THE AQUATIC PLANT COMMUNITY OF MASON LAKE, ADAMS/MARQUETTE COUNTY, WI. DECEMBER 2010

Presented by Reesa Evans, CLM, Lake Specialist
Adams County Land & Water Conservation Department
P.O. Box 287 Friendship, WI 53934
608-339-4268

Executive Summary

Two aquatic macrophytes (plants) surveys in Mason Lake were conducted during the summer of 2009 by Water Resources staff of the West Central Region - Department of Natural Resources (WDNR) and Adams County Land and Water Conservation. These were a follow-up to the prior vegetation studies of Mason Lake completed in 2005, 2001, 1998, and 1992. The two aquatic surveys were done using alternate methods: one by the transect method, in order to match changes from the 2005 results, and one by the point intercept method to establish a new baseline for further aquatic plant surveys. A third survey (using the PI method) was conducted by staff of the WDNR during the summer of 2010 to further check the development of *Najas minor*, the invasive discovered in Mason Lake in the 2009 PI survey.

The combination of phosphorus concentration, chlorophyll concentration and water clarity indicate that Mason Lake is an eutrophic to hypereutrophic lake with high total phosphorus levels and poor Secchi disk readings, plus very high chlorophyll-a levels. This trophic state indicates a turbid system dominated by algae, instead of a clear water system dominated by aquatic plants. Frequent and/or ongoing algal blooms would be expected.

Of the 47 species found in Mason Lake during the 2009 surveys, 29 were emergent species, 2 were floating-leaf species, 3 were free-floating species and 13 were submergent species. No endangered species were found. Five exotic species were found: *Myriophyllum spicatum* (Eurasian watermilfoil); *Najas minor* (Brittle nymph); *Nasturtium microphyllum* (watercress); *Phalaris arundinacea* (Reed canarygrass); and *Potamogeton crispus* (Curly-leaf pondweed). Only 18 species were found during the 2010 survey: 5 emergent species; 3 free-floating species;

rooted floating-leaf specie; and 9 submergent species. Four of those were the same invasive species found before, but watercress was not found during the 2010 survey.

The invasive aquatic plant, *Myriophyllum spicatum* (*Eurasian* watermilfoil) was the most frequently-occurring plant in the PI surveys. The second most frequently-occurring plant in all these surveys was *Ceratophyllum demersum* (Coontail). The most frequently-occurring aquatic plant in the transect survey in 2009 was *Ceratophyllum demersum*, but it was followed closely by *Myriophyllum spicatum*. No other aquatic species were close to these two in frequency of occurrence.

In the PI surveys, the aquatic plants with the highest density were *Myriophyllum spicatum* and *Ceratophyllum demersum*. No aquatic species had a more than average density of growth in the PI surveys. The 2009 transect survey yielded slightly different results. *Ceratophyllum demersum* and *Myriophyllum spicatum* switched places, with the former occurring more densely than the latter. No other aquatic species were close to these two in density of growth.

Combining the relative frequency and relative density of a species into a Dominance Value illustrates how dominant that species is within the aquatic plant community. Based on the Dominance Value, the PI surveys showed that *Myriophyllum spicatum* was the dominant aquatic plant species in Mason Lake during 2009 and 2010. *Ceratophyllum demersum* was sub-dominant. The positions were reversed in the 2009 transect survey results: *Ceratophyllum demersum* was dominant, with *Myriophyllum spicatum* subdominant. These are obviously the most abundant aquatic plants by far in Lake Mason.

The Simpson's Diversity Index (SI) for the transect 2009 survey was .86. It was .89 for the 2009 PI method and down to .75 in 2010. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). Both figures for 2009 place Mason Lake are in the median for diversity for all the lakes in Wisconsin and for the North Central Hardwoods Region. These SI scores place Mason Lake in the fair category of diversity for lakes in Wisconsin and in the North Central Hardwoods Region. The 2010 SI score puts Mason Lake below the median for all Wisconsin lakes and for lakes in the North Central Hardwoods Region.

The Aquatic Macrophyte Community Index (AMCI) for Mason Lake is 44, based on transect survey, and 39 based on the 2009 PI survey. Both of these values are in the lowest quartile for lakes in the North Central Hardwoods Region and all of Wisconsin lakes, indicating that the aquatic plant community in Mason Lake is of below average quality. The 2010 PI score dropped to 30.

It should be noted that the 2009 and 2010 PI surveys did not use exactly the same PI grid for the surveys. Based on permission from the WDNR, the 2009 PI survey added sites closer to shore in order to capture any diversity there. This may account for the higher SI and AMCI scores for the 2009 PI survey compared to the 2010 survey results.

MANAGEMENT RECOMMENDATIONS

1) All lake residents should practice best management on their lake properties. Mason Lake is already on the impaired waterways list. A small increase in nutrients could push the lake past likely recovery, resulting in long-term worse water quality. Reducing nutrients would have a favorable impact on water quality.
    - Keep septic systems cleaned and in proper condition;
    - Use no lawn fertilizers;

- Clean up pet wastes;
- No composting should be done near the water nor should yard wastes nor clippings be allowed to enter the lake (Do not compost near the water or allow yard wastes and clippings to enter the lake)

2) Residents should be involved in the Citizen Lake Monitoring Program, monitoring water quality to track seasonal and year-to-year changes, as well as monitoring invasive species presence & distribution and Clean Boats, Clean Waters.

3) Now that various sensitive areas are designated, a map of these areas should be posted at the public boat ramp and a sign encouraging avoidance of disturbance to these areas should also be posted. Landowners on the lake should designate watch for disturbance of these areas and report any violations. These areas are very important for habitat and maintaining water quality and for preserving endangered and rare species.

4) The Mason Lake Association should start working with the Adams County Land & Water Conservation Department and the WDNR in the ongoing Eurasian Watermilfoil (EWM) and Curly-Leaf Pondweed (CLP) removal projects. These exotic species should be controlled. Initially, hand-pulling for Curly-Leaf Pondweed could be attempted, especially in high density areas, before it becomes fully established.

5) Drawdowns of the lake should only be done when needed. Annual drawdowns destabilize the littoral zone habitat.

6) Traditionally, the Mason Lake District has been unwilling to consider mechanical harvesting as part of its aquatic plant management, preferring to rely entirely on chemicals. Considering the apparent changes in distribution, especially of invasive aquatic species, and the already-high nutrient load in Mason Lake, mechanical harvesting should be pursued to decrease the EWM presence. However, navigation corridors should be monitored in case an increase in aquatic vegetation makes harvesting in those areas appropriate. A harvesting map could then be developed to identify the corridors to be cleared for boating access around the lake or management of aquatic invasive species.

7) Since the shore is so heavily developed, with several older cabins close to the water, installation of vegetative buffers and stormwater runoff management is

essential. An increase in the depth of these buffer areas is recommended. 35 feet landward from shore should be the goal when possible.

8) A report from 1981 recommended that the Mason Lake District work with the Village of Briggsville to install a sewer system to reduce nutrient contributions from aging septic systems around the lake. Nearly 30 years later, no progress has been made. A survey of lakefront owners in 2005 showed that over 50% of the septic systems on Mason Lake were more than 10 years old. Due to a recent state law, Adams County will be establishing periodic inspections of septics in the county. However, a community sewage system with Briggsville might better serve the lake's water quality than the current individual septic systems.

9) Steps should be taken to regulate boat speed in the shallow water areas to reduce disturbance to aquatic plants and the sediment.

10) The aquatic plant survey should be repeated in 3 to 5 years in order to continue to track any changes in the community and the lake's overall health.

11) The aquatic plant community has decreased drastically since 2005, when aquatic plants covered over 90% of the lake and many species occurred in more than average density of growth. While that situation was not ideal, the crash in plant coverage suggests a significant change in the lake's ecosystem. It would be appropriate to conduct some studies to attempt to determine what is causing this change, such as
    - A population study of the carp presence, since recent research has suggested that a large carp presence in a shallow lake causes a reduction in the aquatic plant community occurrence and diversity;
    - An inventory of the watershed to look at potential nutrient sources ending up in the lake;
    - Water quality monitoring of the creeks entering the lake to determine their contribution to the lake's nutrient loading;
    - Sediment testing to help determine internal loading;
    - Besides the general citizen monitoring for water clarity, total phosphorus and chlorophyll-a, additional monitoring for dissolved oxygen and nitrogen levels might also be appropriate.

12) Adams County Land & Water Conservation Department will inventory the watershed lands to map bank erosion, buffer locations, inadequate ditches and buffers, non-point pollution, stormwater runoff, and to identify sites not in

compliance with Wisconsin Agricultural Performance Standards and county ordinances. This inventory will also look at documented wetlands to determine what sites might need maintenance, restoration or enhancement practices to be fully functioning.

I. INTRODUCTION

Two aquatic macrophytes (plants) surveys in Mason Lake were conducted during the summer of 2009 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR) and Adams County Land and Water Conservation. These were a follow-up to the prior vegetation studies of Mason Lake completed in 2005, 2001, 1998, and 1992. The two aquatic surveys were done using alternate methods: one by the transect method, in order to match changes from the 2005 results, and one by the point intercept method to establish a new baseline for further aquatic plant surveys. A third survey (using the PI method) was conducted by staff of the WDNR during the summer of 2010 to further check the development of *Najas minor*, the invasive discovered in Mason Lake in the 2009 PI survey.

A study of the diversity, density, and distribution of aquatic plants is an essential component of understanding a lake ecosystem due to the important ecological role of aquatic vegetation in the lake and the ability of the vegetation to characterize the water quality (Dennison et al. 1993).

Ecological Role: All other life in the lake depends on the plant life - the beginning of the food chain. Aquatic plants and algae provide food and oxygen for fish, wildlife, and the invertebrates that in turn provide food for other organisms. Plants provide habitat, improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake and impact recreation.

Characterize Water Quality: Aquatic plants serve as indicators of water quality because of their sensitivity to water quality parameters, such as water clarity and nutrient levels (Dennison et. al. 1993).

The present study will provide ongoing information that is important for effective management of the lake, including fish habitat improvement, protection of sensitive habitat, aquatic plant management and water quality protection. It will also allow tracking of any significant changes in the aquatic plant community that may indicate changes in the lake's overall health. Finally, the PI survey results will provide a baseline for comparison with future PI survey results.

Background and History:

Mason Lake is an 855-acre impoundment on the South Branch of Neenah Creek, located mainly in Adams County. The eastern ¼ of the lake is located in Marquette County and Amey Pond, to the south of Mason Lake, is in Columbia County. It is a shallow water resource with a maximum depth of 9 feet. The town of Douglas (Marquette County) owns the dam that forms Mason Lake. Two large creeks feed into the lake, as well as some minor creeks. The large creeks—one unnamed and Big Spring Creek—are both on the 303(d) impaired watered waterways list, as is Mason Lake itself.

Mason Lake is part of the WDNR Long Term Trend Monitoring Program involving 50 lakes throughout the state. The program was initiated in 1986 to provide long-term water quality and biological data on a variety of Wisconsin lakes. The lakes were selected to represent a wide range of water quality, size and development pressure. Aquatic plant data is collected every three years and water quality data is collected every year on the trend lakes.

Long term studies of the diversity, density, and distribution of aquatic plants are ongoing and provide information that is valuable for decisions about fish habitat improvements, designation of sensitive wildlife areas, water quality improvement and aquatic plant management. Trend data can reveal changes occurring in the lake ecosystem.

Mason Lake has a long history of algae blooms and abundant plant growth; it also has a long history of chemical treatments that attempted to reduce this growth. The first recorded complaints concerning excessive plant growth occurred in 1947 and concerning algae occurred in 1952. Requests for information about chemical treatments for algae and aquatic plants had been ongoing since 1947, but no record of treatment exists before 1972.

Several chemicals have been applied to the lake during the years 1972-2005 (Figure 1). Some specific past treatments included:

1) 1831 pounds of pure copper from copper sulfate and cutrine;

2) Diquat products and Endothall products are broad-spectrum contact herbicides that kill all aquatic plant species. (part of the endothall was applied in the form of the monoamine salt which is more detrimental to young fish;

3) 2,4-D is a chemical selective for broad-leaf species such as Eurasian watermilfoil.

Treatment areas each year have varied, but over the years, nearly the entire littoral zone has been treated, except for the north bay. Four different channels across the lake have been treated to open navigational channels. No chemical treatment was authorized for 2009, as it appeared that the presence and distribution of Eurasian Watermilfoil had shifted.

FIGURE 1: Chemical Treatment History

	$CuSO_4$ (lbs.)	Cutrine (gal)	Endothall	Diquat (gal.)	2,4-D
1972	700		50 lbs.	1	
1973	1000		10 gal.	4	
1974	750			9	
1975	550			20	
1976	750			25	
1977	440			40	
1978	625			39	
1979	650		5 gal. H	42	
1980				46	
1981	250		30 gal.; 118gal. H		
1982		15	30 gal.; 5 gal. H		
1990		1			32 lbs.
1991		10	40 lbs.		30 lbs.
1992	100		17 gal.	14	8 gal.
1993	400		25 gal.	20	
1994			10.5 gal.	7	
1995		20	20 gal.	20	
1996	600		30 gal.	49.5	
1997	420		44 gal.	59	
1998		~50	~50 gal.	~50	
1999			55 gal.		1600 lbs
2000			49.25 gal.		1646 lbs
2001					1700 lbs
2003					320 gal
2004				65.09gal	1450 lbs
2005			86.5 gal		360gal
2006		4	74.6 gal	4	302.5 gal
2007			73 gal		291 gal
2008			110 gal		264.5 gal
Totals	7235 lbs. x .4 Cu = 2894 lbs Cu	96gal. x .909 Cu = 87 lbs Cu	714.85 gal. & 90 lbs (128gal. H)	514 gal.	6458 lbs. 1546 gal.

Winter drawdowns have also been used to control aquatic plants. The first permit for a drawdown was applied for in 1988; it was a two-year permit. Subsequent permits for winter drawdown have been approved. Winter drawdowns were conducted annually from 1988-1995. There was a discontinuation of winter drawdowns for three years (1995-1998) and resumption of winter drawdowns in 1998-2010 on a multi-year basis.

After 6 years of annual winter drawdowns, *Stuckenia pectinata* appeared to be becoming more abundant in the shallow areas. *Stuckenia pectinata* tolerates winter drawdowns, and the annual drawdowns were likely favoring this species. It was decided that winter drawdowns should be conducted only once every 3 to 5 years in order to control Eurasian watermilfoil without encouraging an overabundance of aquatic plant species tolerant of drawdown. It is time for there to be another drawdown.

Most of the shoreline of Mason Lake is disturbed by long-term development. Because the lake has been developed for so long, many of the dwellings along the lake shore are less than 75 feet landward from the shore, since they were built before state and county shoreline setback laws went into effect. The village of Briggsville is located on the southeast side of the lake.

Several areas on Mason Lake have been designated as critical habitat by the Wisconsin Department of Natural Resources (see Figure 2):

Sensitive Area 1 – Burn's Cove

This sensitive area extends along approximately 4000 feet of shoreline in the cove and up the stream, averaging 3 feet in depth and supports important near-shore terrestrial habitat, shoreline habitat and shallow water habitat. The sediment is sand, silt, rock and peat. This area is also important for maintaining water quality, since it is the site of one of the tributaries feeding into Mason Lake and has a large wetland area that serves as a filter. It has a fairly diverse terrestrial and aquatic plant community (compared to other parts of this lake) and has natural scenic beauty, since it is one of the few fairly undeveloped areas of the lake shore.

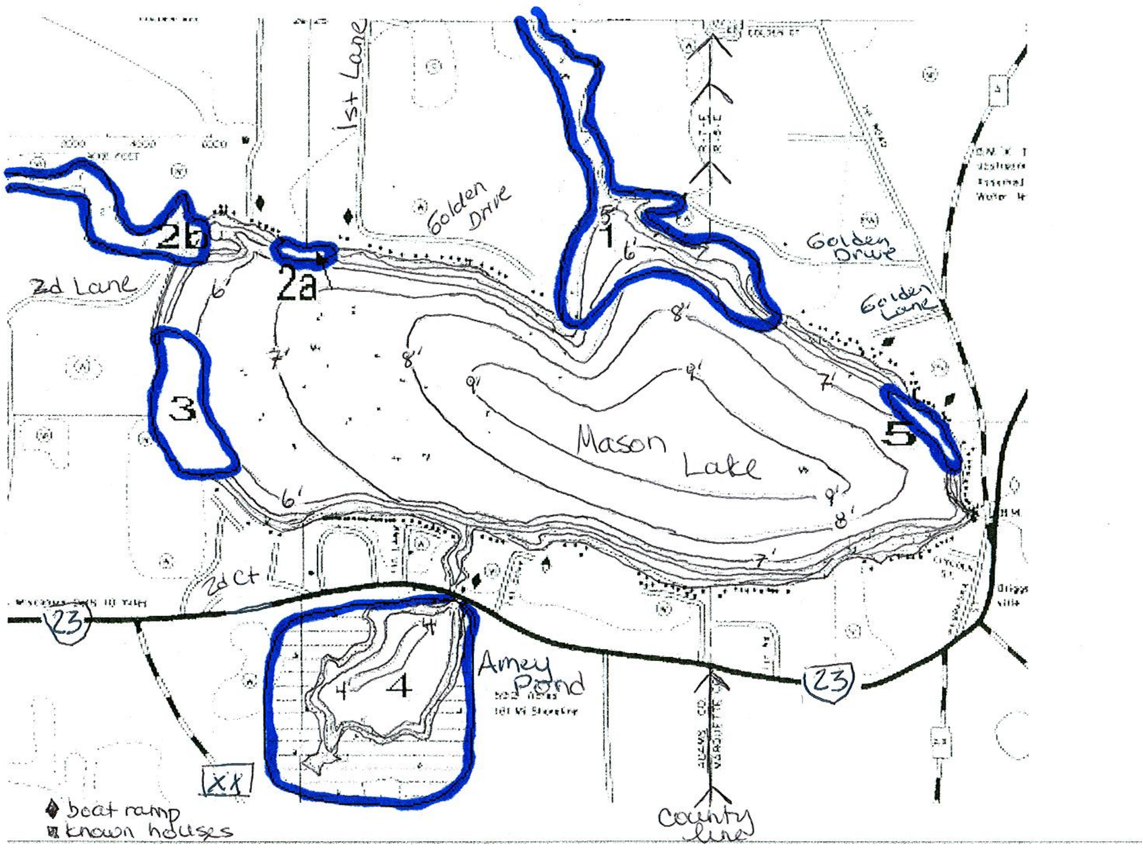


Figure 2: Critical Habitat Areas on Mason Lake

Sensitive Area 2

The sediment is sand and silt. Area 2a extends along 800 feet of the northwest shore and supports near-shore terrestrial habitat. The shoreline is wooded and shrub growth sandwiched between cottage development. There is significant woody debris for fish habitat in the shallow zone. Area 2b, located at the Big Spring Inlet, extends for 800 feet along the lake shore at the mouth and up the Big Spring tributary, averaging 2 feet in depth, and supports important near-shore terrestrial habitat, shoreline habitat and shallow water habitat. The shoreline is entirely wooded with small areas of shrub and herbaceous plant growth. The wetlands contain emergent herbaceous wetlands and shallow open water wetlands.

