Aquatic vegetation of Rush-Hen Lake

July and August, 2010

ID# 18-0311-00

Crow Wing County, Minnesota

Great Blue Heron in the southwest bay of Rush-Hen Lake, 2010.

Minnesota
DEPARTMENT OF NATURAL RESOURCES

Report by:
Stephanie Simon, Aquatic Biologist
Donna Perleberg, Aquatic Plant Ecologist

Minnesota Department of Natural Resources
Division of Ecological and Water Resources
1601 Minnesota Drive, Brainerd, MN 56401

Surveyors:
Stephanie Simon
Donna Perleberg
Zach Van Dyne, Intern, MnDNR Ecological and Water Resources, Brainerd
Nick Whichello, Intern, MnDNR Ecological and Water Resources, Brainerd

Emergent Plant Bed Mapping:
Stephanie Simon

A note to readers:
Text that appears in blue underline is a hypertext link to a web page where additional information is provided. If you are connected to the Internet, you can click on the blue underlined text to link to those web pages.

This report is also available online at:
http://www.dnr.state.mn.us/eco/pubs_aquatics/veg_reports.html

This report should be cited as:
Simon, S. and D. Perleberg. 2010. Aquatic vegetation of Rush-Hen Lake (ID# 18-0311-00), Crow Wing County, Minnesota, 2010. Minnesota Department of Natural Resources, Division of Ecological and Water Resources, 1601 Minnesota Drive, Brainerd, MN 56401. 25 pp.

Summary

Rush-Hen Lake is the 17th largest lake in Crow Wing County and part of the Whitefish Chain of Lakes. In 2010, surveyors conducted a lakewide assessment of Rush-Hen Lake's vegetation that included mapping major emergent and floating-leaf plant beds and sampling aquatic plant distribution and diversity at 558 sites.

The aquatic plant communities of Rush-Hen Lake include a diversity of native plants, with 39 species (types) recorded, including 7 emergent, 5 floating-leaved, 2 free-floating and 25 submerged species. Twenty-four of these species were recorded for the first time in the lake in 2010.

Within the 0-30 feet depth zone of Rush-Hen Lake, 81% of sites contained plants. Plants were most frequent in depths of 15 feet or less and the broadest zones of plants were found in the channels and in the protected bays.

Emergent and floating-leaf plants occupied 35 acres, but were restricted to water depths less than 9 feet. They were most frequent within the 0-5 feet zone, where they occurred in 21% of the sample sites. White waterlily (*Nymphaea odorata*) was the most common floating-leaf plant and occurred in 15% of the shallow water sites (0-5 feet). Other floating-leaf and emergent plants included yellow waterlily (*Nuphar variegata*), watershield (*Brasenia schreberi*), floating smartweed (*Persicaria amphibia*), wild rice (*Zizania palustris*) and cattails (*Typha* spp.).

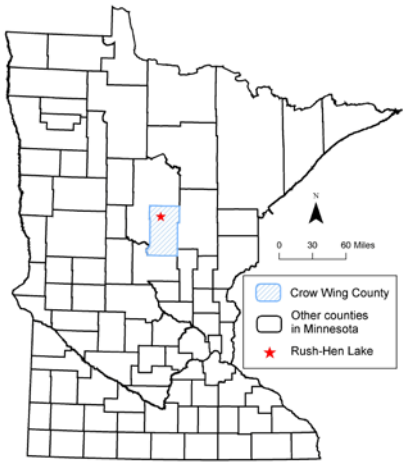
Submerged plants were found to a maximum depth of 30 feet but were sparsely distributed in depths greater than 20 feet. The submerged plant community was composed of a diversity of native species. Coontail was the most common species and occurred in 46% of the survey sites. It dominated the 16 to 20 feet depth zones where it was found in 77% of the sites. Other submerged plants that occurred in at least 20% of the sites were muskgrass (*Chara* sp.), northern watermilfoil (*Myriophyllum sibiricum*), southern naiad (*Najas guadalupensis*), wild celery (*Vallisneria americana*), flat-stem pondweed (*Potamogeton zosteriformis*), and Canada waterweed (*Elodea canadensis*).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was present in the lake but was a minor component of the plant community and was not found in any of the sample sites.

Introduction

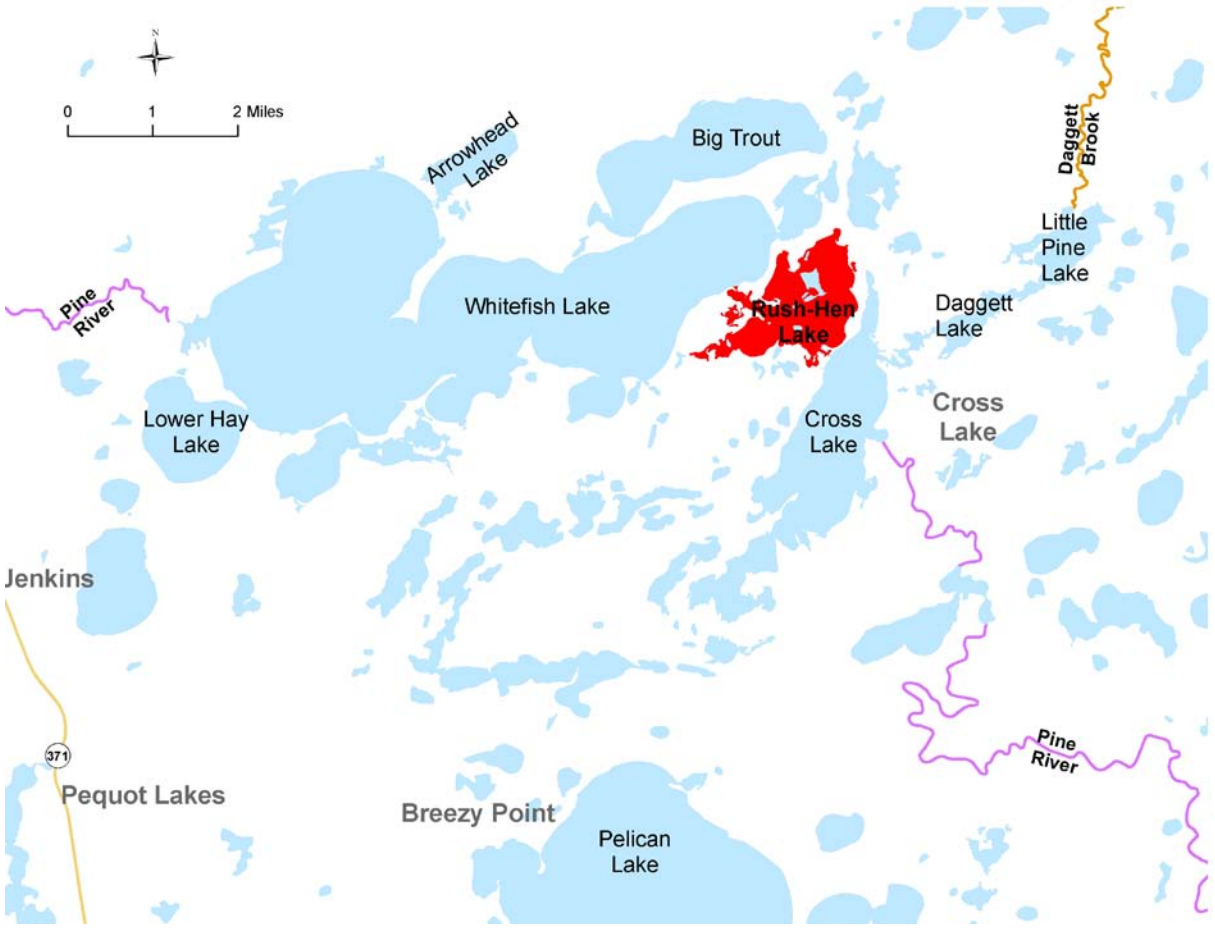
Rush-Hen Lake is located northwest of Cross Lake in Crow Wing County, north central Minnesota (Figure 1). It is a popular lake for fishing, boating and other water recreation activities. Rush-Hen is one of 14 waterbodies in the Whitefish Chain of Lakes and is located between Whitefish Lake and Cross Lake (Figure 2). These lakes were connected in 1886 when the Pine River Dam was completed and raised water levels making channels between the set of lakes. Most of the lakes are connected by the Pine River as it flows east through the chain.

Figure 1. Rush-Hen Lake, Crow Wing County, Minnesota.



