FRESHWATER
Scientific Services, LLC

www.fixmylake.com
18029 83rd Avenue North
Maple Grove, MN 55311
mail@freshwatersci.com
(651) 336-8696

Rice Lake: 2009 Aquatic Vegetation Report

Prepared for the Rice Lake Area Association
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By James A. Johnson – Freshwater Scientific Services, LLC

Introduction

Submersed aquatic vegetation plays an important role in freshwater systems, affecting nutrient dynamics, trophic interactions, biological assemblages, and fish productivity (Jeppeson et al. 1998; Scheffer 2004). These effects are amplified in shallow lakes where much of the lake sediment area can support plant growth. Such lakes tend to persist in one of two states; a clear-water plant-dominated state, or an algae-dominated state with low water clarity. In general, the more fertile a shallow lake is, the more likely it is to persist in the algae-dominated state (Scheffer 2004).

The main basin of Rice Lake (*DOW# 27-0116-01*) is a classic example of a highly fertile (hypereutrophic) shallow lake that is stuck in an algae-dominated state. In contrast, the newly designated western bay of Rice Lake (*DOW# 27-0116-02*) supports dense aquatic plant growth with a fair amount of native plant diversity and consistently clearer water than the main basin. The current water clarity and plant growth conditions in these two adjacent basins provide a great example of the plant-dominated and algae-dominated states. Given the potential influence that aquatic plant growth (or lack thereof) has on the water quality and ecological health of Rice Lake, comprehensive knowledge of the aquatic plant community needs to be considered a key component of any future management planning to improve the recreational and ecological quality of the lake.

The *Rice Lake Area Association* contracted with *Freshwater Scientific Services, LLC* to conduct two point-intercept vegetation surveys on Rice Lake 2009 to enhance their knowledge of the plant community in the lake. The first survey was completed in June to assess the growth and distribution of curlyleaf pondweed (*Potamogeton crispus*) and young native plants, with a second survey in August to assess late summer growth and distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) and native aquatic plants at their expected peak density. These point-intercept surveys differed from the line-transect surveys conducted by *Blue Water Science* in 2005, 2006 and 2007 in that the 2009 surveys assessed vegetation throughout the lake, with measurements collected at over 200 locations including assessment of the main lake basin, the northern channel upstream of the outlet dam, and the newly designated western bay.

Project Objectives

1) Assess the density and distribution of curlyleaf pondweed, Eurasian watermilfoil and native aquatic plants
   - Maximum depth of growth
   - % of lake with plants
   - Census of plant species
   - Growth density
   - Map distribution of plants

2) Collect scientific data to meet Minnesota DNR aquatic vegetation management permit and grant program requirements *

3) Provide information to guide aquatic plant management activities in the western bay, Elm Creek channel, and main basin of Rice Lake.

* *While this monitoring program has been designed to meet or exceed MNDNR vegetation assessment requirements, it will not guarantee a DNR grant or permit variance for lake-wide treatment in the future.*

Invasive Aquatic Plants

Eurasian watermilfoil
Myriophyllum spicatum

Curlyleaf pondweed
Potamogeton crispus

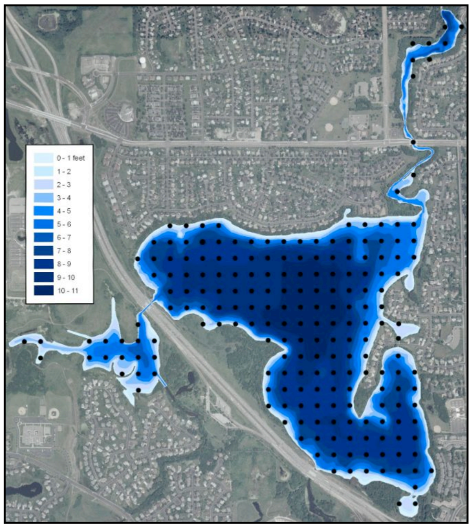
The two most prevalent invasive aquatic plants in Minnesota are curlyleaf pondweed and Eurasian watermilfoil. Together, these non-native plants have dramatically reduced the recreational and ecological quality of many lakes in Minnesota. As of 2008, over 750 Minnesota lakes had documented curlyleaf infestations, and nearly 200 had infestations of Eurasian watermilfoil. Both of these plants are found in Rice Lake at relatively low densities. Large areas of dense curlyleaf or milfoil growth often degrade the recreational and ecological quality of lakes, reduce the aesthetic quality of lake views, reduce lakeshore property values (Krysel et al. 2003), and have the potential to impair summer water quality (Bolduan et al. 1994; James et al. 2001).

These invasive non-native species are often lumped together as “bad plants”, but there are some important differences in how they grow and the nature of the problems they cause. Milfoil sprouts in the early spring from rootstock and stem fragments and grows rapidly, often forming dense surface mats by late spring. These nuisance mats tend to persist for the rest of the summer, shading out beneficial native plants and causing problems for boaters who try to motor through them. Curlyleaf, on the other hand, sprouts from reproductive buds (turions) in the fall and then grows very slowly throughout the winter and early spring. As the ice disappears from lakes and water temperatures warm, it begins to grow more rapidly, often reaching the water surface by late May. As with Eurasian watermilfoil, this propensity for rapid early-season growth and the ability to form dense canopy mats gives curlyleaf a competitive advantage over most native aquatic plants. But with curlyleaf, these dense mats naturally die off and disappear by mid to late June. This rapid die-off of large areas of curlyleaf and subsequent decay of plant shoots may result in a pulse of nutrients (Barko and Smart 1980; Carpenter 1980; Landers 1982; Barko and James 1998). This early summer spike in nutrients may lead to additional recreational and ecological impairment by fueling algae growth, decreasing water clarity, and further reducing native plant growth due to light limitation (Madsen and Crowell 2002).

