Aquatic Vegetation Surveys of

Big Portage Lake (DOW #11-0308-00)
and
Deep Portage Lake (DOW #11-0237-00)

Cass County, Minnesota

2008

Channel between Big Portage and Deep Portage. 2008

Minnesota
DEPARTMENT OF NATURAL RESOURCES

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Summary

Aquatic vegetation surveys of Big Portage Lake (11-0308-00) and Deep Portage Lake (11-0237-00), Cass County, Minnesota, were conducted in June and September 2008. Surveys included a lakewide assessment of vegetation and water depths at over 900 sample stations, characterization of shoal substrate types, and mapping of emergent and floating-leaf plant beds.

Twenty-nine native aquatic plant species were found including three emergent, five floating-leaved, three free-floating and 18 submerged species. Several wetland emergent species were also recorded. Non-native aquatic plant species were not found.

Big Portage Lake has an extensive shallow, soft substrate zone that is conducive to aquatic plant growth. More than 40 percent (392 acres) of Big Portage Lake was covered by emergent and floating-leaf plant beds and wild rice (*Zizania palustris*) was the dominant species. Deep Portage Lake has a narrow zone of shallow water dominated by hard substrates. Fifteen acres of emergent and floating-leaf beds were mapped in Deep Portage Lake and bulrush (*Schoenoplectus* sp.) was the most common species.

Submerged plants were found to a depth of 20 feet in Deep Portage Lake (about 25 percent of the lake) and to 16 feet in Big Portage (about 97 percent of the lake). In both lakes, vegetation was most common from shore to the ten feet depth where about 95 percent of the sample sites contained vegetation. Muskgrass (*Chara* sp.) was the most frequently found submerged plant and occurred in 45 percent of the Big Portage sites and in 88 percent of the Deep Portage sites. Other commonly occurring submerged species were flat-stem pondweed (*Potamogeton zosteriformis*), coontail (*Ceratophyllum demersum*), greater bladderwort (*Utricularia vulgaris*), and southern naiad (*Najas guadalupensis*).

Big Portage Lake, 2008

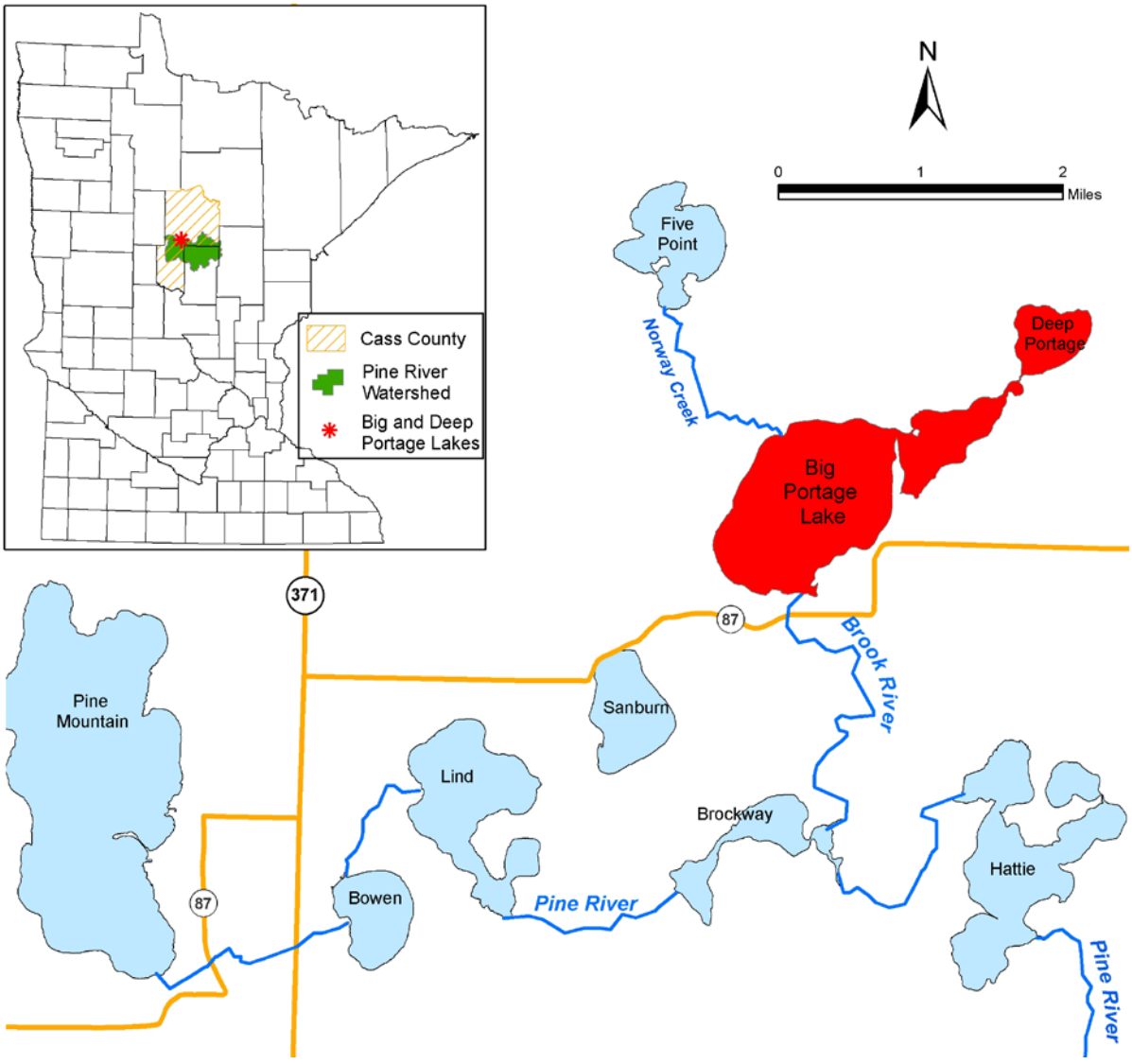
Deep Portage Lake, 2008

Introduction

Big Portage Lake and Deep Portage Lake are located in Cass County, north-central Minnesota in the northwest corner of the Pine River Watershed (Figure 1, inset). Approximately 64 lakes in the Pine River Watershed and about 250 lakes in Cass County are at least 50 acres in size. Big Portage Lake is the fifth largest lake in the watershed and the twelfth largest lake in the county, with a surface area of 902 acres and eight miles of shoreline. Deep Portage Lake ranks 28th in size for the watershed and 204th in size for the county, with a surface area of 129 acres and two miles of shoreline.

