Aquatic vegetation of Island and Loon lakes

August, 2011

Loon Lake, ID# 18-0268-00
Island Lake, ID# 18-0269-00

Crow Wing County, Minnesota

Emergent and floating-leaf aquatic plants along undeveloped shore of Loon Lake, August, 2011.

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
Lakes and Rivers Program
1601 Minnesota Drive, Brainerd, MN 56401

Surveyors (Point-Intercept Survey):
Stephanie Simon
Donna Perleberg
Sam Eininger, Intern, MnDNR Ecological and Water Resources, Brainerd

Emergent Plant Bed Mapping:
Stephanie Simon and Sam Eininger

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Survey Context

This lake vegetation survey of Island and Loon lakes was part of the larger Sensitive Lakeshore Identification project conducted by MNDNR on the Whitefish Chain of Lakes. During 2010 and 2011, MNDNR biologists conducted field surveys of aquatic vegetation, near-shore fish and frogs, and shoreland birds in these lakes: Lower Hay, Bertha, Clamshell, Arrowhead, Whitefish (Upper, Middle and Lower), Pig, Big Trout, Island, Loon, Rush-Hen, Cross, Daggett and Little Pine. Field data will be used to identify areas along lakeshores that provide unique or critical ecological habitat. Once those areas are identified, local and state resource managers can use the information to help ensure that sensitive habitats are receiving sufficient protection.

More information on the MNDNR's Sensitive Lakeshore Identification, including Sensitive Lakeshore reports for individual lakes, can be found online at:
http://www.dnr.state.mn.us/eco/sli/index.html

Summary

Island and Loon lakes are two of 13 connected waterbodies that comprise the Whitefish Chain of Lakes in Crow Wing County. In 2011, as part of the DNR's larger Sensitive Lakeshore Identification project, surveyors assessed the aquatic vegetation of these lakes. Surveys included mapping emergent and floating-leaf plant beds and sampling plant occurrence and diversity at 152 sites.

Island and Loon lakes include a diversity of native plants, with 39 species (types) recorded, including 6 emergent, 5 floating-leaved, 2 free-floating and 26 submerged species. Seventeen of these species were recorded for the first time in these lakes in 2011 and all of the species located during historical surveys are still relatively common in the lakes.

Within the 0 to 25 feet depth zone of Island and Loon lakes, 84% 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 shallow, protected areas.

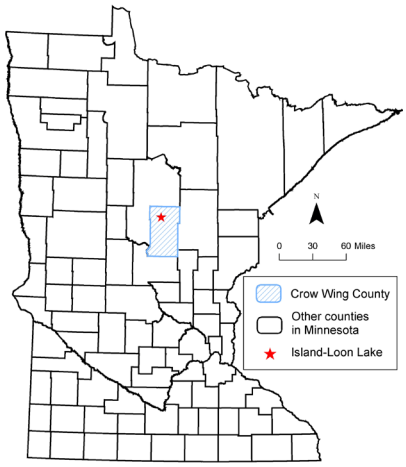
Emergent and floating-leaf plants occupied 22 acres with major beds occurring in shallow water along undeveloped shorelines such as shorelines adjacent to islands or wetlands. About 2/3 of the shoreline (3.5 miles) lacked any emergent or floating-leaved plant beds. White waterlily (*Nymphaea odorata*) was the most common floating-leaf plant and occurred in 23% of the shallow water sites (0 to 5 feet). Other floating-leaf and emergent plants included yellow waterlily (*Nuphar variegata*), watershield (*Brasenia schreberi*), floating-leaf pondweed (*Potamogeton natans*), arrowhead (*Sagittaria* sp.), and burreed (*Sparganium* sp.).

Submerged plants were found to a maximum depth of 23 feet but were sparsely distributed in depths greater than 20 feet. The submerged plant community was composed of a diversity of native species. Naiads (*Najas flexilis and Najas guadalupensis*) were the most common species and occurred in 47% of the survey sites. They co-dominated the 11 to 15 feet depth zone where they were found in 71% of the sites. Other submerged plants that occurred in at least 25% of the sites were flat-stem pondweed (*Potamogeton zosteriformis*), coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), Canada waterweed (*Elodea canadensis*), and wild celery (*Vallisneria americana*).

Introduction

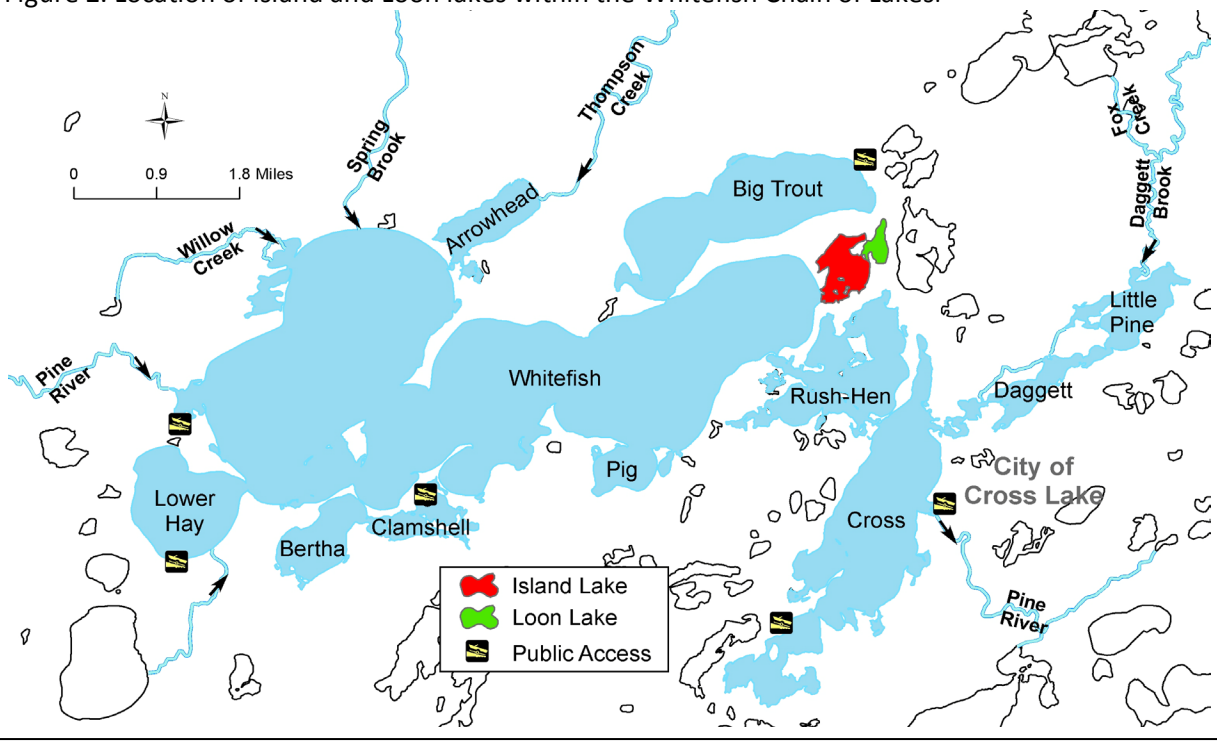
Island and Loon lakes are located in the forested, lake-rich region of north central Minnesota (Figure 1). They are two of 13 waterbodies in the 14,000 acre Whitefish Chain of Lakes[1]. The Pine River flows east through the chain and many of these lakes were connected in 1886 when the Pine River Dam was completed and raised water levels making channels between the lakes (Upham 1920). The U.S. Army Corps of Engineers attempts to maintain fairly stable water levels on the entire chain by regulating outflow at the Cross Lake Dam but heavy rain or drought conditions can also influence the water level.