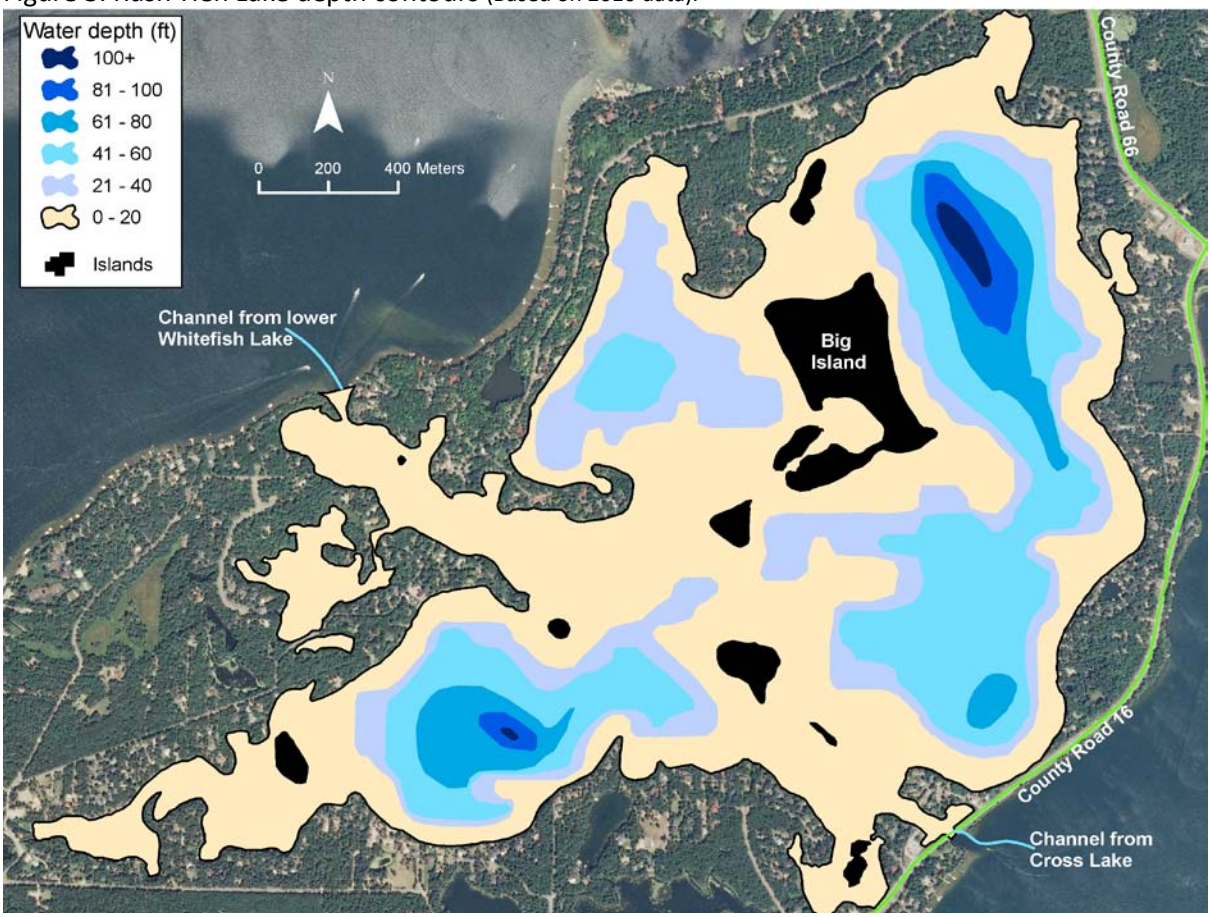
With a surface area of 858 acres, Rush-Hen Lake is the 17th largest lake in Crow Wing County and the 4th largest in the Whitefish Chain of Lakes. The lake is about 2 miles long, from west to east, with an average width of about 1

Figure 2. Rush-Hen Lake within the Whitefish Chain of lakes.



mile. It has 15 miles of shoreline with an irregular outline and numerous bays and islands. The largest island, Big Island, is 3 acres and primarily forested. Rush-Hen Lake was known by the Ojibwas as the "lake of the pine sticking out of the water" (Upham 1920), perhaps in reference to pine trees that may have grown on the numerous islands of this lake. The lake has a maximum depth of 105 feet and 58% of the lake is shallow (15 feet or less in depth) (Figure 3).

Figure 3. Rush-Hen Lake depth contours (Based on 2010 data).



Rush-Hen Lake is characterized as a mesotrophic (moderate nutrients), hard water lake, with relatively clear water. The Secchi disc transparency measures the depth to which a person can see into the lake and provides a rough estimate of the light penetration into the water column. Water clarity can fluctuate annually and depends on the amount of particles in the water. In 2009, mean summer (June through September) water clarity, as measured by Secchi disc readings, was 12 feet in Rush-Hen Lake (MPCA 2010). As a general rule, sunlight can penetrate to a depth of two times the Secchi depth and aquatic plants can grow to a depth of one and a half times the Secchi depth. Based on Secchi disk measurements alone, aquatic plants have the potential to reach depths of 18 feet in this lake.

The majority of Rush-Hen Lake shoreline is privately owned (and developed as residential homes). Public boat ramps exist on adjacent Whitefish and Cross lakes and boat navigation into Rush-Hen Lake is possible through channels from these connected lakes (Figure 3).

Historic aquatic plant community

Previous lakewide, aquatic plant surveys of Rush-Hen Lake were conducted in 1950 and 1990 (MnDNR Lake files). These surveys recorded a total of 22 aquatic plant species: 6 emergent, 3 floating-leaf and 13 submerged species (Appendix 1). Submerged plants were found to a depth of 20 feet and included muskgrass (*Chara* sp.), 6 different native pondweeds (*Potamogeton* spp.), northern watermilfoil (*Myriophyllum sibiricum*), coontail (*Ceratophyllum demersum*), bushy pondweed (*Najas flexilis*), and Canada waterweed (*Elodea canadensis*). Several wetland emergent plants were also recorded during the 1990 survey (Appendix 1). The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was not recorded during formal surveys but has been present in the Whitefish Chain since at least the 1940's.

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2010 plant population of Rush-Hen Lake. Specific objectives included:

1. Describe the shoal sediments of the lake
2. Estimate the maximum depth of rooted vegetation
3. Estimate the percent of the lake occupied by rooted vegetation
4. Record the aquatic plant species that occur in the lake
5. Estimate the abundance of common species
6. Develop distribution maps for the common species

Methods

Mapping floating-leaf and emergent vegetation beds

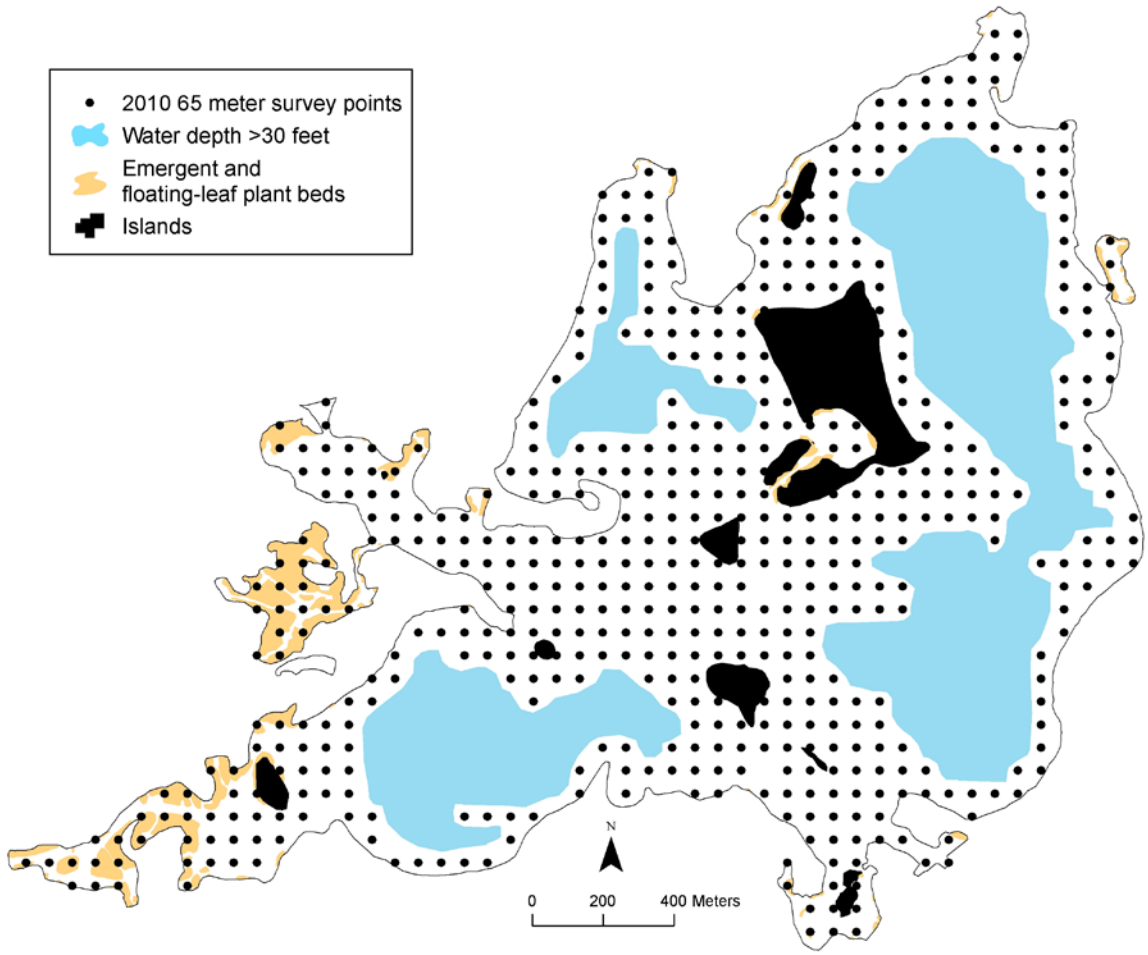
Beds of bulrush and other emergents occur in near-shore areas of Rush-Hen Lake. Waterlilies and cattails were mapped using 2008 Farm Service Administrative (FSA) true color aerial photographs. Field surveys were conducted in September 2010 to map bulrush, which is difficult to identify from aerial photos, and to verify photo-interpretation of other plant beds. Surveyors mapped bulrush beds in the field by motoring around the perimeter of each bed and recording their track with a handheld Global Positioning System (GPS) unit. Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage.

