Changes in the Aquatic Plant Community of Mason Lake, Adams County, Wisconsin

1988-2005

Wisconsin Department of Natural Resources
Eau Claire, WI
June 2006

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Submitted by:

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Executive Summary

Mason Lake is a eutrophic/hypereutrophic lake with very poor water clarity and quality. Since 1986, nutrients in Mason Lake have increased and water clarity has decreased. Filamentous algae has increased dramatically and occurred at nearly all sites.

The aquatic plant community characterized by good 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 82% of the entire lake basin and 91% of the shallow area. Coontail was the dominant aquatic plant species in 2005, especially in the shallowest and deepest depth zones. Eurasian watermilfoil was sub-dominant.

As a fertile shallow water resource, Mason Lake will always be able to support abundant plant growth. 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.

The aquatic plant community has changed significantly in Mason Lake between 1992 and 2005. The two non-native species, Eurasian water milfoil and curly-leaf pondweed have declined, total occurrence and total density of plant growth has decreased, coverage of aquatic plants in the 0-5ft depth zones has decreased, total area of plant growth declined, the diversity of plants increased and the number of species exhibiting a dense growth form have decreased

Recommendations

1) Lake District shall continue winter drawdowns on a decreased frequency of drawdown.
2) Lake District shall decrease frequency of winter drawdowns to once every 3 to 5 years to prevent increased abundance of drawdown tolerant species being favored by annual drawdowns.
3) Lake District and residents shall limit broad spectrum chemical treatments.
4) Lake District shall start a harvesting program that targets the exotic species.
5) Lake residents shall establish a natural buffer zone of native vegetation around Mason Lake. There is too much cultivated lawn, rip-rap and hard surfaces that are impacting the habitat in the lake.
    a) Disturbed shore communities support a less diverse plant community that will support a less diverse fish and wildlife community.
    b) Disturbed shoreline supports much less emergent plant growth which is an important component for wildilfe and fish habitat.
    c) Disturbed shore supported a higher frequency and density of Eurasian watermilfoil, providing a more ideal condition for its growth.
6) Lake District should promote preservation and enhancement of wetlands in and around Mason Lake.
7) Lake District should cooperate with efforts in the watershed to reduce nutrient and toxic run-off.

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I. INTRODUCTION

Studies of the aquatic plants (macrophytes) in Mason Lake were conducted in 1988, June/July 1992 and August 1995 by Water Resource Staff of the North-Central District - Department of Natural Resources (DNR). Using the same methods and sample sites, studies of the aquatic plants were conducted during June and August of 1998 and 1999 and June 2001 and 2005 by Water Resource staff of the West-Central Region - DNR.

The surveys were conducted as part of a 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.

Background & History

Mason Lake is a 855-acre impoundment on the South Branch of Neenah Creek, in Adams 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.

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 (Table 1),

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.

Table 1. Recorded Chemical Treatments in Mason Lake, 1972-2005.

	$CuSO_4$ (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#
2005			86.5 gal		360gal
Totals	7235 lbs.	96gal.	457.25 gal. & 90 lbs (128gal. H)	510gal.	6458 lbs. 688 gal.

* H = Hydrothol formulation of endothall more damaging to young fish

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 (Table 2). 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 1998-2005 (Table 2).

Table 2. Winter Drawdowns on Mason Lake

	Winter	**Depth of Drawdown**
Two-year Permit	1988-1989	5 Feet
	1989-90	4 Feet
Five-year Permit	1990-91	4 Feet
	1991-92	4 Feet
	1992-93	4 Feet
	1993-94	4 Feet
	1994-95	4 Feet
Two-year Permit	1998-99	1.5 Feet
	1999-2000	1.5 Feet
Five-year Permit	2000-2001	1.5 Feet
	2001-2002	3.0 Feet
	2002-2003	3.0 Feet
	2003-2004	3.0 Feet
	2004-2005	3.0 Feet

After 6 years of annual winter drawdowns, *Potamogeton pectinatus* appeared to be becoming more abundant in the shallow areas. *P. pectinatus* tolerates winter drawdown and 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 species tolerant of drawdown.

II. METHODS

Field Methods

The same study design was used for the 1992, 1995, 1998, 1999, 2001 and 2005 plant studies and was based on the rake-sampling method developed by Jessen and Lound (1962). Twenty-six equal-distance transect lines were placed perpendicular to the shoreline with the first transect being randomly placed. These transects were mapped to be used in all aquatic plant surveys (Appendix XIII).

One sampling site was randomly located in each depth zone (0-1.5ft., 1.5-5ft., and 5-10ft.) along each transect. Using a long-handled steel thatching rake, four rake samples were taken at each sampling site. The four samples were taken at each quarter of a 6-foot square quadrat. The species recorded include aquatic vascular plants and algae that have morphologies similar to vascular plants, such as muskgrass and nitella. 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.

A rating of 1 if present on one rake sample at that sampling site;
A rating of 2 if present on two rake samples;
A rating of 3 if present on three rake samples;
A rating of 4 if present on four rake samples;
A rating of 5 if was abundant on all rake samples at that sampling site.

The presence of filamentous algae was recorded at each site. The sediment type at each sampling site was recorded. Visual inspection and periodic samples were taken between transect lines in order to record the presence of any species that did not occur at the sampling sites. Specimens of all plants 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 either side of the transect intercept with the shore and 30 feet back from the shore was evaluated. The percentage of each cover type within this 100 ft. X 30 ft. rectangle was assessed and verified by a second researcher.

Data Analysis

The data for each year was analyzed separately and compared. The frequency of occurrence of each species was calculated (number of sampling sites at which it occurred/total number of sampling sites) (Appendices I-IV). Relative frequency was calculated (number of occurrences of a species/sum of all species occurrences) (Appendices I-IV). The mean density was calculated for each species (sum of a species' density ratings/number of sampling sites) (Appendices V-VIII). Relative density was calculated (sum of a species density / sum of all plant densities) (Appendices V-VIII). “Mean density where present” was calculated for each species (sum of a species' density ratings/number of sampling sites at which it occurred) (Appendices V-VIII). The relative frequency and relative density of each species were summed to obtain a Dominance Value (Appendices IX-XII). Simpson's Diversity Indices (1-sum(relative frequencies)^2) were calculated for each sampling year (Appendices I-IV). Sampling years were compared by Coefficients of Community Similarity.

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 Average 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 factors impact the aquatic plant community. Water quality (nutrient concentration, algal concentration, clarity, hardness) can influence the plant community as the plant community can in turn modify these parameters. Lake morphology, sediment composition and shore land use also impact the plant community.

Water Quality - The trophic state of a lake is an indication of its water quality. Phosphorus concentration, chlorophyll concentration and water clarity data are combined to determine the trophic state.

Oligotrophic lakes are low in nutrients and support limited plant growth and smaller populations of fish.

Eutrophic lakes are high in nutrients and therefore support a large biomass.

Mesotrophic lakes have intermediate levels of nutrients and biomass.

Water quality monitoring has been conducted by both the DNR and Adams County Land Conservation staff.

Nutrients

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

2005 Summer Mean phosphorus was 93ug/l.

Phosphorus concentrations in Mason Lake, 2005, was in the eutrophic range (Table 3).

Table 3. Trophic Status, 2005

	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 – Adams County data - 2005	Very Poor	**93**	**36**	**2.55** (2004 data)

After Lillie & Mason (1983) & Shaw et. al. (1993)

Phosphorus concentrations in Mason Lake have varied, but have remained in the eutrophic range during 1986-2005 (Figure 1). The lowest phosphorus levels were in 1998 and highest in 2001. Phosphorus has increased slightly in Mason Lake since 1986 (Figure 1).

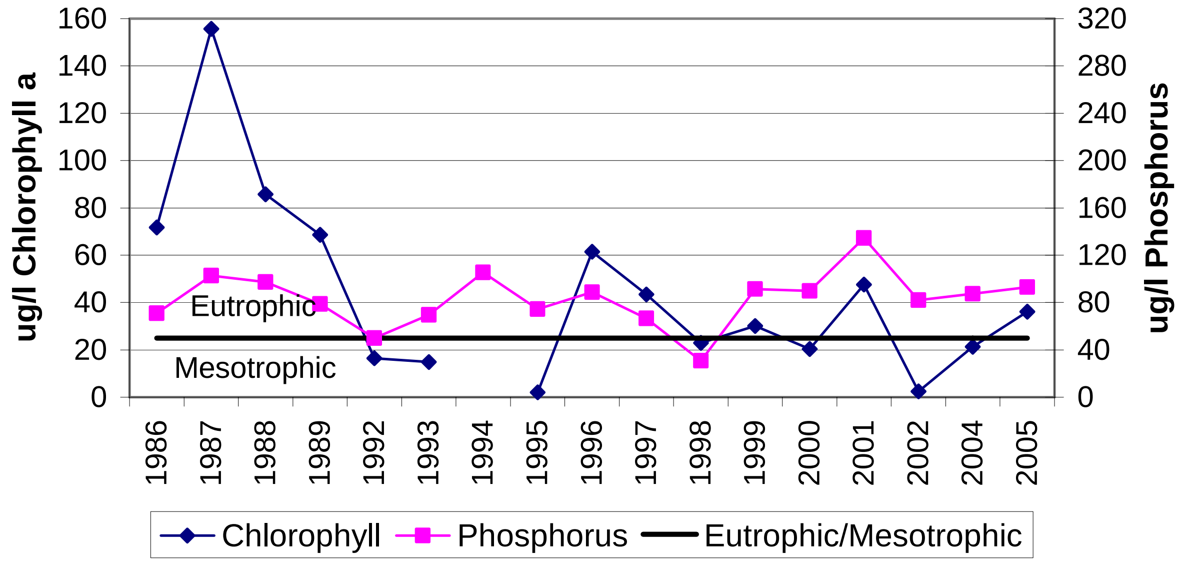


Figure 1. Summer Mean phosphorus and chlorophyll in Mason Lake, 1986-2005.

Algae

Measuring chlorophyll in a lake indicates algae concentrations. Algae is natural and essential in the lake ecosystem, but high algae concentrations decrease water clarity and reduce light availability for aquatic plant growth.

2005 Summer Mean Chlorophyll a was 36ug/l.

The chlorophyll concentrations indicate that Mason Lake in the hypereutrophic range (Table 3).

Chlorophyll concentrations have also remained in the eutrophic range during 1986-2005 (Figure 1). The rise and fall of chlorophyll concentrations have followed the change in phosphorus levels as the algae used the available nutrients to reproduce (Figure 1). However, the variations in chlorophyll concentrations were more extreme than variations in phosphorus concentrations. Other factors such as weather conditions will influence algae growth. There was an extremely high spike in chlorophyll in 1987; the lowest concentrations of chlorophyll were recorded in 2002. Chlorophyll has decreased since 1986 (Figure 1).