Figure 1. Island and Loon lakes, Crow Wing County, Minnesota.



Although lakes in the Whitefish Chain are connected, differences such as lake size, depth, flow, and shoreland management create differences in nutrient levels and water clarity between the lakes. These physical differences influence the types and amounts of plants that occur in each lake.

Figure 2. Location of Island and Loon lakes within the Whitefish Chain of Lakes.



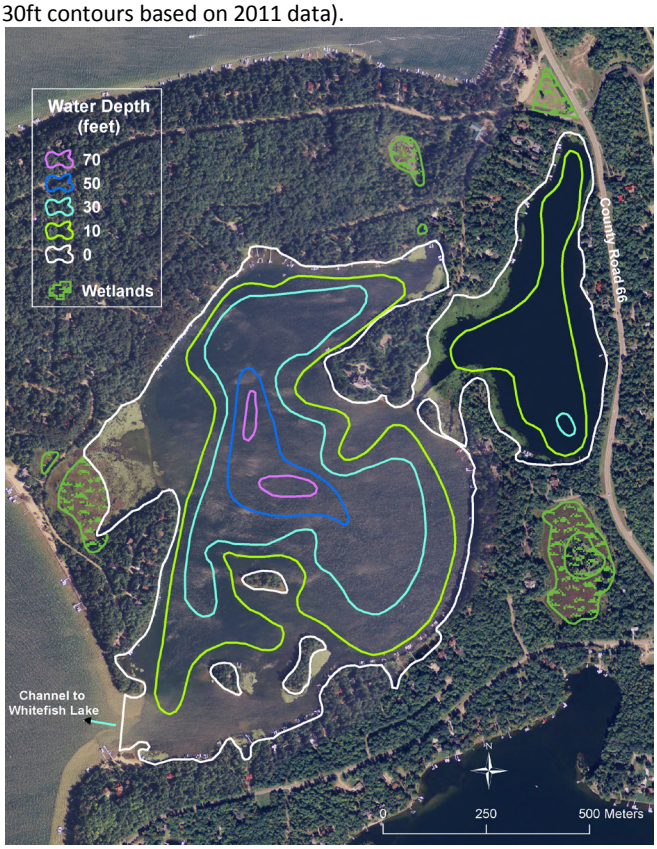
[1] The total number of waterbodies considered to be part of the Whitefish Chain of Lakes varies. We included the lakes that are directly connected within the main portion of the chain.

Lake Characteristics

Island and Loon lakes occur at the northeast end of the chain and are treated as one waterbody for survey purposes. Historically these lakes were not connected to Whitefish Lake but were joined when water levels rose following the construction of the Pine River dam. Flooding resulted in the adjacent lowlands becoming part of the new unified lake and adjacent high ground became isolated as today's islands and sandbars. The lakes are connected to each other by a 25 meter wide channel. There are no permanent inlets to these lakes but a broad opening connects Island Lake to the east shore of Whitefish Lake (Figure 2).

Both Island and Loon lakes are irregular in outline and have a total shoreline length of about 5 miles. Most of the shoreline is forested upland and developed with residential homes. County Road 66 runs parallel to the east shore of Loon Lake resulting in a few narrow (10-30 meter wide) strips of undeveloped shore between the lake and road (Figure 3). A six acre wetland adjoins the west shore of Island Lake. Public boat ramps exist on other lakes in the Whitefish Chain and boat navigation into Island and Loon lakes is possible through the channel at Whitefish Lake.

Figure 3. Island and Loon lakes depth contours (10ft and 30ft contours based on 2011 data).



With a surface area of 176 acres, Island is the 2nd smallest lake in the chain and is named for the presence of three islands. It has a maximum depth of 76 feet and 48% of the lake is shallow (15 feet or less in depth) (Figure 3). Loon Lake is about 50 acres in area, making it the smallest lake in the chain. About 26% of this lake is shallow (15 feet or less) and the maximum depth is 30 feet.

Island and Loon lakes are characterized as oligotrophic (low nutrients) and are among the clearest lakes in the chain. In 2010, mean summer[2] water clarity, as measured by Secchi disc readings[3], was 14 feet in Island and Loon lakes, compared to 11 feet in Whitefish Lake (MPCA

[2] June through September

[3] 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 is influenced by the amount of particles in the water column and can fluctuate seasonally and annually.

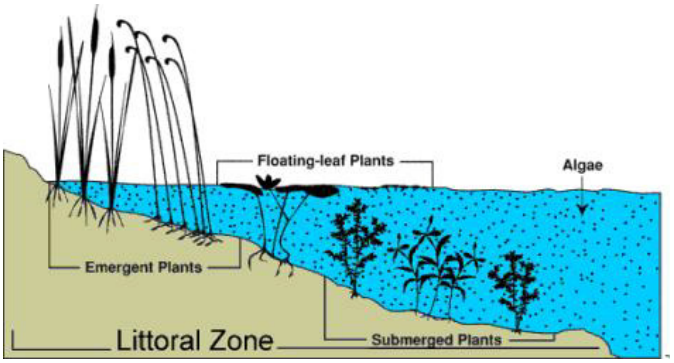
2011). Based on Secchi disk measurements alone, aquatic plants have the potential to reach depths of about 21 feet in Island and Loon lakes[4].

Amounts and types of aquatic plants in Minnesota lakes

Within a lake, types and amounts of aquatic plants are influenced by a variety of factors including water clarity, water chemistry, water depth, substrate, and wave activity. Deep or wind-swept areas may lack aquatic plant growth, whereas sheltered shallow areas may support an abundant and diverse native aquatic plant community. The annual abundance, distribution and composition of aquatic plant communities may change due to environmental factors, predation, the specific phenology of each plant species, introductions of non-native plant or animal species and human activities in and around the lake.

Aquatic plants can be divided into four groups or "life forms" based on whether the main portion of the plant occurs above, on, or below the water surface. These life forms: emergent, floating-leaved, free-floating and submerged plants (Figure 4), often favor certain water depth zones around the lake but overlap occurs with one life form grading into another. Each life form group has unique functions and values.

Figure 4. Forms of aquatic plants found in Minnesota lakes.



