Aquatic Plant Management Plan

Grindstone Lake, Sawyer County Wisconsin
WBIC: 2391200

Sponsored by: Grindstone Lake Association and Wisconsin DNR

Prepared by: Harmony Environmental

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Introduction

This Aquatic Plant Management Plan is for Grindstone Lake, Sawyer County Wisconsin. It presents data about the plant community, watershed, and water quality of Grindstone Lake. Based on this data and public input, this plan provides goals as well as strategies for the sound management of aquatic plants in the lake. This encompasses preservation of native species related to their benefit to the lake ecosystem, enhancing fish habitat, maintaining good water quality, and reducing/preventing the establishment of aquatic invasive species. The plan reviews public input, summarizes data, discusses management options and alternatives, and recommends action items. This plan will guide the Grindstone Lake Association and Wisconsin Department of Natural Resources in aquatic plant management.

Public Input for Development

In June of 2005, the Grindstone Lake Association voted to apply for a large scale Lakes Planning Grant to complete a baseline macrophyte survey and an aquatic plant management plan.[2] In July of 2006, information was provided to the trustees about what a macrophyte study and aquatic plant management plan entails. The importance of plants in the lake ecosystem was also discussed.[3]

The Grindstone Lake Association board members and the Aquatic Plant Management Committee provided the public input. A survey of property owners was conducted in March of 2006. In addition, comments at the 2006 annual meeting provided further input. Both the meeting comments and the survey indicate plant management as a very important issue. The issue largely is based on concerns over water quality, invasive species, as well as loss of native aquatic plants.

The Aquatic Plant Management Committee was comprised of members from the Grindstone Lake Association, with attendance from Lac Courte Oreilles Conservation Department and the Wisconsin Department of Natural Resources. This committee reviewed all data provided and developed goals based on that data as well as comments from concerned citizens. Based on public input, the Aquatic Plant Management Committee recognizes the importance of plant management in Grindstone Lake. They also understand the importance of aquatic plants in the lake ecosystem and the need for education about this issue.

Grindstone Aquatic Plant Management Committee members:

- Bruce Paulson, Grindstone Lake Association Board
- Linn Newton, Grindstone Lake Association Board
- Dan Tyrolt, LCO Conservation Department
- Steve Bucgart, Professional fisherman
- Bob Oesterreicher, Musky fisherman

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2 From minutes of June 11, 2005 Grindstone Lake Association meeting.
3 From minutes of July 8, 2006 Grindstone Lake Assocciation meeting.

Property Owners Survey[4]

The Grindstone Lake Association conducted a survey of Grindstone Lake property owners in March 2006. The following is the rank of top concerns:

1. Quality of the water.
2. Controlling invasive species.
3. Aquatic plant management
4. Boating
5. Quality of fishing[1]
5. Shoreline management[1]
5. Education of lake users[1]
5. Observing wildlife[1]

[1]These four items were a tie for the fifth top concern.

Some of the comments that were present on the survey were in relationship to plant management. Two comments were about the increase in algae growth on the rocks. Another comment expressed concern about education at the boat landings. One comment expressed concern about monitoring the landings to keep milfoil out.

Lake Management Concerns

This Aquatic Plant Management Plan addresses the top concerns of the Aquatic Plant Management Committee, representing the Grindstone Lake Association:

- The introduction of invasive species into Grindstone Lake.
- The increase in algae growth on the lake bottom.
- Reduction of important aquatic plant stands.
- Protection of important fish/wildlife habitats.
- Water quality degradation.

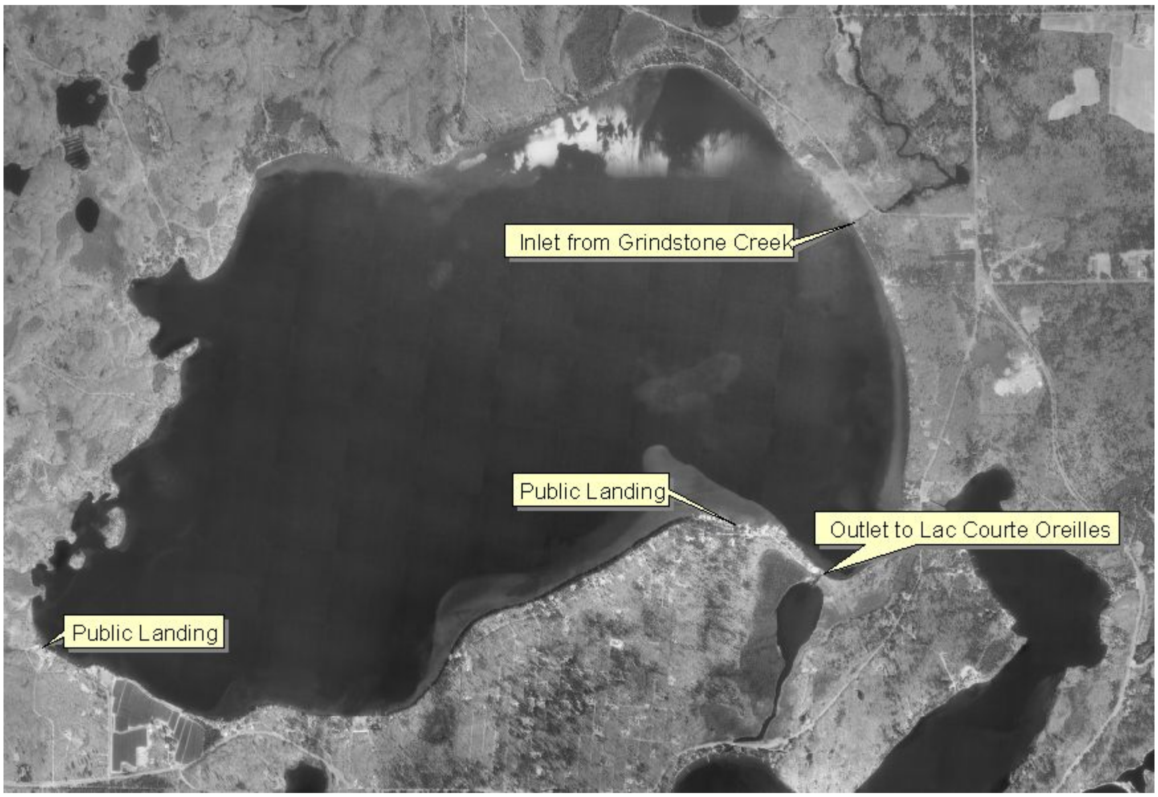
Lake Information

Grindstone Lake is a 3111 acre lake located in Sawyer County, Wisconsin in the Town of Bass Lake (T40N R08W S29); WBIC: 2391200. It is a drainage lake with the main input from Grindstone Creek and outflows into Lac Courte Oreilles. The watershed area is approximately 9675 acres. The maximum depth is 60 feet, with a mean depth of 30 feet.

[4] Grindstone Property Owners Survey, conducted March, 2006 by Grindstone Lake Association.

The Lac Courte Oreilles Conservation Department along with the Wisconsin Department of Natural Resources, sponsored water quality monitoring as well as a water quality comprehensive study in 1998. There have been continued water chemistry and secchi depth readings collected from 1995 until 2005. This monitoring is still being conducted.

Figure 1: Grindstone Lake inlet, outlet and public landings.



Water Quality

Grindstone Lake Water Quality Study[5]

In1998, the Lac Courte Oreilles Conservation Department conducted a comprehensive water quality study. In this study, Grindstone Lake nutrient loading was modeled to determine the trophic status of the lake and identify the nutrient loading sources by land use designation.

Based on the data collected, Grindstone Lake was classified as a mesotrophic lake, with many values very close to the oligotrophic level. The lake has high water clarity, especially when considering the total phosphorus values, which indicate the trophic status should be lower.

[5] Grindstone Lake Water Quality Study. Daniel Tyrolt, LCO Conservation Dept. Sept. 2000.

The phosphorus budget analysis estimated that the total annual phosphorus loading to Grindstone Lake was 3,758 pounds per year. Grindstone creek contributed the largest amount of phosphorus (1161 lbs) at 30.9%. A high volume of low phosphorus water is discharged from the creek on a year round basis, resulting in significant loading to the lake. The next largest phosphorus source is atmospheric deposition. The atmospheric component contributes 20.7% of the annual phosphorus load (778 lbs). Agricultural land uses comprises the next largest loading at 15.9% (598 lbs). The remaining budget contributions are as follows: Forested 13.3%(500 lbs), residential 13% (494 lbs), septic systems 3% (120 lbs), wetlands 1.8% (68 lbs) and cranberry bog 0.4% (13 lbs). There appeared to be very minimal internal loading of 0.7% of the budget (26 lbs) largely due to the fact the lake is anoxic (void of oxygen) in the hypolimnion for a very short period and over a small area during the summer and fall.

Potential land use changes were also modeled. It was predicted that if forested land is converted to agriculture or residential land it could result in a 2 ug/L in-lake phosphorus concentration increase, leading to a decrease in Secchi depth by two feet.

Since 1995 water quality data has been collected during the summer months. The following graphs show the mean values over the years 1995 to 2005. These graphs allow for the analysis of any potential trends in water quality.

Figure 2. Phosphorus trends from 1995-2005

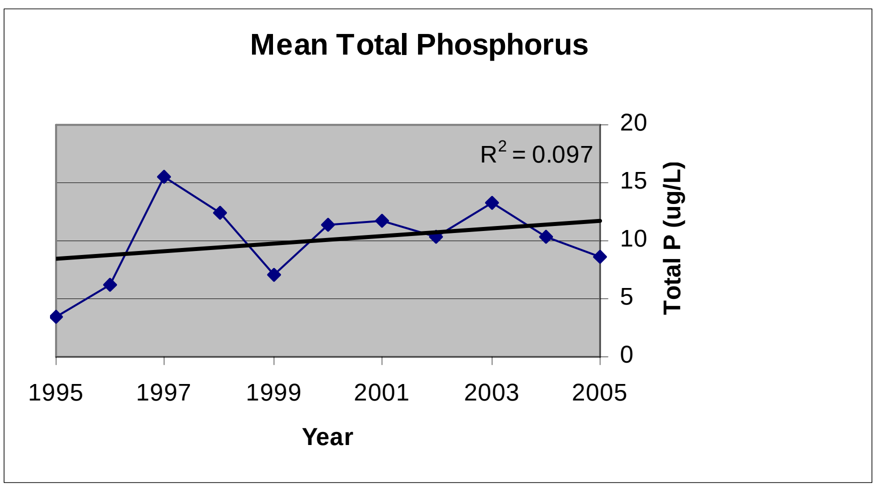


Figure 3. Secchi depth trends 1993-2005

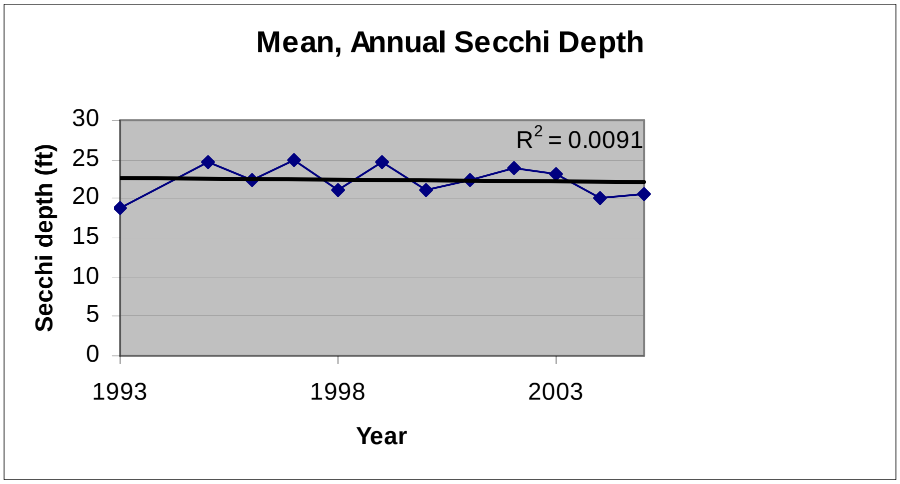
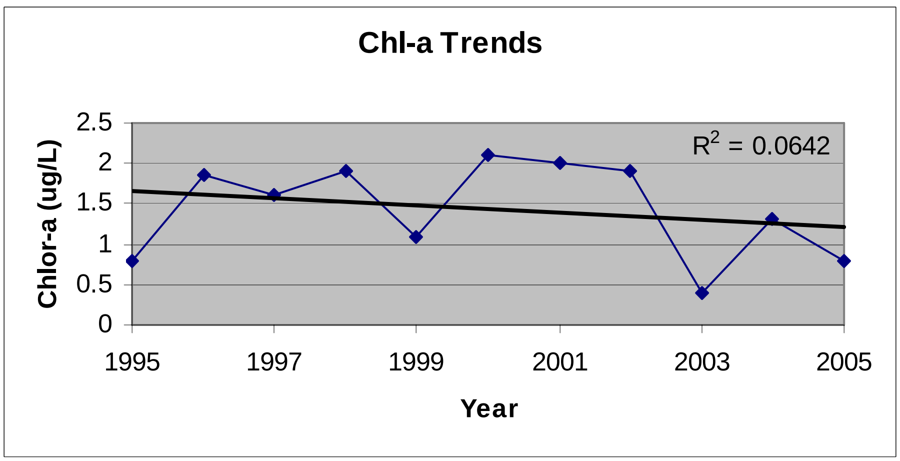


Figure 4. Chlorophyll-a trends 1995-2005

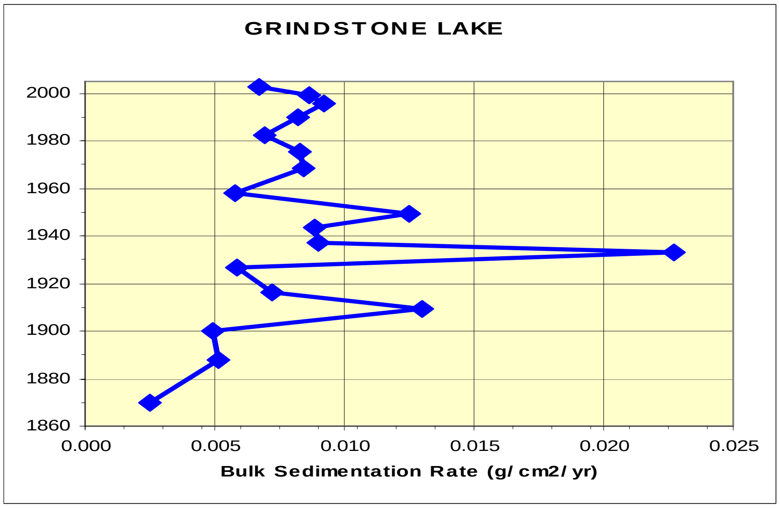


Core sample data[5]

The Wisconsin DNR completed a paleolimnologic analysis on Grindstone Lake in 2006. This analysis involves studying sediment cores. The sediment cores have layers that can be dated. Through composition and diatom analysis, the historical sedimentation rates and nutrient levels in the lake can be determined. The sediment cores obtained in Grindstone Lake allowed the researchers to go back 150 years in time. Below is a graph of the historical sedimentation rates.

5 Information from a preliminary report letter to Dan Tyrolt, Environmental Engineer Lac Courte Oreilles Conservation Dept. from Paul Garrison, Wisconsin DNR Research Scientist. November 2, 2006.

Figure 5. Sedimentation rate of Grindstone Lake over past 150 years.



In a preliminary report letter, Paul Garrison of the Wisconsin DNR writes:

Grindstone Lake has one of the lowest mean sedimentation rates (0.007 g cm^{-2} yr^{-1}) in the last 150 years that I have measured in the 46 Wisconsin lakes. This is not unexpected since the lake's water quality is good. More importantly, the sedimentation rate is relatively unchanged during this time period. The only exception was around 1933 when there was a spike in the rate. The geochemical profiles indicate little change during the last 150 years except for the last 5-10 years. During the last decade it appears that eutrophication is beginning. There has been an increase in the deposition of the nutrients phosphorus and nitrogen. The diatom community also indicates there has been little change in the lake's water quality until the last decade. At the top of the core there is an increase in the diatom species that indicate increased nutrients, especially phosphorus. The core indicates there has been little change in the submerged plant community throughout the last 150 years. In many lakes in the northern part of the state with shoreline development this is not the case. Most of these lakes, including Lac Courte Oreilles, have experienced an increase in the density of plants during the last few decades.

In summary Grindstone Lake has changed little during the last 150 years until the last decade. Since about 1995 the geochemistry and the diatom community indicate that the water quality is being [sic] to degrade, although changes have been small. However, this is an indication that the trend is in the wrong direction and now is the time to reverse this.

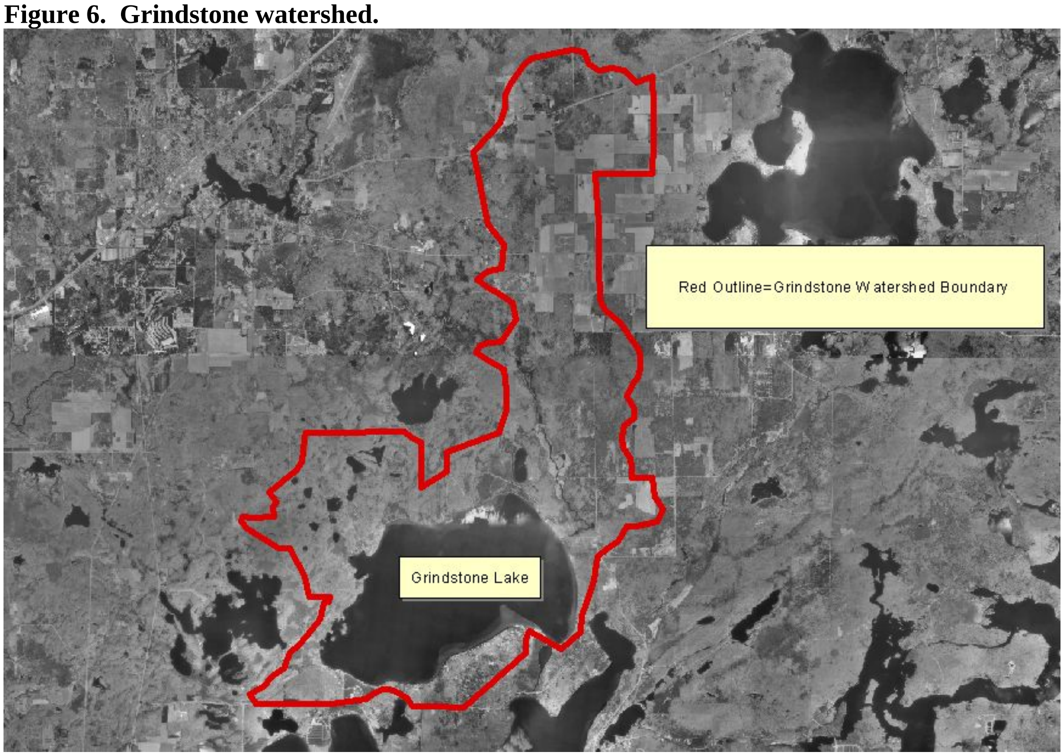
The most recent water quality data would support these findings; the lake is increasing in nutrients. Also, the general observation by residents is that filamentous algae density is increasing. This report would support this observation.

In relation to aquatic plants, the report supports that there is no excessive plant growth in Grindstone Lake. This has also been the case historically.

Watershed

Harmony Environmental and Grindstone Lake Association volunteers re-examined the Grindstone Lake watershed in 2006. The Grindstone Lake watershed is approximately 9765 acres. The land cover is comprised mostly of forested land (62%). Forested land is a good land cover to have around a lake as it contributes much smaller nutrient and sediment amounts into a lake compared to developed land covers. Agriculture and residential make up the next most common land covers, 13.5% and 9.6% respectively. Both of these land covers can have substantial impact on the lake water quality through increased sediment and nutrient loads, as compared to other land covers. Wetland is the next most common at 8.6%. The remaining land covers are as follows: Golf course (2.4%), grassland (1.1%), commercial (0.7%), cranberry bog (0.65%), roads (0.2%), and open water (1.5%). Of these remaining land covers, the golf course, commercial and cranberry bog would have a much higher potential for nutrient loading and sedimentation than forested and wetlands.

Figure 6. Grindstone watershed.



Grindstone Lake Watershed Assessment
January 2007

Methods

- Watershed boundaries were developed by the Lac Courte Oreilles Conservation Department as part of a study completed in 1998.
- The Sawyer County Land Records Department provided digitized watershed boundaries and other digital map information.
- Land cover was digitized on screen using digital orthophotos from 1998 and verified visually with color aerial photos from 2004.

- The Sawyer County Land and Water Conservation Department provided information regarding cropping practices within the watershed.
- Volunteers (Bruce and Margi Paulsen) verified land cover in late summer 2006 by traveling all state, county, town and selected private roads.

Land Cover Descriptions and Concerns

Land cover is frequently used to estimate pollutant loading to lakes. Varying degrees of soil erosion and rainwater runoff result in different loading rates of phosphorus per acre. Phosphorus is the limiting nutrient that affects the growth of algae in Grindstone Lake. Increased phosphorus loading to Grindstone Lake would eventually increase algae blooms and decrease water clarity of the lake.

<u>Commercial = land used for commercial purposes.</u>
Commercial land cover generally has relatively high rates of runoff because impervious surfaces such as rooftops and parking lots do not allow water to infiltrate into the soil. Parking lots tend to generate high concentrations of pollutants from vehicle traffic. These pollutants include sediment, oil and grease, nitrogen and phosphorus along with other chemicals.

<u>Cranberry Bog = areas flooded for the growing of cranberries.</u>
Cranberry growing uses high amounts of phosphorus that may be discharged downstream.

<u>Cropfield = land used to grow agricultural crops.</u>
Phosphorus loading rates depend upon soil erosion, and timing and amount of fertilizer and manure applications. Row crops like corn and soybeans generally result in less crop residue to cover the soil and therefore generate greater soil erosion. Hay crops result in lower soil erosion because the soil is covered. Steep slopes increase soil erosion. Winter spreading of manure increases the likelihood of phosphorus loading from the watershed.

<u>Farmstead = farm buildings, driveways, animal feeding, and parking areas.</u>
Farmsteads have relatively high amounts of impervious surfaces and concentrations of pollutants.

<u>Forest = undeveloped land covered by tree canopy. Forest may or may not be used for timber production.</u>
Forest lands generally have low rates of phosphorus delivery to lakes because forest soils are usually covered by vegetation and fallen leaves and therefore, absorb rainfall and reduce runoff water. Water quality problems sometime result during logging operations from forest road construction, stream crossings, and slopes left bare after clear cutting.

<u>Golf Course = recreation lands developed for golfing</u>
Golf courses have the potential to generate pollutant runoff from lawn fertilization and pesticide application. Runoff of phosphorus from golf courses can be minimized by use of low phosphorus fertilizer based on demonstrated need in soil test results.

<u>Grasslands = undeveloped lands covered by grasses, not generally in agricultural production.</u>
Grasslands tend to have very low rates of phosphorus loading because of good soil cover and lack of fertilization.

<u>Highway =only County Highway B is included in this category. Other roadways are included with the adjacent land use.</u>
Highways generate high amounts of runoff from impervious surfaces. High pollutant loading is present from vehicle traffic.

