Comprehensive Management Plan

White River and Neshkoro Millpond

Marquette County, Wisconsin

Prepared by:

Cason & Associates, LLC

Professional Resources for Management of Lakes, Ponds, Rivers and Wetlands
P.O. Box 230 Berlin, WI 54923 20-361-4088

Sponsored by:

The Friends of the White River Association, Inc.
&
The Wisconsin Department of Natural Resources
River Protection Grant Program

December 2009

Table of Contents Page

Figures Page

Figures		Page

Tables Page

Appendices

Summary

A thorough study of the White River and the Neshkoro Millpond, Marquette County, Wisconsin was conducted in 2008 and 2009. The primary goals of this project have been 1) to gather baseline information on the physical, chemical and biological aspects of the river, lake and surrounding watershed, 2) to identify and prioritize management concerns including sediment accumulation, aquatic plant growth and water quality, and 3) to provide information needed to make informed decisions regarding the future management of the waters both ecologically and sociologically.

Project elements focused primarily on the aquatic plant community of the White River and Neshkoro Millpond, sediment depths, water quality parameters, and an assessment of the lake's watershed. This project was funded in part by the Wisconsin DNR's River Protection Grant program.

Results of this study include:

- In total, 21 aquatic plant species were identified during the July 2008 plant survey. The most abundant plant species encountered in the Neshkoro Millpond were common waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), and flat-stem pondweed (*Potamogeton zosteriformis*).

- Both curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) were found throughout the Neshkoro Millpond. The distribution of curly-leaf pondweed was 77.3 acres at the time of the survey while Eurasian watermilfoil covered 23.8 acres. .

- Both Coefficient of Conservatism and the Floristic Quality Index values suggest the quality of Neshkoro Millpond specifically in terms of the plant community, is at or slightly above average.

- Wild rice (Zizania palustris) was found growing throughout much of the Neshkoro Millpond. Historic data and photos do not provide enough detail to determine the rate of expansion of this species within the millpond.

- The White River and Neshkoro Millpond has fair water quality and exhibits characteristics of a lake near the boundary between a mesotrophic and eutrophic lake.

- Analysis found that the watershed of the Neshkoro Millpond is large (~102 acres) and predominantly active and inactive agriculture fields and forests.

- Soft sediment depths were measured at 45 locations throughout the millpond. The average sediment depth was 5.3 feet. This translates to over 950 acre-feet or over 1.5 million cubic yards of soft sediments throughout the millpond.

Introduction

The project area for this study includes the Lower White River below the North American Hydro dam on County YY (this dam creates the White River Flowage), the Neshkoro Millpond, and the Lower White River below a second North American Hydro dam at the south end of the Neshkoro Millpond up to the White River Marsh wildlife habitat and public hunting zone (**Figure 1**). The millpond is located in Marquette County (**Figure 2**).

This study is intended to enhance the ability of the Friends of the White River Association, Inc. (the Association) to develop, promote, and implement an effective long-range plan to protect the river and restore its ecosystem. The Association is concerned about invasive species proliferation, sedimentation and depth reduction, rapidly fluctuating water levels below the Neshkoro dam, agricultural run-off, Wautoma sanitary sewer discharge and effluent levels, water clarity, temperature, fishery quality, scenic beauty, navigability, etc.

The Association represents the interests of lakeshore property owners and other lake users. The Association was formed in 2005 to address concerns of property owners along the river and millpond, as well as other interested community members and corporate entities, about the general condition of the river and millpond. Anecdotal evidence had indicated a rapid and significant decline in aesthetic and recreational quality in recent years. Included in the goals of the Friends of the White River Association, Inc. are to examine the health/quality of the river, the Neshkoro Millpond, and bordering lands, and to promote the Neshkoro Millpond and the river as good recreational sources and assets to the community.

Overtures have been made for collaboration with North American Hydro, which has joined the Association as a corporate member. North American Hydro plays a major role in the level of the Neshkoro Millpond and the level of the Lower White River below the dams.

The Neshkoro Village Board recognizes and supports the Association. The Smart Growth Plan, based exclusively upon local citizenry input and adopted by the Village of Neshkoro, specifically identifies a healthy White River and Millpond as an essential element in this community.

Figure 1. Area surrounding Neshkoro Millpond in Marquette County, Wisconsin

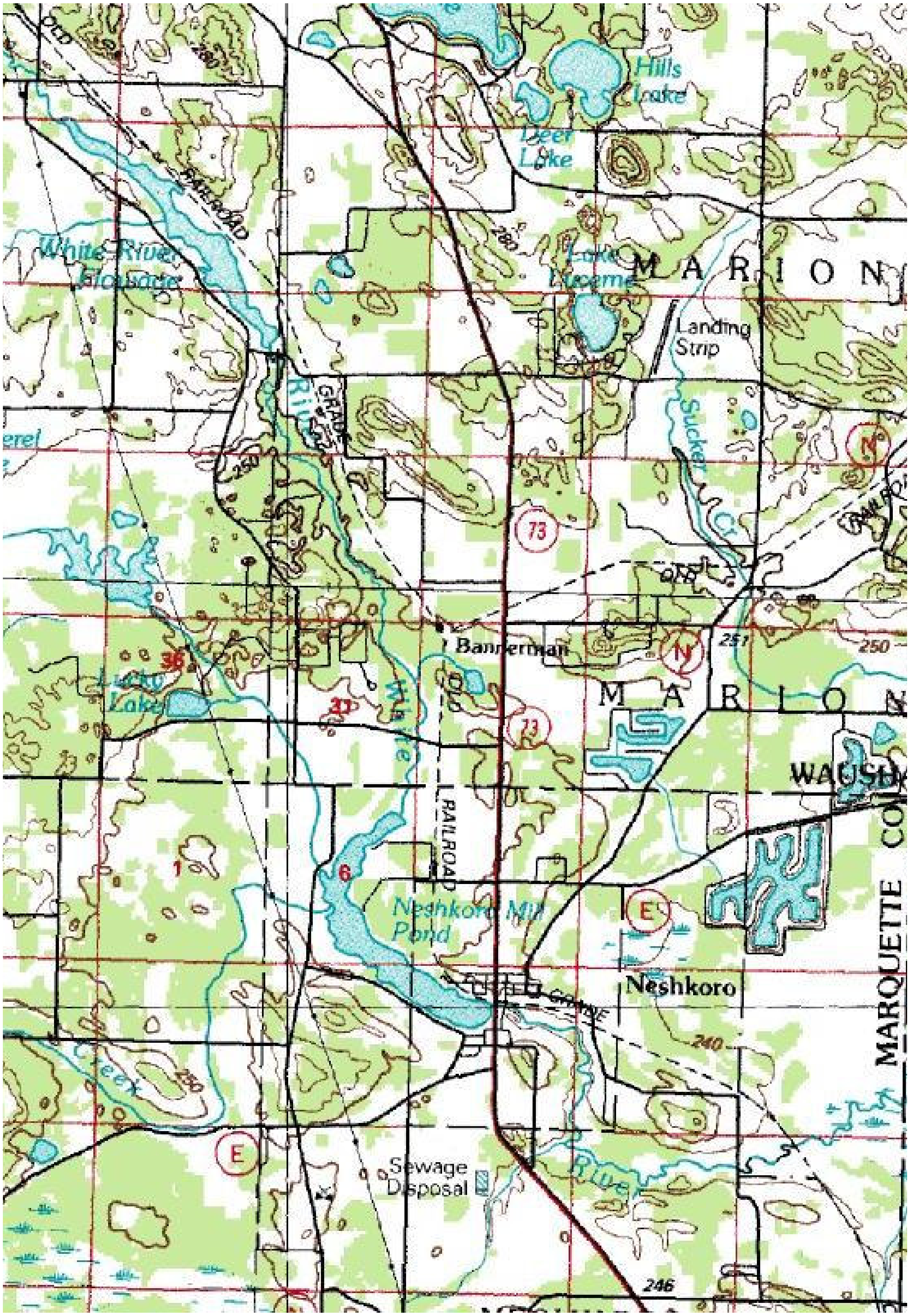
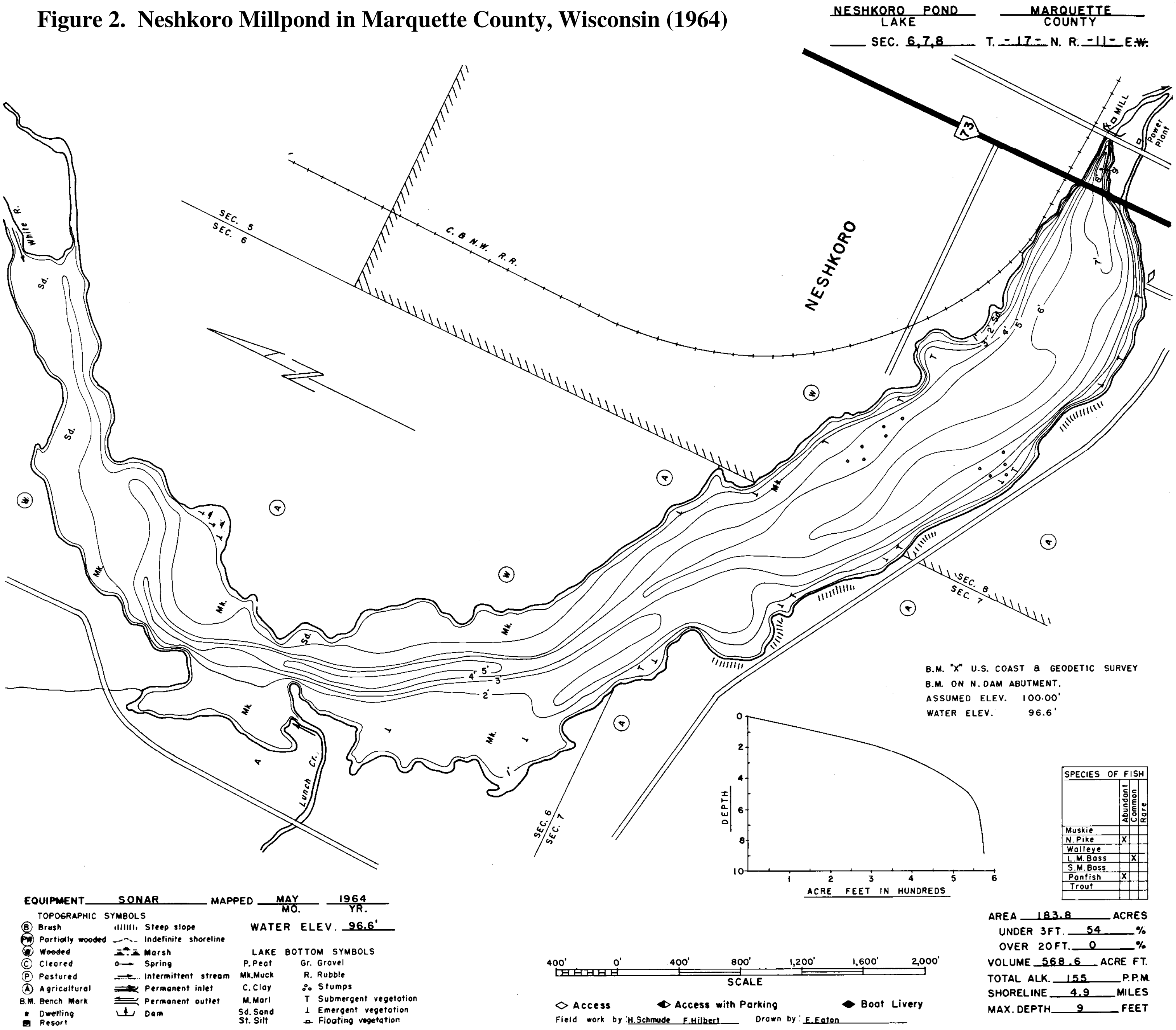


Figure 2. Neshkoro Millpond in Marquette County, Wisconsin (1964)



The Association has chosen to develop a comprehensive management plan for the White River and Neshkoro Millpond. Through the development of a plan, the Association has addressed the concerns of its membership. This report presents the results of the data collected for this project in 2008 and 2009. It also includes interpretation and implications of these results, as well as an analysis of management options. Multiple discussions have taken place with members of the Association, DNR staff, representatives from North American Hydro and Cason & Associates, LLC to discuss the results of this study and lake management options. Subsequently an implementation plan has been developed for the Association. With the knowledge gained by this project, the Association hopes to take the appropriate actions needed to best manage the aquatic plants for lake users and the biotic community alike.

Methods

Aquatic Plant Assessment

On July 15, 2008, a submergent aquatic plant survey was conducted following guidelines established by the Wisconsin Department of Natural Resources. These guidelines specifically require the use of a point-intercept method. Under the guidance of Jennifer Hauxwell from the DNR, an approved plant survey map for the Neshkoro Millpond was developed (**Figure 3**). A series of grid points spaced 53 meters apart were mapped across the lake. At each location, aquatic plant samples were collected from a boat with a single rake tow. The rake used consisted of two short-toothed garden rake heads welded together and attached to a rope which was thrown from the boat. At each sample point, the rake was dragged along the bottom for approximately 2.5 feet to collect plants. All plant samples collected were identified to *genus* and *species* whenever possible, and the information was recorded. An abundance rating was given for exotic species collected using the criteria described in **Figure 4**. In addition to the plant data, depth and bottom substrate composition were recorded for each point intercept. Data collected has been be used to determine species composition, percent frequency and relative abundance. This data has also been used to develop distribution maps of the most abundant plant species.

Figure 3. Aquatic plant survey map provided by the Wisconsin DNR for Neshkoro Millpond, Marquette County, WI.

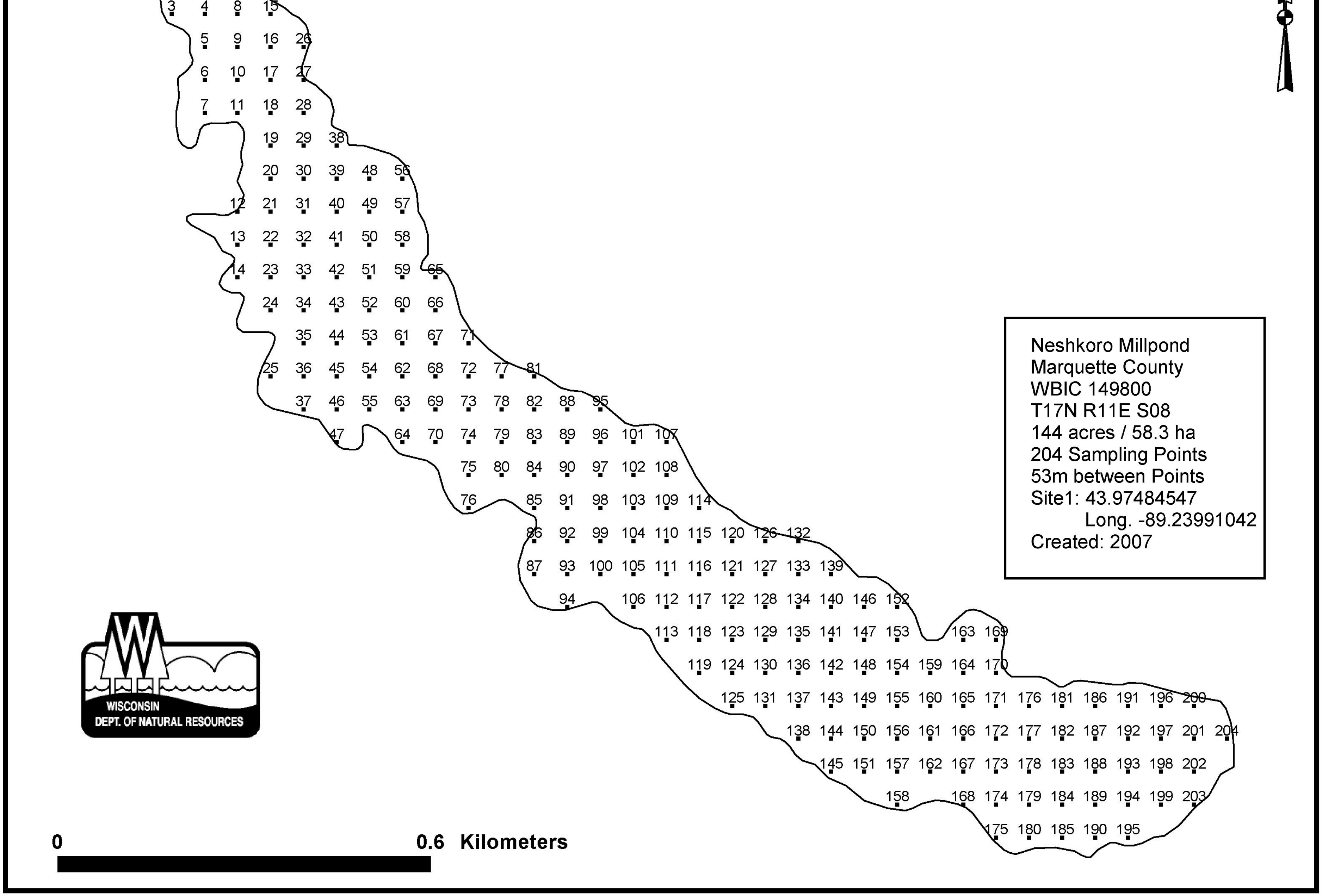
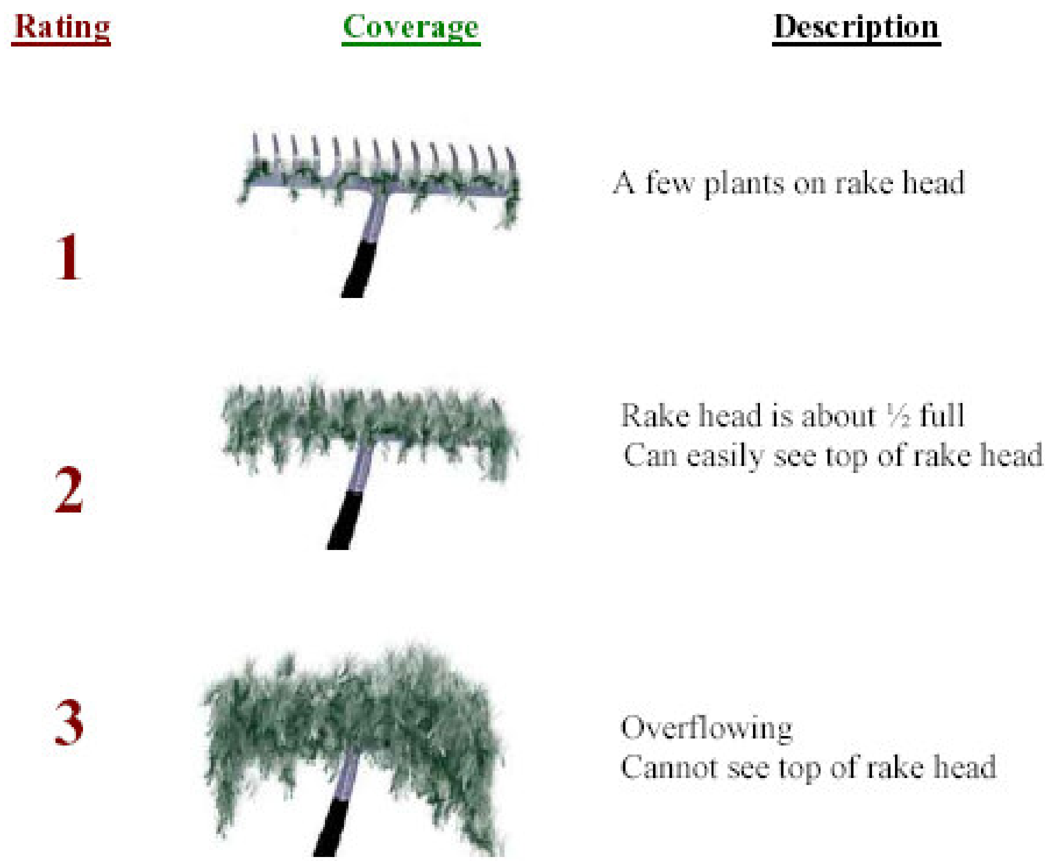


Figure 4 Plant abundance rating criteria used in submergent aquatic plant surveys.