Sensitive Area 3 – West Wetland

This sensitive area extends along 2000 feet of shoreline, averaging 2 feet in depth and supports important shoreline habitat and near-shore terrestrial vegetation. The sediment is sand and silt. The shoreline at this sensitive area extends for about half of its length along a wooded shoreline and half of its length along and emergent wetland. Large woody cover for habitat is present along the wetland, but is common along the wooded stretch. The area has a high quality terrestrial plant community.

Sensitive Area 4 – Amey's Pond

This sensitive area is approximately 60-acres, the entire wetland pond south of the highway, averaging 3 feet in depth and supporting important near-shore terrestrial habitat, shoreline habitat and shallow water habitat. The sediment is comprised of silt and organic muck. The entire shoreline is an emergent shallow water marsh with deep water marsh habitat in the pond itself, with no human development. Additionally, it has high quality wildlife and aquatic habitat. Amey Pond is operated jointly by the WDNR and Ducks Unlimited as a waterfowl sanctuary.

Sensitive Area 5 –Spawning Site

This sensitive area extends along 1000 feet of shoreline and supports important spawning habitat. The sediment is rubble, gravel and sand. The shoreline is 75% developed, 20% wooded and 5% shrub and native herbaceous growth. Maintaining the lakebed of the littoral zone in this area is important for panfish spawning in the lake.

II.METHODS

Field Methods

The transect study design was based on the rake-sampling method developed by Jessen and Lound (1962), using stratified random placement of the transect lines. The shoreline was divided into 16 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment, using a random numbers table. The same transects used in 2005 were also used in 2009.

One sampling site was randomly located in each depth zone (0-1.5 feet, 1.5-5 feet, 5-10 feet and 10-20 feet) along each transect. Using a long-handled steel thatching rake or a thatching rake on a rope, four rake samples were taken at each sampling site, one from each quarter of a 6-foot diameter quadrat. The aquatic plant species that were present on each rake sample were recorded. Each species was given a density rating (0-5), the number of rake samples on which it was present at each sampling site.

> A rating of 1= the species was present on one rake sample at that site;
> A rating of 2 = the species was present on two rake samples at that site;
> A rating of 3 = it was present on three rake samples;
> A rating of 4 = it was present on all four rake samples;
> A rating of 5 = it was abundant on all four rake samples.

Visual inspection and periodic samples were taken between transect lines to record the presence of any species that did not occur at the sampling sites. Specimens of all plant species present were collected and saved in a cooler for later preparation of voucher specimens. Nomenclature was according to Gleason and Cronquist (1991).

The type of shoreline cover was recorded at each transect. A section of shoreline, 50 feet on each side of the transect intercept with the shore and 30 feet landward, was evaluated. The percent cover of each land use category within this 100' x 30' rectangle was visually estimated and.

The second aquatic plant survey method used in 2009 and 2010 was the Point Intercept Method. This method involves calculating the surface area of a lake and dividing it (using a formula developed by the WDNR) into a grid of several points, always placed at the same interval from the next one(s). These points are related to a particular latitude and longitude reading. At each geographic point, the depth is noted and one rake is taken, with a score given between 1 and 3 to each species on the rake.

A rating of 1 = a small amount present on the rake;
A rating of 2 = moderate amount present on the rake;
A rating of 3 = large amount present on the rake.

A visual inspection was done between points to record the presence of any species that didn't occur at the raking sites. Gleason and Cronquist (1991) nomenclature was used in recording plants found.

Data Analysis

The percent frequency of each species was calculated (number of sampling sites at which it occurred/total number of sampling sites). Relative frequency was calculated (number of occurrences of a species/sum of all species occurrences). Mean density was calculated for each species (sum of a species' density ratings/number of sampling sites). Relative density was calculated (sum of a species density/sum of all plant densities). "Mean density where present" was calculated for each species (sum of a species' density ratings/number of sampling sites at which the species occurred). The relative frequency & relative density of each species were summed for a dominance value for each species. Species diversity was measured by Simpson's Diversity Index.

The Aquatic Macrophyte Community Index (AMCI) developed by Nichols (2000) was applied to Mason Lake. Measures for each of seven categories that characterize a plant community are converted to values between 0 and 10 and summed to measure the quality of the plant community.

The Average Coefficient of Conservatism and Floristic Quality Index were calculated, as outlined by Nichols (1998), to measure disturbance in the plant community. A coefficient of conservatism is an assigned value, 0-10, the probability that a species will occur in an undisturbed habitat. The Average Coefficient of Conservatism is the mean of the coefficients for all species found in the lake. The Floristic Quality Index is calculated from the Coefficient of Conservatism (Nichols 1998) and is a measure of a plant community's closeness to an undisturbed condition.

III. RESULTS

PHYSICAL DATA

Many physical parameters impact the aquatic plant community. Water quality (nutrients, algae, water clarity and water hardness) influence the plant community as the plant community can in turn modify these parameters. Lake morphology, sediment composition and shoreline use also impact the aquatic plant community.

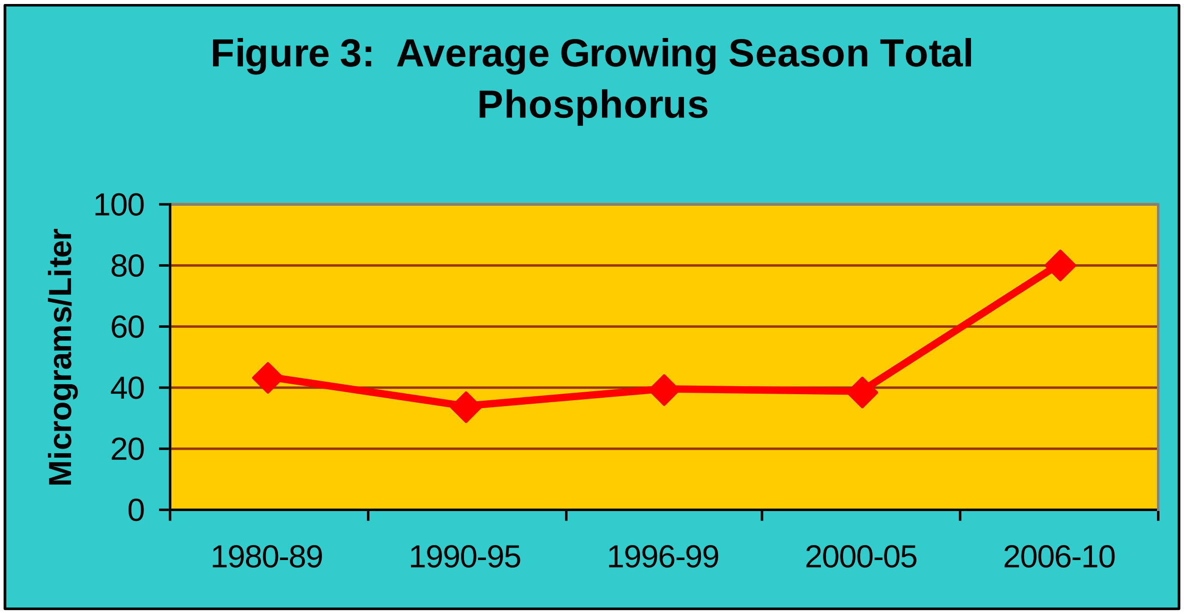
WATER QUALITY - The trophic state of a lake is a classification of its water quality. Phosphorus concentration, chlorophyll concentration and water clarity data are collected and combined to determine the trophic state.

- Eutrophic lakes are high in nutrients and support a large biomass.
- Oligotrophic lakes are low in nutrients and support limited plant growth and smaller populations of fish.
- Mesotrophic lakes have intermediate levels of nutrients and biomass.

Nutrients

Phosphorus is a limiting nutrient in many Wisconsin lakes and is measured as an indication of nutrient enrichment in a lake. Increases in phosphorus in a lake can feed algae blooms and, occasionally, excess plant growth.

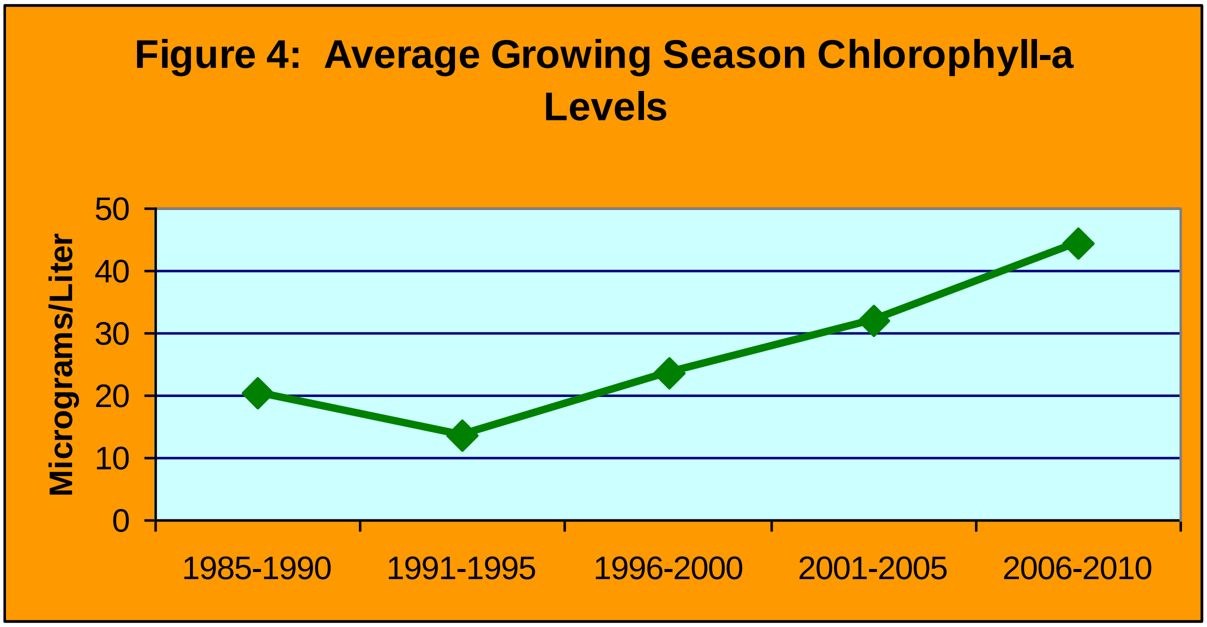
Since Mason Lake is one of the WDNR trend lakes, there is water quality information going back to 1973. The average overall growing season (May through September) Total Phosphorus was 93.9 micrograms/liter from 1973 through 2010. The level was fairly steady from the 1970s into the early 2000s, but it has nearly doubled in the past 5 years (Figure 3). The highest growing season total phosphorus level was recorded in July 2010, when the reading was 702 micrograms/liter. The lowest was 20 micrograms/liter in May 1996.



Algae

Chlorophyll-a concentrations provide a measure of the amount of algae in lake water. Algae are natural and essential in lakes, but high algae populations can increase turbidity and reduce the light available for plant growth.

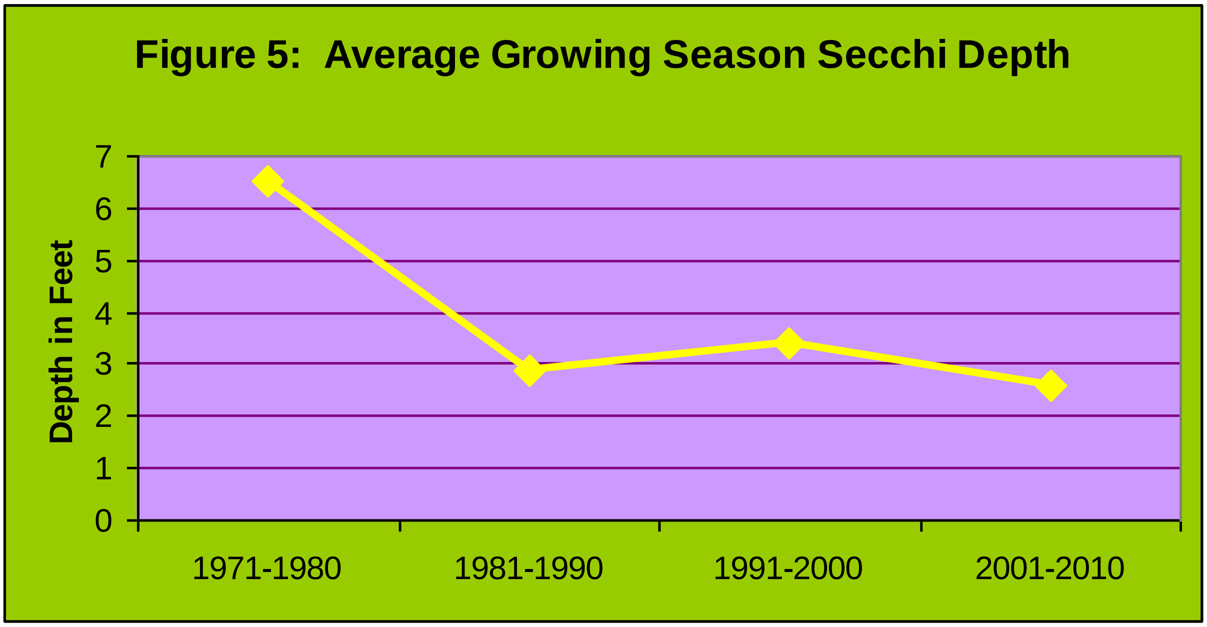
Chlorophyll-a growing season levels are available for Mason Lake back to 1980. The overall growing season chlorophyll-a average from 1985 through 2010 is 26.9 micrograms/liter. A look back at the changes since 1980 show that chlorophyll-a (and thus algae levels) decreased in the early 1990s, but started rising again in the late 1990s and have continued to rise (see Figure 4). The overall growing season chlorophyll-a average from 1977 through 2010 is 45.2 micrograms/liter.



The late 1980s average was 20.6 micrograms/liter, dipping to 13.8 micrograms/liter in the early 1990s, then rising to 23.7 micrograms/liter in the late 1990s. It kept rising in the 2000s, up to an average of 44.5 micrograms/liter by 2006-2010. The highest growing season chlorophyll-a level reported was 125.0 micrograms/liter in August 1996, with the lowest found in June 1995 when it was 1.9 micrograms/liter.

Water Clarity

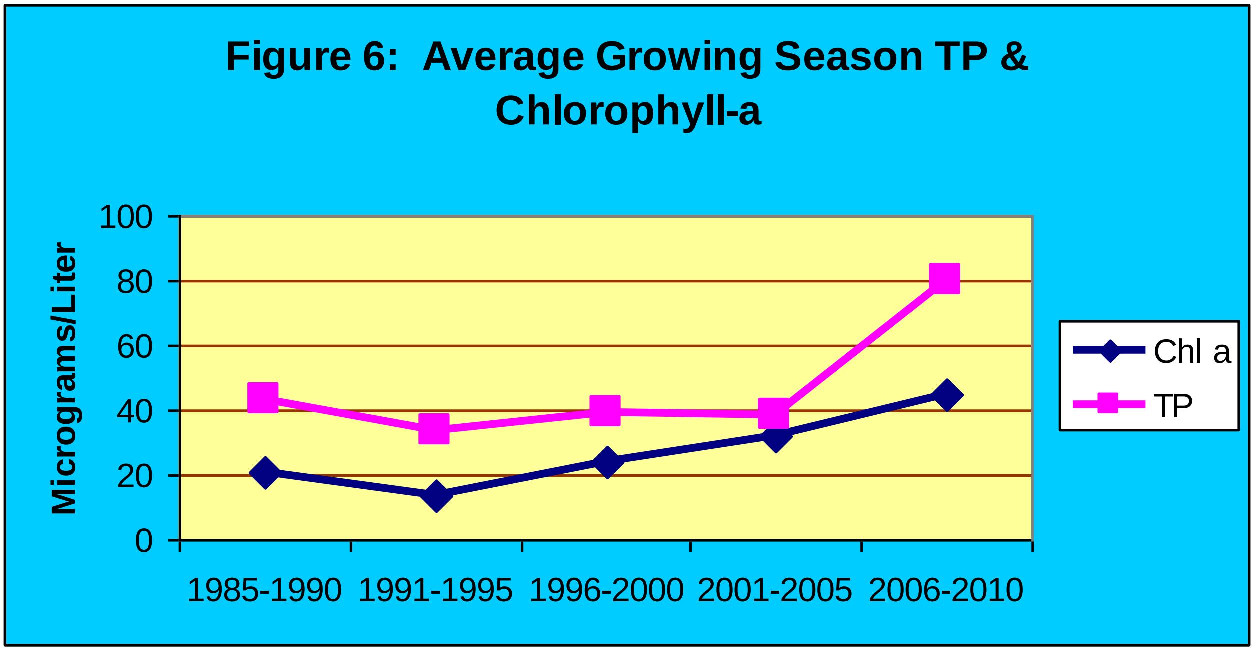
Water clarity is a critical factor for aquatic plants, because if they don't get more than 2% of surface illumination, they won't survive (Chambers and Kalff 1985, Duarte et. al. 1986, Kampa 1994). Water clarity is reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color the water. Water clarity is measured with a Secchi disc that shows the combined effect of turbidity and color. Mason Lake has traditionally had low Secchi disk readings, since they were first taken in May 1973. Secchi disk readings have shown a significant downward trend since 1973 (see Figure 5).



The overall growing season mean for Sechhi disk readings in Mason Lake is 3.2 feet. This goes from a high average of 6.9 feet in the 1970s to the 2.6 feet average of the 2000s. The lowest growing season Secchi disk recorded was .66 feet in August 1997; the highest recorded was 8 feet, found in May 1973, July 1977, June 1992, June 1994, May 1998 and July 2001.

