Presque Isle Wilderness Waters Program

Aquatic Plant Management Plan – Rice Creek

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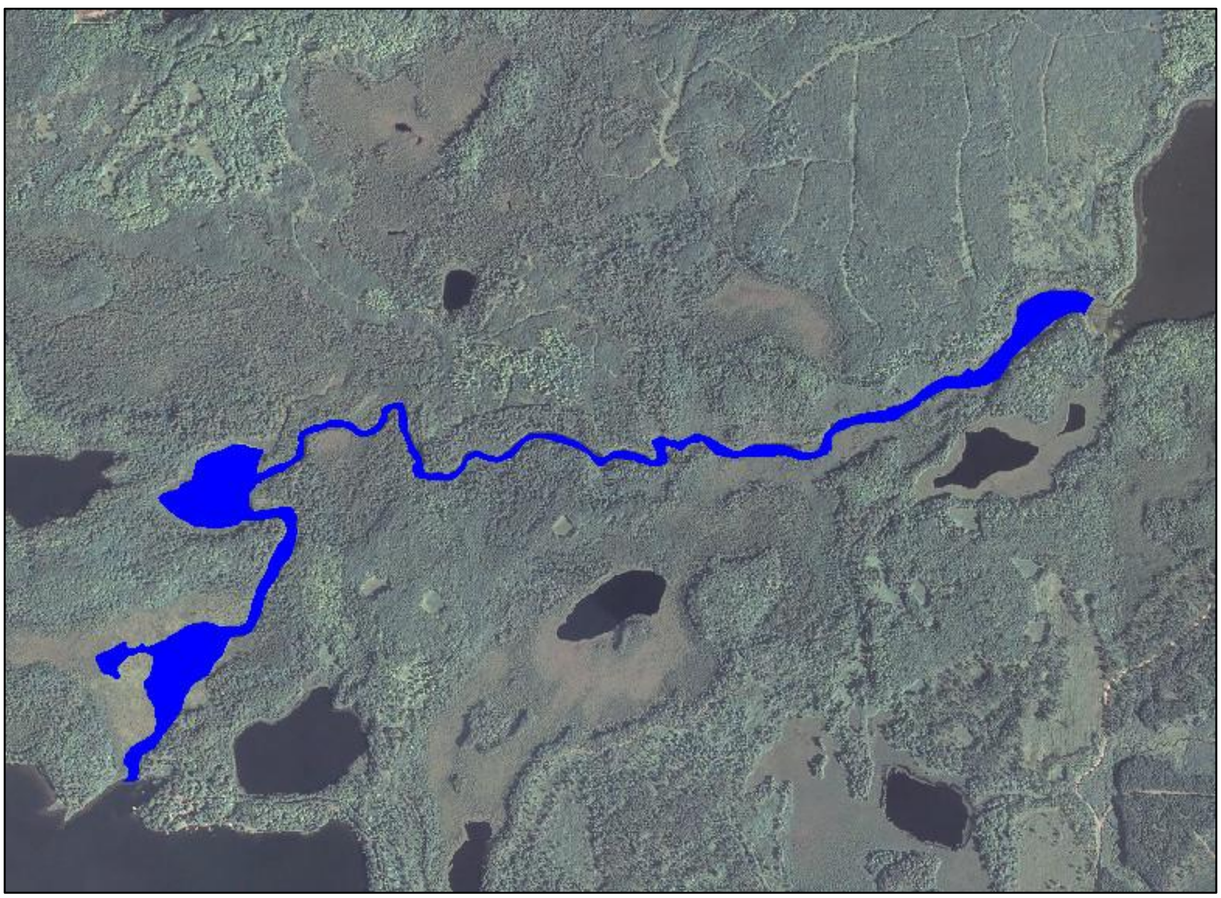

Date: March 2014

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This plan is a product of a WDNR Aquatic Invasive Species Control Grant (Subchapter II – Education, Prevention, and Planning Projects) awarded to:

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WHITE WATER
ASSOCIATES, INC.

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CHAPTER 1 Introduction

The ***Presque Isle Wilderness Waters Program*** results from the efforts of the Presque Isle Town Lakes Committee, an organization that has been active since 2005. The Lakes Committee views stewardship of lakes as an ongoing endeavor that is integrated, coordinated, and administered by the Lakes Committee. This broader perspective accommodates the appropriate range of geographic scales from which to approach lake stewardship: a discrete "lake specific" focus that goes hand-in-hand with waterscape-wide awareness.

This aquatic plant management plan addresses Rice Creek. Despite this specificity, it maintains the waterscape perspective crucial to effective creek stewardship. This is especially important when it comes to preventing introduction and establishment of aquatic invasive species (AIS). The closely related ***Wilderness Waters Adaptive Management Plan*** (Premo et al., 2014) provides additional overarching waterscape level examination that allows greater opportunity and efficiency in water resource management and education.

A systematic survey of aquatic plants using the Wisconsin Department of Natural Resources (WDNR) "point-intercept" method was an important underpinning of this aquatic plant management plan. An analysis of the plant data along with water quality and other stream information allowed the preparation of the plan.

Aquatic plants rarely get the respect they merit, although this is slowly changing. We still call an aquatic plant bed a "weed bed." Many aquatic plants have "weed" in their names (e.g., duckweed, pondweed, or musky weed). Likely this term was borrowed from "seaweed" and not intended as derogatory, but in today's use, "weed" connotes an unwanted, aggressively growing plant. Such is not the case for the vast majority of aquatic plants. In fact, aquatic plants are a vital part of a stream ecosystem, recycling nutrients, providing vertical and horizontal structure, and creating habitat for animal life. Invertebrates, including crustaceans and insects, live on or within this "aquatic forest." Fish find food and shelter within aquatic plant beds. Waterfowl eat parts of plants directly as well as feed on invertebrates associated with the plants. Muskrats eat aquatic plants and particularly love cattails and bulrushes. Otter and mink hunt invertebrates and small vertebrates within the shelter of submergent and emergent beds. In shallow water, great blue herons find fishes among the plants.

In bodies of water that receive an excess of nutrients (particularly from fertilizers or leaking septic tanks), plant growth can become too lush or dominated by only a few species. As these abundant plants die, their decomposition can depress dissolved oxygen levels and diminish suitability for fish. Algae can respond rapidly to nutrient influxes and create nuisance conditions. These phenomena can cause humans to view all aquatic plants in a negative light.

On another negative front, non-native plant species, transported on boats and trailers or dumped from home aquariums, private ponds and water gardens may come to dominate a water body to the exclusion of a healthy diversity of native species. Eurasian water-milfoil (*Myriophyllum spicatum*) is one of the better known examples of these so-called aquatic invasive plant species.

For most bodies of water, native aquatic plants are an overwhelmingly positive attribute, greatly enhancing the aesthetics of the creek and providing good opportunities for fishing, boating, swimming, snorkeling, sight-seeing, and hunting.

When it comes to aquatic plant management, it is useful to heed the mantra of the medical profession: “First, do no harm.” It is both a social and scientific convention that aquatic plant management is more effective and beneficial when a creek is considered as an entire and integrated ecosystem. Anyone involved in aquatic plant management should be aware that a permit may be required to remove, add, or control aquatic plants. In addition, anyone using Wisconsin’s lakes or creeks must comply with the “Boat Launch Law” that addresses transport of aquatic plants on boat trailers and other equipment. A good review of the laws, permits, and regulations that affect management and behavior surrounding aquatic plants can be found in the WDNR guidelines called ***Aquatic Plant Management in Wisconsin***.[1]

In preparing this plan, we followed guidelines in ***Aquatic Plant Management in Wisconsin***. The resulting plan is an adaptive plan (Walters 1986). Simply put, it will be modified as new information becomes available. The WDNR Guidance document outlines three objectives that may influence preparation of an aquatic plant management plan:

- ***Protection*** - preventing the introduction of nuisance or invasive species into waters where these plants are not currently present;
- ***Maintenance*** - continuing the patterns of recreational use that have developed historically on and around a body of water; and

[1] *http://www4.uwsp.edu/cnr/uwexlakes/ecology/APM/APMguideFull2010.pdf*

- ***Rehabilitation*** - controlling an imbalance in the aquatic plant community leading to the dominance of a few plant species, frequently associated with the introduction of invasive non-native species.

Currently, the motivation for this plan lies in the first two objectives. Rice Creek is a tremendous resource with good water quality and a diverse and interesting community of aquatic plants. It also has a recreational history and current human use that has caused only moderate degradation to the ecosystem.

During projects with the WDNR Planning Grant Program and through past efforts, Town Lakes Committee has followed the first five steps in the seven-step plan outlined in the Guidance Document for developing an aquatic plant management plan:

1. Goal setting – Getting the effort organized, identifying problems to be addressed, and agreeing on the goals;
2. Inventory – Collecting baseline information to define the past and existing conditions;
3. Analysis – Synthesizing the information, quantifying and comparing the current conditions to desired conditions, researching opportunities and constraints, and setting directions to achieving the goals;
4. Alternatives – Listing possible management alternatives and evaluating their strengths, weaknesses and general feasibility;
5. Recommendations – Prioritizing and selecting preferred management options, setting objectives, drafting the plan;
6. Implementation – Formally adopting the plan, lining up funding, and scheduling activities for taking action to achieve the goals;
7. Monitor & Modify – Developing a mechanism for tracking activities and adjusting the plan as it evolves.

Besides this introductory chapter, this plan is organized in six Chapters. The study area is described in Chapter 2. Chapter 3 states the purpose and goals for the plan. Chapter 4 presents an inventory and analysis of information that pertain to the plan including the results of the aquatic plant survey. Chapter 5 provides recommendations that support the overall goals and establish the stewardship component of plan. Finally, Chapter 6 presents actions and objectives for implementing the plan. Three appendices complete this document. Appendix A contains literature cited, Appendix B contains tables and figures for the aquatic plant survey, and Appendix C contains a *Review of Rice Creek Water Quality*.

CHAPTER 2

Study Area

Presque Isle Township is one of the northern-most townships in Vilas County, Wisconsin. Presque Isle Township's northern border is shared with the State of Michigan. In fact some of the Presque Township lakes lie on the state border. The location of the subject of this APM Plan (Rice Creek) is shown in Exhibit 1 along with other bodies of water in Presque Isle Township that have had point-intercept aquatic plant surveys conducted. Exhibit 2 is an aerial view of Rice Creek.

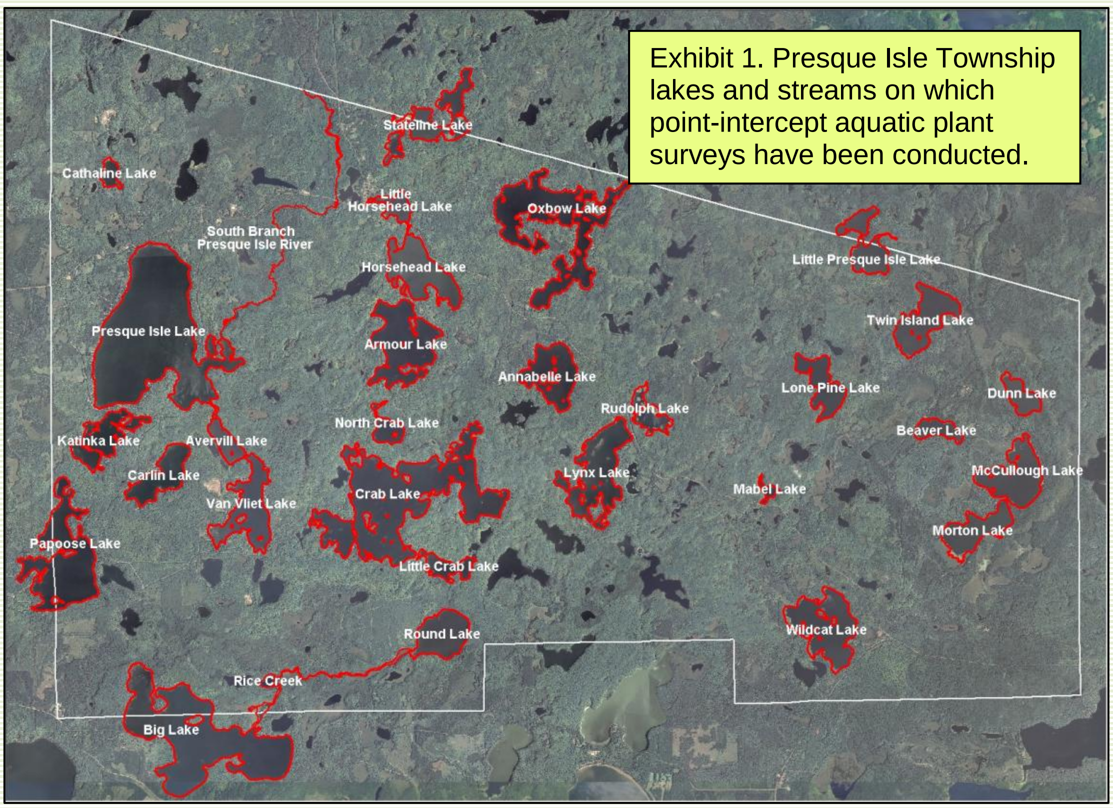


Exhibit 1. Presque Isle Township lakes and streams on which point-intercept aquatic plant surveys have been conducted.

“Almost an island” is the literal translation of the French phrase “Presque Isle.” Early French missionaries, perhaps disoriented by the preponderance of water in this north central Wisconsin landscape applied the name, “Presque Isle” to describe an area where the water seemed to dominate the land. The French visitors and Native Americans certainly recognized this landscape as special. Modern ecologists and recreationist share this view. The region that includes the Township of Presque Isle, Wisconsin is an ecological landscape marvelously rich in surface waters. Aerial photography reveals a concentration of lakes and streams that is unique in North America. Presque Isle Township has eighty-four lakes. The Presque Isle area could as easily be termed a “waterscape” as a “landscape.”

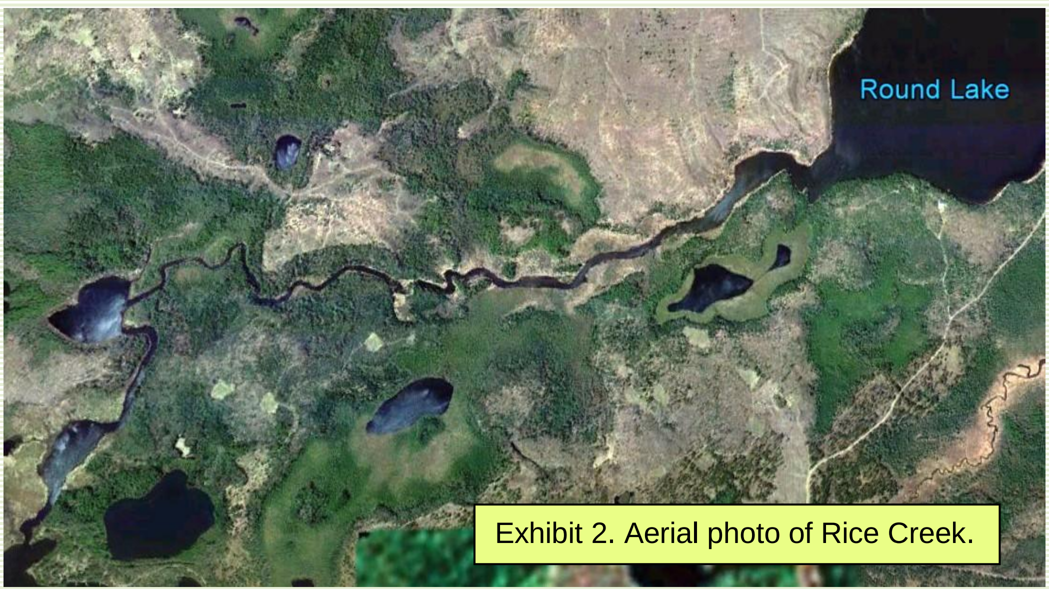


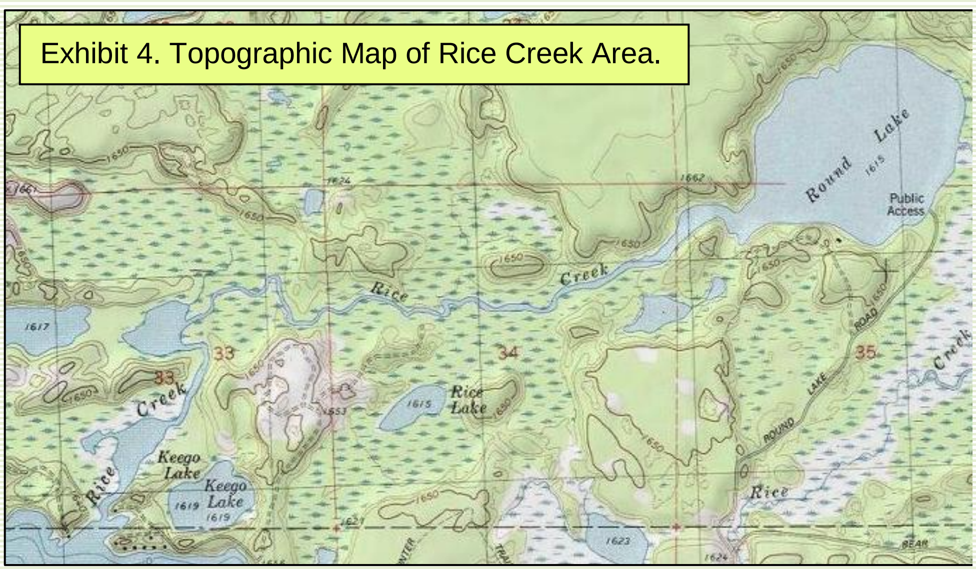
Exhibit 2. Aerial photo of Rice Creek.

