Aquatic vegetation of Bertha Lake

August, 2011

Bertha Lake, ID# 18-0355-00

Crow Wing County, Minnesota

White waterlily plants, Bertha Lake, August 2011.

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Survey Context

This lake vegetation survey of Bertha Lake was part of the larger Sensitive Lakeshore Identification project conducted by MNDNR on the Whitefish Chain of Lakes. During 2010 and 2011, MNDNR biologists conducted field surveys of aquatic vegetation, near-shore fish and frogs, and shoreland birds in these lakes: Lower Hay, Bertha, Clamshell, Arrowhead, Whitefish (Upper, Middle and Lower), Pig, Big Trout, Island, Loon, Rush-Hen, Cross, Daggett and Little Pine. Field data will be used to identify areas along lakeshores that provide unique or critical ecological habitat. Once those areas are identified, local and state resource managers can use the information to help ensure that sensitive habitats are receiving sufficient protection.

More information on the MNDNR's Sensitive Lakeshore Identification, including Sensitive Lakeshore reports for individual lakes, can be found online at:
http://www.dnr.state.mn.us/eco/sli/index.html

Summary

Bertha Lake is one of 13 connected waterbodies that comprise the Whitefish Chain of Lakes in Crow Wing County. In 2011, as part of the DNR's larger Sensitive Lakeshore Identification project, surveyors assessed the aquatic vegetation of the lake. Surveys included mapping emergent and floating-leaf plant beds and sampling plant occurrence and diversity at 152 sites.

Since 1938, a total of 37 aquatic plant species (types) have been recorded in Bertha Lake. In 2011, 32 plant species were found including 7 emergent, 3 floating-leaved, 1 free-floating, and 21 submerged plants. Fourteen of these species were recorded for the first time during the 2011 survey and many of the species located during historical surveys are still relatively common in the lake.

Plants were distributed around Bertha Lake with the broadest zones of vegetation occurring in the protected bays, and along the shallow southern shoreline. Plants were found to a depth of 21 feet and in the 0-25 feet depth zone, 83% of the survey sites contained vegetation. Plants were most common in the 0-15 feet depth zone in depths greater than 20 feet, only 6% of the sites were vegetated.

Approximately 7 acres of plant beds were mapped and included emergent wild rice (*Zizania palustris*) and floating-leaf waterlilies (*Nymphaea odorata* and *Nuphar variegata*). These plant beds occurred in the shallow southern and eastern bays.

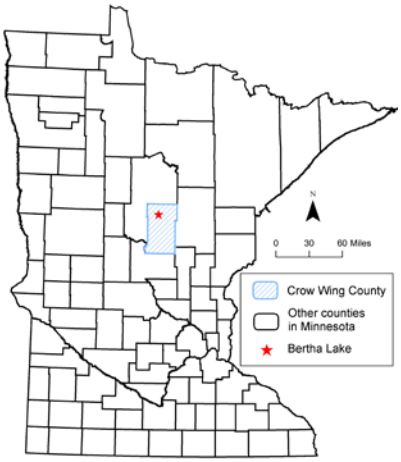
Six species were common (occurring in more than 20% of the sample sites) and distributed around the entire lake. The most frequently occurring species were naiads (*Najas* spp.) (67% occurrence), coontail (*Ceratophyllum demersum*) (41%), northern watermilfoil (*Myriophyllum sibiricum*) (41%), flat-stem pondweed (*Potamogeton zosteriformis*) (41%), clasping-leaf pondweed (*Potamogeton richardsonii*) (22%) and wild celery (*Vallisneria americana*) (22%). All of these species were also recorded in most previous surveys of the lake, indicating that they have historically been common in the lake. No non-native aquatic plants were detected during the survey.

The greatest diversity of plants occurred in the near-shore zone where water depths were 10 feet and less. Ninety-six percent of the plant species were restricted to this shallow zone. This shallow water is also where much recreational activity occurs, some of which may threaten this critical habitat if aquatic plants are damaged or removed. Protecting existing native aquatic plant beds will help maintain critical fish and wildlife habitat and the general water quality of the lake.

Introduction

Bertha Lake is located in the forested, lake-rich region of north central Minnesota (Figure 1). It is one of 13 waterbodies in the 14,000 acre Whitefish Chain of Lakes[1]. The Pine River flows east through the chain and in 1886 the Pine River Dam was completed at Cross Lake (Upham 1920) and raised water levels making channels between the lakes (Figure 2). Bertha Lake occurs on the southwest end of the chain and was not originally connected to the other lakes. Navigable channels now connect Bertha Lake to Whitefish Lake on the north (Figure 3) and to Clamshell Lake in the east (Figure 4).