Lakewide vegetation survey

A lakewide vegetation survey was conducted using a point-intercept survey method (Madsen 1999, MnDNR 2009). Survey waypoints were created using a GIS computer program and downloaded into a handheld GPS unit. Survey points were placed across the entire lake and spaced 65 meters (213 feet) apart. In the field, surveyors sampled sites where water depth was

less than 31 feet. To minimize damage to vegetation, surveyors did not survey sites if they occurred in dense beds of emergent or floating-leaf plants. A total of 558 sites were surveyed in Rush-Hen Lake (Figure 4, Table 1).

Figure 4. 2010 vegetation survey sites on Rush-Hen Lake.



Rush-Hen Lake was surveyed on July 26, 29 and August 2, 12, 2010. The survey was conducted by boat and a GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments using a measured stick in water depths less than 7 feet and an electronic depth finder in deeper water.

Table 1. Survey effort by depth interval.

Water depth (feet)	Number of sample sites
0 to 5	161
6 to 10	256
11 to 15	31
16 to 20	29
21 to 25	38
26 to 30	43
Total	558

Substrate sampling

At each sample site where water depths were 7 feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2). If more than one substrate type was

found, surveyors recorded the most common type. Surveyors attempted to record a substrate description at the shore side of each row of points. If a sample site occurred near shore but in water depth greater than 7 feet, surveyors collected depth and vegetation data and then motored into shallower water and recorded the substrate type adjacent to the actual survey point.

Table 2. Substrate classes

muck	decomposed organic material
marl	calcareous material
silt	fine material with little grittiness
sand	diameter less than 1/8 inch
gravel	diameter 1/8 to 3 inches
rubble	diameter 3 to 10 inches
boulder	diameter over 10 inches

Plant sampling

Surveyors recorded all plant species found within a one square meter sample site at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the water surface (Figure 5). Any additional plant species found outside of sample sites were recorded as "present" in the lake but these data were not used in frequency calculations. Plant identification followed Crow and Hellquist (2000) and Flora of North America (1993+) and nomenclature followed MnTaxa (2010).

Figure 5. Survey rake.

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which the species occurred divided by the total number of sample sites. Frequency was calculated for the entire area from shore to 30 feet and sampling points were also grouped by water depth and separated into 6 depth zones for analysis (Table 1).

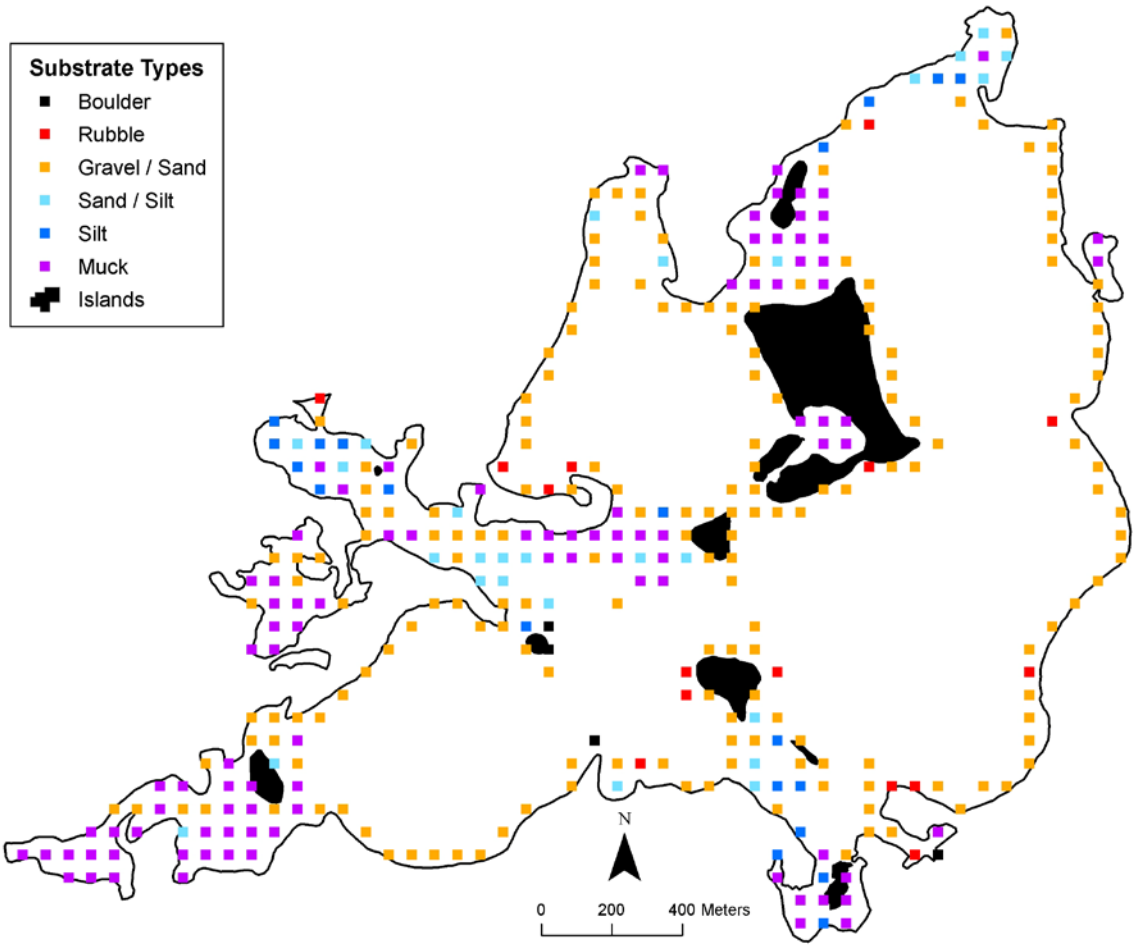
Example:
In Rush-Hen Lake there were 558 samples sites in the 0-30 feet depth zone.
Muskgrass occurred in 156 sites.
Frequency of Muskgrass in 0 to 30 feet zone = (156/ 558)*100 = 28%

Results and Discussion

Shoal Substrates

The shoal substrates of Rush-Hen Lake included hard substrates of sand, gravel, and rubble along the eastern shore, the perimeters of the islands and other exposed shores (Figure 6). Softer substrates of silt and muck were found in protected areas including small bays (Figure 6).

Figure 6. Shoal substrates of Rush-Hen Lake, 2010.



Types of plants recorded

A total of 39 native aquatic plant species (types) were recorded in Rush-Hen Lake including 7 emergent, 5 floating-leaved, 2 free-floating and 25 submerged plants (Table 3). Twenty-four of the 39 aquatic plants were recorded for the first time during the 2010 survey of Rush-Hen Lake.

Submerged plants included macroalgae, an aquatic moss and a diversity of rooted, flowering plants that can be grouped by leaf shape and size: dissected, small, narrow, broad and grass-leaved plants.

Three non-native plants were documented: The submerged plant, curly-leaf pondweed (*Potamogeton crispus*), and the emergent wetland plants, purple loosestrife (*Lythrum salicaria*) and reed canary grass (*Phalaris arundinaceae*).

The 2010 survey did not include an inventory of all shoreland plants but surveyors did record the presence of several emergent wetland plants (Appendix 1).

Table 3. Frequency of aquatic plants in Rush-Hen Lake, July and August, 2010.

[Frequency is the percent of sample sites in which a plant species occurred within the 0 to 30 ft water depth).

