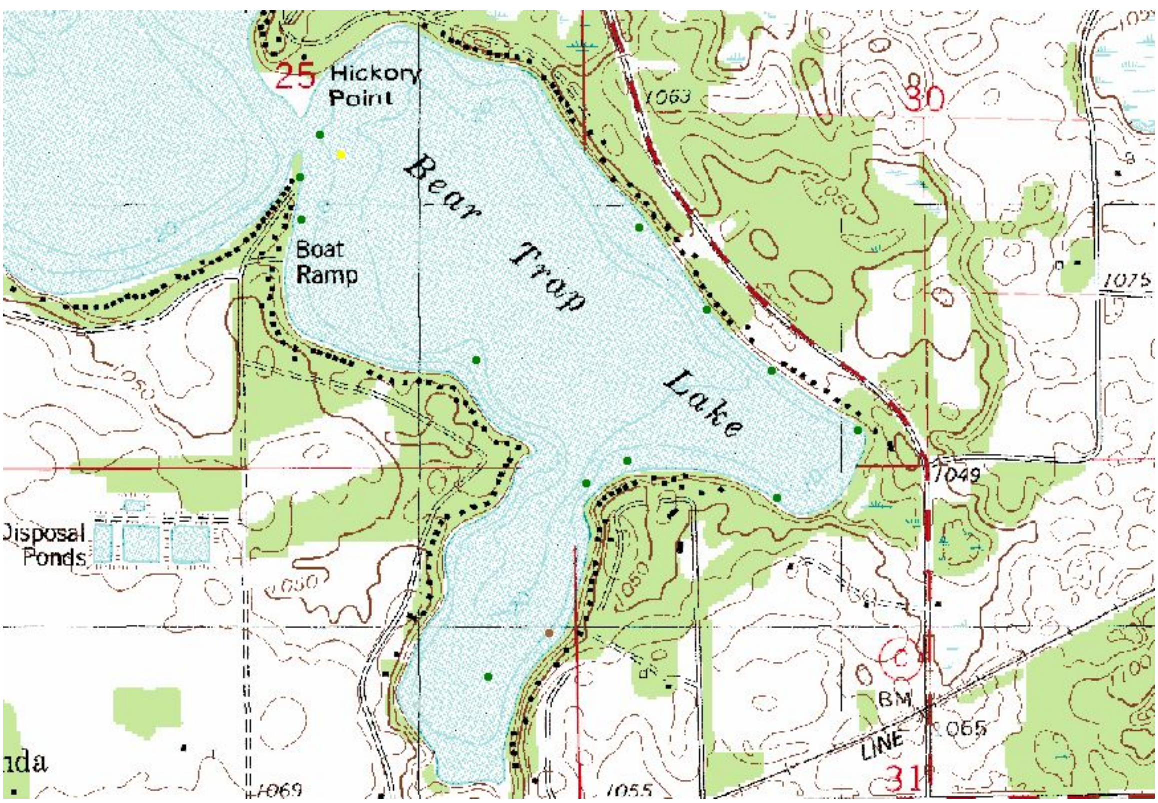
Heteranthera dubia-Water stargrass



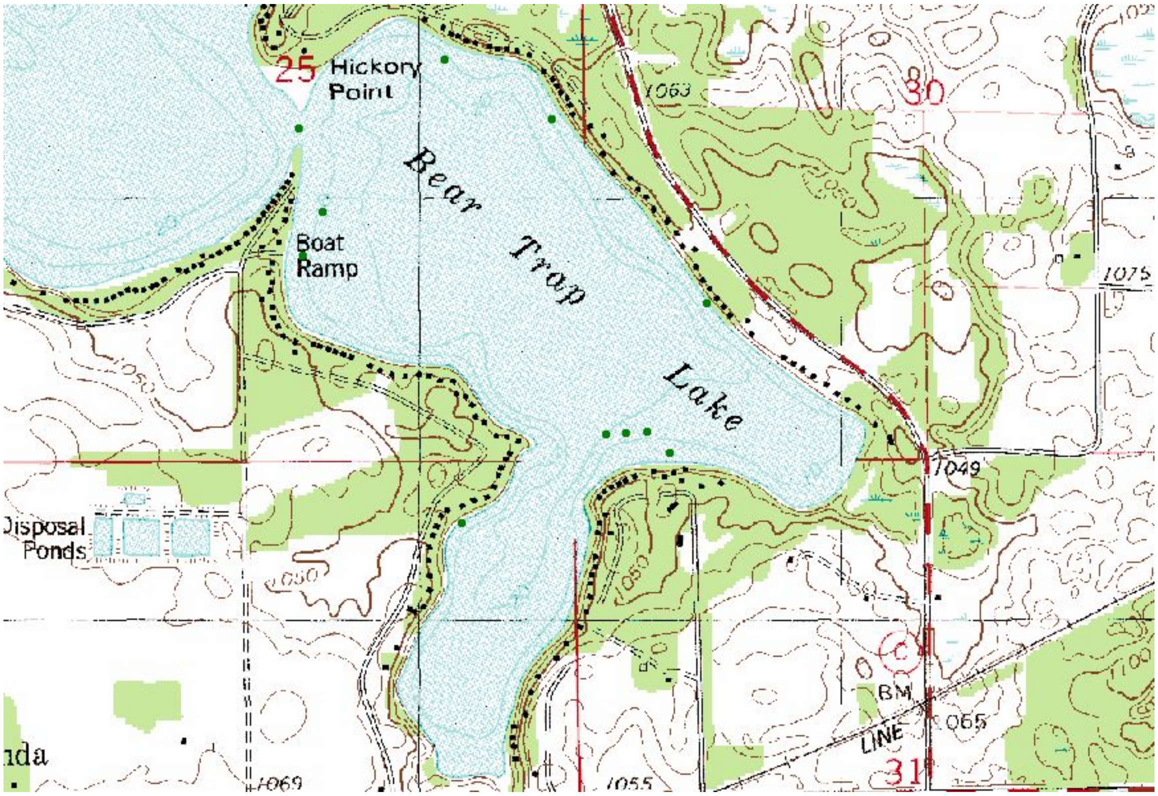
Elodea canadensis-Common waterweed



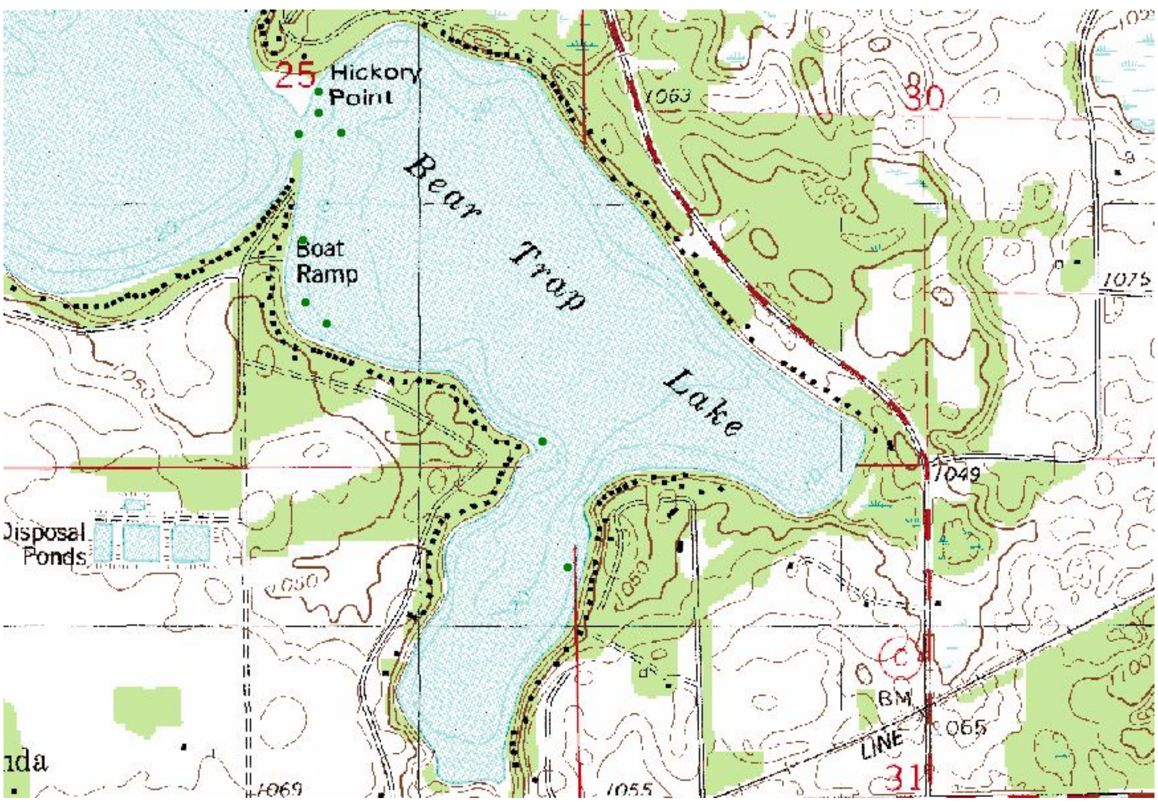
Chara sp.-Muskgrass



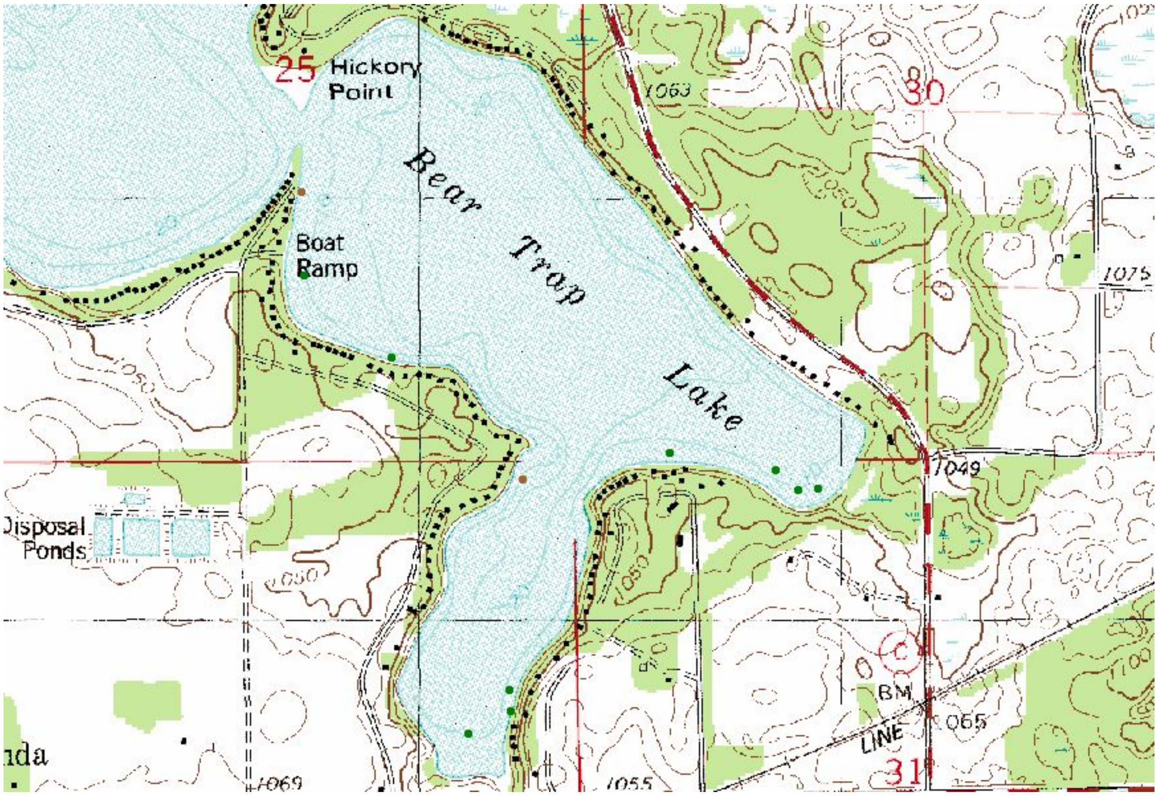
Filamentous algae



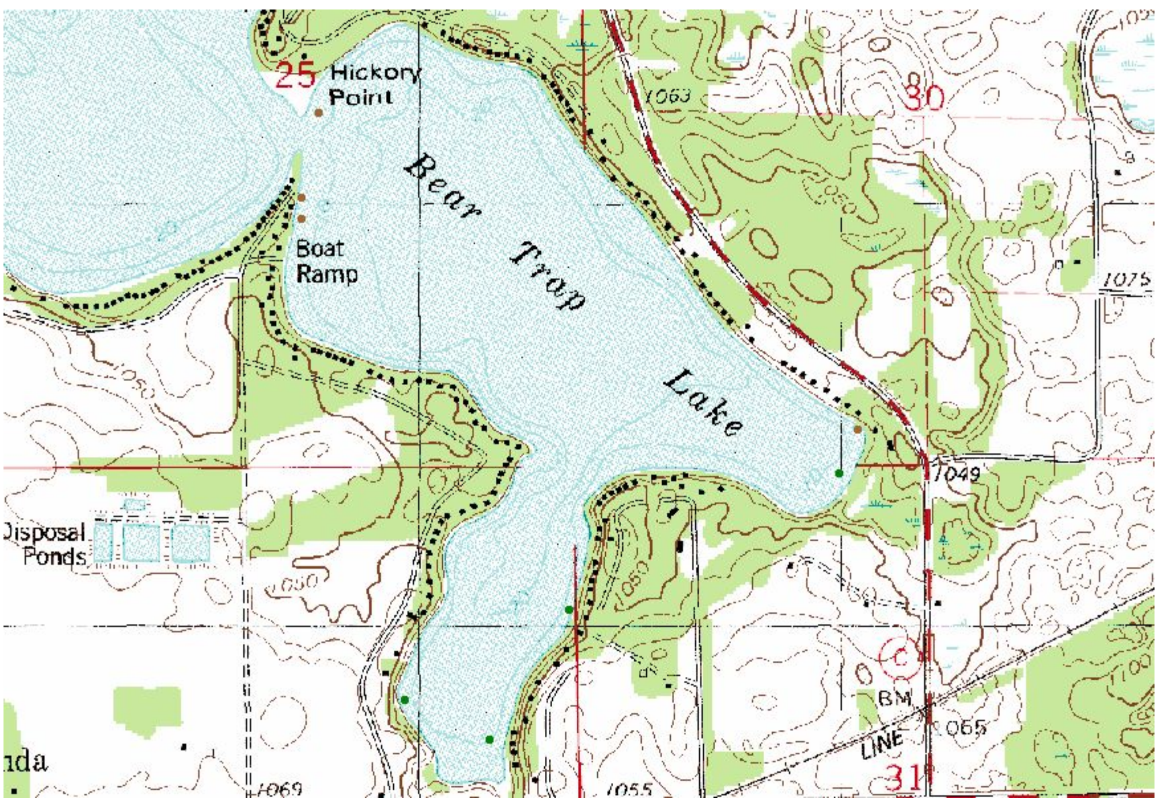
Potamogeton crispus-curly leaf pondweed



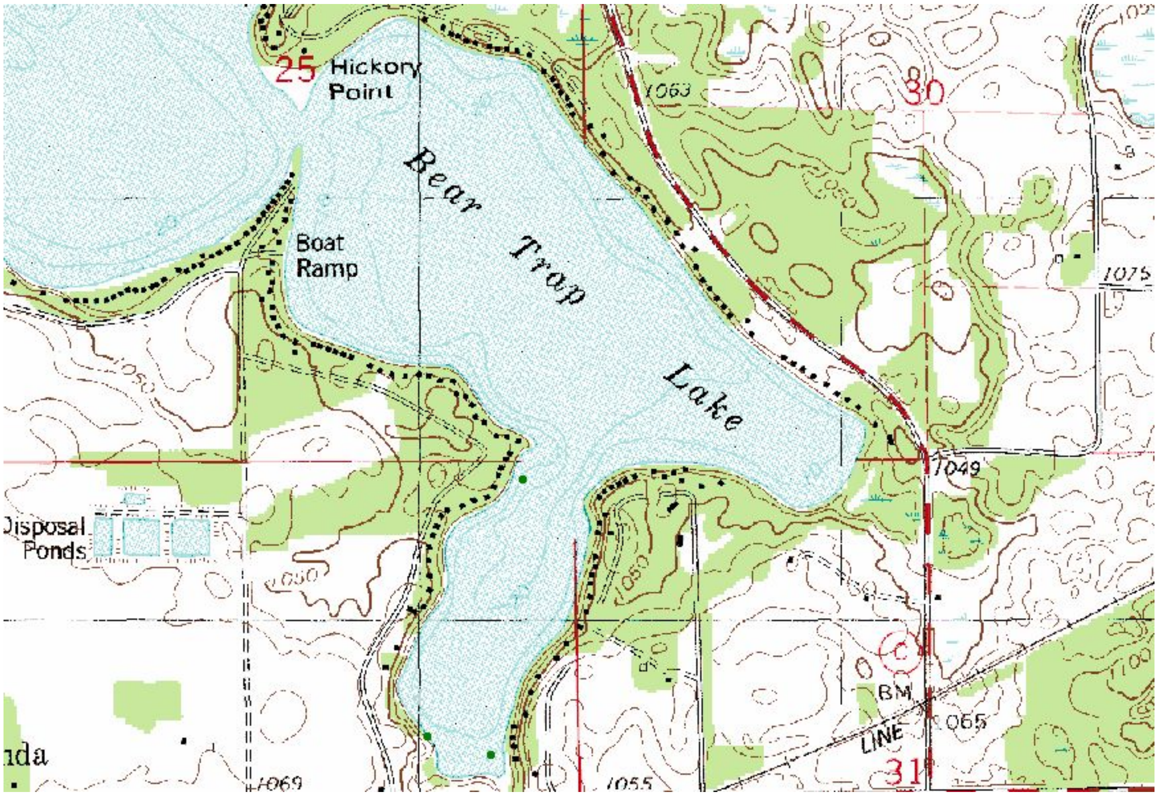
Potamogeton friesii-Fries pondweed



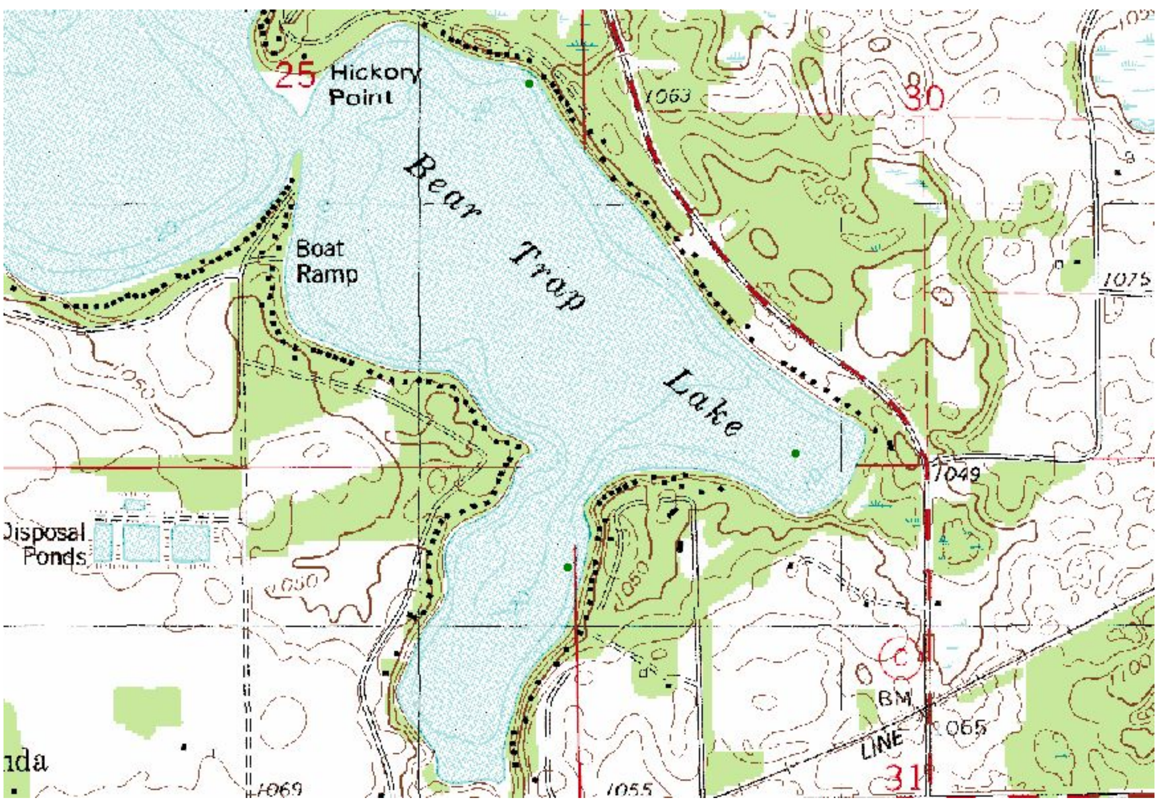
Stuckenia pectinatus-Sago pondweed



Myriophyllum sibiricum-Northern watermilfoil

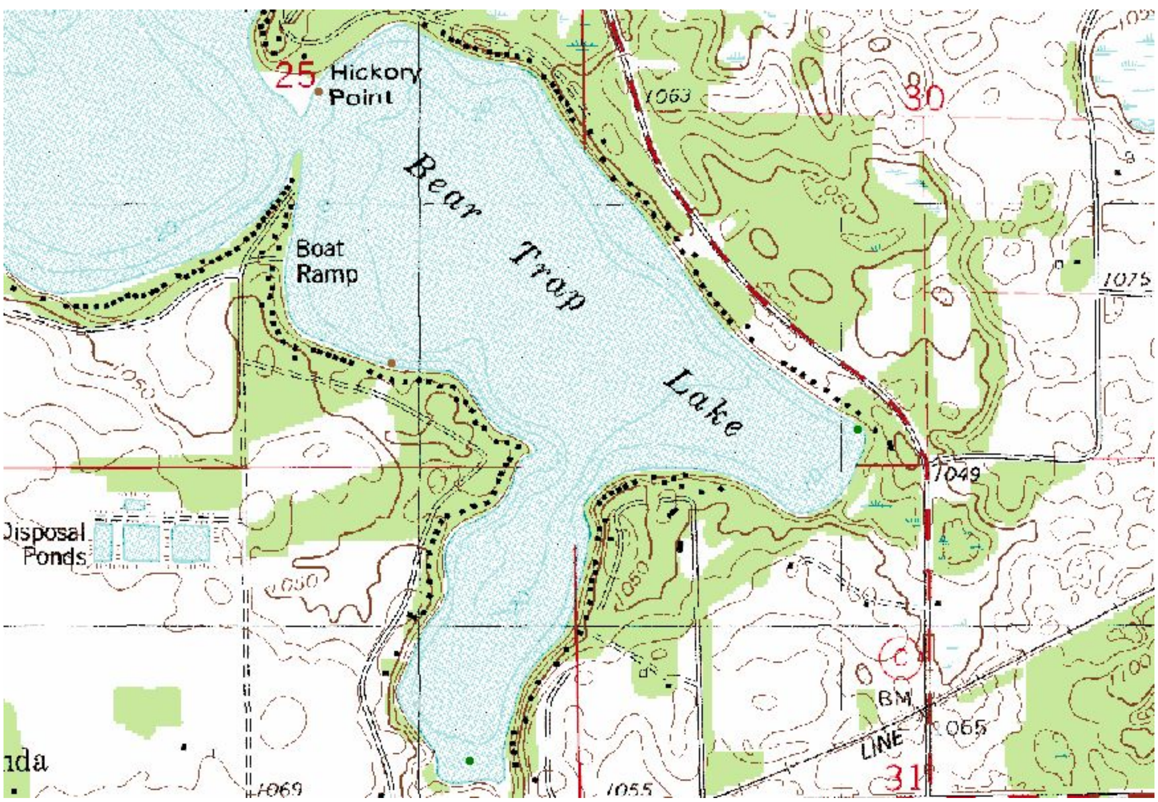


Lemna triscula-Forked duckweed

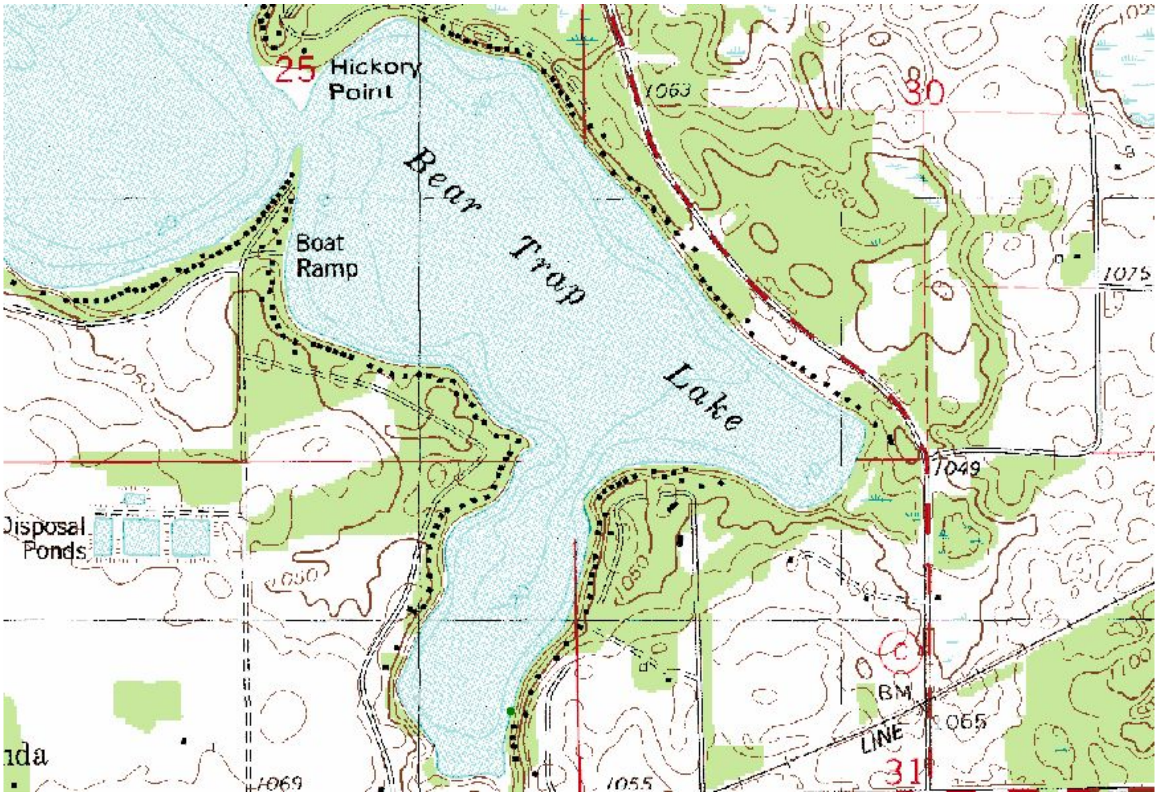


Potamogeton foliosus-Leafy pondweed

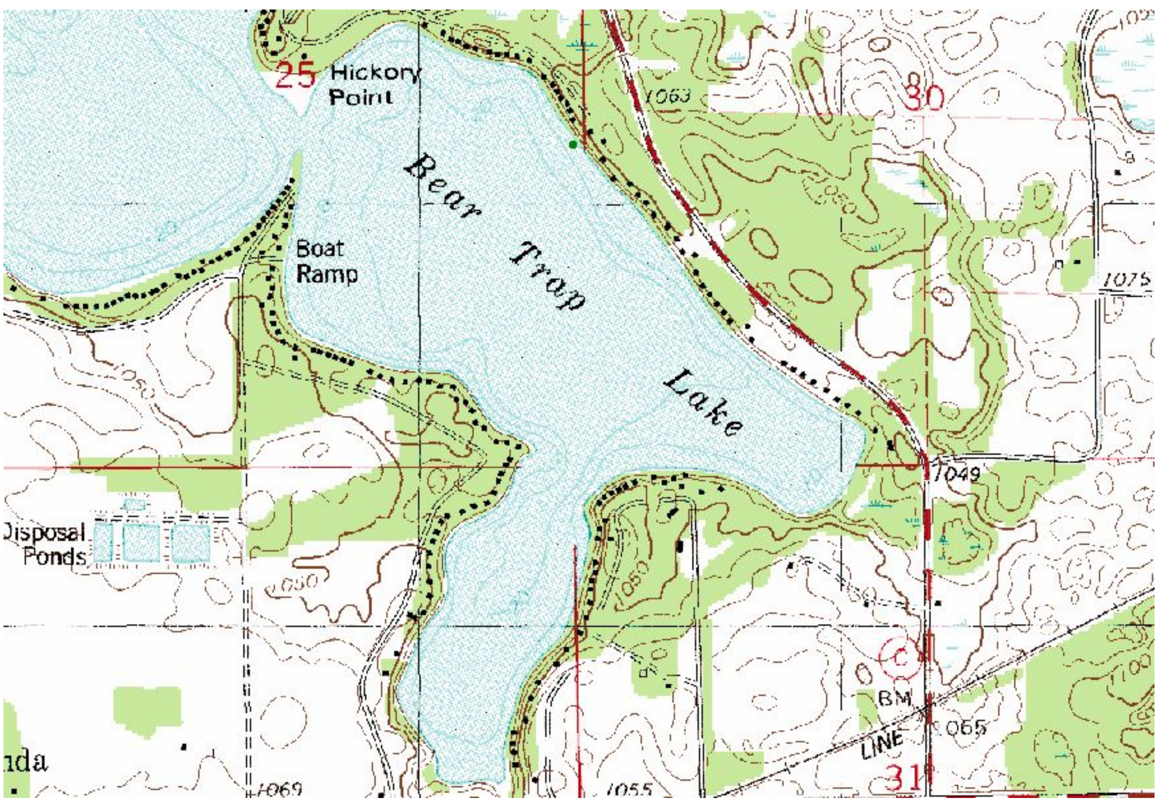
Lemna minor-Small duckweed



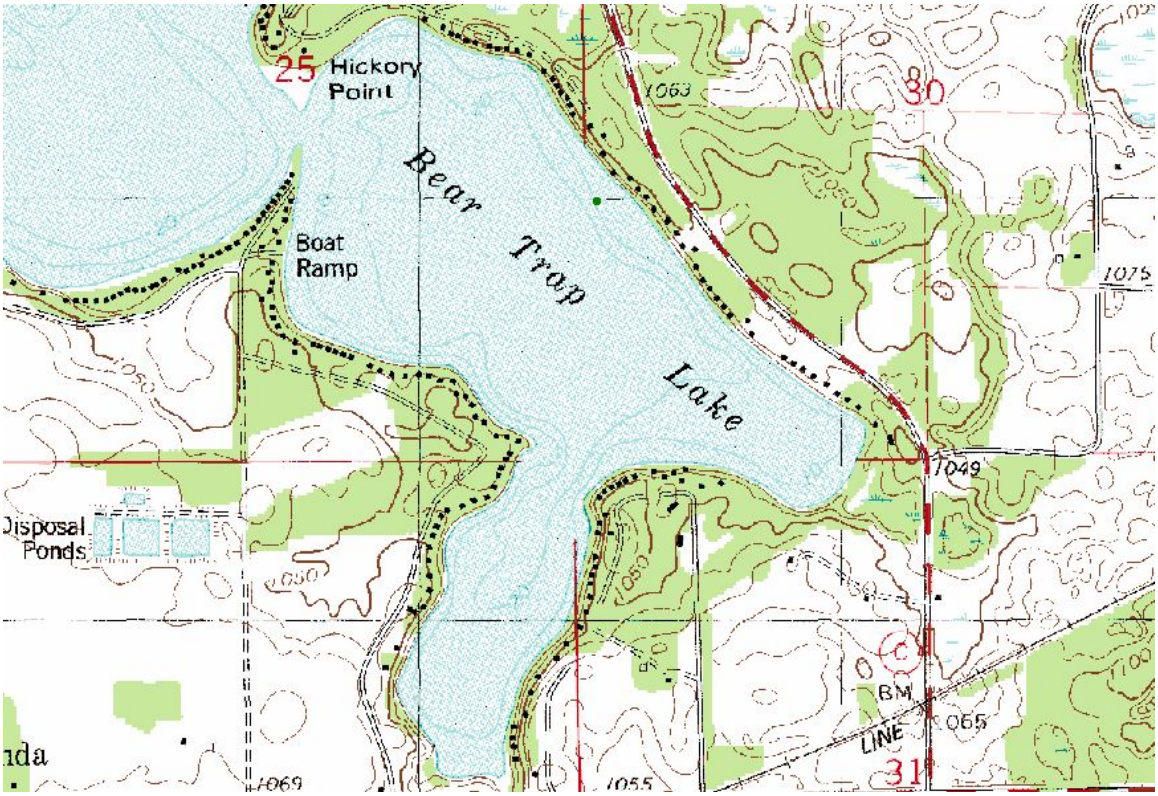
Nymphaea odorata-White water lily



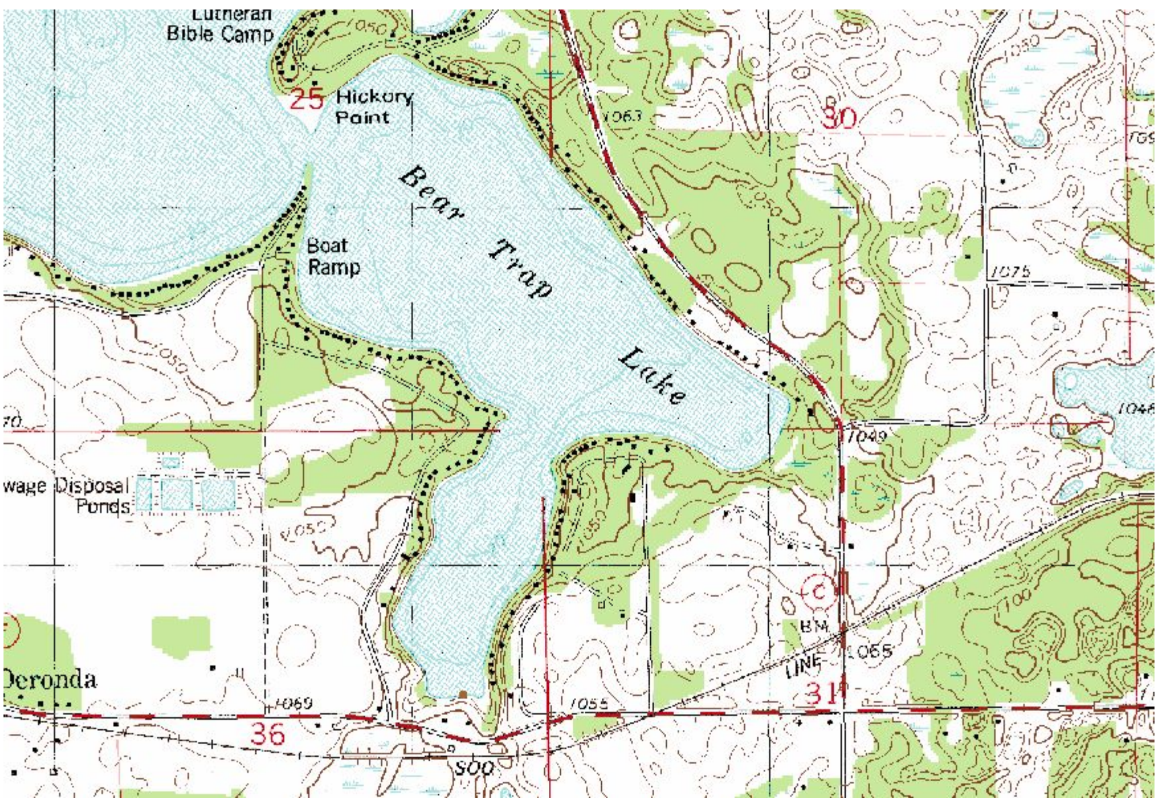
Myriophyllum tenellum-Dwarf watermilfoil



