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Aquatic Plant Community of Rice Lake: 2012

Hennepin County, MN (DOW# 27-0116)

Prepared for Rice Lake Area Association – October 2012

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Executive Summary

Lake-wide Aquatic Vegetation Surveys

This report summarizes the aquatic plant community of Rice Lake in June of 2009 and 2012. These surveys were conducted by James A. Johnson of *Freshwater Scientific Services, LLC* using the point-intercept rake survey method. The findings reported here will help the Rice Lake Area Association plan responsible vegetation management actions and also provide a baseline condition for tracking any changes in the plant community over the coming years.

Summary of Findings: June 2012 Survey

1) Widespread curlyleaf pondweed growth in most shallow near-shore shallow areas of the main basin (< 4.5 feet). However, most of these areas of curlyleaf consisted of only low to moderately dense growth (very little dense surface matting observed). In general, curlyleaf growth in most near-shore areas was sufficiently dense to impair water recreation (slight to moderate impairment).

2) Eurasian watermilfoil was observed growing at only one location in the main lake basin (along southwest shore near to channel from Fish Lake) and at very low density (only a few individual plants).

3) Native plant growth was generally sparse and limited to shallow near-shore areas in the main lake basin and northern channel, but the western bay supported dramatically higher native plant frequency and abundance.

Introduction

Value of Aquatic Plants

Aquatic plants play an important role in freshwater lakes. They anchor sediments, buffer wave action, oxygenate water, and provide valuable habitat for aquatic animals. As a result, the amount and type of plants in a lake can greatly affect nutrient cycling, water clarity, and food-web interactions (Jeppeson et al. 1998). Furthermore, plants are very important for fish reproduction, survival, and growth, and can greatly impact the type and size of fish in a lake. However, healthy aquatic plant communities are frequently degraded by poor water clarity, excessive plant control activities, and the invasion on non-native nuisance plants. These disruptive forces alter the diversity and abundance of aquatic plants in lakes and can lead to changes in many other aspects of a lake's ecology. Consequently, it is very important that lake managers find a balance between controlling nuisance plant growth and maintaining a healthy, diverse plant community.

Purpose of Survey

The vegetation surveys reported here were designed to provide a detailed assessment of the aquatic plant community in Rice Lake, with a particular focus on assessing the distribution and abundance of non-native curlyleaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*). This information will help to guide responsible vegetation management planning and provide a baseline condition for tracking any changes in the plant community over the coming years.

Objectives of Aquatic Plant Survey

1) Develop a list of the aquatic plant taxa found in the lake
2) Estimate the maximum depth of plant growth
3) Estimate the percent of the lake that supports vegetation
4) Characterize the distribution and abundance of native plant taxa in the lake
5) Characterize the distribution and abundance of invasive aquatic plants in the lake

Description of Lake & Watershed

Rice Lake (45°06'54"N, 93°27'58"W; DOW# 27-0116) is a 365-acre shallow (12 ft max depth), eutrophic, drainage lake in Hennepin County, MN (Figures 1 and 2). The lake's hydrology is largely driven by Elm Creek, which drains an area of approximately 20 square miles upstream of the lake. During the summer months (June-August), Rice Lake typically has low water clarity (2 to 3 ft), high total phosphorus (200 to 300 μg/L), and high chlorophyll-a (50 to 100 μg/L). The lake also experiences frequent, severe blue-green algae blooms. These blooms are most prevalent in mid to late summer and during extended dry periods.

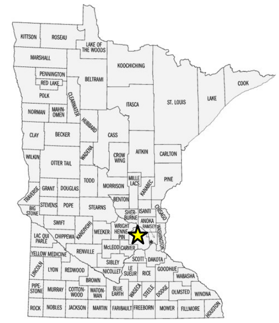


Figure 1. Location of Rice Lake

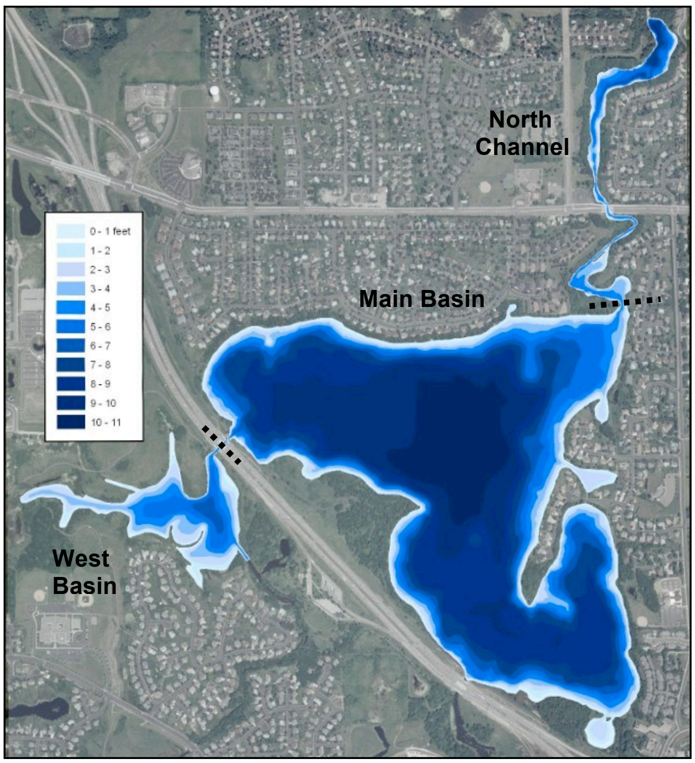


Figure 2. Map of Rice Lake showing depth contours and basins divisions (©2009 - Freshwater Scientific Services, LLC)

	Main Basin	***North Channel***	***West Basin***
Surface Area	314 acres	17 acres	34 acres
Maximum Depth	12 ft	10 ft	7 ft
Average Depth	7.5 ft	5.5 ft	4.8 ft
% Littoral (<15ft)	100%	100%	100%
Watershed Area	16,900 acres	-	-

Table 1. Rice Lake characteristics (listed by basin)

History of Aquatic Plants in Rice Lake

The main basin of Rice Lake has a history of very low summer water clarity. Consequently, in most years, plant growth in this basin is generally limited to shallow, near-shore areas. Transect vegetation surveys conducted between 2006 and 2008 showed that the main basin of Rice Lake supported sparse growth of invasive curlyleaf pondweed (<10 acres) and Eurasian watermilfoil (<1 acre), with total plant coverage ranging from as low as 4 acres in 2007 to as high as 60 acres in 2006 (Figure 3; McComas 2007, 2008, 2009). Since 2006, the plant community in Rice Lake has generally been dominated by coontail (*Ceratophyllum demersum*), Sago pondweed (*Stuckenia pectinata*), and invasive curlyleaf pondweed (*Potamogeton crispus*).

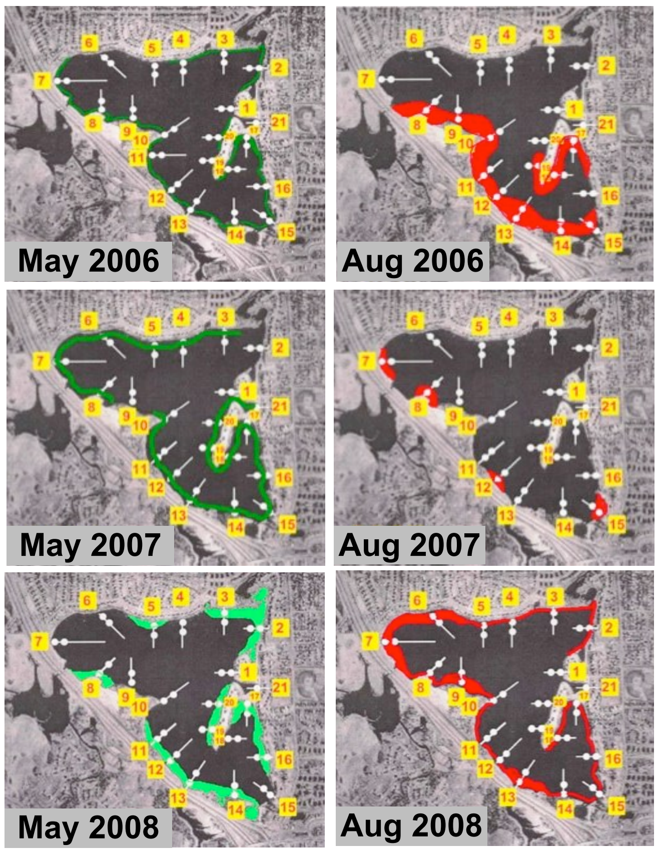


Figure 3. Maps showing transect locations and estimated plant coverage (shaded areas) in Rice Lake between 2006 and 2008. Maps reproduced from reports by Blue Water Science (McComas 2006, 2007, 2008).

