Aquatic Vegetation Survey of

Big Thunder Lake (DOW #11-0062-00)

Cass County, Minnesota

2008

Thunder Lake 2008.

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Summary

Aquatic vegetation surveys of Big Thunder Lake (11-0062-00), Cass County, Minnesota, were conducted in July and August 2008. Surveys included a lakewide assessment of vegetation and water depths at over 1100 sample stations, characterization of shoal substrate types, and mapping of emergent and floating-leaf plant beds.

The aquatic plant community of Thunder Lake is similar to that found in other hard water Cass County lakes. Thirty-five native aquatic plant species were found including ten emergent, four floating-leaved, two free-floating and 19 submerged species. Non-native aquatic plant species were not found.

The vegetated zone of Thunder Lake extended from shore to the 25 feet depth and included about 30 percent of the lake area. Submerged plants occurred to a maximum depth of 25 feet but were most common in depths from shore to 15 feet, where 90 percent of the sites contained vegetation. The most common submerged plant species were muskgrass (*Chara* sp.) (49% occurrence within the shore to 25 feet zone), coontail (*Ceratophyllum demersum*) (26%), Fries' pondweed (*Potamogeton friesii*) (18%), flat-stem pondweed (*Potamogeton zosteriformis*) (14%), and Illinois pondweed (*Potamogeton illinoensis*) (7%).

Emergent and floating-leaved plants were generally restricted to depths of five feet and less. This depth zone is a narrow band in Thunder Lake and covers only 125 acres, or 10 percent of the lake. Within that depth zone, 31% of the survey sites contained at least one emergent or floating-leaf plant. Approximately 36 acres of bulrush (*Scirpus* sp.), and ten acres of waterlily beds (*Nymphaea odorata, Nuphar variegata)* were mapped.

Thunder Lake, 2008 –Great Blue Heron flying over cattails in Thunder Lake

Introduction

Big Thunder Lake (hereafter referred to as Thunder Lake) is located in Cass County, north-central Minnesota and in the western corner of the Mississippi River - Grand Rapids Watershed (Figure 1). There are about 270 lakes in this watershed and about 250 lakes in Cass County that are at least 50 acres in size. Thunder Lake is the 12th largest lake in the watershed and the16th largest lake in the county, with a surface area of 1,347 acres and 16 miles of shoreline.

Thunder Lake receives flow from Laura Lake to the west and from Kidney Lake to the south (Figure 2). Water leaves the Thunder Lake outlet on the east side and flows under State Highway 6 and into Pughole Lake (Figure 2). Flow continues north into Big Rice Lake and then to the Willow River which

Figure 1. Location of Big Thunder Lake.

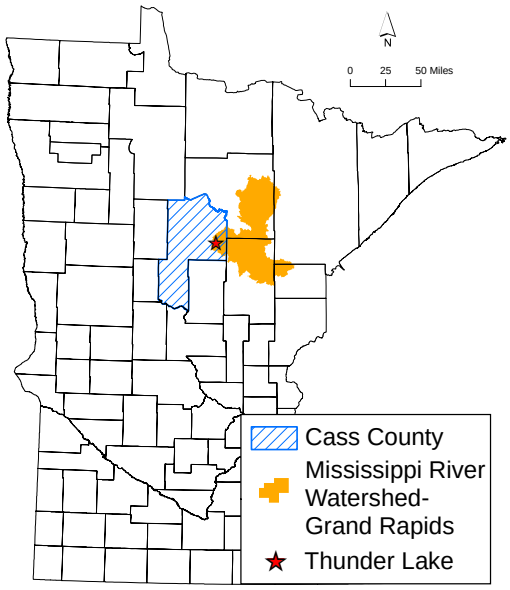
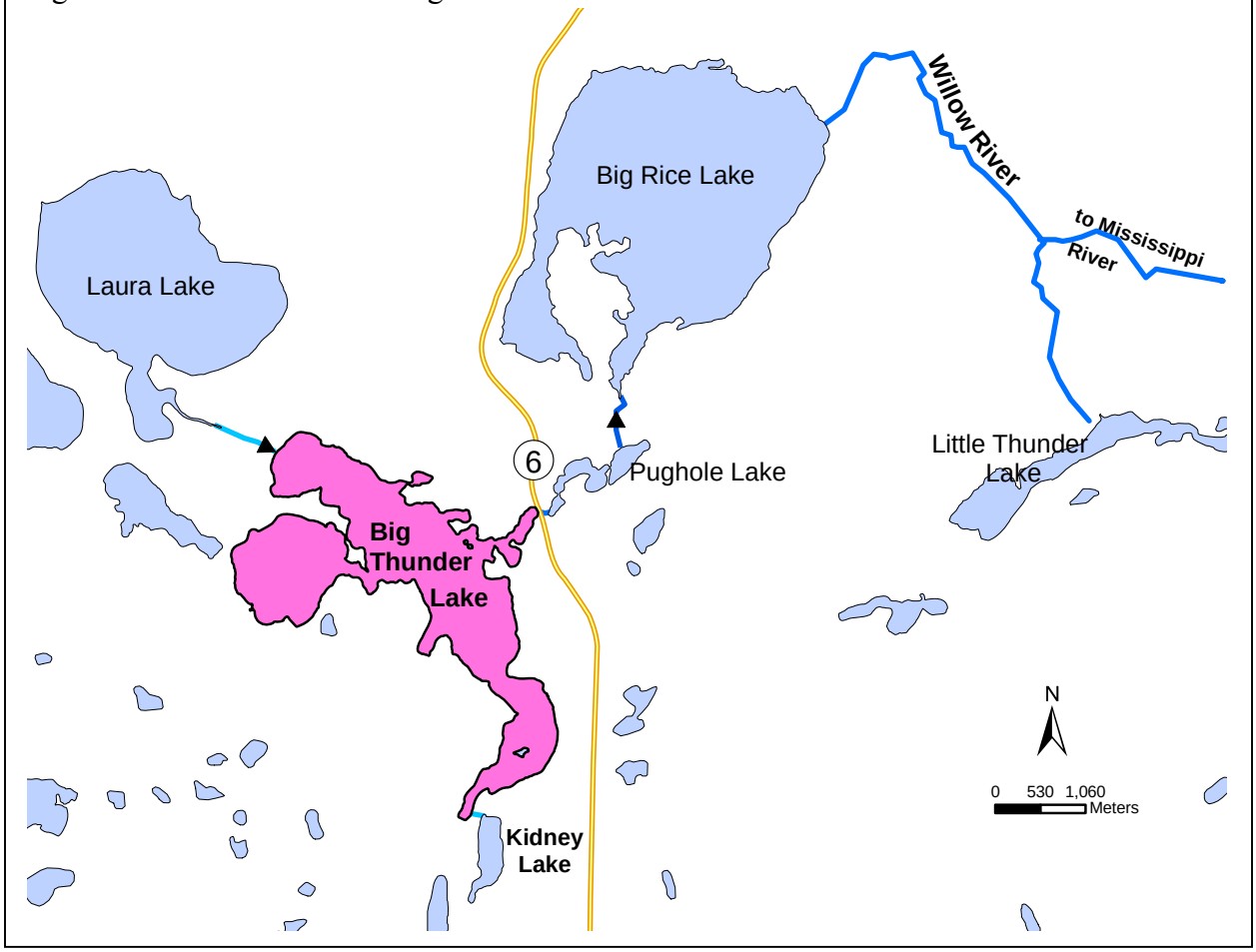


Figure 2. Inlets and outlet of Big Thunder Lake.