<u>Open Water = ponds and small lakes included in the larger Grindstone Lake watershed.</u>
Some of the watershed area may in fact, drain to these smaller water bodies so that runoff water doesn’t reach Grindstone Lake.

Residential = lands developed or clearly planned for residential development.
Residential lands have relatively high rates of pollutant loading – especially those properties where development is dense (with high percentages of impervious surfaces such as roof tops and parking areas) and runoff flows directly to the lake. Lawns do not slow runoff flow because of short stems of grasses.

Wetlands =areas inundated with water for a significant portion of the growing season.
Wetlands tend to have low rates of pollutant loading and may, in fact, absorb pollutants and runoff from other land uses.

In summary, the following land uses are most likely to generate pollutants to Grindstone Lake: commercial, cranberry bog, farmsteads, golf course, highways (and other roadways), and residential land. An attempt was made to select phosphorus loading rates appropriate to general location in the watershed and land characteristics. Estimating the quantities of pollutant loading from specific sites within the Grindstone Lake watershed was outside of the scope of this study.

The Grindstone Lake watershed is illustrated in Figure 1. The watershed is almost 75 percent natural areas of forest, wetland, grassland, and open water. As described above, these land covers deliver low amounts of runoff and phosphorus to the lake.

Land cover acreages and estimated pollutant loading are summarized in Table 1. Pollutant loading estimates in Table 1 are very general. A per acre phosphorus loading for a given land cover is estimated. Actual loading rates may vary because of how the land is managed and whether runoff is delivered directly into the lake. For example, phosphorus loading rates for cropland vary greatly depending upon the type of crop grown, slope, soil type and distance from flowing water.

Wetlands present around Grindstone Creek may absorb pollutants from the upper reaches of the watershed. Small ponds and lakes to the west of Grindstone Lake also serve to capture some of the runoff from the west of the lake. However, the pollutant loading estimate from these forested areas is already quite low.

Figure 7. Grindstone Lake Watershed Land Cover

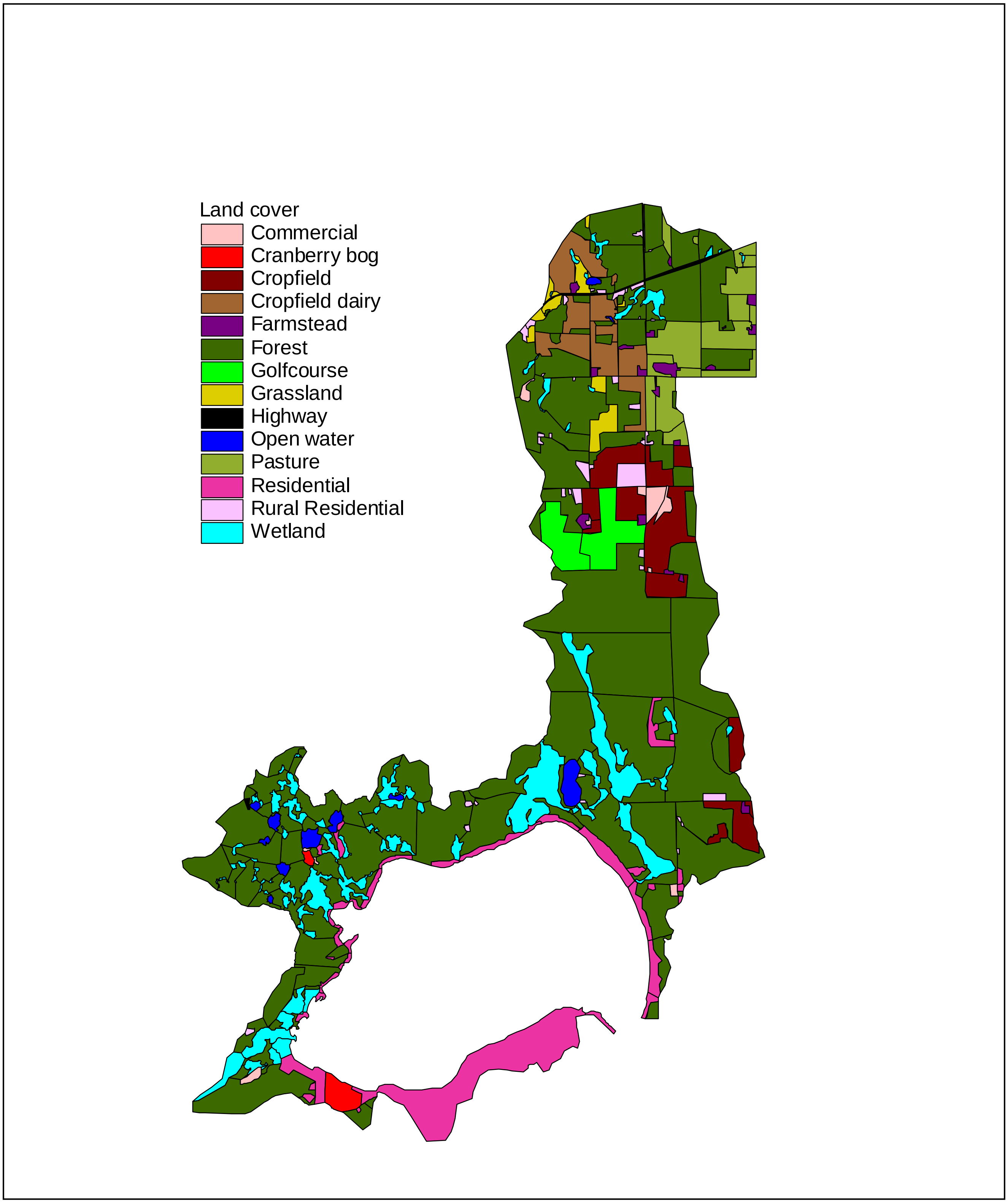


Figure 8. Subwatersheds with Drainage Indicated

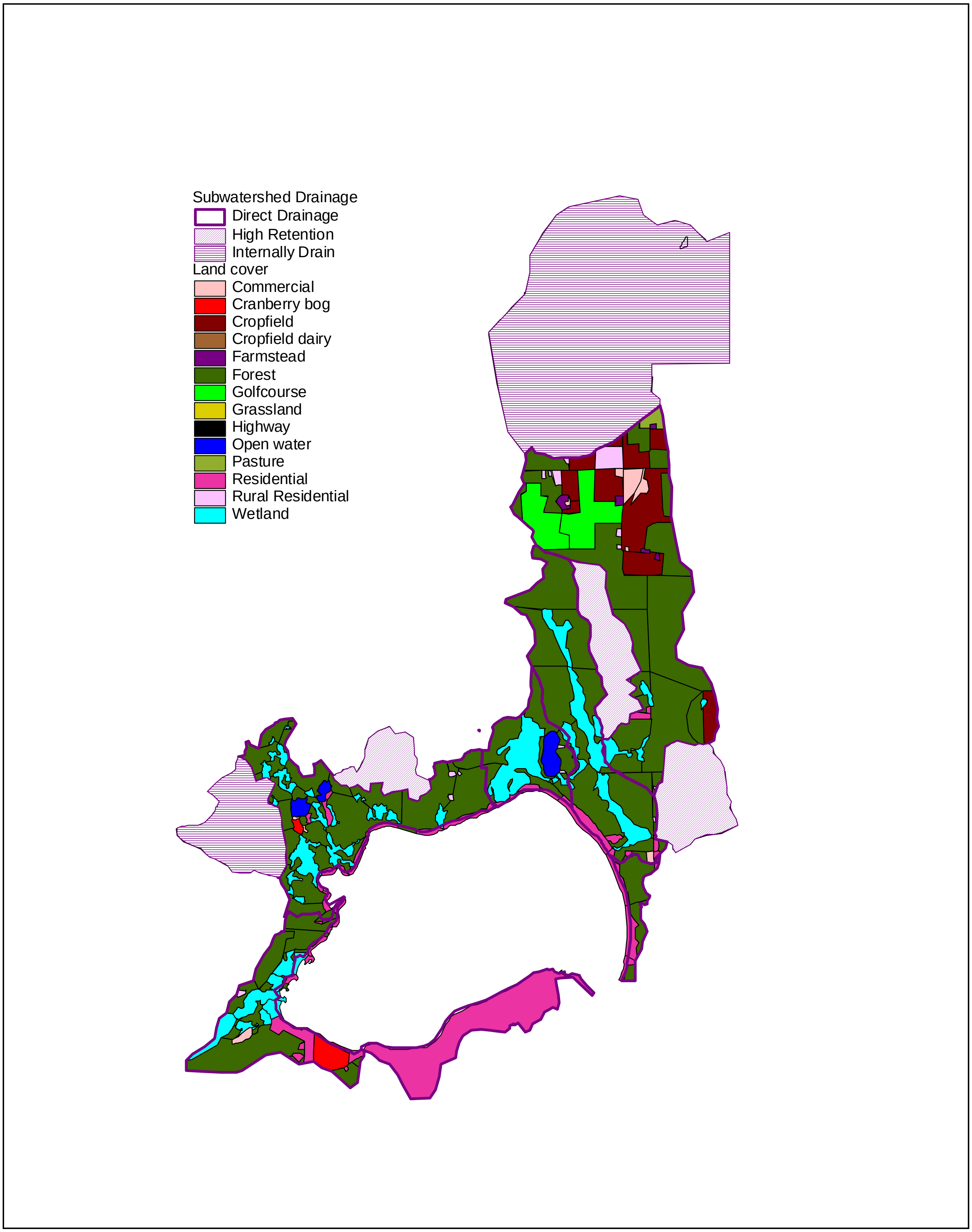


Table 1. Grindstone Lake Land Cover and Estimated Phosphorus Loading				
Land Cover Type	**Acres**	**Percentage**	**Phosphorus Loading Rate (lbs/acre/year)[6]**	**Total Loading (lbs/year)[7]**
Commercial	69	0.8	.88	61
Cranberry Bog	57	0.6	1.8[8]	34
Cropfield – row crops	496	5.4	.44[9]	218
Cropfield – dairy rotation	364	4.0	.33	120
Farmstead	68	0.7	.22	15
Forest	5,604	60.9	.08	448
Golf Course	239	2.6	.44	105
Grassland	105	1.1	.10	10
Highway	24	0.3	.88	21
Open Water	100	1.0	0	0
Pasture	454	4.9	.15	68
Residential	695	7.6	.53	368
Rural Residential	113	1.2	.08	9
Wetland	811	8.8	.09	73
TOTAL	**9,199**	**99.9**		**1,550**

Grindstone Lake Association volunteers completed a shoreline assessment in the summer 2006. The results show that the majority of the shoreline is designated as natural. Only a small percentage was rip rap or lawn. In the riparian zone from the shoreline to 35 feet on land (referred to as buffer zone), the areas of various land use was measured. The largest percentage was designated natural. However, over 20% was developed with lawns, hard surface and cleared. The results of the survey are contained in table 2.

Table 2 . Shoreline assessment summary

Shoreline type	Rip Rap	Structure	Lawn	Natural (includes sand and rock)
Length(ft)	1300	113	1613	40549
Percent of total	2.33%	0.20%	2.89%	94.58%

Buffer region type	Lawn	Hard surface	Sand	Cleared	Natural
Area (ft^2)	181334	41685	128535	169535	1415784
Percent of total	9.37%	2.15%	8.64%	8.76%	73.13%

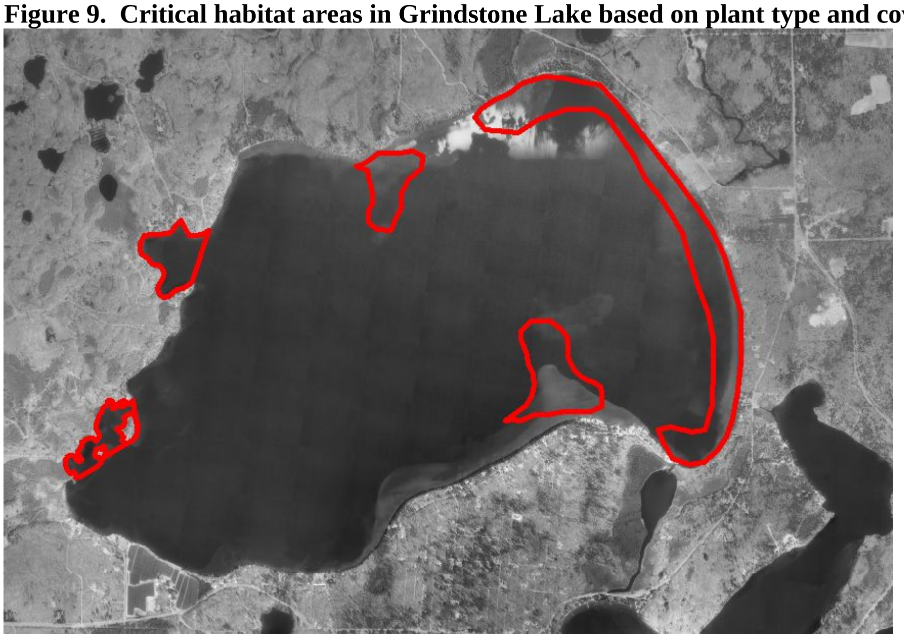
[6] From Grindstone Lake Phosphorus Model. 2000. Most likely phosphorus loading by land use and watershed location.
[7] Loading may be misleading because some watershed area may be internally drained with not all runoff water reaching the lake.
[8] A high value for cranberry bogs was chosen because of location next to the lake and observed algae production where bog outlets to the lake.
[9] A low value for row crops is used because of slope, sandy soils, and location within the watershed.

Aquatic Habitats

Habitat areas of concern

Grindstone Lake has very few areas where various plant species will grow. These include limited numbers of floating plant species and emergent plant species. This is most likely due to the lack of good substrate for rooted plants. Most of the sediment composition is sand and rock, limiting the growth of many plants specially adapted for low nutrient sediments. The importance of these plants and habitats is very high within Grindstone Lake. For this reason their preservation are important. The following map indicates some of these areas that have been identified. These areas are largely designated because they represent the few portions of the lake that have plant growth present. Many of the habitat areas of concern have vegetation that is very important to fish species.

Figure 9. Critical habitat areas in Grindstone Lake based on plant type and coverage.



Rare and endangered species habitat

The east half of Grindstone Lake is in T40N R08W. The west half is in T40N R09W. Rare species are noted in each of these Towns. Records are provided to the public by Town rather than section, so there is no indication if the incidences of these species occur in and immediately surrounding Grindstone Lake.

T40N R08W:

Haliaeetus leucocephalus	Bald Eagle	Special concern
Pandion haliaetus	Osprey	Threatened
Coregonus artedi	Lake Herring	Special concern
Etheostoma microperca	Least Darter	Special concern
Lepomis megalotis	Longear Sunfish	Threatened
Adlumia fungosa	Climbing Fumitory	Special concern

Leucophysalis grandiflora	Large-flowered Ground-cherry	Special concern
Potamogeton vaseyi	Vasey's Pondweed	Special concern

T40NR09W:

Haliaeetus leucocephalus	Bald Eagle	Special concern
Pandion haliaetus	Osprey	Threatened
Coregonus artedi	Lake Herring	Special concern
Lepomis megalotis	Longear Sunfish	Threatened
Moxostoma valenciennesi	Greater Redhorse	Threatened
Alasmidonta marginata	Elktoe mussel	Special concern
Adlumia fungosa	Climbing Fumitory	Special concern
Leucophysalis grandiflora	Large-flowered Ground-Cherry	Special Concern
Scirpus torreyi	Torrey's Bulrush	Special concern

Grindstone Lake Fisheries[10]

Table 3. Fish species of Grindstone Lake

Species(Common name)	Scientific name	Abundance
Walleye	*Sander vitreus*	2.1/acre
Muskellunge	*Esox masquinongy*	1 / 5-10 acres
Northern pike	*Esox lucius*	1/ 5-10 acres
Smallmouth bass	*Micropterus dolomieu*	Common
Largemouth bass	*Micropterus salmoides*	Rare
Bluegill	*Lepomis macrochirus*	Common
Black crappie	*Pomoxis nigromaculatus*	Present
Yellow perch	*Perca flavescens*	Common
Cisco	*Coregonus artedi*	Present
Rock bass	*Ambloplites rupestris*	Common

Other species present (or suspected): White sucker, shorthead redhorse, greater redhorse; bluntnose minnows, spottail shiner, blacknose shiner, golden shiner, common shiner, and other small cyprinid species, trout perch, log perch, johnny darter, rainbow darter, and other small darter species; pumpkinseed, rock bass, longear sunfish; tadpole madtom and black, yellow, and brown bullheads; longnose gar; slimy sculpin, brook trout (from Grindstone Creek and Springs).

Besides walleye, the other species that appear to be dominant or increasing are smallmouth bass. Largemouth and smallmouth bass have exploded statewide since the late 1980s, thanks in part to more restrictive harvest magnified by some exceptional strong year classes. This lake once was a trophy crappie lake. In the late 1970s this lake produced several state record crappies. Then the population crashed due to poor recruitment. There have been two noticeable year classes recently.

In the case of Grindstone, regular walleye stocking commenced in 1977 and the population became self-sustaining by 1984. (The 1976 population estimate showed a remnant

[10] Pratt, 2007 Personal Communication (Grindstone Lake Fishery Mgt. Plan, DRAFT)

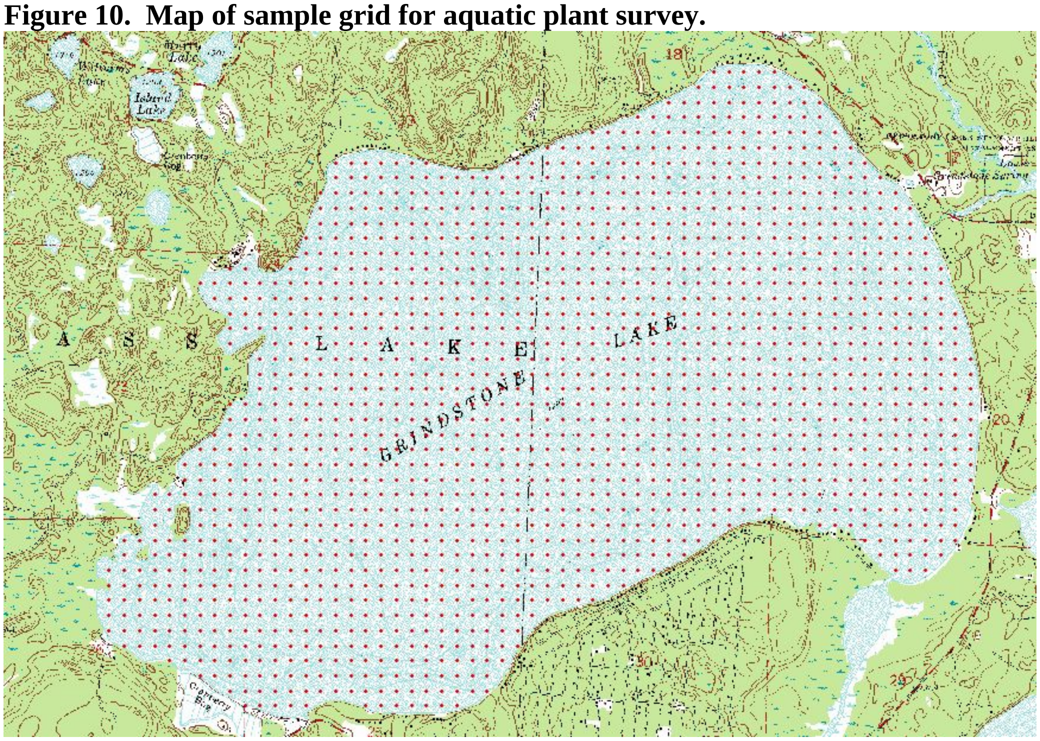
population of less than 1000 extremely old and extremely large walleyes). Lac Courte Oreilles went through the same transition but it took another 20 years for natural reproduction to assert itself, there. There is evidence of a cisco-natural walleye relationship in both lakes. When cisco populations are high walleye seem to have a hard time self-sustaining. In the early 80s, Grindstone's cisco population declined as walleye reproduction took over. In LCO, cisco has only recently declined and walleye have only recently shown any natural reproduction. As natural reproduction increased (for walleye) in Grindstone and population densities increased, their growth rates declined. The growth rates have been average and stable here, since the mid 90s. On average, 15" is attained in 5 summers of growth.

Plant community

Aquatic Plant Survey Results

In June 2006, an early-season survey was completed for curly leaf pondweed and other aquatic invasive plant species. None were located in that survey. In August, 2006, the entire littoral zone and beyond was surveyed with a point-intercept method. In that survey, 22 native vascular aquatic plants, 1 non-native vascular aquatic plant, and 3 algae species were sampled, with 6 vascular plant species visually observed within six feet of the boat. This gives a species richness of 32 species.

Figure 10. Map of sample grid for aquatic plant survey.



Grindstone Lake has a very diverse native plant community with 31 native macrophyte species surveyed (see table 1). No one plant dominates the lake. The highest frequency plant was filamentous algae followed by *Vallisneria americana* (wild celery) (see Table 1). The frequency of each plant is relatively low, demonstrating a varied, healthy community. In relationship to the various species found, *Potamogeton crispus* (curly leaf pondweed) was the only non-native plant found. This plant was only found at one sample site.

The Simpson's diversity index is 0.93. This indicates the likelihood of two plants being different is very high. This demonstrates a high degree of diversity and a healthy ecosystem.

Figure 11. Sites during survey where plants were actually sampled.

