Aquatic Vegetation of Ban Lake
St. Louis County, Minnesota
(DOW 69-0742-00)
August 3-4, 2004

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Funding: Collection of these data was made possible by support from the Heritage Enhancement Fund.

This report should be cited as:

Perleberg, D. 2005. Aquatic vegetation of Ban Lake, St. Louis County, Minnesota (DOW 69-0742-00), August 3-4, 2004. Minnesota Department of Natural Resources, Ecological Services Division, 1601 Minnesota Dr., Brainerd, MN 56401. 14 pp.

Summary

Ban Lake is a 380 acre, soft-water, bog-stained lake of northeastern Minnesota. The aquatic plant community includes a group of species adapted to low nutrients and low alkalinity. Because the lake water is naturally dark, light level limits the depth where plants grow to 8.5 feet.

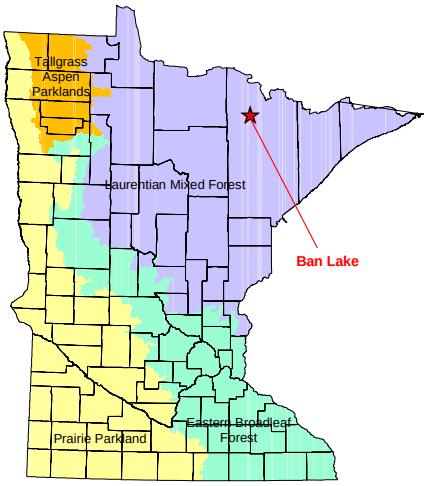
A total of 309 sites were surveyed in Ban Lake and vegetation was found in only 26 percent of the sites. The highest frequency of vegetation was found in the depth zone from shore to five feet, where 88 percent of the sites contained vegetation. However, most of the lake has only a narrow band of shallow water and aquatic plants are concentrated in the shallow east and west ends of the lake.

A total of 25 native plant species were recorded in the lake included eight emergent, five floating-leaved and twelve submerged species. Common plants included waterlilies, floating-leaf burreed, stonewort, narrow-leaf pondweed, water celery, and bladderworts. Some species that are uncommon in the state were present in Ban Lake and included hornwort and Farwell's milfoil.

Ban Lake (69-0742-00) St. Louis County, MN, August 3, 2004.

Introduction

Figure 1. Ban Lake, St. Louis Co., MN

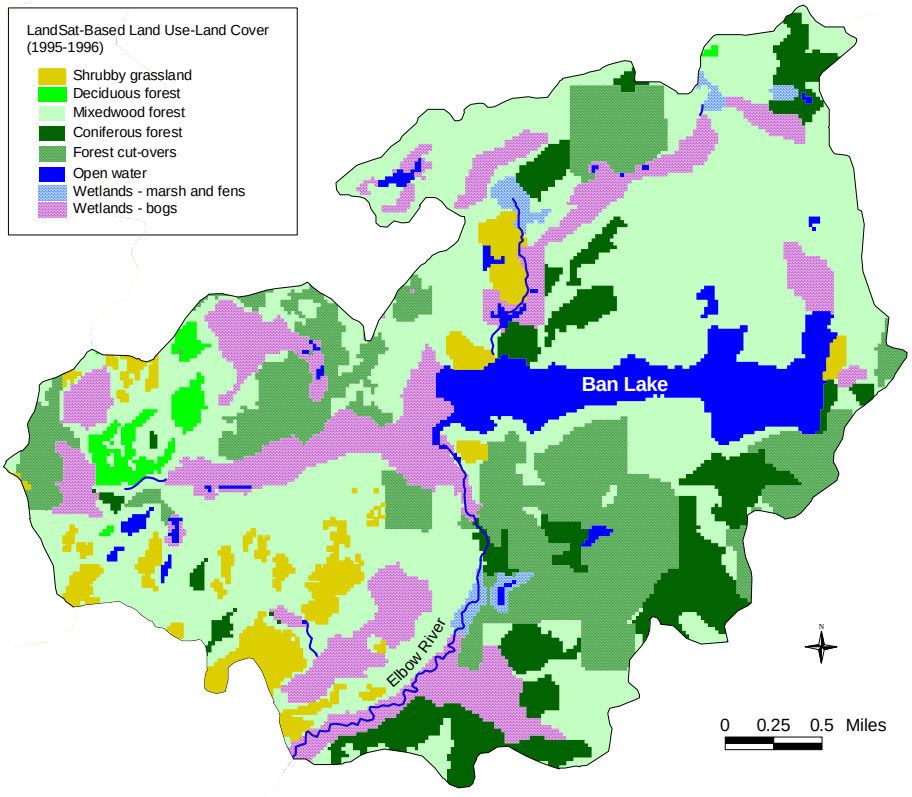


Ban Lake (DOW 69-0742-00) is located about seven miles east of the town of Orr, in St. Louis County, Minnesota. It occurs within the true forested region of the state known as the Laurentian Mixed Forest Province, (Fig. 1).