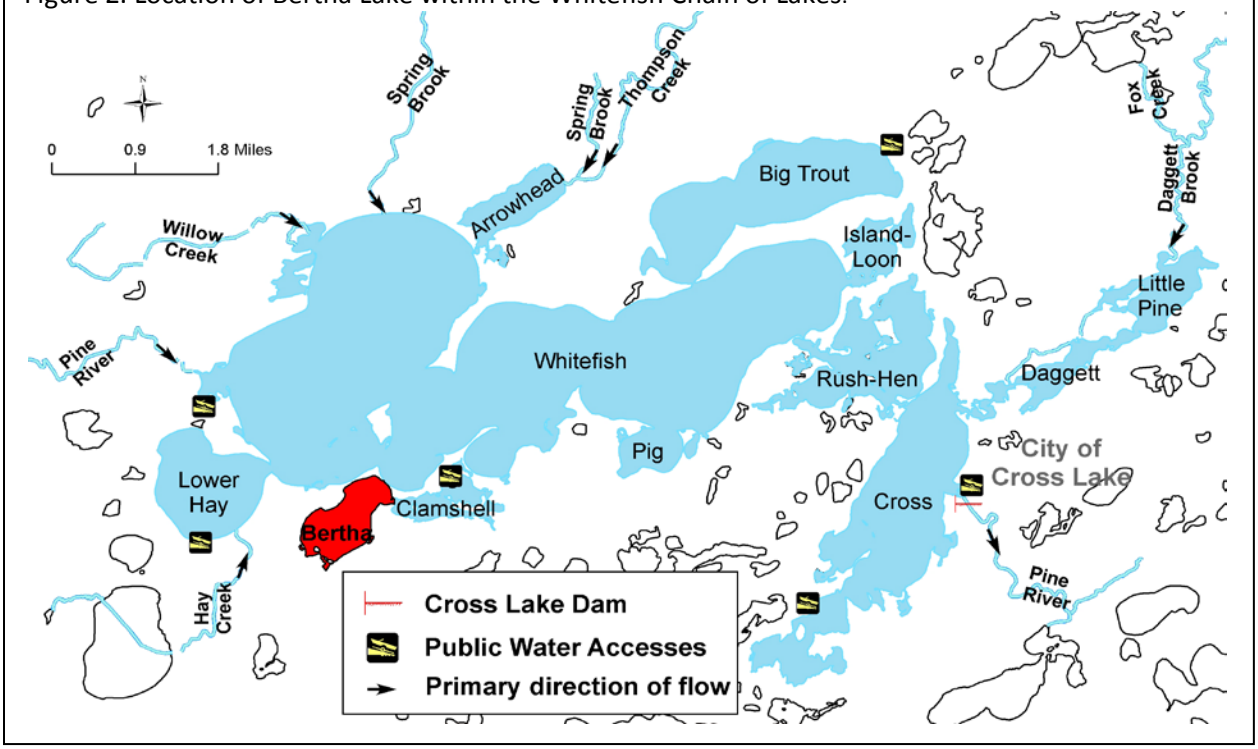
Figure 1. Bertha Lake, Crow Wing County, Minnesota.



Lake Characteristics

Bertha Lake has no major tributaries and water levels are influenced by precipitation, shoreland runoff and flow to and from Whitefish Lake (Figure 2). The U.S. Army Corps of Engineers attempts to maintain fairly stable water levels on the entire chain by regulating outflow at the Cross Lake Dam but heavy rain or drought conditions can also influence the water level.

Figure 2. Location of Bertha Lake within the Whitefish Chain of Lakes.



[1] The total number of waterbodies considered to be part of the Whitefish Chain of Lakes varies. We included the lakes that are directly connected within the main portion of the chain.

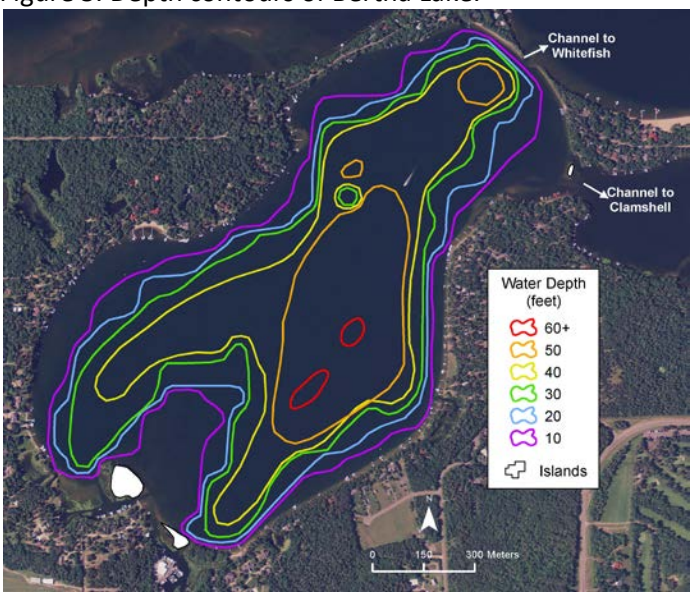
Figure 3. Channel between Bertha and Whitefish lakes.

Figure 4. Channel between Bertha and Clamshell lakes.

Although lakes in the Whitefish Chain are connected, differences such as lake size, depth, flow, and shoreland management create differences in nutrient levels and water clarity between the lakes. These physical differences influence the types and amounts of plants that occur in each lake.

Bertha Lake has a surface area of 334 acres and a total shoreline length of about 2 miles. It is oval shape in outline with several small bays that are connected by narrow channels to the main lake. Small islands (less than 2 acres) occur at the south end and near the channel to Clamshell Lake. The maximum water depth is 64 feet and 43% of the lake is shallow (15 feet or less in depth) (Figure 5).

Figure 5. Depth contours of Bertha Lake.



The shoreline is privately owned and developed with residential homes and a commercial marina. While trees remain on many lake lots, much of the understory vegetation has been removed at developed lots.

Bertha Lake is characterized as mesotrophic, based on phosphorus (nutrients), chlorophyll a (algae concentration) and Secchi[2] depth (transparency). Transparency in the lake stays

[2] 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 is influenced by the amount of particles in the water column and can fluctuate seasonally and annually.

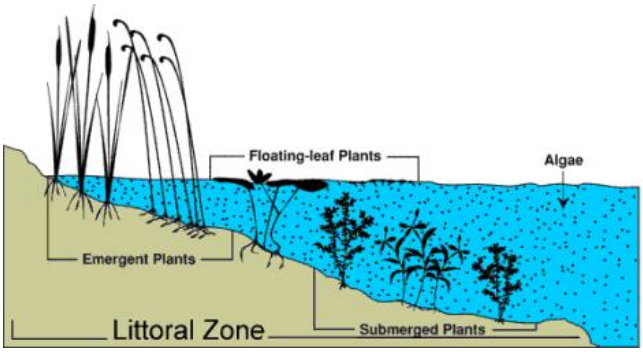
relatively consistent throughout the summer and in 2010, mean summer[3] water clarity was 10 feet (MPCA 2011). Based on Secchi disk measurements alone, aquatic plants have the potential to reach depths of at least 15 feet in Bertha Lake[4].