Emergent plants, like cattails and bulrush, are rooted in the lake bottom with most of their leaves and stems extending above the water surface. Floating-leaf plants, such as waterlilies, are also anchored in the lake bottom with leaves and flowers that float on the water surface. Root systems of these plants form extensive networks that take up nutrients and help consolidate and stabilize bottom substrate. Beds of floating-leaf and emergent plants also help buffer the shoreline from wave action, offer shelter for insects and young fish, and provide shade for fish and frogs. These beds also provide food, cover and nesting material for waterfowl, marsh birds and muskrat. Floating-leaf and emergent plants are most often found in shallow water to depths of about 6 feet and may extend lake-ward onto mudflats and into adjacent wetlands.

Submerged plants have stems and leaves that primarily grow underwater but they may also form flowers, fruits and some leaves that emerge above or float on the water surface. Submerged plants are typically anchored to the lake bottom but some species do drift freely with the currents. This group includes non-flowering plants such as large algae, mosses, and fern-like plants, and flowering plants that may produce flowers above or below the water

[4] 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.

surface. Submerged plants may form low-growing mats or may grow several feet in the water column with leaf shapes that include broad ovals, long and grass-like, or finely dissected. Submerged plants release oxygen into the water column, compete for nutrients with microscopic algae, and provide food and shelter for a variety of invertebrates, fish, amphibians and other wildlife.

Free-floating plants are the smallest of Minnesota's lake plants and include small flowering plants that are commonly known as "duckweeds" as well as microscopic algae. Different survey methods are required to assess microscopic algae and they are not included in this report. Duckweeds are present in many Minnesota lakes and if present in sufficient amounts, they can accumulate into mats and create a shade barrier along protected shorelines. As their name implies, they are also an important food source for waterfowl.

Plant species richness is a term used to describe the total number of plant species present in a lake and it can be used to help describe the general health of the waterbody. In Minnesota, plant species richness can range from zero (un-vegetated lakes) to more than 40 species in a lake[5]. Species richness is generally higher in high clarity lakes than in turbid lakes and more species are usually found in moderately fertile lakes than in nutrient poor lakes. Therefore, lakes of north central Minnesota are often among the "richest" in terms of numbers of plant species. Water quality changes that result in lower clarity may also result in the loss of some plant species, or a lower species richness. However, caution must be used when comparing historical and present survey data because of differences in how the surveys were conducted. For example, if a current MNDNR plant survey locates more species than found during an historical "one-day" survey, it may be due to the more extensive sampling that occurs during current surveys. If fewer species are located during current surveys, it may indicate a true decline in the plant species richness of the lake.

Historic aquatic plant community

Previous lakewide, aquatic plant surveys of Island and Loon lakes were conducted in 1950, 1960, 1990, and 1995 (MnDNR Lake files). These surveys focused on the commonly occurring in-lake plants and recorded a total of 22 native aquatic plant species: 3 emergent, 3 floating-leaf, 2 free-floating, and 14 submerged species (Appendix 1). Plants that were reported in all of the previous surveys included native plants that are commonly found in many Crow Wing County lakes: white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegata*), muskgrass (*Chara* sp.), a variety of pondweeds (*Potamogeton* spp., *Stuckenia pectinata*), northern watermilfoil (*Myriophyllum sibiricum*), coontail (*Ceratophyllum demersum*), and Canada waterweed (*Elodea canadensis*). Non-native plants were not recorded during previous surveys but the submerged species, curly-leaf pondweed (*Potamogeton crispus*) and the emergent plant, purple loosestrife (*Lythrum salicaria*) are known to occur in other lakes in the chain.

[5] These values are from a review of MNDNR lake vegetation surveys.

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2011 plant population of Island and Loon lakes. Specific objectives included:

1. Describe the general distribution of plants in the lake including the depths at which plants occur.
2. Record the aquatic plant species that occur in the lake
3. Estimate the abundance of each species
4. Develop distribution maps for the commonly occurring species

Methods

Mapping floating-leaf and emergent vegetation beds

Mapping focused on plant beds that were at least 0.01 acres, or about 400 square feet, in size. Draft maps of floating-leaf and emergent plant beds were created prior to field surveys using 2010 Farm Service Administrative (FSA) true color aerial photographs. Field surveys were conducted August 31, 2011 to map plants like bulrush (*Schoenoplectus* spp.), which are difficult to identify from aerial photos, and to verify photo-interpretation of other plant beds. Surveyors mapped emergent and floating-leaf plant beds in the field by motoring or wading around the perimeter of each bed and recording a 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. Plant beds were classified by the dominant species.

Lakewide vegetation survey

A lakewide vegetation survey was conducted on August 29 and 30, 2011 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, resulting in about one sample site per acre. In the field, surveyors sampled sites where water depth was less than 31 feet. To minimize damage to vegetation, surveyors did not survey a few sites because they occurred in dense beds of emergent or floating-leaf plants. A total of 152 sites were surveyed in Island and Loon lakes (Figure 5, Table 1).

The survey was conducted by boat and a GPS unit was used to navigate 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.

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

Figure 5. 2011 survey sites on Island and Loon lakes.

Table 1. Survey effort by depth interval.

Water depth (feet)	Number of sample sites
0 to 5	52
6 to 10	44
11 to 15	17
16 to 20	13
21 to 25	16
Total (0-25)	142
26 to 30	10
Total	152

Table 2. Substrate classes

muck	decomposed organic material
marl	calcareous material
silt	fine material with little grittiness
sand	diameter <1/8 inch
gravel	diameter 1/8-3 inches
rubble	diameter 3- 10 inches
boulder	diameter > 10 inches

description at the shore side of each row of points. If a sample site occurred near shore but in water depths 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; this information was used for mapping purposes.

Plant sampling

Surveyors recorded all plant species found at each sample site (approximately 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 6). 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 6. Survey rake.

Island and Loon lakes were treated as one waterbody for data calculations. Frequency was calculated for the area from shore to 25 feet (the depth zone where plants were detected) and