Ban Lake is located west of the Vermilion River in the Vermilion River Watershed. Uplands in this region consist of scoured bedrock or shallow soils on bedrock. Topography is dominantly rolling with irregular slopes and many craggy outcrops of bedrock. Glacial ice moved from west to east across this region, deepening stream valleys in the bedrock. Drainage network is very angular due to development in shallow sediments over bedrock. Long, east-west oriented lakes, like Ban Lake, now occupy these enlarged valleys.

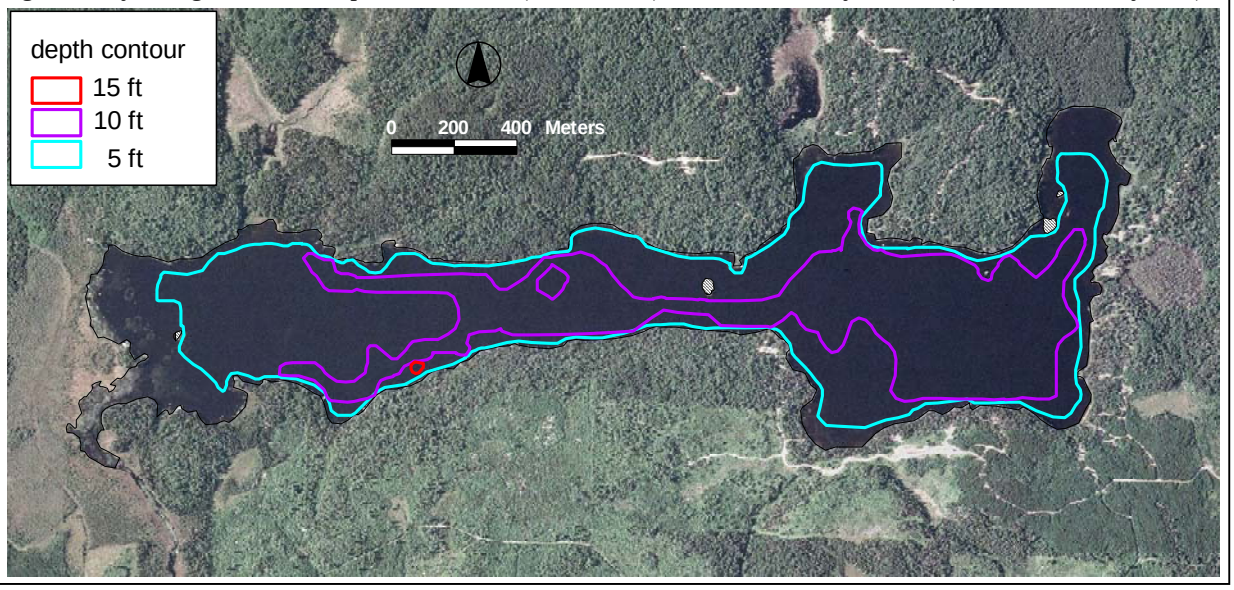
Presettlement vegetation in this region included jack pine forest, white pine-red pine forest, and hardwood- conifer forest. Logging occurred within this area, but today, the land use within the watershed that includes Ban Lake remains primarily forested with several large bog wetlands (Fig. 2). Ban Lake receives inflow from a wetland tributary on the northwest side of the lake and an outlet at the southwest corner flows into the Elbow River (Fig. 2). Flow continues to the Pelican River then to the Vermillion River.

Figure 2. Land use within the Ban Lake (69-0742-00) watershed.



Ban Lake has a surface area of about 380 acres with several small (<0.5 acre) islands. The lake is entirely shallow with a maximum depth of 16 feet (Fig. 3). The west end of the lake and the bays in the east end are less than five feet in depth but the elongated north and south shorelines have only a narrow band of shallow water (Fig. 3).

Figure 3. Hydrologic contour maps of Ban Lake (69-0742-00), St. Louis County, MN. (from 2004 survey data)



Water quality data are limited and water clarity is low as indicated by an average mid-summer Secchi disc reading of 4.4 feet between 1994 and 1998 (MPCA 2005). Low clarity in this lake is mostly due to the natural dark "bog stain" of the water. This dark coloring is natural for many lakes in northern Minnesota. The color results from the incomplete dissolved organic matter, sometimes referred to as tannins, which comes from the decomposition of wetland plants in the watershed. At very high levels, this coloration can limit water transparency.

Many lakes in northeast Minnesota, including Ban Lake, are described as "soft-water" lakes with low alkalinity and slightly acidic pH. The alkalinity of lake water is mostly determined by the geology of the soils and rocks surrounding the lake and lakes with granite geology have little soluble minerals and thus low alkalinity. Productivity, including aquatic plant growth, in these lakes is usually low.