Overall Water Quality

The combination of phosphorus concentration, chlorophyll concentration and water clarity indicate that Mason Lake is an eutrophic to hypereutrophic lake with high total phosphorus levels and low Secchi disk readings, plus high chlorophyll-a levels. Graphing the average growing season total phosphorus against the average growing season chlorophyll-a levels show that both have been increasing (Figure 6). Comparing Figure 6 to Figure 5 reveals that as Secchi disk readings have gone down, both Total Phosphorus and Chlorophyll-a have gone up.



This trophic state indicates a turbid system dominated by algae, instead of a clear water system dominated by aquatic plants. Frequent and/or ongoing algal blooms would be expected.

Figure 7: Trophic Status

	Quality Index	Phosphorus ug/l	Chlorophyll ug/l	Secchi Disc ft.
Oligotrophic	Excellent	<1	<1	> 19
	Very Good	1-10	1-5	8-19
Mesotrophic	Good	10-30	5-10	6-8
	Fair	30-50	10-15	5-6
Eutrophic	Poor	**50-150**	15-30	**3-4**
Hypereutrophic	Very Poor	>150	**>30**	<3
Mason Lake Growing Season 1973-2010		93.9	45.2	3.2

Hardness

The hardness or mineral content of lake water also influences aquatic plant growth. The 1973-2004 hardness values in Mason Lake ranged from 137 to 196 milligrams/liter CaCO3, for an overall average of 164 milligrams/liter CaC03. Lakes with hardness values between 121 and 180 milligrams/liter CaCO3 are considered hard water lakes. Hard water lakes tend to support more plant growth than soft water lakes (B.Shaw, et al, p.13).

LAKE MORPHOMETRY - The morphometry of a lake is an important factor in determining the distribution of aquatic plants. Duarte and Kalff (1986) found that the slope of the littoral zone could explain 72% of the observed variability in the growth of submerged plants. Gentle slopes support more plant growth than steep slopes (Engel 1985).

The littoral zone is very gradually sloped in Mason Lake and the shallow basin provides light availability to nearly the entire lake, when the water is clear. With clearer water, aquatic plant growth over the entire basin would be expected. However, since the water clarity in Mason Lake tends to be poor to very poor, aquatic plant growth should not be expected in the deeper areas of the lake.

SEDIMENT COMPOSITION – The most frequent sediment in Mason Lake was muck or muck mixtures (48%), especially at depths greater than 5 feet (Figure 8). Sand was also common.

Figure 8. Sediment Composition: Mason Lake

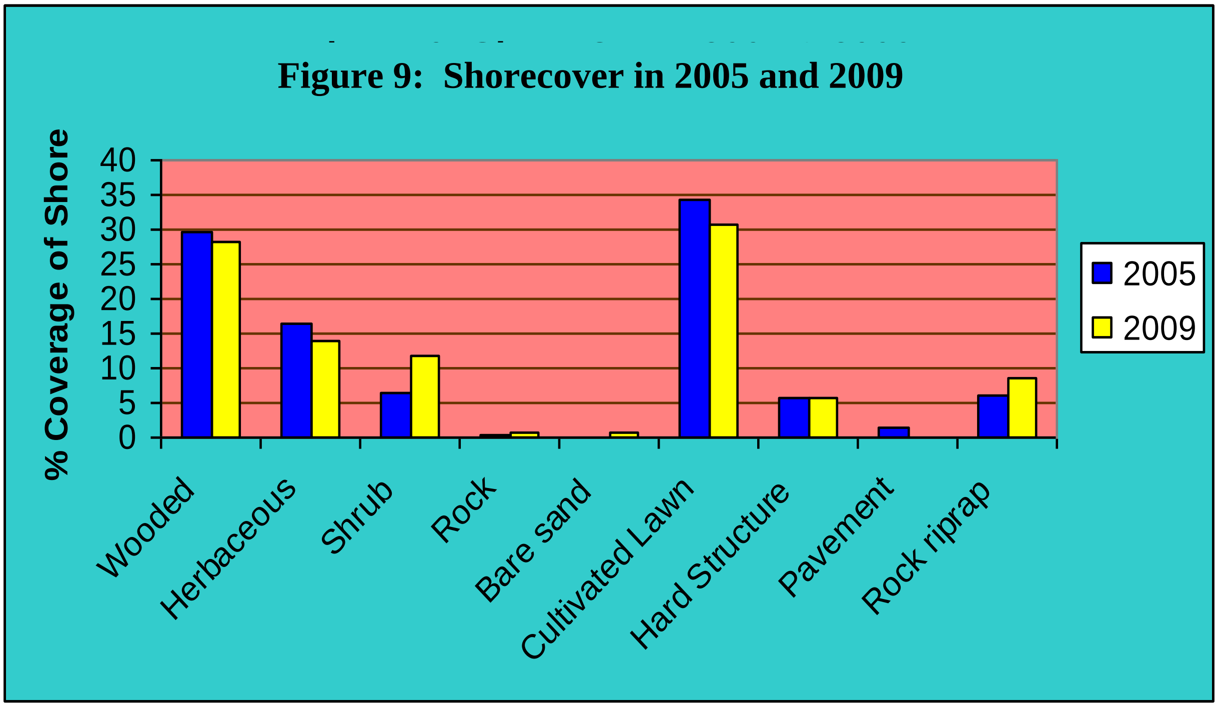
		0-1.5ft Depth Zone	1.5-5ft Depth Zone	5-10ft Depth Zone	Overall
Soft Sediments	**Muck**	12%	12%	74%	31%
	Silt		12%	22%	11%
	Silt/Muck		23%	4%	9%
Mixed Sediments	**Sand/Muck**	12%	12%		8%
	Sand/Silt	12%			4%
Hard Sediments	**Sand**	31%	42%	4%	25%
	Sand/Gravel	19%			7%
	Gravel	8%			3%
	Rock/Gravel	8%			3%

Some plants depend on the sediment in which they are rooted for their nutrients. The richness or sterility and texture of the sediment will determine the type and abundance of plant species that can survive in a location. The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt, so these sediments are considered most favorable for plant growth (Barko and Smart 1986).

In some instances, sand can be a limiting factor in aquatic plant growth. However, since 86.3% of the transect sites were vegetated in Mason Lake, it doesn't appear that sand has a significant limiting effect on determining plant distribution in Mason Lake.

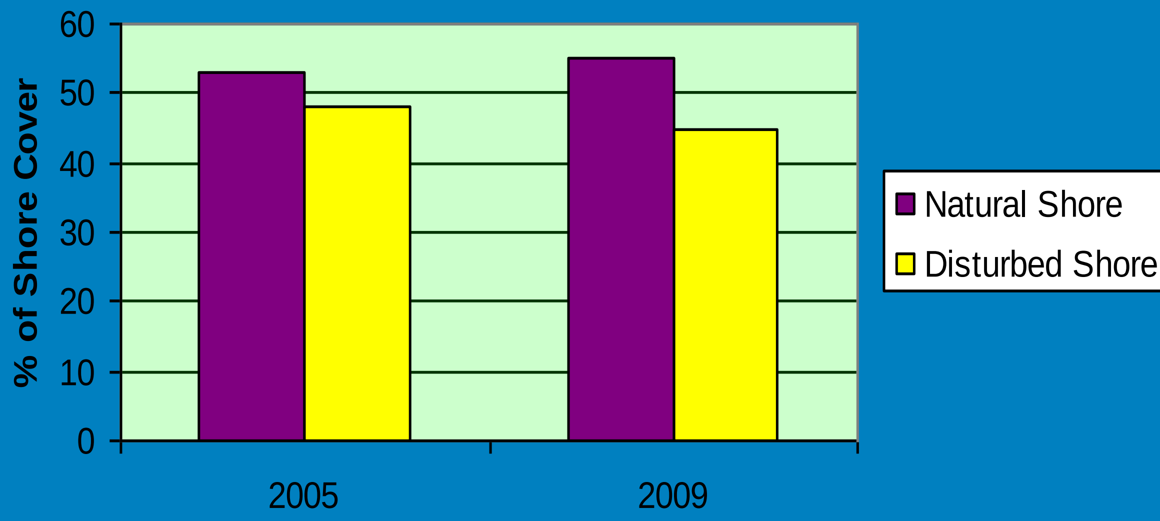
SHORELINE LAND USE

Land use can strongly impact the aquatic plant community and therefore the entire aquatic community. Land use can directly impact the plant community through increased erosion and sedimentation and increased run-off of nutrients, fertilizers and toxics applied to the land. These impacts occur in both rural and residential settings.



Some type of natural shoreline (wooded, shrub, native herbaceous) covered 53% all of the sites in 2005. The coverage occurrence of natural shoreline in 2009 was raised slightly to 55%. Some type of disturbed shoreline (cultivated lawn, rock riprap, hard structure, pavement, etc) covered 45% of the sites in 2009, down slightly from 47% in 2005 (see Figure 10).

Figure 10: Changes in Shore Cover 2005 to 2009



The frequency of occurrence of cultivated lawns stayed the same in 2005 and 2009—both surveys showed a 62% occurrence frequency of cultivated lawn. However, hard structures (piers, boathouses, wooden walkways) increased in frequency of occurrence from 38% to 50% and rock/pavement increased in occurrence frequency from 38% to 54%.

WATERSHED LAND USE

In 2002, Mason Lake was placed on the federal impaired waterways list (commonly called the "303(d)" list). The reasons for this placement included highly-elevated phosphorus level, eutrophication, high turbidity, pH problems, NPS contamination and degraded habitat. Two streams that feed Mason Lake are also on the impaired waterways list. Mason Lake is one of the WDNR's "trend lakes", meaning that the WDNR regularly examines the lake for water quality and related issues. The Mason Lake District, formed in 1955, manages Mason Lake.

The surface watershed for Mason Lake is large. The bulk of the watershed (57.8%) is in agricultural use; second largest land use is woodlands (31.7%). Residential use tends to be scattered, except for around the lake itself. The largest land use in the surface watershed for Mason Lake is non-irrigated agriculture. Woodlands are the second largest land use category in Mason Lake's surface watershed.

The Mason Lake surface watershed was part of the Neenah Creek Priority Watershed program that expired in 2002. Among the projects that program contemplated were several types of shore protection, installation of shore buffers (both lake and stream), wetland restorations, installation of streambank fencing, critical habitat planting and buffer strips to trap animal waste runoff. Not all the planned projects were completed, so a Targeted Runoff Management Grant was applied for in 2003 to continue with the areas of concern. That project has now also expired, with several of the planned projects not completed.

In 1992, Aquatic Resources of Wausau, a private consulting firm, prepared a report on its investigation of the lake and recommendations for management. This study included a survey of the banks of the two main streams feeding into Mason Lake at Morris Cove (Big Spring Creek) and Burn's Cove (an unnamed stream). Along the 83,400 feet of the stream ending into Morris Cove, 3 spring ponds were found. According to this survey, the upper 63,600 feet (76.3%) had been ditched, tiled and straightened. The lower 18,800 feet (23.7%) had been left to its natural meandering. Most of the ditched area did have grass filter strips adjacent to the stream banks. However, the survey did reveal several areas of clay banks collapsing into the ditches or into the stream and some cutting at the banks from high water events. High steep banks with severe erosion were found along the meandering lower stream, as well as heavy unfenced pasturing with signs that cattle had trampled the banks. Since that time, a dam on Big Spring Creek has been removed and construction is ongoing to restore several meanders.

The report noted that the unnamed stream feeding into Burn's Cove was 57,000 feet, with at least 6 spring ponds. 50% of that length had been ditched and straightened; the remaining 50% was in either meanders or pond shores. The report noted that several of the banks had more than a 12% slope, with significant erosion and evidence of heavy pasturing at the shores.

Although some progress has been made since 1992, with the assistance of the Natural Resource Conservation Service and the Adams County Land & Water Conservation Department, much remains to be done to reduce impacts of the watershed land use on Mason Lake.

MACROPHYTE DATA

SPECIES PRESENT

Of the 47 species found in Mason Lake during the 2009 surveys, 29 were emergent species, 2 were floating-leaf species, 3 were free-floating species and 13 were submergent species (Figure 10). No endangered species were found. Five invasive species were found: *Myriophyllum spicatum* (Eurasian watermilfoil); *Najas minor* (Brittle nymph); *Nasturtium microphyllum* (watercress); *Phalaris arundinacea* (Reed canarygrass); and *Potamogeton crispus* (Curly-leaf pondweed). Only 18 species were found during the 2010 survey: 5 emergent; 3 free-floating; 1 rooted floating-leaf; and 9 submergent. Four of those were the same invasive species found before, but watercress was not found during the 2010 survey. Different sampling points were used in the 2009 PI survey than those used in the 2010 PI survey. The 2009 PI points were modified by the permission of the WDNR Eau Claire office to add near-shore points. This resulted in more emergent species being found in the 2009 PI survey.

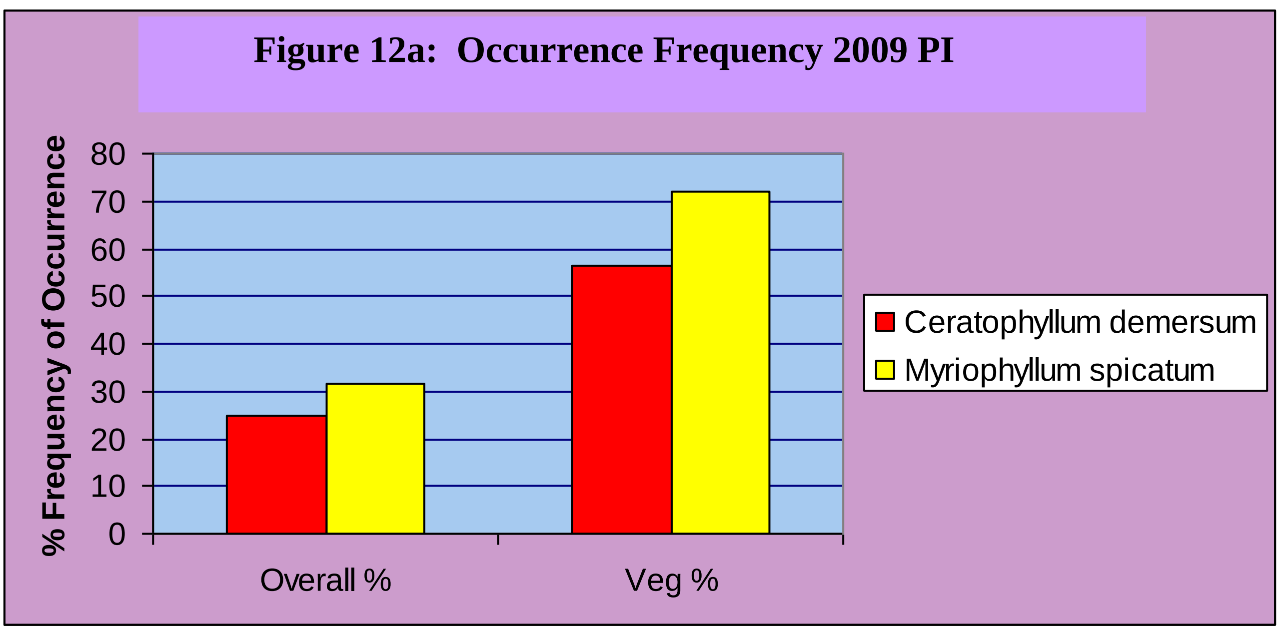
Figure 11: Mason Lake Aquatic Plant Species, 2009-2010

Emergent	2009 (T)	2009 (PI)	2010 (PI)
Asclepias incarnata	X		
Bidens coronatus		X	
Carex spp.	X	X	
Carex comosa	X	X	
Carex stricta		X	
Cyperus odoratus		X	
Decondon verticillatus	X	X	X
Echinochloa muricata		X	
Echinochloa walteri		X	
Eupatorium maculatum		X	
Impatiens capensis		X	
Iris versicolor	X		
Leersia oryzoides	X	X	
Lycopus americanus		X	
Lycopus uniflorus		X	
Onoclea sensibilis		X	
Phalaris arundinacea	X	X	X
Pilea fontana		X	
Polygonum cuspidatum		X	
Rumex orbiculatus		X	
Sagittaria latifolia		X	
Salix spp	X	X	
Schoenoplectus tabernaemontani		X	X
Silphium terebinthinaceum		X	
Sparganium eurycarpum		X	X
Typha spp	X	X	X
Zizania spp.		X	
Submergent			
Ceratophyllum demersum	X	X	X
Chara spp	X	X	
Elodea canadensis	X	X	X
Myriophyllum sibiricum	X	X	
Myriophyllum spicatum	X	X	X
Najas flexilis	X	X	
Najas minor		X	X
Potamogeton crispus	X		X
Potamogeton foliosus	X	X	X
Potamogeton nodosus	X	X	X
Potamogeton praelongus		X	X
Potamogeton zosteriformis	X	X	
Ranunculus longirostris		X	

Stuckenia pectinata	x	x	x
Floating-Leaf	2009 (T)	2009 (PI)	2010 (PI)
Nasturtium microphyllum	x		
Nymphaea odorata		x	x
Free-Floating			
Lemna minor	x	x	x
Spirodela polyrhiza	x	x	x
Wolffia columbiana	x	x	x

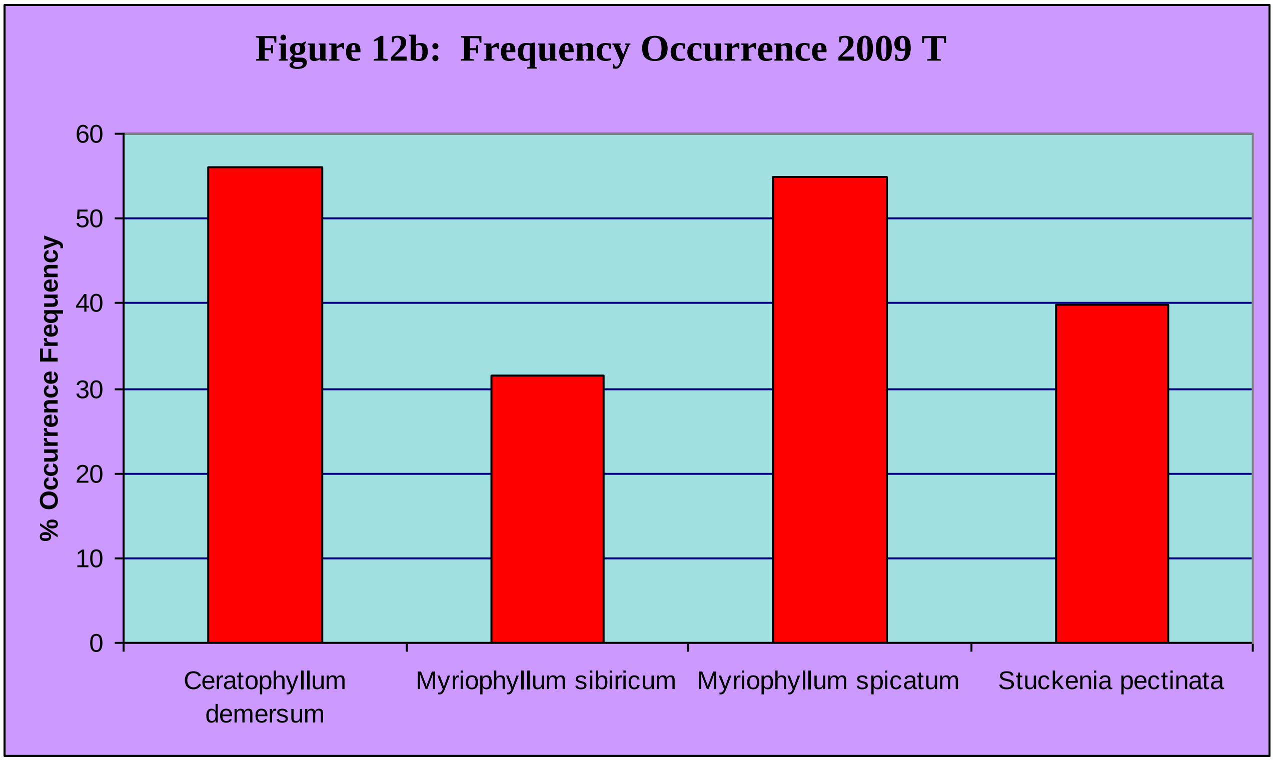
FREQUENCY OF OCCURRENCE

The invasive aquatic plant, *Myriophyllum spicatum* (*Eurasian* watermilfoil) was the most frequently-occurring plant in the PI survey, with an occurrence frequency over 31% in 2009 and over 42% in 2010. The next most frequently-occurring plant in this survey was *Ceratophyllum demersum* (Coontail), a native plant found in many aquatic habitats, with an occurrence frequency of nearly 25% (see Figure 12a). All other species had occurrence frequencies of less than 8% in the PI survey.