For more information on invasive plants and animals in Minnesota lakes, see the *Invasive Species of Aquatic Plants and Wild Animals in Minnesota, Annual Report* (available online at http://www.dnr.state.mn.us/eco/pubs_invasives.html).

Sampling Methodology

Both of the 2009 surveys employed a point-intercept method (Madsen 1999) that incorporated assessments at 207 sample points. These points were determined by using desktop GIS software and a random sample generator program. This produced a grid of equally spaced points across an aerial photograph of the lake, with all of the grid points falling within the boundary of the lake shoreline being included in the final tally. Out of these 207 sample points, 178 were located in the main lake basin, 11 in the northern channel upstream of the outlet dam, and 18 in the newly designated western basin. To maintain the necessary randomization for statistical analysis, I made no attempt to select additional points in any of the lake's bays. Locations for each sample location were loaded onto a handheld GPS unit to allow for rapid and accurate navigation to each point while sampling.



Map showing sampled locations (black dots) for the 2009 aquatic vegetation surveys. (see pages 15 and 16 for full-size maps)

At each designated point, vegetation was sampled using a weighted double-headed 14-tine rake attached to a rope. To ensure that each sample collected vegetation from a consistent area of the lake sediment, the rake (13 inches wide) was dragged for roughly 10 feet along the bottom before retrieving, resulting in a sample area of roughly 10 square feet. Retrieved plant fragments were piled on top of the rake head and assigned density ratings from 1 to 5 based upon rake coverage as described by Deppe and Lathrop (1992).

0 = Observed growing in area, but not retrieved on rake
1 = 1-20% rake head coverage
2 = 21-40%
3 = 41-60%
4 = 61-80%
5 = 81-100%

James A. Johnson, *Aquatic Ecologist* from *Freshwater Scientific Services, LLC* evaluating a retrieved rake sample.

Density ratings were assigned for all plants collectively (whole rake density) as well as for individual plant species retrieved on the rake head. Additional plant species that were observed growing within 10 feet of the designated points but not retrieved on the rake were given a rating of zero and were included in final species lists, but zero ratings were not included in the calculated plant community metrics.

The high-resolution data from these point-intercept surveys provides a more detailed assessment of plant growth than past line-transect surveys and more thoroughly covers the entire lake basin. This will allow for better management planning and greater sensitivity for detecting changes in the plant community in the coming years.

Results

June 2009 Survey

The first vegetation survey was completed on June 1, 2009. Late spring plant growth in the main basin and northern channel was generally limited to areas shallower than 5 ft with only a few instances of small fragments of coontail found in deeper areas up to 7.5 ft. Curlyleaf pondweed and Eurasian watermilfoil were observed growing to the surface in areas between 1.0 and 4.5 ft deep, but there were no expansive areas of dense nuisance growth. Curlyleaf in particular was widespread within this narrow depth range, but was generally encountered at low densities and only occurred at 7% of the sampled sites in the main lake basin.

The newly designated western bay showed a dramatically different pattern of plant growth, with much higher native plant diversity, widespread dense growth, and a higher incidence of surface growth than the main basin or northern channel. Though a total of 11 native plant species were encountered in Rice Lake during the June survey, only Coontail (*Ceratophyllum demersum*) and sago pondweed (*Stuckenia pectinata*) were found at more than 5% of the sampled locations, and 40% of the total observed occurrences of native plants were found within the western bay.

August 2009 Survey

The second vegetation survey was conducted on August 18, 2009. Overall late summer plant growth in the main basin and northern channel were confined to even shallower regions than seen in the June survey, with maximum depth of plant growth in these areas being less than 4 feet and extremely sparse. The main lake basin was essentially devoid of plant growth during the August survey except for small patches of coontail and milfoil immediately along shore (usually in water <1.0 feet deep). These small areas of growth provided little habitat for fish and wildlife, and did not protect shorelines or sediments from erosion and resuspension.

As observed in June, the western bay had dramatically higher plant growth and native plant diversity than the rest of Rice Lake. As stated in the introduction, the differences in water clarity and plant growth conditions in these two adjacent basins provide a great example of the plant-dominated and algae-dominated stable states common in shallow lakes.

Rice Lake Morphometry

	Main Basin	***Northern Channel***	***West Basin***
Surface Area	314 acres	17 acres	34 acres
Maximum Depth	11 ft	10 ft	7 ft
Average Depth	7 ft	-	-
% Littoral (<15ft)	100%	100%	100%
Watershed Area	16,900 acres	-	-

Key Findings

1. Sparse plant growth and low native plant diversity in main basin and northern channel, with dramatically higher plant growth and native diversity in the western bay

2. Widespread but sparse curlyleaf pondweed and Eurasian watermilfoil growth in shallow areas of the main basin (< 4.5 feet) in June (no dense surface matting). Eurasian watermilfoil growth highest along the southwestern shoreline of the main basin.

