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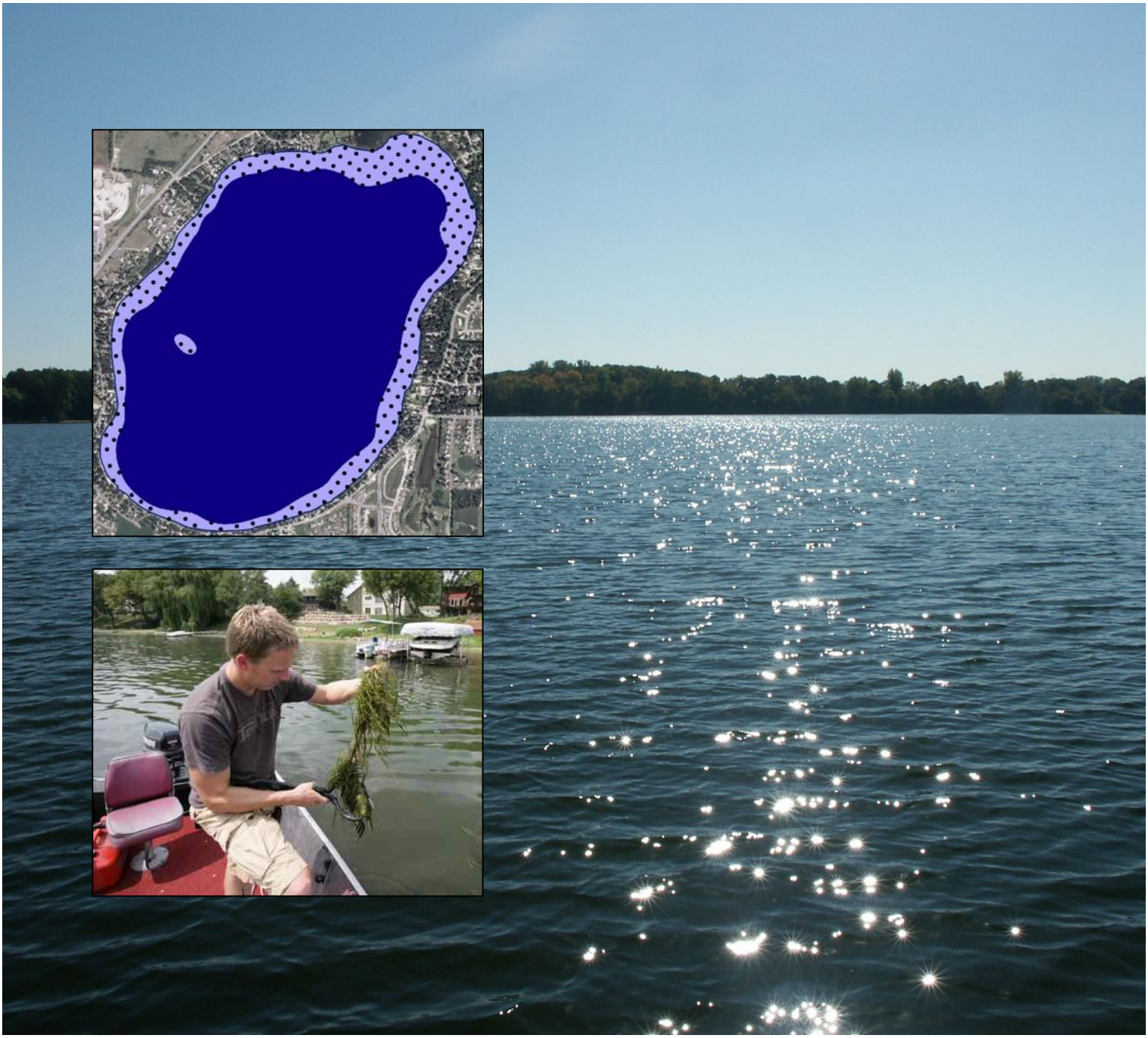
Lake Pulaski: 2010 Aquatic Vegetation Report



Prepared for the Pulaski Lake Improvement District
By James A. Johnson – Freshwater Scientific Services, LLC
June 2010

Introduction

Submersed aquatic plants play an important role in freshwater lakes, affecting nutrient dynamics, water clarity, food-web interactions, biological assemblages, and fish productivity (Jeppeson et al. 1998; Scheffer 2004). Healthy aquatic plant communities can become impaired due to low water clarity, over-management by lakeshore homeowners, or infestation by invasive non-native plants and carp. In turn, these changes in the plant community can lead to degradation of the ecological and recreational quality of lakes. Given the strong influence that plants can have on the overall health of lakes, it is vital that vegetation management decisions be founded upon solid understanding of the current condition of the plant community and the potential impacts (positive or negative) of management activities on other aspects of lake quality.

To enhance knowledge of the plant community in Lake Pulaski (*Lake Inventory #86-0053-02*) and Little Pulaski Lake (#86-0053-01), the *Pulaski Lake Improvement District* contracted with *Freshwater Scientific Services, LLC* to conduct a point-intercept vegetation surveys in August 2009 and June 2010. These surveys were designed to assess the growth and distribution of exotic invasive aquatic plants, as well as native aquatic plants. The results of these surveys provide a detailed assessment of the current aquatic plant communities in the two lake basins. This information will help to guide responsible vegetation management planning and will provide a baseline condition for tracking changes in the plant community and evaluating the success of any future vegetation management activities.

Project Objectives

1) Assess the density and distribution of exotic invasive and native aquatic plants.
   - Maximum depth of growth
   - % of lake with plants
   - Census of plant species
   - Growth density
   - Map distribution of plants

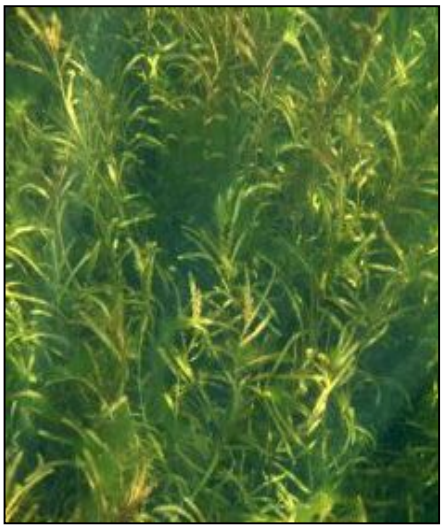
2) Collect scientific data to meet Minnesota DNR aquatic vegetation management permit and grant requirements *

3) Provide information to guide aquatic plant management activities

* *Although this monitoring program has been designed to meet or exceed MNDNR vegetation assessment requirements, it will not guarantee a DNR grant or permit for plant management in the future.*

Invasive Aquatic Plants

Eurasian watermilfoil
Myriophyllum spicatum



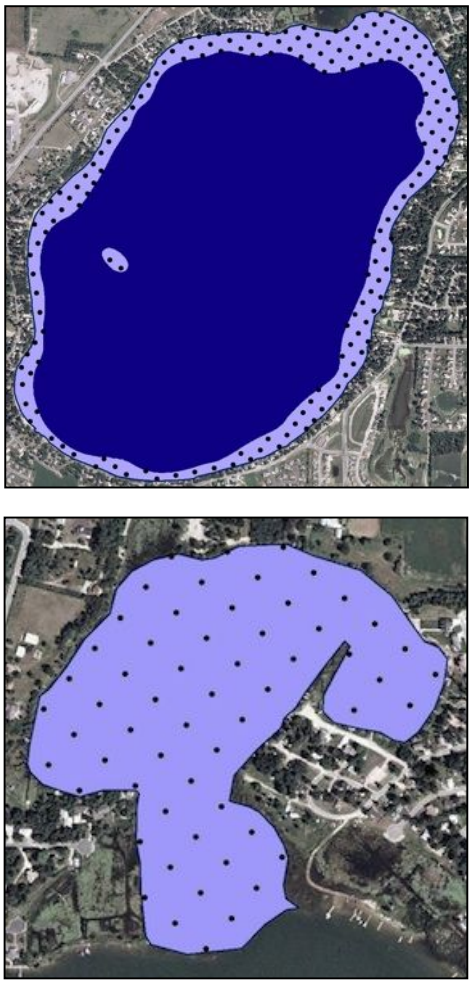
Curlyleaf pondweed
Potamogeton crispus

The two most prevalent invasive aquatic plants in Minnesota are curlyleaf pondweed ("curlyleaf") and Eurasian watermilfoil ("milfoil"). Large areas of dense curlyleaf or milfoil growth often impair the recreational and ecological quality of lakes, degrade 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). Together, these invaders 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 milfoil infestations. Both of these invasive non-native plants currently grow in Lake Pulaski and Little Pulaski Lake (milfoil confirmed in 1991).