Descriptive parameters for Rice Creek are in Exhibit 3. It is 7.7 miles long in its entire length and has an average width of 25 feet. For the purposes of this study and plan, we examined that portion of Rice Creek between Round Lake and Big Lake (approximately 2.75 miles).

Exhibit 3. Water Body Parameters	
Water Body Name	Rice Creek
County	Vilas
Township/Range/Section	T43N-R06E-S33,S34
Water Body Identification Code	2334500
Water Body Type	Creek
Maximum Length (miles)	7.7
Average Width (feet)	25

Rice Creek has no public access site; however, access to the portion of Rice Creek that is the subject of this plan can be gained through Round Lake or Big Lake. There is no human development on this portion of Rice Creek. The riparian area consists of both upland and wetland areas (Exhibit 4).

Exhibit 4. Topographic Map of Rice Creek Area.



CHAPTER 3

Purpose and Goal Statements

This plan approaches aquatic plant management with a healthy dose of humility. We do not always understand the causes of environmental phenomena or the effects of our actions to manage the environment. With that thought in mind, we have crafted a statement of purpose and for this plan:

> ***Rice Creek has a healthy and diverse aquatic plant community that was documented by a point-intercept aquatic plant survey. This plant community is essential to, and part of, a high quality aquatic ecosystem that benefits the human community with its recreational and aesthetic features. The purpose of this aquatic plant management plan is to maintain the aquatic plant community in its present high quality state.***

Supporting this purpose, the goals of this aquatic plant management plan are:

(1) Monitor and protect the native aquatic plant community;
(2) Prevent establishment of AIS and nuisance levels of native plants;
(3) Promote and interpret APM efforts; and
(4) Educate riparian owners and lake and stream users on preventing AIS introduction, reducing nutrient inputs that potentially alter the plant community, and minimizing physical removal of native riparian and littoral zone plants.

The purpose and goals are the foundation for the aquatic plant management plan presented in this document. They inform the objectives and actions outlined in Chapter 5 and are the principal motivation of Rice Creek stewards.

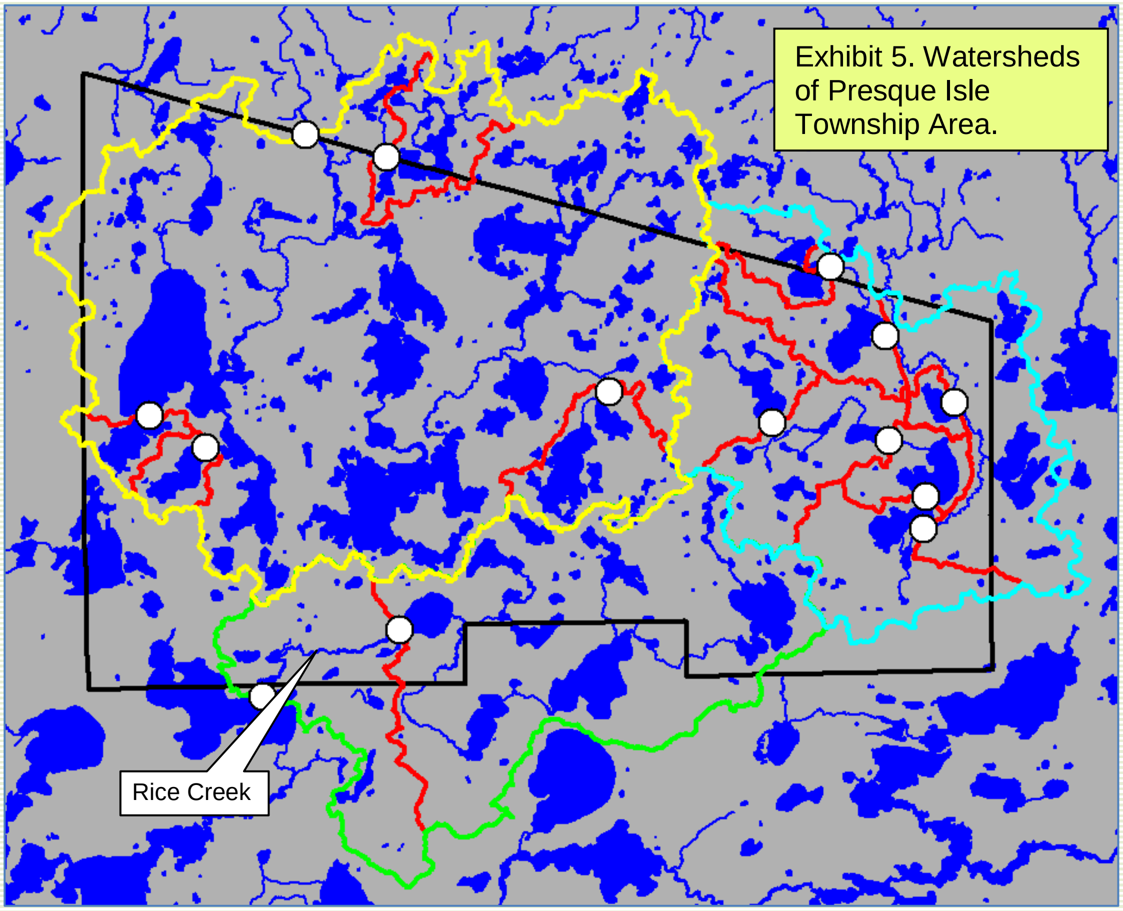
CHAPTER 4

Information and Analysis

Our efforts in the Wilderness Waters Program have compiled information about historical and current conditions of the Rice Creek ecosystem and its surrounding watershed. Of particular importance to this aquatic plant management plan is the aquatic plant survey that was conducted in using the ***WDNR Protocol for Aquatic Plant Survey, Collecting, Mapping, Preserving, and Data Entry*** (Hauxwell et al., 2010). The results of this comprehensive "point-intercept" survey along with relevant components of other information are presented in this chapter under nine respective subheadings: watershed, aquatic plant management history, aquatic plant community description, fish community, water quality and trophic status, water use, riparian area, wildlife, and stakeholders.

Part 1. Watershed

The Presque Isle Township waterscape sits on a large-scale watershed divide. Some of the water drains north through the Presque Isle River system and eventually enters Lake Superior. Some of the water drains into the Wisconsin River system to the Mississippi River and to the Gulf of Mexico. In fact there are two federal hydrologic sub-basins (designated by 8-digit HUC codes) that include Presque Isle Township. The Black-Presque Isle Rivers sub-basin (HUC#04020101) drains north to Lake Superior and the Flambeau River sub-basin (HUC#0705002) drains southwesterly to the Mississippi River. The Black-Presque Isle Rivers sub-basin contains two federal hydrologic sub-watersheds within Presque Isle Township: the South Branch Presque Isle River sub-watershed (HUC#040201010303) and the Pomeroy Creek-East Branch Presque Isle River sub-watershed (HUC#040201010301). The Flambeau River sub-basin contains one sub-watershed within Presque Isle Township: the Rice Creek sub-watershed (HUC#07050020103). Exhibit 5 illustrates these watersheds and the watersheds of the water bodies subject to the Wilderness Waters Program studies. Rice Creek is contained within the Rice Creek sub-watershed (Exhibit 5).



Description: Portions of 3 federal hydrologic sub-watersheds are illustrated: (1) S.Br. Presque Isle River (bounded by yellow), (2) Pomeroy Cr-E.Br. Presque Isle River (bounded by blue and yellow), and (3) Rice Cr. (bounded by green, yellow, and blue). Also shown are the smaller watersheds of individual water bodies subject to the Wilderness Waters studies (bounded by red). White dots show outlet points for the smaller watersheds.

The elevation in Presque Isle Township ranges from around 1,550 feet above sea level to 1,750 feet above sea level. A digital elevation model is provided as Exhibit 6 and shows the relative elevations for the area with orange areas of the landscape being the highest elevations and greens and blues being the lowest elevations.

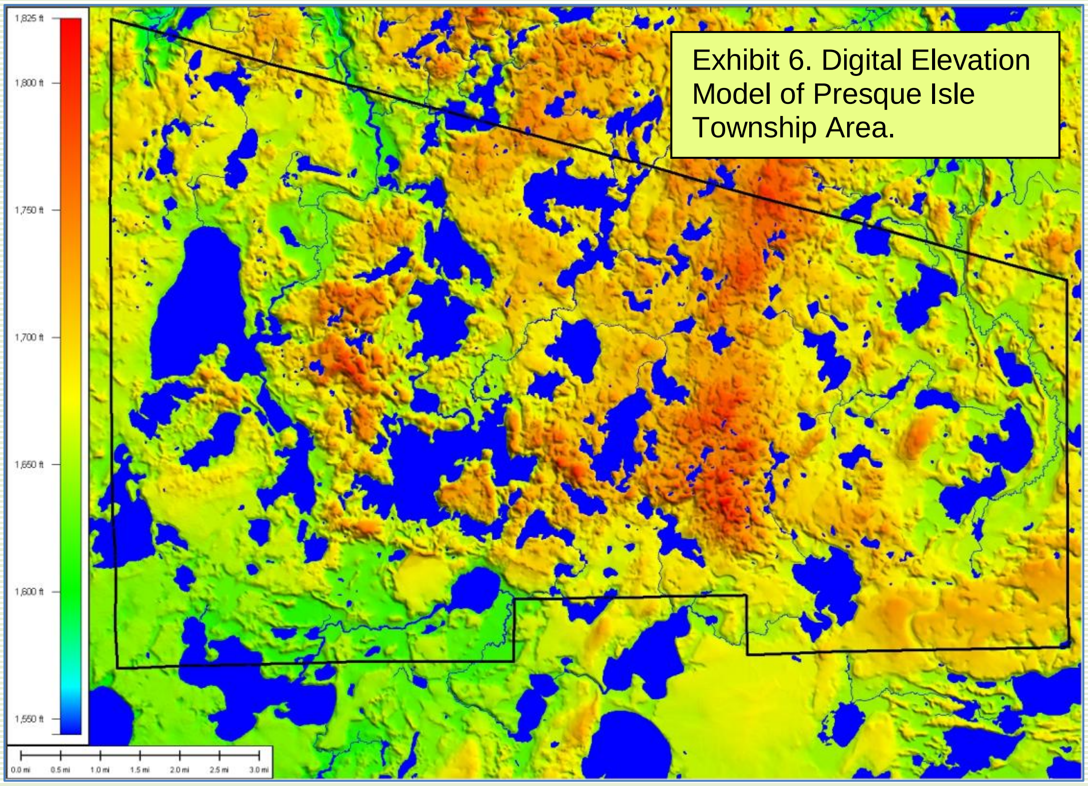


Exhibit 6. Digital Elevation Model of Presque Isle Township Area.

The watershed (drainage basin) is all of the land and water areas that drain toward a particular river or lake. A water body is greatly influenced by its watershed. Watershed size, topography, geology, land use, soil fertility and erodibility, and vegetation are all factors that influence water quality. The Rice Creek watershed is about 13,789.5 acres. It is identified in Exhibit 5 and bounded by the green, yellow and blue lines. The cover types in the watershed are presented in Exhibit 7. Forest and surface water comprise the largest components. Soil groups A, B, and D are present, with group A covering 41%, and groups B and D present in equal acreages (29%). Soil group A has high infiltration capacity; B has moderate infiltration capacity and D has very low infiltration capacity. In larger watersheds, runoff water can leach more minerals and nutrients and carry them to the creek. The runoff to a creek (such as after a rainstorm or snowmelt) differs greatly among land uses. Forest cover is the most protective as it exports much less soil (through erosion) and nutrients (such as phosphorus and nitrogen) to the creek than agricultural or urban land use.

Exhibit 7. Cover Types and Soil Groups of the Rice Creek Watershed.		
Cover Type	Acres	Percent
Agriculture	0	0
Commercial	0.9	0.01
Forest	8231.1	59.7
Grass/Pasture	33.7	0.2
High-density Residential	1.2	0.01
Low-density Residential	589.7	4.3
Water	4932.9	35.8
Total	13789.5	100.0

Soil Group	Acres	Percent	**Hydrologic Soil Groups** - Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups* based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Where A has the smallest runoff potential and D the greatest.
A	4011.3	29	**Group A** is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
B	5714	41	**Group B** is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
C	0	0	**Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
D	4064.2	29	**Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This soil has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

*****(*USDA, Natural Resources Conservation Service, 1986)*

Part 2. Aquatic Plant Management History

As far as we can determine, no systematic or large-scale plant management activity has ever taken place in Rice Creek. Over the years, no particular nuisance issues have demanded control action. It is our understanding that the plant survey conducted as part of the 2010/2011 Wilderness Water Program was the first effort of its kind on this water body.

Part 3. Aquatic Plant Community Description

Why do creeks need aquatic plants? In many ways, they are underwater forests. Aquatic plants provide vertical and horizontal structure in the creek just like the many forms and variety of trees do in a forest. Imagine how diminished a forest's biodiversity becomes in the advent of a clear-cut. Similarly, a creek's biodiversity in large part depends on a diversity of plants.

Aquatic plants are beneficial in many ways. Areas with plants produce more food for fish (insect larvae, snails, and other invertebrates). Aquatic vegetation offers fish shelter and spawning habitat. Many submerged plants provide food for waterfowl and habitat for insects on which some waterfowl feed. Aquatic plants further benefit creeks by producing oxygen and absorbing nutrients (phosphorus and nitrogen) from runoff. Aquatic plants also protect shorelines and water body bottoms by dampening wave action and stabilizing sediments.

The distribution of plants within a body of water is generally limited by light availability, which is, in turn, controlled by water clarity. Aquatic biologists often estimate the depth to which rooted aquatic plants can exist as about two times the average Secchi clarity depth. For example, if the average Secchi depth is eight feet then it is fairly accurate to estimate that rooted plants might exist in water as deep as sixteen feet. At depths greater than that (in our hypothetical example), light is insufficient for rooted plants to grow. In addition to available light, the type of substrate influences the distribution of rooted aquatic plants. Plants are more likely to be found in muddy or soft sediments containing organic matter, and less likely to occur where the substrate is sand, gravel, or rock. Finally, water chemistry influences which plants are found in a body of water. Some species prefer alkaline lakes and streams while others prefer more acidic bodies of water. The presence of nutrients like phosphorous and nitrogen also influence plant community composition.

As mentioned earlier, non-native invasive plant species can reach high densities and wide distribution within a body of water. This diminishes the native plant community and the related habitat. At times, even a native plant species can reach nuisance levels with respect to certain kinds of human recreation. These cases may warrant some kind of plant management.

We conducted a WDNR point-intercept aquatic plant survey on Rice Creek in summer 2010. Since the WDNR point-intercept protocol is designed for lakes and impoundments, we modified it to accommodate the more linear habitat found in a stream. In the laboratory, we used the hydro layer centerline down the stream and using GIS software, placed points every 75 meters along the centerline of the subject stream reach. In the case of Rice Creek, the stream reach went from Round Lake downstream to Big Lake. The coordinates for these centerline points were those to which the field crew navigated. Also in the laboratory we randomly selected for each centerline point from three categories (center, left, right). Using latitude-longitude coordinates and a handheld GPS unit, we navigated to the center line points and referred to a table that indicated "center," "left," or "right" for a given point. If it was "left", then the sample was taken from a point half the distance from the stream left bank and the stream center point. If it was a "center" the sample was taken at the stream center. We used a rake mounted on a pole to sample plants. These were identified and recorded, and put into a dedicated spreadsheet for storage and data analysis. This formal survey assessed the plant species composition throughout the stream reach we sampled. This systematic survey provides baseline data about the creek. Future monitoring will be able to identify and track changes in the plant community. Changes in a creek environment might manifest as loss of species, change in species abundance or distribution, difference in the relative composition of various plant life forms (emergent, floating leaf, or submergent plants), and/or appearance of an AIS or change in its population size. Monitoring can track changes and provide valuable insight on which to base management decisions. In the remainder of this section (Part 3) we report the findings of the point-intercept aquatic plant survey. The supporting tables and figures for the aquatic plant survey are provided in Appendix B.