Amounts and types of aquatic plants in Minnesota lakes

Within a lake, types and amounts of aquatic plants are influenced by a variety of factors including water clarity, water chemistry, water depth, substrate and wave activity. Deep or wind-swept areas may lack aquatic plant growth, whereas sheltered shallow areas may support an abundant and diverse native aquatic plant community. The annual abundance, distribution and composition of aquatic plant communities may change due to environmental factors, predation, the specific phenology of each plant species, introductions of non-native plant or animal species and human activities in and around the lake.

Aquatic plants can be divided into four groups or "life forms" based on whether the main portion of the plant occurs above, on, or below the water surface. These life forms: emergent, floating-leaved, free-floating and submerged plants (Figure 6), often favor certain water depth zones around the lake but overlap occurs with one life form grading into another. Each life form group has unique functions and values.

Figure 6. Forms of aquatic plants found in Minnesota lakes.



Emergent plants, like cattails and bulrush, are rooted in the lake bottom with most of their leaves and stems extending above the water surface. Floating-leaf plants, such as waterlilies, are also anchored in the lake bottom with leaves and flowers that float on the water surface. Root systems of these plants form extensive networks that take up nutrients and help consolidate and stabilize bottom substrate. Beds of floating-leaf and emergent plants also help buffer the shoreline from wave action, offer shelter for insects and young fish, and provide shade for fish and frogs. These beds also provide food, cover and nesting material for waterfowl, marsh birds and muskrat. Floating-leaf and emergent plants are most often found in shallow water to depths of about 6 feet and may extend lake-ward onto mudflats and into adjacent wetlands.

Submerged plants have stems and leaves that primarily grow underwater but they may also form flowers, fruits and some leaves that emerge above or float on the water surface. Submerged plants are typically anchored to the lake bottom but some species do drift freely with the currents. This group includes non-flowering plants such as large algae, mosses, and

[3] June through September

[4] 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.

fern-like plants, and flowering plants that may produce flowers above or below the water surface. Submerged plants may form low-growing mats or may grow several feet in the water column with leaf shapes that include broad ovals, long and grass-like, or finely dissected. Submerged plants release oxygen into the water column, compete for nutrients with microscopic algae, and provide food and shelter for a variety of invertebrates, fish, amphibians and other wildlife.

Free-floating plants are the smallest of Minnesota's lake plants and include small flowering plants that are commonly known as "duckweeds" as well as microscopic algae. Different survey methods are required to assess microscopic algae and they are not included in this report. Duckweeds are present in many Minnesota lakes and if present in sufficient amounts, they can accumulate into mats and create a shade barrier along protected shorelines. As their name implies, they are also an important food source for waterfowl.

Plant species richness is a term used to describe the total number of plant species present in a lake and it can be used to help describe the general health of the waterbody. In Minnesota, plant species richness can range from zero (un-vegetated lakes) to more than 40 species in a lake[5]. Species richness is generally higher in high clarity lakes than in turbid lakes and more species are usually found in moderately fertile lakes than in nutrient poor lakes. Therefore, lakes of north central Minnesota are often among the "richest" in terms of numbers of plant species. Water quality changes that result in lower clarity may also result in the loss of some plant species, or a lower species richness. However, caution must be used when comparing historical and present survey data because of differences in how the surveys were conducted. For example, if a current MNDNR plant survey locates more species than found during an historical "one-day" survey, it may be due to the more extensive sampling that occurs during current surveys. If fewer species are located during current surveys, it may indicate a true decline in the plant species richness of the lake.

Historic aquatic plant community

Previous lakewide, aquatic plant surveys of Bertha Lake were conducted in 1938, 1950, 1982, 1990, and 1995 (MnDNR Lake files). These surveys focused on the commonly occurring in-lake plants and recorded a total of 23 aquatic plant species: 3 emergent, 2 floating-leaf, 2 free-floating, and 16 submerged species (Appendix 1). The 1990 survey reported submerged plants to a depth of 17 feet and emergent plants were found only in the southern bays. Plants that were reported in most of the previous surveys included native plants that are commonly found in many Crow Wing County lakes: coontail (*Ceratophyllum demersum*), Canada waterweed (*Elodea canadensis*), northern watermilfoil (*Myriophyllum sibiricum*), clasping-leaf pondweed (*Potamogeton richardsonii*), and flat-stem pondweed (*Potamogeton zosteriformis*).

[5] These values are from a review of MNDNR lake vegetation surveys.

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2011 plant population of Bertha Lake. Specific objectives included:

1. Describe the general distribution of plants in the lake including the depths at which plants occur.
2. Record the aquatic plant species that occur in the lake
3. Estimate the abundance of each species
4. Develop distribution maps for the commonly occurring species

Methods

Mapping floating-leaf and emergent vegetation beds

Mapping focused on plant beds that were at least 0.01 acres, or about 400 square feet, in size (generally larger than the surface area covered by a pontoon boat). Draft maps of floating-leaf and emergent plant beds were created prior to field surveys using 2010 Farm Service Administrative (FSA) true color aerial photographs. Field surveys were conducted August 22, 2011 to map plants like bulrush (*Schoenoplectus* spp.), which are difficult to identify from aerial photos, and to verify photo-interpretation of other plant beds. Surveyors mapped emergent and floating-leaf plant beds in the field by motoring or wading around the perimeter of each bed and recording a 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. Plant beds were classified by the dominant species or species-group.

Lakewide vegetation survey

A lakewide vegetation survey was conducted on August 15, 2011 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. In the field, surveyors sampled sites where water depth was less than 31 feet. A total of 152 sites were surveyed including 143 sites within the 0-25 feet zone (Figure 7, Table 1).

Table 1. Survey effort by depth interval.

Water depth (feet)	Number of sample sites
0 to 5	30
6 to 10	68
11 to 15	20
16 to 20	7
21 to 25	18
Total (0-25)	143
26 to 30	9
Total	152

The survey was conducted by boat and a GPS unit was used to navigate 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.

