Aquatic vegetation of Big Trout Lake

July, 2010

ID# 18-0315-00

Crow Wing County, Minnesota

Southwest bay of Big Trout Lake, 2010.

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Summary

Big Trout Lake is the 6th largest lake in Crow Wing County and the 3rd largest in the Whitefish Chain of Lakes, with a surface area of about 1,342 acres. Aquatic plant surveys were conducted in July 2010 and included a lakewide assessment of vegetation and water depths at 434 sampling sites and mapping of major emergent and floating-leaf plant beds.

The aquatic plant communities of Big Trout Lake are similar to those found in other hard water, clear lakes in Crow Wing County. Plants were distributed around the entire perimeter of the lake, with the broadest bands of vegetation occurring along the shallower north shore and in the southwest bay. A total of 41 native aquatic plant species (types) were recorded, including 10 emergent, 4 floating-leaved, 3 free-floating and 24 submerged species. Twenty-two of these taxa were identified for the first time in the lake in 2010.

Emergent and floating-leaf plants were restricted to water depths less than 6 feet and occupied 19 acres, or 6% of the shallow water (0-5 feet) zone. These plant beds occurred in protected bays of the north and southwest shores and included white and yellow waterlilies (*Nymphaea odorata; Nuphar variegata*), bulrush (*Schoenoplectus* sp.), wild rice (*Zizania palustris*), burreed (*Sparganium* sp.), and cattails (*Typha* spp.).

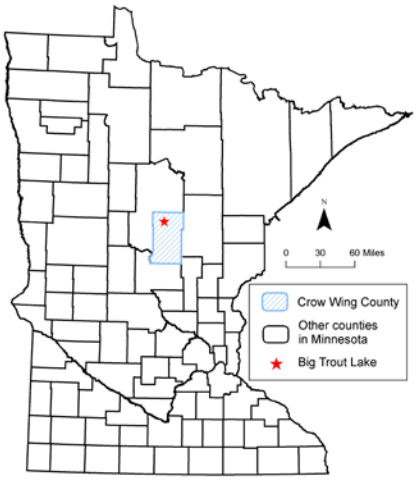
Submerged plants were found to a depth of 27 feet and were most frequent in the 6 to 15 feet depth zones, where 94% of the sites were vegetated. The submerged macroalgae, muskgrass (*Chara* sp.) was the most common plant in Big Trout Lake and occurred in 61% of the survey sites. It dominated the 0 to 15 feet depth zones where it was found in 70% of the sites. Submerged species were found in 46% of the sample sites and commonly occurring species included coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), flat-stem pondweed (*Potamogeton zosteriformis*), and Canada waterweed (*Elodea canadensis*).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was first documented in Big Trout Lake in 1942. It was found during the 2010 survey but occurred infrequently and was not present at any of the survey sites.

Introduction

Big Trout Lake is located in the city of Manhattan Beach in Crow Wing County, north central Minnesota (Figure 1). Big Trout Lake is one of only two trout lakes in the Brainerd Lakes Area. It is a popular lake for trout fishing, boating and other water recreation activities.

Figure 1. Big Trout Lake, Crow Wing County, Minnesota.



Lake Characteristics

Big Trout Lake is the northern-most water body in the Whitefish Chain of Lakes (Figure 2). This chain of 14 waterbodies was connected in 1886 when the Pine River Dam was completed and raised water levels making channels between the set of lakes. Most of the lakes are connected by the Pine River as it flows east through the chain. Big Trout Lake has no inlets and it outlets through a channel to Whitefish Lake (Figure 3).

Figure 2. Big Trout Lake within the Whitefish Chain of lakes.

