Aquatic Vegetation of
Woman Lake (DOW 11-0201-00)
Cass County, Minnesota

June 2006

Wild rice bed on Woman Lake, Cass County, MN. August 2006

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Summary

An aquatic vegetation survey of Woman Lake (11-0201-00), Cass County, Minnesota, was conducted between June 26 and July 10, 2006. The results of this survey were combined with emergent plant bed maps that were delineated in 2003 by DNR Fisheries staff.

A total of 42 native aquatic plant taxa were recorded, making Woman Lake among the richest lake plant communities in the state. Non-native aquatic plants were not found. Plant growth was sparse in the main lake but within Broadwater Bay, Lantern Bay and Bungey Bay, 70 percent of the sites were vegetated.

Approximately 180 acres of wild rice (*Zizania palustris*), 17 acres of bulrush (*Scirpus* spp.) and 16 acres of mixed waterlily beds occurred within Lantern Bay and Broadwater Bay. Submerged plants occurred to a depth of 23 feet but were most common from shore to a depth of 15 feet. Common submerged plants included muskgrass (*Chara* sp.), narrow-leaved and broad-leaved pondweeds (*Potamogeton spp.*), wild celery (*Vallisneria americana*), Canada waterweed (*Elodea canadensis*), and coontail (*Ceratophyllum demersum*).

Introduction

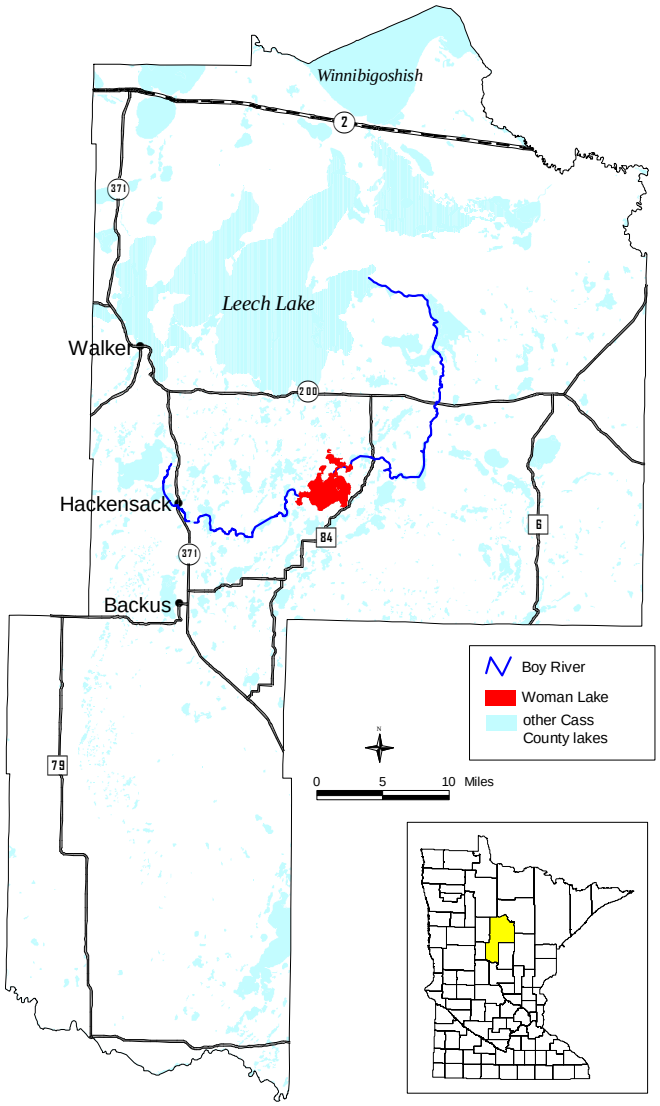
Woman Lake (DOW 11-0201-00) is located about nine miles east of the city of Hackensack, in Cass County, north-central Minnesota (Fig. 1).

Woman Lake is part of a chain of lakes along the Boy River. Boy River enters the west side of Woman Lake from Child Lake and exits on the east side into Girl Lake and then continues north to Leech Lake (Fig. 1).

Woman Lake has a surface area of 4,782 acres making it one of the largest lakes in the state and the sixth largest in Cass County. The lake includes a central basin and several large bays; Broadwater Bay is the largest with an area of about 1000 acres (including channel to main basin) (Fig. 2). Horseshoe Island, a forested island on the east side of the main basin, is approximately 11 acres in area.

Woman Lake has a maximum depth of 54 feet and about 40 percent of the lake is less than 15 feet in depth. Most of the shallow areas are located in the northern end of the lake, including Broadwater and Lantern Bays (Fig. 2).

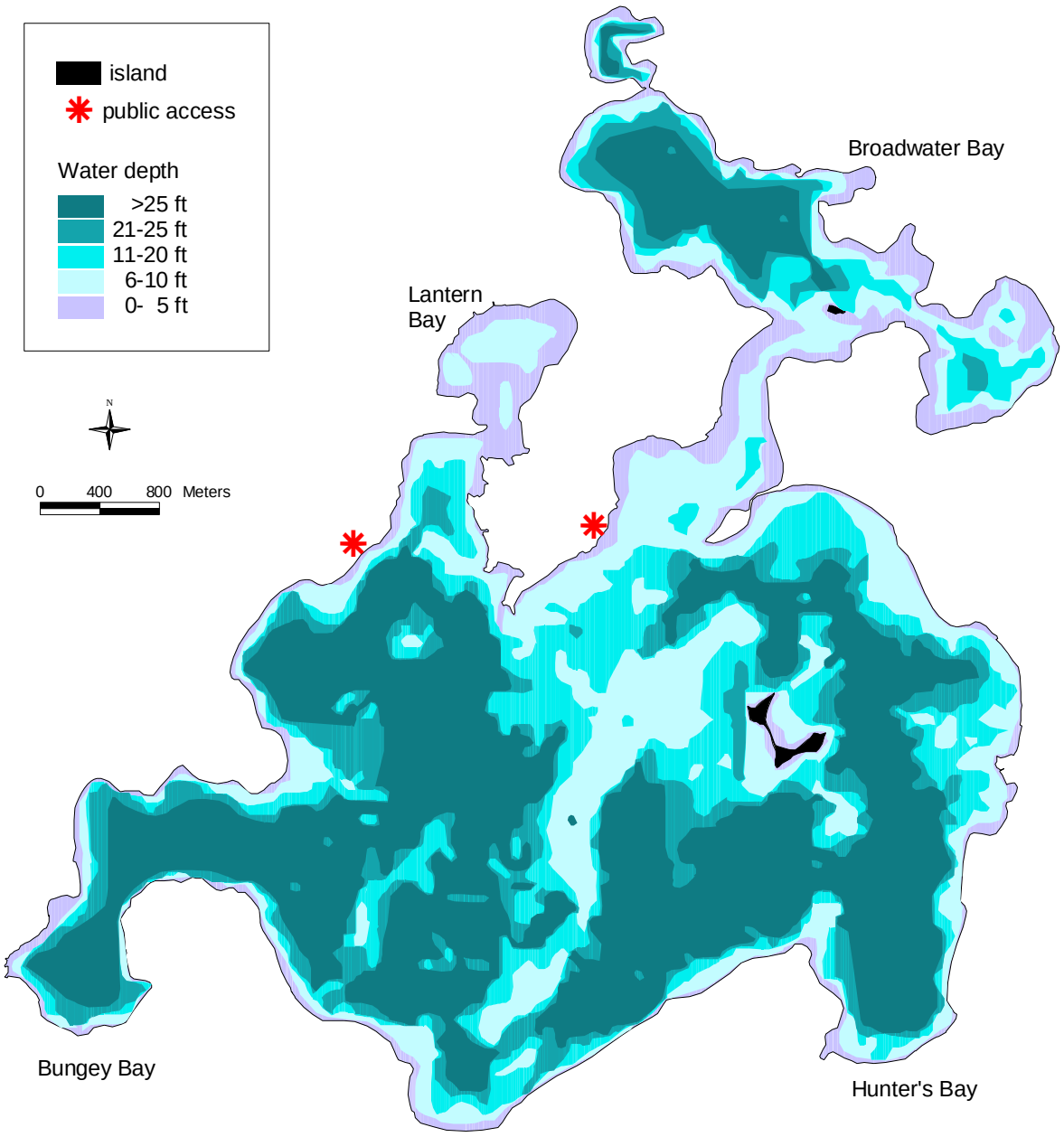
Figure 1. Location of Woman Lake in Cass County, Minnesota.



