Aquatic Vegetation of
Upper Gull Chain of Lakes
Cass and Crow Wing Counties, Minnesota
2008

Spider Lake in the Upper Gull chain of lakes, June 2008

Upper Gull (DOW 11-0218-00)
Ray (DOW 11-0220-00)
Spider (DOW 11-0221-00)
Roy (DOW 18-0398-00)
Nisswa (DOW 18-0399-00)

Report by: Donna Perleberg[1] and Stephanie Loso
Minnesota Department of Natural Resources
Division of Ecological Resources
1601 Minnesota Dr., Brainerd, MN 56401
[1]Phone: 218.833.8727
Email: donna.perleberg@dnr.state.mn.us

Lake sampling: Donna Perleberg, Aquatic Plant Ecologist
Stephanie Loso, Aquatic Biologist
Kevin Mortensen, Student Intern
Michael Kobberdahl, Student Intern

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Report review: Kevin Mott, Aquatic Plant Management Specialist, MnDNR Fisheries, Brainerd
Tim Brastrup, MnDNR Area Fisheries Manager, Brainerd
Chip Welling, Eurasian Watermilfoil Program Coordinator, MnDNR Ecological Resources, St. Paul

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Summary

The Upper Gull chain of lakes includes Upper Gull, Ray, Spider, Roy and Nisswa lakes. These water bodies support abundant and diverse aquatic plant communities. A total of 39 native aquatic plant taxa were recorded including ten emergent, four floating-leaved, seven free-floating and 18 submerged plants. One non-native species, curly-leaf pondweed (*Potamogeton crispus*) was identified.

Aquatic plants occurred around the entire perimeter of each lake. Emergent beds of wild rice (*Zizania palustris*) and hard-stem bulrush (*Scirpus acutus*) as well as floating-leaf beds of white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*) covered more than 200 acres.

Submerged plants were found to an average depth of 18 feet in the chain of lakes. Plants occurred to 20 feet in Ray, 19 feet in Nisswa, 18 feet in Spider and Roy and to 16 feet in Upper Gull Lake, but in all lakes plant occurrence was sparse beyond the depth of 15 feet. Plant occurrence was greatest in depth less than 11 feet, where vegetation was found in at least 80 percent of the sample sites.

The most frequently occurring submerged and free-floating species in these lakes were coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), flat-stem pondweed (*Potamogeton zosteriformis*), greater bladderwort (*Utricularia vulgaris*), broad-leaf pondweeds (*Potamogeton sp*.), and star duckweed (*Lemna trisulca*).

The non-native species, curly-leaf pondweed (*Potamogeton crispu*s) occurred in all five lakes, but occurred less frequently than many of the native plant species. It occurred with a frequency of six percent in Upper Gull Lake, eight percent in Ray Lake, 18 percent in Spider Lake, 13 percent in Roy Lake, and 18 percent in Nisswa Lake. Curly-leaf pondweed was most common in water depths of 6 to ten feet and often co-occurred with the common native species.

Introduction

The Upper Gull chain of lakes is located about 1.5 miles northwest of the city of Nisswa, in north-central Minnesota. The chain of lakes occurs in the eastern portion of the Crow Wing River Watershed (Figure 1). The five lakes included in the Upper Gull chain are Nisswa, Roy, Spider, Ray and Upper Gull.

Water drains into the chain on both the eastern end at inlets to Nisswa Lake and the western end at inlets to Upper Gull Lake. Flow is westward from Nisswa Lake through Roy, Spider, and Ray and then to Upper Gull Lake (Figure 2). Upper Gull Lake drains southward into Gull Lake that empties to the Gull River, and flow continues to the Crow Wing River.

Figure 1. Location of the Gull Lake Chain in Cass and Crow Wing Counties, Minnesota.

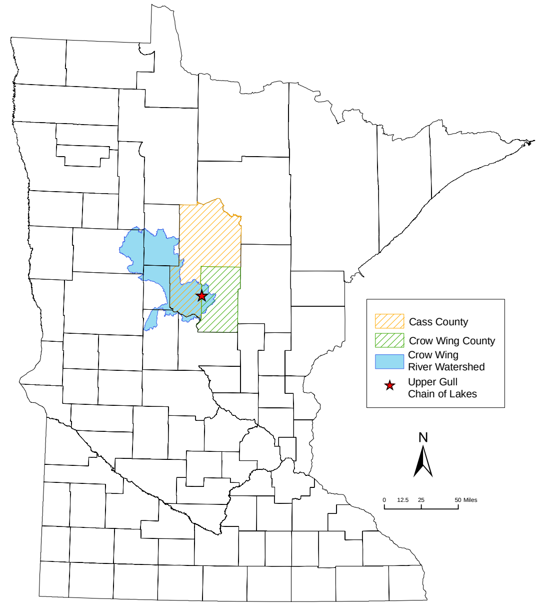
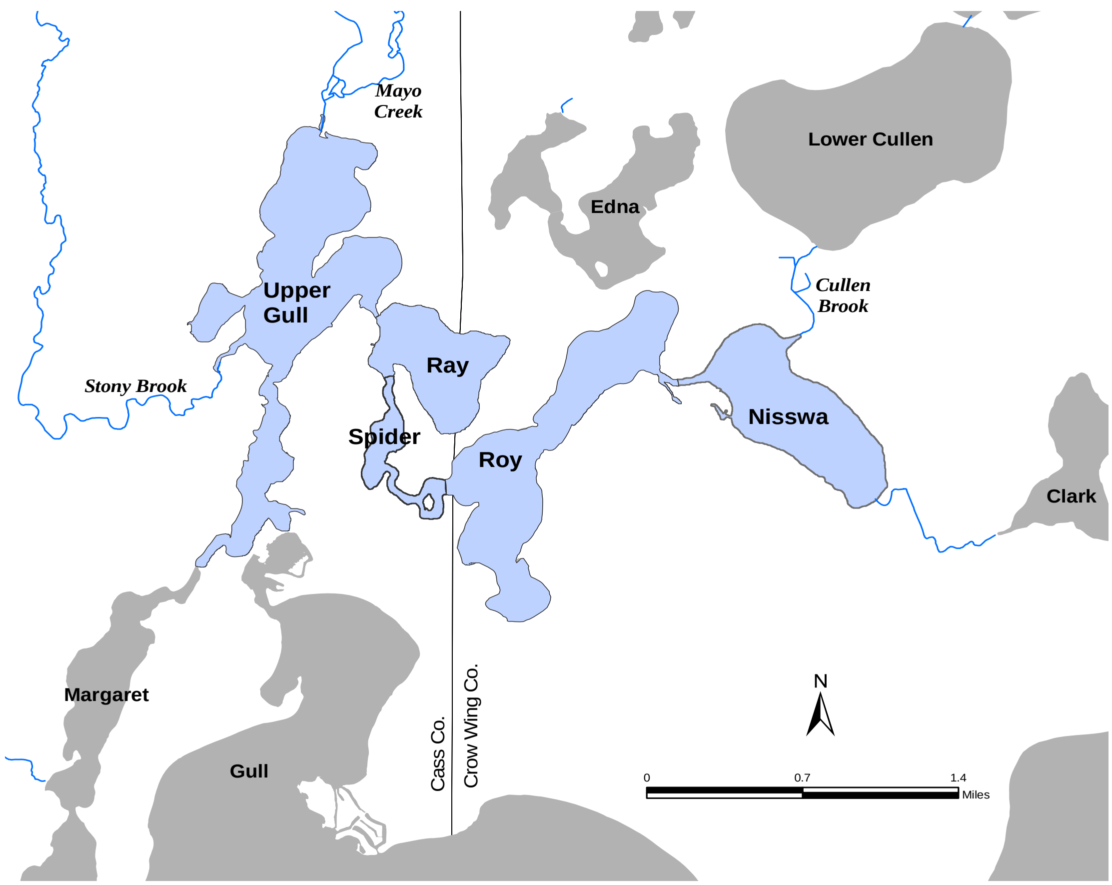


Figure 2. Flow through Upper Gull Lake chain from Nisswa Lake to Gull Lake.



The Upper Gull chain of lakes covers a total of 1,070 surface acres. Upper Gull is the largest and deepest waterbody with a surface area of 371 acres and a maximum depth of 54 feet. The other lakes are less than 300 acres in surface area and less than 30 feet in depth (Table 1, Figure 3).