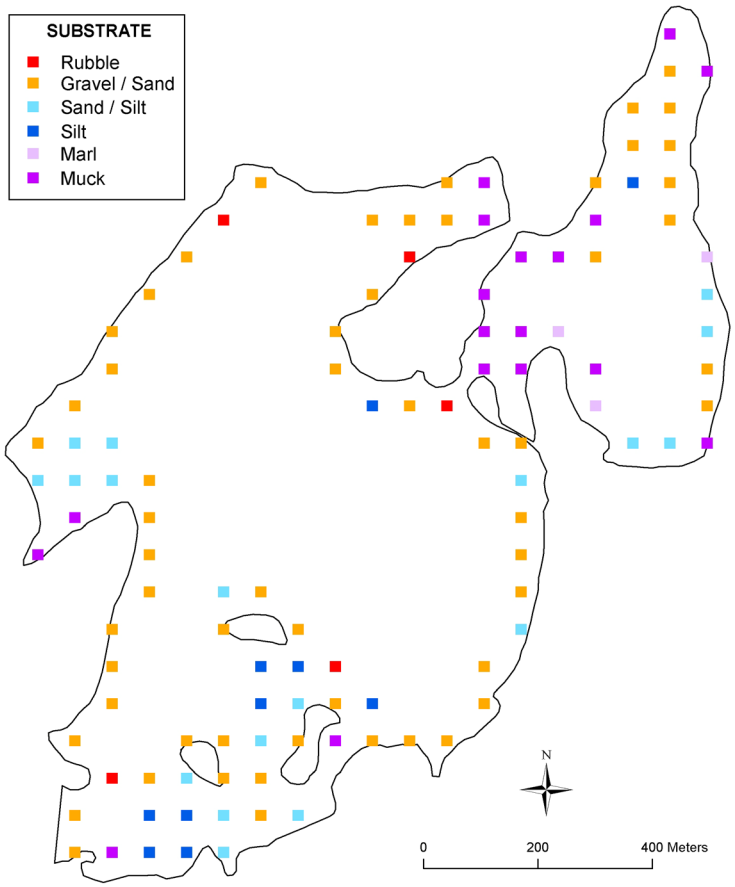
data were also separated into 5 feet increment depth zones for analysis (Table 1). Frequency estimates were also calculated for individual species and selected groups of species (example calculations shown in Appendix 2).

Results and Discussion

Shoal Substrates

The shoal substrates of Island and Loon lakes included hard substrates of sand, gravel, and rubble throughout the main basin of the lake, the perimeters of the islands and other exposed shores (Figure 7). Softer substrates of silt and muck were found in protected areas including small bays and the channel from Island Lake to Loon Lake.

Figure 7. 2011 substrate on Island and Loon lakes.



Types of plants recorded

A total of 39 aquatic plant species (types) were recorded in Island and Loon lakes, making them among the richest lakes in the state in terms of number of plant species. The plants found were all native to Minnesota and included 6 emergent, 5 floating-leaved, 2 free-floating, and 26 submerged plants (Table 3). Seventeen of these species were recorded for the first time during the 2011 survey (Appendix 1). One species, star duckweed, was reported in a previous survey but not recorded in 2011; this small, free-floating plant may have been present in 2011 but not located during the survey.

Table 3. Frequency of submerged aquatic plants in Island and Loon lakes, August, 2011.
[Frequency is the percent of sample sites in which a plant species occurred within the 0 to 25 ft water depth).

Life Form		Common Name	Scientific Name	Frequency (% occurrence) 142 sites
EMERGENT[1]		Arrowhead	*Sagittaria* sp.	1
		Three-square bulrush	*Schoenoplectus pungens*	P
		Bulrush	*Schoenoplectus* sp.[a]	P
		Eastern burreed	*Sparganium americanum*[b]	P
		Broad-leaved cattail	*Typha latifolia*	P
		Narrow-leaved cattail	*Typha* sp.[c]	P
FLOATING-LEAVED		White waterlily	*Nymphaea odorata*	8
		Yellow waterlily	*Nuphar variegata*	6
		Floating-leaf pondweed	*Potamogeton natans*	6
		Watershield	*Brasenia schreberi*	1
		Floating-leaf smartweed	*Persicaria amphibia*	P
SUBMERGED	Macroalgae	Muskgrass	*Chara* sp.	18
	Moss	Watermoss	*Not identified to genus*	5
	Dissected-leaf rooted plants	Coontail	*Ceratophyllum demersum*	40
		Northern watermilfoil	*Myriophyllum sibiricum*[d]	31
		Whorled watermilfoil	*Myriophyllum verticillatum*[d]	
		Water marigold	*Bidens beckii*	8
		White-water buttercup	*Ranunculus aquatilis*	8
		Greater bladderwort	*Utricularia vulgaris*	8
		Flat-leaf bladderwort	*Utricularia intermedia*	2
		Lesser bladderwort	*Utricularia minor*	1
		Creeping spearwort	*Ranunculus flammula*	P
	Small-leaf rooted plants	Southern naiad	*Najas guadalupensis*[e]	47
		Bushy pondweed	*Najas flexilis*[e]	
		Canada waterweed	*Elodea canadensis*	31
	Narrow-leaf pondweeds	Narrow-leaf pondweed group[f]	*Potamogeton friesii*	13
		Sago pondweed	*Stuckenia pectinata*	9
	Broad-leaf pondweeds	Clasping-leaf pondweed	*Potamogeton richardsonii*	15
		Large-leaf pondweed	*Potamogeton amplifolius*	8
		White-stem pondweed	*Potamogeton praelongus*	8
		Illinois pondweed	*Potamogeton illinoensis*	7
		Variable pondweed	*Potamogeton gramineus*	4
	Grass-leaf rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	41
		Wild celery	*Vallisneria americana*	28
		Water star-grass	*Heteranthera dubia*	10
		Robbin's pondweed	*Potamogeton robbinsii*	6
		Water bulrush	*Schoenoplectus subterminalis*	1
FREE-FLOATING		Lesser duckweed	*Lemna* sp.	P
		Greater duckweed	*Spirodela polyhriza*	P

P=Present in lake but did not occur in any sample sites [1]includes only in-lake emergents and not wetland plants

Table 3 (continued). Frequency of aquatic plants in Island and Loon lakes, August, 2011.

The following taxonomic groupings were made because field identification to the species level was difficult or not possible:
[a]species of bulrush (*Schoenoplectus* sp.) was used to record bulrush plants that was hard-stem bulrush (*Schoenoplectus acutus*), soft-stem bulrush (*S. tabernaemontani*) or the hybrid.

[b]Some plants of emergent burreed were identified as American burreed (*Sparganium americanum*) but other plants did not have fruits and could not be identified to the species level. It is possible that more than one species of burreed were present in the lake.

[c]Narrow-leaf cattail was identified in survey but it is not known whether this included narrow-leaf cattail (*Typha angustifolia*) and/or the hybrid of narrow-leaf and broad-leaf cattail (*Typha x glauca*).

[d]Northern watermilfoil (*Myriophyllum sibiricum*) and whorled watermilfoil (*Myriophyllum verticillatum*) were grouped together for analysis because field identification to the species level was difficult.

[e]Bushy pondweed (*Najas flexilis*) and Southern naiad (*Najas guadalupensis*) were grouped together for analysis because field identification to the species level was difficult.

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

Distribution of aquatic plants

Plants were distributed around the entire shoreline of Island and Loon lakes with the broadest zones of vegetation occurring along the shallow south shore of Island Lake and the west shore of Loon Lake (Figure 8). On the north shore of Island Lake, where water depth increases rapidly, vegetation beds were narrow and extended less than 30 meters lakeward.