The shoreline of Woman Lake is primarily forested but also heavily developed with residential homes. There is a public boat launch on northwest shore and on the north shore between Lantern Bay and Broadwater Bay (Fig. 2).

Woman Lake is a mesotrophic, or moderately nutrient enriched lake, with relatively high water clarity. A 1989 Minnesota Pollution Control study found that water quality parameters of Woman Lake fell within a range typical for minimally impacted northern Minnesota lakes (Heiskary and Dindorf 1989). Between 1987 and 2005, water clarity, as measured by Secchi disc readings, ranged from seven feet to 15 feet, with a mean of 11 feet (MPCA 2007).

Figure 2. Depth contours of Woman Lake, Cass County.



Historical vegetation surveys

Previous vegetation surveys of Woman Lake were conducted in 1922 (Hotchkiss 1932), 1948, 1956, 1974, 1986, 1996 and 2003 (MnDNR Fisheries Lake Files). These surveys varied in

methodology and types of data collected but collectively, they provide a general description of Woman Lake's aquatic plant communities. At least 31 different aquatic plant taxa have previously been recorded in the lake including 17 submerged, four floating-leaved, two free-floating, and eight emergent plant taxa. Plants that were commonly found include muskgrass (*Chara* sp.), Canada waterweed (*Elodea canadensis*), northern watermilfoil (*Myriophyllum*

sibiricum), a variety of pondweeds (*Potamogeton* spp.), bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), wild celery (Vallisneria americana), white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegata*), bulrush (*Scirpus sp.*) and wild rice (*Zizania palustris*).

These previous surveys report vegetation growth to a maximum depth of about 25 feet with sparse aquatic plants in the main basin but abundant plant growth in Lantern Bay, Broadwater Bay and other protected areas. In 1922, Woman Lake was described as the fourth best duck lake in Cass County, after Leech, Big Rice and Mud (Hotchkiss 1932).

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2006 plant population of Woman Lake. Specific objectives included:

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

Methods

Floating-leaf and emergent vegetation

Many of the near-shore, shallow areas of Woman Lake contain extensive beds of emergent and floating-leaf. To avoid damage to these plant beds, surveyors did not motor into these sites. DNR Fisheries staff mapped major beds of emergent vegetation in 2003 by boating around the edge of each emergent plant bed and recording the boundary using a Global Positioning System (GPS) receiver. In 2006, surveyors repeated this survey around bulrush beds and used aerial photographs to help delineate waterlily beds.

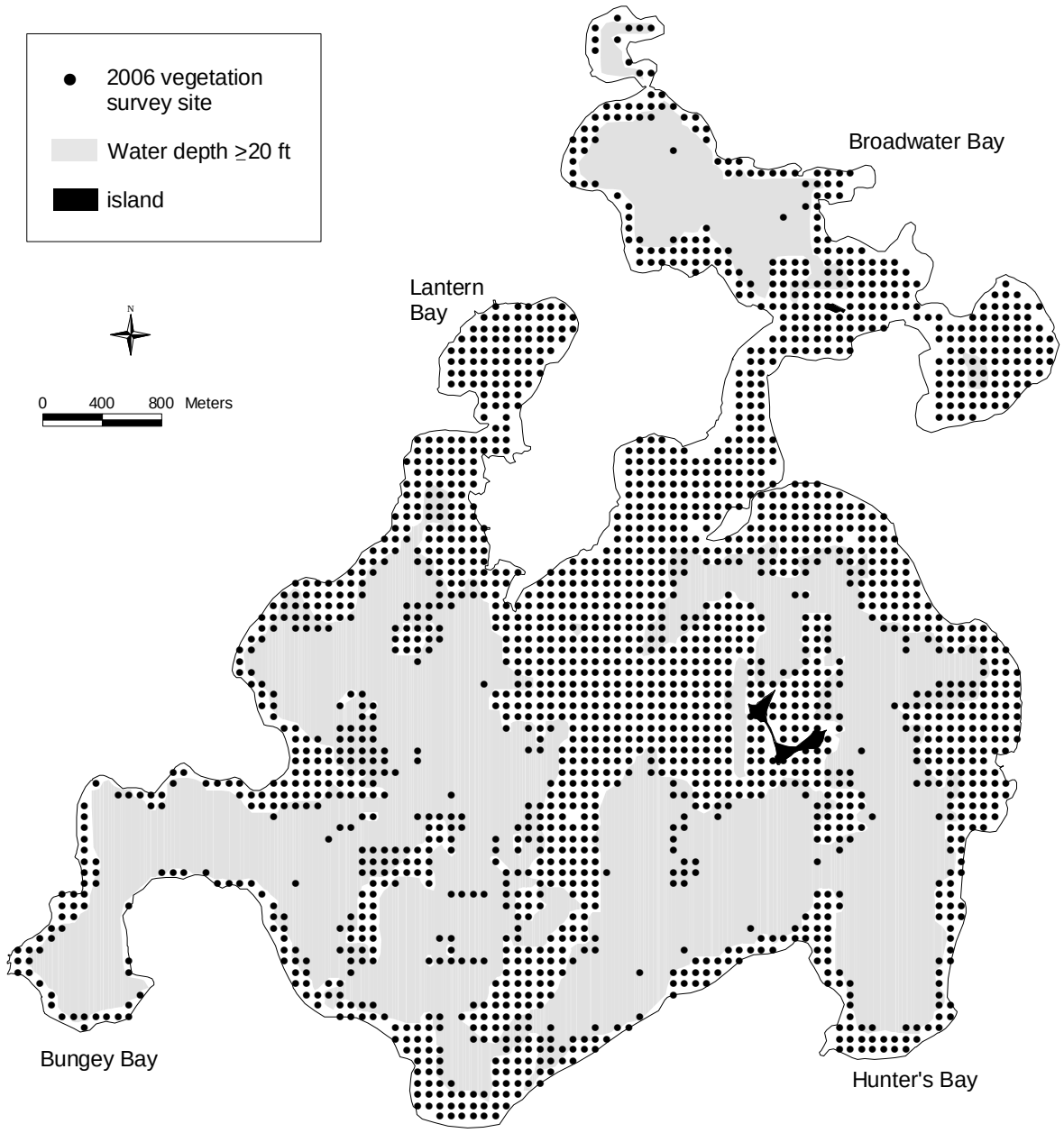
Submerged vegetation survey

A submerged vegetation survey of Woman Lake was conducted on June 26-20, July 5-7, and July 10, 2006. A Point-intercept survey method was used and followed the methods described by Madsen (1999). Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a GPS receiver. Survey points were spaced 75 meters apart, resulting in about one survey point per 1.5 acres. Two field crews, each consisting of one boat and two surveyors, conducted the survey. In the field, surveyors infrequently found vegetation beyond a depth of 20 feet and therefore sampled all survey points between shore and 20 feet and only a

Table 1. Sampling effort by water depth, Woman Lake, 2006.