The occurrence of filamentous algae was not recorded in 1988 or 1995. Its frequency in June was:

24% in 1992
51% in 1998
49% in 2001
96% in 2005

The frequency of occurrence of filamentous algae has increased dramatically since 1992 and is high in all depth zones (Figure 2).

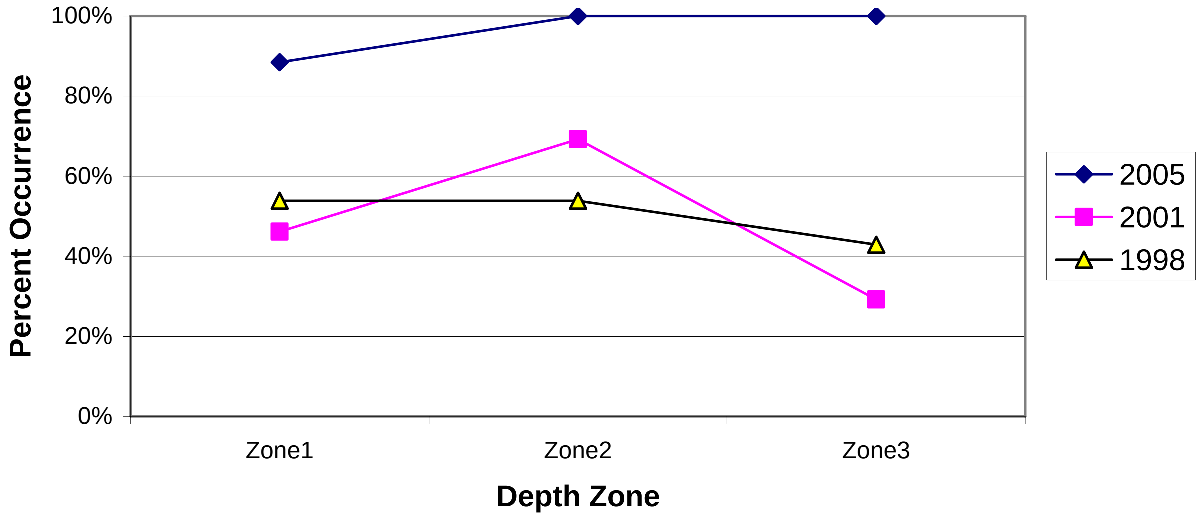


Figure 2. Occurrence of filamentous algae by depth zone in Mason Lake, 2001-2005.

Water clarity

Water clarity is a critical factor for aquatic plant growth. When plants receive less than 1-2% of the surface illumination, they can not survive. Water clarity is reduced by dissolved organic chemicals that color the water and suspended materials such as algae and silt. Water clarity is measured with a Secchi Disc that measures the combined effect of color and suspended materials.

2004 Summer mean Secchi Disc water clarity was 2.55 feet.

The water clarity indicates that Mason Lake is a hypereutrophic lake with very poor water clarity (Table 3).

Mean summer water clarity in Mason Lake has ranged from less than 2 feet in 1987 and 1999 to more than 7 feet in 1992 (Figure 3). Trend analysis indicates that overall, water clarity in Mason Lake has been declining slightly since 1986 (Figure 3).

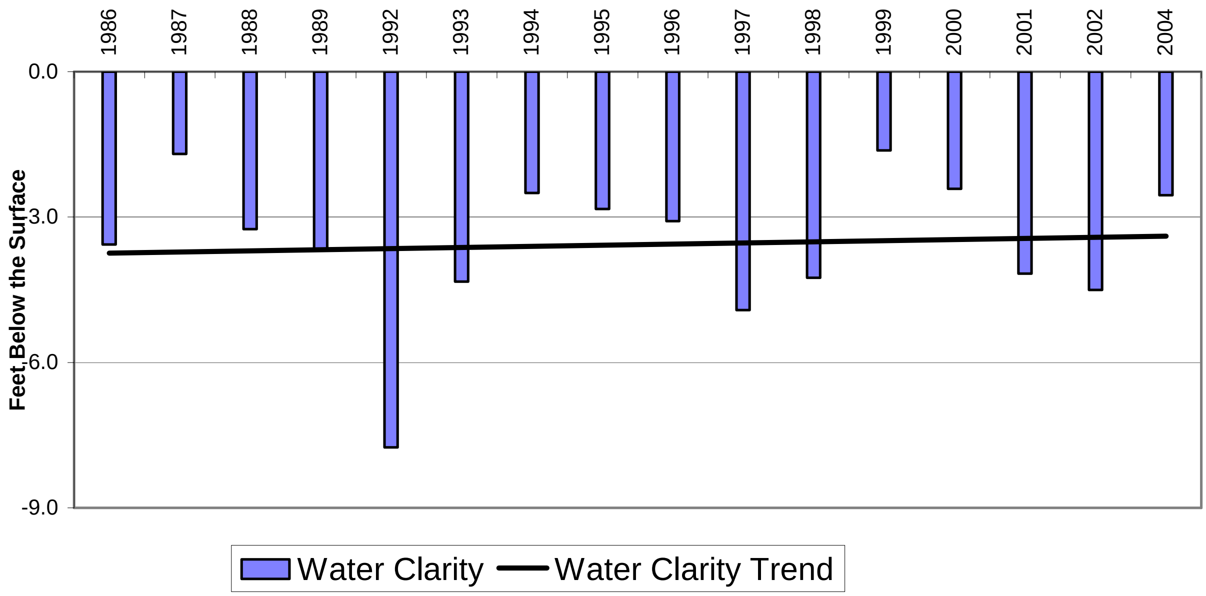


Figure 3. Water clarity in Mason Lake, 1986-2004.

The combination of phosphorus, chlorophyll and clarity data indicate that Mason lake is eutrophic/hypereutrophic lake with poor-to-very poor water quality. The trophic stat would support abundant plant growth and frequent and severe algae blooms.

Hardness

Hardness in Mason Lake varied between 72-189mg/l $CaCO_3$. Water in the range of 121-180mg/l $CaCO_3$ is considered hard. Hard water lakes support more plant growth than soft water lakes.

Lake Morphometry

The morphometry of a lake is an important factor in analyzing the distribution of aquatic plants. Duarte and Kalff (1986) found that the slope of the littoral zone accounted for 72% of the observed variability in the growth of submergent vegetation. Gentle slopes support a broader zone of potential plant growth than steep slopes.

The littoral zone is very gradually sloped in Mason Lake and the shallow basin provides light availability to nearly the entire lake (Appendix XIII). This condition would favor aquatic plant growth over the entire basin.

Sediment Composition

Many aquatic plant species depend on the sediment for required nutrients. The richness or sterility, the hardness and the texture of the sediments can determine the type and abundance of species that can survive in a location.

Organic muck sediment was the dominant sediment in Mason Lake, especially at depths greater than 5 feet (Table 4) (Figure 4). Muck mixed with silt was common at depths of 1.5-5 feet; silt sediment was common at depths of 5-10 feet.

Sand sediments were also commonly occurring, abundant at depths less than 5 feet (Table 4).

Table 4. Composition of the Sediments in Mason Lake: 2005

		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%

The availability of mineral nutrients for plant growth is highest in sediments of intermediate density such as silt, making it most favorable for plant growth (Barko and Smart 1986). Sand and rock sediments are high-density sediments and may be limiting to aquatic plant growth due to lower nutrient availability.

All sediment types supported a high percentage of vegetation in Mason Lake (Table 5), although high density sand and sand/gravel sediments supported the least amount of vegetation.

Table 5. Influence of Sediment type on Plant Growth

		Percent Vegetated	Overall Occurrence
Soft Sediments	**Muck**	100%	31%
	Silt	100%	11%
	Silt/Muck	100%	9%
Mixed Sediments	**Sand/Muck**	100%	8%
	Sand/Silt	100%	4%
Hard Sediments	**Sand**	78%	25%
	Sand/Gravel	40%	7%
	Gravel	100%	3%
	Rock/Gravel	100%	3%

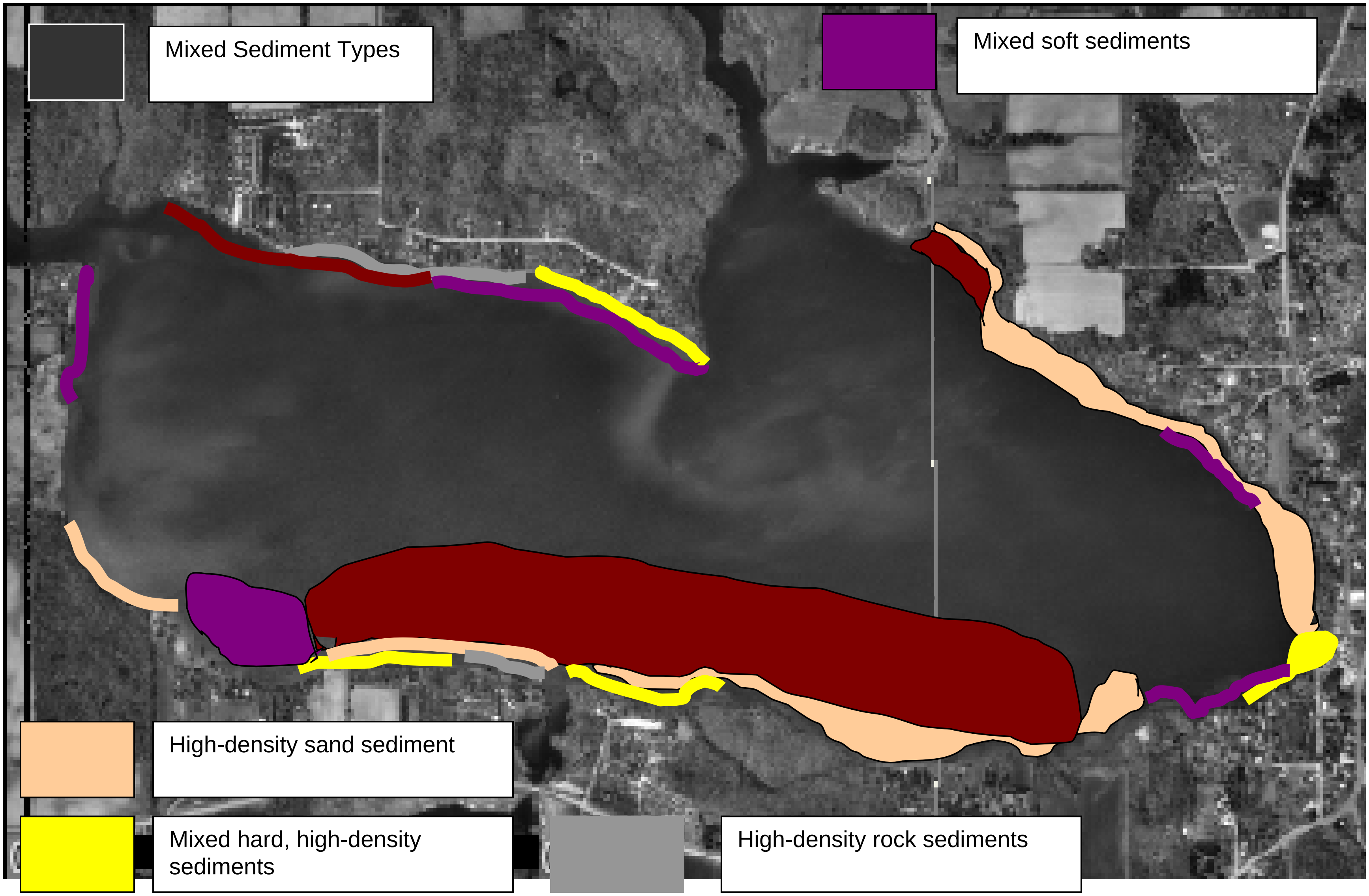


Figure 4. Sediment distribution in Mason Lake, 2005

Shoreline Land Use

Land use activities on shore can directly impact the plant community through increased sedimentation from erosion, increased nutrient input from fertilizer run-off and erosion and increased toxics from farm and urban run-off.