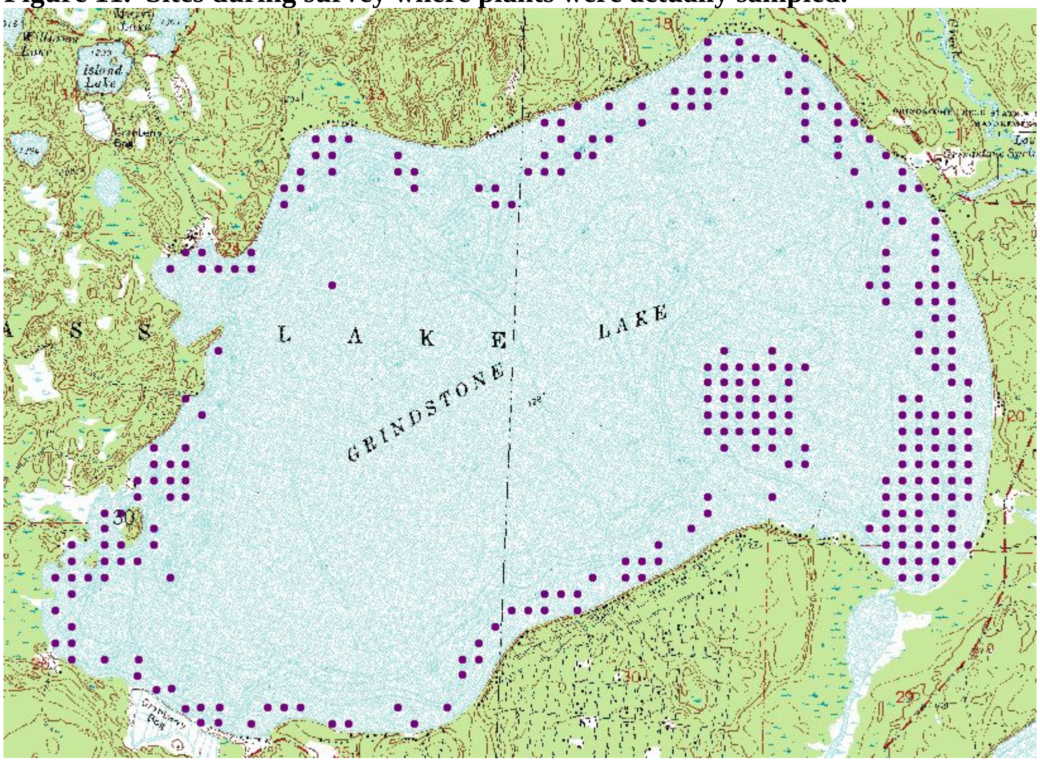


Table 4-Species richness and frequency data:

Species name	Common name	Relative Freq(%)	Freq littoral zone(%)
Filamentous algae	Filamentous algae	12.50	13.59
Vallisneria americana	Wild celery	11.60	12.58
Chara sp	Muskgrass	9.60	10.34
Najas flexilis	Bushy pondweed	8.60	9.33
Potamogeton zosteriformis	Flat stem pondweed	7.90	8.52
Potamogeton gracimeus	Variable pondweed	7.70	8.32
Myriophyllum sibiricum	Northern water milfoil	7.10	7.71
Potamogeton robbinsii	Fern pondweed	6.90	7.51
Elodea canadensis	Waterweed	5.10	5.48
Potamogeton richarsonii	Clasping leaf pondweed	4.30	4.67
Ceratophyllum demensum	Coontail	3.90	4.26
Potamogeton praelongus	White stem pondweed	3.00	3.25
Megalodonta beckii	Water marigold	2.20	2.43
Myriophyllum tenellum	Dwarf water milfoil	2.20	2.43
Potomageton illinoensis	Illinois pondweed	1.70	1.83
Nitella sp.	Stonewort	1.10	1.22
Potamogeton amplifolius	Large leaf pondweed	1.10	1.22
Eriocaulon aquaticum	Pipewort	0.90	1.01
Ranunculus flammula	Creeping spearwort	0.50	0.61
Isoetes sp.	Quillwort	0.40	0.41

Species name	Common name	Relative Freq(%)	Freq littoral zone(%)
Ranunculus aquatilis	White water crowfoot	0.40	0.41
Potamogeton pusillus	Small pondweed	0.40	0.41
Potamogeton crispus	Curly leaf pondweed	0.20	0.20
Stuckenia pectinatus	Sago pondweed	0.20	0.20
Nymphaea odorata	White water lily	0.20	0.20
Heteranthera dubia	Water stargrass	0.20	0.20
Nuphar variegata	Spatterdock	visual only	
Pontederia cordata	Pickerelweed	visual only	
Potamogeton natans	Floating leaf pondweed	visual only	
Schoenoplectus pungens	Three-square rush	visual only	
Schoenoplectus acutus	Soft-stem bullrush	visual only	
Typha latifolia	Cattail	visual only	
Total species richness = 32 species	**(including visuals)**		

The most common species sampled was filamentous algae, with a relative frequency of 12.5%. The most common vascular plant sampled was *Vallisnaria americana*, commonly referred to as wild celery. No rare species or species of special concern were sampled. However, there were some plants sampled with very high conservatism values and plants specially adapted to low nutrient sediments. These include *Myriophyllum tenellum, Potamogeton praelongus, Potamogeton robbinsii Eriocaulon aquaticum, and Isocetes sp.*

Filamentous algae is normal to have present in a lake. It usually grows on the bottom on rocks, macrophytes or other substrates in shallow enough water that allows adequate light penetration. The more water clarity there is, the deeper it can grow. Since this organism is not rooted, it absorbs nutrients directly from the water. As nutrients in the water increase, so can the growth of these algae. Grindstone Lake has some areas of filamentous algae that are of higher density. This seems to be mainly in the area near the cranberry bog. Although this growth is not a problem at this time, there has been anecdotal observation that its growth is increasing. With the lack of baseline data, this claim cannot be substantiated.

Figure 12. All sites with filamentous algae sampled.

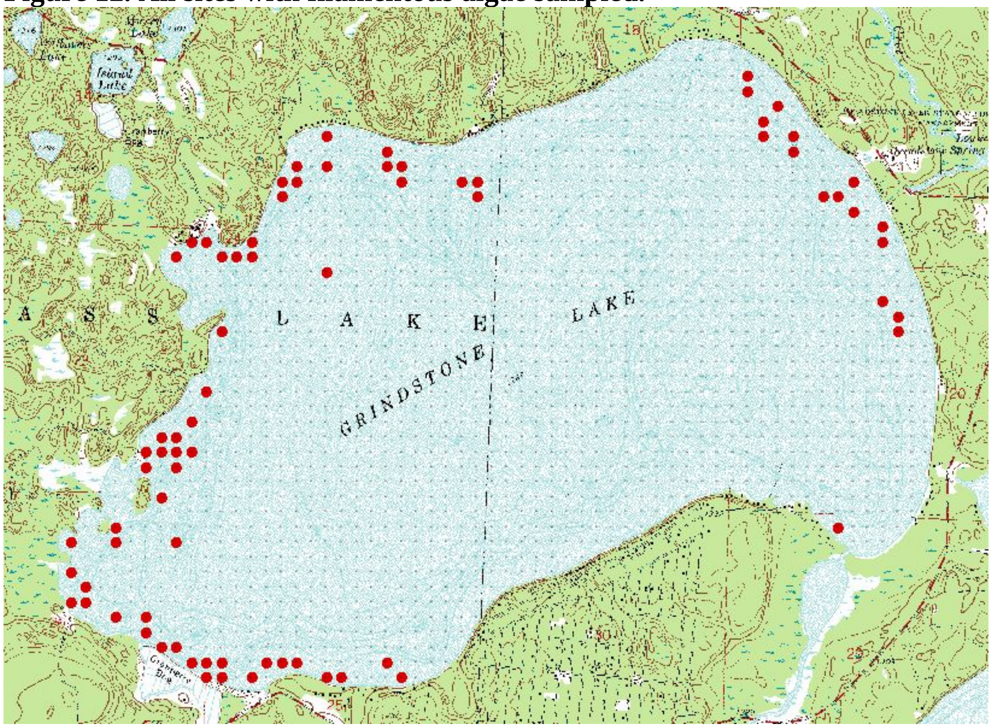
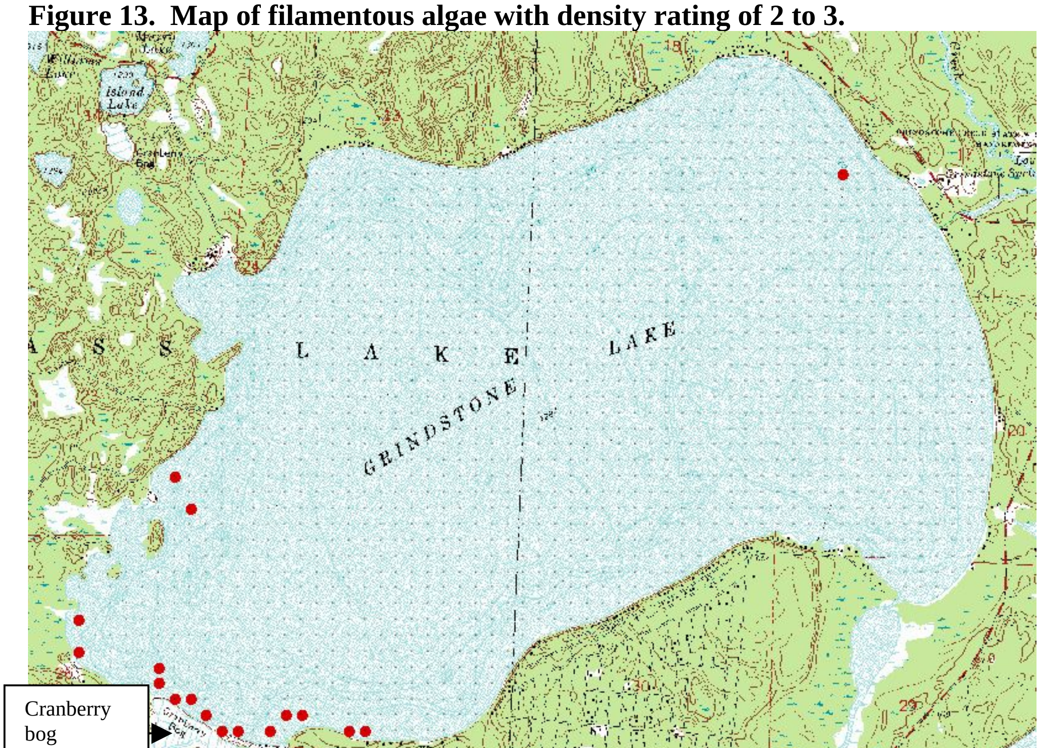


Figure 13. Map of filamentous algae with density rating of 2 to 3.



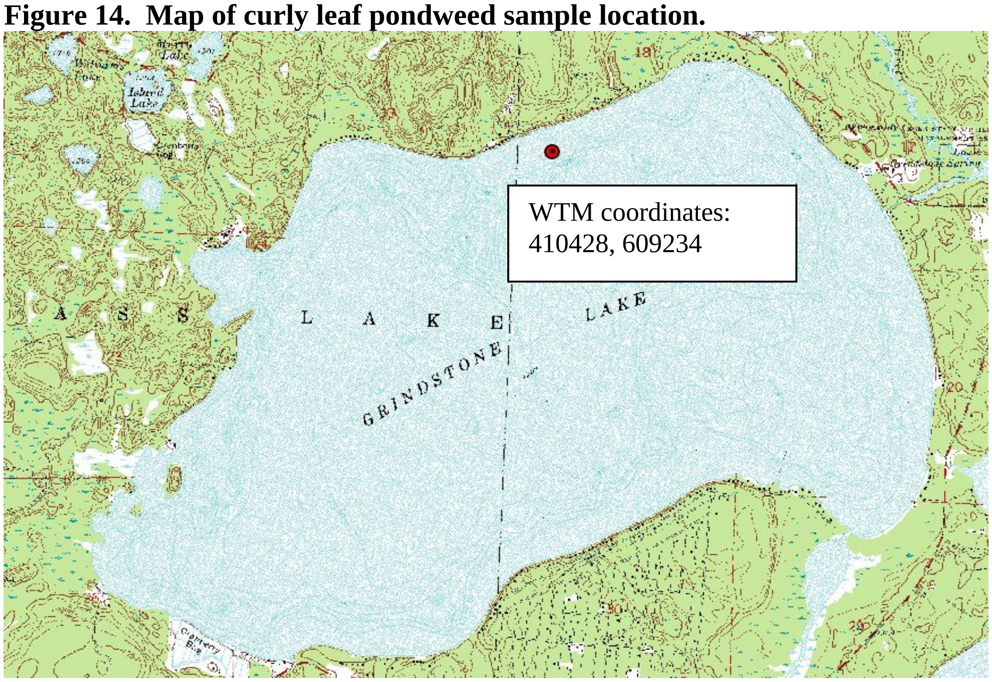
The Floristic Quality Index (FQI) for Grindstone Lake indicates a healthy plant community in relationship to water quality. A higher FQI generally indicates higher water quality. This index can also indicate adverse affects on water quality and sediment composition changes in regards to human practices, namely development. As human impact increases on a lake, the water quality can degrade and be reflected by the plant community, thus lowering the FQI. One must use this index cautiously as increased nutrients (enough to degrade water quality) and/or sediment composition changes, which can be a result of human practices, may not be reflected by the FQI. If the increased nutrients cause algae blooms, the FQI could reflect these changes by going down.

Table 5-Floristic Quality Data

FQI Data	**Grindstone Lake**	**Mean for Northern Lakes and Forests Ecoregion**
Species observed	29 (not all species used in FQI)	13
Average conservatism	6.31	6.7
FQI	33.98	24.3

Curly leaf pondweed was the only non-native species found. The plant was not located in the early season survey specifically designed to locate such species. In the late season survey, the one single curly leaf pondweed plant was sampled in a single location. This single plant was removed at the time of sampling and pressed as a herbarium specimen. Based on these observations, logic would indicate that this plant is not established in the lake. It is possible a pioneer stand was located. Upon further surveying, no more plants were located, therefore the stand should be small. For this reason, **location and removal of any curly leaf pondweed located in this vicinity may eliminate this plant from taking hold in Grindstone Lake**.

Figure 14. Map of curly leaf pondweed sample location.



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 Grindstone Lake, and the resultant impacts on native plants and fish and wildlife habitats. At this time, it appears curly leaf is not well established in Grindstone Lake. It is therefore imperative to locate and remove plants. However, should the plant spread in the lake, management issue could arise in the future.

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.[11]

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.[12]

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[11]Wisconsin's Comprehensive Management Plant to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species. Prepared by Wisconsin DNR. September 2003.
[12]Information from Minnesota DNR (www.dnr.state.mn.us/aquatic_plants.

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

Curly leaf pondweed (*Potamogeton crispus*)[13]

<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.

<u>Characteristics:</u>
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.

<u>Reproduction and dispersal:</u>
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.

<u>Ecological impacts:</u>
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.

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

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

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

Eurasian watermilfoil[14]
The ecological risks associated with an infestation of Eurasian water milfoil appear to surpass those associated with curly leaf pondweed. This plant is also not yet present in Grindstone Lake. However, there is a risk that Eurasian water milfoil may become established in Grindstone Lake.

A public boat landing is located at the southwest side of the lake and one landing toward the southeast shore (see Figure 1). Grindstone Lake is a popular lake as are many other lakes in the area. Many fishermen and residents may travel from the Twin Cities, Minnesota metropolitan area, Chicago or Milwaukee and access the lake at these boat landings. With Eurasian water milfoil present in many urban Twin Cities lakes, such as White Bear Lake and Lake Minnetonka, as well as lakes in southern Wisconsin and northern Illinois, the danger of transporting plant fragments on boats and motors is very real. The lake is also situated near a major highway, providing easy access to the Twin Cities. As a result, landings in Grindstone Lake should be evaluated and determine if monitoring is a necessary precaution. According to the Minnesota Sea Grant Office:

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

Department of Natural Resource scientists have also found Eurasian water milfoil in the nearby counties of Burnett (Ham Lake and Round Lake) Washburn (Nancy Lake, Totagatic River and the Minong Flowage), Barron (Beaver Dam, Sand, Kidney, Shallow, Duck, and Echo Lakes), Sawyer (Callahan, Clear, Conners, Little Round, Mud, Osprey, Round Lakes and Lake Chippewa, Raddison flowage) and Polk (Long Trade) in Wisconsin. Lake users moving from one of these lakes into Grindstone Lake can dramatically increase the chance for infestation.

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

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

Identification

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

Characteristics

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

Reproduction and dispersal:

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

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

Ecological impacts:

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

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

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

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

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

Because Eurasian water milfoil is found in nearby lakes, it is prudent to provide a contingency plan to be best prepared to control milfoil, should it be found in the lake. A contingency plan should include a systematic monitoring program and a fund to provide timely treatments. This plan is outlined as an action item in the management portion of the this plan.

Aquatic Plant Management

This section presents aquatic plant management goals for Grindstone Lake, the potential management methods available to reach these goals, and selection of action items for plant management.

Grindstone Lake Aquatic Plant Management Goals:

1. Preserve and restore native plant communities.
2. Enhance fish habitat within the plant community.
3. Restore native shoreline vegetation.
4. Reduce human impact on water quality.
5. Prevent the introduction of non-native, invasive plant species.
6. Respond rapidly with an organized plan to new introductions of non-native, invasive plant species.
7. Monitor and reduce filamentous algae growth.

Management Recommendations

Outreach through techniques identified in an Education and Information Plan will be critical for many of the plan goals. One of the first tasks is to raise awareness about the plan itself. All action items are to be conducted by the Grindstone Lake Association in partnership with other agencies unless otherwise indicated.

Educational and Information Plan

Plan Action Item
Grindstone Lake Association will raise awareness of this aquatic plant management plan and its recommendations through newsletter articles and handouts and presentations at annual meetings.

Goal 1: Preserve and restore native plant communities.

The plant community in Grindstone Lake is very diverse and extensive. Approximately 17% of the lake area is covered with aquatic plants, which is very low coverage. Due to the low density of plants in Grindstone Lake, it is important to preserve the native plants that are present. Some area residents have indicated an observed decline in plant growth at some key fishing locations. Frank Pratt, Wisconsin DNR fisheries biologist for the region covering Grindstone Lake indicated that it may be just a natural cycle.[15] Lack of baseline data does not allow verification, but it is a concern and should be monitored in the future.

Aquatic plants in Grindstone Lake provide key habitat for a diverse fish population. They also provide protection from shoreline erosion in some key areas. It is important to understand that these plants play a very important role in the lake ecosystem. Reducing the plant community could lead to very adverse affects in Grindstone Lake. The plant growth present is limited to a few small areas and a very narrow littoral zone in other parts of the lake. A property owner that removes plants could have a very significant impact on the limited Grindstone Lake plant community.

Waterfront activities

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

- Boats may uproot native plants and break aquatic plants into fragments
- Bare substrate is more likely to be colonized by non-native species
- Plant fragments contribute phosphorus to the water as they decay
- Curly leaf pondweed fragments (if present in denser stands) broken up by boat propellers may root and encourage uncontrolled spread of this invasive plant.
- Water quality impacts from sediment resuspension.

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

If Grindstone Lake is losing plant populations, the cause is not certain. This could be a cycle that occurs in this lake. However, based on observations by recreational divers, there is speculation that there may be a crayfish population impacting the plant beds through omnivorous feeding behavior. This could be the case if it is non-native rusty crayfish. The identification of the crayfish present is uncertain. There has been some information that it is believed they are native, but again this not certain[16]. It is recommended that monitoring program for crayfish be implemented.

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[15] Personal communication with Frank Pratt, Wisconsin DNR fisheries biologist. October, 2006.

[16] Frank Pratt, Wisconsin DNR, indicated that he felt they were native, but had not monitored the crayfish.

Plan Action Item
Provide residents with written materials and present information regarding aquatic plant values, and methods at annual meetings and in newsletters to limit impacts to native aquatic plants.

Plan Action Item

Implement a crayfish monitoring program to determine if the crayfish population is comprised of native and/or non-native crayfish (rusty crayfish are non-native). If non-native rusty crayfish are present, a population assessment will be conducted. Grindstone Lake Association may consider a small-scale Lakes Planning Grant, subcategory-Studies, Assessment, and Other Activities to help fund this assessment. This survey may be conducted or assisted by the LCO Conservation Dept.

Plan Action Item
The Grindstone Lake Association will provide residents with the information needed to accurately identify curly leaf pondweed. Residents will be encouraged to hand-pull small stands adjacent to their property. The importance of positive identification and removal of plant fragments will be emphasized. The need to notify the Grindstone Lake Association so that their site may be monitored will also be communicated.

Goal 2: Enhance fish habitat within the plant community.

There are many fish present in Grindstone Lake that require aquatic vegetation. Muskellunge reproduce through dispersal of eggs onto submersed vegetation, woody debris, or dead matter in less than one meter of water. Their eggs are non-adhesive and require fairly high dissolved oxygen. Northern pike spawn in similar areas with their adhesive eggs, which attach directly to emergent and submergent vegetation.

Other fish require plant stands for cover from predatory fish as well as forage areas for them to feed on planktonic organisms. As a result, these plant stands are paramount for fish reproduction and survival.

There some critical habitat areas in Grindstone Lake in relationship to fisheries. Due to the fact that Grindstone Lake has such limited aquatic plant growth, the few areas that harbor plants and the areas that have unique emergent stands, are critical to preserve.

Plan Action Item

Conduct a sensitive area survey within the next two years (2007-2008), preferably by the Wisconsin DNR, but may be coordinated by another entity such as the LCO Conservation Dept.

Goal 3: Restore native shoreline vegetation

Shoreline vegetation is very important to a lake ecosystem. This vegetation provides key habitat for amphibians, reptiles, insects, birds and aquatic mammals. Furthermore, it buffers the lake from non-point source pollution and reduces erosion into the lake. As development occurs, the native vegetation that was present around the lake shore gets replaced by lawns and/or non-native, ornamental plants. Many times the tree and shrub layers are reduced or eliminated resulting in heavier runoff occurrences. It is important that these key plants be preserved and areas that have been adversely affected, restored to a more natural state.

Grindstone Lake riparian owners are strongly encouraged to consider a shoreline restoration project. Sawyer County appears to have a very good program in place for helping with such projects. The cost of projects can be shared between the owner and the County. This cost sharing is fairly limited compared to other programs. Furthermore, the County can provide expertise in design and implementation.

Plan Action Item

Organize and provide education about the importance of native shoreline vegetation and encourage restoration.

Plan Action Item

Encourage shoreline restoration projects and facilitate shoreline restoration through incentives and/or cost share programs with Sawyer County or other financial support such as grants.

It was determined in the shoreline assessment that 73% of the shoreline/35 foot depth was natural, indicating the majority of the near shore area have buffers. However, the nutrient loading indicates a high load from near-lake residential land. It would be prudent to increase buffers in this land cover type.

Goal 4: Reduce human impact on water quality

Grindstone Lake has excellent water quality. However, there are signs that the nutrients are increasing in the lake. The largest contributors of phosphorus are somewhat hard to control by Lake Association actions or programs. These would include agriculture practices around Grindstone Creek and the atmospheric load. However, the residential load is 13% and can be reduce through various management practices.

Plan Action Item

Collect and disperse educational materials as well as presentations at meetings information about:

1. Lawn care practices that help a lake and why they help the lake.
2. How buffer installations can help the lake and how to install.
3. What infiltration practices are and how they help.
4. Example photos of "good" vs "bad" practices.
5. Implement watershed recommendations.

Watershed Recommendations[18]

Watershed protection measures should concentrate on areas where phosphorus loading potential is the highest and runoff to the lake is most direct. A discussion of such priority areas for watershed protection is included below.

The Lake Association is encouraged to work with property owners, the Lac Courte Oreilles Tribe, the Sawyer County Land Conservation Department, the Department of Natural Resources, and other partners to further assess pollutant loading concerns and options for management.

Residential development

- Examine opportunities for stormwater retrofit in Northwoods Beach
- Encourage Northwoods Beach and lakeshore residents to install infiltration practices
- Encourage lakeshore residents to preserve and restore shoreline buffers
- Discourage use of phosphorus fertilizer on lawns

[17] Assistance with watershed background came from Dale Olson, Sawyer County Conservationist and Dan Tyrolt, Environmental Engineer, Lac Courte Oreilles Conservation Department. Personal Communication. January 4, 2007.

[18] Assistance with watershed background came from Dale Olson, Sawyer County Conservationist and Dan Tyrolt, Environmental Engineer, Lac Courte Oreilles Conservation Department. Personal Communication. January 4, 2007.

- Monitor and follow stormwater permitting and erosion control requirements for new development

Past residential development likely took place without attention to where runoff would drain. There may be opportunities to infiltrate or capture and treat runoff from Northwoods Beach. The Lake Association should work in cooperation with the Sawyer County Land and Water Conservation Department and the Town of Bass Lake to investigate the potential for stormwater treatment practices in this subdivision.

The Lake Association should encourage residents to protect water quality by installing infiltration practices such as rain gardens, rain barrels, and infiltration pits and trenches. These practices capture water from roofs and paved areas allowing water to soak into the ground rather than flowing to the lake. Buffers of natural vegetation along the shoreline also help to slow runoff water and allow infiltration and should be encouraged. Use of phosphorus fertilizers should be discouraged. Residents may be encouraged to follow the practices described above through education and incentive programs.