Depth interval in feet	Number of sample points
0 to 5	317
6 to 10	821
11 to 15	325
16 to 20	336
21 to 25	327
26 to 30	46
Total number of sample points	2172

Figure 3. 2006 vegetation survey sites on Woman Lake.



selected number of points in deeper water. A total of 2172 points were surveyed (Table 1). About 70
percent of the sites were in the main basin and 30 percent were within the bays (Fig. 3).

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 sites, water depth was recorded in one-foot increments using a measured stick in water depths less than eight feet and an electronic depth finder in

Figure 4. Sampling rake.

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
bolder	Diameter over 10 inches

depths greater than eight feet. The surveyors recorded all plant species found within a one meter squared 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 (Fig. 4). At each sample site where water depths was six feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2).

Plant identification and nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species and are stored at the MnDNR in Brainerd. 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.

Example:

In Woman Lake there were 2126 samples sites in the zone from shore to the 25 feet depth.

Muskgrass (*Chara* sp.) occurred in 437 of those sites.

Frequency of muskgrass in the shore to 30 feet depth zone = 437/2126 (*100) = 41 %

Frequency was calculated for the entire area from shore to 25 feet and sampling points were also grouped by water depth and separated into six depth zones for analysis (Table 1).

In August, surveyors re-visited shorelines of Woman Lake to search for additional plant taxa that may have been overlooked during the Point-Intercept survey. Any additional plant taxa found were recorded.

Results

Shoal substrates

Shallow water sites (shore to a water depth of six feet) of the main basin had hard substrates including sand, gravel, rubble and bolder (Fig. 5). Natural sand beaches occur along shores of the main basin (Fig. 6). Softer substrate types occurred at the north end of Horseshoe Island and in Broadwater Bay, Lantern Bay and Bungey Bay (Fig. 5).

Figure 5. Shoal sediments of Woman Lake, 2006.

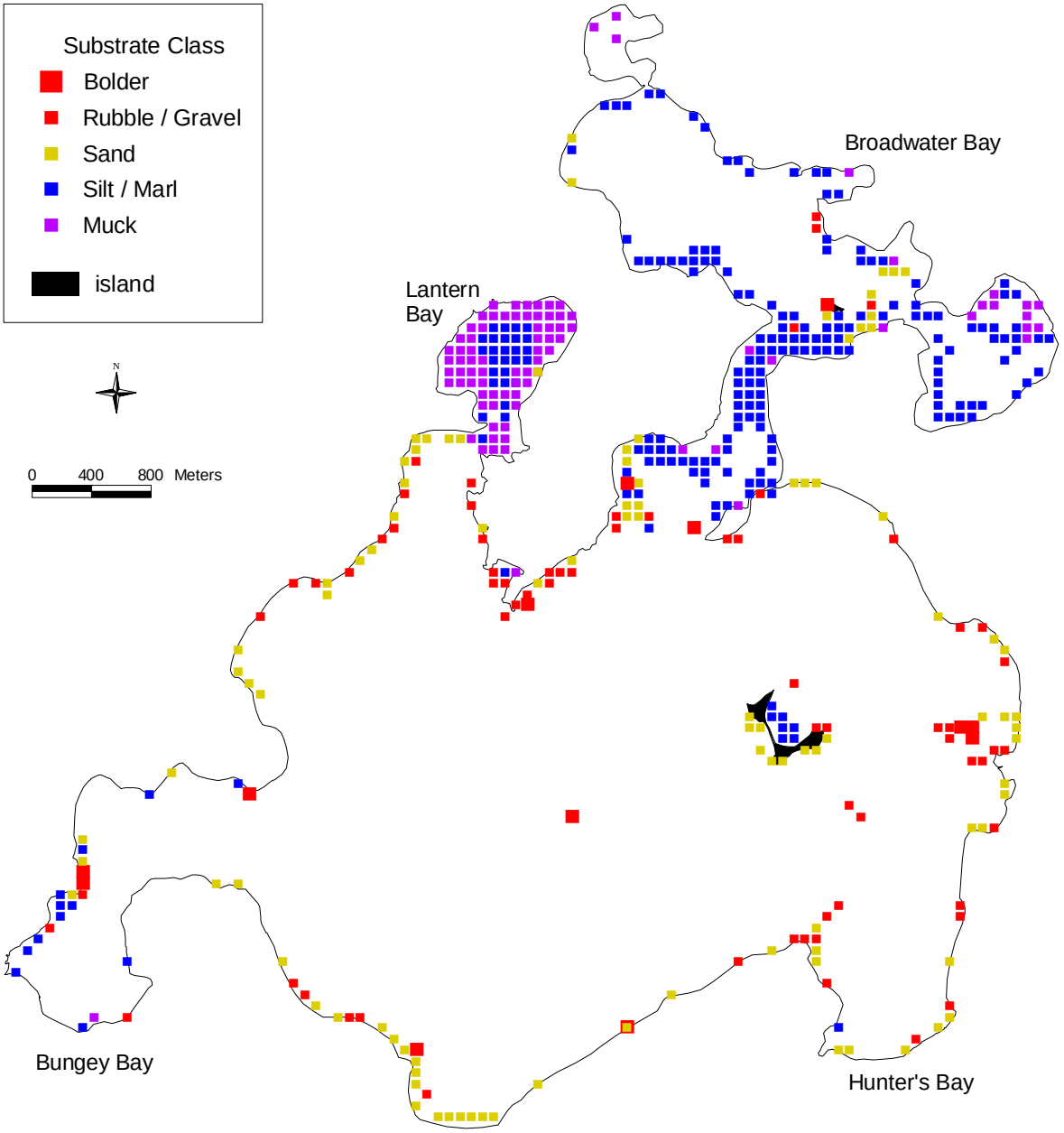


Figure 6. Shoreline with natural sand beach. Woman Lake 2006.

Figure 7. Shoreline with muck substrates, waterlilies and wild rice, Woman Lake 2006.

Number and types of plants recorded

A total of 42 native aquatic plant taxa were recorded in Woman Lake including 12 emergent, four floating-leaved, three free-floating and 23 submerged plants (Table 3). Submerged plants included two types of large algae, an aquatic moss, and numerous flowering plants.

Table 3. Frequency of aquatic plants in Woman Lake Point-intercept survey, June 2006.

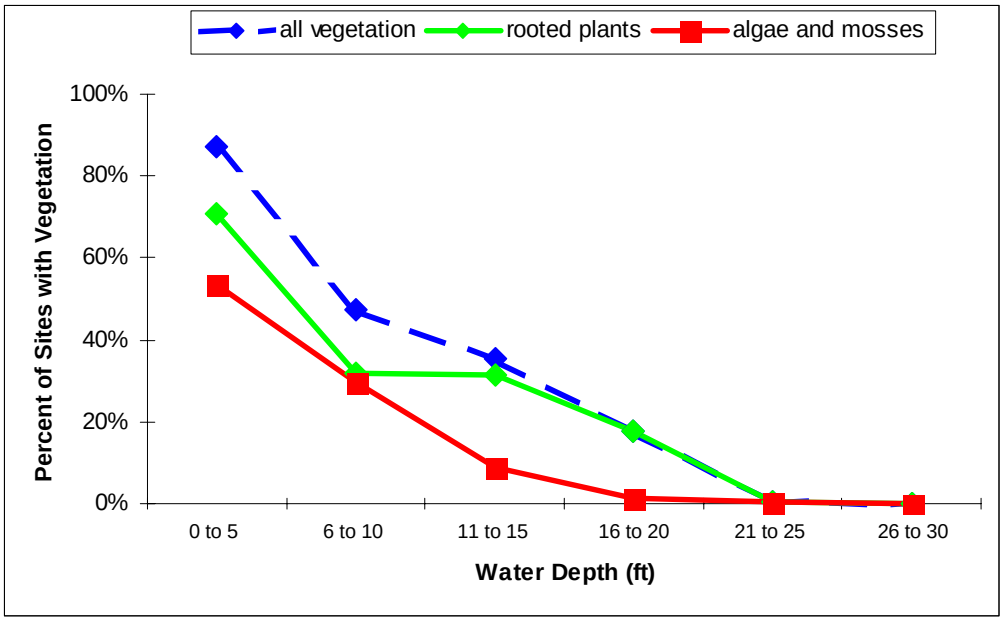
* Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 25 ft water depth.
**present – indicates plant taxa was observed outside of sample sites.