Species richness refers to the total number of species recorded. We recorded 36 species of aquatic plants. Of these, 27 were collected at sampling sites and the others were observed from the boat. Table 1 displays summary statistics for the survey. Table 2 provides a list of the species encountered, including common and scientific name along with summarizing statistics.[2] The number of species encountered at any given sample point ranged from 0 to 8 and 57 sample points were found to have aquatic vegetation present. The average number of species encountered at these vegetated sites was 3.28. The actual number of species encountered at each of the vegetated sites is graphically displayed on Figure 1. Plant density is estimated by a "rake

[2] *If you are interested in learning more about the plant species found in the lake, visit the University of Wisconsin Steven Point Freckmann Herbarium website at: http://wisplants.uwsp.edu/ or obtain a copy of "Through the Looking Glass (A Field Guide to the Aquatic Plants in Wisconsin)."*

fullness" metric (3 being the highest possible density). These densities (considering all species) are displayed for each sampling site on Figure 2.

The maximum depth of plant colonization is 7.5 feet (Table 1 and Figure 3). Rooted vegetation was found at 57 of the 61 sample sites with depth ≤ the maximum depth of plant colonization (93.44% of sites). These sites are displayed as a black dot within a circle on Figure 4. This indicates that although availability of appropriate depth may limit the distribution of plants, it is not the only habitat factor involved. Substrate is another feature that influences plant distribution (e.g., soft substrate often harbors more plants than hard substrate). Figures 5 presents the substrates encountered during the aquatic plant survey (mud, sand, or rock).

Table 2 provides information about the frequency of occurrence of the plant species recorded in the creek. Several metrics are provided, including total number of sites in which each species was found and frequency of occurrence at sites ≤ the maximum depth of rooted vegetation. This frequency metric is standardized as a "relative frequency" (also shown in Table 2) by dividing the frequency of occurrence for a given species by the sum of frequency of occurrence for all plants and multiplying by 100 to form a percentage. The resulting relative frequencies for all species total 100%. The relative frequencies for the plant species collected with a rake are graphically displayed in descending order on Figure 6. This display shows that *Ceratophyllum demersum* (Coontail) had the highest relative frequency followed by *Utricularia vulgaris* (Common bladderwort). The lowest relative frequencies are at the far right of the graph. As examples of individual species distributions, we show the occurrences of a few of the most frequently and least frequently encountered plants in Figures 7-15.

Species richness (total number of plants recorded at the creek) is a measure of species diversity, but it doesn't tell the whole story. As an example, consider the plant communities of two hypothetical ponds each with 1,000 individual plants representing ten plant species (in other words, richness is 10). In the first pond each of the ten species populations is comprised of 100 individuals. In the second pond, Species #1 has a population of 991 individuals and each of the other nine species is represented by one individual plant. Intuitively, we would say that first pond is more diverse because there is more "even" distribution of individual species. The "Simpson Diversity Index" takes into account both richness and evenness in estimating diversity. It is based on a plant's relative frequency in a lake. The closer the Simpson Diversity Index is to 1, the more diverse the plant community. The Simpson Diversity Index for Rice Creek aquatic plants is 0.92 (Table 1) which indicates a highly diverse aquatic plant community.

Another measure of floristic diversity and quality is the *Floristic Quality Index* (FQI). Floristic quality is an assessment metric designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions (Nichols 1999). Among other applications, it forms a standardized metric that can be used to compare the quality of different bodies of water (or different locations within a single body of water) and monitor long-term changes in a creek's plant community (an indicator of creek health). The FQI for a body of water is determined by using the average *coefficient of conservatism* times the square root of the number of native plant species present in the body of water. Knowledgeable botanists have assigned to each native aquatic plant a *coefficient of conservatism* representing the probability that a plant is likely to occur in pristine environments (relatively unaltered from pre-settlement conditions). The coefficients range from 0 to 10, with 10 being assigned to those species most sensitive to disturbance. As more environmental disturbance occurs, the less conservative species become more prevalent.

Nichols (1999) analyzed aquatic plant community data from 554 Wisconsin Lakes to ascertain geographic (ecoregional) characteristics of the FQI metric. This is useful for considering how the Rice Creek FQI (32) compares to other lakes, rivers, creeks and regions. The statewide medians for number of species and FQI are 13 and 22.2, respectively. Rice Creek values are quite high compared to these statewide values. Nichols (1999) determined that there are four ecoregional-lake types groups in Wisconsin: (1) Northern Lakes and Forests lakes, (2) Northern Lakes and Forests flowages, (3) North Central Hardwoods and Southeastern Till Plain lakes and flowages, and (4) Driftless Area and Mississippi River Backwater lakes. Rice Creek is located in the Northern Lakes and Forests lakes group. Nichols (1999) found species numbers for the Northern Lakes and Forests lakes group had a median value of 13. Rice Creek data is consistent with that find. Finally, the Rice Creek FQI (32) is higher than the median value for the Northern Lakes and Forests lakes group (24.3). These findings support the contention that the Rice Creek plant community is healthy and diverse.

We observed no aquatic plants in Rice Creek that would be considered a nuisance-level population density/distribution. However, during the 2010 survey, a single purple loosestrife (*Lythrum salicaria*) plant was found on a beaver dam (Coordinates: 46.16515, -89.73687). Purple loosestrife is considered a *Restricted* invasive species in Wisconsin. A *Restricted* species is one that has already been established in the state and causes or has the potential to cause significant environmental or economic harm or harm to human health (WDNR, 2012b). The plant was dug up and the entire plant was bagged and disposed of properly. Further monitoring for purple loosestrife is recommended so that this aggressive plant will not infest Rice Creek. It was also noted that a potentially aggressive native plant, water arum (*Calla palustris*), was seen in several locations along Rice Creek (46.16531, -89.73103; 46.16502,

-89.73734; 46.16550, -89.73889; 46.16524, -89.74097; 46.16515, -89.73687). We found no state or federally listed species.

Wild rice (*Zizania palustris*) was observed at 31 sites (on the rake or as a visual sighting) in the Rice Creek aquatic plant survey. Of the sites in Rice Creek that had vegetation, wild rice was present at 23% of these sites.

Wild rice is an important food source for many waterfowl and animals. It also has cultural significance to the Anishinaabe (Chippewa or Ojibwa), who call it *manoomin* (GLIFWC, *Wild Rice* brochure). Because of its ecological and cultural importance, the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has systematically collected wild rice data, including: acreage, density, pounds collected by tribal and state peoples, and other useful data. GLIFWC also conducts aerial surveys of rice beds and maintains an aerial photography archive. Aerial images of Rice Creek from 2003 and 2008 can be seen below.

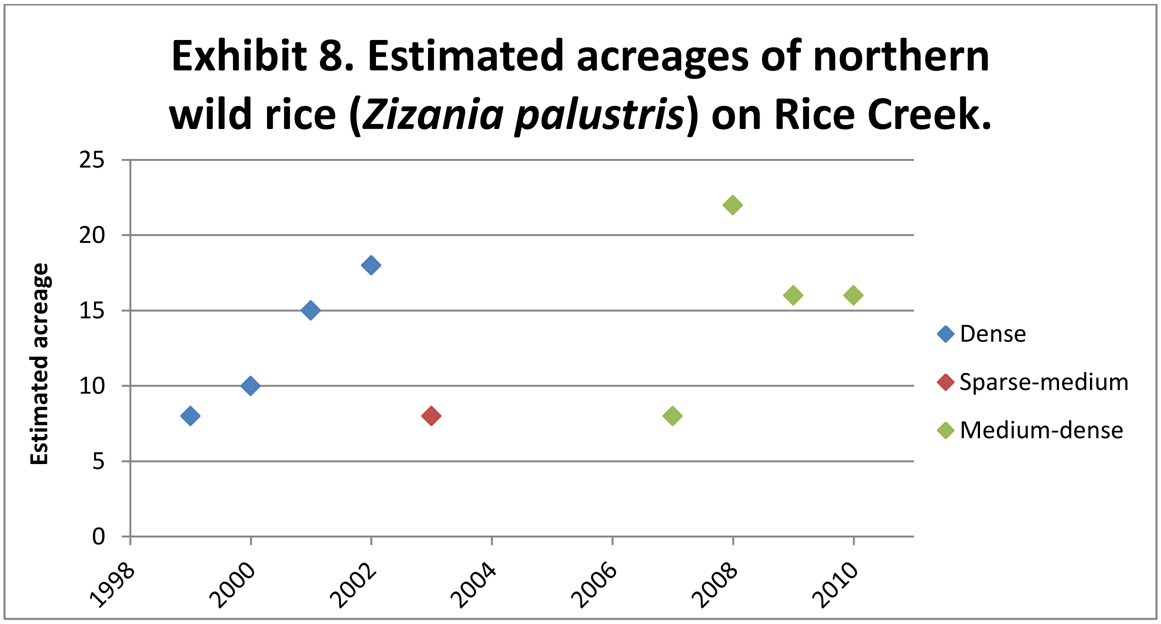
Aerial image of Rice Creek (GLIFWC, 2003).

Aerial image of Rice Creek (GLIFWC, 2008).

According to the *Wisconsin Ceded Territory Manoomin Inventory* (David, 2010), "Rice Creek supports significant amounts of rice. However, the section currently marked on the Surface Water Viewer (above Round Lake) is not known to support appreciable amounts of rice except very close to its mouth on Round Lake. The section between Round Lake and Big Lake supports substantial beds, and including along this section is a small unnamed (Duck) lake (seen in above images). Rice is also abundant on the section between County Road K and the unnamed water body above Island Lake" (David, 2010).

Exhibit 8 displays GLIFWC's estimated acreages (via aerial survey) of wild rice in Rice Creek. During each aerial survey, estimated density was also recorded (different colors in

Exhibit 8). As we can see, the densest wild rice stands were recorded from 1999 to 2002. In 2003, both the acreage and the density of wild rice diminished. The largest estimated acreage was seen in 2008 (22 acres). By comparing the 2003 and 2008 aerial images above with the estimated acreages in Exhibit 8, we have a better idea of what "sparse-medium" and "medium-dense" rice stands look like.



(Adapted from David, 1999-2010)

Part 4. Fish Community

A fish study was conducted in 1970 and 1975 on Rice Creek. The population of grass pickerel and hybrid northern pike X grass pickerel in Rice Creek represents the northernmost known distribution for this species and hybrid in North America.

Part 5. Water Quality and Trophic Status

Water quality data was collected in October, 1960 (Black). On 7/20/1995, a site study was conducted for aquatic vegetation. Data was also collected from the DNR (SWIMS database) for Secchi depth, which was taken using a Landsat satellite in 2009 (WDNR, 2012c). On April 8, 2010 a macroinvertebrates study was conducted and on August 16, 2010 White Water Associates Inc. sampled Rice Creek. That water quality information is briefly summarized in this section, but more fully interpreted in Appendix C.

Water clarity for Rice Creek is poor. Turbidity has not been sampled in the past, but Black (1960) said the water column appearance was clear. Water quality would be classified as good with respect to phosphorus concentrations. Chlorophyll *a* (a measure of the amount of algae) is low. Nitrogen, conductivity, sodium, and potassium are considered low. The conductivity in Rice Creek in 1960 was 118 mmhos which is considered low. The calcium level was borderline with respect to suitability for zebra mussels. The alkalinity was also tested in 1960 with a value of 57 ppm. The pH of Rice Creek is slightly alkaline.

Part 6. Water Use

Rice Creek has no public access site, however, Round Lake, which is navigable from Rice Creek, does have a public access. The creek is used for a variety of recreational activities including fishing. There majority of the land surrounding Rice Creek is owned by the State of Wisconsin and is called the Northern Highland State Forest.

Part 7. Riparian Area

Part 1 (Watershed) describes the larger riparian area context of Rice Creek. The near shore riparian area can be appreciated by viewing Exhibits 2 and 4. The portion of Rice Creek that is subject to this plan has no development. The riparian zone is intact and extends back for hundreds of feet from the creek. The riparian zone is typically emergent wetland and some forested wetland. Our review of 2011 aerial photography reveals zero houses on the creek. This intact riparian area provides numerous important functions and values to the creek. It effectively filters runoff to the water. It provides excellent habitat for birds and mammals. Trees that fall into the creek from the riparian zone contribute important habitat elements to the body of water. Educating riparian owners as to the value of riparian areas is important to the maintenance of these critical areas.

Part 8. Wildlife

A study of wildlife was beyond the scope of the current study, but would be valuable to study and interpret in future iterations of the plan. This would be especially true of wetland and water oriented wildlife such as frogs, waterfowl, fish-eating birds, aquatic and semi-aquatic mammals, and invertebrate animals. In the future, it would be desirable to monitor indicator species of wildlife such as common loons, bald eagles, and osprey. Also of special importance would be monitoring for the presence of aquatic invasive wildlife species (for example, spiny water fleas or zebra mussel) and fish species (for example, rainbow smelt or common carp).

Rice Creek currently designated as an *area of special natural resource interest* (ASNRI) (WDNR, 2012a). A water body designated as an Area of Special Natural Resource Interest can be any of the following: WDNR trout streams; Outstanding or Exceptional Resource Waters (ORW/ERW); waters or portions of waters inhabited by endangered, threatened, special concern species or unique ecological communities; wild rice waters; waters in ecologically significant coastal wetlands along Lake Michigan and Superior; or federal or state waters designated as wild or scenic rivers (WDNR, 2012a). Rice Creek is considered an ASNRI because it lies within a State Natural Area and it inhabits state or federally designated threatened or endangered species. The Wisconsin Natural Heritage Inventory (NHI) lists the following plants and animals as rare or sensitive species and/or communities that are considered high-quality and significant natural features. They are found in the same town/range is Rice Creek (NHI, 2013).

Exhibit 9. Rare Species and Communities located near Rice Creek.

Common Name	*Scientific Name*	*State Status*[3]	*Group Name*
Trumpeter swan	*Cygnus buccinators*	SC/M	Bird
Bald eagle	*Haliaeetus leucocephalus*	SC/P	Bird
A predaceous diving beetle	*Agabus wasastjernae*	SC/N	Beetle
Fairy slipper	*Calypso bulbosa*	THR	Plant
Downy willow-herb	*Epilobium strictum*	SC	Plant
Boreal rich fen		NA	Community
Emergent marsh-wild rice		NA	Community
Ephemeral pond		NA	Community
Lake-deep, soft, seepage		NA	Community
Lake-spring		NA	Community
Northern mesic forest		NA	Community
Northern wet forest		NA	Community
Northern wet-mesic forest		NA	Community
Poor fen		NA	Community

3 **END**=Endangered; **THR**=Threatened; **SC**=Special Concern; **SC/P**=fully protected; **SC/N**=no laws regulating use, possession or harvesting; **SC/H**=take regulated by establishment of open/closed seasons; **SC/FL**=federally protected as endangered or threatened, but not so designated by DNR; **SC/M**=fully protected by federal and state laws under Migratory Bird Act.

Part 9. Stakeholders

At this juncture in the ongoing aquatic plant management planning process, the Town Lakes Committee has represented the Rice Creek stakeholders. Additional stakeholders and interested citizens are invited to participate as the plan is refined and updated in order to broaden input, build consensus, and encourage participation in stewardship. No contentious direct plant management actions (for example, harvesting or use of herbicides) are a component of the current plan. The Town Lakes Committee has conducted a township wide lake users' survey that is presented in the overarching ***Wilderness Waters Adaptive Management Plan*** (Premo et al., 2014).

CHAPTER 5

Recommendations, Actions, and Objectives

In this chapter we provide recommendations for specific objectives and associated actions to support the APM Plan's goals stated in Chapter 3 and re-stated here for convenient reference:

(1) Monitor and protect the native aquatic plant community;

(2) Prevent establishment of AIS and nuisance levels of native plants;

(3) Promote and interpret APM efforts; and

(4) Educate riparian owners and lake users on preventing AIS introduction, reducing nutrient inputs that potentially alter the plant community, and minimizing physical removal of native riparian and littoral zone plants.

Since Rice Creek is a healthy and diverse ecosystem, we could simply recommend an alternative of "no action." In other words, Rice Creek continues without any effort or intervention on part of lake stewards. Nevertheless, we consider the "no action" alternative imprudent. Many forces threaten the quality of the lake and streams, and Wilderness Waters Program and Town Lakes Committee feels a great responsibility to minimize the threats. We therefore outline in this section a set of actions and related management objectives that will actively engage lake stewards in the process of management.