Table 2. Summary of past transect-based aquatic vegetation surveys for Rice Lake (2003-2008; McComas 2008)

	2006 May 24 (41 sites)	2007 May 23 (41 sites)	2008 May 27 (41 sites)	2003 Sep 30 (20 sites)	2006 Aug 27 (41 sites)	2007 Aug 20 (41 sites)	2008 Aug 19 (41 sites)
Duckweed (*Lemna sp*)	--	--	--	--	--	--	7
Coontail (*Ceratophyllum demersum*)	5	2	10	--	7	10	46
Eurasian watermilfoil (*Myriophyllum spicatum*)	--	--	--	--	7	--	2
Curlyleaf pondweed (*Potamogeton crispus*)	39	39	10	5	--	--	--
Stringy pondweed (*P. sp*)	41	15	15	--	--	--	2
Sago pondweed (*Stuckenia pectinata*)	--	--	--	35	27	--	20

History of Aquatic Plant Management in Rice Lake

Water Level Drawdown for Curlyleaf Control

Rice Lake was drawn down (partially drained) in the fall and winter of 1996-1997, 1997-1998, 2002-2003 (Fig. 4), and 2004-2005 to control curlyleaf pondweed and Eurasian watermilfoil. These winter drawdowns were conducted to expose sediment in near-shore areas to allow for desiccation and freezing over the winter months. Past studies have suggested that such desiccation and freezing can kill buried curlyleaf turions and milfoil root-balls, leading to reduced levels of infestation in the years immediately following drawdowns.

Figure 4. Exposed sediment during the Rice Lake drawdown conducted over the fall and winter of 2002-2003.

Assessment of Carp Impacts on Aquatic Plants

In 2011, Freshwater Scientific Services, LLC conducted a carp exclosure study in Rice Lake (Fig. 5) to determine whether carp activity was limiting plant growth in shallow near-shore areas of the lake (Johnson 2011). Results from this study indicated that carp were having a major impact on the survival and growth of aquatic plants in the lake. In addition, the study evaluated several species of plants to determine which native plants would most likely be able to reestablish in the lake if carp were controlled.

Figure 5. Carp exclosure study plot with plant markers and safety buoys (2011, Freshwater Scientific Services, LLC).

Survey & Analysis Methods

2009 and 2012 Aquatic Vegetation Surveys

Freshwater Scientific Services, LLC completed whole-lake surveys of the plants in Rice Lake on June 1, 2009, August 17, 2009 and June 1, 2012 using the point-intercept method described by Madsen (1999). These surveys incorporated assessments at 207 sample points arranged in a grid to cover the entire lake (Figs. 6 and 7). We generated these sample points using desktop GIS software, the MDNR *Random Sample Generator* extension, and aerial imagery of the lake. We then loaded the sample locations onto a handheld GPS unit (Garmin GPSMAP-78) to enable navigation to each point while in the field.

At each designated sample point, we sampled plants using a weighted, double-headed, 14-tine rake attached to a rope. To ensure that each sample collected plants from a consistent area of lake sediment, the rake (13 inches wide) was dragged approximately 10 feet along the bottom before retrieving (sample area ~10 square feet). For each rake sample, all of the retrieved plants were piled on top of the rake head and assigned density ratings from 1 to 5 based upon rake coverage as described below.

<u>Rake Density Ratings</u>
1 = 1-25% rake head coverage
2 = 25-50%
3 = 50-75%
4 = 75-100%
5 = 100% coverage with additional plants hanging off rake

Density ratings were assigned for all plants collectively (whole rake density) as well as for each individual plant species retrieved on the rake. Additional species that were observed growing within 10 ft of a sample point but not retrieved on the rake were given a rating of zero for that site. These "zero" species were included in the final species lists and distribution maps, but were not included in the calculation of plant community metrics and statistics.

Figure 6. Map of sample points used for the 2009 and 2012 Rice Lake point-intercept vegetation surveys (see Figure 13 for greater detail)

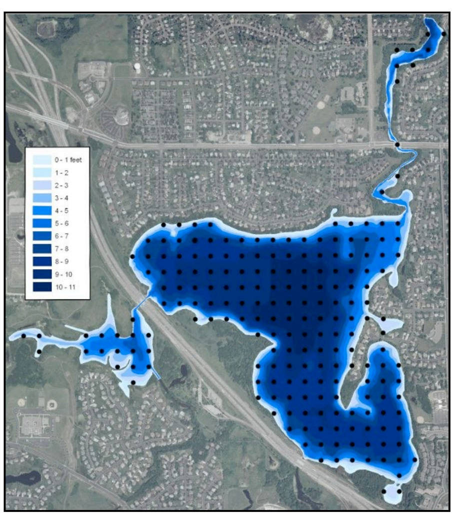
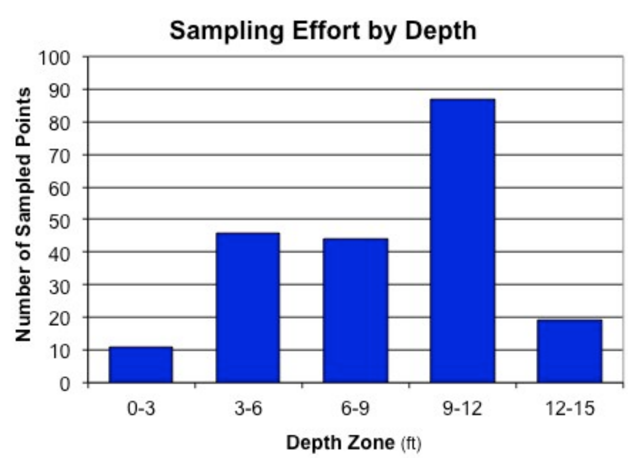


Figure 7. Sampling effort (number of points by depth zone) for the 2012 Rice Lake vegetation survey



Aquatic Plant Survey Data Analysis

% Occurrence

Description: The percent of sampled locations (<15 ft) where a given plant taxon was found

Formula: Number of littoral sites with a given taxon ÷ N_{lit}

- N_{lit} = Total # of littoral points sampled

% Littoral Area Vegetated

Description: The percent of the littoral area (<15 ft deep) that supported plants of any kind

Formula: $VA_{lit} \div TA_{lit}$

- VA_{lit} = Vegetated Littoral Area = ∑ Thiessen polygon areas for vegetated littoral points
- TA_{lit} = Total Littoral Area = (Total Basin Area) – (Area >15 ft)

% Lake Area Vegetated

Description: The percent of the entire lake area that supported plants of any kind

Formula: Vegetated Area ÷ Total Lake Area

- Vegetated Area = ∑ Thiessen polygon areas for points with vegetation
- Total Lake Area = Area calculated using delineated shoreline in ArcView GIS

% Lake with Plants to Surface

Description: The percent of the entire lake area with plants that reach the water's surface. This is a good indicator of recreational impairment.

Formula: (Area with surface growth) ÷ Total Lake Area

- Area with surface growth = ∑ Thiessen polygon areas for points with surface vegetation
- Total Lake Area = Area calculated using delineated shoreline in ArcView GIS

Species Richness

Description: The number of different plant taxa found in the lake. Greater richness often translates into greater habitat diversity for fish.

Formula: Total number of taxa encountered in each surveyed year

Simpson's Diversity

Description: How "mixed" or diverse is the plant community? Lakes with many plant species that are evenly mixed throughout the lake have high diversity; those dominated heavily by only one or two species have low diversity. A higher number (up to 1.0) indicates greater diversity.

Formula: $1 - \sum (\text{Relative Frequency of encountered species})^2$

- Relative Frequency = (% occurrence of given species) ÷ (∑ % occurrence for encountered species) (see Nichols et al. 2000)

Average Number of Native Species/Point

Description: Another measure of the diversity of native plants in the lake.