Cultivated lawn and native herbaceous growth were the most frequently encountered land use types at the shore. Lawn had the highest mean coverage (Table 6). Rip-rap and hard pavement were other commonly encountered disturbed shoreline land uses.

Native herbaceous cover, wooded cover and shrub cover were commonly encountered natural shoreline types; wooded cover had a fairly high mean coverage (Table 6).

Table 6. Shoreline Land Use, Mason Lake 2005

	Cover Type	Frequency of Occurrence	Mean Coverage
Disturbed Shoreline	**Cultivated lawn**	**61%**	**34%**
	Rip-rap	**35%**	**6%**
	Hard Structure	**38%**	**6%**
	Pavement	**4%**	**1%**
Total Disturbed			**47%**
Natural Shoreline	**Native Herbaceous**	**65%**	**16%**
	Wooded	**46%**	**29%**
	Shrub	**42%**	**6%**
	Rock	**12%**	**1%**
Total Natural			**52%**

Some type of natural shoreline occurred at 81% of the sites and covered approximately 52% of the shore. Some type of disturbed shoreline occurred at 69% of the sites and covered 47% of the shore.

<u>MACROPHYTE DATA</u>

SPECIES PRESENT

A total of 36 different species of aquatic plants were found during the 1988-2005 studies: 15 emergents species, 5 floating leaf species, and 16 submergent species (Table 7).

No endangered of threatened species were found.

Two non-native species were found:

Myriophyllum spicatum (Eurasian water milfoil)
Potamogeton crispus (curly-leaf pondweed)

Table 7. Mason Lake Aquatic Plant Species, 1988-2005

Scientific Name	Common Name	I.D. Code
Emergent Species		
1) *Asclepias incarnata* L.	swamp milkweed	ascin
2) *Bidens connata* Muhl.	purplestem beggar-tick	bidco
3) *Carex* spp.	sedge	carsp
4) *Cornus sericeus* L.	red-osier dogwood	corse
5) *Decodon verticillatus* (L.) Elliott.	water willow	decve
6) *Echinochloa walteri* (Pursh) Heller.	wild millet	echwa
7) *Eleocharis palustris* L.	creeping spikerush	elepa
8) *Impatiens capensis* Meeb.	orange jewelweed	impca
9) *Iris versicolor* L.	northern blue flag	irive
10) *Phalaris arundinacea* L.	reed canary grass	phaar
11) *Polygonum amphibium* L.	water smartweed	polam
12) *Sagittaria latifolia* Willd.	common arrowhead	sagla
13) *Scirpus validus* Vahl.	softstem bulrush	sciva
14) *Sparganium eurycarpum* Engelm.	giant bur-reed	spaeu
15) *Typha angustifolia* L.	narrow-leaf cattail	typan
Floating leaf Species		
16) *Lemna minor* L.	small duckweed	lemmi
17) *Nuphar variegata* Durand.	bull-head pond lily	nupva
18) *Nymphaea odorata* Aiton.	white water lily	nymod
19) *Spirodela polyrhiza* (L.) Schleiden.	great duckweed	spipo
20) *Wolffia columbiana* Karsten.	common watermeal	wolco
Submergent Species		
21) *Ceratophyllum demersum* L.	coontail	cerde
22) *Chara* sp.	muskgrass	chasp
23) *Elodea canadensis* Michx.	common waterweed	eloca
24) *Myriophyllum sibiricum* Komarov.	common water milfoil	myrsi
25) *Myriophyllum spicatum* L.	Eurasian watermilfoil	myrsp
26) *Najas flexilis* (Willd.) Rostkov & Schmidt.	slender naiad	najfl
27) *Potamogeton amplifolius* Tuckerman.	large-leaf pondweed	potam
28) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
29) *Potamogeton foliosus* Raf.	leafy pondweed	potfo
30) *Potamogeton nodosus* Poiret.	long-leaf pondweed	potno
31) *Potamogeton pectinatus* L.	sago pondweed	potpe
32) *Potamogeton praelongus* Wulf.	whitestem pondweed	potpr
33) *Potamogeton pusillus* L.	slender pondweed	potpu
34) *Potamogeton richardsonii*	clasping-leaf pondweed	potri
35) *Ranunculus longirostris* Gordon.	white water-crowfoot	ranlo
36) *Zosterella dubia* (Jacq.) Small.	water stargrass	zosdu

FREQUENCY OF OCCURRENCE

The 1988 data can not be compared to later data, since only 6 species were recorded in 1988 and no distinction was made between native watermilfoil and Eurasian watermilfoil. The sampling effort was likely not as rigorous.

Myriophyllum spicatum (Eurasian watermilfoil) was the most frequently occurring species in 1992. Its frequency declined in 1998, then increased to the most frequent again in 2001, along with *Potamogeton crispus,* and declined again in 2005 (Table 8). When *M. spicatum* declined, *C. demersum* became the most frequent species in 1995 and 1998 (Table 8).

Table 8. Frequencies of Prevalent Aquatic Plants in Mason Lake, June 1992-2005.

Species	**1992**	**1998**	**2001**	**2005**
Ceratophyllum demersum	62%	**75%**	41%	**65%**
Chara spp.	0	12%	8%	36%
Elodea canadensis	3%	12%	24%	28%
Myriophyllum sibiricum	18%	18%	32%	31%
Myriophyllum spicatum	**92%**	66%	**78%**	43%
Najas flexilis	36%	7%	18%	9%
Potamogeton crispus	22%	73%	**78%**	20%
Potamogeton pectinatus	17%	23%	5%	20%
Potamogeton zosteriformis	32%	0%	1%	0%

DENSITY

Myriophyllum spicatum (Eurasian watermilfoil) had the highest mean density in 1992 (Table 9). When the density of *M. spicatum* declined in 1998, *Potamogeton crispus* (curly-leaf pondweed) had the highest mean density. The density of *M. spicatum* increased again by 2001 to its highest. In 2005, *M. spicatum* declined again and *Ceratophyllum demersum* was the species with the highest mean density (Table 9).

Table 9. Mean Densities of Prevalent Plant Species in Mason Lake 1992-2005.

Species	1992	1998	2001	2005
Ceratophyllum demersum	2.32	1.82	0.75	**1.60**
Chara spp.	0	0.34	0.20	0.87
Elodea canadensis	0.03	0.19	0.45	0.51
Myriophyllum sibiricum	0.37	0.48	0.42	0.55
Myriophyllum spicatum	**3.34**	1.79	**2.46**	0.96
Najas flexilis	1.07	0.07	0.42	0.17
Potamogeton crispus	0.47	**2.00**	2.09	0.27
Potamogeton pectinatus	0.51	0.52	0.09	0.49
Potamogeton zosteriformis	0.83	0	0.01	0

The "mean density where present" measures the aggregation or density of growth form of a species. For the first time in 2005, no species exhibited a growth form of above average density in Mason Lake (Appendices V-VIII). In previous years, *Certophyllum demersum, Chara* spp., *Lemna minor, Myriophyllum sibiricum, M. spicatum, Najas flexilis, Potamogeton crispus, P. pectinatus* and *P. zosteriformis* had exhibited dense growth forms in some years.

DOMINANCE

Combining the relative frequency and relative density of a species into a Dominance Value indicates how dominant a species is in the community. *Myriophyllum spicatum* (Eurasian watermilfoil) was the dominant species in 1992 with *Ceratophyllum demersum* as sub-dominant (Figure 5). In 1998, *Potamogeton crispus* was co-dominant with *C. demersum*. In 2001, *Myriophyllum spicatum* (Eurasian watermilfoil) again became the dominant with *P. crispus* as sub-dominant. In 2005, *C. demersum* was again the dominant species with *M. spicatum* the sub-dominant (Figure 5).