Big Portage Lake has two distinct basins that are separated by a shallow channel. Another shallow channel connects the east basin of Big Portage Lake to Deep Portage Lake. Norway Creek flows south from Five Point Lake into the northwest side of Big Portage Lake (Figure 1). Big Portage outlets to Brook River and flow continues south and east to Pine River and

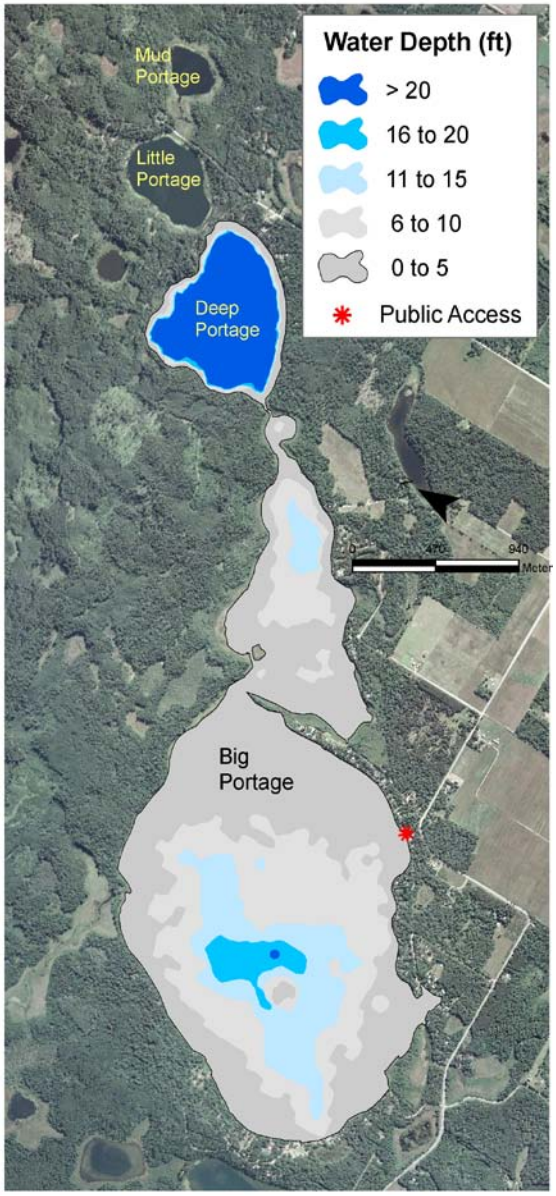
Figure 1. Big Portage and Deep Portage Lakes in Pine River Watershed, Cass County, MN.



eventually to the Mississippi River.

The southern shores of Big and Deep Portage lakes are privately owned and have been developed with residential homes. Large forested tracts on the north end are in state or county ownership. A public access is located on the east shore of Big Portage Lake off State Highway 87 (Figure 2).

Figure 2. Depth contours of Big Portage and Deep Portage Lakes (2008 data).



In addition to size, Big and Deep Portage lakes differ in depth and the potential available area for aquatic vegetation (Figure 2). Big Portage Lake is primarily shallow with 95 percent of the lake basin less than 15 feet in depth and a maximum depth of only 23 feet. Deep Portage Lake has a maximum depth of 105 feet and only 25 percent of the lake basin is less than 15 feet in depth. This shallow area is referred to as the littoral zone. Rooted submerged plants are often common in the littoral zone if adequate sunlight reaches the lake bottom.

Big Portage and Deep Portage Lakes are mesotrophic, or moderately nutrient enriched lakes but differ in water clarity. The Secchi disc (Figure 3) 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. Between 1987 and 2006, summer water clarity, as measured by Secchi disc readings, averaged about eight feet in Big Portage Lake and about 13 feet in Deep Portage Lake (MPCA, 2008). 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 half times the Secchi depth.

Based on Secchi disk measurements alone, aquatic plants are expected to grow to about 12 feet in Big Portage Lake and to about 20 feet in Deep Portage Lake. Other factors that may influence the depth of plant growth include substrate type, wind fetch, and plant species composition.

Previous vegetation surveys of Big Portage found plants growing to depths of 15 to 21 feet with abundant plant growth described in the west and southeast bays (MnDNR Fisheries Lake Files). In Deep Portage Lake, plants have been recorded to depths of 16 to18 feet (MnDNR Fisheries Lake Files). More than 25 different aquatic plant taxa have previously been recorded in these

lakes including bulrush (*Scirpus* spp.), wild rice (*Zizania aquatica*), waterlilies (*Nymphaea odorata* and *Nuphar variegata*), muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), Canada waterweed (*Elodea canadensis*), northern watermilfoil (*Myriophyllum* sp.), bladderwort (*Utricularia vulgaris*), and a variety of pondweeds (*Potamogeton* spp.).

Figure 3. Measuring Secchi Disc transparency

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2008 plant population of Big Portage and Deep Portage lakes. 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 taxa that occur in the lake
5. Estimate the abundance of common taxa
6. Develop distribution maps for the common tax

Methods

Mapping floating-leaf and emergent vegetation beds

Extensive beds of wild rice (*Zizania palustris*) cover much of Big Portage Lake. To avoid damage to these plant beds, the vegetation survey was conducted in early summer while the wild rice was still submerged. Surveyors did not motor into sites where wild rice was at or above the water surface. Aerial photographs were used to delineate beds of wild rice and waterlilies. Field surveys to map floating-leaf and emergent vegetation were conducted in September 2008. Ground truthing was conducted to verify plant community composition within major beds. Bulrush plants are difficult to observe on aerial photographs and therefore, surveyors motored around the perimeter of each bed and mapped the locations using a handheld Global Positioning System (GPS) receiver. Field data were uploaded to a computer and Geographic Information System (GIS) software program was used to estimate acreage

Lakewide vegetation survey

Big Portage Lake was surveyed on June 18, 19 and 23, 2008. Deep Portage Lake was surveyed on June 24, 2008. A Point-intercept survey method was used and followed the methods described by Madsen (1999) and MnDNR (2008a). Survey waypoints were created using a GIS computer program and downloaded into a handheld Global Positioning System (GPS) receiver. On Big Portage Lake, survey points were placed across the entire lake and spaced 65 meters (213 feet) apart, resulting in about one survey point per acre. Only the shallow area (less than 25 feet depth) of Deep Portage was surveyed and survey points were placed closer (30 meters = 98 feet) on this lake to ensure that sufficient sample points were included in the vegetated zone. Two field crews, each consisting of two surveyors and one boat, conducted the survey. A total of 833 sites were surveyed in Big Portage Lake and 132 sites were surveyed in Deep Portage Lake (Figure 4, Table 1). Four additional sites were sampled in Deep Portage Lake but because

they occurred in water depth greater than 20 feet and no vegetation was found, these sites were not included in the analysis.