Exotic Plant Distribution Mapping

On two occasions, the extent and locations of the exotic plant species Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), in Neshkoro Millpond were determined from surface observations and rake tows. The point intercept locations identified in **Figure 3** were used as a guide for these surveys as well. The first survey was conducted on June 4, 2008. This survey was conducted earlier in the season to best identify curly-leaf pondweed, which dies back later in the summer, when water temperature rises. A second exotic species mapping effort was made at the time of the point-intercept survey on July 15, 2008.

Water Quality Assessment

Water testing took place at three locations (**Figure 5**). The first location was upstream of the millpond where Czech Lane crosses the White River. The second location was in the millpond itself at the deepest point. The third location was downstream of the millpond near Pearl Street.

The Association conducted a majority of the water quality sampling as part of this study. At the beginning of the season, volunteers were trained by Cason & Associates staff to collect and ship the necessary water samples from the millpond. Sampling was expected to occur during spring turnover and during the months of July, August, and September. However, due to miscommunications between volunteers and the State Lab of Hygiene, sampling took place in the spring and fall only. Subsequently, additional samples were collected in the summer of 2009.

Samples were sent to the State Lab of Hygiene and analyzed for the following parameters:

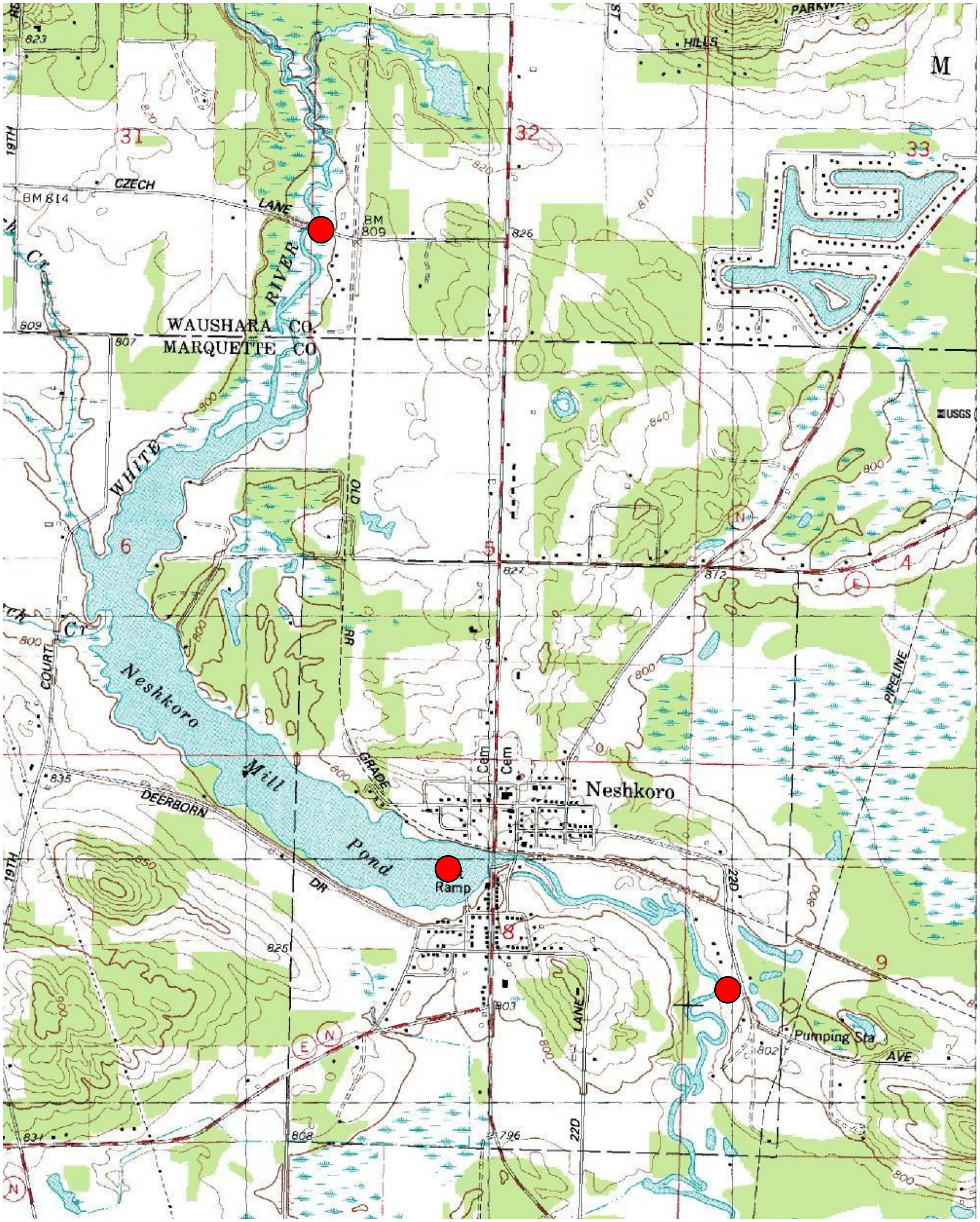
- Chlorophyll *a*
- Total phosphorus
- Total nitrogen (Kjeldahl)
- Nitrate and Nitrite as N
- pH

In addition, water clarity was monitored near the dam with a Secchi disk. Chlorophyll *a*, total phosphorus and Secchi depth data have been used to quantify the productivity of the lake (Trophic State Index).

Historic water quality data for the Neshkoro Millpond has been collected from a number of sources including the DNR's Surface Water Integrated Monitoring System (SWIMS) and the EPA's Storet site. Unfortunately, a very limited amount of historic water quality or clarity data is available for the millpond. All available data has been collected and used to assess the chemical characteristics of the water in the White River and Neshkoro Millpond.

Software available from the WDNR entitled Wisconsin Lake Modeling Suite (WiLMS) can be used to predict the trophic state of a lake given its size, watershed area, mean depth and ecoregion. Comparisons were made between the predicted TSI values and those calculated from the phosphorus, chlorophyll and Secchi data collected in 2008.

Figure 5. Water sampling locations for the 2008 survey of the White River and Neshkoro Millpond, Marquette County.



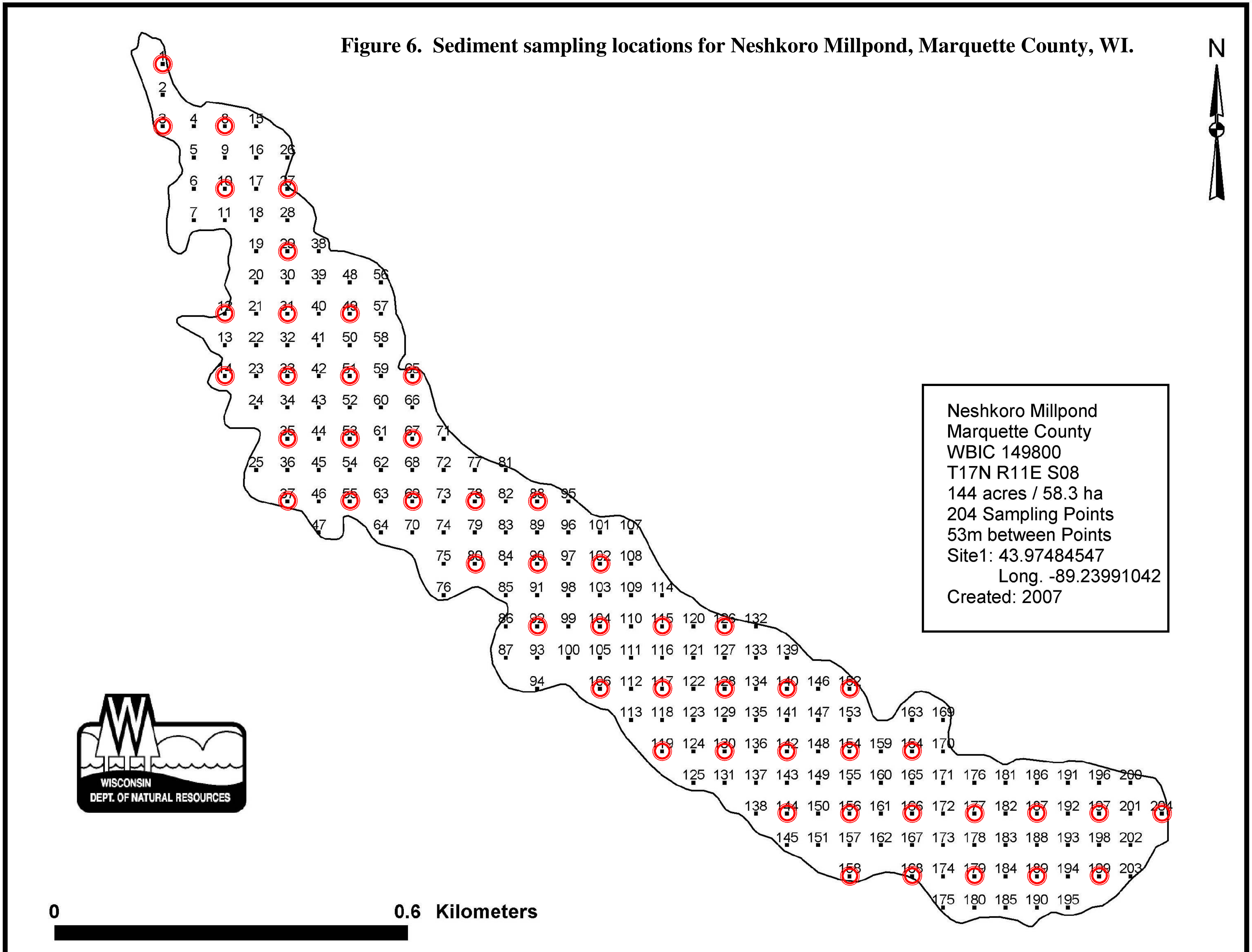
Watershed Assessment

The boundary of the watershed of the White River and Neshkoro Millpond was delineated using topographic maps. ArcView GIS software was used to determine land-use patterns and vegetative cover. A ground survey of the watershed was conducted in an effort to identify potential nutrient loading sources and environmentally sensitive areas. The WiLMS software was used to estimate external and internal loading of phosphorus by assessing point and non-point sources of nutrients.

Bottom Sediment Evaluation

Sediment depths were measured at various locations during the aquatic plant survey in July 2008 and separately in June 2009. Measurements were made at pre-determined locations based on the point-intercept map of the Neshkoro Millpond. These locations are highlighted in **Figure 6**. At each location, water depths were measured with an on-board sonar unit or by lowering a weighted Secchi disk to the lakebed (upper surface of the soft sediment). The thickness of soft sediment was determined at these locations by inserting a pole to the depth of hard sediment. This allowed for a measurement of the thickness of soft sediment at each location (depth to hard sediment – depth of water = depth of soft sediment). The data collected has been used to estimate the volume of soft sediments in the Neshkoro Millpond.

Figure 6. Sediment sampling locations for Neshkoro Millpond, Marquette County, WI.



Results and Discussion

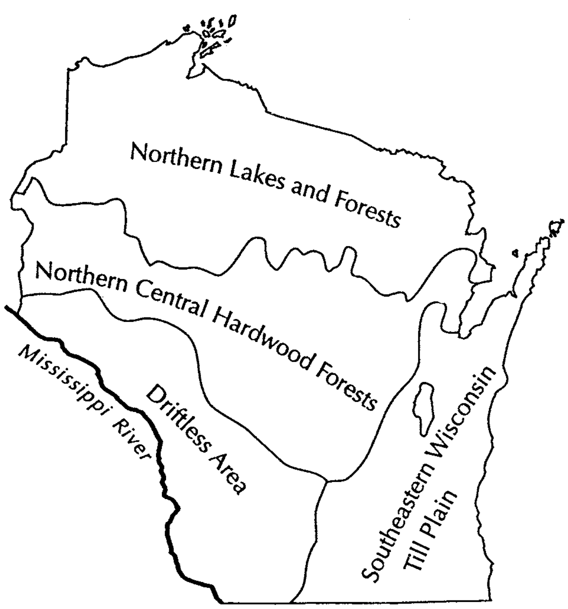
Aquatic Plant Communities

Coordinates for the sampling points within the Neshkoro Millpond can be found in **Appendix A**.

At the time of the July 15, 2008 survey of the Neshkoro Millpond, many locations were not navigable. This was due to shallow water and dense plant growth, particularly wild rice in the upper half of the millpond. Only 98 of the 204 locations mapped across the surface of the millpond were reachable at the time of the survey.

A total of 21 aquatic plant species were found during the July 2008 survey (**Table 1, Appendix B**). This is above the state-wide average of 13 species. The Neshkoro Millpond lies near the border of the Northern Central Hardwood Forests and Southeastern Wisconsin Till Plain regions of Wisconsin (**Figure 7**). The average number of species found in lakes in this region is 14 species (Nichols, 1999). The most abundant plant species encountered in Neshkoro Millpond were common waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*) and flat-stem pondweed (*Potamogeton zosteriformis*). Each of these species was found at over 60% of the sampling points. **Figures 8-10** show the distribution and density of these species across Neshkoro Millpond at the time of the survey. These species are common in shallow warm systems such as the Neshkoro Millpond. Shallow warm systems are typically highly productive and receive large quantities of nutrients and sediments.

Figure 7. Ecoregions of Wisconsin (after Omernick and Gallant, 1988)



Percent frequency values reflect the relationship between the number of locations where a particular species was found versus the total number of locations sample. Relative frequency values reflect the abundance of a particular species in relation to all other species found.

Figure 11 presents the relative abundance of submergent aquatic plant species found in Neshkoro Millpond at the time of the July 2008 survey.

Table 1. Results of the submergent aquatic plant survey conducted on Neshkoro Millpond on July 15, 2008.

Species common name	scientific name	**Percent Frequency**	**Relative Frequency**
Common waterweed	*Elodea canadensis*	69.0	16.3
Coontail	*Ceratophyllum demersum*	68.0	16.0
Flat-stem pondweed	*Potamogeton zosteriformis*	65.0	15.3
filamentous algae	--	44.0	10.4
Stiff water crowfoot	*Ranunculus aquatilis*	34.0	8.0
Northern water milfoil	*Myriophyllum sibiricum*	30.0	7.1
Small duckweed	*Lemna minor*	28.0	6.6
Common watermeal	*Wolffia columbiana*	20.0	4.7
Forked duckweed	*Lemna trisulca*	15.0	3.5
Water star-grass	*Heteranthera dubia*	14.0	3.3
Eurasian watermilfoil	*Myriophyllum spicatum*	12.0	2.8
Curly-leaf pondweed	*Potamogeton crispus*	7.0	1.7
Floating-leaf pondweed	*Potamogeton natans*	4.0	0.9
White water lily	*Nymphaea odorata*	3.0	0.7
Sago pondweed	*Stuckenia pectinata*	3.0	0.7
Northern wild rice	*Zizania palustris*	3.0	0.7
Bushy pondweed	*Najas flexilis*	2.0	0.5
Long-leaf pondweed	*Potamogeton nodosus*	1.0	0.2
Small pondweed	*Potamogeton pusillus*	1.0	0.2
Wild celery	*Vallisneria americana*	1.0	0.2
Spatterdock	*Nuphar variegata*	present	present

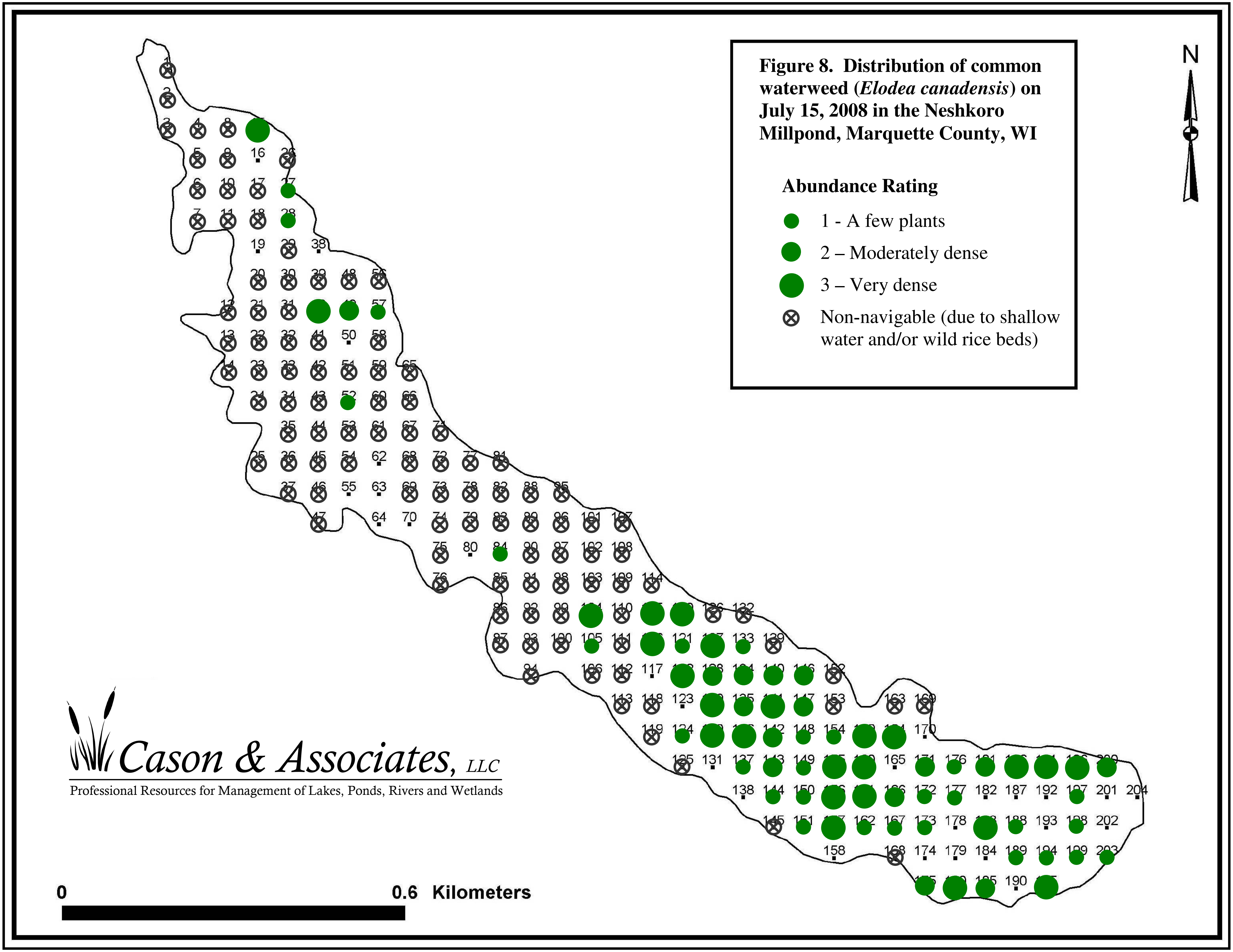


Figure 8. Distribution of common waterweed (*Elodea canadensis*) on July 15, 2008 in the Neshkoro Millpond, Marquette County, WI