Milfoil and curlyleaf 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 and swimmers who try to venture 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, these curlyleaf shoots begin to grow more rapidly, often reaching the water surface by late May. As with milfoil, 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. Unlike milfoil, these dense mats of curlyleaf naturally die off and disappear by mid to late June. This rapid die-off of large areas of curlyleaf and subsequent decay of large amounts of plant material 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 in some lakes by fueling algae growth, decreasing water clarity, and reducing native plant growth due to shading (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* currently available online at the following URL: http://www.dnr.state.mn.us/eco/pubs_invasives.html

Sampling Methodology



Sampled locations (black dots) for the 2009 aquatic vegetation survey of Lake Pulaski and 2010 survey of Little Pulaski Lake with the littoral area (≤15 ft) shown in light blue. (see pages 20 and 21 for full-size maps)

The 2009 and 2010 surveys employed a point-intercept method (Madsen 1999) that incorporated assessments at a total of 232 sample points (173 on Pulaski Lake, 59 on Little Pulaski). 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 and in areas shallower than 20 feet being included in the final tally. Locations for each set of sample points were loaded onto a handheld GPS unit to allow for rapid and accurate navigation to each point while sampling.

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 one to five based upon a modified version of the rake coverage as described by Deppe and Lathrop (1992), with an added rating of zero for plants that were observed growing within 10 feet of the sample point but not retrieved on the rake.

0 = Observed growing in area, but not retrieved on rake
1 = 1-25% rake head coverage
2 = 26-50%
3 = 51-75%
4 = 76-100%
5 = >100% Rake saturated with additional plants hanging off

Density ratings were assigned for all plants collectively as well as for each individual plant species retrieved on the rake head. Additional plant species that were given a rating of zero were included in the final species list, but were not included in the calculated plant community metrics.

The high-resolution data from this point-intercept survey provides a detailed assessment of plant growth throughout the entire littoral area (<15 ft) of the surveyed lake basins. This will allow for better management planning and will provide sufficient sensitivity to detect any meaningful changes in the plant community in the coming years.

Summary of Results

Lake Pulaski Morphometry

Surface Area	741 acres
% Littoral (<15ft)	20% (149 acres)
Maximum Depth	87 ft
OHW Elevation	967.5 ft
Shoreline Length	4.0 miles

Little Pulaski Morphometry

Surface Area	57 acres
% Littoral (<15ft)	100% (57 acres)
Maximum Depth	15 ft
OHW Elevation	967.5 ft
Shoreline Length	1.6 miles

Key Findings

1. The main basin (Lake Pulaski; 86-0053-01) supported widespread, low to moderate density Eurasian watermilfoil growth, but no expansive surface matting or monotypic milfoil stands encountered. However, some sporadic patches of surface matted milfoil growth occurred in the area surrounding the channel between the main basin and Little Pulaski and in the small eastern-most bay of Little Pulaski.
2. Both basins supported widespread, diverse, and abundant native plant growth; native plants found at 100% of the sampled littoral (≤15ft) locations in both surveys.
3. Eurasian watermilfoil appeared to be well established throughout both basins but has not effectively out-competed native plants despite nearly 20 years of infestation. This suggests that current local conditions do not favor severe nuisance milfoil growth over expansive areas in either basin.

Freshwater Scientific Services, LLC completed aquatic plant surveys on the main basin of Lake Pulaski on August 31, 2009 and on Little Lake Pulaski on June 10, 2010. Both basins were found to support an abundant and diverse aquatic plant community that included over 20 native species and two non-native invasive species (curlyleaf pondweed and Eurasian watermilfoil). Observed curlyleaf growth was sporadic and very light in the main basin, but the late summer survey was conducted several months after typical curlyleaf senescence and thus did not likely provide an accurate assessment of curlyleaf growth in the main basin of Lake Pulaski. Curlyleaf growth was more widespread and denser in Little Lake Pulaski, occurring at 49% of the sampled locations. Eurasian watermilfoil was widespread in both of the sampled basins, occurring at over 50% of the sampled littoral (<15ft) locations in the main basin and at 42% of the sampled locations in Little Lake Pulaski. In general, this Eurasian watermilfoil growth was of low to moderate density, but there were sporadic patches of nuisance surface-matted milfoil growth in the area surrounding the channel connecting Little Pulaski to the main basin.

The native plant community was found to be very diverse with widespread abundant growth in both of the sampled basins. Native plant growth in the main basin was dominated by coontail (*Ceratophyllum demersum*) and wild celery (*Vallisneria americana*), followed in order of decreasing dominance by muskgrass (*Chara* spp.), northern watermilfoil (*Myriophyllum sibiricum*), and flat-stem pondweed (*Potamogeton zosteriformis*). Native plant growth in Little Pulaski dominated by coontail, followed in order of decreasing dominance by flat-stem pondweed, northern watermilfoil, wild celery, bluntleaf pondweed (*Potamogeton friesii*), and stiff water-crowfoot (*Ranunculus longirostris).* Native plants were encountered at 100% of the sampled littoral points (≤15 ft) in both basins, and generally occurred at moderate to high density. The high diversity and widespread abundant growth of the native plant community, even after 20 years of infestation by Eurasian watermilfoil, suggests that the milfoil has not able to effectively out-compete many of the native species in either the main basin of Pulaski Lake or in Little Pulaski. This is likely due to a combination of local conditions, including sediment characteristics, nutrient availability, and water clarity. Eurasian watermilfoil has also been observed to be held at bay in some lakes by high densities of milfoil weevils (Newman 2004), but little to no weevil damage was observed during the plant surveys (anecdotal observation by surveyor: no systematic evaluation of weevil damage was conducted).

Aquatic Vegetation Survey Results

Key plant community metrics from point-intercept vegetation surveys

Plant Community Metrics	Lake Pulaski *(86-0053-02)* August 2009	Little Pulaski *(86-0053-01)* June 2010
Whole-Lake Metrics		
Total # of Points Sampled *(whole-basin)*	173	59
% Lake Area Vegetated [1]	16	100
% Lake w/ Surface Growth [1,2]	2	28
Max Depth of Growth *(ft)*	20.0	15.0
# of Native Plant Species Encountered	20	21
Littoral Metrics (≤15 ft)		
# of Littoral Points Sampled	137	59
% Littoral Area Vegetated [3]	100	100
Average # of Natives per Point	3.1	3.8
Eurasian watermilfoil % Occurrence	51	42
Curlyleaf pondweed % Occurrence*	4	49
Average Curlyleaf Density *(0-5)*	<0.1	0.6
Average Eurasian watermilfoil Density *(0-5)*	0.9	0.6

[1] *[∑ Theissen polygon area associated with selected sampled points] ÷ [total lake area]*

[2] *Surface growth = plants growing to within 1 foot of the water surface*

[3] *[∑ Theissen polygon area associated with vegetated points] ÷ [littoral area (<15ft)]*