Life Form		Common Name	Scientific Name	Frequency (%) 558
SUBMERGED	Macroalgae	Muskgrass	*Chara* sp.	28
		Stonewort	*Nitella* sp.	<1
	Moss	Watermoss	*Not identified to genus*	5
	Dissected-leaf rooted plants	Coontail	*Ceratophyllum demersum*	46
		Northern watermilfoil	*Myriophyllum sibiricum*	42
		Water marigold	*Bidens beckii*	9
		White-water buttercup	*Ranunculus aquatilis*	8
		Greater bladderwort	*Utricularia vulgaris*	7
		Flat-leaf bladderwort	*Utricularia intermedia*	1
		Lesser bladderwort	*Utricularia minor*	1
		Humped bladderwort	*Utricularia gibba*	<1
	Small-leaf rooted plants	Southern naiad	*Najas guadalupensis*	41
		Canada waterweed	*Elodea canadensis*	24
		Bushy pondweed	*Najas flexilis*	9
	Narrow-leaf pondweeds	Narrow-leaf pondweed group[a]	*Potamogeton friesii*	15
		Sago pondweed	*Stuckenia pectinata*	7
	Broad-leaf pondweeds	White-stem pondweed	*Potamogeton praelongus*	13
		Clasping-leaf pondweed	*Potamogeton richardsonii*	8
		Illinois pondweed	*Potamogeton illinoensis*	7
		Large-leaf pondweed	*Potamogeton amplifolius*	7
		Variable pondweed	*Potamogeton gramineus*	3
		Curly-leaf pondweed (I)	*Potamogeton crispus*	<1
	Grass-leaf rooted plants	Wild celery	*Vallisneria americana*	27
		Flat-stem pondweed	*Potamogeton zosteriformis*	25
		Water star-grass	*Heteranthera dubia*	7
		Robbin's pondweed	*Potamogeton robbinsii*	3
Free-floating	Duckweeds	Star duckweed	*Lemna trisulca*	6
		Water meal	*Wolffia* sp.	<1

I = introduced species

[a] Species in this genus were grouped together for analysis because field identification to the species level was difficult. At least two species of narrow-leaf pondweeds were identified in the lake: Fries' pondweed (*Potamogeton friesii*) and small pondweed (*Potamogeton pusillus*). Additional narrow-leaf pondweed species (*Potamogeton* spp.) may have also been present.

Table 3 (cont). Frequency of aquatic plants in Rush-Hen Lake, July and August, 2010.
[Frequency is the percent of sample sites in which a plant species occurred within the 0 to 30 ft water depth).

Life Form	Common Name	Scientific Name	Frequency (%)
			558
FLOATING-LEAVED	White waterlily	*Nymphaea odorata*	4
	Yellow waterlily	*Nuphar variegata*	1
	Floating-leaf pondweed	*Potamogeton natans*	1
	Watershield	*Brasenia schreberi*	1
	Water smartweed	*Persicaria amphibia*	<1
EMERGENT (includes only in-lake emergents and not wetland plants)	Needlegrass	*Eleocharis acicularis*	1
	Burreed	*Sparganium* sp.	<1
	Bulrush	*Schoenoplectus* sp.	*Present
	Arrowhead	*Sagittaria* sp.	*Present
	Arum-leaved arrowhead	*Sagittaria cuneata*	*Present
	Narrow-leaved cattail[b]	*Typha* spp.	*Present
	Wild rice	*Zizania palustris*	*Present

I = introduced species
*Present = found in lake but did not occur in any sample sites
[b] narrow leaf cattail was identified in survey but it is not known whether this included *Typha angustifolia* and/or *Typha* x *glauca*.

Distribution of aquatic plants

Plants were found to a depth of 30 feet in Rush-Hen Lake and in the 0-30 feet depth zone, 81% of the survey sites contained vegetation. Vegetation was most common in the 0 to 15 feet depth zone, where 97% of sites contained plants (Figure 7). Plant abundance declined with increasing water depth and in depths of 26 to 30 feet, only 5% of sites contained plants.

Plants were distributed around the entire shoreline and the broadest zone of vegetation occurring in the shallow central portion of the lake and the southwest bay (Figure 8). Along shore where the depth contours are close together, vegetation beds were narrow and extended less than 100 meters lakeward.

Figure 7. Aquatic plant frequency vs. water depth.

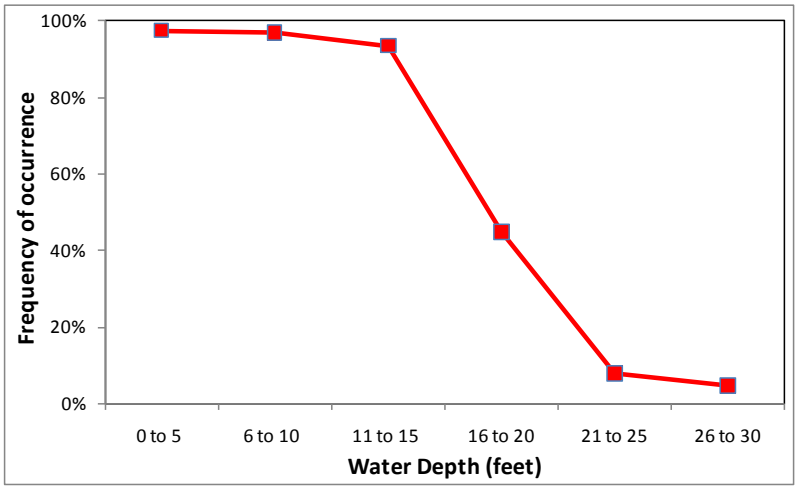
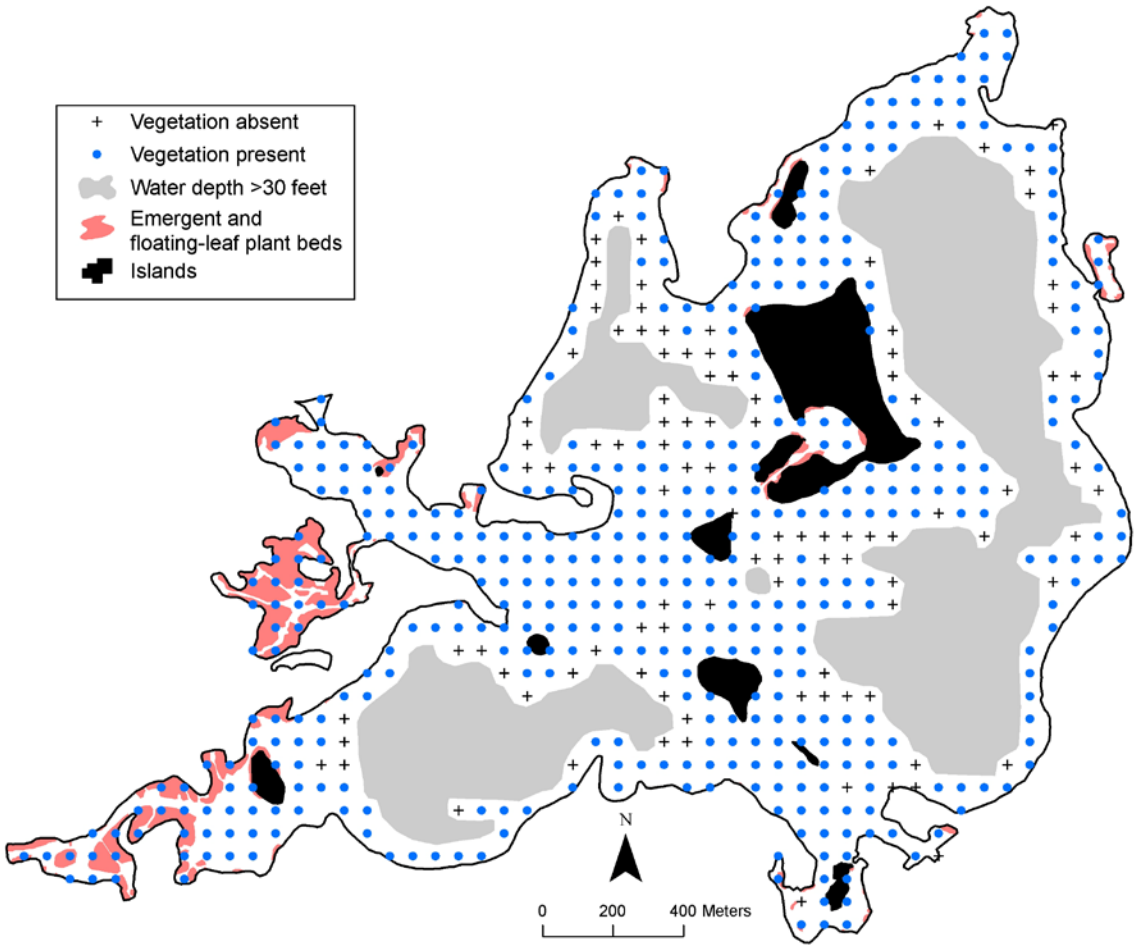


Figure 8. Distribution of aquatic plants, Rush-Hen Lake 2010



Plant communities richness

The highest number of plant species was found in shallow water, from shore to a depth of 5 feet (Figure 9). Most emergent and floating-leaf plants were restricted to shallow water (less than 6 feet). Most submerged species were found in depths of 10 feet and less and only 4 species (muskgrass, stonewort, coontail, and southern naiad) occurred in depths greater than 20 feet. Southern naiad was the only species found in depths greater than 25 feet.

The number of plant species found at each one square meter sample site ranged from 0 to 13 with a mean of 4 species per site. Sites of high species richness (4 or more species per site) occurred at numerous locations around the lake (Figure 10).

Figure 9. Number of plant species vs. water depth, Rush-Hen Lake, 2010.