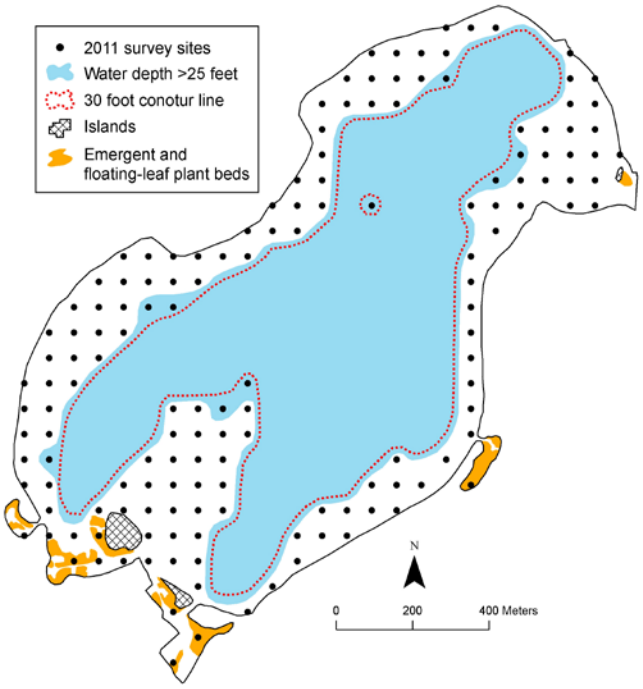
Substrate sampling

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 depths 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; this information was used for mapping purposes.

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

Figure 7. 2011 vegetation survey sites on Bertha Lake.



Plant sampling

Surveyors recorded all plant species found at each sample site (approximately 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 8). 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 (2011).

Figure 8. Survey rake.

Frequency was calculated for the area from shore to 25 feet (the depth zone where plants were detected) and data were also separated into 5 feet increment depth zones for analysis (Table 1). Frequency estimates were also calculated for individual species and selected groups of species (example calculations shown in Appendix 2).

Results and Discussion

Shoal Substrates

The shoal substrates of Bertha Lake were primarily hard substrates of sand, gravel and rubble throughout the main part of the lake (Figure 9). Softer substrates of muck and silt were found in the two southern bays and the east bay.

Types of plants recorded

A total of 32 aquatic plant species (types) were recorded in Bertha Lake. The plants found included 7 emergent, 3 floating-leaved, 1 free-floating, and 21 submerged plants (Table 3). Fourteen of these species were recorded for the first time during the 2011 survey (Appendix 1).

Distribution of aquatic plants

Plants were distributed around Bertha Lake with the broadest vegetation occurring along the shallow southern shoreline (Figure 10). On the east shores vegetation was restricted to a narrow band of shallow water that extended less than 50 meters from shore.

Plants were found to a depth of 21 feet in Bertha Lake and in the 0-25 feet depth zone, 83% of the survey sites contained vegetation. Vegetation was most common in the 0- 15 feet depth zone, where 96% of sites contained plants (Figure 11). Plant abundance declined with increasing water depth and in depths of 21-25 feet, 6% of the sites were vegetated.

Figure 9. 2011 substrate on Bertha Lake.

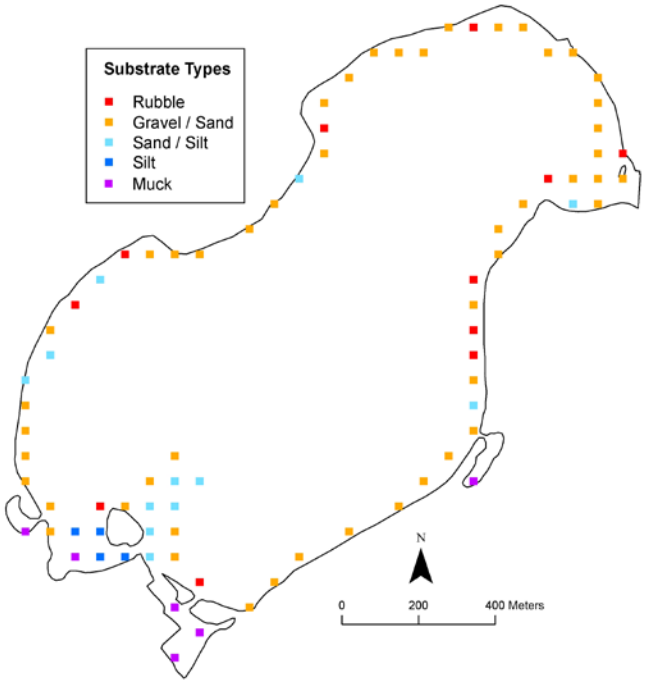


Figure 10. Number of species per site, Bertha Lake 2011.

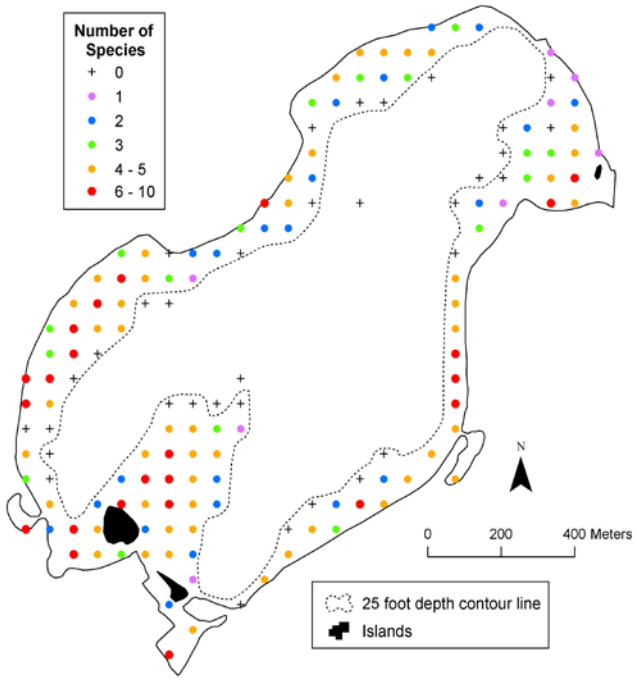


Table 3. Frequency of submerged aquatic plants in Bertha Lake, August, 2011.
[Frequency is the percent of sample sites in which a plant species occurred within the 0 to 25 ft water depth).