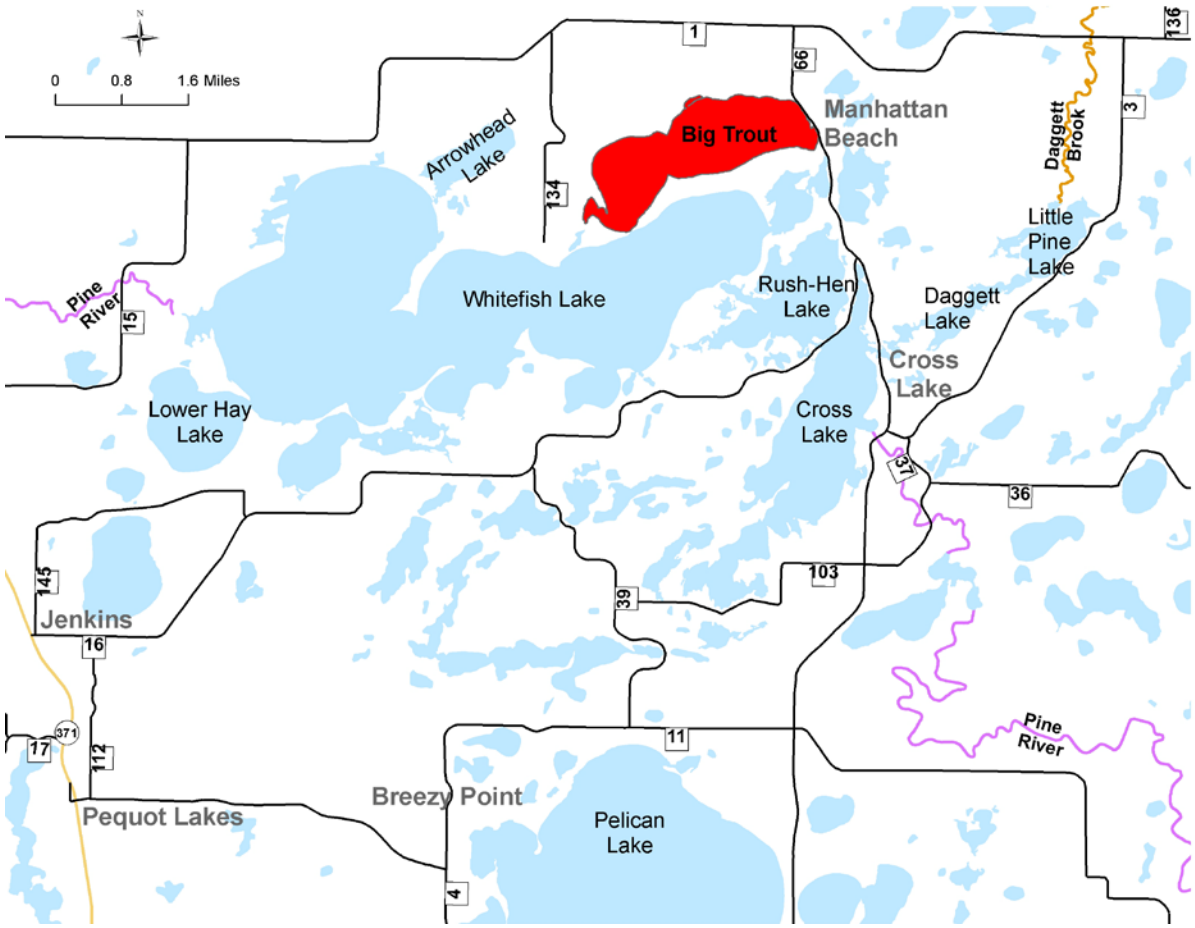
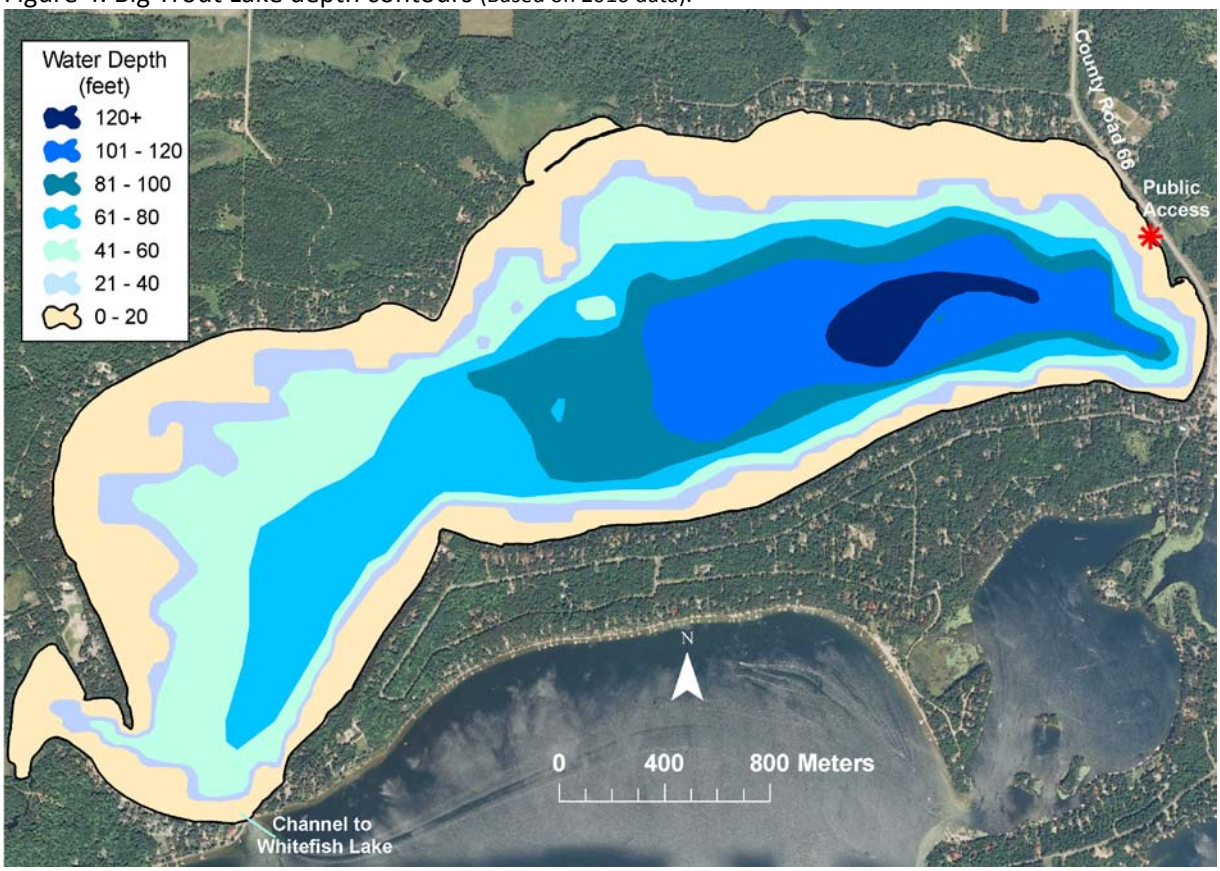


Figure 3. Channel between Big Trout Lake and Whitefish Lake.

With a surface area of 1,342 acres 21 miles of shoreline, Big Trout Lake is the 6th largest lake in the county and the 3rd largest in the Whitefish Chain. It has a long and narrow outline, stretching about 3 miles long, from west to east, with an average width of about 1 mile (Figure 4).

Big Trout Lake has a maximum depth of 128 feet but only 27% of the lake is shallow (15 feet or less in depth). The broadest areas of shallow water occur along the north shores and in the southwest bay (Figure 4).

Figure 4. Big Trout Lake depth contours (Based on 2010 data).



Big Trout Lake is characterized as a mesotrophic (moderate nutrients), hard water lake, with relatively clear water. The Secchi disc transparency measures the depth to which a person can see into the lake and provides a rough estimate of the light penetration into the water column. Water clarity can fluctuate annually and depends on the amount of particles in the water. In 2009, mean summer (June through September) water clarity, as measured by Secchi disc readings, was 13 feet in Big Trout Lake (MPCA 2010). As a general rule, sunlight can penetrate to a depth of two times the Secchi depth and aquatic plants can grow to a depth of one and a half times the Secchi depth. Based on Secchi disk measurements alone, aquatic plants have the potential to reach depths of 20 feet in this lake.

The majority of Big Trout Lake shoreline is privately owned and developed with residential homes. There is a MnDNR public access on the east side of the lake off County Road 66.

Historic aquatic plant community

Previous lakewide, aquatic plant surveys of Big Trout Lake were conducted in 1942, 1955, 1961 and 1990 (MnDNR Lake files). These previous surveys found a total of 22 native aquatic plant types including 7 emergent, 4 floating-leaf and 11 submerged species (Appendix 1). Submerged plants were found to a depth of 25 feet and include 8 different native pondweeds (*Potamogeton* spp.), northern watermilfoil (*Myriophyllum sibiricum*), coontail (*Ceratophyllum demersum*), bushy pondweed (*Najas flexilis*), and Canada waterweed (*Elodea canadensis*).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*) was first documented in the lake in 1942 but to date has not occurred frequently in the lake.

Objectives

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

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

Methods

Mapping floating-leaf and emergent vegetation beds

Emergent and floating-leaf plant beds were delineated using 2008 Farm Service Administrative (FSA) true color aerial photographs. Field surveys were conducted in September 2010 to map bulrush, which is difficult to identify from aerial photos, and to verify photo-interpretation of other plant beds. Surveyors mapped bulrush beds in the field by motoring around the perimeter of each bed and recording their track with a handheld Global Positioning System

(GPS) unit. Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage.

Lakewide vegetation survey

A lakewide vegetation survey was conducted using a point-intercept survey method (Madsen 1999, MnDNR 2009). Survey waypoints were created using a GIS computer program and downloaded into a handheld GPS unit. Survey points were placed across the entire lake and spaced 65 meters (213 feet) apart. This resulted in about one survey point per acre.

In the field, surveyors sampled sites where water depth was less than 31 feet. To minimize damage to vegetation, surveyors did not survey sites if they occurred in dense beds of emergent or floating-leaf plants. A total of 434 sites were surveyed in Big Trout Lake (Figure 5, Table 1).

Figure 5. 2010 vegetation survey sites on Big Trout Lake.