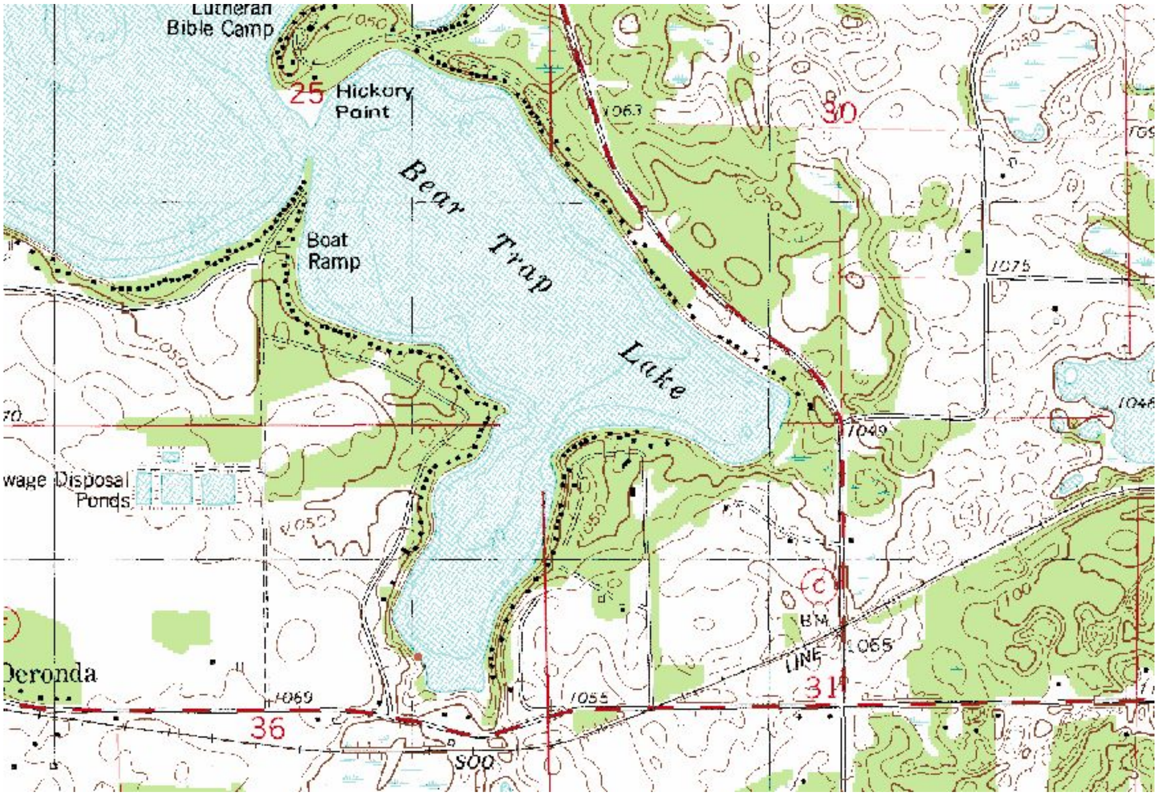
Potamogeton amplifolius-Large-leaf pondweed



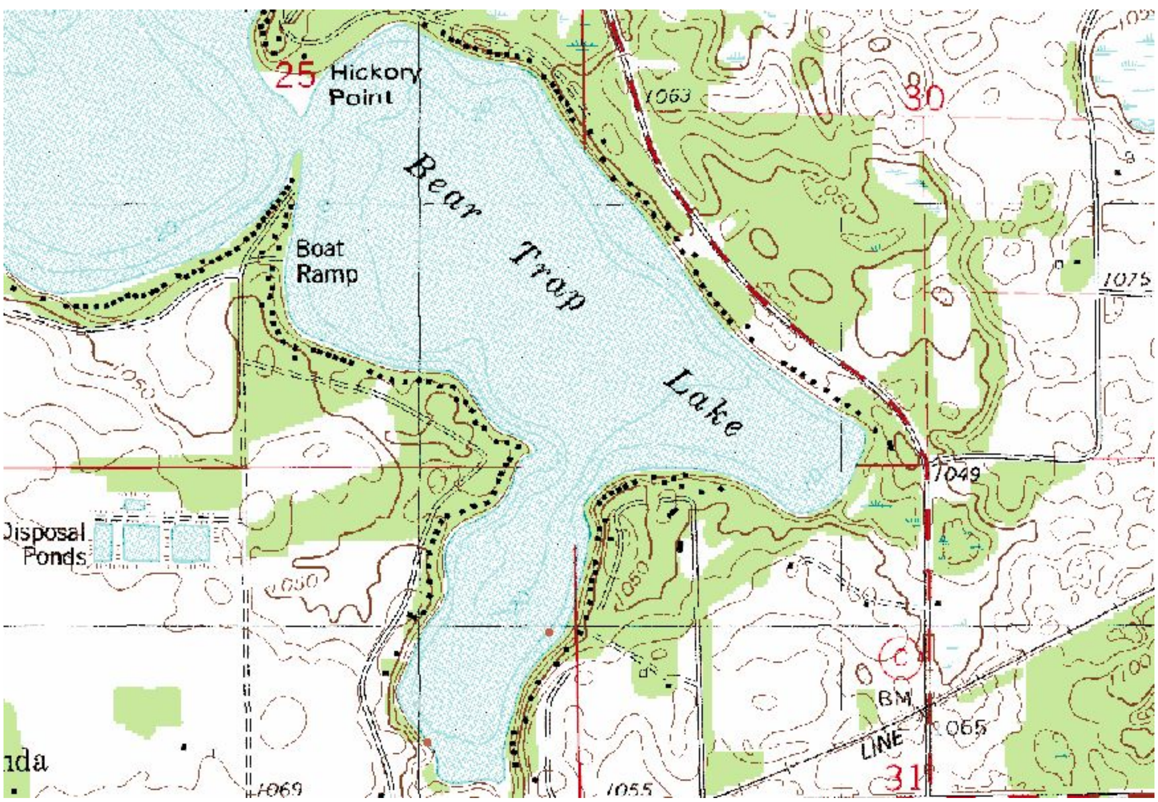
Potamogeton praelongus-White-stem pondweed



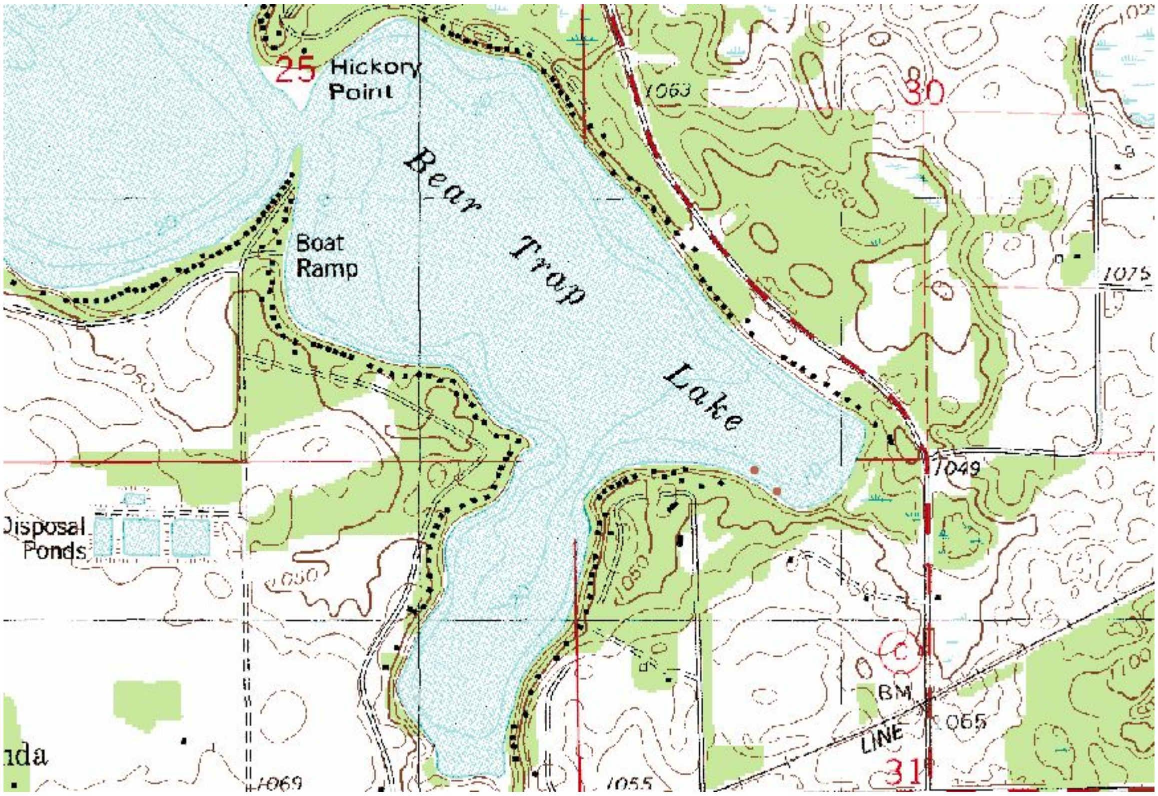
Iris versicolor-Blue flag iris



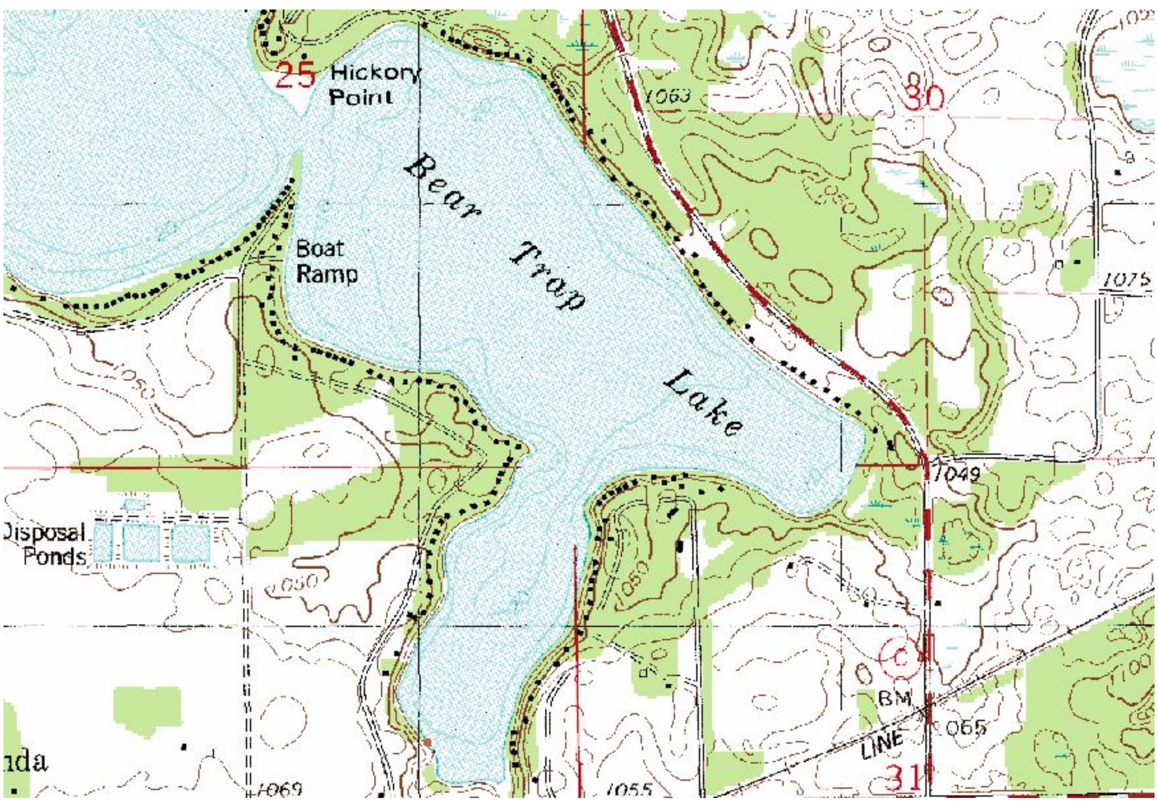
Nuphar variegata-Spatterdock



Sagittaria graminea-Grass leaved arrowhead

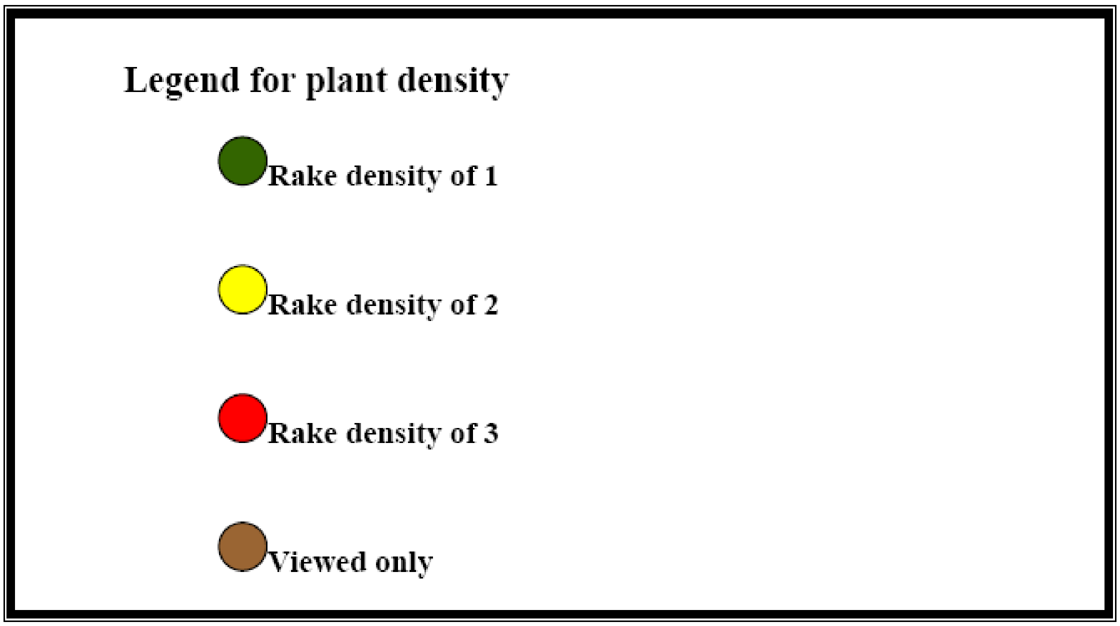


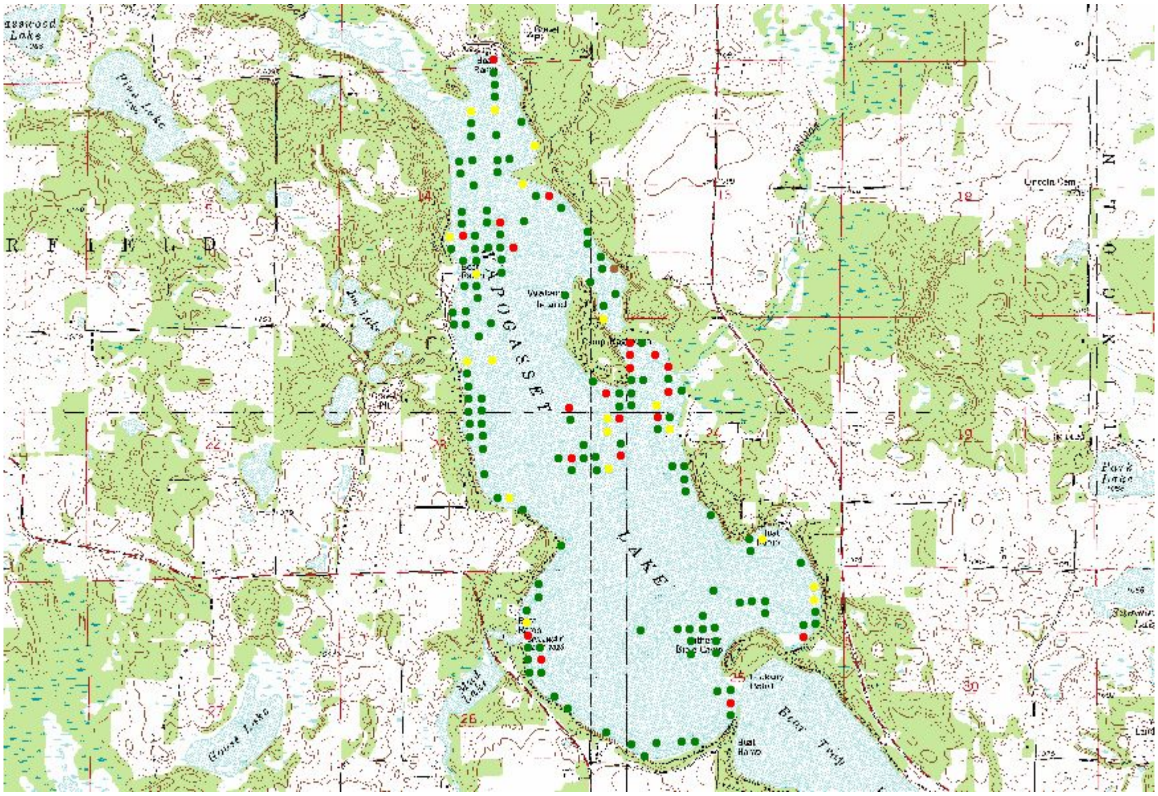
Sagittaria rigida-Stiff arrowhead



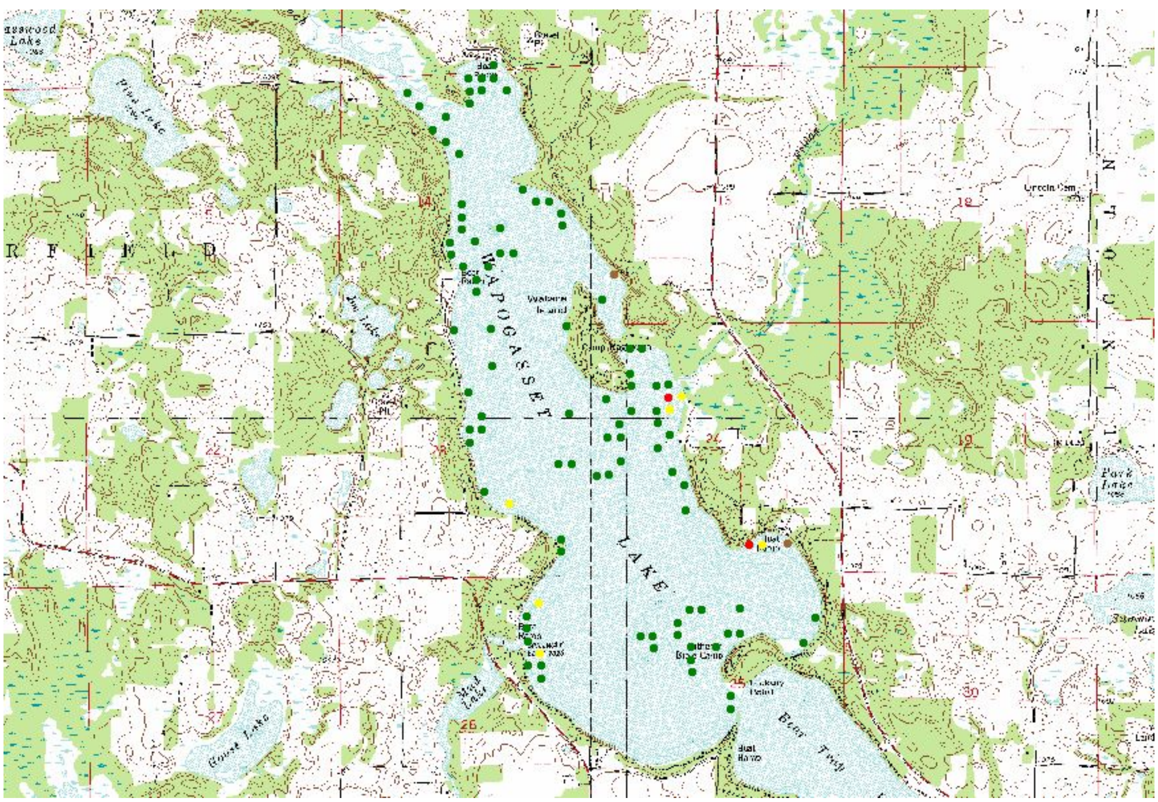
Sporangium eurycarpum-Common burreed

Appendix B-Maps of all plants-Lake Wapogasset

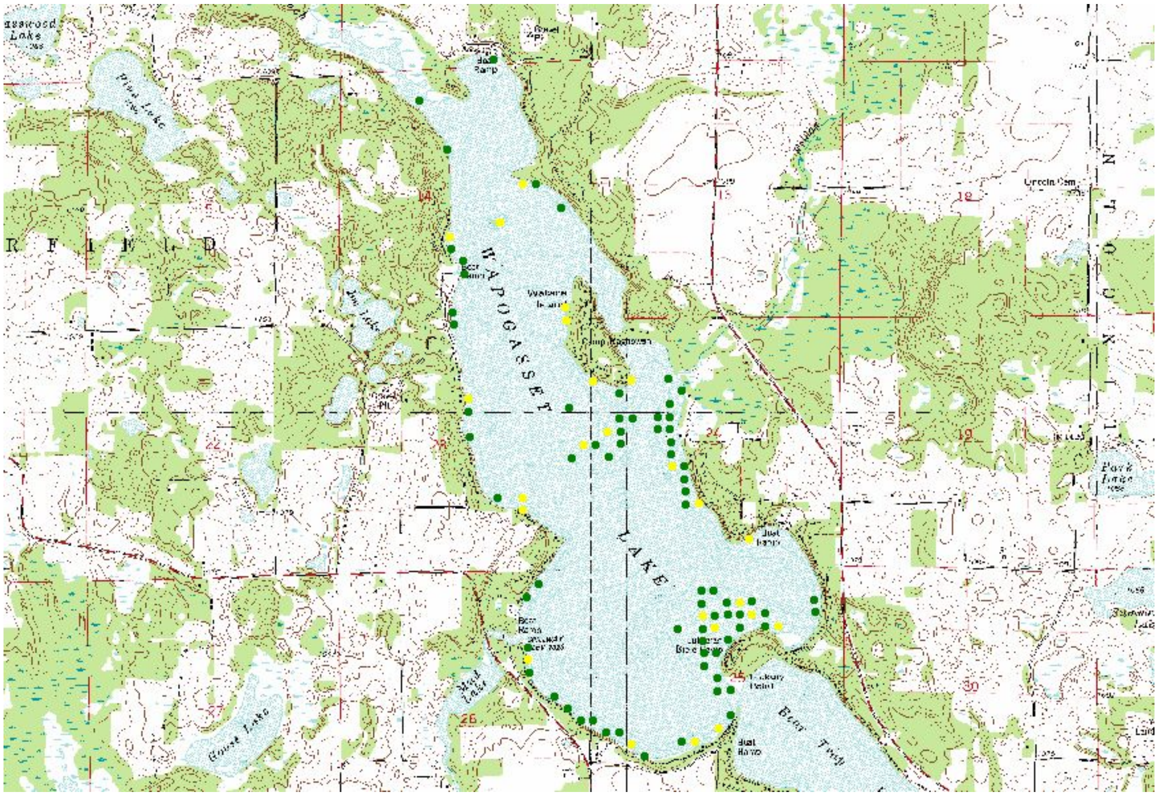




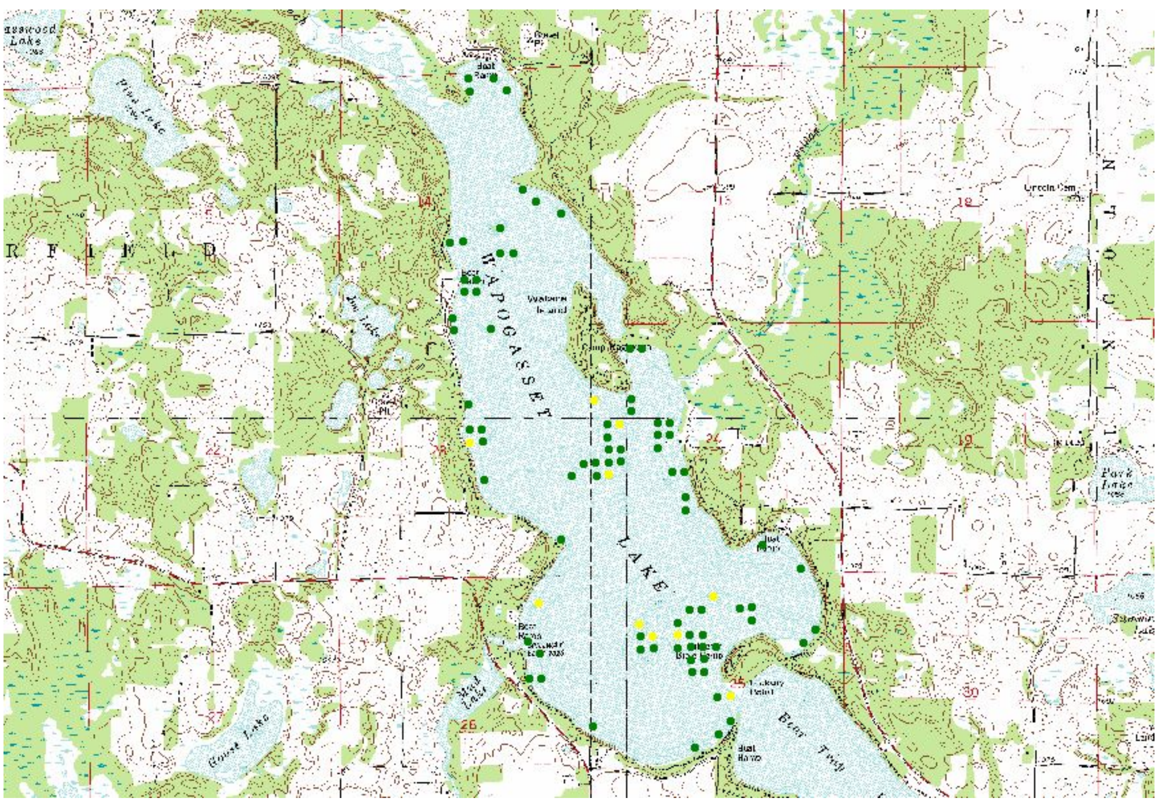
Ceratophyllum demersum-Coontail



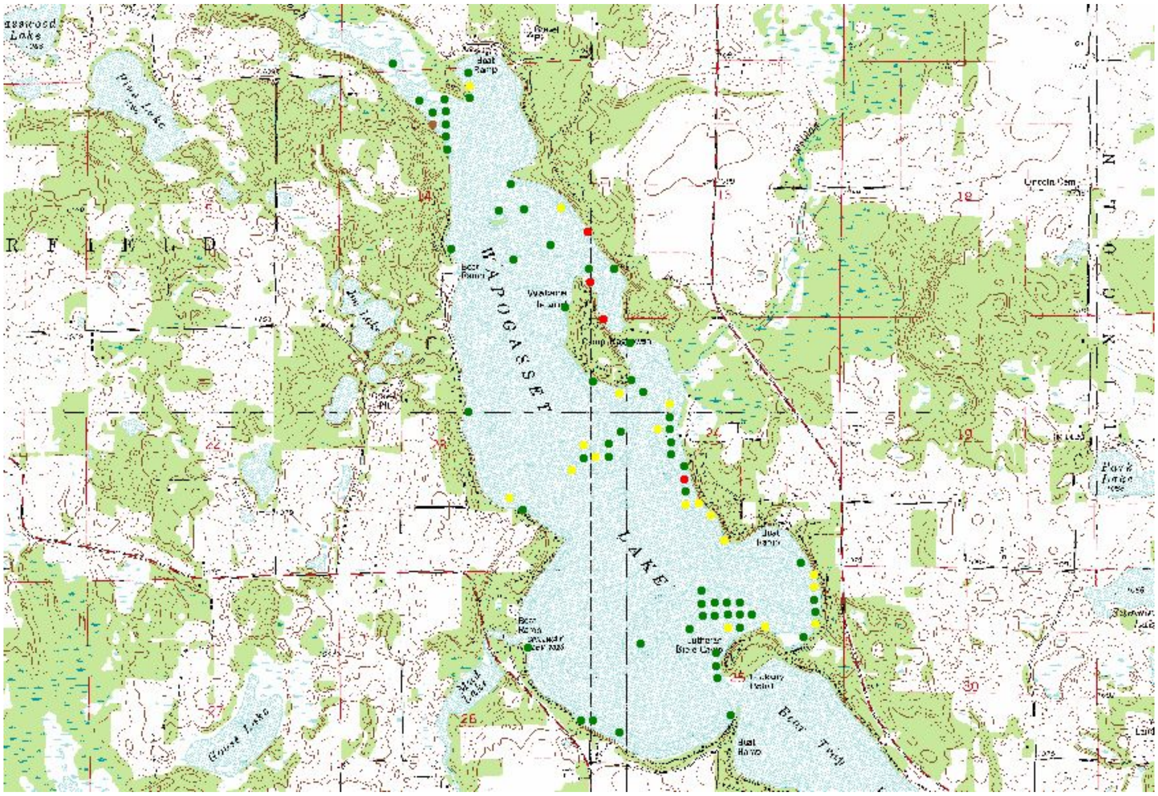
Potamogeton zosteriformis-Flatstem pondweed