Grindstone Lake has a well-preserved shoreline buffer zone for much of the lake shoreline. Of the immediate shoreline, 95 percent was found to be in natural vegetation. The shoreline buffer extending back 35 feet from the ordinary high water mark was 73 percent natural.[19] This means that as whole, waterfront properties are meeting clearing limits of 30 percent in the shoreland buffer area. Runoff may still channelize to the lake from homes, driveways, and other impervious surfaces through cleared areas to the lake. Limiting cutting in a pathway even more narrow than the allowed 30 foot corridor is highly recommended to preserve lake water quality and habitat.

Commercial properties

- Examine stormwater runoff patterns of flow
- Develop methods to capture and treat stormwater runoff
- Monitor and follow stormwater permitting requirements for new development

The Lac Courte Oreilles (LCO) Casino, Lodge and Convention Center is currently the largest commercial development in the Grindstone Lake watershed. Stormwater management practices to infiltrate or capture and treat runoff water are not currently in place. There are likely opportunities to encourage infiltration of runoff water with the sandy soils in this area. New development could certainly be planned with stormwater containment and treatment practices. The Lac Courte Oreilles Conservation Department would be critical partner in this effort.

The Casino is located on sandy soils with relatively flat slopes that encourage infiltration and limit the amount of stormwater runoff. There is also a significant buffer of woodland vegetation before any channelized surface water flow to Grindstone Creek. Because of these factors, stormwater practices for the Casino development are of lower priority than existing residential development and potential future development closer to Grindstone Creek and Grindstone Lake.

[19] Grindstone Lake Association Shoreline Survey. Summer 2006.

Future commercial and residential development

- Be aware of stormwater and erosion control requirements and monitor development in the watershed
- Identify and preserve critical areas for watershed protection

Stormwater runoff from future commercial and residential development is a concern. Erosion control during construction is also critical The Department of Natural Resources regulates stormwater and erosion control through required plans and permits.

An **erosion control plan** specifies how soil erosion will be limited during construction. A **stormwater plan** describes how runoff water will be contained and treated when development is complete.

A landowner is required to obtain a construction site stormwater runoff permit from the DNR[20] when there will be one acre or more of disturbance. The Towns are responsible to enforce the construction site erosion control provisions within the state Uniform Dwelling Code. These provisions apply to one and two family dwellings. Towns contract with building inspectors for on-site inspections. The Sawyer County Shoreland Zoning Ordinance regulates development within the one thousand feet of the lake and three hundred feet of Grindstone Creek. The Lake Association can help to ensure that the requirements of these programs are carried out by informing the DNR or Towns about new construction and potential stormwater and erosion control violations.

Land conservation

An investigation of ownership of currently undeveloped parcels and identification of those parcels that are critical for watershed protection is recommended. The Lake Association should take an active role in the purchase of title or conservation easements to preserve such properties.

The cranberry bog

- Examine methods to capture and treat phosphorus-rich discharge water from cranberry-growing
- Encourage stormwater management and erosion control for residential development
- Investigate options for purchase of back lot property (with residential development)

While the cranberry bog is still currently producing cranberries, there are plans for residential development in this area. If cranberry production continues, it would be worthwhile to investigate methods to capture and treat runoff water and to examine fertilization practices to minimize release of phosphorus into the water.

With residential development likely, greater benefit may accrue from focusing on how the property is developed. The Lake Association should examine plans for stormwater and erosion control to ensure stormwater runoff into Grindstone Lake is limited. The goal for this development should be to have no discharge of runoff water to the lake

[20] The current DNR stormwater contact for Sawyer County is Ellen Granquist. Her telephone number is 715-395-6907.

Plan Action Item

Groundwater flow near the cranberry bog will be determined and monitored for nutrients to quantify the real potential impact this bog has on the Grindstone Lake. Also, surface water flow from the bog will be monitored if possible.

The golf course[21]

- Encourage the golf course to develop a nutrient management plan
- Monitor pumpage records from high capacity wells

Groundwater contamination is the greatest concern in this area. High nitrate levels have already been identified in the shallow aquifer. The golf course has wells in both the shallow and deep aquifer. Use of the shallow aquifer well for irrigation would encourage uptake and removal of nitrogen from the groundwater. The golf course is required to keep pumpage records, summarize them monthly, and report the records annually (in January) to the Department of Natural Resources as part of their high capacity well permit.[22] Development and implementation of a nutrient management plan may limit the amount of fertilizer used on the golf course and encourage the use of water from the shallow aquifer.

A recently completed United States Geologic Survey and Lac Courtes Oreilles Conservation Department study concluded that the groundwater withdrawals at the golf course are not significantly impacting the groundwater volume for the Grindstone Springs complex.[23]

Surface water runoff of phosphorus to Grindstone Lake is limited because much of the golf course is internally drained. The water that runs off the course appears to infiltrate nearby or run through an extensive woodland buffer between the golf course and the Grindstone Springs complex.

Cropland

Look for opportunities to support the Sawyer County Land and Water Conservation Department as they develop conservation practices for agricultural landowners.

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[21] Information from Chuck Revak. Wisconsin Department of Natural Resources. Personal Communication. January 12, 2007.

[22] These public records are available from the Department of Natural Resources in Madison. Contact Norm Hahn.

[23] Dan Tyrolt. Lac Courte Oreilles Conservation Department. Personal Communication. January 4, 2007.

Local and State Requirements for Watershed Protection

Sawyer County Subdivision Ordinance
The Sawyer County Zoning Committee reviews subdivisions for compliance with the ordinance. Subdivisions may be rejected because of flooding, inadequate drainage, severe erosion potential, or unfavorable topography. There are no specific erosion control or stormwater requirements in the ordinance, nor is there a separate ordinance for either.

Sawyer County Shoreland Zoning Ordinance
The Shoreland zoning provisions establish minimum lot sizes, structure setbacks, controls for excavation and earth moving, and restrictions on removal of shoreline cover. Grindstone Lake is classified as a Class 1 General Development Lake requiring a minimum lot size of 20,000 square feet, a minimum 100-foot lot width, and a 75-foot minimum structure setback from the ordinary high water mark. Class 1 standards are the least restrictive.

For all Sawyer County lakes, shoreline clearing is limited to preserve a minimum thirty-five foot shoreline buffer zone of natural shoreline vegetation yet allow shoreline property owners access to the waters abutting their property. For any 100 feet of shoreline, a property owner may create an area up to thirty feet wide and thirty-five feet inland more or less perpendicular to the shore through mowing, pruning and selective removal of trees, stumps, and shrubbery.

Impervious surface limits are established for modifications to resort structures, noncomforming shoreland structures and for new construction. Within 300 feet of the ordinary high water mark, impervious surfaces are limited to 15 percent or to 25 percent with a conditional use permit and "standard erosion control and stormwater measures." Impervious surfaces are limited to 30 percent except by special approval of the zoning office with a runoff retention plan between 300 and 1000 feet from a lake.

Permits are required for excavation that disturbs more than ten thousand square feet, and erosion control measures are required for these permits.

Stormwater and Erosion Control Permit (WI DNR)[24]
Owners of construction sites that will have one acre or more of disturbance must obtain a construction site storm water permit from the Wisconsin Department of Natural Resources to address erosion control and storm water management. It is the responsibility of the landowner to develop and implement site-specific erosion control and storm water management plans and to maintain all best management practices. Best management practices are the practices, techniques or devices used to avoid or minimize soil, sediment or pollutants carried to waters of the state. The erosion control plan details how sediment and other pollutants will be controlled on the site. The storm water management plan includes practices such as wet ponds, infiltration structures, grass swales, vegetation filter strips, and vegetative buffers to control runoff from the site after construction is completed. The storm water management plan must meet the requirements of NR 151 Wisconsin Administrative Code.

[24] Does Your Construction Site Need a Storm Water Permit? WI DNR. 2006.

NR151 Non-Agricultural Performance Standards
Construction Sites >1 acre – must control 80% of sediment load from sites

Stormwater management plans (>1 acre)
- Total suspended solids
- Peak discharge rate
- Infiltration
- Buffers around water

Developed urban areas (>1,000 persons/square mile)
- Public education
- Yard waste management
- Nutrient management
- Reduction of suspended solids

Construction Site Erosion Control (WI Department of Commerce)
The Wisconsin Department of Commerce has authority and responsibility for construction site erosion control for building sites for public buildings and places of employment and one and two-family dwellings. For commercial building sites and places of employment, the erosion control plan must comply with the performance standards listed in s. NR 151.11, Wis. Adm. Code.

If a one- or two-family construction site disturbs less than one acre, the specific erosion control requirements in the Uniform Dwelling Code Chapters 20 and 21 must be met. Municipalities (Towns) are required to enforce the erosion control provisions of the Uniform Dwelling Code. Standard erosion control plan sheets and a checklist is available from the DNR and UWEX.

Goal 5: Prevent introduction of non-native, invasive plant species.

Grindstone Lake is a very large, high water quality lake. It also has diverse fish populations including walleye, muskellunge, northern pike, smallmouth bass, largemouth bass, crappie and bluegills. As a result, the potential use is high. Anglers and recreational use can significantly increase the risk of invasive plant introduction. Furthermore, it appears that Grindstone Lake may be at the early stages of a curly leaf pondweed introduction. However, Grindstone Lake does not have a coordinated effort to reduce invasive introductions. Since curly leaf pondweed has been sampled, it is important to monitor and record its location. Also, single plants can be removed by hand and disposed of. This may be effective since curly leaf pondweed was sample in a single location. If more curly leaf pondweed is found, a Rapid Response Grant would be a prudent step to secure funds for eradication.

Plan Action Item

Monitor for curly leaf pondweed, especially near the point sampled. Record location sampled with GPS. If single plants are located, hand pulling is recommended.

It is very important that lake residents become educated about the identification of curly leaf pondweed and Eurasian watermilfoil. This will allow many to monitor the presence of these plants, should the curly leaf pondweed become more dense or Eurasian watermilfoil get introduced into the lake. There are many information sources available for the public. It is also time for the Grindstone Lake Association to implement a Clean Boats/Clean Waters Program. This program is provided through the University of Wisconsin Extension in cooperation with the Wisconsin DNR. The program will train volunteers on how to identify and monitor invasive species. In addition, training is provided on how to inspect boats and trailers. They also can provide many educational materials to lake users. The Grindstone Lake Association should also make public landing inspections either through volunteer or hire.

There is an annual clean-up that occurs by a group of volunteer SCUBA divers on Grindstone Lake. It would be an opportune time to educate these divers on the identification of curly leaf pondweed and Eurasian watermilfoil so they can monitor for these plants while completing the clean-up.

Plan Action Item

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

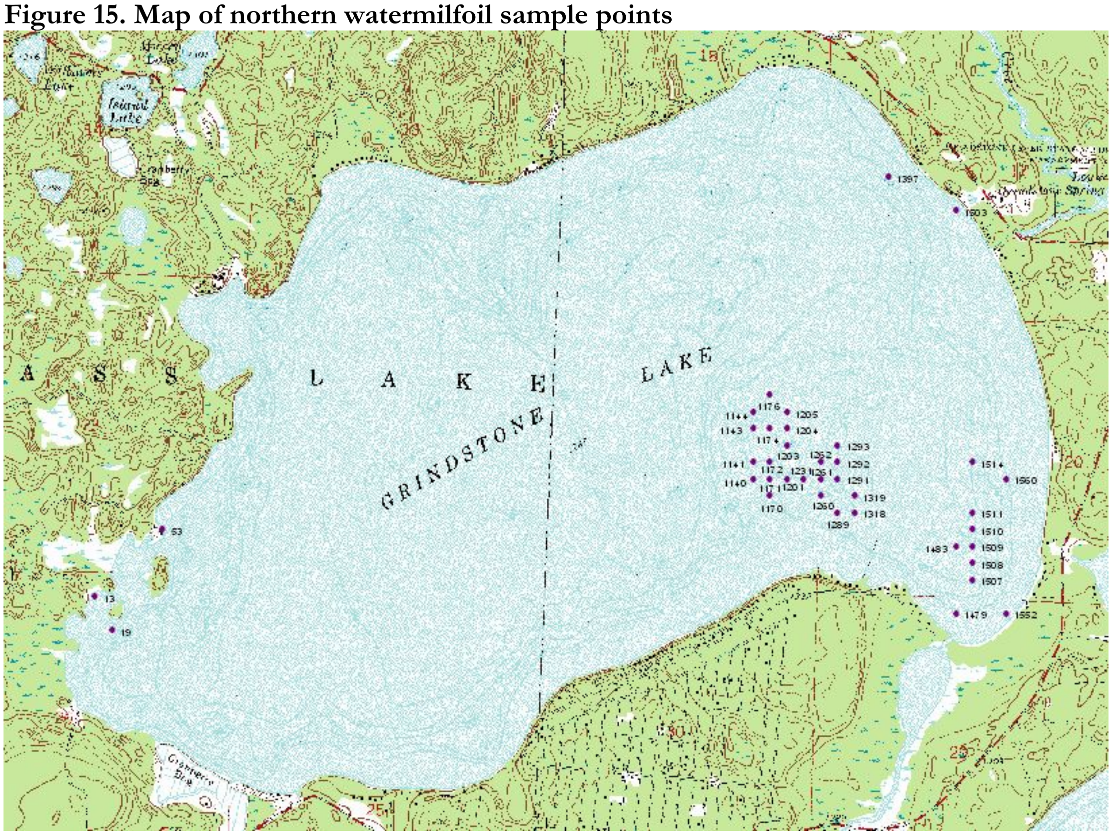
Plan Action Item

Implement a Clean Boats/ Clean Waters program for Grindstone Lake. This will include public access education and inspection. This program may be strictly conducted by volunteers or hired staff.
Website: http://www.uwsp.edu/cnr/uwexlakes/cbcw/

Plan Action Item

Monitor for the presence of Eurasian watermilfoil, curly leaf pondweed and other aquatic invasive species. The areas around public boat landings will be the focal points for monitoring, as these are the most likely introduction sites. The area near the inflow will be a second focal point as this could be another introduction site. Sites where northern water milfoil is present will also be monitored since Eurasian water milfoil will generally take hold in those same habitats. Lake residents will be encouraged to learn to identify Eurasian watermilfoil, curly leaf pondweed and purple loosestrife and establish a contact for verification of identification. This contact may be a local plant expert, a DNR or County employee, or consultant.

Figure 15. Map of northern watermilfoil sample points



The aquatic invasive prevention through activities discussed can be funded through an aquatic invasive species grant, available from the Wisconsin DNR. This grant and other grant programs are discussed in the appendix of this plan.

Goal 6: Respond rapidly with an organized plan to new introduction of non-native invasive species.

Plan Action Item

Implement an Eurasian watermilfoil rapid response program for detection and rapid response if an invasion is discovered. Establish funding mechanisms to respond to an Eurasian watermilfoil infestation. A file with the rapid response steps will be held by the Grindstone Lake Association's president. **Included in the file will be the forms and guidelines for an Invasive Species Rapid Response Grant, sponsored by the Wisconsin DNR.**

If a new non-native, invasive species introduction should occur, the following plan should be followed once a potential identification has occurred.

Plan Action Item

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

1. Positive identification of invasive species (contact designated local plant identification expert and DNR).

2. Notify DNR aquatic plant management specialists of positive identification. Collect plant for a voucher specimen.

3. Carry out response plan using one or more of the following methods:
    a. Hand pulling (with diver if needed)
    b. Herbicide use (permits required)

4. If warranted, apply for invasive species rapid response grant.

5. Notify residents of positive invasive species identification and location.

6. Carefully monitor infested area and nearby for effectiveness of control methods.

7. Repeat controls as needed.

Goal 7: Monitor and reduce growth of filamentous algae.

Filamentous algae is a normal, common inhabitant of Wisconsin Lakes. It was the most frequently sampled macrophyte in the aquatic plant survey. There has been some anecdotal evidence provided by lake users about the increase in growth. Although there is a lack of baseline data to substantiate this concern, there are a few areas where filamentous algae grows in fairly high density. These areas are very limited in coverage, thus not justifying algaecide treatments. However, monitoring is crucial to indicate any changes in coverage and density in the future.

The most effective method for reducing future growth of filamentous algae is controlling nutrients, mainly phosphorus. Since filamentous algae is not a rooted vascular plant, it absorbs nutrients directly from the water column. The more available nutrients (phosphorus is usually limiting), the more the algae can grow. Filamentous algae can be good in the sense that unicellular algae could otherwise absorb dissolved phosphorus, causing nuisance algae blooms that reduce water clarity and lake asthetics. Filamentous algae can also become a nuisance, but usually less commonly than unicellular blooms.

Plan Action Item

Sample filamentous algae at several sites in 2007 and have species identified and recorded.

Plan Action Item

Monitor Grindstone Lake at present filamentous algae sites. The density of each site should be recorded. In addition, any sites not presently noted should be added as observed. Density and coverage changes can then be evaluated.

Plan Action Item

Implement watershed recommendations from Goal 4. These BMP's can help reduce nutrient loading into Grindstone Lake, thereby reducing phosphorus available for increased filamentous algae growth.

Monitoring and Assessment

Aquatic Plant Surveys

Aquatic plant (macrophyte) surveys are the primary means to track achievement toward plan goals. Plan goals are to: 1) Preserve and restore native plant communities; 2) Enhance fish habitat within the plant community; 3) Restore native shoreline vegetation; 4) Reduce human impact on water quality; 5) Prevent introduction of non-native, invasive plant species; 6) Respond rapidly with an organized plan to new introductions of non-native, invasive species; 7) Monitor and reduce filamentous algae growth.

Plan Action Item

Conduct whole lake aquatic plant surveys approximately every 5 years to track plant species composition and distribution. Whole lake plant surveys will include identification and measurement of density of filamentous algae at each sample point.

Plan Action Item

Conduct an annual survey of highly sensitive plants will be conducted. This survey will allow for the indication of water quality changes as represented by these highly sensitive plants found in shallow areas. This survey may be completed by volunteers with guidance and oversight by a plant specialist.

Plan Action Item

Maintain water quality monitoring program for continued trend evaluation. This may be done in conjunction with the LCO Conservation Dept. or through expanded self-help program.

Whole lake surveys

The whole lake surveys conducted in the future will be in accordance with the guidelines established by the Wisconsin DNR. This includes a point-intercept method with data entered into the Aquatic Plant Worksheet available online at the Wisconsin DNR website. Any new species sampled as compared to the 2006 survey will be saved for pressed and mounted voucher specimen (two specimens).

Sensitive area survey

It is recommended that the sensitive area survey be conducted by the Wisconsin Department of Natural Resources. This survey would include a fisheries biologist, water quality expert and an aquatic plant expert. The survey will evaluate key habitat regions within Grindstone Lake that are important for fish, wildlife and other organisms. In addition, the survey will identify key plant habitats that can help preserve water quality and aesthetics.

Annual sensitive plant survey

This survey is designed to monitor plants with a high conservatism value and assess how these populations change over time. Two areas, where populations of these sensitive plants are known to be present (as a result of the 2006 plant survey) will be monitored. The plants found in Grindstone Lake that have a high conservatism value that could be used in a survey are: Pipewort (*Eriocaulon aquaticum*), quillwort (*Isoetes sp.*), and dwarf water milfoil (*Myriophyllum tenellum*).

Using SCUBA, a transect will be established at each site. At designated points along the transect, a 0.1 m^2 quadrant will be placed along the transect. All plants in that quadrant will be identified and counted. The data will then be recorded as plant species, stem count, and conservatism value. The same transects and points along transect will be used each year to monitor any changes. When the transects and points along transects are determined, their GPS coordinates will be recorded for future reference.

Filamentous algae monitoring

The sites with filamentous algae sampled from the 2006 whole lake survey will be referenced by GPS coordinates. At each of these points, a rake sample using a metal, 14 tine rake will be obtained by pulling the rake approximately one meter along the bottom substrate. The algae density will be recorded (if present) based on the density ratings as follows:

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

Note: If a large amount of aquatic plants are sampled and covered with filamentous algae, estimate what the coverage would be without the plants.

Crayfish survey[25]

The first objective of the crayfish survey is to determine which species of crayfish are present in Grindstone Lake. This survey will monitor the native crayfish populations as well as rusty crayfish (*Orconectes rusticus*) populations. The survey should be conducted when the water temperatures are above 54 degrees F. The crayfish are most active from late June to mid-August. All crayfish fishing regulations must be followed to carry out this survey. Please refer to crayfish fishing regulations in *Guide to Wisconsin Hook and Line Fishing Regulations.*

The survey will consist of placing 5 traps along two different transects for a total of 10 traps. It is preferred that the transects are on opposite sides of the lake. The traps will be modified minnow traps with the opening modified to about 2 inches. The traps should be placed along 2 transects that will encompass a variety of habitats conducive to crayfish. This includes rocky substrates, sand flats and aquatic plant beds. The transect should be at a depth of 0.5 to 3.0 meters. The traps are baited with ¼ pound of sardines and/or dead fish. The traps should be placed at least 30 feet (10 meters) apart and allowed to sit overnight and removed the next day. Collect the crayfish from the traps until 30 crayfish have been collected or all traps are retrieved. All crayfish are to be preserved and later identified by employees of the UW-Madison Center for Limnology.

An alternative is to collect crayfish during daylight hours with snorkel and mask. The sampling should be along a transect and sampling should continue until 30 crayfish are collected or when 40 minutes of total search time has elapsed.
Preserve crayfish in Whirl-Paks (only fill Whirl-Pak ¼ full of crayfish). Use different Whirl-Paks for different sites. Fill the pack with 70% (or stronger) alcohol. Label container with the following :

Date
Site #
Lake name
WBIC number
County
Whirl-Pak # of total

Place sealed Whir-Pak with crayfish into freezer or deliver to local DNR office.

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[25] University of Wisconsin Extension. *Citizen Lakes Monitoring Manual: Section 5, Rusty Crayfish Protocol.*

Implementation Plan

Action Items	Timeline	Responsible party
Overall aquatic plant management planning	Ongoing	Grindstone Lake Association
Education of residents	Ongoing meetings/Annual meeting	Grindstone Lake Association/LCO Cons. Dept/Sawyer County LWCD/Wisconsin DNR
Invasive identification/monitoring	June-August, 2007 Subsequent summer monitoring	Grindstone Lake Volunteers
Curly leaf pondweed monitoring/hand removal	Spring 2007	Grindstone Lake Volunteers Sawyer County LWCD
Clean Boats/Clean Waters Program	Spring/Summer 2007 Ongoing summers	Grindstone Lake Volunteers UW-Extension
Sensitive area survey	By 2009	Wisconsin DNR or LCO Conservation Dept.
Crayfish monitoring	Spring/Summer 2007	Grindstone Lake volunteers/Wisconsin DNR/LCO Conservation Dept
Whole lake plant survey	Summer 2011 and every 5 years	Consultant
Sensitive plant survey	Annually starting summer 2007	Volunteer divers facilitated by consultant, Wisconsin DNR or Sawyer County LWCD
Filamentous algae monitoring	Annually each summer starting 2007	Grindstone volunteers/consultant
Watershed/Best Management Practices Education	2007-2008	Grindstone Lake Association/LCO Conservation Dept/Sawyer County LWCD
Groundwater flow analysis	By 2008	LCO Conservation Dept.
Water quality monitoring	Ongoing	LCO Conservation Dept.