3. Very little plant growth observed in the main basin in August, but continued high plant density and diversity in the western bay

2009 Vegetation Surveys: Key Findings
Summary of key plant community metrics from the Rice Lake point-intercept vegetation survey conducted on June 1 and August 17, 2009. Percentages were calculated as the number of sites with the vegetation or surface growth present divided by the total number of samples sites within each section of the lake.

	Main Basin		Northern Channel		Western Bay	
	June	*Aug*	*June*	*Aug*	*June*	*Aug*
# of Points Sampled	178	178	11	11	18	18
% Vegetated *(all littoral)*	13	1	36	27	100	100
% Surface Growth	10	1	9	18	72	61
Max Depth of Growth *(ft)*	7.5	3.0	7.5	3.9	6.3	6.6
# of Native Plant Species	5	4	2	4	7	8
Avg # of Natives per Point	0.2	<0.1	0.4	0.5	2.9	3.1
Avg Curlyleaf Density *(0-5)*	0.1	0.0	0.2	0.0	0.6	0.1
Avg E. Milfoil Density *(0-5)*	<0.1	<0.1	<0.1	<0.1	0.0	0.0

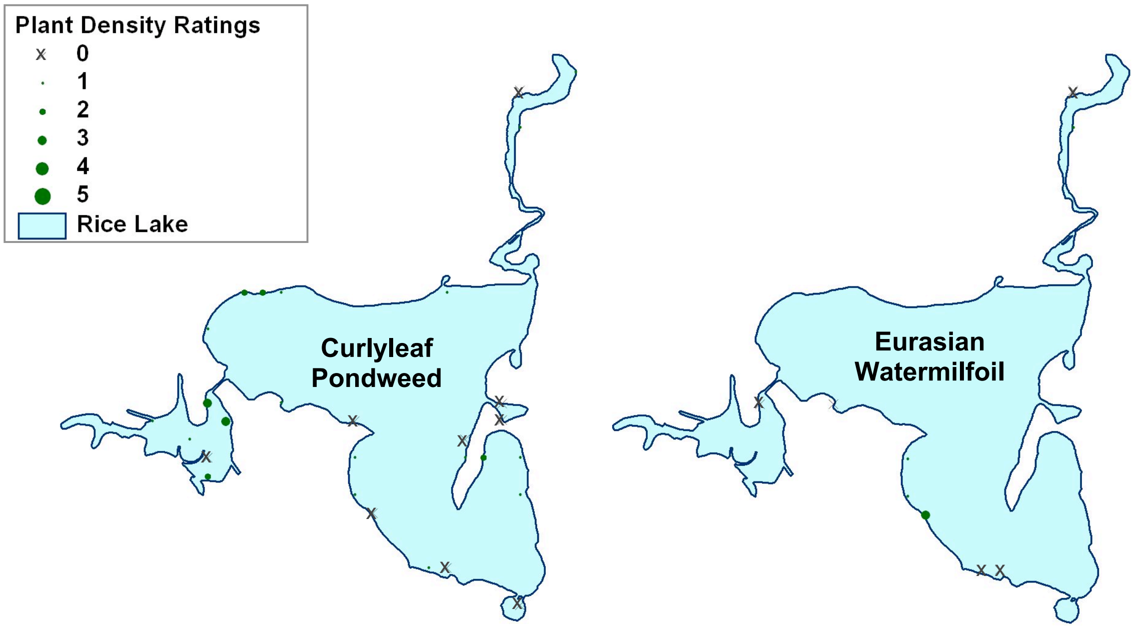
Curlyleaf Pondweed
Curlyleaf pondweed was widespread in near-shore areas between 1.0 and 4.5 ft deep, but generally occurred at low density with no observed areas of severe nuisance growth. Low-density curlyleaf surface growth occurred at only 9% of the sampled locations. No turions were observed on standing plants at the time of the survey. This was common in other Minnesota lakes in 2009 and was likely the result of the cool spring. It is likely that the observed curlyleaf shoots in Rice Lake produced turions later in June.

Eurasian Watermilfoil
Despite fairly frequent observations of milfoil reaching the surface of the lake in shallow (<5 ft) near-shore areas, it was not observed to form dense nuisance growth in any areas of the lake. Like curlyleaf, milfoil in Rice Lake is confined to shallow near-shore areas.

Native Aquatic Plants
In 2009, Rice Lake supported a low abundance and low diversity of native plant growth. Turbidity-tolerant plants, such as sago pondweed, horned pondweed, and coontail were widespread but very sparse in the main basin and northern channel. The western bay supported a richer assemblage of native plants and at much higher densities than in the rest of the lake. Considering that the western bay is upstream from the main basin, it may serve as a natural source of seeds and viable plant fragments for reestablishing native plant growth in the rest of Rice Lake if conditions become more amenable to plant growth in the future. This potential as a source of native stock is supported by the existence of higher species diversity in the area of the main basin directly adjacent to the channel from the western bay. If water clarity in the main basin is improved in tandem with management activities to control the carp population and limit the growth of curlyleaf and Eurasian milfoil, native plants currently found in the western bay would likely spread into the main basin and quickly recolonize.