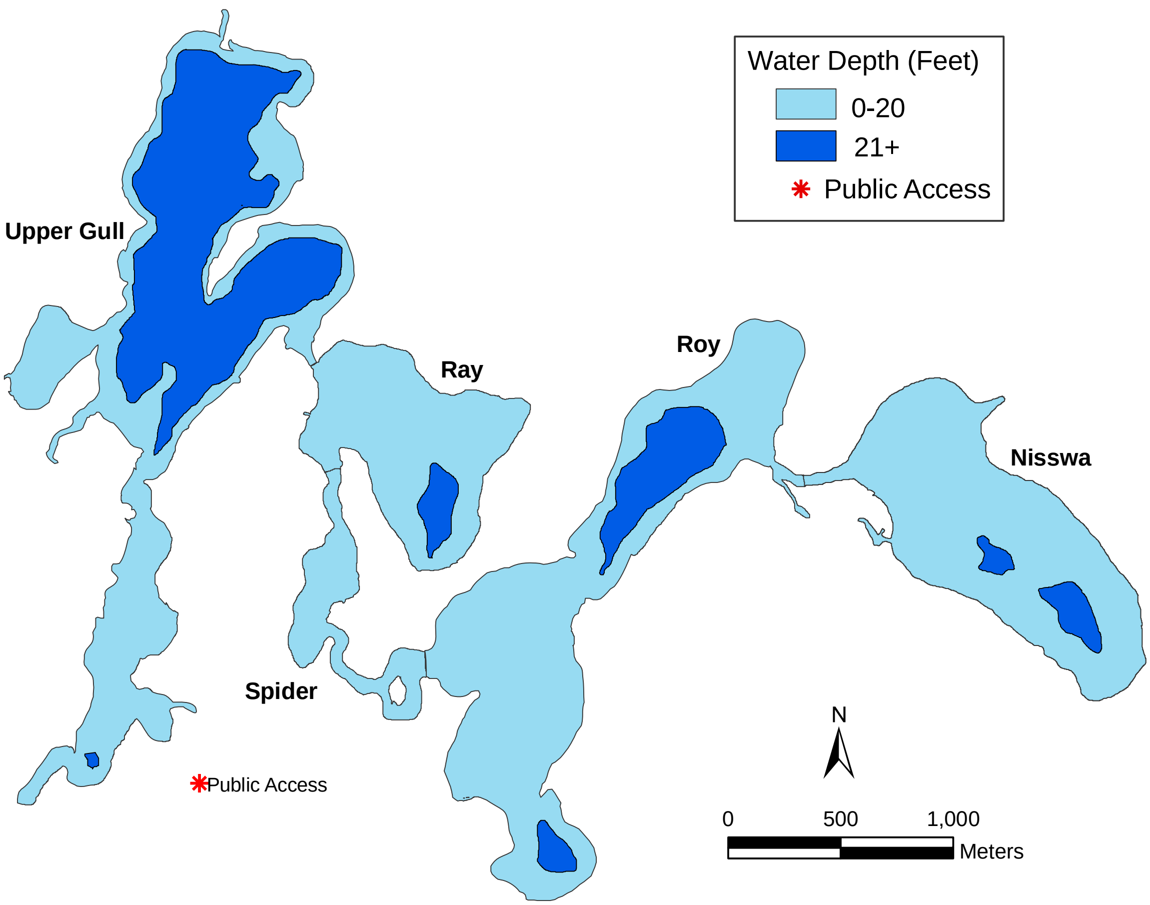
The lakes vary in trophic status from mesotrophic (moderately nutrient enriched) to eutrophic (highly nutrient enriched) and the previous mid-summer Secchi disk readings range from six to 11 feet (MPCA 2007).

Table 1. Physical characteristics of lakes in the Upper Gull chain.

	Surface Area (Acres)	Maximum depth (feet)
Upper Gull	371	54
Ray	136	27
Spider	85	17
Roy	271	26
Nisswa	207	23
Entire chain	1,070	

The Secchi disc transparency measures the depth to which a person can see into the lake and provides an estimate of the light penetration into the water column. 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 might be expected to grow to depths of nine to 17 feet in these lakes. Other factors that may

Figure 3. Depth contours of Upper Gull chain of lakes, Cass and Crow Wing County



influence the depth of plant growth include substrate types, wind fetch, and plant species composition.

The shorelines of the Upper Gull chain of lakes are heavily developed with private homes and resorts but uplands remain primarily forested and large wetland tracts occur on the north end of Nisswa Lake and the south end of Roy Lake. There is a public boat launch on Upper Gull and navigable channels exist between all of the lakes in the chain.

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the spring 2008 plant population of the Upper Gull chain of lake. Specific objectives included:

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

Because this survey was conducted in the spring, before native plants reach maximum growth, the distribution and abundance of some native plant species may be underestimated.

Methods

Floating-leaf and emergent vegetation

Many of the near-shore, shallow areas of these lakes contain extensive beds of emergent and floating-leaf vegetation. To avoid damage to these plant beds, surveyors did not motor into these sites. Farm Service Administration (FSA) true color aerial photographs (2003-2004) were used to delineate beds of floating-leaved and broad-leaf emergent vegetation, such as wild rice. Bulrush beds cannot be seen on aerial photos and were not mapped as part of this survey.

In-lake vegetation survey

A vegetation survey of the Upper Gull chain of lakes was conducted in early June 2008 (Table 2). A Point-intercept survey method was used and followed the methods described by MnDNR (2008) and Madsen (1999). Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a hand-held Global Positioning System (GPS) receiver. Survey points were spaced 65 meters apart, resulting in about one survey point per acre. Two field crews, each consisting of one boat and two surveyors, conducted the survey. In the field, surveyors did not find vegetation beyond a depth of 20 feet and therefore sampled all survey points between shore and a depth of 20 feet and only a selected number of points in deeper water. A total of 762 points were surveyed and 754 points occurred between shore and the 20 feet depth (Table 2, Figure 4).

Figure 4. 2008 vegetation survey sites on Upper Gull chain of lakes.

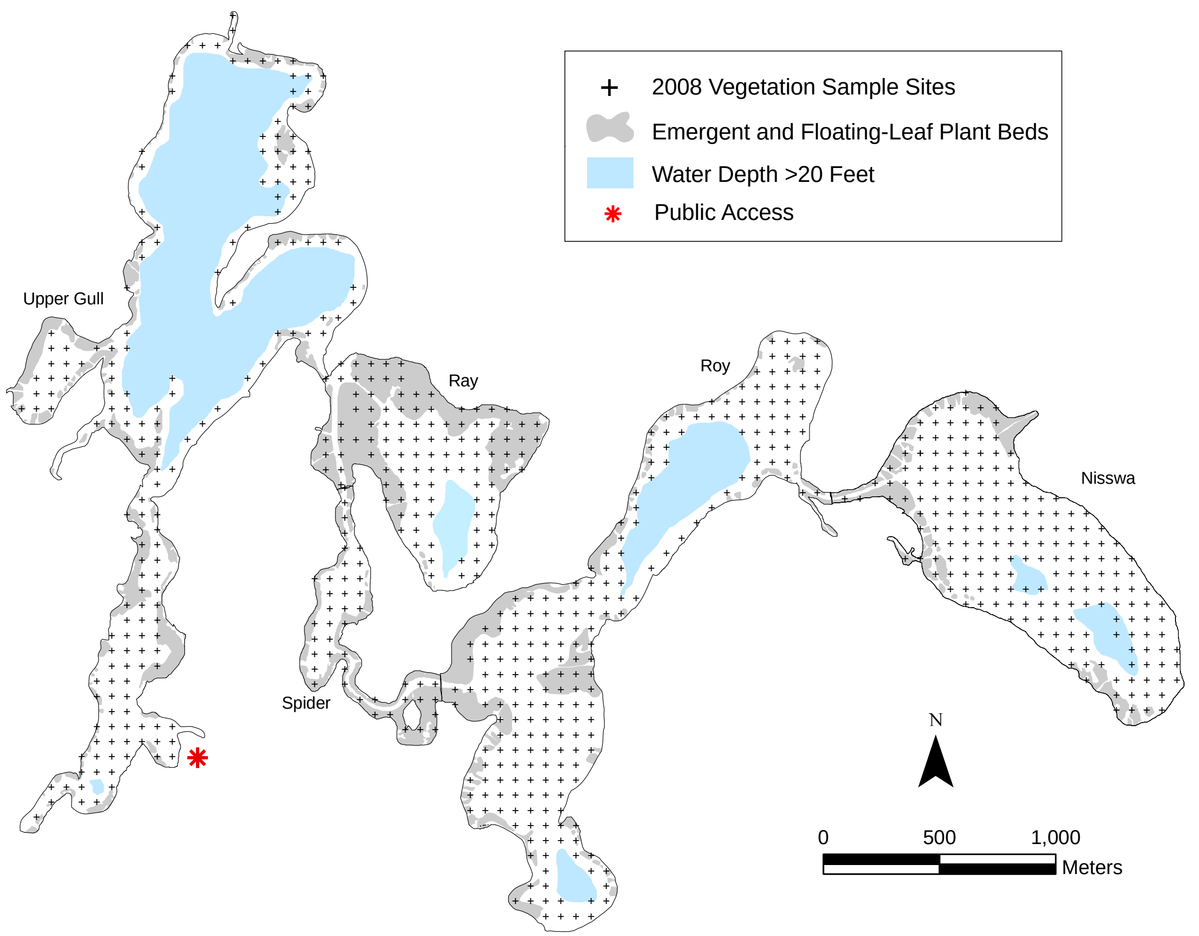


Table 2. Survey dates and sampling effort by water depth, Upper Gull chain of lakes, 2008.

	Number of sample points					
Depth interval in feet	Upper Gull	Ray	Spider	Roy	Nisswa	All
0 to 5	67	64	26	87	67	311
6 to 10	39	15	8	20	17	99
11 to 15	43	14	7	39	61	164
16 to 20	22	18	3	85	52	180
21 to 25	4	0	0	0	4	8
Total number of sample points	171	111	44	231	197	762
Survey Date(s)	June 3-4	June 12	June 12	June 9-10	June 9	

Surveyors navigated to each sample point using the GPS unit. One side of the boat was designated as the sampling area. At each site, water depth was recorded to the nearest foot using an electronic depth finder or a measuring stick. The surveyors recorded all plant species found within one-meter square sample site on 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 surface (Figure 5). Plant identification and nomenclature followed Crow and Hellquist (2000).