Life Form			Common name	Scientific name	Frequency of occurrence		
					Bays	Main basin	Lake wide
Submerged	Non-flowering plants	Algae	Muskgrass	*Chara sp.*	41	9	21
			Stonewort	*Nitella*	1	<1	<1
		Watermoss		*Not identified to genus*	<1	<1	<1
	Perennial	Narrow-leaf Pondweeds	Flat-stem pondweed	*Potamogeton zosteriformis*	35	2	14
			Narrow-leaf pondweed	*Potamogeton freisii*	17	2	7
			Robbins Pondweed	*Potamogeton robbinsii*	<1	0	<1
			Sago pondweed	*Stuckenia pectinata*	1	<1	<1
		Broad-leaf pondweeds	White-stem pondweed	*Potamogeton praelongus*	11	<1	4
			Clasping-leaf pondweed	*Potamogeton richardsonii*	5	<1	2
			Large-leaf pondweed	*Potamogeton amplifolius*	4	<1	2
			Illinois pondweed	*Potamogeton illinoensis*	2	<1	1
			Variable pondweed	*Potamogeton gramineus*	1	1	1
			Wild Celery	*Vallisneria americana*	19	3	9
			Canada waterweed	*Elodea canadensis*	16	3	8
			Coontail	*Ceratophyllum demersum*	14	2	6
			Northern watermilfoil	*Myriophyllum sibiricum*	6	1	2
			Water marigold	*Megaladonta beckii*	2	<1	1
			White Water Buttercup	*Ranunculus spp.*	<1	<1	<1
			Greater Bladderwort	*Utricularia vulgaris*	7	<1	2
			Flat-leaved bladderwort	*Utricularia intermedia*	<1	0	<1
			Bladderwort	*Utricularia sp.*	<1	0	<1
			Water stargrass	*Heteranthera dubia*	3	2	2
	Annual		Bushy pondweed	*Najas flexilis*	9	<1	3
Free-floating			Star duckweed	*Lemna trisulca*	<1	0	<1
			Lesser duckweed	*Lemna minor*			**present
			Greater duckweed	*Spirodela polyrhiza*			present
Floating			Floating-leaf pondweed	*Potamogeton natans*	3	<1	1
			White water lily	*Nymphaea odorata*	4	0	1
			Yellow water lily	*Nuphar variegata*	3	0	1
			Watershield	*Brasenia schreberi*	<1	0	<1
Emergent			Bulrush	*Scirpus sp.*	1	0	<1
			Wild rice	*Zizania palustris*	9	0	3
			Spikerush	*Eleocharis sp.*	<1	0	<1
			Needle grass	*Eleocharis sp.*	<1	0	<1
			Narrow-leaf cattail	*Typha sp.*	<1	0	<1
			Broad-leaf cattail	*Typha latifolia*			present
			Water arum	*Calla palustris*			present
			Iris	*Iris sp.*			present
			Giant cane	*Phragmites australis*			present
			Burreed	*Sparganium emersum*			present
			Broad-leaf arrowhead	*Sagittaria latifolia*			present
			Arrowhead	*Sagittaria sp.*			present
Percent of sites with vegetation					77	20	40

Distribution of plants by water depth

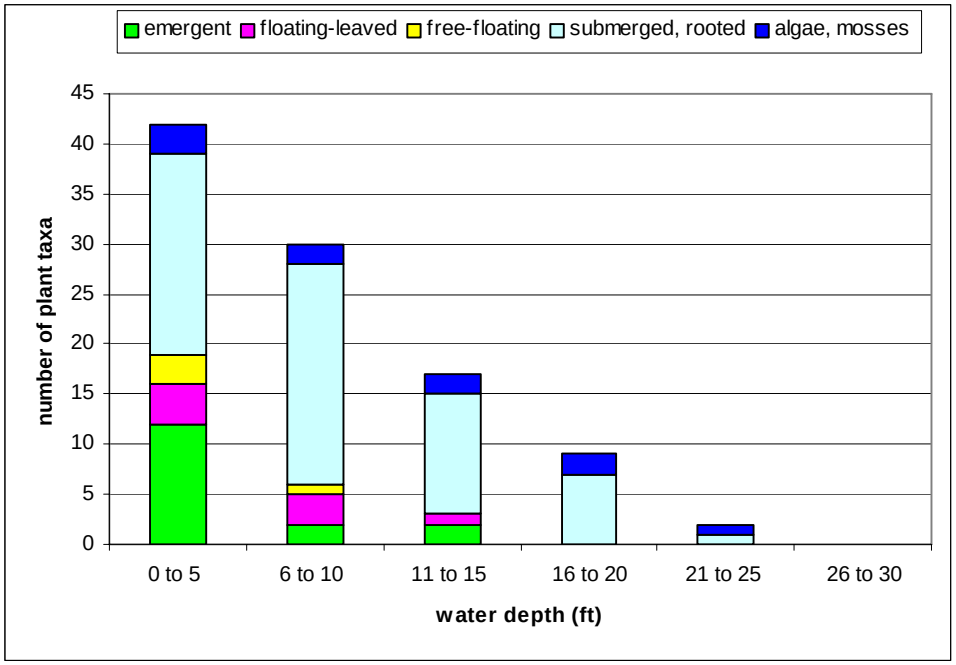
Plants were found to a maximum depth of 23 feet in Woman Lake but beyond the depth of 20 feet, only one percent of the sites contained vegetation (Fig. 8). Plant occurrence was greatest in depths from shore to five feet, where vegetation was found in 87 percent of the sample sites (Fig. 7). All plant types, including rooted, large algae and mosses, decreased in frequency with increasing water depth.

Figure 8. Plant abundance vs. water depth. Woman Lake, June 2006.



The highest number of plant taxa was found in shallow water, from shore to a depth of five feet (Fig. 9). Emergent plants were restricted to water depths of six feet and less and floating-leaved plants were most common to a depth of five feet. Free-floating duckweeds were only found in protected bays and occurred in depths less than six feet. Submerged rooted plants were found to a maximum depth of 23 feet but only two taxa occurred in depths greater than 20 feet.

Figure 9. Number of plant taxa vs. water depth. Woman Lake, 2006.



Distribution of plants in main basin versus bays

Plants occurred around the entire perimeter of Woman Lake but were concentrated within the bays (Fig. 10). Lakewide, 40 percent of the survey sites (in the shore to 25 feet water depth zone) contained plants. Only 20 percent of the main basin sites contained plants, compared to 70 percent of the bay sites.