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Appendix A-Sample points for reference

1. Sample points for Northern watermilfoil

Sampling point	Lat (WTM)	Long (WTM)		Sampling point	Lat (WTM)	Long (WTM)
13	407739	606993		1262	411593	607710
19	407829	606814		1289	411683	607441
53	408098	607351		1291	411683	607620
1140	411235	607620		1292	411683	607710
1141	411235	607710		1293	411683	607800
1143	411235	607889		1318	411773	607441
1144	411235	607979		1319	411773	607531
1170	411325	607531		1397	411952	609234
1171	411325	607620		1479	412311	606903
1172	411325	607710		1483	412311	607262
1174	411325	607889		1503	412311	609054
1176	411325	608068		1507	412400	607082
1201	411414	607620		1508	412400	607172
1203	411414	607800		1509	412400	607262
1204	411414	607889		1510	412400	607351
1205	411414	607979		1511	412400	607441
1231	411504	607620		1514	412400	607710
1260	411593	607531		1552	412579	606903
1261	411593	607620		1560	412579	607620

2. Sample points for filamentous algae

Sample point	LAT (WTM)	LONG (WTM)_	Depth(ft)	Filamentous density
1	407650	606455	7	2
3	407650	606634	1	2
5	407650	606814	2	1
7	407739	606455	4	1
8	407739	606545	6	1
21	407919	606365	13	1
26	407919	606814	6	1
27	407919	606903	1	1
43	408098	606276	7	2
44	408098	606365	18	2
52	408098	607262	4	1
53	408098	607351	9	1
55	408187	606186	3	3
65	408187	607082	4	1
68	408187	607351	4	1
69	408187	607441	7	2
72	408277	606186	19	2
79	408277	606814	8	1
84	408277	607262	10	2
85	408277	607351	6	1
86	408277	607441	7	1
90	408277	608517	11	1
91	408367	606096	10	3
105	408367	607351	4	1
107	408367	607531	6	1
116	408367	608606	2	1
117	408456	606007	25	2
118	408456	606096	18	1
136	408456	607710	10	1

Sample point	LAT (WTM)	LONG (WTM)_	Depth(ft)	Filamentous density
142	408456	608606	5	1
143	408546	606007	9	3
144	408546	606096	24	1
166	408546	608068	10	1
170	408546	608517	4	1
199	408636	608517	4	1
200	408725	606007	4	2
228	408725	608517	6	1
229	408725	608606	2	1
231	408815	606096	6	2
262	408904	606096	10	2
293	408904	608875	6	1
294	408904	608965	3	1
296	408994	606096	9	1
328	408994	608965	4	1
329	408994	609054	3	1
368	409173	606007	9	2
395	409173	608427	6	1
402	409173	609054	4	1
404	409173	609234	4	1
405	409263	606007	13	3
517	409532	606096	7	1
550	409532	609054	5	1
551	409532	609144	3	1
553	409622	606007	11	1
586	409622	608965	8	1
587	409622	609054	6	1
725	409980	608965	6	1
756	410070	608875	6	1
757	410070	608965	9	1
1312	411683	609503	17	1
1313	411683	609592	13	1
1338	411773	609234	24	1
1339	411773	609323	25	1
1370	411862	609413	11	1
1396	411952	609144	20	2
1397	411952	609234	15	1
1447	412131	608875	20	1
1452	412221	606903	29	1
1474	412221	608875	11	1
1500	412311	608785	5	1
1502	412311	608965	2	1
1545	412490	608248	5	1
1549	412490	608606	4	1
1550	412490	608696	3	1
1565	412579	608068	7	1
1566	412579	608158	5	1

Appendix B

Management Options for control of aquatic plants

The following is a synopsis of management options. Grindstone Lake is not in need of plant management involving reduction of plants. Therefore, this information is placed in the appendix. Should the plant community change in Grindstone Lake causing a need for management, this appendix may be referenced.

Permitting requirements

The Wisconsin Department of Natural Resources regulates the removal of aquatic plant 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.[1]

Biological control[2]

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

[1] More information regarding DNR permit requirements and aquatic plant management contacts is found on the DNR website www.dnr.state.wi.us

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

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 will not be utilized in Grindstone Lake.

Re-vegetation with native plants

Another aspect to biological control is native plant restoration. The rationale for re-vegetation is that restoring a native plant community should be the end goal of most aquatic plant management programs (Nichols, 1991; Smart and Doyle, 1995). However, in communities that have only recently been invaded by non-native species, a propagule bank probably exists that will restore the community after non-native plants is controlled (Madsen, Getsinger, and Turner, 1994). Re-vegetation following plant removal not necessary as plant will not be removed. However, there has been concern over plant population decline and future re-vegetation may be considered.

Physical control[3]

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 will not be used in Grindstone Lake as there are no sediment problems causing nuisance plant growth.

Draw down, 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

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

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 draw down period. Lastly, species respond in very different manners to draw down and often not in a consistent fashion (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy or adventive species, particularly annuals. There will be no need for drawdown on Grindstone Lake as there is no reason to reduce plant populatioins and the outlet is connected to another lake which affects that lake's level.

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 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. There is no need for plant reduction in Grindstone Lake, therefore this method will not be utilized.

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.

Manual removal

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

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. Unless an invasive should infest Grindstone Lake, these methods will not need to be utilized.

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.

Diver dredging operations use pump systems to collect plant and root biomass. The pumps are mounted on 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.

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.

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.

General descriptions of chemical control are included below.[4]

Contact Herbicides

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

[4] This Discussion is taken directly from: Managing Lakes and Reservoirs. North American Lake Management Society.

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

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

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

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

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[5]

Copper

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

2,4-D

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

Diquat

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

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.

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.

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

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

Algaecide treatments for filamentous algae
Copper-based compounds are generally used to treat filamentous algae. Common chemicals used are copper sulfate and Cutrine Plus, a chelated copper herbicide.

Herbicide use to manage invasive species

Curly leaf pondweed

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

Early season herbicide treatment:[6]
Studies have demonstrated that curly leaf can be controlled with Aquathol K (a formulation of Endothall) in 55 - 60 degree F water, and that treatments of curly leaf this early in its life cycle can prevent turion formation. Staff from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center is conducting further trials of this method. Balsam Lake (Polk County, Wisconsin) treated two sites totaling 13 acres in early June of 2004, and will follow up with ongoing treatment and monitoring of the effectiveness of this method.

Because the dosage is at lower rates than dosage recommended on the label, a greater herbicide residence time is necessary. To prevent drift of herbicide and allow greater contact time, application in shallow bays is likely to be most effective. Herbicide applied to a narrow band of vegetation along the shoreline is likely to drift, rapidly decrease in concentration, and be rendered ineffective.[7]

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[6] Research in Minnesota on Control of Curly Leaf Pondweed. Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[7] Personal communication, Frank Koshere. Wisconsin DNR. March 2005.

Eurasian water milfoil

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

Appendix C

Funding Source Reference Guide

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

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

AGRICULTURAL BEST MANAGEMENT PRACTICES

Contact Sawyer County Land and Water Conservation Department
715-634-6463

EDUCATION AND PLANNING

Grant Program: Environmental Education Grant Program
US EPA
Program Goals/Objectives: Enhance the public's awareness, knowledge, and skills to help people make informed decisions that affect environmental quality
Eligible Applicants: non-profit corporation, local or tribal education agency
Eligible Project Elements:
Funding Limits and Rates: more than 75% of the grants are less than $15,000
Application Deadline: Mid-November each year
Contact: www.epa.gov/enviroed/grants.html
Comments:
Notice for 2007 grants expected in January 2007. Generally 200 grants are funded out of 1000 applications received.

Grant Program: Forest Stewardship
Wisconsin Department of Natural Resources
Program Goals/Objectives: encourage private non-industrial forest landowners to consider all resources in the management of their forestlands
Eligible Applicants: groups, organizations, government agencies
Eligible Project Elements: wages, consultant services, equipment, and supplies
Funding Limits and Rates: up to $15,000, 50% matching grant
Application Deadline: January of each year
Contact: Nicole Potvin nicole.potvin@dnr.state.wi.us
Comments: Project emphasis –

- provide info on multi-resource management of forest lands to the general public
- train resource professionals and service providers
- direct assistance to private forest landowners
- develop new informational materials

Grant Program: River Protection Planning
Wisconsin Department of Natural Resources
Program Goals/Objectives: River protection (Grindstone Creek)
Eligible Applicants: Qualified river organizations
Eligible Project Elements: planning, organizational assistance, assessments, education – newsletters, brochures, etc.
Funding Limits and Rates: 75 % of project costs up to $10,000
Application Deadline: May 1st each year
Contact: Pamela Toshner 715.635.4073

Grant Program: Wisconsin Environmental Education Board
University of Wisconsin – Stevens Point
Program Goals/Objectives: Carry out environmental education activities
Eligible Applicants: Nonprofit corporations, public agencies
Eligible Project Elements: salaries, travel, supplies, software, capital expenses for environmental education
Funding Limits and Rates: $1,000 (mini-grant), $5,000 (environmental ed.), $20,000 (forestry education) pays up to 75% of project costs
Application Deadline: January 13, 2007
Contact: 715-346-3805
www.uwsp.edu/cnr/weeb/grantprogram

PROPERTY AND EASEMENT ACQUISITION[1]

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: property acquisition, engineering, conservation easement, wetland restoration
Funding Limits and Rates: 75 % of project costs up to $200,000
Application Deadline: May 1st each year
Contact: Pamela Toshner 715.635.4073

Grant Program: North American Wetland Conservation Act (Federal)
Program Goals/Objectives: long-term enhancement of wetlands
Eligible Applicants: local conservation groups
Eligible Project Elements: wetland restoration and acquisition
Funding Limits and Rates: 50% up to $75,000
Application Deadline: open each year
Contact: Barb Pardo 612.713.5433 (Joint Venture Coordinator)
Comments/concerns:
Since this is a federal program, state grant money could be used as match.

Grant Program: River Protection Management
Wisconsin Department of Natural Resources
Program Goals/Objectives: river protection and restoration
Eligible Applicants: Qualified river organizations
Eligible Project Elements: property acquisition, engineering, conservation easements, restoration
Funding Limits and Rates: 75 % of project costs up to $50,000
Application Deadline: May 1st each year
Contact: Pamela Toshner 715.635.4073

[1] A note about acquisition grants
Grant projects offer revenue to preserve conservation features of properties. They are highly competitive, and awards are generally given only where considerable work is already completed to clearly frame and commit a project. This work requires investment for initial steps such as surveys, appraisals, preliminary landowner approval, development of conservation easement requirements, and grant writing. While many of these costs are reimbursable expenses under the grant, grants are certainly not guaranteed. Allowing unrestricted public access increases grant funding possibilities.

Grant Program: Acquisition and Development of Local Parks (Stewardship)
Wisconsin Department of Natural Resources
Program Goals/Objectives: expand opportunities for outdoor recreation
Eligible Applicants: Non-profit organizations (acquisitions only)
Local governments including Sawyer County (acquisition and park development)
Eligible Project Elements: property acquisition and park development (trails, restroom facilities, picnic areas, parking)
Funding Limits and Rates: 50% funding of appraised value
Application Deadline: May 1st each year
Contact: Pat Zatopa, Community Services Specialist 715.365.8928
Comments/concerns:

- Park development would require partnering with a local government such as the Town of Bass Lake, or Sawyer County.
- Land donation may be used as match for the acquisition.
- Federal dollars for outdoor recreation are also funneled through the Stewardship program to local government. The Land and Water Conservation Fund and Recreational Trails Act have similar goals and eligible elements.

Grant Program: Acquisition of Development Rights (Stewardship)
Wisconsin Department of Natural Resources
Program Goals/Objectives: protect natural, agricultural, or forestry values that would enhance nature based outdoor recreation
Eligible Applicants: Local Government
Eligible Project Elements: purchase of development rights (conservation easements)
Funding Limits and Rates: 50% funding of appraised value
Application Deadline: May 1 of each year
Contact: Pat Zatopa, Community Services Specialist 715.365.8928

Grant Program: Farm and Ranchlands Protection
Natural Resources Conservation Service
Program Goals/Objectives: Purchase development rights to keep productive farm and ranchland in agricultural uses.
Eligible Applicants: nongovernmental organization; state, tribal or local government with existing farm and ranch protection programs
Eligible Project Elements: Acquisition of conservation easements from landowners
Funding Limits and Rates: 50% of fair market easement value
Application Deadline: not currently available on web site
Contact: http://www.nrcs.usda.gov/programs/frpp/
Comments: Farm must be part of a pending offer from a protection program; must have a conservation plan for highly erodible land
Landowner may provide donation of up to 25% of easement value; applicant must provide at least 25%

Appendix D

Introduction

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

Grindstone Lake (WBIC: 2391200) is a 3111-acre lake in Sawyer County, Wisconsin in the Town of Bass Lake (T40N R08W S29). It is a drainage lake with the main input from Grindstone Creek and outflows into Lac Courte Oreilles. The Grindstone Lake Association sponsored this aquatic macrophyte survey, with assistance from Wisconsin Department of Natural Resources planning grant funds.

Field methods

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

At each sample location, a double-sided, fourteen tine rake was used to rake a 1m tow off the bow of the boat. All plants contained on the rake and those that fell off of rake when removing from lake were identified and rated as to rake fullness. The rake fullness value was used based on the criteria contained in the table below.

Rake fullness rating	Criteria for rake fullness rating
1	Plant present, occupies less than ½ of tine space
2	Plant present, occupies more than ½ tine space
3	Plant present, occupies all or more than tine space
v	Plant not sampled but observed within 6 feet of boat

The depth and predominant bottom type was also recorded for each sample point. All plants needing verification were bagged and cooled for later examination. Two plants from each species were also collected for creation of a voucher or herbarium collection.

Data analysis methods

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

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

An explanation of each of these data are provided below.

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

Frequency of occurrence example:

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

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

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

Relative frequency-This value shows, as a percentage, the frequency of a particular plant relative to other plants. This is not dependent on the number of points sampled. The relative frequency of all plants will add to 100%. This means that if plant A had a relative frequency of 30%, it occurred 30% of the time compared to all plants sampled or makes up 30% of all plants sampled. This value allows us to see which of the plants are the dominant species in the lake. The higher the relative frequency the more common the plant is compared to the other plants.

Relative frequency example:

Suppose we were sampling 10 points in a very small lake and got the following results:

	Frequency sampled
Plant A present at 3 sites	3 of 10 sites
Plant B present at 5 sites	5 of 10 sites
Plant C present at 2 sites	2 of 10 sites
Plant D present at 6 sites	6 of 10 sites

So one can see that Plant D is the most frequent sampled at all points with 60% (6/10) of the sites having plant D. However, the relative frequency allows us to see what the frequency is compared the other plants, without taking into account the number of sites. It is calculated by dividing the number of times a plant is sampled by the total of all plants sampled. If we add all frequencies (3+5+2+6), we get a sum of 16. We can calculate the relative frequency by dividing by the individual frequency.

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

Now we can compare the plants to one another. Plant D is still the most frequent, but the relative frequency tells us that of all plants sampled at those 10 sites, 37.5% of them are Plant D. This is much lower than the frequency of occurrence (60%) because although we sampled Plant D at 6 of 10 sites, we were sampling many other plants too, thereby giving a lower frequency when compared to those other plants. This then gives a true measure of the dominant plants present.

Total sample points-This is the total number of points created for sampling on the lake. This may not be the same as the actual points sampled. When doing a survey, we don't sample at depths outside of the littoral zone (the area where plants can grow). Once the maximum depth of plants is established, many of the points deeper than this are eliminated to save time and effort.

Sample sites with vegetation- The number of sites where plants were actually sampled. This gives a good idea of the plant coverage of the lake. If 10% of all sample points had vegetation, it implies about a 10% coverage of plants in the whole lake, assuming an adequate number of sample points have been established. We also look at the number of sample sites with vegetation in the littoral zone. If 10% of the littoral zone had sample points with vegetation, then the plant coverage in the littoral zone would be estimated at 10%.

Simpson's diversity index-To measure how diverse the plant community is, Simpson's diversity index is calculated. This value can run from 0 to 1.0. The greater the value, the more diverse the plant community is in a particular lake. In theory, the value is the chance that two species sampled are different. An index of "1" means that the two will always be different (very diverse) and a "0" would indicate that they will never be different (only one species found). The more diverse the plant community, the better the lake ecosystem.

> Simpson's diversity example:
>
> If one went into a lake and found just one plant, the Simpson's diversity would be "0." This is because if we went and sampled randomly two plants, there would be a 0% chance of them being different, since there is only one plant.
>
> If every plant sampled were different, then the Simpson's diversity would be "1." This is because if two plants were sampled randomly, there would be a 100% chance they would be different since every plant is different.
>
> These are extreme and theoretical scenarios, but they do make the point. The greater the Simpson's index is for a lake, the greater the diversity since it represents a greater chance of two randomly sampled plants being different.

Maximum depth of plants-This depth indicates the deepest that plants were sampled. Generally more clear lakes have a greater depth of plants while lower water clarity limits light penetration and reduces the depth at which plants are found.

Species richness-The number of different individual species found in the lake. There is a number for the species richness of plants sampled, and another number that takes into account plants viewed but not actually sampled during the survey.

Floristic Quality Index-The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. This index is a measure of the plant community in response to development (and human influence) on the lake. It takes into account the species of aquatic plants found and their tolerance for changing water quality and habitat quality. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A high conservatism value indicates that a plant is intolerant while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes, largely due to human influence. The FQI is calculated using the number of species and the average conservatism value of all species used in the index. Therefore, a higher FQI, indicates a healthier aquatic plant community. This value can then be compared to the mean for other lakes in the assigned eco-region. There are four ecoregions used throughout Wisconsin. These are Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. Grindstone Lake is in the Northern Lakes and Forest eco-region.

Based on statistics presented in Floristic Qualtiy research, Floristic Quality has a significant correlation with area of lake (+), alkalinity(-), conductivity(-), pH(-) and Secchi depth (+). In a positive correlation, as that value rises so will FQI, while with a negative correlation, as a value rises, the FQI will decrease[1].

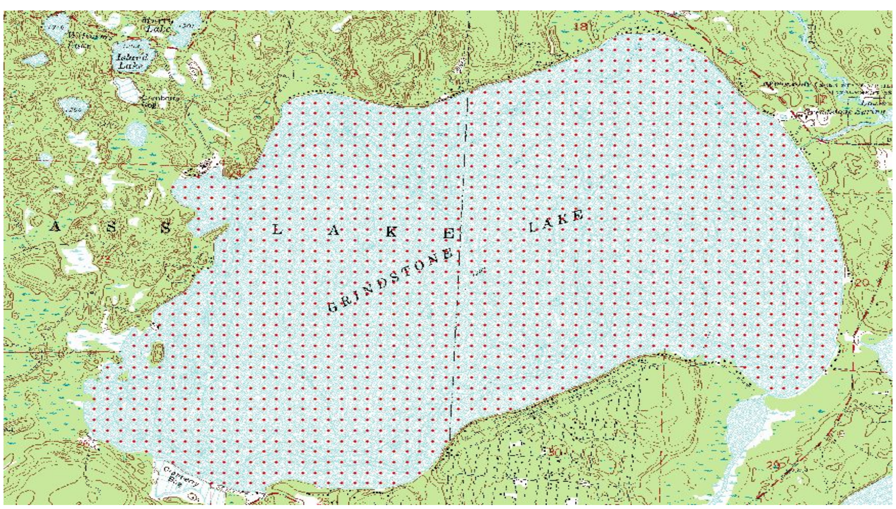
Summary of Northern Lakes and Forest Mean Values for Floristic Quality Index:
Mean species richness = 13
Mean average conservatism = 6.7
Mean Floristic Quality = 24.3*

Results

In the early season (June) survey, **no** *Potamogeton crispus* (curly leaf pondweed) was sampled or observed. It was sampled once in the July, main survey (See table 1).

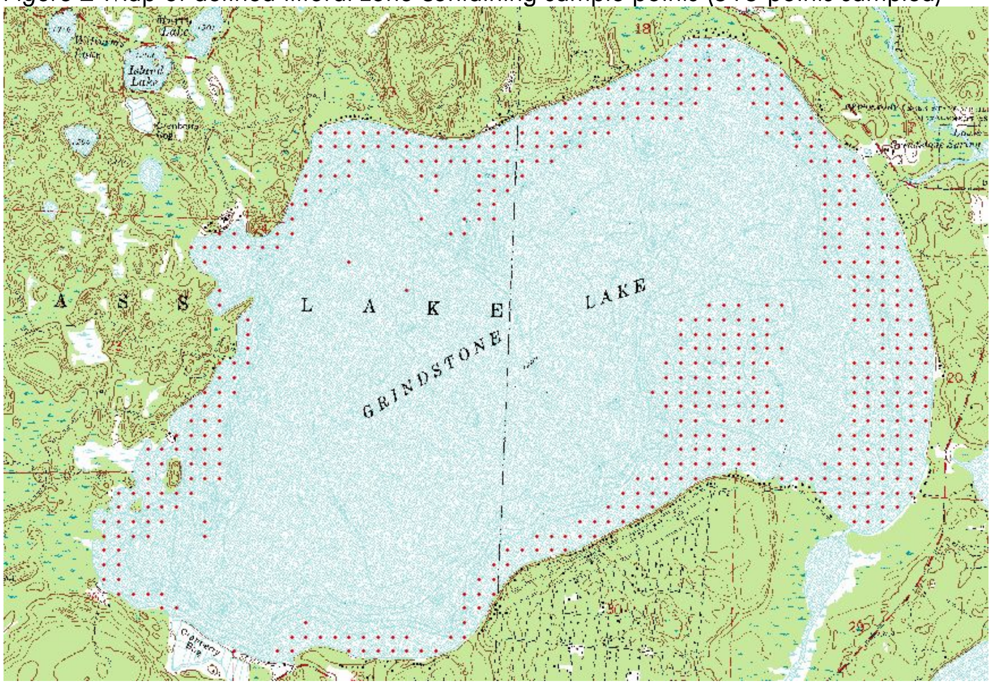
Below is a map of the point-intercept grid for Grindstone Lake. Once it was established that plants were not growing at 30 feet or more, all point at or greater than 30 feet were eliminated. When actual sampling indicated no plants at a particular depth (edge of littoral zone), one sample point beyond this was taken. Points beyond this were then eliminated.

Figure 1: Point grid for Grindstone Lake (1585 points)



[1] Statistics acquired and reviewed from Nichols, Stanley A. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications.* Journal of Lake and Reservoir Management 15 (2): 133-141. 1999.

Figure 2-Map of defined littoral zone containing sample points (515 points sampled)



The following map illustrates where vegetation was found. This generally defines the littoral zone of the lake. Depending on the lake, the depth shallow enough to grow plants may or may not contain plants.