* August survey likely underestimates % occurrence of curlyleaf in main basin

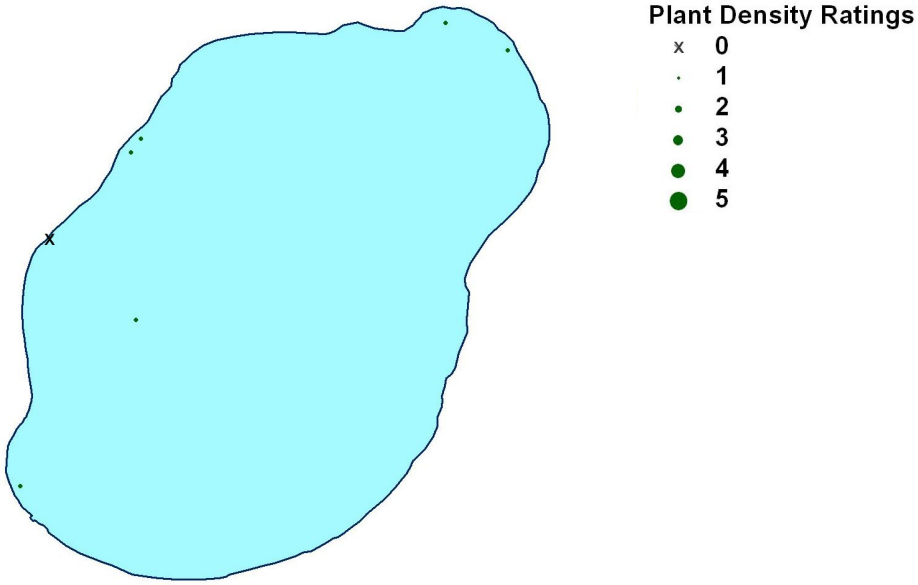
		Lake Pulaski *August 2009*	*Little Pulaski* *June 2010*
Submersed	**Coontail** *Ceratophyllum demersum*	63	83
	Eurasian watermilfoil *Myriophyllum spicatum*	51	42
	Wild celery *Vallisneria americana*	42	27
	Flat-stem pondweed *Potamogeton zosteriformis*	28	64
	Muskgrass *Chara spp.*	26	12
	Northern watermilfoil *Myriophyllum sibiricum*	26	31
	Clasping-leaf pondweed *Potamogeton richardsonii*	25	20
	Bushy pondweed *Najas flexilis*	20	-
	Sago pondweed *Stuckenia pectinata*	16	-
	Beck's water-marigold *Bidens beckii*	15	14
	Variable-leaf pondweed *Potamogeton gramineus*	9	-
	White-stem pondweed *Potamogeton praelongus*	9	14
	Water star-grass *Zosterella dubia*	9	-
	Large-leaf pondweed *Potamogeton amplifolius*	7	5
	Curlyleaf pondweed *Potamogeton crispus*	4	49
	Illinois pondweed *Potamogeton illinoensis*	4	-
	Elodea *Elodea canadensis*	2	17
	Water crow-foot *Ranunculus longirostris*	2	22
	Fries' pondweed *Potamogeton friesii*	1	24
	Narrow-leaf pondweed *Potamogeton pusillus/foliosus*	1	10
	Floating-leaf pondweed *Potamogeton natans*	1	-
	Southern naiad *Najas guadalupensis*	-	10
	Star duckweed *Lemna trisulca*	-	3
	Fern pondweed *Potamogeton robbinsii*	-	3
	Horned pondweed *Zannichellia palustris*	-	2
Floating	**White water-lily** *Nymphaea odorata*		12
	Spatterdock *Nuphar variegata*		3
Emergent	**Grassy arrowhead** *Sagittaria graminea*	P	-
	Bulrush *Schoenoplectus spp.*	-	P
	Water smartweed *Polygonum amphibium*	-	P

Littoral % Occurrence for Encountered Plant Species

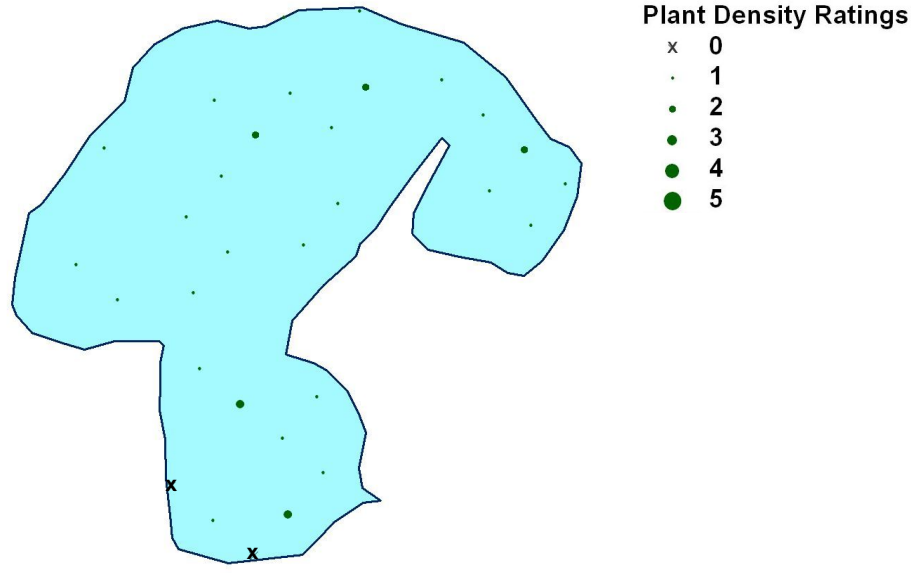
% Occurrence values were calculated as the number of sampled littoral sites (<15 ft) where a given species was found divided by the total number of littoral sites sampled in each basin. Plant species that were observed growing but not retrieved on any rake samples are noted as being present (P). Invasive non-native species are indicated with shading.

Curlyleaf Pondweed Distribution and Density

Locations where curlyleaf pondweed was encountered in Lake Pulaski (August 2009) and Little Pulaski Lake (June 2010), with growth densities indicated by the size of each dot. Density ratings of zero (shown as x's) indicate sites were curlyleaf was observed growing within 10 feet of the designated sample point but not retrieved on the rake. Curlyleaf pondweed normally senesces well before August, so these results should not be considered an accurate assessment of peak curlyleaf distribution or density in the main basin of Lake Pulaski.