Figure 5. Sampling rake.

At each sample site where water depth was six feet or less, surveyors described the bottom substrate using standard substrate classes (Table 3).

Table 3. 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

Data were entered into a Microsoft Access database and frequency of occurrence was calculated as the number of sites in which a species occurred divided by the total number of sample sites. Frequency was calculated for each species in each individual lake as well as for the entire chain of lakes.

For submerged and free-floating species, frequency was calculated for the entire area from shore to 20 feet. In addition, sampling points were grouped by water depth into four depth zones for analysis (Table 2). For floating-leaved and emergent species, frequency was calculated for the entire area from shore to 20 feet and sampling points were also grouped by water depth into four depth zones for analysis (Table 2). Because emergent and floating-leaved species did not grow beyond a depth of six feet, frequency within the shore to five feet depth zone was reported.

Example: Frequency calculations for coontail and wild rice in specific areas of the chain of lakes

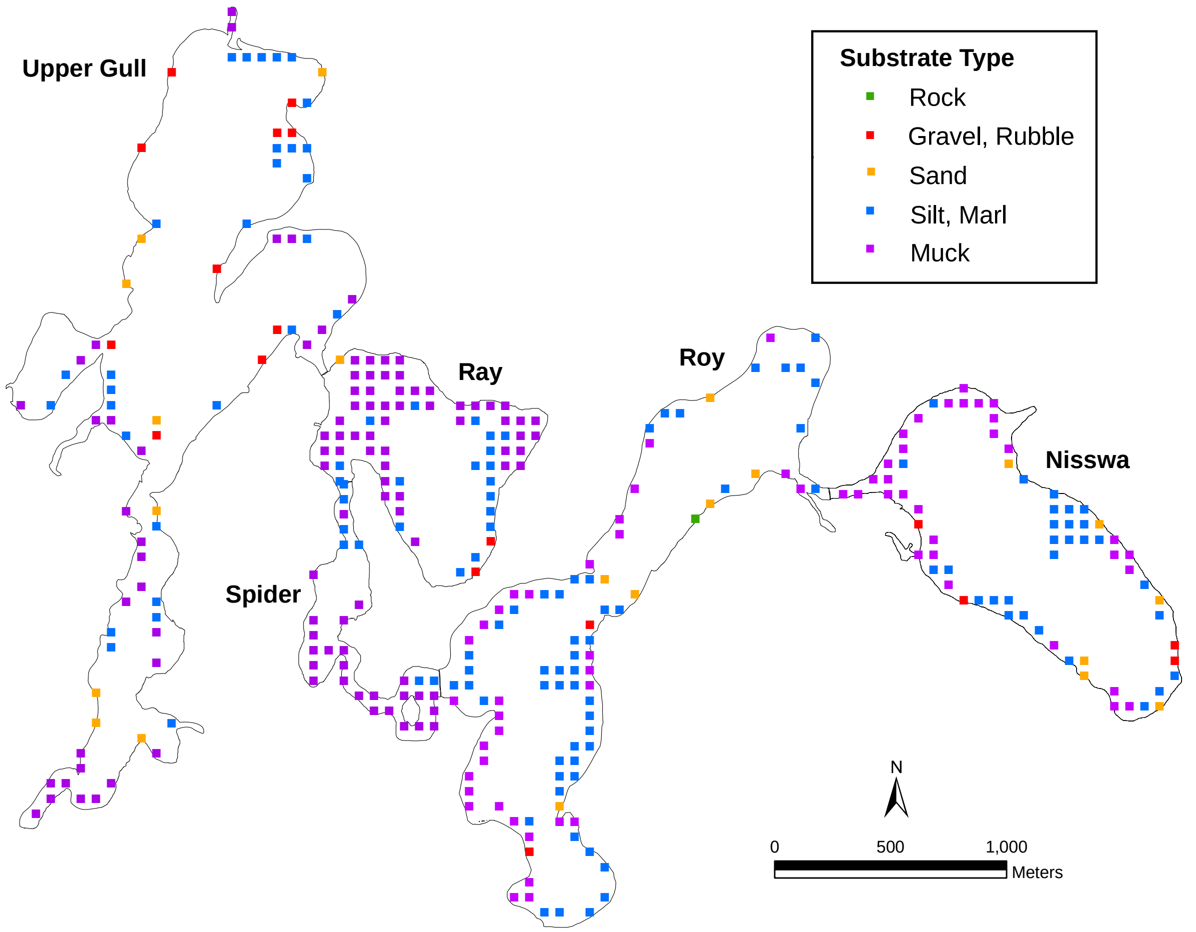
Area of interest	Number of sample sites	Species of interest	Number of sites where species of interest occurred	Calculation	Frequency of occurrence
Nisswa Lake, shore to 20 feet depth zone	197	Coontail	84	84 / 197 x 100	43%
Entire chain of lakes, shore to 20 feet depth zone	754	Coontail	296	296 / 754 x 100	39%
Entire chain of lakes, shore to 6 feet depth zone	337	Wild rice	101	101 / 337 x 100	30%

Results

Shoal substrates

Shallow water sites (shore to a water depth of six feet) had predominantly soft substrates of silt, marl and muck (Figure 6). Hard substrates of sand, gravel, rubble and rock were scattered around the lakes (Figure 6).

Figure 6. Shoal substrates of Upper Gulls chain of lakes.



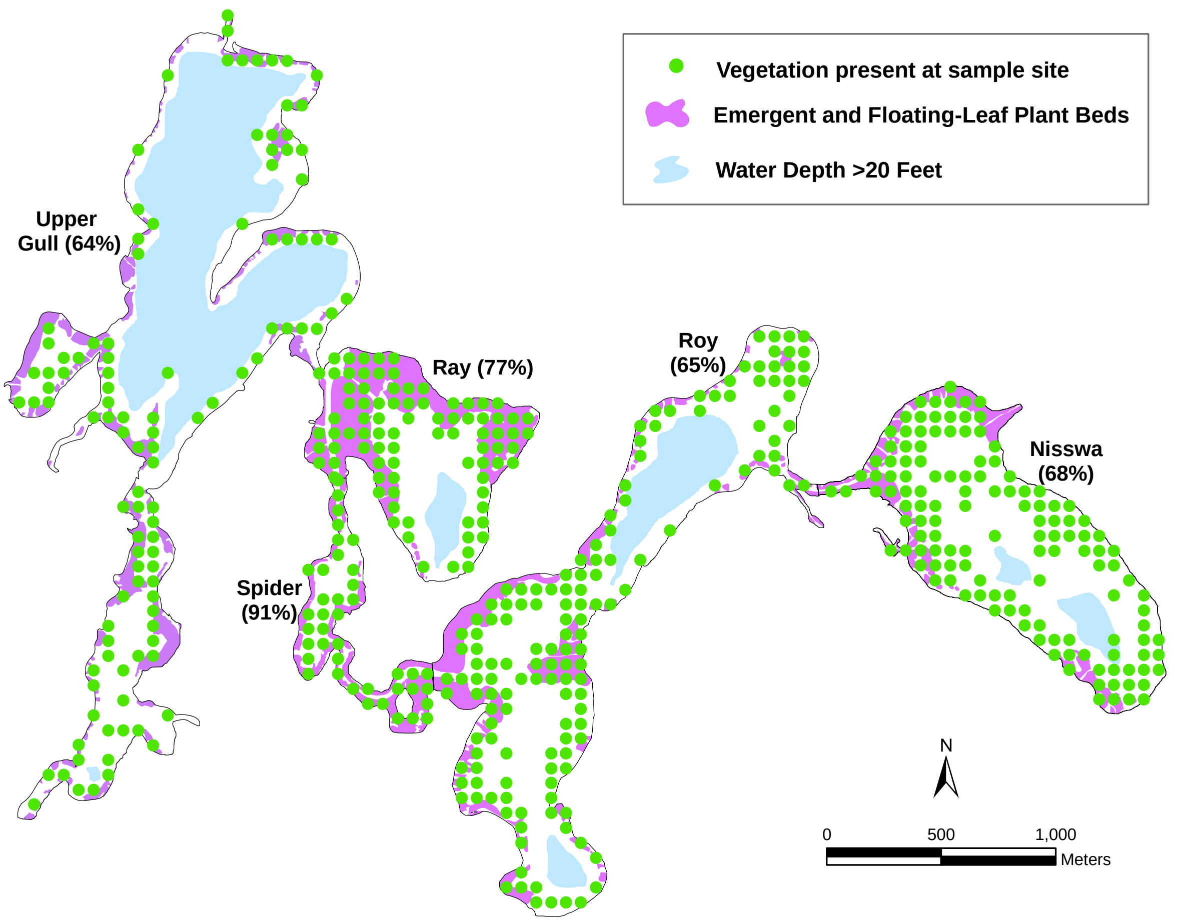
Number and types of plants recorded

A total of 39 native aquatic plant taxa were recorded in the Upper Gull chain of lakes including ten emergent, 4 floating-leaved, 7 free-floating and 18 submerged plants (Tables 4 and 5). Submerged plants included two types of large algae, an aquatic moss, and numerous flowering plants. One non-native submerged species; curly-leaf pondweed (*Potamogeton crispus*) was identified.