Formula: ∑(#Native species per littoral point) ÷ N_{lit}

- N_{lit} = Total # of littoral points sampled

Results & Discussion

Frequency of Aquatic Plant Species in Rice Lake

Plant frequency is the percent of sampled points where a given taxon of plant was retrieved on the sample rake. Frequency (% occurrence) indicates how common and widespread each species of plant was in the lake, but does not reflect the density of plants at each location. Additional details on the distribution of plants in Rice Lake are provided on pages 16-25.

Table 3. Frequency (% occurrence) of aquatic plant species in Rice Lake (all basins collectively). Plant species are listed from most common to least common within each plant category (submersed, floating, emergent). P (present) denotes taxa that were observed growing in the lake but not retrieved on any rake sample; "–" indicates species that were not encountered, but were found during other surveys.

		% OCCURRENCE		
SCIENTIFIC NAME	COMMON NAME	Jun 2009	Aug 2009	Jun 2012
SUBMERSED PLANTS				
Ceratophyllum demersum	Coontail	18	10	19
Potamogeton crispus *	Curlyleaf pondweed	10	1	22
Stuckenia pectinata	Sago pondweed	9	4	9
Lemna trisulca	Star duckweed	1	4	6
Potamogeton zosteriformis	Flat-stem pondweed	3	1	4
Elodea canadensis	Canadian waterweed	4	1	2
Zannichellia palustris	Horned pondweed	3	–	4
Zosterella dubia	Water stargrass	2	5	P
Myriophyllum spicatum *	*Eurasian watermilfoil*	2	1	P
Potamogeton foliosus	Leafy pondweed	–	–	2
FLOATING PLANTS				
Lemna minor	Small duckweed	3	4	P
Wolffia columbiana	Watermeal	P	P	6
Spirodella polyrhiza	Giant duckweed	P	P	4
Nymphaea odorata	White waterlily	P	P	P
EMERGENT PLANTS				
Schoenoplectus acutus	Hardstem bulrush	P	P	P
Typha sp.	Cattail	P	P	P

* Invasive, non-native species

Aquatic Plant Community Statistics & Metrics

% Lake Area Vegetated
In June 2012, a total of 114 acres supported plants (33% of whole lake). This metric is highly variable between years in Rice Lake, increasing in years with higher water clarity and decreasing in years with low water clarity. If water clarity is improved, the percent of the lake vegetated will likely increase substantially.

% Lake with Plants to Surface
The amount of surface plant growth is a good indicator of recreational impairment by plants. In June 2012, about 80 acres (22% of whole lake) had plants growing to the surface of the water. In the main lake basin, surface growth occurred in a narrow band along shore (~45 acres total in the main basin) and consisted of low to moderate-density curlyleaf pondweed. The northern channel portion of the lake supported only a few very isolated areas of low-density surface growth. By contrast, nearly the entire western basin supported dense surface growth (34 acres) consisting mostly of coontail, flat-stem pondweed, and curlyleaf pondweed.

% Littoral Area Vegetated
The "littoral area" is defined as the portion of lakes that can support plants. Technically, this is dependent upon water depth and light availability. However, for legal and permit purposes, the MDNR considers all areas shallower than 15 ft to be within the littoral area. By this definition, this includes the entirity of Rice Lake, but water clarity currently limits plant growth to shallower portions of the lake. If water clarity increases, plants will likely expand into deeper areas.

Maximum Depth of Growth
This aspect of the plant community is highly dependent upon water clarity. In Rice Lake, the maximum depth of growth in June 2012 was 10 ft (Table 4). However, most plant growth was found in areas shallower than 6 ft (Figs. 8 to 11).

Species Richness (total number of species)
In June 2012, Rice Lake supported 13 different plant species (Table 3, Fig. 9). This is fairly typical of lakes with low water clarity and established infestations of curlyleaf pondweed and Eurasian watermilfoil.

Table 4. Plant community statistics and metrics for Rice Lake from the Jun/Aug 2009 and Jun 2012 surveys

Statistic / Metric	Jun 2009	Aug 2009	Jun 2012
WHOLE LAKE			
% Lake Area Vegetated	22	11	33
% Lake Surface w/ Plants	13	6	22
LITTORAL *(<15 ft deep)*			
% Littoral Area Vegetated	22	11	33
Average Plant Height *(ft)*	0.6	0.3	1.4
Average Plant Density	0.6	0.4	0.7
Plant Community Metrics			
Max Depth of Growth *(ft)*	8	7	10
Species Richness	12	10	13
Simpson's Diversity	0.82	0.82	0.84
Native Species/Sample	0.4	0.3	0.6

Figure 8. Percent of sampled points (by depth zone) where plants were found in June 2012

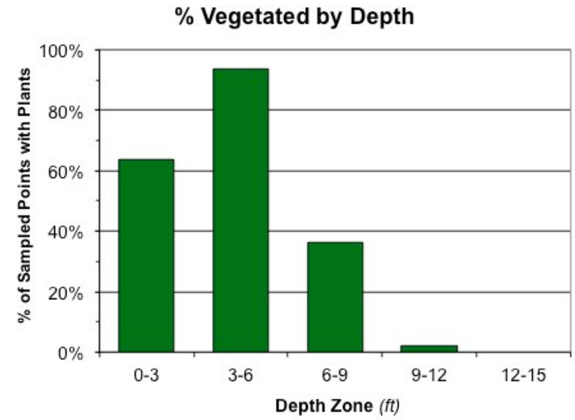
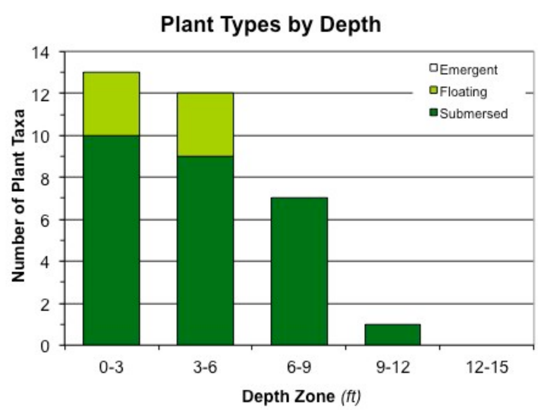


Figure 9. Number of plant species (grouped by type) found in each depth zone in June 2012



Simpson's Diversity Index
Diversity is a measure of both the number of species and the degree to which the species are equally mixed. Values close to 1.0 reflect a very diverse plant community with many species that are equally common (no strong dominance by any one species). Lower values reflect lower diversity (fewer species and clearly dominated by one or two species). In Rice Lake, this index was 0.84 in June 2012; indicating a moderately diverse plant community. This reflects the overall diversity throughout the entire lake. However, most of this diversity was due to the abundant plant growth in the western basin; diversity was substantially lower in the main lake basin (0.76 when data from the western basin are excluded).

Native Species per Sample
This metric provides another measure of aquatic plant diversity in the lake. In June 2012, the average number of native species per sample in Rice Lake was 0.6 (Table 4, Fig. 12). This is substantially lower than observed in other local lakes, further indicating that most areas of Rice lake supported either no plants or only 1 or 2 species of native plants. Furthermore, this value reflects the number of native species per sample throughout the entire lake; it was higher in the western basin and lower in the main lake basin.

Native Plant Abundance (Density Rating)
We found 8 submersed native plant taxa in Rice Lake during the 2012 survey. However, coontail (*Ceratophyllum demersum*) was consistently the most frequently encountered and abundant native plant across all sampled depths (Figs. 10 and 11). All other plant taxa grew less densely (average littoral density rating ≤1) than coontail (Fig. 11).