Of the 42 plant taxa found, all were present in at least one bay but only 21 were found in the main basin (Table 3). All taxa were found more frequently in the bays than in the main basin (Table 3). Areas of the main basin that did contain rooted plants were relatively protected shorelines such as the north side of the island and the northwest shore, which receives some protection from the island (Fig. 10). Scattered rooted plants occurred along several off-shore shallow reefs and sparse stands of the large algae, muskgrass (*Chara* sp.) were found to the west of Horseshow Island. Emergent plant beds within the main basin were not common but included smaller wild rice beds in Hunters Bay and Bungey Bay (Fig. 10).

Aquatic plants were most abundant within Broadwater Bay and Lantern Bay where water depths are mostly shallow. Beds of wild rice, bulrush and waterlilies were common along shorelines of these bays and a diverse mix of submerged plants occurred to water depths of 15 to 20 feet (Fig. 10).

The number of different plant taxa found at each survey site ranged from zero to 10. In the main basin, the mean number of plant taxa per site was less than one. The bays contained the greatest number of taxa and several areas contained between six and ten species per square meter (Fig. 11).

Figure 10. Distribution of aquatic plants in Woman Lake, June-July 2006.

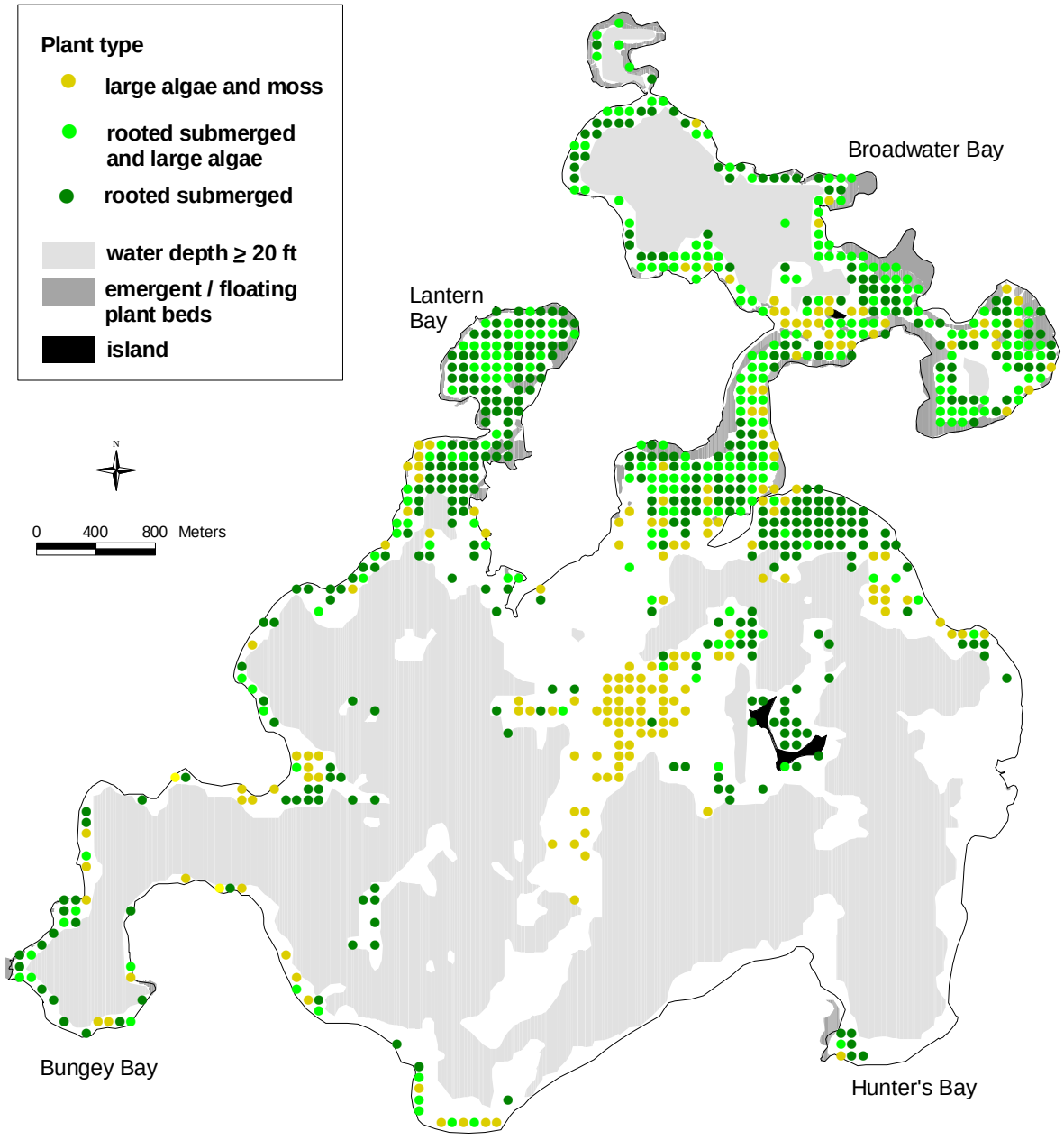
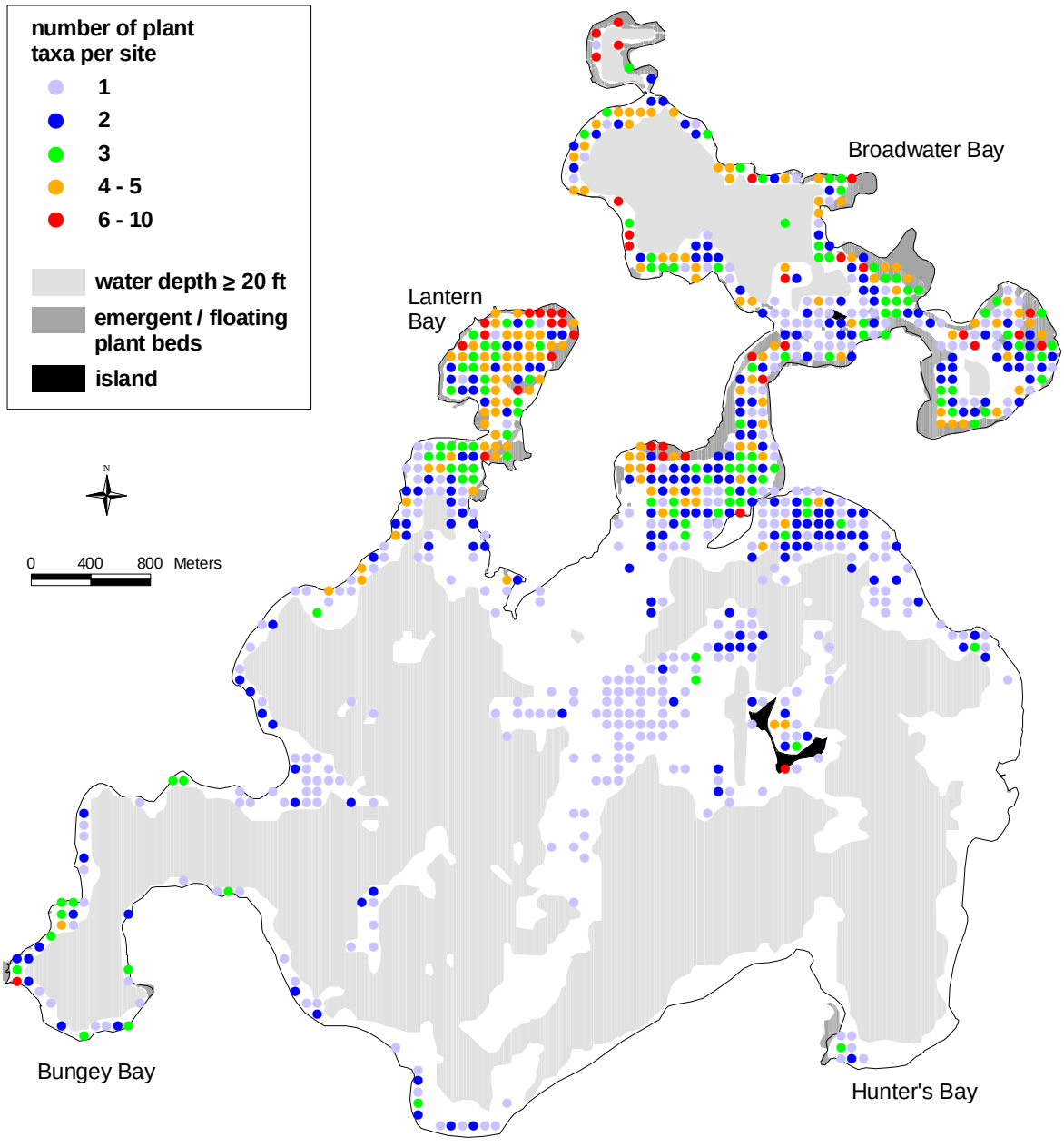


Figure 11. Number of plant taxa found at each sample site. Woman Lake, June 2006.