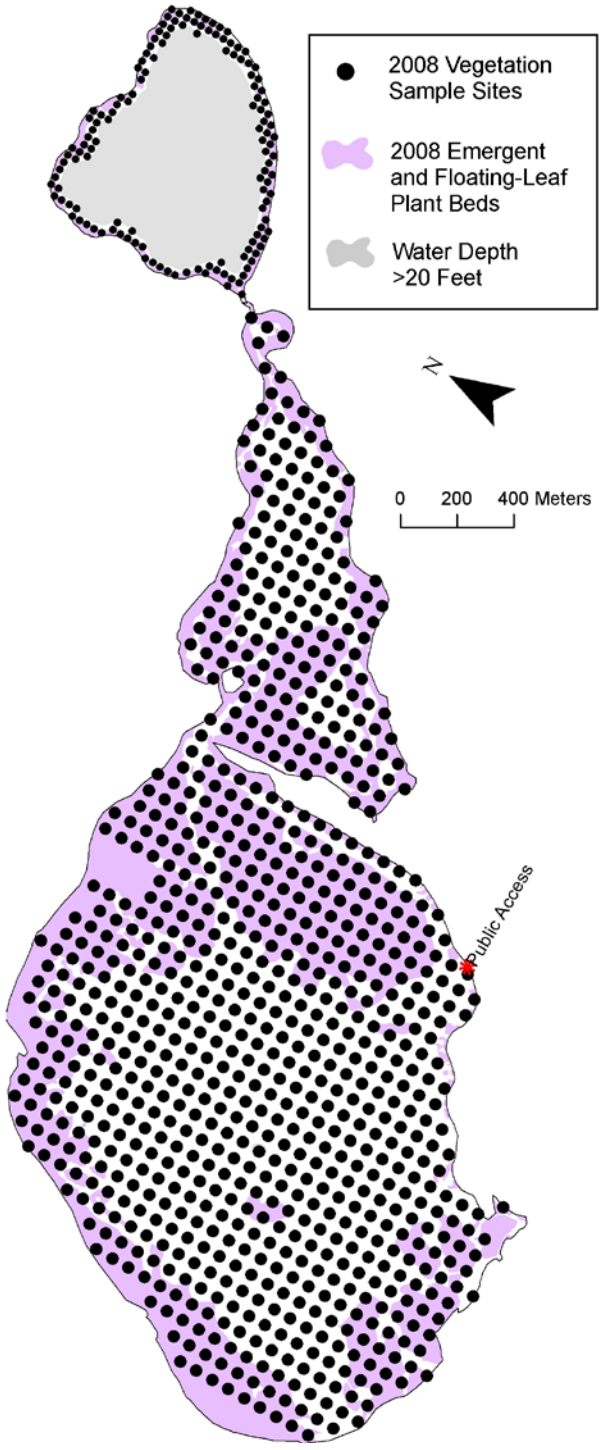
The GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments using a measured stick in water depths less than seven feet and an electronic depth finder in depths greater than eight feet.

Surveyors recorded all plant taxa 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 surface (Figure 5). Plant identification and nomenclature followed MnTaxa 2009. Voucher specimens were collected for most plant taxa and are stored at the MnDNR in Brainerd.

Figure 5. Sampling 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 a species occurred divided by the total number of sample sites. Frequency was calculated for the entire area from shore to 20 feet and sampling points were separated into four depth zones for analysis (Table 1). Any additional plant species found outside of the survey sites were

Figure 4. 2008 vegetation survey sites on Big Portage and Deep Portage lakes.



recorded as "present" in the lake but were not used in frequency calculations.

Table 1. Sampling effort by water depth.

Water depth interval	Big Portage	Deep Portage	Total
0 to 5	434	90	524
6 to 10	267	16	283
11 to 15	111	15	126
16 to 20	21	11	32
Sub-total	833	132	965
21 to 25	0	4	4
Total	833	136	969

At each sample site where water depths was seven feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2). If a mixture of substrates occurred at a site, surveyors recorded the most abundant 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 seven feet, surveyors collected depth and vegetation data and then motored into shallower water and recorded the substrate type adjacent to the actual survey point.

Example:
There were 833 samples sites in Big Portage Lake.
Muskgrass (*Chara* sp.) occurred in 370 sites.
Frequency of muskgrass in Big Portage Lake = (370/833) *100 = 44 %

Results

Substrate

Big Portage Lake was dominated by soft substrates of muck, marl and silt with areas of sand and occasional gravel in the western basin (Figure 6). Shoal substrates in Deep Portage Lake were primarily sand with muck on the west side. The substrate in the channel between the two lakes was muck.

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

Distribution of aquatic plants

Aquatic plants occurred around the entire perimeter of each lake. Big Portage Lake had a broad vegetated zone that, in many areas, extended the entire width of the lake while Deep Portage Lake had a narrow vegetated zone of about 75 meters (250 feet) (Figure 7).

Figure 6. Shoal water sediments of Big Portage and Deep Portage Lakes, 2008.