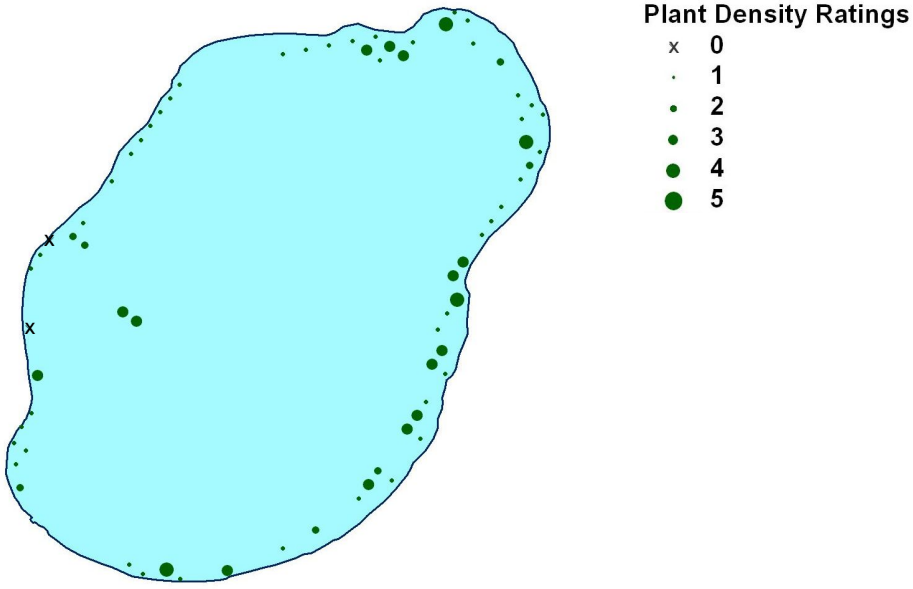
Lake Pulaski



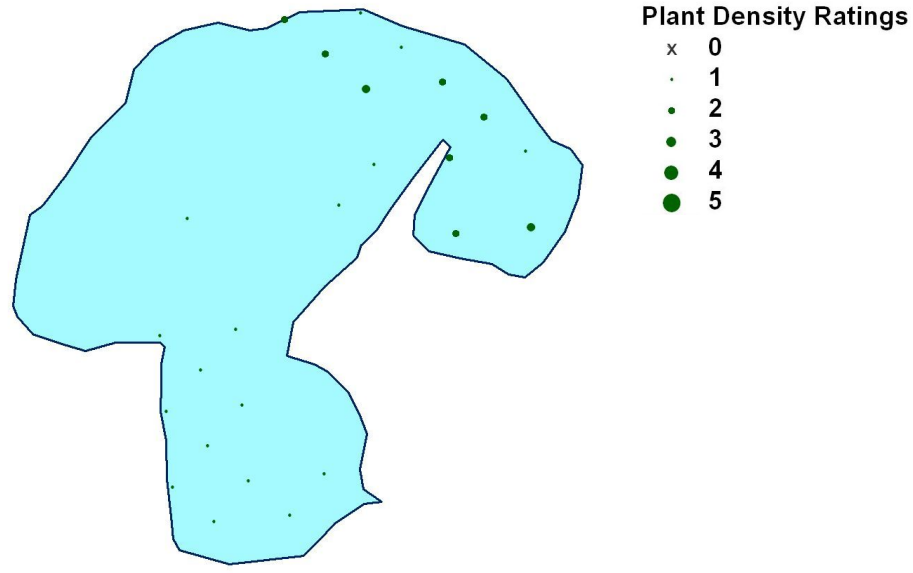
Little Pulaski Lake

Eurasian watermilfoil Distribution and Density

Map showing locations where Eurasian watermilfoil was encountered in Lake Pulaski (August 2009) and Little Pulaski Lake (June 2010), with growth densities indicated by the size of each dot. Density ratings of zero (shown as x's) indicate sites were Eurasian watermilfoil was observed growing within 10 feet of the designated sample point but not retrieved on the rake.



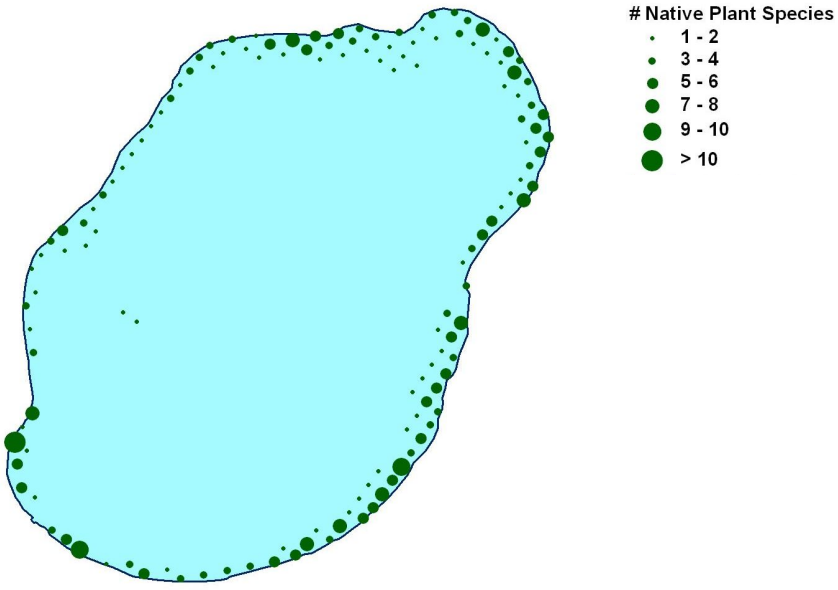
Lake Pulaski



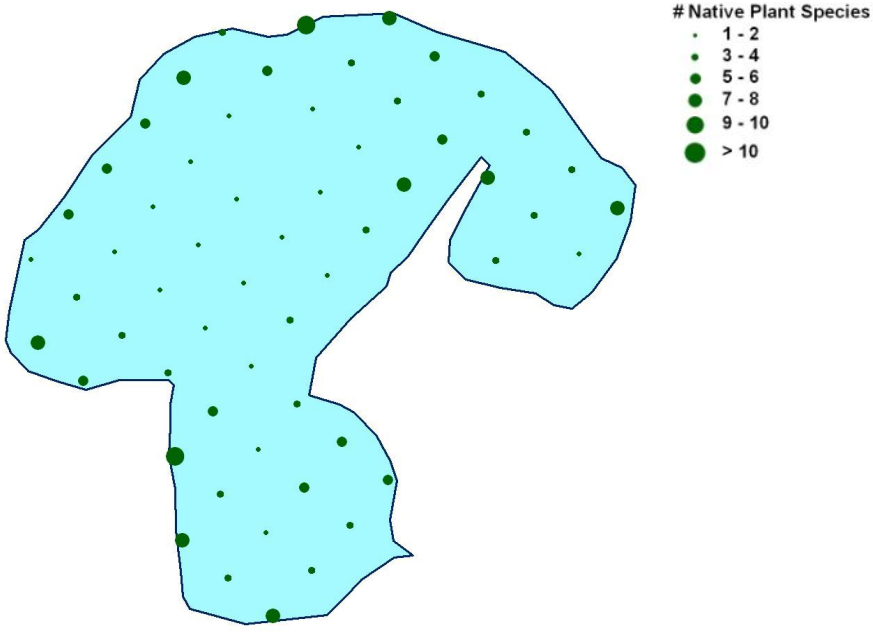
Little Pulaski Lake

Native Plant Distribution and Diversity

Locations where native plants were encountered in Lake Pulaski (August 2009) and Little Pulaski Lake (June 2010), with the number of native species encountered at each site indicated by the size of each dot.