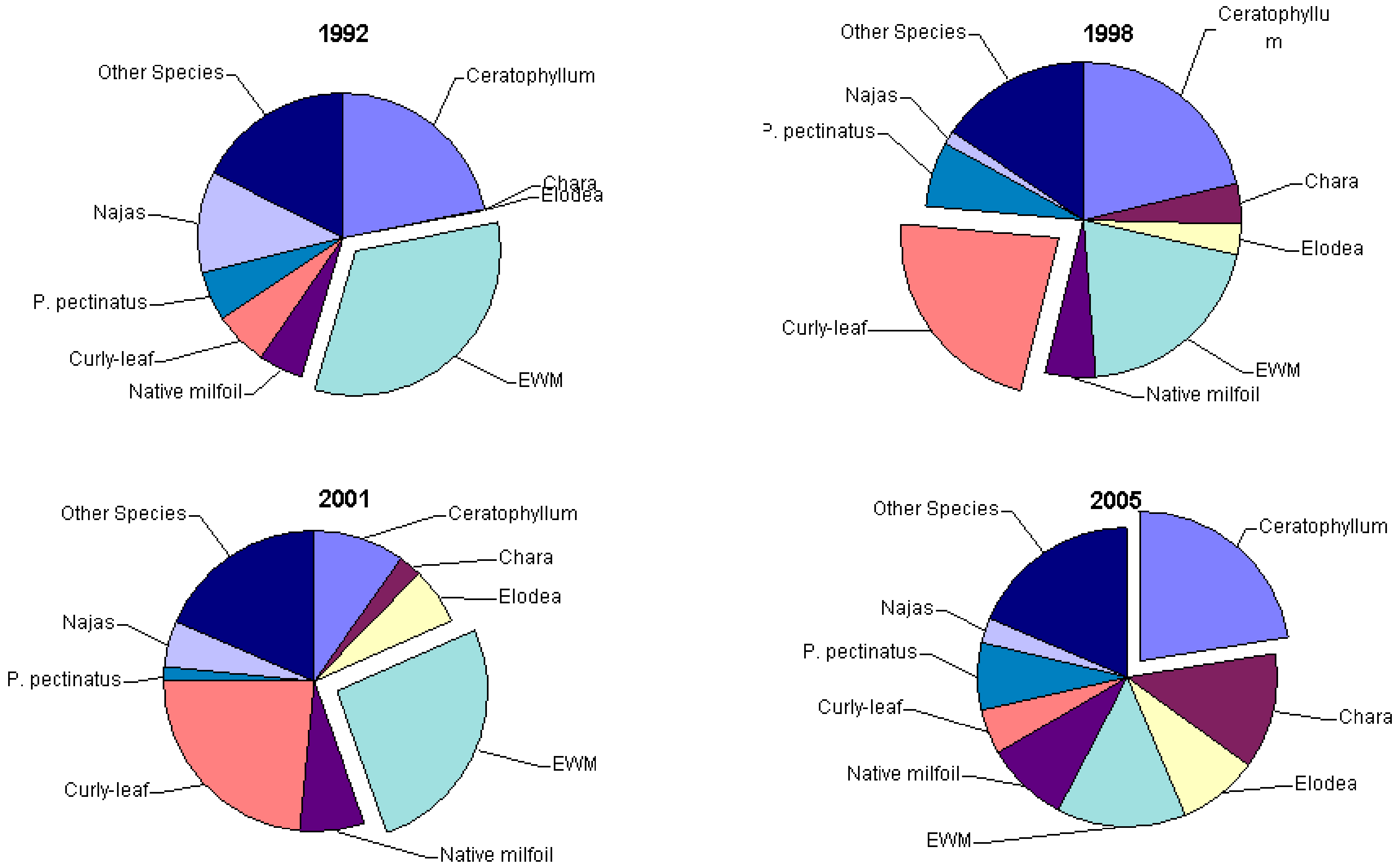


Figure 5. Dominance of prevalent aquatic plant species in Mason Lake, June 1992-2005

DISTRIBUTION

Aquatic plants occur throughout Mason Lake, colonizing 700-acres (82%) of the lake (Figure 6); 91% of the sites.

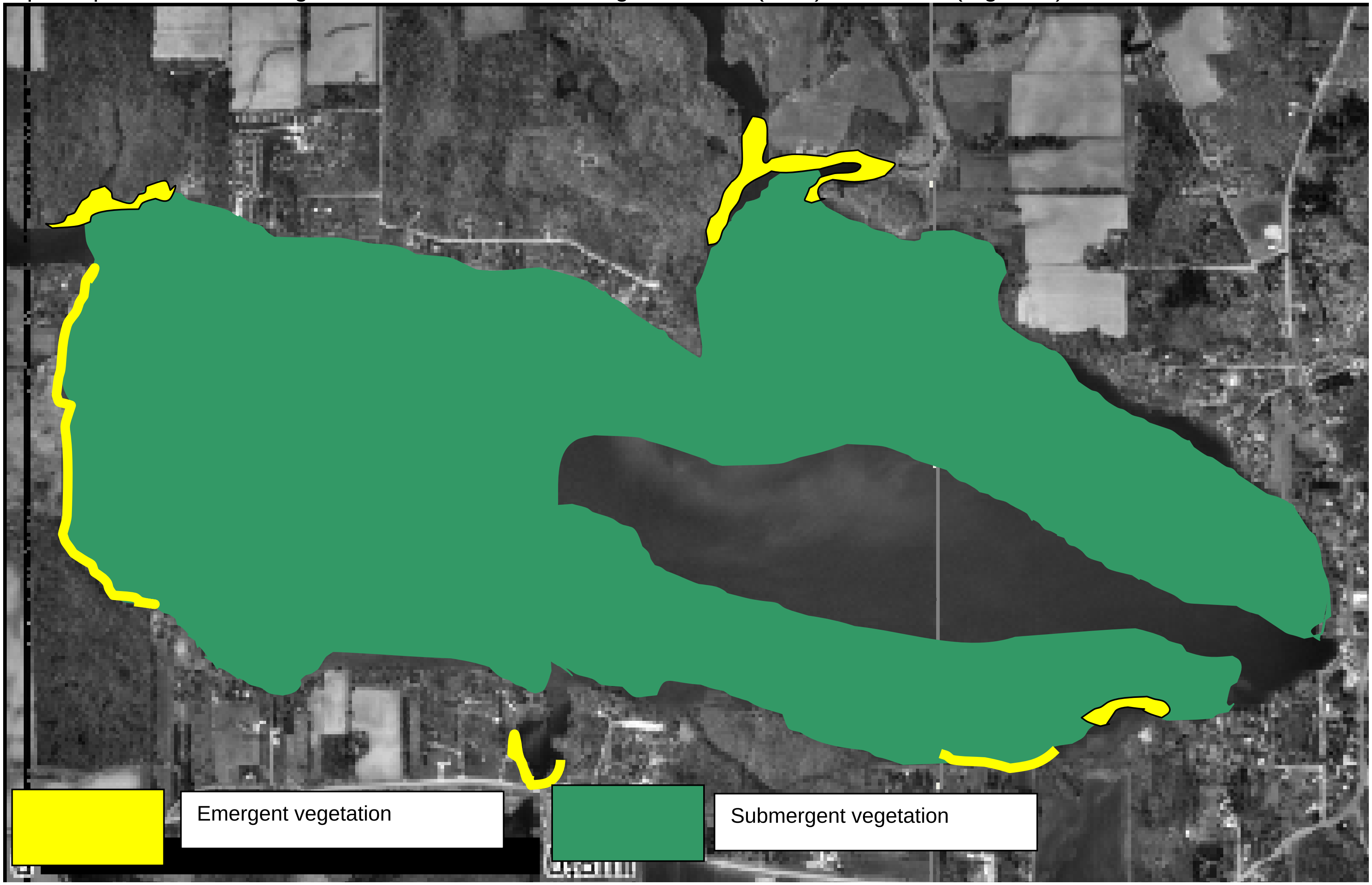


Figure 6. Distribution of aquatic vegetation in Mason Lake, June 2005.

The percentage of vegetated sites has been high in all depth zones and all years (Figure 7). The highest percentage of vegetated sites was in 1992, the lowest in 2005.

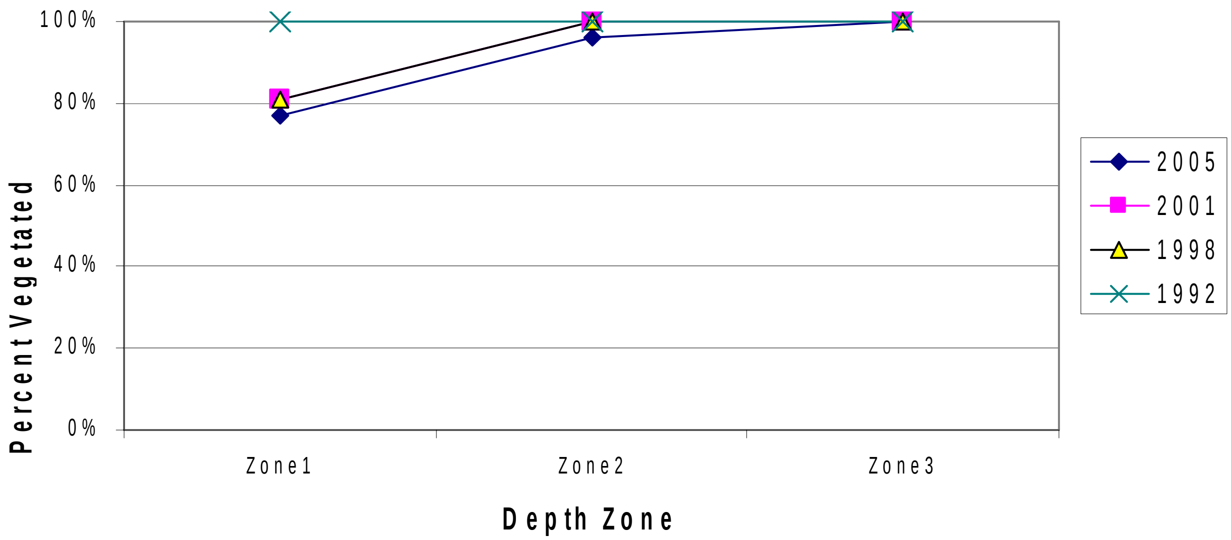


Figure 7. Percentage of the littoral zone vegetated by depth zone in Mason Lake, 1992-2005.

The highest total occurrence of aquatic plant growth was in 2001; the lowest total occurrence was in 1992 and 2005 (Figure 8). The depth zone with the highest total occurrence of plants has been the 1.5-5 ft. depth zone. Total occurrence of plants has been very similar over the years.

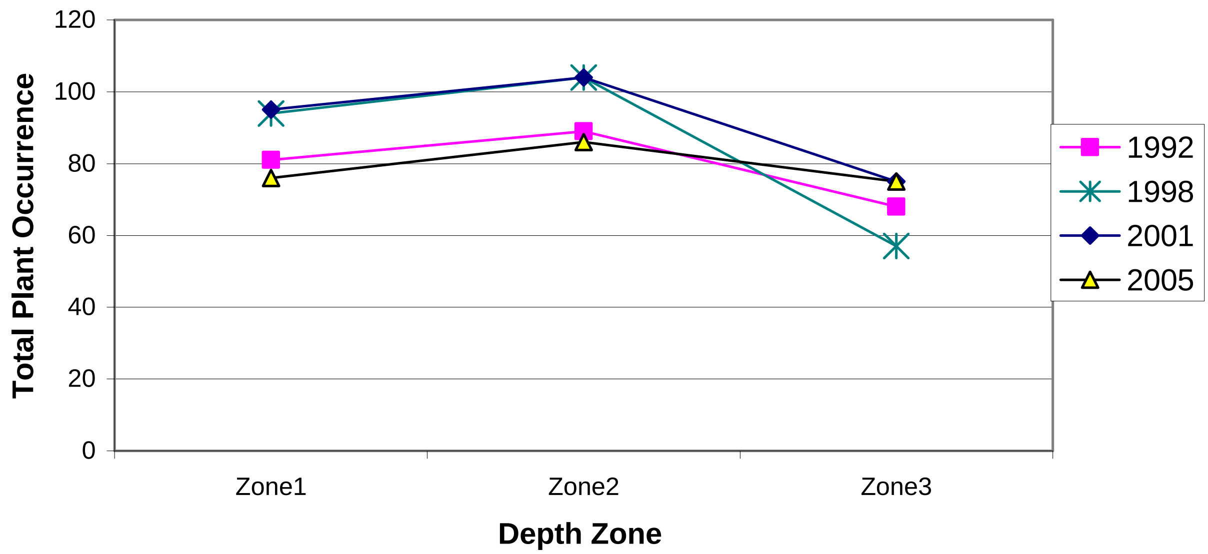


Figure 8. Total occurrence of aquatic plants in Mason Lake, by depth zone, 1992-2005.