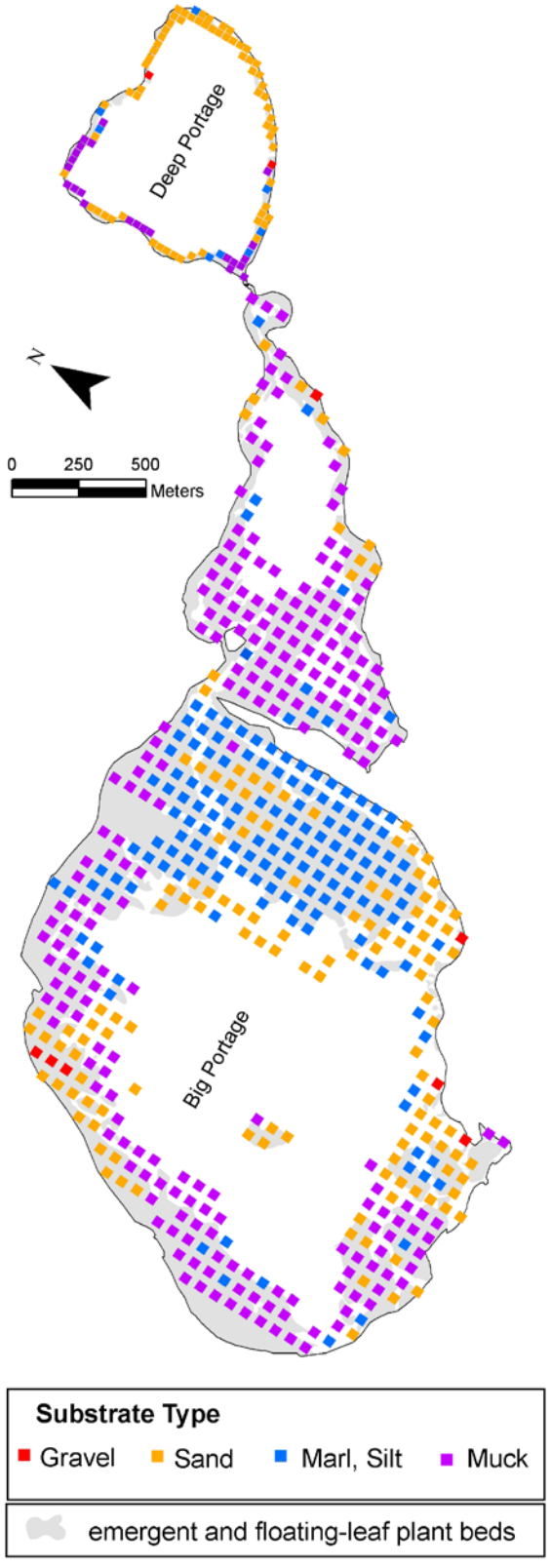
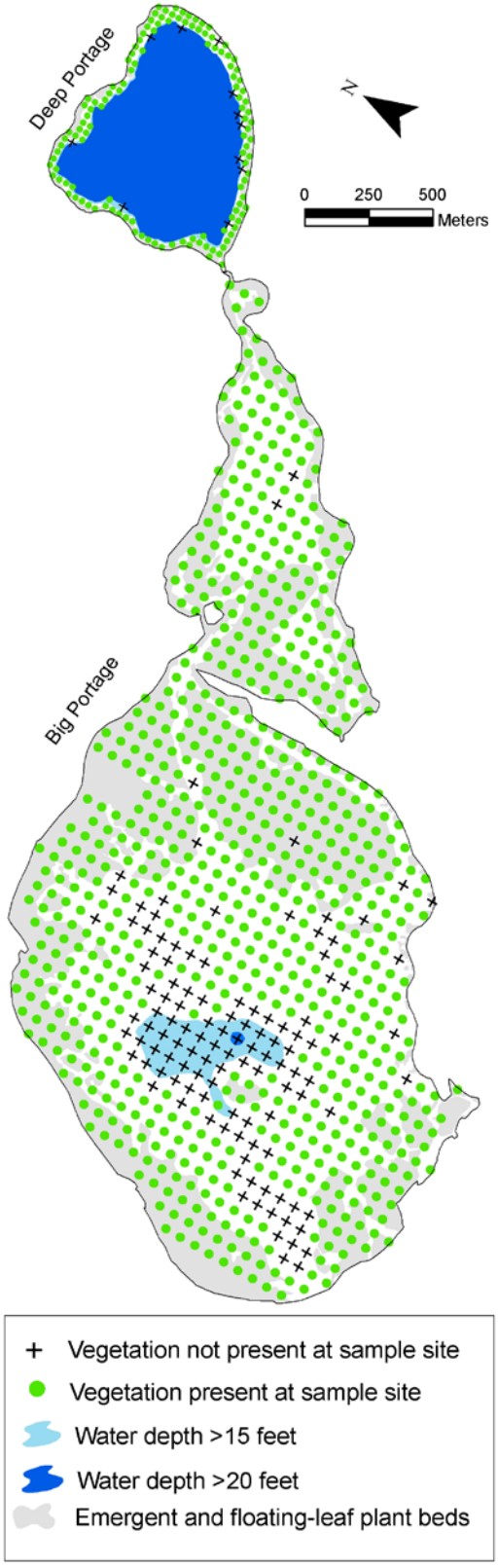


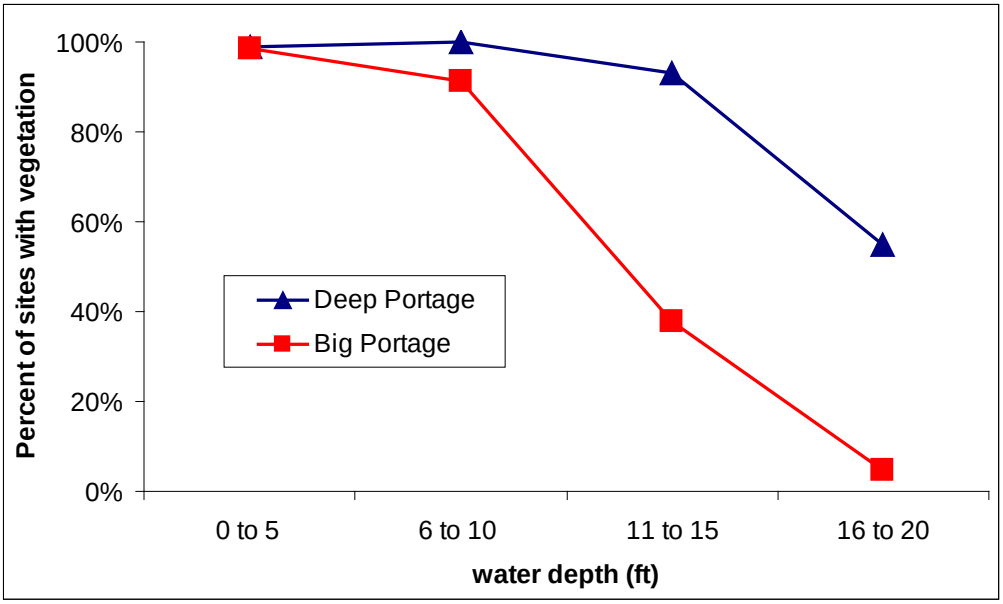
Figure 7. Distribution of aquatic plants in Big Portage and Deep Portage lakes, 2008.



Plants were found to a maximum depth of 16 feet in Big Portage Lake and that included 97 percent of the lake area. Plants extended to a depth of 20 feet in Deep Portage Lake, which included about 25 percent of the lake. Within the shore to 20 feet zone, vegetation occurred in 86 percent of the Big Portage sites and in 95 percent of the Deep Portage sites.

Percent of vegetated sites decreased with increasing water depth (Figure 8). In Big Portage Lake, vegetation was most common in the shore to ten feet zone where 84 percent of the sites contained plants. In Deep Portage, vegetation was commonly found from shore to 15 feet, where 92 percent of sites were vegetated.

Figure. 8. Percent frequency of vegetation types by water depth interval.



Number of plant species recorded and distribution by water depth

A total of 29 native aquatic plant species were recorded in Big and Deep Portage lakes including three emergent, five floating-leaved, 18 submerged and three free-floating species (Tables 3 and 4). Several additional emergent native aquatic plants were observed along wetland shores of these lakes (Table 3).

Table 3. Frequency of floating-leaved and emergent aquatic plants in Big Portage and Deep Portage Lakes Point-intercept survey, 2008. (Frequency is the percent of sample sites in which a species occurred in the 0 to 20 ft zone.)

Life Forms	Common Name	Scientific Name	Frequency of occurrence	
			Big Portage 833 Sites	Deep Portage 132 Sites
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface.	White waterlily	*Nymphaea odorata*	13	9
	Yellow waterlily	*Nuphar variegata*	7	4
	Floating leaf pondweed	*Potamogeton natans*	5	9
	Watershield	*Brasenia schreberi*	1	--
	Water smartweed	*Polygonum amphibium*	--	Present
EMERGENT These plants are rooted and extend well above water.	Wild Rice	*Zizania palustris*	47	18
	Bulrush	*Schoenoplectus* sp.	6	39
	Giant burreed	*Sparganium eurycarpum*	--	1
WETLAND EMERGENT These plants were present along wetland shores.	Sedge	*Carex* sp.	<1	--
	Water arum	*Calla palustris*	Present	Present
	Blue flag iris	*Iris versicolor*	Present	Present
	Giant cane	*Phragmites australis*	Present	Present
	Swamp five-finger	*Potentilla palustris*	Present	---

"Present" indicates plant was observed in the lake but did not occur within any of the sample sites
"---" indicates plant taxa was not found in lake

Table 4. Frequency of submerged and free-floating aquatic plants in Big Portage and Deep Portage Lakes Point-intercept survey, 2008. (Frequency is the percent of sample sites in which a species occurred in the 0 to 20 ft zone.)