Figure 3-Map of points with vegetation

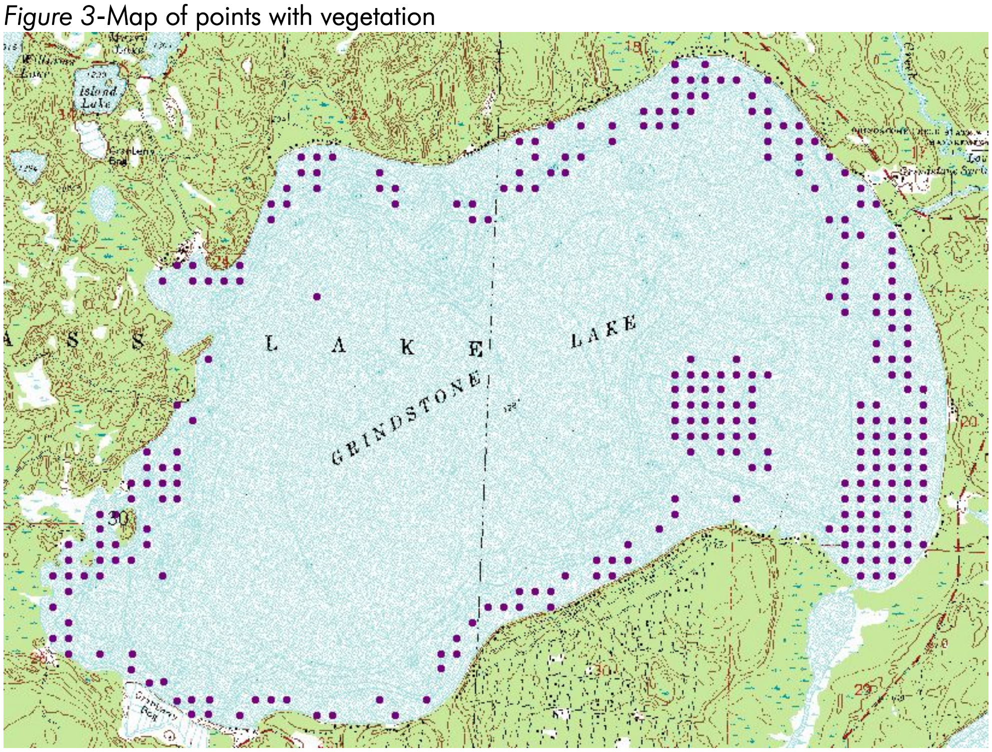


Table 1-Species richness and frequency data:

Species name	Common name	Relative Freq(%)	Freq littoral zone(%)
Filamentous algae	Filamentous algae	12.50	13.59
Vallisneria americana	Wild celery	11.60	12.58
Chara sp	Muskgrass	9.60	10.34
Najas flexilis	Bushy pondweed	8.60	9.33
Potamogeton zosteriformis	Flat stem pondweed	7.90	8.52
Potamogeton gracimeus	Variable pondweed	7.70	8.32
Myriophyllum sibiricum	Northern water milfoil	7.10	7.71
Potamogeton robbinsii	Fern pondweed	6.90	7.51
Elodea canadensis	Waterweed	5.10	5.48
Potamogeton richarsonii	Clasping leaf pondweed	4.30	4.67
Ceratophyllum demensum	Coontail	3.90	4.26
Potamogeton praelongus	White stem pondweed	3.00	3.25
Megalodonta beckii	Water marigold	2.20	2.43
Myriophyllum tenellum	Dwarf water milfoil	2.20	2.43
Potomageton illinoensis	Illinois pondweed	1.70	1.83
Nitella sp.	Nitella	1.10	1.22
Potamogeton amplifolius	Large leaf pondweed	1.10	1.22
Eriocaulon aquaticum	Pipewort	0.90	1.01
Ranunculus flammula	Creeping spearwort	0.50	0.61
Isoetes sp.	Quillwort	0.40	0.41
Ranunculus aquatilis	White water crowfoot	0.40	0.41
Potamogeton pusillus	Small pondweed	0.40	0.41
Potamogeton crispus	Curly leaf pondweed	0.20	0.20
Potamogeton pectinatus	Sago pondweed	0.20	0.20
Nymphaea odorata	White water lily	0.20	0.20
Heteranthera dubia	Water stargrass	0.20	0.20
Nuphar variegata	Spatterdock	visual only	
Pontederia cordata	Pickerelweed	visual only	
Potamogeton natans	Floating leaf pondweed	visual only	
Schoenoplectus pungens	Three-square rush	visual only	
Schoenoplectus acutus	Soft-stem bullrush	visual only	
Typha latifolia	Cattail	visual only	

Total species richness = 32 species (including visuals)

Table 2-Floristic Quality Data

Floristic Quality (FQI): Value for Grindstone (mean for Northern Lakes and Forests)
Species observed for FQI (N) = 29 (13)
Average conservatism = 6.31 (6.7)
FQI = 33.98 (24.3)

Table 3-Misc. Data

Number of points sampled in defined littoral zone = 515
Number of points with vegetation = 274
Percentage of littoral zone with plants = 53.2%
Percentage of entire lake with plants = 17.3 %
Greatest depth plants sampled = 29.2 ft
Average number of species per site in littoral zone = 1.13
Average number of species per site when vegetated = 2.04
Simpson's diversity index = 0.93

Figure 4-Map of filamentous algae sites with density higher than 1 (2-3).

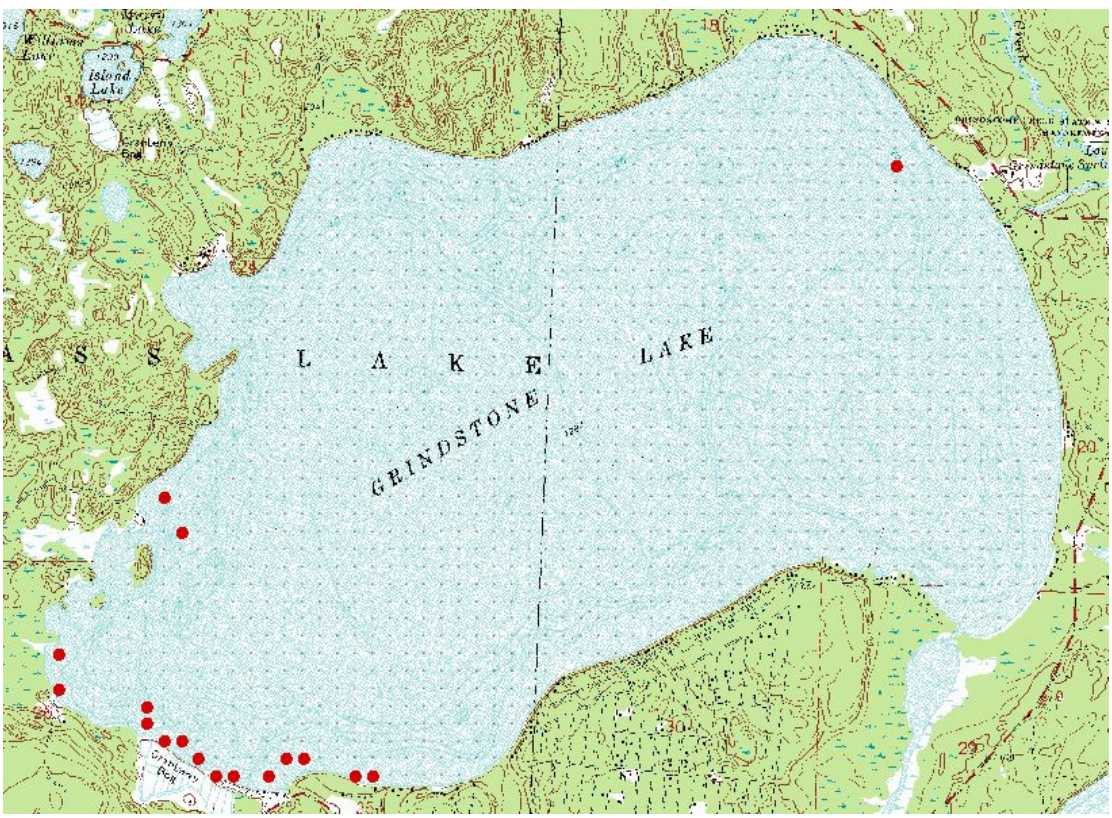
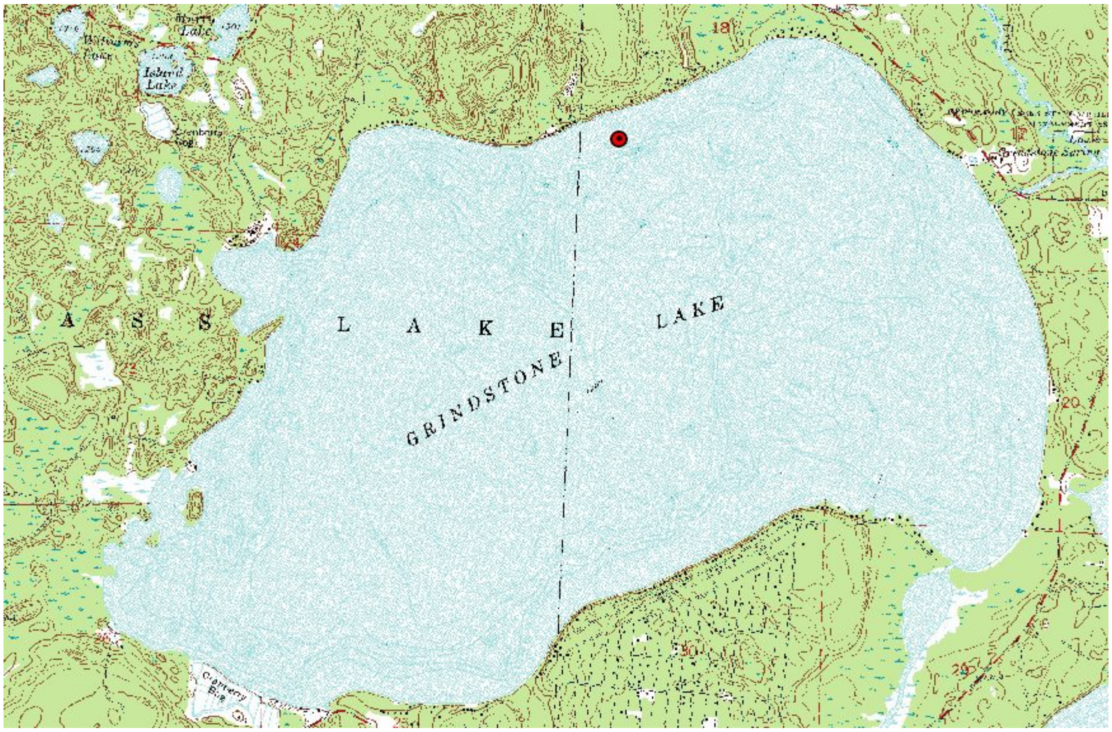


Figure 5-Potamogeton crispus (curly leaf pondweed) location



Discussion of results

Grindstone Lake has a very diverse native plant community with thirty native macrophyte species surveyed (see table 1). The fact that thirty species were found indicates a very diverse plant community in Grindstone Lake. No one plant dominates the lake. The highest frequency plant was filamentous algae followed by *Vallisneria americana* (wild celery) (see table 1). The frequency of each plant is relatively low, demonstrating a varied, healthy community. In relationship to the various species found, *Potamogeton crispus* (curly leaf pondweed) was the only non-native plant found. This plant was only found at one sample site.

The Simpson's diversity index is 0.93. This indicates the likelihood of two plants being different is very high. This demonstrates a high degree of diversity and a healthy ecosystem.

The plant community indicates Grindstone Lake has a very high water quality. Some of the natives located in Grindstone are very desirable plants. *Myriophyllum tellenum* (dwarf water milfoil) is a plant that is very susceptible to poor water quality. In addition, *Potamogeton praelongus* (white stem pondweed) and *Eriocaulon aquaticum* (pipewort) presence indicate sustained high water quality. The maximum littoral zone depth plants were sampled extended to 29.2 feet (see table 3). This can only occur with very high water clarity because light has to penetrate to this depth during much of the growing season for the plants to be able to photosynthesize.

Grindstone Lake has a higher number of species present and a higher Floristic Quality Index (FQI) than the mean for lakes within this ecoregion (Northern Lakes and Forests) (see table 2). The high FQI represents a plant community that is in tolerant to development and other human disturbances. Again, these values show that Grindstone Lake has high water quality and excellent conditions for in-tolerant plants. Although there is fair amount of development on the lake, the plant community is not responding adversely.

Plant coverage is quite limited in Grindstone Lake. As seen in table 3, there were 515 sample points defining the littoral zone. Only 53% of those points had plants present. This indicates low amounts of plant growth in the littoral zone, where plants can potentially grow. Furthermore, there are plants located at just 17% of all 1585 sample points. Again, this is low plant coverage for a lake. This is probably due to the limited nutrients in Grindstone Lake and the type of substrate in the lake. The vast majority of the sample points had either rock and/or sand for substrates. Both of these substrates are very limited in nutrients, and the plants must be adapted to grow in these areas. This selects the plants that can grow in these areas, thereby reducing the potential species in the lake. In areas where mucky sediments have accumulated, the diversity and density of plant growth increases immensely.

Filamentous algae was the most frequently sampled. In discussing this with a few lake residents, their opinion is that this growth has been increasing over last several years. With the lack of any baseline studies in this matter, it is difficult to assess changes in filamentous algae growth. If filamentous algae growth is increasing, one could potentially conclude that the nutrients are increasing in Grindstone Lake. Filamentous algae need no particular substrate in which to grow and water clarity in Grindstone Lake is high, therefore nutrients can be a very important limiting factor. For this reason, increased growth can indicate increased nutrients. The fact remains that filamentous algae is found in many of the littoral sample points with vegetation and is rather dense in a few locations.

Considerations for management

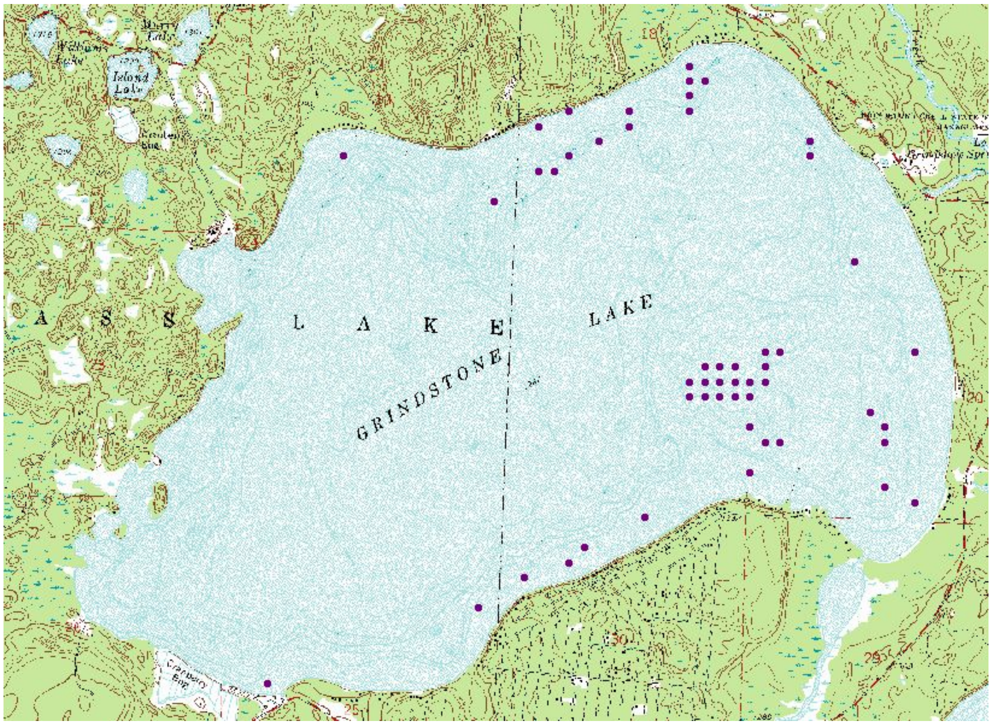
First, Grindstone Lake has very limited coverage of aquatic plants (see table 2). The habitats conducive for plant growth are limited to a few areas within the littoral zone. Aquatic plants play a very important role in the lake ecosystem. Fish and other organisms rely a great deal on plants for cover, habitat and food. Therefore, it is imperative to protect and preserve the present native plant beds to help facilitate a healthy, diverse lake ecosystem. Since many lake residents and lake users may be unaware of the importance of plants to a lake ecosystem, it is recommended that an education protocol be implemented.

Potamogeton crispus (curly leaf pondweed) was fortunately the only non-native plant sampled in Grindstone lake. There was only one plant sampled in the main survey and zero plants sampled in the June survey, which was done specifically to survey for this plant. Therefore, it appears this plant has not established itself in this lake at this point. It is possible that this survey was completed during a new introduction of this non-native plant. Curly leaf pondweed is a cold-water plant usually found in high nutrient sediments. Grindstone Lake has temperatures that would allow curly leaf pondweed to grow; however it has very limited high nutrient sediments. If curly leaf pondweed were to get established, it could become infested in some of these small areas. For this reason, it is recommended that public education be implemented to provide identification of curly leaf pondweed and have local residents monitor areas with suitable habitat to reduce the chance of this plant becoming established. Furthermore, this education should include identification of Eurasian Water Milfoil (EWM) to help avoid invasion of this species at the same time.

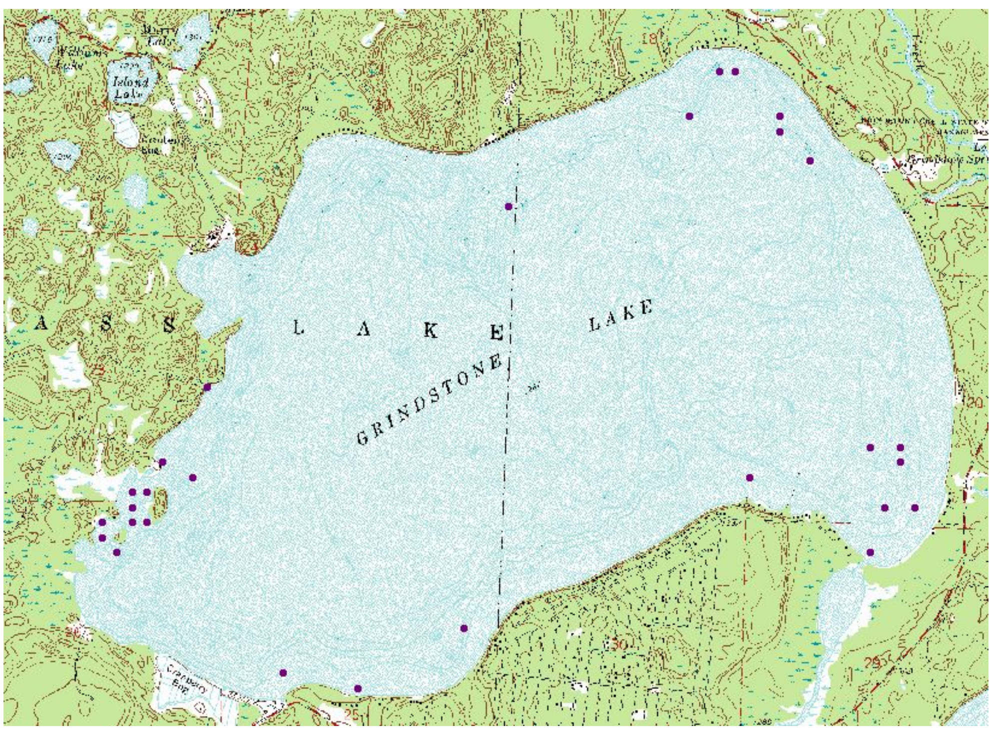
The presence of filamentous algae may indicate that the nutrients in Grindstone Lake are on the rise. Without historical data to verify this theory, it is important to monitor any changes in filamentous algae coverage and density. Map 3 shows where filamentous algae were sampled and the spreadsheet in the appendix indicates the density. It is recommended that local residents set up a monitoring scheme to observe any changes in growth and coverage.

Recommendations:

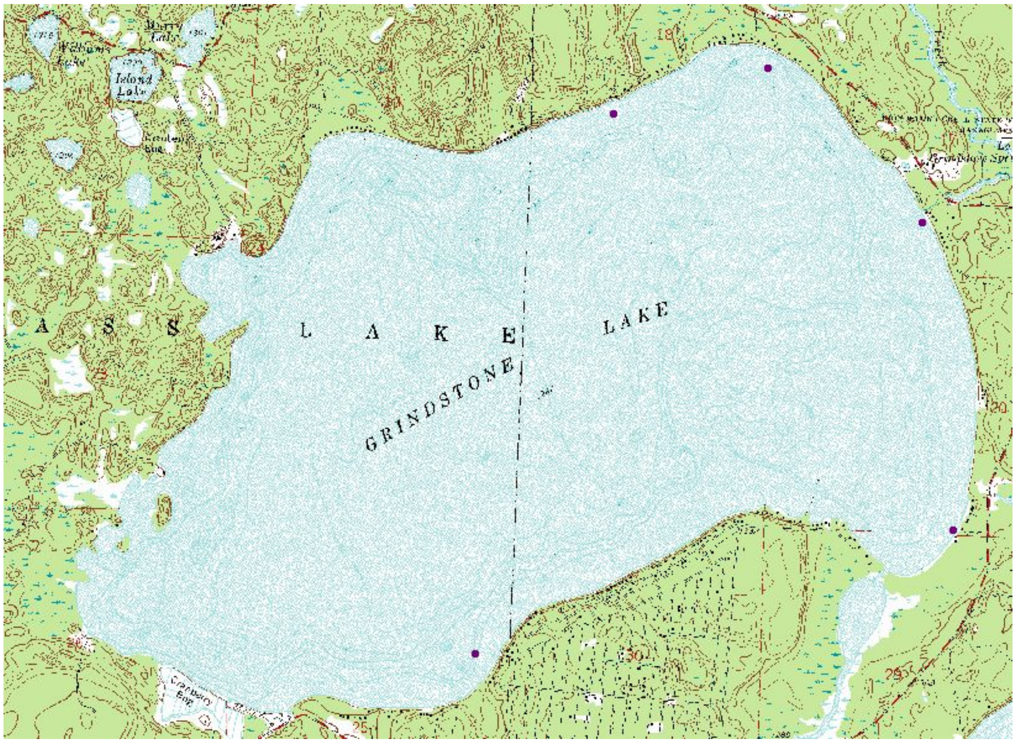
- Educate identification of invasive, non-native species, especially curly leaf pondweed and Eurasian water milfoil.
- Monitor for the existence of curly leaf pondweed at other sites in areas conducive for its growth.
- Monitor the growth of filamentous algae to establish any long-term trends.
- Protect and preserve the present native plant population.
- Educate lake users about the importance of Grindstone Lake's aquatic plant community.