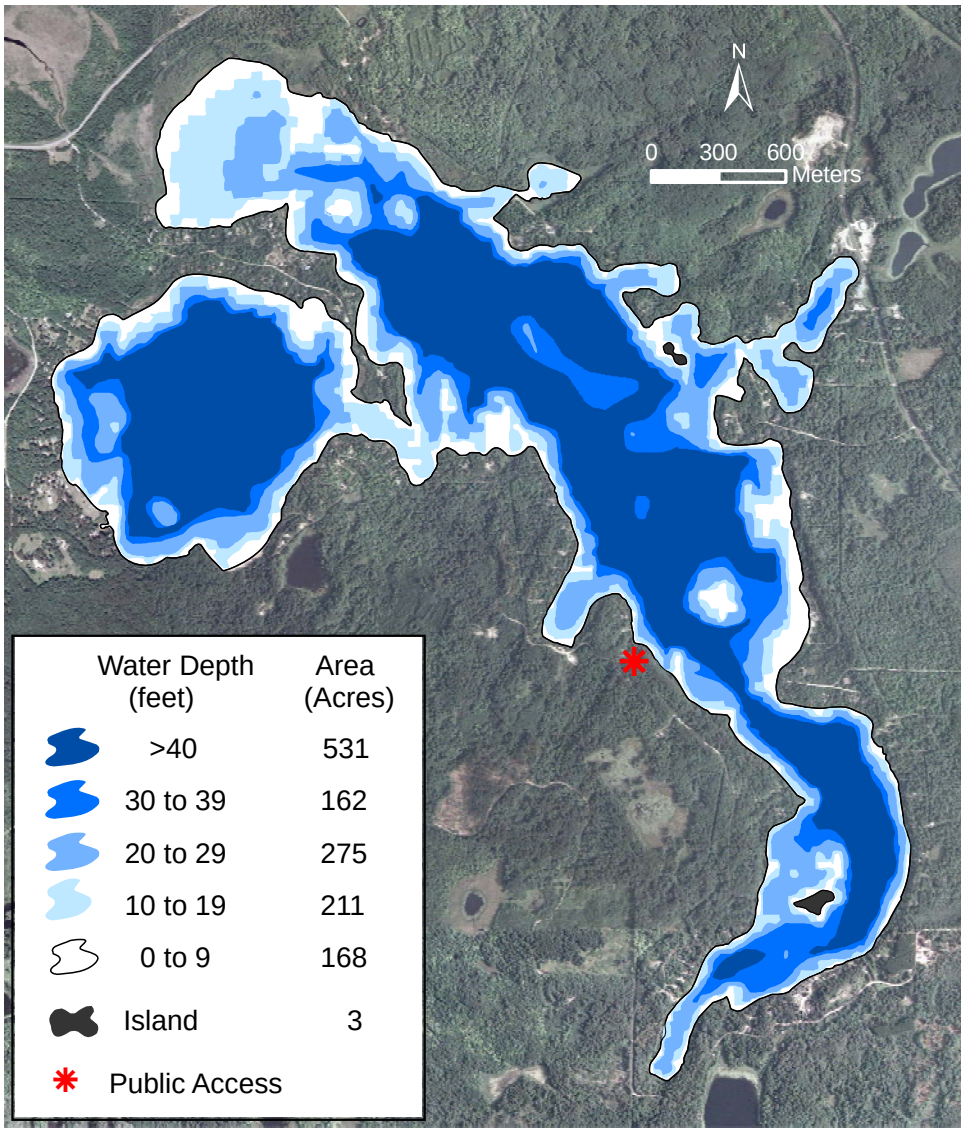


flows east to the Mississippi River.

Thunder Lake occurs just south of the Chippewa National Forest boundary and near the Land O'Lakes State Forest. Large tracts of deciduous forest surround the lake but the immediate shoreline of Thunder Lake is privately owned and developed with residential homes and several resorts. There is a public access on the west side of the lake (Figure 3).

The shoreline of Thunder Lake is irregular in outline. An elongated, three-mile long basin, makes up the main part of the lake. A second, round basin on the northwest end of the lake is connected to the main lake by a shallow channel. Several smaller bays are found around the lake. There are two, small (one to two acre) islands in the lake. Thunder Lake has a maximum depth of 95 feet and is primarily deep with only 17 percent of the lake basin less than 15 feet in depth (Figure 3). This shallow area that rings the lake shoreline is referred to as the littoral zone.

Figure 3. Depth contours of Big Thunder Lake.



Rooted submerged plants are often common in the littoral zone if adequate sunlight reaches the lake bottom.

Figure 4. Measuring Secchi Disc transparency

The lake is oligotrophic, or minimally nutrient enriched, with relatively high water clarity. Water quality data for Thunder Lake are limited but the mean summer water clarity, as measured by Secchi disc readings, is reported to be about 17 feet (MPCA, 2008). The Secchi disc (Figure 4) 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. 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 25 feet in Thunder Lake. Other factors that may influence the depth of plant growth include substrate type, wind fetch, and plant species composition.

Previous vegetation surveys of Thunder Lake found plants growing to depths of 20 feet with abundant plant growth described in protected bays and along the north shore (MnDNR Fisheries Lake Files). More than 17 different aquatic plant species have previously been recorded in the lake including muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), northern water milfoil (*Myriophyllum sibiricum*) and several broad-leaf pondweeds (*Potamogeton* spp.).

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2008 plant population of Thunder 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

Lakewide vegetation survey

Thunder Lake was surveyed on July 23, 24, 28, 29 and 30, 2008. A point-intercept survey method was used and followed the methods described by Madsen (1999) and MnDNR (2008). Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a handheld Global Positioning System (GPS) receiver. Survey points were placed across the entire lake and spaced 40 meters (131 feet) apart, resulting in about two survey points per acre. In the field, surveyors found only scattered vegetation in depths greater than 22 feet and therefore sampled all sites less than 26 feet and only a few sites in deeper water. A total of 1160 sites were surveyed (Figure 5, Table 1).

Two field crews, each consisting of two surveyors and one boat, conducted the survey. 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 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 surface (Figure 6). Plant identification and nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most

Figure 5. 2008 vegetation survey sites in Big Thunder Lake.