Life Forms		Common Name	Scientific Name	Frequency of occurrence	
				Big Portage 833 Sites	Deep Portage 132 Sites
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.	Large algae	Muskgrass	*Chara sp.*	45	88
	Grass-leaved rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	28	11
	Dissected-leaf rooted plants	Greater bladderwort	*Utricularia vulgaris*	20	--
		Coontail	*Ceratophyllum demersum*	15	9
		Humped bladderwort	*Utricularia gibba*	3	--
		Minor bladderwort	*Utricularia minor*	2	--
		Flat-Leaved bladderwort	*Utricularia intermedia*	1	1
		Northern water milfoil	*Myriophyllum sibiricum*	1	1
	Small-leaved plants	Southern naiad	*Najas guadalupensis**	14	3
		Canada waterweed	*Elodea canadensis*	2	1
		Narrow-leaf pondweed	*Potamogeton* sp.	2	--
		Fries pondweed	*Potamogeton friesii***	1	2
		Sago pondweed	*Stuckenia pectinata*	1	3
	Broad-leaved rooted plants ("cabbage")	White-stem pondweed	*Potamogeton praelongus*	2	5
		Illinois pondweed	*Potamogeton illinoensis*	2	2
		Clasping-leaf pondweed	*Potamogeton richardsonii*	<1	--
		Large-leaf pondweed	*Potamogeton amplifolius*	<1	--
		Variable pondweed	*Potamogeton gramineus*	<1	--
	Moss	Watermoss	*Not identified to species*	<1	--
FREE-FLOATING These plants float on the water and drift with water currents.		Greater duckweed	*Spirodela polyrhiza*	<1	--
		Star duckweed	*Lemna trisulca*	--	1
		Lesser duckweed	*Lemna minor*	<1	--

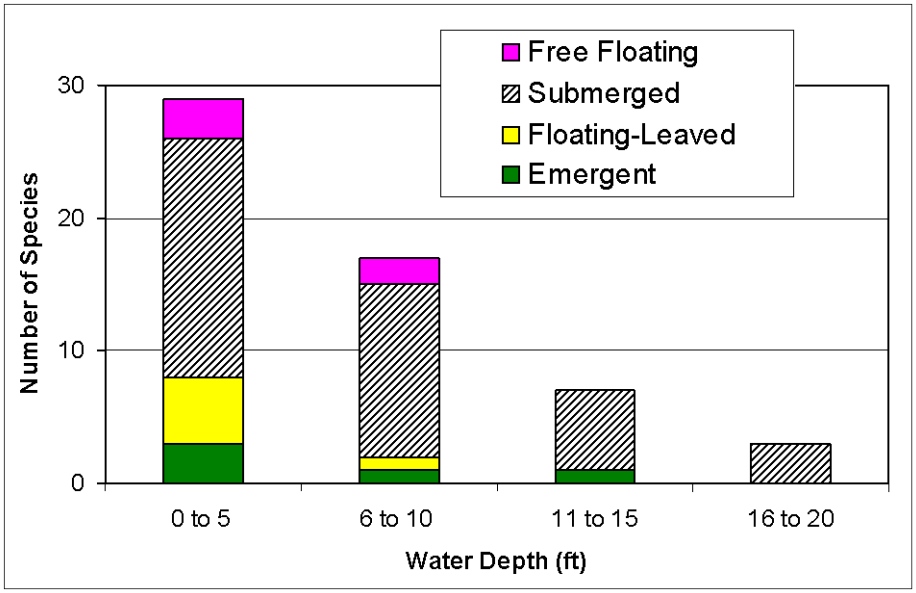
* May also include *Najas flexilis*

**Some specimens of "narrow-leaved pondweeds" were positively identified as *Potamogeton friesii* (Fries pondweed). However, it is not known whether other "look-a-like" narrow-leaf pondweed species occurred in the lake. therefore, a separate group of "unidentified narrow-leaf pondweeds" (*Potamogeton* sp.) are reported here but not counted in species tally.

"Present" indicates plant was observed in the lake but did not occur within any of the sample sites
"---" indicates plant taxa was not found in lake

Most emergent plant and floating-leaf plants occurred in water depths of five feet and less and most rooted submerged plants were restricted to depths of ten feet and less (Figure 9). Only six submerged species occurred in depth greater than ten feet and only three species occurred in depths greater than 15 feet.

Figure. 9. Number of taxa found at each water depth interval.



The number of plant species found at each one square meter sample site ranged from zero to nine, with a mean of two. Sites with the highest number of species occurred near shore, within mixed beds of emergent, floating-leaved and submerged plants (Figure 10). In water depths greater than ten feet, most sites contained one or no species.

Emergent and floating-leaf plants

Approximately 407 acres of emergent and floating-leaf plant beds were mapped with about 392 acres in Big Portage, and 15 acres in Deep Portage Lake. Fifty percent of the Big Portage survey sites and 48 percent of the Deep Portage sites contained at least one emergent or floating-leaf plant. Major plant bed types included wild rice, wild rice mixed with waterlilies and other species, and bulrush (Figure 11). Wild rice and waterlilies were often associated with soft substrates and bulrush was more typically found on hard substrates.