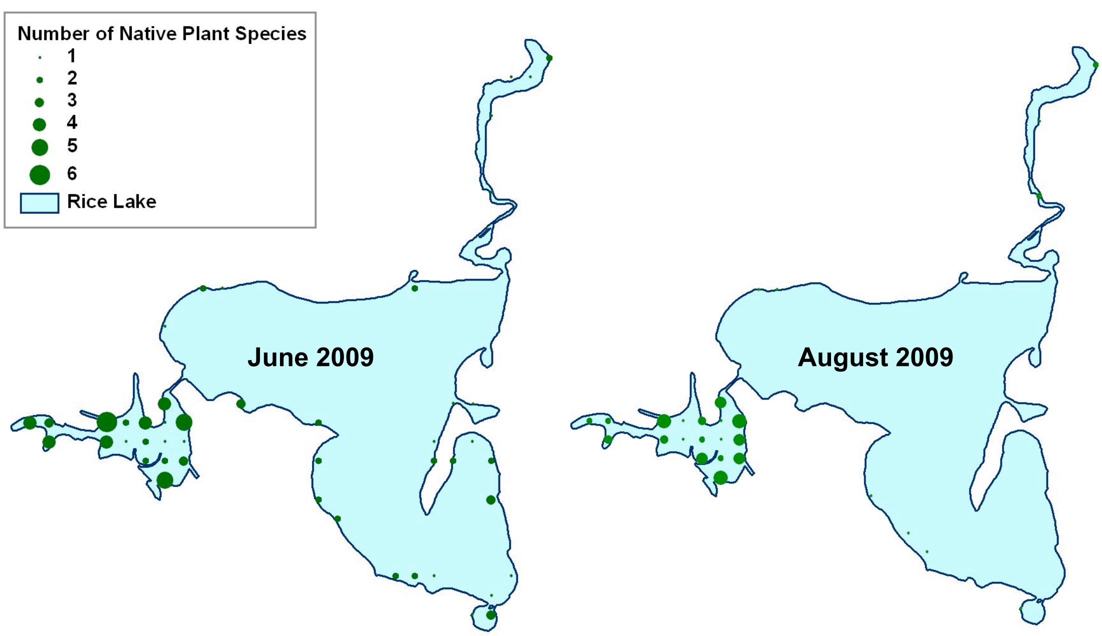
2009 Curlyleaf Pondweed and Eurasian watermilfoil Distribution and Diversity

Maps showing locations where curlyleaf pondweed and Eurasian watermilfoil were encountered in 2009, with growth densities indicated by the size of each dot.



2009 Native Plant Distribution and Diversity

Maps showing locations where native plants were encountered, with the number of native species encountered at each site indicated by the size of each dot.



2009 Plant Species % Occurrence

Summary of % occurrence for plant species encountered during the Rice Lake point-intercept vegetation surveys. % occurrence values were calculated as the number of sampled sited where a given species was found divided by the total number of sites sampled in each section of the lake as indicated. Plant species that were observed growing but not retrieved on any rake samples are noted as being present (P).

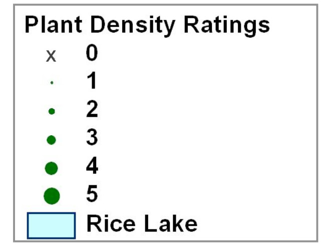
		Main Basin		Northern Channel		Western Bay	
		June	*Aug*	*June*	*Aug*	*June*	*Aug*
Submersed	**Curlyleaf pondweed** *Potamogeton crispus*	7	-	18	-	28	11
Submersed	**Eurasian watermilfoil** *Myriophyllum spicatum*	2	1	9	9	-	-
Submersed	**Coontail** *Ceratophyllum demersum*	9	P	36	27	100	100
Submersed	**Sago pondweed** *Stuckenia pectinata*	6	-	-	-	39	44
Submersed	**Elodea** *Elodea canadensis*	1	-	-	-	39	17
Submersed	**Water stargrass** *Zosterella dubia*	-	-	-	9	33	50
Submersed	**Flat-stem pondweed** *Potamogeton zosteriformis*	-	-	-	-	39	11
Submersed	**Horned Pondweed** *Zannichellia palustris*	3	-	-	-	-	-
Submersed	**Star duckweed** *Lemna trisulca*	-	-	-	9	17	44
Floating	**Lesser duckweed** *Lemna minor*	-	-	-	1	39	44
Floating	**White waterlily** *Nymphaea odorata*	P	P	P	P	P	P
Emergent	**Hardstem bulrush** *Scirpus acutus*	-	-	P	P	-	-
Emergent	**Broad-leaf cattail** *Typha latifolia*	P	P	P	P	P	P