The actions are presented in tabular form. Each "action" consists of a set of four statements: (1) a declarative "action" statement that specifies the action (2) a statement of the "objective" that the action serves, (3) a "monitoring" statement that specifies the party responsible for carrying out the action and maintaining data, and (4) a "status" statement that suggests a timeline/calendar and indicates status (not yet started, ongoing, or completed).

At this time, we recommend no direct manipulation of plant populations in Rice Creek. No aquatic invasive plant species are known to be present and no native plants exhibit nuisance population size or distribution.

Recommended Actions for the Rice Creek APM Plan
Action #1: Formally adopt the Aquatic Plant Management Plan. ***Objective:*** To provide foundation for long-term native plant community conservation and stewardship and to be prepared for response to AIS introductions. ***Monitoring:*** The Lake Association and Town Lakes Committee oversee activity. ***Status:*** Planned for 2013.
Action #2: Monitor water quality. ***Objective***: Continue with collection and analysis of water quality parameters to detect trends in parameters such as nutrients, chlorophyll *a*, and water clarity. ***Monitoring:*** The Lake Association or Town Lakes Committee oversees activity. ***Status:*** Ongoing.
Action #3: Monitor the creek for aquatic invasive plant species. ***Objective***: To understand the creek's biotic community, provide for early detection of AIS and continue monitoring any existing populations of AIS. ***Monitoring:*** The Lake Association or Town Lakes Committee oversees activity and maintains data. ***Status:*** Ongoing.
Action #4: Monitor the creek for aquatic invasive animal species. ***Objective***: To understand the creek's biotic community, provide for early detection of AIS and continue monitoring any existing populations of AIS. ***Monitoring:*** The Lake Association or Town Lakes Committee oversees activity and maintains data. ***Status:*** Ongoing.
Action #5: Monitor the population of purple loosestrife in Rice Creek. ***Objective***: Determine potential effects of these aquatic invasive plants. ***Monitoring:*** The Lake Association or Town Lakes Committee oversees activity. ***Status:*** Planned for 2013.

Action #6: Form an Aquatic Invasive Species Rapid Response Team and interface with the Town Lakes Committee AIS Rapid Response Coordinator.

Objective: To be prepared for AIS discovery and efficient response.

Monitoring: The Lake Association and/or Town Lakes Committee coordinate activity.

Status: Planned for 2013.

Action #7: Conduct quantitative plant survey every five years using WDNR Point-Intercept Methodology.

Objective: To watch for changes in native species diversity, floristic quality, plant abundance, and plant distribution and to check for the occurrence of non-native, invasive plant species.

Monitoring: Town Lakes Committee (Wilderness Waters Program) oversees and maintains data; copies to WDNR.

Status: Anticipated in 2015 or 2016.

Action #8: Update the APM plan approximately every five years or as needed to reflect new plant information from plant surveys and monitoring.

Objective: To have current information and management science included in the plan.

Monitoring: Lake Association and/or Town Lakes Committee (Wilderness Waters Program) oversees and maintains data; copies to WDNR.

Status: Ongoing.

Action #9: Develop a Citizen Lake Monitoring Network to monitor for invasive species and develop strategies including education and monitoring activities (see http://www.uwsp.edu/cnr/uwexlakes/clmn for additional ideas).

Objective: To create a trained volunteer corps to monitor aquatic invasive species and to educate recreational users regarding AIS.

Monitoring: The Lake Association oversees activity and reports instances of possible introductions of AIS.

Status: Anticipated to begin in 2013.

Action #10: Become familiar with and recognize the water quality and habitat values of ordinances and requirements on boating, septic, and property development.

Objective: To protect native aquatic plants, water quality, and riparian habitat.

Monitoring: Lake residents and other stakeholders.

Status: Ongoing.

Action #11: Promote adherence to, and enforcement of, the Town of Presque Isle's 200 foot no-wake ordinances (from shoreline and islands).

Objective: To minimize recreational impacts on the aquatic plant community and shoreline habitats, and promote safe boating.

Monitoring: Town Lakes Committee oversees activity and assesses effectiveness.

Status: Ongoing.

Action #12: Create an education plan for the property owners and other stakeholders that will address issues concerning aquatic and riparian plant communities.

Objective: To educate stakeholders about issues and topics that affect the creek's aquatic and riparian plant communities, including topics such as: (1) the importance of the aquatic plant community; (2) no or minimal mechanical removal of plants along the shoreline is desirable and that any plant removal should conform to Wisconsin regulations; (3) the value of a natural shoreline in protecting the aquatic plant community and lake health; (4) nutrient sources to the creek and the role excess nutrients play in degradation of the aquatic plant community; (5) the importance of reducing or eliminating use of fertilizers on creek front property; (6) the importance of minimizing transfer of AIS to the creek by having dedicated watercraft and cleaning boats that visit the creek.

Monitoring: Town Lakes Committee oversee(s) activity and assesses effectiveness.

Status: Anticipated to begin in 2013.

Action #13: Monitor the creek watershed for purple loosestrife.

Objective: Identify purple loosestrife populations before they reach large size.

Monitoring: The Lake Association and/or Town Lakes Committee oversees activity.

Status: Anticipated in 2013.

CHAPTER 6

Contingency Plan for AIS

Unfortunately, sources of aquatic invasive plants and other AIS are numerous in Wisconsin. Some infested lakes are quite close to Presque Isle Township. There is an increasing likelihood of accidental introduction of AIS to Presque Isle Township lakes and streams through conveyance of life stages by boats, trailers, and other vectors. It is important for the Town Lakes Committee and other stewards to be prepared for the contingency of aquatic invasive plant species colonization in a Presque Isle Township water body.

For riparian owners and users of a creek ecosystem, the discovery of AIS is a tragedy that elicits an immediate desire to "fix the problem." Although strong emotions may be evoked by such a discovery, a deliberate and systematic approach is required to appropriately and effectively address the situation. An aquatic plant management plan (one including a contingency plan for AIS) is the best tool by which the process can be navigated. In fact the APM plan is a requirement in Wisconsin for some kinds of aquatic plant management actions. One of the actions outlined in the previous chapter was to establish an Aquatic Invasive Species Rapid Response Team. This team and its coordinator are integral to the management process. It is important for this team to be multi-dimensional (or at least have quick access to the expertise that may be required). AIS invade not just a single body of water, but an entire region since the new infestation is an outpost from which the AIS can more easily colonize other nearby water bodies. For this reason it is strategic for the Rapid Response Team to include representation from regional stakeholders.

Exhibit 10 provides a flowchart outlining an appropriate rapid response to the suspected discovery of an aquatic invasive plant species. The response will be most efficient if an AIS Rapid Response Team has already been established and is familiar with the contingency plan. In the remainder of this chapter we further describe the approach.

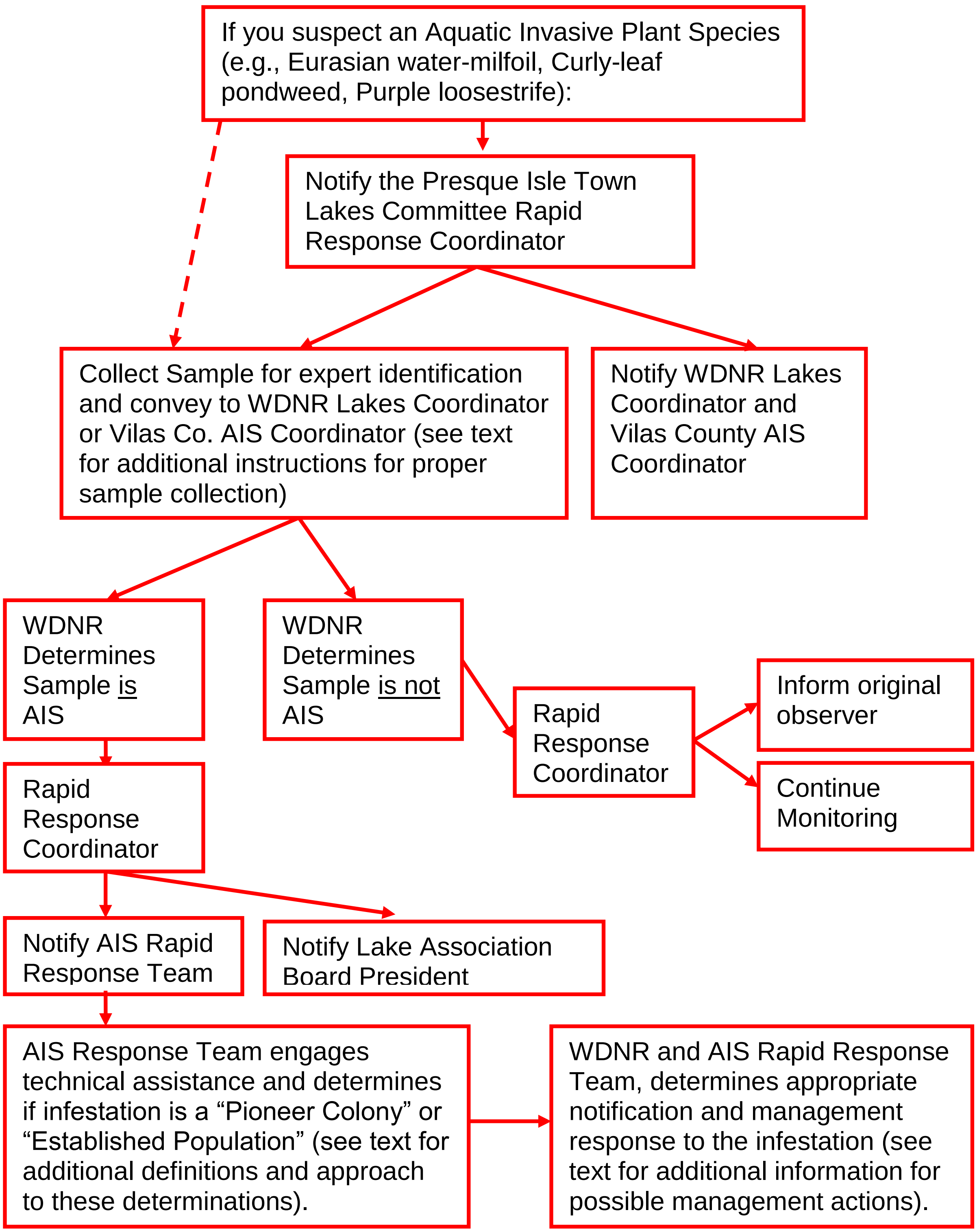
When a suspect aquatic invasive plant species is found, either the original observer or a member of the Rapid Response Team (likely the coordinator) should collect an entire plant specimen including roots, stems, and flowers (if present). The sample should be placed in a sealable bag with a small amount of water to keep it moist. Place a label in the bag written in pencil with date, time, collector's name, lake/river/creek name, location, town, and county. Attach a map to the bag that has the location of the suspect AIS marked and GPS coordinates recorded (if GPS is available). The sample should be placed on ice in a cooler or in a refrigerator. Deliver the sample to the WDNR Water Resource Management Specialist (Kevin Gauthier in Woodruff) or the Vilas County AIS Coordinator (Ted Ritter) as soon as possible (at least within three days). The WDNR or their botanical expert(s) will determine the species and confirm whether or not it is an aquatic invasive plant species.

If the suspect specimen is determined to be an invasive plant species, the next step is to determine the extent and density of the population since the management response will vary accordingly. The Rapid Response Team should conduct (or have its consultant conduct) a survey to define the colony's perimeter and estimate density. If less than five acres (or <5% of the water surface area), it is designated a "Pioneer Colony." If greater than five acres (or >5% of the water surface area) then it is designated an "Established Population." Once the infestation is characterized, "at risk" areas should also be determined and marked on a map. For example, nearby boat landing sites and areas of high boat traffic should be indicated.

When "pioneer" or "established" status has been determined, it is time to consult with the WDNR Lakes Coordinator to determine appropriate notifications and management responses to the infestation. Determining whether hand-pulling or chemical treatment will be used is an important and early decision. Necessary notifications of landowners, governmental officials, and recreationists (at boat landings) will be determined. Whether the population's perimeter needs to be marked with buoys will be decided by the WDNR. Funding sources will be identified and consultants and contractors will be contacted where necessary. The WDNR will determine if a further baseline plant survey is required (depending on type of treatment). A post treatment monitoring plan will be discussed and established to determine the efficacy of the selected treatment.

Once the Rapid Response Team is organized, one of its first tasks is to develop a list of contacts and associated contact information (phone numbers and email addresses). At a minimum, this contact list should include: the Rapid Response Coordinator, members of the Rapid Response Team, County AIS Coordinator, WDNR Lakes Management Coordinator, Lake Association Presidents (or other points of contact), local WDNR warden, local government official(s), tribal contacts, other experts, chemical treatment contractors, and consultant(s).

Exhibit 10. Aquatic Invasive Plant Species Rapid Response



Appendix A
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Appendix B

Aquatic Plant Survey Tables and Figures

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Table 1. Summary statistics for the 2010 point-intercept aquatic plant surveys for Rice Creek.

Summary Statistic	Value	Notes
Total number of sites on grid	61	Total number of sites on the original grid (not necessarily visited)
Total number of sites visited	61	Total number of sites where the boat stopped, even if much too deep to have plants.
Total number of sites with vegetation	57	Total number of sites where at least one plant was found
Total number of sites shallower than maximum depth of plants	61	Number of sites where depth was less than or equal to the maximum depth where plants were found. This value is used for Frequency of occurrence at sites shallower than maximum depth of plants.
Frequency of occurrence at sites shallower than maximum depth of plants	93.44	Number of times a species was seen divided by the total number of sites shallower than maximum depth of plants.
Simpson Diversity Index	0.92	A nonparametric estimator of community heterogeneity. It is based on Relative Frequency and thus is not sensitive to whether all sampled sites (including non-vegetated sites) are included. The closer the Simpson Diversity Index is to 1, the more diverse the community.
Maximum depth of plants (ft.)	7.50	The depth of the deepest site sampled at which vegetation was present.
Number of sites sampled with rake on rope	0	
Number of sites sampled with rake on pole	61	
Average number of all species per site (shallower than max depth)	3.07	
Average number of all species per site (vegetated sites only)	3.28	
Average number of native species per site (shallower than max depth)	3.07	Total number of species collected. Does not include visual sightings.
Average number of native species per site (vegetated sites only)	3.28	Total number of species collected including visual sightings.
Species Richness	27	
Species Richness (including visuals)	36	
Floristic Quality Index (FQI)	32.0	

Table 2. Plant species recorded and distribution statistics for the 2010 Rice Creek aquatic plant survey.

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Coontail referring	*Ceratophyllum demersum*	49.18	53.57	16.13	30	38	1.30
Common bladderwort	*Utricularia vulgaris*	34.43	37.50	11.29	21	27	1.14
Water star-grass	*Heteranthera dubia*	29.51	32.14	9.68	18	37	1.06
Common waterweed	*Elodea canadensis*	21.31	23.21	6.99	13	18	1.00
Small duckweed	*Lemna minor*	21.31	23.21	6.99	13	33	1.00
Large duckweed	*Spirodela polyrhiza*	21.31	23.21	6.99	13	33	1.00
Northern wild rice	*Zizania palustris*	21.31	23.21	6.99	13	31	1.69
Blunt-leaf pondweed	*Potamogeton obtusifolius*	16.39	17.86	5.38	10	11	1.00
Wild celery	*Vallisneria americana*	16.39	17.86	5.38	10	12	1.00
White water lily	*Nymphaea odorata*	14.75	16.07	4.84	9	50	1.00
Forked duckweed	*Lemna trisulca*	13.11	14.29	4.30	8	11	1.00
Water marigold	*Bidens beckii (*formerly *Megalodonta)*	9.84	10.71	3.23	6	14	1.33
Flat-stem pondweed	*Potamogeton zosteriformis*	4.92	5.36	1.61	3	6	1.00
Northern water-milfoil	*Myriophyllum sibiricum*	3.28	3.57	1.08	2	4	1.00
Slender naiad	*Najas flexicaulis*	3.28	3.57	1.08	2	3	1.00
Ribbon-leaf pondweed	*Potamogeton epihydrus*	3.28	3.57	1.08	2	3	2.00
Clasping-leaf pondweed	*Potamogeton richardsonii*	3.28	3.57	1.08	2	7	1.00
Fern pondweed	*Potamogeton robbinsii*	3.28	3.57	1.08	2	3	1.00
Potamogeton spp.	*Potamogeton* spp.	3.28	3.57	1.08	2	6	1.00
Muskgrasses	*Chara* spp.	1.64	1.79	0.54	1	1	1.00
Nitella	*Nitella* spp.	1.64	1.79	0.54	1	3	1.00
Small pond lily	*Nuphar microphylla*	1.64	1.79	0.54	1	2	1.00
Spatterdock	*Nuphar variegata*	1.64	1.79	0.54	1	19	1.00
Large-leaf pondweed	*Potamogeton amplifolius*	1.64	1.79	0.54	1	3	1.00

Frequency of occurrence within vegetated areas (%): Number of times a species was seen in a vegetated area divided by the total number of vegetated sites.