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

The predicted maximum rooting depth varies with the water clarity, but in most years would extend to nearly the deepest part of the lake (Figure 9). This verifies that Mason Lake has the potential to support aquatic plant growth over the entire basin in most years.

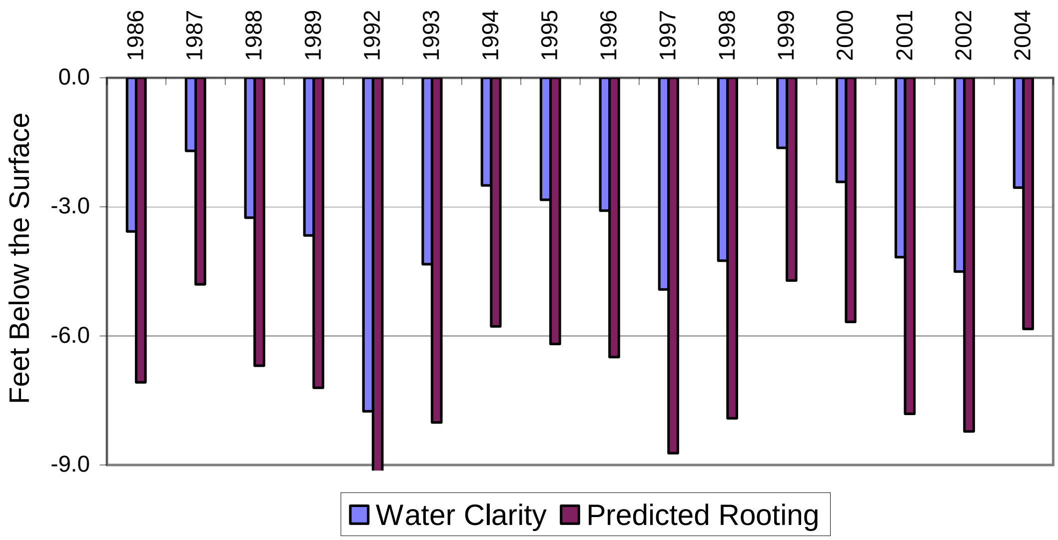


Figure 9. Predicted Maximum Rooting Depth in Mason Lake, 1986-2004.

Myriophyllum spicatum (Eurasian watermilfoil) was the dominant species in 1992 and dominated at depths greater than 1.5 feet (Figure 10, 11). *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 (Figure 10, 11). The frequency and density of *M. spicatum* has increased with increasing depth and may likely be due to the winter drawdowns that control this species in the shallow water areas.

In June 2005, Eurasian watermilfoil colonized approximately 550 acres of Mason Lake, 65% of the lake (Figure 12).

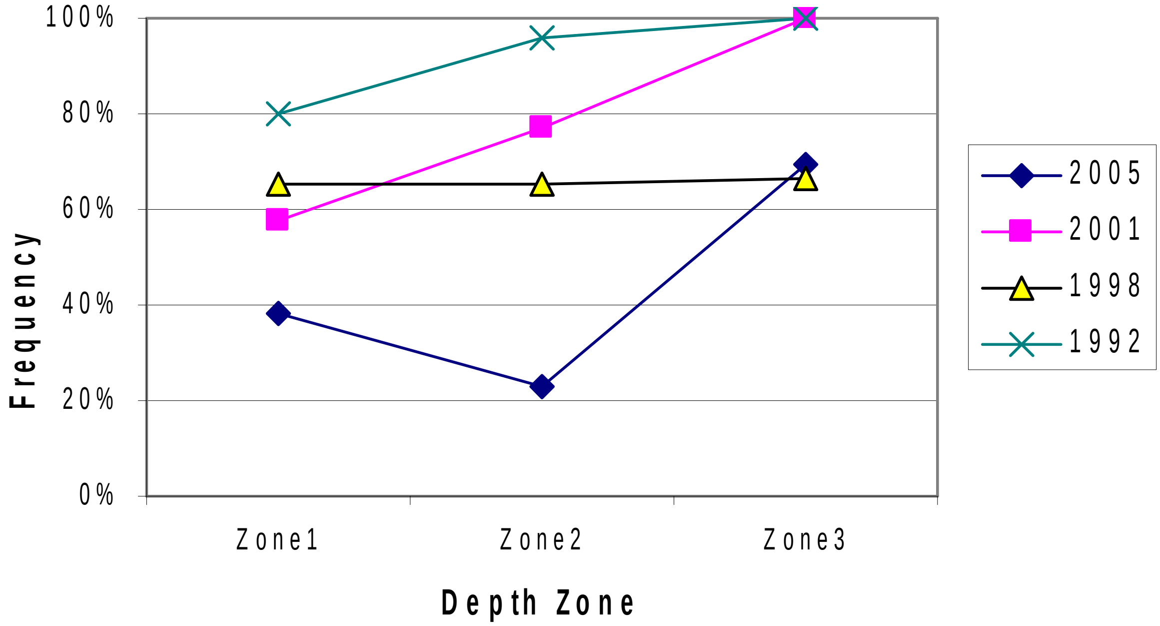


Figure 10. Frequency of occurrence of Eurasian watermilfoil, by depth zone, 1992-2005.

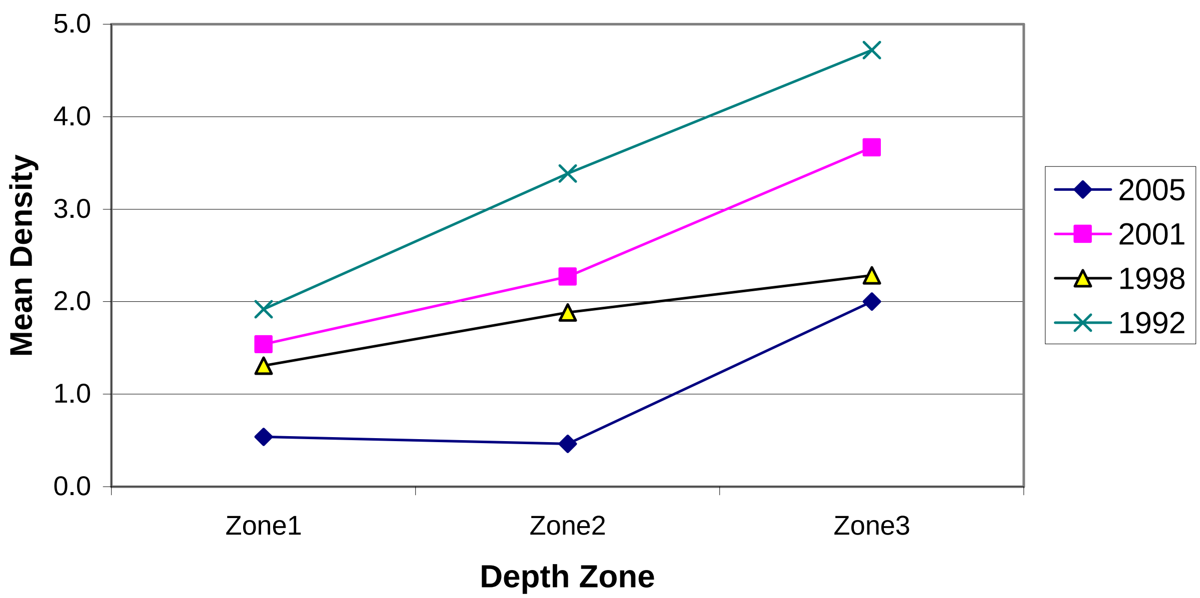


Figure 11. Mean density of Eurasian watermilfoil, by depth zone, 1992-2005.

Figure 12. Eurasian watermilfoil distribution in Mason Lake, June 2005.

Potamogeton crispus (curly-leaf pondweed) became the dominant species in 1998 when Eurasain watermilfoil, which had been dominant in 1992, declined. *P. crispus* dominated the 1.5-5ft depth zone (Figure 13, 14).

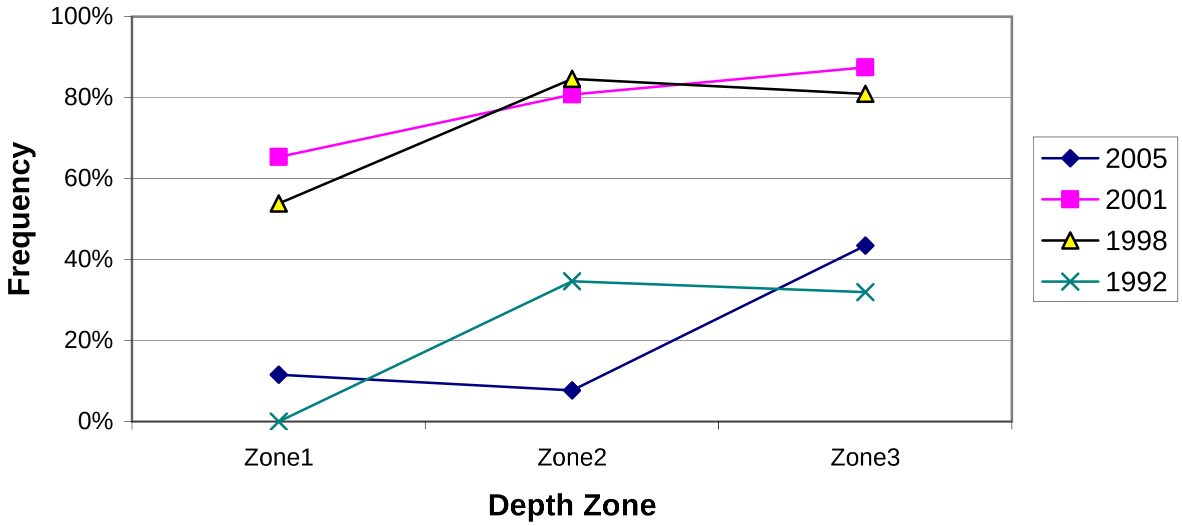


Figure 13. Frequency of occurrence of curly-leaf pondweed, by depth zone, 1992-2005.