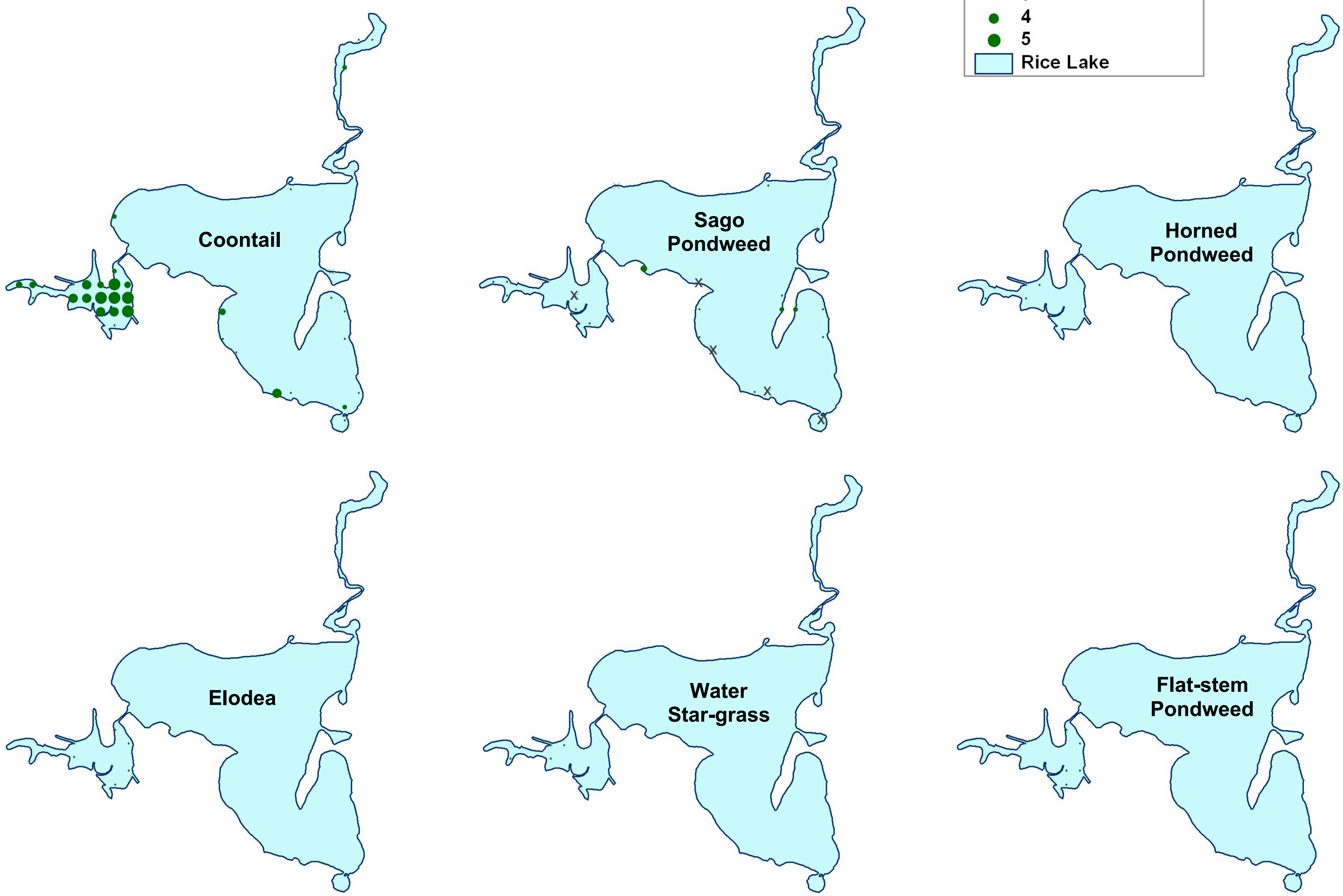
Past August Vegetation Survey Results *(from 2008 Blue Water Science report)*

	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

Native Aquatic Plant Species: June 1, 2009

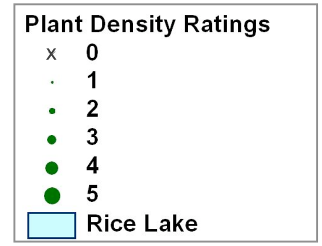
Maps showing location and density of select native aquatic plants with growth density indicated by the size of each dot.