Table 2. Continued.

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Common arrowhead	*Sagittaria latifolia*	1.64	1.79	0.54	1	9	1.00
Hardstem bulrush	*Schoenoplectus acutus*	1.64	1.79	0.54	1	9	1.00
Short-stemmed bur-reed	*Sparganium emersum*	1.64	1.79	0.54	1	14	1.00
Pickerelweed	*Pontederia cordata*				Visual	23	
Cattail	*Typha* spp.				Visual	13	
Water smartweed	*Polygonum amphibium*				Visual	10	
Wild calla	*Calla palustris*				Visual	7	
Floating-leaf pondweed	*Potamogeton natans*				Visual	5	
Bottle brush sedge	*Carex comosa*				Visual	2	
Water horsetail	*Equisetum fluviatile*				Visual	2	
Northern blue flag iris	*Iris versicolor*				Visual	1	
Sago pondweed	*Stuckenia pectinata*				Visual	1	

Frequency of occurrence within vegetated areas (%): Number of times a species was seen in a vegetated area divided by the total number of vegetated sites.

Figure 1. Number of plant species recorded at Rice Creek sample sites (2010).

Figure 2. Rake fullness ratings for Rice Creek sample sites (2010).

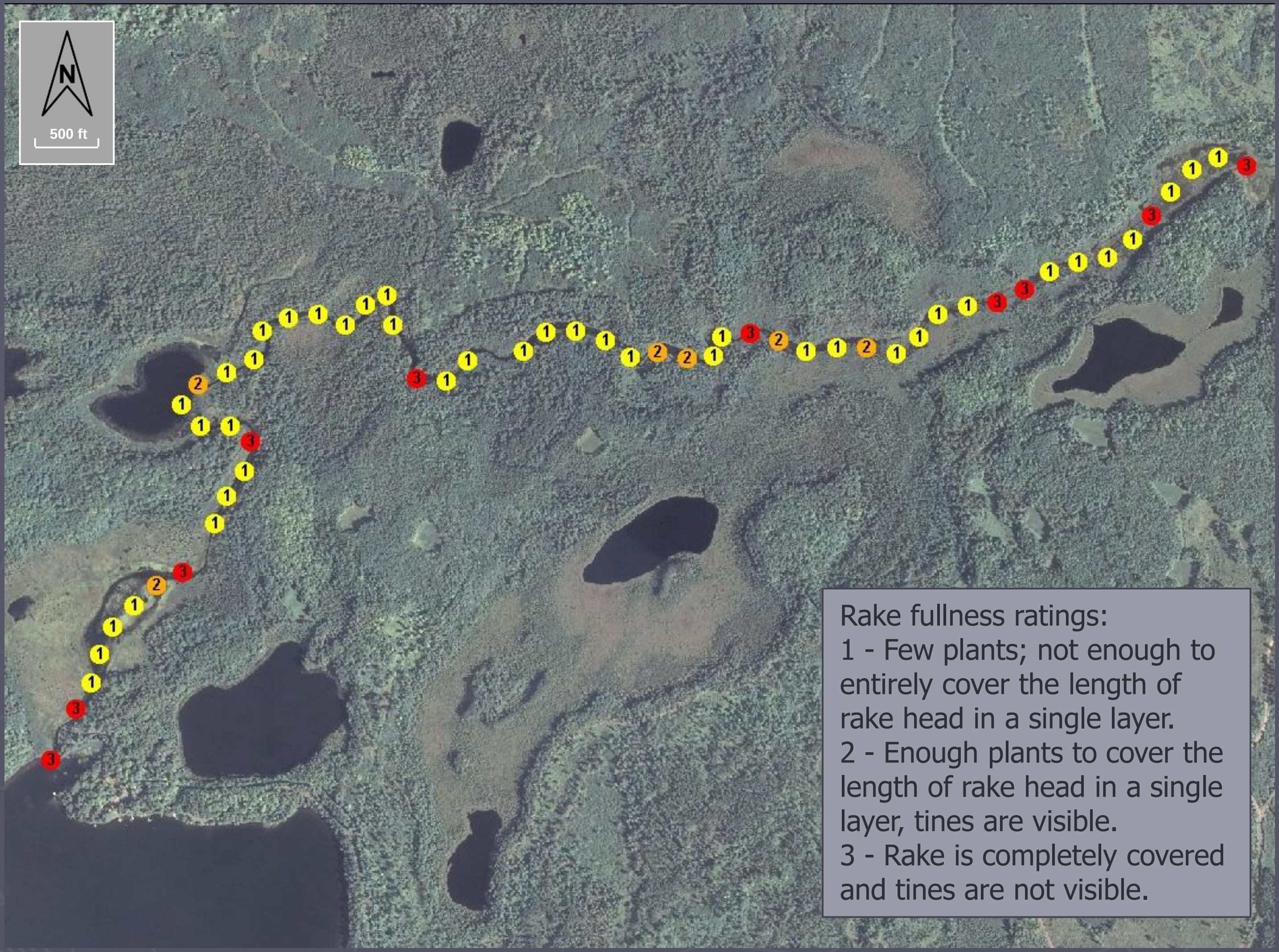


Figure 3. Maximum Depth of Plant Colonization in Rice Creek.

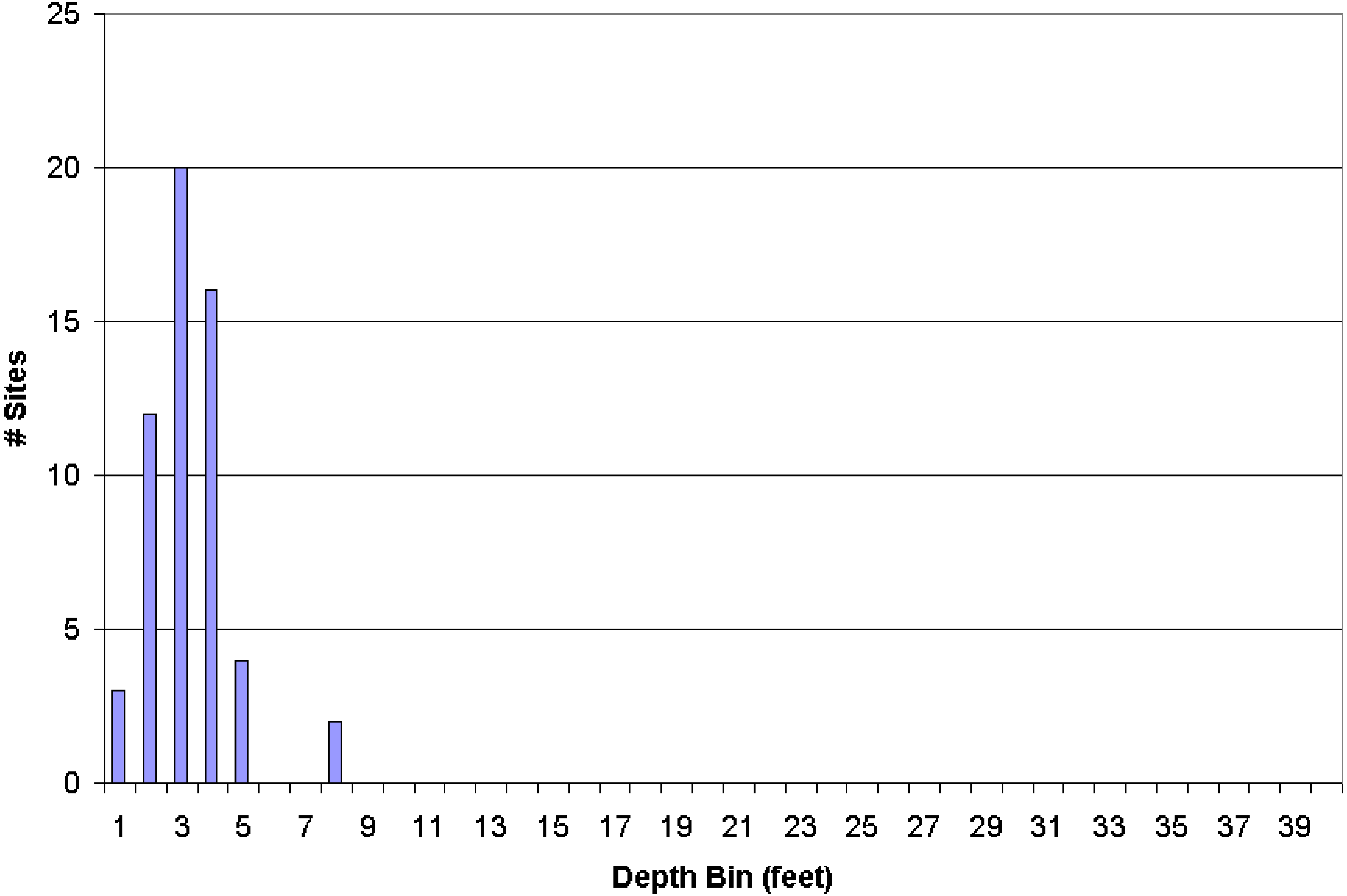


Figure 4. Rice Creek sampling sites less than or equal to maximum depth of rooted vegetation (2010).

Figure 5. Rice Creek substrate encountered at point-intercept plant sampling sites (2010).

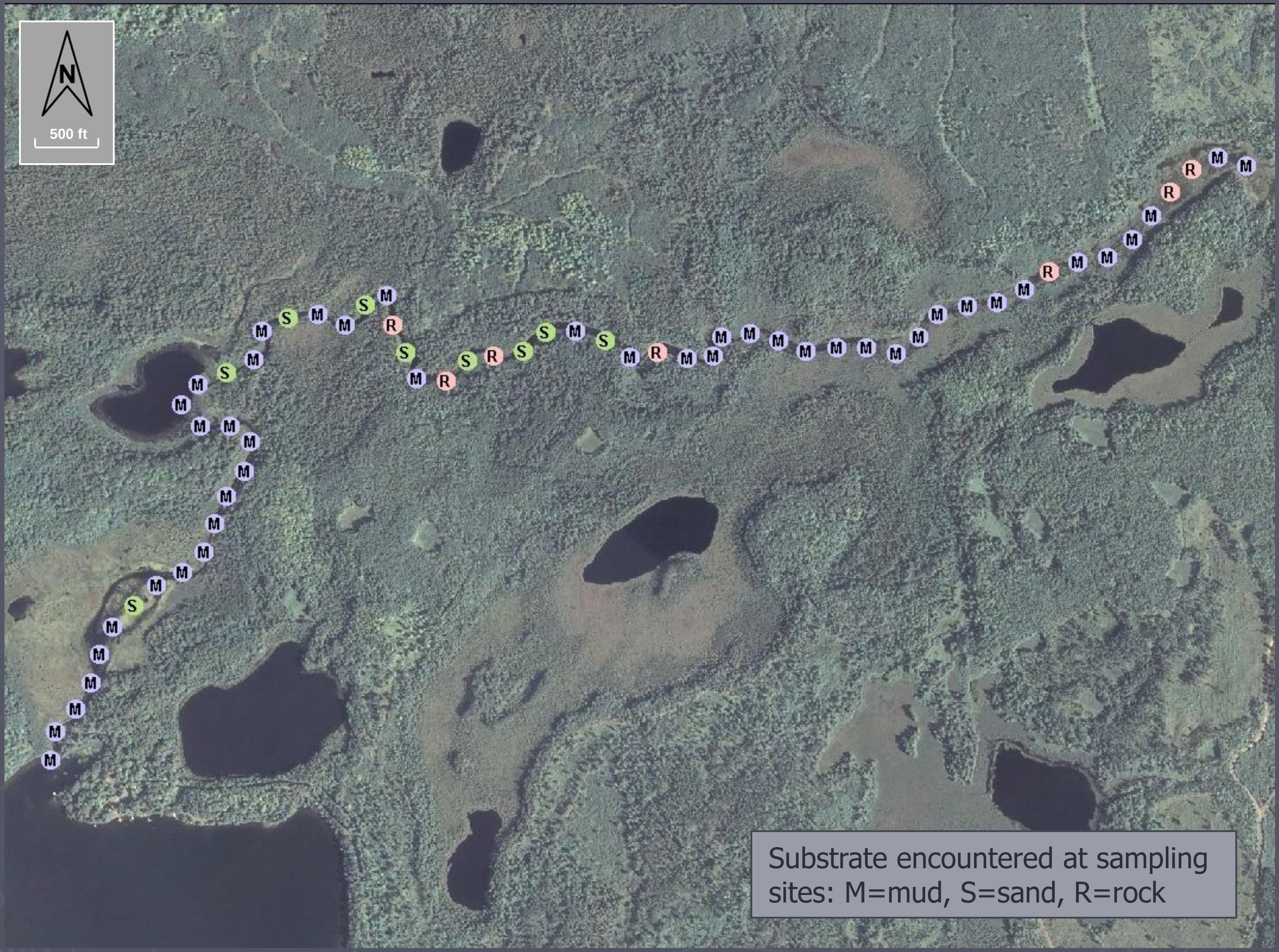


Figure 6. Rice Creek aquatic plant occurrences for 2010 point-intercept survey data.