Plants were found to a depth of 23 feet in Island and Loon lakes and in the 0 to 25 feet depth zone, 84% of the survey sites contained vegetation. Vegetation was most common in the 0 to 15 feet depth zone, where 98% of sites contained plants (Figure 9). Plant abundance declined with increasing water depth and in depths of 16 to 25 feet, 28% of the sites were vegetated. No plants were detected in the 26 to 30 feet zone but scattered vegetation may have occurred at this depth zone.

Plant communities richness

The highest number of plant species was found in shallow water, from shore to a depth of 5 feet (Figure 10). Emergent and floating-leaf plants were restricted to this shallow depth zone. Most submerged species were found in depths of 10 feet and less and only 3 species (coontail, muskgrass and naiads) occurred in depths greater than 20 feet.

The number of plant species found at each sample site ranged from 0 to 11 with a mean of 3 species per site. Sites of high species richness (6 or more species per site) often occurred in depths less than 10 feet and included sites where emergent, floating-leaf, and submerged plants co-occurred (Figure 8).

Figure 8. Number of species per site, Island and Loon lakes 2011.

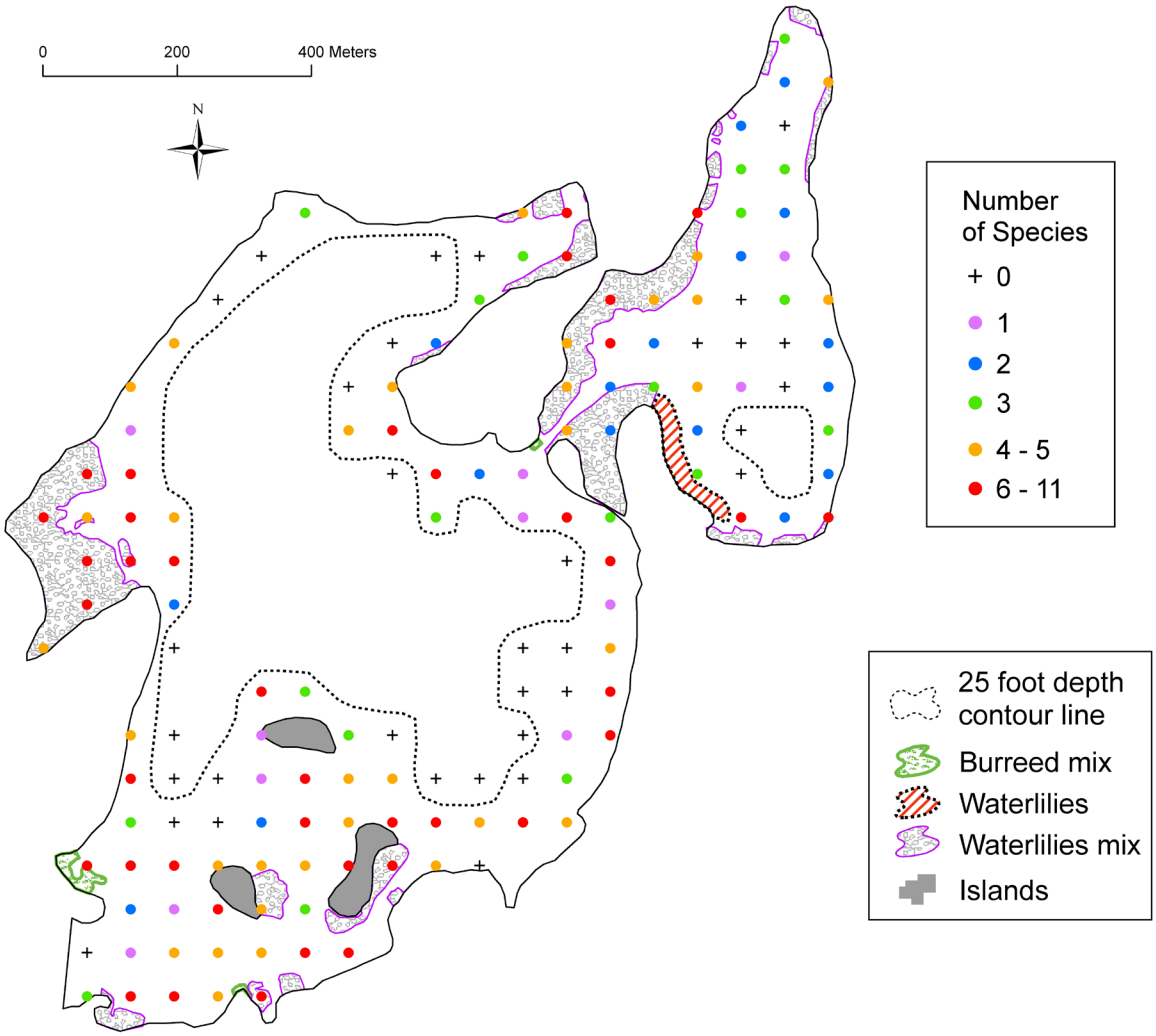


Figure 9. Aquatic plant frequency vs. water depth.

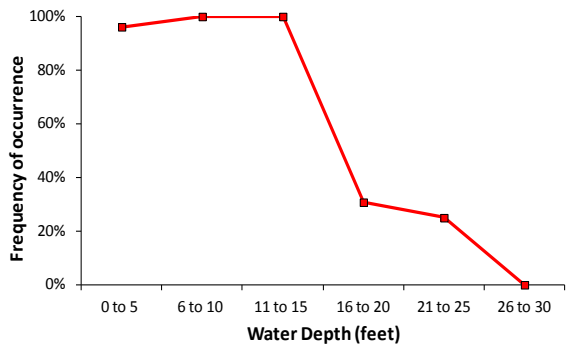
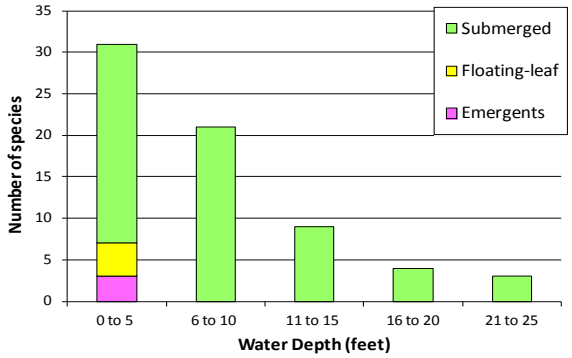


Figure 10. Number of plant species vs. water depth.



Emergent and Floating-leaf Plant Beds

Approximately 22 acres of emergent and floating-leaf plant beds were mapped in Island and Loon lakes. These plants were restricted to shallow water (0-5 feet) and within that depth zone 21% of the survey sites contained at least one emergent or floating-leaf plant. The major sites of emergent and floating-leaf plant beds were along undeveloped shorelines such as shorelines adjacent to islands or wetlands. About 2/3 of the shoreline (3.5 miles) lacked any emergent or floating-leaved plant beds.