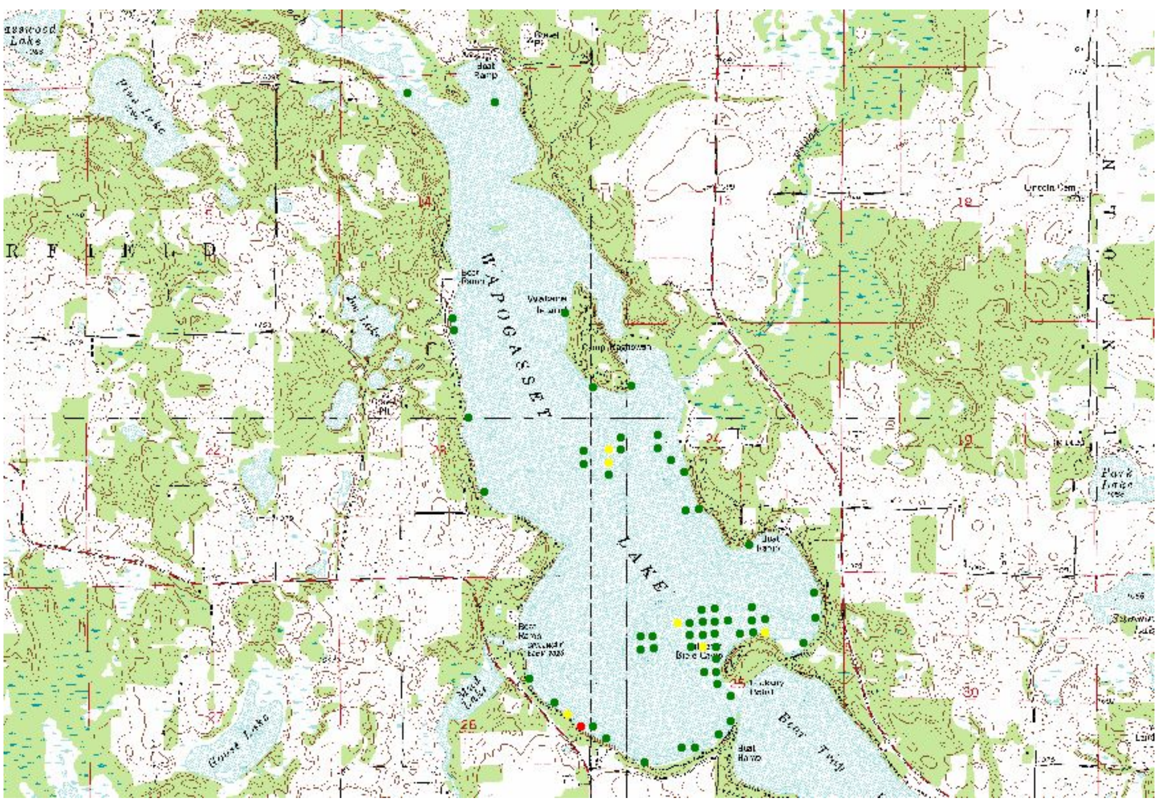
Vallisneria Americana-Wild celery



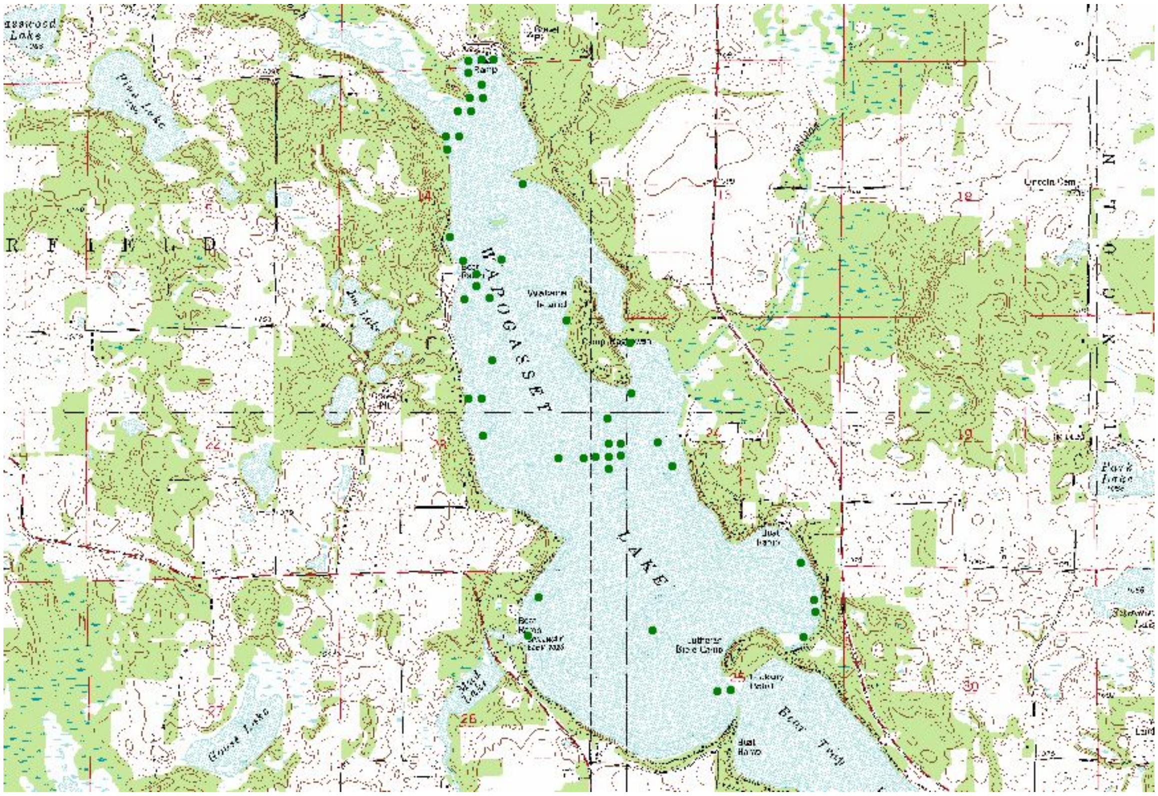
Potamogeton pusillus-Small pondweed



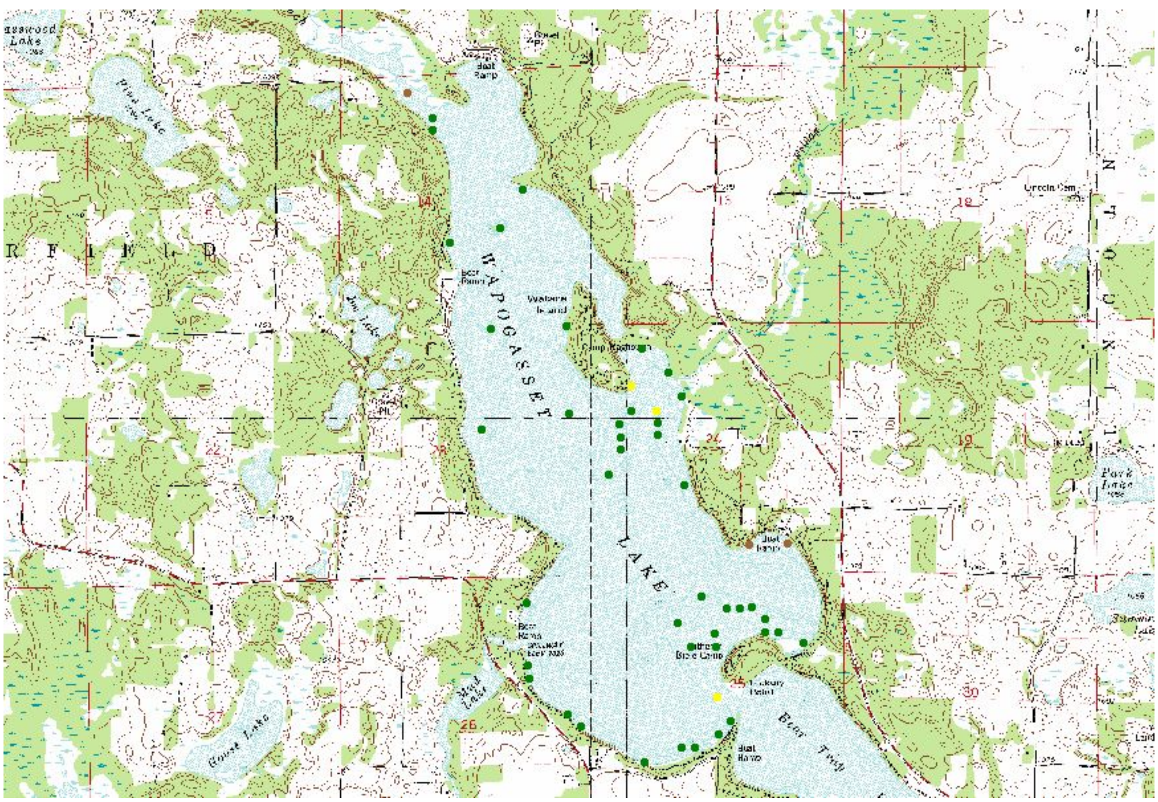
Filamentous algae



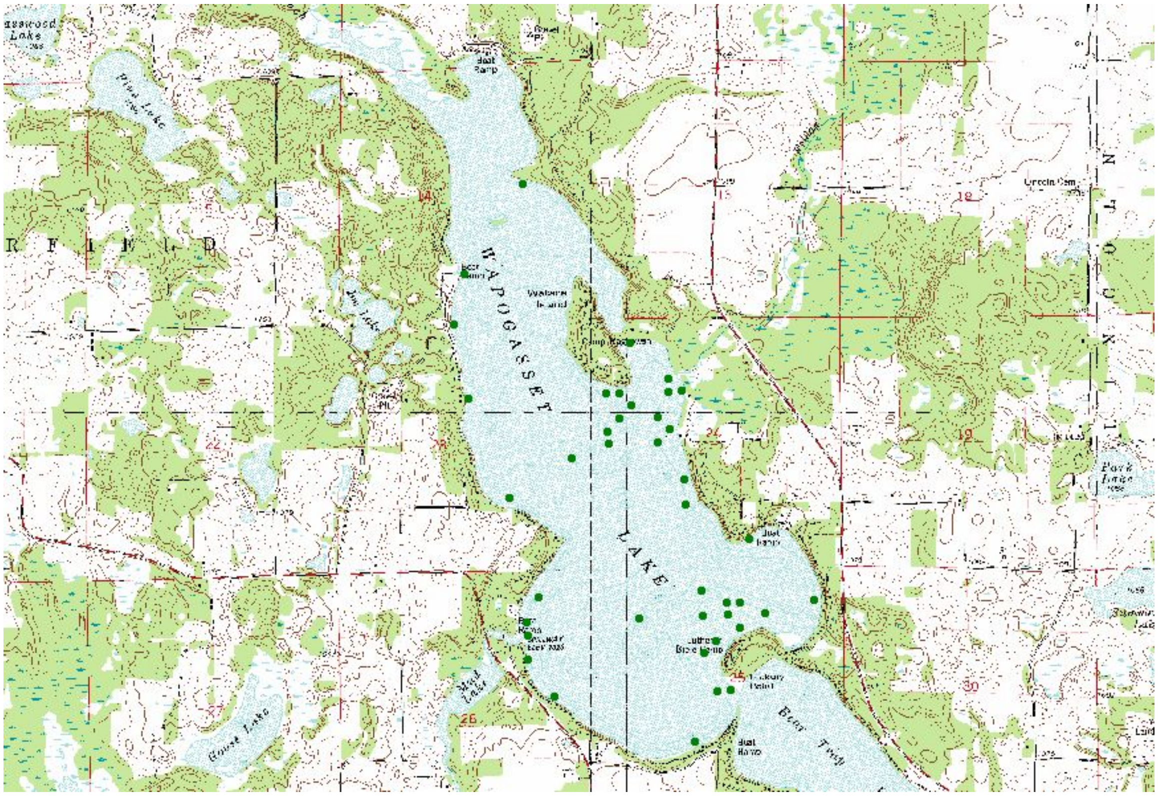
Najas flexilis-Bushy pondweed



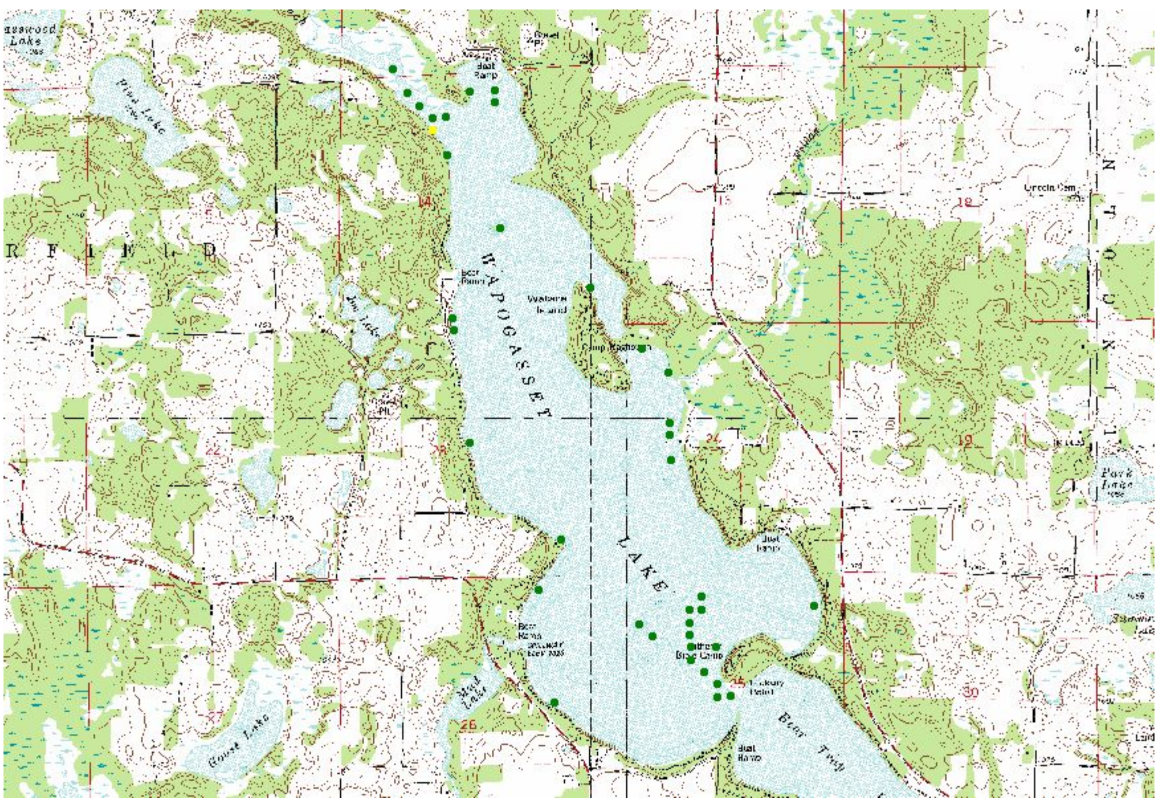
Potamogeton crispus-Curly leaf pondweed



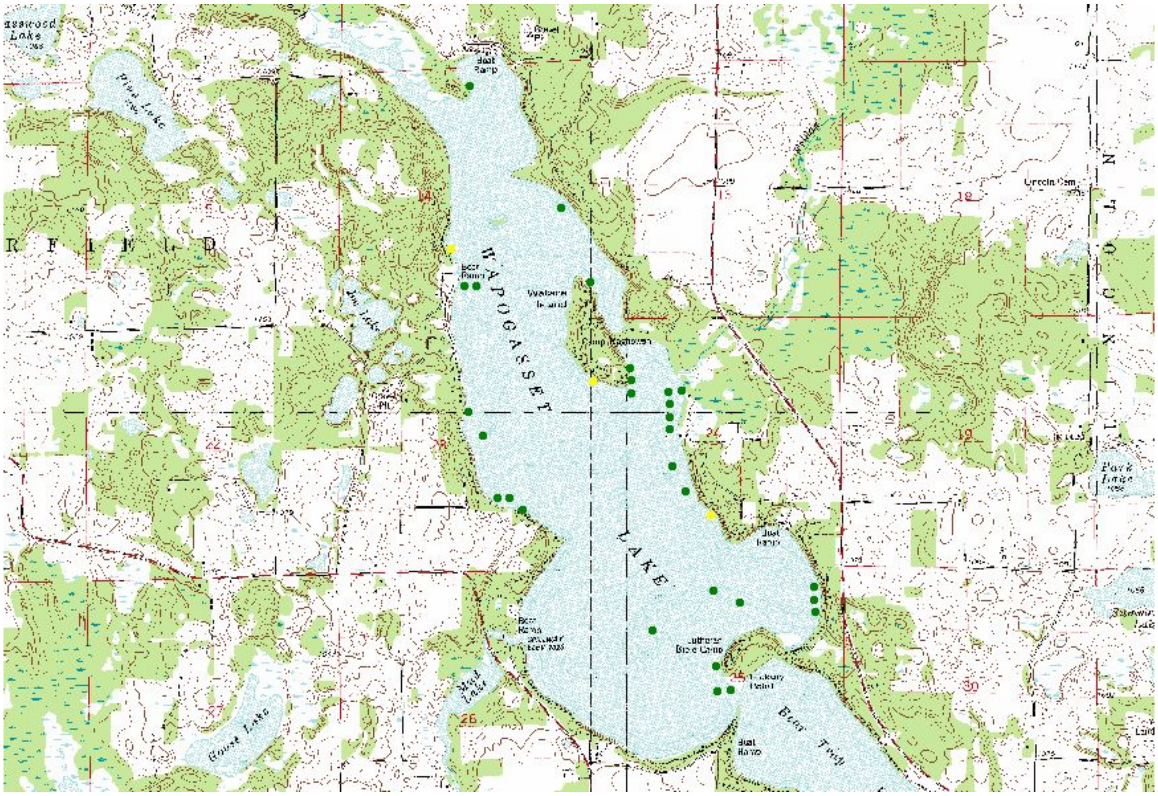
Potamogeton richardsonii-Clasping pondweed



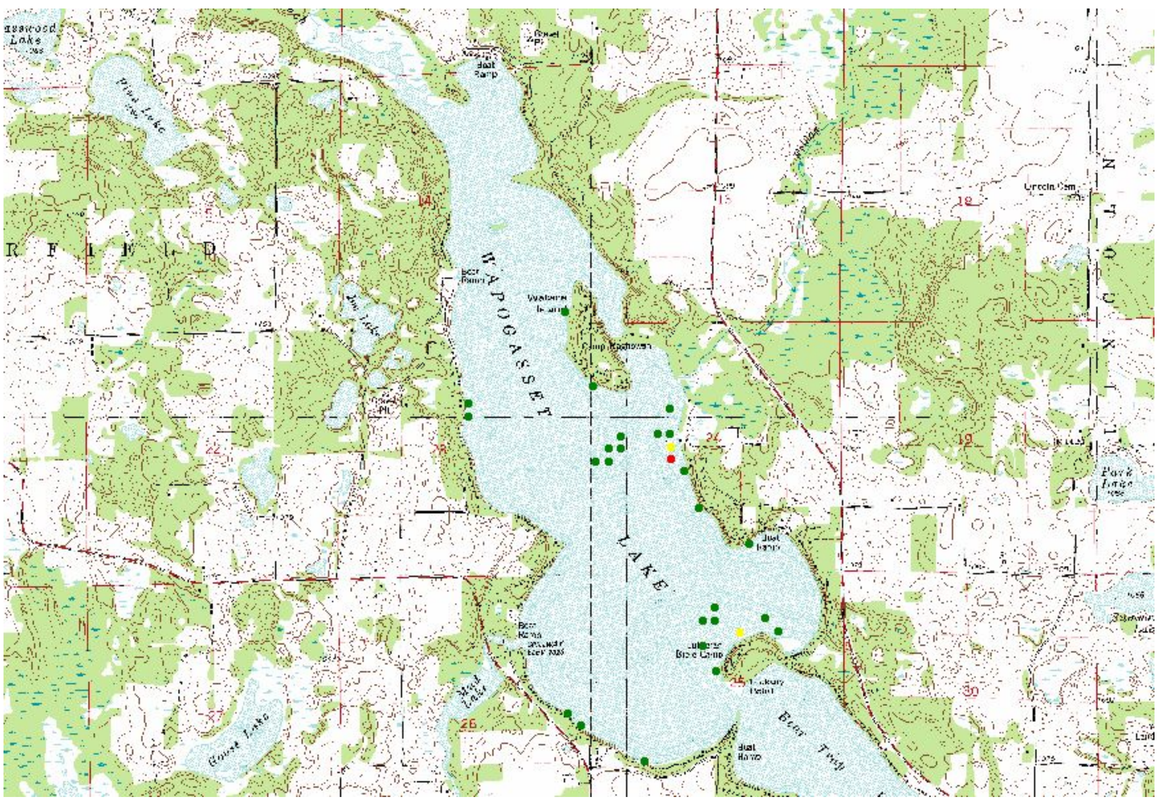
Potamogeton friesii-Fries' pondweed



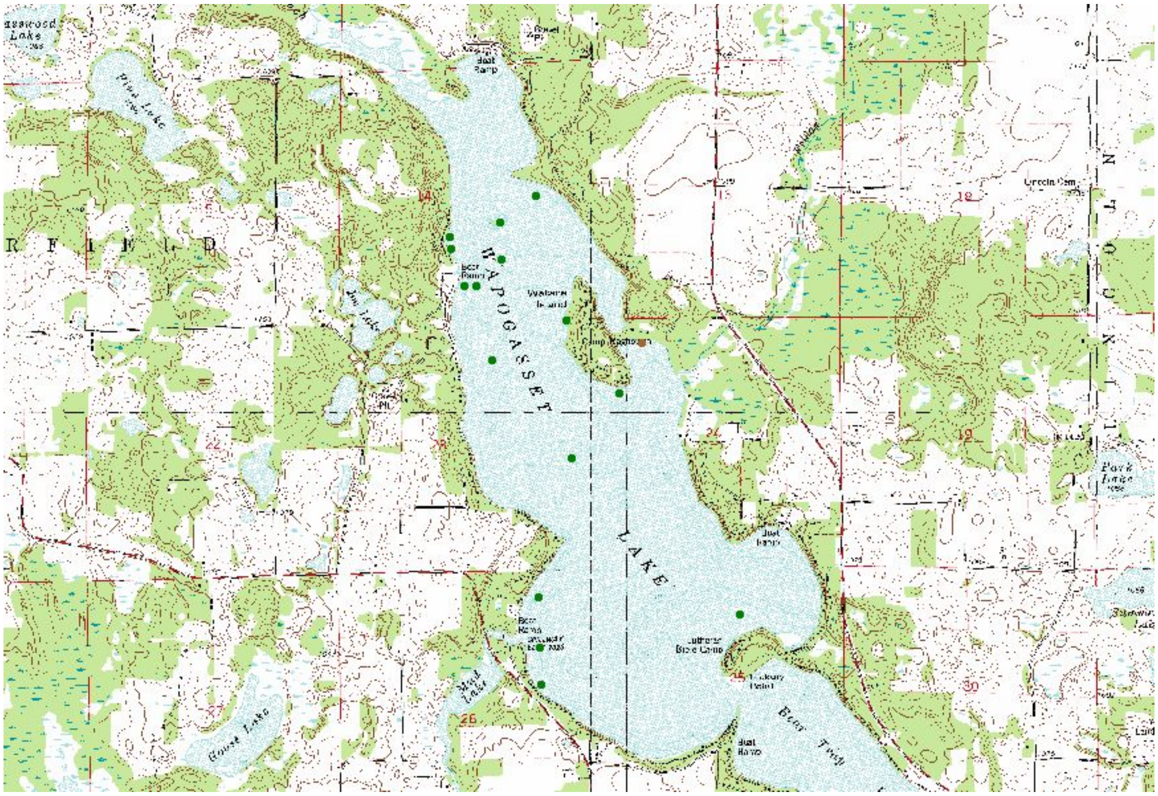
Elodea Canadensis-Common waterweed



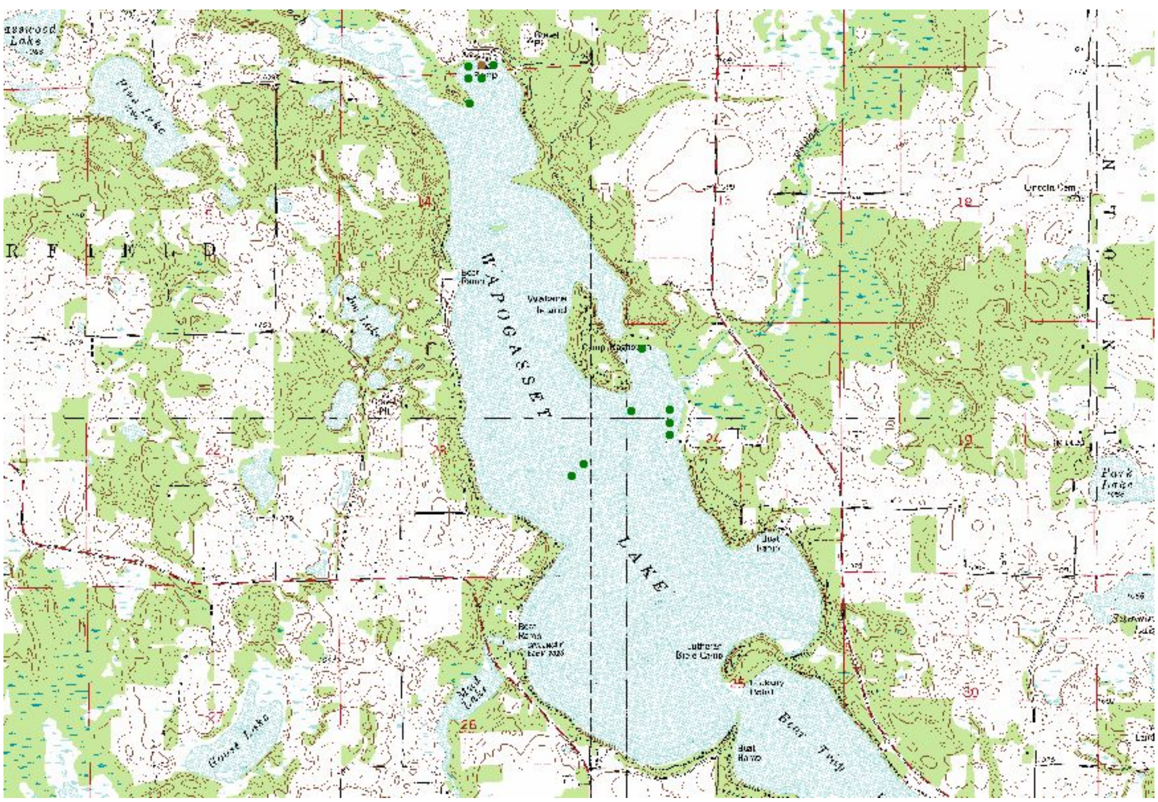
Ranunculus aquatilis-Stiff water crowfoot



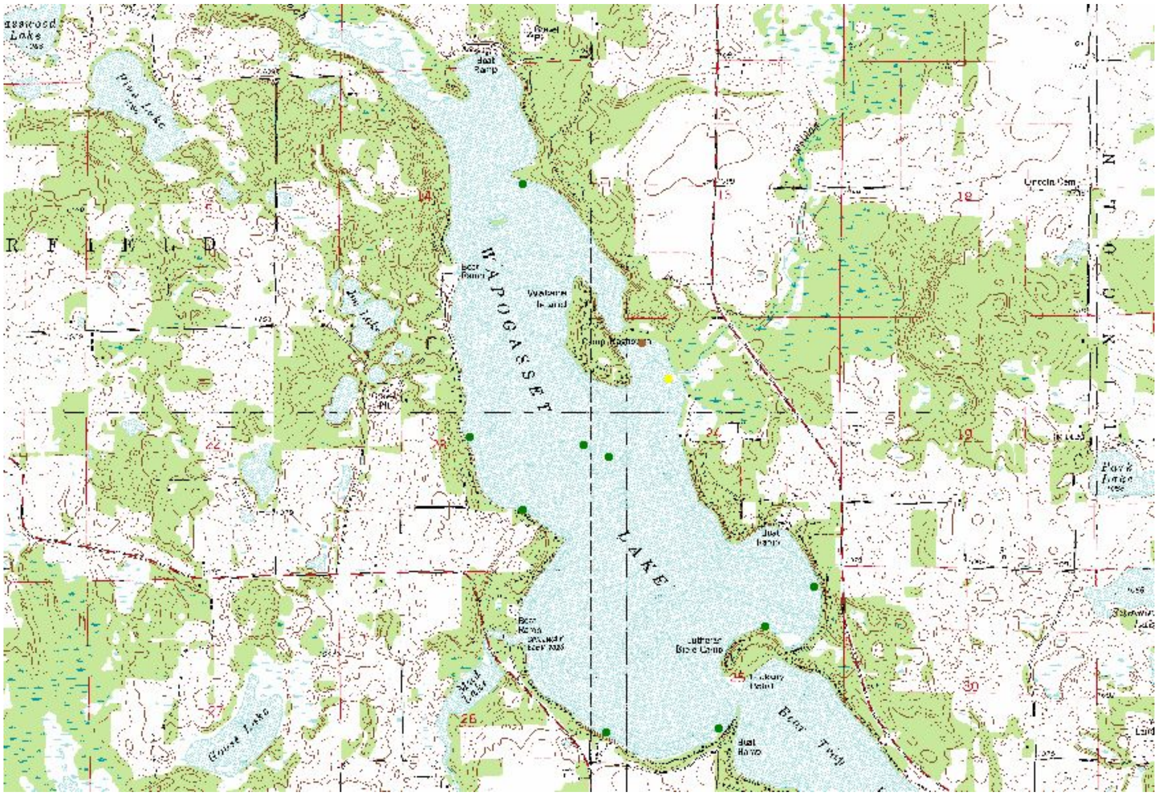
Chara sp.-Muskgrass



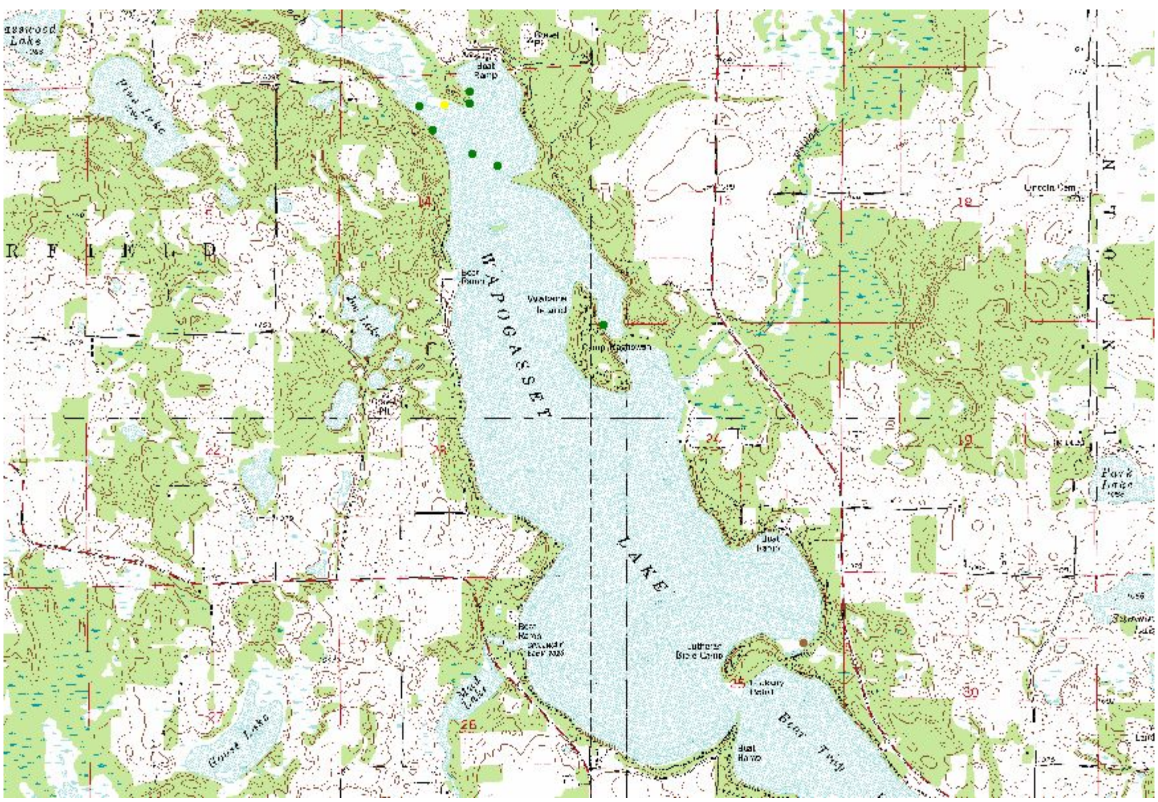
Myriophyllum sibiricum-Northern watermilfoil