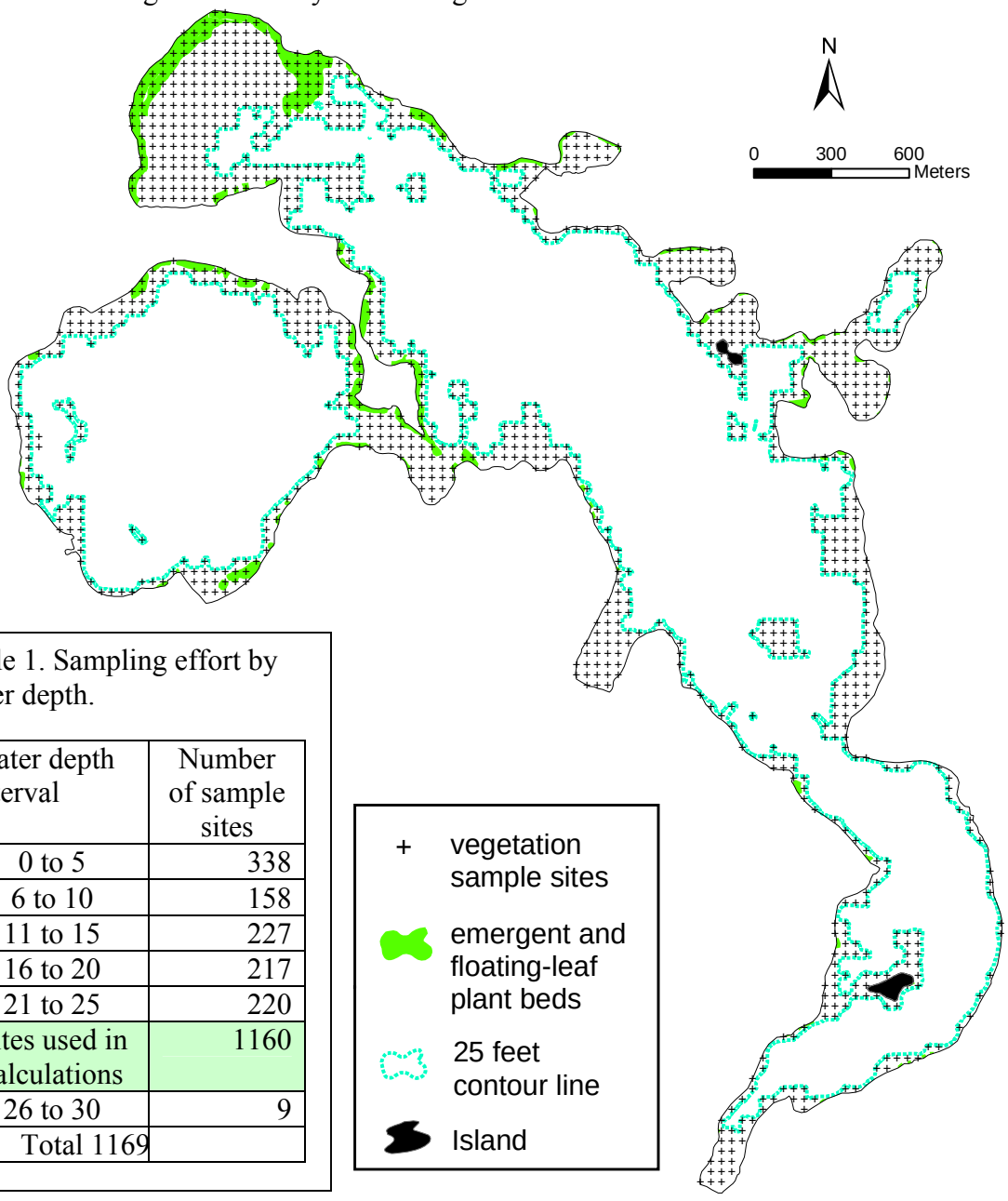


Table 1. Sampling effort by water depth.

Water depth interval	Number of sample sites
0 to 5	338
6 to 10	158
11 to 15	227
16 to 20	217
21 to 25	220
Sites used in calculations	1160
26 to 30	9
Total 1169	

plant species and are stored at the University of Wisconsin at Stevens Point, as part of a student internship project.

Figure 6. 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 25 feet and sampling points were also grouped by water depth and separated into five depth zones for analysis (Table 1). Any additional plant species found outside the sample stations were recorded as "present" in the lake but these data were not used in frequency calculations.

Example: In Thunder there were 1160 samples sites between the shore and 25 feet depth. Muskgrass (*Chara* sp.) occurred in 568 sites.
Frequency of Muskgrass in Thunder Lake = 568/1160 (*100) = 49 %

At each sample site where water depths was seven feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2). If several substrate types occurred at a site, 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 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.

Table 2. Substrate classes

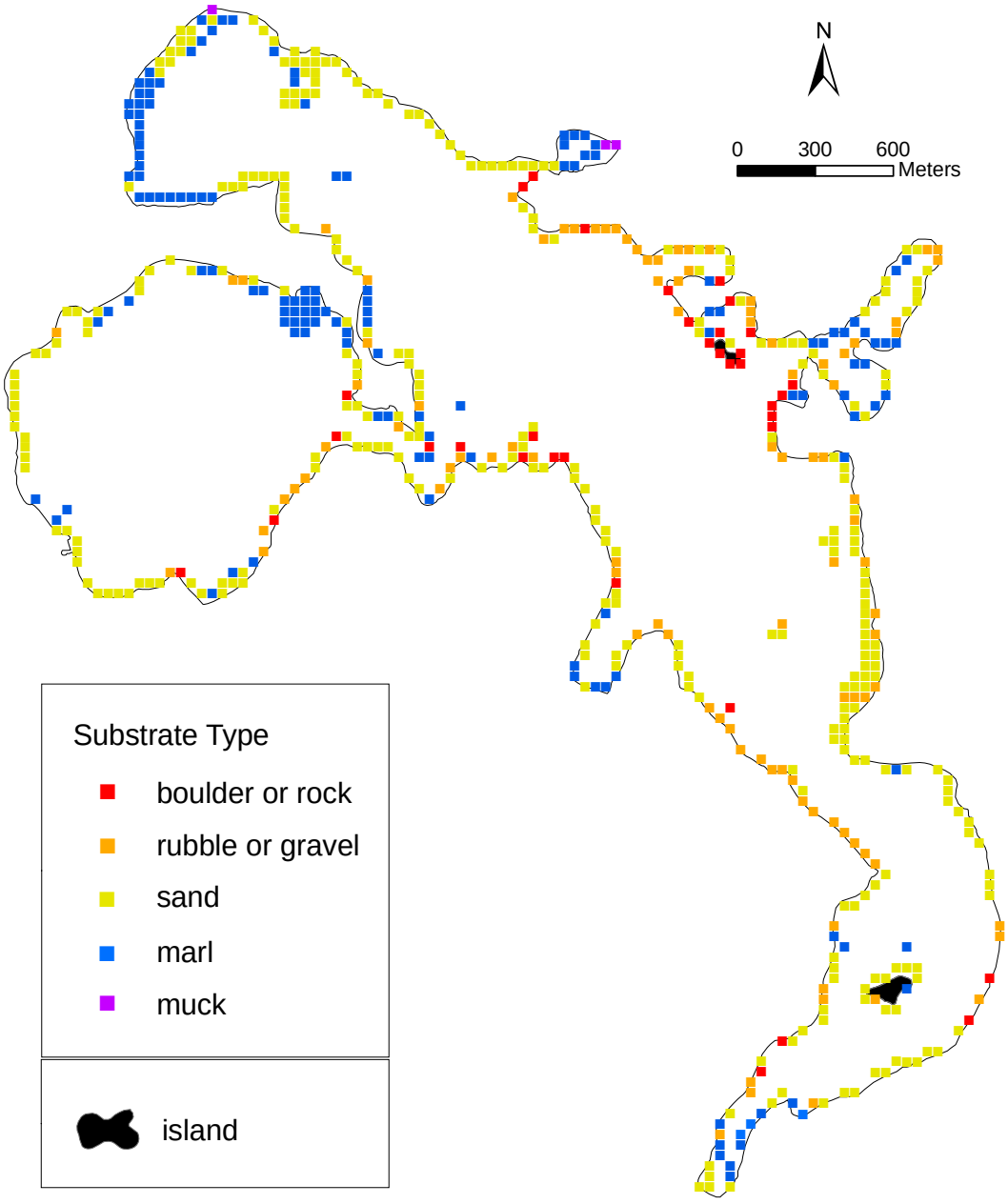
muck	decomposed organic material
marl calca	reous material
silt	fine material with little grittiness
sand	diameter less than 1/8 inch
gravel	diameter 1/8 to 3 inches
rubble	diameter 3 to 10 inches
boulder	diameter over 10 inches

Mapping floating-leaf and emergent vegetation beds
Field surveys to map floating-leaf and emergent plant beds were conducted in August 2008. Surveyors mapped the perimeter of these beds using a handheld gps unit. Field data were uploaded to a computer and a GIS software program was used to estimate acreage.