Emergent and floating-leaf plants

Emergent and floating-leaf plant beds were primarily located in Broadwater Bay and Lantern Bay. The most common emergent plant in Woman Lake was wild rice (*Zizania palustris*) (Fig. 12). Wild rice occurred in shallow areas with muck substrates. Beds of wild rice covered about 180 acres and approximately nine miles of shoreline including areas of Lantern Bay, the channel to Broadwater Bay, the northeast bay, and the north and east shores of Broadwater Bay (Fig. 13).

Bulrush (*Scirpus* spp.) (Fig. 14) was the second most common emergent plant and was found in areas with hard substrate to a depth of about six feet. About 17 acres of bulrush were mapped and the largest bulrush beds occurred in Broadwater Bay at the north end of the channel (Fig. 13).

Figure 12. Wild rice (*Zizania palustris*)

Figure 13. Emergent and floating-leaf plant beds in Broadwater and Lantern Bays, Woman Lake

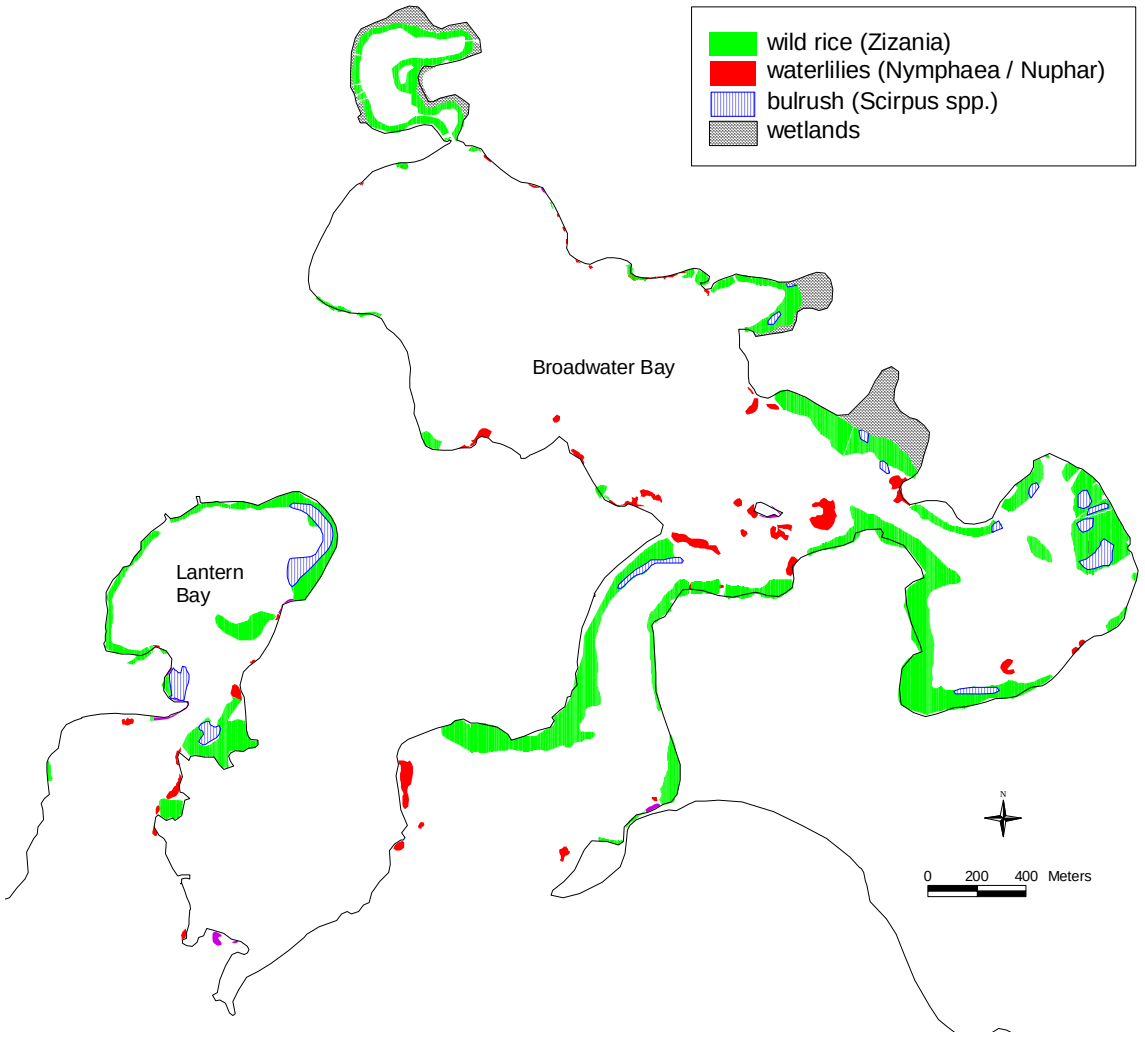


Figure 14. Bulrush (*Scirpus*) bed on Woman Lake, 2006.

Other emergent plants occurred in smaller beds or mixed within wild rice and bulrush beds and included spikerush (*Eleocharis* spp.) cattail (*Typha* spp.), arrowhead (*Sagittaria* spp.), and burreed (*Sparganium* spp.)

About 16 acres of water lily beds were mapped (Fig. 13) and floating-leaf pondweed (*Potamogeton natans*), white water lily (*Nymphaea odorata*) (Fig. 15) and yellow water lily (*Nuphar variegata*) (Fig. 16) were the most common species. Waterlily beds often contained scattered bulrush or wild rice plants as well as submerged plants. Waterlily beds were often associated with muck sediments.

Figure 15. White water lily (*Nymphaea odorata*)

Figure 16. Yellow water lily (*Nuphar variegata*)

Emergent aquatic plants offer shelter for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats. Water lily beds provide similar benefits and also provide shade for fish and frogs. The root systems of emergent and floating-leaf plants act to stabilize the lake bottom and beds of these plants help buffer the shoreline from wave action.

Submerged plants

Submerged plants occurred in 39 percent of all Woman Lake sample sites and in 61 percent of the sites within bays. Submerged plants included a wide variety of forms including large algae, grass-leaved plants, broad-leaved plants, and plants with finely dissected leaves. The most common submerged plants were muskgrass (*Chara* sp.), narrow-leaved pondweeds (*Potamogeton* spp.), broadleaf pondweeds (*Potamogeton spp.)*, wild celery (*Vallisneria americana*), Canada waterweed (*Elodea canadensis*), and coontail (*Ceratophyllum demersum*) (Table 3).