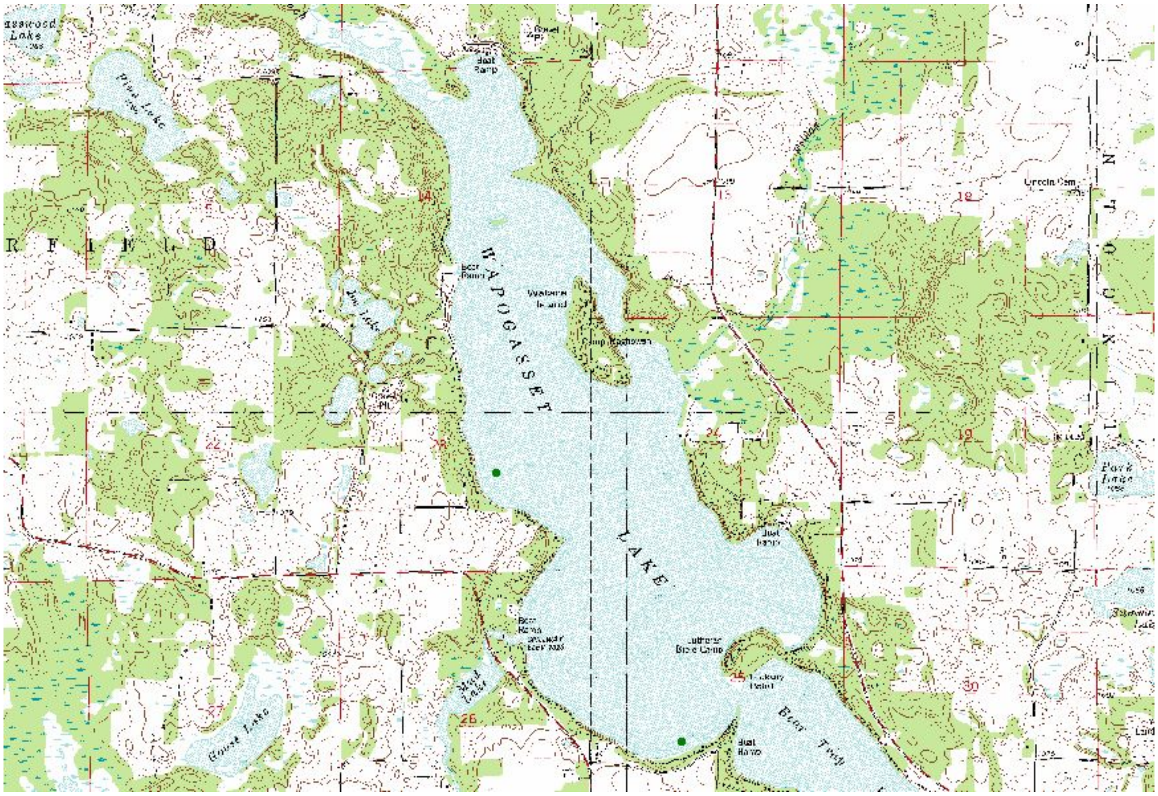
Lemna triscula-Forked duckweed



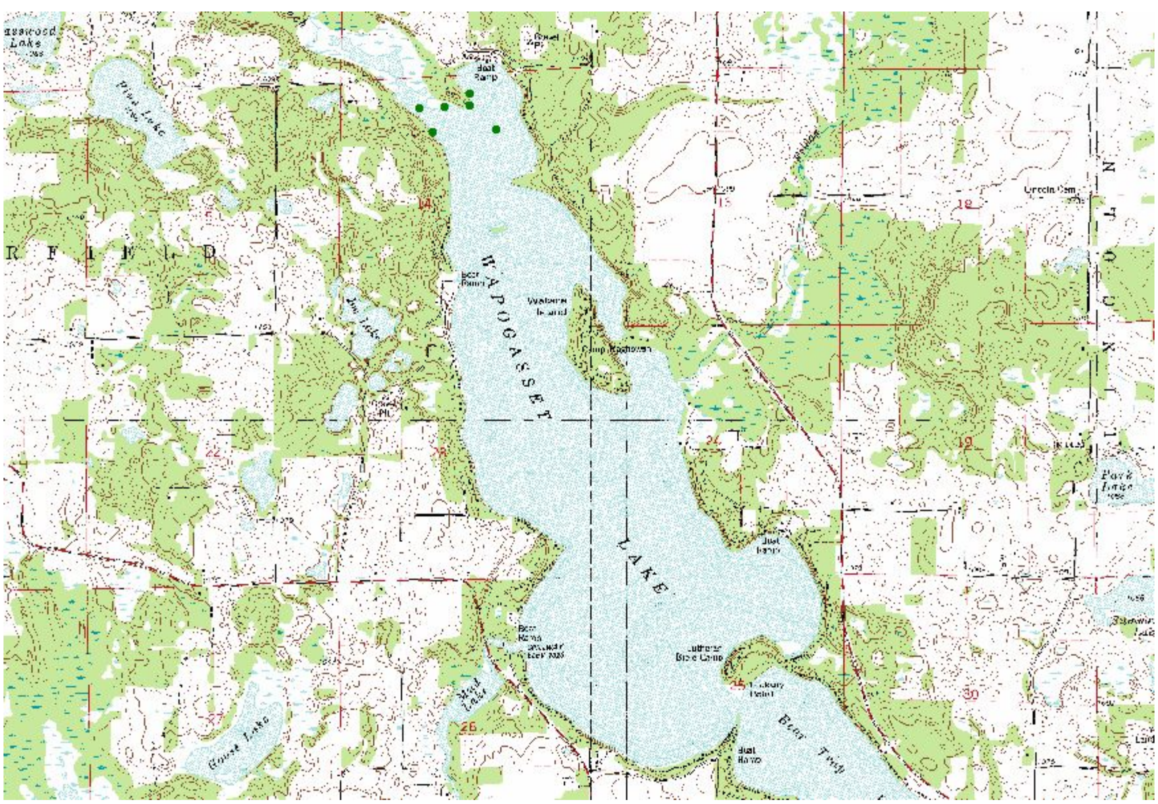
Stuckenia pectinatus-Sago pondweed



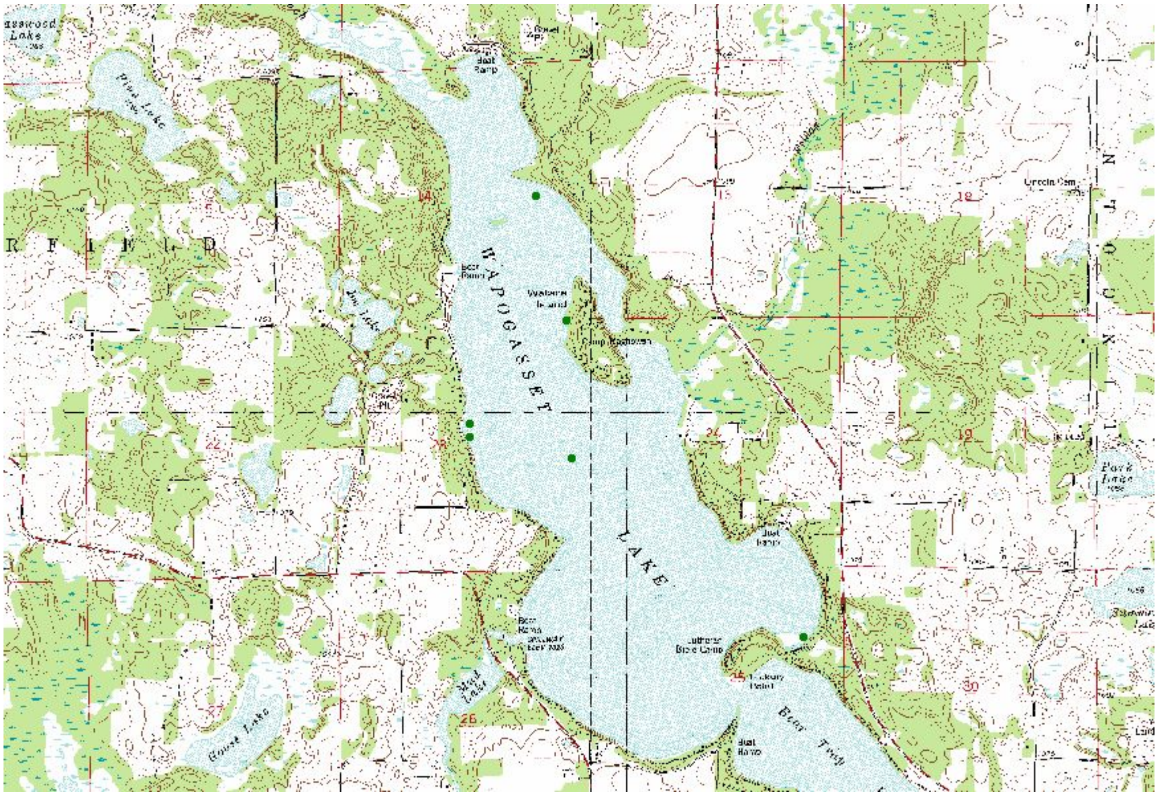
Lemna minor-Small duckweed



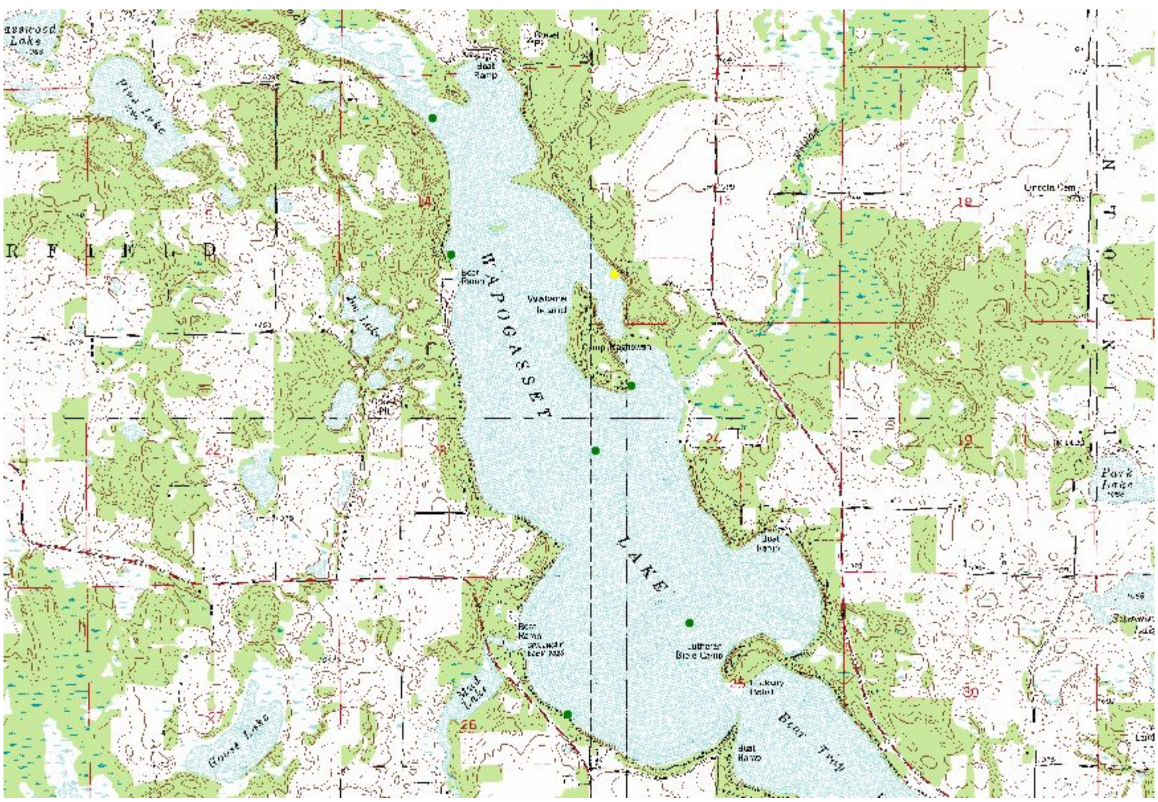
Hydrodictyon reticulatum-Water net



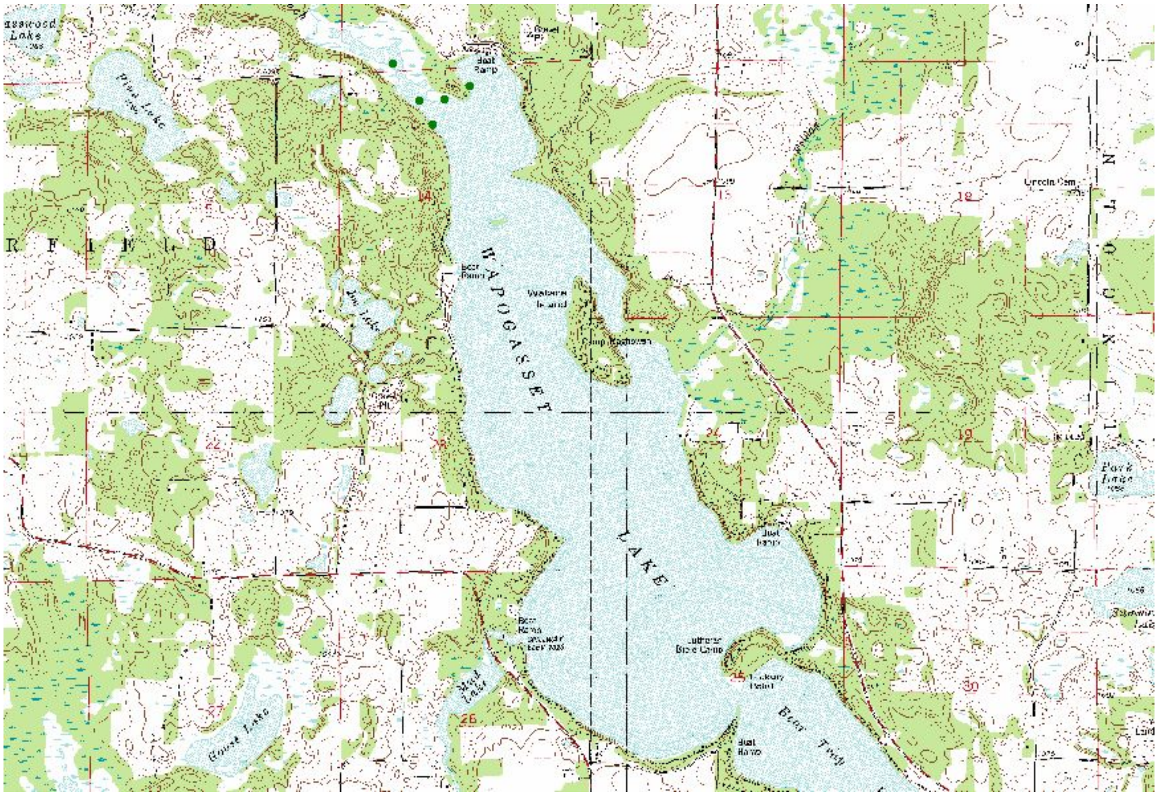
Spirodela polyrhiza-Large duckweed



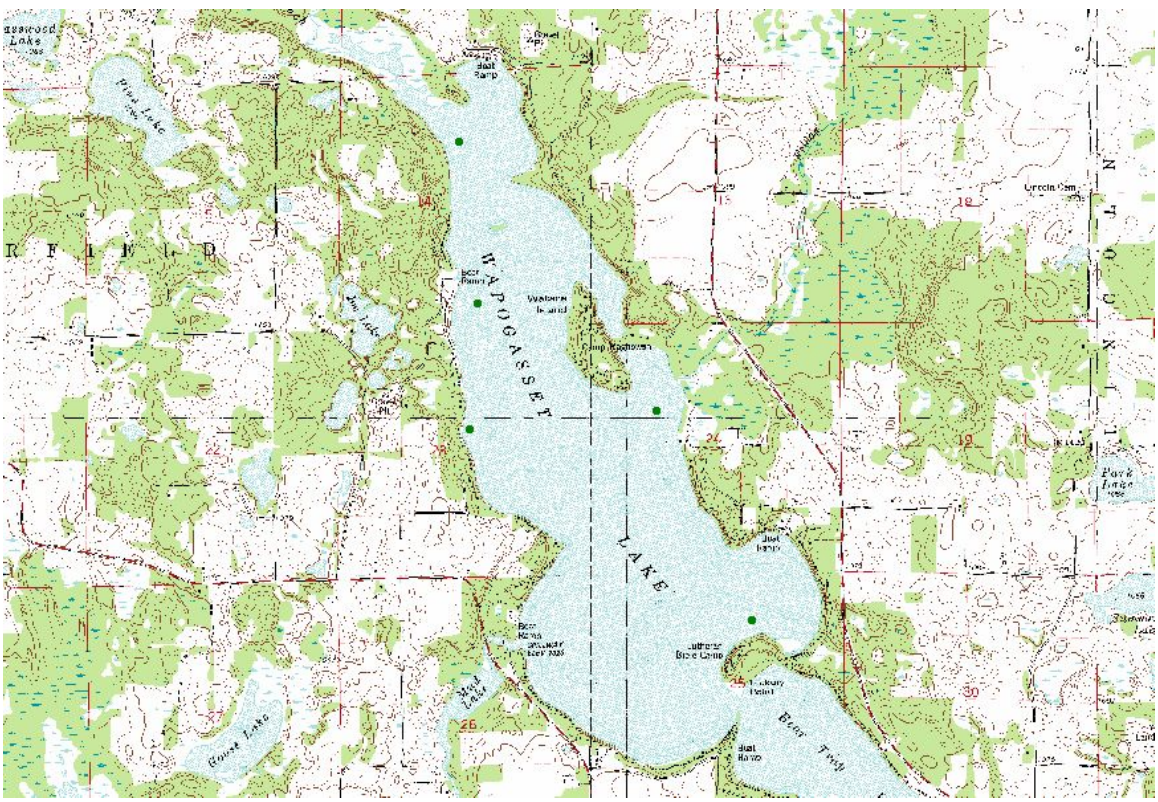
Potamogeton foliosus-Leafy pondweed



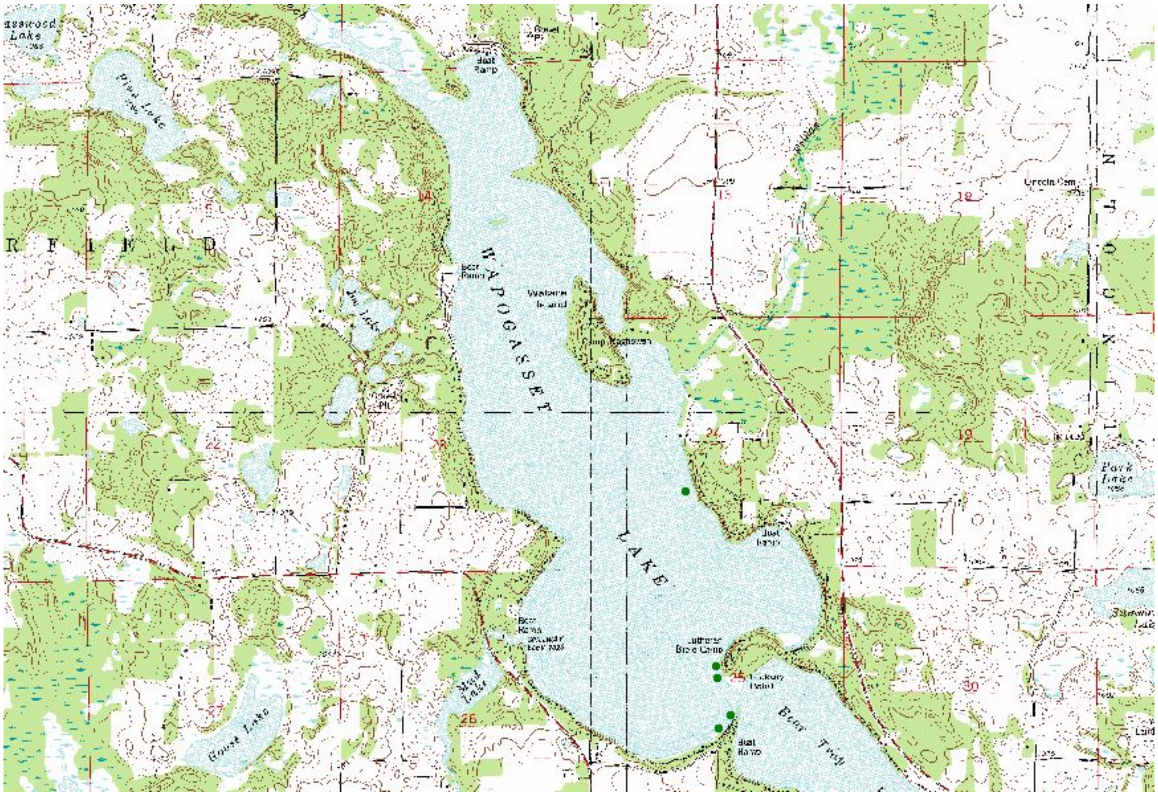
Heteranthera dubia-Water stargrass



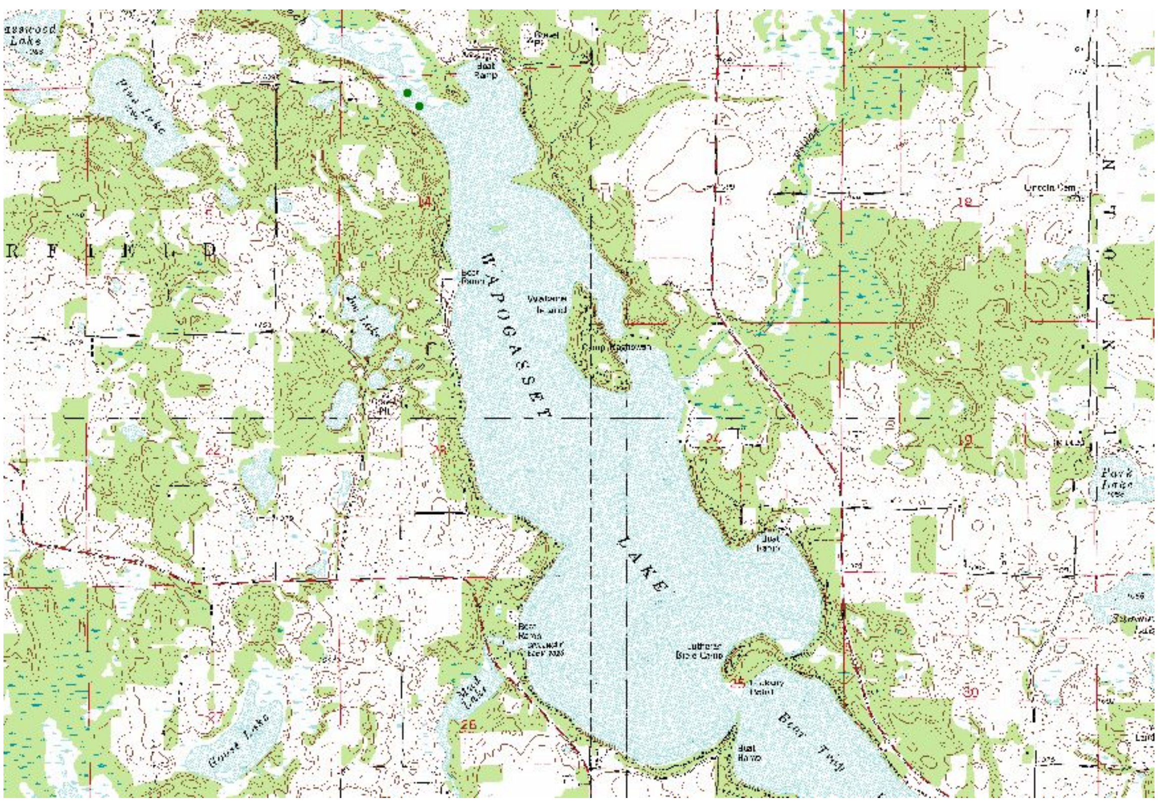
Wolfia columbiana-Common watermeal



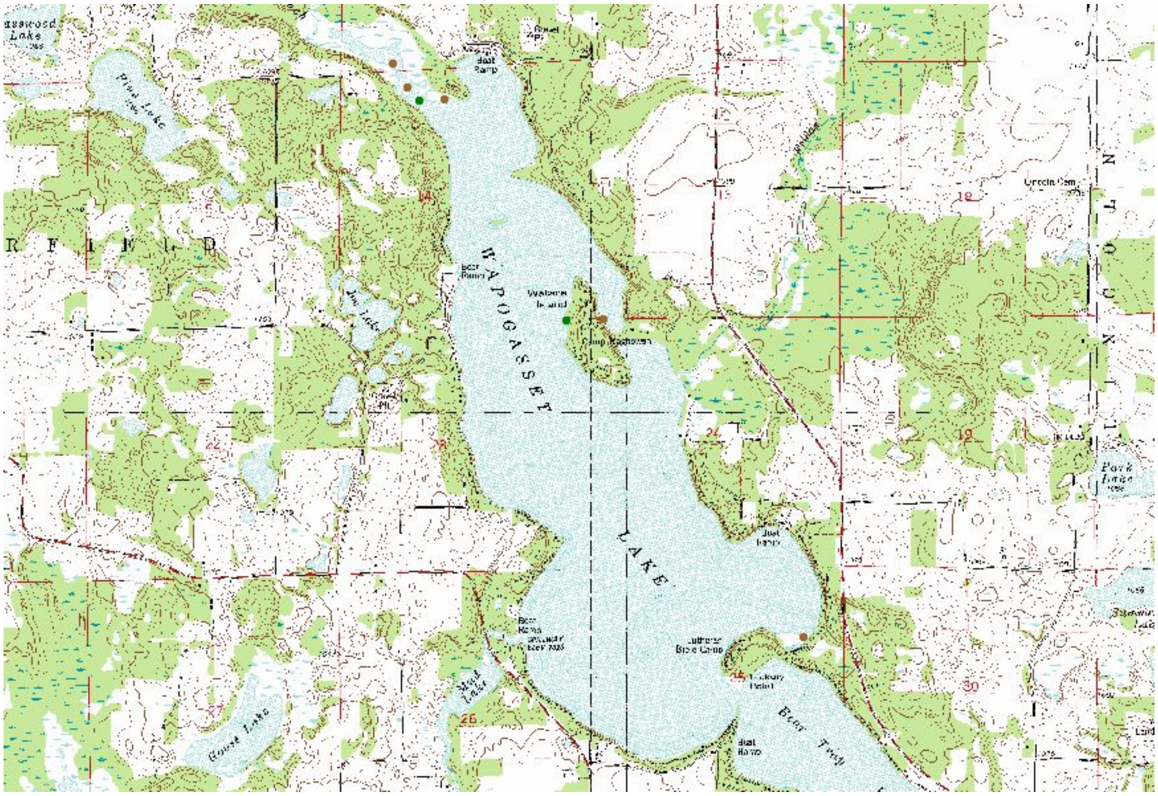
Potamogeton praelongus-White-stem pondweed



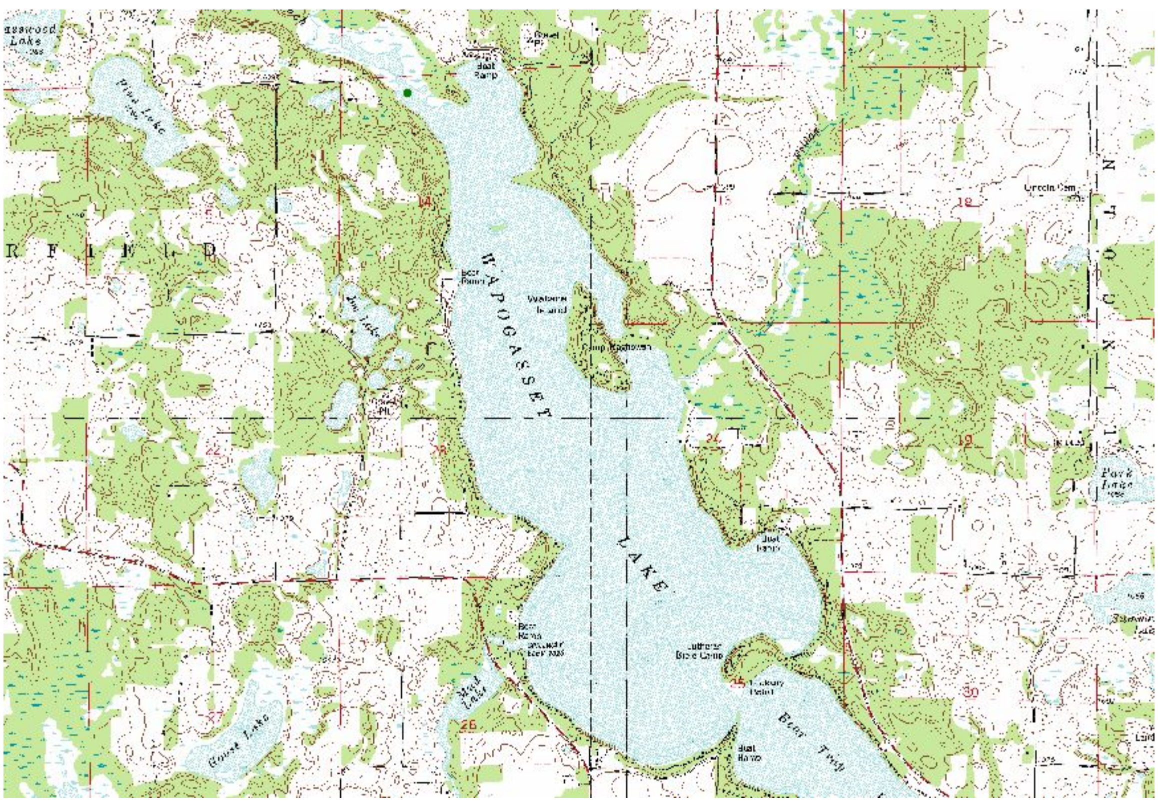
Potamogeton illinoensis-Illinois pondweed



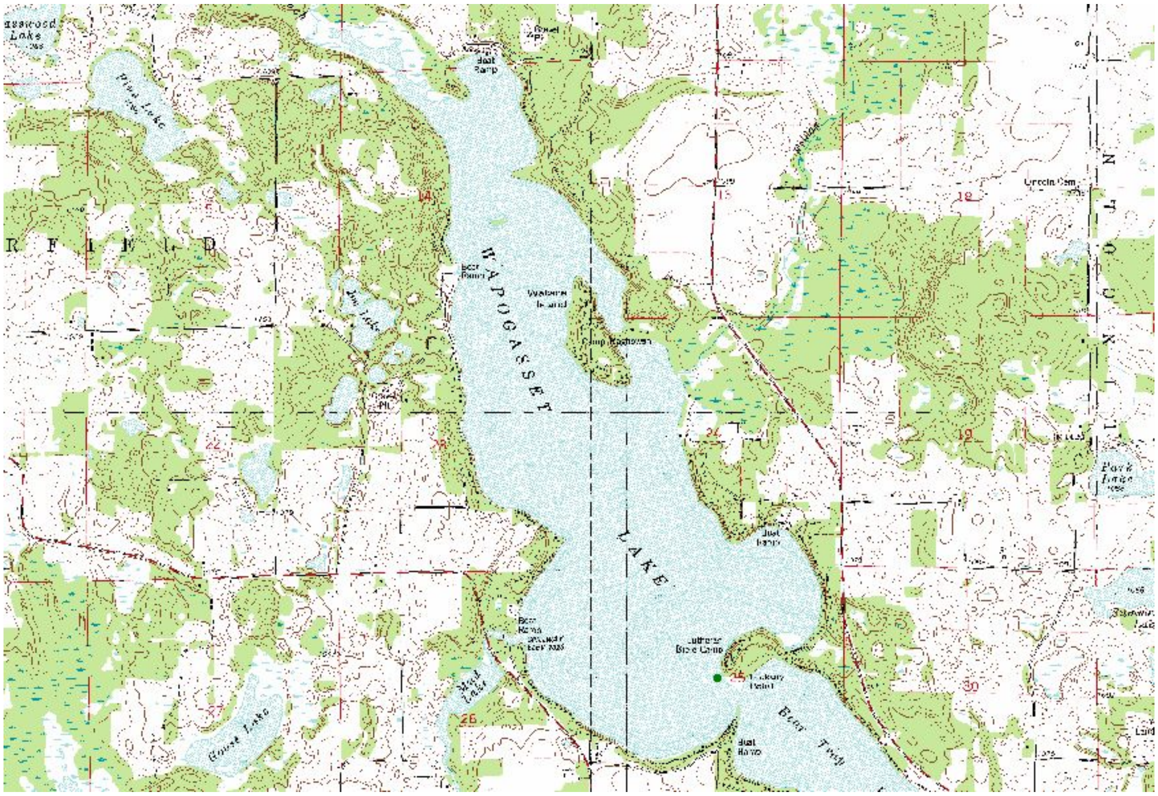
Potamogeton amplifolius-Large-leaf pondweed