Results

Shoal substrates
The shoal substrates of Thunder Lake are primarily hard substrates of sand, gravel and rubble. Boulders were found at scattered locations. Softer substrates of marl and muck were found throughout the smaller bays and at the inlet area of the north shore (Figure 7).

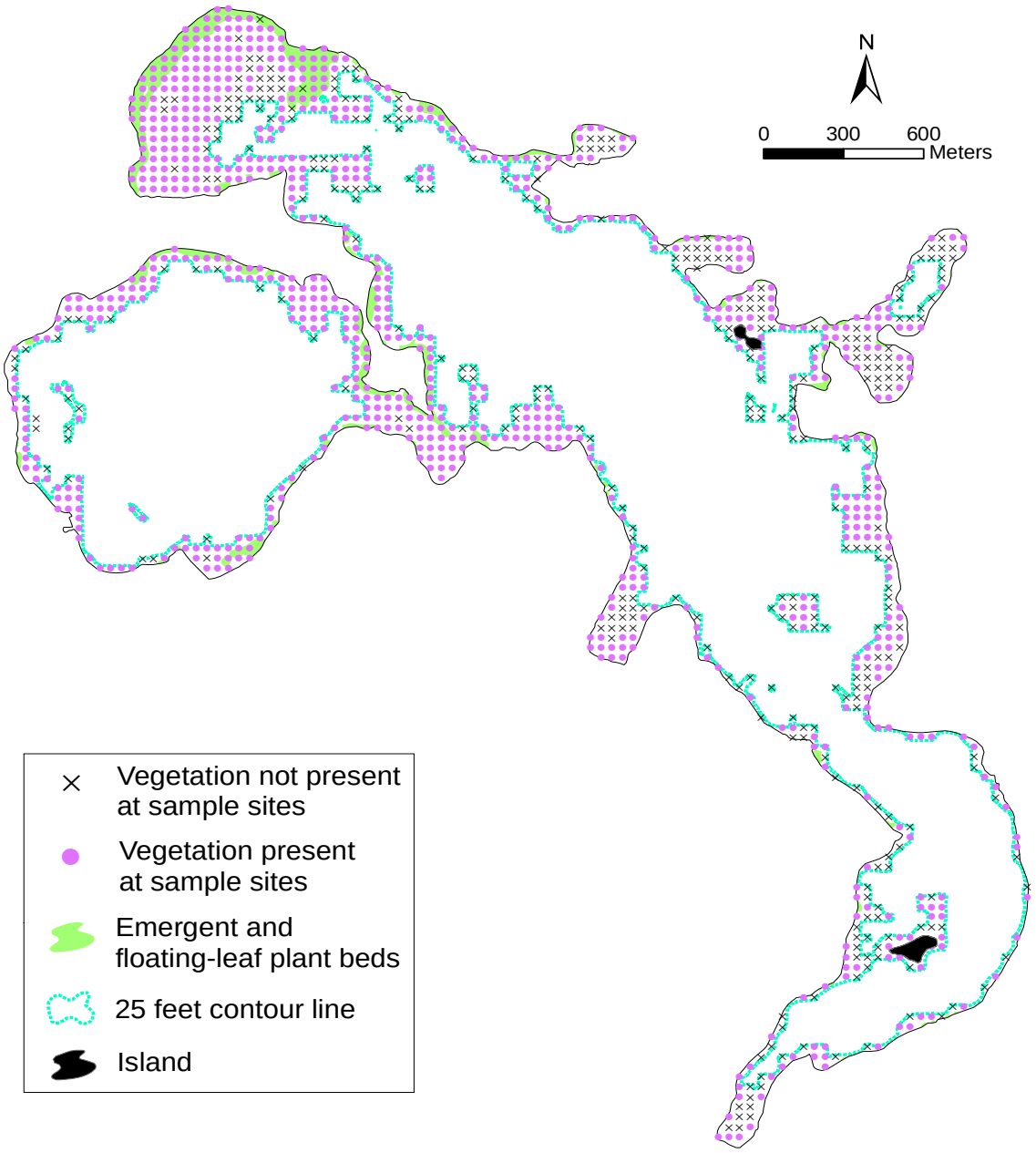
Figure 7. Shoal water sediments of Big Thunder Lake, 2008.



Distribution of aquatic plants

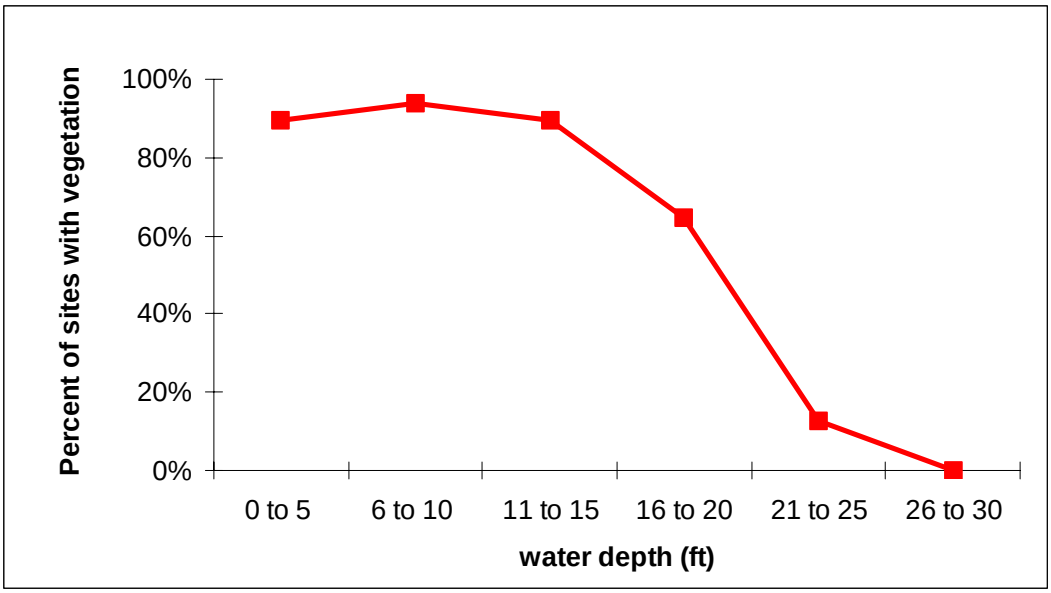
Aquatic plants occurred around the entire perimeter of the lake and the broadest zones of vegetation occurred at the northern tip of the lake where plants extended about 400 meters (1300 feet) into the lake (Figure 8). In areas with narrow shallow zones, such as the southeast shore, the vegetated zone was sometimes less than 40 meters (120 feet). Most of the offshore shallow sites contained vegetation.

Figure 8. Distribution of aquatic plants in Big Thunder Lake, 2008.