Muskgrass (*Chara* sp.) (Fig. 17) is a macroscopic, or large, algae that is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because this species does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low "carpets" on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important habitat for fish spawning and nesting.

Figure 17. Bed of Muskgrass (*Chara* sp.)

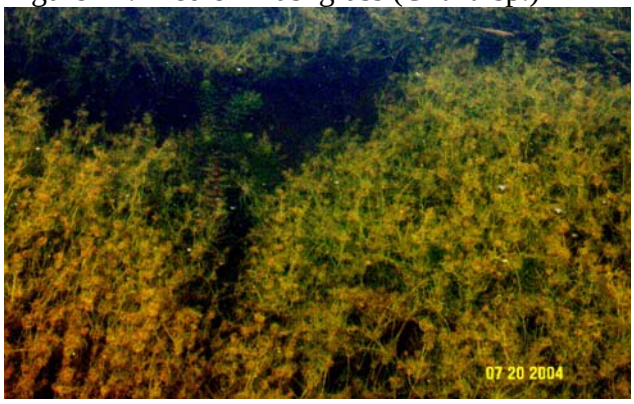


Figure 18. Distribution of common submerged species by water depth, Woman Lake, June 2006.

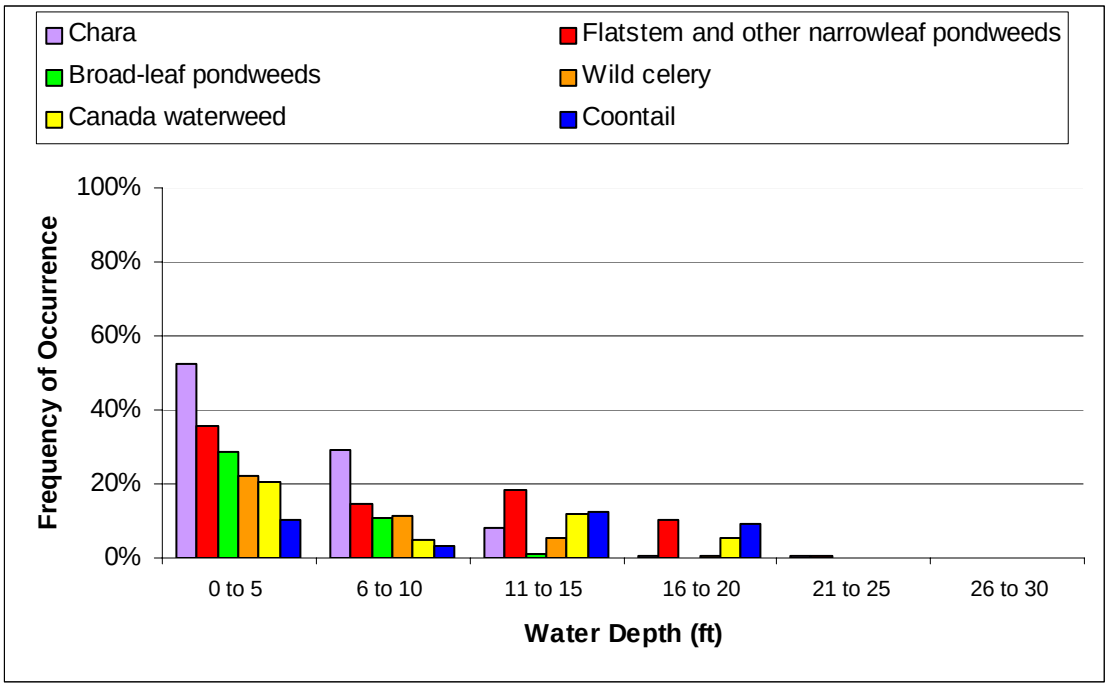
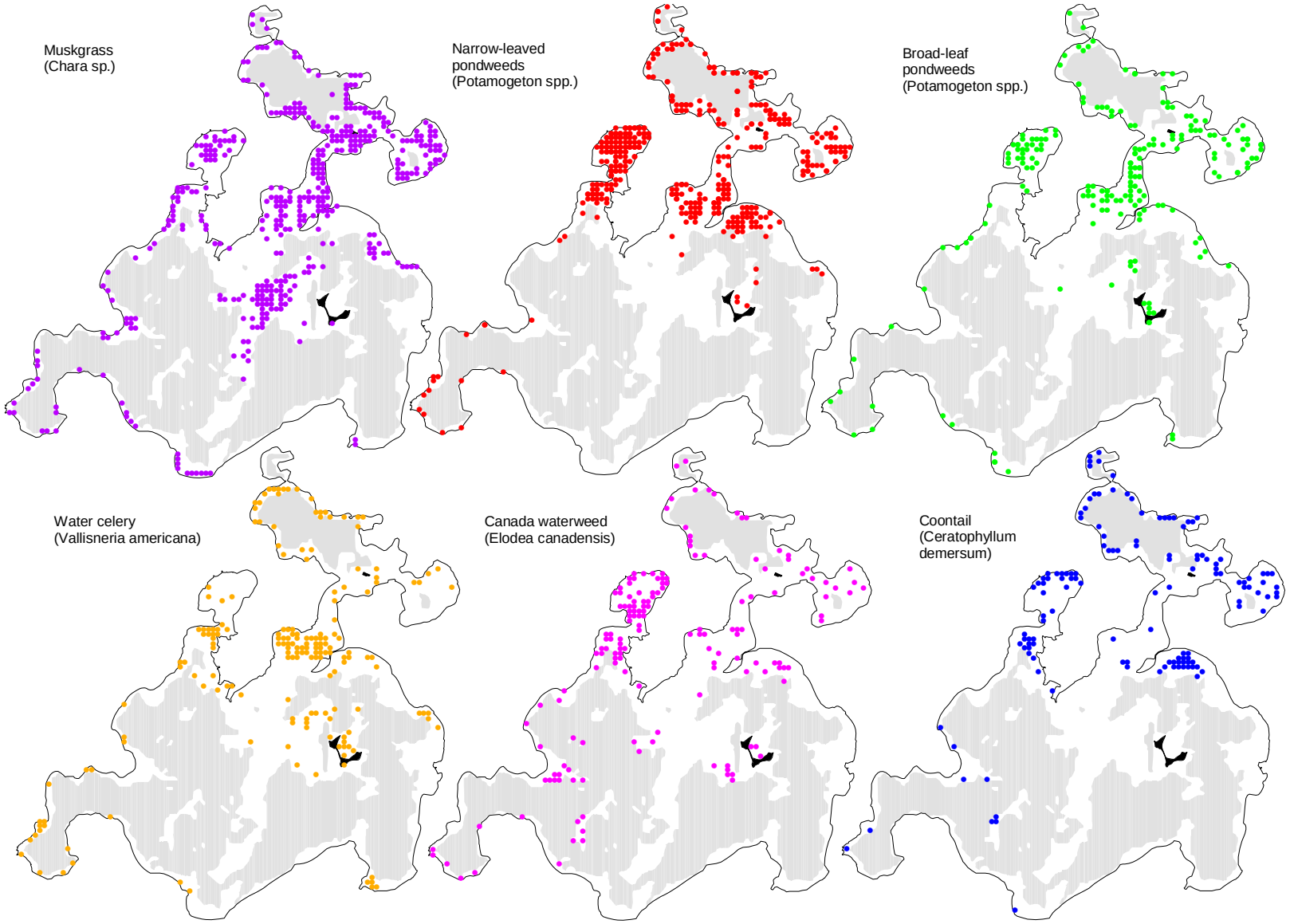


Figure 19. Distribution of common submerged plant groups, Woman Lake, June 2006.