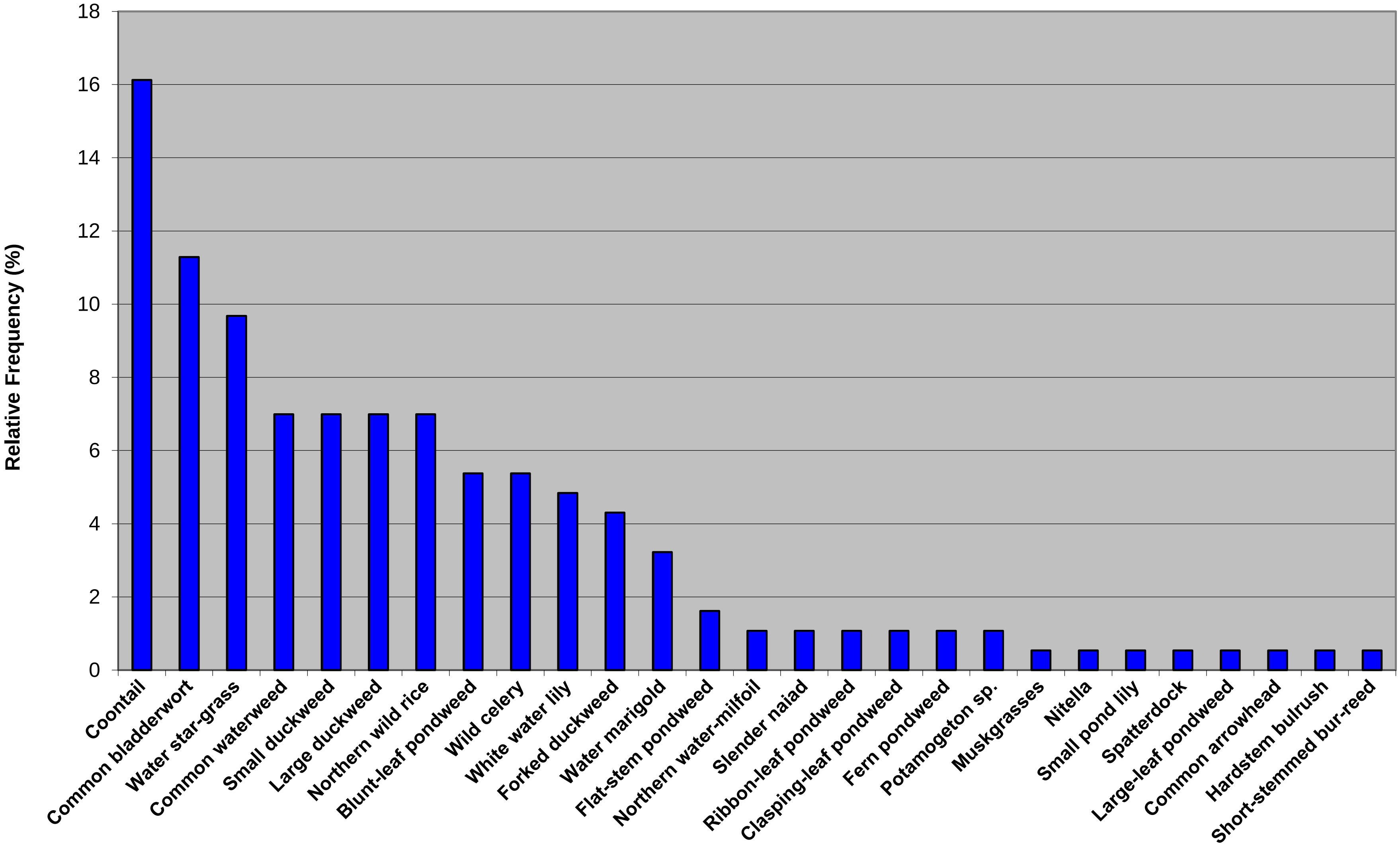
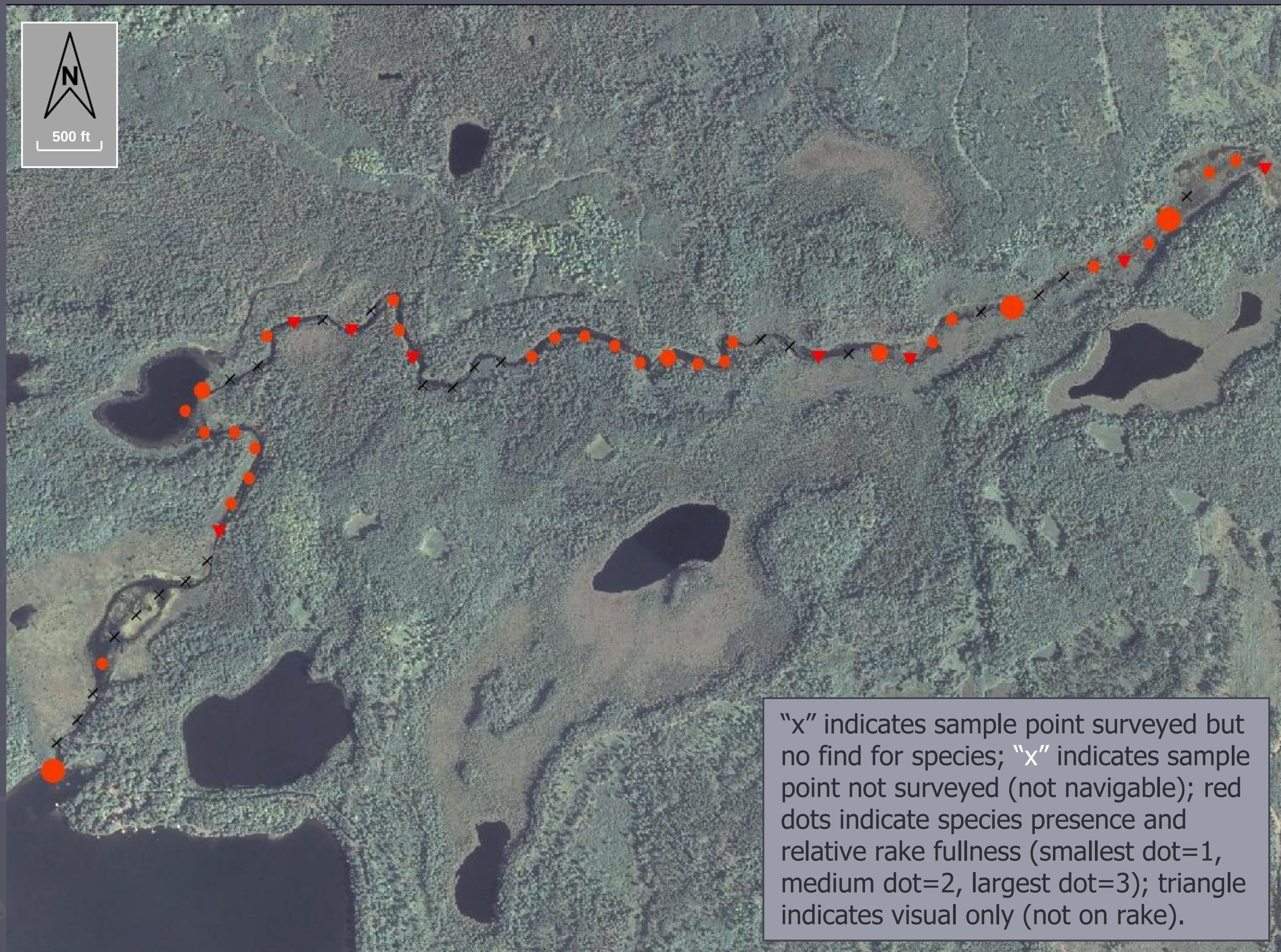
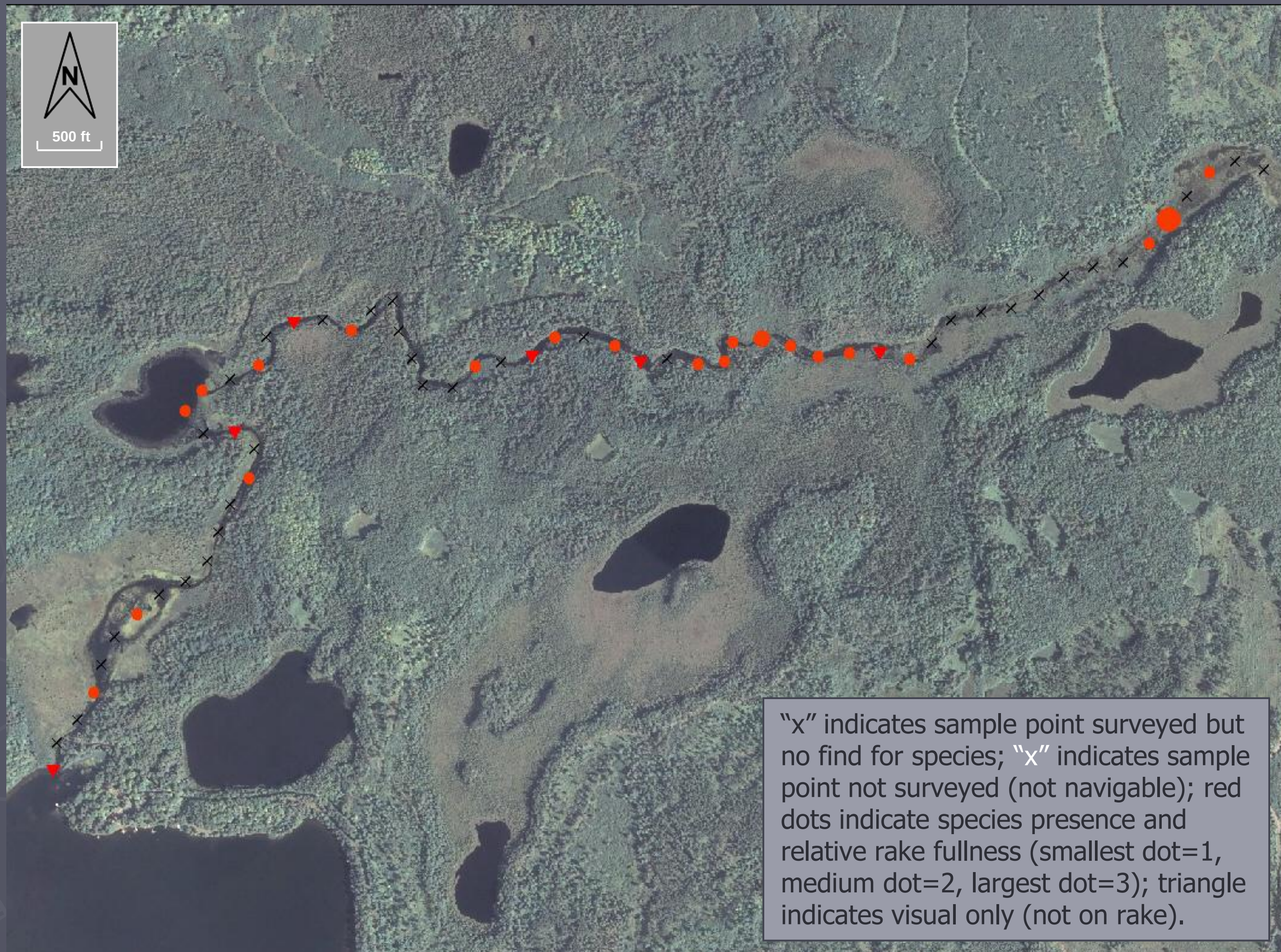


Figure 7. Distribution of plant species, Rice Creek (2010)



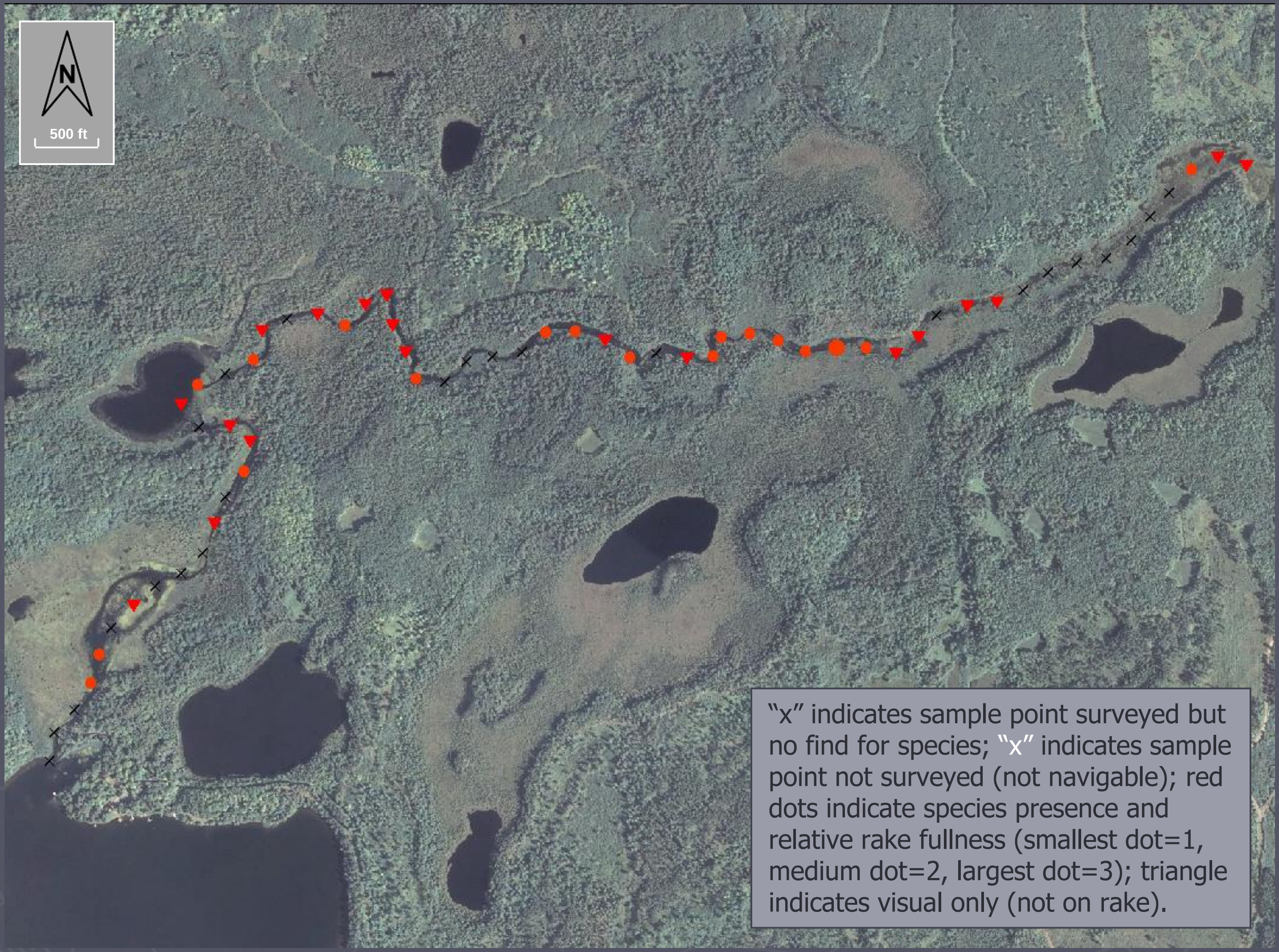
Ceratophyllum demersum (Coontail)

Figure 8. Distribution of plant species, Rice Creek (2010)



Utricularia vulgaris (Common bladderwort)

Figure 9. Distribution of plant species, Rice Creek (2010)



Heteranthera dubia (Water star-grass)

Figure 10. Distribution of plant species, Rice Creek (2010)

Chara sp. (Muskgrasses)

Figure 11. Distribution of plant species, Rice Creek (2010)

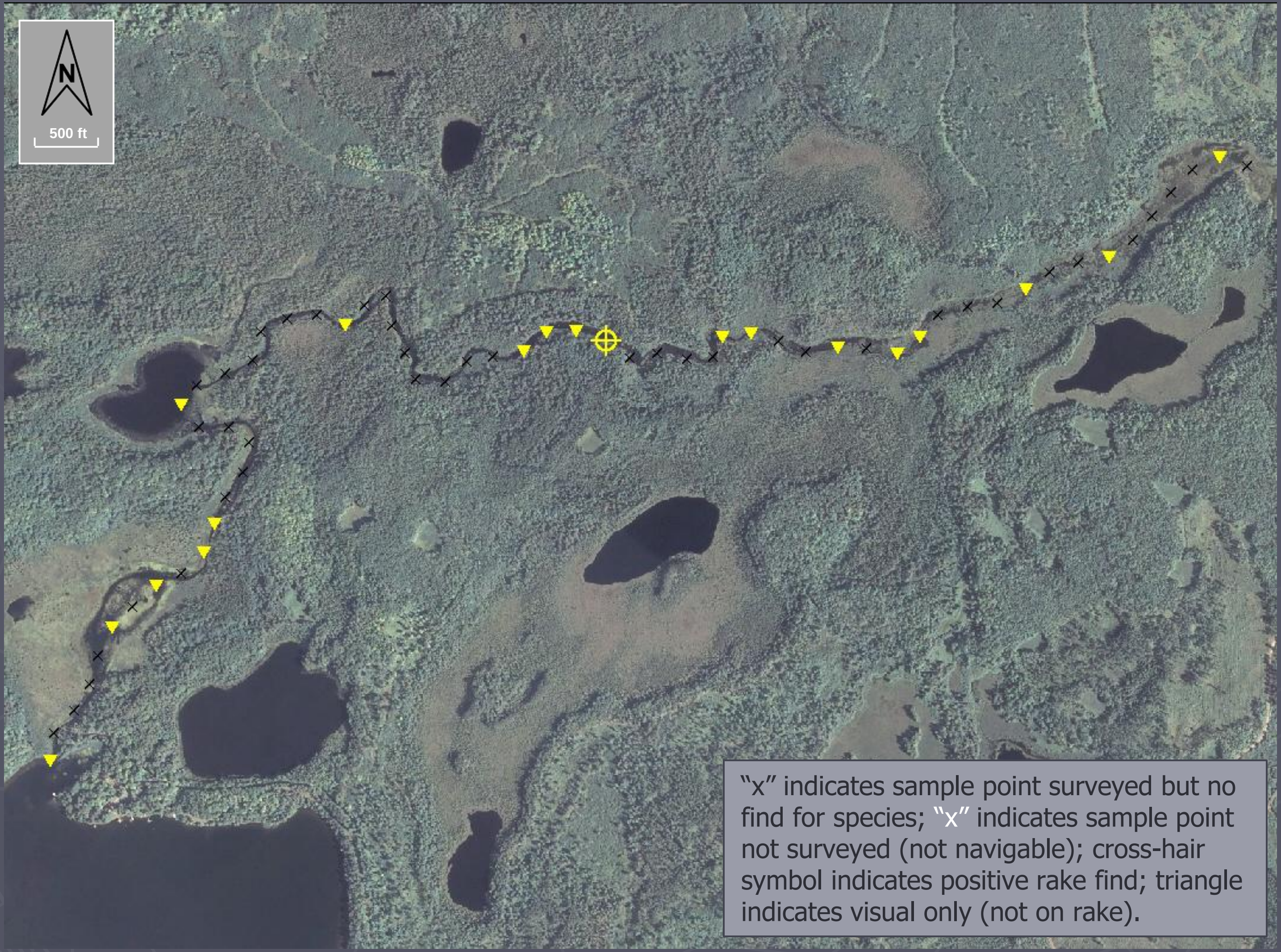
"x" indicates sample point surveyed but no find for species; "x" indicates sample point not surveyed (not navigable); cross-hair symbol indicates positive rake find; triangle indicates visual only (not on rake).

Nitella sp.