Emergent plants included species with broad grass-like leaves such as cattails (*Typha* sp.) and burreed (*Sparganium* sp.) and narrow-leaf bulrush (*Schoenoplectus* sp.) plants. Most emergent plants were found growing in narrow bands at the shoreward edge of larger waterlily beds or intermixed within waterlily beds. The largest emergent bed (7 acres) occurred just north of the channel to Whitefish Lake (Figure 8) and was dominated by burreed.

Burreeds (Figures 11, 12) are perennial, emergent plants with leaves that resemble cattails but they are shorter in height with triangular shaped leaves. Burreed grows in shallow water (typically less than 4 feet) along shorelines and in wetlands throughout Minnesota. Some burreed species form only floating-leaves, some are only emergent and some can form both types of leaves. The plants produce fruits with nut-like achenes that are eaten by ducks, common snipe and rails; the stems and leaves are a preferred food of muskrats and deer (Newmaster et al. 1997).

Figure 11. Burreed.

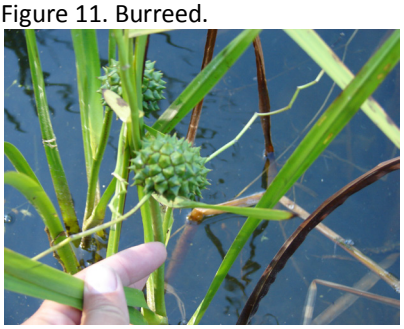


Figure 12. Emergent burreed and floating-leaf waterlilies along undeveloped shore of Loon Lake, August, 2011.

Most of these plant beds were classified as "mixed waterlily" beds and were dominated by floating-leaf plants such as white waterlily (*Nymphaea odorata*; Figure 13), yellow waterlily (*Nuphar variegata*; Figure 14), watershield (*Brasenia schreberi*; Figure 15) and floating-leaf pondweed (*Potamogeton natans*). Waterlily beds often contained scattered emergent plants such as burreed, arrowhead (*Sagittaria* sp.) and submerged plants. The floating leaves of waterlilies provide shade and shelter for fish, frogs and invertebrates. The showy flowers produce seeds that are eaten by waterfowl and the rhizome are a food source for muskrats and deer (Borman et al. 2001).

Figure 13. White waterlily

Figure 14. Yellow waterlily

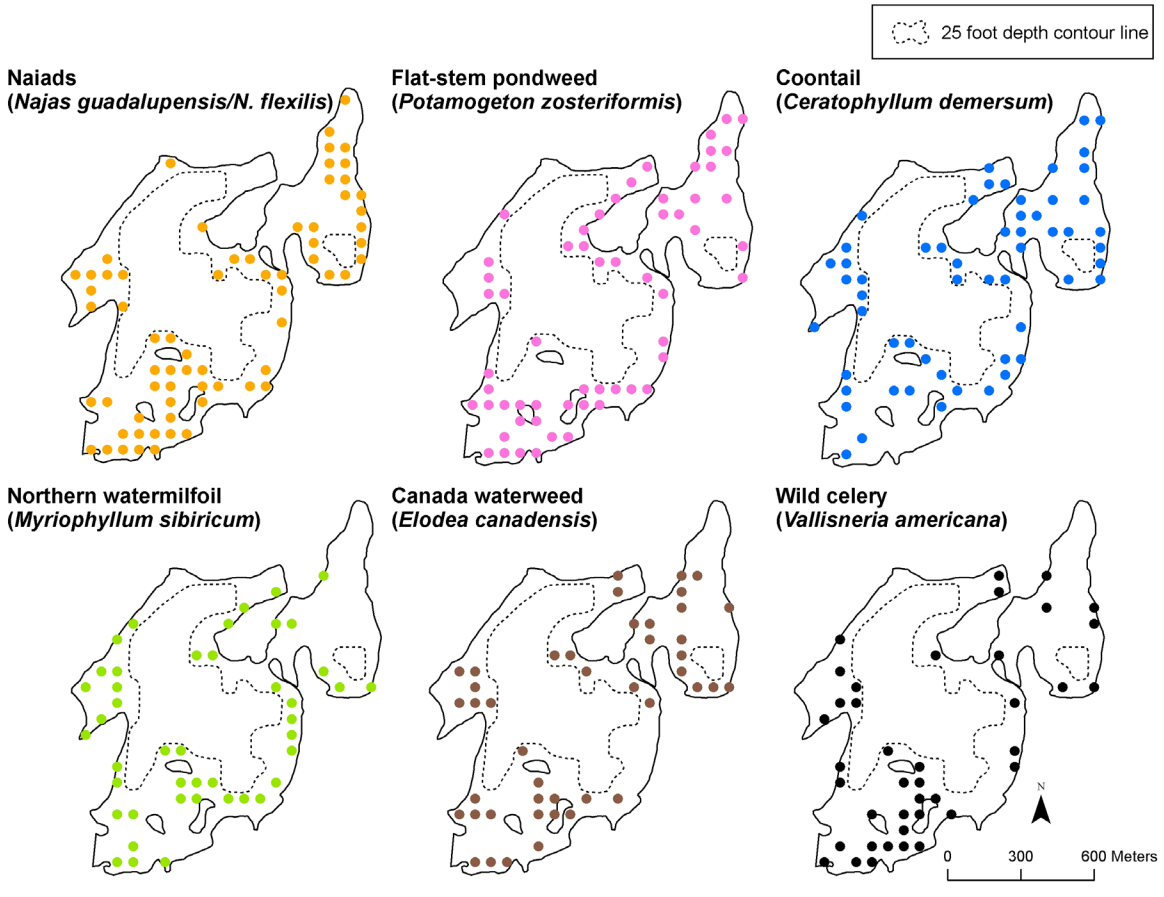
Figure 15. Watershield

In addition to providing valuable fish and wildlife habitat, the extensive root network of these emergent and floating-leaf plants help to stabilize sandy shoreline. In shallow water, they may spread by underground rhizomes but these plants are particularly susceptible to destruction by direct cutting by humans, motorboat activity and excess herbivory. Restoration of emergent and floating-leaf plant beds can be very difficult, making established beds particularly unique and valuable.