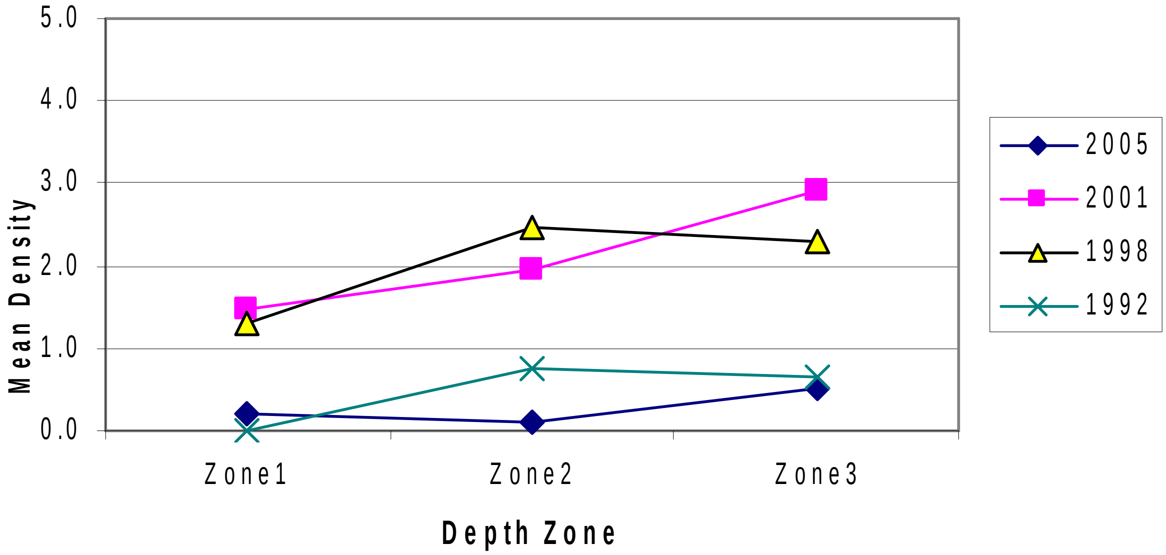


Figure 14. Mean density of curly-leaf pondweed, by depth zone, 1992-2005.

Curly-leaf pondweed colonized approximately 240 acres in Mason Lake, 28% of the lake in June 2005 (Figure 15).

Figure 15. Distribution of curly-leaf pondweed in Mason Lake, June 2005.

Potamogeton pectinatus (sago pondweed) appears to be increasing in abundance in Lake Mason, perhaps favored by the winter drawdowns. The frequency and density of *P. pectinatus* have increased and decreased from one survey year to the next, with an increase in 2005 (Figure 16, 17). These cycles may be natural or may be determined by winter drawdowns.

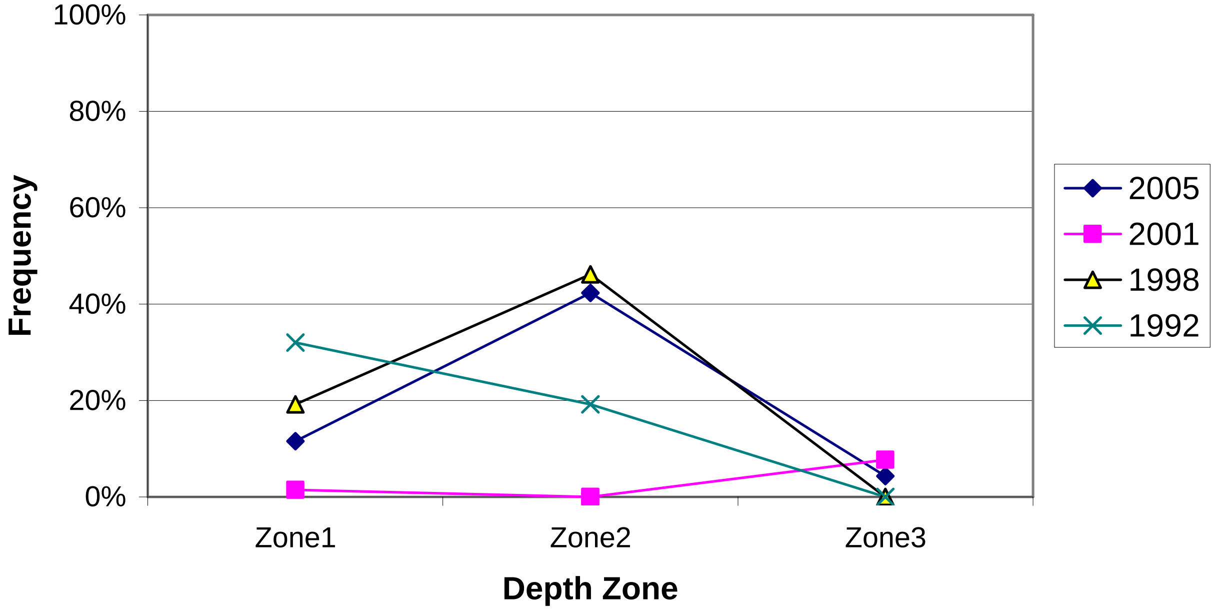


Figure 16. Frequency of occurrence of sago pondweed, by depth zone, 1992-2005.

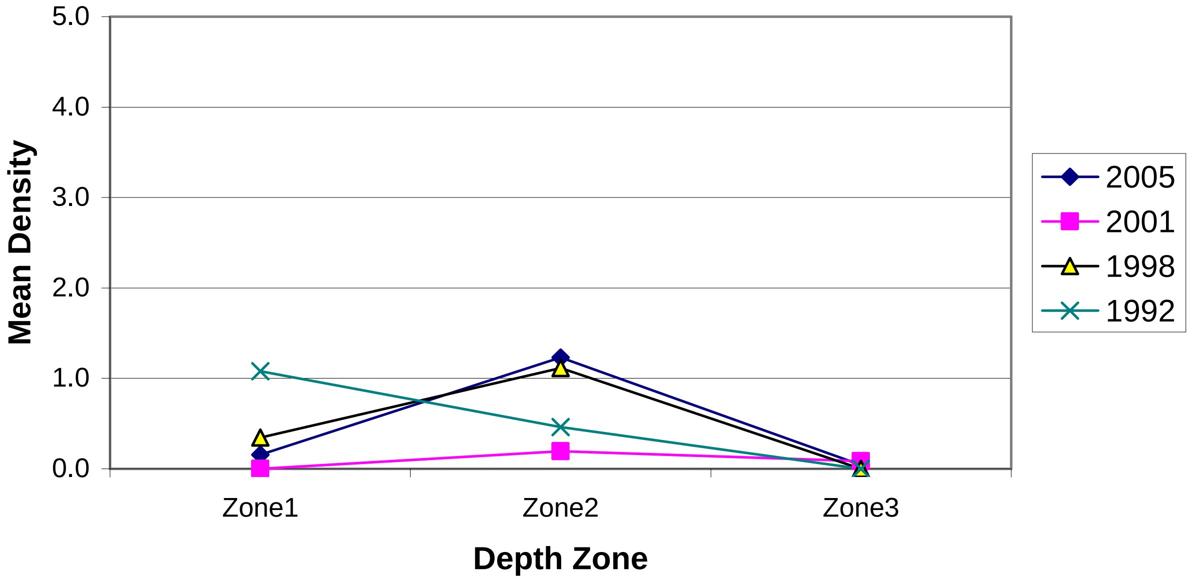


Figure 17. Mean density of sago pondweed, by depth zone, 1992-2005.

MACROPHYTE COMMUNITY

The Coefficient of Community Similarity indicates the percent similarity between two communities; values less than 0.75 indicate the two communities are less than 75% and therefore significantly different. The Coefficients indicate that the aquatic plant community in Mason Lake has changed significantly between some years.

The 1992 and 1998 aquatic plant communities were significantly different. The 1998 and 2001 communities were not significantly different (Table 10). The plant community changed significantly again between 2001 and 2005.

The accumulated change from 1992 to 2005 has resulted in the present (2005) community being only 58% similar to the plant community in 1992. This means that only 58% of the community in 1992 has been retained in the 2005 community (Table 10).

Table 10. Coefficients of Community Similarity.

	Coefficient	% Similarity
1992-1998	0.606	61%
1998-2001	0.754	75%
2001-2005	0.630	63%
1992-2005	0.577	58%

Several parameters can be used to characterize an aquatic plant community and measure what changes have occurred within the community (Table 11).

The number of species occurring at the sample sites, species richness, cover of emergent species and cover of floating-leaf lily pad species increased from 1992 to 2001 and then declined in 2005 (Table 11).

The maximum rooting depth increased from 1992-1998, but declined 1998-2005, as has the quality of the plant community as measured by AMCI Index (discussed later in this document).

Simpson's Diversity Index has steadily increased from poor diversity in 1992 to good diversity in 2005. A Diversity index of 1.0 would mean that each individual in a community was a different species, the most diversity that could be found.

The percentage of the littoral zone that is vegetated and coverage of submergent species have steadily decreased (Table 11).

The coverage of free-floating species has varied up and down as have the Average Coefficients of Conservatism and Floristic Quality Indices (discussed later in this document).

Table 11. Changes in the Aquatic Plant Community; Mason Lake, 1992-2005.

	1992	1998	2001	2005	1992-2005 Change	1992-2005 %Change
Number of Species	16	20	25	19	3.0	18.8%
Maximum Rooting Depth	8.0	9.0	8.0	7.0	-1.0	-12.5%
% of Littoral Zone Vegetated	100	93	93	91	-0.1	-9.0%
AMCI Index	39	46	45	42	3.0	7.7%
%Sites/Emergents	5	6	13	11	6.0	120.0%
%Sites/Free-floating	62	75	50	76	14.0	22.6%
%Sites/Submergents	99	92	91	84	-15.0	-15.2%
%Sites/Floating-leaf		1	3	0	0.0	
Species Richness	3.13	3.49	3.6	3.16	0.0	1.0%
Simpson's Diversity Index	0.84	0.86	0.87	0.89	0.1	6.0%
Average Coefficient of Conserv.	4.07	4.68	4.32	4.41	0.3	8.4%
Floristic Quality	15.75	20.42	20.25	18.19	2.4	15.5%

The cover of emergent species has increased the most, more than doubling. The cover of submergent species has decreased the most, (15% decrease) (Table 9).

The Aquatic Macrophyte Community Index (AMCI) developed for Wisconsin lakes (Nichols 2000) was applied to Mason Lake. The quality of the aquatic community in Mason Lake was in the lowest quartile for lakes in Wisconsin and in the North Central Hardwoods Region of the state in 1992. The quality increased to below average quality for lakes in the state in 1998-2001, although Mason Lake was still in the lowest quartile of lakes in the region. The quality dropped again in 2005 to the lowest quartile of lakes in the state and region (Table 12). This indicates that Mason Lake is with in the group of lakes in the state and region with the lowest quality aquatic plant community.

Table 12. Aquatic Macrophyte Community Index Values for Mason Lake, 1992-2005.