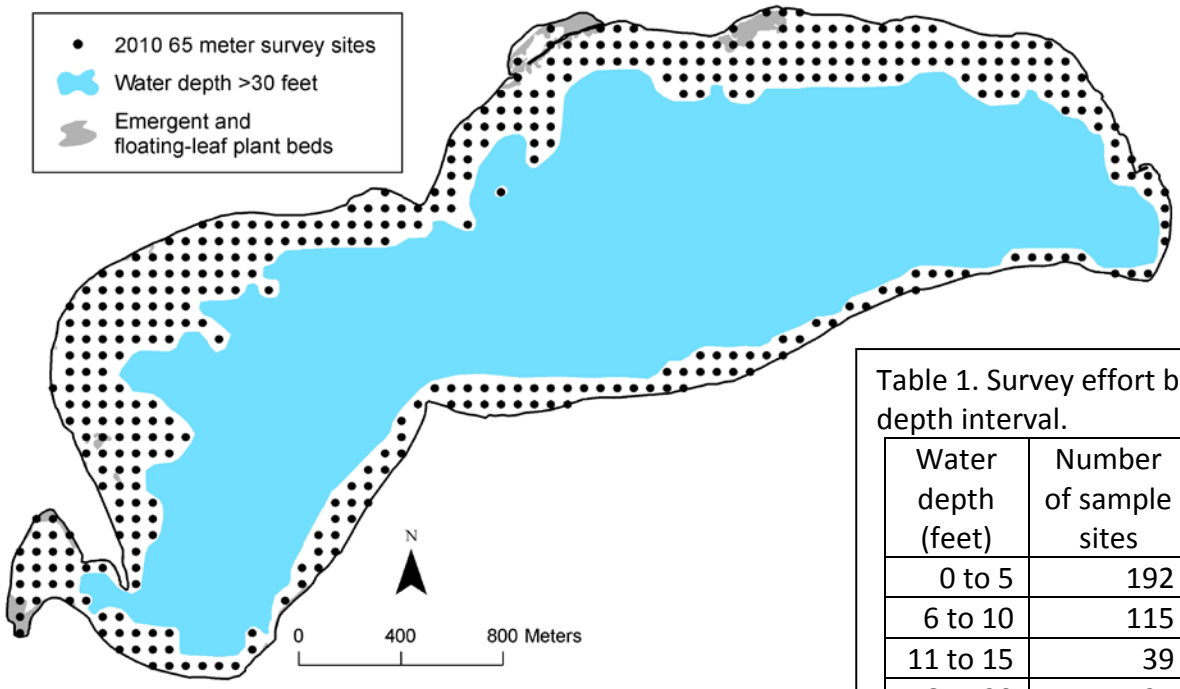


Table 1. Survey effort by depth interval.

Water depth (feet)	Number of sample sites
0 to 5	192
6 to 10	115
11 to 15	39
16 to 20	27
21 to 25	31
26 to 30	30
Total	434

Big Trout Lake was surveyed on July 21, 22, 2010. The survey was conducted by boat and a GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments using a measured stick in water depths less than 7 feet and an electronic depth finder in deeper water.

Substrate sampling

At each sample site where water depths were 7 feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2). If more than one substrate type was found, surveyors recorded the most common type. Surveyors attempted to record a substrate description at the shore side of each row of points. If a sample site occurred near shore but in water depth greater than 7 feet, surveyors collected depth and vegetation data and then motored into shallower water and recorded the substrate type adjacent to the actual survey point.

Table 2. Substrate classes

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

Plant sampling

Surveyors recorded all plant species found within a one square meter sample site at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the water surface (Figure 6). Any additional plant species found outside of sample sites were recorded as "present" in the lake but these data were not used in frequency calculations. Plant identification followed Crow and Hellquist (2000) and Flora of North America (1993+) and nomenclature followed MnTaxa (2010).

Figure 6. Survey rake.

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

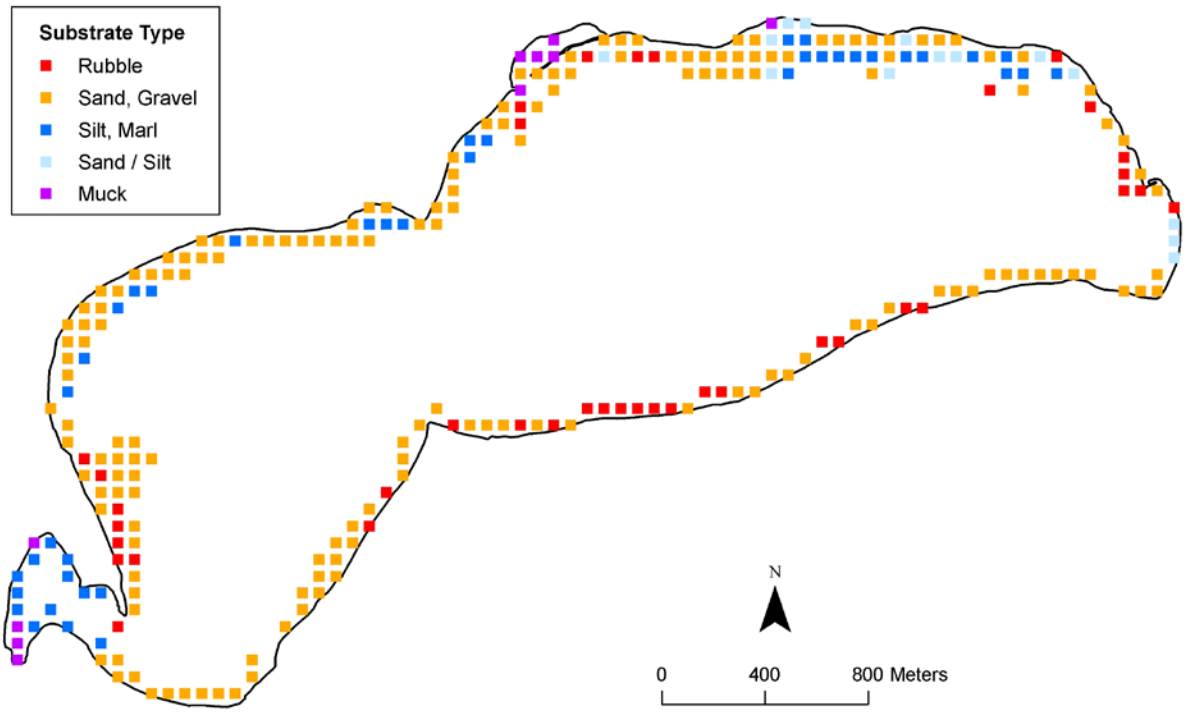
Example:
In Big Trout Lake there were 434 samples sites in the 0-30 feet depth zone.
Muskgrass occurred in 265 sites.
Frequency of Muskgrass in 0 to 30 feet zone = (265/ 434)*100 = 61%

Results and Discussion

Shoal Substrates

The shoal substrates of Big Trout Lake were primarily hard substrates of sand, gravel, and rubble (Figure 7). Softer substrates of silt and muck were found in shallow, protected bays (Figure 7).

Figure 7. Shoal substrates of Big Trout Lake, 2010.