Plant abundance and distribution

Approximately 65 percent of the Upper Gull Lake chain is less than 20 feet in depth (Figure 3) and can potentially support aquatic vegetation. Within those shallow areas, during the spring 2008 survey, vegetation occurred in 68 percent of the sites. Plants occurred around the entire perimeter of each lake (Figure 7). In shallow areas, such as the northwest end of Ray Lake, vegetation extended across the entire bay. Spider Lake contained the highest percent (91 percent) of vegetated sites within the shore to 20 feet depth zone and Roy contained the lowest percent (65 percent).

Figure 7. Aquatic plant distribution in Upper Gull Chain of Lakes, June 2008. Percentage of vegetated sites in shore to 20 feet zone shown in parentheses).



Plant distribution and abundance were influenced by water depth and plant occurrence decreased with increasing water depth (Figure 8). Vegetation occurred to depth of 16 feet in Upper Gull Lake, 14 feet in Ray Lake, 18 feet in Spider Lake, 18 feet in Roy Lake, and 19 feet in Nisswa Lake, but plant occurrence was sparse beyond the depth of 15 feet (Figure 8). In all five lakes, plant occurrence was greatest in depth less than 11 feet, where vegetation was found in 80 to 90 percent of the sample sites.

Most species were restricted to water depths less than ten feet and the highest number of plant species was found from shore to a depth of five feet (Figure 9). Emergent plants were found to

Figure 8. Plant abundance vs. water depth. (percent of all vegetated sites shown in parenthesis)

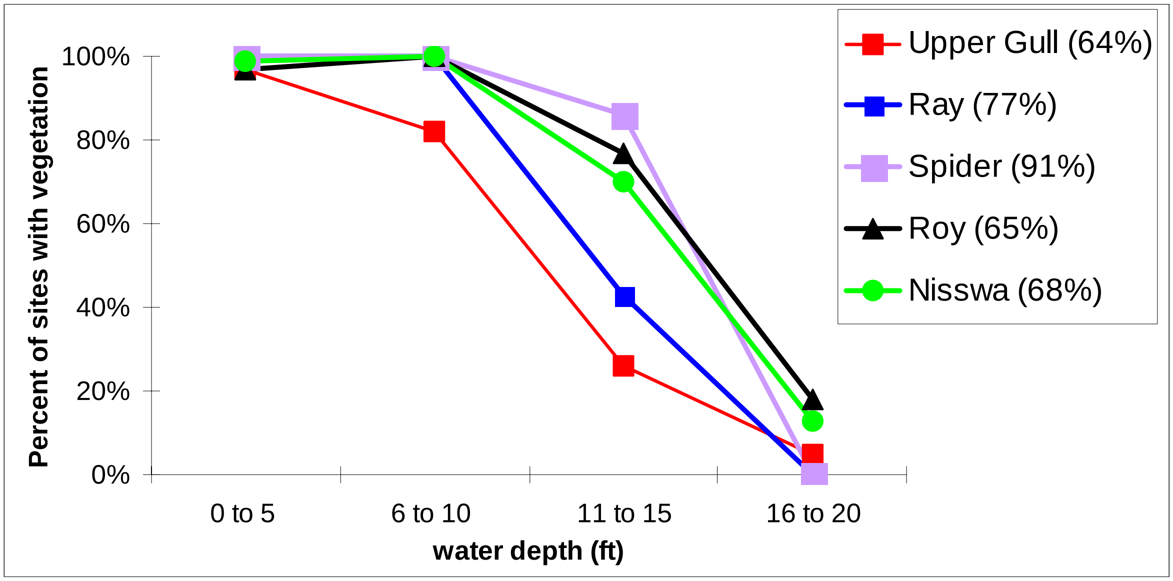
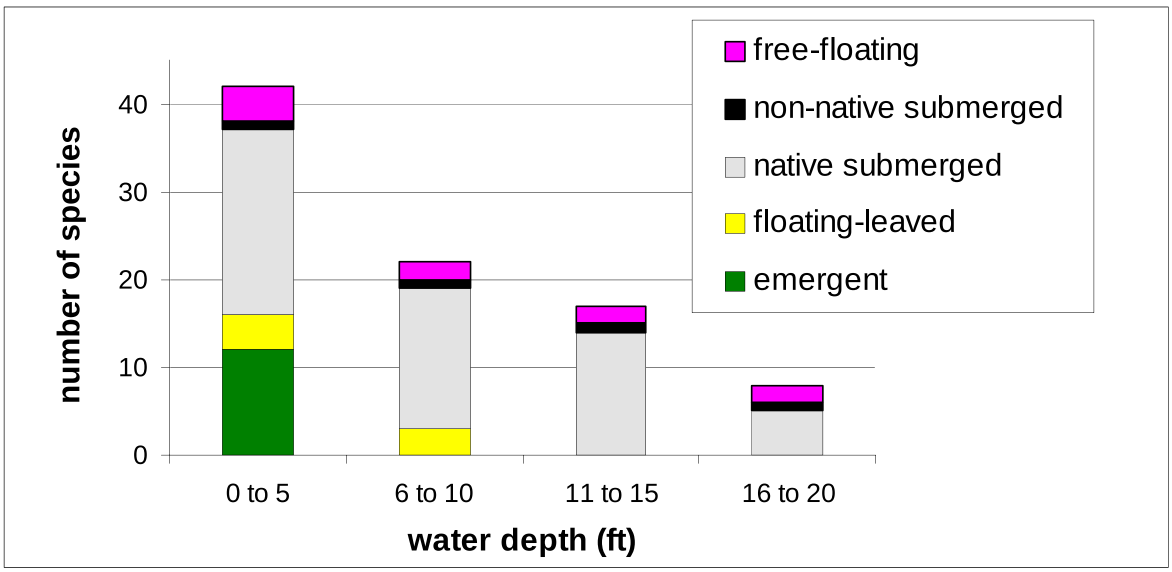


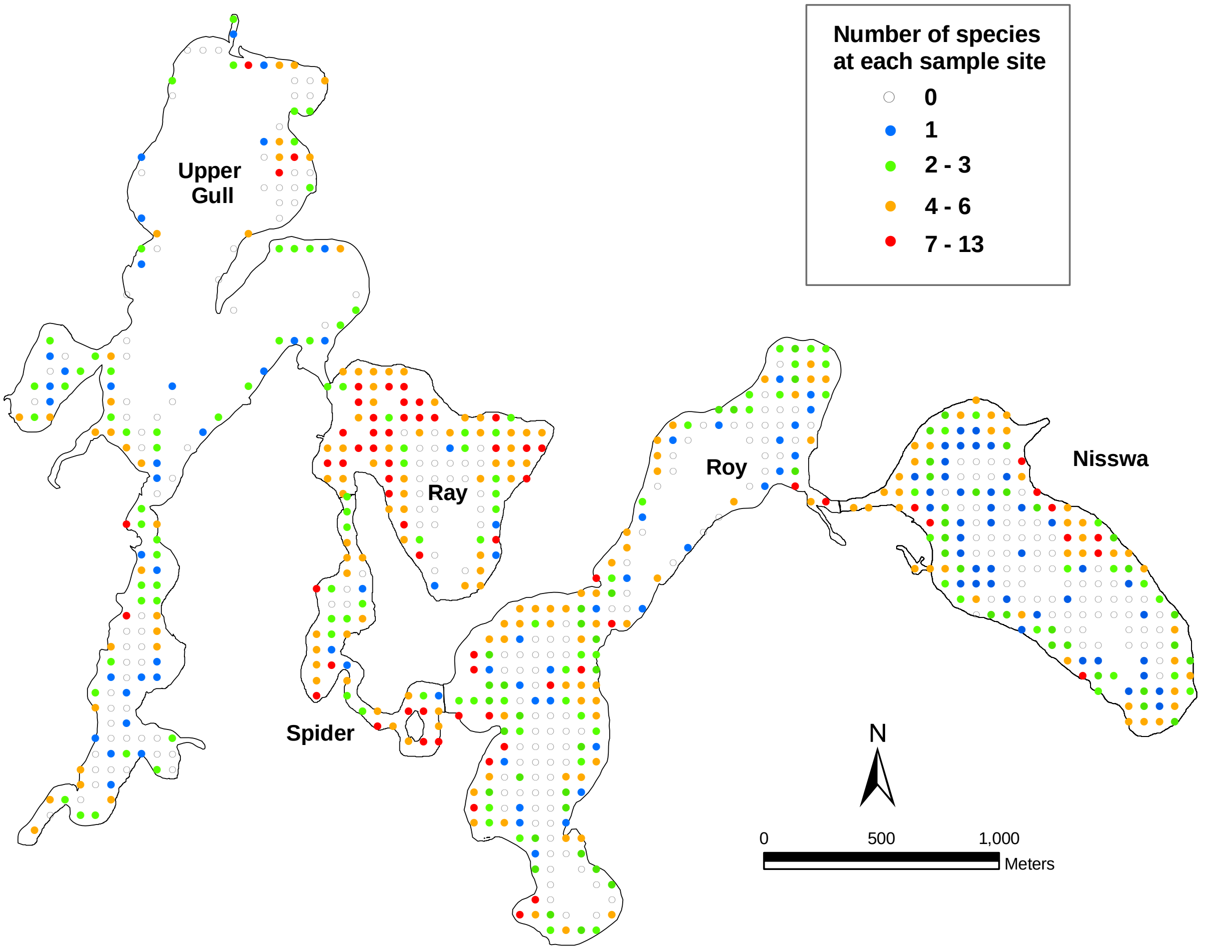
Figure 9. Number of plant species at each water depth.



five feet and floating-leaf plants occurred to six feet. Only six submerged species and two free-floating species were found in depths greater than 16 feet.