Life Form		Common Name	Scientific Name	Frequency (% occurrence) 143 sites
EMERGENT[1]		Stiff wapato	*Sagittaria rigida*[a]	1
		Giant burreed	*Sparganium eurycarpum*	1
		River bulrush	*Bolboschoenus fluviatilis*	P
		Bulrush	*Schoenoplectus* sp.[b]	P
		Three-square bulrush	*Schoenoplectus pungens*	P
		Narrow-leaved cattail	*Typha* sp.[c]	P
		Wild rice	*Zizania palustris*	P
FLOATING-LEAVED		White waterlily	*Nymphaea odorata*	4
		Yellow waterlily	*Nuphar variegata*	P
		Floating-leaf smartweed	*Persicaria amphibia*	P
SUBMERGED	Macroalgae	Muskgrass	*Chara* sp.	15
	Dissected-leaf rooted plants	Coontail	*Ceratophyllum demersum*	41
		Northern watermilfoil	*Myriophyllum sibiricum*	41
		Water marigold	*Bidens beckii*	6
		White-water buttercup	*Ranunculus aquatilis*	2
	Small-leaf rooted plants	Bushy pondweed	*Najas flexilis*[d]	67
		Southern naiad	*Najas guadalupensis*[d]	
		Canada waterweed	*Elodea canadensis*	20
		Needlegrass	*Eleocharis acicularis*	P
	Narrow-leaf pondweeds	Narrow-leaf pondweed group[e]	*Potamogeton friesii*	9
			Potamogeton pusillus	
		Sago pondweed	*Stuckenia pectinata*	10
	Broad-leaf pondweeds	Clasping-leaf pondweed	*Potamogeton richardsonii*	22
		White-stem pondweed	*Potamogeton praelongus*	13
		Illinois pondweed	*Potamogeton illinoensis*	6
		Variable pondweed	*Potamogeton gramineus*	3
		Large-leaf pondweed	*Potamogeton amplifolius*	3
	Grass-leaf rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	41
		Wild celery	*Vallisneria americana*	22
		Water star-grass	*Heteranthera dubia*	5
		Robbin's pondweed	*Potamogeton robbinsii*	2
FREE-FLOATING		Star duckweed	*Lemna trisulca*	6

P=Present in lake but did not occur in any sample sites [1]includes only in-lake emergents and not wetland plants

Table 3 (continued). Frequency of submerged aquatic plants in Bertha Lake, August, 2011.

The following taxonomic groupings were made because field identification to the species level was difficult or not possible:

[a]Most arrowhead plants that were found in the lake were not in flower or fruit and could not be identified to the species level. A few plants were positively identified as *Sagittaria rigida*, but it is not known if that was the only species of arrowhead present.

[b]species of bulrush (*Schoenoplectus* sp.) was used to record bulrush plants that was hard-stem bulrush (*Schoenoplectus acutus*), soft-stem bulrush (*S. tabernaemontani*) or the hybrid.

[c]Narrow-leaf cattail was identified in survey but it is not known whether this included narrow-leaf cattail (*Typha angustifolia*) and/or the hybrid of narrow-leaf and broad-leaf cattail (*Typha x glauca*).

[d]Bushy pondweed (*Najas flexilis*) and Southern naiad (*Najas guadalupensis*) were grouped together for analysis because field identification to the species level was difficult.

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

Plant communities richness

The number of plant species found at each sampe site ranged from 0 to 10 with a mean of 3 species per site. Sites of high species richness (6 or more species per site) often occurred in depths less than 10 feet and included sites of where emergent, floating-leaf, and submerged plants co-occurred (Figure 10). The greatest number of plant species were found in shallow water, from 0-5 feet (Figure 12).

Figure 11. Aquatic plant frequency vs. water depth.

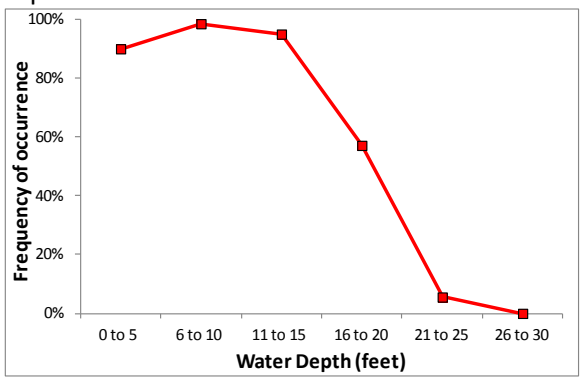
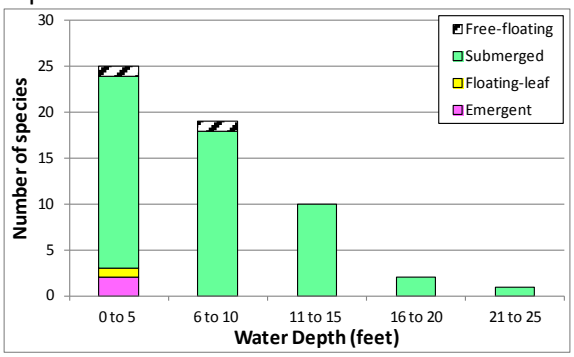


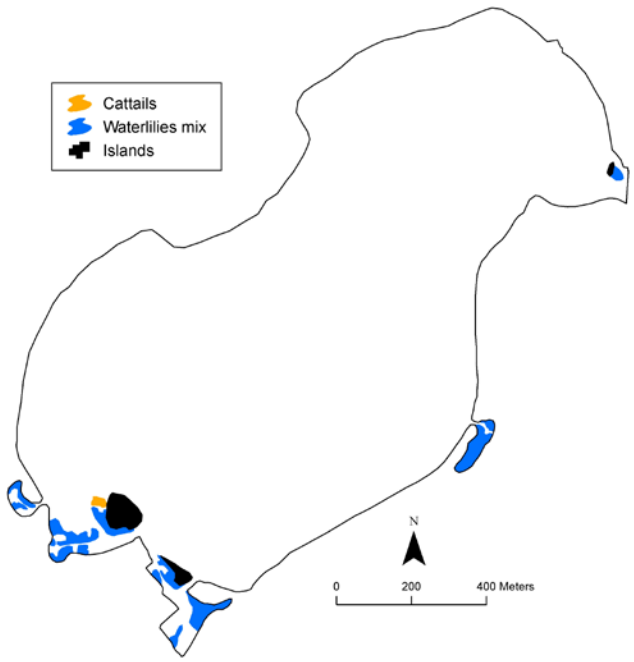
Figure 12. Aquatic plant frequency vs. water depth.