Types of plants recorded

A total of 41 native aquatic plant species (types) were recorded in Big Trout Lake including 10 emergent, 4 floating-leaved, 3 free-floating and 24 submerged plants (Table 3). Submerged plants included macroalgae, and a diversity of rooted plants that can be grouped by leaf shape and size: dissected, small, narrow, broad and grass-leaved plants. One non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was found.

Twenty-two of the 41 aquatic plant species found were recorded for the first time during the 2010 survey of Big Trout Lake. Two species that were present during historical surveys but were not found in 2010. Floating-leaf burreed (*Sparganium fluctuans*) grow in shallow waters near shore and may still be present in the lake but may occur infrequently. Robbin's pondweed (*Potamogeton robbinsii*) is a submerged plant that was described as "common" in 1990 but was not found in 2010.

Distribution of aquatic plants

Plants were distributed around the entire perimeter of the lake. The broadest zones of vegetation were along the shallow north shore and the southwest bay (Figure 8).

Table 3. Frequency of submerged and free-floating aquatic plants in Big Trout Lake, July 2010.

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

Life Form		Common Name	Scientific Name	Frequency (%)
				434
SUBMERGED	Macroalgae	Muskgrass	*Chara* sp.	61
		Stonewort	*Nitella* sp.	<1
		Watermoss	*Not identified to genus*	2
	Dissected-leaf rooted plants	Coontail	*Ceratophyllum demersum*	15
		Northern watermilfoil	*Myriophyllum sibiricum*	13
		White-water buttercup	*Ranunculus aquatilis*	6
		Greater bladderwort	*Utricularia vulgaris*	4
		Water marigold	*Bidens beckii*	3
		Flat-leaf bladderwort	*Utricularia intermedia*	<1
	Small-leaf rooted plants	Canada waterweed	*Elodea canadensis*	10
		Bushy pondweed	*Najas flexilis*	6
		Southern naiad	*Najas guadalupensis*	2
		Creeping spearwort	*Ranunculus flammula*	<1
	Narrow-leaf pondweeds	Narrow-leaf pondweed group[a]	*Potamogeton friesii*	12
			Potamogeton strictifolius	
		Sago pondweed	*Stuckenia pectinata*	6
	Broad-leaf pondweeds	Illinois pondweed	*Potamogeton illinoensis*	6
		Clasping-leaf pondweed	*Potamogeton richardsonii*	6
		White-stem pondweed	*Potamogeton praelongus*	5
		Variable pondweed	*Potamogeton gramineus*	4
		Large-leaf pondweed	*Potamogeton amplifolius*	1
		Curly-leaf pondweed (I)	*Potamogeton crispus*	*Present
	Grass-leaf rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	12
		Wild celery	*Vallisneria americana*	3
		Water star-grass	*Heteranthera dubia*	1
Free-floating	Duckweed	Greater duckweed	*Spirodela polyhriza*	1
		Lesser duckweed	*Lemna* sp.	<1
		Star duckweed	*Lemna trisulca*	<1

I = introduced species

*Present = found in lake but did not occur in any sample sites

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

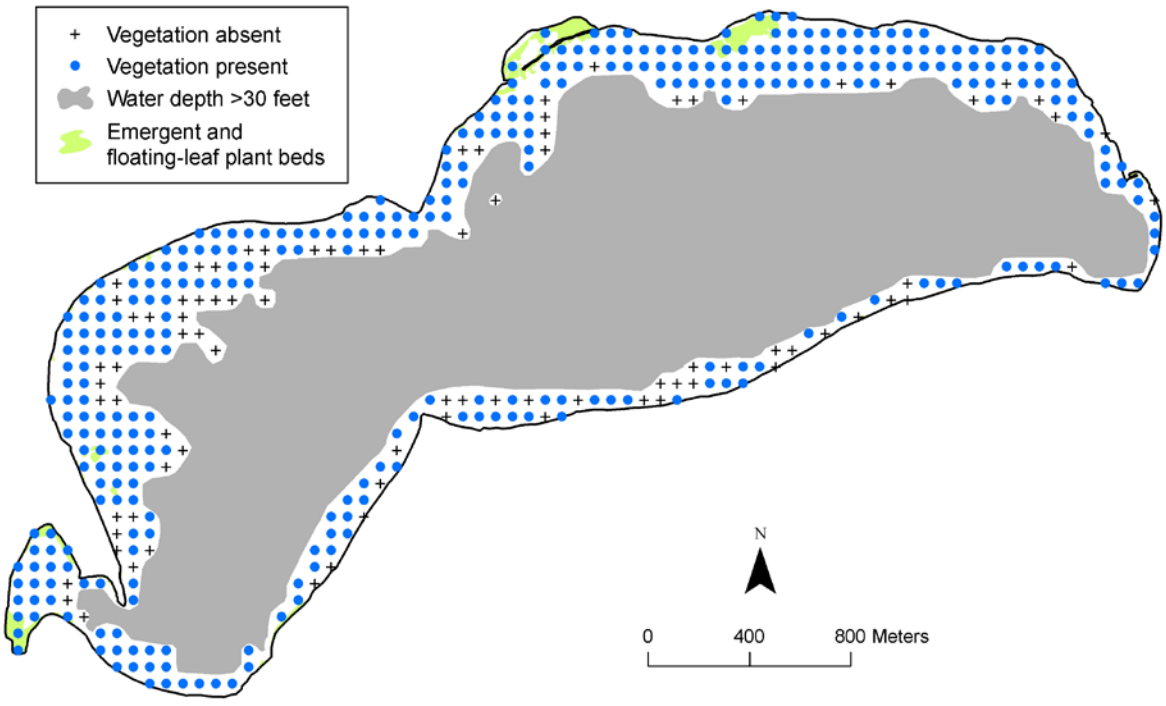
Table 3 (cont). Frequency of floating-leaved and emergent aquatic plants in Big Trout Lake, July 2010.
[Frequency is the percent of sample sites in which a plant species occurred within the 0 to 30 ft water depth).

Life Form	Common Name	Scientific Name	Frequency (%) 434
FLOATING-LEAVED	White waterlily	*Nymphaea odorata*	1
	Yellow waterlily	*Nuphar variegata*	1
	Floating-leaf pondweed	*Potamogeton natans*	1
	Floating smartweed	*Persicaria amphibia*	*Present
EMERGENT (includes only in-lake emergents and not wetland plants)	Needlerush	*Eleocharis acicularis*	1
	Bulrush	*Schoenoplectus* sp.	<1
	Spikerush	*Eleocharis* sp.	<1
	Broad-leaved arrowhead	*Sagittaria latifolia*	<1
	Giant burreed	*Sparganium eurycarpum*	<1
	Arum-leaved arrowhead	*Sagittaria cuneata*	*Present
	Horsetail	*Equisetum fluviatile*	*Present
	Wild rice	*Zizania palustris*	*Present
	Broad-leaved cattail	*Typha latifolia*	*Present
	Narrow-leaved cattail	*Typha* sp[b.]	*Present