The vegetated zone (shore to the 25 feet depth) included about 410 acres, or 30 percent of the lake area. Within that zone, vegetation occurred in 71 percent of the survey sites and was most common in the shore to 15 feet zone where 90 percent of the sites contained plants. Percent of vegetated sites decreased with increasing water depth (Figure 9). In depths of 23 to 25 feet, only five percent of sites were vegetated.

Figure 9. Percent frequency of vegetation types by water depth interval.



Number of plant species recorded and distribution by water depth

A total of 35 native aquatic plant species were recorded in Thunder Lake including ten emergent, four floating-leaved, 19 submerged and two free-floating species (Table 3). Most emergent and floating-leaf plants occurred in water depths of five feet and less and most rooted submerged plants were restricted to depths of 15 feet and less (Figure 10). Only six submerged species occurred in depth greater than 15 feet and only four species occurred in depths greater than 20 feet.

Figure 10. Number of plant species found at each water depth interval.

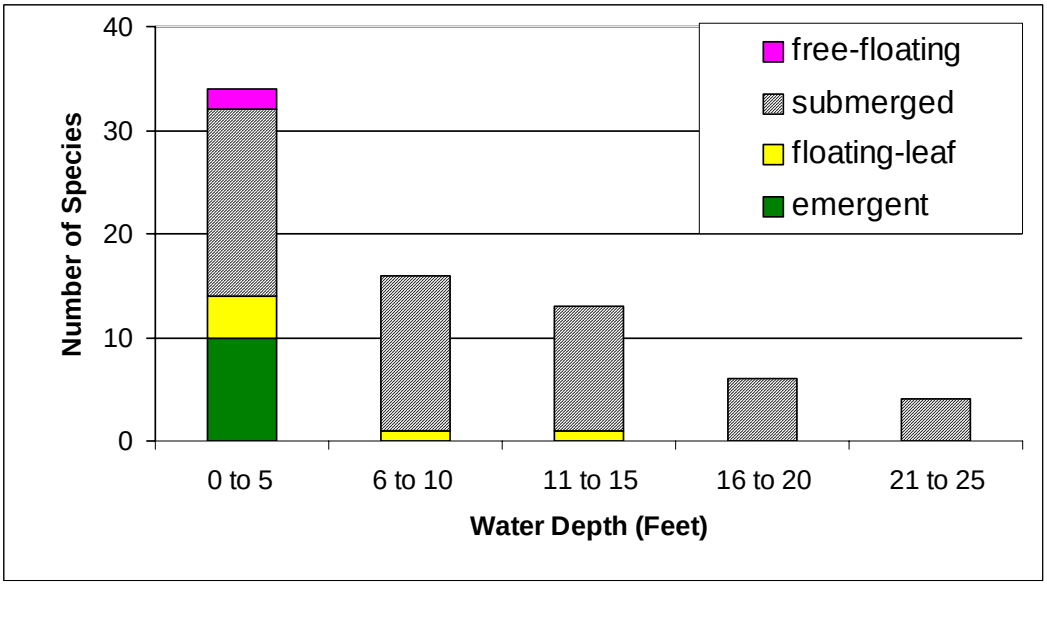


Table 3. Frequency of aquatic plants in Big Thunder Lake Point-intercept survey, July 2008.

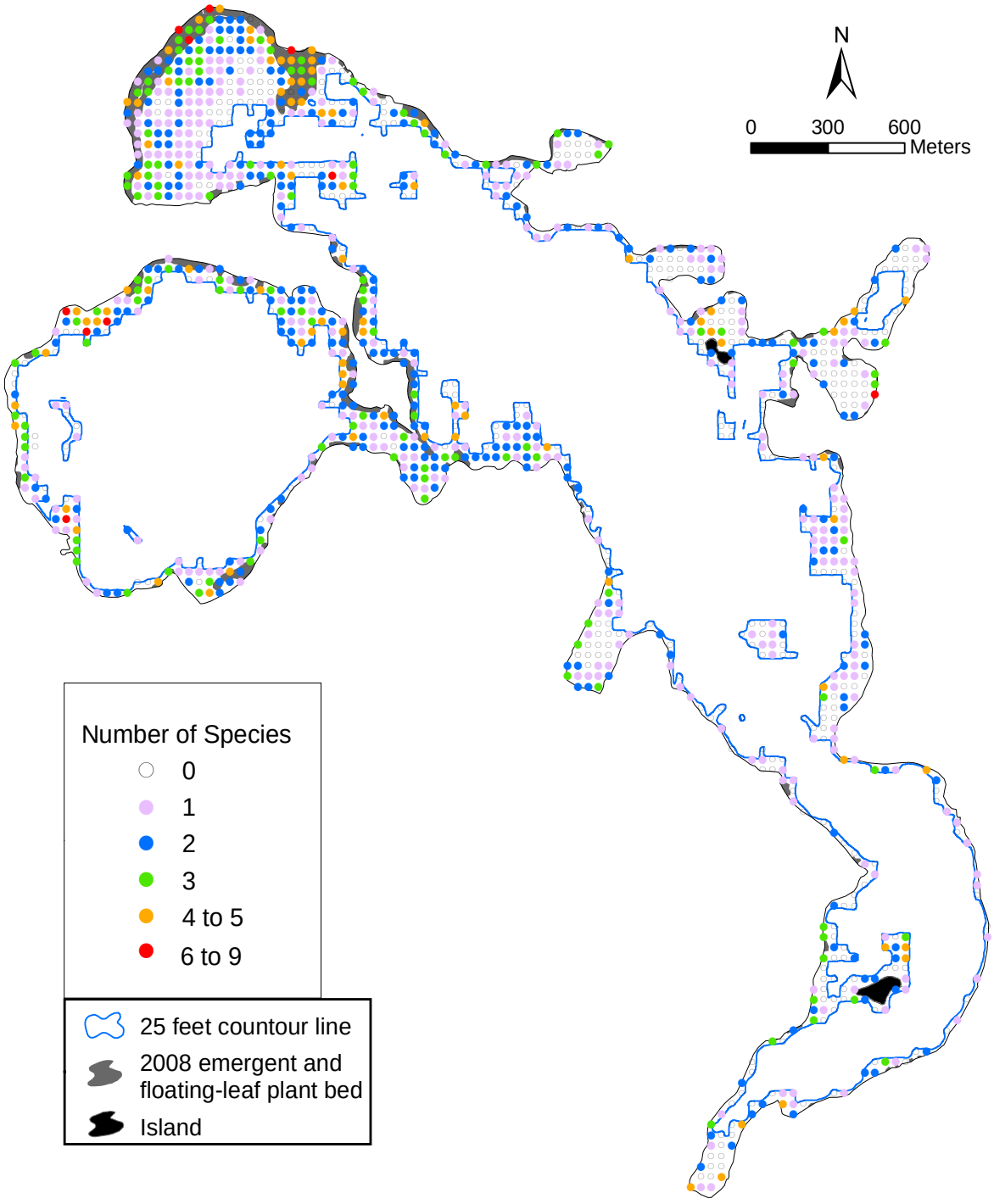
(Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 25 ft water depth.)
1160 sample sites