The number of different plant species found at each survey site ranged from zero to 13 and the mean number of species found per site was three. The highest concentration of species-rich sites occurred in Ray Lake and Spider Lake, where 25 percent and 18 percent of the survey sites, respectively, contained at least seven species (Figure 10).

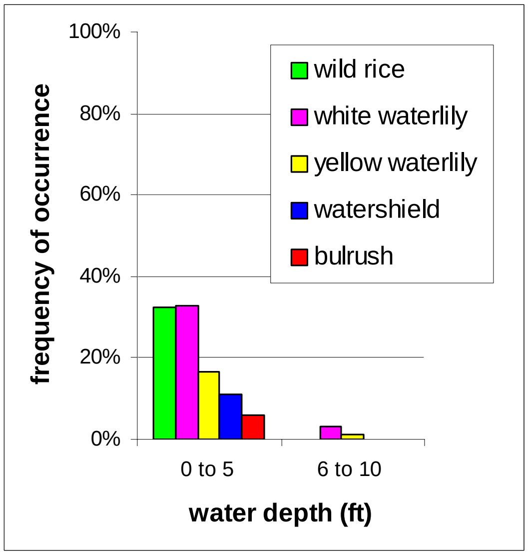
Figure 10. Number of plant species observed at each sample site in Upper Gull chain of lakes, June 2008.



Emergent and floating-leaved species
Over 200 acres of the Upper Gull chain of lakes contain emergent and floating-leaf plant beds (Figure 7). The most extensive beds occurred in the north end of Ray Lake, in Spider Lake, and the shallow bays of the other lakes.

Wild rice (*Zizania palustris*) was the most common emergent plant found and occurred in 30 percent of all sites between shore and the six feet depth (Figure 11). It was most frequent in Ray and Spider lakes, where it was found in 52 percent and 42 percent of the shallow sites, respectively (Table 5). These numbers likely underestimate the actual occurrence of wild rice in these lakes

Figure 11. Abundance of common floating-leaved and emergent species vs. water depth.



because surveyors did not sample dense areas of wild rice in order to avoid unnecessary damage to the plants. During the June 2008 field survey, wild rice was primarily in the early floating-leaf stage (Figure 12).

Hardstem bulrush (*Scirpus acutus*) (Figure 13) occurred in six percent of sites in the shore to six feet depth zone (Table 5). As with wild rice, this is likely an underestimate of the actual occurrence of bulrush in these lakes because of the early timing of the survey.

Floating-leaf plants (Figure 14) included white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegata*), watershield (*Brasenia schreberi*), and floating-leaf pondweed (*Potamogeton natans*). In the shore to six feet depth zone, 39 percent of the sites contained at least one floating-leaf species.

Bulrush, wild rice and other emergent aquatic plants offer shelter for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats. Waterlily beds provide similar benefits and also provide shade for fish and frogs. Emergent and floating-leaf plants help buffer the shoreline from wave action and their root systems stabilize the lake bottom.

Figure 12. Floating stage of wild rice (*Zizania palustris*).

Figure 13. Bulrush (*Scirpus*) in Ray Lake, 2008.

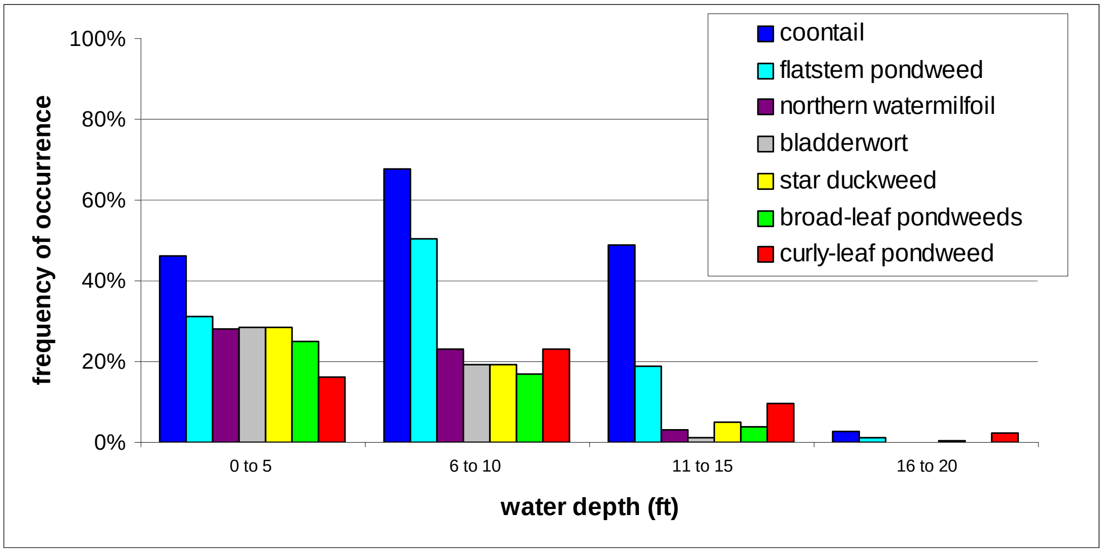
Figure 14. Yellow waterlily (*Nuphar*) and watershield (*Brasenia*) in Spider Lake, 2008.

Figure 15. Wildlife use of emergent and floating-leaf vegetation in Upper Gull chain, spring 2008.

Submerged and free-floating species

The most frequently occurring submerged and free-floating species in these lakes were coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*), star duckweed (*Lemna trisulca)*, greater bladderwort (*Utricularia vulgaris)*, and broad-leaved pondweeds (P*otamogeton* spp.). The non-native species, curly-leaf pondweed (*Potamogeton crispus*) occurred in all five lakes, but was not among the most frequently sampled plants in any of the lakes. The abundance of each of these species varied with water depth (Figure 16).

Figure 16. Abundance of common submerged and free-floating species vs. water depth.



Coontail *(Ceratophyllum demersum)* is the most common submerged flowering plant in Minnesota. This perennial grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. The finely dissected leaves of coontail provide habitat for invertebrates and its dense growth form is excellent cover for fish. It is often found growing in deeper water than other native species because it is more tolerant of low light conditions.

Coontail was found in 39 percent of Upper Gull chain survey sites, ranging from 32 percent occurrence in Roy Lake to 52 percent in Spider Lake (Table 4, Figure 17). It was the most frequent plant found at each water depth zone and was one of only four species found in depths greater than 15 feet (Figure 16).

Flat-stem pondweed *(Potamogeton zosteriformis)* is a rooted, perennial submerged plant with grass-like leaves. Flat-stem pondweed grows entirely submerged except for the flower and fruit stalks which emerge out of the water. Waterfowl feed on the fruits and tubers of these plants and the foliage is important fish cover.

In the Upper Gull chain of lakes, it occurred in 24 percent of the survey sites (Table 4, Figure 18). It was most common in depths of 12 feet or less (Figure 16) and often occurred in mixed beds with coontail, Canada waterweed and northern watermilfoil.

Figure 17. Distribution of coontail (*Ceratophyllum demersum*)