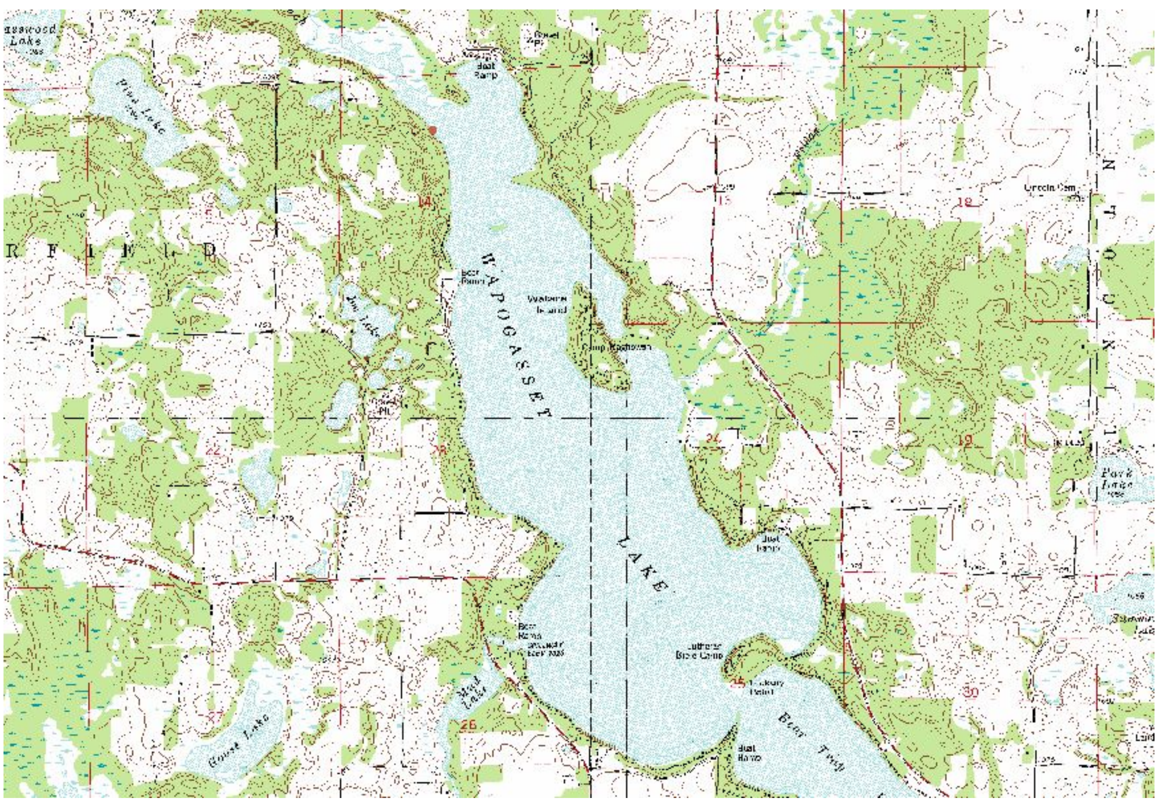
Nymphaea odorata-White lily



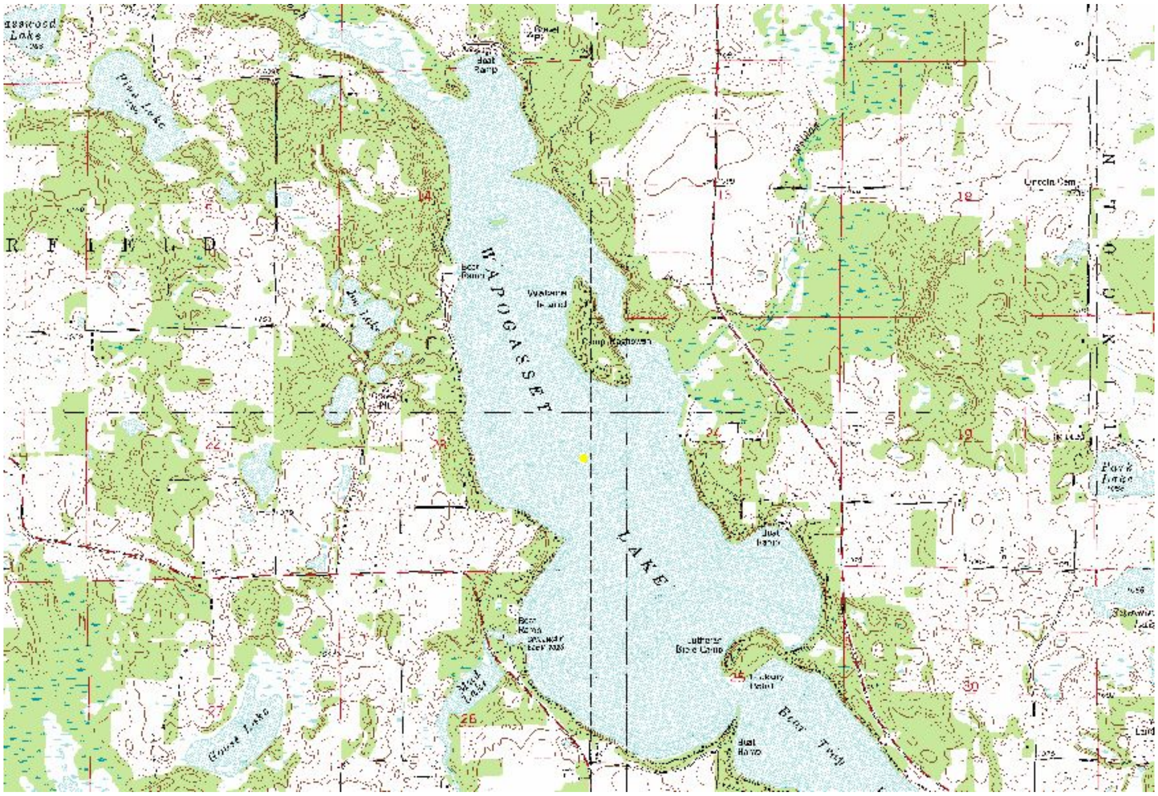
Sporangium eurycarpum-Common bur-reed



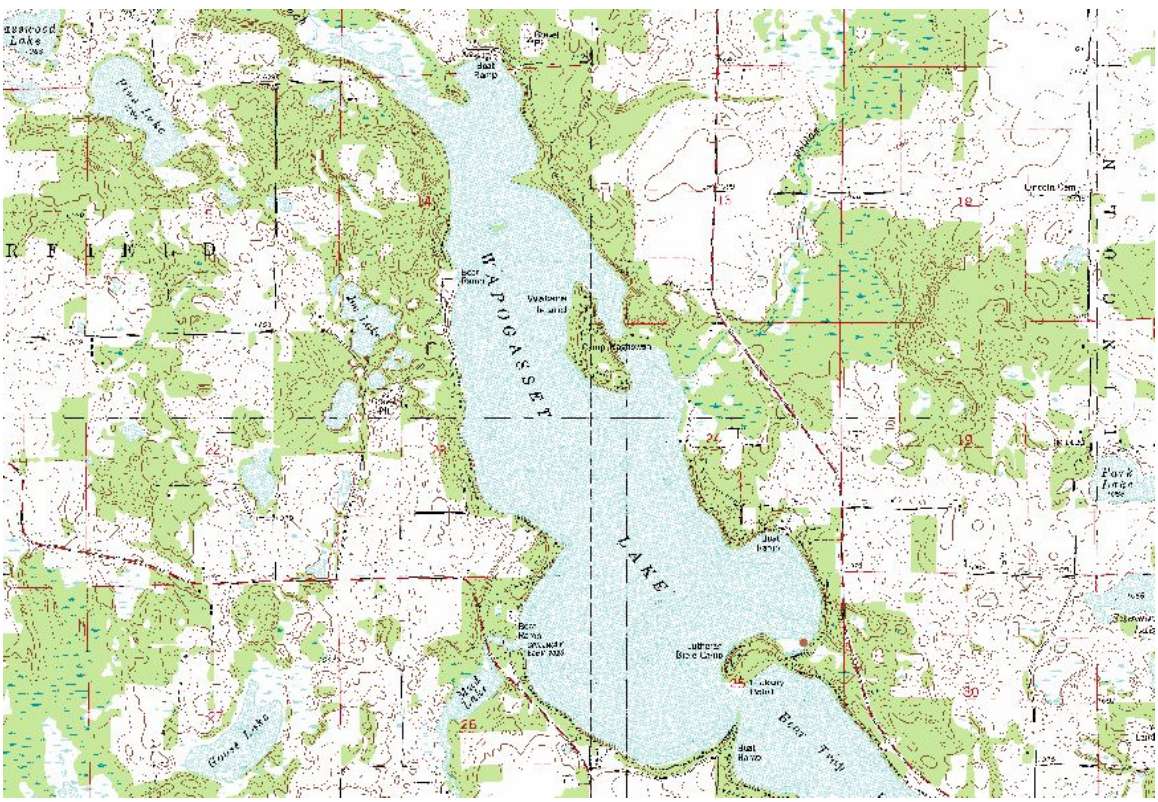
Potamogeton alpinus-Alpine pondweed



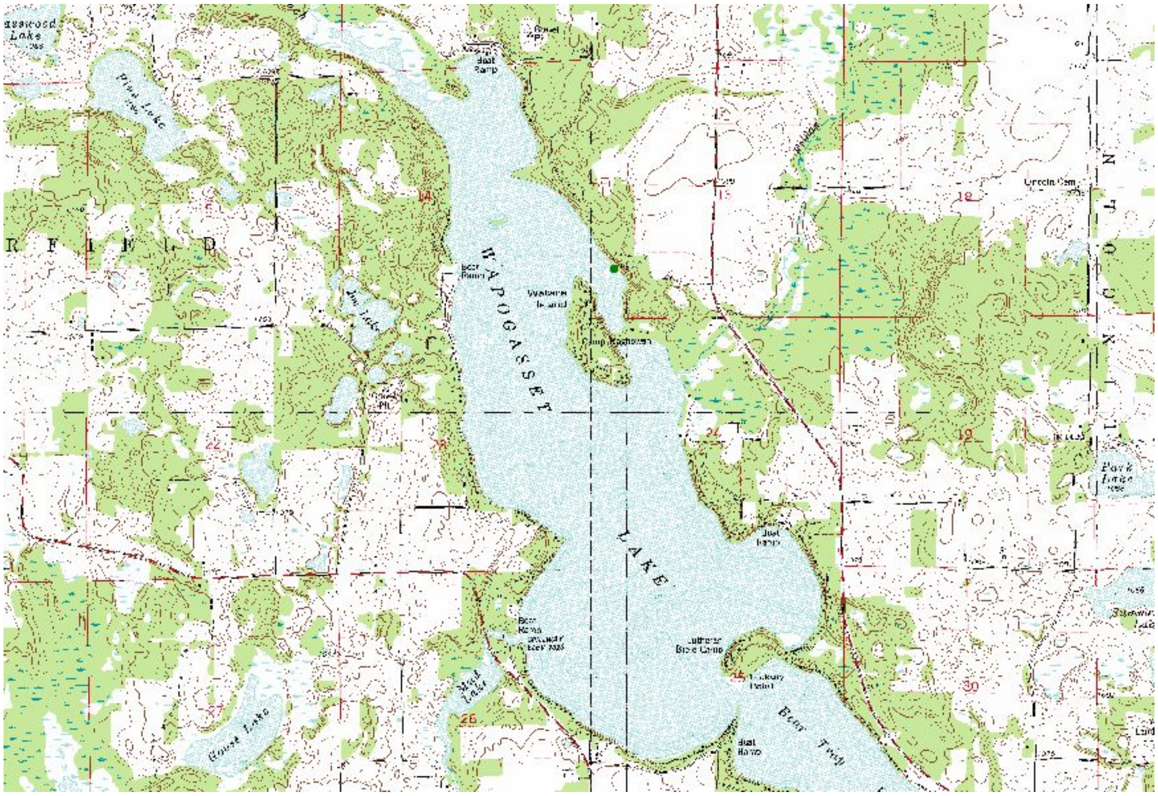
Nuphar variegata-Spatterdock



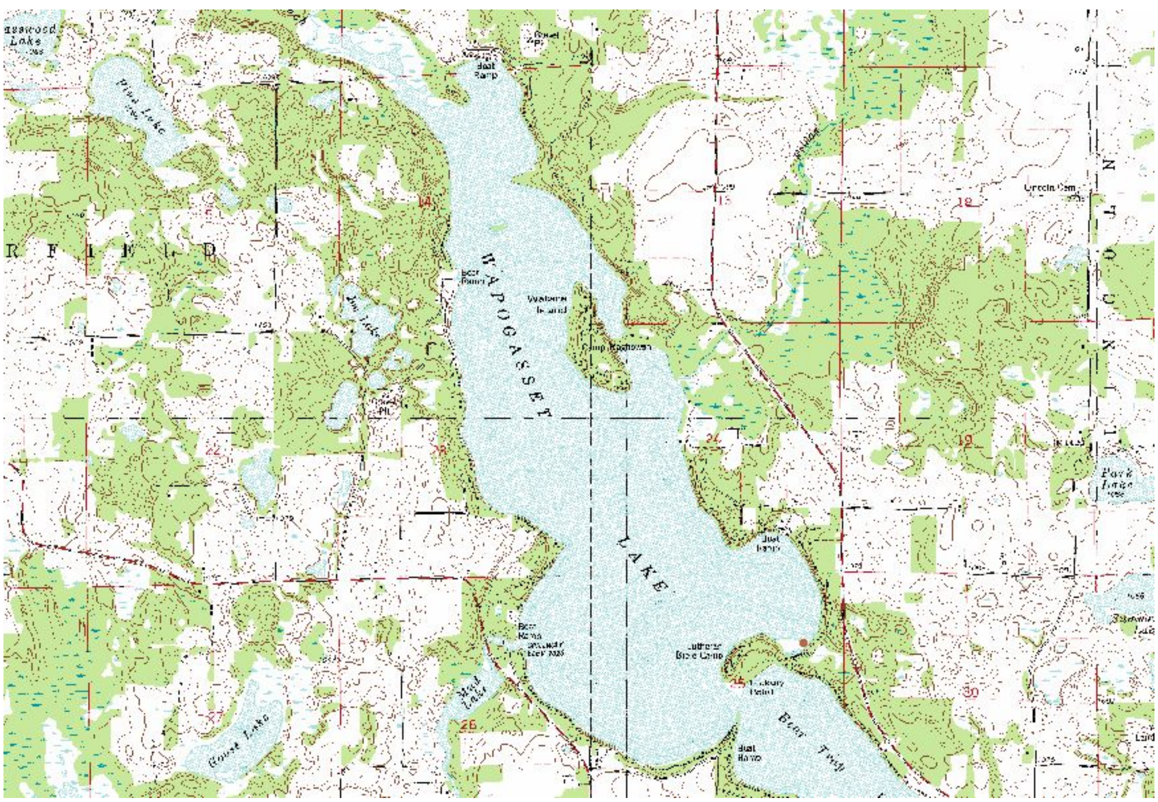
Nitella sp.-Nitella



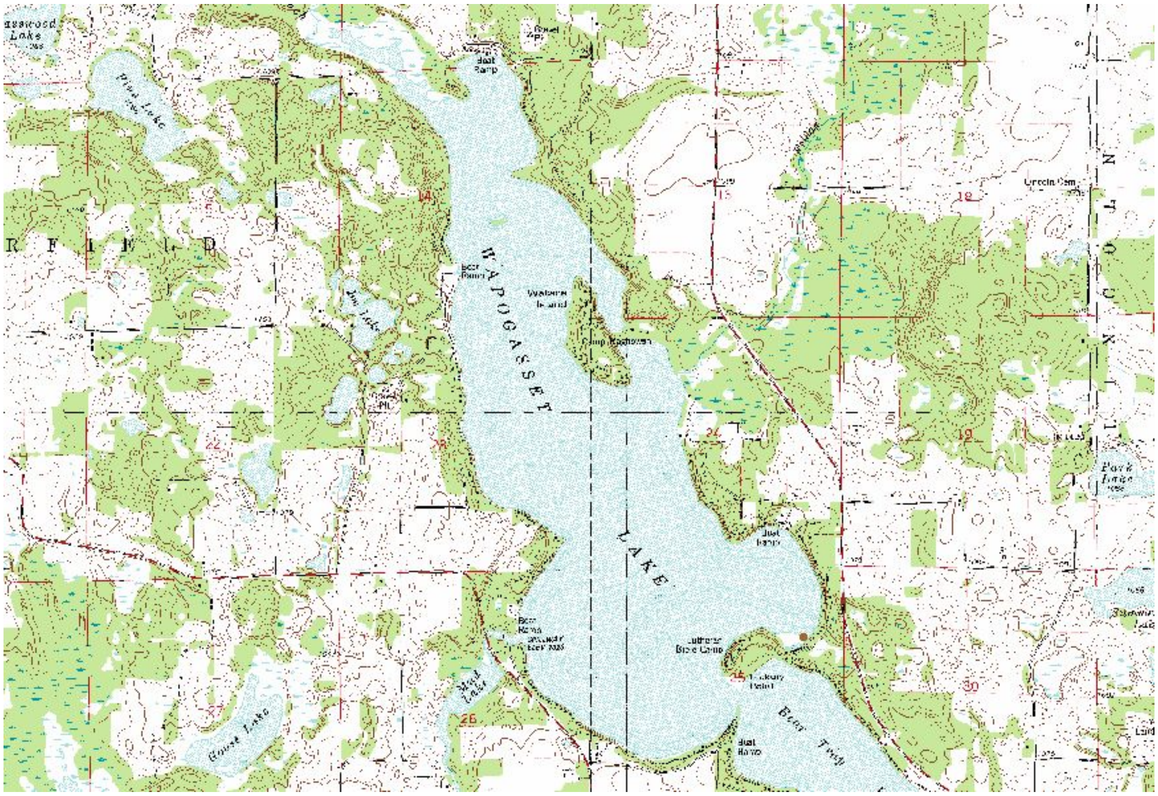
Eleocharis palustris-Creeping spikerush



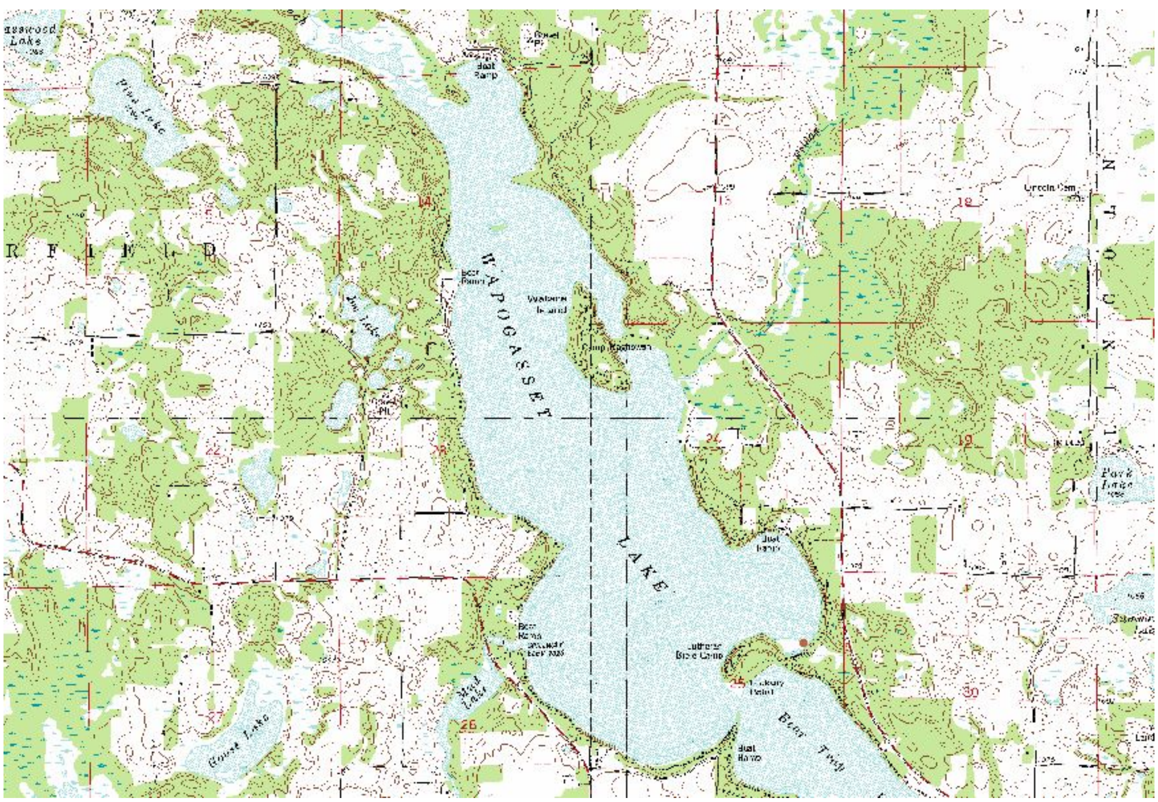
Brasenia schreberi-Watershield



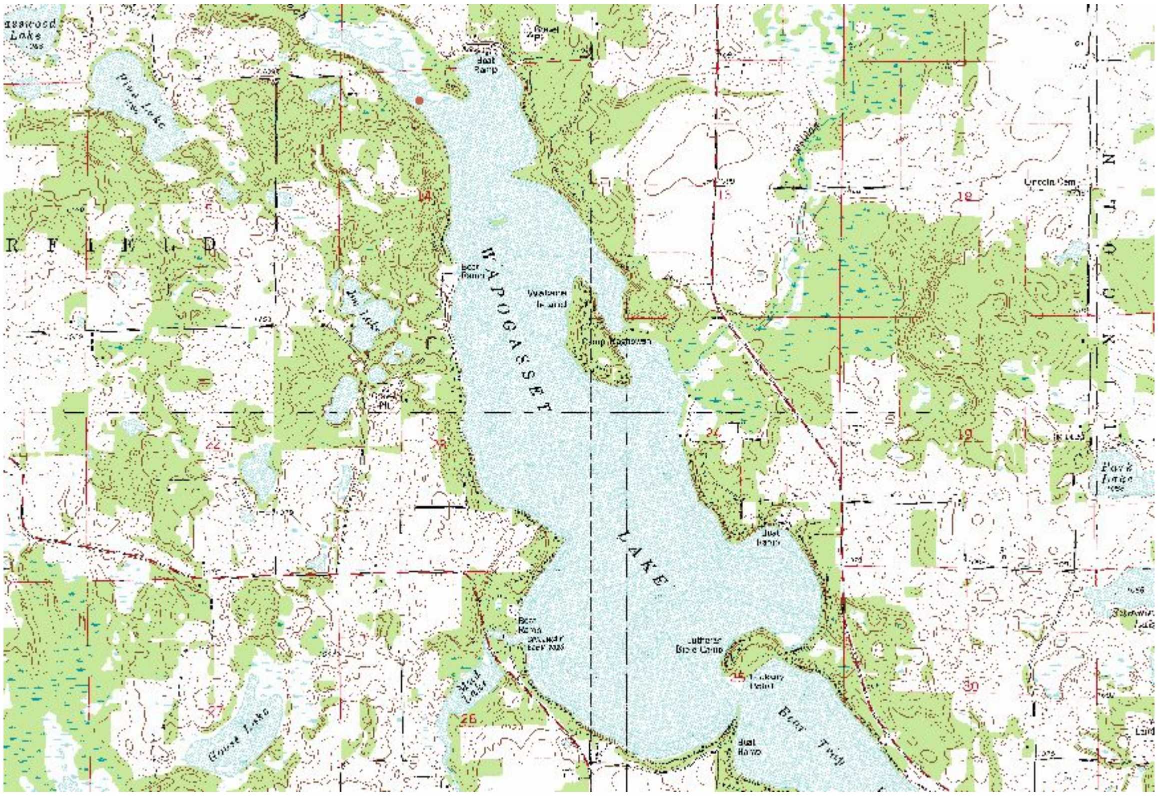
Myosotis scorpoides-Aquatic forget-me-not



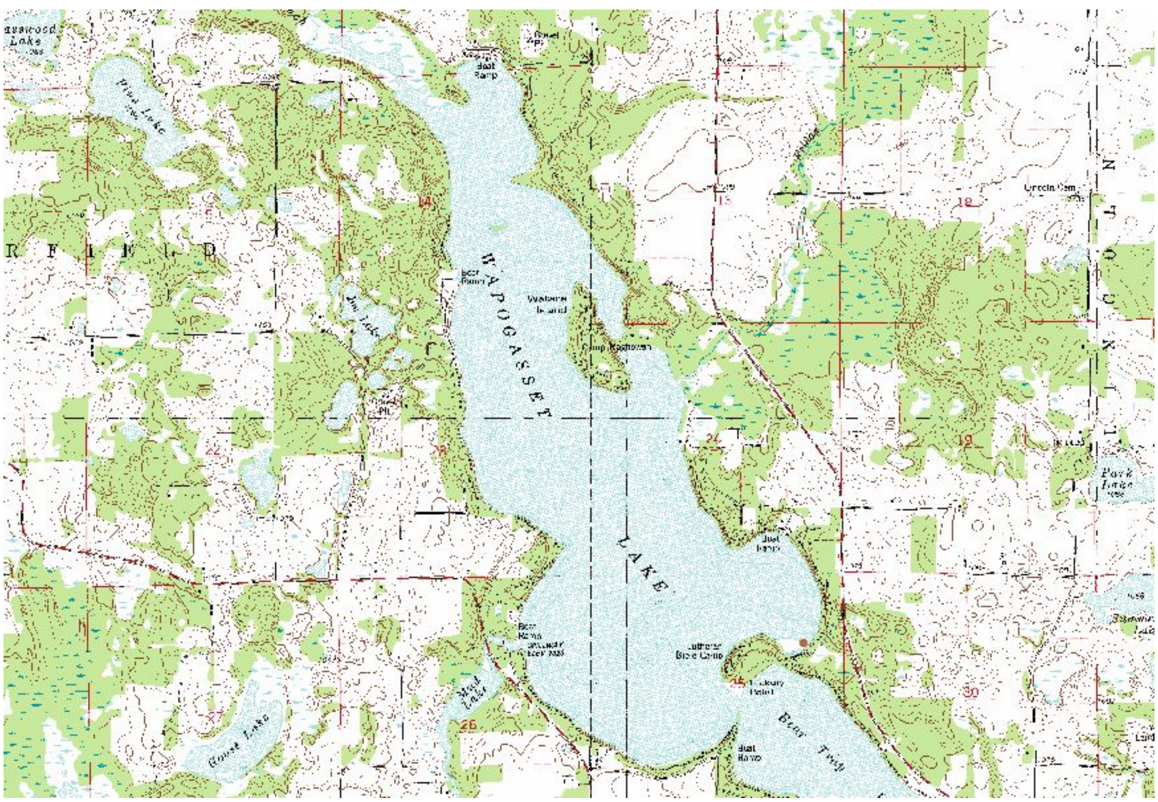
Carex comosa-Bottle brush sedge



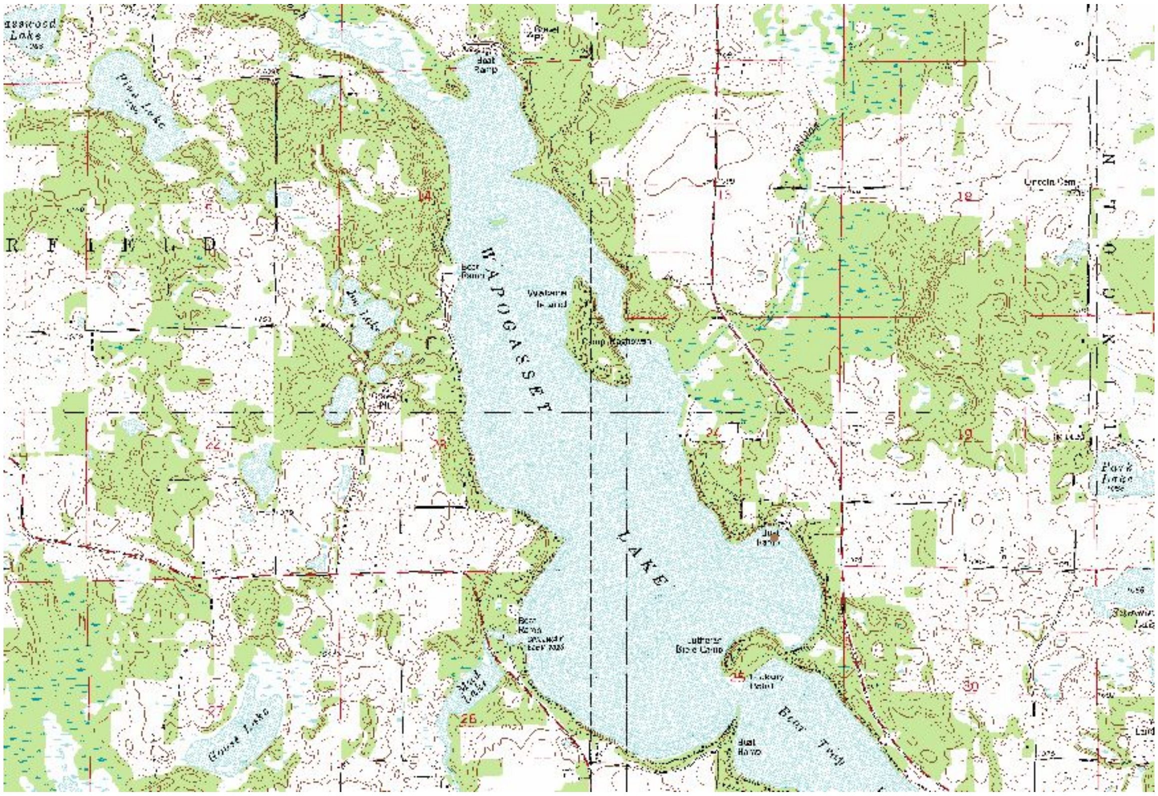
Eleocharis acicularis-Needle spikerush



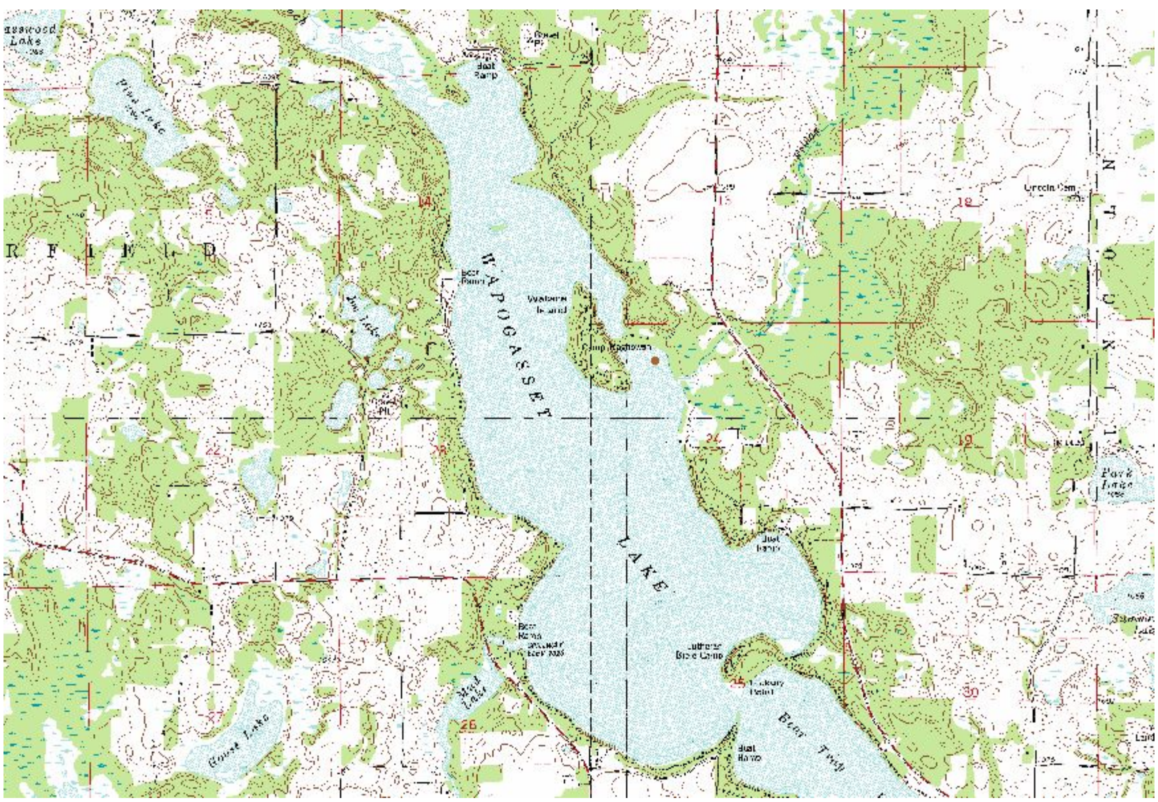
Sagittaria graminea-Grass leaved arrowhead



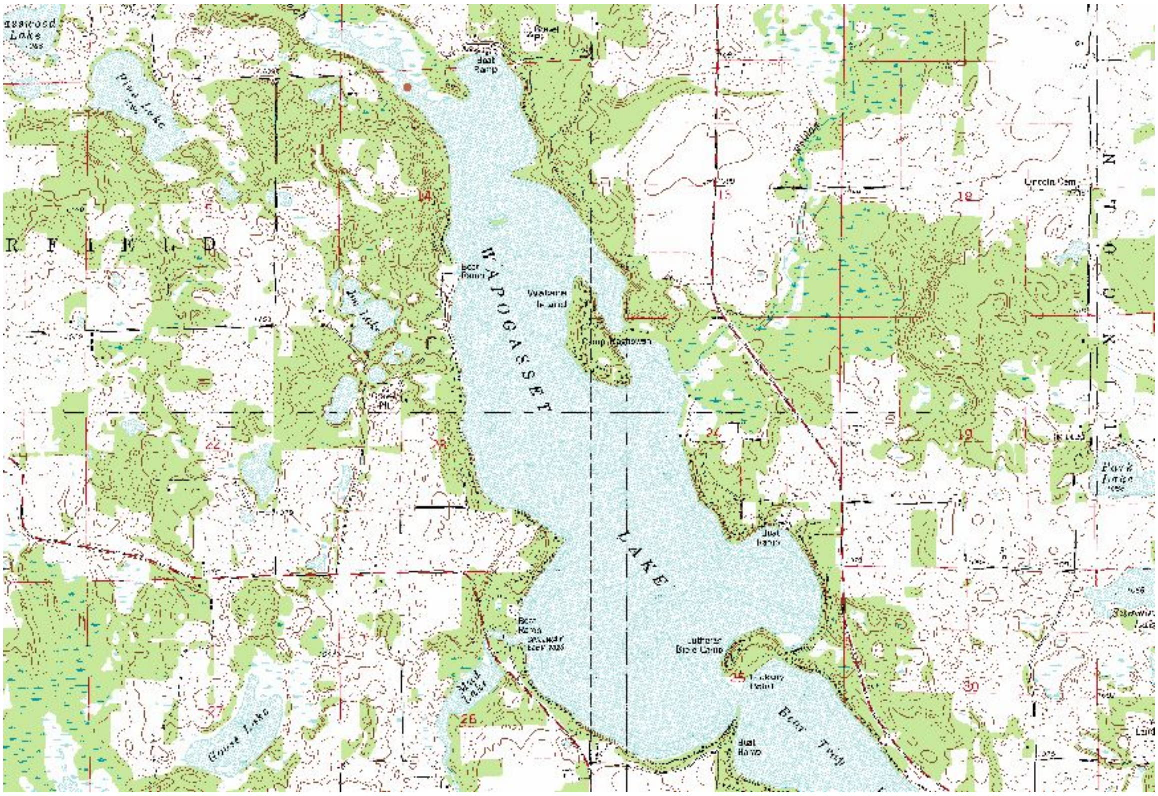
Sagittaria latifolia-Common arrowhead



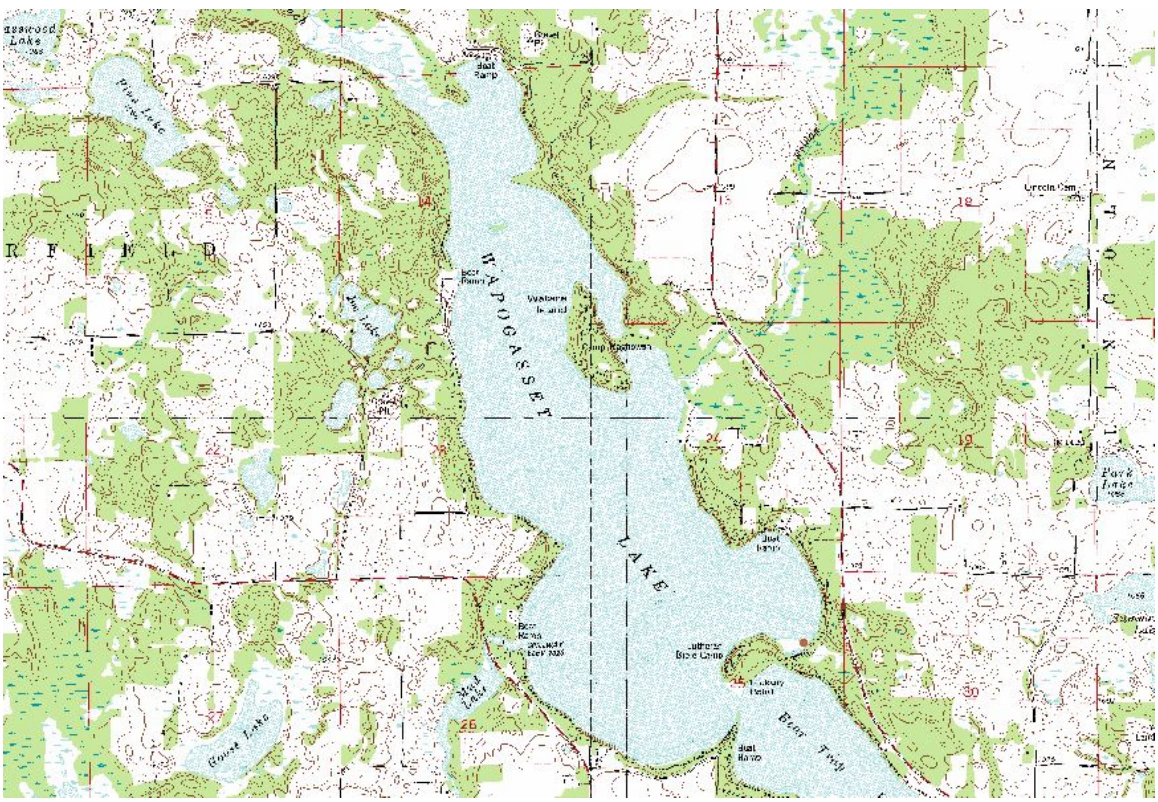
Sagittaria rigida-Stiff arrowhead



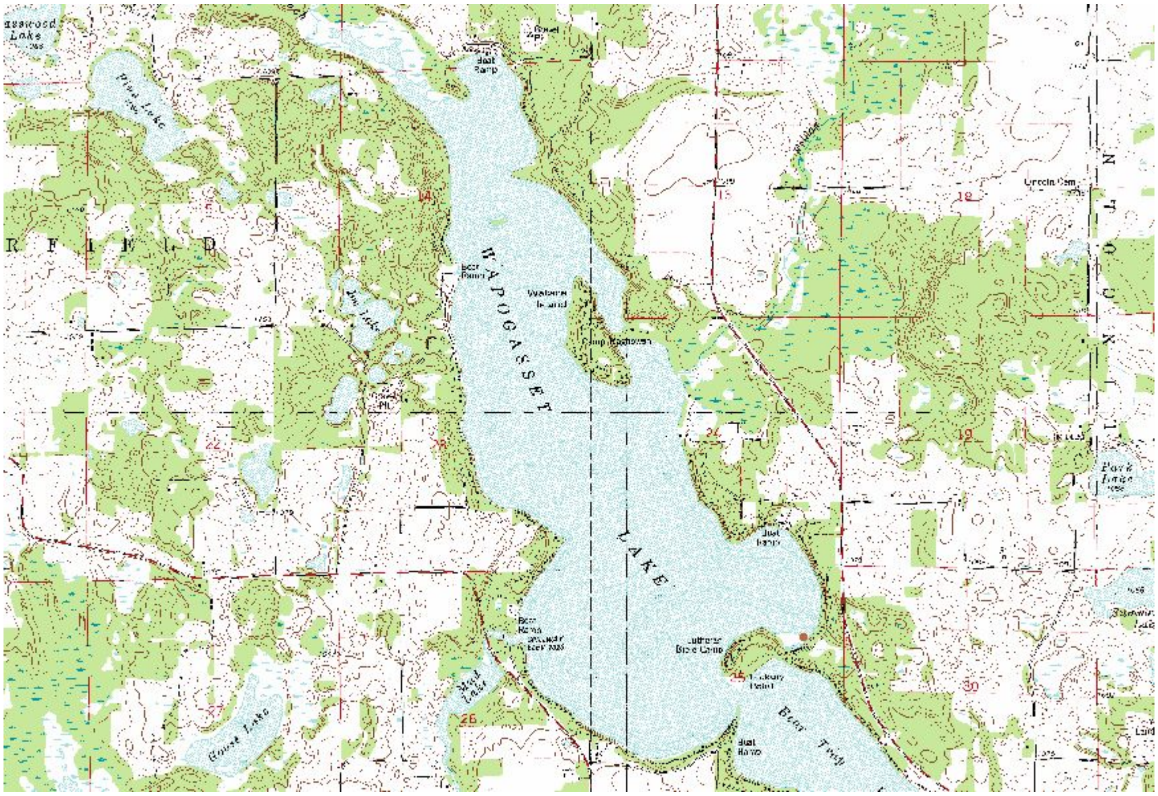
Sporangium fluctuans-Floating burreed



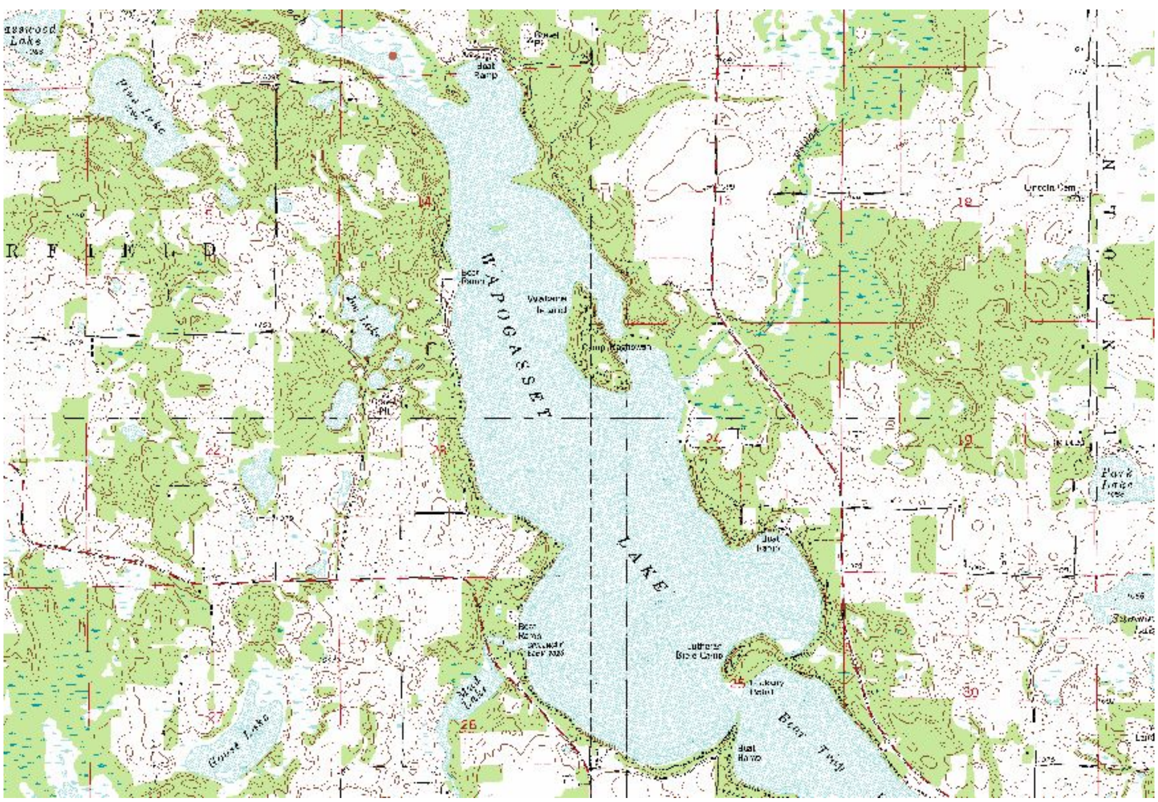
Typha latifolia-Broad leaf cattail



Justicia Americana-Water willow



Calla palustris-Wild calla



Zizania palustris-Wild rice

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: 75% of project costs up to $75,000 for education, prevention, planning and controlling established infestations; 75% of project costs up to $10,000 for early detection and rapid response
Application Deadline: February 1st of each year
Contact: Pamela Toshner 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: Pamela Toshner 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 Toshner 715-635-4073