Life Form		Common Name	Scientific Name	Frequency %
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.*	49
	Dissected-leaf rooted plants	Coontail	*Ceratophyllum demersum*	27
		Northern water milfoil	*Myriophyllum sibiricum*	3
		Greater bladderwort	*Utricularia vulgaris*	2
		Flat-leaved bladderwort	*Utricularia intermedia*	<1
		White water buttercup	*Ranunculus aquatilis*	Present
		Water marigold	*Megalodonata beckii*	Present
	Small-leaf rooted plants	Fries' pondweed	*Potamogeton friesii*	18
		Sago pondweed	*Stuckenia pectinata*	4
		Bushy pondweed	*Najas flexilis*	2
		Canada waterweed	*Elodea canadensis*	1
	Grass-leaf rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	14
		Wild celery	*Vallisneria americana*	<1
		Water stargrass	*Zosterella dubia*	<1
	Broad-leaf rooted plants ("cabbage")	Illinois pondweed	*Potamogeton illinoensis*	7
		White-stem pondweed	*Potamogeton praelongus*	3
		Large-leaf pondweed	*Potamogeton amplifolius*	1
		Clasping-leaf pondweed	*Potamogeton richardsonii*	1
		Variable pondweed	*Potamogeton gramineus*	<1
FREE-FLOATING These plants drift freely with the water current and are often found floating near or on the water surface.		Star duckweed	*Lemna trisulca*	1
		Greater duckweed	*Spirodela polyrhiza*	<1
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface.		Floating leaf pondweed	*Potamogeton natans*	2
		White waterlily	*Nymphaea odorata*	1
		Watershield	*Brasenia schreberi*	Present
		Yellow waterlily	*Nuphar variegata*	Present
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.		Hardstem bulrush	*Scirpus acutus*	7
		Horsetail	*Equisetum sp.*	4
		Broad-leaf Cattail	*Typha latifolia*	<1
		Narrow-leaf Cattail	*Typha angustifolia*	Present
		Arrowhead	*Sagittaria latifolia*	<1
		Giant burreed	*Sparganium eurycarpum*	<1
		Spikerush	*Eleocharis sp.*	<1
		Needlegrass	*Eleocharis sp.*	<1
		Leafy Bulrush	*Scirpus atrovirens*	<1
		Blue-flag iris	*Iris versicolor*	Present

"Present" indicates species was found in lake but did not occur within one of the 1160 sample sites.

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 11). In water depths greater than 15 feet, the mean number of species found per site was less than one.

Figure 11. Number of plant species at each sample site, Big Thunder Lake, 2008.

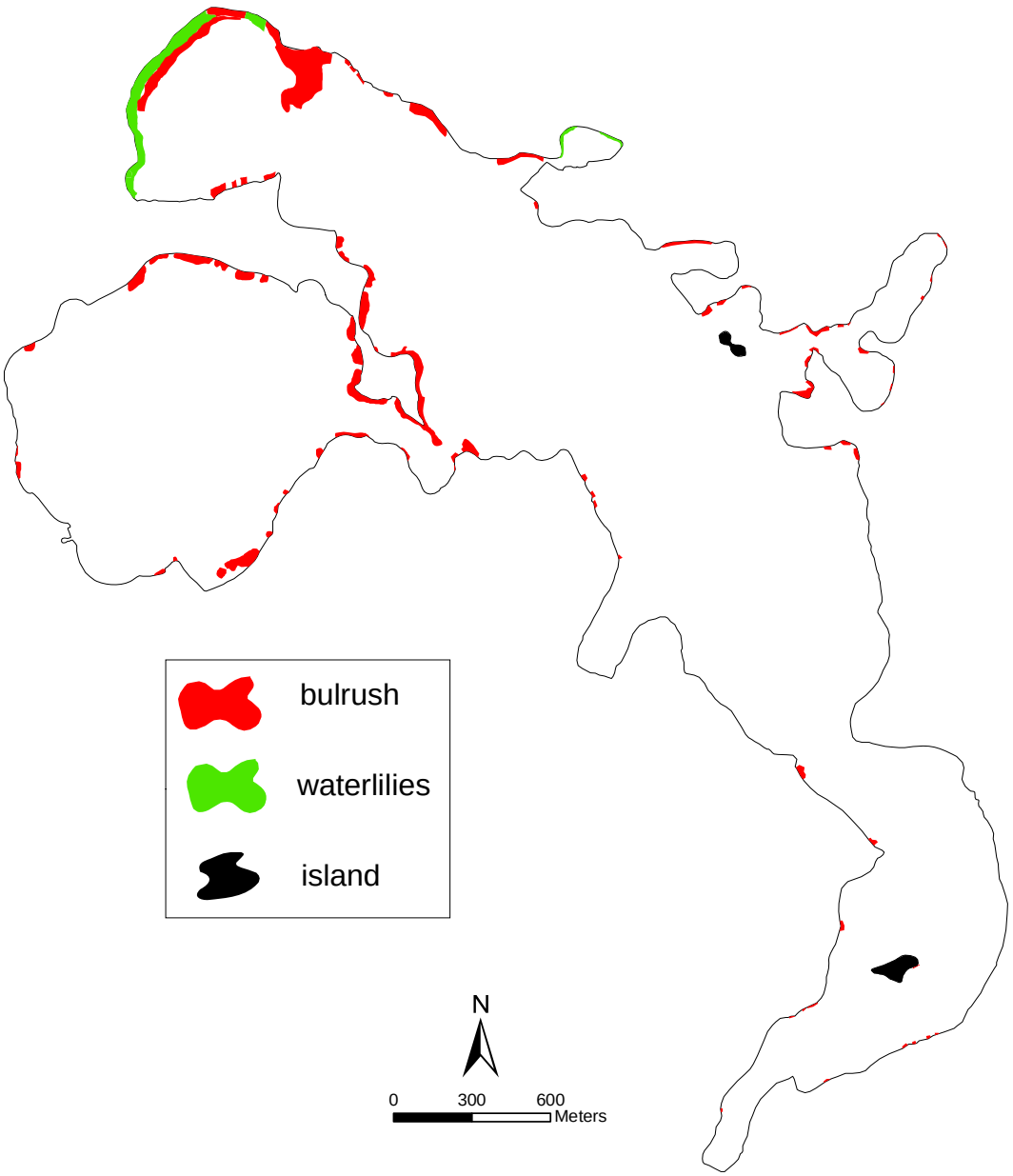


Emergent and floating-leaf plants

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.

Approximately 46 acres of emergent and floating-leaf plant beds were mapped. Nine percent of all survey sites, and 31% of shallow sites (0-5ft) had at least one emergent or floating-leaf plant. Majore plant bed types included bulrush and waterlilies (Figure 12).

Figure 12. Emergent and floating-leaf plant beds of Big Thunder Lake.



Hard-stem bulrush (*Scirpus acutus*) (Figure 13) was the most common emergent in Thunder Lake and was found in seven percent of the sites (Table 3). About 36 acres of bulrush beds were mapped and some beds extended nearly 1,000 meters (3,300 feet) along shore and as much as 250 meters (820 feet) lake ward (Figure 12). Bulrush was found in 24 percent of the sample sites between shore and the five feet depth and usually occurred in sand.

Figure 13. Emergent bulrush (*Scirpus*) beds in Thunder Lake, August 2008.

Waterlily beds, or mixed beds of waterlilies and emergents, covered about nine acres in Thunder Lake. Floating-leaf plants included white waterlily (*Nymphaea odorata*) (Figure 14), yellow waterlily (*Nuphar variegata*), watershield (*Brasenia schreberi*), and floating-leaf pondweed (*Potamogeton natans*). Waterlily beds were often associated with soft substrates and included submerged and/or emergent plants. Other emergent plants found included giant burreed (*Sparganium eurycarpum*), arrowhead (*Sagittaria latifolia*) and spikerush (*Eleocharis* sp).