Emergent and Floating-leaf Plant Beds

Approximately 7 acres of emergent and floating-leaf plant beds were mapped in Bertha Lake and most of these plant beds occurred in the shallow southern and eastern bays (Figure 13). Emergent plants did not often occur in large beds but were found mixed within stands of waterlilies or growing in narrow bands near shore. They included species with broad grass-like leaves such as cattails (*Typha* sp.), wild rice (*Zizania palustris*) and burreed (*Sparganium* sp.) plants and narrow-leaf plants like bulrush (*Schoenoplectus* spp.).

Figure 13. Emergent and floating-leaf plant beds, Bertha Lake 2011.



Most of these plant beds were classified as "mixed waterlily" beds and were dominated by floating-leaf plants such as white waterlily (*Nymphaea odorata*; Figure 14), yellow waterlily (*Nuphar variegata*), and floating-leaf smartweed (*Persicaria amphibia*).

Figure 14. White waterlily

Emergent and floating-leaf plants provide shade and shelter for fish, frogs, and invertebrates. The flowers produce seeds that are eaten by waterfowl and the rhizomes are a food source for muskrats and deer (Borman et al. 2001). The extensive root network of these plants helps to stabilize shorelines. These plants are particularly susceptible to destruction by direct cutting by humans, motorboat activity and excess herbivory. In shallow water, they may spread by underground rhizomes but restoration of emergent and floating-leaf plant beds can be very difficult, making established beds particularly unique and valuable.

Submerged aquatic plants

Submerged plants were found to a maximum depth of 21 feet, but most submerged species were found in depths of 15 feet and less (Figure 12). The majority of plants present at sample sites were submerged species. Six species were common (occurring in more than 20%[6] of the sample sites) and distributed around the entire lake (Figure 15). The most frequently occurring species were naiads (*Najas* spp.), coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), flat-stem pondweed (*Potamogeton zosteriformis*), clasping-leaf pondweed (*Potamogeton richardsonii*) and wild celery (*Vallisneria americana*). All of these species were also recorded in most previous surveys of the lake, indicating that they have historically been common in the lake.

The species with the highest lakewide occurrence (naiads and coontail), were frequent in both shallow and deep water, while the other species were not detected in depths greater than 15 feet (Figure 16).

[6] Unless otherwise noted, frequency values are calculated for the 0-25 feet depth zone.

Figure 15. Distribution of commonly occurring submerged plants in Bertha Lake, 2011.