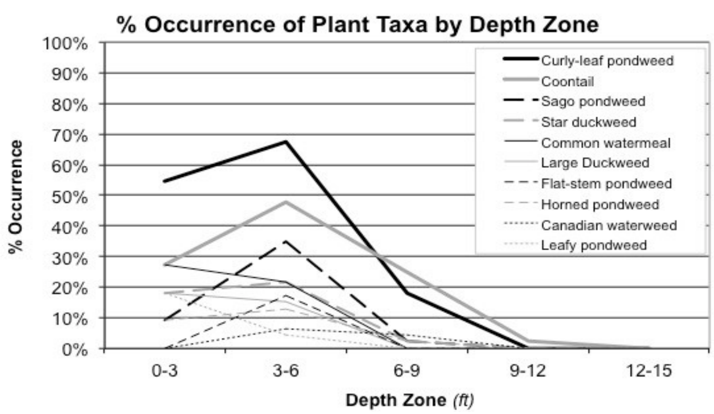


Figure 10. Frequency (% occurrence) of aquatic plant species by depth zone (June 2012)

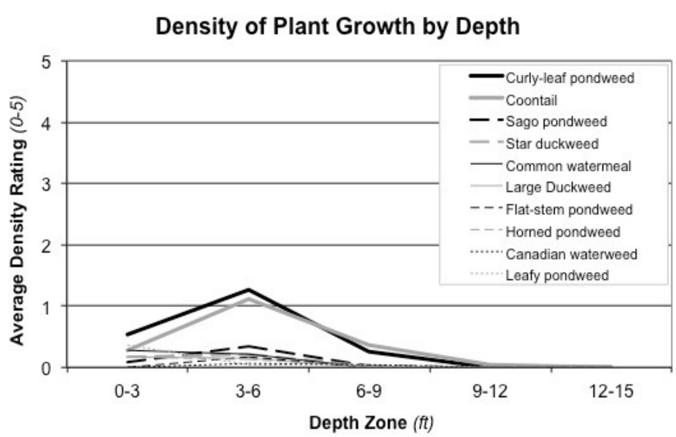


Figure 11. Plant density (0-5 rating; lake-wide average) of aquatic plant species by depth zone (June 2012)

Figure 12. Number of native plant species found at each location in 2012.

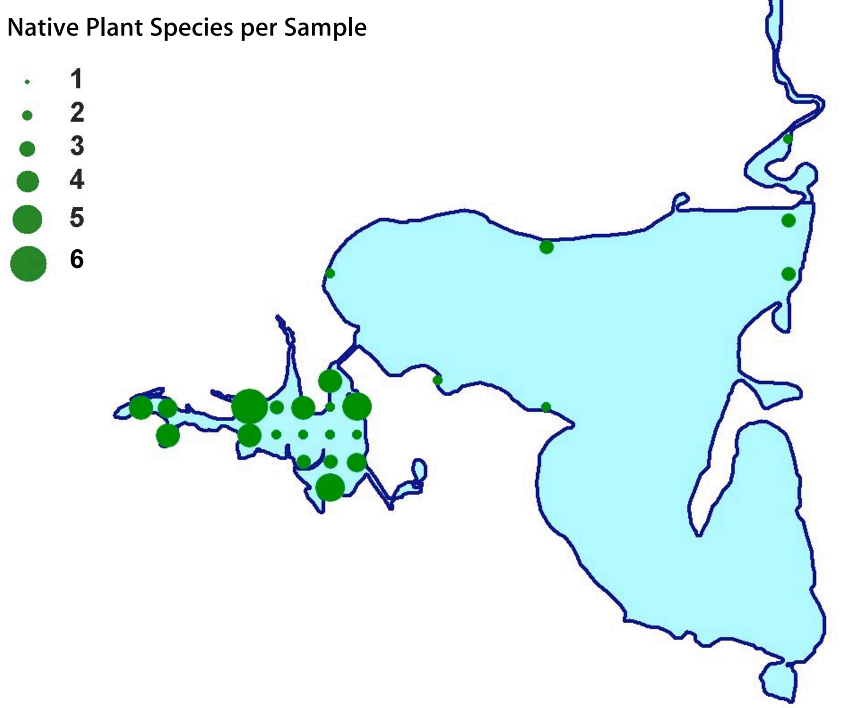
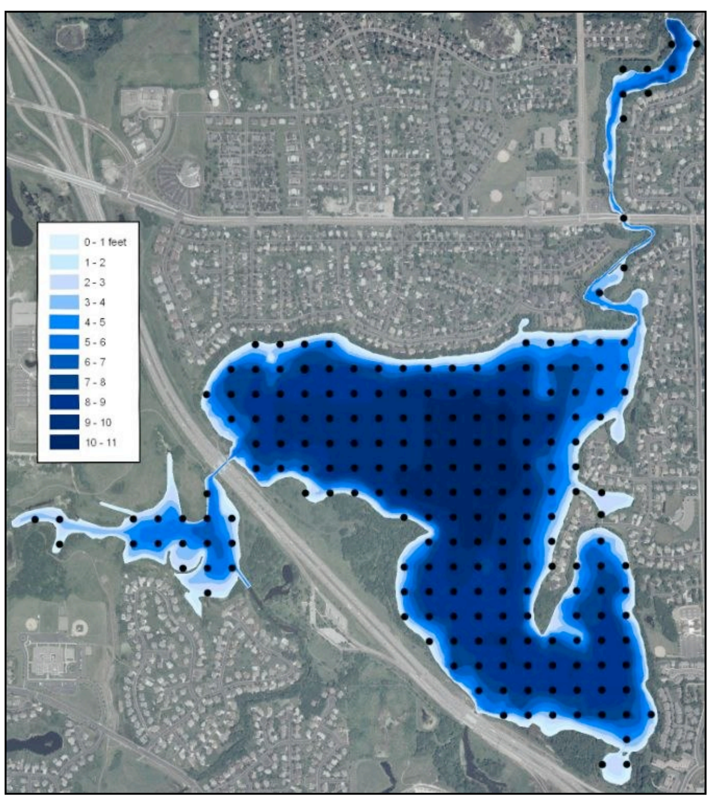


Figure 13. Locations sampled during the June 2012 point-intercept aquatic vegetation survey.



Curlyleaf Pondweed

Potamogeton crispus

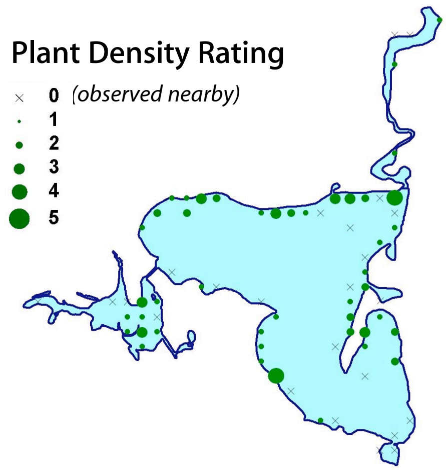
Invasive / Non-Native

Ecological Value: Low

Statistical Summary

% Occurrence *(littoral)*	22%
Max Depth of Growth *(ft)*	8.9
Average Density *(littoral)*	0.4
Max Density	4.0

Plant Density Rating

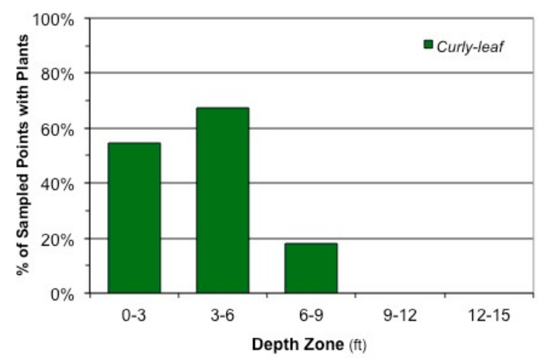


Description

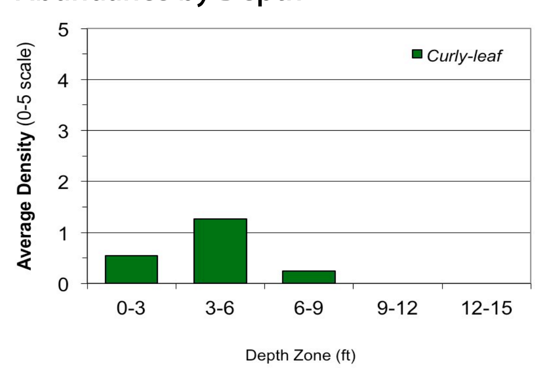
Curlyleaf has an unusual life-cycle that gives it a competetive advantage over native aquatic plants. It sprouts in the fall from turions or "reproductive buds", whereas most of our native aquatic plants sprout in the spring. New curlyleaf sprouts then overwinter as small shoots. When the ice disappears in the spring and the lake water warms, these curlyleaf shoots begin to grow very rapidly. By mid to late May, these plants begin to form very dense mats on the lake's surface and start to make new turions. These dense surface mats can severely impair recreational use of lakes (Bolduan et al. 1994).