In Woman Lake, muskgrass was the most frequent submerged plant found and occurred in 21 percent of all survey sites (shore to 25 feet depth zone) (Table 3) Within the bays, muskgrass was found in 41 percent of the survey sites, compared to nine percent of the sites in the main basin. Muskgrass occurred to a maximum depth of 23 feet but was most common in depths from shore to 10 feet where it occurred in 36 percent of the sites (Fig. 18). In depths greater than 20 feet, muskgrass was found in less than one percent of the sample sites. Muskgrass was commonly found in Broadwater Bay, Lantern Bay, Bungey Bay and the southwest shore. It was one of only a few taxa found on the shallow offshore reef to the west of Horseshoe Island (Fig. 19).

Nine different native submerged "pondweed" (*Potamogeton spp.*) taxa occurred in Woman Lake and most are named for their unique leaf structure. All pondweeds have submerged leaves and some also have floating leaves; both leaf types provide food and shelter for fish. The "cigar-shaped" fruits of pondweeds emerge above the water surface and are a favorite duck food

Narrow-leaved pondweeds found in Woman Lake include Flat-stem pondweed (*Potamogeton zosteriformis*) (Fig. 21) and Freis pondweed (*Potamogeton freisii*). These plants have 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.

Figure 20. Flat-stem pondweed (*Potamogeton zosteriformis*)

As a group, narrow-leaved pondweeds occurred in 15 percent of all survey sites and in 36 percent of the bay sites. Flat-stem pondweed was found in 14 percent of the sites surveyed and was the most frequently found rooted submerged plant. Freis pondweed occurred in seven percent of all sites. Both species were most common within the bays where they occurred in 35 percent and 17 percent of the sample sites, respectively (Table 3). They were most frequent in depths of 15 feet and less but were occasionally found in water as deep as 23 feet (Fig. 18). These plants were primarily found in sheltered areas including the bays and the north side of Horseshoe Island (Fig. 19).

Figure 21. A broad-leaf pondweed or "cabbage" (*Potamogeton amplifolius*) with cigar-shaped fruit

Broad-leaved pondweeds in Woman Lake include large-leaf pondweed (*Potamogeton amplifolius*), variable pondweed (*P. gramineus*), Illinois pondweed (*P. illinoensis)*, white-stem pondweed (*P. praelongus*), and clasping-leaf pondweed (*P. richardsonii*). These rooted, perennial plants with wide leaves are often called "cabbage" plants by anglers.

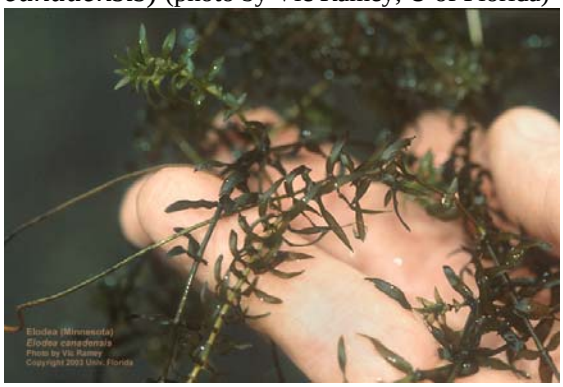
Collectively, broad-leaved pondweeds occurred in nine percent of the Woman Lake sites and in 29 percent of the sites within bays. White-stem pondweed was the most abundant broad-leaf pondweed in Woman Lake and was found in four percent of all sample sites and in 11 percent of the sites within bays (Table 3). Broad-leaved pondweeds were more common in depths of 15 feet and less (Fig. 18) and often co-occurred with narrow-leaved pondweeds (Fig. 19).

Figure 22. Water celery (*Vallisneria americana)*

Wild Celery (*Vallisneria americana*) is a rooted, perennial submerged plant with long, grass-like leaves (Fig. 22). 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. 1997). Wild celery is a particularly important food source for canvasback ducks (Varro 2003).

In Woman Lake, wild celery occurred primarily in the bays where it was found in 19 percent of the sample sites. It was most common in depths of 10 feet and less (Fig. 18). Large beds of wild celery were found at the south end of the channel to Broadwater Bay, the west side of Broadwater Bay, the south end of Lantern Bay, and the north side of Horseshoe Island (Fig. 19).

Figure 23. Canada waterweed (*Elodea canadensis*) (photo by Vic Ramey, U of Florida)



Canada waterweed (*Elodea canadensis*) (Fig. 23) is a rooted, perennial submerged species that is widespread throughout Minnesota and is adapted to a variety of conditions. It is tolerant of low light and prefers soft substrates. This species can over winter as an evergreen plant and spreads primarily by fragments. The branching stems of this plant can form thick underwater plant beds that are valuable habitat for a variety of fish and invertebrates.

In Woman Lake, it occurred from shore to a depth of 22 feet (Fig. 17). It was found in seven percent of all sample sites and was most common within the bays where it occurred in 15 percent of the sites (Table 3, Fig 19). Canada waterweed was one of the few flowering plants found at offshore sites in the main basin of Woman Lake.

Coontail (*Ceratophyllum demersum*) (Fig. 24) is the most common submerged flowering plant in Minnesota lakes. It grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is a perennial and can overwinter as a green plant under the ice and then begins new growth early in spring. Because it is only loosely rooted to the lake bottom it may drift between depth zones (Borman et al. 1997). Coontail provides important cover for

young fish, including bluegills, perch, largemouth bass and northern pike. It also supports aquatic insects beneficial to both fish and waterfowl.

Figure 24. Coontail (*Ceratophyllum demersum*)

In Woman Lake, coontail occurred in only six percent of all survey sites but within the bays it was found in 14 percent of the sites (Table 3). Coontail occurred to a depth of 20 feet (Fig. 18) and was primarily found along north shores of the lake (Fig. 19) where its loosely anchored stems are blown into near-shore sites by prevailing winds.

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, water depth, substrate and wave activity. Much of Woman Lake is too deep or wind-swept for aquatic plant growth. The sheltered shallow areas do support an abundant and diverse native aquatic plant community that in turn, provides critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

The high number of plant species found in Woman Lake is a reflection of the excellent water clarity. Many of the plants found require clear water and are not found in lakes with higher turbidity. Another reason for the high diversity of plant types is that Woman Lake has a variety of sediment types and a mix of protected bays and open water sites. Plant species with different habitat requirements can co-exist within this system.

Data collected in 2006 can be used to monitor changes that may occur in the plant community, such as an increase in a particular species or a change in the depths at which individual species 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 in Woman Lake 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.
- Non-native, invasive plant species
  Non-native species have **not** been documented in Woman Lake 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.
- Crayfish
  The non-native rusty crayfish (*Orconectes rusticus*) has been documented in Woman Lake and anglers have questioned whether crayfish abundance has caused the decline of submerged plants. Both rusty crayfish and native crayfish graze on aquatic plants. In some northern Wisconsin lakes, anecdotal information suggests that rusty crayfish have had a negative impact on submerged plants (Olsen et al. 1991). It is difficult to know how rusty crayfish have impacted the aquatic plant community of Woman Lake because historical data are primarily descriptive. The 1922 survey describes abundant vegetation in the protected bays and sparse plants in the main lake but detailed historical data are not available to compare to the 2006 survey data. In general, high abundance of crayfish may lead to a decrease in aquatic plants but the extent and duration of that decrease are unknown. Crayfish grazing on plants may be decreased if there is an alternative source of food, especially invertebrates (Lodge and Lorman 1987).
- Natural fluctuation in plant species
  Many submerged plants are perennial and regrow in similar locations each year. However, a few species such as bushy pondweed (*Najas flexilis*) and 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.

Woman Lake, August 2006. Example of dock placement with minimal disturbance to wild rice and other plants.

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