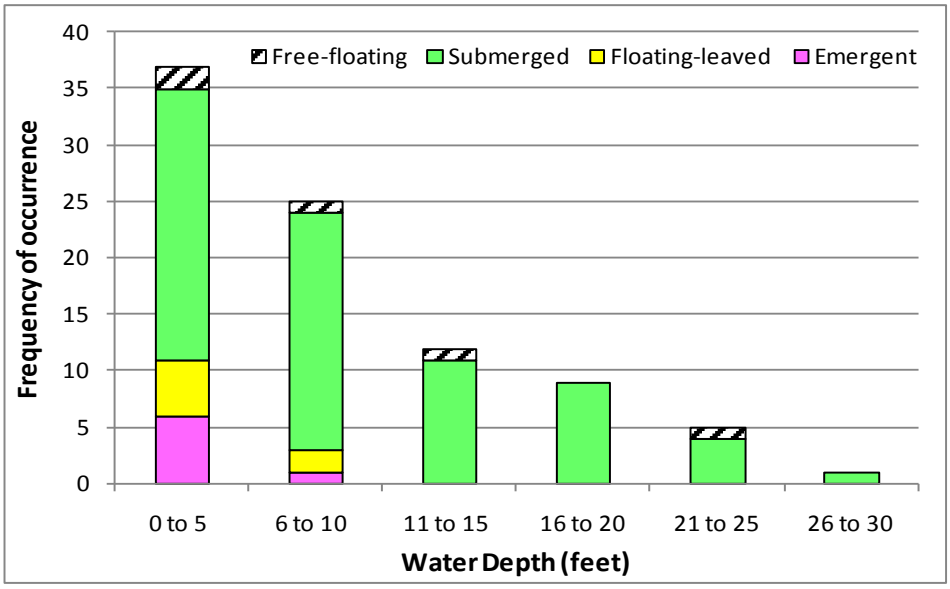
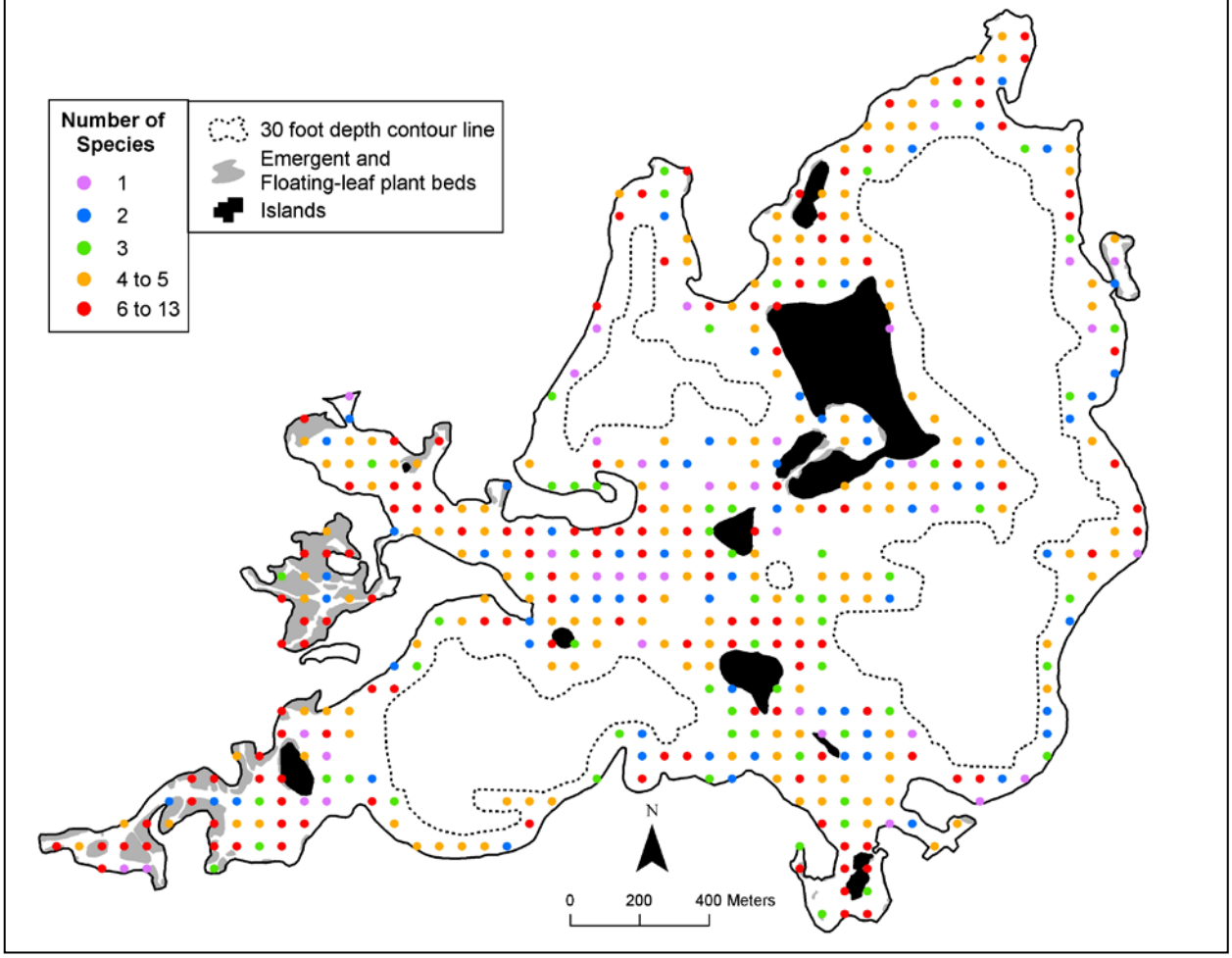


Figure 10. Number of species per site, Rush-Hen Lake 2010.

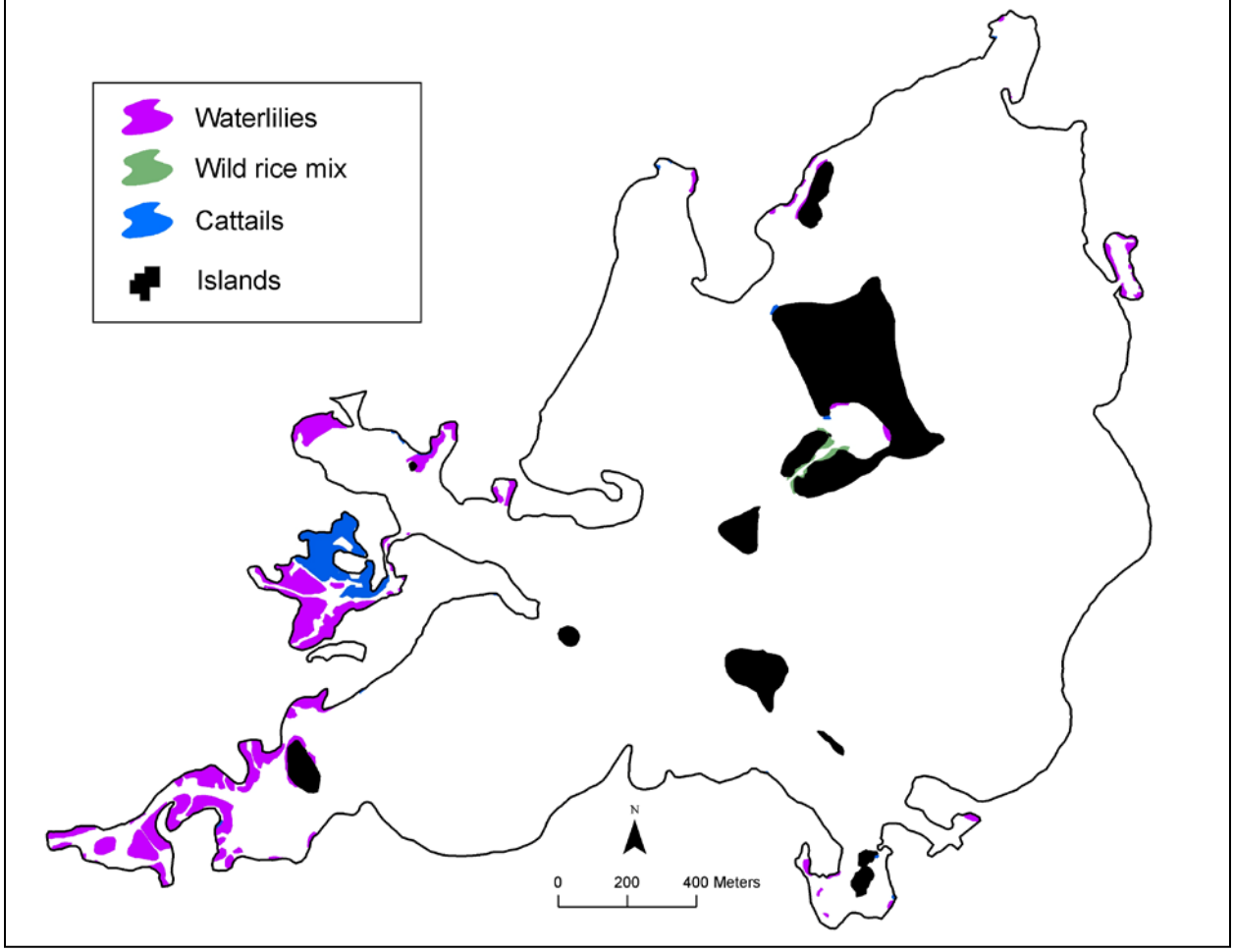


Emergent and Floating-leaf Plant Beds

Emergent and floating-leaf aquatic plants offer food, cover and nesting material for waterfowl, marsh birds and muskrats, and provide shelter and shade for insects, young fish, and amphibians. The root systems of emergent and floating-leaf plants protect shorelines against erosion by buffering the wave action and by holding soil in place.