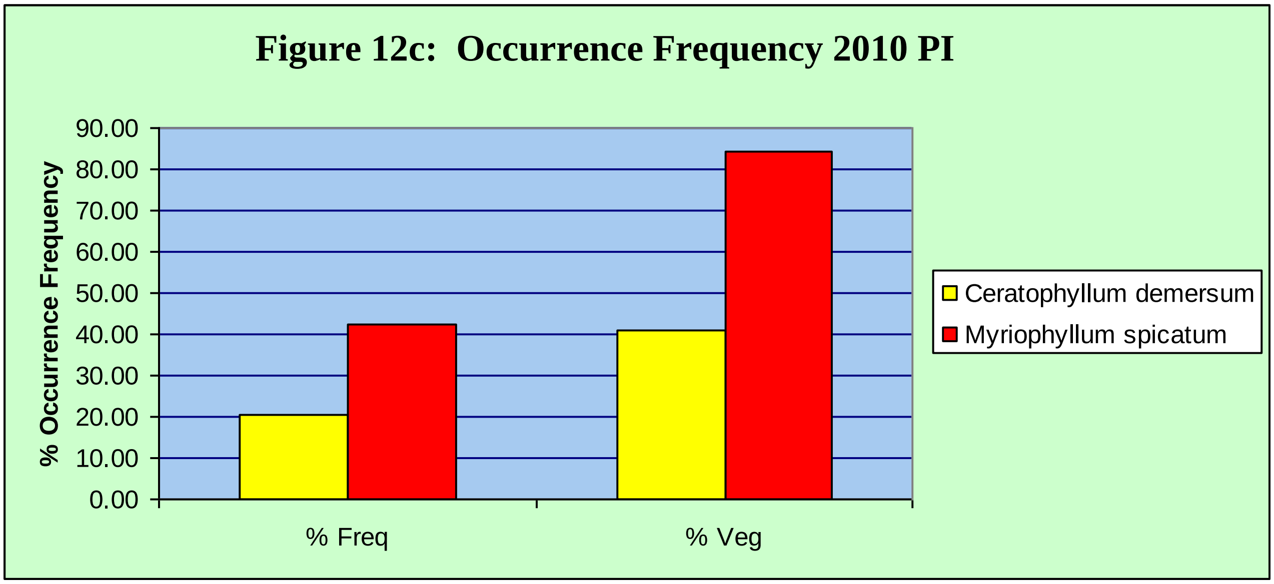


The most frequently-occurring aquatic plant in the transect survey in 2009 was *Ceratophyllum demersum*, with an occurrence frequency of 56%, but it was followed closely by *Myriophyllum spicatum* with an occurrence frequency of 55%. Both

Myriophyllum sibiricum (Northern watermilfoil) and *Stuckenia pectinata* (Sago pondweed) had occurrence frequencies between 30% and 40% (see Figure 12b). All other plants occurred at less than 13% frequency.

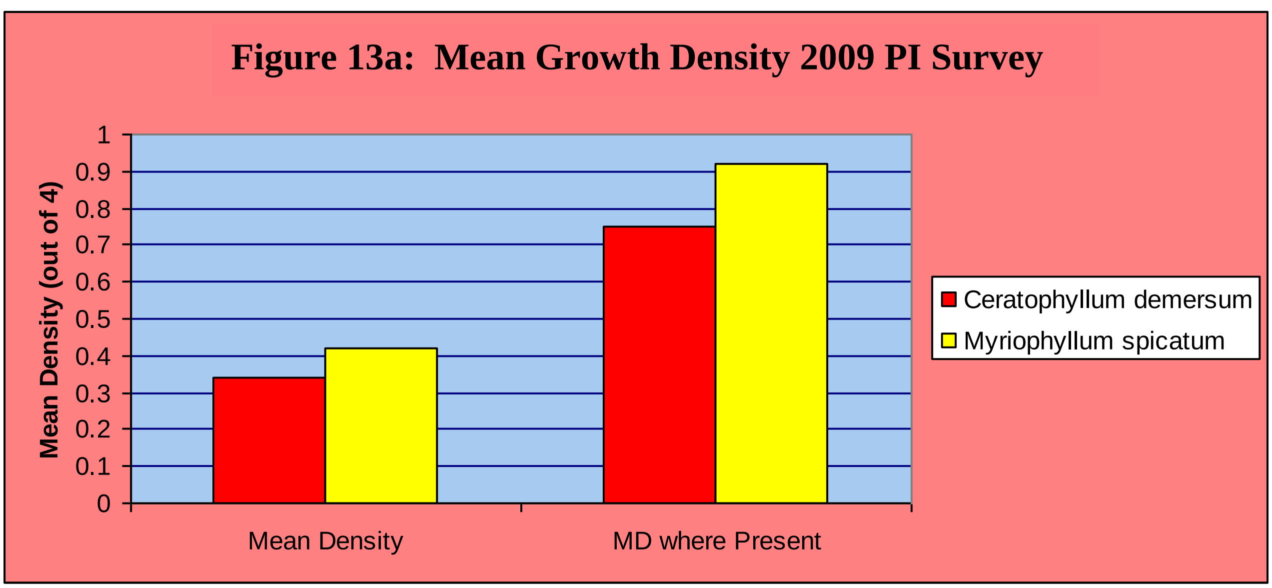


The only two species with any significant frequency of occurrence in the 2010 PI survey were *Myriophyllum spicatum* and *Ceratophyllum demersum.* All of the rest of the species found in 2010 had less than 3% frequency of occurrence overall and less than 5% frequency of occurrence where vegetation was found.

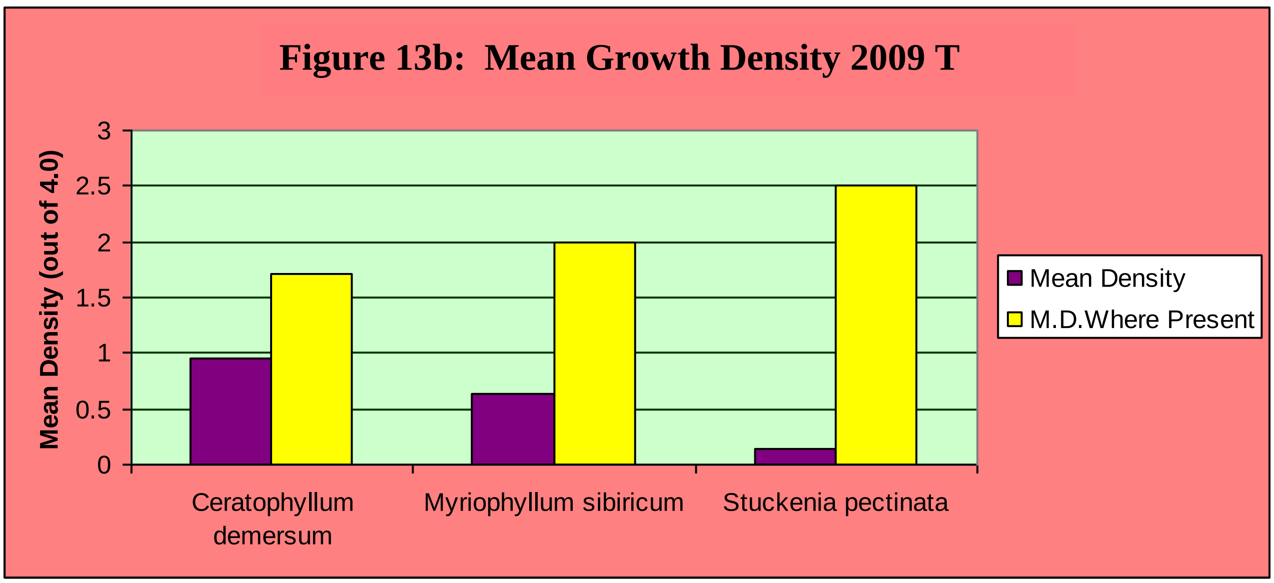


DENSITY

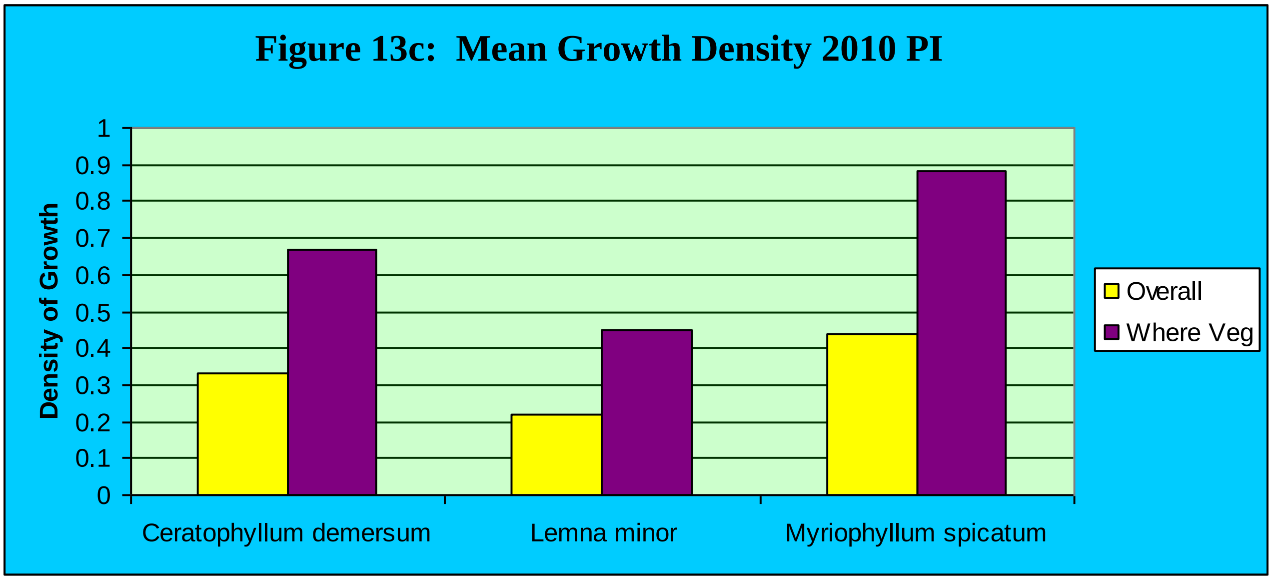
In the 2009 PI survey, the aquatic plants with the highest density were *Myriophyllum spicatum* and *Ceratophyllum demersum* (see Figure 13a). No aquatic species had a more than average density of growth either in overall density or in density where present under the PI results.



The transect survey yielded slightly different results. *Ceratophyllum demersum* and *Myriophyllum spicatum* switched places, with the former occurring more densely than the latter. However, *Myriophyllum spicatum* had a higher density where present than did *Ceratophyllum demersum*, although neither had a higher growth density than average. *Potamogeton nodosus*, also known as Long-Leaved Pondweed, had a low density overall, but had a higher than average density of growth where present (see Figure 13b).

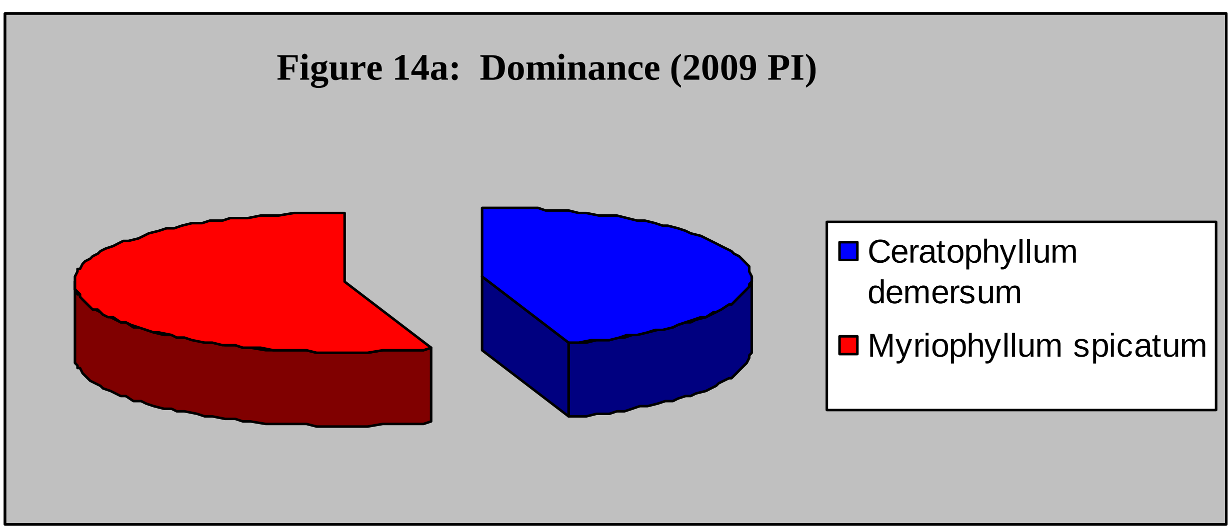


In the 2010 PI survey, even the most frequently-occurring aquatic plants had a low growth density. All of the species had a less than 1 (on 4-point scale) growth density, even just using data from vegetated sites. Highest growth density was found in *Ceratophyllum demersum* and *Myriophyllum spicatum* (see Figure 13c).

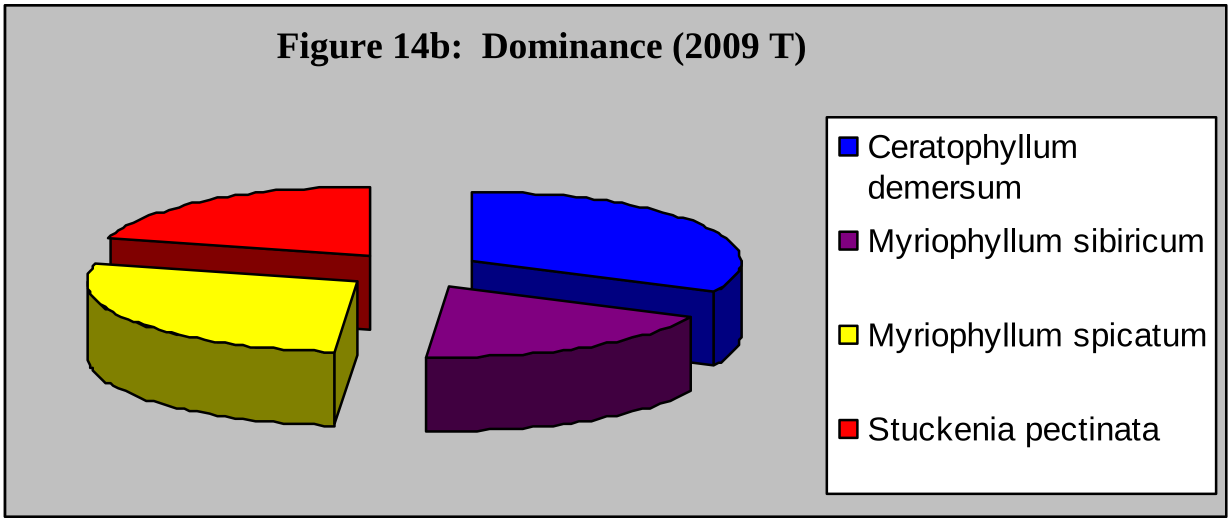


DOMINANCE

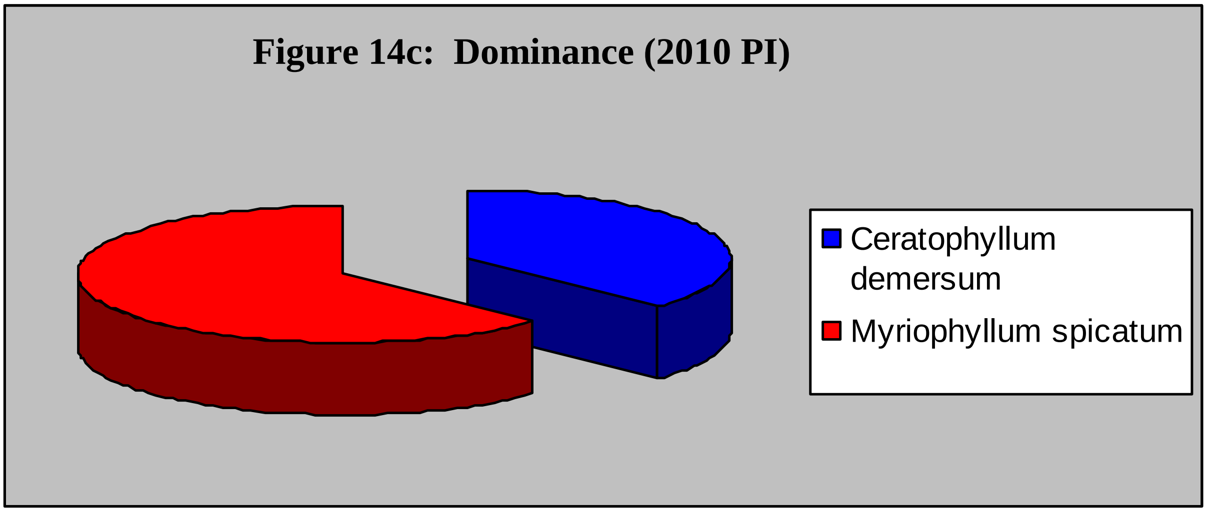
Combining the relative frequency and relative density of a species into a Dominance Value illustrates how dominant that species is within the aquatic plant community. Based on the Dominance Value, the 2009 PI survey showed that *Myriophyllum spicatum* was the dominant aquatic plant species in Mason Lake during 2009 (Figure 14a). *Ceratophyllum demersum* was sub-dominant.