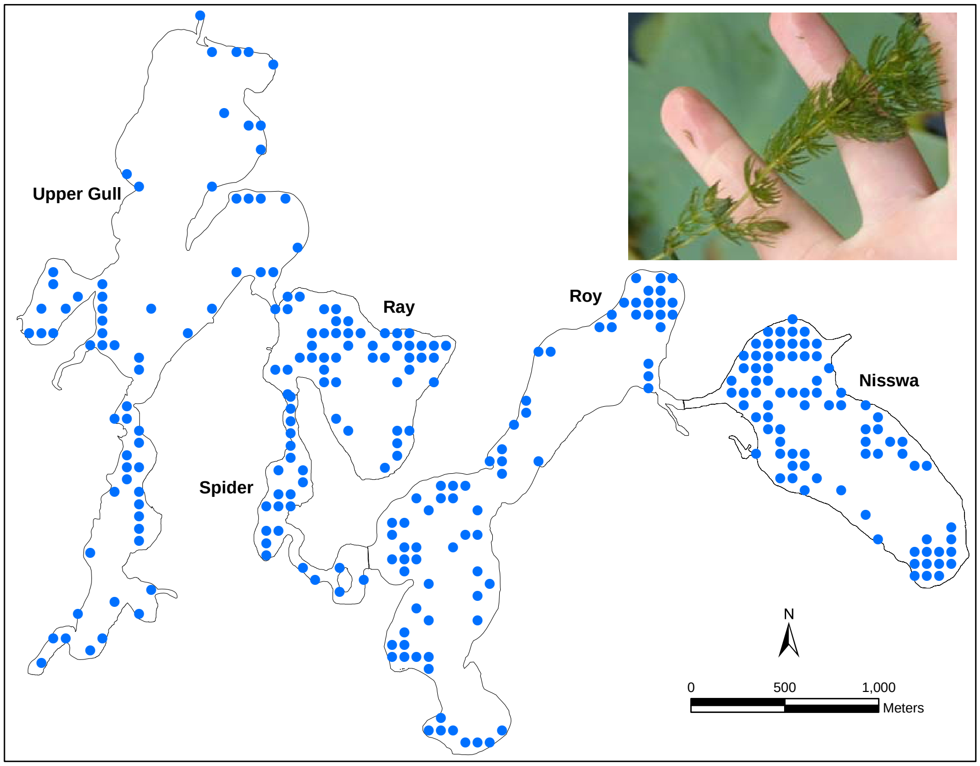
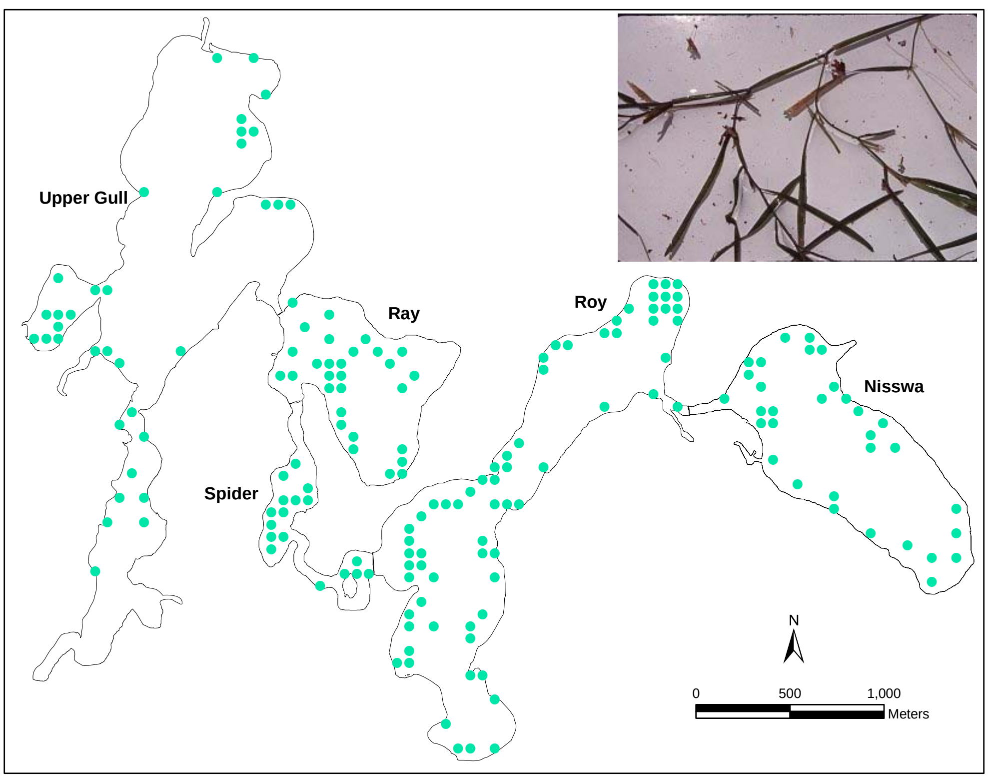


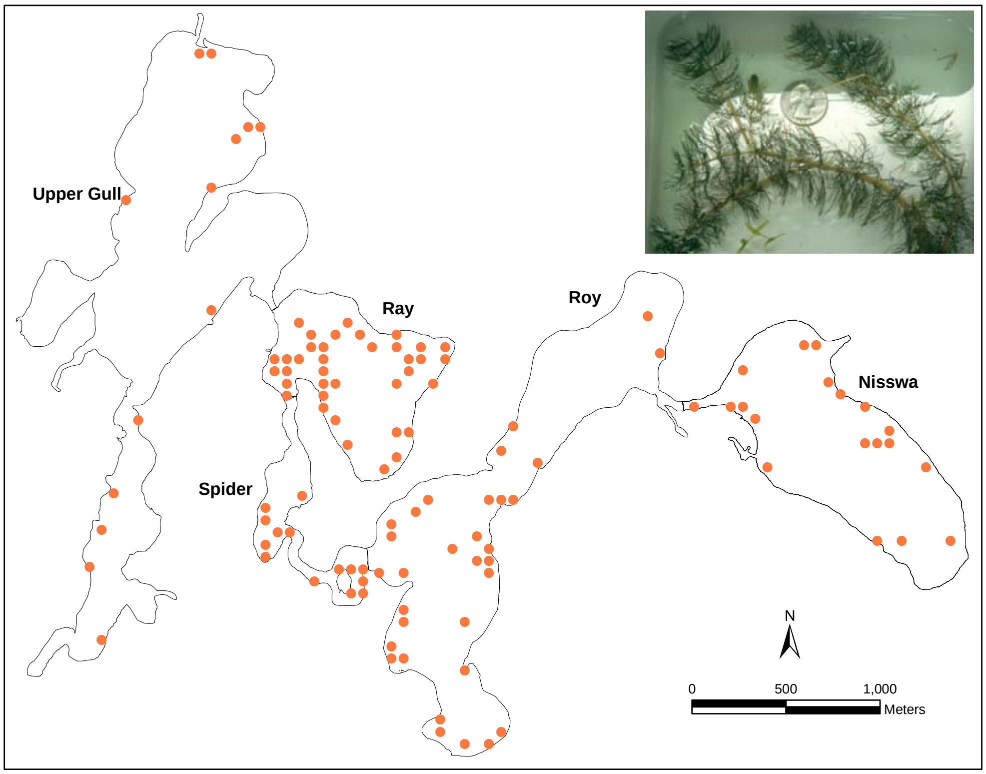
Figure 18. Distribution of flat-stem pondweed (*Potamogeton zosteriformis*)



Northern watermilfoil (*Myriophyllum sibiricum*) is a rooted, perennial submerged species that prefers soft substrates and is not tolerant of turbidity. Like coontail, it has finely dissected leaves but can be distinguished by its feather-shaped leaves that are characteristics of watermilfoil plants. Northern watermilfoil is native to Minnesota and provides valuable fish and wildlife habitat.

Northern watermilfoil was found in 15 percent of the Upper Gull chain of lakes sites and was most common in Ray and Spider lakes (Table 4, Figure 19). It was most frequent in water depths of shore to ten feet depth zone where it occurred in at least 20 percent of the survey sites (Figure 16).

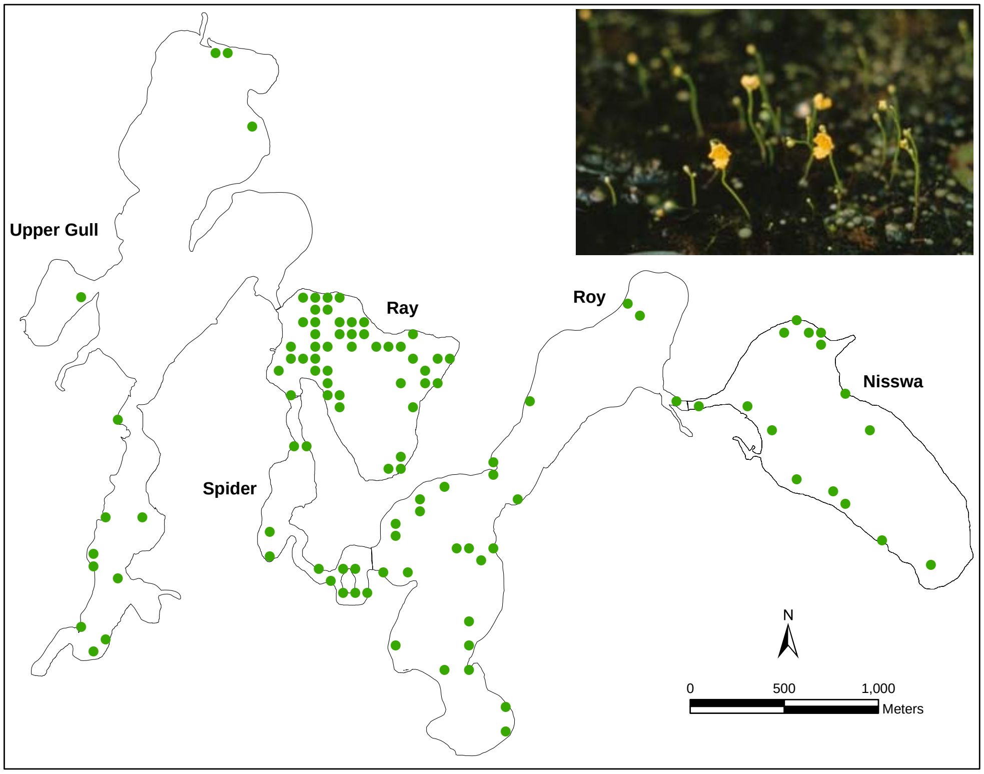
Figure 19. Distribution of northern watermilfoil *(Myriophyllum sibiricum)*



Greater bladderwort (*Utricularia vulgaris*) is an entirely submerged plant except during bloom when its small, showy yellow flower extends above the water. This plant is weakly rooted to the substrate and may drift freely through the water column. Bladderwort is tolerant of turbid water. It reproduces by fragments and winter buds that can float to new areas of the lake. Bladderwort is an insectivorous plant and uses its small "bladders" to trap invertebrates.