Appendix D-Management options for Aquatic Plants from Wisconsin DNR

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
No Management	N	Do not actively manage plants	Minimizing disturbance can protect native species that provide habitat for aquatic fauna; protecting natives may limit spread of invasive species; aquatic plants reduce shoreline erosion and may improve water clarity	May allow small population of invasive plants to become larger, more difficult to control later
			No immediate financial cost	Excessive plant growth can hamper navigation and recreational lake use
			No system disturbance	May require modification of lake users' behavior and perception
			No unintended effects of chemicals	
			Permit not required	
Mechanical Control	May be required under NR 109	Plants reduced by mechanical means	Flexible control	Must be repeated, often more than once per season
		Wide range of techniques, from manual to highly mechanized	Can balance habitat and recreational needs	Can suspend sediments and increase turbidity and nutrient release
a. Handpulling/Manual raking	Y/N	SCUBA divers or snorkelers remove plants by hand or plants are removed with a rake	Little to no damage done to lake or to native plant species	Very labor intensive
		Works best in soft sediments	Can be highly selective	Needs to be carefully monitored
			Can be done by shoreline property owners without permits within an area <30 ft wide OR where selectively removing exotics	Roots, runners, and even fragments of some species, particularly Eurasian watermilfoil (EWM) will start new plants, so all of plant must be removed
			Can be very effective at removing problem plants, particularly following early detection of an invasive exotic species	Small-scale control only

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
b. Harvesting	Y	Plants are "mowed" at depths of 2-5 ft, collected with a conveyor and off-loaded onto shore	Immediate results	Not selective in species removed
		Harvest invasives only if invasive is already present throughout the lake	EWM removed before it has the opportunity to autofragment, which may create more fragments than created by harvesting	Fragments of vegetation can re-root
			Minimal impact to lake ecology	Can remove some small fish and reptiles from lake
			Harvested lanes through dense weed beds can increase growth and survival of some fish	Initial cost of harvester expensive
			Can remove some nutrients from lake	
Biological Control	Y	Living organisms (e.g. insects or fungi) eat or infect plants	Self-sustaining; organism will over-winter, resume eating its host the next year	Effectiveness will vary as control agent's population fluctates
			Lowers density of problem plant to allow growth of natives	Provides moderate control - complete control unlikely
				Control response may be slow
				Must have enough control agent to be effective
a. Weevils on EWM	Y	Native weevil prefers EWM to other native water-milfoil	Native to Wisconsin: weevil cannot "escape" and become a problem	Need to stock large numbers, even if some already present
			Selective control of target species	Need good habitat for overwintering on shore (leaf litter) associated with undeveloped shorelines
			Longer-term control with limited management	Bluegill populations decrease densities through predation

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
b. Pathogens	Y	Fungal/bacterial/viral pathogen introduced to target species to induce mortalitiy	May be species specific May provide long-term control Few dangers to humans or animals	Largely experimental; effectiveness and longevity unknown Possible side effects not understood
c. Allelopathy	Y	Aquatic plants release chemical compounds that inhibit other plants from growing	May provide long-term, maintenance-free control Spikerushes (*Eleocharis* spp.) appear to inhibit Eurasian watermilfoil growth	Initial transplanting slow and labor-intensive Spikerushes native to WI, and have not effectively limited EWM growth Wave action along shore makes it difficult to establish plants; plants will not grow in deep or turbid water
d. Planting native plants	Y	Diverse native plant community established to repel invasive species	Native plants provide food and habitat for aquatic fauna Diverse native community may be "resistant" to invasive species Supplements removal techniques	Initial transplanting slow and labor-intensive Nuisance invasive plants may outcompete plantings Largely experimental; few well-documented cases If transplants from external sources (another lake or nursury), may include additional invasive species or "hitchhikers"

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Physical Control	Required under Ch. 30 / NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a. Fabrics/ Bottom Barriers	Y	Prevents light from getting to lake bottom	Reduces turbidity in soft-substrate areas	Eliminates all plants, including native plants important for a healthy lake ecosystem
			Useful for small areas	May inhibit spawning by some fish
				Need maintenance or will become covered in sediment and ineffective
				Gas accumulation under blankets can cause them to dislodge from the bottom
				Affects benthic invertebrates
				Anaerobic environment forms that can release excessive nutrients from sediment
b. Drawdown	Y, May require Environmental Assessment	Lake water lowered with siphon or water level control device; plants killed when sediment dries, compacts or freezes	Winter drawdown can be effective at restoration, provided drying and freezing occur. Sediment compaction is possible over winter	Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling
		Season or duration of drawdown can change effects	Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction	May impact attached wetlands and shallow wells near shore
			Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization, and increased water quality	Species growing in deep water (e.g. EWM) that survive may increase, particularly if desirable native species are reduced
			Success demonstrated for reducing EWM, variable success for curly-leaf pondweed (CLP)	Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning
			Restores natural water fluctuation important for all aquatic ecosystems	Winter drawdawn must start in early fall or will kill hibernating reptiles and amphibians
				Navigation and use of lake is limited during drawdown

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
c.	Dredging	Y	Plants are removed along with sediment	Increases water depth	Severe impact on lake ecosystem
			Most effective when soft sediments overlay harder substrate	Removes nutrient rich sediments	Increases turbidity and releases nutrients
			For extremely impacted systems	Removes soft bottom sediments that may have high oxygen demand	Exposed sediments may be recolonized by invasive species
			Extensive planning required		Sediment testing may be necessary
					Removes benthic organisms
					Dredged materials must be disposed of
d.	Dyes	Y	Colors water, reducing light and reducing plant and algal growth	Impairs plant growth without increasing turbidity	Appropriate for very small water bodies
				Usually non-toxic, degrades naturally over a few weeks	Should not be used in pond or lake with outflow
					Impairs aesthetics
					Effects to microscopic organisms unknown
e.	Non-point source nutrient control	N	Runoff of nutrients from the watershed are reduced (e.g. by controlling construction erosion or reducing fertilizer use) thereby providing fewer nutrients available for plant growth	Attempts to correct source of problem, not treat symptoms	Results can take years to be evident due to internal recycling of already-present lake nutrients
				Could improve water clarity and reduce occurrences of algal blooms	Requires landowner cooperation and regulation
				Native plants may be able to better compete with invasive species in low-nutrient conditions	Improved water clarity may increase plant growth

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Chemical Control	Y, Required under NR 107	Granules or liquid chemicals kill plants or cease plant growth; some chemicals used primarily for algae	Some flexibility for different situations	Possible toxicity to aquatic animals or humans, especially applicators
		Results usually within 10 days of treatment, but repeat treatments usually needed	Some can be selective if applied correctly	May kill desirable plant species, e.g. native water-milfoil or native pondweeds; maintaining healthy native plants important for lake ecology and minimizing spread of invasives
		Chemicals must be used in accordance with label guidelines and restrictions	Can be used for restoration activities	Treatment set-back requirements from potable water sources and/or drinking water use restrictions after application, usually based on concentration
				May cause severe drop in dissolved oxygen causing fish kill, depends on plant biomass killed, temperatures and lake size and shape
				Often controversial
a. 2,4-D	Y	Systemic[1] herbicide selective to broadleaf[2] plants that inhibits cell division in new tissue	Moderately to highly effective, especially on EWM	May cause oxygen depletion after plants die and decompose
		Applied as liquid or granules during early growth phase	Monocots, such as pondweeds (e.g. CLP) and many other native species not affected	May kill native dicots such as pond lilies and other submerged species (e.g. coontail)
			Can be selective depending on concentration and seasonal timing	Cannot be used in combination with copper herbicides (used for algae)
			Can be used in synergy with endothall for early season CLP and EWM treatments	Toxic to fish
			Widely used aquatic herbicide	

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
b.	Endothall	Y	Broad-spectrum[3], contact[4] herbicide that inhibits protein synthesis	Especially effective on CLP and also effective on EWM	Kills many native pondweeds
			Applied as liquid or granules	May be effective in reducing reestablishment of CLP if reapplied several years in a row in early spring	Not as effective in dense plant beds; heavy vegetation requires multiple treatments
				Can be selective depending on concentration and seasonal timing	Not to be used in water supplies; post-treatment restriction on irrigation
				Can be combined with 2,4-D for early season CLP and EWM treatments, or with copper compounds	Toxic to aquatic fauna (to varying degrees)
				Limited off-site drift	
c.	Diquat	Y	Broad-spectrum, contact herbicide that disrupts cellular functioning	Mostly used for water-milfoil and duckweed	May impact non-target plants, especially native pondweeds, coontail, elodea, naiads
			Applied as liquid, can be combined with copper treatment	Rapid action	Toxic to aquatic invertebrates
				Limited direct toxicity on fish and other animals	Must be reapplied several years in a row
					Ineffective in muddy or cold water (<50°F)
d.	Fluridone	Y; special permit and Environmental Assessment may be required	Broad-spectrum, systemic herbicide that inhibits photosynthesis	Effective on EWM for 1 to 4 years with aggressive follow-up treatments	Affects non-target plants, particularly native milfoils, coontails, elodea, and naiads, even at low concentrations
			Must be applied during early growth stage	Some reduction in non-target effects can be achieved by lowering dosage	Requires long contact time at low doses: 60-90 days
			Available with a special permit only; chemical applications beyond 150 ft from shore not allowed under NR 107	Slow decomposition of plants may limit decreases in dissolved oxygen	Demonstrated herbicide resistance in hydrilla subjected to repeat treatments
			Applied at very low concentration at whole lake scale	Low toxicity to aquatic animals	In shallow eutrophic systems, may result in decreased water clarity
					Unknown effect of repeat whole-lake treatments on lake ecology

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
e.	Glyphosate	Y	Broad-spectrum, systemic herbicide that disrupts enzyme formation and function	Effective on floating and emergent plants such as purple loosestrife	RoundUp is often incorrectly substituted for Rodeo - Associated surfactants of RoundUp believed to be toxic to reptiles and amphibians
			Usually used for purple loosestrife stems or cattails	Selective if carefully applied to individual plants	Cannot be used near potable water intakes
			Applied as liquid spray or painted on loosetrife stems	Non-toxic to most aquatic animals at recommended dosages	Ineffective in muddy water
				Effective control for 1-5 years	No control of submerged plants
f.	Triclopyr	Y	Systemic herbicide selective to broadleaf plants that disrupts enzyme function	Effective on many emergent and floating plants	Impacts may occur to some native plants at higher doses (e.g. coontail)
			Applied as liquid spray or liquid	More effective on dicots, such as purple loosestrife; may be more effective than glyphosate	May be toxic to sensitive invertebrates at higher concentrations
				Control of target plants occurs in 3-5 weeks	Retreatment opportunities may be limited due to maximum seasonal rate (2.5 ppm)
				Low toxicity to aquatic animals	Sensitive to UV light; sunlight can break herbicide down prematurely
				No recreational use restrictions following treatment	Relatively new management option for aquatic plants (since 2003)
g.	Copper compounds	Y	Broad-spectrum, systemic herbicide that prevents photosynthesis	Reduces algal growth and increases water clarity	Elemental copper accumulates and persists in sediments
			Used to control planktonic and filamentous algae	No recreational or agricultural restrictions on water use following treatment	Short-term results
			Wisconsin allows small-scale control only	Herbicidal action on hydrilla, an invasive plant not yet present in Wisconsin	Long-term effects of repeat treatments to benthic organisms unknown
					Toxic to invertebrates, trout and other fish, depending on the hardness of the water
					Clear water may increase plant growth

[1]Systemic herbicide - Must be absorbed by the plant and moved to the site of action. Often slower-acting than contact herbicides.
[2]Broadleaf herbicide - Affects only dicots, one of two groups of plants. Aquatic dicots include waterlilies, bladderworts, watermilfoils, and coontails.
[3]Broad-spectrum herbicide - Affects both monocots and dicots.
[4]Contact herbicide - Unable to move within the plant; kills only plant tissue it contacts directly.
Specific effects of herbicide treatments dependent on timing, dosage, duration of treatment, and location.
References to registered products are for your convenience and not intended as an endorsement or criticism of that product versus other similar products.
This document is intended to be a guide to available aquatic plant control techniques, and is not necessarily an exhaustive list.
Please contact your local Aquatic Plant Management Specialist when considering a permit.

2 Eurasian Water-milfoil

Monitoring Protocol

Appendix E-Monitor Protocol

Background/Overview

Eurasian water-milfoil (EWM) is a submerged aquatic plant that poses a serious threat to a lake's native aquatic plants and the animals that depend on these diverse ecosystems. Since it is not native to Wisconsin or the United States, it has very few natural predators. EWM can form thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. It can crowd out native plants and become so thick that the larger fish cannot swim through the tangled mats. When EWM mats get well established, channels are needed to allow access from the shoreline out into deeper water areas. EWM is now one of the most troublesome submerged aquatic plants in Wisconsin.

There are 11 native water-milfoil species in North America. Of these 11 native species, seven are native to Wisconsin. The native water-milfoils are not as aggressive as the exotic water-milfoil and they have natural predators. Some Wisconsin species of water-milfoil are quite rare and are on the Wisconsin Threatened and Endangered species list.

EWM is native to Europe, Asia and northern Africa. It may have been brought in to the United States via aquaculture and the aquarium trade. The first authenticated record of EWM in the United States was in 1942 in a Washington D.C. pond. In 2007 it was found in 48 of the 50 states. EWM was first documented in Wisconsin in the 1960's. The list of waterbodies in Wisconsin where EWM has been verified can be found at http://dnr.wi.gov/lakes/AIS/index.asp?folder=CLMN.

Volunteers play an integral part in learning to recognize the plant and checking local lakes for the presence of EWM. Early identification of the plant makes control much easier, and can help prevent the spread into other waterbodies. If you detect the invasives early enough, you may be able to prevent them from spreading throughout your lake system. It is cheaper to control small patches of invasives than to control invasives that have taken over an entire lake system. Once invasives are established in a lake, they are nearly impossible to eradicate.

Life Cycle

EWM is an evergreen plant. The plant remains alive over the winter and starts growing when water temperatures reach 50° F (Bode, J. et al. 1992). EWM begins growing earlier in the season than the native water-milfoils. This makes early spring chemical treatment an option for control of EWM as it is more selective for EWM than late spring or summer treatments. In spring and summer, EWM can grow up to two inches a day. If EWM plant growth reaches the surface of the lake, the plant will continue to grow and can form a canopy over the surface of the lake often making the area nearly impassable with a motor boat. This canopy can also shade out native plants. Excessive growth affects recreational use by interfering with swimming, fishing, and boating and reducing the aesthetics of the lake. EWM grows in water depths ranging from less than one-foot to over 20-feet. Thick beds can form in water depths from 3 to 20 feet deep (Smith, C and J. Barko, 1990), but most commonly reach nuisance levels in water depths of 6-15 feet. EWM is tolerant of disturbance and can grow in most water conditions. One way to protect your lake from EWM or other invasives is to maintain native aquatic plant beds.

EWM produces seeds and runners, but the main method of spread is through plant fragmentation (vegetative propagation) by boats and wave action. In the late summer and early fall, auto fragmentation may occur. Auto fragmentation is when the plant "breaks itself into smaller pieces". Plant cells at leaf nodes and side-branch connections become weak, die and break off. These newly formed fragments float to new locations where they fall to the substrate, root and establish new beds of EWM.

Identification

In your packet is a card with a picture of EWM (*Myriophyllum spicatum*, pronounced MIR-ee-ah-FILL-um spi-KAY-tum) on one side and northern water-milfoil (*Myriophyllum sibiricum*, pronounced MIR-ee-ah-FILL-um si-BIR-I-cum) on the other side. Northern water-milfoil is the Wisconsin native that is sometimes confused with EWM. In your packet, you will also find a laminated example of EWM, as well as a fact sheet on water-milfoil turions (overwintering buds). Several of the native water-milfoil species produce turions. EWM does not produce turions, so if you see turions in the fall, or turion leaves in the spring, you do not have EWM.

EWM has been known to hybridize with northern water-milfoil. The hybrids cannot be distinguished by visual characteristics, but rather have to be identified through DNA analysis. If you suspect that you have the hybrid, please contact your local Aquatic Plant Management staff http://dnr.wi.gov/lakes/contacts for assistance.

Refer to pictures on next page, as well as reference materials in your packet, to see the characteristics listed below:

Eurasian Water-milfoil (EWM) Characteristics:
- Delicate feather-like leaves
- Leaves are arranged in whorls (circles), 3 to 5 leaves around the stem
- Usually 12-21 leaflet pairs per leaf
- Lower leaflets pairs are about the same length as upper leaflet pairs
- Leaves are fairly limp when pulled out of the water
- In the summer, the plants can be 20 feet tall
- In the summer, the distance between the leaf whorls can be several inches
- Upper part of the plant stem often has a pink or reddish color. (Some native species of water-milfoils may also have pink stems.)
- EWM does not produce turions (overwintering buds)
- Adventitious roots (roots growing along the stem) develop on EWM in late summer to early fall

Northern Water-milfoil Characteristics:
This is the native water-milfoil that is most often confused with EWM.
- Rigid feather-like leaves
- Leaves are arranged in whorls (circles), 4-6 leaves around the stem

- Usually 10 leaflet pairs per leaf
- Lower leaflet pairs are longer than upper ones, creating a Christmas tree shape
- Leaves are usually stiff when pulled out of the water
- In the summer, the plants can reach 10-12 feet in height
- In the summer, the distance between the leaf whorls is quite short
- Stems are often whitish or whitish-green in color
- Most native water-milfoils produce turions (overwintering buds), EWM does not
- Adventitious roots (roots growing along the stem) develop on Northern water-milfoil in late summer to early fall

Eurasian Water-milfoil whorl

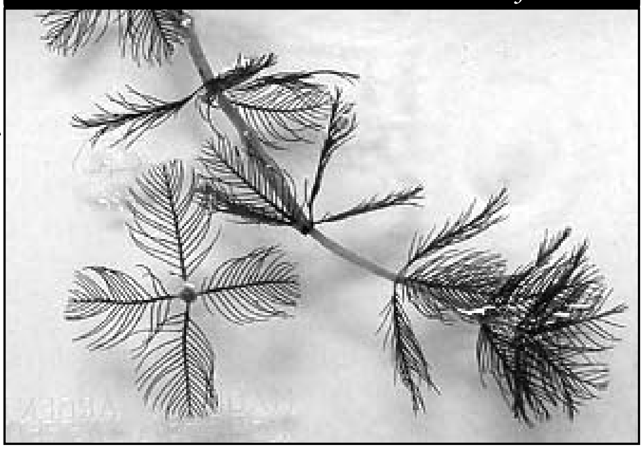


Photo by Sara Schmidt

EWM whorl showing four leaves with leaflets. On each leaf, lower leaflet pairs are about the same length as upper leaflet pairs.

Northern Water-milfoil whorl

Photo by Sara Schmidt

Northern water-milfoil whorl showing four leaves with leaflets. On each leaf, lower leaflet pairs are longer than upper leaflet pairs, creating a Christmas tree shape.

NWM *EWM*

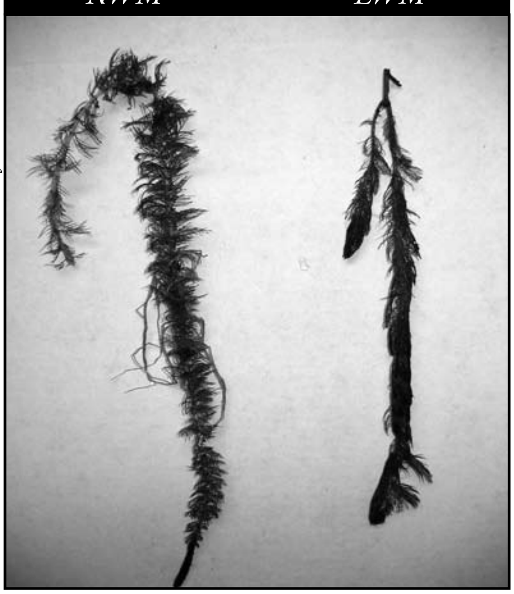


Photo by Laura Herman

Northern water-milfoil on the left. EWM on the right. Northern water-milfoil leaves are stiff when pulled out of water. EWM leaves are limp when pulled out of water.

Eurasian Water-milfoil

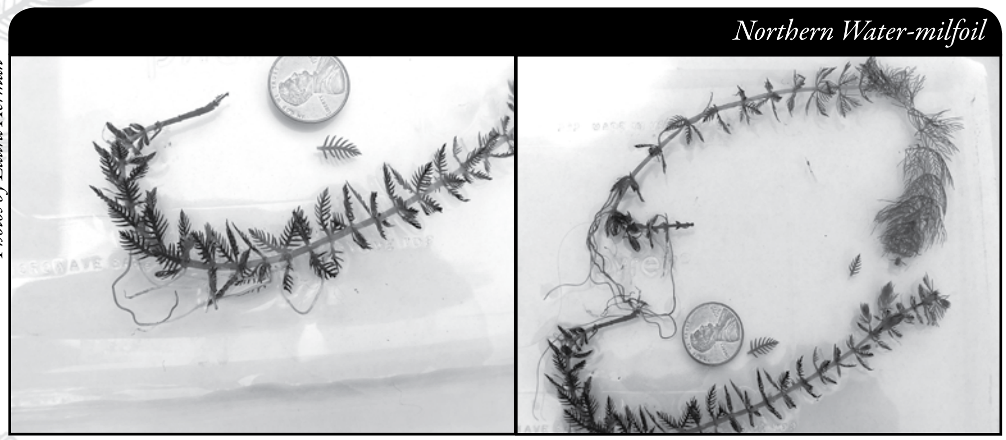
Photo by Ted Ritter

EWM often develops adventitious roots along its stem.

Shown below are turions on whorled water-milfoil and northern water-milfoil. EWM **does not** form turions.

Eurasian Water-milfoil

Several native species of water-milfoil form turions (winter buds).



Northern water-milfoil turion leaves.

In the spring the winter turion will "expand" revealing the turion leaves. New summer leaves will start growing from the top of the turion. The summer leaves have a different look than the winter turion leaves. EWM does not produce turions.

EWM Monitoring

Types of Monitoring

There are two types of monitoring for EWM - Prevention Monitoring and Established Population Monitoring.

Prevention Monitoring

If a lake is not known to have EWM, citizen lake monitors can play a very important role by regularly monitoring the lake for EWM and reporting if EWM is found or that nothing has been found. The "negative" information is important as it lets the lake managers know when EWM is not in a lake so they can better focus their work efforts. If EWM is found at an early stage, there may be hope of knocking it back. Several lakes that found EWM at an early stage have been able to keep it "in check" with minimal cost and efforts.

Established Population Monitoring

If a lake is already known to have EWM, citizen lake monitors can help track its spread. If treatment options are being used to control EWM, citizen lake monitors can track the effectiveness of the management options by monitoring the spread or decline of EWM.

Even if your lake group is controlling EWM, you still want to monitor for EWM. You want to know if they have spread to any new locations, so that you can begin control of these new beds ASAP. The earlier you find a new invasive, the easier it will be to control.

When to Monitor

Prevention monitoring

Volunteers should try to monitor once a month from ice-off to mid-September, as EWM begins growing early and keeps growing late into the fall. The first half of the summer is especially important to keep up steady (monthly) monitoring because EWM biomass is at its greatest during this time of the season, and if EWM is found early enough, there may be adequate time to plan and implement a first response yet that season. If a previously undiscovered bed is found later in the season, it can be planned into management for the following season. Given the lag time from discovery to a first response, monthly monitoring is very prudent. In drought years you will want to start monitoring earlier because spring drought conditions can cause high EWM growth early in the growing season.

When checking the shorelines, it is especially important to check piles of plants and debris **after storms and high boat traffic times**, as this is when plant fragments will be the heaviest.

Established Population Monitoring

If you or your lake group have found new beds of EWM, volunteers will probably want to monitor more carefully and more often than once a month. If treatment options are being used, it is very helpful to have volunteers monitor before and after treatment, especially around the treatment beds. In cases where treatment is occurring, more monitoring is better, especially if the plant may still be in an expanding stage within the lake. This allows the lake community to see if management options are working to meet their goals. The more involved lake residents are in monitoring, the more likely they will understand the process and support actions they see as reasonable and worthwhile.

Regular monitoring of a lake with EWM allows you to locate new beds so they can be treated (by hand-pulling, chemical treatments, or other means) while the beds are still small. Since chemical treatment is usually conducted in the spring, and since EWM starts growing in cool water, beds need to be located early. An aquatic plant management plan (often required as a part of a permit for chemical treatment) may prescribe a monitoring schedule. For example, you may be requested to follow the Pre- and Post-Treatment Evaluation of Aquatic Plant Community, DNR, 2008 (http://dnr.wi.gov/org/water/fhp/lakes/PrePostEvaluation.pdf).

Where Do I Look for EWM?

If EWM gets established, it probably has the capability to survive in all lakes in Wisconsin. It can tolerate a wide range of conditions. EWM can grow in water depths ranging from less than 1-foot to over 20-feet. In Wisconsin, EWM gets the most dense in water depths of 6-15 feet, but can reach nuisance levels in as little as 2 feet. EWM can grow in the clearest of lakes to some of the most turbid lakes, but it does best in moderate to fertile lakes. EWM can grow in rocky areas, sandy areas, and mucky areas, but does best in areas with silt. EWM even has the ability to survive in wetland areas, although it will not grow to be dense in these areas. Please remember, EWM will grow throughout the entire lake where water depths are less than 20 feet, so do not just rely on monitoring "prime habitat" areas.

Prevention Monitoring

When looking for floating plant fragments, think about your lake. Which way does the wind blow from and where does the wind blow the plants and floating debris? Go to areas where you have seen the piles of plants and debris, especially after storms and high boat traffic times, as this is when plant fragments will be the heaviest. Check **beach areas, inlets, boat launches, high use areas and the perimeter of the lake**. In mid-summer, EWM may start to break up into smaller pieces and these pieces often wash up along shorelines. These smaller fragments may establish new populations.

When looking for rooted plants, look for EWM in both sandy and mucky areas.

Established Population Monitoring

If EWM has been verified in your lake, you will probably want to monitor the existing beds as well as checking the rest of the lake to locate any new beds (especially if the plant may still be in an expanding stage within the lake). In cases where treatment is occurring, you will probably want to monitor in and around the treatment beds, as well as new areas around the lake to locate new plants if they have spread.

Photo by Robert Korth

How to Monitor

Prevention Monitoring

Shorelines

Even before looking for beds of EWM, you will want to look for floating plant fragments. Look in shallow water areas and in piles of washed up plant fragments along the shoreline to see if you can find any EWM plant fragments. It is especially important to visit these areas after storms and high boat traffic times, as this is when plant fragments will be the heaviest. If you find any EWM fragments, you know the invasive is in your lake.

Shallow-water Areas

Boat or walk around the shoreline of your lake and look for EWM in the shallow water areas.

Deeper-water Areas

Once you have monitored a variety of near shore areas, go out in your boat and begin to collect plants in the deeper water areas. It will be easiest to see the plants if you are wearing polarized sunglasses and/or using an Aqua-View Scope. Make sure the weather will allow for successful and safe sampling. Clear, calm weather is the best for sampling. Sunny skies make it easier to see into the water.

Later in the season there tends to be more suspended algae in the water column and it may be more difficult to see the plants, thus you may need to adjust your monitoring depth.

Use a long-handled rake to collect plants that are hard to reach or difficult to identify. In deeper areas, you can lower the rake to the bottom of the lake and drag the rake along. Pull the rope so that the rake pulls across several feet of the lake bed. This makes for relatively easy monitoring of deep water areas. This method will also help you pull up roots and collect plants that are not readily visible from the lake's surface. Be sure to monitor over sand as well as muck areas.

If you find beds of EWM, you may want to determine how dense the beds are. This information will be very useful when determining the proper control method for your invasive.

Note

Please do not throw plants that you collect back into the lake. Instead, dispose of them on shore or take them for mulch or compost for your garden. If you toss back plants, you may inadvertently spread plants to different locations on the lake. Since it's sometimes difficult to know which plants are native and which are non-native, it is best not to throw any plants back into the lake.

Appendix E-Monitor Protocol

Established Population Monitoring

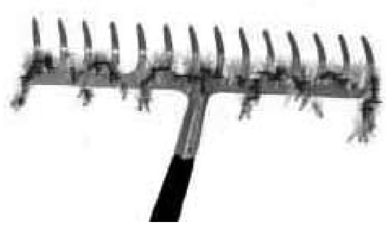
In cases where treatment is occurring, more monitoring is better, especially if the plant may still be in an expanding stage within the lake. This allows the lake community to see if management options are working to meet their goals. The more involved lake residents are in monitoring, the more likely they will understand the process and support actions they see as reasonable and worthwhile.

Look for EWM plants in and around existing beds using polarized sunglasses and/or an Aqua-View Scope. Make sure the weather will allow for successful and safe sampling. Clear, calm weather is the best for sampling. Sunny skies make it easier to see into the water.

Use a rake to pull up and record the plant density of EWM beds. In deeper areas, you can lower the rake to the bottom of the lake and drag the rake along. Pull the rope so that the rake pulls across several feet of the lake bed. This makes for relatively easy monitoring of deep water areas. This method will also help you pull up roots and collect plants that are not readily visible from the lake's surface.

On the Plant Bed Density Report Form (3200-132) (found at the end of this section and at http://dnr.wi.gov/lakes/forms) use the following numbers to denote the plant density for each invasive aquatic plant bed found:

Rake fullness ratings are given from 1-3. Conditions of the ratings are described below:

Rating	Coverage	Description
1		A few plants on rake head
2		Rake head is about ½ full Can easily see top of rake head
3		Overflowing Cannot see top of rake head

> **NOTE**
>
> Please do not throw plants that you collect back into the water. Instead, dispose of them in the trash or take them for mulch or compost for your garden.

Other Information You May Want to Collect

Sample Location

Record the sample GPS position.

Depth

Measure depth at each sampling site regardless of whether vegetation is present. A variety of options exist for taking depth measurements, including SONAR guns, depth finders that attach to the boat, or an anchor attached to a line with depth increments.

Dominant Sediment Type

Record sediment type (based on how the rake feels when in contact with the bottom) at each site where plants are sampled as: (a) mucky, (b) sandy, or (c) rocky.

If you are checking the rest of the lake to locate potential new beds of EWM, follow the instructions in the Prevention Monitoring section above.