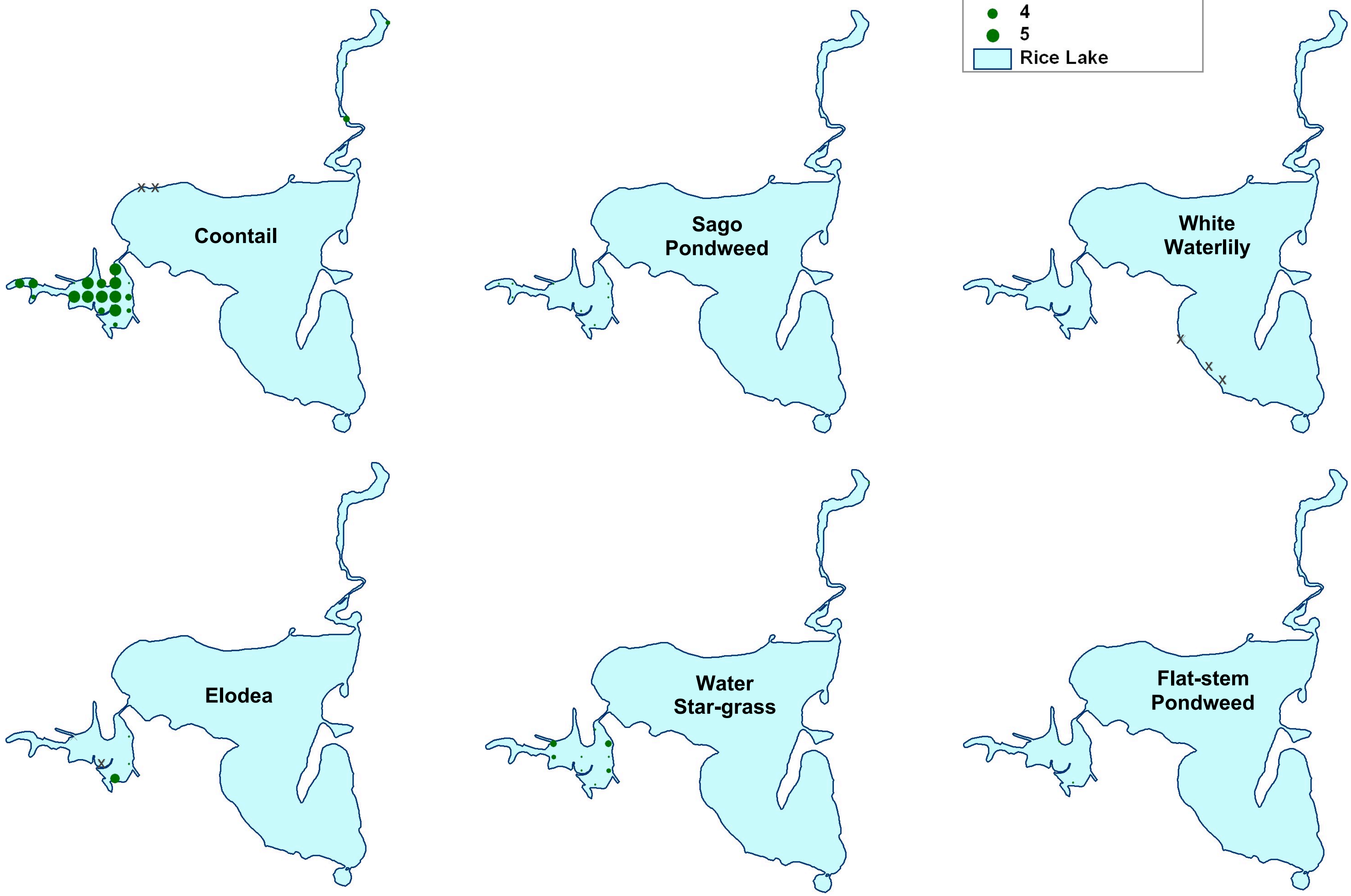




Native Aquatic Plant Species: August 17, 2009

Maps showing location and density of select native aquatic plants with growth density indicated by the size of each dot.





Discussion of Results

Water clarity is currently the most important factor limiting plant growth in Rice Lake. Although the western bay supports a dense and diverse native plant community, the rest of the lake is nearly devoid of plants. As stated in the introduction, the current low water clarity and lack of vegetation in the main basin is a classic example of the algae-dominated stable state commonly seen in shallow lakes. This algae-dominated condition favors high internal release of phosphorus from lake sediments (due to very high rates of photosynthesis and respiration by algae which lead to high pH during the day and low oxygen at night) and inhibits plant growth by drastically reducing light levels penetration to the sediment. Given the high summer phosphorus concentrations in Rice Lake (TP>120 μg/L), this algae-dominated condition is likely to persist unless major nutrient reductions can be achieved in tandem with reestablishment of plant growth. The amount of curlyleaf growth observed in 2009 was very low compared to many other infested lakes, and was not large enough to be an important contributor to internal nutrient loading. Future vegetation management activities should focus on promoting native plant growth and maintaining the current low density and distribution of curlyleaf and Eurasian watermilfoil.

Vegetation Management Recommendations

1. **Decrease nutrient loading**: Low water clarity in the main basin and northern channel of Rice Lake currently inhibits plant growth in areas deeper than 5 feet. Without substantial reductions in the inflow of nutrients from Elm Creek and internal release of phosphorus from lake sediments, this condition will likely persist. This management option is in large part beyond the abilities of the RLAA, but the RLAA should continue or expand involvement with the Maple Grove Lake Quality Commission and Elm Creek Watershed Management Commission in working toward this goal. Local nutrient reduction strategies such as stormwater pond maintenance, erosion control, frequent street sweeping, and the use of phosphorus-free lawn fertilizers should be promoted by the RLAA to minimize local nutrient inputs. In addition to promoting native plant growth, nutrient reductions would reduce the frequency of noxious algae blooms.

2. **Suppress carp population**: This is a daunting task that is also likely beyond the financial abilities of the RLAA, but members should stay apprised of new research on carp control (Dr. Peter Sorenson – UMN) for possible future management strategies. Periodic fish surveys to track changes in the carp population may also be useful in guiding management strategies. As discussed in past years, it would be useful to test whether carp are actively uprooting plants or if water clarity is the main limitation to plant growth. Experimental revegetation plots (see discussion #3 below) that included carp exclosure fences would be very useful in answering this question. I am currently working with the University of Minnesota on such a project in Lake Susan, MN.

3. **Promote native plant growth**: Minimize harm to existing native plants in Rice Lake and promote new growth in unvegetated areas through responsible shoreline stewardship and low-impact vegetation management practices that promote and protect native plants. I recommend establishing several small near-shore planting sites to test whether “founder colonies” of native plants currently found in the western bay can be established in unvegetated areas of the main basin. I am currently working with Dr. Ray Newman and Dr. Peter Sorenson at the University of Minnesota to establish such plots in Lake Susan (Chanhassesn, MN). If small founder colonies can be established, they may spread to other unvegetated areas. This has the potential to reduce internal release of phosphorus from Rice Lake sediments, reduce sediment resuspension, and increase water clarity.

4. **Maintain low levels of curlyleaf pondweed and Eurasian watermilfoil**: Though neither of these invasive non-native plants is currently causing nuisance conditions in Rice Lake, they may rapidly expand in coverage and density if water quality conditions improve. Maintaining the current low levels will be much easier and less expensive than trying to manage large areas of dense growth in the future. Lake drawdowns are likely the least expensive management alternative for controlling curlyleaf and Eurasian milfoil in Rice Lake, but the following strategies should also be considered to reduce potential impacts to fish and wildlife, native aquatic plants, and downstream areas of Elm Creek.