In the transect method, *Ceratophyllum demersum* and *Myriophyllum spicatum* reversed their positions in from the dominance in the PI survey. The former was dominant, with the latter sub-dominant. Third most dominant species were *Potamogeton pectinatus* and *Myriophyllum sibiricum* (see Figure 14b).



In the 2010 PI survey, only *Ceratophyllum demersum* and *Myriophyllum spicatum* had any significant dominance values. The latter had a dominance value 1.7 times that of *Ceratophyllum demersum* and a dominance value over 4 times more than the next highest dominance value, *Lemna minor*.



DISTRIBUTION

The predicted maximum rooting depth can be calculated from the Secchi Disc water clarity.

Predicted Rooting Depth (ft.) = (Secchi Disc (ft.) * 1.22) + 2.73

Using the growing season Secchi disk readings taken since the last aquatic plant survey in 2005, the average growing season Secchi disk reading in Mason Lake has been 2.3 feet. If that information is plugged into the formula above, the predicted rooting depth is 5.5 feet. Actual rooting depth in Mason Lake, despite its very limited water clarity, is 7.25 to 7.5 feet.

In the past, aquatic plants tended to occur throughout Mason Lake, since the entire lake is a littoral zone. The predicted rooting depth calculated above suggests that this is no longer the case in Mason Lake. Indeed, during the surveys in 2009, several areas of the lake bed had no aquatic vegetation. These areas were in the deeper parts of the lake in both surveys. The most reason likely is the decrease in water clarity, resulting in little or no light for photosynthesis reaching those areas of the lake. Besides the long-time high nutrient load in Mason Lake, it suffers from a significant carp population. The carp presence may be adding to the turbidity of Mason Lake's water, since carp not only prefer dirty water, but also actually create dirty water by resuspending sediment when bottom feeding, excreting nutrients causing a spike in phytoplankton biomass and causing sediment resuspension by vegetation destruction (Dibble et al, 1997; Warner, 2004).

Figure 15a: Location of Emergent, Floating-Leaf & Free-Floating Plants
Mason Lake 2009 (PI)

Emergent Plants Found ● Both Emergent & Free-Floating Plants Found ●

Free-Floating Plants Found ● Both Free-Floating & Floating Leaf Plants Found ●

These maps, drawn from the 2009 PI survey results, visually outline the lack of aquatic plants in the deeper areas of the lake. During the PI survey, the only rooted plant found in water over 6 feet deep was the invasive Eurasian watermilfoil (*Myriophyllum spicatum)*, and no plants at all were found in water more than 7.5 feet deep. As Figures 15a and 15b also show, very little of Mason Lake has a diversity of plant structure, i.e., a combination of submergent, emergent, free-floating and rooted floating-leaf aquatic plants. Emergent and rooted floating-leaf plants are especially sparse in Mason Lake.

Figure 15b: Location of Submergent Plants--Mason Lake 2009 (PI)

The 2010 PI survey continued to show reduced areas of vegetation. Figures 16a and 16b show what was found during the 2010 survey. Both the 2009 and 2010 PI surveys revealed that depths over 7 feet in Mason Lake are either sparsely vegetated or not vegetated at all. It is possible that this condition existed prior to 2009, since the prior transect surveys usually had maximum sample sites at slightly more than 7 feet, rather than between 8 and 9 feet.

Figure 16a: Distribution of Submerged Plants in Mason Lake—2010 PI

Figure 16b: Distribution of Emergent, Floating-Leaf and Free-Floating Aquatic Plants in Mason Lake—2010 PI

Although the transect survey was done in July 2009 and the PI survey done in August 2009, results from the transect survey similarly showed no rooted plants found in over 7 feet of water (see Figures 17a and 17b). Eurasian watermilfoil, Northern milfoil (*Myriophyllum sibiricum*) and Sago pondweed (*Stuckenia pectinata*) were found in water between 6 and 7 feet deep. 41% of the sites over 5 feet deep had no vegetation or only the unrooted Coontail (*Ceratophyllum demersum*).

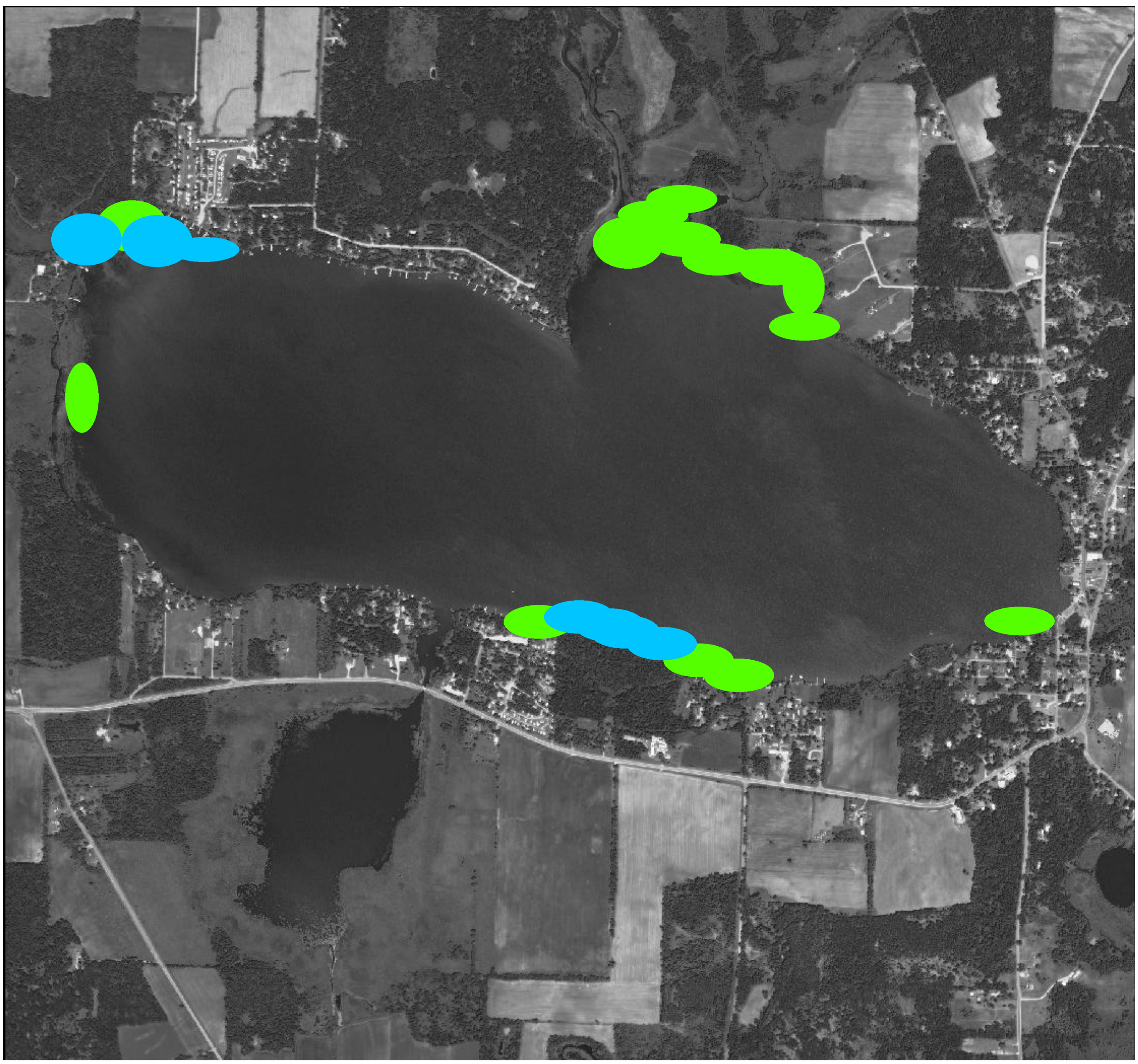


Figure 17a: Emergent Plants (T) 2009 marked in green—Both Free-Floating & Emergent Plants marked in blue

No rooted floating-leaf plants were found during the transect survey and only a few free-floating plants were found. The most frequent aquatic vegetation found in Mason Lake during the transect survey was submergent plants.

As Figure 16b shows, although the transect survey found more submergent aquatic plants in more areas than did the PI survey, aquatic vegetation still tended to be sparse or non-existent in the deeper areas of the lake. Under the transect method, aquatic vegetation in the deeper water in 2009 was confined to Coontail, a submerged unrooted native plant; Northern milfoil, a submerged rooted native plant; Sago pondweed, a submerged rooted native plant; and Eurasian watermilfoil, an aquatic invasive that has plagued Mason Lake for many years. Eurasian watermilfoil was found at ½ of the sites located in over 5 feet of water. Sago pondweed was found in only one spot. The other two plants were found at 32% of the sites in water over 5 feet deep.

Figure 17b: Submergent Plants (T) 2009 found in lake areas not marked in blue

Myriophyllum spicatum (Eurasian watermilfoil) was the dominant species in 1992 and dominated at depths greater than 1.5 feet. *M. spicatum* declined in 1998, but increased again in 2001, becoming the dominant species again, this time dominating depths greater than 5 feet deep. *M. spicatum* declined again in 2005 to its lowest frequency. In the past, the frequency and density of *M. spicatum* has increased with increasing depth, perhaps due to the winter drawdowns that control this species in the shallow water areas. However, in 2009 (transect), *M. spicatum* had its highest frequency in the 0 to 1.5 feet depth (69.23%), with its frequency decreasing to 33.33% in the over 5 feet deep area. Its overall frequency in the 2009 transect survey was nearly 60% and went up to over 65% in vegetated spots. The 2009 PI survey also found *M. spicatum* over all the lake at about 32%, but it increased to over 71% in vegetated areas. Figure 18 shows the distribution of *M. spicatum* in 2009 from both surveys.

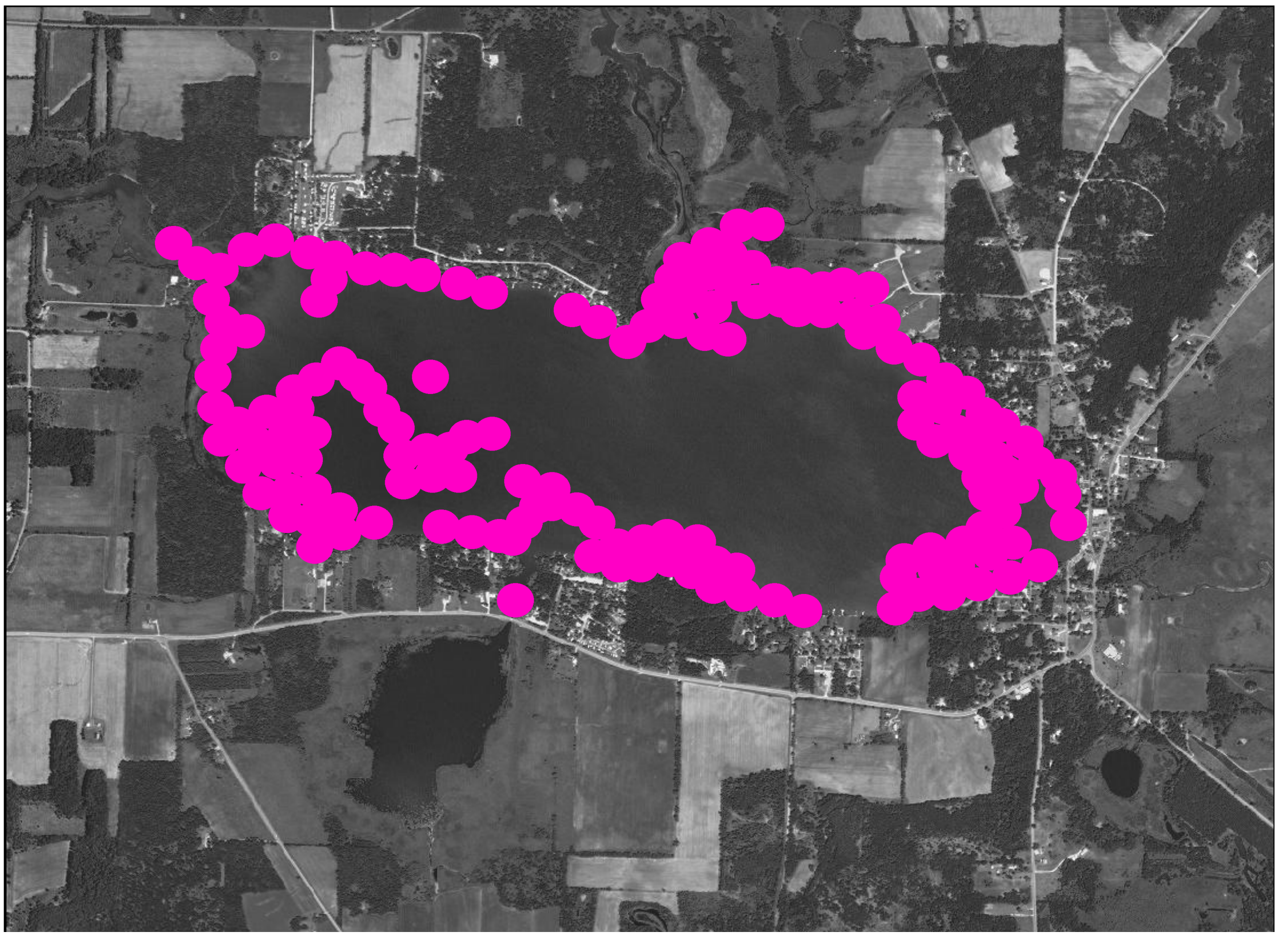


Figure 18: Location of Eurasian Watermilfoil in Mason Lake 2009

In the 2010 PI survey, overall frequency of occurrence of *M. spicatum* increased to just over 42% and, in vegetated portions, it had over 84% frequency of occurrence (see Figure 19).

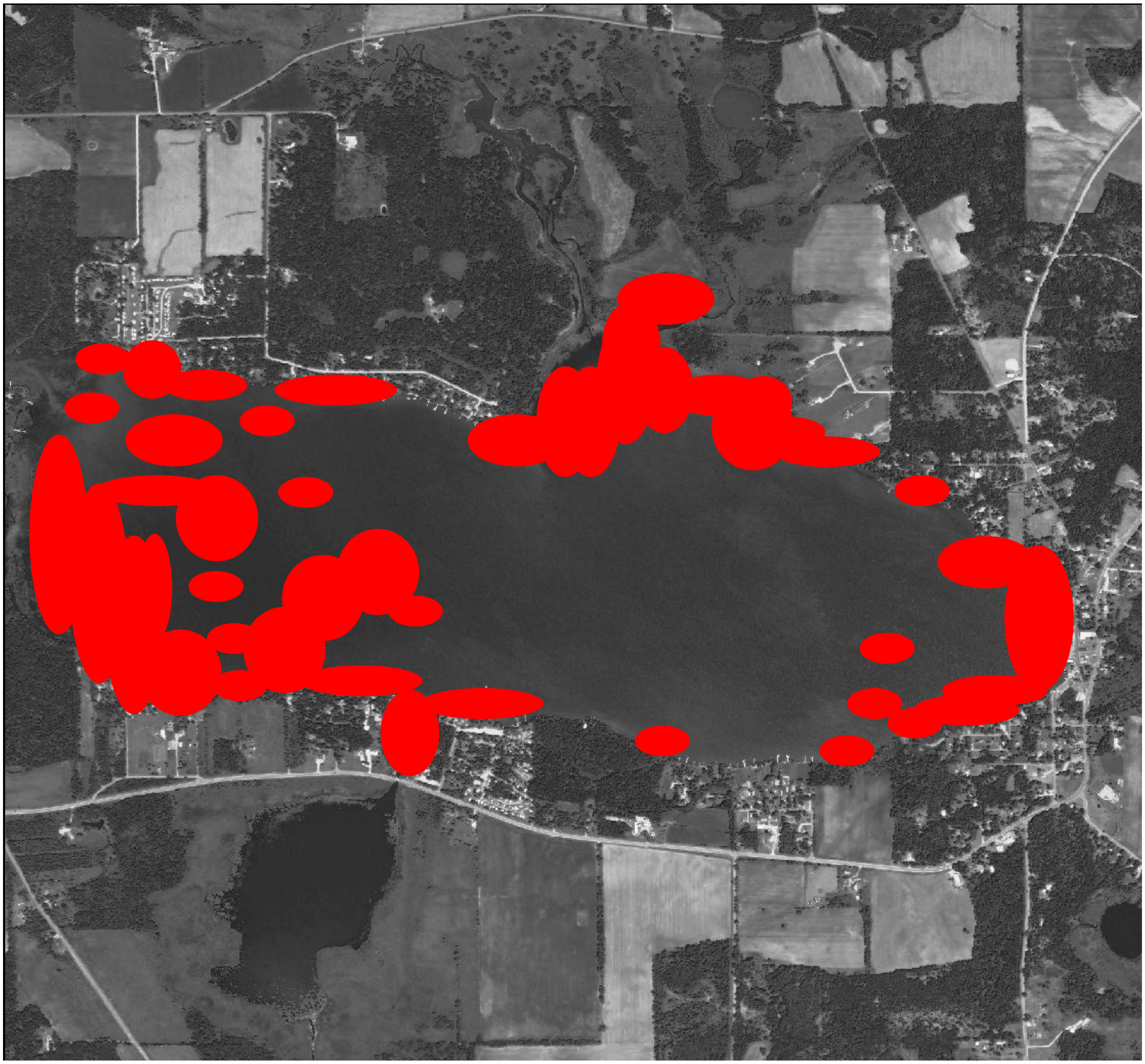


Figure 19: Distribution of Eurasian Watermilfoil in 2010 (PI)

Potamogeton crispus (Curly-Leaf Pondweed) has decreased in Mason Lake since 2005. In 2005, *P. crispus* was found with 22.1% frequency (transect), with its highest frequency of occurrence found in over 5 feet of water, where it had a 43.5% frequency of occurrence. However, in 2009, not only had the occurrence frequency (transect) declined to 12.3%, but its maximum frequency of occurrence was found in less than 1.5 feet of water, with none at all found in over 5 feet of water. In the PI survey, *P. crispus* had an occurrence frequency of only 2.91%. Since the PI survey was done in late August 2009, the occurrence frequency probably underrepresents the occurrence of Curly-Leaf Pondweed, which is a plant that usually dies off by mid-July.