Equipment Needed

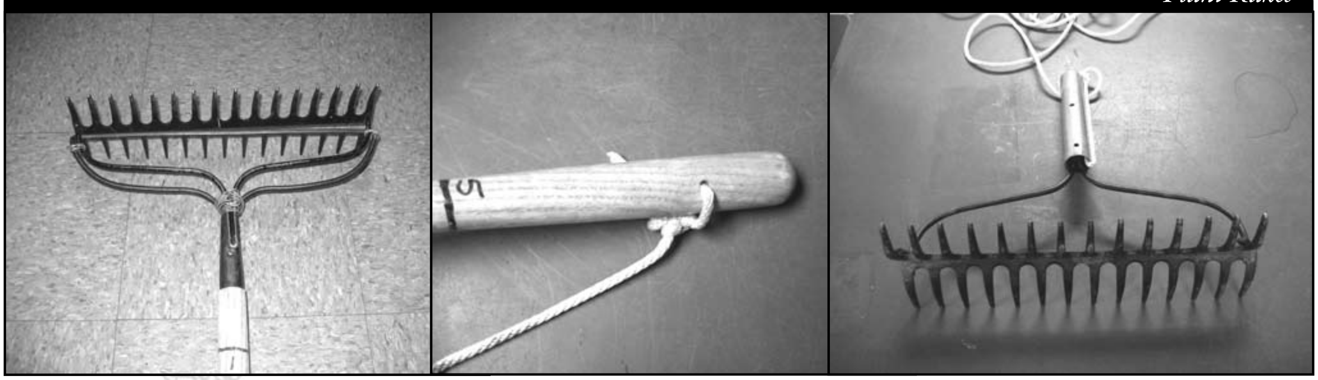
- ☐ Boat (canoe, kayak, fishing boat, paddle boat, etc.)
- ☐ Personal Floatation Device (PFD)
- ☐ Long handled rake with attached rope (see description and pictures on the next page)
- ☐ Lake map for marking suspect EWM beds and keeping track of where you have been.
- ☐ Pencil for marking on map
- ☐ Clip board or other hard surface for writing
- ☐ Ziploc bags
- ☐ Waterproof sharpie pen (to write on Ziploc bags)
- ☐ Cooler to keep plants in
- ☐ GPS unit (optional)
- ☐ Polarized sunglasses (optional)
- ☐ Aqua-View Scope (optional). To build your own Aqua-View Scope, see construction directions at the end of this section (page 43-44).
- ☐ A copy of appropriate report form(s) (found at the end of this section and at http://dnr.wi.gov/lakes/forms) depending on the type of monitoring you are doing:
  - Aquatic Invasives Presence/Absence Report, Form 3200-124
  - Aquatic Invasive Plant Incident Report Form, 3200-125
  - Plant Bed Density Reporting Form, 3200-132

Plant Rakes

Since it is sometimes difficult to identify plants under water, volunteers use rakes to sample plants. When the rake is thrown into the water, it settles to the bottom of the lake. When the rake is hauled back into the boat, aquatic plants come with it making for easier identification. A thatching rake can be used, or you can make a "2-headed" garden rake by purchasing 2 garden rakes (try looking at garage sales). Disconnect the head from one rake and wire or weld the rake heads together (teeth facing out). To monitor in deeper water, drill a hole in the end of the handle and tie a rope to it. With the two heads, no matter which way the rake falls to the lake bed, the teeth will catch the roots of the plants making plant collection a lot easier. If you need to make the rake heavier, you can use cable ties to attach duck decoy weights, a small brick or other weights. Some volunteers do not like to deal with a rake handle in deeper water, so they cut off the rake handle and attach the rope directly to the rake heads. If you use this type of rake, it is essential that you weigh the rake by using the decoy weights, a small brick, hand weights, etc. No matter which rake is used, please be sure to tie the loose end of the rope to the boat. This way you will not lose your sampling rake.

Plant Rakes

Photos by Sandy Wickman



A rope is tied to the handle of this "2-headed" garden rake, so it can be used in deep water.

Setting up a Monitoring Team

Often it is easier to "divide" up the work than to rely on one volunteer to monitor an entire lake for invasives. Designate a team leader (and maybe an assistant) who is willing to keep track of what areas are being monitored and who is doing monitoring. The team leader can also be the person who enters the monitoring results on the CLMN website http://dnr.wi.gov/lakes/CLMN and the person to whom other volunteers can bring suspect species. If assistance in identification is needed, the team leader can take the species to DNR, UW-Extension, or the County Land and Water Conservation staff for vouchering. By having the team leader take in suspect plants, you will not have the confusion of every team member taking in plants and you will be able to keep a list of what plants have been taken in and identified. Some groups have asked bait dealers or other businesses to "hold" suspect plants bought in by residents. Then the team leader can collect the plants from the bait dealers and take them in for identification when necessary. By the end of the summer, your team leader should be quite familiar with the native plants in your lake. If you are mapping native plants as part of your CLMN monitoring, you will probably not have to submit all your plants to be vouchered. Be creative and most importantly, do not burn out your team leaders!

Appendix E-Monitor Protocol

Consider having a mini-plant training session for your team. The Citizen Lake Monitoring Network Coordinator or the Aquatic Plant Management Coordinator (refer to front of manual and http://dnr.wi.gov/lakes/contacts) in your area may be able to assist you with a training session. If not, contact your local CLMN contact to see if an Aquatic Invasive Species training session will be scheduled for your area. These sessions are often set up in conjunction with local lake fairs and conventions. AIS workshops and training sessions are also listed at http://www.uwsp.edu/cnr/uwexlakes/CLMN/training.asp.

Mapping

A map is a very quick and reliable way to assure that everyone knows the place you are talking about when you describe a certain point on your lake. A map will assist you in locating plant communities, recreational and habitat use areas, and more. At the end of the season, you can map all of the sites visited.

If you have a team of monitors, a map will also assist your team in deciding who will monitor where. Once you have your "team" together, print out a map so that you can mark which areas each volunteer is monitoring. Your team leader should keep the master copy of the map. It may be easiest to have volunteers monitor the areas by their homes or where they fish. Assigning smaller (1/2 or 1-mile) stretches of shoreline per volunteer will be less overwhelming than monitoring larger areas of the lake.

You can get maps from your local DNR office, Fishing Hot Spots, fishing map books, etc. Basic lake maps can also be generated through the DNR Surface Water Viewer: http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer. When using the surface water viewer to generate a basic lake map, the easiest way to get where you want to go is by using the "Zoom To" button.

For example, say you want a basic lake map of Bearskin Lake in Oneida County. Use the drop down button at the left of the screen (it will say city or village) click on the down arrow and click on 'County'. Then go to the drop down arrow in the next line and click on Oneida. Then click on [Go!]. The Oneida County map will appear on the right. If you move your cursor/mouse on the map and left click, the map will zoom to the area under the cursor. Keep zooming in until you have the lake you want (you can zoom out if you overshoot your target lake). Once you have your lake in the box, click on the print button near the top of your screen and then click on ok. To see what you will be printing, click on [open map]. Once you try this a few times, it will get easier. Also, via the Layers tab, you can select what you want to show.

You might want to consider obtaining a surveyed contour or bathymetric map of your lake. The DNR has many of these maps on their website at http://dnr.wi.gov/org/water/fhp/lakes/lakemap/ .

For example, if you want to print out a bathymetric map for Bearskin Lake, Oneida County, click on the down arrow key next to Counties. Select Oneida County. Then page down to Bearskin Lake. Left click on Bearskin Lake. Click on "For a More Detailed Lake Map". Now just follow the directions. To print this to a letter size paper, right click on the map and "save picture as" a file on your computer. Start Microsoft Word (or other word processing program), then click on the tabs: "File" "Page Setup" "Paper Size" "Landscape" "ok" and "insert" "picture" "from file" and pick the lake map file and then print it.

Use a map source that is most convenient for you. Make sure the following information is on your lake map: lake name, county, sites monitored, date(s), volunteer(s), and any additional observations.

If you are monitoring existing beds of EWM and you have a GPS unit, you may want to mark in the edges of the beds, and then load this data into a mapping program and print out maps of the beds. You may also want to mark other locations monitored.

Reporting

What would all the work that goes into gathering accurate information be worth if others could not read, review and act on it? Reporting is one of the most important parts of monitoring for invasive species. Knowing where species are not, as well as where they are, is extremely important in being able to track and understand their spread. Knowing how often monitors are looking for species and what they are finding is very important information.

The DNR, lake managers, researchers, and others use the information that is reported through the Citizen Lake Monitoring Network to study lakes and better understand aquatic invasive species. The information reported by volunteers is also provided to the state legislature, federal, tribal and local agencies/organizations that in turn may use this data to help determine funding for invasive species grants and programs.

You can enter your monitoring results on the CLMN website: http://dnr.wi.gov/lakes/CLMN (click "Enter Data" on the left side bar). If you don't yet have a user id and password, click 'Request a Wisconsin User ID and Password', then email Jennifer at jennifer.filbert@wisconsin.gov with your User ID and what monitoring you are involved in. Jennifer will set up your accounts and email you back. Once you receive a confirmation email, you can log in. Once you're logged in, go to the 'Submit Data' tab and click "Add New" to start entering data. Choose the AIS monitoring project for your lake in the *Project* dropdown box.

Appendix E-Monitor Protocol

- For prevention monitoring, report your results using the: Aquatic Invasives Presence/ Absence Report, Form 3200-124.

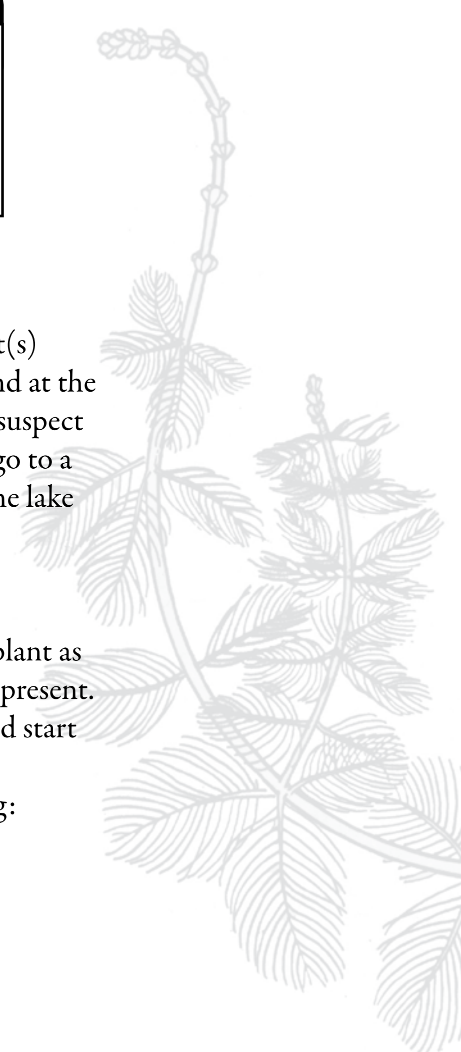
- If you find EWM for the first time on your lake, report your results using the: Aquatic Invasive Plant Incident Report, Form 3200-125.

- For established population monitoring, report your results using the Plant Bed Density Report, Form 3200-132. At this time, there is no computer data entry option for this form. Online data forms will be created as time allows. The data collected with this form will be very useful in tracking the spread of EWM throughout the lake if EWM does spread and is necessary in tracking success of your management option. Keep hard copies for your reference and/or submit them to your local DNR Aquatic Plant Management Coordinator.

You can report your results as often as you wish, but be sure to at least report results once a year, at the end of the monitoring season. If you are doing Established Population Monitoring, you will probably want to report your results more often. If you have any questions about reporting, contact your local DNR CLMN contact (page viii).

NOTE

Remember, for prevention monitoring, a report of 'no EWM' at a location is just as important as finding EWM. One cannot confidently state that EWM is not present in an area if no one has looked.



What to do with Suspect Plants

Note the "suspect" plant's location on your map, making sure you can find the spot(s) again. Fill out the Aquatic Invasive Plant Incident Report (Form 3200-125) (found at the end of this section, and at http://dnr.wi.gov/lakes/forms/, and deliver it with the suspect plant to your team leader or local DNR CLMN contact. Suspect plants need to go to a herbarium for vouchering. DNR staff can transport plants to the herbarium for the lake group.

To collect a specimen of the plant:

- Gently pull the plant from the lake bottom. Be sure to collect as much of the plant as possible, paying special attention to getting the leafy and flowering portion, if present. Try not to break up or rip the plant as the pieces of the plant can float away and start new plants.
- Use a permanent marker and record the following information on a plastic bag:
    a. Date
    b. Water body
    c. Description of where the sample was found.

- Put the sample in the plastic bag and keep it in a cool place (a cooler in your car or refrigerator at home). Take the specimen to your team leader, your local CLMN contact, your local Land and Water Conservation Department, UW-Extension office or the local DNR contact for identification. If you found EWM in a lake where it has not been verified before, it is important to get the plants verified and vouchered (usually by an herbarium botanist) ASAP, so that control can take place in a timely manner. Your local CLMN contact will get the plant to the DNR or local herbarium.

> **NOTE**
>
> If your lake has been verified to have EWM, samples do not need to go to the DNR for vouchering – you can just take the plants to your team leader.

- If you cannot bring the plant in to your team leader or other contact:
  - Rinse the plant under running tap water or in a large pan of water. This will slow the rotting process.
  - Blot the plant dry with a paper towel.
  - Spread the plant out on a dry paper towel or newspaper. Try to spread the leaflets apart to help with identification.
  - Cover with a dry paper towel and press in a catalog or phone book for about a week.
  - Complete a label (see example at the end of this section) and the Aquatic Invasive Plant Incident Report (Form 3200-125) (found at the end of this section and at http://dnr.wi.gov/lakes/forms/).
  - When the plant is dry, place it between sheets of thin cardboard (like a cereal box). Mail the plant, map and the reporting form to your local CLMN contact.
  - Remember to make a copy of your map and reporting forms for your records.

Remember if you find "something," don't give up; there are a variety of control and management options to address invasive species on your lake. Early detection is the key to controlling the situation!

> **PREVENTION STARTS WITH US**
>
> Whether you are out monitoring, or just boating for fun, be sure to remove all aquatic plants from boating equipment, including your trailer, boat, motor/propeller and anchor before launching and after leaving the water. By removing aquatic plants from boating equipment and encouraging others to do the same, you can help protect Wisconsin lakes from Eurasian water-milfoil.

Additional Materials and Supporting Documentation

Plant Identification Sources

Through the Looking Glass. 1997. Susan Borman, Robert Korth, Jo Temte. Wisconsin Lakes Partnership. DNR publication # FH-207-97.

Common Aquatic Plants of Wisconsin list prepared by Stan Nichols, Wisconsin Geological and Natural History Survey, Madison, WI. (This is not a true key, but it is easy for all to use.)

Aquatic and Wetland Plants of Northeastern North America. Garrett E. Crow and C. Barre Hellquist. University of Wisconsin Press.

A Manual of Aquatic Plants. 1957. Norman C. Fassett. University of Wisconsin Press.

Aquatic Plants of Illinois. 1966. Glen S. Winterringer and Alvin C. Lopinot. Department of Registration and Education, Illinois State Museum Division and the Department of Conservation, Division of Fisheries.

Michigan Flora. 1985. Edward G. Voss. University of Michigan Press.

References

Smith, C.S. and J.W. Barko. 1990. *Ecology of Eurasian watermilfoil*. J. Aquat. Plant Manage. 28:55-64.

Bode, J. et al. 1992. *Eurasian Water Milfoil in Wisconsin: A Report to the Legislature*.

DNR. 2008. *Pre and Post Treatment Evaluation of Aquatic Plant Community.*

State of Wisconsin
Department of Natural Resources
Wisconsin Lakes Partnership

Aquatic Invasives Presence/Absence End of Season Report

Form 3200-124 (R 2/09)

Personally identifiable information collected on this form will be incorporated into the DNR aquatic invasive species database. It is not intended to be used for any other purposes, but may be made available to requesters under Wisconsin's Open Records laws, s. 19.32 - 19.39, Wis. Stats.

Data Collectors

Primary Data Collector Name	Phone Number	Email
Additional Data Collector Names		
Total Paid Hours Spent (# people x # hours each)	Total Volunteer Hours Spent (# people x # hours each)	

Monitoring Location

Waterbody Name	Township Name	County	Boat Landing (if you only monitor at a boat landing)

Dates Monitored

Start Date (when you first monitored this season)	End Date (when you last monitored this season)
Did you monitor in... May? June? July? August? (circle all that apply)	

Did you monitor…		Did you…	
All Beaches and Boat Landings?	Yes No	Walk along the shoreline?	Yes No
Perimeter of whole lake?	Yes No	Observe only from the surface?	Yes No
Docks or piers?	Yes No	Observe entire shallow water area (up to 3 feet deep)?	Yes No
Other: ______________________________		Use rake to extract plant samples?	Yes No
		Check underwater solid surfaces (boat hulls, dock legs, rocks)?	Yes No
		Other: ______________________________	

Did you find…

Banded Mystery Snail?	Yes No	Hydrilla?	Yes No
Chinese Mystery Snail?	Yes No	Purple Loosestrife?	Yes No
Curly-Leaf Pondweed?	Yes No	Rusty Crayfish?	Yes No
Eurasian Water Milfoil?	Yes No	Spiny Waterfleas?	Yes No
Fishhook Waterfleas?	Yes No	Zebra Mussels?	Yes No
Freshwater Jellyfish?	Yes No	Other?: ___________	

If you find an aquatic invasive

If you find an aquatic invasive and it is not listed at http://dnr.wi.gov/lakes/AIS fill out an incident report for the species. Then bring the form, a voucher specimen if possible, and a map showing where you found it to your regional DNR Citizen Lake Monitoring Coordinator as soon as possible (to facilitate control if control is an option).

If you don't find an aquatic invasive

If you submit your data online, that is all you need to do. Otherwise, please mail a copy to your regional DNR Citizen Lake Monitoring Coordinator.

Appendix E-Monitor Protocol

Appendix E-Monitor Protocol

State of Wisconsin
Department of Natural Resources
Wisconsin Lakes Partnership

Aquatic Invasives Presence/Absence Report
Multiple Locations, One Date

Form 3200-130 (R 3/09)

Personally identifiable information collected on this form will be incorporated into the DNR aquatic invasive species database. It is not intended to be used for any other purposes, but may be made available to requesters under Wisconsin's Open Records laws, s. 19.32 - 19.39, Wis. Stats.

Data Collectors		
Primary Data Collector Name	Phone Number	Email
Additional Data Collectors		

Date and Time		
Date	Start Time	End Time

				Y=Yes N=No N/A = Didn't Look For																			
				Did you monitor			Did you				Did you find?												
Waterbody	**County**	**Township**	**Boat Landing (if you only monitor at boat landings)**	All Beaches and Boat Landings?	Perimeter of Whole lake?	Docks or piers?	Walk along the shoreline?	Observe entire shallow water area (up to 3 feet deep)?	Use rake to extract plant samples?	Check underwater solid surfaces (boat hulls, dock legs, rocks)?	Banded Mystery Snail?	Chinese Mystery Snail?	Curly-Leaf Pondweed?	Eurasian Water Milfoil?	Fishhook Waterfleas?	Freshwater Jellyfish?	Hydrilla?	Purple Loosestrife?	Rusty Crayfish?	Spiny Waterfleas?	Zebra Mussels?	Other?: ______	

If you find an aquatic invasive
If you find an aquatic invasive and it is not listed at http://dnr.wi.gov/lakes/AIS fill out an incident report for the species. Then bring the form, a voucher specimen if possible, and a map showing where you found it to your regional DNR Citizen Lake Monitoring Coordinator as soon as possible (to facilitate control if control is an option).

If you don't find an aquatic invasive
If you submit your data online, that is all you need to do. Otherwise, please mail a copy to your regional DNR Citizen Lake Monitoring Coordinator.

Appendix E-Monitor Protocol

State of Wisconsin
Department of Natural Resources
Wisconsin Lakes Partnership

Aquatic Invasive Plant Incident Report

Form 3200-125 (R 2/09)

Only use this form if you found an aquatic invasive plant on a lake where it hasn't been found previously.
To find where aquatic invasives have already been found, visit: http://dnr.wi.gov/lakes/ais.

Personally identifiable information collected on this form will be incorporated into the DNR aquatic invasive species database. It is not intended to be used for any other purposes, but may be made available to requesters under Wisconsin's Open Records laws, s. 19.32 - 19.39, Wis. Stats.

Primary Data Collector

Name	Phone Number	Email

Monitoring Location

Waterbody Name	Township Name	County

Boat Landing (if you only monitor at a boat landing)

Date and Time of Monitoring

Monitoring Date	Start Time	End Time

Information on the Aquatic Invasive Plant Found

Which aquatic invasive plant did you find?:

☐ Curly-leaf Pondweed ☐ Eurasian Water-milfoil ☐ Hydrilla ☐ Other ___________________

Where did you find the invasive plant?

Latitude	Longitude

Approximately how large an area do the plants occupy?

☐ A Few Plants ☐ One or a few beds ☐ Many beds ☐ A Whole Bay or Portion of Lake
☐ Widespread, covering most shallow areas of lake ☐ Don't know (e.g. didn't check the whole lake)

Was the plant floating or rooted? ☐ Floating ☐ Rooted

Estimated percent cover in the area where the invasive was found (Optional)

Substrate cobble, %	Substrate muck, %	Substrate boulders, %	Substrate sand, %	Bottom covered with plants, %

Voucher Sample

Did you collect a sample of the plant (a voucher specimen) and bring it to your local DNR office? If so, which office?

☐ Rhinelander ☐ Spooner ☐ Green Bay ☐ Oshkosh ☐ Did not take plant sample to a DNR office
☐ Fitchburg ☐ Waukesha ☐ Eau Claire ☐ Superior ☐ Other Office ____________________

Please collect up to 5-10 intact specimens. Try to get the root system, all leaves as well as seed heads and flowers when present. Place in ziplock bag with no water. Place on ice and transport to refrigerator. Bring samples, a copy of this form, along with a map showing where you found the suspect plants to your regional AIS or Citizen Lake Monitoring Coordinator at the DNR.

For DNR AIS Coordinator to fill out

AIS Coordinator(s) or other qualified professional(s) who verified the occurrence: __________________________ __________________________

Was the specimen confirmed as the species indicated above? ☐ Yes ☐ No — If no, what was it?

Herbarium or museum where specimen is housed: ____

Have you entered the results of the voucher in SWIMS? ☐ Yes ☐ No

AIS Coordinator: Please enter the incident report in SWIMS under the Incident Report project for the county the AIS was found in. Then, keep the paper copy for your records.

Appendix E-Monitor Protocol

State of Wisconsin
Department of Natural Resources
Wisconsin Lakes Partnership

Plant Bed Density Report

Form 3200-132 (R 02/08)

Use this form when you have verified that your lake has Eurasian Water-Milfoil or Curly-leaf Pondweed and you want to assess the densities of the bed(s). Please use one form per plant bed raked.

Personally identifiable information collected on this form will be incorporated into the DNR aquatic invasive species database. It is not intended to be used for any other purposes, but may be made available to requesters under Wisconsin's Open Records laws, s. 19.32 - 19.39, Wis. Stats.

Primary Data Collector

Name	Phone Number	Email

Monitoring Location

Waterbody Name	Township Name	County	Station Name

Latitude of approx. center of plant bed	Longitude of approx. center of plant bed

Method of obtaining Latitude and Longitude: ☐ GPS ☐ Online Surface Water Data Viewer ☐ Other Mapping Software ☐ Other ___________________

Date and Time of Monitoring

Monitoring Date	Start Time	End Time

Estimated percent cover in the sample area (Optional)

Substrate cobble, %	Substrate muck, %	Substrate boulders, %	Substrate sand, %	Bottom covered with plants, %

Monitoring Results

Which aquatic invasive plant are you monitoring the density of?:

☐ Curly-leaf Pondweed ☐ Eurasian Water-milfoil ☐ Other __________________

Plant Density Rating

☐ 1-A few plants on rake head ☐ 2-Rake Head is about 1/2 full ☐ 3-Overflowing

Depth to lake bottom at edge of plant bed closest to shore (min depth) feet/meters (circle one)

Depth to lake bottom at edge of plant bed furthest shore (max depth) feet/meters (circle one)

Estimated Height of Plants (use marked-off rake handle to determine)

☐ 0.5 - 1 foot ☐ 1 - 2 feet ☐ >2 feet

If monitoring Eurasian Water-Milfoil, did you notice any holes or damage to the stems that could possibly be weevil damage ?

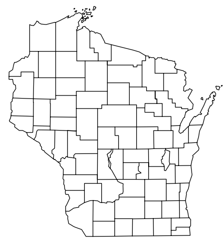
☐ Yes ☐ No

Appendix E-Monitor Protocol

PLANT LABELS

Project Name: Citizen Lake Monitoring Network

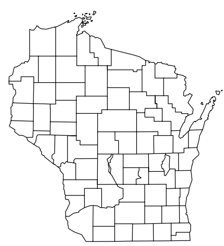
(Scientific Name & authority)



Common Name:
Lake Name:
Water Body ID code#:
County:
Collected by:
Date:
Depth:
Location and Habitat:

Project Name: Citizen Lake Monitoring Network

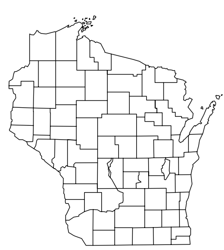
(Scientific Name & authority)



Common Name:
Lake Name:
Water Body ID code#:
County:
Collected by:
Date:
Depth:
Location and Habitat:

Project Name: Citizen Lake Monitoring Network

(Scientific Name & authority)



Common Name:
Lake Name:
Water Body ID code#:
County:
Collected by:
Date:
Depth:
Location and Habitat:

Appendix E-Monitor Protocol

Aqua-View Scope Construction Directions

- 1 - 3 foot section of 4” diameter plastic pipe. We use ABS pipe because it is black and because it is lighter than PVC pipe. If you are unable to find ABS pipe, PVC pipe will work just fine. Your hardware store may have a short piece of pipe they will sell you. We bought a 10-foot piece of pipe and cut it.
- 1 or 2 - 5 ½” pull handles (we used one, it was easier to hold and guide)
- Screws if not supplied with handle
- 1 - 4” ABS coupler
- 1 - 4 3/8” diameter lexan disk – Lexan is non-breakable plexiglass that we had cut at our local glass repair shop. You can use plexiglass for the disk but it is difficult to cut the plexiglass in a circle.
- Clear silicone rubber sealant
- Drill and screw driver
- Weatherstripping for around the top of the aqua-view scope. Marine and automotive weatherstrip tape works well.

How to Make an Aqua-view scope (picture on next page)

Cut a 3 foot section of 4” diameter ABS or PVC pipe. The cut must be straight and square to the pipe. If you can’t find pipe with a black interior, you can paint the inside a flat black. If the pipe is shiny on the inside, rough it up using sandpaper or steel wool so that there won’t be any glare inside the tube. **If you are going to rough it up on the inside, make sure to do that before you attach the screws so you don’t scratch your hand!**

Attach one or two handles on either side of the pipe about four inches from one end. ABS pipe is fairly soft, you can use a screw driver to put the screws in or you can drill pilot holes and put the screws in. If you are using a drill, make sure to make the hole smaller than the screw so the screw will hold. If using PVC pipe, you will need to drill the holes.

Run a bead of clear silicone rubber sealant on the bottom of the squared off end of pipe. Place the lexan disk on the bead of sealant.

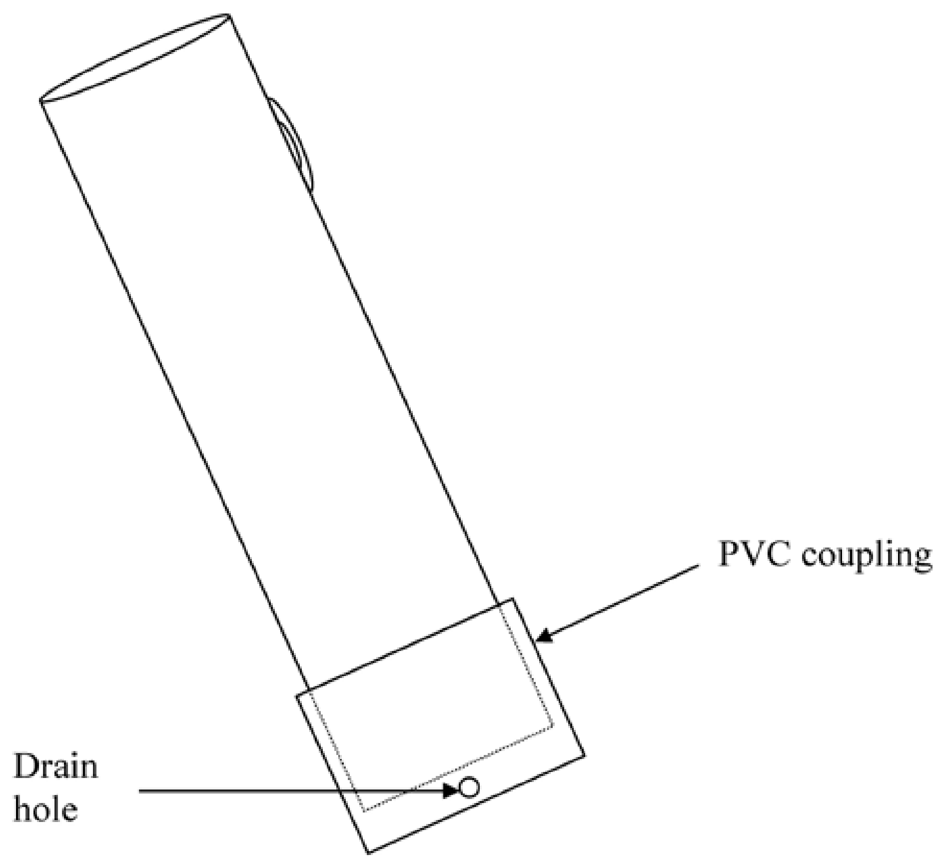
Smear a small amount of silicon sealant on the outside of the pipe one half inch from the end of the pipe with the lexan. Slide the coupling over the end and give it a slight twist to distribute the sealant evenly. Slide the coupling on as far as it will go. The collar will extend out beyond the lexan disk protecting it from scratching.

Drill two small (1/4”) holes in the side of the collar close to the lexan so that air won’t be trapped in the open end of the coupler when you put the view scope into the water. The holes should be drilled on opposite sides of the pipe.

Weatherstripping is placed around the top of the open end of the scope (the side you look into). Weatherstripping has a sticky side that sticks to the plastic and the foam makes it a little more comfortable for your face to rest against.

Aqua-view scope instructions adapted from those designed by Jeff Schloss, coordinator of New Hampshire Lakes Lay Monitoring Program (603) 862-3848.

Aqua-view scope drawing



3 Curly-leaf Pondweed

Monitoring Protocol

Appendix E-Monitor Protocol

Background/Overview

Curly-leaf pondweed is a non-native submerged aquatic plant. Its unique ability to thrive in cool water allows it to out-compete other aquatic plants. Curly-leaf pondweed can grow under the ice while most plants are dormant, but then dies back in mid-July when other plants are just reaching peak growth. This mid-summer die-off can cause dense mats of dying vegetation on the lake surface. When the plants die, nutrients such as phosphorus are released into the water, fueling algal blooms.

Curly-leaf pondweed is one of 80 pondweed species found throughout the world. It is native to the fresh waters of Eurasia, Africa and Australia. This aquatic plant was accidentally introduced into the United States when the common carp was brought in during the mid 1800's. It is thought to have made its way to Wisconsin in 1905 along with fish imported from Europe. DNR staff have just recently begun tracking lakes with curly-leaf pondweed, so there is not yet a complete listing of waterbodies in Wisconsin with curly-leaf pondweed. The information currently available on waterbodies known to have curly-leaf pondweed can be found at http://dnr.wi.gov/lakes/AIS/index.asp?folder=CLMN. **We need your help to determine which additional lakes have curly-leaf pondweed.**

Volunteers play an integral part in learning to recognize the plant and checking local lakes for the presence of curly-leaf pondweed. Early identification of the plant makes control much easier, and can help prevent the spread into other waterbodies. If you detect the invasives early enough, you may be able to prevent them from spreading throughout your lake system. It is cheaper to control small patches of invasives than to control invasives that have taken over an entire lake system. Once invasives are established in a lake, they are nearly impossible to eradicate.

Life Cycle

Curly-leaf pondweed has a unique life cycle. Unlike most of our native aquatic plants that come out of dormancy in spring and reach their maximum growth in late summer or early fall, curly-leaf pondweed normally begins growing in the fall. Depending upon snow cover and winter severity, curly-leaf pondweed may be dormant or actively growing under the ice. Curly-leaf pondweed has a large growth spurt from ice out to early spring.

Its natural inclination for low water temperatures helps it avoid competition with other plant species. Its fast, early spring growth allows the stems to reach the water's surface before any other plant. By late spring, a dense canopy of curly-leaf can form, blocking sun light from reaching other plants.

Curly-leaf pondweed plants usually complete their life cycle in June or July. When they die back, they can form dense mats of dying vegetation on the surface. If you notice that plants on your lake are dying back in June or early July, you will want to check to see if it is curly-leaf pondweed.

Turions and seeds are formed on the plants before they die. A turion is a dormant shoot segment (vegetative bud) that can form most anywhere on the plant. It is a hard structure that looks a little bit like a burr or pinecone. Although the plants also produce seeds, the turions are probably the most reliable form of reproduction. The turion falls to the bottom of the lake as the plant dies and begins to decay. Most of the turions begin to sprout in fall, responding either to the shortening day length or to water temperature. However, some turions will actually sprout in the spring and some will lie dormant in the sediment until environmental conditions are favorable to sprouting (turions can remain dormant for years).

For the plants that sprout in the fall, the initial growth form is a winter foliage that stays green (sometimes dormant or sometimes actively growing) even under the ice. The curly-leaf pondweed foliage in winter to early spring are quite narrow and lack the wavy edges. A few days after ice off, curly-leaf pondweed begins to grow more rapidly and attain its spring foliage (lasagna noodle wavy edges with the crispy appearance). Those turions that sprout in the spring also have the narrow "non-wavy" leaves when the plant first sprouts, then the wavy leaves develop as the plant grows.

Curly-leaf pondweed is tolerant of disturbance and can grow in most water conditions. One way to protect your lake from curly-leaf pondweed and other invasives is to protect and maintain native aquatic plant beds.

The turions are sometimes carried in muck attached to an anchor or dropped in the bottom of your boat. These turions can sprout and grow new curly-leaf pondweed colonies. Be sure to remove all aquatic plants from boating equipment, including your trailer, boat, motor/propeller and anchor before launching and after leaving the water. By removing aquatic plants from boating equipment and encouraging others to do the same, you can help protect Wisconsin lakes from curly-leaf pondweed and other invasives.

Identification

In your packet you will find a laminated example of curly-leaf pondweed (*Potomogeton crispus*, pronounced POT-a-mo-JEE-ton CRISP-us).

Refer to the pictures on the next page, as well as reference materials in your packet, to see the following characteristics:

Curly-leaf pondweed Characteristics:

- Alternate leaves that are minutely toothed (you may need a magnifying glass to see the teeth).
- Leaf edges are wavy and have a crispy appearance – hence the name. The leaves are often described as mini "lasagna noodle" looking leaves.
- Most leaves have a prominent red-tinged mid-vein.
- The stem is slightly flattened.
- No floating leaves. (Some native pondweeds produce specialized floating leaves that are thicker than submerged leaves and often have a waxy feel.)

- A short flower stalk may rise above the water's surface in spring, though the rest of the plant is submersed.
- Turions are produced and drop to the lake bottom when the plants decay in late summer. Turions are vegetative reproductive buds that are very rigid and resemble small pinecones.
- In winter and very early spring, the leaves on the plant are quite narrow and lack the wavy edges.

Curly-leaf pondweed can be confused with Clasping-leaf pondweed (*Potamogeton richardsonii*). Clasping-leaf pondweed does not have toothed leaf edges nor does it produce turions.