Lake Pulaski



Little Pulaski Lake

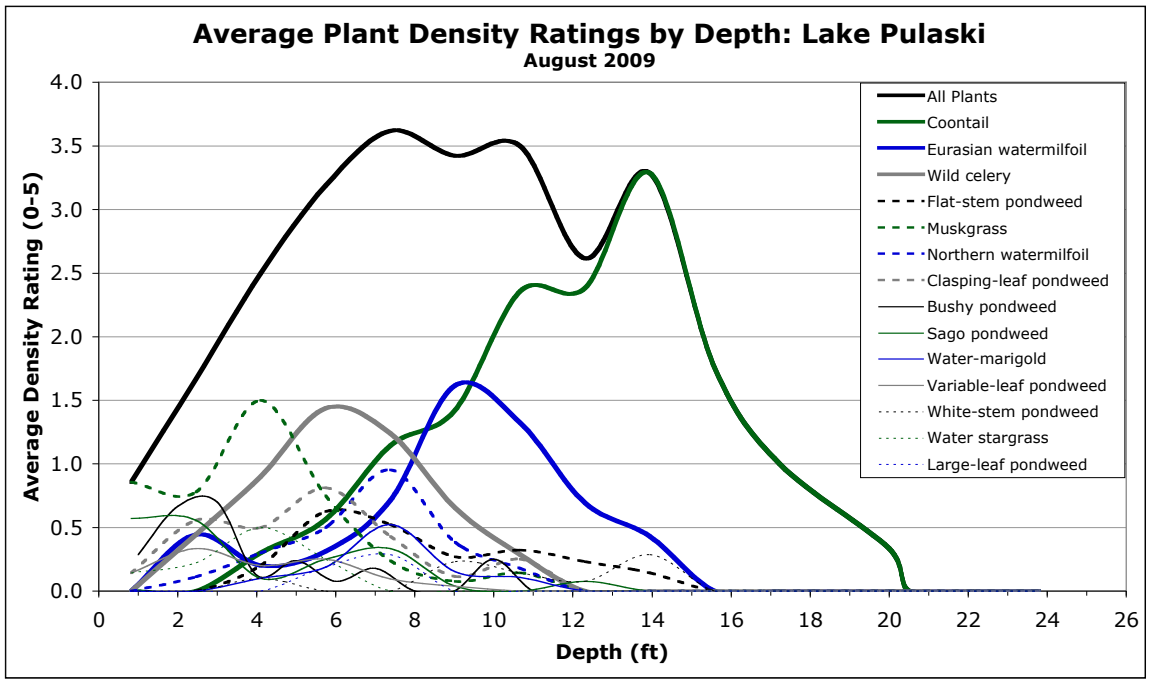
Average Littoral Plant Growth Density

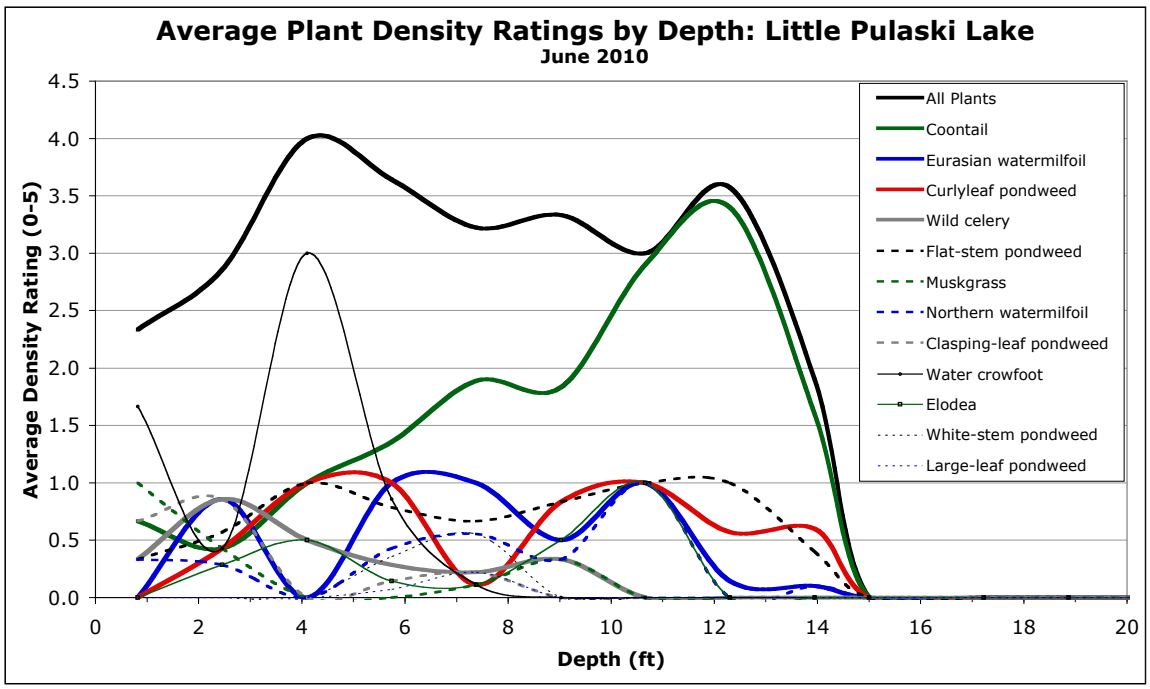
Average littoral (<15 ft) density ratings for plant species encountered in Lake Pulaski (August 2009) and Little Pulaksi Lake (June 2010). Density ratings (0 to 5 scale) are based upon a modification of the rake coverage scoring method described by Deppe and Lathrop (1992). Note that density ratings are not necessarily additive, so the sum of density ratings for individual species is not equal to the density rating for all species combined. All species not listed had average littoral growth densities ≥ 0.1.

	Lake Pulaski *August 09*	**Little Pulaski** *June 2010*
All Plants (combined)	3.0	3.1
Coontail *Ceratophyllum demersum*	1.4	1.6
Eurasian watermilfoil *Myriophyllum spicatum*	0.9	0.6
Curlyleaf pondweed *Potamogeton crispus*	<0.1	0.6
Water crow-foot *Ranunculus longirostris*	<0.1	0.5
Wild celery *Vallisneria americana*	0.6	0.3
Muskgrass *Chara spp.*	0.4	0.2
Flat-stem pondweed *Potamogeton zosteriformis*	0.3	0.7
Narrowleaf pondweed *Potamogeton richardsonii*	<0.1	0.2
Northern watermilfoil *Myriophyllum sibiricum*	0.3	0.3
Clasping-leaf pondweed *Potamogeton richardsonii*	0.3	0.2
White-stem pondweed *Potamogeton praelongus*	<0.1	0.2
Bushy pondweed *Najas flexilis*	0.2	-
Sago pondweed *Stuckenia pectinata*	0.2	-
Beck's water-marigold *Bidens beckii*	0.2	0.2

Average Plant Growth Density by Depth

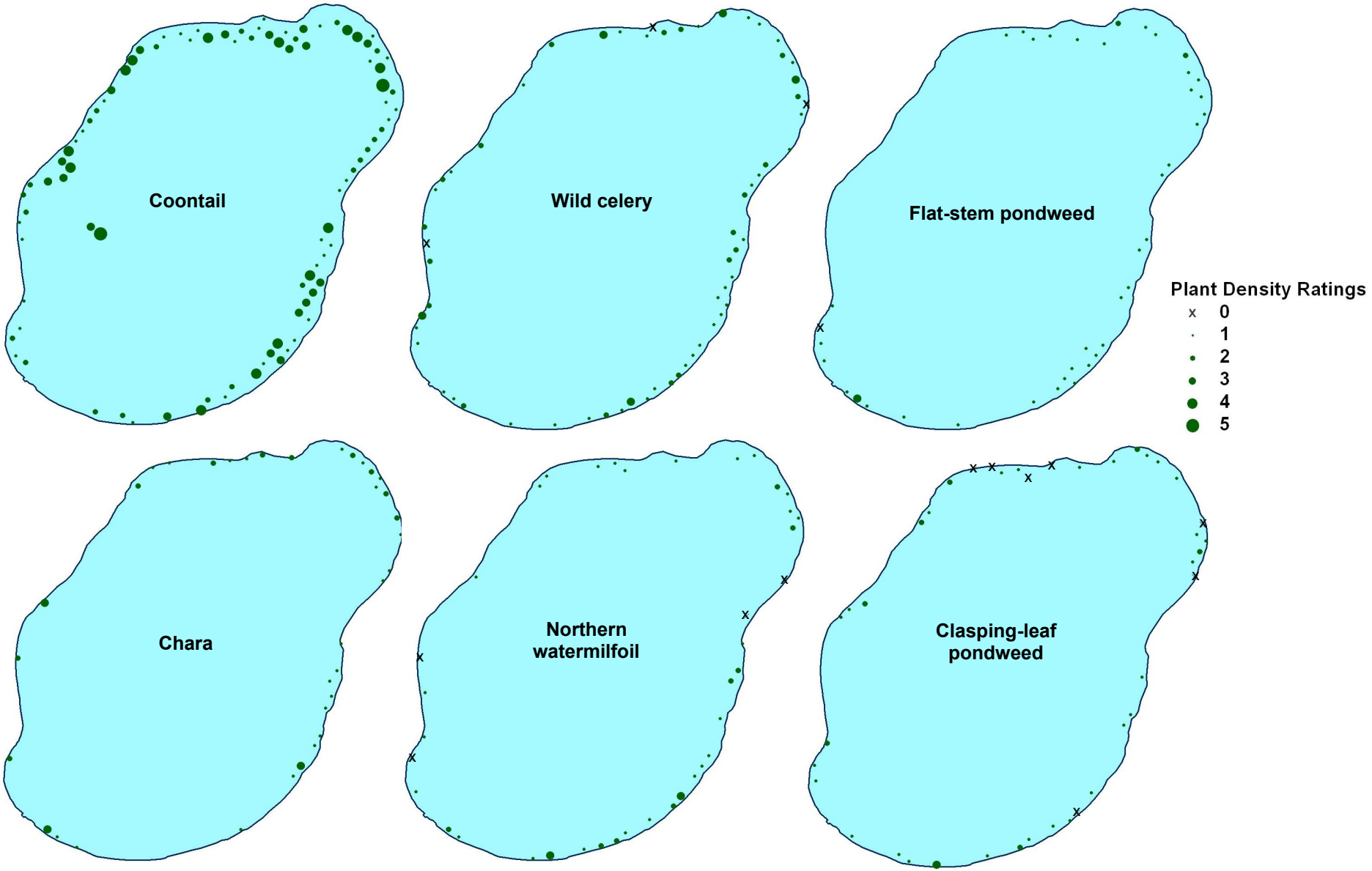
Average density ratings by depth for total vegetation (all plants combined) and common plant species found in Lake Pulaski (August 2009) and Little Pulaski Lake (June 2010). Density ratings are based upon a modified version of the rake fullness scores described by Deppe and Lathrop (1992). See page 4 for details.