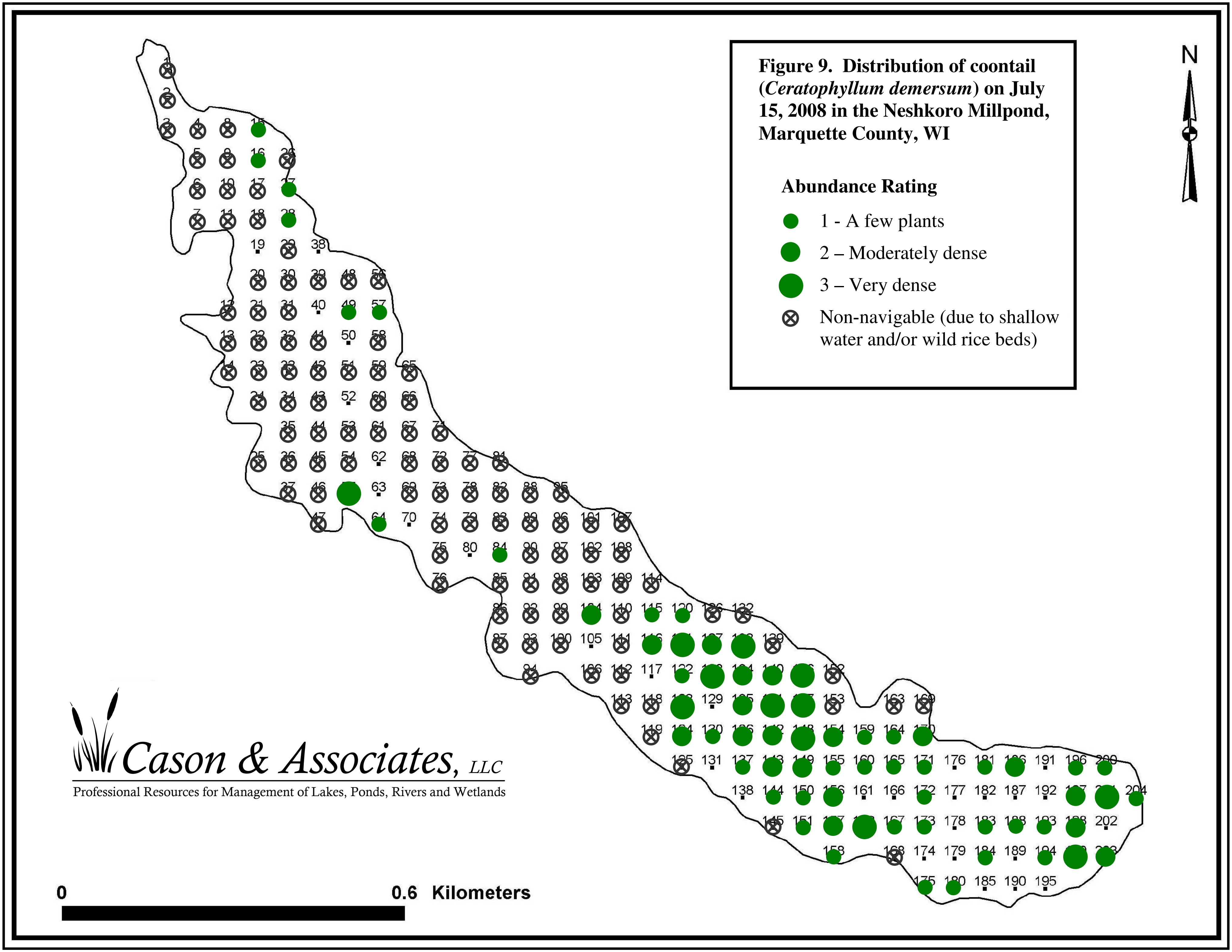


Figure 9. Distribution of coontail (*Ceratophyllum demersum*) on July 15, 2008 in the Neshkoro Millpond, Marquette County, WI

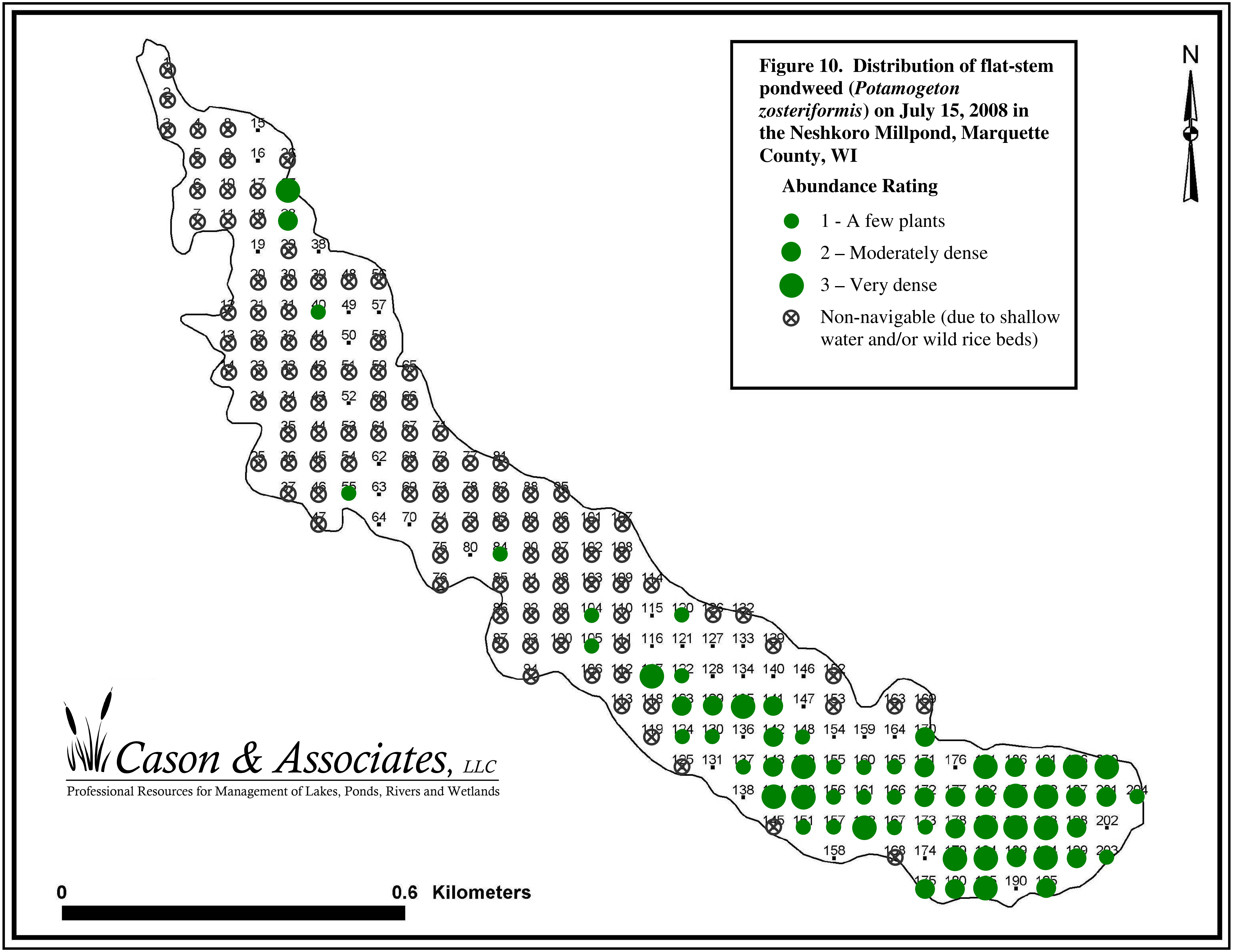
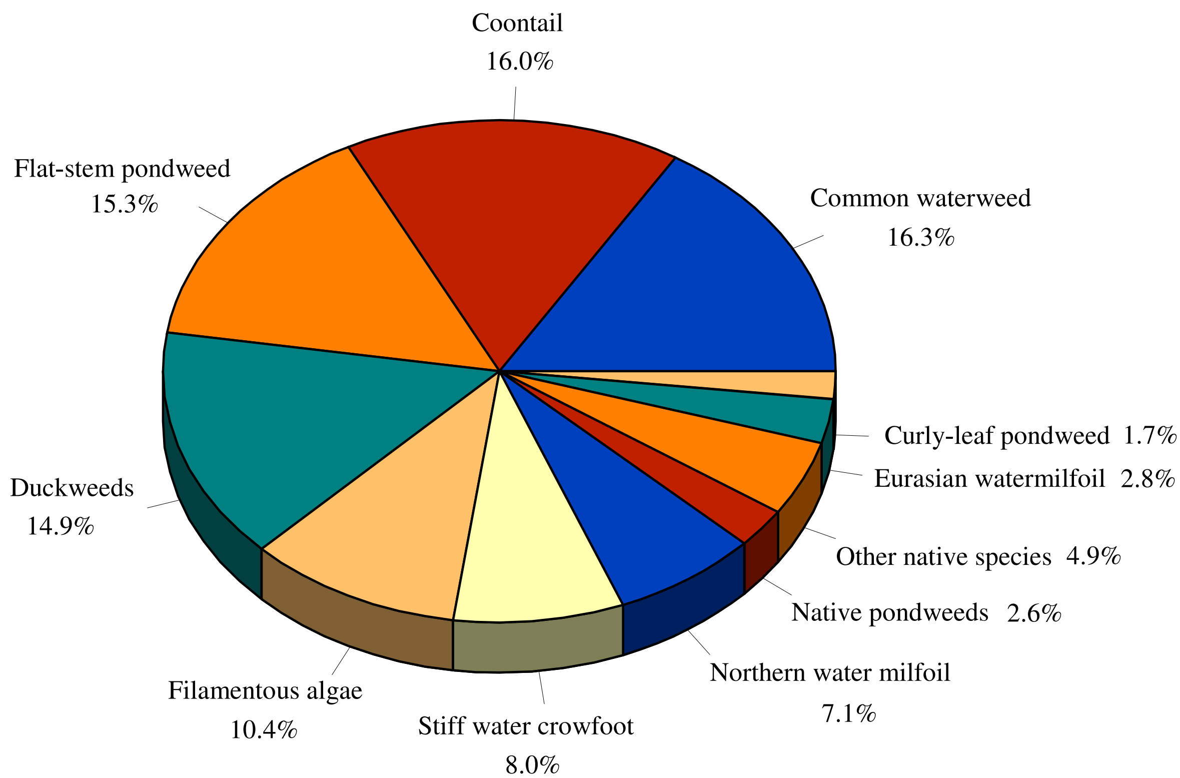


Figure 10. Distribution of flat-stem pondweed (*Potamogeton zosteriformis*) on July 15, 2008 in the Neshkoro Millpond, Marquette County, WI

Figure 11. Submergent aquatic plant community composition for Neshkoro Millpond, Marquette County, July 15, 2008.



Simpson Diversity Index

In order to estimate the diversity of the aquatic plant community, the Simpson Diversity Index takes in account both the number of species identified (richness) and the distribution or relative abundance of each species. As these parameters increase, so does the overall diversity. With the Simpson Diversity Index (D), 1 represents infinite diversity and 0, no diversity. That is, the bigger the value of D, the higher the diversity. The value of D calculated for Neshkoro Millpond based on the 2008 data was 0.89 representing above average diversity.

Assessment of Floristic Quality

The plant data collected for Neshkoro Millpond were used to assess the "floristic quality" of the lake. The method used assigns a value to each *native* plant species called a Coefficient of Conservatism. It does not take in account the presence of exotic species or filamentous algae. Coefficient values range from 0 - 10 and reflect a particular species' likelihood of occurring in a relatively undisturbed landscape. Species with low coefficient values, such as coontail, are likely to be found in a variety of habitat types and can tolerate high levels of human disturbance. On the other hand, species with higher coefficient values, such as wild rice, are much more likely to be restricted to high quality, natural areas. By averaging the coefficient values available for the submergent and emergent species found in Neshkoro Millpond, a lake-wide value of 5.67 was calculated (see **Table 2**). The average value for lakes in Wisconsin is 6.0 while the combined average for lakes in the Northern Central Hardwood Forests and Southeastern Wisconsin Till Plain regions of Wisconsin. is 5.6 (Nichols, 1999).

Table 2. Neshkoro Millpond Floristic Quality Index (FQI) analysis table.

Species	Common Name	C
Ceratophyllum demersum	Coontail	3
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	5
Lemna trisulca	Forked Duckweed	6
Myriophyllum sibericum	Northern water-milfoil	7
Najas flexilis	Bushy pondweed	6
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton natans	Floating-leaf	5
Potamogeton nodosus	Long-leaf pondweed	7
Potamogeton pusillus	Small pondweed	7
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	Stiff water crowfoot	7
Stuckenia pectinata	Sogo pondweed	3
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
Zizania palustris	Northern wild rice	8
	N	18
	mean C	5.67
	FQI	24.0

By utilizing the Coefficients of Conservatism for the plant species of Neshkoro Millpond, further assessment of floristic quality can be made. By multiplying the average coefficient values for Neshkoro Millpond by the square root of the number of plant species found, a Floristic Quality Index (FQI) was calculated at 24.0 (see **Table 2**). In general, higher FQI values reflect higher lake quality. The average for Wisconsin lakes is 22.2. The average for lakes in the Northern Central Hardwood Forests and Southeastern Wisconsin Till Plain regions is 20.9 (Nichols, 1999). Both Coefficient of Conservatism and the Floristic Quality Index values suggest the quality of Neshkoro Millpond specifically in terms of the plant community, is at or slightly above average.

Aquatic plants serve an important purpose in the aquatic environment. They play an instrumental role in maintaining ecological balance in ponds, lakes, wetlands, rivers, and streams. Native aquatic plants have many values. They serve as important buffers against nutrient loading and toxic chemicals, act as filters that capture runoff-borne sediments, stabilize lakebed sediments, protect shorelines from erosion, and provide critical fish and wildlife habitat. Therefore, it is essential that the native aquatic plant community in

Neshkoro Millpond be protected. **Appendix C** provides a list of the more abundant native aquatic plant species that were found in Neshkoro Millpond. Ecological values and a description are given for each species.

Aquatic Plants Below the Millpond

The aquatic plant community below the dam on the Neshkoro Millpond is noticeably less dense than in the millpond itself. The most abundant species in this section of the White River include common waterweed, coontail, flat-stem pondweed, floating-leaf pondweed (*Potamogeton natans*), long-leaf pondweed (*Potamogeton nodosus*), and sago pondweed (*Stuckenia pectinata*). The main channel of the river is generally clear of plants. Other shallow bay/backwater areas have denser aquatic plant growth. There are also areas below the dam where emergent plants species such as bur-reed (*Sparganium* spp.) and cattails (*Typha* spp.) are abundant.

Exotic Plant Distribution Mapping

Curly-leaf pondweed was found in abundance growing in Neshkoro Millpond during the June 4, 2008 survey. **Figure 12** shows the locations where this species was identified. **Figure 13** shows delineated beds of curly-leaf pondweed with the associated plant densities and acreage estimates. At the time of the survey, it was the most abundant plant. Along with the areas of shallow water and/or high sediment accumulation, curly-leaf pondweed posed a nuisance to navigation as early as the spring survey. By the July 15, 2008 point intercept survey of the millpond, curly-leaf pondweed was found at only five locations. This is due to the growth cycle of this species. Curly-leaf pondweed is an aquatic plant species that prefers colder conditions. It begins growing early in the spring; sometimes before ice-out. As water temperatures warm, curly-leaf pondweed produces vegetative structures called turions. By mid to late summer, these turions fall to the sediment and the curly-leaf pondweed plants die back. It is the turions that sprout again in the spring as the next crop of plants. Historically, this characteristic of curly-leaf pondweed has complicated management efforts.

Eurasian watermilfoil was also identified during the July 15, 2008 aquatic plant survey. **Figure 14** shows the locations where this species was identified. **Figure 15** shows delineated beds of Eurasian watermilfoil, plant densities and acreage estimates. It was found growing in the lower half of the millpond. At the time of the survey, it was not found to be in abundance, particularly when compared to the abundance of the native plant species found in **Figures 8-10**.

The Wisconsin Department of Natural Resources (WDNR) annually publishes lists of lakes in the State that contain the exotic species Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). The latest lists, made available in February and March 2008, respectively, do not list the Neshkoro Millpond. Both of these species are potentially aggressive exotic plant species.

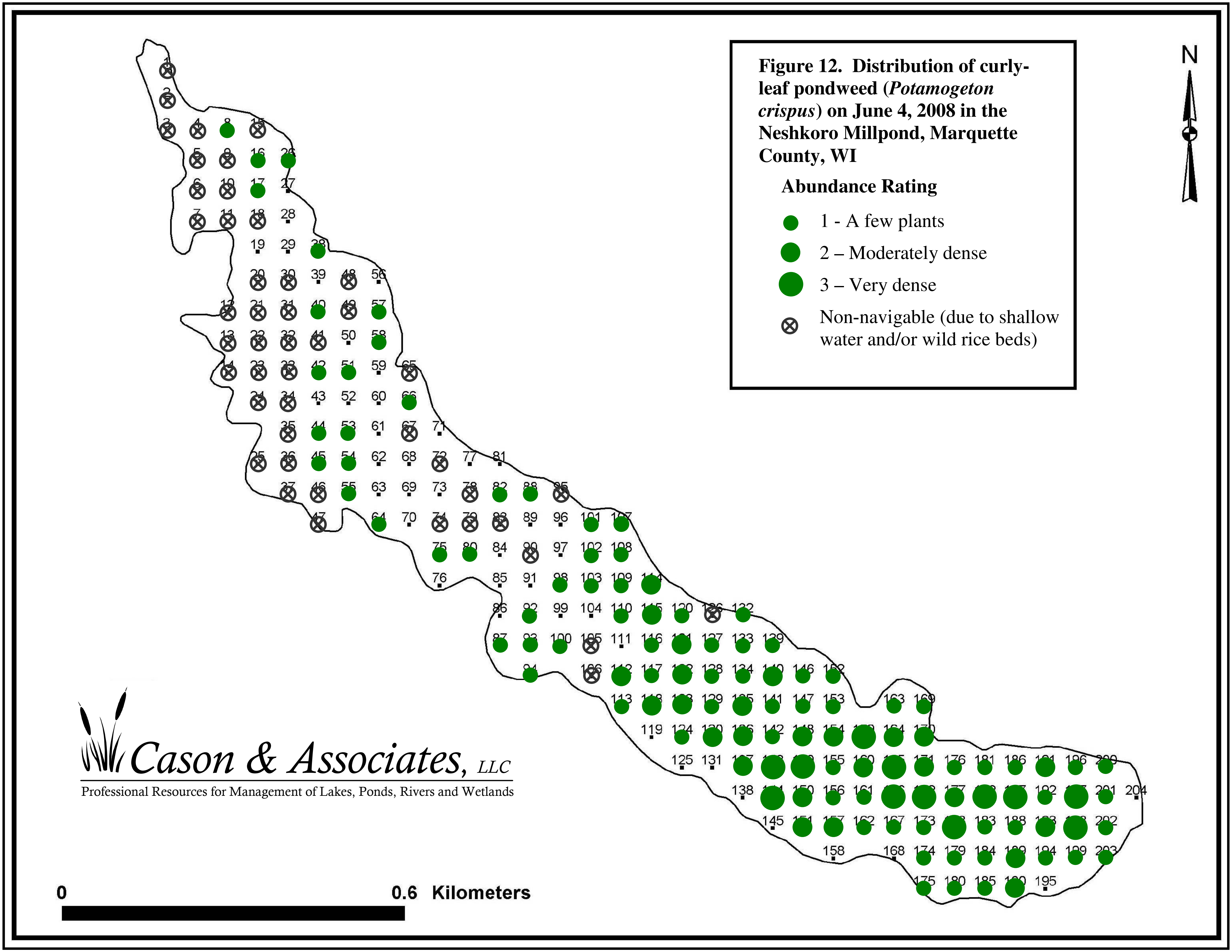


Figure 12. Distribution of curly-leaf pondweed (*Potamogeton crispus*) on June 4, 2008 in the Neshkoro Millpond, Marquette County, WI