Figure 12. Distribution of plant species, Rice Creek (2010)

Nuphar microphylla (Small pond lily)

Figure 13. Distribution of plant species, Rice Creek (2010)



Nuphar variegata (Spatterdock)

Figure 14. Distribution of plant species, Rice Creek (2010)

Potamogeton amplifolius (Large-leaf pondweed)

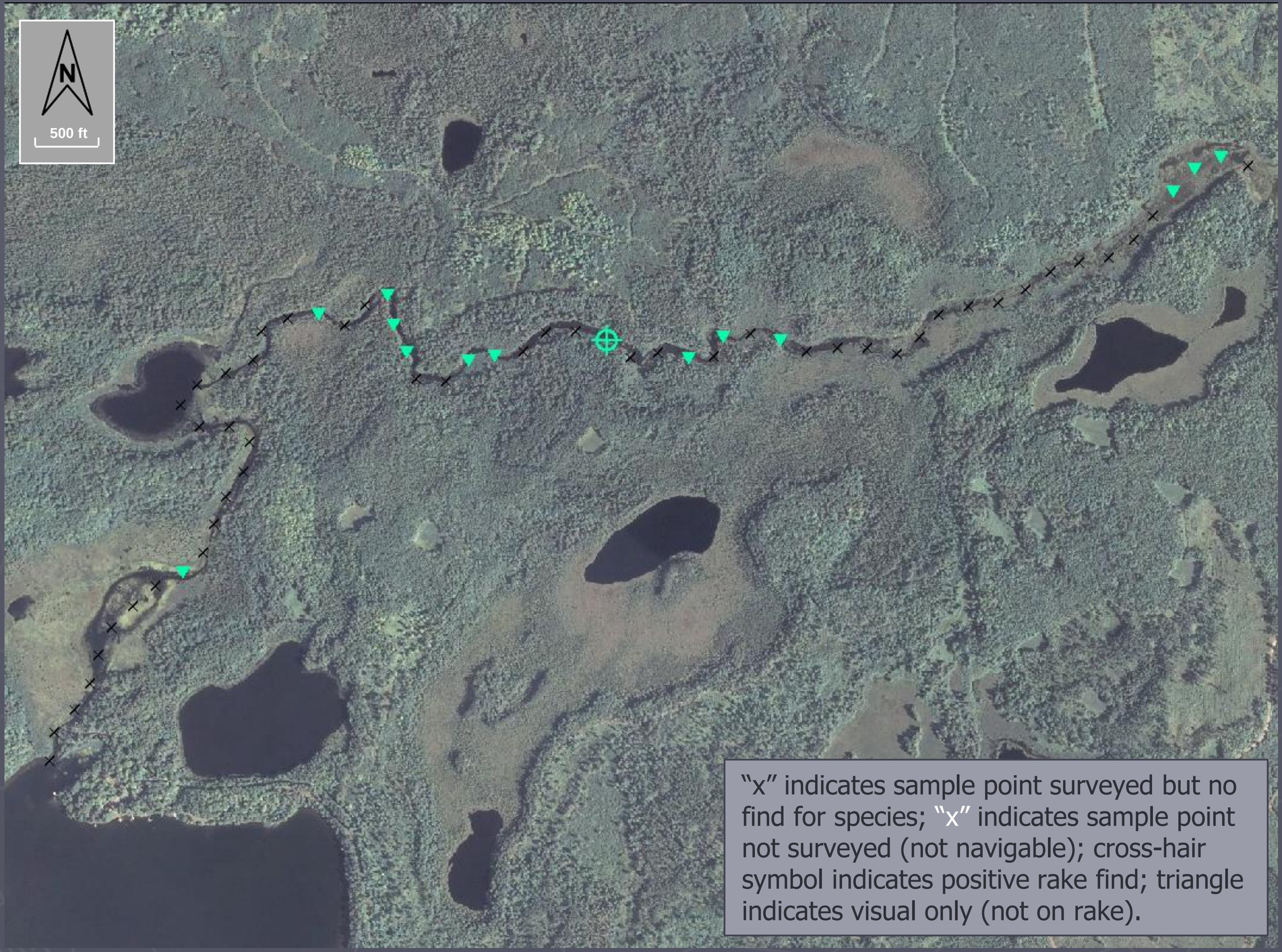
Figure 15. Distribution of plant species, Rice Creek (2010)

Sagittaria latifolia (Common arrowhead)

Figure 16. Distribution of plant species, Rice Creek (2010)

Schoenoplectus acutus (Hardstem bulrush)

Figure 17. Distribution of plant species, Rice Creek (2010)



Sparganium emersum (Short-stemmed bur-reed)

Appendix C

Review of Lake Water Quality

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Review of Rice Creek Water Quality

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Introduction

Rice Creek is 7.7 miles long and the average width is 25 feet. Rice Creek is part of the Manitowish River drainage and generally flows in a southeasterly direction from its source in Little Crooked Lake to Round Lake and Big Lake, and on to Island Lake. Rice Creek has slightly alkaline, clear water of high fertility. There are 800 acres of adjoining wetlands. Bottom materials consist of sand and some gravel. The stream bank is natural cover. Little is known of the fish species present in this stream (Black, 1963). For the purpose of this review, water quality data was obtained from Black in October 1963; from a site study conducted for aquatic vegetation on July 20, 1995; from the DNR SWIMS database (WDNR, Sept 2012), including Secchi depth data that was analyzed using the Landsat satellite, in 2009 (WDNR, June 2012); and from a macroinvertebrate study conducted on April 8, 2010. On August 16, 2010, White Water Associates sampled Rice Creek.

The Vilas County Land and Water Division (VCLWD) describes Rice Creek as follows: Rice Creek State Natural Area (SNA) features a two-mile stretch of creek surrounded by a large wetland complex of conifer swamp, boreal rich fen, sedge meadow, and northern wet-mesic forest. White cedar dominates the forest but cover is variable with balsam fir, black spruce, tamarack, black ash, red maple, white spruce, yellow birch, paper birch, and hemlock all present in the canopy. Thickets of mountain maple and alder are found in some areas. The understory is diverse and includes heart-leaf twayblade, blunt-leaved orchis, naked miterwort, three-leaved goldthread, yellow blue-bead lily, early coralroot, and striped coralroot. The slow, warm, hard-water Rice Creek has extensive lush beds of aquatic macrophytes including dense stands of wild rice. Just west of Keego Lake are two small, but high quality stands of old-growth hemlock with super-canopy white and red pines. The undeveloped, 24-acre lake is a deep, soft-water seepage lake with a maximum depth of 18 feet. Situated between Rice Creek and the rich conifer swamp is an undisturbed, diverse boreal rich fen, which is fed by a small seepage flowing through the westernmost portion. Characteristic species include American woolly-fruit sedge, bog birch, pitcher plant, bog buckbean, three-leaf Solomon's-seal, alpine cotton-grass, and marsh cinquefoil. Orchids are well-represented with at least seven species present. The special concern species, common bog-arrow grass, also occurs here. Rare animals include the bog copper butterfly, gray jay, and yellow-bellied flycatcher. Other birds include barred owl, red-breasted nuthatch, pine siskin, and winter wren. Rice Creek is owned by the DNR and was designated a State Natural Area in 2007 (VCLWD, 2011).

Temperature

Measuring the temperature of a creek at different depths will determine the influence it has on the physical, biological, and chemical aspects of the stream. Water temperature influences the rate of decomposition, nutrient recycling, lake stratification, and dissolved oxygen (D.O.) concentration. Temperature can also affect the distribution of fish species throughout a waterbody. Temperature data was not collected for Rice Creek, and future water quality sampling should include measurements of this parameter.

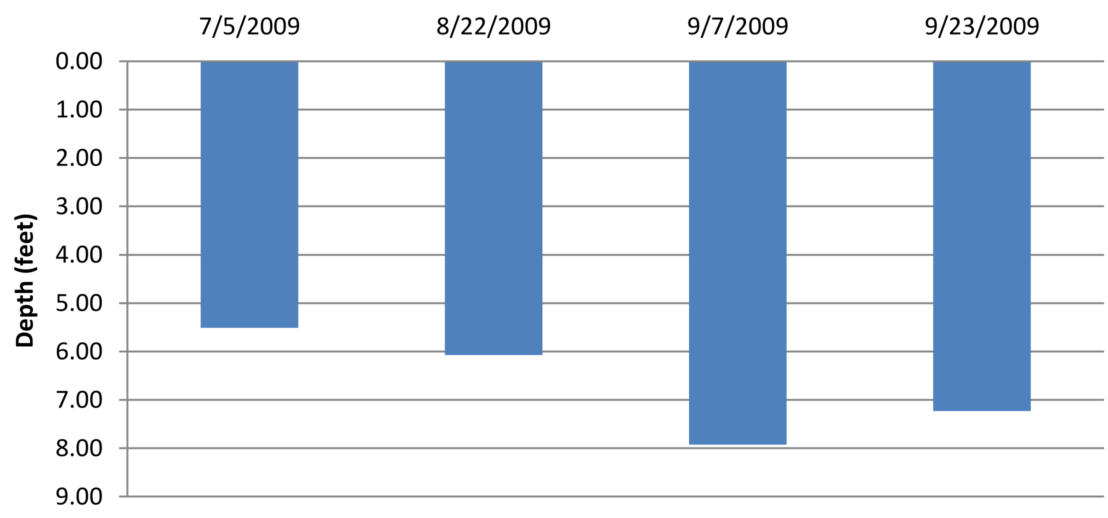
Dissolved Oxygen

The dissolved oxygen content of water is vital in determining presence of fish species and other aquatic organisms. Dissolved oxygen also has a strong influence on the chemical and physical conditions of a stream. The amount of dissolved oxygen is dependent on the water temperature, atmospheric pressure, and biological activity. Oxygen levels are increased by aquatic plant photosynthesis, but reduced by respiration of plants, decomposer organisms, fish, and invertebrates. The amount of dissolved oxygen available in a stream, particularly in the deeper parts, is critical to overall health. Because dissolved oxygen is not known for Rice Creek, future water sampling should include measurement of this parameter.

Water Clarity

Water clarity has two main components: turbidity (suspended materials such as algae and silt) and true color (materials dissolved in the water) (Shaw et al., 2004). Water clarity gives an indication of the overall water quality in a waterbody. Water clarity is typically measured using a Secchi disk (black and white disk) that is lowered into the water column on a tether. In simple terms, the depth at which the disk is no longer visible is recorded as the Secchi depth. Secchi depth was taken by a Landsat satellite in 2009 (WDNR, June 2012). Figure 1 illustrates the summer Secchi depths over several years and demonstrates year to year variability. Rice Creek had an average Secchi depth of 5.79 feet.

Figure 1. Rice Creek Secchi depths.



Turbidity

Turbidity is another measure of water clarity, but is caused by suspended particulate matter rather than dissolved organic compounds (Shaw et al., 2004). Particles suspended in the water dissipate light and reduce the depth at which the light can penetrate. This affects the depth at which plants can grow. Turbidity also affects the aesthetic quality of water. Water that runs off the watershed into a stream can increase turbidity by introducing suspended materials. Turbidity caused by algae is the most common reason for low Secchi readings (Shaw et al., 2004). In terms of biological health of a water ecosystem, measurements less than 10 Nephelometric Turbidity Units (NTU) represent healthy conditions for fish and other organisms. Rice Creek has not had turbidity sampled in the past, so future sampling should include measurements of this parameter. In 1963, Black stated that the water column appearance was "clear" (Black, 1963).

Water Color

Color of water is related to the type and amount of dissolved organic chemicals. Its main significance is aesthetics, although it may also influence light penetration and in turn affect aquatic plant and algal growth. Many waterbodies have naturally occurring color compounds from decomposition of plant material in the watershed (Shaw et al., 2004). Units of color are determined from the platinum-cobalt scale and are therefore recorded as Pt-Co units. Shaw states that a water color between 0 and 40 Pt-Co units is low. Water color was never recorded for Rice Creek, so future water sampling should include measurement of this parameter.

Water Level

When volunteers collect Secchi depth readings, they also record the water level as "high," "normal," or "low." Water level data was not collected for Rice Creek.

User Perception

When Secchi depth readings are collected, the volunteers record their perceptions of the water, based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the user would experience the water at that time. When interpreting the transparency data, we see that when the Secchi depth decreases, the rating of the water's physical appearance also decreases. These perceptions were never recorded for Rice Creek, and future sampling should include this data.

Chlorophyll *a*

Chlorophyll *a* is the photosynthetic pigment that makes plants and algae green. Chlorophyll *a* in streams is therefore an indicator of the amount of algae. Chlorophyll *a* concentrations greater than 10 µg/L are perceived as a mild algae bloom, while concentrations greater than 20 µg/L are perceived as a nuisance. Because chlorophyll *a* is not known for Rice Creek, future water sampling should include measurement of this parameter.

Phosphorus

While phosphorus occurs naturally in low concentrations, too much phosphorus in the water can promote growth of algae and cause our waters to look green or brown with globs of slime which have a strong odor. In 2010, phosphorous criteria were implemented to provide that Wisconsin streams should not have more than 100 parts per billion (0.1 mg/L) of phosphorous, and that Wisconsin streams should not have more than 75 parts per billion (0.075 mg/L). These numbers were developed by Wisconsin DNR scientists by evaluating the effects of phosphorous pollution on Wisconsin rivers, lakes, and streams. Rice Creek total phosphorus levels were collected on August 16, 2010 and had a value of 0.02 mg/L.

Trophic State

Trophic state is another indicator of water quality (Carlson, 1977). Waterbodies can be divided into three categories based on trophic state – oligotrophic, mesotrophic, and eutrophic. These categories reflect the water's nutrient and clarity levels (Shaw et al., 2004). Trophic state was not collected for Rice Creek, so future water quality sampling should include measurements of this parameter.

Nitrogen

Nitrogen is second only to phosphorus as an important nutrient for aquatic plant and algae growth (Shaw et al., 2004). Human activities on the landscape greatly influence the amount of nitrogen in a stream. Nitrogen may come from lawn fertilizer or septic systems near the waterbody or from agricultural activities in the watershed. Nitrogen may enter a waterbody from surface runoff or groundwater sources.

Nitrogen exists in streams in several forms. Rice Creek was analyzed on August 16, 2010 for Nitrate-Nitrite, and it was not detected. Nitrogen is a major component of all organic (plant and animal) matter. Decomposing organic matter releases ammonia, which is converted to nitrate if oxygen if present (Shaw et al., 2004). All inorganic forms of nitrogen can be used by aquatic plants and algae (Shaw et al., 2004). If these inorganic forms of nitrogen exceed 0.3 mg/L (as N) in spring, there is sufficient nitrogen to support summer algae blooms (Shaw et al., 2004). Elevated concentrations of ammonium, nitrate, and nitrate, derived from human activities, can stimulate or enhance the development, maintenance and proliferation of primary producers (phytoplankton, benthic algae, marcrophytes), contributing to the widespread phenomenon of the cultural (human-made) eutrophication of aquatic ecosystems (Camargo et al., 2007). The nutrient enrichment can cause important ecological effects on aquatic communities, since the overproduction of organic matter, and its subsequent decomposition, usually lead to low dissolved oxygen concentrations in bottom waters, and sediments of eutrophic and hypereutrophic aquatic ecosystems with low turnover rates (Camargo et al., 2007).

Biological Oxygen Demand

Biochemical oxygen demand (BOD) is another factor that affects D.O. concentrations in streams. BOD is the amount of oxygen consumed by microbial decomposition of organic waste, and is measured by the change in D.O. in a sealed water sample over a five-day incubation period (UWGB, 2012). High levels of organic pollution, such as from sewage treatment plants, agricultural runoff, or industrial wastes, can significantly increase the BOD in a stream. Relatively healthy streams will have a 5-day BOD reading of less than 2 mg/L, whereas polluted streams may approach 10 mg/L (UWGB, 2012). Because BOD data was not collected, future water quality sampling should include measurements of this parameter.

Chloride

The presence of chloride (Cl^-) where it does not occur naturally indicates possible water pollution (Shaw et al., 2004). Chloride does not affect plant and algae growth and is not toxic to aquatic organisms at most of the levels found in Wisconsin (Shaw et al., 2004). Chloride values were not collected for Rice Creek, so future water quality sampling should include measurements of this parameter.

Sulfate

Sulfate in water is primarily related to the types of minerals found in the watershed, and to acid rain (Shaw et al., 2004). Sulfate concentrations are noted to be less than 10 mg/L in Vilas County (Lillie and Mason, 1983). Sulfate values were not collected for Rice Creek, so future water quality sampling should include measurements of this parameter.