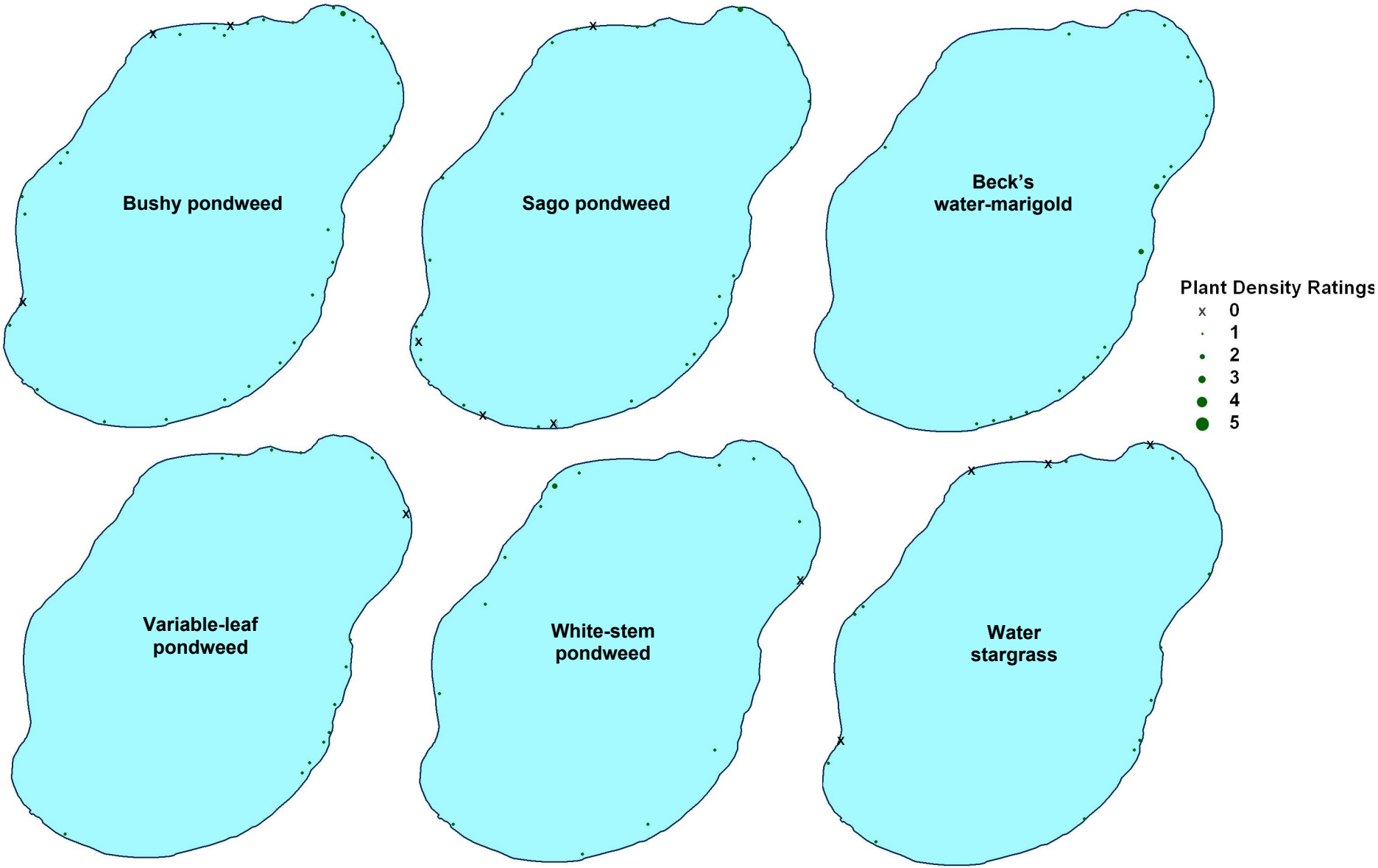
Native Aquatic Plant Species: Lake Pulaski - August 31, 2009

Maps showing location and density of native aquatic plants that were encountered at more than 8% of the sampled sites in Lake Pulaski. Growth density is indicated by the size of each dot. Density ratings of zero (shown as x's) indicate sites where the given species was observed growing within 10 feet of the designated sample point but was not retrieved on the rake. Density ratings are based upon a modified version of the rake fullness scores described by Deppe and Lathrop (1992). See page 4 for details.



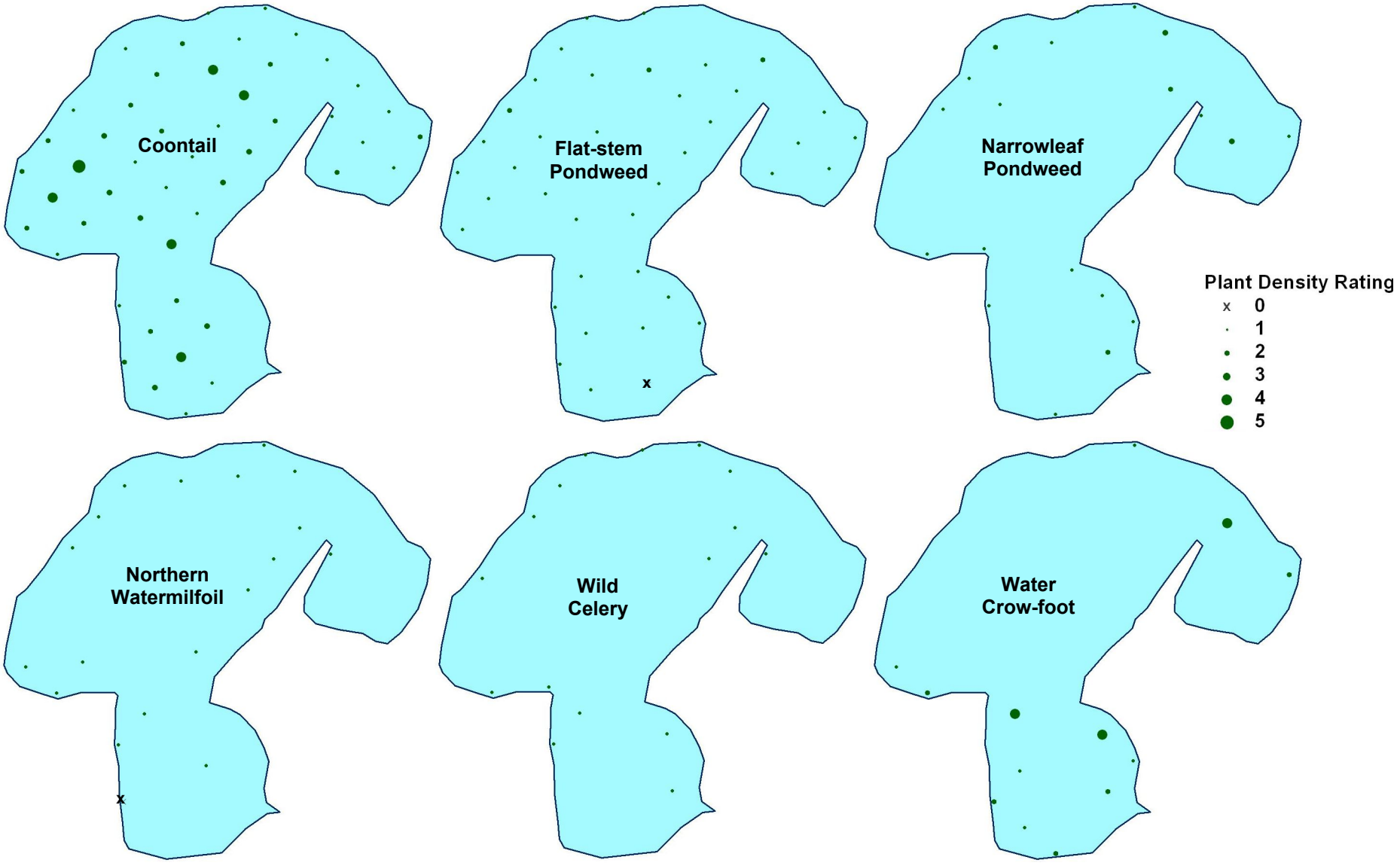
Native Aquatic Plant Species: Lake Pulaski - August 31, 2009 *(continued from previous page)*