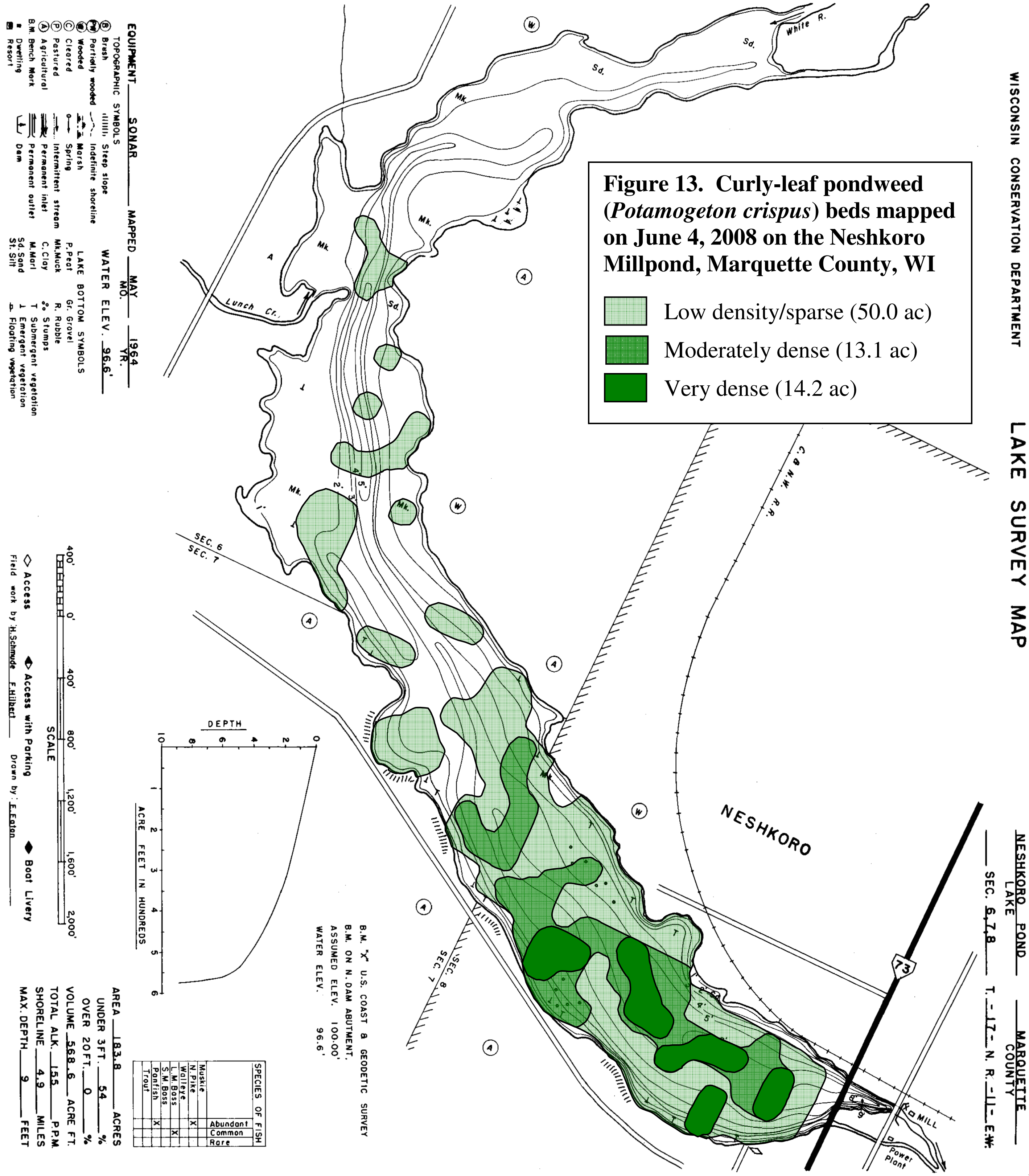


Figure 13. Curly-leaf pondweed (*Potamogeton crispus*) beds mapped on June 4, 2008 on the Neshkoro Millpond, Marquette County, WI

Low density/sparse (50.0 ac)

Moderately dense (13.1 ac)

Very dense (14.2 ac)

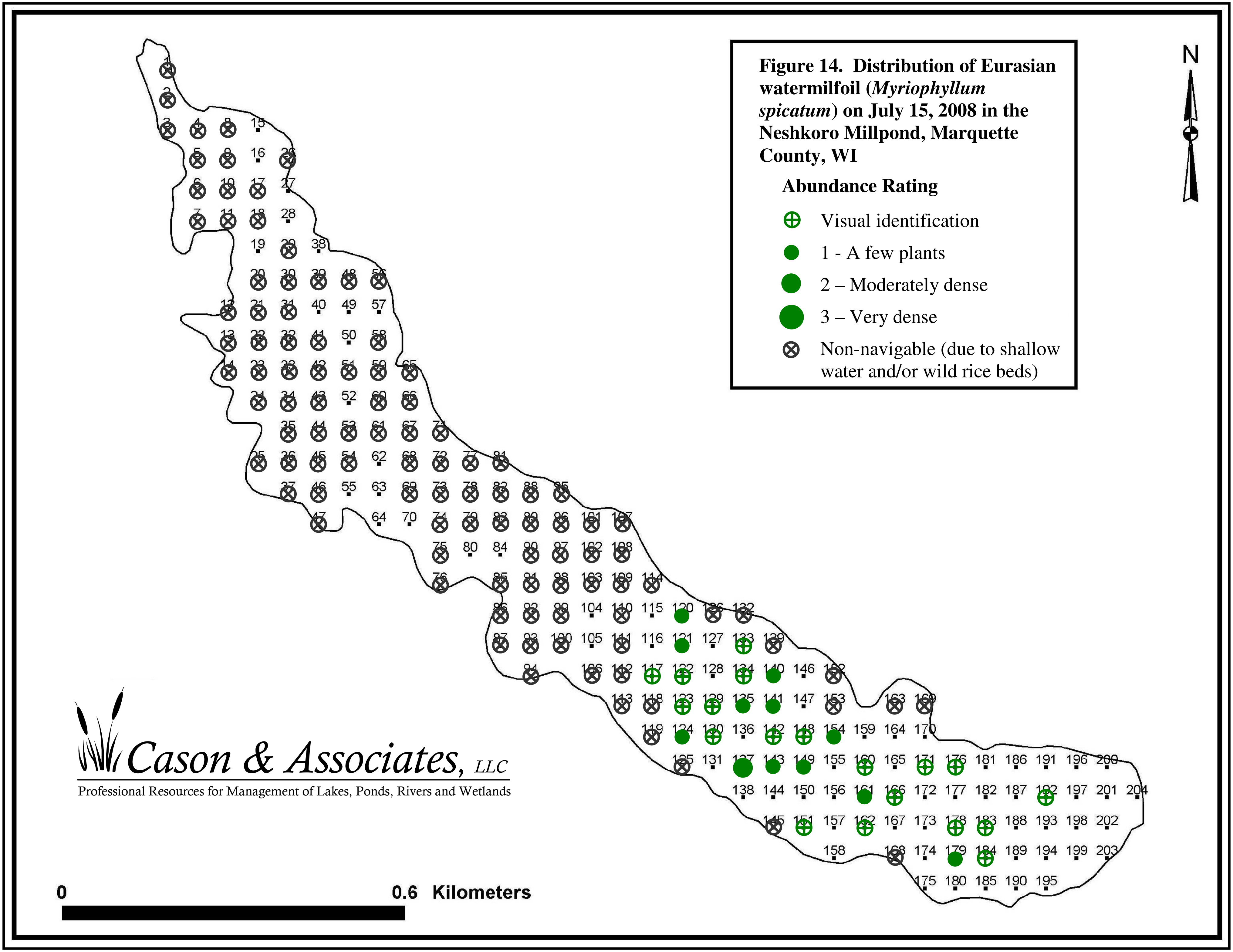


Figure 14. Distribution of Eurasian watermilfoil (*Myriophyllum spicatum*) on July 15, 2008 in the Neshkoro Millpond, Marquette County, WI

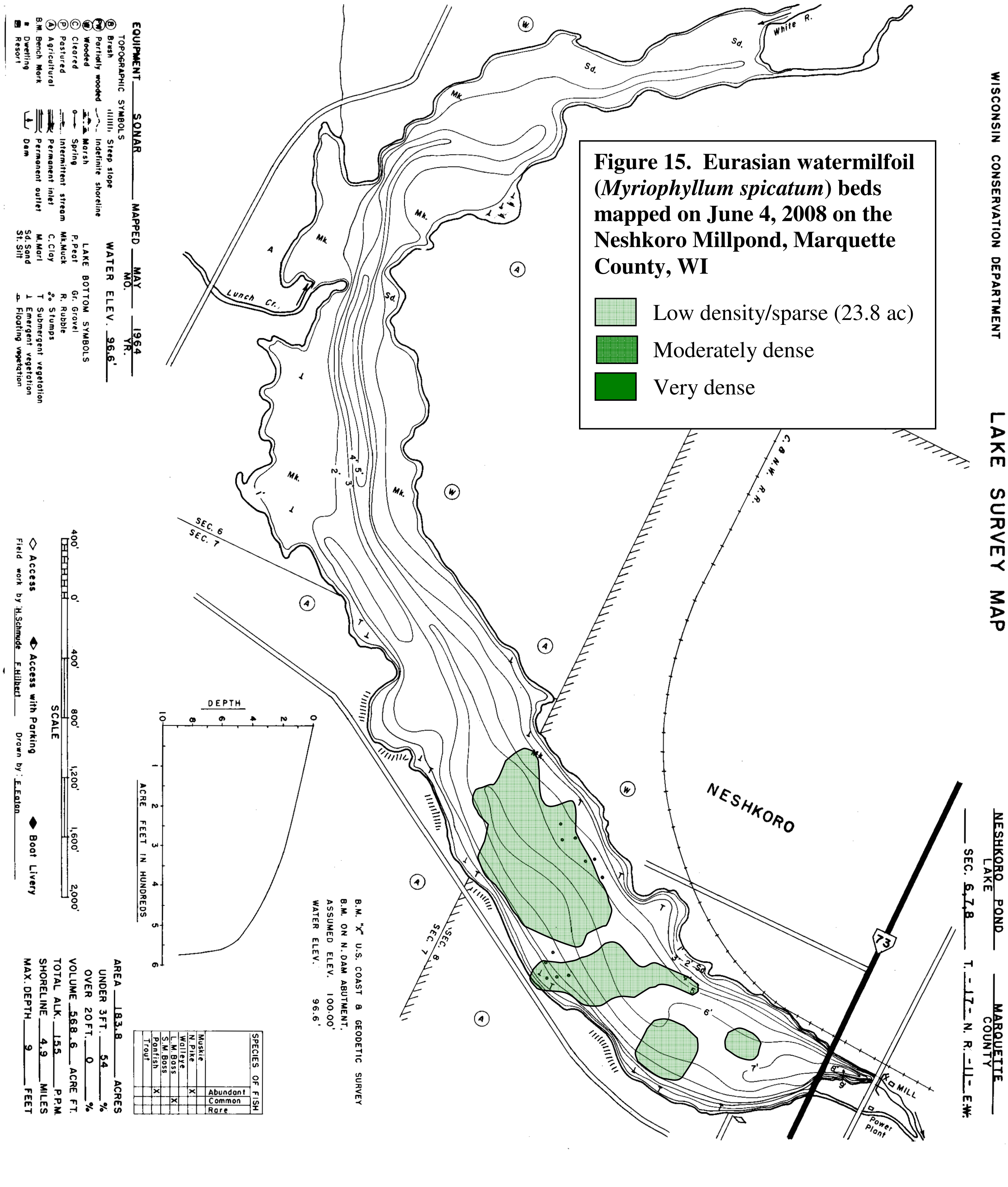


Figure 15. Eurasian watermilfoil (*Myriophyllum spicatum*) beds mapped on June 4, 2008 on the Neshkoro Millpond, Marquette County, WI

Wild Rice Concerns

The spread of wild rice in the Neshkoro Millpond is a concern of many property owners and lake users. Some have noted that over the past ten or 15 years, wild rice has become more abundant and wide-spread in the Millpond. At the time of the July aquatic plant survey, the locations of wild rice were recorded. However, as previously stated, shallow water and dense plant growth prohibited navigation in much of the millpond. In particular, areas in the upper portion of the lake were impossible to reach primarily due to the abundance of wild rice. **Figure 16** shows the locations of wild rice found during the July plant survey. Because of these navigation issues, this map greatly under-represents the full distribution of wild rice in the Neshkoro Millpond. Some of these locations no longer include standing water. Instead many locations appeared to be mud flats with very little vegetation. Lake residents assisting with the plant survey noted that these areas were previously dominated by wild rice and that in the past few years some of the wild rice stands had died back. This is understandable. Wild rice has specific habitat requirements. In Wisconsin, it grows best in slow-moving water between 10 and 100 cm deep in streams, rivers, and as in the case of the Neshkoro Millpond, in lakes that are part of river systems. Shallower waters (<30 cm) tend to support denser stands compared to deeper water where plants tend to be single-stemmed and more widely spaced. This growth characteristic is evident in the Neshkoro Millpond. In addition, wild rice prefers to grow in soft-textured sediments such as organic muck. It is likely that wild rice has died back in some areas because the water has become too shallow or no longer flows. The years of sediment accumulation, due in part to a build up of dead aquatic plant matter, has created unfavorable growing conditions for wild rice. Instead, it grows in new locations as the physical characteristics of the millpond change to conditions more favorable to wild rice growth (e.g. soft sediment accumulation, shallow flowing water). The presence of rice growing, albeit sparsely, in the lower portion of the millpond was found during the plant survey. It's presence at these locations was alarming to the lake residents assisting at the time.

Figure 17 helps illustrate the issue of wild rice growth and shallow water. This photo was taken in August 2008. The deepest area of the lake near the Town of Neshkoro is clearly visible. Also visible is the large shallow portion of the lake. Unfortunately it is difficult to specifically identify wild rice. However, the issue of navigability is evident particularly when the distribution of wild rice documented onsite is overlaid onto this map (**Figure 18**). Other aerial photos dating back to 1981 were obtained from the US Geological Survey office in Westfield, WI. They can be found in **Appendix D**. These images were taken for agricultural purposes. As a result, they were all taken in the late summer when crops were actively growing. These photos show shallow conditions dating back nearly 30 years. However, the quality of the images is not high enough to make effective comparisons from year to year. Many are copied from slides which are discolored or do not show the entire millpond. The clearest images from the 1980s appear to show shallow water and dense plant and algae growth in the upper portions of the millpond.

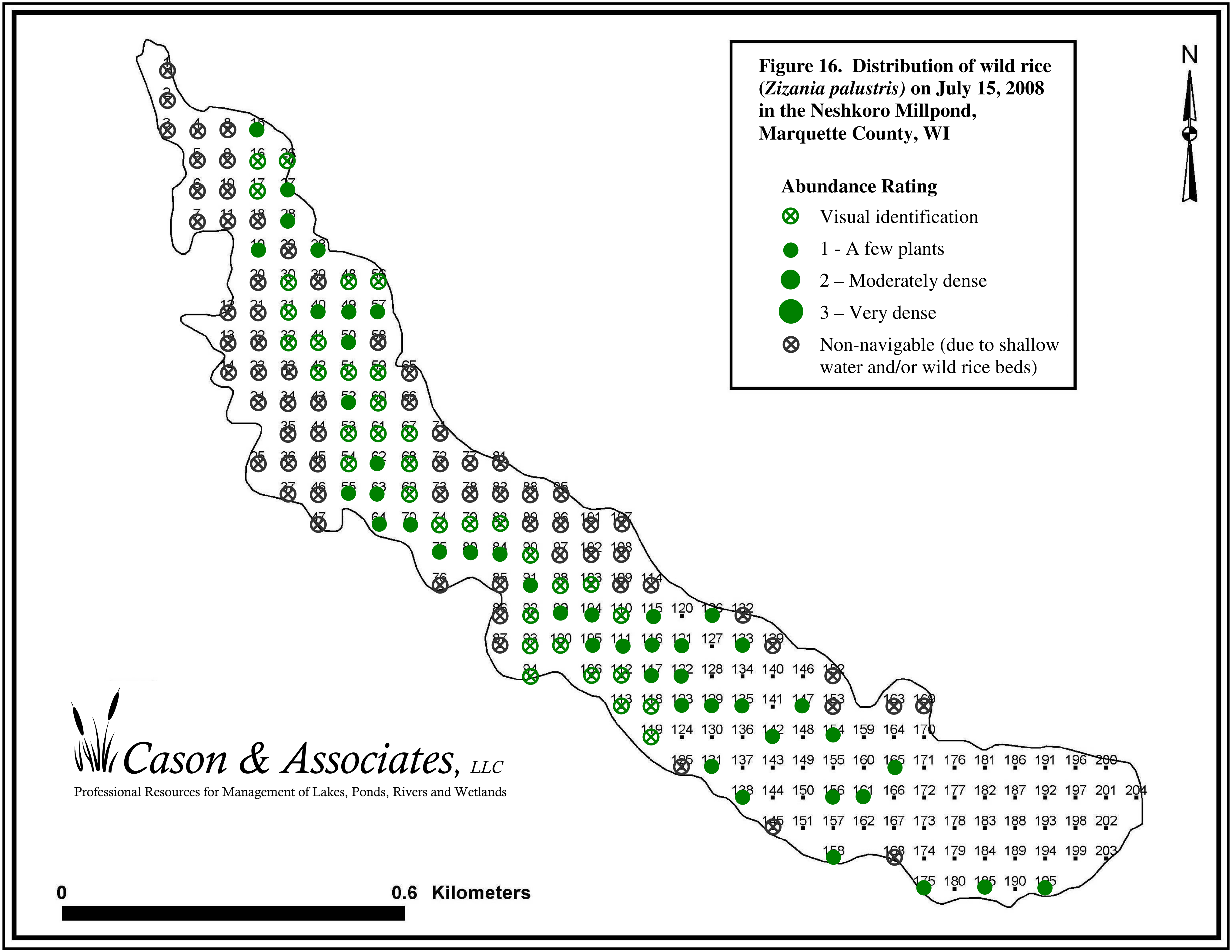


Figure 16. Distribution of wild rice (*Zizania palustris*) on July 15, 2008 in the Neshkoro Millpond, Marquette County, WI

Figure 17. August 2008 aerial photo of the Neshkoro Millpond, Marquette County, WI.