Submerged aquatic plants

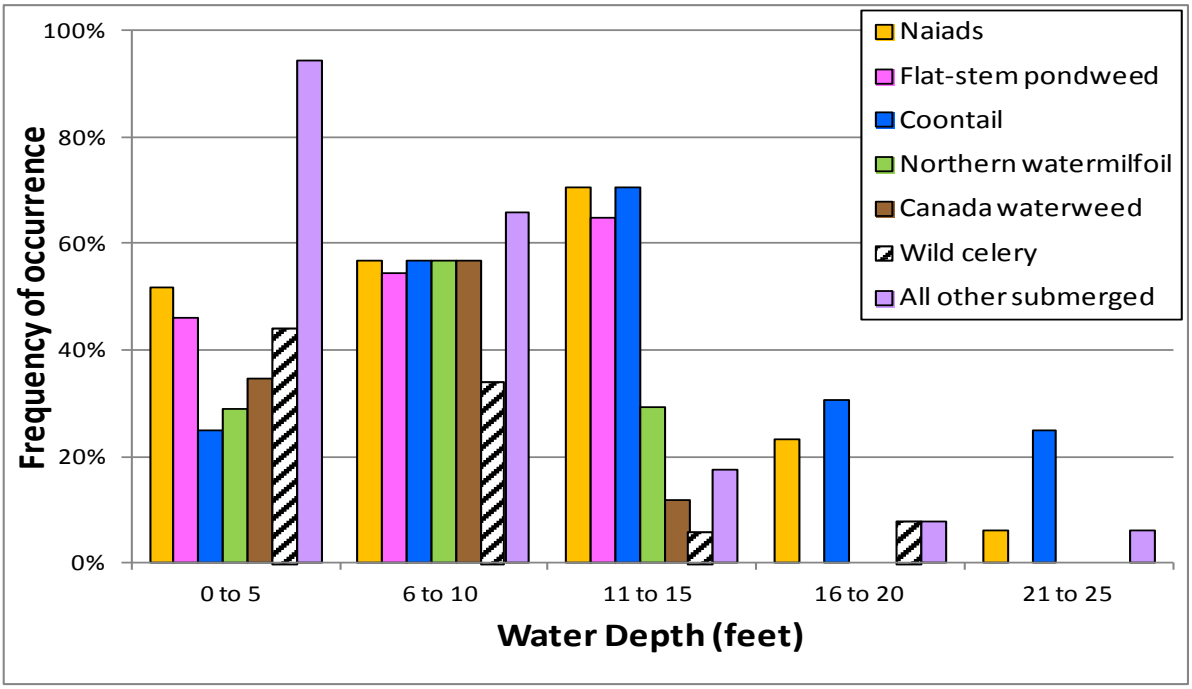
Submerged plants were found around the entire shoreline of Island and Loon lakes and within the 0-25 feet zone, occurred in 78% of the sample sites (Figure 16). The most frequently occurring species, or species groups, were naiads (*Najas* spp.), flat-stem pondweed (*Potamogeton zosteriformis*), coontail (*Ceratophyllum demersum*), native watermilfoil (*Myriophyllum sibiricum and M. verticillatum*), Canada waterweed (*Elodea canadensis*), and

Figure 16. Distribution of commonly occurring submerged plants in Island and Loon lakes, 2011.



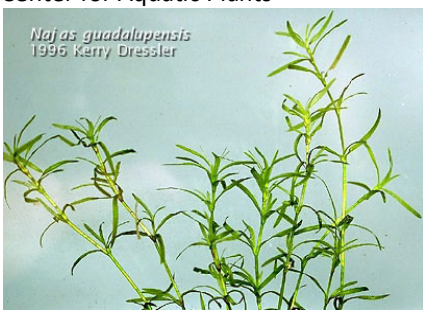
wild celery (*Vallisneria americana*). These species were found in both lakes (Figure 16) and each occurred with a frequency of at least 25%[6] (Table 3). The species were frequent in both shallow and deep water, while most other species were generally restricted to depths of 10 feet and less (Figure 17).

Figure 17. Common submerged plants at each water depth interval, Island and Loon lakes 2011.



Naiads (*Najas guadalupensis* and *N. flexilis*) grow low in the water column and produce seeds and foliage that provide important duck food and good fish cover. Southern naiad (*Najas guadalupensis*; Figure 18) can sprout from seed or overwinter as a perennial plant. It has not been found in many Minnesota lakes but 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. Both plants occurred in Island and Loon lakes, and 47% of the sites contained at least one of these species (Table 3). Within the 0-15 feet zone, naiads co-dominated with several other species (Figure 16) and occurred in 53% of the sites (Figure 17). They were one of only 5 species that occurred in deeper water.

Figure 18. Southern naiad. Photo: Kerry Dressler ©1996 Univ. of Florida Center for Aquatic Plants



Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 19) is one of 10 native pondweeds found in Island and Loon lakes. Pondweeds (*Potamogeton* spp. and *Stuckenia* spp.) are

[6] Unless otherwise noted, all frequency values are calculated for the 0-25 feet depth zone.

Figure 19. Flat-stem pondweed.

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). Flat-stem pondweed is named for its flattened, grass-like leaves. It was the most common pondweed in Island and Loon lakes, occurring with a frequency of 41% (Table 3). Within the 0-15 feet depth zone, it had a similar distribution as naiads and was found in 51% of the sites (Figure 17). Unlike some of the other commonly occurring species, it was not found beyond the 15 feet depth. Other native pondweeds in Island and Loon lakes included plants with broad-leaved (often called "cabbage" by anglers) and narrow-leaved plants (Table 3).

Figure 20. Coontail

Coontail (*Ceratophyllum demersum*; Figure 20) 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 (Nichols 1999). 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 40% of the sample sites in Island and Loon lakes (Table 3) and at each depth zone it occurred in at least 20% of the sites and was most frequent in the 6-15 feet zone where it occurred in 61% of the sites (Figure 17). Coontail was the most frequent plant found in depths greater than 15 feet where it occurred with a frequency of 28%.

Figure 21. Northern watermilfoil

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

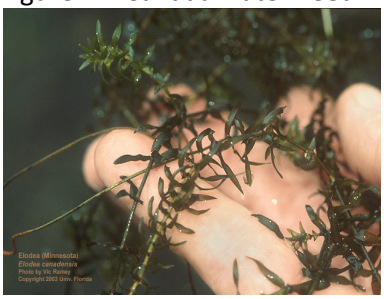
Northern watermilfoil (*Myriophyllum sibiricum*; Figure 21) is a native[7], submerged plant. It is a rooted perennial with finely dissected leaves. Particularly in depths less than 10 feet, this plant may reach the water surface and its flower stalk will extend above the water surface. It spreads primarily by stem fragments and over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity (Nichols 1999) and grows best in clear water lakes. Northern watermilfoil was found in 31% all sites (Table 3) but was mostly found in Island Lake (Figure 16). Like many of the pondweed species, it was only found in the 0-15

[7] For information on how to distinguish the native northern watermilfoil from the non-native, Eurasian watermilfoil, click here: identification.

feet depth zone (Figure 17).

Canada waterweed (*Elodea canadensis*; Figure 22) is a perennial submerged species that is widespread throughout Minnesota. It is adapted to a variety of conditions and is tolerant of low light and prefers soft substrates (Nichols 1999). Canada waterweed can overwinter as an evergreen plant and spreads primarily by fragments. Canada waterweed was found in 31% of the Island and Loon lakes survey sites (Table 3). It was found to a depth of 13 feet but was most frequent in depths of 10 feet and less (Figure 17).

Figure 22. Canada waterweed.



Wild celery (*Vallisneria americana*; Figure 23) is a rooted, perennial submerged plant that resembles ribbon-leaved pondweeds. Unlike the pondweeds that have branches of leaves, wild 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 28% of the sample sites (Table 3), was found to a depth of 19 feet (Figure 16) and was most frequent to depths of 10 feet (Figure 17).