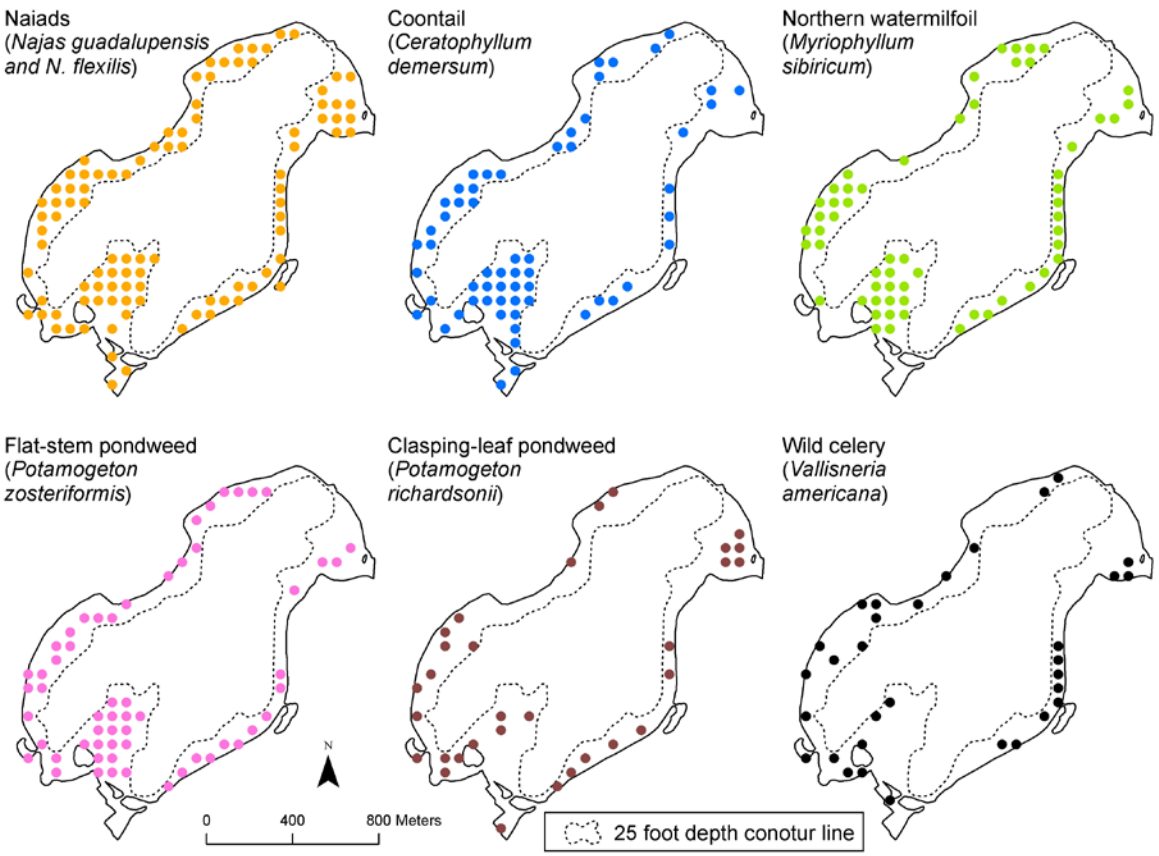
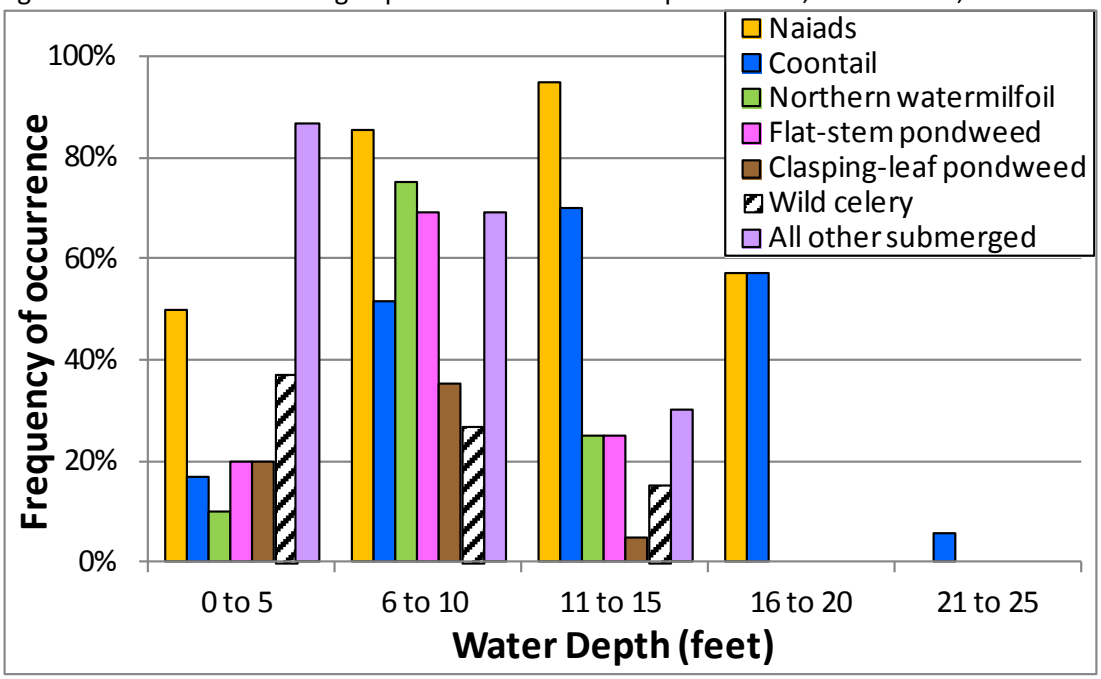


Figure 16. Common submerged plants at each water depth interval, Bertha Lake, 2011.



Naiads (*Najas guadalupensis* and *N. flexilis*) were the most commonly found submerged plant group in Bertha Lake and occurred in 67% of the sample sites (Table 3). Two species of naiads were found in Bertha Lake and since they can be difficult to distinguish, they were grouped together for analyses. Southern naiad (*Najas guadalupensis*; Figure 17) can sprout from seed or overwinter as a perennial plant. Bushy pondweed is an annual plant that grows each year from seed. Both species grow entirely submerged and produce seeds and foliage that provide important duck food and good fish cover. Within the 6-15 feet zones, naiads dominated (Figure 15) and occurred in 91% of the sites (Figure 16).

Figure 17. Southern naiad.
Photo: Kerry Dressler ©1996 Univ. of Florida Center for Aquatic Plants

Coontail (*Ceratophyllum demersum*; Figure 18) 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 (Nichols 1999). 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 41% of the sample sites in Bertha Lake (Table 3) and was most frequent in the 11-15 feet zone where it occurred in 70% of the sites (Figure 16).

Figure 18. Coontail

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 19) is a native[7], submerged plant. It is a rooted perennial with finely dissected leaves. Particularly in depths less than 10 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 (Nichols 1999) and grows best in clear water lakes. Northern watermilfoil was found in 41% of all sites (Table 3). It occurred to a depth of 15 feet and was most common in the 6-10 feet depth zone (Figure 16).

Figure 19. Northern watermilfoil

Photo by: Andrew Hipp (UW Madison-Wisc State Herbarium)

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

[7] For information on how to distinguish the native northern watermilfoil from the non-native, Eurasian watermilfoil, click here: identification.

(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 20. Flat-stem pondweed.

Flat-stem pondweed (*Potamogeton zosteriformis*; Figure 20) is one of 8 native pondweeds found in Bertha Lake. Flat-stem pondweed is named for its flattened, grass-like leaves. It was the most common pondweed in Bertha Lake, occurring with a frequency of 25% (Table 3). It was most frequent in the 6-10 feet depth zone, where it was found in 46% of the sites (Figure 16).

Figure 21. Clasping-leaf pondweed

Clasping-leaf pondweed (*Potamogeton richardsonii*; Figure 21) was the most abundant broad-leaf pondweed in Bertha Lake, occurring in 22% of the sites. Clasping-leaf pondweed was common in depths less than 10 feet where it occurred in 31% of the sites (Figure 16).

Figure 22. Wild celery

Wild celery (*Vallisneria americana*; Figure 22) is a rooted, perennial submerged plant that resembles ribbon-leaved pondweeds. Unlike the pondweeds that have branches of leaves, wild celery leaves all arise from the base of the plant. 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. 2001). Wild celery is a particularly important food source for canvasback ducks (Varro 2003). Wild celery occurred in 22% of the sample sites (Table 3), was found to a depth of 13 feet (Figure 15) and was most frequent to depths of 10 feet (Figure 16).