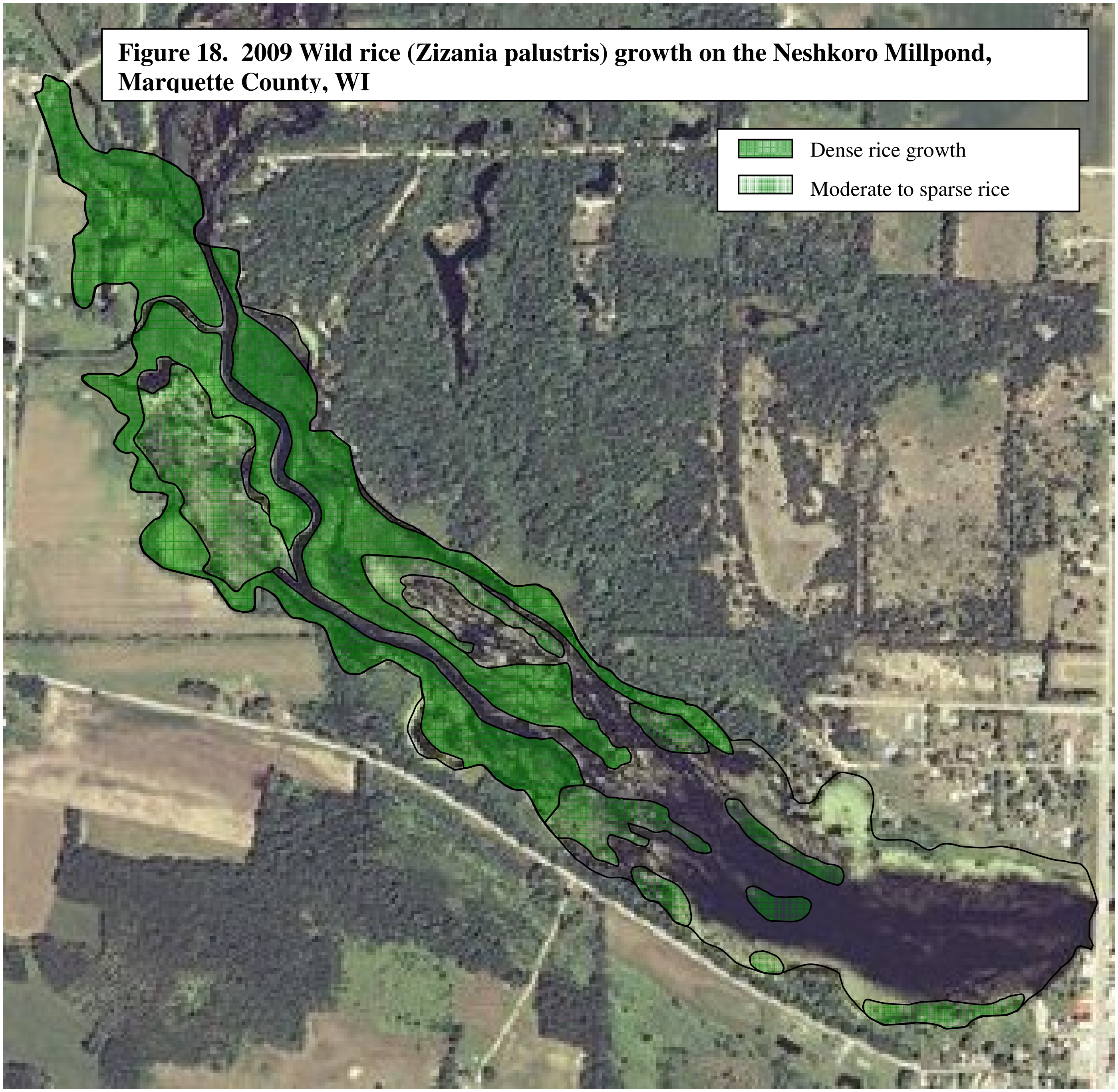


Figure 18. 2009 Wild rice (Zizania palustris) growth on the Neshkoro Millpond, Marquette County, WI
Dense rice growth
Moderate to sparse rice

Water Depths

Figure 2 shows the depth contours of the Neshkoro Millpond from 1964. The information provided on this map indicates the average water depth to be 3.1 feet. Data collected during the July 2008 plant survey was used to develop the map shown in **Figure 19.** By approximating the depths of the non-navigable areas of the lake, an average depth of the lake was estimated at 2.0 feet. It is safe to assume that in an artificially impounded system such as the Neshkoro Millpond, sediments have been accumulating over the past 40 years or more reducing the depth of water. However, the comparison between these two sets of depth data would suggest the rate of accumulation has not changed the overall depth of the millpond significantly since 1964. The aerial photos available from the 1980s support this theory as well. Although these photos are lower quality than the 2008 aerial photo shown in **Figure 17,** they do show that similar shallow conditions existed in the millpond 20 to 25 years ago.

Sediment Depths

As with the aquatic plant survey, a limited number of sediment sampling locations could be reached during the two sediment sampling efforts. As a result, it was not practical to develop a map showing the distribution of sediment depths in the millpond. In total, soft sediment depths were measured at 45 locations throughout the millpond. Sediment depths ranged from one foot to over nine feet (**Table 3**). The average sediment depth was 5.3 feet. This translates to over 950 acre-feet or over 1.5 million cubic yards of soft sediments throughout the millpond.

Figure 19. 2008 Depth contour map of the Neshkoro Millpond, Marquette County, Wisconsin

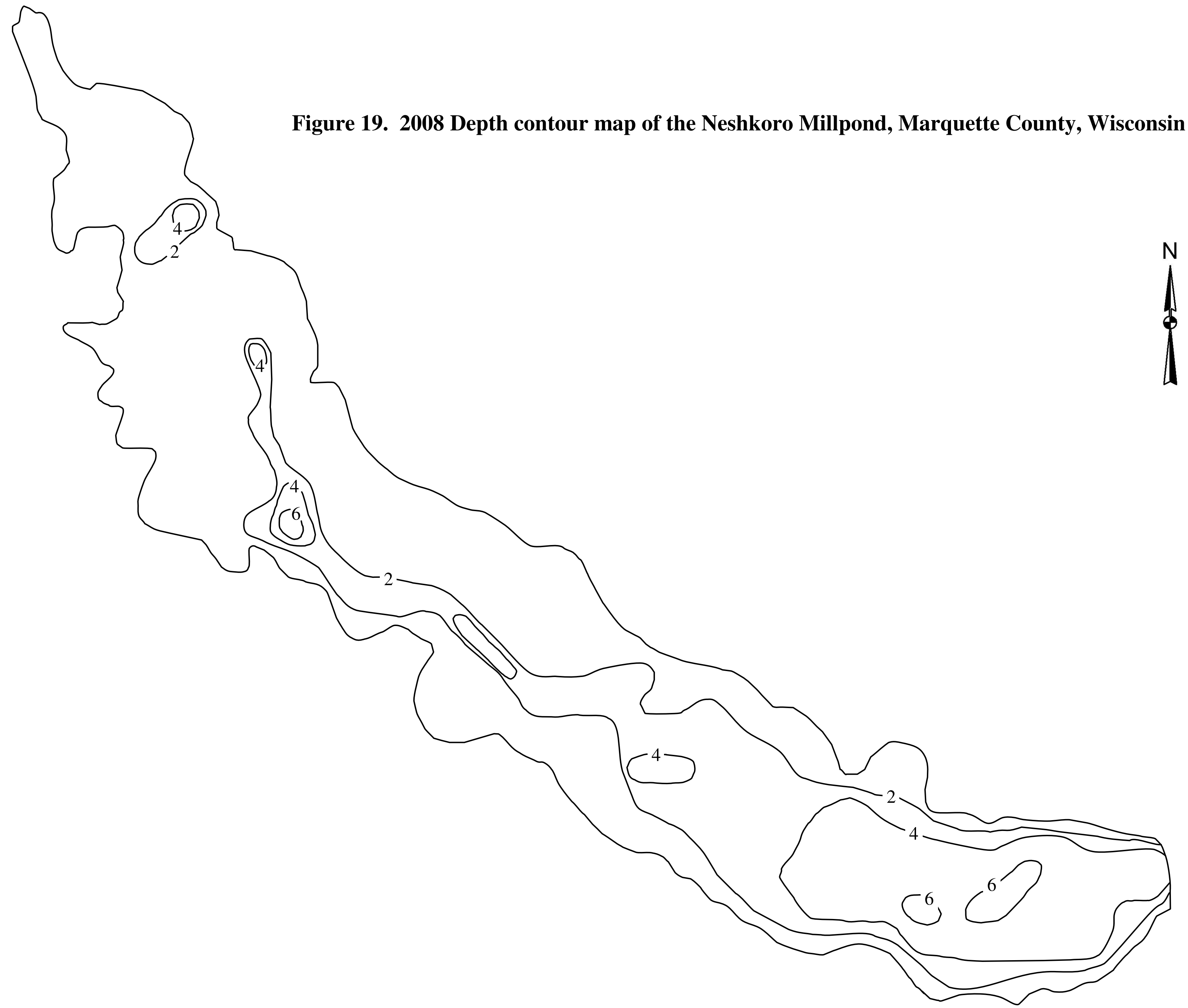


Table 3. Soft sediment depths measured within the Neshkoro Millpond on July 15, 2008.

Site #	Depth of Water	Depth of Sediment & Water	Depth of Sediment
1	0.4	6.7	6.3
3	1.6	6.1	4.5
8	0.2	6.8	6.6
16	3.5	6.8	3.3
12*	--	--	--
14*	--	--	--
27	1.0	2.0	1.0
29	0.0	7.2	7.2
31	0.0	6.8	6.8
33*	--	--	--
35*	--	--	--
37	1.3	5.7	4.4
49	1.8	6.8	5.0
51	0.7	6.9	6.2
53	0.2	6.6	6.4
55	2.9	7.5	4.6
65*	--	--	--
67	0.0	5.7	5.7
69	0.4	8.6	8.2
78*	--	--	--
80	4.4	9.6	5.2
88*	--	--	--
90	1.1	7.7	6.6
92*	0.9	7.0	6.1
94*	--	--	--
99	5.0	8.3	3.3
102	2.7	7.2	4.5

* Not navigable

Site #	Depth of Water	Depth of Sediment & Water	Depth of Sediment
104	1.0	9.8	8.8
105	1.4	8.8	7.4
109	3.2	7.0	3.8
115	2.9	6.9	4.0
117	1.8	8.7	6.9
119	1.9	7.8	5.9
126	1.9	7.7	5.8
128	3.0	7.8	4.8
130	2.9	12.0	9.1
140	2.2	7.3	5.1
142	3.0	8.2	5.2
144	2.9	8.8	5.9
152	1.7	7.2	6.5
154	4.0	10.7	6.7
156	4.6	9.5	4.9
158	1.5	4.9	3.4
164	3.1	9.5	6.4
166	4.8	13.7	8.9
168	1.5	2.7	1.2
177	5.1	9.8	4.7
179	5.4	10.6	5.2
187	6.4	9.6	3.2
189	5.3	8.8	3.5
197	5.3	9.5	4.2
199	4.5	9.5	5.0
204	6.0	6.2	0.2
		Average	5.3

Water Quality Analysis

A limited amount of water quality data is available for the Neshkoro Millpond. In fact, prior to this study only three sampling dates were found over the past 30 years. However, given the limitations, some conclusions can be drawn regarding the water quality of the millpond. All available results from 1979 to 2009 can be found in **Tables 4-6**.

Conductivity
Conductivity is the measure of the inorganic compounds in a body of water as determined by how well an electrical current is carried through a water sample. Conductivity is dependant upon the concentration of inorganic compounds suspended in the water column. High conductivity values may indicate contamination from septic systems, fertilizers, animal wastes or road salts. As a result, conductivity can be used to determine if human activities are influencing water quality. The recommended value for conductivity in lake samples is below 300 μmhos/cm. The data from all three sites in 2008 and 2009 were between 300 and 400 μmhos/cm.

Alkalinity
Alkalinity is a measure of the amount of carbonates, bicarbonates and hydroxide present in water. Alkalinity is predominantly determined by soil and bedrock characteristics. Lakes and ponds fed by groundwater from limestone aquifers tend to have high alkalinity. High alkalinity can also be a result of high algae and aquatic plant production. Low alkalinity (< 25 mg/L) waters are susceptible to acid rain. Alkalinity levels above 25 mg/L in the Neshkoro Millpond are indicative of a hard water system able to withstand acid rain conditions. These levels do not warrant concern.

pH
pH is the measure of a lake's acid level. It is the negative log of the hydrogen ion concentration in the water. Many factors influence pH including geology, productivity, pollution, etc. pH levels between 7 and 9 are not uncommon for lakes in Wisconsin. The pH levels for the Neshkoro Millpond and the White River measured in 2008 and 2009 were between 8.0 and 8.75. This does not raise concern over water quality in the lake.

Nitrogen
Excess nutrients (nitrates) entering groundwater in the watershed can be a significant threat to the overall water quality of the Neshkoro Millpond. Nitrogen is an important nutrient for plants and algae. It can enter lakes from groundwater, surface runoff (livestock manure and agricultural fertilizers) and precipitation. In addition, decomposing organic matter releases nitrogen.

Nitrogen can exist in a number of forms in aquatic systems. Samples collected from the Neshkoro Millpond in 2008 were tested for nitrates and nitrites and for total Kjeldahl nitrogen. Nitrates and nitrites are inorganic forms of nitrogen which can be readily used by plants and algae. Kjeldahl nitrogen is organic nitrogen plus ammonia. Water

Table 4. Water quality data available from the White River above the Neshkoro Millpond, Marquette County, WI.

		Date							
Parameter	**untis**	**8/14/1979**	**7/27/1999**	**9/2/2001**	**4/25/2008**	**11/4/2008**	**6/23/2009**	**7/29/2009**	**8/31/2009**
pH	SU	7.70	--	--	8.18	8.34	8.44	8.71	8.27
Conductivity	umhos/cm	314	--	--	348	373	342	--	--
Alkalinity	mg/L $CaCO_3$	147	--	--	156	174	160	--	--
Magnesium	mg/L $CaCO_3$	21	--	--	--	--	--	--	--
Calcium	mg/L $CaCO_3$	31	--	--	--	--	--	--	--
Total hardness	mg/L $CaCO_3$	164	--	--	--	--	--	--	--
Turbidity	NU	0.7	--	--	--	--	--	--	--
Reactive Phosphorus	mg/L P	0.005	--	--	--	--	--	--	--
Total Phosphorus	mg/L P	0.014	--	--	0.039	0.013	0.032	0.033	0.022
Ammonium	mg/L N	0.03	--	--	--	--	--	--	--
Nitirate - Nitrite	mg/L N	0.26	--	--	1.79	2.07	1.32	1.42	1.41
Total Kjeldahl N	mg/L N	--	--	--	0.43	0.29	0.61	0.45	0.48
Total Nitrogen	mg/L N	--	--	--	2.22	2.36	1.93	1.87	1.89
Organic Nitrogen	mg/L N	0.29	--	--	--	--	--	--	--
N/P Ratio		--	--	--	56.9	181.5	60.3	56.7	85.9
Chloride	mg/L Cl	3.0	--	--	--	--	--	--	--
Sodium	mg/L Na	1.0	--	--	--	--	--	--	--
Potassium	mg/L K	0.5	--	--	--	--	--	--	--
Chlorophyll a	µg/L	4.01	--	--	3.01	2.98	4.19	1.9	2.0
Surface Temperature	° F	--	--	--	--	--	--	--	--
Surface Dissolved Oxygen	mg/L	--	--	--	--	--	--	--	--
Secchi depth	feet	--	--	--	--	--	--	--	--
Secchi depth	meters	--	--	--	--	--	--	--	--

Table 5. Water quality data available from the Neshkoro Millpond, Marquette County, WI.

		Date							
Parameter	**untis**	**8/14/1979**	**7/27/1999**	**9/2/2001**	**4/25/2008**	**11/4/2008**	**6/23/2009**	**7/29/2009**	**8/31/2009**
pH	SU	--	--	--	8.15	8.22	8.12	8.27	8.13
Conductivity	umhos/cm	--	--	--	329	373	346	--	--
Alkalinity	mg/L $CaCO_3$	--	--	--	147	172	158	--	--
Magnesium	mg/L $CaCO_3$	--	--	--	--	--	--	--	--
Calcium	mg/L $CaCO_3$	--	--	--	--	--	--	--	--
Total hardness	mg/L $CaCO_3$	--	--	--	--	--	--	--	--
Turbidity	NU	--	--	--	--	--	--	--	--
Reactive Phosphorus	mg/L P	--	--	--	--	--	--	--	--
Total Phosphorus	mg/L P	--	--	--	0.036	0.014	0.047	0.027	0.015
Ammonium	mg/L N	--	--	--	--	--	--	--	--
Nitirate - Nitrite	mg/L N	--	--	--	1.52	2.13	1.29	1.01	1.31
Total Kjeldahl N	mg/L N	--	--	--	0.54	0.43	0.67	0.30	0.54
Total Nitrogen	mg/L N	0.57	--	--	2.06	2.56	1.96	1.31	1.85
Organic Nitrogen	mg/L N	--	--	--	--	--	--	--	--
N/P Ratio		--	--	--	57.2	182.9	41.7	48.5	123.3
Chloride	mg/L Cl	--	--	--	--	--	--	--	--
Sodium	mg/L Na	--	--	--	--	--	--	--	--
Potassium	mg/L K	--	--	--	--	--	--	--	--
Chlorophyll a	µg/L	--	--	--	2.70	1.47	6.10	1.2	1.9
Surface Temperature	° F	--	--	--	--	--	--	--	--
Surface Dissolved Oxygen	mg/L	8.10	--	--	--	--	--	--	--
Secchi depth	feet	7.0	6.5	5.5	6.0	--	8.7	9.0	8.8
Secchi depth	meters	2.13	1.97	1.67	1.83	--	2.7	2.7	2.7

Table 6. Water quality data available from the White River below the Neshkoro Millpond, Marquette County, WI.

		Date							
Parameter	**untis**	**8/14/1979**	**7/27/1999**	**9/2/2001**	**4/25/2008**	**11/4/2008**	**6/23/2009**	**7/29/2009**	**8/31/2009**
pH	SU	8.30	--	--	8.17	8.30	8.03	8.33	8.15
Conductivity	umhos/cm	--	--	--	332	370	349	--	--
Alkalinity	mg/L $CaCO_3$	174	--	--	148	171	159	--	--
Magnesium	mg/L $CaCO_3$	--	--	--	--	--	--	--	--
Calcium	mg/L $CaCO_3$	--	--	--	--	--	--	--	--
Total hardness	mg/L $CaCO_3$	--	--	--	--	--	--	--	--
Turbidity	NU	2	--	--	--	--	--	--	--
Reactive Phosphorus	mg/L P	ND	--	--	--	--	--	--	--
Total Phosphorus	mg/L P	0.021	--	--	0.040	0.021	0.039	0.024	0.015
Ammonium	mg/L N	0.08	--	--	--	--	--	--	--
Nitirate - Nitrite	mg/L N	1.42	--	--	1.51	2.06	1.14	0.98	1.10
Total Kjeldahl N	mg/L N	0.4	--	--	0.58	0.42	0.64	0.39	0.27
Total Nitrogen	mg/L N	--	--	--	2.09	2.48	1.78	1.37	1.37
Organic Nitrogen	mg/L N	--	--	--	--	--	--	--	--
N/P Ratio		--	--	--	52.3	118.1	45.6	57.1	91.3
Chloride	mg/L Cl	6	--	--	--	--	--	--	--
Sodium	mg/L Na	--	--	--	--	--	--	--	--
Potassium	mg/L K	--	--	--	--	--	--	--	--
Chlorophyll a	µg/L	5	--	--	3.40	2.89	3.13	0.13	2.5
Surface Temperature	° C	20	--	--	--	--	--	--	--
Surface Dissolved Oxygen	mg/L	9.4	--	--	--	--	--	--	--
Secchi depth	feet	--	--	--	--	--	--	--	--
Secchi depth	meters	--	--	--	--	--	--	--	--

naturally contains less than 1 ppm of nitrogen. If the inorganic forms of nitrogen exceed 0.3 mg/l in spring, there is sufficient nitrogen to support summer algae blooms and negatively affect water quality. Results from the Neshkoro Millpond, in the spring were 1.5 to 1.8 mg/l. Fall concentrations were higher yet. Total nitrogen is determined by adding nitrate + nitrite to Kjeldahl nitrogen. Total nitrogen levels were between 1.3 and 2.6 mg/l in 2008 and 2009. These are higher than desired levels for nitrogen and are a cause for concern. In addition, the data do not suggest that the millpond itself is either removing or contributing significant amounts of nitrogen to the White River.