   - *Early-spring herbicide application* (endothall and triclopyr combined treatment in April)
     The MNDNR and US Army Corps of Engineers has been testing these combined treatments for controlling curlyleaf and Eurasian watermilfoil for several years. Since both of these invasive plants are confined to a narrow band around the main basin of Rice Lake, the cost for treatment would likely be relatively low ($5000-8000), and you would likely be able to treat the entire area where these plants grow under the current 15% littoral limit set by the DNR under their vegetation management permit program. Herbicide formulation should be an important consideration given the potential for flow from Elm Creek (almost certainly flowing in the early spring) and narrowness of the area that would need to be treated (roughly out to the 5-foot contour). These conditions would likely lead to dilution of any liquid herbicide applied. Consequently, any plans to pursue herbicide treatment should include discussions on the use of granular formulations or possible “overdosing” of some areas to maintain sufficient herbicide concentrations for the requisite contact period to achieve control.
   - *Mechanical harvesting* (in late spring prior to curlyleaf turion formation)
     This alternative is less feasible than herbicide application since most of the growth of curlyleaf and Eurasian watermilfoil occurs in very shallow areas along shore. A small harvester would likely be sufficient given the low density of growth. A small vessel would also be more able to work in shallow water near shore. This strategy would likely be comparable in cost to herbicide application, but may not be as effective. For this reason it should only be favored over herbicides if the RLAA or its members are resistant to the use of herbicides.
   - *Eurasian watermilfoil weevil surveys* may also be useful to determine if Rice Lake supports a population of these natural native beetles. Milfoil weevils can greatly reduce milfoil density when present at high numbers. If the lake was found to support enough weevils, there may be less of a need to manage Eurasian watermilfoil through herbicide application or harvesting.

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Pictures of Major Native Plants in Rice Lake