Maps showing location and density of native aquatic plants that were encountered at more than 8% of the sampled sites in Lake Pulaski. Growth density is indicated by the size of each dot. Density ratings of zero (shown as x's) indicate sites where the given species was observed growing within 10 feet of the designated sample point but was not retrieved on the rake. Density ratings are based upon a modified version of the rake fullness scores described by Deppe and Lathrop (1992). See page 4 for details.



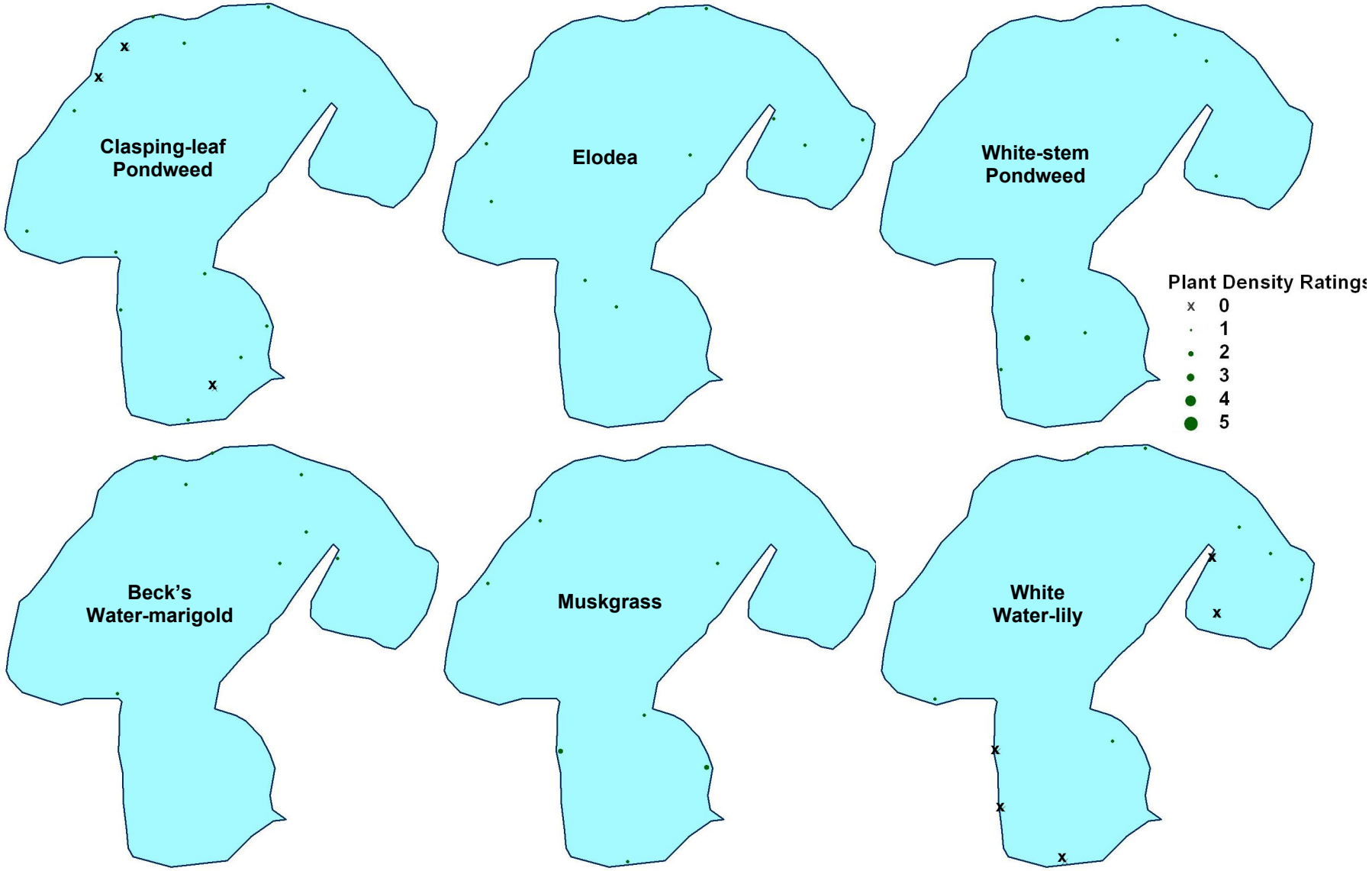
Native Aquatic Plant Species: Little Pulaski Lake - June 10, 2010

Maps showing location and density of native aquatic plants that were encountered at more than 8% of the sampled sites in Little Pulaski Lake. Growth density is indicated by the size of each dot. Density ratings of zero (shown as x's) indicate sites where the given species was observed growing within 10 feet of the designated sample point but not retrieved on the rake. Density ratings are based upon a modified version of the rake fullness scores described by Deppe and Lathrop (1992). See page 4 for details.



Native Aquatic Plant Species: Little Pulaski Lake - June 10, 2010 *(continued from previous page)*

Maps showing location and density of native aquatic plants that were encountered at more than 8% of the sampled sites in Little Pulaski Lake. Growth density is indicated by the size of each dot. Density ratings of zero (shown as x's) indicate sites where the given species was observed growing within 10 feet of the designated sample point but not retrieved on the rake. Density ratings are based upon a modified version of the rake fullness scores described by Deppe and Lathrop (1992). See page 4 for details.



Discussion of Results

The surveys reported here provide valuable assessments of the state of the aquatic plant community in Pulaski Lake and Little Pulaski Lake. However, comparison of the results with past and future plant survey data may provide additional insights into the impact of aquatic invasive plants, fluctuations in the frequency and extent of nuisance milfoil and curlyleaf growth, and changes in the native plant community over time.

Both of the surveyed lake basins (Lake Pulaski and Little Pulaski Lake) supported widespread, low-density curlyleaf pondweed growth, and widespread low to moderate-density Eurasian watermilfoil growth. However no expansive areas of surface matting or monotypic stands of either of these invasive plants were encountered during the 2009 and 2010 surveys. The densest Eurasian watermilfoil growth occurred in localized patches along the eastern shoreline of the main basin, in the area surrounding the channel between the main basin and Little Pulaski Lake, and in the small north-eastern bay of Little Pulaski Lake. Little Pulaski Lake did support sporadic localized patches of surface-matted Eurasian watermilfoil, however these areas did not appear to severely impair lake-wide navigation or recreation, but likely impaired lake access for some private homeowners who may have found it difficult to get boats through matted areas of milfoil to open water. Despite the widespread Eurasian watermilfoil growth and 20-year history of infestation, the native plant communities in both of the surveyed basins appeared to be maintaining high diversity and dense growth. In fact, dense, expansive areas of surface-matted native plant growth - predominantly water crow-foot, coontail, and flat-stem pondweed - impaired navigation and recreation in Little Pulaski Lake to a greater degree than Eurasian watermilfoil or curlyleaf pondweed. These areas of dense native plant growth may be easily mistaken for dense milfoil growth (see photos below).

(a) Surface-matted growth in Little Pulaski Lake (predominantly native plants with some patches of Eurasian watermilfoil and curlyleaf pondweed). Note flower spikes of Eurasian watermilfoil in foreground.