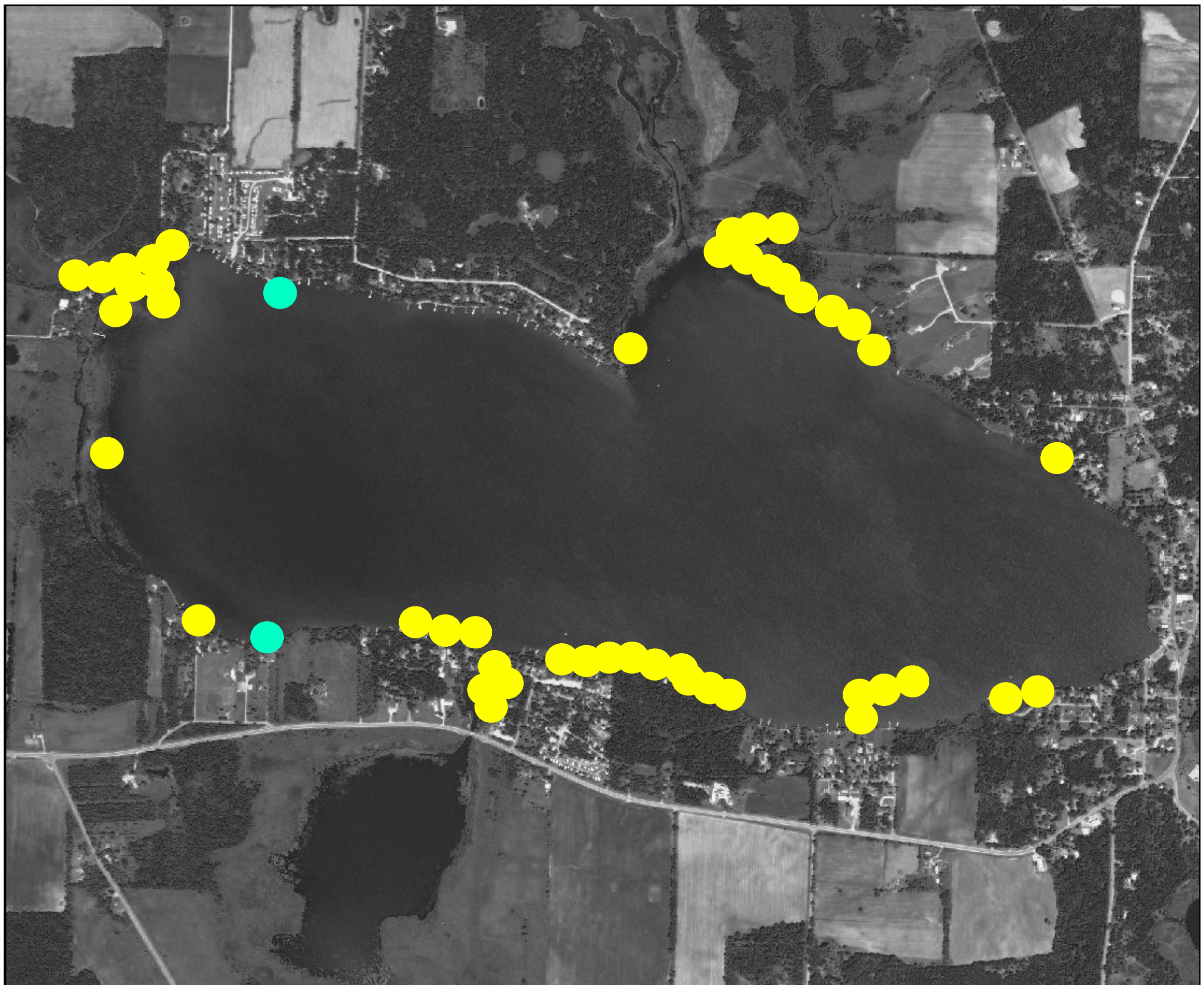


Figure 20: Location of Curly-Leaf Pondweed in Mason Lake 2009-2010

CLP found in 2009 **CLP found in 2010**

Curly-Leaf Pondweed was only found in two spots in the 2010 survey.

Two of the new invasives found in Mason Lake in 2009 were found at a very low occurrence frequency. *Polygonum cuspidatum* (Japanese Knotweed) was found in one spot at the east end of the lake on the lakeshore, plus just south of the lake past the dam that impounds Mason Lake. These locations have been reported to the state invasive species coordinator. *Nasturtium microphyllum* (Watercress) was found at one location in the channel between Mason Lake and Amey Pond. A third invasive species, *Phalaris arundinacea* (Reed Canarygrass), which has been present at Mason Lake for some time, continued to be at less than 9% frequency of occurrence in 2009 and was only found in a few places in the 2010 survey.

However, a new invasive found in Mason Lake in 2009, *Najas minor* (Brittle Nymph), was found at several places throughout the lake. Mason Lake was only the second lake in Wisconsin in which *Najas minor* has been found. In 2009, it had a 4% frequency of occurrence in the lake overall and a 9% occurrence frequency in vegetated sites on the lake. Since this is such a new invasive to Wisconsin, this population will need to be watched closely to determine if any control action will be required. In the 2010 survey, *Najas minor* occurred only at 1.7% overall frequency and only at 3.4% frequency in vegetated sites.

Figure 21: Location of Brittle Nymph in Mason Lake 2009-2010

Found in 2009 only **Found in 2010 only** **Found in both years**

A comparison of the zone frequency of occurrence and zone density of occurrence between 2005 and 2009 further illustrates what a drop there was by 2009 in the deeper waters of Mason Lake. While the frequency of occurrence in the 0 to 1.5 deep zone increased between 2005 and 2009, there was a decrease in the 1.5 to 5 foot depth zone and a large decrease in the over 5 feet depth zone (see Figure 22). A similar pattern was found when comparing the zone density of occurrence of the two years (see Figure 23).

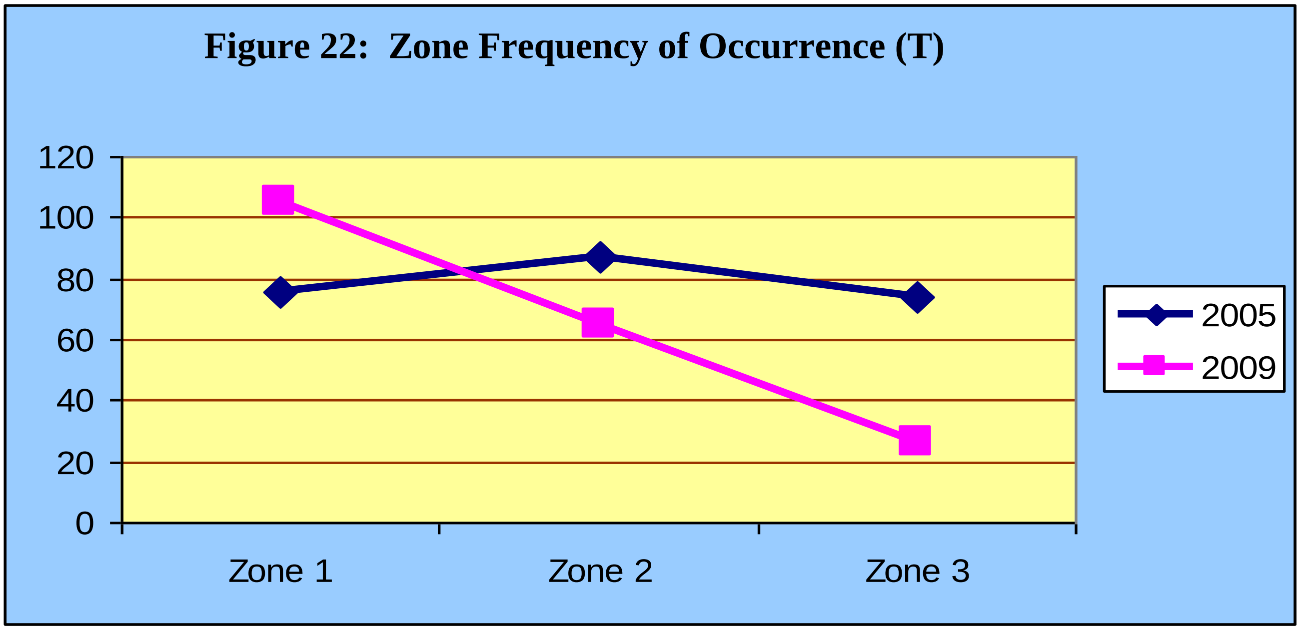


Figure 22: Zone Frequency of Occurrence (T)

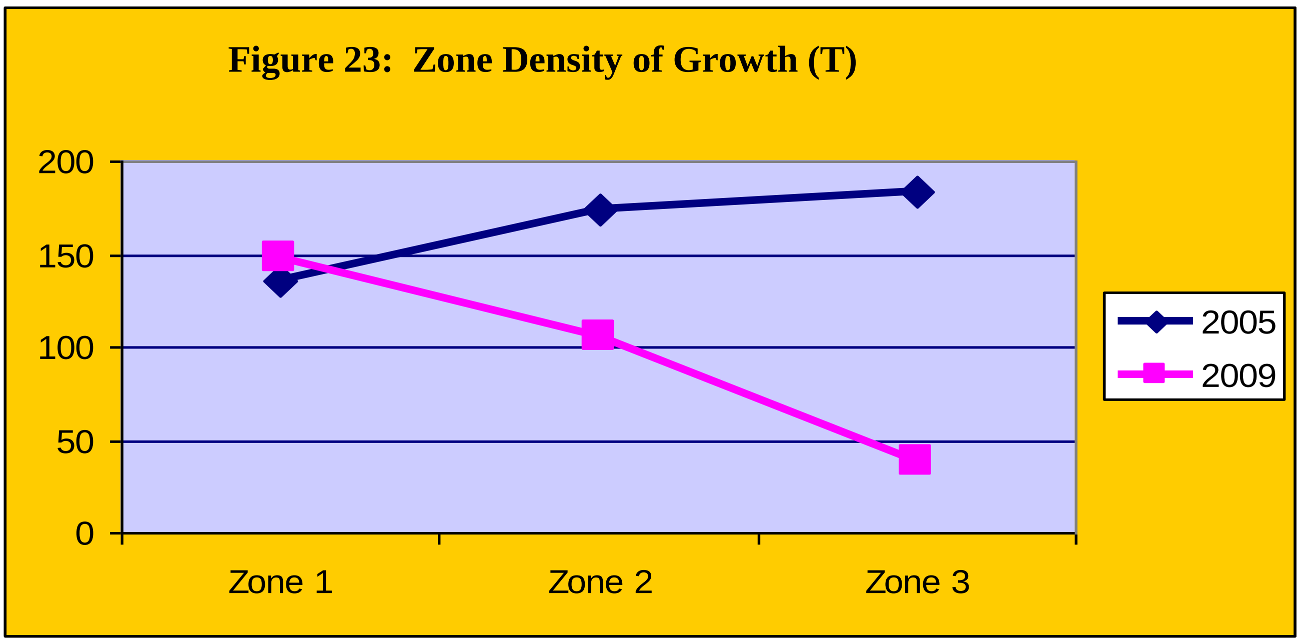


Figure 23: Zone Density of Growth (T)

No similar conclusions can be drawn from the PI results, since the data collection and ranking methods differ and there is no delineation by depth zone.

THE COMMUNITY

The Simpson's Diversity Index for the transect 2009 survey was .86. It was .89 for the PI method in 2009 and down to .75 in 2010. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). Both figures for 2009 place Mason Lake in the median for diversity for all the lakes in Wisconsin and for the North Central Hardwoods Region. These SI scores place Mason Lake in the fair category of diversity for lakes in Wisconsin and in the North Central Hardwoods Region. The .75 score is below the median for both categories.

Species richness is the number of species in a given area. When looking at aquatic survey results, high species richness indicates a higher quality aquatic plant community. The overall transect species richness was 2.7. Species richness calculated using only the vegetated sites was 3.1. Zone 1 (0-1.5 feet deep) had the highest species richness with 4, followed by Zone 2 (1.5-5 feet deep) with a species richness of 2.5. Species richness dropped to 1.2 in Zone 3 (5 to 10 feet deep). Overall species richness for the PI method was 0.98. Calculated using only vegetated sites, PI species richness was 2.1.

The Average Coefficient of Conservation and Floristic Quality Index were calculated as outlined by Nichols (1998) to measure plant community disturbance. A coefficient of conservation is an assigned value between 0 and 10 that measures the probability that the species will occur in an undisturbed habitat. The Average Coefficient of Conservationism is the mean of the coefficients for the species found in the lake. The coefficient of conservatism is used to calculate the Floristic Quality Index (FQI), a measure of a plant community's closeness to an undisturbed condition.

The Average Coefficient of Conservatism for Mason Lake was 3.95 for the transect method and 4.51 for the PI method. The FQI from the transect method was 18.55, with 28.89 the PI score. Both Average Coefficients of Conservatism scores place Mason Lake in the lowest quartile of lakes for Average Coefficient of Conservatism for lakes in Wisconsin overall (range 5.5-6.9) and for the North Central Hardwoods Region (range 5.2-5.8).

The Floristic Quality Index is a tool that can be used to identify areas of high conservation value, monitor sites over time, assess the anthropogenic (human-caused) impacts affecting an area and measure the ecological condition of an area (M. Bourdaghs, 2006). The Floristic Quality Index of the transect method aquatic plant community in Mason Lake was in the average range for both all Wisconsin lakes (range 16.9-27.5) and North Central Hardwood Region lakes (range 17-24.4). The PI FQI score of 28.89 places the lake above the average of all Wisconsin Lakes and the North Central Hardwood Region. The transect FQI score of 18.55 is in the median range for both all Wisconsin lakes and the North Central Hardwood Area.

These values were based only on the occurrence of disturbance tolerant or intolerant species and did not take into consideration the frequency or dominance of these tolerant or intolerant species in the community. The Floristic Quality was recalculated, weighting each species coefficient with its relative frequency and dominance value. When that figure is adjusted for frequency of occurrence, the transect FQI drops to 13.6 and the PI FQI drops to 18.3, putting Mason Lake's FQI average to below average. This indicates that the plant community in Mason Lake is within the group of lakes subject to median disturbance or subject to high disturbance, depending on the scale used. This is in keeping with the 2002 placement of Mason Lake on the federal impaired (303(d)) list.

Disturbances can be of many types:

1) Physical disturbances to the plant beds result from activities such as boat traffic, plant harvesting, chemical treatments, the placement of docks and other structures and fluctuating water levels.
2) Indirect disturbances are the result of factors that impact water clarity and thus stress species that are more sensitive: resuspension of sediments, sedimentation from erosion and increased algae growth due to nutrient inputs.
3) Biological disturbances include competition from the introduction of a non-native or invasive plant species, grazing from an increased population of aquatic herbivores and destruction of plant beds by a fish or wildlife population.

Major disturbances in Mason Lake likely include past broad-spectrum chemical treatments, fairly heavy boat traffic in the shallow basin, introduction of several exotic invasive aquatic plant species, winter drawdowns, significant shoreline development and very poor water clarity.

The Aquatic Macrophyte Community Index (AMCI) for Mason Lake (Figure 24) is 44, based on transect survey, and 42 based on the PI survey. Both of these values are in the lowest quartile for lakes in the North Central Hardwoods Region and all of Wisconsin lakes, indicating that the aquatic plant community in Mason Lake is of below average quality.

Figure 24: AMCI	Parameter	2009(T) Values	Parameter	2009(PI) Values
Maximum rooting depth	7	3	7	3
% Littoral Zone Vegetated	86.3	10	45.6	9
Simpson's Diversity Index	0.86	7	0.89	8
% Submersed Species	87	9	61	6
% Sensitive Species	2	3	3	4
% Exotic Species	29	3	32	2
# Taxa	24	9	44	10
total		44		42

COMPARISON TO PRIOR RESULTS

There are aquatic plant survey records from Mason Lake going back to 1988. In that time, the aquatic plant community has changed significantly. Records from 1988 indicate that only 5 plant species were found: *Ceratophyllum demersum, Myriophyllum* spp, *Najas fleixilis, Potamogeton* spp, and *Potamogeton praelongus.* This increased to 16 by 1992, 26 in 1995, then down to 20 in 1998. The number of species went up to 25 in 2002, but decreased again in 2005 to 19. The combined number of species found during the 2009 surveys was 47. Figure 25 shows the changes in the AMCI since 1992.

Figure 25: Aquatic Macrophyte Community Indices 1992-2009

	1992	1998	2001	2005	2009 (t)	2009 (PI)
Maximum rooting depth	3	4	3	3	3	3
% Littoral Zone Veg	10	10	10	10	10	8
Simpson's Index	6	7	7	8	7	8
% Submersed Species	9	9	9	6	9	7
% Sensitive Species	1	5	5	4	3	3
% Exotic Species	2	2	2	3	3	3
# Taxa	8	9	9	8	9	10
total	39	46	45	42	44	42

Increases since 1992 include more species present, more sites with emergent species, higher Simpson's Diversity Index, higher Floristic Quality Index, and higher Aquatic Macrophyte Community Index. However, decreases since 1992 were found in a lower percent of littoral zone vegetation, reduced maximum rooting depth, fewer free-floating & rooted floating-leaf plant sites, fewer submersed plant sites, lower species richness and lower average coefficient of conservatism.