Phosphorus

Phosphorus is one of the most important water quality indicators. Phosphorus levels can determine the amount of algae growth in a lake. Phosphorus can come from external sources within the watershed (fertilizers, livestock, septic systems) or to a lesser extent, from groundwater. Phosphorus can also come from within the lake through a process called internal loading. Internal loading occurs when plants and chemical reactions release phosphorus from the lake sediments into the water column.

The average phosphorus concentration for natural lakes in Wisconsin is 0.025 mg/L or 25 ppb (Shaw, et al, 2004). Values above 0.05 mg/L are indicative of poor water quality. The data available for the Neshkoro Millpond do not contain any phosphorus levels above 0.05 mg/L (**Table 5**). In general, these data indicate fair water quality for Neshkoro Millpond.

When the ratio of total nitrogen to total phosphorus is less than 15:1, a lake is considered nitrogen limited. When this occurs, additions of nitrogen to the lake can lead to increased plant productivity. Nitrogen: phosphorus ratios for the Neshkoro Millpond in 2008 were much greater than 15:1, indicating that the lake is phosphorus limited. Additional phosphorus inputs (rather than nitrogen inputs) are of greater concern in terms of increased plant and algae growth.

Chlorophyll

Chlorophyll is the pigment found in all green plants, including algae, that give them their green color. It is the site in plants where photosynthesis occurs. Chlorophyll absorbs sunlight to convert carbon dioxide and water to oxygen and sugars. Chlorophyll data is collected to estimate how much phytoplankton (algae) there is in a lake. Generally, the more nutrients there are in the water and the warmer the water, the higher the production of algae and consequently chlorophyll.

Chlorophyll concentrations below 10 ppb are most desirable for lakes. The highest concentration of chlorophyll recorded during this study was 6.1 ppb measured during June 2009.

Secchi Transparency

Water clarity is often used as a quick and easy test for a lake's overall water quality, especially in relation to the amount of algae present. There is an inverse relationship between Secchi depth and the amount of suspended matter, including algae, in the water column. The less suspended matter, the deeper the Secchi disc is visible. Because a certain amount of water depth is needed to measure the clarity of a lake, the only data available for Neshkoro Millpond are from Site B; the main body of the millpond. Water clarity readings collected for Neshkoro Millpond over the past 30 years ranged between 5.5 and 9.0 feet. Secchi depths greater than six feet are generally indicative of good water quality. Again this indicates fair water quality for Neshkoro Millpond. It is likely the depth of the water prohibited accurate data collection under clear conditions since depths greater then nine feet are not found in the millpond.

Trophic State

There is a strong relationship between levels of phosphorus, chlorophyll and water clarity in lakes. As a response to rising levels of phosphorus, chlorophyll levels increase and transparency values often decrease. The effect of this is viewed as an increase in the productivity of a lake.

Lakes can be categorized by their productivity or trophic state. When productivity is discussed, it is normally a reflection of the amount of plant and animal biomass a lake produces or has the potential to produce. The most significant and often detrimental result is elevated levels of algae and nuisance aquatic plants. Lakes can be categorized into three trophic levels:

- oligotrophic - low productivity, high water quality
- mesotrophic - medium productivity and water quality
- eutrophic - high productivity, low water quality

These trophic levels form a spectrum of water quality conditions. Oligotrophic lakes are typically deep and clear with exposed rock bottoms and limited plant growth. Eutrophic lakes are often shallow and marsh-like, typically having heavy layers of organic silt and abundant plant growth. Mesotrophic lakes are typically deeper than eutrophic lakes with significant plant growth, and areas of exposed sand, gravel or cobble-bottom substrates.

Lakes can naturally become more eutrophic with time, however the trophic state of a lake is more influenced by nutrient inputs than by time. When humans negatively influence the trophic state of a lake the process is called *cultural eutrophication*. A sudden influx of available nutrients may cause a rapid change in a lake's ecology. Opportunistic plants such as algae and nuisance plant species are able to out-compete other more desirable species of macrophytes. The resulting appearance is typical of poor water quality.

Total phosphorus, chlorophyll and Secchi depth are often used as indicators of the water quality and productivity (trophic state) in lakes. Values measured for these parameters can be used to calculate Trophic State Index (TSI) values (Carlson 1977). The formulas for calculating the TSI values for Secchi disk, chlorophyll, and total phosphorus are as follows:

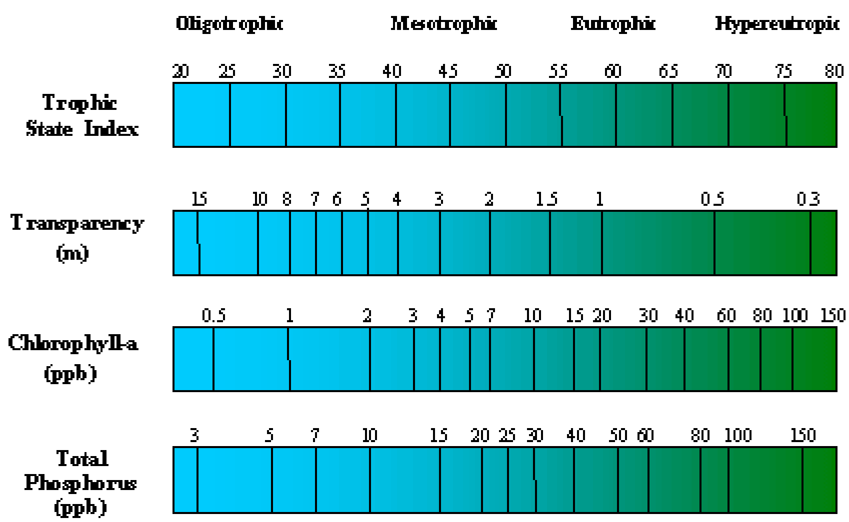
$$TSI = 60 - 14.41 \ln \text{Secchi disk (meters)}$$

$$TSI = 9.81 \ln \text{Chlorophyll } (\mu g/L) + 30.6$$

$$TSI = 14.42 \ln \text{Total phosphorus } (\mu g/L) + 4.15$$

The higher the TSI calculated for a lake, the more eutrophic it is (**Figure 20**). Classic eutrophic lakes have TSI values starting around 50. Because of the limited data available, Secchi, chlorophyll and phosphorus data for Neshkoro Millpond over the past 30 years were used to calculate TSI values. Most of the average TSI values calculated from the Neshkoro Millpond water quality data were between 40 and 50 (**Table 7**). Occasionally TSI values above 50 were calculated. TSI values indicate the Neshkoro Millpond exhibits characteristics of a lake near the boundary between a mesotrophic and eutrophic lake.

Figure 20. Relationship between trophic state in lakes and parameters including Secchi transparency, chlorophyll, and total phosphorus.



The WiLMS program includes a module entitled Lake Eutrophication Analysis Procedure (LEAP). This module predicts values for Secchi depth, chlorophyll and phosphorus based on physical and chemical information regarding the lake and its watershed. It then compares the predicted values to the observed or measured values. The observed values for total phosphorus and chlorophyll a were far less than the values predicted by the WiLMS software. Similarly the observed Secchi depth value was greater than predicted. In other words, water quality of Neshkoro Millpond is greater than expected for a lake with as large a watershed in either the North Central Harwood Forests or Southeast Wisconsin Till Plain Ecoregions.

Table 7. Water quality and Trophic State Index values for the Neshkoro Millpond, Marquette County, WI.

Location	Sample Date	T. Phosphorus (mg/l)	T. Phosphorus (µg/l)	Phosphorus TSI	Chlorophyll a (ug/l)	Chlorophyll a TSI	Secchi Depth (m)	Secchi TSI	Average TSI
	8/14/1979	0.014	14	*42.21*	4.01	*44.22*	--	--	*43.21*
Above Millpond	7/27/1999	--	--	--	--	--	--	--	--
(Site A)	9/2/2001	--	--	--	--	--	--	--	--
	4/25/2008	0.039	39	*56.98*	3.01	*41.41*	--	--	*49.19*
	11/4/2008	0.013	13	*41.14*	2.98	*41.31*	--	--	*41.22*
	6/23/2009	0.032	32	*54.13*	4.19	*44.65*	--	--	*49.39*
	7/29/2009	0.033	33	*54.57*	1.9	*36.90*	--	--	*45.73*
	8/31/2009	0.022	22	*48.72*	2.0	*37.40*	--	--	*43.06*
	8/14/1979	--	--	--	--	--	2.13	*49.08*	*49.08*
Main Body of Millpond	7/27/1999	--	--	--	--	--	1.97	*50.23*	*50.23*
(Site B)	9/2/2001	--	--	--	--	--	1.67	*52.61*	*52.61*
	4/25/2008	0.036	36	*55.82*	2.70	*40.34*	1.83	*51.29*	*49.15*
	11/4/2008	0.014	14	*42.21*	1.47	*34.38*	--	--	--
	6/23/2009	0.047	47	*59.67*	6.10	*48.34*	2.65	*45.95*	*51.32*
	7/29/2009	0.027	27	*51.68*	1.2	*32.39*	2.74	*45.46*	*43.17*
	8/31/2009	0.015	15	*43.20*	1.9	*36.90*	2.68	*45.78*	*41.96*
	8/14/1979	0.021	21	*48.05*	5	*46.39*	1.83	*51.30*	*48.58*
Below Millpond	7/27/1999	--	--	--	--	--	2.92	*44.57*	*44.57*
(Site C)	9/2/2001	--	--	--	--	--	2.29	*48.09*	*48.09*
	4/25/2008	0.040	40	*57.34*	3.40	*42.61*	2.90	*44.68*	*48.21*
	11/4/2008	0.021	21	*48.05*	2.89	*41.01*	3.35	*42.57*	*43.88*
	6/23/2009	0.039	39	*56.98*	3.13	*41.79*	--	--	*49.39*
	7/29/2009	0.024	24	*49.98*	0.13	*10.59*	--	--	*30.28*
	8/31/2009	0.015	15	*43.20*	2.5	*39.59*	--	--	*41.39*
Averages		0.03	26.59	*50.23*	2.85	*38.84*	2.41	*47.63*	*45.89*

Watershed Analysis

In August 2008, the watershed analysis of the Neshkoro Millpond was conducted. **Figures 21 and 22** show the delineation of the Neshkoro Millpond watershed and the land-use types present. The data for the land-use map (**Figure 22**) was provided by the Wisconsin DNR's Bureau of Technology Services.

The survey and resulting analysis found that the watershed of Neshkoro Millpond is approximately 101.8 square miles. This area includes the waters of the White River upstream of the Neshkoro Millpond, portions of the City of Wautoma and Town of Neshkoro, and the surrounding forests, fields and wetlands.

Table 8 contains a breakdown of land-use and cover types within the watershed of Neshkoro Millpond. Not surprisingly, the watershed as a whole is dominated by agriculture (50.9%) and coniferous and deciduous forests (33.9%).

Table 8. Land-use and cover types found within the watershed of Neshkoro Millpond, Waushara and Marquette Counties, Wisconsin.

Land Type	% cover
Agriculture (general)	32.5
Forest (deciduous)	25.3
Agriculture (row crops)	18.4
Wetland (forested/shrub/wet meadow)	11.6
Forest (coniferous)	8.6
Surface water (not including millpond)	2.7
Urban (Wautoma & Neshkoro)	0.9
	100

During the on-site survey of the Neshkoro Millpond watershed, a number of observations were made. The agricultural areas of the watershed include crops such as soy beans, corn, and alfalfa. There are also many fallow areas within the watershed that are identified as agriculture in **Figure 22**. These areas appear to have been in crop production at some point in the recent past but now make up a majority of the areas identified as agricultural lands. Some of these areas include shrub and small tree growth indicating that they have been out of production for a number of years. It is likely some of these areas have been placed under the Conservation Reserve Program (CRP). By taking land out of production, farmers help reduce soil erosion, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. At the time of the survey, volunteers indicated that some areas previously farmed were too sandy and/or wet to continue farming and were subsequently taken out of production.

Figure 21. Watershed of the Neshkoro Millpond, Waushara and Marquette Counties, Wisconsin.

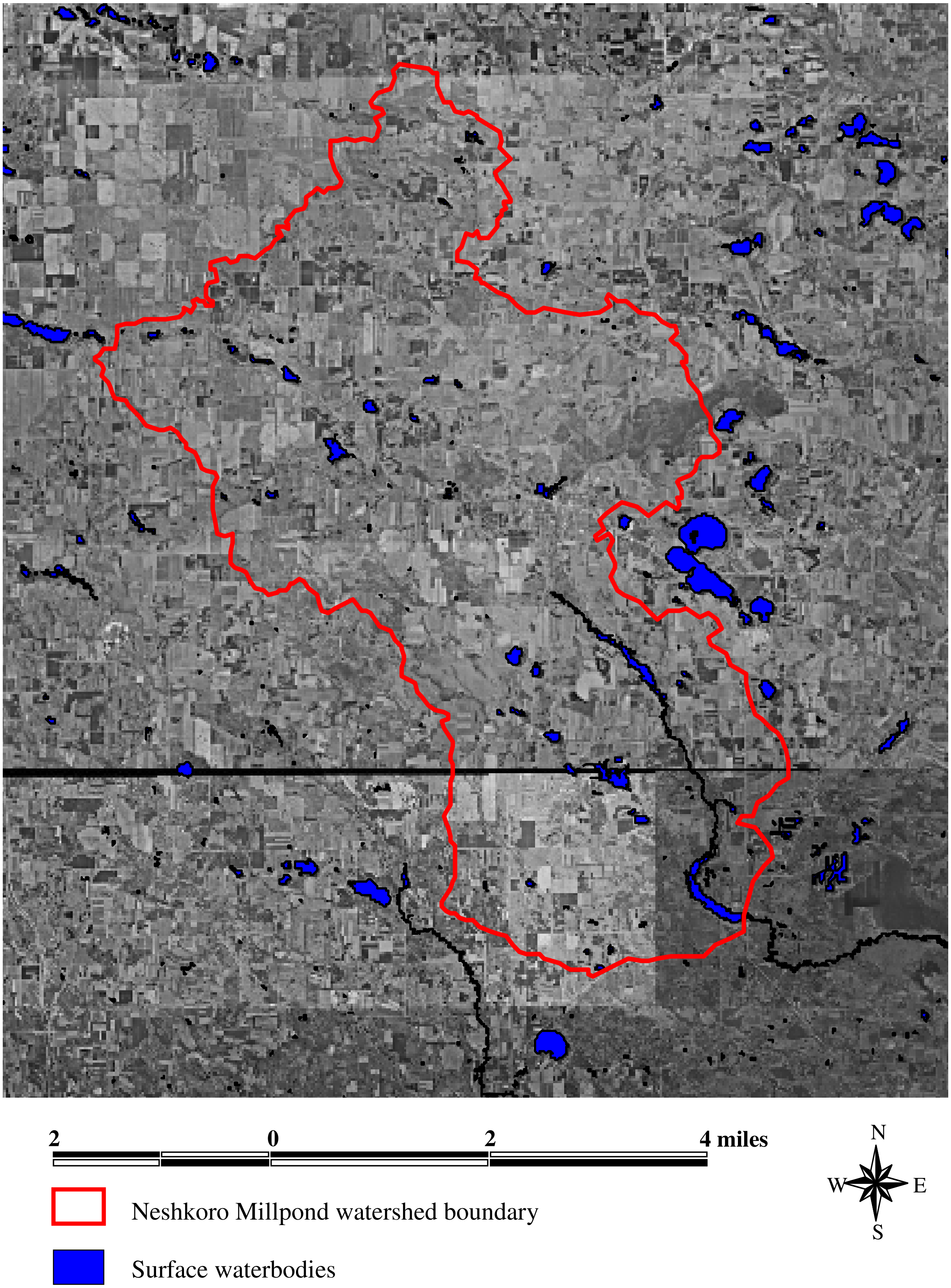
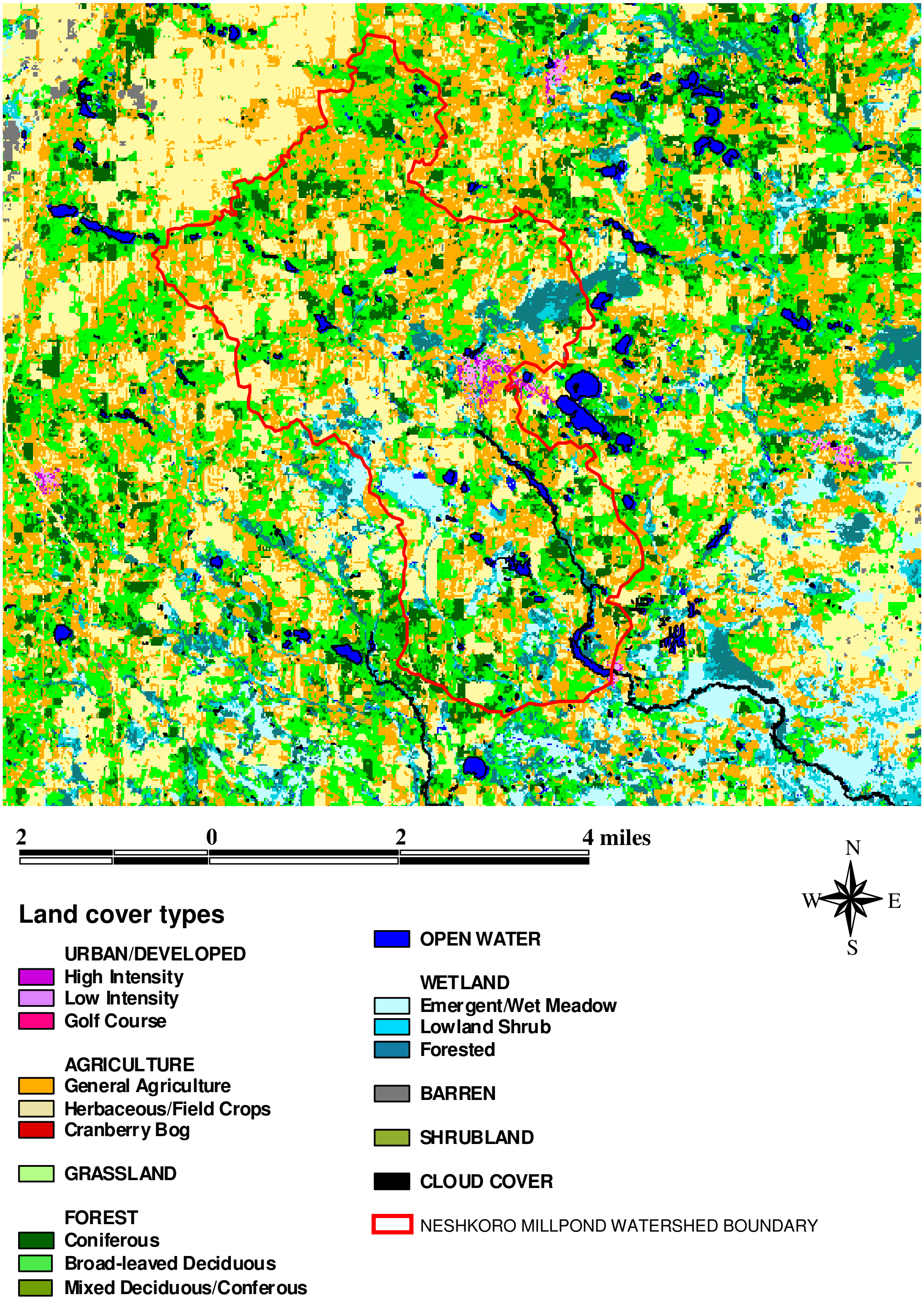


Figure 22. Land cover types and watershed delineation for the Neshkoro Millpond, Waushara and Marquette Counties, Wisconsin.