Figure 10. Number of plant species per site, Big and Deep Portage lakes, 2008

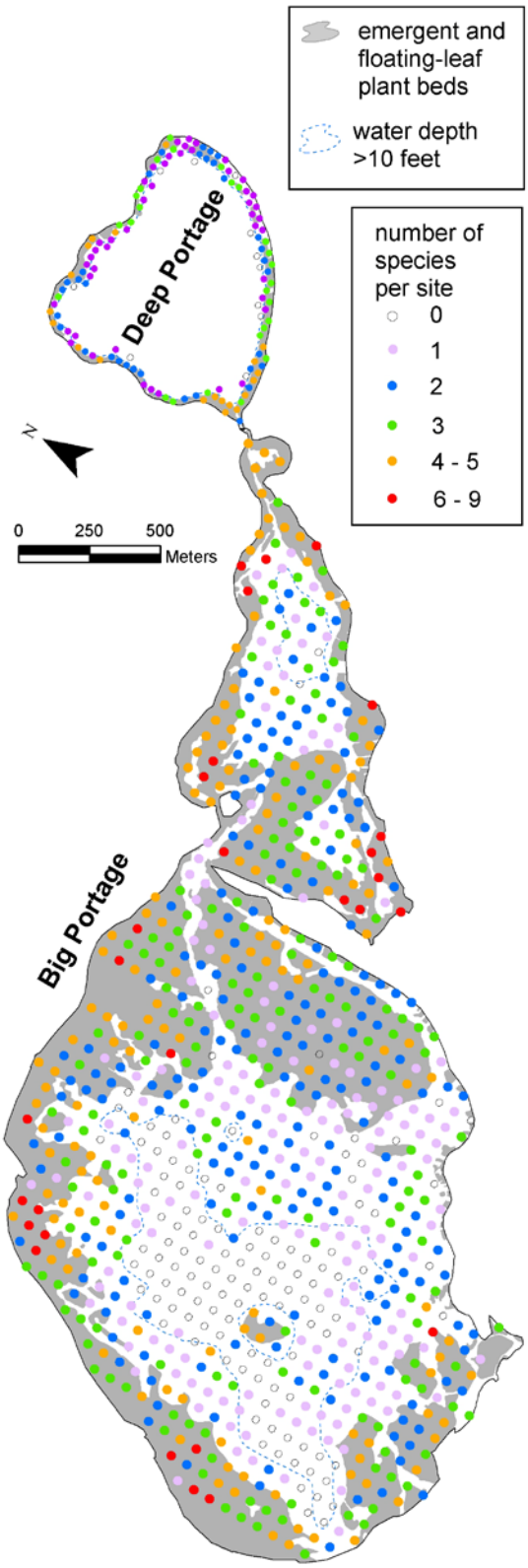
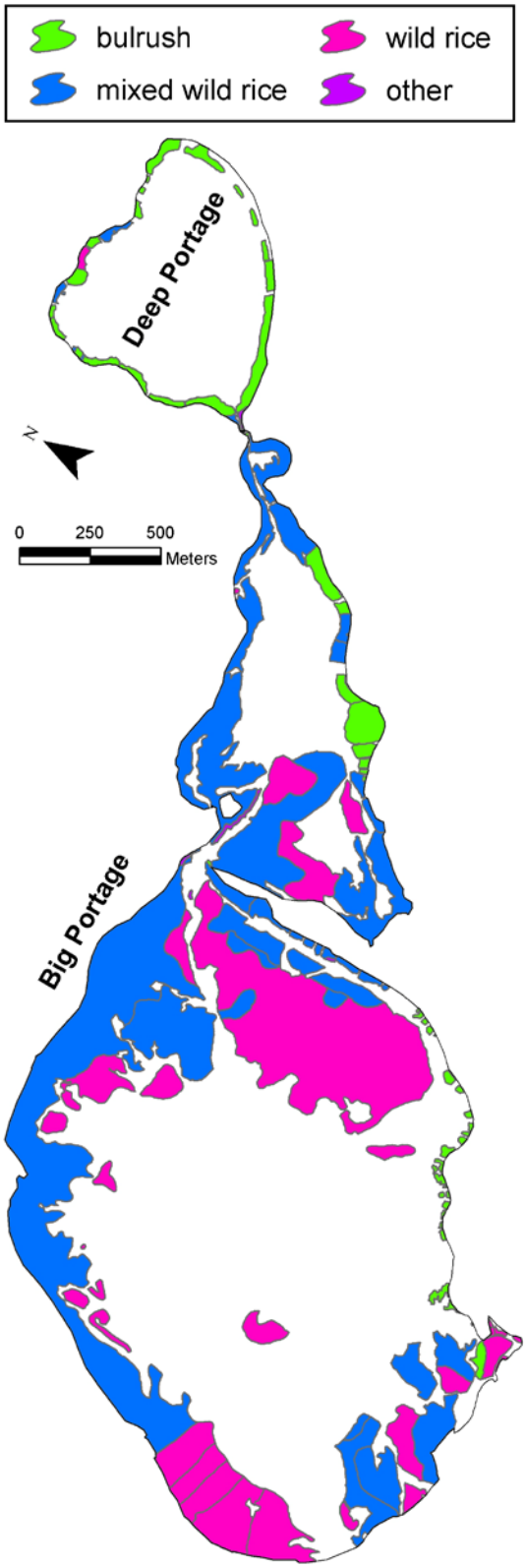


Figure 10. Emergent and floating-leaf plant beds, Big and Deep Portage lakes, 2008



Wild rice (*Zizania palustris*) (Figure 12) was the most common emergent plant in Big Portage Lake and was found in 47 percent of the sites (Table 3). A total of 377 acres of wild rice were mapped including 153 acres dominated by wild rice and 224 acres of wild rice mixed with bulrush, waterlilies or other emergent vegetation (Figure 13). Deep Portage had approximately ten acres of wild rice and it was the third most common species, occurring in 18 percent of the survey sites (Table 3). Wild rice was most common in depths of five feet or less in both lakes (Figure 14).

Figure 12. Wild rice (*Zizania palustris*).

Wild rice is an annual plant that germinates each year from seed that fell to the lake bottom in the previous fall. It prefers soft substrates (Lee 1986, Nichols 1999) and generally requires moving water for growth (MnDNR 2008b). The plant begins growth underwater and then forms a floating-leaf stage before becoming fully emergent. Wild rice is susceptible to disturbance because it is weakly rooted to the lake bottom.

Figure 13. Mixed bed of wild rice and waterlilies in Big Portage Lake, 2008.

In addition to its ecological value as habitat and food for wildlife, wild rice has important cultural and economic values in Minnesota (MnDNR 2008b). This valuable plant is increasingly threatened by factors such as lakeshore development and increased water recreational use (MnDNR 2008b).

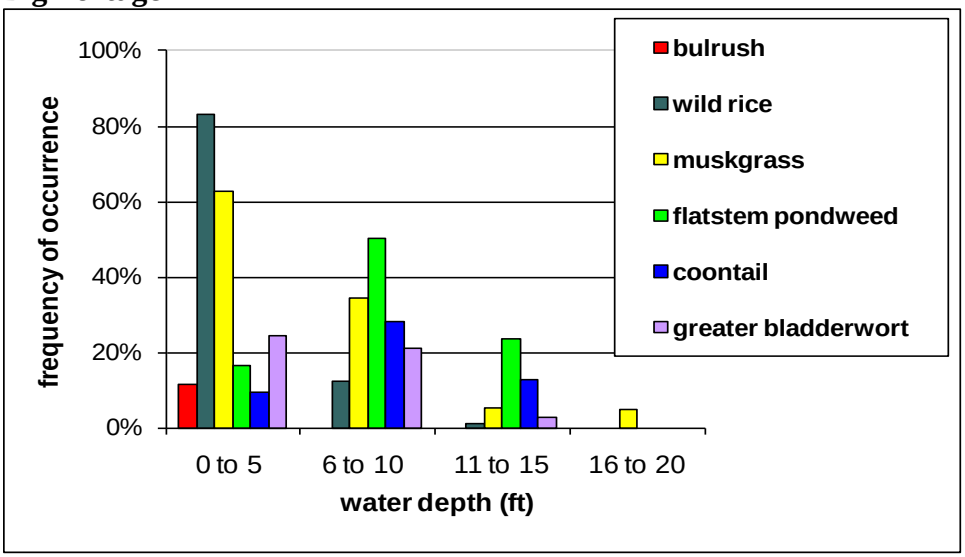
Hard-stem bulrush (*Schoenoplectus acutus*) (Figure 15) was the most common emergent in Deep Portage and was found in 39 percent of the sites (Table 3). About 13 acres of bulrush beds were mapped in this lake and some beds extended nearly 1,000 meters along shore and as much as 250 meters lakeward (Figure 11). Bulrush was found in 57 percent of the sample sites between shore and the five feet depth and usually occurred in sand. In Big Portage Lake, about 14 acres of bulrush beds were mapped and six percent of the shallow survey sites (shore to five feet depth) contained bulrush.