	1992	1998	2001	2005
Maximum Rooting Depth	3	4	3	3
% Littoral Zone Vegetated	10	10	10	10
Simpson's Diversity Index	6	7	7	8
Relative Frequency of Submersed Species	9	9	9	6
Relative Frequency of Sensitive Species	1	5	5	4
Relative Frequency of Exotic Species	2	2	2	3
# of Taxa	8	9	9	8
Total	39	46	45	42

The maximum value is 70

The Average Coefficient of Conservatism for the Mason Lake aquatic plant community has remained in the lowest quartile for all Wisconsin lakes and lakes in the North Central Hardwood Region (Table 13). This suggests that the plant community in Mason Lake is among the 25% of lakes most tolerant of disturbance, probably the result of being subjected to high levels of disturbance. Although the Average Coefficient has remained in the lowest quartile, it has increased slightly, suggesting a slight decrease in disturbance tolerance.

Table 13. Floristic Quality and Coefficient of Conservatism of Mason Lake, Compared to Wisconsin Lakes and Region Lakes, 1992-2005.

	Average Coefficient of Conservatism†	Floristic Quality‡	Based on Relative Frequency	Based on Dominance Value
Wisconsin Lakes	5.5, 6.0, 6.9*	16.9, 22.2, 27.5*		
NCHF	5.2, 5.6, 5.8*	17.0, 20.9, 24.4*		
1992	4.07	15.75	11.36	11.08
1998	4.68	20.42	12.38	11.55
2001	4.32	20.25	12.21	11.26
2005	4.41	18.19	14.83	15.21

* Values indicate the highest value of the lowest quartile, the mean, the lowest value of the upper quartile

†Average Coefficient of Conservatism for all Wisconsin lakes ranged from a low of 2.0 (most tolerant of disturbance) to a high of 9.5 (least disturbance tolerant).

‡lowest Floristic Quality was 3.0 (farthest from an undisturbed condition) and the high was 44.6 (closest to an undisturbed condition)

The Floristic Quality of the plant community in Mason Lake was in the lowest quartile of Wisconsin lakes and Northern Central Hardwood lakes in 1992 (Table 13). In 1998 - 2005, the Floristic Quality increased to below average for both Wisconsin lakes and Region Lakes (Table 13). This indicates that the plant community in Mason Lake was farther from an undisturbed condition than the average lake in the state and region.

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. The recalculated values indicated something slightly different. The values suggest the aquatic plant community in Mason Lake was within the lowest quartile for all study years and that Mason Lake has remained within the group of lakes in the state and region farthest from an undisturbed condition. Although the Floristic Quality has remained within the lowest quartile, the Index has increased slightly, suggesting slightly less disturbance.

Disturbances can be of many types:

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

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

Changes in the plant community are seen when there have been changes in the individual species within the community. Many species have changed in frequency and density in Mason Lake during the study years (Appendix XIV).

Nine species have appeared and disappeared in various years, but these species occurred at only one or two sites. These species are likely uncommon species that are being missed when study sites shift slightly.

Six new species have appeared since 1992: *Chara* spp., *Lemna minor, Phalaris arundinacea, Potamogeton nodusus, P. richardsonii* and *Spiodela polyrhiza.* In addition to the newly appearing species, five other species have increased in frequency, density and dominance. *Elodea canadensis* has increased the most, nearly 10-fold in frequency and 16-fold in density and dominance, increasing from a rarely occurring species to a common species. The frequency and density of *Elodea canadensis, Lemna minor* and *Spirodela polyrhiza* have increased steadily since 1992. Of the species that have increased or appeared since 1992, three-quarters of the species are species that are tolerant of lower water clarity and favor soft substrate.

Three species have disappeared from the study sites since 1992: *Nitella* spp., *Potamogeton zosteriformis* and *Ranunculus longirostris.* Each of these species had been commonly occurring at one time. In addition to the species that have disappeared, three species have decreased in frequency, density and dominance, including the two exotic species *Myriophyllum spicatum* and *Potamogeton crispus*.

IV. DISCUSSION

Based on water clarity and the concentrations of algae and nutrients, Mason Lake is a eutrophic/hypereutrophic lake with very poor water quality and water clarity during the study period (1986-2005). Since 1986, nutrients have increased and water clarity has decreased. Filamentous algae has increased dramatically and is abundant throughout the lake.

Plant growth in Mason Lake is favored by the high nutrients of its trophic state, the hard water, the dominance of rich sediments, the shallow depth of the lake and the very gradually sloped littoral zone. The predicted maximum rooting depth is nearly equal to the maximum depth of Mason Lake. This means that there is a potential for plant growth to colonize the entire basin. The very poor water clarity could limit aquatic plant growth.

The aquatic plant growth in Mason Lake colonizes 82-91% 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.

Ceratophyllum demersum (coontail) was the dominant species in 2005, especially in the shallowest and deepest depth zone. The frequency and density of *C. demersum* increases with increasing depth. *Myriophyllum spicatum* (Eurasian watermilfoil) an aggressive non-native species, was the sub-dominant species, colonizing 65% of the lake. The frequency and density of Eurasian watermilfoil increases with increasing depth and may be due to the impact of winter drawdown.

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. Dense plant beds of exotic species do not provide a diverse habitat; this lack of diversity can not provide a variety of microhabitats 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, removing habitat and allowing the decaying pondweed to release nutrients for algae growth, thus reducing water clarity. In June 2005, curly-leaf pondweed colonized 28% of Mason Lake.

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:

<u>Chemical treatments, 1972-82 and 1990-2005</u>.

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 1998-2005

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

The drawbacks of winter drawdowns are:

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

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).

Changes

The aquatic plant community in Mason Lake has changed significantly between 1992 and 2005. The two communities are only 58% similar.

In various years, *Ceratophyllum demersum, Myriophyllum spicatum* and *Potamogeton crispus* have traded dominance and sub-dominance. The percent of the littoral zone vegetated and total occurrence of plant growth have remained high and similar in all study years.

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

1) There was a slight decrease in coverage of vegetation in the 0-5 ft. depth zone (in the zone impacted by drawdown).
2) There was a slight decrease in coverage of submerged plant growth.
3) There was decreased total occurrence and total density of plants.
4) The frequency, density and dominance of the two exotic, nuisance plant species, Eurasian watermilfoil and curly-leaf pondweed, have decreased.
5) There was increased quality of the plant community as measured by the Aquatic Macrophyte Community Index (AMCI).
6) There was increased diversity in the plant community seen in an increase in species richness, number of species and Simpson's Diversity Index.
7) There was an increase in coverage of emergent species. These species are valuable habitat species favored by winter drawdown. Seed germination is more effective on mud flats.
8) The number of species that exhibited a dense form of growth decreased from 5 in 1992 to none in 2005.

9) There was a slight decrease in disturbance as measured by the Floristic Quality Index and Average Coefficient of Conservatism.

Some of these changes such as decreased plant cover, decreased density of plants, decreased abundance of exotic species and increased cover of emergent species are likely due to winter drawdown. Some changes may be due to poor water clarity. 75% of the species that have increased or newly appeared since 1992 are tolerant of poor water clarity and favor soft substrate (Nichols 1999). This includes the free-floating species (coontail, lesser duckweed, greater duckweed and watermeal).

Decreased vegetation is not always an improvement in a lakes ecosystem, but since plant coverage greater than 85% is not ideal for fish habitat, a decrease in vegetation can be an improvement in Mason Lake.

In 1998 and 1999, the impacts of winter drawdown was 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 (FQI Index).

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).

Shoreline Impacts

Large areas of the shoreline on Mason lake are disturbed (cultivated lawn, rip-rap and hard structures). Disturbed shoreline occurred at more than half of the sites and covered approximately 47% of the shoreline. Cultivated lawn was the dominant shoreline cover. Rip-rap and hard structures were abundant. 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.

To determine if there was a difference in the aquatic plant community at the sites with lawn, the aquatic plant transect sites of sites with 100% natural shoreline were compared to aquatic plant transect sites off shoreline that contained any amount of lawn or other disturbance (Appendices XV-XVI).

The comparison of various parameters indicate that disturbance on the shore has impacted the aquatic plant community at the disturbed sites in Mason Lake.

The disturbance has impacted the habitat in the lake. The number of species recorded at natural shoreline sites was greater, the Simpson's diversity Index was higher and species richness (mean number of species per site) was higher at natural shoreline. Species Richness was higher overall and at all depth zones at natural shore sites. Greater diversity in the plant community will support greater diversity in the fish and wildlife community.

Another indicator of better habitat at natural shore aquatic plant communities is that the colonization of emergent species is higher at natural shoreline communities. Emergent vegetation is very important habitat structure for fish spawning and wildlife resources.

Disturbed shoreline does appear to be creating a better habitat for one species – Eurasian watermilfoil. The frequency of occurrence of this exotic invasive species is higher at disturbed shoreline. This suggests that disturbance on the shore is providing a more ideal condition for the colonization and spread of exotic species.

Table 14. Comparison of the Aquatic Plant Community at Natural Shoreline Sites and Disturbed Shoreline Sites.

Parameter		**Natural Shoreline**	**Disturbed Shoreline**
Simpson's Diversity Index		0.920	0.872
Number of species		17	16
Species Richness	Overall	3.85	2.96
	0-1.5ft	3.62	2.61
	1.5-5 ft	3.62	3.17
	5-10ft	4.75	3.11
Eurasian watermilfoil (exotic species)	Frequency	35%	46%
	Density where present	1.33	3.00
Important habitat	Emergent species	33%	6%

V. CONCLUSIONS

Mason Lake is a eutrophic/hypereutrophic lake with very poor water clarity and quality. Since 1986, nutrients in Mason Lake have increased and water clarity has decreased. Filamentous algae has increased dramatically and occurred at nearly all sites.

The aquatic plant community characterized by a good diversity, a 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 82% of the entire lake basin and 91% of the shallow area.

Coontail was the dominant aquatic plant species in 2005, especially in the shallowest and deepest depth zones. Eurasian watermilfoil was sub-dominant, colonizing more than half of Mason Lake.

The aquatic plants in the Mason Lake provide nearly 100% cover at the sample sites, which is more than the ideal of 25-85% cover appropriate for a number of fish species.

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) the 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.