Curly-leaf pondweed

Photo provided by www.ppws.vt.edu/

Curly-leaf pondweed leaves are often light green and fairly transparent.

Curly-leaf pondweed

Photo by Susan Knight

Note the "lasagna-like" wavy leaves of curly-leaf pondweed.

Curly-leaf pondweed turion

Photo by Frank Koshere

Curly-leaf pondweed turion with leaves still attached. The leaves will eventually rot and fall off of the turion.

Clasping-leaf pondweed (native)

Photo provided by www.mlswa.org

Potamogeton richardsonii (Clasping-leaf pondweed)

Curly-leaf Pondweed Monitoring

Types of Monitoring

There are two types of monitoring for curly-leaf pondweed - Prevention Monitoring and Established Population Monitoring.

Prevention Monitoring

If a lake is not known to have curly-leaf pondweed, citizen lake monitors can play a very important role by regularly monitoring the lake for curly-leaf pondweed and reporting if curly-leaf pondweed is found or that nothing has been found. The "negative" information is important as it lets the lake managers know when curly-leaf pondweed is not in a lake so they can better focus their work efforts. If curly-leaf pondweed is found at an early stage, there may be hope of knocking it back. With the turions remaining viable for several years, multiple years of control are necessary – but with each control year, the treatment area and density should decrease. Several lakes that found curly-leaf pondweed at an early stage have been able to keep it "in check" with minimal cost and efforts.

Established Population Monitoring

If a lake is already known to have curly-leaf pondweed, citizen lake monitors can help track its spread. If treatment options are being used to control curly-leaf pondweed, citizen lake monitors can track the effectiveness of the management options by monitoring the spread or decline of curly-leaf pondweed. With the turions remaining viable for several years, multiple years of control are necessary – but with each control year, the treatment area and density should decrease.

Even if your lake group is controlling curly-leaf pondweed, you still want to monitor for curly-leaf pondweed. You want to know if they have spread to any new locations, so that you can begin control of these new beds ASAP. The earlier you find a new invasive, the easier it will be to control.

When to Monitor

Prevention Monitoring

Volunteers should try to monitor twice a month in May and June when curly-leaf pondweed is at its peak density. With this early season monitoring, it might be easier to see and identify. If you notice plants that suddenly disappear in late June or early July, it may be curly-leaf pondweed. Since curly-leaf pondweed is normally only dense for a few months, most groups monitor every 2-3 weeks. Some groups also check for curly-leaf pondweed in the late fall, as the new plants will be growing at this time and the native pondweeds are dying back. If curly-leaf pondweed plants are found in fall, a response could be planned into management for the following spring, if needed. This will increase the chances for control of curly-leaf pondweed. When checking the shorelines, it is especially important to check piles of plants and debris **after storms and high boat traffic times**, as this is when plant fragments will be the heaviest.

Established Population Monitoring

If you or your lake group have found new beds of curly-leaf pondweed, volunteers will probably want to monitor more carefully and more often. If treatment options are being used, it is very helpful to have volunteers monitor before and after treatment, especially around the treatment beds. In cases where treatment is occurring, more monitoring is better, especially if the plant may still be in an expanding stage within the lake. This allows the lake community to see if management options are working to meet their goals. The more involved lake residents are in monitoring, the more likely they will understand the process and support actions they see as reasonable and worthwhile.

Since curly-leaf pondweed comes from the over-summering turions, additional monitoring should take place in late fall or early the next season. Regular monitoring of a lake with curly-leaf pondweed allows you to locate new beds so they can be treated (by hand-pulling, chemical treatments, or other means) while the beds are still small. If curly-leaf pondweed plants are found in fall, beds can be treated as early in the spring as possible. This will increase the chances for control. An aquatic plant management plan (often required as a part of a permit for chemical treatment) may prescribe a monitoring schedule. For example, you may be required to follow the Pre- and Post-Treatment Evaluation of Aquatic Plant Community, DNR, 2008 (http://dnr.wi.gov/org/water/fhp/lakes/PrePostEvaluation.pdf).

Where do I Look for Curly-leaf pondweed?

Curly-leaf pondweed can survive in a wide range of lake conditions. It grows in water depths of less than 1-foot to water depths of about 15-feet. In Wisconsin, curly-leaf pondweed becomes the most dense in water depths of 3-10 feet, but can reach nuisance levels in as little as 1-foot to as deep as 15-feet. Curly-leaf pondweed does best in moderate to fertile lakes and does well in turbid water conditions. Curly-leaf pondweed is often associated with degraded water quality. Curly-leaf pondweed can live in sandy soils, but prefers soft substrates. Please remember, curly-leaf pondweed will grow throughout the entire lake where water depths are less than 15 feet, so do not just rely on monitoring "prime habitat" areas.

Prevention Monitoring

Even before looking for beds of curly-leaf pondweed, you will want to look for floating plants. Think about your lake. What is the direction of the prevailing winds and where are plants and floating debris likely to be? Go to the areas where you have seen the piles of plants and debris. Look in these piles to see if you can find any curly-leaf pondweed plant fragments. It is especially important to visit these areas **after storms and high boat traffic times**, as this is when the plant fragments will be the heaviest. Check **beach areas, inlets, boat launches, high use areas and the perimeter of the lake**.

When looking for rooted plants, look for curly-leaf pondweed in both sandy and mucky areas. Curly-leaf pondweed will grow in a variety of sediment conditions, but will do the best in areas with a mucky bottom.

Established Population Monitoring

If curly-leaf pondweed has been verified in your lake, you will probably want to monitor the existing beds as well as checking the rest of the lake to locate any new beds (especially if the plant may still be in an expanding stage within the lake). In cases where treatment is occurring, you will probably want to monitor in and around the treatment beds, as well as new areas around the lake to locate new plants if they have spread.

How to Monitor

Prevention Monitoring

Shorelines

When looking for floating plant fragments, look in shallow water areas and in piles of washed up plant fragments along the shoreline to see if you can find any curly-leaf pondweed plant fragments. It is especially important to visit these areas after storms and high boat traffic times, as this is when plant fragments will be the heaviest. If you find any curly-leaf pondweed fragments, you know the invasive is in your lake.

Shallow-water Areas

Boat or walk around the shoreline of your lake and look for curly-leaf pondweed in the shallow water areas.

Deeper-water Areas

Once you have monitored a variety of near shore areas, go out in your boat and begin to collect plants in the deeper water areas. It will be easiest to see the plants if you are wearing polarized sunglasses and/or using an Aqua-View Scope. Make sure the weather will allow for successful and safe sampling. Clear, calm weather is the best for sampling. Sunny skies make it easier to see into the water.

Use a long-handled rake to collect plants that are hard to reach or difficult to identify. In deeper areas, you can lower the rake to the bottom of the lake and drag the rake along. Pull the rope so that the rake pulls across several feet of the lake bed. This makes for relatively easy monitoring of deep water areas. This method will also help you pull up roots and collect plants that are not readily visible from the lake's surface. Be sure to monitor over sand as well as muck areas.

If you find beds of curly-leaf pondweed, you may want to determine how dense the beds are. This information will be very useful when determining the proper control method for your invasive.

Note

Please do not throw plants that you collect back into the lake. Instead, dispose of them on shore or take them for mulch or compost for your garden. If you toss back plants, you may inadvertently spread plants to different locations on the lake. Since it's sometimes difficult to know which plants are native and which are non-native, it is best not to throw any plants back into the lake.

Established Population Monitoring

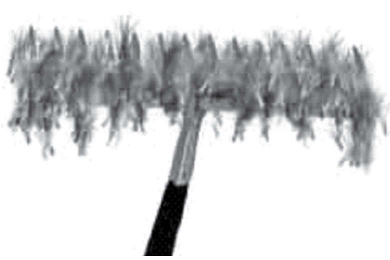
In cases where treatment is occurring, more monitoring is better, especially if the plant may still be in an expanding stage within the lake. This allows the lake community to see if management options are working to meet their goals. The more involved lake residents are in monitoring, the more likely they will understand the process and support actions they see as reasonable and worthwhile.

Look for curly-leaf pondweed plants in and around existing beds using polarized sunglasses and/or an Aqua-View Scope. Make sure the weather will allow for successful and safe sampling. Clear, calm weather is the best for sampling. Sunny skies make it easier to see into the water.

Use a rake to pull up and record the plant density of curly-leaf pondweed beds. In deeper areas, you can lower the rake to the bottom of the lake and drag the rake along. Pull the rope so that the rake pulls across several feet of the lake bed. This makes for relatively easy monitoring of deep water areas. This method will also help you pull up roots and collect plants that are not readily visible from the lake's surface.

On the Plant Bed Density Report, Form 3200-132, found at the end of this section and http://dnr.wi.gov/lakes/forms/, use the following numbers to denote the plant density for each invasive aquatic plant bed found.

Rake fullness ratings are given from 1-3. Conditions of the ratings are described below.

Rating	Coverage	Description
1		A few plants on rake head
2		Rake head is about ½ full Can easily see top of rake head
3		Overflowing Cannot see top of rake head

> **NOTE**
> Please do not throw plants that you collect back into the water. Instead, dispose of them in the trash or take them for mulch or compost for your garden.

Other Information You May Want to Collect

Sample Location

Record the sample GPS position.

Depth

Measure depth at each sampling site regardless of whether vegetation is present. A variety of options exist for taking depth measurements, including SONAR guns, depth finders that attach to the boat, or an anchor attached to a line with depth increments.

Dominant Sediment Type

Record sediment type (based on how the rake feels when in contact with the bottom) at each site where plants are sampled as: (a) mucky, (b) sandy, or (c) rocky.

If you are checking the rest of the lake to locate potential new beds of curly-leaf pondweed, follow the instructions in the Prevention Monitoring section above.

Equipment Needed

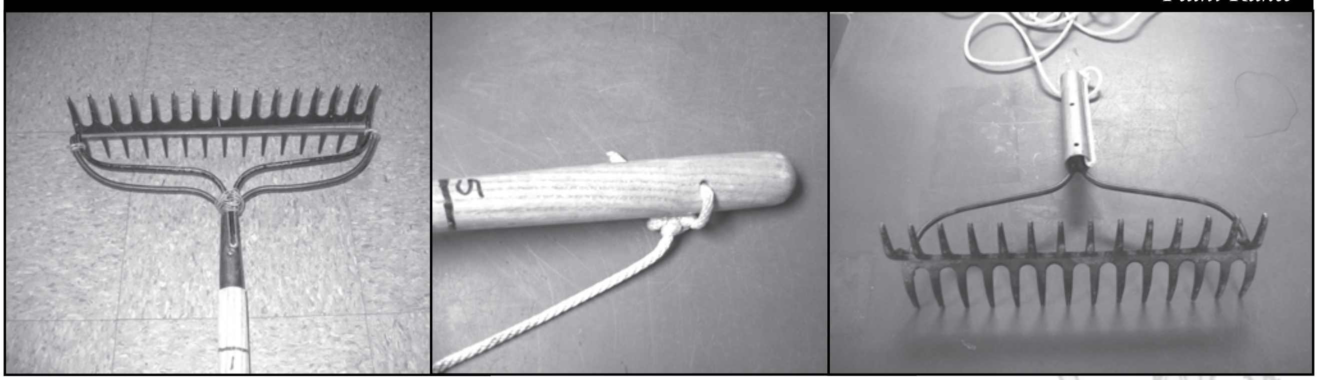
- ☐ Boat (canoe, kayak, fishing boat, paddle boat, etc.)
- ☐ Personal Floatation Device (PFD)
- ☐ Long handled rake with attached rope (see description and pictures on the next page)
- ☐ Lake map for marking suspect curly-leaf pondweed beds and keeping track of where you have been.
- ☐ Pencil for marking on map
- ☐ Clip board or other hard surface for writing
- ☐ Ziploc bags
- ☐ Waterproof sharpie pen (to write on Ziploc bags)
- ☐ Cooler to keep plants in
- ☐ GPS unit (optional)
- ☐ Polarized sunglasses (optional)
- ☐ Aqua-View Scope (optional). To build your own Aqua-View Scope, see construction directions at the end of this section (page 43-44).
- ☐ A copy of appropriate report form(s) (found at the end of this section and at http://dnr.wi.gov/lakes/forms) depending on the type of monitoring you are doing:
  - Aquatic Invasives Presence/Absence Report, Form 3200-124
  - Aquatic Invasive Plant Incident Report Form, 3200-125
  - Plant Bed Density Reporting Form, 3200-132

Plant Rakes

Since it is sometimes difficult to identify plants under water, volunteers use rakes to sample plants. When the rake is thrown into the water, it settles to the bottom of the lake. When the rake is hauled back into the boat, aquatic plants come with it making for easier identification. A thatching rake can be used, or you can make a "2-headed" garden rake by purchasing 2 garden rakes (try looking at garage sales). Disconnect the head from one rake and wire or weld the rake heads together (teeth facing out). To monitor in deeper water, drill a hole in the end of the handle and tie a rope to it. With the two heads, no matter which way the rake falls to the lake bed, the teeth will catch the roots of the plants making plant collection a lot easier. If you need to make the rake heavier, you can use cable ties to attach duck decoy weights, a small brick or other weights. Some volunteers do not like to deal with a rake handle in deeper water, so they cut off the rake handle and attach the rope directly to the rake heads. If you use this type of rake, it is essential that you weigh the rake by using the decoy weights, a small brick, hand weights, etc. No matter which rake is used, please be sure to tie the loose end of the rope to the boat. This way you will not lose your sampling rake.

Plant Rakes

Photos by Sandy Wickman



A rope is tied to the handle of this "2-headed" garden rake, so it can be used in deep water.

Setting up a Monitoring Team

Often it is easier to "divide" up the work than to rely on one volunteer to monitor an entire lake for invasives. Designate a team leader (and maybe an assistant) who is willing to keep track of what areas are being monitored and who is doing monitoring. The team leader can also be the person who enters the monitoring results on the CLMN website http://dnr.wi.gov/lakes/CLMN and the person to whom other volunteers can bring suspect species. If assistance in identification is needed, the team leader can take the species to DNR, UW-Extension, or the County Land and Water Conservation staff for vouchering. By having the team leader take in suspect plants, you will not have the confusion of every team member taking in plants and you will be able to keep a list of what plants have been taken in and identified. Some groups have asked bait dealers or other businesses to "hold" suspect plants bought in by residents. Then the team leader can collect the plants from the bait dealers and take them in for identification when necessary. By the end of the summer, your team leader should be quite familiar with the native plants in your lake. If you are mapping native plants as part of your CLMN monitoring, you will probably not have to submit all your plants to be vouchered. Be creative and most importantly, do not burn out your team leaders!

Consider having a mini-plant training session for your team. The Citizen Lake Monitoring Network Coordinator or the Aquatic Plant Management Coordinator (refer front of manual and http://dnr.wi.gov/lakes/contacts for your area may be able to assist you with a training session. If not, contact your local CLMN contact to see if an Aquatic Invasive Species training session will be scheduled for your area. These sessions are often set up in conjunction with local lake fairs and conventions. AIS workshops and training sessions are also listed at http://www.uwsp.edu/cnr/uwexlakes/CLMN/training.asp.

Mapping

A map is a very quick and reliable way to assure that everyone knows the place you are talking about when you describe a certain point on your lake. A map will assist you in locating plant communities, recreational and habitat use areas, and more. At the end of the season, you can map all of the sites visited.

If you have a team of monitors, a map will also assist your team in deciding who will monitor where. Once you have your "team" together, print out a map so that you can mark which areas each volunteer is monitoring. Your team leader should keep the master copy of the map. It may be easiest to have volunteers monitor the areas by their homes or where they fish. Assigning smaller (1/2 or 1-mile) stretches of shoreline per volunteer will be less overwhelming than monitoring larger areas of the lake.

You can get maps from your local DNR office, Fishing Hot Spots, fishing map books, etc. Basic lake maps can also be generated through the DNR Surface Water Viewer: http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer. When using the surface water viewer to generate a basic lake map, the easiest way to get where you want to go is by using the "Zoom To" button.

For example, say you want a basic lake map of Bearskin Lake in Oneida County. Use the drop down button at the left of the screen (it will say city or village) click on the down arrow and click on 'County'. Then go to the drop down arrow in the next line and click on Oneida. Then click on [Go!]. The Oneida County map will appear on the right. If you move your cursor/mouse on the map and left click, the map will zoom to the area under the cursor. Keep zooming in until you have the lake you want (you can zoom out if you overshoot your target lake). Once you have your lake in the box, click on the print button near the top of your screen and then click on ok. To see what you will be printing, click on [open map]. Once you try this a few times, it will get easier. Also, via the Layers tab, you can select what you want to show.

You might want to consider obtaining a surveyed contour or bathymetric map of your lake. The DNR has many of these maps on their website at http://dnr.wi.gov/org/water/fhp/lakes/lakemap/ .

For example, if you want to print out a bathymetric map for Bearskin Lake, Oneida County, click on the down arrow key next to Counties. Select Oneida County. Then page down to Bearskin Lake. Left click on Bearskin Lake. Click on "For a More Detailed Lake Map". Now just follow the directions. To print this to a letter size paper, right click on the map and "save picture as" a file on your computer. Start Microsoft Word (or other word processing program), then click on the tabs: "File" "Page Setup" "Paper Size" "Landscape" "ok" and "insert" "picture" "from file" and pick the lake map file and then print it.

Use a map source that is most convenient for you. Make sure the following information is on your lake map: lake name, county, sites monitored, date(s), volunteer(s), and any additional observations.

If you are monitoring existing beds of curly-leaf pondweed and you have a GPS unit, you may want to mark in the edges of the beds, and then load this data into a mapping program and print out maps of the beds. You may also want to mark other locations monitored.

Reporting

What would all the work that goes into gathering accurate information be worth if others could not read, review and act on it? Reporting is one of the most important parts of monitoring for invasive species. Knowing where species are not, as well as where they are, is extremely important in being able to track and understand their spread. Knowing how often monitors are looking for species and what they are finding is very important information.

The DNR, lake managers, researchers, and others use the information that is reported through the Citizen Lake Monitoring Network to study lakes and better understand aquatic invasive species. The information reported by volunteers is also provided to the state legislature, federal, tribal and local agencies/organizations that in turn may use this data to help determine funding for invasive species grants and programs.

You can enter your monitoring results on the CLMN website: http://dnr.wi.gov/lakes/CLMN (click "Enter Data" on the left side bar). If you don't yet have a user id and password, click 'Request a Wisconsin User ID and Password', then email Jennifer at jennifer.filbert@wisconsin.gov with your User ID and what monitoring you are involved in. Jennifer will set up your accounts and email you back. Once you receive a confirmation email, you can log in. Once you're logged in, go to the 'Submit Data' tab and click "Add New" to start entering data. Choose the AIS monitoring project for your lake in the *Project* dropdown box.

- For prevention monitoring, report your results using the: Aquatic Invasives Presence/ Absence Report, Form 3200-124.

- If you find curly-leaf pondweed for the first time on your lake, report your results using the: Aquatic Invasive Plant Incident Report, Form 3200-125.

- For established population monitoring, report your results using the Plant Bed Density Report, Form 3200-132. At this time, there is no computer data entry option for this form. Online data forms will be created as time allows. The data collected with this form will be very useful in tracking the spread of curly-leaf pondweed throughout the lake if curly-leaf pondweed does spread and is necessary in tracking success of your management option. Keep hard copies for your reference and/or submit them to your local DNR Aquatic Plant Management Coordinator.

You can report your results as often as you wish, but be sure to at least report results once a year, at the end of the monitoring season. If you are doing Established Population Monitoring, you will probably want to report your results more often. If you have any questions about reporting, contact your local DNR CLMN contact (page viii).

NOTE

Remember, for prevention monitoring, a report of 'no curly-leaf pondweed' at a location is just as important as finding curly-leaf pondweed. One cannot confidently state that curly-leaf pondweed is not present in an area if no one has looked.

What to do with Suspect Plants

Note the "suspect" plant's location on your map, making sure you can find the spot(s) again. Fill out the Aquatic Invasive Plant Incident Report (Form 3200-125) (found at the end of this section, and at http://dnr.wi.gov/lakes/forms/, and deliver it with the suspect plant to your team leader or local DNR CLMN contact. Suspect plants need to go to a herbarium for vouchering. DNR staff can transport plants to the herbarium for the lake group.

To collect a specimen of the plant:

- Gently pull the plant from the lake bottom. Be sure to collect as much of the plant as possible, paying special attention to getting the leafy and flowering portion, if present. Try not to break up or rip the plant as the pieces of the plant can float away and start new plants.
- Use a permanent marker and record the following information on a plastic bag:
  a. Date
  b. Water body
  c. Description of where the sample was found.

Appendix E-Monitor Protocol

- Put the sample in the plastic bag and keep it in a cool place (a cooler in your car or refrigerator at home). Take the specimen to your team leader, your local CLMN contact, your local Land and Water Conservation Department, UW-Extension office or the local DNR contact for identification. If you found curly-leaf pondweed in a lake where it has not been verified before, it is important to get the plants verified and vouchered (usually by an herbarium botanist) ASAP, so that control can take place in a timely manner. Your local CLMN contact will get the plant to the DNR or local herbarium.

> **NOTE**
> If your lake has been verified to have curly-leaf pondweed, samples do not need to go to the DNR for vouchering – you can just take the plants to your team leader.

- If you cannot bring the plant in to your team leader or other contact:
  - Rinse the plant under running tap water or in a large pan of water. This will slow the rotting process.
  - Blot the plant dry with a paper towel.
  - Spread the plant out on a dry paper towel or newspaper. Try to spread the leaflets apart to help with identification.
  - Cover with a dry paper towel and press in a catalog or phone book for about a week.
  - Complete a label (see example at the end of this section) and the Aquatic Invasive Plant Incident Report (Form 3200-125) (found at the end of this section and at http://dnr.wi.gov/lakes/forms/).
  - When the plant is dry, place it between sheets of thin cardboard (like a cereal box). Mail the plant, map and the reporting form to your local CLMN contact.
  - Remember to make a copy of your map and reporting forms for your records.

Remember if you find "something," don't give up; there are a variety of control and management options to address invasive species on your lake. Early detection is the key to controlling the situation!

> **PREVENTION STARTS WITH US**
>
> Whether you are out monitoring, or just boating for fun, be sure to remove all aquatic plants from boating equipment, including your trailer, boat, motor/propeller and anchor before launching and after leaving the water. By removing aquatic plants from boating equipment and encouraging others to do the same, you can help protect Wisconsin lakes from Curly-leaf Pondweed.

Appendix E-Monitor Protocol

Algae — Small aquatic plants containing chlorophyll and without roots that occur as single cells or multi-celled colonies. Algae form the base of the food chain in aquatic environments.

Algal bloom — A heavy growth of algae in and on a body of water as a result of high nutrient concentrations.

Alkalinity — The acid combining capacity of a (carbonate) solution, also describes its buffering capacity.

Aquatic Invasive Species (AIS) — Refers to species of plants or animals that are not native to a particular region into which they have moved or invaded. Zebra mussels and Eurasian water-milfoil are examples of AIS. Wisconsin has laws preventing the spread on boats and trailers.

Aquatic plant survey — a systematic mapping of types and location of aquatic plants in a water body, usually conducted by means of a boat. Survey information is presented on an **aquatic plant map**.

BMP's (Best Management Practices) — practices or methods used to prevent or reduce amounts of nutrients, sediments, chemicals or other pollutants from entering water bodies from human activities. BMP's have been developed for agricultural, forestry, construction, and urban activities.

Bathymetric map — a map showing depth contours in a water body. Bottom contours are usually presented as lines of equal depth, in meters or feet. Often called a hydrographic map.

Benthal — Bottom area of the lake (Gr. *benthos* depth).

Biocontrol — management using biological organisms, such as fish, insects or micro-organisms like fungus.

Biomass — The total organic matter present (Gr. *bios* life).

Bottom barriers — synthetic or natural fiber sheets of material used to cover and kill plants growing on the bottom of a water body; also called sediment covers.

Chlorophyll — The green pigments of plants (Gr. *chloros* green, *phyllon* leaf).

Consumers — Organisms that nourish themselves on particulate organic matter (Lat. *consumere* to take wholly).

Contact herbicide — An herbicide that causes localized injury or death to plant tissues with which it contacts. Contact herbicides do not kill the entire plant.

Decomposers — Organisms, mostly bacteria or fungi, that break down complex organic material into its inorganic constituents.

Detritus — Settleable material suspended in the water: organic detritus, from the decomposition of the broken down remains of organisms; inorganic detritus, settleable mineral materials.

Dissolved oxygen — A measure of the amount of oxygen gas dissolved in water and available for use by microorganisms and fish.

Drainage basin — The area drained by, or contributing to, a stream, lake, or other water body (see watershed).

Drawdown — Decreasing the level of standing water in a water body to expose bottom sediments and rooted plants. Water level drawdown can be accomplished by physically releasing a volume of water through a controlled outlet structure or by preventing recharge of a system from a primary external source.

Dredging — A physical method of digging into the bottom of a water body to remove sediment, plants or other material. Dredging can be performed using mechanical or hydraulic equipment.

Ecology — A scientific study of relationships between organisms and their surroundings (environment).

Ecosystems — Any complex of living organisms together with all the other biotic and abiotic (non-living) factors which affect them.

Emergent plants — Aquatic plants that are rooted or anchored in the sediment around shorelines, but have stems and leaves extending well above the water surface. Cattails and bulrushes are examples of emergent plants.

Endothall — The active chemical ingredient of the aquatic contact herbicide Aquathol®.

Epilimnion — The uppermost, warm, well-mixed layer of a lake (Gr. *epi* on, *limne* lake).

Eradication — Complete removal of a specific organism from a specified location, usually refers to a noxious, invasive species. Under most circumstances, eradication of a population is very difficult to achieve.

Euphotic zone — That part of a water body where light penetration is sufficient to maintain photosynthesis.

Eutrophic — Waters with a good supply of nutrients and hence a rich organic production (Gr. *eu* well, *trophein* to nourish).

Exotic — Refers to species of plants or animals that are not native to a particular region into which they have moved or invaded. Eurasian water-milfoil is an exotic plant invader.

Floating-leafed plant — Plants with oval or circular leaves floating on the water surface, but are rooted or attached to sediments by long, flexible stems. Waterlilies are examples of rooted floating-leafed plants.

Fluridone — The active chemical ingredient of the systemic aquatic herbicide SONAR®.

Flushing rate — Term describing rate of water volume replacement of a water body, usually expressed as basin volume per unit time needed to replace the water body volume with inflowing water. The inverse of the flushing rate is the (hydraulic) detention time. A lake with a flushing rate of 1 lake volume per year has a detention time of 1 year.

Freely-floating plants — Plants that float on or under the water surface, unattached by roots to the bottom. Some have small root systems that simply hang beneath the plant. Water hyacinth and tiny duckweed are examples of freely-floating plants.

Glyphosate — The active chemical ingredient of the systemic herbicide RODEO®.

Grass carp — Also known as white amur, grass carp is a large, vegetation-eating member of the minnow family (*Ctenopharyngodon idella*). Originally from Russia and China, these plant grazers are sometimes used as biological agents to control growth of certain aquatic plants. Regulated use of sterile (non-reproducing) grass carp has been recently permitted in Washington State for aquatic plant control.

Herbicide — A chemical used to suppress the growth of or kill plants.

Habitat — The physical place where an organism lives.

Hydraulic detention time — The period of detention of water in a basin. The inverse of detention time is flushing rate. A lake with a detention time of one year has a flushing rate of 1 lake volume per year.

Hypolimnion — The cold, deepest layer of a lake that is removed from surface influences (Gr. *hypo* under, *limne* lake).

Limiting nutrient — Essential nutrient needed for growth of plant organism which is the scarcest in the environment. Oftentimes, in freshwater systems, either phosphorus or nitrogen may be the limiting nutrient for plant growth.

Limnology — The study of fresh water (Gr. *limne* lake).

Littoral — The region of a body of water extending from shoreline outward to the greatest depth occupied by rooted aquatic plants.

Macro-algae — Large, easily seen (macroscopic) algae. The macro-algae *Nitella* sp. sometimes forms dense plant beds and can be a conspicuous member of the aquatic plant community.

Macrophyte — Large, rooted or floating aquatic plants that may bear flowers and seeds. Some plants, like duckweed and coontail, are free-floating and are not attached to the bottom. Occasionally, filamentous algae like *Nitella* sp. can form large, extensive populations and be an important member of the aquatic macrophyte community.

Mitigation — Actions taken to replace or restore animals or plants that may have been damaged or removed by certain prior activities.

Morphology — Study of shape, configuration or form (Gr. *morphe* form, *logos* discourse).

Niche — The position or role of an organism within its community and ecosystem.

Nitrogen — A chemical constituent (nutrient) essential for life. Nitrogen is a primary nutrient necessary for plant growth.

Non point (pollutant) source — A diffuse source of water pollution that does not discharge through a pipe or other readily identifiable structure. Non point pollution typically originates from activities on land and the water. Examples of non point sources are agricultural, forest, and construction sites, marinas, urban streets and properties.

Non-target species — A species not intentionally targeted for control by a pesticide or herbicide.

Noxious weed — A non-native plant species that, because of aggressive growth habits, can threaten native plant communities, wetlands or agricultural lands.

Nutrient — Any chemical element, ion, or compound required by an organism for the continuation of growth, reproduction, and other life processes.

Oligotrophic — Waters that are nutrient poor and have little organic production (Gr. *oligos* small, *tropheín* to nourish).

Oxidation — A chemical process that can occur in the uptake of oxygen.

pH — The negative logarithm of the hydrogen ion activity. pH values range from 1-10 (low pH values are acidic and high pH levels are alkaline).

Phosphorus — A chemical constituent (nutrient) essential for life. Phosphorus is a primary nutrient necessary for plant growth.

Photosynthesis — Production of organic matter (carbohydrate) from inorganic carbon and water in the presence of light (Gr. *phos*, *photos* light, *synthesis* placing together).

Phytoplankton — Free floating microscopic plants (algae) (Gr. *phyton* plant).

Point (pollutant) source — A source of pollutants or contaminants that discharges through a pipe or culvert. Point sources, such as an industrial or sewage outfall, are usually readily identified.

Pollutant — A contaminant, a substance that is not naturally present in water or occurs in unnatural amounts that can degrade the physical, chemical, or biological properties of the water. Pollutants can be chemicals, disease-producing organisms, silt, toxic metals, oxygen-demanding materials, to name a few.

Primary production — The rate of formation of organic matter or sugars in plant cells from light, water and carbon dioxide (Lat. *primus* first, *producere* to bring forward). Algae are primary producers.

Problem statement — A written description of important uses of a water body that are being affected by the presence of problem aquatic plants. See Chapter 3.

Producers — Organisms that are able to build up their body substance from inorganic materials (Lat. *producere* to bring forward).

Public Trust Doctrine — A body of law Programs having roots in Roman law, English common law and the North West Ordinance of 1787. It grants authority to the state to regulate it's waters, it establishes public rights of use and defines state property rights in navigable waters.

Residence time — The average length of time that water or a chemical constituent remains in a lake.

Rotovation — A mechanical control method of tilling lake or river sediments to physically dislodge rooted plants. Also known as bottom tillage or derooting.

Secchi disc — A 20-cm (8-inch) diameter disc painted white and black in alternating quadrants. It is used to measure light transparency in lakes.

Sediment — Solid material deposited in the bottom of a basin.

Sensitive areas — Critical areas in the landscape, such as wetlands, aquifer recharge areas, and fish and wildlife habitat conservation areas, that are protected by state law (Growth Management Act of 1990).

Standing crop — The biomass present in a body of water at a particular time.

Steering committee — A small group of people organized to represent the larger community of individuals, businesses and organizations who have an interest in management of a particular water body. The steering committee is responsible for following the planning steps outlined in this manual.

Stratification — Horizontal layering of water in a lake caused by temperature-related differences in density. A thermally stratified lake is generally divided into the epilimnion (uppermost, warm, mixed layer), metalimnion (middle layer of rapid change in temperature and density) and hypolimnion (lowest, cool, least mixed layer).

Submersed plants — An aquatic plant that grows with all or most of its stems and leaves below the water surface. Submersed plants usually grow rooted in the bottom and have thin, flexible stems supported by the water. Common submersed plants are milfoil and pondweeds.

Susceptibility — The sensitivity or level of injury demonstrated by a plant to effects of an herbicide.

Systemic herbicide — An herbicide in which the active chemicals are absorbed and translocated within the entire plant system, including roots. Depending on the active ingredient, systemic herbicides affect certain biochemical reactions in the plant that can cause plant death. SONAR® and RODEO® are systemic herbicides.

Thermal stratification — Horizontal layering of water in a lake caused by temperature-related differences in density. A thermally stratified lake is generally divided into the epilimnion (uppermost, warm, mixed layer), metalimnion (middle layer of rapid change in temperature and density) and hypolimnion (lowest, cool, least mixed layer).

Thermocline — (Gr. *therme* heat, *klinein* to slope.) Zone (horizontal layer) in water body in which there is a rapid rate of temperature decrease with depth. Also called metalimnion, it lies below the epilimnion.

Topographic map — A map showing elevation of the landscape in contours of equal height (elevation) above sea level. This can be used to identify boundaries of a watershed.

Transect lines — Straight lines extending across an area to be surveyed.

Tributaries — Rivers, streams or other channels that flow into a water body.

Triclopyr — The active ingredient of a systemic herbicide being evaluated in Washington for aquatic plant control.

Triploid — A genetic term referring to non-reproducing (sterile) forms of grass carp induced by manipulating reproductive genes. Reproducing grass carp have two pairs of chromosomes and are termed diploid. Triploid fish have three sets of chromosomes.

Trophic state — Term used to describe the productivity of the lake ecosystem and classify it as oligotrophic (low productivity, "good" water quality), mesotrophic (moderate productivity), or eutrophic (high productivity; "poor" water quality).

Vascular plant— A vascular plant possesses specialized cells that conduct fluids and nutrients throughout the plant. The xylem conducts water and the phloem transports food.

Water body usage map — A map of a water body showing important human use areas or zones (such as swimming, boating, fishing) and habitat areas for fish, wildlife and waterfowl. See Chapter 7.

Watershed — The entire surface landscape that contributes water to a lake or river. See drainage area.

Watershed management — The management of the natural resources of a drainage basin for the production and protection of water supplies and water-based resources.

Wetland — A generalized term for a broad group of wet habitats. Wetlands are areas of vegetation that are transitional between land and water bodies and range from being permanently wet to intermittently water covered.

Zooplankton — Microscopic animal plankton in water (Gr. *zoion* animal). *Daphnia* sp. or water fleas are freshwater zooplankton.

Thank you to the Washington State Department of Ecology; Maribeth Gibbons Jr.

http://www.ecy.wa.gov/programs/wq/plants/management/manual/