Waterlily beds, or mixed beds of waterlilies and emergents, covered less than half an acre in Deep Portage Lake, and one acre in Big Portage. Other emergent plants found included giant burreed (*Sparganium eurycarpum*) and spikerush (*Eleocharis* sp.). Floating-leaf plants included yellow waterlily (*Nuphar variegata*), white waterlily (*Nymphaea odorata*), and floating-leaf pondweed (*Potamogeton natans*). Waterlily beds often contained wild rice, scattered bulrush plants, and submerged plants.

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 and 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.

Figure 14. Frequency of common plants by water depth interval. Big Portage and Deep Portage lakes, June 2008.

Big Portage



Deep Portage

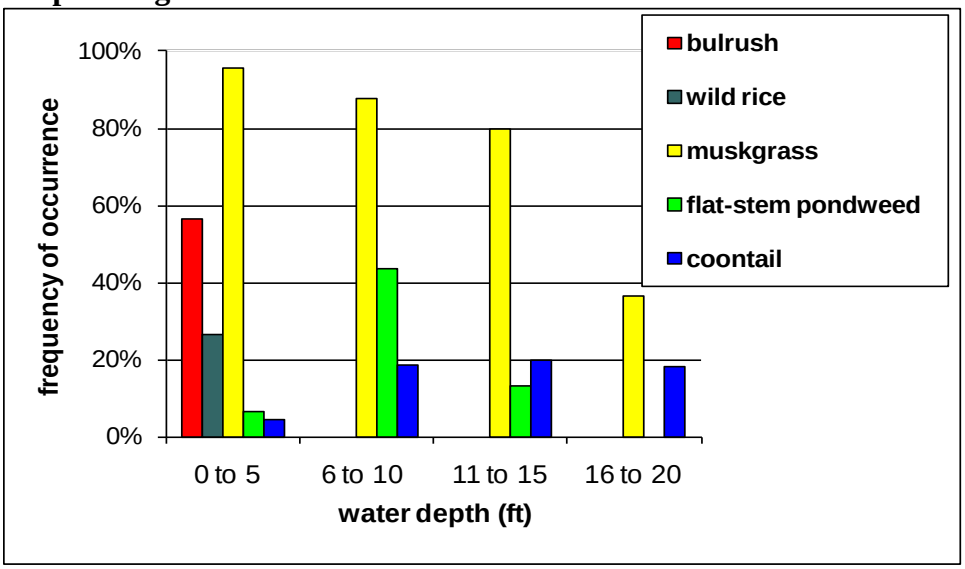
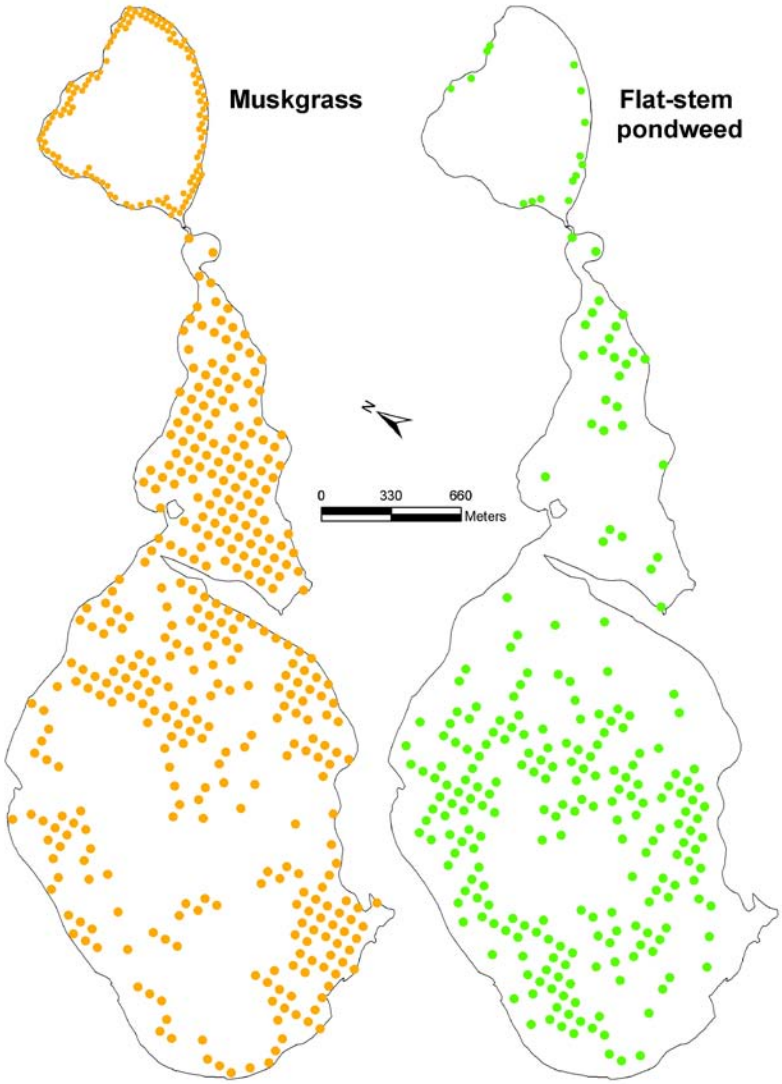


Figure 15. Emergent bulrush (*Scirpus*) beds in Big Portage, 2008.

Submerged plants

Submerged plants occurred in 79 percent of the Big Portage sites, and 95 percent of the Deep Portage Lake sites. The two most common species, muskgrass (*Chara* sp.) and flat-stem pondweed (*Potamogeton zosteriformis*) were widespread in both lakes (Figure 17).

Figure 16. Distribution of muskgrass (*Chara* sp.) and Flat-stem pondweed (*Potamogeton zosteriformis*)



Muskgrass (*Chara* sp.) (Figure 17) was the most common submerged plant in Big and Deep Portage Lakes, occurring in 45 percent and 88 percent of the sites, respectively (Table 4). This macroscopic, or large, algae 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

taxa 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 17. Muskgrass (*Chara* sp.)