Figure 14. Waterlilies (*Nymphaea odorata*) in Thunder Lake, August 2008.

Submerged plants

Submerged plants occurred in 71 percent of the Thunder Lake sites. The five most common species or species groups were muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), Fries' pondweed (*Potamogeton friesii*), flat-stem pondweed (*Potamogeton zosteriformis*) and Illinois pondweed (*Potamogeton illinoensis*). These species were found throughout the lake (Figures 15 and 16) and muskgrass, coontail, Fries's pondweed and flat-stem pondweed were the only species found in the 20 to 25 feet depth zone.

Figure 15. Distribution of muskgrass (*Chara sp.*), coontail (*Ceratophyllum demersum*), and Fries' Pondweed (*Potamogeton friesii*), Thunder Lake, 2008.

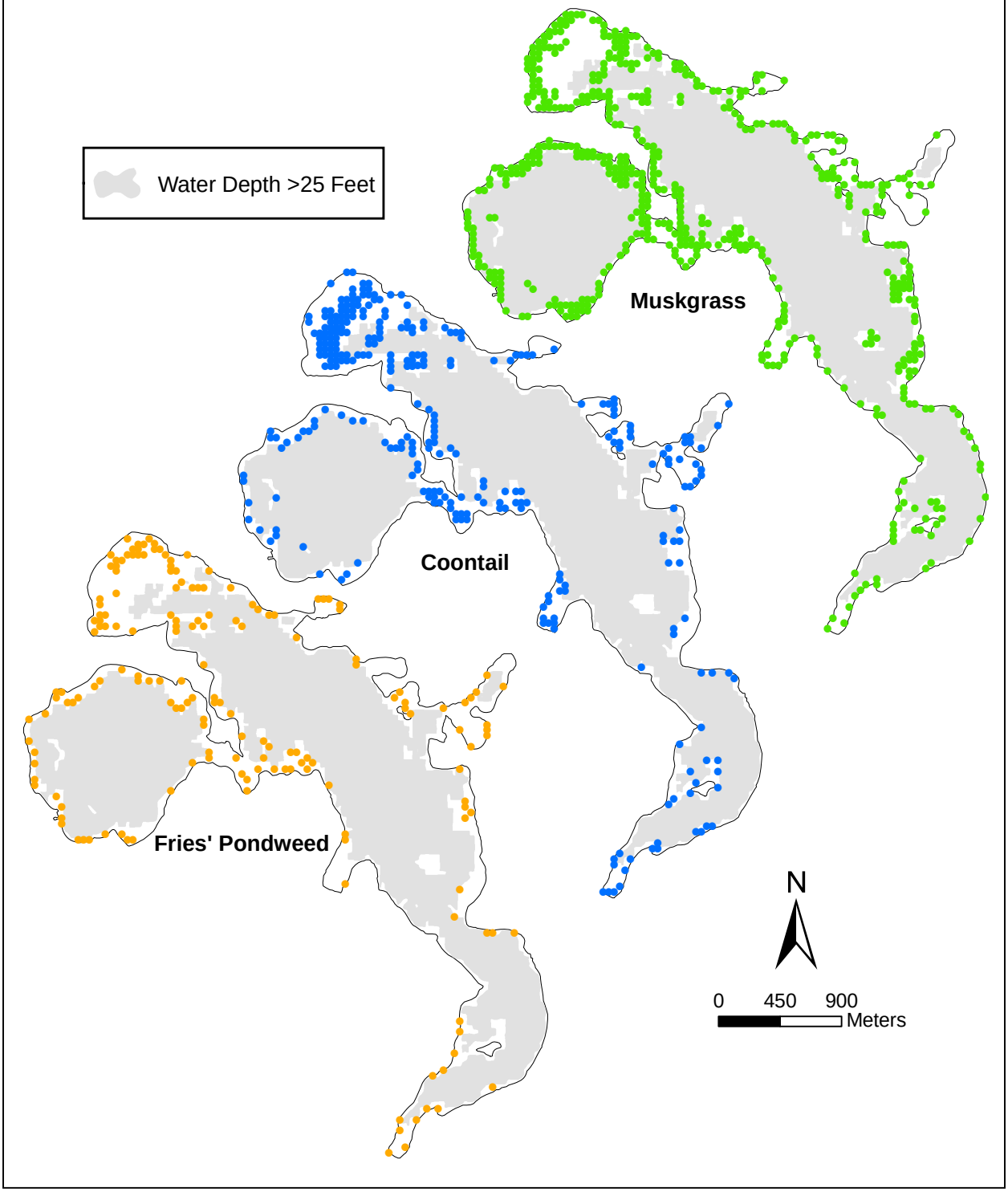
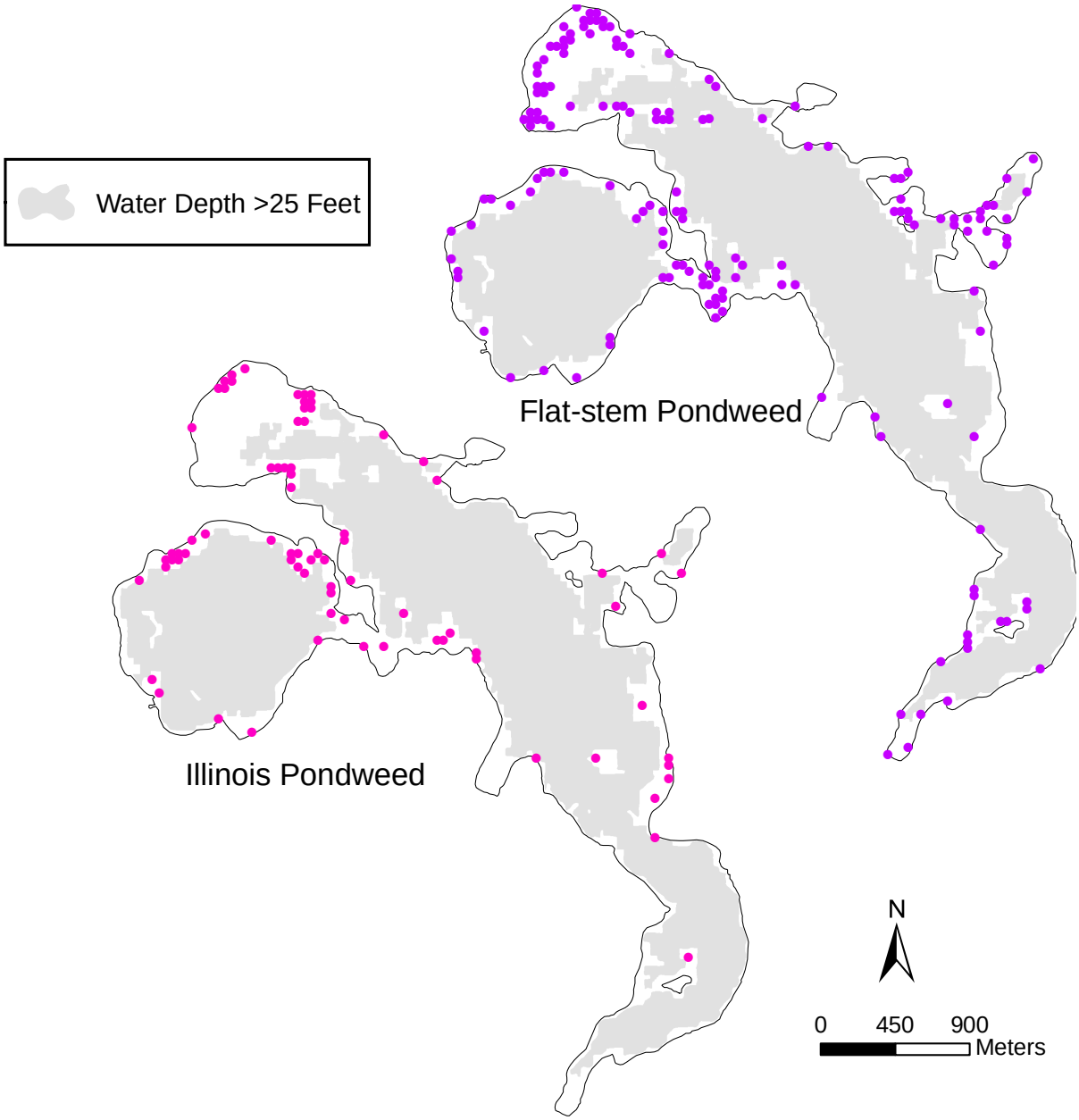