During the watershed assessment, no signs of significant runoff or erosion were found in the outlying areas. While a number of homes can be found on the shore of Neshkoro Millpond, areas of significant erosion were not evident near shore either. Human activity can contribute to shoreline erosion. An increase in development translates to increases in the number of lawns, driveways and other hard surfaces which are known to contribute nutrients and sediments to a lake. Often it is those areas closest to the lakes which have the greatest influence on water quality.

External nutrient loading

The external loading of runoff pollutants, namely phosphorus, into Neshkoro Millpond have been approximated using the WiLMS predictive modeling software. Export coefficients are available for a number of land-use types as kilograms of pollutant per hectare per year. By utilizing the data available for land-use types in the Neshkoro Millpond watershed, it was estimated that the total annual input of phosphorus from nonpoint sources is approximately 28,573 lbs (12,961 kg). These sources include predominantly land uses, but also atmospheric contributions (namely precipitation), groundwater, and internal cycling through anoxic (anaerobic) release of nutrients from the sediment (Holdren, 2001). The fact that a significant portion of the agricultural areas within the watershed are fallow or out of production suggests that the phosphorus input levels estimated by the WiLMS software are likely exaggerated.

By inputting additional data related to the oxygen stratification, measured phosphorus concentrations during turnover and the growing season, and estimated area of anoxia, the WiLMS software was able to predict the total annual phosphorus load into Neshkoro Millpond. Since the Neshkoro Millpond is so shallow, stratification likely does not occur. In addition, oxygen data was not collected during this study. Therefore it is difficult to predict the level of anoxia within the millpond. As a result, no internal load through nutrient release from the sediments was predicted.

Silver Lake Sanitary Association

In 1989, the wastewater treatment facility operated by the Silver Lake Sanitary Association began operating. At that time it treated wastewater from properties around Silver, Irogami, Bughs, Little Hills and Deer Lakes in Waushara County. Prior to this date, property owners on these lakes used private septic systems. In 1995 the facility was expanded to accommodate the wastewater from the City of Wautoma. Currently the facility treats 300,000-400,000 gallons a day. The treatment plant utilizes a secondary clarifier and aerobic ditch to remove solids and nutrients from the wastewater. Aeration and microbes are the tools used to remove these components. Effluent is pumped to a location south of the White River Flowage dam.

The Wisconsin DNR requires regular water testing at wastewater treatment plants. The plant conducts three 24-hour composite tests weekly. Reports are created monthly and are public record. Effluent pH must be maintained between 6.0 and 9.0. Limits are set for total phosphorus, biological oxygen demand (BOD)/solids and ammonia. The limit for BOD/solids is set at 30 mg/L. The Association's wastewater plant routinely keeps BOD/solids level at a level of 5-10 mg/L. The total phosphorus limit is set at 1.0 mg/L.

Through biological phosphorus removal, phosphorus levels in the effluent of the plant in 2008 were between 0.4 and 0.6 mg/L. Limits for ammonia vary throughout the year but range between 12-29 mg/L. Ammonia levels in the effluent of the plant are consistently far below these levels. In February 2009, the ammonia level in the effluent was 0.14 mg/L. In the event of high nutrient levels, the plant has the capability of chemically removing phosphorus. However, biological phosphorus removal has been able to keep levels well below the set limit.

Lake Management Alternatives

Management of Near-shore Vegetation

Manual removal of vegetation
Manual removal options include raking or hand-pulling aquatic plants. Individuals can remove aquatic vegetation in front of their homes, however, there are limitations as to where plants can be hand-pulled and how much can be removed. In most instances, control of native aquatic plants is discouraged and is limited to areas next to piers and docks. When aquatic vegetation is manually removed it is restricted to an area that is 30 feet or less in width along the shore. Exotic species (Eurasian watermilfoil, curly-leaf pondweed, and purple loosestrife) may be manually removed beyond 30 feet without a permit, as long as native plants are not harmed. Manual removal beyond the 30 foot area would require a Chapter 109 (Wisconsin Administrative Code - NR 109) permit. Benefits of manual removal include low cost compared to other control methods. However, raking or hand-pulling aquatic plants can be labor intensive.

Herbicide treatment of navigation lanes
As was evident from the results of the aquatic plant survey, native aquatic plants play a large part in interfering with navigation in the Neshkoro Millpond. Given the shallow nature of the millpond, herbicide treatments is another option to consider. A broad spectrum herbicide or mixture of herbicides can be used to target all plant species in a treatment area. If individual species are targeted, a more specific herbicide may be applied in a manner that would target that particular species. Herbicide treatment of native plants may be a less desirable option when exotic species are a threat. Because the herbicides kill plants instead of merely cutting them, more opportunistic exotic plants may be better able to colonize the treated areas. With any herbicide treatment, the risk of dilution exists. This is particularly a concern within a flowing system such as Neshkoro Millpond. In addition, free floating species such as duckweeds, algae, and coontail can quickly return to treated areas.

The method used for this type of treatment involves spraying herbicides to the surface of the water within the treatment area. Only those chemicals registered with the U.S. EPA and the Wisconsin Department of Agriculture, Trade, and Consumer Protection may be used. Herbicides registered for use in Wisconsin undergo a strict registration process. Before they are labeled for aquatic use, the data must demonstrate that they pose minimal risk to human health or the environment when used according to label requirements. Often a mixture of three chemicals (Cutrine®, Aquathol K®, and Reward®), will be used to target all plants and algae. This approach should be used for early season applications on low-growing plants to minimize the amount of plant matter dying off at once. However, sometimes a later season follow-up treatment is needed to maintain open water. If this approach is used, it is likely that annual treatments would be needed to maintain effective control. Any treatment of this type would require a Chapter 107 permit.

Herbicide treatment of shorelines
As with manual removal, herbicide treatment of near-shore vegetation is an option with certain restraints. Individuals must obtain a Chapter 107 permit from the Wisconsin DNR to chemically treat aquatic plants in a 30-foot strip along their property extending out 150 feet if necessary. If native plants species are targeted, the same three chemicals used in treating navigation lanes would be use in this approach as well. Herbicides are able to provide control in shallow confined areas such as around docks. However, there is a negative public perception of chemicals. In addition, care must be taken to minimize the affect to non-target plant species. Water use restrictions after application are often necessary.

Exotic Species Management

Because both Eurasian watermilfoil and curly-leaf pondweed exist in the Neshkoro Millpond, control options for these species should be considered. Eurasian watermilfoil and curly-leaf pondweed have interfered with recreational activities including swimming, pleasure boating, hunting, and fishing in numerous lakes throughout Wisconsin. Communities of native aquatic plants, as well as fish and wildlife, have also suffered as a result of these aquatic invaders. In terms of exotic species, curly-leaf pondweed is currently the most abundant, and poses the greatest threat to the Neshkoro Millpond.

Herbicide treatment of exotics
The herbicide most often used to control curly-leaf pondweed is endothall (e.g. Aquathol®). While endothall herbicides are effective on a broad range of aquatic monocots, early season applications made at low rates are highly species-selective for curly-leaf pondweed. Endothall herbicides effectively kill the parent plant, but the turions are resistant to herbicides, allowing curly-leaf pondweed to regenerate annually.

Studies conducted by the Army Corps of Engineers have found that conducting treatments of curly-leaf pondweed using Aquathol® when water temperatures are in the 50-60° F range will kill plants before turions form, thus providing long-term control. Researchers found that conducting two or more treatments over consecutive seasons for established curly-leaf pondweed populations will target both the standing crop of the pondweed as well as the resulting regrowth from the turions (Skogerboe and Poovey, 2002).

Herbicides have been the most widely used and often most successful tools for controlling Eurasian watermilfoil. The most commonly employed herbicide in Wisconsin is 2,4-D (e.g. Navigate®, DMA4 IVM®, Weedar 64®). 2,4-D herbicides have been effective at managing Eurasian watermilfoil in hundreds of Wisconsin lakes. When applied at labeled rates, 2,4-D has been shown to be an effective tool at selectively controlling Eurasian watermilfoil.

Both endothall and 2,4-D are herbicides which break down microbially and do not persist in the environment. When applied at the labeled rates, herbicides are an effective management tool for control of many aquatic plant species. While no control method could be considered cheap, herbicide treatments are among the least costly of methods. This is in part due to the relatively low labor costs in comparison to measures such as hand-pulling, mechanical harvesting, etc. Perhaps the greatest consideration is that these herbicides often produce long-term control of exotics. The greatest disadvantage of herbicide treatments is that they rarely produce 100% control. In most cases, herbicides tend to work only where applied. This is more so the case with granular formulations. Unnoticed and untreated plants may eventually grow to dense beds if left unchecked. Factors such as pH and plant maturity may also reduce treatment efficacy. Several follow-up treatments, whether in-season or in subsequent years, may be needed to reduce exotic species to target levels.

Biological control - milfoil weevils

There has been considerable research on biological vectors, such as insects, and their ability to affect a decline in Eurasian watermilfoil populations. Of these, the milfoil weevil (*Euhrychiopsis lecontei*) has received the most attention. Native milfoil weevil populations have been associated with declines in Eurasian watermilfoil in natural lakes in Vermont (Creed and Sheldon, 1995), New York (Johnson et al., 2000) and Wisconsin (Lilie, 2000). While numerous lakes have attempted stocking milfoil weevils in hopes of controlling milfoil in a more natural manner, this method has not proven successful in Wisconsin. A twelve-lake study called “The Wisconsin Milfoil Weevil Project” (Jester et al. 1999) conducted by the University of Wisconsin, Stevens Point in conjunction with the Wisconsin DNR researched the efficacy of weevil stocking. This report concluded that milfoil weevil densities were not elevated, and that Eurasian watermilfoil was unaffected by weevil stocking in any of the study lakes. Recently, however, work carried out on a number of Portage County lakes has shown some promise at enhancing milfoil weevil populations. In order for weevils to be successful in reducing the extent of Eurasian watermilfoil, a number of environmental criteria are needed, including the availability of proper year-round habitat.

Aquatic Plant Harvesting

Mechanical harvesting involves the removal of aquatic plants from a lake using a machine that cuts and collects the plants for transport to an off-shore disposal site. Generally, harvesting equipment can be adjusted to cut to a desired depth up to 5 feet. Harvesting operations often include equipment, such as a barge, to transport plant materials from a harvester to the shore where a conveyor is used to transfer the materials to a waiting truck. Harvesting is often used for areas where dense monotypic plant growth significantly interferes with navigation. Harvesting produces fast results, and a removal of plant biomass from a lake. However, this method is limited to deeper water. In addition, harvesting is not used to restore aquatic plant communities. It is a maintenance approach used primarily for navigational issues. Harvesting can complicate the management of exotic species, particularly Eurasian watermilfoil. Because milfoil spreads efficiently through fragmentation, and harvesting results in a large number of fragments, the two are incompatible. Harvesting also comes with high initial equipment costs, as well as relatively high maintenance, labor, and insurance costs, disposal site requirements, and a need for trained staff. A WDNR permit is required by NR 109 for aquatic plant harvesting.

Lake Drawdown

Since it is an impoundment, the water level of the Neshkoro Millpond can be lowered. Drawdown is a proven aquatic plant management technique. Anecdotal evidence, and experiences with nearby lakes, suggest that long-term control of Eurasian watermilfoil can be attained with lake drawdown. It is unclear what impact a drawdown would have on curly-leaf pondweed – the lake's primary nuisance. Some sources indicate that curly-leaf pondweed turions will survive and regrow following a drawdown.

Drawdowns can be performed at different times of the year. Sometimes, water is drawn out of the lake beginning in the fall and refilled in the spring. By exposing the plants to drying and freezing conditions, impact to nuisance plant species is achieved. Similar results are obtained during a drawdown over the growing season. The exposure to air and warm conditions cause plants to die and promote the decomposition of plant biomass. As a result, a longer drawdown, over a growing season would likely have a greater impact to aquatic plants including exotic species than a shorter winter drawdown.

Drawdowns can be a useful tool in restoring emergent plant communities near shore, since most emergent species require fluctuating water levels to regenerate. The downside to most drawdowns can include negative impacts to native plant communities, as well as invertebrate and fish communities in a lake. In the past, fish were brought back to a lake from downstream. However, with the current concern over the transport of fish and Viral Hemorrhagic Septicemia (VHS) restocking in this fashion may not be possible. Also, because nuisance growth of native aquatic plants is often one of the problems facing millponds, the end result has been shown to be a long-term improvement in the native plant community both in terms of abundance and diversity. It is unclear what impact, either short-term or long-term a drawdown will have on the growth and spread of wild rice in the Neshkoro Millpond.

Drawdowns can also be used to manage organic sediments in a lake. Again by exposing the sediment, the volume of sediments can be reduced. This is achieved by decomposition of organic sediments when exposed to the air and by the drying and compaction of sediments. These effects can result in significant increases in water depth after the millpond is refilled.

Other benefits of a water level drawdown include the relative low cost of the action itself. However, when hydropower is an issue, as with the Neshkoro Millpond and North American Hydro, reimbursement for lost revenue needs to be considered.

Sediment Reduction Options

Increased sedimentation in shallow lakes can lead to obstructions in navigation as has occurred in the Neshkoro Millpond. Consequently, effective management of sediments must be carried out in both the lake and the watershed to maximize its effectiveness. This management must include practices which reduce the input of sediments, nutrients, and contaminants from external sources and the internal control of these elements within the lake. If sediment removal alone is chosen, any improvements to the lake will be short-lived and limited by the continued addition of nutrients and organic matter from external sources. To best meet the wishes of all concerned, the symptoms *and* causes of sediment accumulation must be addressed.

Management of existing sediments

A limited number of options are available to reduce accumulated sediments in lakes. The following is a description of these options along with their associated advantages and disadvantages.

Dredging

The dredging of sediments is a commonly used method for maintaining navigation in surface waters. Historically, dredging was a crude and inefficient method of sediment removal. With the assistance of today's GPS technology, dredge operators are able to achieve much greater efficiency, saving time and money while providing safer navigation. The selection of the dredging technique and equipment should be based on the accuracy and speed of sediment removal and the impact of resuspended matter to the environment. Two types of dredges that are most commonly employed are mechanical dredges and hydraulic dredges.

Mechanical Dredges

Mechanical dredges remove lake sediments by physically digging the desired materials from the bottom and disposing of the dredged materials. Mechanical dredges are rugged devices often mounted on barges and secured in place with specialized anchors. Dredged materials are removed and placed onto a barge. The barge is used to transport the dredged materials to a predetermined disposal location. Mechanical dredges are best suited for use with denser, consolidated materials including rocks and large debris. This method of sediment removal is not efficient at removing loose materials such as finer sediments that can easily wash from the dredge bucket.

Hydraulic Dredges

Hydraulic dredges remove lake sediments by sucking a mixture of dredged materials and water from the lakebed. Like mechanical dredges, hydraulic dredges are often mounted on barges. Dredge materials are sucked through a large intake pipe and discharged directly into a barge or other the disposal site. These dredges have a cutter head, a mechanical devise with rotating blades or teeth used to break up or loosen the sediment materials. As a result, cutter head dredges are able to excavate most materials. These dredges can be operated continuously and therefore are more cost efficient. Cutterhead pipeline dredges work best where the cutterhead is buried deep in the sediment. The amount of water removed should be controlled during operation for best efficiency. Water that is pumped with the dredge material must be contained on site until a reasonable amount of solids settle out. The water can then be discharged back into the waterbody.

Removal of sediments from lakes and ponds is an established management technique intended to enhance sport fisheries, manage aquatic plants, and improve navigation. However, data available on the effects of dredging on lake ecosystems is limited. By its nature, dredging causes physical changes to the lake ecosystem, both in terms of the sediments and the water column. Sediment resuspension and increases in nutrient and other pollution levels are constant concerns associated with dredging operations (Marsh, 2003). Research has suggested that physical sediment removal can be detrimental to certain wildlife species including populations of reptiles and amphibians (Aresco and Gunzburger, 2004). Whenever possible, the best management practices available should be utilized to reduce sediment resuspension during dredging.

One of the most challenging problems associated with dredging is in the disposal of the dredged materials. If the sediments to be removed have relatively low concentrations of compounds such as heavy metals and/or organic pollutants, they can be applied to agricultural soils as a fertilizer or soil conditioner. Ideally, disposal on nutrient poor soils can be of great benefit to the disposal site. In addition, dredged sediments can make ideal substrate for establishing upland prairie areas because they contain little or no upland weed seeds.

Regardless of possible contamination, sediment resuspension and relocation are two of the most significant environmentally damaging results of dredging. Rates of sediment resuspension are higher for mechanical dredging than for hydraulic dredging. This is simply due to the techniques used in these two approaches. Because mechanical dredging is inefficient at removing the finer loose sediments, they become easily resuspended. Ranges for total suspended solids (TSS) concentrations near mechanical *and* hydraulic dredging operations rarely, if ever, reach levels of acute (short-term) lethal toxicity. However, levels do often exceed chronic (long-term) sublethal toxicity levels. This means that although there often are no immediate lethal effects to the biota of a lake, there are other less than lethal stresses placed on the lake community in the long term. There are a number of control options that can be used to reduce the incidence of both chemical and physical impacts. These include physical controls (silt curtains, silt booms, settling chambers, etc.), operational controls, and specialty dredging equipment. Improper implementation of these practices can affect their performance (Stivers et al., 2004, Rokosch and Berb, 2003).

Because of the extensive nature of a dredging project, costs are often quite high. It is likely a significant area of the millpond would need to be dredged for navigation and recreational purposes. A project of this nature would likely cost between $10 - $20 per cubic yard of dredged material. This estimate is for sediment removal only. This estimate does not include the costs for sediment testing, establishing the disposal site and staging area preparations, or the cost for the permitting process. The Association should expect this type of project to cost $100,000 or more upon completion.