Greater bladderwort was found in 14 percent of all of the survey sites (Table 4) but was most common in Spider and Ray Lakes and protected bays of the other lakes (Figure 20).

Figure 20. Distribution of greater bladderwort *(Utricularia vulgaris)*.



Star duckweed (*Lemna trisulca*) is a free-floating species that often occurs submerged near the lake bottom but it does not anchor to the substrate and can float freely with the current. This plant was present in 16 percent of the Upper Gull chain of lakes survey sites (Table 4). It was most common in the southern half of Upper Gull Lake, and the west shores of Roy, Spider and Nisswa lakes (Figure 21). This plant was most often found in water depths of ten feet and less (Figure 16).

Broad-leaf pondweeds (*Potamogeton* spp.*)* often called "cabbage" plants by anglers, are rooted, submerged perennial plants with wide leaves. The fruits of pondweeds are a favorite duck food and the broad leaves provide shelter for fish.

Broad-leaf pondweeds found in the Upper Gull chain of lakes include large-leaf pondweed (*Potamogeton amplifolius*), Illinois pondweed (*P. illinoensis*), white-stem pondweed (*P. praelongus*), and clasping-leaf pondweed (*P. richardsonii*). Thirteen percent of the survey sites contained at least one broad-leaf pondweed species (Figure 22, Table 4). Broad-leaf pondweeds were well distributed around the lake and were most often found in depths of ten feet and less (Figure 16).

Figure 21. Distribution of star duckweed *(Lemna trisulca)* (Photo: Robert Freckman, Univ. of Wisconsin).

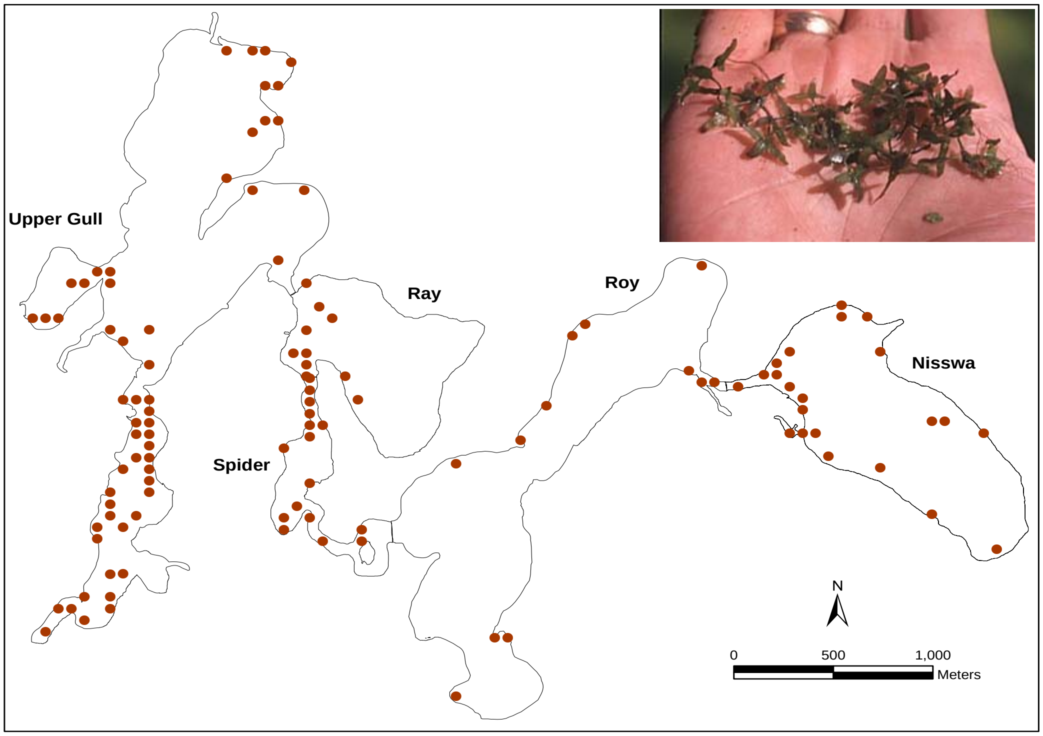
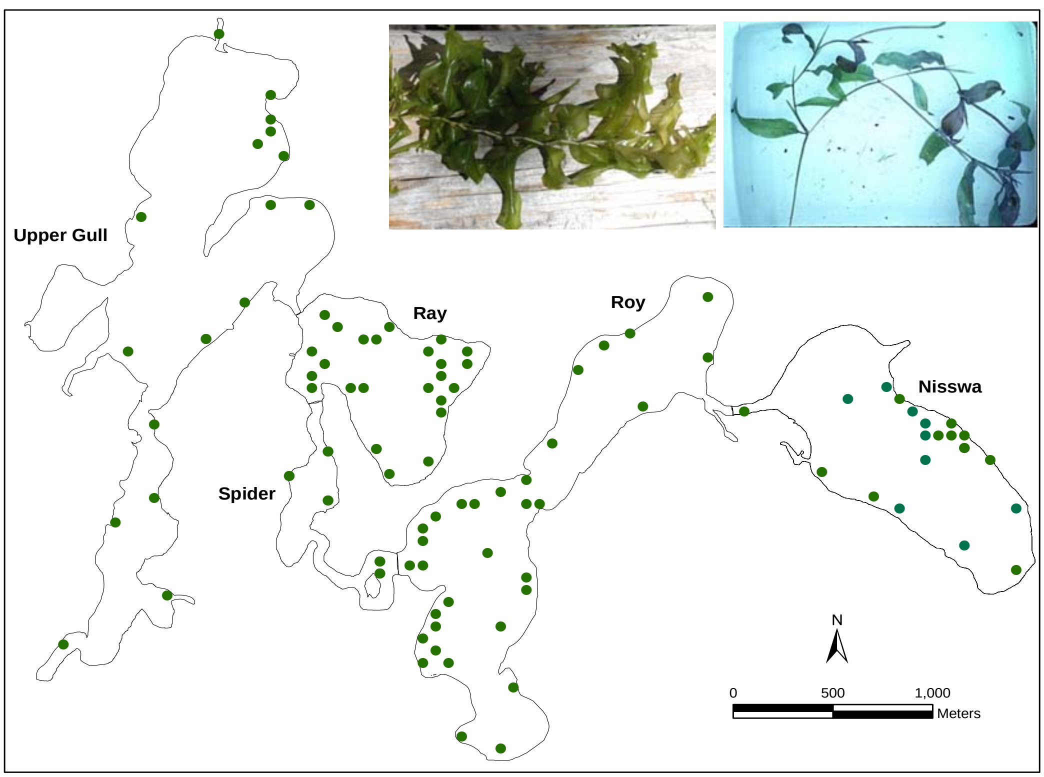


Figure 22. Distribution of broad-leaf pondweeds *(Potamogeton* spp.*)*
Left photo © 2006 Dean Wm. Taylor, Ph.D. / Right photo: Robert Freckman, Univ. of WI)



Curly-leaf pondweed (*Potamogeton crispus*) 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 at least 700 Minnesota lakes (Invasive Species Program 2005). Like many native submerged plants, it is perennial but 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 (Figure 23). 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 present in 12 percent of the Upper Gull chain of lakes. Its frequency ranged from six percent occurrence in Upper Gull Lake to 18 percent in Spider Lake (Table 4). Curly-leaf pondweed was most common in water depths of six to ten feet but did not dominate the plant community at any water depth (Figure 16). It was scattered around the shoreline (Figure 24) and often co-occurred with native plant species.

Figure 23. Life cycle of Curly-leaf pondweed (*Potamogeton crispus*).