Curlyleaf plants naturally die off by late June and deposit their new turions to the lake sediment. Although this means that the dense, matted growth is generally short-lived and out of the way by the 4th of July, its effects linger on. Curlyleaf's early growth and tendency to form thick, light-blocking surface mats allow it to easily out-compete and displace most native aquatic plants (Madsen and Crowell 2002, Bolduan et al. 1984). This can greatly reduce habitat quality and lead to undesirable changes to the lake's fish community. Curlyleaf die-off can also releases a pulse of nutrients that may promote summer algae blooms in some heavily-infested lakes (James et al. 2001, 2007).

% Occurrence by Depth



Abundance by Depth



Management

Harvesting: removes biomass and some turions, but does not give long-term control

Herbicides: sensitive to endothall, fluridone

Eurasian Watermilfoil

Myriophyllum spicatum

Invasive / Non-Native

Ecological Value: Low

Description

Eurasian watermilfoil (EWM) is an aggressive, non-native, invasive plant that currently infests about 200 Minnesota lakes. EWM sprouts in the early spring from rootstock, stem fragments, or seeds. New sprouts grow rapidly (up to several inches per day under ideal conditions), often forming dense surface mats by late spring. These nuisance surface mats tend to persist through the early fall, shading out beneficial native plants and causing problems for boaters and swimmers who try to venture through them.

Because EWM out-competes most native aquatic plants, severe infestations can greatly alter the quality of habitat for fish and lead to changes to the lake's fish community.

EWM readily sprouts from plant fragments. Although the plants naturally release plant fragments ("autofragmenting") in the late summer and fall, additional fragmentation by boat motors or harvestors can lead to rapid spread of EWM within lakes. Furthermore, these plant fragments are easily transported by boaters between lakes, potentially leading to new infestations.

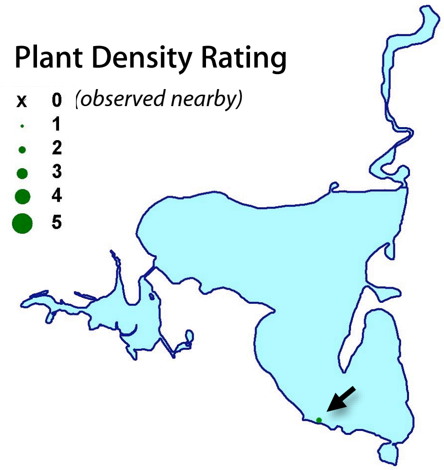
Management

Harvesting: removes biomass and matted growth, but does not give long-term control
Herbicides: sensitive to 2,4-D, triclopyr, and fluridone.

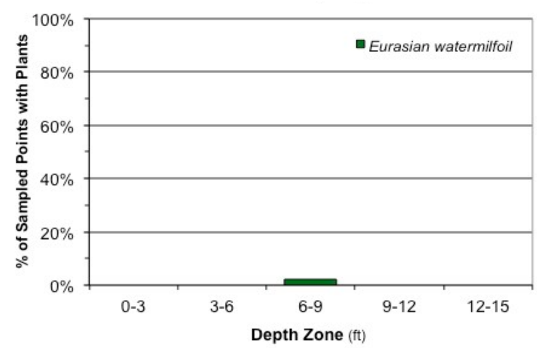
Statistical Summary

% Occurrence *(littoral)*	<1%
Max Depth of Growth *(ft)*	6.2
Average Density *(littoral)*	<0.1
Max Density	1.0

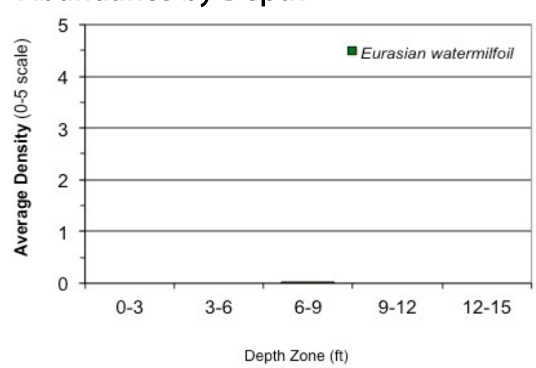
Plant Density Rating



% Occurrence by Depth



Abundance by Depth



Coontail
Ceratophyllum demersum

Native
Ecological Value: Moderate to High

Description
Coontail is a very common native aquatic plant that can thrive in many lakes. Unlike most aquatic plants, it does not produce roots. Consequently, it can drift around lakes and pile up along shorelines on windy days. Coontail tends to grow as a dense carpet on the bottom of lakes, but can also form dense masses of intertwining stems that look like underwater bushes. Dense coontail can form areas of nuisance surface-matted growth in some lakes, but typically only reaches the water surface in nearshore areas (<5 ft).

Coontail's dense growth makes it a good oxygen producer and provides a great habitat for aquatic insects and other similar sources of food fish. At moderate densities, it can also provide a great place for young and small fish to hide from predators. However, very dense coontail beds can be too thick for many fish to swim through, making it less valuable for habitat.

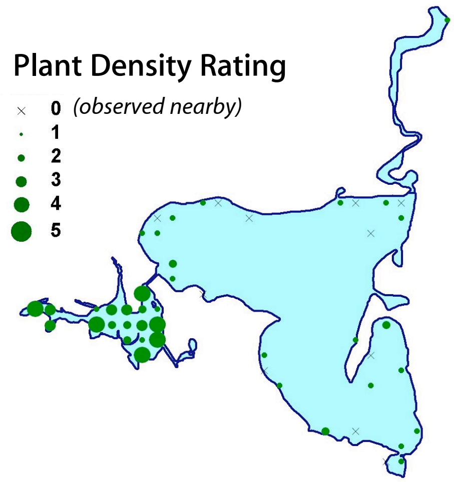
Coontail can survive in areas with very low light, and is often one of the deepest growing plants found during plant surveys. In addition, its tolerance of low light allows it to over-winter in many lakes, even when ice and snow block most of the sun's rays.

Management
Harvesting: removes biomass (temporary)
Herbicides: sensitive to endothall (>4 mg/L), and fluridone (only sensitive in spring)

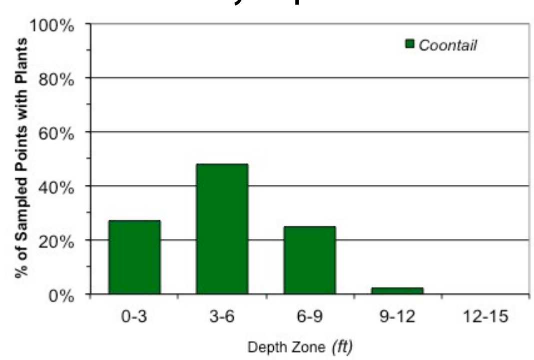
Statistical Summary

% Occurrence *(littoral)*	19%
Max Depth of Growth *(ft)*	10.2
Average Density *(littoral)*	0.4
Max Density	4.0

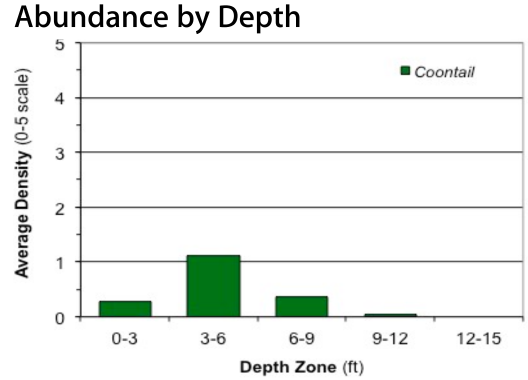
Plant Density Rating



% Occurrence by Depth



Abundance by Depth



Canadian waterweed (or "Elodea")

Elodea canadensis

Native

Ecological Value: Moderate to High

Description

Elodea is a very common native aquatic plant that can thrive in many lakes. It tends to grow as a dense carpet on the bottom of lakes, but can form areas of nuisance, surface-matted growth in some lakes (typically only in nearshore areas <5 ft deep).