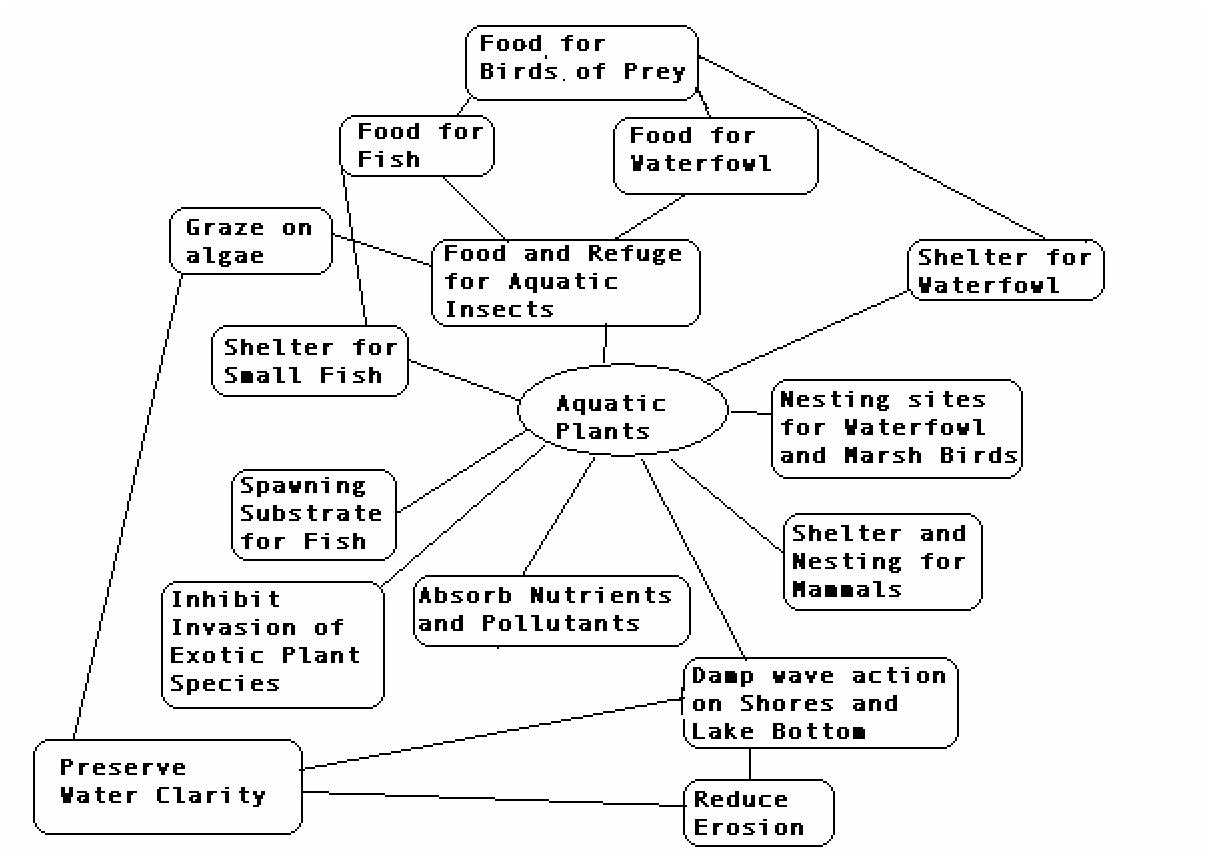
Aquatic Plant Management in Mason Lake

The aquatic plant community has changed significantly in Mason Lake between 1992 and 2005. Two types of plant management have been conducted on Mason Lake: chemical treatments and winter drawdown. Studies suggest that both methods can adversely impact plant species diversity and increase disturbance within the plant community. However, studies suggest that the two exotic species can have a greater adverse impact on the plant community. During the period of winter drawdown:

1) the two non-native species, Eurasian water milfoil and curly-leaf pondweed, declined
2) total occurrence and total density of plant growth have decreased
3) coverage of aquatic plants in the 0-5ft depth zones have decreased
4) total area, frequency and density of plant growth have declined
5) the diversity of plants has increased
6) the number of species exhibiting a dense growth form has decreased

Benefits of the aquatic plant community

Aquatic plants are the cornerstones of the aquatic habitat and lake ecosystem. Aquatic plants in a lake are the habitat for fish and wildlife.



1) Plants start the food chain that all other life uses.
2) Plant beds provide shelter, cover, spawning and nesting areas for fish, waterfowl and other aquatic animals (Table 15).
3) Plants produce the oxygen that other aquatic inhabitants need.
4) A healthy aquatic plant community can prevent an exotic plant species from becoming dominant in a lake.
5) Healthy plant communities (on shore and in the water) improve water quality in many ways:
    a) they trap nutrients, debris, and pollutants entering a water body;
    b) they can absorb and break down some pollutants;
    c) they reduce erosion by stabilizing banks, shorelines and lake bottoms and reducing wave action that resuspends sediments;
    d) they remove nutrients from the water that would otherwise be available for algae blooms (Engel 1985).

Table 15. Wildlife and Fish Uses of Aquatic Plants in Mason Lake

Aquatic Plants	Fish	Water Fowl	Song and Shore Birds	Upland Game Birds	Muskrat	Beaver	Deer
Submergent Plants							
Ceratophyllum demersum	F,I*, C, S	F(Seeds*), I, C			F		
Chara sp.	F*, S	F*, I*					
Elodea canadensis	C, F, I	F(Foliage) I					
Myriophyllum sibiricum	F*, I*, S	F(Seeds, Foliage)	F(Seeds)		F		
Myriophyllum spicatum	F, C						
Najas flexilis	F, C	F*(Seeds, Foliage)	F(Seeds)				
Potamogeton amplifolius	F, I, S*,C	F*(Seeds)			F*	F	F
Potamogeton crispus	F, C, S	F(Seeds, Tubers)					
Potamogeton foliosus	F, I, S*,C	F*(All)			F*	F	F
Potamogeton nodosus	F, I, S*,C	F*(Seeds)			F*	F	F
Potamogeton pectinatus	F, I, S*,C	F*			F*	F	F
Potamogeton praelongus	F, I, S*,C	F*(All)			F*	F	F
Potamogeton pusillus	F, I, S*,C	F*(All)			F*	F	F
Potamogeton richardsonii	F, I, S*,C	F*(All)			F*	F	F
Ranunculus longirostris	F	F(Seeds, Foliage)		F			
Zosterella dubia	F, C, S	F(Seeds)					

Aquatic Plants	Fish	Water Fowl	Song and Shore Birds	Upland Game Birds	Muskrat	Beaver	Deer
Floating-leaf Plants							
Lemna minor	F	F*, I	F	F	F	F	
Nuphar variegata	F,C, I, S	F, I	F		F*	F	F*
Nymphaea odorata	F,I, S, C	F(Seeds)	F		F	F	F
Spirodela polyrhiza	F	F		F			
Wolffia columbiana		F			F		
Emergent Plants							
Asclepias incarnata				Nest fibers	F, Roots		
Bidens spp.		F (Seeds),	F	F	F		
Carex spp.	S*	F*(Seeds), C	F*(Seeds)	F*(Seeds)	F	F	F
Cornus spp.			F (berry)	F (berry)		F	F (fruit)
Decodon verticillatus		F (seeds)			F, C		
Echinochloa walterii		F*	F	F	F		
Eleocharis smallii (palustris)	I	F, C					
Iris versicolor		F, C	F		F		
Polygonum amphibium	F, C	F*(Seeds)	F	F	F		F

Aquatic Plants	Fish	Water Fowl	Song and Shore Birds	Upland Game Birds	Muskrat	Beaver	Deer
Sagittaria latifolia		F, C	F(Seeds), C	F	F	F	
Scirpus validus	F, C, I	F (Seeds)*, C	F(Seeds, Tubers), C	F (Seeds)	F	F	F
Sparganium eurycarpum	I	F(Seeds), C	F, C		F		F*
Typha angustifolia	S, C					F	

F=Food, I= Shelters Invertbrates, a valuble food source C=Cover, S=Spawning
***=Valuable Resource in this category**

*Current knowledge as to plant use. Other plants may have uses that have not been determined.

After Fassett, N. C. 1957. A Manual of Aquatic Plants. University of Wisconsin Press. Madison, WI

Nichols, S. A. 1991. Attributes of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Info. Circ. #73

Recommendations to Mason Lake District and Lake Residents for Aquatic Plant Management

1) **Continue winter drawdowns on a decreased frequency of drawdown**. This method has been shown to reduce the two exotic plant species in the zone impacted by drawdown and reduce overall plant density to some extent. When compared with selective chemical treatments, winter drawdown had a less severe impact on species diversity and was more successful in controlling both exotic species and opening up areas in the dense vegetation beds. However, winter drawdowns could not have an impact on vegetation in the deeper portions of the lake. Eurasian watermilfoil and curly-leaf pondweed show a lower frequency and density in the shallow water that is impacted by winter drawdown.
2) **Decrease frequency of winter drawdowns to once every 3 to 5 years.** Some species that tolerate winter drawdowns appear to be increased and may be favored by the annual drawdowns. Less frequent drawdowns can control Eurasian water milfoil without encouraging increased abundance of drawdown tolerant species
3) **Limit broad spectrum chemical treatments**. The earlier chemical treatments that were not selective for the exotic nuisance-causing species were. Ironically, promoted the spread of nuisance-causing, exotic plant species. Future chemical treatments should be conducted to target the two non-native species: Eurasian watermilfoil and curly-leaf pondweed.
4) **Start a harvesting program**. This program should target the exotic species. Harvesting the exotic species will have short-term and long-term benefits.
    a. Harvesting curly-leaf pondweed in May has the potential to prevent the formation of the curly-leaf pondweed's turions (the source of the next year's curly leaf problem).
    b. May and June harvesting of curly-leaf will reduce the amount of curly-leaf decomposing in the lake, thus reducing nutrients released that feed summer algae blooms.
    c. Harvesting Eurasian watermilfoil just before it reaches the surface in May and June will reduce the vigor of this species and remove more nutrients.
    d. Harvesting through the summer will remove more nutrients in the plant biomass and keep navigation channels open for boat use and fishing.
    e. Cutting channels can modify the habitat by creating openings in the dense plant beds and increase the success of predatory fish, promoting a more balanced fish community.
    f. Harvesting Eurasian watermilfoil in the late summer/fall will remove biomass before it autofragments and decays.
    g. Harvesting removes plant material from the lake, unlike chemical treatments that allow the vegetation to decompose in place, consuming dissolved oxygen, releasing nutrients and further enriching the sediments.
5) **Establish a natural buffer zone of native vegetation around Mason Lake.** There is too much cultivated lawn, rip-rap and hard surfaces at the shoreline and not enough natural area to absorb nutrients, pesticides or toxics. Protecting the shoreline will improve water quality and increase wildlife habitat. Comparisons of the aquatic plant communities at natural and disturbed shoreline show that

disturbed shoreline has impacted the habitat in the lake.

   a. Disturbed shore communities support a less diverse plant community that will support a less diverse fish and wildlife community.
   b. Disturbed shoreline supports much less emergent plant growth, an important component for wildilfe and fish habitat.
   c. Disturbed shore supported a higher frequency and density of Eurasian watermilfoil, providing a more ideal condition for its growth.

6) **Preserve and enhance wetlands in the around Mason Lake and in the watershed.** The wetlands are acting as filters that clean the water before it enters the lake. They also regulate the water flow so that there are not drastic changes in the water level of the lake.
7) **Cooperate with educational and other efforts** in the watershed to reduce nutrient and toxic run-off.

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