Chara sp. (Muskgrass)

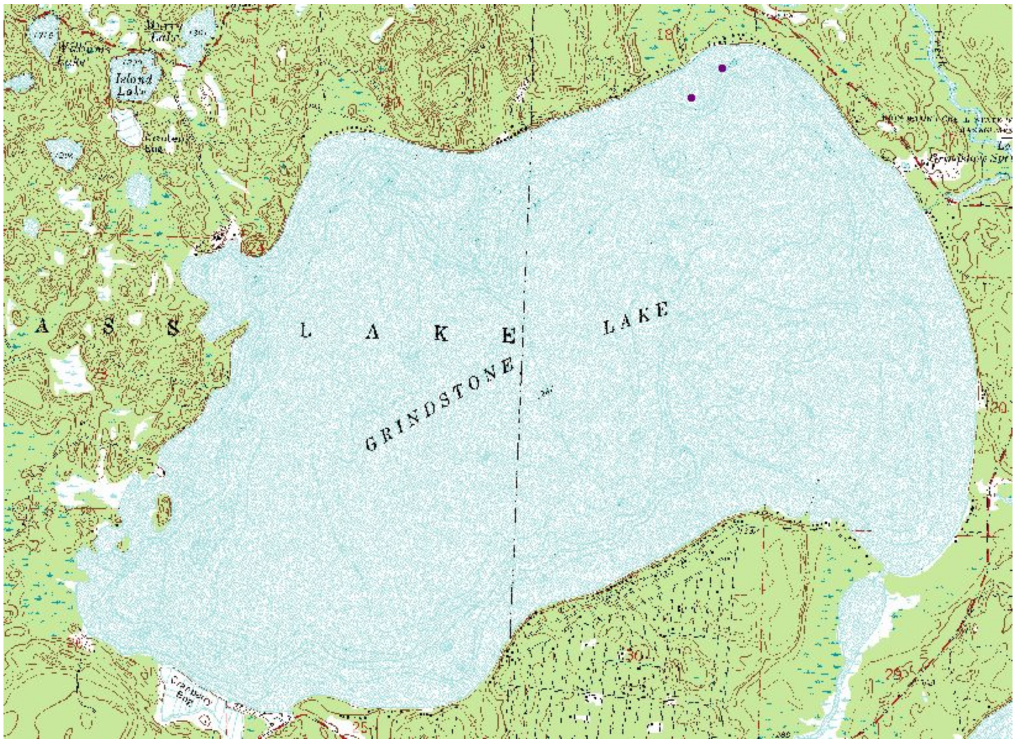


Elodea canadensis (Waterweed)

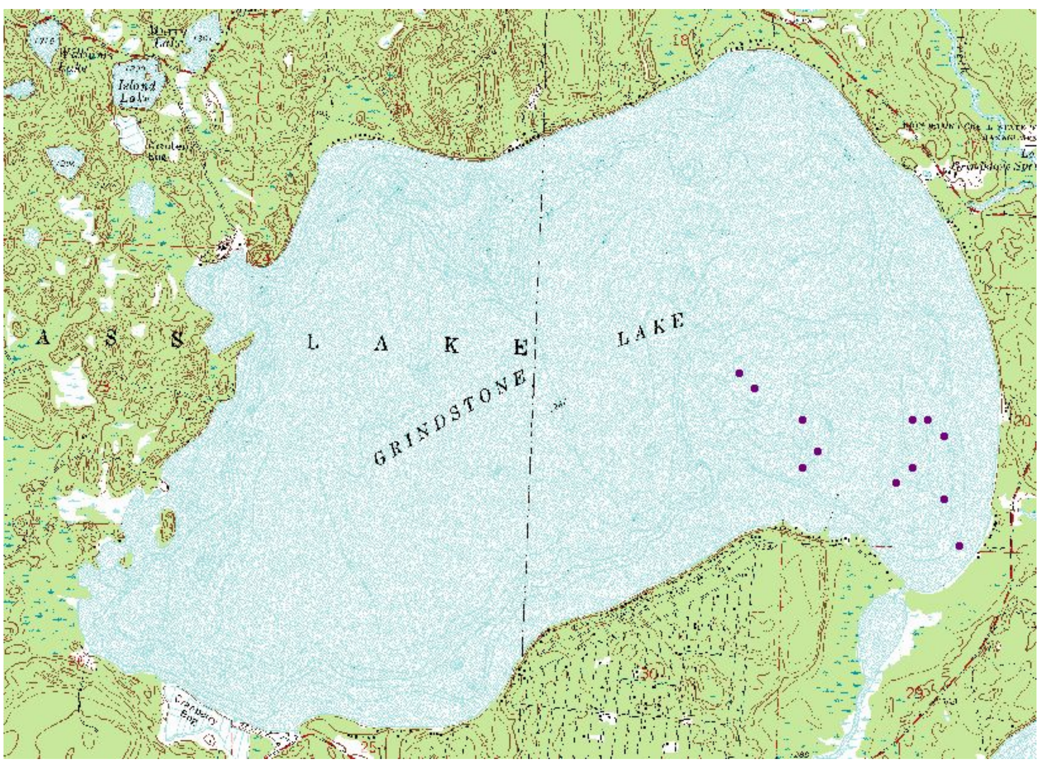


Eriocaulon aquaticum (Pipewort)

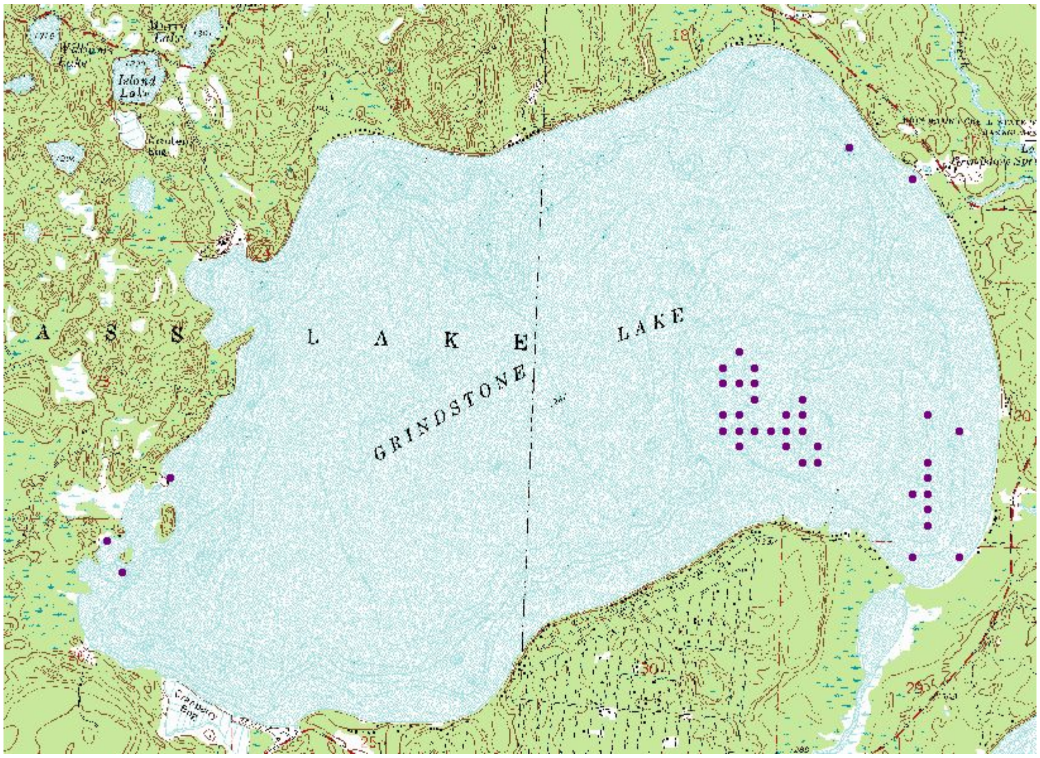
Heteranthera dubia (Water stargrass)



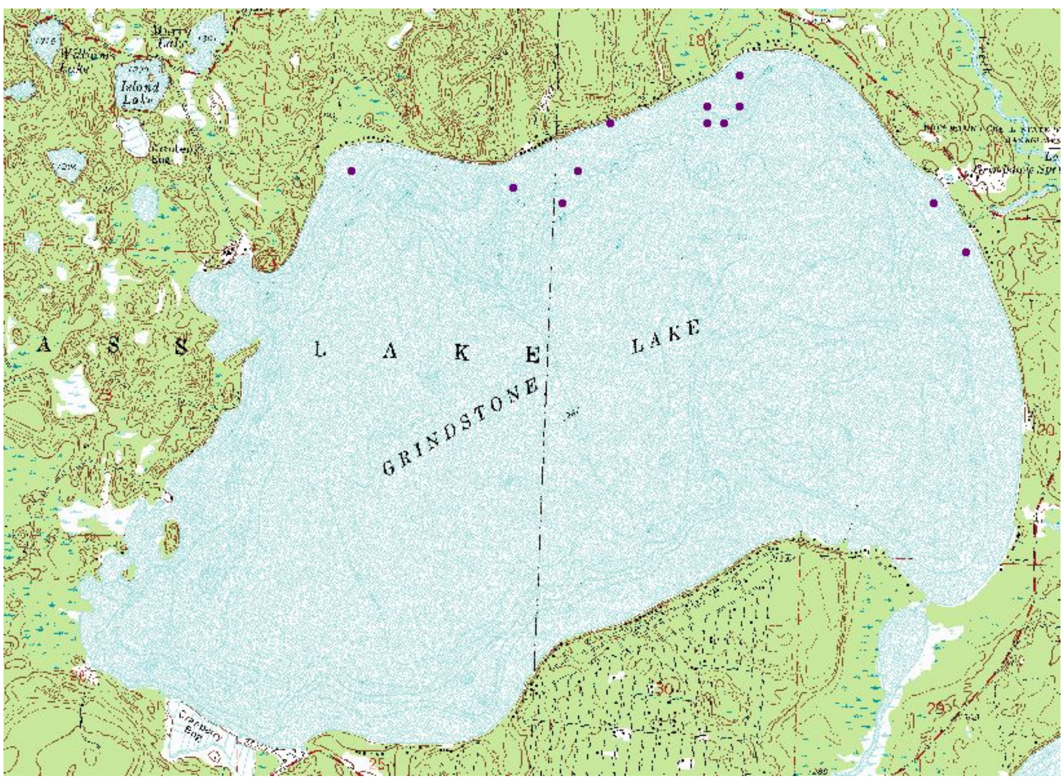
Isoetes sp. (Quillwort)



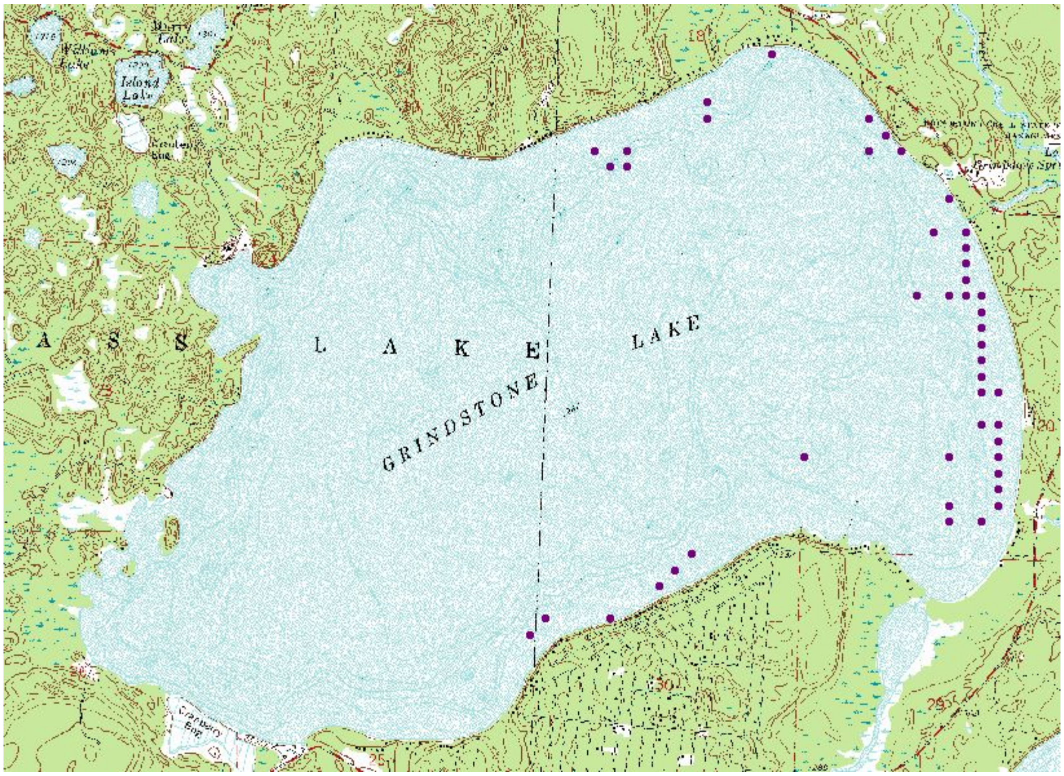
Megalodonta beckii (Water marigold)



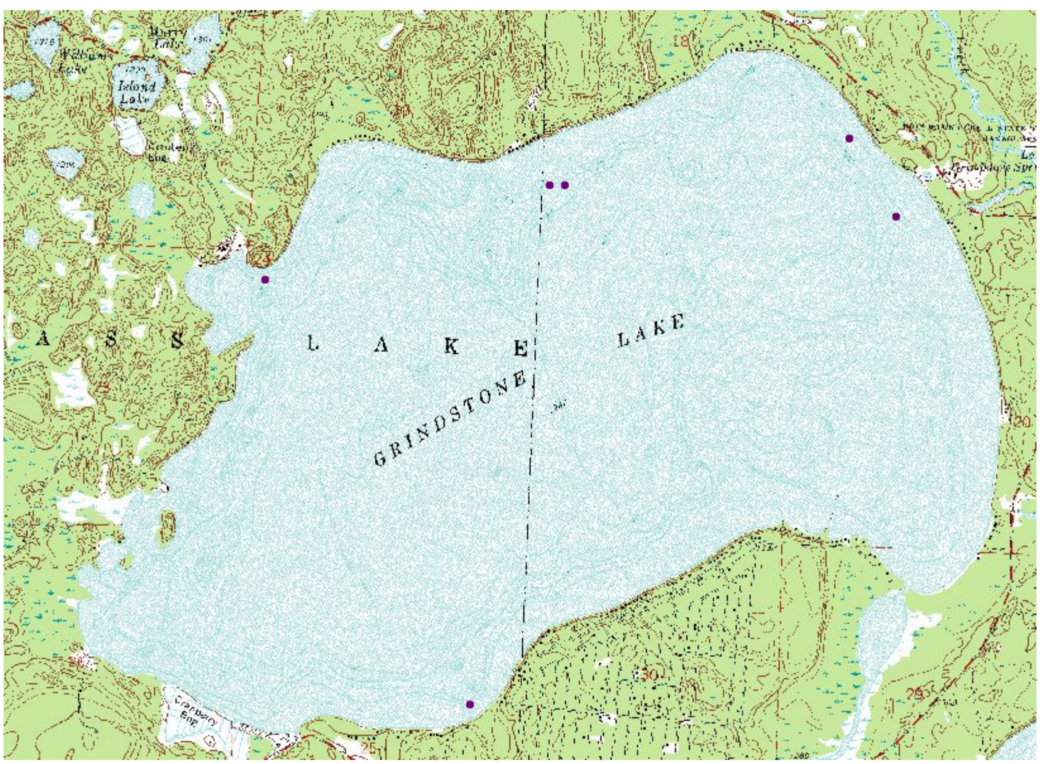
Myriophyllum sibiricum (Northern milfoil)



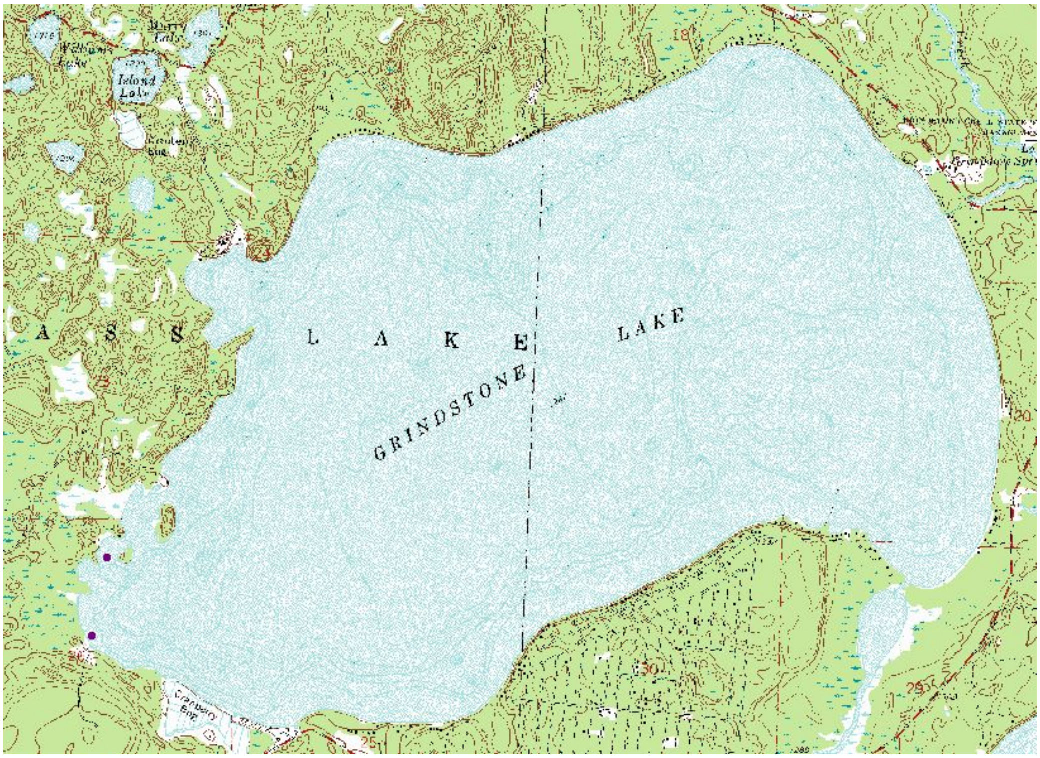
Myriophyllum tenellum (Dwarf water milfoil)



Najas flexilis (Bushy pondweed)



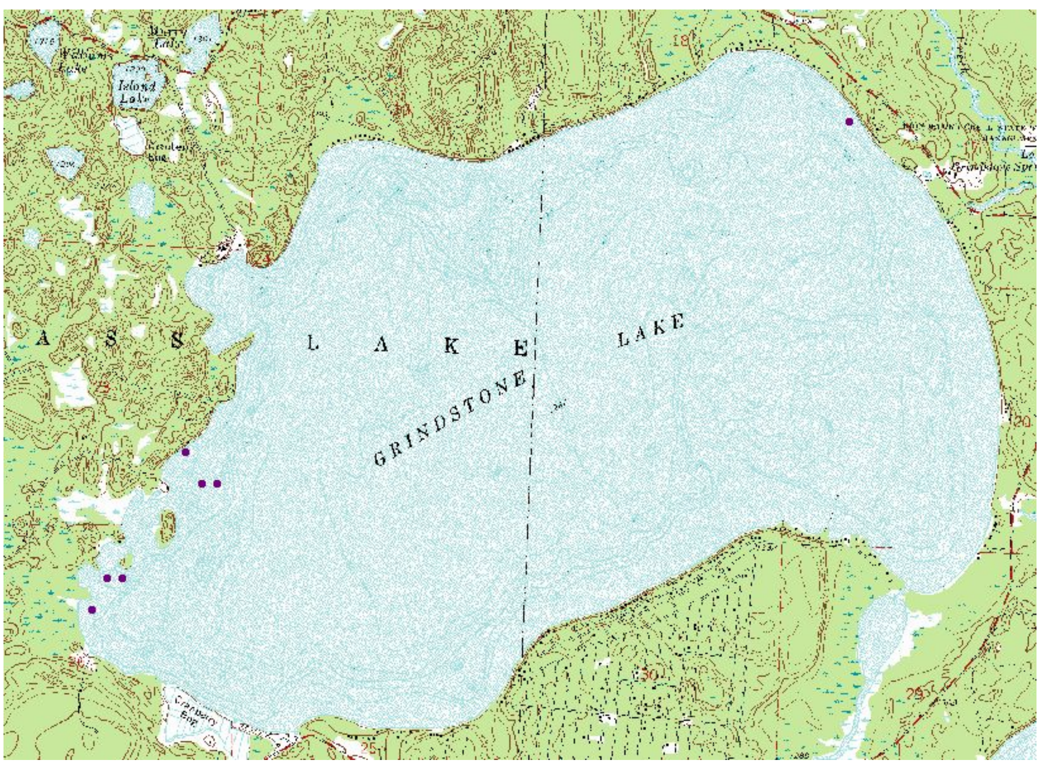
Nitella sp. (Stonewort)



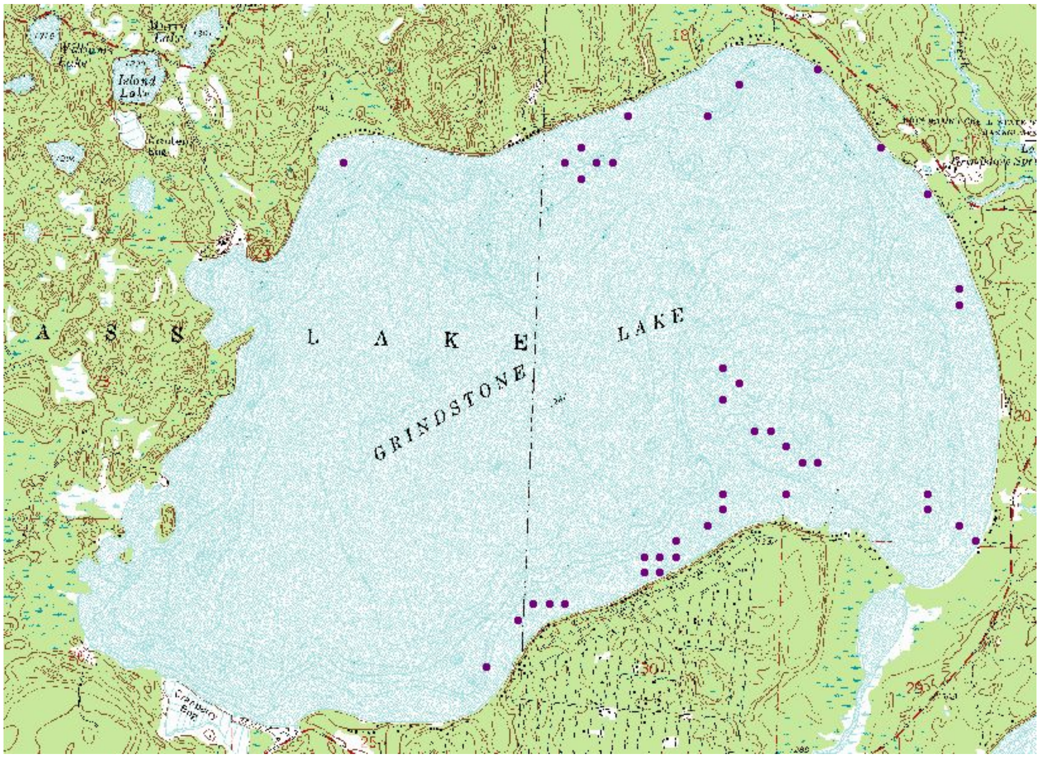
Nuphar variegata (Spatterdock)

Nymphaea odorata (White lily)