Figure 26: Changes in Aquatic Plant Community in Mason Lake (T)

Mason	1992	1998	2001	2005	2009	Change	%Change
Number of Species	16	20	25	19	24	8	50.0%
Maximum Rooting Depth	8.0	9.0	8.0	7.0	7.0	-1	-12.5%
% of Littoral Zone Vegetated	100%	93%	93%	91%	86%	0	-13.7%
%Sites/Emergents	5%	6%	13%	11%	11%	0.06	119.2%
%Sites/Free-floating	62%	75%	50%	76%	5%	-0.57	-91.2%
%Sites/Submergents	99%	92%	91%	84%	86%	-0.13	-12.8%
%Sites/Floating-leaf	0%	1%	3%	0%	0%	-1.00	-100.0%
Simpson's Diversity Index	0.84	0.88	0.87	0.89	0.86	0.02	2.4%
Species Richness	3.1	3.5	3.6	3.2	2.7	-0.45	-14.4%
Floristic Quality	15.8	20.4	20.23	18.2	18.5	2.80	17.8%
Average Coefficient	4.1	4.7	4.3	4.4	3.95	-0.12	-2.9%
of Conservatism							
AMCI Index	39	46	45	42	44	5.00	12.8%

The largest change since 1992 is in the number of emergent plants. Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife, so such a large increase at Mason Lake since 1992 is a positive factor in the overall health of the aquatic macrophyte community. Free-floating rooted plants, which provide cover and dampen waves to protect the shore, have never been a significant part of the Mason Lake aquatic plant community. The 2009 surveys show that these plants continue to be absent or scarce in Mason Lake. Only 5 emergents were found in the 2010 survey, all of which were in low frequency and density.

The coefficient of similarity is an index, first developed by Jaccard in 1901, which compares the similarity and diversity of sample sets. In this instance, the figure considers the frequency of occurrence and relative frequency of all species found, then determines how similar the overall aquatic plant communities are. Similarity percentages of 75% or more are considered statistically similar (Dennison et al, 1993).

The transect plant communities of various years were compared by calculating coefficients of similarity, using actual frequency of occurrence (Figure 27). The accumulated change over the years of the studies has resulted in the present (2009) community being only 59% similar to the plant community in 1992. This means that only 58% of the community in 1992 has been retained in the 2009 community. The 2009 community is therefore not statistically similar using actual frequency of occurrence to the aquatic plant communities of any of the prior years in which aquatic surveys were performed.

Figure 27: Similarity Comparison by Actual Frequency (T)

Comparison Years	% Similarity	Comparison Years	% Similarity
1992 to 1995	61%	1992 to 2009	59%
1998 to 2001	75%	1995 to 2009	55%
2001 to 2005	63%	1998 to 2009	61%
2005 to 2009	73%	2001 to 2009	61%

Calculations were also performed to compare the 2009 aquatic plant community to those found in 1992, 1995, 1998 and 2005 (Figure 28). Using this figure, the 2009 plant community was only 63% similar to the 1992 plant community and only 72% similar to the community found in 2005.

Figure 28: Similarity Comparison Using Relative Frequency (T)

Comparison Years	% Similarity
1992 to 2009	63%
1995 to 2009	42%
1998 to 2009	63%
2001 to 2005	62%
2005 to 2009	72%

The table below shows the specifics of various aquatic species as they appeared and/or disappeared through the years (Figure 29).

FIGURE 29:	**1988**	**1992**	**1995**	**1998**	**2001**	**2005**	**2009 (t)**	**2009 (pi)**	**2010(pi)**
Emergent Plants									
Asclepias incarnata					x		x		
Bidens connata				x				x	
Carex spp		x			x	x	x	x	
Cornus sericea					x				
Cyperus odoratus								x	
Decodon verticillatus				x	x		x	x	x
Echinochloa muricata								x	
Echinochloa walteri			x					x	
Eleocharis palustris			**x**						
Eupatorium maculatum								x	
Impatiens capensis			x	x				x	
Iris versicolor			x				x	x	
Leersia oryzoides							x		
Lycopus americanus								x	
Lycopus uniflorus								x	
Onoclea sensibilis								x	
Phalaris arundinacea			x		x	x	x		x
Pilea fontana								x	
Polygonum cuspidatum								x	
Rumex spp								x	

Sagittaria latifolia		x	x					x	
Salix spp							x	x	
Schoeneplectus tabernaemontani		x			x				x
Silphium terebinthinaceum								x	x
Sparganium eurycarpum		x	x	x	x	x		x	
Typha spp		x	x	x	x	x	x	x	x
Zizania spp								x	
Floating Leaf Plants									
Nasturtium microphyllum							x		
Nuphar variegata					x				
Nymphaea odorata			x		x			x	x
Free Floating Plants									
Lemna minor			x	x	x	x		x	x
Spirodela polyrhiza			x	x	x	x	x	x	x
Wolffia columbiana				x	x	x	x	x	x
Submergent Plants									
Ceratophyllum demersum	x	x	x	x	x	x	x	x	x
Chara spp			x	x	x	x	x	x	
Elodea canadensis		x	x	x	x	x	x	x	x
Myriophyllum spp	x								
Myriophyllum sibiricum		x	x	x	x	x	x	x	
Myriophyllum spicatum		x	x	x	x	x	x	x	x
Najas flexilis	x	x	x	x	x	x	x	x	
Najas minor								x	x
Nitella spp		**x**							
Potamogeton spp	x	x	x						
Potamogeton amplifolius			x			x			
Potamogeton crispus		x	x	x	x	x	x	x	x
Potamogeton foliosus						x	x	x	x
Potamogeon nodusus			x			x	x	x	x
Potamogeton praelongus	x		x	x				x	x
Potamogeton pusillus			x	x			x		
Potamogeton richardsonii						x			
Potamogeon zosteriformis		x			x			x	
Ranunculus longirostris		x		x	x			x	
Stuceknia pectinata		x	x	x	x	x	x	x	x
Zosterella dubia			x	x	x			x	

Only 12 species found in 2009 had not been previously found at Mason Lake: *Cyperus odoratus* **(E)**; *Echinochloa muricata* (E); *Lycopus americanus* (E); *Lycopus uniflorus* (E); *Najas minor* (S); *Nasturtium microphyllum* (FL); *Onoclea sensibilis* (E); *Pilea fontana* (E); *Polygonum cuspidatum* (E); *Rumex* spp (E); and *Silphium terebinthinaceum* (E). Three of these, *Najas minor*, *Nasturtium microphyllum* and *Polygonum cuspidatum*, are invasive non-native species. Two species—*Eleocharis* *palustris* (E) and *Nitella* spp (S)—have disappeared since 1998.

Figure 30 outlines the changes in specific species in their actual frequency of occurrence, density of growth and dominant value in the aquatic community.

Figure 30: Changes in Aquatic Plant Species (t)

Species		1988	1992	1995	1998	2001	2005	2009	Year1-7	%
Asclepias incarnata	Frequency		0.00		0	2.63	0	2.74	0.11	4.2%
	Mean Density		0		0	0.03	0	0.03	0.00	0.0%
	Dom. Value		0		0	0.01	0	0.02	0.01	100.0%
Bidens connata	Frequency				1.35				-1.35	-100.0%
	Mean Density				0.01				-0.01	-100.0%
	Dom. Value				0.01				-0.01	-100.0%
Carex spp	Frequency		1.32		1.37	2.63	2.67	5.48	4.16	315.2%
	Mean Density		0.01		0.03	0.05	0.04	0.06	0.05	500.0%
	Dom. Value		0.01		0.01	0.01	0.01	0.04	0.03	300.0%
Ceratophyllum	Frequency	97.96	61.84	83.33	97.3	40.79	65.33	56.16	-41.80	-67.6%
demersum	Mean Density	3.9	2.32	2.78	5.2	0.75	1.6	0.96	-2.94	-126.7%
	Dom. Value	0.87	0.44	0.83	0.7	0.2	0.45	0.45	-0.42	-95.5%
Chara spp	Frequency		0	12.82	12.16	7.89	36	12.33	-0.49	-4.0%
	Mean Density		0	0.27	0.39	0.2	0.87	0.21	-0.06	-15.4%
	Dom. Value		0	0.1	0.07	0.05	0.25	0.1	0.00	0.0%
Elodea canadensis	Frequency		2.63	6.41	22.97	23.68	28	1.37	-1.26	-47.9%
	Density		0.03	0.15	0.59	0.45	0.51	0.01	-0.02	-66.7%
	Dom Val		0.01	0.05	0.1	0.12	0.17	0.01	0.00	0.0%
Impatiens capensis	Frequency			1.28	1.35				-1.28	-100.0%
	Density			0.01	0.02				-0.01	-100.0%
	Dom Val			0.01	0.01				-0.01	-100.0%
Iris versicolor	Frequency		0		0	0	0	1.37	1.37	100.0%
	Density		0		0	0	0	0.01	0.01	100.0%
	Dom Val		0		0	0	0	0.01	0.01	100.0%
Leersia oryzoides	Frequency		0		0	0	0	1.37	1.37	100.0%
	Density		0		0	0	0	0.01	0.01	100.0%

	Dom Val		0		0	0	0	0.01	0.01	100.0%
Lemna minor	Frequency		0	3.85	9.46	11.84	16	5.48	1.63	17.2%
	Density		0	0.1	0.31	0.22	0.33	0.07	-0.03	-9.7%
	Dom Val		0	0.03	0.05	0.06	0.1	0.04	0.01	20.0%
Myriophyllum sibircum	Frequency		18.42	12.82	31.08	31.58	30.57	31.51	18.69	101.5%
	Density		0.37	0.33	0.88	0.42	0.55	0.63	0.30	81.1%
	Dom Val		0.1	0.11	0.16	0.14	0.18	0.27	0.16	160.0%
Myriophyllum spicatum	Frequency		93.11	19.23	64.86	77.63	42.67	9.59	-9.64	-10.4%
	Density		3.34	0.5	2.12	2.46	0.96	0.75	0.25	7.5%
	Dom Val		0.65	0.17	0.36	0.52	0.28	0.39	0.22	33.8%
Najas flexis	Frequency	16.33	35.53	25.64	24.32	18.42	9.33	9.59	-6.74	-19.0%
	Density	0.29	1.07	0.45	0.63	0.42	0.17	0.07	-0.22	-20.6%
	Dom Val	0.1	0.23	0.19	0.12	0.1	0.06	0.05	-0.05	-21.7%
Nasturtium	Frequency		0		0	0	0	1.37	1.37	100.0%
microphyllum	Density		0		0	0	0	0.01	0.01	100.0%
	Dom Val		0		0	0	0	0.01	0.01	100.0%
Nitella spp	Frequency		13.16		0	0	0	0	-13.16	-100.0%
	Density		0.25		0	0	0	0	-0.25	-100.0%
	Dom Val		0.07		0	0	0	0	-0.07	-100.0%
Nuphar variegata	Frequency		0		1.37	1.32	0	0	-1.37	-100.0%
	Density		0		0.03	0.01	0	0	-0.03	-100.0%
	Dom Val		0		0.01	0.01	0	0	-0.01	-100.0%
Nymphaea odorata	Frequency		0	1.28	0	1.32	0	0	-1.28	-97.0%
	Density		0	0.01	0	0.03	0	0	-0.01	-33.3%
	Dom Val		0	0.01	0	0.01	0	0	-0.01	-100.0%
Phalaris arundinacea	Frequency		0	3.85	0	6.58	5.33	8.22	4.37	66.4%
	Density		0	0.05	0	0.09	0.08	0.08	0.03	33.3%
	Dom Val		0	0.03	0	0.03	0.03	0.05	0.02	66.7%
Polygonum amphibium	Frequency		0		0	2.63	0	0	-2.63	-100.0%
	Density		0		0	0.04	0	0	-0.04	-100.0%
	Dom Val		0		0	0.01	0	0	-0.01	-100.0%
Potamogeton spp	Frequency	32.65	1.32						-32.65	-100.0%
	Density	0.61	0.03						-0.61	-100.0%
	Dom Val	0.2	0.01						-0.20	-100.0%
Potamogeton	Frequency		0	6.41		0	1.33	0	-6.41	-100.0%
amplifolius	Density		0	0.15		0	0.01	0	-0.15	-100.0%

	Dom Val		0	0.05		0	0.01	0	-0.05	-100.0%
Potamogeton crispus	Frequency		22.37	7.69	24.32	77.63	20	12.33	-10.04	-44.9%
	Density		0.47	0.13	0.57	2.09	0.27	0.15	-0.32	-68.1%
	Dom Val		0.12	0.05	0.12	0.47	0.1	0.08	-0.04	-33.3%
Potamogeton foliosus	Frequency		1.32	2.56		19.74	6.67	1.37	0.05	3.8%
	Density		0.03	0.03		0.46	0.13	0.01	-0.02	-66.7%
	Dom Val		0.01	0.02		0.11	0.04	0.01	0.00	0.0%
Potamogeton nodosus	Frequency		0	1.28		0	8	5.48	4.20	328.1%
	Density		0	0.01		0	0.23	0.14	0.13	1300.0%
	Dom Val		0	0.01		0	0.06	0.05	0.04	400.0%
Stuckenia pectinata	Frequency		17.11	11.54	14.86	5.26	20	39.73	22.62	132.2%
	Density		0.51	0.29	0.33	0.09	0.49	0.56	0.05	9.8%
	Dom Val		0.11	0.1	0.07	0.03	0.14	0.29	0.18	163.6%
Potamogeton	Frequency	12.49		1.28	2.7				-12.49	-100.0%
praelongus	Density	0.51		0.01	0.03				-0.51	-100.0%
	Dom Val	0.12		0.01	0.01				-0.12	-100.0%
Potamogeton pusillus	Frequency			7.69	6.76				-7.69	-100.0%
	Density			0.14	0.11				-0.14	-100.0%
	Dom Val			0.06	0.03				-0.06	-100.0%
Potamogeton	Frequency		0		0	0	1.33	0	-1.33	-100.0%
richardsonii	Density		0		0	0	0.01	0	-0.01	-100.0%
	Dom Val		0		0	0	0.01	0	-0.01	-100.0%
Potamogeton	Frequency	8.16							-8.16	-8.3%
robbinsii	Density	0.16							-0.16	-4.1%
	Dom Val	0.05							-0.05	-5.7%
Potamogeton	Frequency		31.58		0	1.32	0	1.37	-30.21	-95.7%
zosteriformis	Density		0.83		0	0.03	0	0.01	-0.82	-98.8%
	Dom Val		0.19		0	0.01	0	0.01	-0.18	-94.7%
Ranunculus longirostris	Frequency		1.32		9.46	2.63	0	0	-1.32	-100.0%
	Density		0.01		0.18	0.03	0	0	-0.01	-100.0%
	Dom Val		0.01		0.05	0.01	0	0	-0.01	-100.0%
Sagittaria latifolia	Frequency		2.63	1.28	0	0	0	0	-2.63	-100.0%
	Density		0.04	0.01	0	0	0	0	-0.04	-100.0%
	Dom Val		0.01	0.01	0	0	0	0	-0.01	-100.0%
Salix spp	Frequency		0		0	0	0	5.48	5.48	100.0%
	Density		0		0	0	0	0.05	0.05	100.0%
	Dom Val		0		0	0	0	0.03	0.03	100.0%

Scirpus validus	Frequency		0		0	2.63	0	0	-2.63	-100.0%
	Density		0		0	0.03	0	0	-0.03	-100.0%
	Dom Val		0		0	0.01	0	0	-0.01	-100.0%
Sparganium	Frequency		3.95	2.56	5.41	5.26	4	0	-3.95	-100.0%
eurycarpum	Density		0.08	0.04	0.09	0.09	0.07	0	-0.08	-100.0%
	Dom Val		0.02	0.02	0.03	0.03	0.02	0	-0.02	-100.0%
Spirodela polyrhiza	Frequency		0	2.56	5.41	7.89	9.33	5.48	5.48	101.3%
	Density		0	0.04	0.08	0.09	0.12	0.07	0.07	87.5%
	Dom Val		0	0.02	0.03	0.03	0.05	0.03	0.03	100.0%
Tyhpa spp	Frequency		5.26	3.85	2.7	3.95	8	2.74	-2.52	-47.9%
	Density		0.11	0.06	0.07	0.05	0.13	0.04	-0.07	-63.6%
	Dom Val		0.03	0.03	0.02	0.02	0.05	0.02	-0.01	-33.3%
Wolffia columbiana	Frequency		0		6.76	2.63	1.33	1.37	-5.39	-79.7%
	Density		0		0.12	0.04	0.01	0.01	-0.11	-91.7%
	Dom Val		0		0.03	0.01	1	0.01	-0.02	-66.7%
Zosterella dubia	Frequency		0	5.13	9.46	0	0	0	-5.13	-100.0%
	Density		0	0.05	0.18	0	0	0	-0.05	-100.0%
	Dom Val		0	0.03	0.05	0	0	0	-0.03	-100.0%

Similar calculations were done to compare the results of the 2009 and 2010 PI surveys. The difference in the percentage of sites with emergents and submergents, plus the differences in the FQI, Coefficient of Conservatism and Species Richness, are probably accounted for by the addition of near-shore sites in the 2009 PI survey. The summer of 2010 also brought a lot of rain and wind, which might account for the difference in the presence of free-floating plant sites—these get moved around by wind and rain easily. Calculations of the coefficient of similarity based on actual frequency of occurrence suggested that the 2009 and 2010 PI surveys were over 99% similar; results based on relative frequency yielded of coefficient of similarity of over 82%. Despite these differences, these two communities scored as substantially similar.

Figure 31	Changes in the Macrophyte Community			
Mason--PI	2009	2010	Change	%Change
Number of Species	20	18	-2	-10.0%
Maximum Rooting Depth (feet)	7.3	7.5	0.25	3.4%
% of Littoral Zone Vegetated	34	45	11	33.5%
%Sites/Emergents	4.3%	0.2%	-0.04	-95.3%
%Sites/Free-floating	7.0%	2.2%	-4.80	68.6%
%Sites/Submergents	99.1%	45.4%	-0.54	-54.2%
%Sites/Floating-leaf	0.9%	0.4%	-0.50	-155.6%
Simpson's Diversity Index	0.74	0.74	0	0.0%
Species Richness	0.63	0.65	0.02	3.2%
Floristic Quality	17.94	12.48	-5.46	-30.4%
Average Coefficient of Conservatism	4.22	3.46	-0.76	-18.0%
AMCI Index	39	37	-2	-5.1%

V. DISCUSSION

Based on water clarity and the concentrations of algae and nutrients, Mason Lake was an eutrophic/hypereutrophic lake with poor to very poor water quality and poor water clarity during the study period (1986-2009). Since 1986, nutrient levels have increased and water clarity has decreased.