Factors influencing 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 2011 can be used to monitor finer-scale changes that may occur, such as an increase in a particular species, loss of species, or changes in the depths at which individual species occur. In general, factors that may lead to change in aquatic plant communities include:

- Change in water clarity

  If water clarity in Bertha Lake increases, submerged vegetation may be more common at depths greater than 15 feet. Declines in water clarity may lead to fewer plants and fewer types of plants in the deep end of the current vegetated zone.

- Snow and ice 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, submerged plants may increase in abundance or there may be a shift in species dominance.

- 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 Bertha Lake provide critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

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Appendix 1. Historical aquatic and wetland plants of Bertha Lake

Blue highlight indicates species that were common (occurring in at least 20% of sites) in 2011.

Submerged plants

Common Name	Scientific Name	1938	1950	1982	1990	1995	2011
Water marigold	*Bidens beckii*						X
Coontail	*Ceratophyllum demersum*	X	X	X	X	X	X
Muskgrass	*Chara* sp.	X				X	X
Needlerush	*Eleocharis acicularis*						X
Canada waterweed	*Elodea canadensis*		X	X	X	X	X
Water star-grass	*Heteranthera dubia*						X
Northern watermilfoil	*Myriophyllum sibiricum*	X	X		X	X	X
Bushy pondweed	*Najas flexilis*	X				X	X
Southern naiad	*Najas guadalupensis*						X
Large-leaf pondweed	*Potamogeton amplifolius*				X	X	X
Narrow-leaf pondweed group[1]	*Potamogeton* sp.			X		X	
	Potamogeton friesii						X
	Potamogeton pusillus						X
	Potamogeton strictifolius				X		
Variable pondweed	*Potamogeton gramineus*					X	X
Illinois pondweed	*Potamogeton illinoensis*						X
White-stem pondweed	*Potamogeton praelongus*	X					X
Clasping leaf pondweed	*Potamogeton richardsonii*		X	X	X	X	X
Robbin's pondweed	*Potamogeton robbinsii*					X	X
Flat-stem pondweed	*Potamogeton zosteriformis*	X	X	X	X	X	X
White water buttercup	*Ranunculus aquatilis*					X	X
Sago pondweed	*Stuckenia pectinata*					X	X
Wild celery	*Vallisneria americana*	X				X	X
	Total	7	5	5	7	14	21

Floating-leaved plants

Common Name	Scientific Name	1938	1950	1982	1990	1995	2011
White waterlily	*Nymphaea odorata*			X		X	X
Yellow waterlily	*Nuphar variegata*						X
Floating-leaf pondweed	*Potamogeton natans*	X					
Floating-leaf smartweed	*Persicaria amphibia*						X
	Total	1	0	1	0	1	3

Free-floating plants

Common Name	Scientific Name	1938	1950	1982	1990	1995	2011
Star duckweed	*Lemna trisulca*			X		X	X
Duckweed	*Lemna* sp.					X	
	Total	0	0	1	0	2	1

Emergent plants

Common Name	Scientific Name	1938	1950	1982	1990	1995	2011
River bulrush	*Bolboschoenus fluviatilis*						X
Spikerush	*Eleocharis* sp.					X	
Arrowhead	*Sagittaria rigida*						X
Bulrush[2]	*Schoenoplectus* sp.				X[a]		X[a]
Three-square bulrush	*Schoenoplectus pungens*						X
Giant burreed	*Sparganium eurycarpum*						X
Broad-leaved cattail	*Typha latifolia*				X		
Narrow-leaved cattail[3]	*Typha angustifolia*						X
Wild rice	*Zizania aquatica*						X
Total		0	0	0	2	1	7

Wetland plants

Common Name	Scientific Name	1938	1950	1982	1990	1995	2011
Alder	*Alnus* sp.						X[a]
Swamp milkweed	*Asclepias incarnata*						X
Sedges	*Carex* spp.						X[a]
Iris species	*Iris* sp.						X[a]
Wild Grape	*Vitis* sp.						X[a]
Total		0	0	0	0	0	5

X[a] = Plant was identified only to genus level.

[1] narrow-leaf pondweed (*Potamogeton* sp.). This may have been one of several different *Potamogeton* species that have narrow, submerged leaves. In 2011, two narrow-leaved pondweed, *Potamogeton friesii and P. pusillus*, were positively identified but it is not known whether all narrow-leaved pondweeds found in that survey were *P. friesii* or *P. pusillus*. Plants identified as *P. friesii, P. pusillus* or *Potamogeton* sp. were grouped together for analysis.

[2] a species of bulrush (*Schoenoplectus* sp.) was used to record bulrush plants that were hard-stem bulrush (*Schoenoplectus acutus*), soft-stem bulrush (*S. tabernaemontani*) or the hybrid.

[3] Narrow-leaf cattail was identified in survey but it is not known whether this included narrow-leaf cattail (*Typha angustifolia*) and/or the hybrid of narrow-leaf and broad-leaf cattail (*Typha x glauca*).

Sources:
1938 (July 29): Robert Sharp, Division of Game and Fish
1950 (July 17-18): Maloney, Division of Game and Fish
1982 (September 8): Paul Liemandt, Pesticide enforcement officer
1990 (June 13-15): Wayne Mueller (Crew Leader); DNR Fisheries Survey
1995 (June 14): MnDNR Fisheries Survey
2011 (August): Simon, Perleberg, Eininger, Dickson, MnDNR Division of Ecological and Water Resources

Appendix 2: Calculation of plant abundance

Frequency of occurrence was calculated as the percent of sites, within a specific depth zone, where a plant species was detected. Unless otherwise noted, frequency values were calculated for the 0-25 feet depth zone.

Example:

In Bertha Lake there were 143 sample sites in the 0-25 feet depth zone.
Coontail occurred in 59 sites.
Frequency of Coontail in 0-25 feet zone = (59/143)*100 = 41%