*Present = found in lake but did not occur in any sample sites

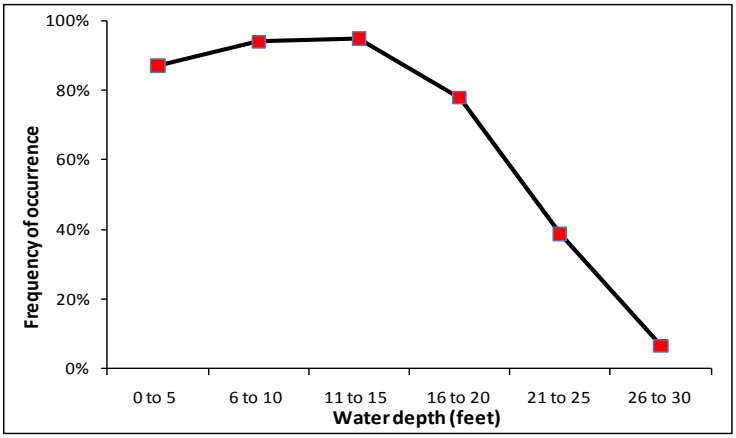
[b] narrow leaf cattail was identified in survey but it is not known whether this included *Typha angustifolia* and/or *Typha* x *glauca*.

Figure 8. Distribution of aquatic plants, Big Trout Lake 2010



Plants were found to a depth of 27 feet in Big Trout Lake and in the 0-30 feet depth zone, 80% of the survey sites contained vegetation. Vegetation was most common in the 0 to 15 feet depth zone, where 90% of sites contained plants (Figure 9). Plant occurrence decreased with increasing water depth and in water depths greater than 20 feet, only 23% of sites contained plants.

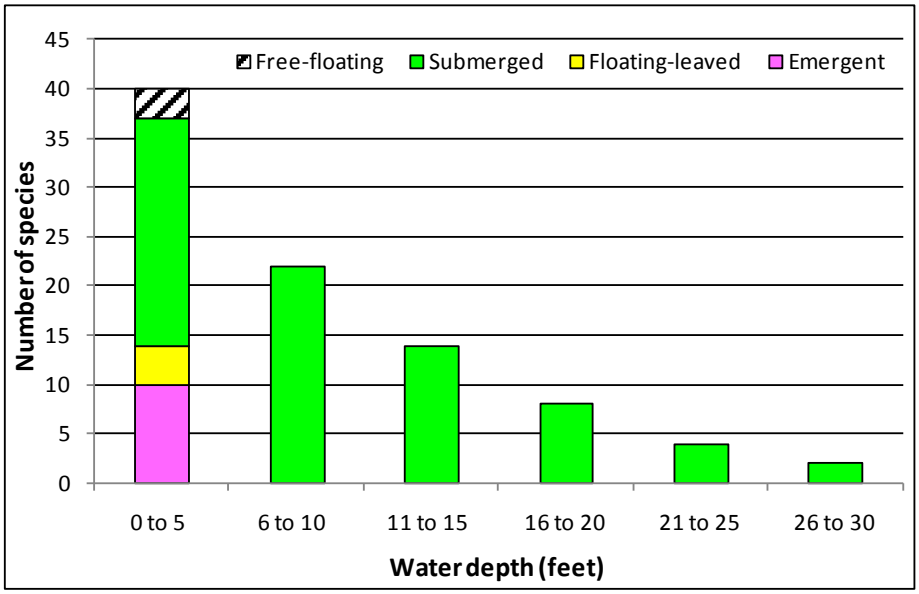
Figure 9. Aquatic plant frequency vs. water depth.



Plant communities richness

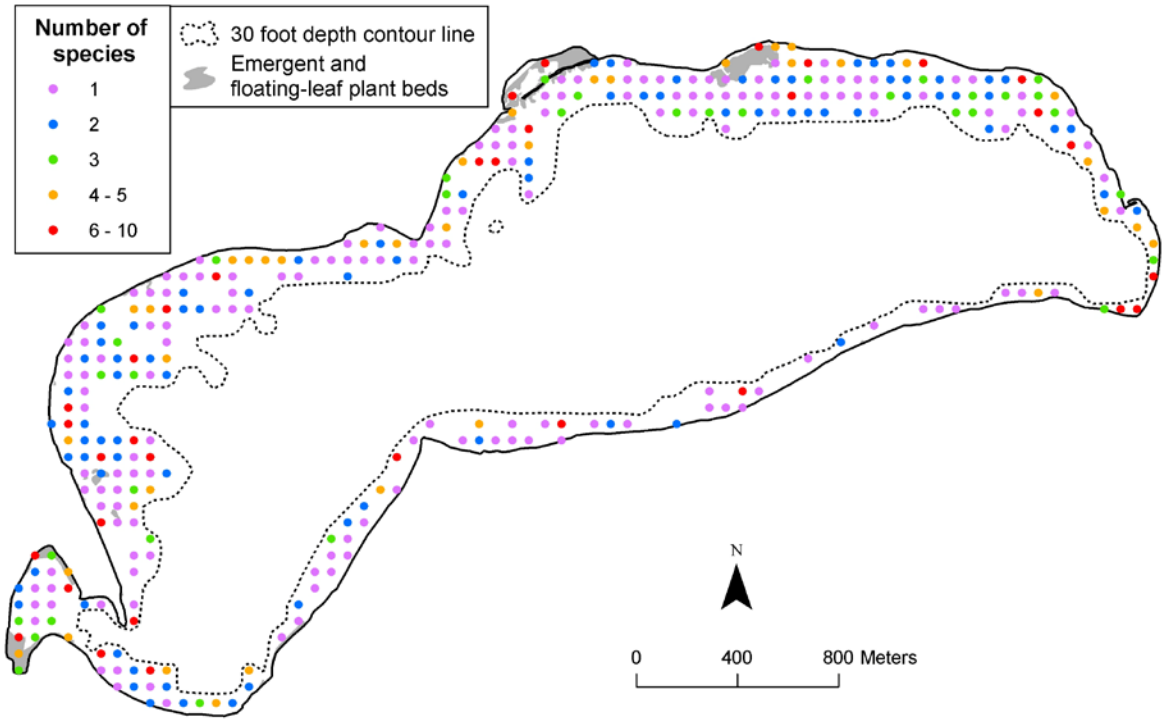
The highest number of plant species was found in shallow water, from shore to a depth of 5 feet where nearly all of the plant species were found (Figure 10). Emergent plants were restricted to water depths of 5 feet and less and floating-leaved plants were most common to a depth of 5 feet. Submerged plants were found to a maximum depth of 27 feet but only 8 species occurred in depths greater than 15 feet and only 2 species (muskgrass and coontail) occurred in depths greater than 25 feet.

Figure 10. Number of plant species vs. water depth, Big Trout Lake, 2010.



The number of plant species found at each one square meter sample site ranged from 0 to 10 with a mean of 2 species per site (Figure 11). Sixty-nine percent of the vegetated sites contained only 1 or 2 species. Sites with a high number of species included protected bays where emergent and floating-leaf plants co-occurred with a diversity of submerged species.

Figure 11. Number of species per site, Big Trout Lake 2010.