Plant growth in Mason Lake is favored by the high nutrients of its trophic state, hard water, dominance of rich sediments, the shallow depth of the lake and the very gradually sloped littoral zone. The predicted maximum rooting depth is less than the maximum depth of Mason Lake, likely due to the poor water clarity. The aquatic plant growth in Mason Lake has decreased in its coverage of the lake. The community is characterized by abundant growth, good species diversity, low quality, a high tolerance to disturbance and a condition that is far from an undisturbed condition.

Under the transect method, *Ceratophyllum demersum* (coontail) continued to be the dominant species in 2009, especially in the shallowest depth zone. *Myriophyllum spicatum* (Eurasian watermilfoil), an aggressive non-native species, was the sub-dominant species under the transect method. Its occurrence frequency was over 50% in all three depth zones. The positions were reversed for the PI surveys, but with the same two plants dominating the aquatic plant community.

Both Coontail and Eurasian watermilfoil can be limiting for habitat; when they occur as dense mats, fish movement is hindered. The two exotic species, Eurasian watermilfoil and curly-leaf pondweed, can limit the quality of the habitat in the lake when they become too dominant. One of the new invasives found in 2009, Brittle Nymph, has been aggressive in growth in several northeastern states, suggesting it has the ability to survive Wisconsin winters and may become an additional problem for management in Mason Lake. In general, dense plant beds of exotic species do not provide a diverse habitat; this lack of diversity fails to provide the variety of microhabitats needed to accommodate a variety of insect, fish and wildlife species. Curly-leaf pondweed adds an extra problem because it dies back early in the summer; this removes habitat and the decaying pondweed will release nutrients for algae growth which reduces water clarity.

Stuckenia pectinata, sago pondweed, has increased in frequency of occurrence in Lake Mason since 2005, perhaps due to the winter drawdowns history favoring it. However, in 2005, it had a higher than average growth density where present; in 2009, it did not have a higher than average growth density at any spot on the lake. Over the years, the frequency and density of *Stuckenia pectinata* have increased and decreased from one survey year to the next. These cycles may be natural or may be determined by winter drawdowns.

As a shallow water resource, Mason Lake will always support plant growth throughout the lake. Two methods have been used in the past to manage the aquatic plant growth in Mason Lake:

Chemical treatments, 1972-82 and 1990-2005.

Chemicals have, over the years, been applied to almost the entire littoral zone and several channels across the lake.

The drawbacks of chemical treatments are:

1) they leave the plant material in the lake to decay, adding nutrients and fertile sediment for increased algae and plant growth
2) copper added to control the algae will build up in the sediment resulting in toxicity to portions of the aquatic food chain
3) broad-spectrum chemical used in 1972-2000 non-selectively killed all plant species, facilitating the spread of the exotic species
4) many invertebrates (food source for fish) are killed by aquatic herbicides

Winter drawdowns, 1988-1995 and 1998-2010

The winter drawdowns in Mason Lake were conducted by drawing the lake down 1.5-4 feet to control drawdown sensitive species like Eurasian watermilfoil. Drawdowns of 1.5 feet could provide control up to depths of 3 feet; drawdowns of 4 feet could potentially provide control up to depths of 5.5 feet.

The drawbacks of winter drawdowns are

1) they are only somewhat selective, controlling all species that are sensitive to winter drawdown
2) only impact plant species up to a depth of about 3-5.5 feet, depending on the depth of the drawdown

Changes in the aquatic plant community of Mason Lake, in 1992-2005:

1) There was an increase in coverage of vegetation in the 0-1.5 feet depth zone;
2) There was a slight decrease in overall coverage of the lake bed by aquatic plant growth. Although decreased vegetation is not always an improvement in a lakes ecosystem. Since plant coverage greater than 85% is not ideal for fish habitat, a decrease in vegetation can be an improvement in Mason Lake.
3) There was a slight decrease in coverage of submerged plant growth;
4) There was decreased total occurrence, but increased total density of plants;
5) The frequency, density and dominance of Eurasian watermilfoil and Curly-Leaf Pondweed have decreased since 1992, although they are elevated from 2005;
6) New invasive species have been found that have resulted in an increased frequency of occurrence of invasives in Mason Lake;
7) There was slight increase in the quality of the plant community as measured by the Aquatic Macrophyte Community Index (AMCI).
8) There was increased diversity in the plant community seen in increases of the Simpson's Diversity Index and Floristic Quality Index since 1992.
9) There were decreases in the Species Richness and Average Coefficient of Conservatism, suggesting that plants being found are tolerant of disturbance.
10) There was an increase in coverage of emergent species. These species offer valuable habitat species. The history of winter drawdowns may have allowed more effective seed germination on the mud flats.
11) The number of species that exhibited a dense form of growth decreased from 5 in 1992 to none in 2009.
12) There was an increase in the number of species present since 1992.

In 1998 and 1999, the impacts of winter drawdown were compared to the impacts of selective chemical treatments (Konkel 2002). Both winter drawdown and selective chemical treatments resulted in increased disturbance to the aquatic plant community (FQIndex). According to that WDNR report, the annual drawdowns had the following effects:

1) The winter drawdown resulted in a 3-14% decline in plant species diversity, but the selective chemical treatment resulted in a 30% decline in plant species diversity.
2) The winter drawdown resulted in a decrease in the two exotic species and the three duckweed species while the selective chemical treatment resulted in an increase of one of the exotic species (curly-leaf pondweed) and a decrease in the other exotic species (Eurasian watermilfoil).

In spite of the drawback to winter drawdowns, some improvements were seen in the aquatic plant community in Mason Lake in 1995, after seven years of winter drawdown. All of these improvements were reversed in the 1998 aquatic plant community after three years of no winter drawdowns (Konkel 2002).

Shoreline Impacts

Large areas of the shoreline on Mason lake is disturbed (cultivated lawn, rip-rap and hard structures). Disturbed shoreline occurred at more than half of the sites and covered approximately 45% of the shoreline, down slightly from 47% coverage of 2005. Cultivated lawn was the dominant shoreline cover and rip-rap and hard structures were common. These types of disturbed shoreline can result in degraded water quality through increased run-off carrying added nutrients from lawn chemicals, soil erosion and pet waste. Mowed lawn, rip-rap and hard structures speed run-off to the lake without filtering out nutrients and impurities as natural shoreline would. Natural shoreline, however, can help prevent shoreline erosion and reduce additional nutrient/chemical run-off that can add to algae growth and sedimentation of the lake bottom.

To determine if there was a difference in the aquatic plant community at the sites with lawn, the aquatic plant transect sites off sites with 100% natural shoreline were compared to aquatic plant transect sites off shoreline that contained any amount of lawn or other disturbance. The comparison of various parameters indicate that disturbance on the shore has negatively impacted the aquatic plant community at those sites. Most of the parameters discussed earlier for evaluating the quality of the aquatic plant community were higher at the undisturbed shores than at the few shores with disturbance (Figure 32). At the natural shores, there were higher: number of species; higher FQI; higher SI; higher average Coefficient of Conservatism; higher AMCI; and higher species richness overall and in all 3 depth zones.

Figure 32: Comparison of Natural & Disturbed Shores at Mason Lake 2009

	NATURAL		**DISTURBED**	
	Parameter	Value	Parameter	Value
AMCI				
rooting depth	7	3	7	3
% littoral zone vegetated	100	10	86.8	10
% submersed species	74	9	91	8
# taxa	20	9	15	7
% sensitive species	0	1	2	3
% exotic species	27	3	31	2
Simpson's Index	0.87	7	0.86	7
total		42		40
Floristic Quality Index		16.77		14.98
Average Coefficient of C		3.75		3.87
Simpson's Index		0.87		0.86
Species number		20		15
Species richness	overall	3.7		2.2
	Zone 1	5.9		3.2
	Zone 2	3.1		2.2
	Zone 3	1.6		1.2

V. CONCLUSIONS

Mason Lake is an eutrophic/hypereutrophic lake with poor to very poor water clarity and quality. Since 1986, nutrient levels in Mason Lake have increased and water clarity has decreased. The aquatic plant community characterized by fair diversity, low quality,

a high tolerance to disturbance, a condition far from an undisturbed condition and abundant growth distributed throughout the entire lake basin. Plant growth colonized over 86% of the shallow area (less than 5 feet deep).

Under the transect method, Coontail was the dominant aquatic plant species in 2009 and Eurasian watermilfoil was sub-dominant. Under the PI method in 2009 and 2010, the situation was reversed: Eurasian watermilfoil was dominant and Coontail was subdominant. In each instance, no other aquatic species came very close to these two plants in occurrence frequency and growth density.

Mason Lake will always be able to support abundant plant growth because of several factors that favor plant growth:

1) fertile organic sediments;
2) hard water;
3) more than adequate nutrients;
4) broad, gradually sloped littoral zone;
5) shallow lake basin.

The only variable is what kind of plant growth it will support - a healthy native plant community - or - a community dominated by nuisance growth of non-natives - or - a community of dense algae.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in: 1) improving water quality; 2) providing valuable habitat resources for fish and wildlife; 3) resisting invasions of non-native species; and 4) checking excessive growth of tolerant species that could crowd out the more sensitive species, thus reducing diversity.

Aquatic plant communities improve water quality in many ways (Engel 1985):

- they trap nutrients, debris, and pollutants entering a water body;
- they absorb and break down some pollutants;
- they reduce erosion by damping wave action and stabilizing shorelines and lake bottoms;
- they remove nutrients that would otherwise be available for algae blooms.

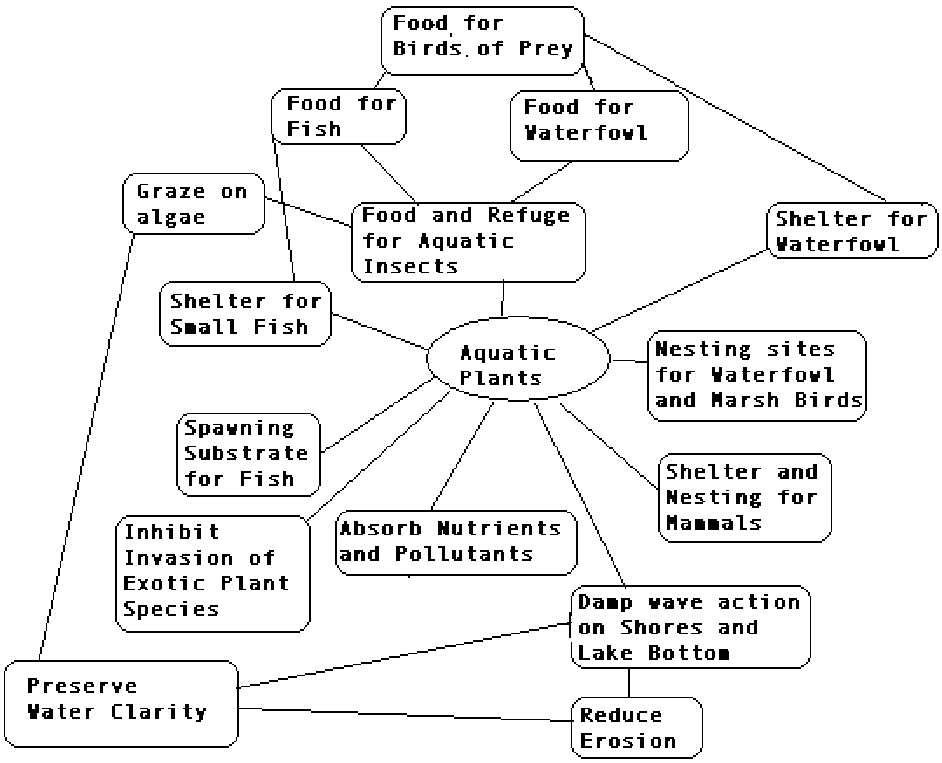


Figure 33: Ecological Web

Aquatic plant communities provide important fishery and wildlife resources. Plants and algae start the food chain that supports many levels of wildlife, and at the same time produce oxygen needed by animals. Plants are used as food, cover and nesting/spawning sites by a variety of wildlife and fish and are an essential part of the ecological web of a lake (Figure 33).

Lakes with diverse aquatic plant beds support larger, more diverse invertebrate populations that in turn support larger and more diverse fish and wildlife populations (Engel 1985). Additionally, mixed stands of aquatic plants support 3-8 times as many invertebrates and fish as monocultural stands (Engel 1990). Diversity in the plant community creates more microhabitats for the preferences of more species. Aquatic plant beds of moderate density support adequate numbers of small fish without restricting the movement of predatory fish (Engel 1990).

Three long-term invasives continue to be found at Mason Lake. Despite several chemical treatments and drawdowns, Mason Lake continues to have a significant population of Eurasian watermilfoil and showed an increase in occurrence frequency between 2005 and 2009, after a previous decline. It has also moved back into the shallow depths, where in 2005, it was found more in the deeper areas of the lake.

The invasive Curly-Leaf Pondweed decreased in frequency in 2009 (transect method) to 12.3% frequency of occurrence, down from the 2005 figure of 22.1%. However, it increased slightly in dominance in 2009 (transect). This invasive continues to be far less of a management problem that Eurasian watermilfoil.

Phalaris arundinacea (Reed Canarygrass), an invasive emergent, has increased slightly since 2005 to an occurrence frequency of 8.2% from 5.6%. Its dominance value increased slightly since 2005 (transect). It still has a frequency of occurrence of less than 9% and a low dominance value. The upsurge in the diversity of emergent plants at Mason Lake found in 2009 may help keep this invasive emergent from taking over.

Problematic, however, is the new presence of Brittle Nymph and Japanese Knotweed. Japanese Knotweed possesses the ability to spread drastically and crowd out all other vegetation in a waterbody shore. It already appears to have colonized one deep steep bank just below the dam and has moved from there to occupy almost an entire lot width on Mason Lake itself. At least there are other counties in Wisconsin to whom the Mason Lake District can get information on management of Japanese Knotweed. In the instance of Brittle Nymph, there are no developed recommendations in Wisconsin for management.

MANAGEMENT RECOMMENDATIONS

1) All lake residents should practice best management on their lake properties. Mason Lake is already on the impaired waterways list. A small increase in nutrients could push the lake past likely recovery, resulting in long-term worse water quality. Reducing nutrients would have a favorable impact on water quality.
   - Keep septic systems cleaned and in proper condition;
   - Use no lawn fertilizers;
   - Clean up pet wastes;
   - No composting should be done near the water nor should yard wastes nor clippings be allowed to enter the lake (Do not compost near the water or allow yard wastes and clippings to enter the lake)

2) Residents should be involved in the Citizen Lake Monitoring Program, monitoring water quality to track seasonal and year-to-year changes, as well as monitoring invasive species presence & distribution and Clean Boats, Clean Waters.

3) Now that various sensitive areas are designated, a map of these areas should be posted at the public boat ramp and a sign encouraging avoidance of disturbance to these areas should also be posted. Landowners on the lake should designate watch for disturbance of these areas and report any violations. These areas are very important for habitat and maintaining water quality and for preserving endangered and rare species.

4) The Mason Lake Association should start working with the Adams County Land & Water Conservation Department and the WDNR in the ongoing Eurasian Watermilfoil (EWM) and Curly-Leaf Pondweed (CLP) removal projects. These exotic species should be controlled. Initially, hand-pulling for Curly-Leaf Pondweed could be attempted, especially in high density areas, before it becomes fully established.

5) Drawdowns of the lake should only be done when needed. Annual drawdowns destabilize the littoral zone habitat.

6) Traditionally, the Mason Lake District has been unwilling to consider mechanical harvesting as part of its aquatic plant management, preferring to rely entirely on chemicals. Considering the apparent changes in distribution, especially of invasive aquatic species, and the already-high nutrient load in Mason Lake, mechanical harvesting should be pursued to decrease the EWM presence. However, navigation corridors should be monitored in case an increase in aquatic vegetation makes harvesting in those areas appropriate. A harvesting map could then be developed to identify the corridors to be cleared for boating access around the lake or management of aquatic invasive species.

7) Since the shore is so heavily developed, with several older cabins close to the water, installation of vegetative buffers and stormwater runoff management is essential. An increase in the depth of these buffer areas is recommended. 35 feet landward from shore should be the goal when possible.

8) A report from 1981 recommended that the Mason Lake District work with the Village of Briggsville to install a sewer system to reduce nutrient contributions from aging septic systems around the lake. Nearly 30 years later, no progress has been made. A survey of lakefront owners in 2005 showed that over 50% of the septic systems on Mason Lake were more than 10 years old. Due to a recent state law, Adams County will be establishing periodic inspections of septics in the county. However, a community sewage system with Briggsville might better serve the lake’s water quality than the current individual septic systems.

9) Steps should be taken to regulate boat speed in the shallow water areas to reduce disturbance to aquatic plants and the sediment.

10) The aquatic plant survey should be repeated in 3 to 5 years in order to continue to track any changes in the community and the lake's overall health.

11) The aquatic plant community has decreased drastically since 2005, when aquatic plants covered over 90% of the lake and many species occurred in more than average density of growth. While that situation was not ideal, the crash in plant coverage suggests a significant change in the lake's ecosystem. It would be appropriate to conduct some studies to attempt to determine what is causing this change, such as

- A population study of the carp presence, since recent research has suggested that a large carp presence in a shallow lake causes a reduction in the aquatic plant community occurrence and diversity;
- An inventory of the watershed to look at potential nutrient sources ending up in the lake;
- Water quality monitoring of the creeks entering the lake to determine their contribution to the lake's nutrient loading;
- Sediment testing to help determine internal loading;
- Besides the general citizen monitoring for water clarity, total phosphorus and chlorophyll-a, additional monitoring for dissolved oxygen and nitrogen levels might also be appropriate.

12) Adams County Land & Water Conservation Department will inventory the watershed lands to map bank erosion, buffer locations, inadequate ditches and buffers, non-point pollution, stormwater runoff, and to identify sites not in compliance with Wisconsin Agricultural Performance Standards and county ordinances. This inventory will also look at documented wetlands to determine what sites might need maintenance, restoration or enhancement practices to be fully functioning.

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