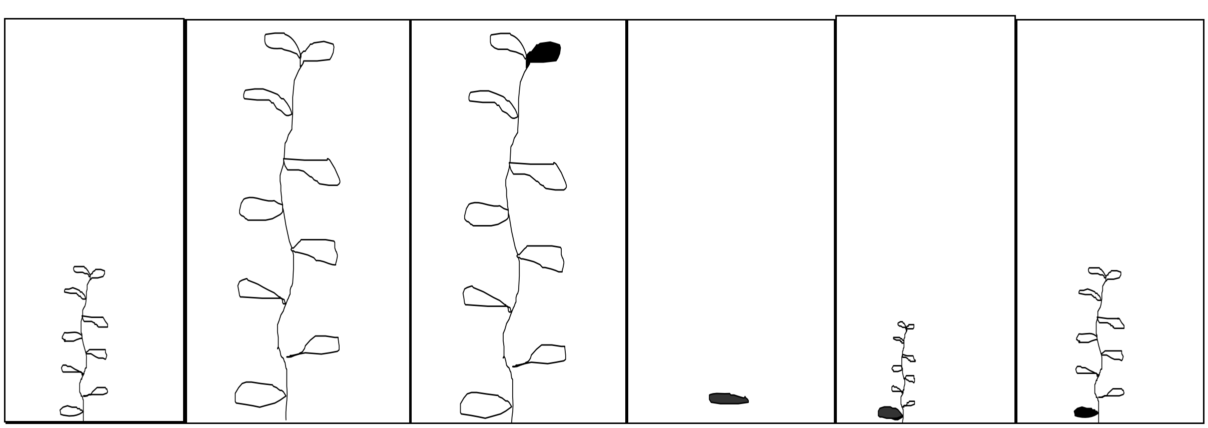
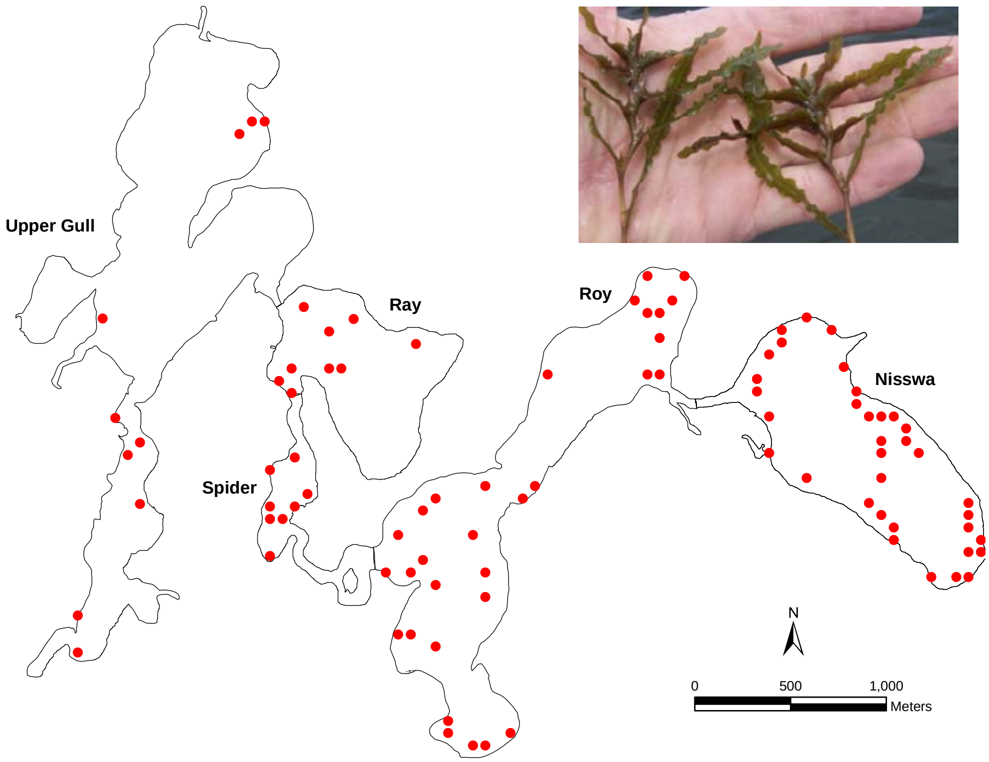


Figure 24. Distribution of curly-leaf pondweed *(Potamogeton crispus)*.



Discussion

The Upper Gull chain of lakes supports abundant and diverse native plant communities. Native vegetation provides critical habitat for fish and invertebrates, buffers the shorelines from wave action, and stabilizes sediments and utilizes nutrients that would otherwise be available for algae. (Click here for more information on: value of aquatic plants). The native plant species observed in the Upper Gull chain of lakes are also commonly found in other central Minnesota lakes with similar water clarity and chemistry.

Because the spring 2008 survey was conducted before peak aquatic plant growth, it is important to note that the mid-summer 2008 distribution and abundance of some of the native species may be greater than that observed in June. Nevertheless, the results from the spring 2008 vegetation survey provide a good general representation of the plant community composition.

The non-native, curly-leaf pondweed is probably not a recent invader in the Upper Gull chain of lakes. It has been present in Minnesota for at least 100 years and common in central Minnesota lakes for at least the past 20 years. Although curly-leaf pondweed has invaded these lakes, it does not dominate in any of the Upper Gull lakes.

Curly-leaf pondweed has a greater potential to create recreational nuisances in lakes with broad shallow zones. In lakes with steep drop-offs, and/or where curly-leaf frequency is less than 20 percent, it may form smaller, localized beds but creates fewer lakewide problems for boaters. During the spring 2008 survey, areas of matted curly-leaf pondweed were observed in some areas of the Upper Gull chain of lakes. However, the location and extent of matted curly-leaf pondweed may fluctuate from year to year in lakes. For more information on biology and management of curly-leaf pondweed see page 51 in this report: MnDNR Invasive Species Annual Report.

Monitoring changes in aquatic plant community

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity and water chemistry. 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 from the 2008 Upper Gull chain of lakes vegetation survey can also be used to monitor annual changes in the native and non-native plant species composition. 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 the Upper Gull chain of lakes increases, submerged vegetation may be more common at depths greater than 15 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.
- Natural fluctuation in plant species
  Many submerged plants are perennial and regrow in similar locations each year. However, a few species such as wild rice (*Zizania palustris*) are annuals and are dependant on the previous years seed set for regeneration.
- Aquatic plant management activities
  Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. For information on the laws pertaining to aquatic plant management: MnDNR APM Program. 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. These control activities should be monitored to reduce potential negative impacts to non-target species.

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Figure 25. undeveloped shore on Upper Gull chain of lakes, June 2008

Table 4. Frequency of aquatic plants in Upper Gull Chain of Lakes, June 2008.
(Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 20 feet water depth.)

Life Form		**Common name**	**Scientific name**	**Upper Gull**	**Ray**	**Spider**	**Roy**	**Nisswa**	**Entire chain**
			Number of sample sites	**171**	**111**	**44**	**231**	**197**	**754**
SUBMERGED These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants may or may not be anchored to the lake bottom.	Dissected leaved plants	Coontail	*Ceratophyllum demersum*	39	44	52	32	43	**39**
		Northern water milfoil	*Myriophyllum sibiricum*	8	33	32	14	10	**15**
		White water buttercup	*Ranunculus aquatilis*	4	3	2	1	1	2
		Water Marigold	*Megladonta beckii*	0	6	0	11	0	7
	Grass-leaved plants	Flat-stem pondweed	*P. zosteriformis*	20	26	39	29	16	**24**
		Water stargrass	*Zosterella dubia*	10	5	5	8	4	8
		Narrow-leaf pondweed	*Potamogeton freisii**	9	19	14	9	10	11
		Water Bulrush	*Scirpus subterminalis*	0	1	2	0	0	<1
		Sago pondweed	*Stuckenia pectinata*	<1	<1	0	<1	1	1
	Broad-leaved plants	Illinois pondweed	*P. illinoensis*	<1	4	0	4	4	**13**
		Large-leaf pondweed	*Potamogeton amplifolius*	5	11	0	4	5	
		White-stem pondweed	*Potamogeton praelongus*	5	8	11	6	1	
		Clasping-leaf pondweed	*Potamogeton richardsonii*	<1	0	0	<1	2	
		Curly-leaf pondweed	*Potamogeton crispus*	6	8	18	13	18	**12**
	Small-leaved plants	Canada waterweed	*Elodea canadensis*	7	20	14	7	2	8
		Bushy pondweed	*Najas guadalupensis*	<1	7	--	6	25	10
	Bladderworts	Greater bladderwort	*Utricularia vulgaris*	8	39	25	11	8	**14**
		Lesser bladderwort	*Utricularia minor*	0	7	0	0	0	1
		Flat-leaf bladderwort	*Utricularia intermedia*	<1	14	0	0	0	3
	Large Algae	Muskgrass	*Chara sp.*	<1	23	16	10	7	9
		Stonewort	*Nitella sp.*	0	11	9	1	0	3
FREE-FLOATING These plants drift freely with the water current.	Duckweeds	Star duckweed	*Lemna trisulca*	33	9	36	5	12	**16**
		Greater duckweed	*Spirodela polyrhiza*	1	0	5	0	1	1
		Lesser duckweed	*Lemna minor*	1	0	0	0	1	<1
		Watermoss	*Not identified to genus*	0	9	11	13	14	10

* *Potamogeton freisii* was positively identified in these lakes but there may have been other narrow-leaved pondweed (*Potamogeton*) species present as well.

Table 5. Frequency of aquatic plants in Upper Gull chain of lakes, June 2008.
(Frequency is the percent of sample sites in which a plant taxon occurred within the shore to six feet water depth.)

Life Form			Upper Gull	Ray	Spider	Roy	Nisswa	Entire chain
		Number of sample sites	**71**	**69**	**31**	**94**	**72**	**337**
	Common name	**Scientific name**						
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface.	White waterlily	*Nymphaea odorata*	13	28	42	13	6	31
	Yellow waterlily	*Nuphar variegata*	13	61	26	28	21	15
	Watershield	*Brasenia schreberi*	0	0	32	0	0	10
	Floating leaf pondweed	*Potamogeton natans*	0	0	13	13	0	4
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Wild Rice	*Zizania palustris*	6	52	42	38	18	30
	Bulrush	*Scirpus* sp.	4	10	3	10	3	6
	Spikerush	*Eleocharis* sp.	3	0	3	2	4	2
	Arrowhead	*Sagittaria latifolia*	0	0	0	3	1	1
	Burreed	*Sparganium* sp.	1	1	0	0	0	1
	Giant Cane	*Phragmites australis*	1	0	0	0	0	<1
	Cattail	*Typha sp.*	0	0	3	0	0	<1
	Needlerush Group	*Eleocharis* sp.	0	0	0	0	0	<1
	Three-square	*Scirpus* sp.	0	0	0	0	0	P
	Water arum	*Calla palustris*	0	0	0	0	0	P

P = present in lake but not found within sample sites.