Emergent and Floating-leaf Plant Beds

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

Approximately 19 acres of emergent and floating-leaf plant beds were mapped in Big Trout Lake. Emergent and floating-leaf plants were restricted to the 0-5 feet depth zone and within that area, 6% of the Big Trout Lake sites contained at least one emergent or floating-leaf plant. Plant beds were classified by the dominant species (Figure 12).

Figure 12. Major emergent and floating-leaf plant beds of Big Trout Lake, 2010.

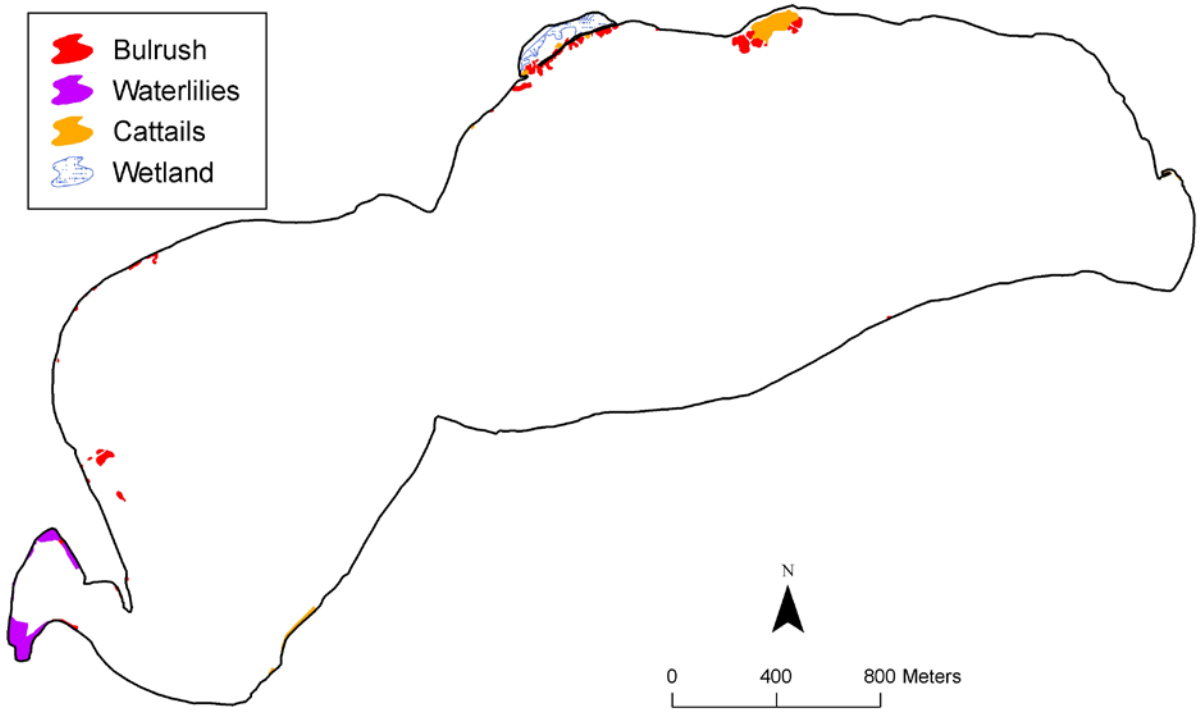


Figure 13. Bulrush in shallow water in Big Trout Lake

Bulrush (*Schoenoplectus* sp.) (Figure 13) and spikerush (*Eleocharis* sp.) are emergent, perennial plants that are rooted in the lake bottom with narrow stems that may extend several feet above the water. In addition to providing valuable fish and wildlife habitat, the extensive root network of these plants help to stabilize sandy shorelines. In shallow water, they may spread by underground rhizomes but these plants are particularly susceptible to destruction by direct cutting by humans, motorboat activity and excess herbivory. Restoration of these plant beds can be very difficult, making established beds particularly unique and valuable. In Big Trout Lake, bulrush was most often found on sandy or rocky shores of the north and west shores (Figure 12). A total of 5 acres of bulrush, spikerush or mixed bulrush beds were mapped.

Figure 14. Cattails

Cattails (*Typha* spp.; Figure 14) are emergent plants that are found in lakes and marshes throughout Minnesota. They are perennial plants that emerge from a spreading rhizome and they have long and narrow leaves. Cattails provide shelter and food for many different kinds of fish

and bird species. A total of 4 acres of cattails were mapped in Big Trout Lake and the largest bed was along the north shore (Figure 12).

Floating-leaf plants included white waterlily (*Nymphaea odorata*; Figure 15), yellow waterlily (*Nuphar variegata*; Figure 16), floating-leaf smartweed (*Persicaria amphibia*; Figure 17) and floating-leaf pondweed (*Potamogeton natans*). Waterlily beds often contained scattered bulrush, other emergents and submerged plants (Figure 18). Waterlily beds, or mixed beds of waterlilies and emergent plants, covered about 5 acres in Big Trout Lake and were primarily found in the southwest bay (Figure 12).

Figure 15. White waterlily

Figure 16. Yellow waterlily

Figure 17. Floating smartweed

Figure 18. Cattails and waterlilies along undeveloped shore of Big Trout Lake.

Native Submerged Plants

Submerged plants occurred in 80% of the Big Trout Lake sample sites and were found around the entire shoreline (Figures 19). The most frequently occurring species were muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), flat-stem pondweed (*Potamogeton zosteriformis*), and Canada waterweed (*Elodea canadensis*). These species were all common in depths less than 16 feet, while muskgrass and coontail occurred at all depths sampled (Figure 20).

Figure 19. Distribution of commonly occurring native submerged plants in Big Trout Lake, 2010.