Approximately 35 acres of emergent and floating-leaf plant beds were mapped in Rush-Hen Lake. Emergent and floating-leaf plants were restricted to 9 feet and less, but were common from 0 to 5 feet where 21% of the Rush-Hen Lake sites contained at least one emergent or floating-leaf plant. Plant beds were classified by the dominant species (Figure 11).

Figure 11. Emergent and floating-leaf plant beds of Rush-Hen Lake, 2010.



Floating-leaf plants are rooted in the lake bottom and most of their leaves float on the water surface; they often produce showy flowers that emerge out of the water. In Rush-Hen Lake, these plants included white waterlily (*Nymphaea odorata*; Figure 12), yellow waterlily (*Nuphar variegata*; Figure 13) watershield (*Brasenia schreberi*; Figure 14), floating smartweed (*Persicaria amphibia*; Figure 15) and floating-leaf pondweed (*Potamogeton natans*). Waterlily beds often contained scattered burreed plants, and submerged plants (Figure 16). Waterlily beds, or

mixed beds of waterlilies and emergent plants, covered about 27 acres in Rush-Hen Lake (Figure 11).

Figure 12. White waterlily

Figure 13. Yellow waterlily

Figure 14. Watershield

Figure 15. Floating smartweed

Figure 16. Waterlilies and burreed in Rush-Hen Lake.

Figure 17. Cattails

Cattails (*Typha* spp.; Figure 17) are emergent plants that are found in lakes and marshes throughout Minnesota. They are perennial plants that emerge from a spreading rhizome and they have long and narrow leaves. Cattails provide shelter and food for many different kinds of fish and bird species. A total of 7 acres of cattails were mapped in Rush-Hen Lake and the largest bed was in the western bay (Figure 11).

Figure 18. Emergent stage of Wild Rice

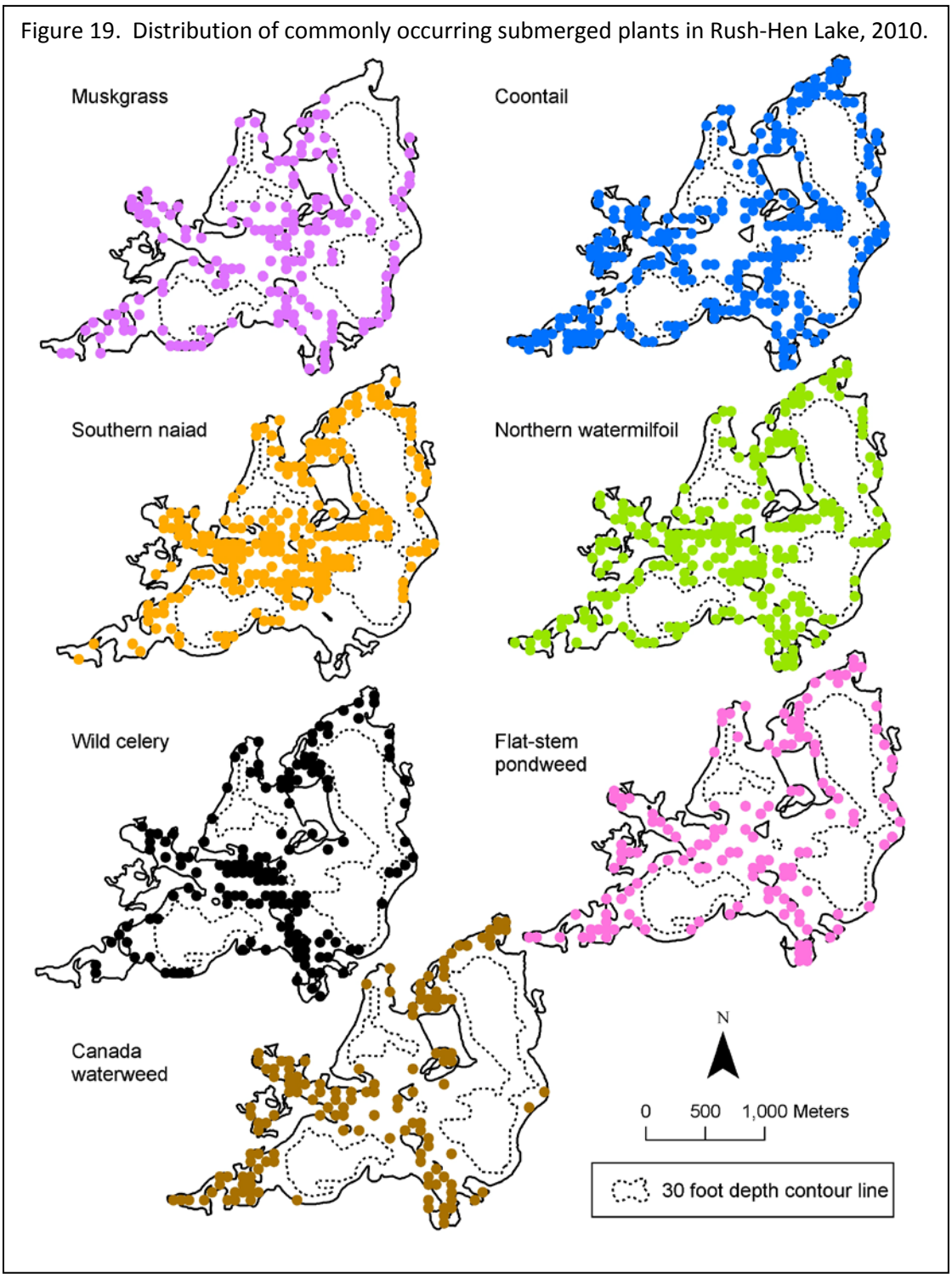
Wild rice (*Zizania palustris*) is an annual plant that germinates each year from seed that fell to the lake bottom in the previous fall. The plant begins growth underwater and then forms a floating-leaf stage before becoming fully emergent (Figure 18). It prefers soft substrates (Lee 1986, Nichols 1999) and generally requires moving water for growth (MnDNR 2008). Wild rice is susceptible to disturbance because it is weakly rooted to the lake bottom. In addition to its ecological value as habitat and food for wildlife, wild rice has important cultural and economic values in Minnesota (MnDNR 2008). This valuable plant is increasingly threatened by factors such as lakeshore development and increased water recreational use (MnDNR 2008).

In Rush-Hen Lake, wild rice did not occur in any sample sites but one acre of wild rice was mapped between the two islands on the north side of the lake (Figure 11). This site of wild rice is described as a mixed bed because it also contained bulrush, waterlilies and other emergent vegetation.

Submerged aquatic plants

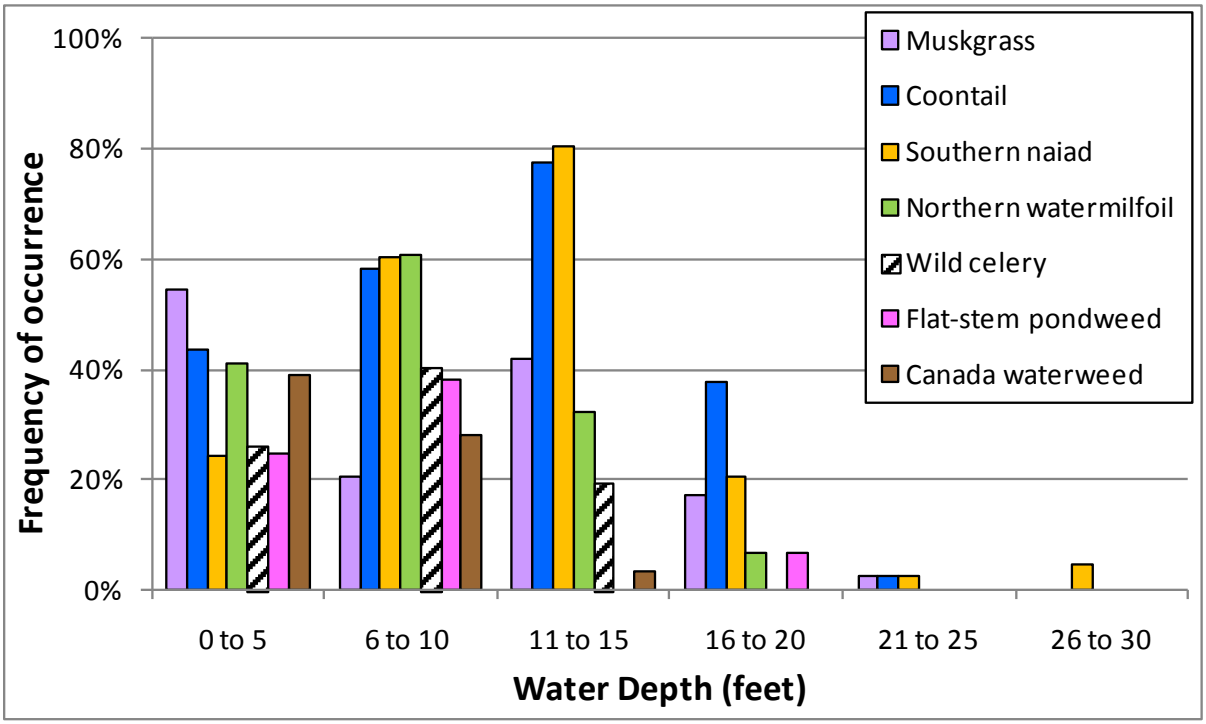
Submerged plants occurred in 81% of the Rush-Hen Lake sample sites and were found throughout the littoral zone (Figure 19). The most frequently occurring species were muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), southern naiad (*Najas guadalupensis*), northern watermilfoil (*Myriophyllum sibiricum*), wild celery (*Vallisneria americana*), flat-stem