Elodea's dense growth makes it a good oxygen producer and provides a great habitat for aquatic insects and other similar sources of food fish. At moderate densities, it can also provide a great place for young and small fish to hide from predators. However, very dense beds of Elodea can be too thick for many fish to swim through, making it less valuable as fish habitat than some other plants.

Elodea can persist to some degree over the winter, and thus may quickly form areas of dense growth in the spring in some lakes. However, it tends to die back in mid to late summer.

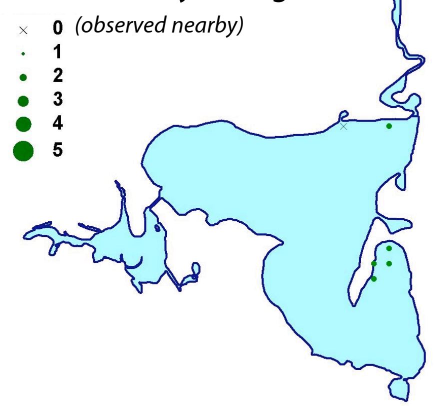
Management

Harvesting: removes biomass (temporary)
Herbicides: sensitive to diquat and fluridone; tolerant of endothall and may increase dramatically in endothall-treated lakes

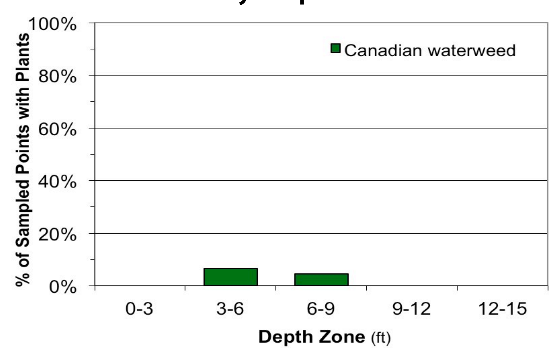
Statistical Summary

% Occurrence *(littoral)*	2%
Max Depth of Growth *(ft)*	8.5
Average Density *(littoral)*	<0.1
Max Density	1.0

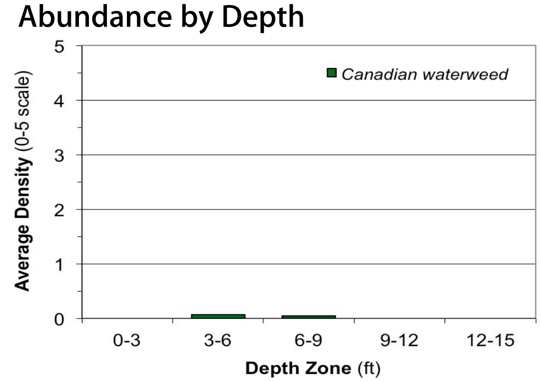
Plant Density Rating



% Occurrence by Depth



Abundance by Depth



Flat-stem Pondweed

Potamogeton zosteriformis

Native

Ecological Value: Moderate to High

Description

Flat-stem pondweed produces long, thin leaves (~6 to 8 inches long and 1/8 inch wide) on a very flattened stem. This growth form provides vertical structure for fish, but does not provide as much surface area for aquatic insects as some other plants. However, the thin leaves and tall growth of this plant allow it to tolerate turbidity (murky water) better than broad-leaved natives. Flat-stem reproduces via seeds and heavy production of fan-shaped winter buds.

Flat-stem generally does not form large areas of nuisance growth, but can grow to the surface in some lakes.

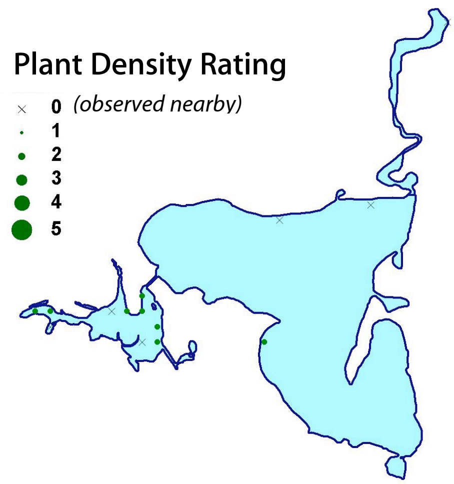
Management

Flat-stem pondweed is rarely the focus of control strategies in lakes. However, this species is very sensitive to endothall herbicide. Vegetation management plans should strive to protect and promote areas of this species.

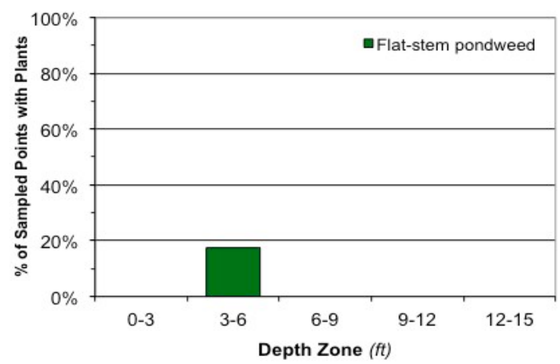
Statistical Summary

% Occurrence *(littoral)*	4%
Max Depth of Growth *(ft)*	7.5
Average Density *(littoral)*	<0.1
Max Density	1.0

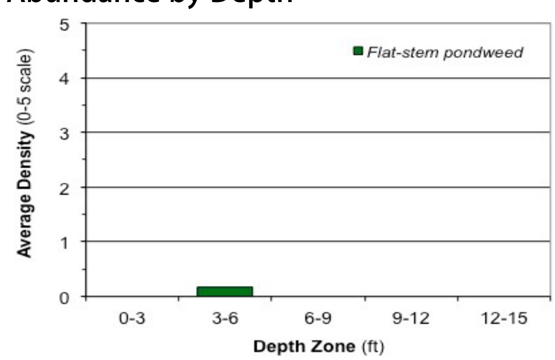
Plant Density Rating



% Occurrence by Depth



Abundance by Depth



Sago Pondweed

Stuckenia pectinata

Native

Ecological Value: Moderate to High

Description

Sago pondweed is a common native aquatic plant that can thrive in many lakes, but it is generally limited to areas shallower than 6 ft deep. It is adapted for life in murky water and is one of the few plant species that can thrive in hypereutrophic shallow lakes with severe algae blooms. In addition, it is a rapid colonizer, and is often one of the first plants to colonize areas of bare sediment after intensive plant management (such as large-scale herbicide treatment).

Sago pondweed produces long, thin, vertical stems with many narrow, thread-like leaves. These stems often reach the water surface, where they form broom-like tufts of thin leaves. Although sago pondweed does not typically form large areas of nuisance growth in lakes, it can form localized dense beds that can clog boat motors in nearshore areas. In addition to providing habitat for insects and other invertebrates, this plant produces tubers that are a major source of food for waterfowl.

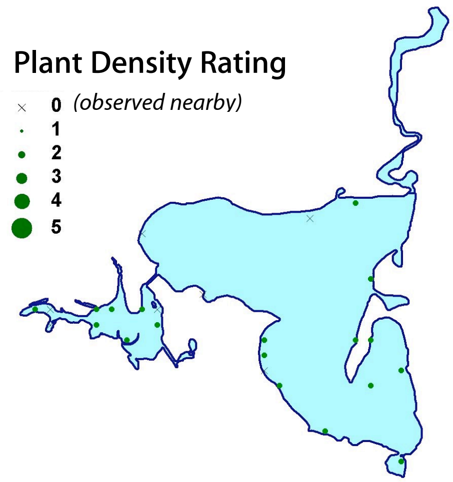
Management

Sago pondweed is rarely the focus of control strategies in lakes. Vegetation management plans should strive to protect and promote areas of this species.