Conductivity

Conductivity is a measure of the ability of water to conduct an electric current. Conductivity is reported in micromhos per centimeter (µmhos/cm) and is directly related to the total dissolved inorganic chemicals in the water. Usually, values are approximately two times the water hardness, unless the water is receiving high concentrations of human-induced contaminants (Shaw et al., 2004). Streams in Northeast Wisconsin typically have conductivity values between 300 and 1800 µmhos/cm (UWGB, 2012). In 1963 the conductivity in Rice Creek was 118 µmhos/cm.

pH

The acidity level of a waterbody regulates the solubility of many minerals. A pH level of 7 is considered neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid, bog lakes to 8.4 in hard water, marl lakes (Shaw et al., 2004). Natural rainfall in Wisconsin averages a pH of 5.6. Some minerals become available under low pH (especially aluminum, zinc, and mercury) and can inhibit fish reproduction and/or survival. Mercury and aluminum are not only toxic to many kinds of wildlife, but also to humans (especially those that eat tainted fish). The pH scale is logarithmic, so every 1.0 unit change in pH increases the acidity tenfold. Water with a pH of 6 is 10 times more acidic than water with pH of 7. Streams in Northwest Wisconsin typically have pH values between 7.0 and 9.0; depending on the time of year that sampling occurs. The water quality standard for most surface waters in Wisconsin to support fish and aquatic life is a pH between 5.0 and 9.0, with no change greater than 0.5 units outside the estimated natural seasonal maximum and minimum values (UWGB, 2012). In 1963, Rice Creek had a pH of 7.3, which is alkaline.

Alkalinity

Alkalinity levels in a stream are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between creek water and these materials (Shaw et al., 2004). Alkalinity is important in a waterbody to buffer the effects of acidification from the atmosphere. Acid rain has long been a problem with waterbodies that have low alkalinity levels and high potential sources of acid deposition. Alkalinity was tested by Black in 1963, with a value of 57 mg/L $CaCO_3$. Based on this value, Rice Creek is not sensitive to acid rain, although new samples should be collected (Figure 2).

Figure 2. Sensitivity of Lakes to Acid Rain (Shaw et al., 2004)	
Sensitivity to acid rain	***Alkalinity value (mg/L or ppm $CaCO_3$)***
High	0-2
Moderate	2-10
Low	10-25
Non-sensitive	>25

Hardness

Hardness levels in a stream are also affected by the soil minerals, bedrock type in the watershed, and frequency of contact between creek water and these materials (Shaw et al., 2004). One method of evaluating hardness is to test for calcium carbonate ($CaCO_3$). Because no hardness data was collected for Rice Creek, future water quality sampling should include measurements of this parameter.

Calcium and Magnesium Hardness

The carbonate system provides acid buffering through two alkaline compounds: bicarbonate and carbonate. These compounds are usually found with two hardness ions: calcium and magnesium (Shaw et al., 2004). Calcium is the most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-bearing minerals in the lake watershed (Shaw et al., 2004). Aquatic organisms such as native mussels use calcium in their shells. The aquatic invasive zebra mussel tends to need calcium levels greater than 20 mg/L to maintain shell growth. Rice Creek had borderline calcium levels (19.2 mg/L) which is an indication that zebra mussels could flourish.

Sodium and Potassium

Sodium and potassium are possible indicators of human pollution in a waterbody, since naturally occurring levels of these ions in soils and water are very low. Sodium is often associated with chloride and gets into streams from road salting, fertilizations, and human and animal waste (Shaw et al., 2004). Potassium is the key component of commonly-used potash fertilizer, and is abundant in animal waste. Both of these elements are held by soils to a greater extent than is chloride or nitrate; therefore, they are not as useful as indicators of pollution impacts (Shaw et al., 2004). Although not normally toxic themselves, they provide a strong indication of possible contamination by more damaging compounds (Shaw et al., 2004). Because sodium and potassium levels are not known for Rice Creek, future water sampling should include measurement of this parameter.

Dissolved Organic Carbon

Dissolved Organic Carbon (DOC) is a food supplement, supporting growth of microorganisms, and plays an important role in global carbon cycle through the microbial loop (Kirchman et al., 1991). In general, organic carbon compounds are a result of decomposition processes from dead organic matter such as plants. When water contacts highly organic soils, these components can drain into streams and lakes as DOC. DOC is also extremely important in the transport of metals in aquatic systems. Metals form extremely strong complexes with DOC, enhancing metal solubility while also reducing metal bioavailability. Baseflow concentrations of DOC in undisturbed watersheds generally range from 1 to 20 mg/L carbon. DOC was not sampled in Rice Creek, so future sampling should include the parameter.

Silica

The earth's crust is abundant with silicates or other compounds of silicon. Water dissolves the silica and pH can be a key factor in regulating the amount of silica that is dissolved. Silica concentrations are usually within the range of 5 to 25 mg/L. Generally waterbodies that are fed by groundwater have higher levels of silica. Because silica levels are not known for Rice Creek, future water sampling should include measurement of this parameter.

Aluminum

Aluminum occurs naturally in soils and sediments. In low pH (acidic) environments aluminum solubility increases greatly. With a low pH and increased aluminum values, fish health can become impaired. This can have impacts on the entire food web. Aluminum also plays an important role in phosphorus cycling in waterbodies. When aluminum precipitates with phosphorus in creek sediments, the phosphorus will not dissolve back into the water column as readily. Because aluminum levels are not known for Rice Creek, future water sampling should include measurement of this parameter.

Iron

Iron also forms sediment particles that bind with and store phosphorus when dissolved oxygen is present. When oxygen concentration gets low (for example, in winter or in the deep water near sediments) the iron and phosphorus dissolve in water. This phosphorus is available for algal blooms. Because iron levels are not known for Rice Creek, future water sampling should include measurement of this parameter.

Manganese

Manganese is a mineral that occurs naturally in rocks and soil. In streams, manganese is usually in particulate form. When the dissolved oxygen levels decrease, manganese can convert from an insoluble form to soluble ions. A manganese concentration of 0.05 mg/L can cause color and staining problems. Because manganese levels are not known for Rice Creek, future water sampling should include measurement of this parameter.

Sediment

Stream sediments are sometimes analyzed for chemical constituents that they contain. This is especially true for potentially toxic metals such as mercury, chromium, selenium, and others. Sediments also tend to record past events as particulates settle down and become part of the sediment. Biological clues for the historic conditions in the creek can be gleaned from sediment samples. Examples include analysis of pollen or diatoms that might help understand past climate or trophic states in the waterbody. Sediment data was not collected for Rice Creek, and future sampling should include this parameter.

Total Suspended Solids

Total suspended solids are all particles suspended in the water. Silt, plankton, and wastes are examples of these solids and can come from runoff of agricultural land, erosion, and can be produced by bottom-feeding fish. As the suspended solid levels increase, they absorb heat from sunlight which can increase the water temperature. They can also block the sunlight that plants need for photosynthesis. These events can in turn affect the amount of dissolved oxygen in the creek. Waterbodies with total suspended solids levels less than 20 mg/L are considered "clear," while levels between 40 and 80 mg/L are "cloudy." The TSS values were not collected in Rice Creek, so future sampling should include measurement of this parameter.

Aquatic Invasive Species

During the 2011 survey, a single purple loosestrife (*Lythrum salicaria*) plant was found on a beaver dam. The plant was dug up and the entire plant was bagged and disposed of properly. Future monitoring for purple loosestrife is recommended so that this aggressive plant will not infest Rice Creek. It was also noted that a potentially aggressive native plant, water arum (*Calla palustris*), was seen in several locations along Rice Creek.

Northern Pike and Grass Pickerel Study

Rice Creek contains northern pike (*Esox americanus vermiculatus* Lesueur) along with several other warm water fish species. Five suspected northern pike X grass pickerel hybrids were captured in Rice Creek in the spring of 1970 and 1975 (Sterns and McKnight, 1977). Nine northern pike and six grass pickerel were also collected from Rice Creek in April, 1975. All of the fish were captured in 25-mm square mesh fyke nets. The population of grass pickerel in Rice Creek, and other portions of the Manitowish River System appear to be isolated, and may be caused by an accidental introduction during fish-transfer operations in the early 1940's (Kleinert and Mraz, 1966). Characteristic body markings and meristic counts, which were generally intermediate to identical counts on individuals of the parent species, suggested the identity of the hybrids (Table 1). The identification of one of the hybrids was verified by E.J. Crossman, of the Royal Ontario Museum of Toronto (Sterns and McKnight, 1977). The meristic counts for the northern pike, grass pickerel and the hybrids from Rice Creek were generally similar to published accounts, except for the lateral line scale counts which were lower than previously reported data (Crossman and Buss, 1965). The population of grass pickerel and hybrid northern pike X grass pickerel represents the northernmost known distribution for this species and hybrid in North America (Sterns and McKnight, 1977). The largest hybrids collected in Rice Creek were 585 mm (total length) long and weighed 1,400 g; and 581 mm long and weighed 1, 670 g, respectively. Both of these fish were 5 years old. The largest grass pickerel was a 5 year old female collected from Rice Creek and was 376 mm long and weighed 346 g. The largest ever reported in Canada was 328 mm long and weighed 204 g, while the largest known from the United States (Ohio) was 381 mm long and weighed 397 g (Trautman, 1957).

TABLE 1. CHARACTERISTIC FEATURES OF NORTHERN PIKE, NORTHERN PIKE × GRASS PICKEREL HYBRIDS, AND GRASS PICKEREL FROM RICE CREEK, WISCONSIN.

	Esox lucius	*E. lucius* × *E. americanus vermiculatus*	*E. a. vermiculatus*
Number of fish	9	6	6
Mean total length (mm)	396	541	297
Mean weight (g)	434	1,151	174
Left submandibular pores	5.0	4.7	4.0
Right submandibular pores	5.0	4.7	4.0
Left branchiostegal rays	15.0	14.2	12.5
Right branchiostegal rays	14.8	14.0	12.5
Left ventral rays	10.3	9.8	9.0
Right ventral rays	10.0	9.7	9.3
Left pectoral rays	14.7	15.2	14.0
Right pectoral rays	14.5	15.3	14.0
Principal dorsal rays	20	19	15.3
Principal anal rays	16.3	16.2	13.8
Lateral line scales (total)	119.3	114.7	110.0
Opercle scalation	½	½–¾	Full
Cheek scalation	Full	Full	Full
Subocular bar	Absent	Absent	Present
Gonads	Developed	Undeveloped	Developed
Body markings	Horizontal rows of light spots on a dark background	White, wormlike reticulations on dark background slanting forward from dorsal to ventral surface	Olive to dark brown wavy bars on a light back-ground

(Sterns and McKnight, 1977)

1995 Site Survey

A site survey was done on July 20, 1995 in Rice Creek by Susan Knight and June Dobberpuhl. They described Rice Creek as a slow moving, fairly wide creek as it empties out of Round Lake. The mouth was abundant with wild rice. The vegetation was abundant, and rich diversity indicates nutrient-rich waters. The stream was bordered by mostly second growth mixed hardwoods, fir, and pine. There was one large beaver dam and at least one beaver lodge. There was one fast riffle area downstream of the beaver dam. The river valley was quite wide with considerable wetlands. Much of the land nearest Round Lake was private land and was under logging operation. They said the logging operations were a serious threat to this creek and could cause significant changes in water temperature and clarity. Beaver activity could also change this creek because beaver dam removal changes the flow and speed of the creek. The plants that were found are listed in Table 2.

Table 2. Rice Creek Aquatic Plant Survey, 1995.

Rice Creek
Vilas County
T43N-R6E-S34
7/20/95

Ceratophyllum demersum
Chara
Elodea canadensis
Heteranthera dubia
Lemna minor
Lemna trisulca
Megalodonta beckii
Najas flexilis
Nitella
Nuphar pumilla
Nymphaea odorata
Pontederia cordata
Potamogeton alpinus
Potamogeton amplifolius
Potamogeton natans
Potamogeton obtusifolius
Potamogeton pectinatus
Potamogeton pusillus
Potamogeton richardsonii
Potamogeton zosteriformis
Ranunculus trichophyllus
Sagittaria latifolia
Sagittaria sp.
Scirpus validus
Sparganium chlorocarpum
Utricularia macrorhiza
Valisneria americana
Zizania aquatica

The Northern Highland-American Legion State Forest (B-27) looked at the Rice Creek Complex. The Rice Creek Complex contains excellent stands of both common and rare natural communities and aquatic features, supports a high concentration of rare plants and animals, and is large enough to maintain most, if not all, of the ecological processes and functions necessary for long-term maintenance.

Also in 1995, these communities, animals, and plants were looked at:

- Communities: Boreal Rich Fen 1995, Emergent Aquatic 1992, Lake-Deep, Soft Seepage 1997, Northern Mesic Forest 1997, and Northern Wet-Mesic Forest 1994.
- Animals: Bog Copper, Bull Frog, Gray Jay, and Yellow-Bellied Flycatcher were present.
- Plants: Common Bog Arrow-Grass, Downy Willow-Herb, Leafy White Orchis, Purple Clematis, Showy Lady’s Slipper, and the Swamp Pink were present and noted.

Macroinvertebrate Study Rice Creek

The benthic (bottom-dwelling) macroinvertebrates supported by a stream are an indicator of overall stream health due to their variable tolerance of pollution. Generally speaking mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), and riffle beetle larvae (Coleoptera) require a relatively pristine environment. Macroinvertebrates are highly tolerant of pollution, midge larvae (Diptera), snails (Gastropoda), leeches (Hirundinea), and aquatic worms (Oligochaeta). Because macroinvertebrates are relatively immobile, as compared to other aquatic organisms, they provide a quick snapshot of the condition of their surrounding habitat and the state of the stream's food web. High diversity indicates good water quality conditions, whereas presence of only pollution tolerant species or absence of macroinvertebrates suggests a degraded environment.

Hilsenhoff's Biotic Index (HBI) (Table 3) represents the average weighted pollution tolerance value of all arthropods present in a sample (excluding organisms either too immature or damaged to allow for correct identification, and organisms which have not been assigned a pollution tolerance value) (Lillie et al., 2003). The HBI in Rice Creek was 4.787 (Table 5) which gives Rice Creek a rating of "good."

Table 3. *Water quality ratings for HBI values (from Hilsenhoff 1987).*

HBI Value	Water Quality Rating	Degree of Organic Pollution
≤ 3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

(Lillie et al., 2003)

The FBI level in Rice Creek was 5.475 (Table 5), which is "fair" (Table 4) for a water quality rating. The degree of organic pollution was substantial.

Table 4. *Water quality index for the family-level HBI (from Hilsenhoff 1988a).*

FBI Value	Water Quality Rating	Degree of Organic Pollution
≤ 3.75	Excellent	Unlikely
3.76-4.25	Very Good	Possible Slight
4.26-5.00	Good	Some Probable
5.01-5.75	Fair	Fairly Substantial
5.76-6.50	Fairly Poor	Substantial Likely
6.51-7.25	Poor	Very Substantial
7.26-10.00	Very Poor	Severe

(Lillie et al., 2003)

Species Richness (SR) is based on a count of the number of species identified in a HBI sample. Generic Richness (GR) refers to the number of different genera represented in a biotic index subsample. EPT Generic Richness (EPTG) is the third richness metric that represents the number of distinct genera found only among the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a biotic index subsample. These three orders are separated from the other taxa because they generally represent the more organic pollution intolerant organisms present in rivers and streams (Lillie et al., 2003). The species richness in Rice Creek was 21, and the genera richness was 20 (Table 5).

Table 5. Summary of Macroinvertebrate Study, 4/8/2010.

HILSENHOFF'S BIOTIC INDEX (HBI)	4.787
INDEX OF BIOTIC INTEGRITY (IBI)	5.64846
SPECIES RICHNESS	21
GENERA RICHNESS	20
FAMILY-LEVEL BIOTIC INDEX (FBI)	5.475
SHANNON'S DIVERSITY INDEX	3.368
HBI Max 10	5.433
PERCENT SCRAPERS	0
PERCENT FILTERER	38
PERCENT SHREDDERS	22
PERCENT GATHERERS	41
PERCENT CHIRONOMIDAE INDIVIDUALS	33
PERCENT EPHEMEROPTERA, PLECOPTERA, TRICHOPTERA (EPT) - INDIVIDUALS	36
PERCENT EPT GENERA	15
Macroinvertebrate Family Rank 1	CHIRONOMIDAE
Macroinvertebrate Genus Rank 1	PROSTOIA
Macroinvertebrate Family Rank 2	SIMULIIDAE
Macroinvertebrate Genus Rank 2	SIMULIUM
Macroinvertebrate Family Rank 5	HEPTAGENIIDAE
Macroinvertebrate Genus Rank 5	PROSIMULIUM
Macroinvertebrate Family Rank 4	ASELLIDAE
Macroinvertebrate Genus Rank 4	RHEOTANYTARSUS
Macroinvertebrate Family Rank 3	NEMOURIDAE
Macroinvertebrate Genus Rank 3	CAECIDOTEA

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