Muskgrass was found throughout both lakes but was less common in the soft substrates of the west bay of Big Portage Lake (Figure 17). Muskgrass could be found growing in thick beds with no other vegetation and in other areas it co-occurred within mixed beds of pondweeds and other submerged plants. In Big Portage, muskgrass was common in depths less than six feet and in Deep Portage, it was the most common submerged plant at all depths sampled (Figure 11).

Flat-stem pondweed (*Potamogeton zosteriformis*) (Figure 18) was found in 28 percent of the Big Portage sites and in 11 percent of the Deep Portage sites (Table 4). In both lakes it was most common in depths of six to ten feet (Figure 11).

Figure 18. Flat-stem pondweed (*Potamogeton zosteriformis*)

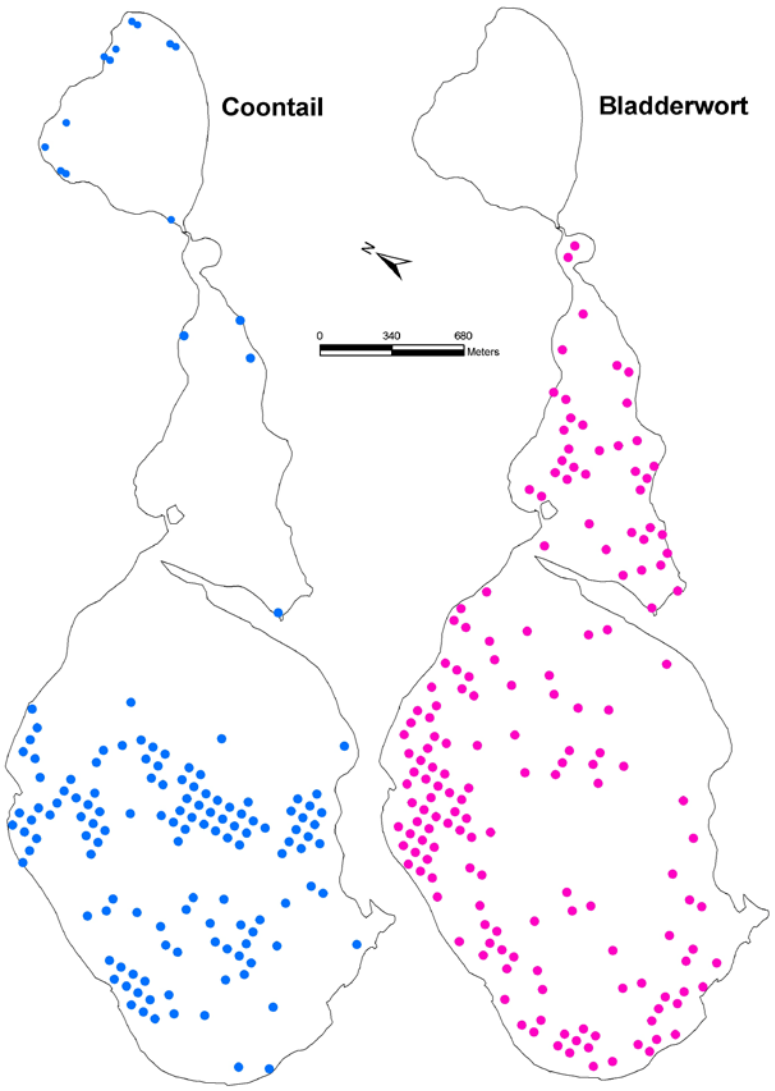
Flat-stem pondweed is a perennial plant that is anchored to the lake bottom by underground rhizomes. It is named for its flattened, grass-like leaves. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. These pondweeds are anchored to the lake bottom by rhizomes and overwinter by winter buds.

Coontail (*Ceratophyllum demersum*) (Figure 19) occurred in 15 percent of the Big Portage sites and in nine percent of the Deep Portage sites (Table 4) and did not dominate at any water depth (Figure 11). In Deep Portage Lake, it was found around the entire perimeter of the lake but in Big Portage its distribution was concentrated in the west half of the lake (Figure 20).

Figure 19. Coontail (*Ceratophyllum demersum*)

Coontail 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.

Figure 20. Distribution of coontail (*Ceratophyllum demersum*) and greater bladderwort (*Utricularia vulgaris*).



Greater bladderwort *(Utricularia vulgaris)* (Figure 21) was not found within any of the Deep Portage Lake sites but occurred in 20 percent of the Big Portage Lake sites (Figure 20) where it was most common in depths of ten feet and less (Figure 11).

Greater bladderwort grows entirely submerged except during bloom when its small, showy yellow flower extends above the water. Bladderwort often floats freely in the water column and is tolerant of turbid water. It reproduces by fragments and winter

Figure 21. Flowers of greater bladderwort (*Utricularia vulgaris*).

buds that can float to new areas of the lake. Bladderwort is an insectivorous plant and uses its small "bladders" to trap invertebrates.

Discussion

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. The water clarity of Big Portage Lake is sufficiently high to allow aquatic plant growth to a depth of about 15 feet but available light beyond that depth is not sufficient for most rooted plants. Water clarity in Deep Portage Lake is higher which allows plants to grow to deeper depths. However, the steep drop-off of Deep Portage Lake provides only a narrow zone for aquatic plant growth.

The plant communities of Big and Deep Portage Lakes are similar to that found in other hardwater Cass County lakes such as Leech, Woman and Boy lakes. Muskgrass is the dominant submerged plant in all of these lakes and numerous other submerged species co-occur and provide a diverse habitat structure. These lakes are also similar in their abundance of wild rice, particularly in shallow areas with soft substrates. The abundant and diverse native aquatic plant communities found in these lakes provides critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

A review of past vegetation surveys of these lakes indicates that the general aquatic plant community has not likely changed greatly in these lakes. In all survey years, a relatively high number of native plants have been recorded, the same species remain common and rooted plants remain well distributed throughout the lakes. Data collected in 2008 can be used to monitor finer-scale changes that may occur, such as an increase in a particular taxa or a change in the depths at which individual taxa occur. 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.

In general, factors that may lead to change in the aquatic plant communities include:

- Change in water clarity
  If water clarity decreases, submerged vegetation may be restricted to shallower water.
- Change in water level
  Many aquatic plants are adaptable to water level fluctuations and in low water years, aquatic plants may expand in distribution. The extent and duration of these distribution changes can be difficult to predict.
- Snow and ice cover
  Many submerged plants 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, some 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.
- Invasive species

Non-native submerged species have **not** been documented in these lakes but if they invade the lake, they may directly or indirectly impact the native plant community. Non-native plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curly-leaf pondweed (*Potamogeton crispus*) may form dense surface mats that may shade out native plants. The impact of these invasive species varies among lakes but the presence of a healthy native plant community may help mitigate the harmful effects of these exotics.

- Natural fluctuation in plant species abundance
  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, click here: MnDNR APM Program or contact your local DNR office. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and 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. Herbicide and mechanical control of aquatic plants can directly impact the aquatic plant community. Limiting these types of activities can help protect native aquatic plant species.

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