Lake Drawdown

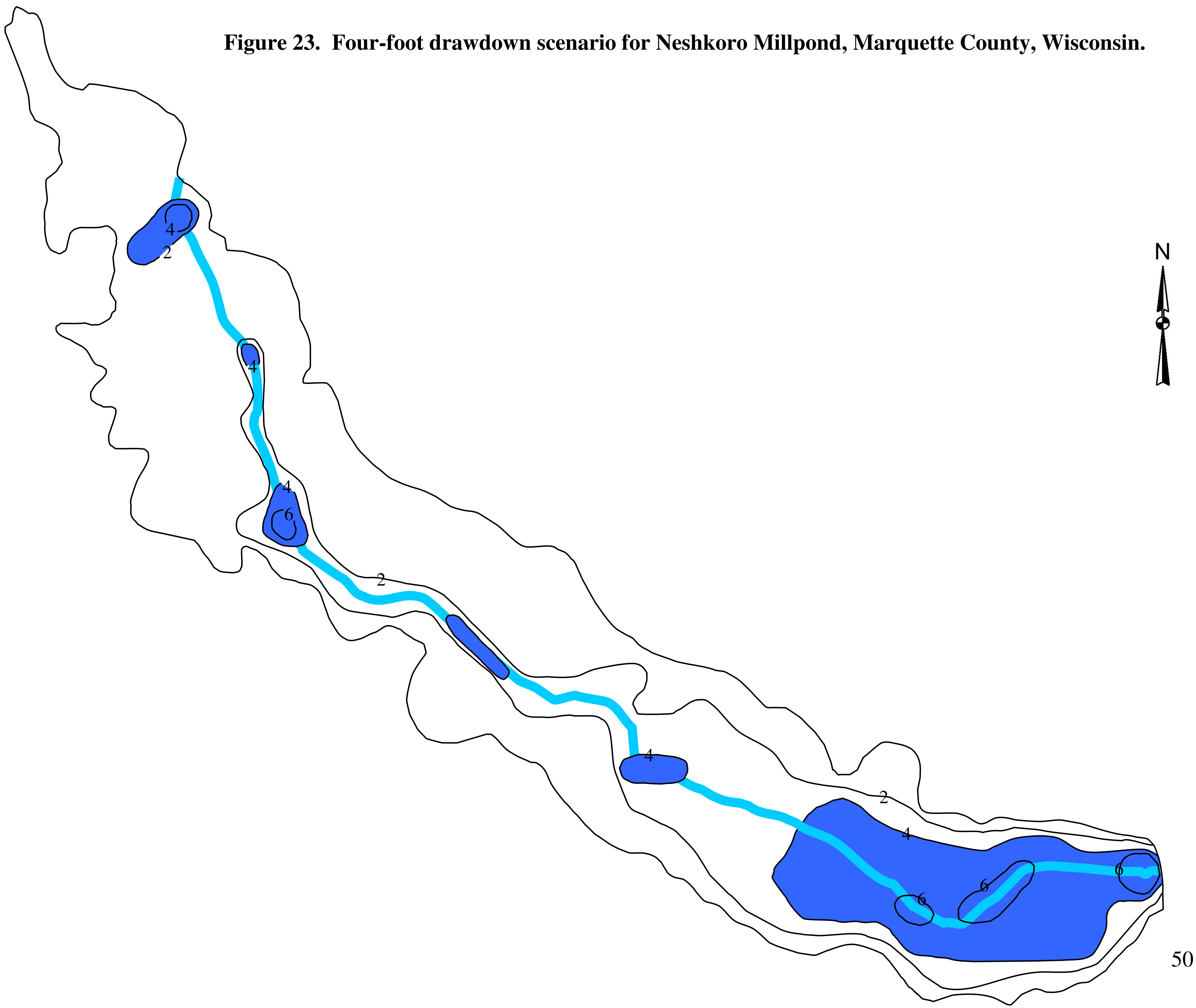
The primary modes of sediment reduction during a drawdown are decomposition and compaction. As the sediments become exposed to the air, the organic components begin to decompose. The longer the drawdown continues, particularly during the warmer summer months, the more decomposition. Winter only drawdowns result in reduced sediment removal from decomposition. The effects of decomposition are reduced in systems with higher inorganic (mineral) components to their sediments. Although lab analyses of the Neshkoro Millpond's sediments were not conducted, field observations suggest the soft sediments of the millpond are highly organic (muck) in nature. It is reasonable to assume that decomposition would cause a significant reduction in sediments within the Neshkoro Millpond. Compaction is also caused by exposure of the sediments to the air. As the exposed sediments dry out, they lose volume. The loss of water through evaporation causes the sediments of the lake compact. The impact is related in part to the weather conditions during a drawdown. Drier conditions can result in greater evaporation and more compaction. Rainier weather slows this process.

The cost of a drawdown can vary depending most often on the dam. In the case of the Neshkoro Millpond, a hydroelectric facility exists at the outflow of the lake. This facility is operated by North American Hydro. An agreement exists between the Village of Neshkoro and North American Hydro. This agreement states that the Village must compensate North American Hydro for any loss of revenue as a result of the Village's or Association's action on the millpond. It is likely a drawdown would decrease the ability to produce electricity. However, recent communications between the Association and North American Hydro have suggested that the facility on the Neshkoro Millpond may remain operational during the time of a drawdown. The nature of the turbines in place at the Neshkoro facility allows for the continued production of electricity at decreased water flow rates. It is difficult to determine how low the flow will become during the drawdown since much depends on climatic conditions.

If the millpond is drawn down by four feet (**Figure 23**), the Association could minimize the loss of flow while maintaining a sizeable pool of water just upstream of the road. This pool could serve as a refuge for the lake's fishery. Recent regulations related to the transport of fish between lakes have been enacted. Due to the looming threat of the VHS fish virus (viral hemorrhagic septicemia), fish that end up downstream of the dam during a drawdown cannot be captured and returned. However, exotic plants will also survive in a refuge pool. It is possible additional measures will need to be taken to address the threat of exotic species following the drawdown.

During the drawdown, it is likely a channel would be scoured by the inflowing White River. This has been seen on a number of other drawdown projects in the State. This scouring can be significant resulting in improved navigation within the millpond following the drawdown as well as increase sediment flow downstream It is unclear what impacts the added sediments will have downstream. However, if the flow remains high, it is likely a vast majority of the sediments will be carried beyond the boundaries of the Association.

Figure 23. Four-foot drawdown scenario for Neshkoro Millpond, Marquette County, Wisconsin.



Perhaps the biggest disadvantage of a drawdown is the loss of recreational use of the waterbody and the associated socio-economic concerns that often arise. The Neshkoro Millpond attracts numerous anglers to the area throughout the year. Many property owners and other lake users also enjoy the lake. However, Association members have commented on the decreased value of the lake for recreation. Sediment accumulation and nuisance plant growth have greatly impeded the use of the lake. Clearly a trade off exists and tough decisions, as well as educational efforts, have to be made before a drawdown can be agreed upon.

Preventing Sediment Accumulation

It is important to not only consider the current sediment accumulation in the channels but to also plan for the mitigation of future sedimentation from external sources. A number of control efforts should be considered for implementation. Many efforts to control sediment accumulation will also result in benefits to water quality and wildlife habitat. It should be noted that preventing sediment accumulation often does not impact the sediment already present. Also, these efforts are not short-term fixes. They often require years before changes in the lake become apparent.

Watershed Sediment Control

Erosion is a natural process. However, human activities often accelerate rates of erosion leading to detrimental effects. In watersheds, the erosion of shorelines, riverbanks, and drainage ditches account for large quantities of sediments reaching lakes. This type of erosion is primarily due to the removal of shoreline vegetation for agriculture and urbanization. Consequently, control practices should be carried out for the benefit of the landowners and the health of the lake. The prevention of soil erosion in watersheds is an imperative step in the control of non-point sources of nutrients and sediments. Where possible, erosion control efforts should be used to compensate for the losses that have occurred because of previous mismanagement. Careful planning must be an integral part of landscape management.

Sedimentation Basins

The use of sediment basins or traps is an additional watershed sediment control option. These basins are man-made depressions designed to collect and store runoff water and to allow suspended solids to settle out. The design and construction of these basins vary depending upon flow rates and site requirements. The basin must be large enough to allow sediments to drop out before the water is discharged into the lake. These basins are created by excavating, or by building earthen embankments across low areas or drainage paths. As a result the creation of sedimentation basins would likely require the acquisition of land for construction and possibly the diversion of storm water to the construction location. Although, sedimentation basins can have long-term benefits, finding an appropriate location for a sedimentation basin may be the biggest challenge.

Shoreline vegetation
Natural vegetation is one of the most important and effective erosion control options. Shoreline plants can stabilize the bank by holding soil particles together and dampening wave action. Vegetation also acts as a buffer to trap suspended sediment and induce its deposition. To prevent continued bank erosion where vegetative cover has been removed, it is important to restore the slope of the bank and reestablish ground cover vegetation, such as native trees, shrubs, and aquatic riparian vegetation. The creation of a native vegetative buffer strip would not only be a benefit to sediment management, but also to water quality protection. This buffer also provides excellent fish and wildlife habitat, including nesting sites for birds, and spawning habitat for fish.

Research has shown that the placement of wire-wrapped square straw bales, coconut fiber logs, and pine logs are also effective in controlling wave action and trapping sand (Sistani and Mays 2001). Brush mats, and rock riprap are also options against erosion.

A recommended buffer zone consists of native vegetation that may extent from 25 – 100 feet or more from the water's edge onto land, and up to 50 feet into the water depending upon water depth. The buffer should cover at least 50%, and preferably 75% of the shoreline frontage (Henderson, et al., 1998). In most cases this still allows plenty of room for a dock, a swimming area and a lawn. Buffer zones are made up of a mixture of native trees, shrubs, upland plants, and aquatic plants and are quite aesthetically pleasing.

Lawn care practices
Individuals can play a large part in reducing sedimentation from local sources. Mowed grass up to the water's edge is a poor choice for the well-being of a lake. Studies show that a mowed lawn can cause 7 times the amount of phosphorus and 18 times the amount of sediment to enter a waterbody (Korth and Dudiak, 2003). Lawn grasses also tend to have shallow root systems that cannot protect the shoreline as well as deeper-rooted native vegetation (Henderson et al., 1998). Property owners within the Association should take care to keep leaves and grass clippings out of the lake whenever possible. They contain nitrogen and phosphorus. The best disposal for organic matter, like leaves and grass clippings is to compost them.

Fertilizers that enter the millpond will encourage an increase in plant biomass. Fertilizers contain nutrients, including phosphorus and nitrogen that can wash directly into the lake. While elevated levels of phosphorus can cause unsightly algae blooms, nitrogen inputs have been shown to increase weed growth. Increases in plant biomass will lead to further sedimentation and navigational issues.

Landowners are encouraged to perform a soil test before fertilizing. A soil test will help determine if you need to fertilize, and give you direction on fertilizing. For assistance in having your soil tested, contact your county UW-Extension office. If there is a need to fertilize your lawn, use a fertilizer that does not include phosphorus. Most lawns in Wisconsin don't need additional phosphorus. The numbers on a bag of fertilizer are the percentages of available nitrogen, phosphorus and potassium found in the bag. Phosphorus free fertilizers will have a 0 for the middle number (e.g. 10-0-3).

Implementation Plan

Management Goal 1: Reduce accumulated sediments within the Neshkoro Millpond.

Management Action: Four-foot drawdown of the lake.
Timeframe: Permit submitted, drawdown expected to begin in the spring of 2010 and end later in the fall.
Facilitator: Association Board, Village of Neshkoro, North American Hydro.

Description:
The Friends of the White River Association proposes to conduct a drawdown of the Neshkoro Millpond in Marquette County, WI. A study of the millpond over the past two years found a large volume of soft sediment in the millpond. On average the soft sediment is 5.3 feet deep. By conducting a drawdown in the near future members of the Association hope to reduce sediments and increase water depths. Exposed sediments are expected to decompose, dry out and compact. Communications among the groups involved will need to continue in an effort to address concerns regarding issues such as dam operations, lost revenue, water levels. If approved, the permit will last for three years. The Association intends to assess the results of the initial drawdown to determine if a second drawdown would be warranted.

Management Goal 2: Reduce nuisance aquatic plant growth within the Neshkoro Millpond.

Management Action: Four-foot drawdown of the lake.
Timeframe: Permit submitted, drawdown expected to begin in the spring of 2010 and end later in the fall.
Facilitator: Association Board, Village of Neshkoro, North American Hydro.

Description: The purpose of this drawdown will also be to control aquatic plants, both native and exotic, in the millpond. Aquatic plants have become very abundant in the millpond. These plants impede navigation and fishing, contribute to decreased water quality and limit the environmental viability of the millpond. Plants exposed during the drawdown are expected to die from lack of water. The timing of the drawdown should allow for maximized decomposition of plant materials including roots and turions in the lake bed.

Management Goal 3: Maintain fishery of the Neshkoro Millpond

Management Action: Provide refuge for fish during partial drawdown of the lake.
Timeframe: Spring to Fall 2010
Facilitator: Association Board, Village of Neshkoro.

Description: Due to the concern over the spread of the VHS fish virus, the State has prohibited the transportation of fish between water bodies. The partial drawdown of the lake will leave a pool of water upstream of the dam to serve as a refuge for fish. This partial drawdown should minimize any loss to the millpond's fishery. The drawdown will conclude in time for the lake to refill for the winter ice fishing event organized by the Lions Club. Following the drawdown, the Association and Village will discuss whether the need exists to restock certain species and size categories to compensate for losses during the drawdown.

Management Goal 4: Maintain or improve water quality conditions within the Neshkoro Millpond.

Management Action: Educate Association members regarding the reduction of nutrients and sediments from immediate watershed.
Timeframe: Start in 2010
Facilitator: Association Board

Description: Water quality data suggest that the Millpond is in fair condition. Nitrogen levels were elevated, phosphorus and chlorophyll levels were not. In order to maintain or improve conditions, the Association board plans to provide information to its membership regarding shoreline improvement options ad other actions the group and individuals can take. This information will also include improvements to fishery habitat. Resources included in this plan as well as those available from the Wisconsin DNR, Marquette County and UW-Extension will be utilized. The Association will also solicit appropriate speakers to address these issues at membership meetings.

Management Goal 5: Monitor post-drawdown conditions on the Neshkoro Millpond.

Management Action: Survey the Neshkoro Millpond in the years following the drawdown to assess the changes that have taken place and the potential need to employ additional management options. .
Timeframe: Start in spring 2011
Facilitator: Association Board

Description: The Association acknowledges the importance of monitoring post-drawdown conditions on the lake. In 2011, a number of surveys will be conducted to determine changes in sediment depths, exotic species distribution, the native aquatic plant community, and if needed, water quality. The Association will also request an assessment by the Wisconsin DNR of the millpond's fishery. It will be important to understand the changes that have taken place, whether the drawdown was considered effective, and if another drawdown or other management option should be used. The Association will continue with annual monitoring efforts as needed and as recommended by the Wisconsin DNR. The Association will investigate the possibility of obtaining grant funding to fund monitoring efforts.

Citizen Participation

In March 2009, hardcopies of the initial draft report from this study were provided to the Friends of the White River Association. The Association was given the opportunity to review and provide feedback and questions regarding the study findings. Copies were also sent to the Wisconsin DNR for review and feedback. Due to missed sampling events in 2008, additional fieldwork, primarily to collect water quality data, was planned in 2009. In addition, changes to report were requested by the DNR and the Association following the initial review.

On June 27, 2009, a special meeting was held by the Association to review and discuss the results of the study up to that point. This meeting was an opportunity to review various options for improving conditions in the waterway. Numerous options were discussed, primarily chemical treatments, mechanical harvesting, dredging and a drawdown of the millpond. There were approximately 30 individuals in attendance. In the months following this meeting, the Association Board considered the options discussed. The board decided to investigate the options of mechanical harvesting and a lake drawdown.

On September 4, 2009 Dennis Timm of Silver Mist Aquatic Plant Management conducted a demonstration of harvesting equipment. A number of Association members, as well as representatives from the Wisconsin DNR, North American Hydro, the Village of Neshkoro, were present. After the demonstration and much discussion, it was decided that this style of mechanical harvesting would not be pursued nor would it be permitted by the DNR.

On September 11, 2009 an informal meeting was held at the residence of Deb Teske, Vice-president of the Association. Approximately 15 Association members as well as Brad Roost of Cason & Associates, LLC and Ted Johnson of the DNR were in attendance. Again management options were discussed. In light of the results of the harvesting demonstration, the focus of the meeting and planning efforts shifted to the options of a lake drawdown. On the following day, September 12, 2009 a second special meeting was held by the Association. In addition to a number of Association members and the board, representatives of from North American Hydro, Cason & Associates, LLC and the Village of Neshkoro were present at this meeting. Again results of the study were presented and management options were discussed. It was decided that the primary management tool to be pursued would be a four-foot drawdown of the millpond in 2010.
The Implementation Plan presented in this document is a direct result of the discussion and decisions made at this meeting. Since that time, the Association has applied for a three-year permit to conduct an initial drawdown which is expected to begin in the spring of 2010.

References

Aresco, Matthew J. and Margaret S. Gunzburger. 2004. *Effects of large-scale sediment removal on herpetofauna in Florida wetlands.* Journal of Herpetology 38(2):275-279.

Carlson Robert E. 1977. *A trophic state index for lakes*. Limnology and Oceanography. 22(2):361-369.

Creed, R.P. Jr., and S.P. Sheldon. 1995. *Weevils and Watermilfoil: Did a North American herbivore cause the decline of and exotic weed?* Ecological Applications 5(4): 1113-1121.

Henderson, C.L., C.J. Dindorf, and F. J. Rozumalski. 1998. *Lakescaping for Wildlife and Water Quality.* State of Minnesota, Department of Natural Resources.

Holdren, C., W. Jones and J. Taggart, 2001. *Managing Lakes and Reservoirs*. North American Lake Management Society and Terrene Institute, in cooperation with Office of Water Assessment. Watershed Protection Division. U.S. Environmental Protection Agency, Madison, Wisconsin.

Jester, Laura L., Daniel R. Helsel and Michael A. Bozek. 1999. *Wisconsin Milfoil Weevil Project – Gilbert Lake Final Report.* University of Wisconsin – Stevens Point.

Johnson, R.L., P.J. Van Dusen, J.A. Tonerand N.G. Hairston. 2000. *Eurasian watermilfoil biomass associated with insect herbivores in New York.* Cornell University.

Korth, Robert and Tamara Dudiak. 2003. *The Shoreland Stewardship Series #1.* University of Wisconsin-Extension, Wisconsin Department of Natural Resources, The Wisconsin Lakes Partnership, Wisconsin Association of Lakes, River Alliance of Wisconsin.

Lilie, R.A. 2000. *Temporal and spatial changes in milfoil distribution and biomass associated with weevils in Fish Lake, WI.* Wisconsin Department of Natural Resources.

Marsh, Nonathan. 2003. *Monitoring the physical effects of Sediments and contaminants during dredging operations to assess environmental impact*. From Dredging '02: Key Technologies for Global Prosperity. Proceedings Of The Third Specialty Conference On Dredging And Dredged Material Disposal. May 5-8, 2002, Orlando Florida.

Nichols. 1999. *Floristic quality assessment of Wisconsin lake plant communities with example applications.* Journal of Lake and Reservoir Management. 15(2):133-141.

Rokosch, W. Dieter and Niek J. Berg. 2003. *Dredging efficiently – dredging techniques and its effects to the environment*. From Dredging '02: Key Technologies for Global Prosperity. Proceedings Of The Third Specialty Conference On Dredging And Dredged Material Disposal. May 5-8, 2002, Orlando Florida.

Shaw, Bryon, Christine Mechenich, and Lowell Klessig. 2004. *Understanding lake data.* University of Wisconsin – Extension. RP-03. 20 pp.

Sistani, K.R. and D.A. Mays. 2001. Nutrient requirements of seven plant species with potential use in shoreline erosion control. Journal of Plant Nutrition. 24(3): 459-467.

Skogerboe, J. and A. Poovey. 2002. *Long-term control of curly-leaf pondweed on Minnesota Lakes using Aquathol-K: Return of the natives.* Midwest Aquatic Plant Management Society annual conference. Brookfield, Wisconsin.

Stivers, Carl, Steve Bay, Steve Cappellino, and Tom Wang. 2004. *Review of effects of resuspended sediments: implications for dredging water quality monitoring and compliance*. Conference Proceeding. Ports 2004: Port Development in the Changing World. Pp. 1-10.

Appendix A

- GPS coordinates for aquatic plant surveys conducted on the Neshkoro Millpond, Marquette County, WI.

Appendix B

- Aquatic plant survey data from July 15, 2008 for the Neshkoro Millpond, Marquette County, WI.

Appendix C

- The Importance of Aquatic Plants

Appendix D

- Aerial photographs from 1981 to 1989 of the Neshkoro Millpond, Marquette County, WI.