Figure 23. Wild celery

Other submerged species found in Island and Loon lakes were frequent in the 0-10 feet depth zone. The plant community included a diversity of growth forms including broad-leaf "cabbage" plants, grass-leaved plants and finely-divided leaf plants.

Factors influencing 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 2011 can be used to monitor finer-scale changes that may occur, such as an increase in a particular species, loss of species, or changes in the depths at which individual species occur. In general, factors that may lead to change in aquatic plant communities include:

- Change in water clarity
  If water clarity in Island and Loon lakes increases, submerged vegetation may be more common at depths greater than 20 feet. Declines in water clarity may lead to fewer plants and fewer types of plants in the deep end of the current vegetated zone.

- Snow and ice 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, submerged plants may increase in abundance or there may be a shift in species dominance.

- 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 abundance and assortment of aquatic plants found in Island and Loon lakes provides a habitat complexity that can be utilized by a variety of fish and wildlife and also provides a variety of other lake benefits. Protecting existing native aquatic plant beds will help maintain critical fish and wildlife habitat and the general water quality of the lake.
(Click here for more information on: value of aquatic plants).

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Appendix 1. Historical aquatic and wetland plants of Island and Loon lakes

Blue highlight indicates species that were common (occurring in at least 25% of sites) in 2011.

Submerged plants

Common Name	Scientific Name	1950	1960	1990	1995	2011
Water marigold	*Bidens beckii*					X
Coontail	*Ceratophyllum demersum*	X	X	X	X	X
Muskgrass	*Chara* sp.			X	X	X
Canada waterweed	*Elodea canadensis*	X	X	X	X	X
Water star-grass	*Heteranthera dubia*					X
Northern watermilfoil	*Myriophyllum sibiricum*	X	X	X	X	X
Whorled watermilfoil	*Myriophyllum verticillatum*					X
Bushy pondweed	*Najas flexilis*				X	X
Southern naiad	*Najas guadalupensis*					X
Large-leaf pondweed	*Potamogeton amplifolius*	X	X	X	X	X
Fries' pondweed	*Potamogeton friesii*					X
Narrow-leaf pondweed	*Potamogeton* sp.[1]			X	X	
Variable pondweed	*Potamogeton gramineus*	X	X		X	X
Illinois pondweed	*Potamogeton illinoensis*					X
White-stem pondweed	*Potamogeton praelongus*					X
Clasping-leaf pondweed	*Potamogeton richardsonii*	X	X	X	X	X
Robbin's pondweed	*Potamogeton robbinsii*	X	X	X	X	X
Flat-stem pondweed	*Potamogeton zosteriformis*	X	X	X	X	X
White water buttercup	*Ranunculus aquatilis*				X	X
Creeping spearwort	*Ranunculus flammula*					X
Water bulrush	*Schoenoplectus subterminalis*					X
Sago pondweed	*Stuckenia pectinata*	X	X	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	9	11	14	26

Floating-leaved plants

Common Name	Scientific Name	1950	1960	1990	1995	2011
Watershield	*Brasenia schreberi*					X
Floating-leaf pondweed	*Potamogeton natans*	X	X	X	X	X
White waterlily	*Nymphaea odorata*		X	X	X	X
Yellow waterlily	*Nuphar variegata*		X	X	X	X
Floating-leaf smartweed	*Persicaria amphibia*					X
	Total	1	3	3	3	5

Appendix 1 (continued)

Free-floating plants

Common Name	Scientific Name	1950	1960	1990	1995	2011
Lesser duckweed	*Lemna* sp.[2]				X	X
Star duckweed	*Lemna trisulca*			X	X	
Greater duckweed	*Spirodela polyhriza*					X
	Total	0	0	1	2	2

Emergent plants

Common Name	Scientific Name	1950	1960	1990	1995	2011
Arrowhead	*Sagittaria* sp.			X	X	X
Bulrush	*Schoenoplectus* sp.[3]					X
Three-square bulrush	*Schoenoplectus pungens*					X
Eastern burreed	*Sparganium americanum*					X
Burreed	*Sparganium* sp.			X[a]	X	
Broad-leaved cattail	*Typha latifolia*		X[a]	X		X
Narrow-leaved cattail[4]	*Typha angustifolia*					X
	Total	0	1	3	2	6

Wetland emergent plants[5]

Common Name	Scientific Name	1950	1960	1990	1995	2011
Blue flag iris	*Iris versicolor*			X		
Reed canary grass (I)	*Phalaris arundinaceae*			X		X
Smartweed	*Polygonum* sp.		X[a]			
Water Dock	*Rumex* sp.			X[a]		
Skullcap	*Scutellaria galericulata*					X
	Total	0	1	3	0	2

I = introduced

X[a] = Plant was identified only to genus level.

[1] narrow-leaf pondweed (*Potamogeton* sp.). This may have been one of several different *Potamogeton* species that have narrow, submerged leaves. In 2011, one narrow-leaved pondweed, *Potamogeton friesii*, was positively identified but it is not known whether all narrow-leaved pondweeds found in that survey were *P. friesii*. Plants identified as *P. friesii* or *Potamogeton* sp. were grouped together for analysis.

[2] a species of duckweed (*Lemna* sp.) was used to record duckweed plants that were not star duckweed (*Lemna trisulca).*

[3] a species of bulrush (*Schoenoplectus* sp.) was used to record bulrush plant that was hard-stem bulrush (*Schoenoplectus acutus*), soft-stem bulrush (*S. tabernaemontani*) or the hybrid.

[4]Narrow-leaf cattail was identified in survey but it is not known whether this included narrow-leaf cattail (*Typha angustifolia*) and/or the hybrid of narrow-leaf and broad-leaf cattail (*Typha x glauca*).

[5]These surveys focused on in-lake aquatic plants and surveyors occasionally recorded some wetland plants. The list of wetland emergent plants was not intended to represent the thorough survey of shoreline plants.

Sources:
1950 (August 23): John Maloney (Crew Leader), MnDNR Fisheries Survey
1960 (August – September): Thomas Bonde (Crew Leader), Howard Knight, Howard Trick, MnDNR Fisheries Survey
1990 (July 2): Wayne Mueller (Crew Leader), MnDNR Fisheries Survey
1995 (June 27): MnDNR Fisheries Survey
2011 (August): Simon, Perleberg, Eininger, Point Intercept survey, MnDNR Division of Ecological and Water Resources

Appendix 2: Calculation of plant abundance

Frequency of occurrence was calculated as the percent of sites, within a specific depth zone, where a plant species was detected. Unless otherwise noted, frequency values were calculated for the 0 to 25 feet depth zone.

Example:

In Island and Loon lakes there were 142 sample sites in the 0 to 25 feet depth zone.
Coontail occurred in 57 sites.
Frequency of Coontail in 0 to 25 feet zone = (57/142)*100 = 40%