(b) Expansive area of surface-matted water crow-foot (*Ranunculus longirostris*) in Little Pulaski Lake. Note the white flowers – easily distinguished from Eurasian watermilfoil flower spikes seen in (a)

(c) Side-by-side comparison of water crowfoot (left) and Eurasian watermilfoil (right)

Based upon these results, Eurasian watermilfoil does not appear to be severely impacting the overall recreational or ecological quality of either basin, but localized sporadic patches of dense, surface-matted Eurasian watermilfoil may impair access to open water in Little Pulaski Lake, and navigation between the two lake basins. In the near term, management should focus primarily on managing localized patches of nuisance milfoil and curlyleaf growth as they occur. This would minimize the cost of management, maximize the positive impact to the recreational quality of the lake per dollar spent, and protect the current diverse and abundant native plant growth in Lake Pulaski and Little Pulaski Lake. However, additional management strategies may be warranted If Eurasian milfoil or curlyleaf pondweed begin forming more expansive areas of surface-matted growth in the future.

Summary of Management Recommendations

1. Manage nuisance curlyleaf pondweed and Eurasian watermilfoil growth. The Minnesota DNR and similar agencies in other states have been evaluating the use of lake-wide herbicide treatments to control invasive aquatic plants. Given the current high diversity and abundance of native plant growth in Lake Pulaski and Little Pulaski Lake, and the relatively low incidence of dense matted milfoil growth, I believe that lake-wide herbicide treatments would not dramatically improve the recreational or ecological quality of the lake, and would pose an unacceptable risk to the native plants. Alternatively, the Pulaski LID should focus on short-term small-scale management of nuisance milfoil and curlyleaf growth with herbicide spot-treatments or harvesting of localized areas of dense surface growth and navigational channels as needed. If Eurasian watermilfoil and curlyleaf begin to form more expansive areas of matted nuisance growth and begin displacing native plants more severely in the future, larger-scale strategies may be warranted.

2. Protect the native plant community by working with local agencies and municipalities to manage nutrient loading to the lake and educate lakeshore homeowners on the beneficial value of aquatic plant growth and strategies for responsible plant management. However, some localized management of dense native plant growth in near-shore areas and navigation channels may be needed to improve access to open water areas and maintain boating channels – particularly in Little Pulaski Lake.

3. Conduct periodic point-intercept surveys to track changes in plant community. The aquatic plant community in Lake Pulaski and Little Pulaski Lake should be surveyed at least every 5 years to provide adequate information to track changes in curlyleaf, Eurasian watermilfoil, and native plants. This will help guide management decisions and will allow for scientific evaluation of the success/impact of any future management activities. If substantial management activities are planned, additional (more frequent) monitoring should be included in the project plan to evaluate the effectiveness/impacts of management.

4. Develop an early detection / rapid response plan to address potential future invasions by new invasive species like *Hydrilla*. This plan would lay out specific strategies for detecting any new infestations before they become major problems, and would streamline the process of getting permits for control, applying for funding assistance, developing an effective management strategy, and monitoring results.

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Common Submersed Native Plants in Lake Pulaski / Little Pulaski Lake

Coontail

Bushy pondweed

Clasping-leaf pondweed

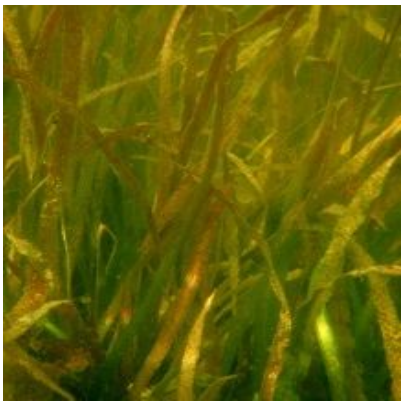
Water crow-foot

Flat-stem pondweed

Northern watermilfoil

Sago pondweed

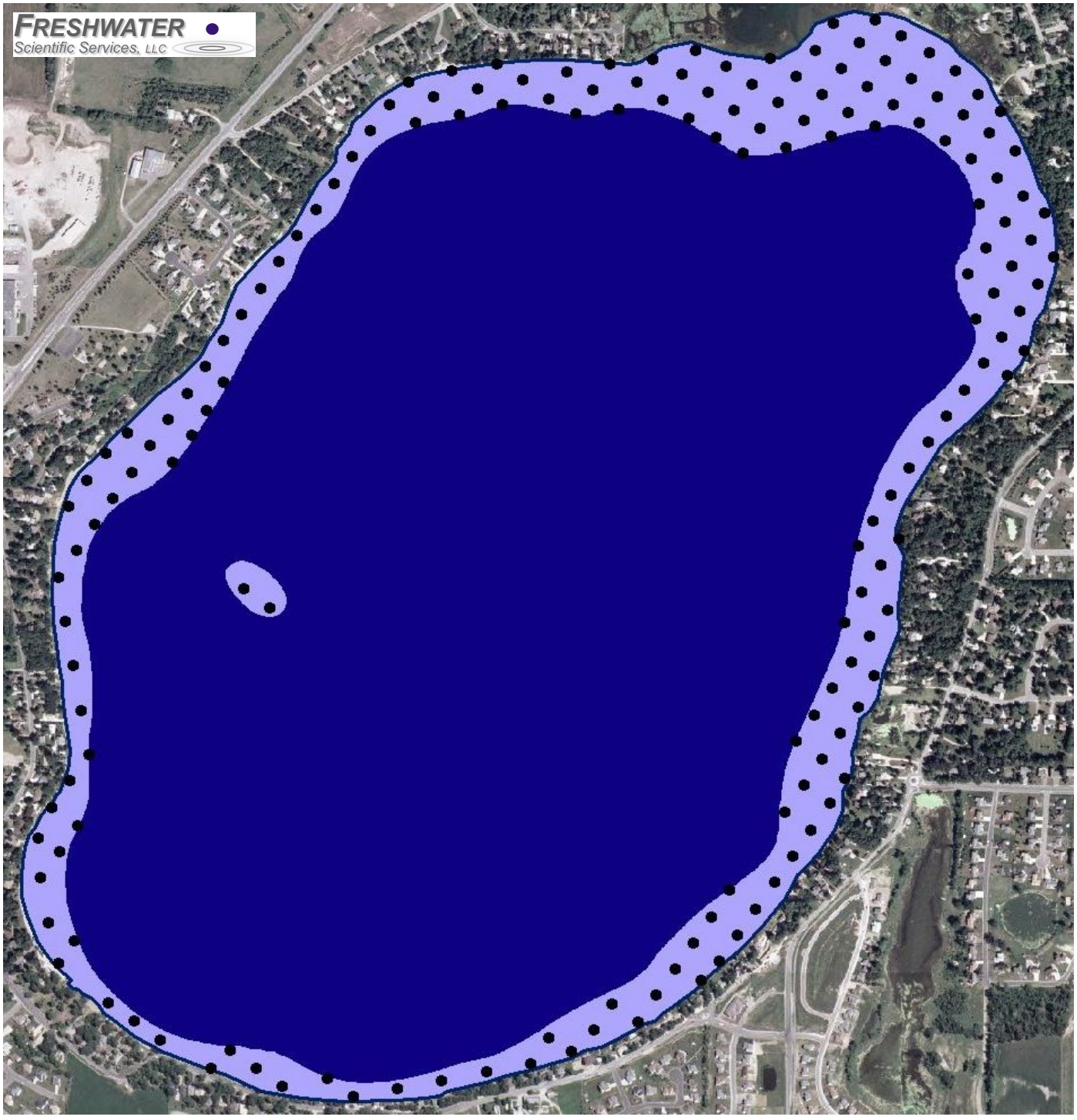
Narrow-leaf pondweed



Wild celery

Map of Point-Intercept Aquatic Vegetation Survey Sample Locations

Lake Pulaski



Map of Point-Intercept Aquatic Vegetation Survey Sample Locations

Little Pulaski Lake

Bathymetric Map of Lake Pulaski *(MNDNR)*