Figure 19. Distribution of commonly occurring submerged plants in Rush-Hen Lake, 2010.



pondweed (*Potamogeton zosteriformis*), and Canada waterweed (*Elodea canadensis*). These species were all common in the 0-10 feet zone, where they each occurred with a frequency of at least 20%. In deeper water, muskgrass, coontail and southern naiad were the dominant species (Figure 20).

Figure 20. Common submerged plants at each water depth interval, Rush-Hen Lake 2010.



Submerged native macroalgae

Algae are primitive forms of plants that do not form true roots, flowers or vascular tissue. They range in size from single cell to giant seaweed. Freshwater algae that live in Minnesota lakes include tiny, free-floating planktonic algae, filamentous algae, and macroalgae. Macroalgae often resemble rooted plants and provide similar habitat and water quality benefits and were therefore included in this survey.

Muskgrass (*Chara* sp.; Figure 21) is a freshwater macroalgae and is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because muskgrass does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low "carpets" on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important fish spawning and nesting habitat.

Figure 21. Muskgrass

In Rush-Hen Lake, muskgrass occurred with a frequency of 29% (Table 3). It occurred along the shoreline of Rush-Hen Lake (Figure 19) and was the dominant plant in the 0 to 5 feet depth zone where it was found in 55% of the sites (Figure 20).

Submerged native rooted plants

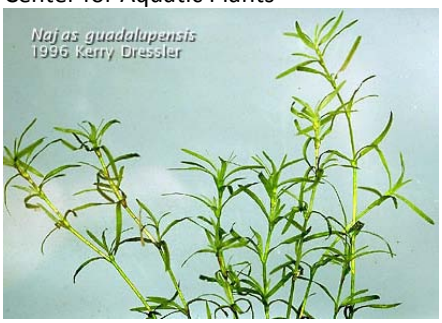
As a group, rooted submerged plants occurred in 78% of the Rush-Hen Lake sample sites and often co-occurred with muskgrass (Figure 19).

Coontail (*Ceratophyllum demersum*; Figure 22) grows entirely submerged and its roots are only loosely anchored to the lake bottom. It is adapted to a broad range of lake conditions and is tolerant of higher turbidity and can grow in muck substrates. Coontail is perennial and can over winter as a green plant under the ice and then begins new growth early in the spring, spreading primarily by stem fragmentation. The finely divided leaves of this plant provide a home for insects valuable as fish food. Coontail was found in 46% of the sample sites in Rush-Hen Lake (Table 3) and was most common in the 11 to 15 feet depth zone where it occurred in 77% of the sites (Figure 20).

Figure 22. Coontail

Southern naiad (*Najas guadalupensis*; Figure 23) has not been reported in many Minnesota lakes but it is native to the state. It closely resembles a related submerged species, bushy pondweed (*Najas flexilis*) and it can be difficult to distinguish the two species. Bushy pondweed is an annual plant that grows each year from seed. Southern naiad can sprout from seed and overwinter as a perennial plant. Both species grows low in the water column and produce seeds and foliage that provide important duck food and good fish cover.

Figure 23. Southern naiad. Photo: Kerry Dressler ©1996 Univ. of Florida Center for Aquatic Plants



Both plants occurred in Rush-Hen Lake but southern naiad was more frequent, occurring in 41% of the sample sites compared to 9% occurrence of bushy pondweed (Table 3). Southern naiad was frequently found throughout the littoral zone (Figure 19). It was most common in the 11 to 15 feet depth zone where it was found in 81% of the sites (Figure 20).

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 24) is a native, submerged plant. It is a rooted perennial with finely dissected leaves. Particularly in depths less than 10 feet, this plant may reach the water surface and its flower stalk will extend above the water surface. It spreads primarily by stem fragments and

Figure 24. Northern watermilfoil

Photo by: Andrew Hipp (UW Madison-Wisc State Herbarium)

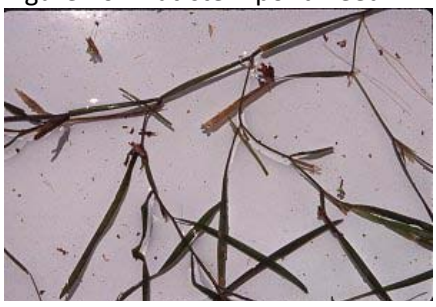
over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes. For information on how to distinguish the native northern watermilfoil from the non-native, Eurasian watermilfoil, click here: identification. Northern watermilfoil was found in 42% of the Rush-Hen Lake sites (Table 3). Northern watermilfoil was found throughout the littoral zone of Rush-Hen Lake (Figure 19) and was the most frequently occurring plant in the 6 to 10 feet depth zone where it occurred in 61% of the sites (Figure 20).

Wild celery (*Vallisneria americana*; Figure 25) is a rooted, perennial submerged plant that resembles ribbon-leaved pondweeds. Unlike the pondweeds that have branches of leaves, water celery leaves all arise from the base of the plant. Beds of wild celery provide food and shelter for fish and all parts of the plant are consumed by waterfowl, shorebirds and muskrats (Borman et al. 2001). Wild celery is a particularly important food source for canvasback ducks (Varro 2003). Wild celery occurred in 27% of the sample sites (Table 3). Wild celery was found throughout the littoral zone of Rush-Hen Lake (Figure 19) and was found to a depth of 13 feet (Figure 20).

Figure 25. Wild celery

Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 26) is one of nine native pondweeds found in Rush-Hen Lake. Pondweeds (*Potamogeton spp. and Stuckenia spp.*) are primarily submerged, perennial plants that are anchored to the lake bottom by underground rhizomes. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. Pondweed seeds and tubers are an important source of waterfowl food (Fassett 1957) and the foliage of pondweeds is food for a variety of marsh birds, shore birds and wildlife and provides shelter, shade and spawning sites for a range of fish species (Borman et al. 2001).

Figure 26. Flat-stem pondweed.



Flat-stem pondweed is named for its flattened, grass-like leaves. It was the most common pondweed in Rush-Hen Lake and occurred with a frequency of 25% (Table 3). It was concentrated throughout the littoral zone (Figure 19) and was found to a depth of 19 feet (Figure 20). Other native pondweeds in Rush-Hen Lake included plants with broad leaves (often called "cabbage" by anglers) and narrow-leaved plants (Table 3).

Figure 27. Canada waterweed.

Canada waterweed (*Elodea canadensis*; Figure 27) was found in 24% of the Rush-Hen Lake survey sites (Table 3). It was concentrated in the shallow areas of Rush-Hen Lake (Figure

19) and was most frequent in depths of 0 to 10 feet (Figure 20). This perennial submerged species is widespread throughout Minnesota. It is adapted to a variety of conditions and is tolerant of low light and prefers soft substrates. Canada waterweed can overwinter as an evergreen plant and spreads primarily by fragments.

Non-native submerged plant

Curly-leaf pondweed (*Potamogeton crispus*; Figure 28) is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in more than 750 Minnesota lakes (Invasive Species Program 2010). This plant has been present in the Whitefish Chain since at least the early 1940's (DNR Fisheries lake files). It is not known when it first entered Rush-Hen Lake because most previous vegetation surveys have been conducted in July and August, after this plant has naturally died back.

Figure 28. Curly-leaf pondweed

Like many submerged plants, it is perennial but it has a unique life cycle that may provide a competitive advantage over native species. Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall. Winter foliage is produced and continues to grow under ice (Wehrmeister and Stuckey 1978). Curly-leaf reaches its maximum growth in May and June, when water temperatures are still too low for most native plant growth. In late spring and early summer, curly-leaf plants form structures called "turions" which are hardened stem tips that break off and fall to the substrate. Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson 1985).

The foliage of curly-leaf pondweed does provide some fish and wildlife habitat, but it may also create problems in some lakes, or in areas of some lakes. During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats. These dense growths may compete with native vegetation and can also cause problems for recreational lake users.