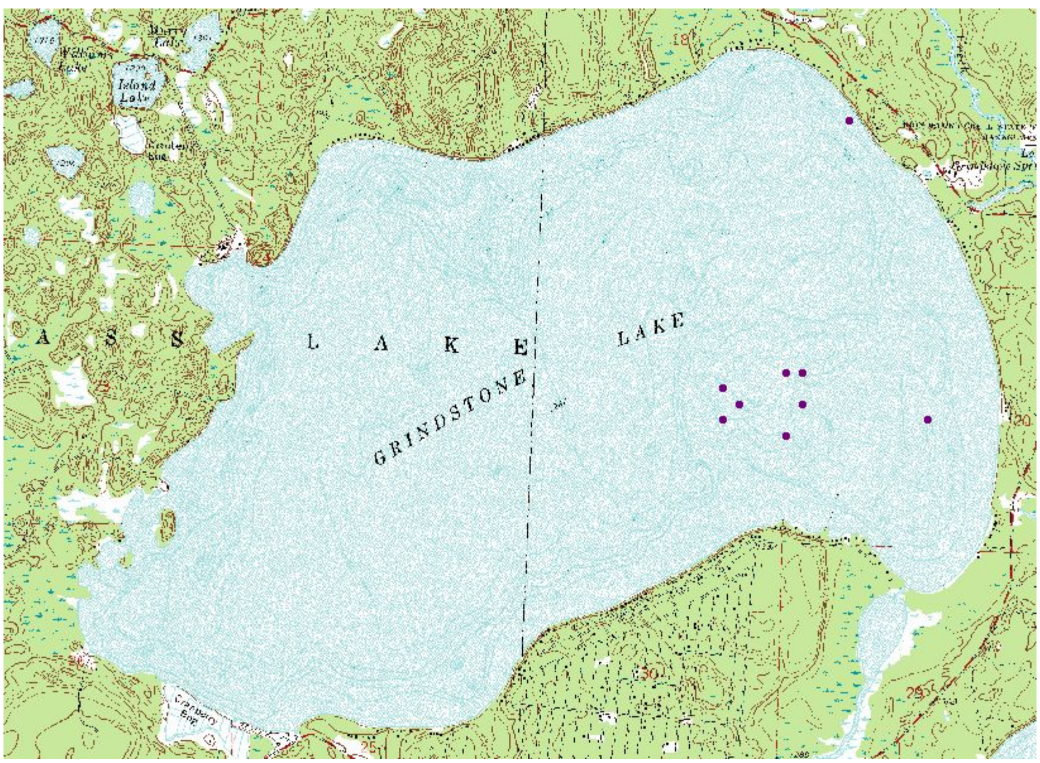
Pontederia cordata (Pickerelweed)



Potamogeton amplifolius (Large leaf pondweed)

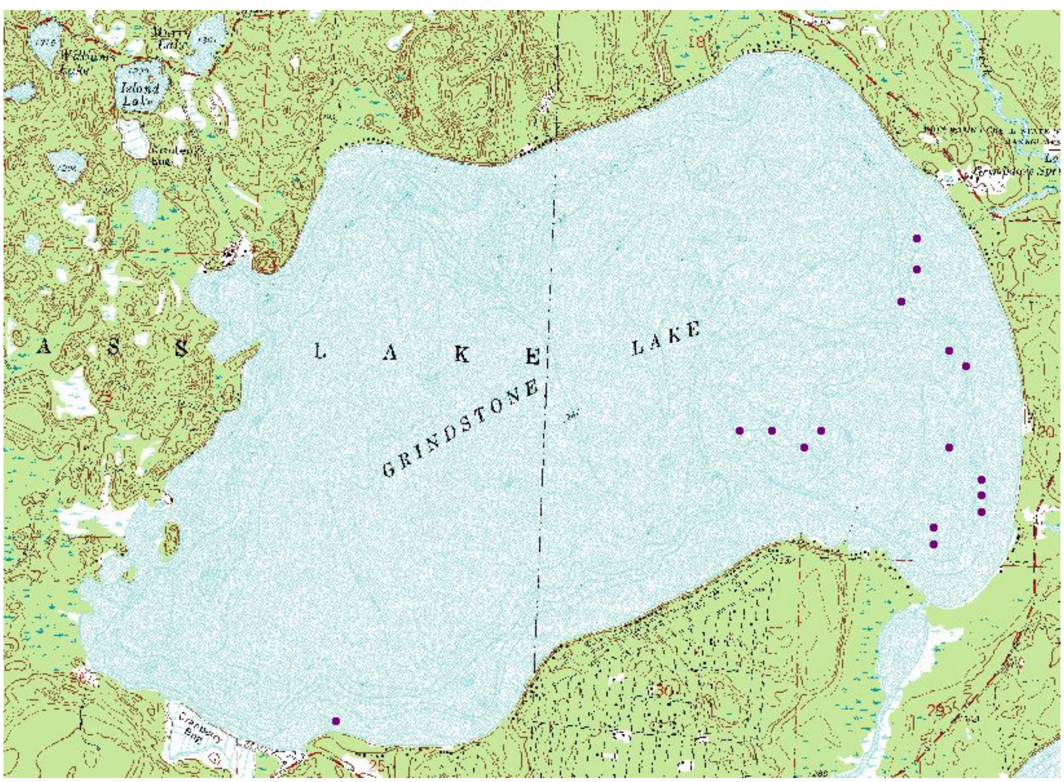


Potamogeton gramineus (Variable pondweed)



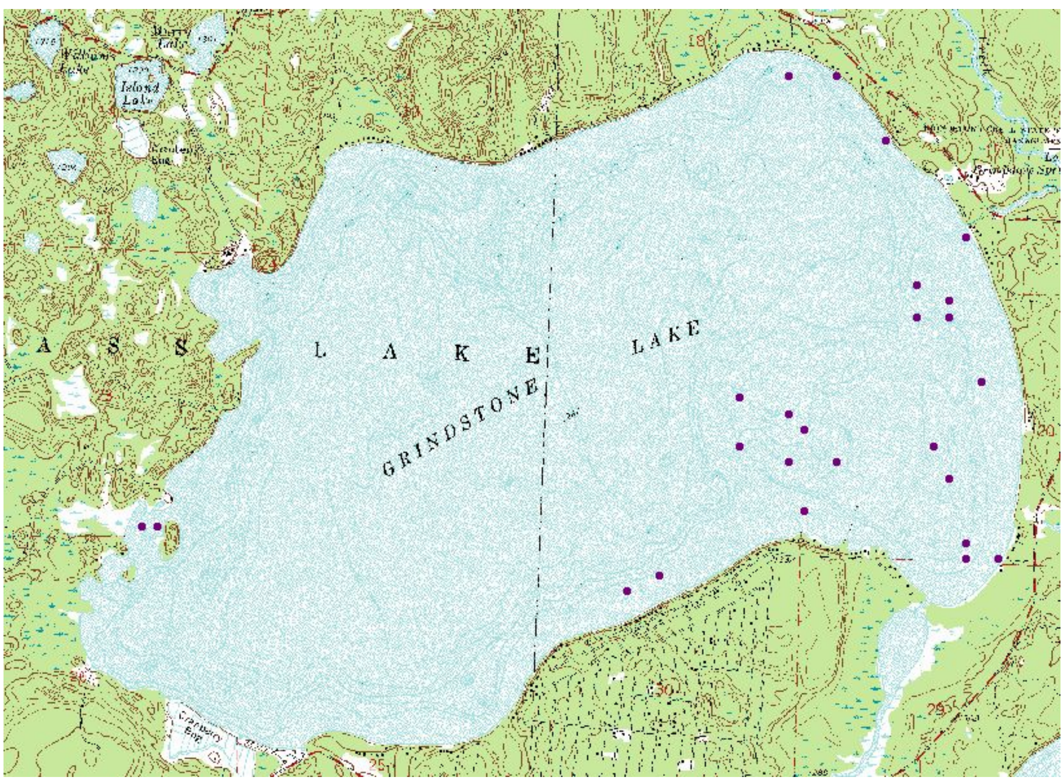
Potamogeton illinoensis (Illinois pondweed)

Potamogeton natans (Floating pondweed)

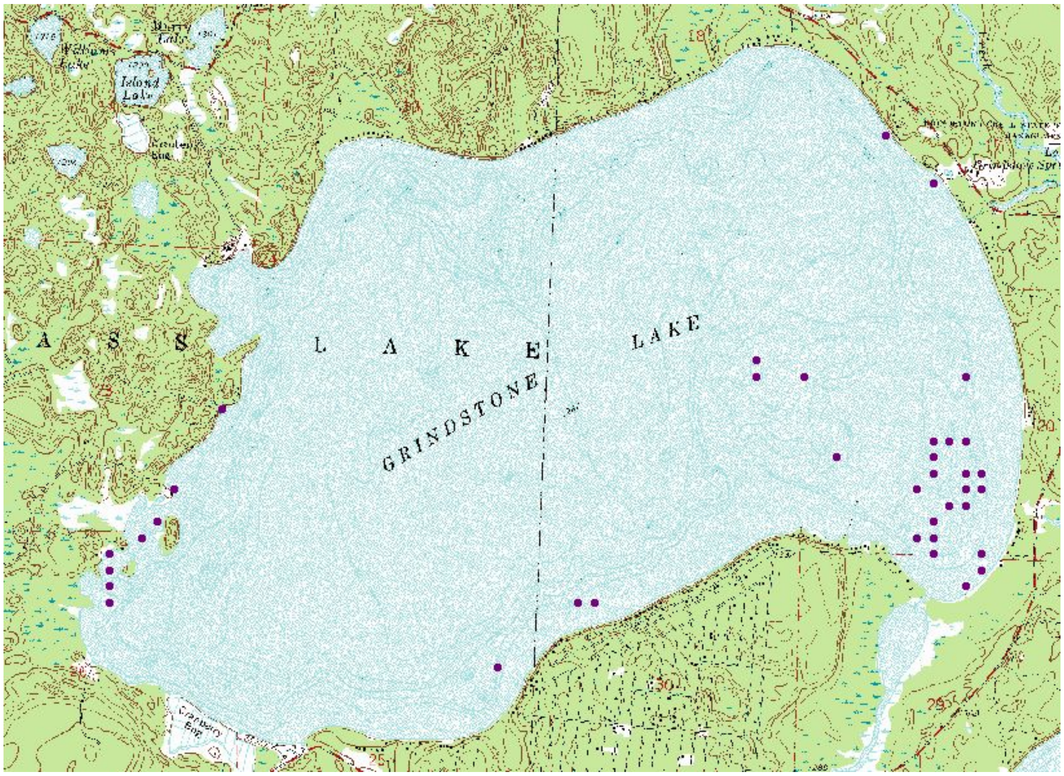


Potamogeton praelongus (White stem pondweed)

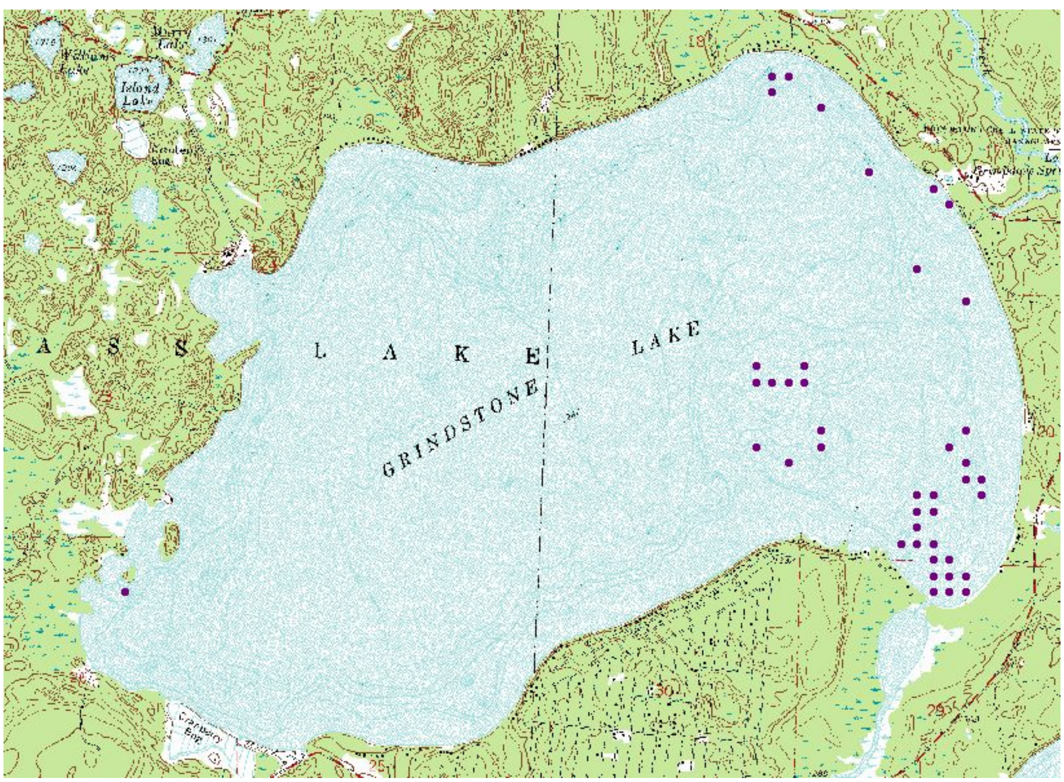
Potamogeton pusillus (Small pondweed)



Potamogeton richarsonii(Clasping leaf pondweed)

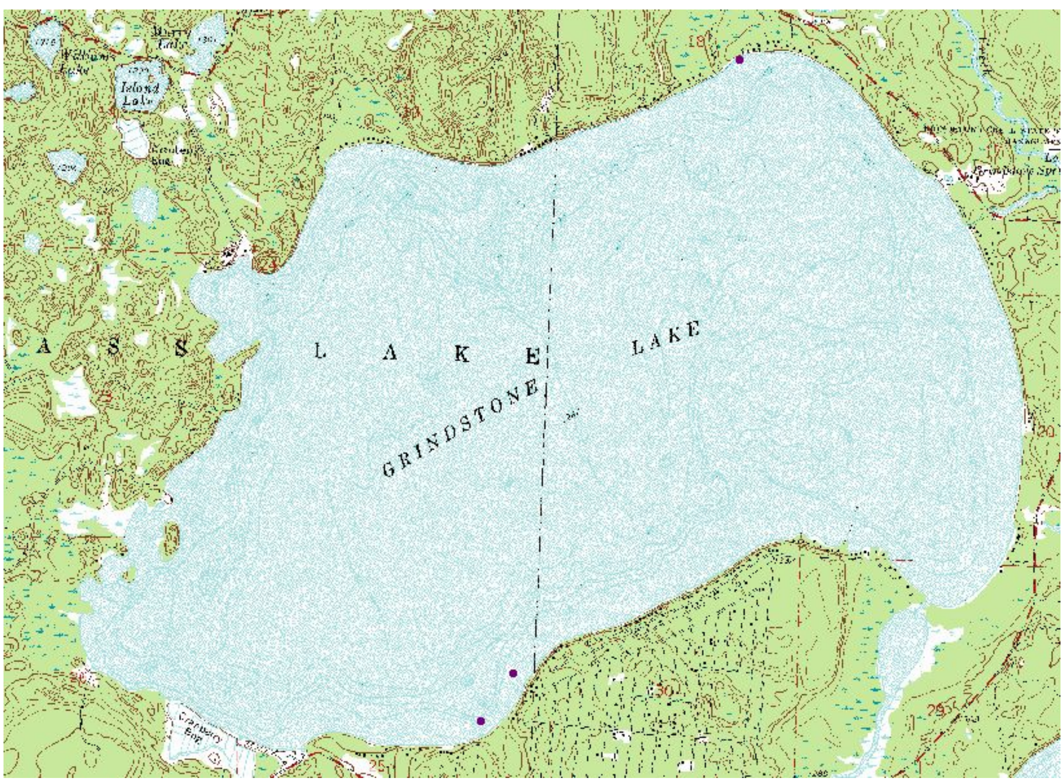


Potamogeton robbinsii(Robbin’s pondweed)



Potamogeton zosteriformis (Flat stem pondweed)

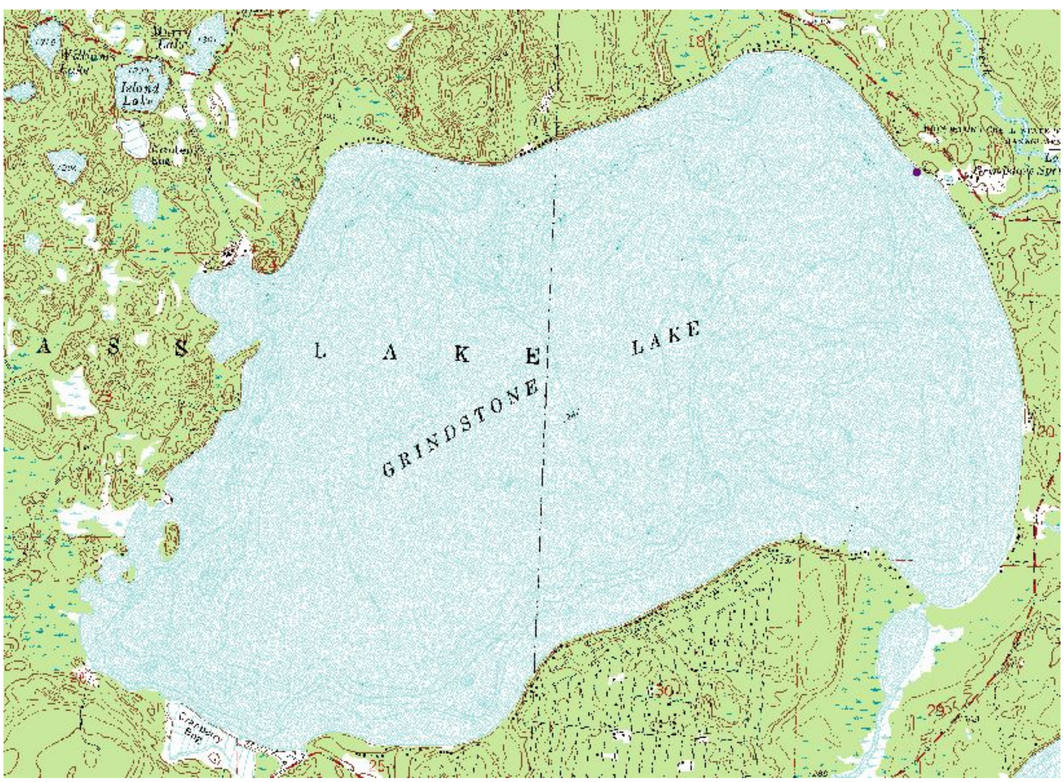
Ranunculus aquatilis (White water crowfoot)



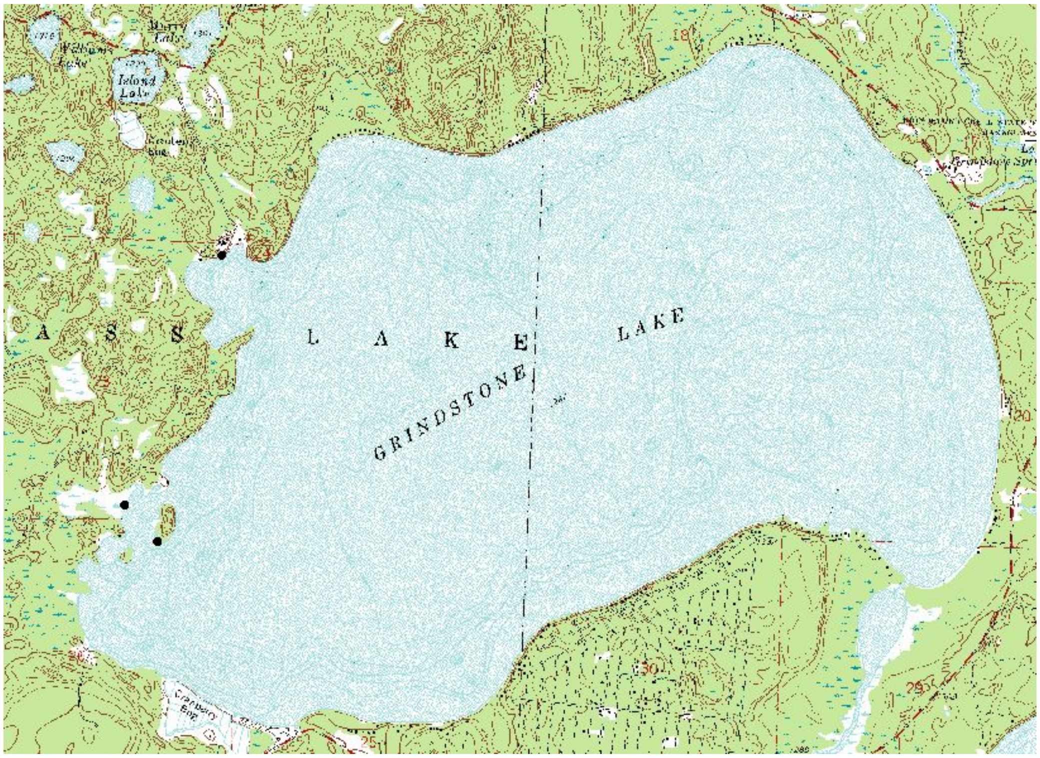
Ranunculus flammula (Creeping spearwort)

Schoenoplectus acutus (Softstem bullrush)

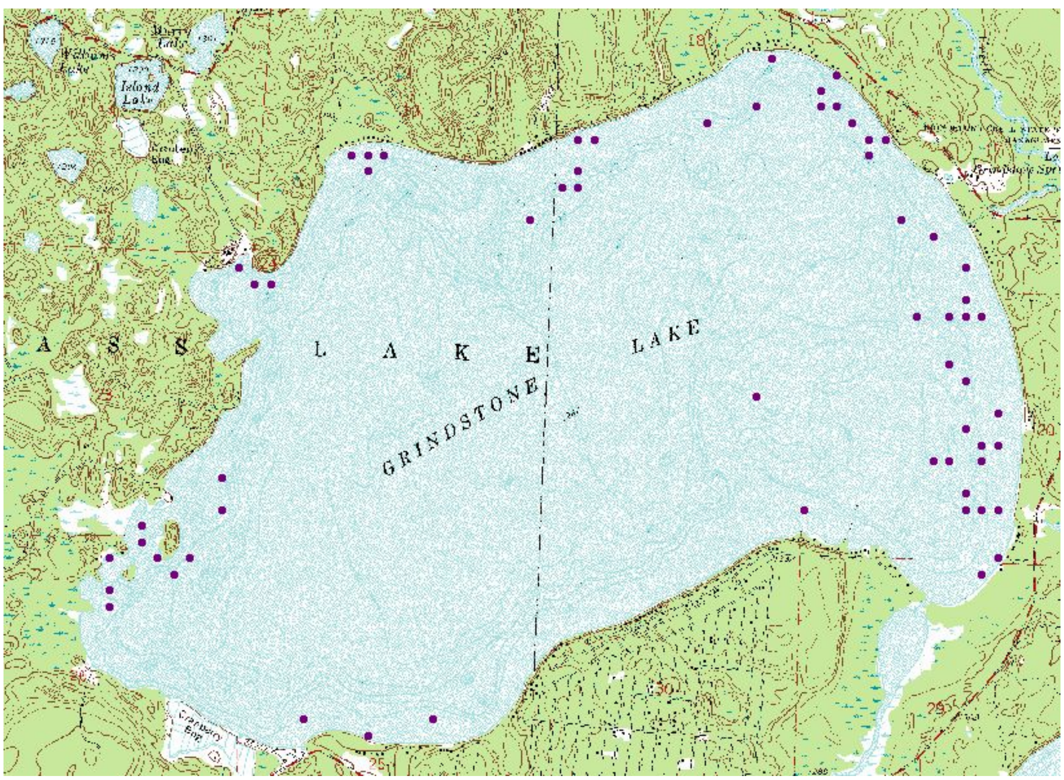
Schoenoplectus pungens (Three square bulrush)



Stuckenia pectinata (Sago pondweed)



Typha latifolia (Cattail)



Vallisnaria americana (Wild celery)