Figure 16. Distribution of flat-stem pondweed (*Potamogeton zosteriformis*), and Illinois pondweed (*Potamogeton illinoensis*), Thunder Lake, 2008.



Muskgrass (*Chara* sp.) (Figure 17) was the most common submerged plant in Thunder Lake, occurring in 49 percent of the sites (Table 3). It was found throughout the lake (Figure 15) and could be found growing in thick beds with no other vegetation or co-occurring within mixed beds of pondweeds and other submerged plants. In Thunder, muskgrass was common in depths less than 16 feet (Figure 18). 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.)

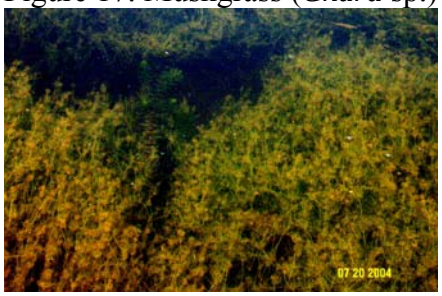
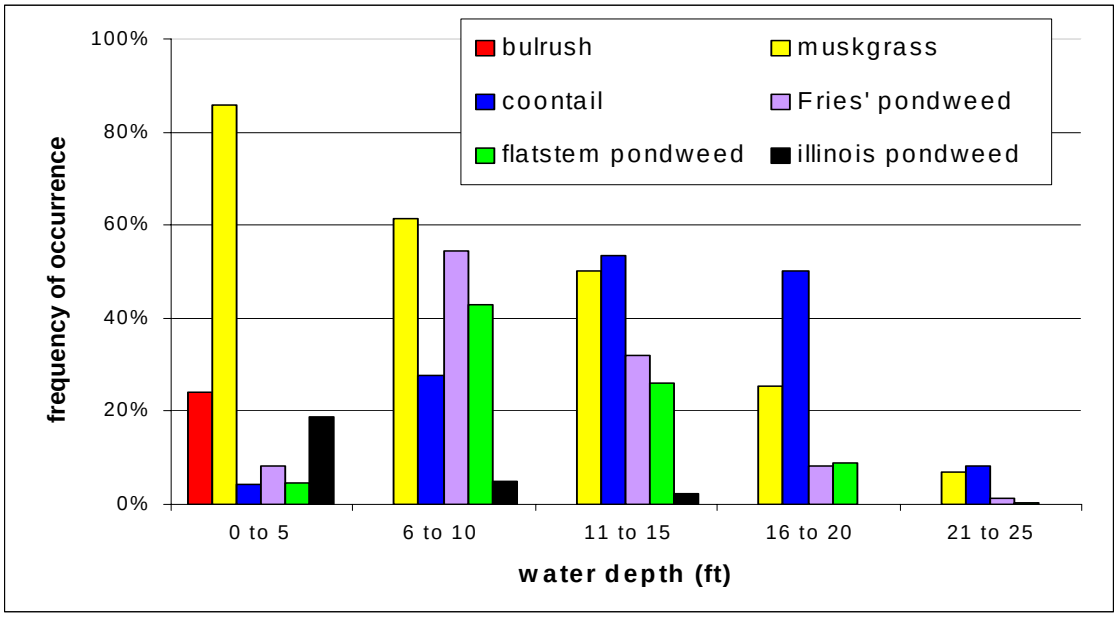


Figure 18. Frequency of common plants by water depth interval. Thunder Lake, 2008.



Coontail (*Ceratophyllum demersum*) (Figure 19) occurred in 26 percent of the survey sites (Table 3) and was most common at water depths of 16 to 20 feet (Figure 18). In Thunder Lake, it was found around the entire perimeter of the lake and was the dominant plant in deeper water of the northern bay (Figure 15). 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, 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

Figure 19. Coontail (*Ceratophyllum demersum*)

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.

Fries' pondweed (*Potamogeton friesii*) (Figure 20) occurred in 18 percent of the survey sites (Table 3) and did not dominate at any water depth. It was most common in the six to ten feet depth zone (Figure 18). This rooted, perennial submerged plant has small, thin leaves that grow entirely below the water surface but flowers extend above the water. This plant over-winters as rhizomes and winter buds. There are several species of narrow-leaf pondweeds and they can be difficult to identify if not found in flower or fruit. Fries' pondweed (*Potamogeton friesii*) was positively identified in the lake, but additional narrow-leaf species may have also been present. For analysis, all narrow-leaf pondweeds were grouped together.

Figure 20. Fries' pondweed (*Potamogeton friesii*)

Flat-stem pondweed (*Potamogeton zosteriformis*) (Figure 21) was found in 14 percent of the survey sites (Table 3) and was most common in depths of six to ten feet (Figure 18). 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

Figure 21. Flat-stem pondweed (*Potamogeton zosteriformis*)

Illinois pondweed (*Potamogeton illinoensis*) (Figure 22) is one of several species that are often called "cabbage" plants by anglers. This is a rooted, wide-leaved submerged perennial plant that may form floating leaves in shallow and protected water. Illinois pondweed was the most abundant broadleaf pondweed in Thunder Lake and was found in seven percent of all sample sites (Table 3). Broad-leaf pondweeds were more common in depths of 15 feet and less (Figure 16, 18). In Thunder Lake, broadleaf pondweeds included large-leaf pondweed (*Potamogeton amplifolius*), variable pondweed (*P. gramineus*), Illinois pondweed (*P. illinoensis)*, clasping-leaf pondweed (*P. richardsonii*), and white-stem pondweed (*P. praelongus*). The fruits of pondweeds are a favorite duck food and the broad leaves provide food and shelter for fish.

Figure 22. Illinois pondweed (*Potamogeton illinoensis*) © Alison Fox 1996

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 diversity of substrate types provides for a mixed near-shore habitat of bulrush beds along sandy shores and waterlily beds in softer sediments. The water clarity of Thunder Lake is sufficiently high to allow submerged aquatic plant growth to a depth of about 22 feet but available light beyond that depth is not sufficient for most rooted plants. 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 Thunder Lake indicates that the general aquatic plant community has not changed greatly in the last 50 years. In all survey years, a relatively high number of native plants have been recorded and rooted plants remain well distributed throughout the bays. 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 Bushy Pondweed (*Najas flexilis*) 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 waterlilies. 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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