Curly-leaf pondweed was found in less than 1% of the Rush-Hen sample sites and it only occurred in the 11 to 15 feet depth zone where it was found in 3% of the sites.

Change in aquatic plant communities

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity, water chemistry, depth, substrate type and wave activity. Monitoring change in the aquatic plant community can be helpful in determining whether changes in the lake water quality are occurring and for estimating the quality of vegetation habitat available for fish and wildlife communities. Data collected in 2010 can be used to monitor finer-scale changes that may occur, such as an increase in a particular species

or a change in the depths at which individual species occur. In general, factors that may lead to change in native and non-native aquatic plant communities include:

- Change in water clarity
  If water clarity in Rush-Hen Lake increases, submerged vegetation may be more common at depths greater than 20 feet.

- Snow and ice cover
  Curly-leaf pondweed, in particular, may fluctuate in abundance in response to snow cover. Many native submerged plants also have the ability to grow under the ice, especially if there is little snow cover and sunlight reaches the lake bottom. In years following low snow cover, and/or a reduced ice-over period, curly-leaf and some native submerged plants may increase in abundance.

- Water temperatures / length of growing season
  In years with cool spring temperatures, submerged plants may be less abundant than in years with early springs and prolonged warm summer days.

- Aquatic plant management activities
  Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. The results of these control activities can be difficult to predict and should be conducted with caution to reduce potential negative impacts to non-target species. Motorboat activity in vegetated areas can be particularly harmful for species such as wild rice. Shoreline and watershed development can also indirectly influence aquatic plant growth if it results in changes to the overall water quality and clarity. For information on the laws pertaining to aquatic plant management: MnDNR APM Program.

The abundant and diverse aquatic plant communities found in Rush-Hen Lake provide critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

Literature Cited

Borman, S., R. Korth and J. Temte. 2001. Through the looking glass: A field guide to aquatic plants. The Wisconsin Lakes Partnership. Stevens Point, Wisconsin. 248 pp.

Catling, P. M. and I. Dobson. 1985. The biology of Canadian weeds. 69. *Potamogeton crispus* L. Canadian Journal of Plant Science 65:655-668.

Crow, G.E. and C.B. Hellquist. 2000. Aquatic and wetland plants of Northeastern North America. 2 volumes. The University of Wisconsin Press.

Fassett, N.C. 1957. A manual of aquatic plants. The University of Wisconsin Press. 405 pp.

Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 12+ vols. New York and Oxford. www.efloras.org

Invasive Species Program. 2010. Invasive Species of Aquatic Plants and Wild Animals in Minnesota: Annual Report for 2009. Minnesota Department of Natural Resources, St. Paul, MN. http://www.dnr.state.mn.us/eco/pubs_invasives.html

Lee, P. F. 1986. Ecological relationships of wild rice, *Zizania aquatica*. 4. Environmental regions within a wild rice lake. Canadian Journal Botany 64:2037-2044.

Madsen, J. D. 1999. Point intercept and line intercept methods for aquatic plant management. *APCRP Technical Notes Collection* (TN APCRP-M1-02). U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/aqua

MnDNR Fisheries Lake Files. Minnesota Department of Natural Resources. Division of Fish and Wildlife, Section of Fisheries, Lake Survey Program. 500 Lafayette Rd., St. Paul, MN 55155.

MnDNR. 2008. Natural wild rice in Minnesota. A wild rice study document submitted to the Minnesota Legislature by the Minnesota Department of Natural Resources, February 15, 2008. 117 pp.
http://files.dnr.state.mn.us/fish_wildlife/legislativereports/20080215_wildricestudy.pdf

MnDNR. 2009. Minnesota's Sensitive Lakeshore Identification Manual: a conservation strategy for Minnesota lakeshores (version 2). Division of Ecological and Water Resources, Minnesota Department of Natural Resources.

MnTaxa. 2010. Minnesota State checklist of vascular plants. Minnesota Department of Natural Resources, Division of Ecological Resources, St. Paul.

Moyle, J. B. and N. Hotchkiss. 1945. The aquatic and marsh vegetation of Minnesota and its value to waterfowl. Minnesota Department of Conservation. Technical Bulletin 3. 122 pp.

MPCA. 2010. Minnesota Pollution Control Agency. St. Paul, MN. Lake Water Quality Assessment Program. Lake Water Quality Data Search website: http://www.pca.state.mn.us/water/lkwqSearch.cfm (accessed December 2010)

Nichols, S.A. 1999. Distribution and habitat descriptions of Wisconsin lake plants. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison. 266 pp.

Upham, W. 1920. Minnesota Geographic Names: their origin and historic significance. Collections of the Minnesota Historical Society Vol. 17. Minnesota Historical Society, St. Paul, MN. 440 pp.

Varro, F. 2003. The interactions between *Aythya vallisineria* (Canvasback Duck) and *Vallisneria americana* (Wild Celery): Effects on restoration in the Upper Mississippi River. Restoration and Reclamation Review. Student on-line journal. University of Minnesota, St. Paul. 8 pp.

Wehrmeister and Stuckey. 1978. The life history of *Potamogeton crispus* with emphasis on its reproductive biology. Ohio Journal of Science. 78 (April program and abstract) supplement: 16.

Appendix 1. Historical aquatic and wetland plants of Rush-Hen Lake

Submerged plants

Common Name	Scientific Name	1950	1990	2010
Water marigold	*Bidens beckii*			X
Coontail	*Ceratophyllum demersum*	X	X	X
Muskgrass	*Chara* sp.		X	X
Canada waterweed	*Elodea canadensis*	X	X	X
Water star-grass	*Heteranthera dubia*			X
Northern watermilfoil	*Myriophyllum sibiricum*	X	X	X
Bushy pondweed	*Najas flexilis*		X	X
Southern naiad	*Najas guadalupensis*			X
Stonewort	*Nitella* sp.			X
Large-leaf pondweed	*Potamogeton amplifolius*	X	X	X
Curly-leaf pondweed (I)	*Potamogeton crispus*			X
Fries pondweed	*Potamogeton friesii*			X
Variable pondweed	*Potamogeton gramineus*	X		X
Illinois pondweed	*Potamogeton illinoensis*			X
White-stem pondweed	*Potamogeton praelongus*			X
Clasping leaf pondweed	*Potamogeton richardsonii*	X	X	X
Robbin's pondweed	*Potamogeton robbinsii*		X	X
Narrow-leaf pondweed	*Potamogeton* spp.		X	X
Flat-stem pondweed	*Potamogeton zosteriformis*	X	X	X
White water buttercup	*Ranunculus aquatilis*			X
Sago pondweed	*Stuckenia pectinata*	X	X	X
Greater bladderwort	*Utricularia vulgaris*			X
Lesser bladderwort	*Utricularia minor*			X
Flat-leaved bladderwort	*Utricularia intermedia*			X
Wild celery	*Vallisneria americana*	X	X	X
Watermoss	*Not identified to genus*			X
	Total	9	12	26

Floating-leaved plants

Common Name	Scientific Name	1950	1990	2010
Floating leaf pondweed	*Potamogeton natans*		X	X
White waterlily	*Nymphaea odorata*	X	X	X
Yellow waterlily	*Nuphar variegata*	X	X	X
Watershield	*Brasenia schreberi*			X
Floating smartweed	*Persicaria amphibia*		X	X
	Total	2	4	5

Free-floating plants

Common Name	Scientific Name	1950	1990	2010
Star duckweed	*Lemna trisulca*			X
Water meal	*Wolffia* sp.			X
	Total	0	0	2

Emergent plants

Common Name	Scientific Name	1950	1990	2010
Needlerush	*Eleocharis acicularis*		X	X
Arum-leaved arrowhead	*Sagittaria cuneata*			X
Broad-leaved arrowhead	*Sagittaria latifolia*		X	X[a]
Stiff Wapato	*Sagittaria rigida*		X	
Hard-stem bulrush	*Schoenoplectus acutus*			X[a]
Soft-stem bulrush	*Schoenoplectus validus*			
Burreed	*Sparganium* sp.		X	X
Wild rice	*Zizania palustris*		X	X
Narrow-leaved cattail	*Typha* spp.		X[a]	X
	Total	0	6	7

Wetland emergent plants

Common Name	Scientific Name	1950	1990	2010
Swamp milkweed	*Asclepius incarnata*		X	
Sedge	*Carex* spp.		X	
Blue flag iris	*Iris versicolor*		X	X[a]
Purple loosestrife (I)	*Lythrum salicaria*			X
Reed canary grass (I)	*Phalaris arundinaceae*		X	
Great water Dock	*Rumex orbiculatus*		X	
	Total	0	5	2

I = introduced

X[a] = Species identified only to genus level

Sources:

1950 (June, 19-21): Maloneys, DNR Fisheries Survey
1990 (July, 9- 13): Wayne Mueller, DNR Fisheries Survey
2010 (July and August): Simon, Perleberg, Van Dyne, Whichello, Point Intercept survey, MnDNR Division of Ecological and Water Resources