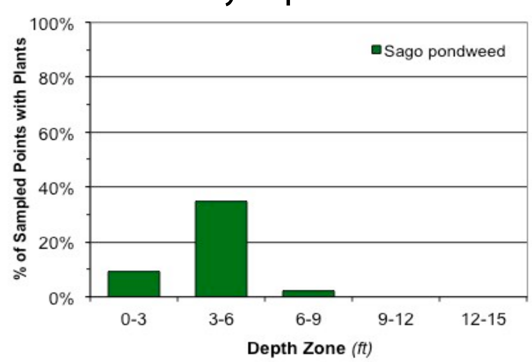
Statistical Summary

% Occurrence *(littoral)*	9%
Max Depth of Growth *(ft)*	6.2
Average Density *(littoral)*	0.1
Max Density	1.0

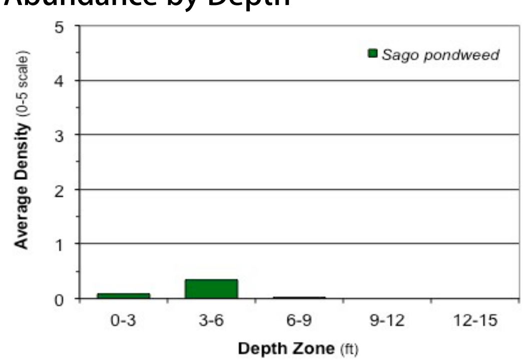
Plant Density Rating



% Occurrence by Depth



Abundance by Depth



Star Duckweed

Lemna trisulca

Native

Ecological Value: Moderate to High

Description

Star duckweed looks like miniature canoe paddles that have been glued together. This plant forms free-floating clumps of small leaves (called "fronds") that can drift around lakes. Unlike other duckweeds, this plant does not typically float on the surface of lakes. Instead, it can be found tangled among other plants or as a layer on the lake bottom in near-shore areas. Although it can form large, dense clumps in some fertile lakes, it tends to stay near the bottom of lakes and does not typically impair lake recreation.

This plant can provide important cover for aquatic insects and small fish. Furthermore, it is highly digestible (low in structural cellulose) and very high in protein and nutrients. Consequently, it is an important source of food for wildlife – especially waterfowl.

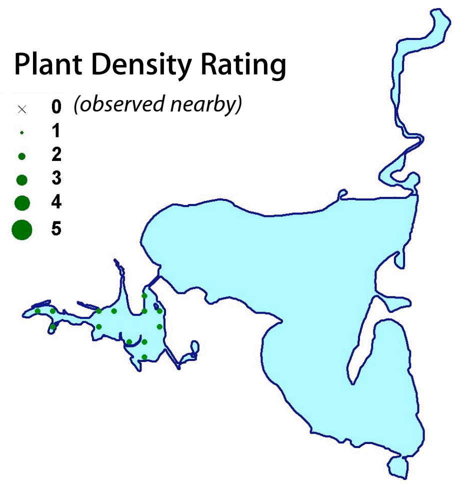
Management

Star duckweed is rarely the focus of control strategies in lakes. Furthermore, this plant reproduces very quickly, so any control is likely to be very short lived. However, star duckweed is sensitive to some herbicides.

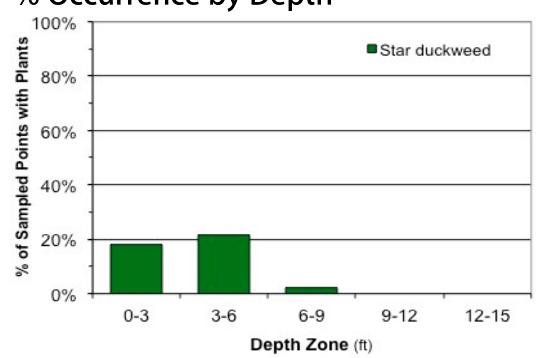
Statistical Summary

% Occurrence *(littoral)*	6%
Max Depth of Growth *(ft)*	7.5
Average Density *(littoral)*	0.1
Max Density	1.0

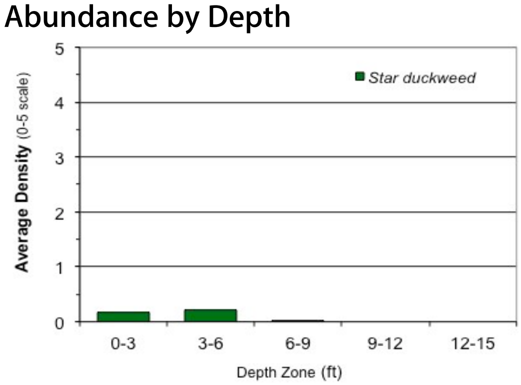
Plant Density Rating



% Occurrence by Depth



Abundance by Depth



Management Context

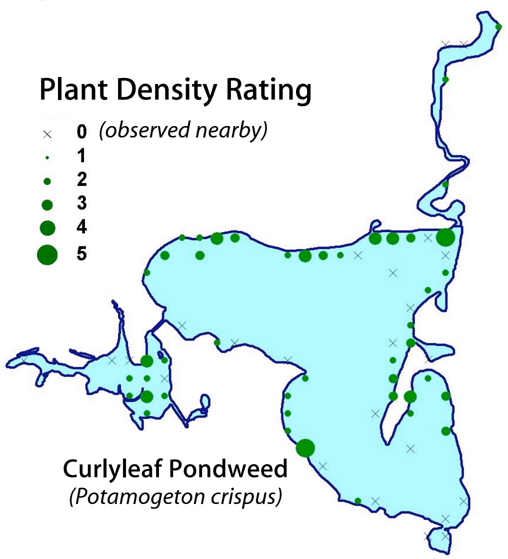
The results of the 2012 plant survey indicated that curlyleaf pondweed was widespread in Rice Lake, but generally limited to nearshore areas. Furthermore, most of this curlyleaf growth was low or moderate in density, and thus only presented a slight to moderate impairment of water recreation in the lake. Overall, plant frequency and abundance appeared to be slightly higher in 2012 than seen in 2009, but were well within the normal range of variation seen in previous surveys (McComas and Stuckert 2007a, 2007b, 2009). Although we did not find a substantial amount of dense surface-matted curlyleaf in 2012, two factors may lead to increased nuisance growth of curlyleaf in the years to come: (1) buildup of turions in near-shore sediments in the time since the last lake drawdown, and (2) the potential for increased water clarity as the Elm Creek TMDL is implemented in the coming years.

Invasive aquatic plants, such as curlyleaf pondweed and Eurasian watermilfoil, have become a major focus of lake management activities throughout the upper Midwest. Past management strategies have generally used biomass removal (harvesting) and small-scale herbicide treatments to maintain navigational channels and minimize the effects of dense canopy growth on recreational use of waters. However, these approaches have proven to be short-term solutions that do little to reduce the overall level of infestation in lakes. Moreover, these actions usually need to be repeated at least annually to control nuisance growth (Madsen and Crowell, 2002). Consequently, citizen lake groups, local governmental units, and state agencies have been very interested in identifying new, effective management tools to reduce the impacts of invasive plants in recreational waters.

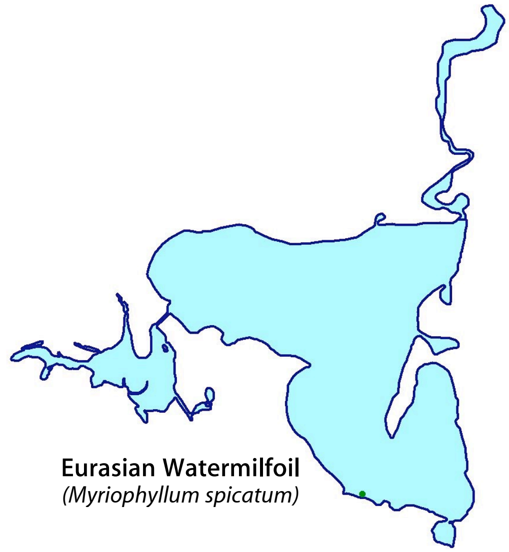
Unlike most lakes, Rice Lake has the option of using lake drawdown as a means to control invasive plant growth in near-shore areas. This option offers a low-cost and effective tool, but the RLAA may also want to consider using herbicide treatments in some areas, particularly in years when the amount of curlyleaf or milfoil does not warrant a lake-wide drawdown. In recent years, early-season, low-dose herbicide treatments have been shown to dramatically reduced curlyleaf and milfoil biomass, inhibit the production of new curlyleaf turions, and reduce turion abundance in lake sediments (Johnson et al. *in press*; Skogerboe et al. 2006, 2008; Poovey et al. 2002). In addition, these treatments generally do not appear to harm the native plant community, and in some cases have promoted enhanced expansion and growth of native plants (Jones et al. *in press*). However, even after up to 5 consecutive years of treatment for curlyleaf, treated lakes still had viable curlyleaf turions present in their sediments. Based upon these findings, early-spring treatments appear to be a valuable tool for managing severely infested lakes. Given the documented persistence of viable curlyleaf turions (and possibly seeds), treatments should not be expected to eradicate curlyleaf or milfoil from infested lakes. More realistically, the goal of such treatments should be to reduce the frequency and abundance of invasives in infested lakes to a point where less intensive management strategies (spot herbicide treatments, localized cutting and harvesting) can effectively maintain low levels of nuisance growth and eliminate surface-matting.