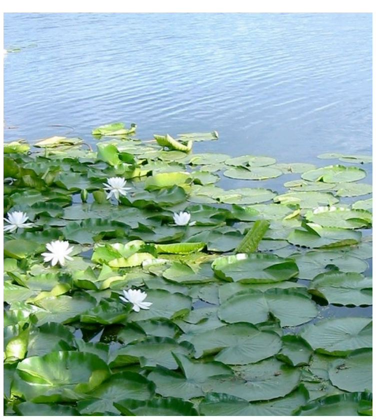
Coontail

Elodea

Sago pondweed

Flat-stem pondweed

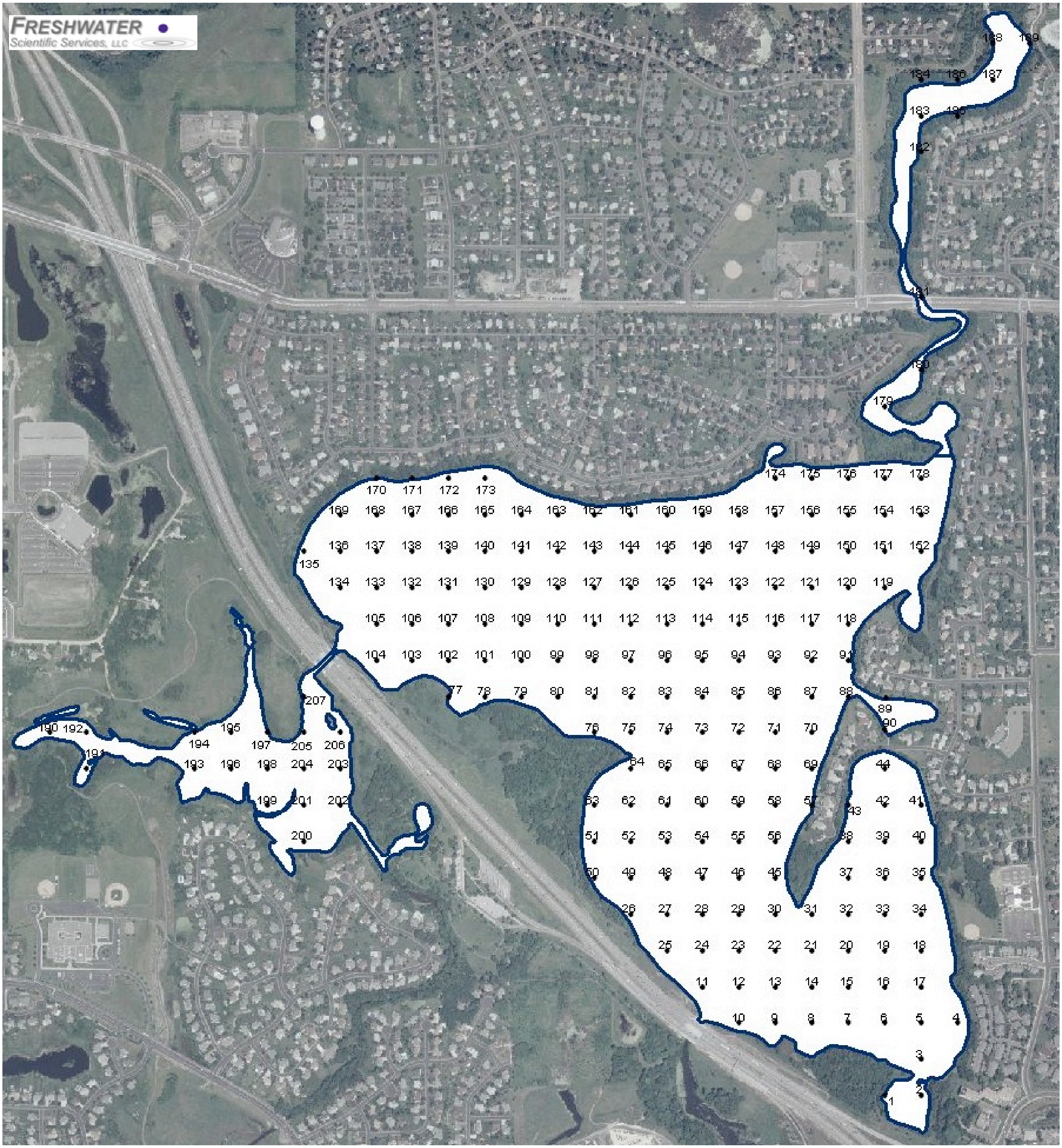
Water star-grass



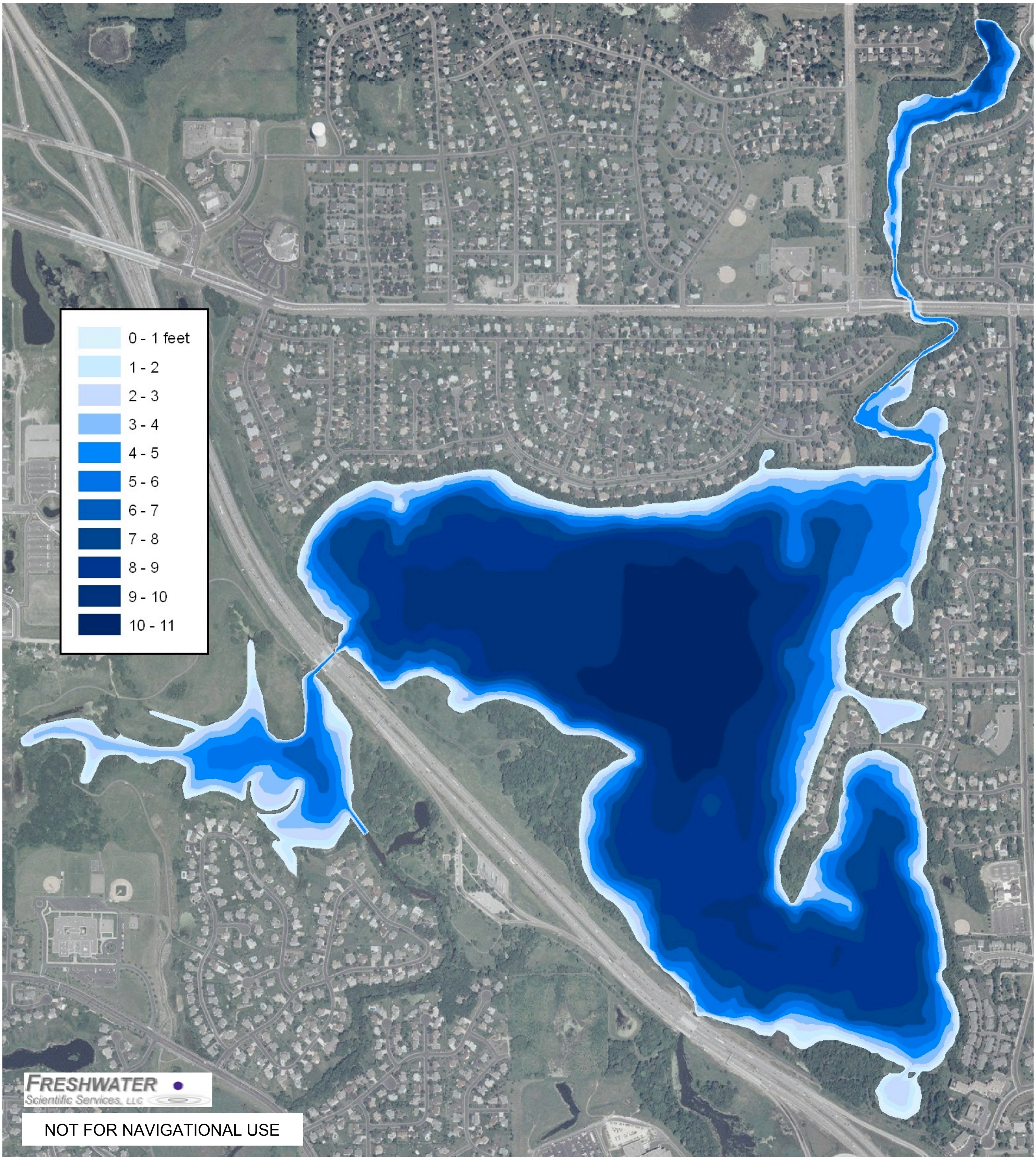
White waterlily

Horned pondweed

Map of Point-Intercept Aquatic Vegetation Survey Sample Locations: 2009



Updated Bathymetric Map of Rice Lake: 2009



Rice Lake Hypsographic Curves *(based upon updated 2009 lake bathymetry data)*

These curves are very useful for determining the volume of water or area of sediment above or below a certain depth contour. Potential uses include evaluating drawdown volumes, estimating lake refill times, sediment area exposed during drawdowns, and estimation of sediment area that receives sufficient light to support plants under different water clarity conditions.