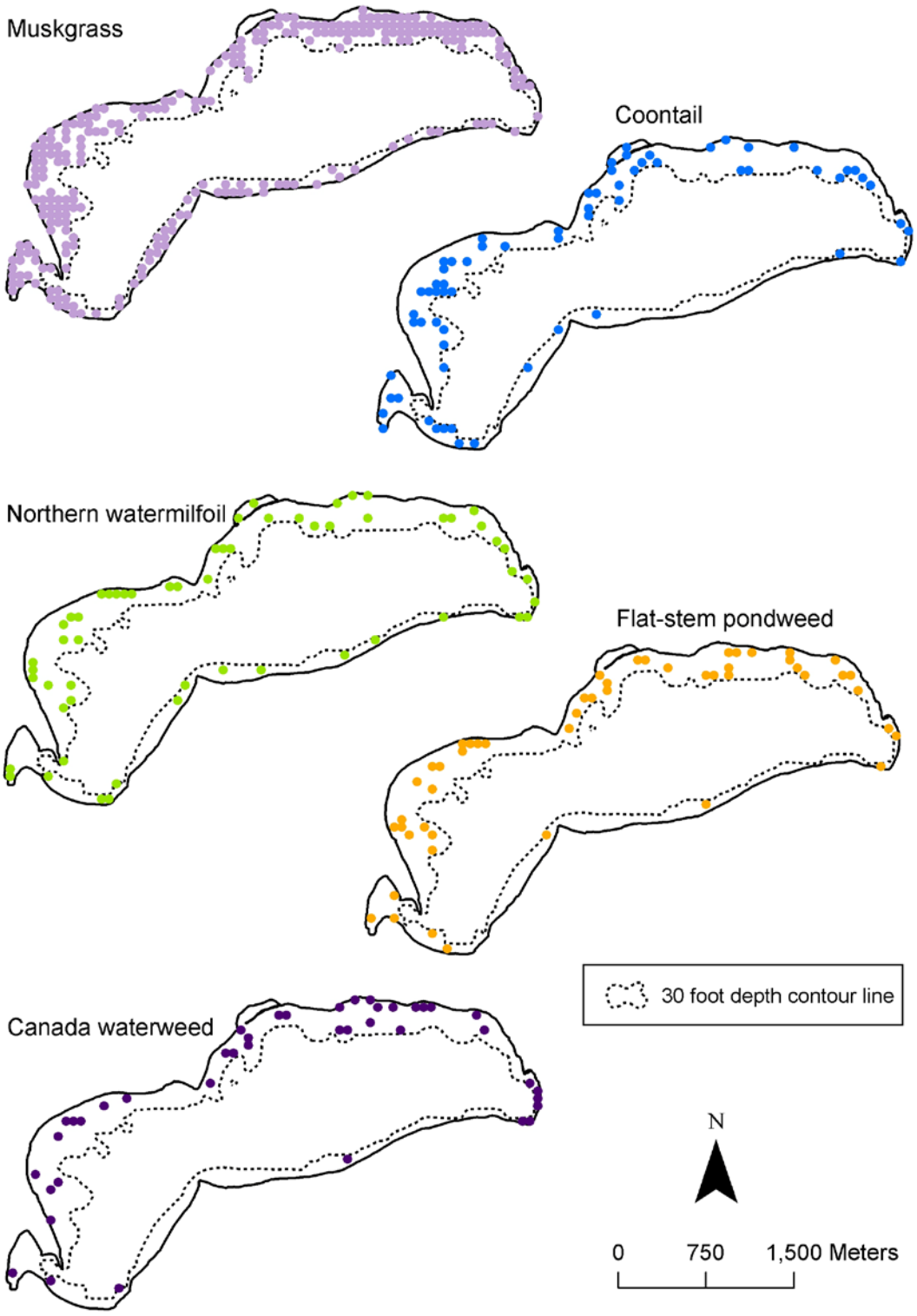


Figure 20. Common submerged plants at each water depth interval, Big Trout Lake, 2010.

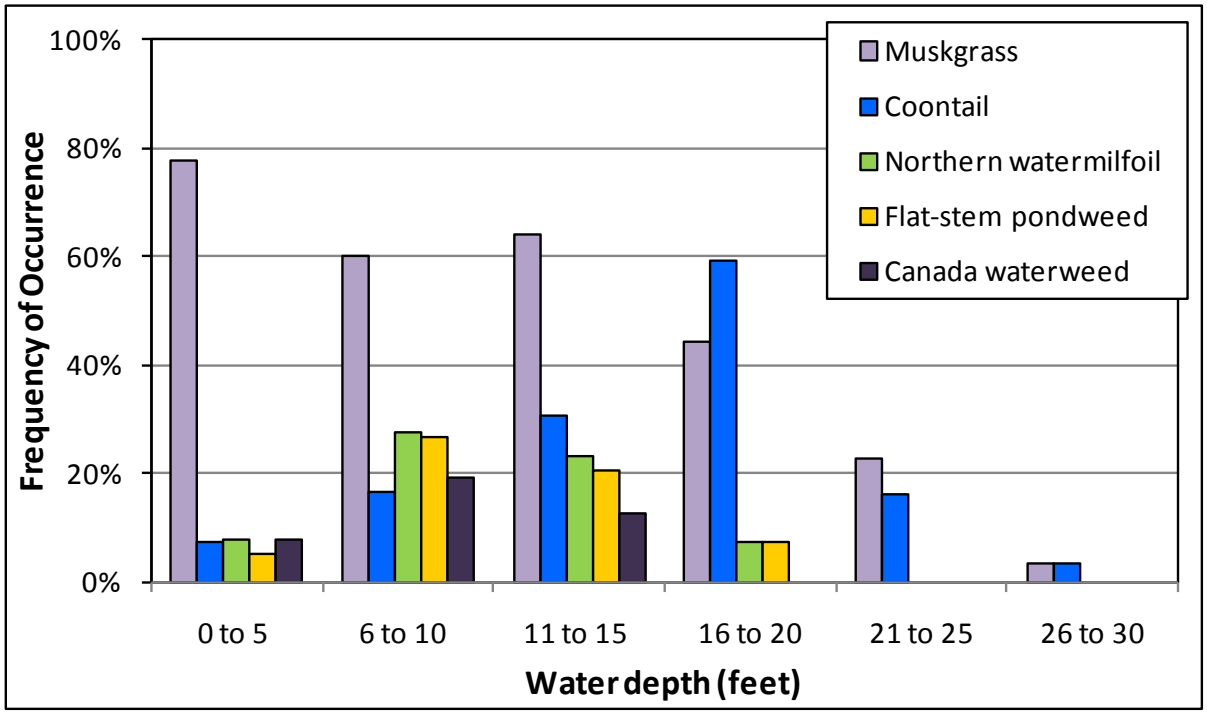


Figure 21. Muskgrass

Muskgrass (*Chara* sp.; Figure 21) was the most common submerged plant in Big Trout Lake. This plant is a freshwater macroalgae. Algae are primitive forms of plants that do not form true roots, flowers or vascular tissue. They range in size from single cell to giant seaweed. Freshwater algae that live in Minnesota lakes include tiny, free-floating planktonic algae, filamentous algae, and macroalgae. Macroalgae often resemble rooted plants and provide similar habitat and water quality benefits and were therefore included in this survey. Muskgrass 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. It may grow in deeper water than rooted plants and beds of muskgrass can provide important fish spawning and nesting habitat.

In Big Trout Lake, muskgrass was found to a depth of 27 feet and occurred with a frequency of 61% (Table 3). It occurred around the entire lake (Figure 19) and was the dominant plant in the 0 to 15 feet depth zones where it was found in 70% of the sites (Figure 20).

Coontail (*Ceratophyllum demersum*; Figure 22) grows entirely submerged and its roots are only loosely anchored to the lake bottom. It is adapted to a broad range of lake conditions and is

tolerant of higher turbidity and can grow in muck substrates. Coontail is perennial and can over winter as a green plant under the ice and then begins new growth early in the spring, spreading primarily by stem fragmentation. The finely divided leaves of this plant provide a home for insects valuable as fish food. Coontail was found in 15% of the sample sites (Table 3) and like muskgrass, coontail was concentrated to north and west shores (Figure 19).

Figure 22. Coontail

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 23) is a native, submerged plant. It is a rooted perennial with finely dissected leaves. Particularly in depths less than ten feet, this plant may reach the water surface and its flower stalk will extend above the water surface. It spreads primarily by stem fragments and over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes. For information on how to distinguish the native northern watermilfoil from the non-native, Eurasian watermilfoil, click here: identification. Northern watermilfoil was found in 13% of the Big Trout Lake sites (Table 3; Figure 20).