This survey establishes a solid benchmark that will allow for more effective management planning and evaluation of management outcomes in the coming years. The Rice Lake Area Association should continue to monitor the aquatic plant community of Rice Lake at least every 5 years to track any changes, or more frequently if intensive management is planned or notable changes in plant abundance or water clarity occur.

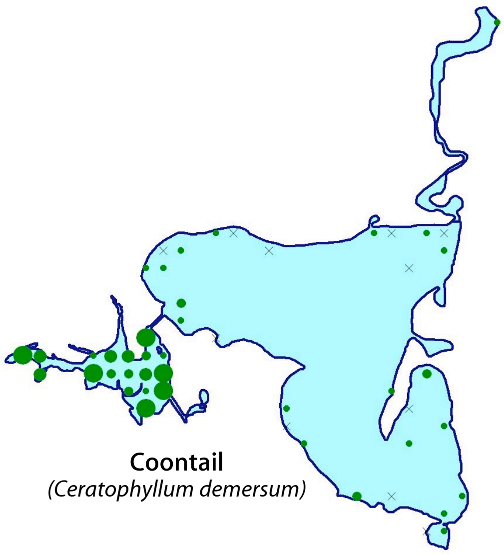
Species Distribution and Density Maps



Curlyleaf Pondweed
(Potamogeton crispus)

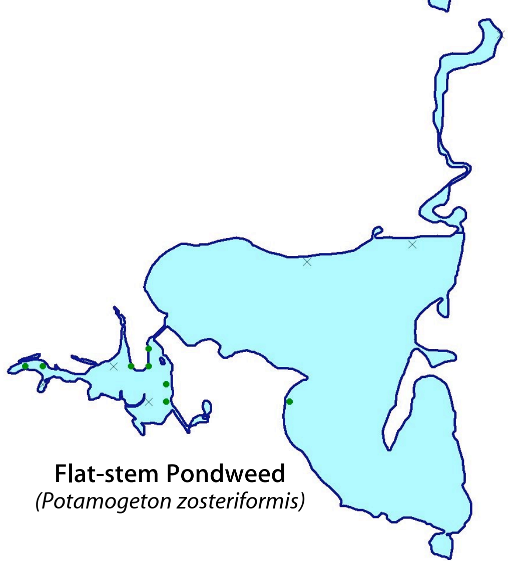


Eurasian Watermilfoil
(Myriophyllum spicatum)

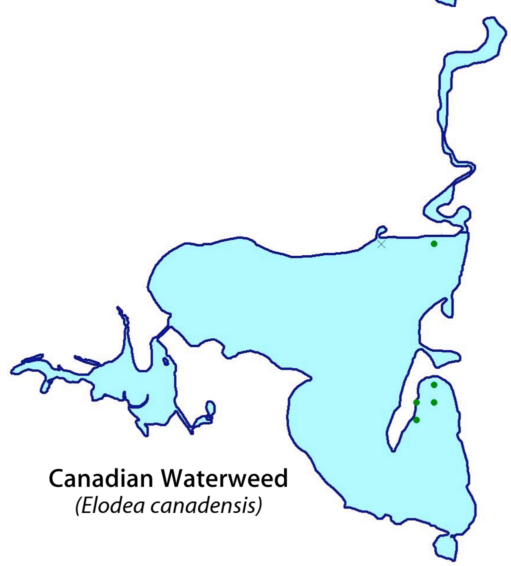


Coontail
(Ceratophyllum demersum)

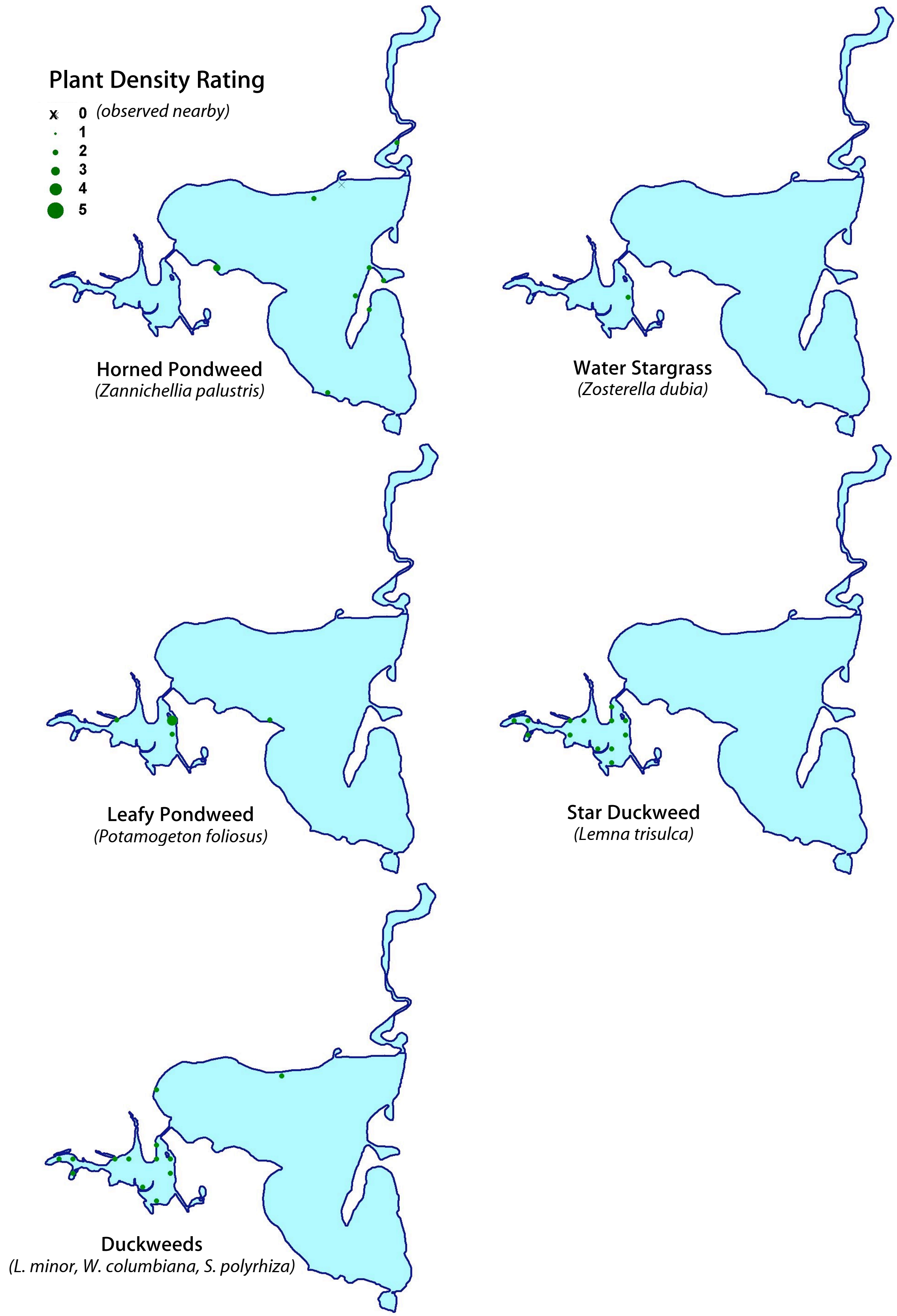
Sago Pondweed
(Stuckenia pectinata)



Flat-stem Pondweed
(Potamogeton zosteriformis)



Canadian Waterweed
(Elodea canadensis)


Plant Density Rating
0 (observed nearby)
1
2
3
4
5
Horned Pondweed
(Zannichellia palustris)
Water Stargrass
(Zosterella dubia)
Leafy Pondweed
(Potamogeton foliosus)
Star Duckweed
(Lemna trisulca)
Duckweeds
(L. minor, W. columbiana, S. polyrhiza)

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