Figure 23. Northern watermilfoil

Photo by John Maunder

Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 24) is one of nine native pondweeds found in Big Trout Lake. Pondweeds (*Potamogeton spp. and Stuckenia spp.*) are primarily submerged, perennial plants that are anchored to the lake bottom by underground rhizomes. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. Pondweed seeds and tubers are an important source of waterfowl food (Fassett 1957) and the foliage of pondweeds is food for a variety of marsh birds, shore birds and wildlife and provides shelter, shade and spawning sites for a range of fish species (Borman et al. 2001).

Figure 24. Flat-stem pondweed.

Flat-stem pondweed is named for its flattened, grass-like leaves. It was the most common pondweed in Big Trout Lake and occurred with a frequency of 12% (Table 3). It was found to a depth of 19 feet (Figure 19) and was concentrated along the northern shores (Figure 20). Other native pondweeds in Big Trout Lake included plants with broad leaves (often called “cabbage” by anglers) and narrow-leaved plants (Table 3).

Figure 25. Canada waterweed.

Canada waterweed (*Elodea canadensis*; Figure 25) is a perennial submerged species that is widespread throughout Minnesota. It is adapted to a variety of conditions and is tolerant of low light and prefers soft substrates. Canada waterweed can overwinter as an evergreen plant and spreads primarily by fragments. This plant was found in 10% of the Big Trout Lake survey sites (Table 3). It was concentrated to the north shores of Big Trout Lake and was most frequent in depths of 6 to 15 feet (Figure 19, 20).

Non-native submerged plant

Curly-leaf pondweed (*Potamogeton crispus*; Figure 26) is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in more than 750 Minnesota lakes (Invasive Species Program, 2010). Like native pondweeds, Curly-leaf pondweed is perennial but it has a unique life cycle that may provide a competitive advantage over native species. It is actually dormant during late summer and begins new growth in early fall. Winter foliage is produced and continues to grow under ice (Wehrmeister and Stuckey 1978). Curly-leaf reaches its maximum growth in May and June, when water temperatures are still too low for most native plant growth. In late spring and early summer, curly-leaf plants form structures called "turions" which are hardened stem tips that break off and fall to the substrate. Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson 1985).

Figure 26. Curly-leaf pondweed

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 has been in Big Trout Lake since at least the 1940's (DNR Fisheries Lake Files). It was found during the 2010 survey but occurred infrequently and was not present at any of the sample sites.

Change in aquatic plant communities

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

- Change in water clarity

If water clarity in Big Trout Lake increases, submerged vegetation may be more common at depths greater than 20 feet.

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

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

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

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

Literature Cited

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix 1. Historical aquatic and wetland plants of Big Trout Lake

Submerged plants

Common Name	Scientific Name	1942	1955	1961	1990	2010
Water marigold	*Bidens beckii*					X
Coontail	*Ceratophyllum demersum*	X	X		X	X
Muskgrass	*Chara* sp.	X	X	X	X	X
Canada waterweed	*Elodea canadensis*	X	X	X	X	X
Water star-grass	*Heteranthera dubia*					X
Northern watermilfoil	*Myriophyllum sibiricum*			X	X	X
Bushy pondweed	*Najas flexilis*				X	X
Southern naiad	*Najas guadalupensis*					X
Stonewort	*Nitella* sp.					X
Large-leaf pondweed	*Potamogeton amplifolius*			X	X	X
Curly-leaf pondweed (I)	*Potamogeton crispus*	X		X		X
Fries' pondweed	*Potamogeton friesii*					X
Variable pondweed	*Potamogeton gramineus*					X
Illinois pondweed	*Potamogeton illinoensis*					X
White-stem pondweed	*Potamogeton praelongus*				X	X
Clasping leaf pondweed	*Potamogeton richardsonii*				X	X
Robbin's pondweed	*Potamogeton robbinsii*				X	
Narrow-leaved pondweed	*Potamogeton* sp.					X
Straight-leaved pondweed	*Potamogeton strictifolius*					X
Flat-stem pondweed	*Potamogeton zosteriformis*			X		X
White water buttercup	*Ranunculus aquatilis*					X
Creeping spearwort	*Ranunculus flammula*					X
Sago pondweed	*Stuckenia pectinata*					X
Greater bladderwort	*Utricularia vulgaris*					X
Flat-leaved bladderwort	*Utricularia intermedia*					X
Wild celery	*Vallisneria americana*				X	X
Watermoss	*Not identified to genus*					X
	Total	4	3	6	10	25

Floating-leaved plants

Common Name	Scientific Name	1942	1955	1961	1990	2010
Floating leaf pondweed	*Potamogeton natans*	X		X		X
White waterlily	*Nymphaea odorata*				X	X
Yellow waterlily	*Nuphar variegata*				X	X
Floating smartweed	*Persicaria amphibia*					X
Floating-leaf burreed	*Sparganium fluctuans*				X	
	Total	1	0	1	3	4

Free-floating plants

Common Name	Scientific Name	1942	1955	1961	1990	2010
Lesser duckweed	*Lemna* sp.					X
Star duckweed	*Lemna trisulca*					X
Greater duckweed	*Spirodela polyrhiza*					X
	Total	0	0	0	0	3

Emergent plants

Common Name	Scientific Name	1942	1955	1961	1990	2010
Needlerush	*Eleocharis acicularis*					X
Spikerush	*Eleocharis* sp.				X	X
Horsetail	*Equisetum fluviatile*				X	X
Arum-leaved arrowhead	*Sagittaria cuneata*				X	X
Broad-leaved arrowhead	*Sagittaria latifolia*					X
Hard-stem bulrush	*Schoenoplectus acutus*	X		X	X	Xa
Soft stem bulrush	*Schoenoplectus validus*				X	
Giant burreed	*Sparganium eurycarpum*				X	X
Wild rice	*Zizania palustris*					X
Broad-leaved cattail	*Typha latifolia*			Xa	Xa	X
Narrow-leaved cattail	*Typha* spb.					X
	Total	1	0	2	7	10

Wetland emergent plants

Common Name	Scientific Name	1942	1955	1961	1990	2010
Swamp milkweed	*Asclepias incarnata*				X	
Bottlebrush sedge	*Carex comosa*				X	
Upland Horsetail	*Equisetum* sp.				X	
Reed canary grass (I)	*Phalaris arundinaceae*				X	
	Total	0	0	0	3	0

I = introduced

Xa = Plants were only identified to genus level

b narrow leaf cattail was identified in survey but it is not known whether this included *Typha angustifolia* and/or *Typha* x *glauca*.

Sources:

1942 (June 5 - 7): DNR Fisheries Survey
1955 (June, 13-15): Donald Woods, Ronald Kolowski, DNR Fisheries Survey
1961 (September 7): Thomas Bonde, Howard Trick, DNR Fisheries Survey
1990 (July 30, Aug. 2): Lloyd Anderson, DNR Fisheries Survey
2010 (July): Simon, Perleberg, Van Dyne, Whichello, Point Intercept survey, MnDNR Division of Ecological and Water Resources