Ban Lake is remote and until recently the lakeshore was mostly undeveloped with a few residential homes concentrated on the east and southeast shores. Until 2000, a trail on Potlatch Corporation land at the southeast side of the lake was used for public access but the property has since been sold. Potential increases in shoreline development may impact the lakeshore vegetation and/or lake water quality, which in turn may impact the in-lake aquatic plant community.

Soft-water lakes with soft substrates and dark water often have sparse submerged vegetation (Moyle 1945). Previous vegetation surveys of Ban Lake were conducted in 1974 and 1993 and common plant species included cattail, waterlilies, floating-leaf burreed and a variety of

submerged species. Submerged vegetation has been found to depths of four to five feet (MnDNR Fisheries Lake Files).

The purpose of the 2004 survey of Ban Lake is to describe the current aquatic plant community including:

1) Estimate the maximum depth of rooted vegetation
2) Estimate the percent of the lake occupied by rooted vegetation
3) Record the aquatic plant species that occur in the lake
4) Estimate frequencies of occurrence of individual species
5) Develop maps of the distribution of the common species

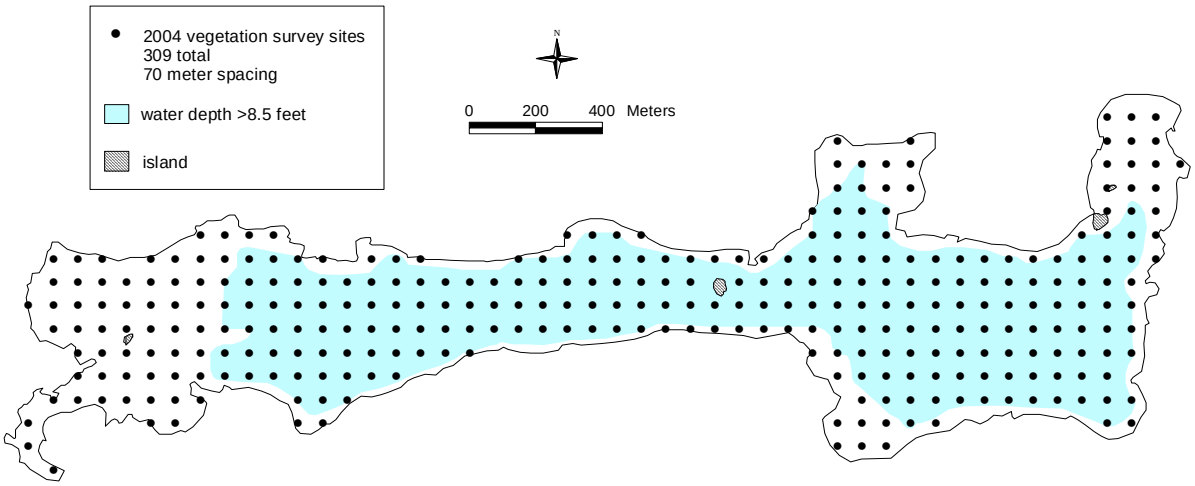
Methods

Aquatic Vegetation Survey Methods

A Point-Intercept vegetation survey of Ban Lake was conducted on August 3 and 4, 2004 following the methodology described by Madsen (1999). At a minimum, we wanted to sample 100 points within the littoral zone of the lake and place sample points no further than 100 meters apart for mapping purposes. Sample points were established with a geographic information system (GIS) software using a 70 meter by 70 meter grid across the lake surface. This resulted in a total of 309 sample sites and 120 of those fell within the vegetated zone from shore to the 8.5 foot depth (Fig. 4).

Survey waypoints were created and downloaded into a global position system (GPS) unit. 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 0.5 foot increments using a measured stick in water depths less than eight feet and an electronic depth finder in deeper water. The surveyors recorded all plant species found within a one meter squared

Figure 4. 2004 vegetation sample sites on Ban Lake (69-0742-00) St. Louis County.



sample area at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Fig. 5).

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

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which a species occurred divided by the total number of sample sites. Frequency was calculated for the entire lake and for the vegetated zone (0 to 8.5 feet). Sampling points were also grouped by water depth and separated into three depth zones for analysis: 0 to 5 feet, 6 to 10 feet and 11 to 16 feet.

Figure 5. Rake used to sample vegetation.

Example:
There were 309 sample sites and 120 sites in the vegetated zone.
White waterlily occurred in 10 of those sites.
Lakewide frequency of white waterlily = 10 / 309 = 3%
Frequency of white waterlily in vegetated zone = 10 / 120 = 8%

Results / Discussion

Distribution of plants by water depth

Aquatic plants occurred in 26 percent of the Ban Lake survey sites. Plant growth was concentrated in the shallow western end of the lake and the shallow bays on the east end (Fig. 6). Plants were found to a maximum depth of 8.5 feet and were most common in the zone from shore to five feet, where 88 percent of the sites contained vegetation. But in depths from 5.5 to 8.5 feet, only 12 percent of the sites contained vegetation (Fig. 7).

Figure 6. Distribution of aquatic plants in Ban Lake (69-0742-00) Aug 2-3, 2004.

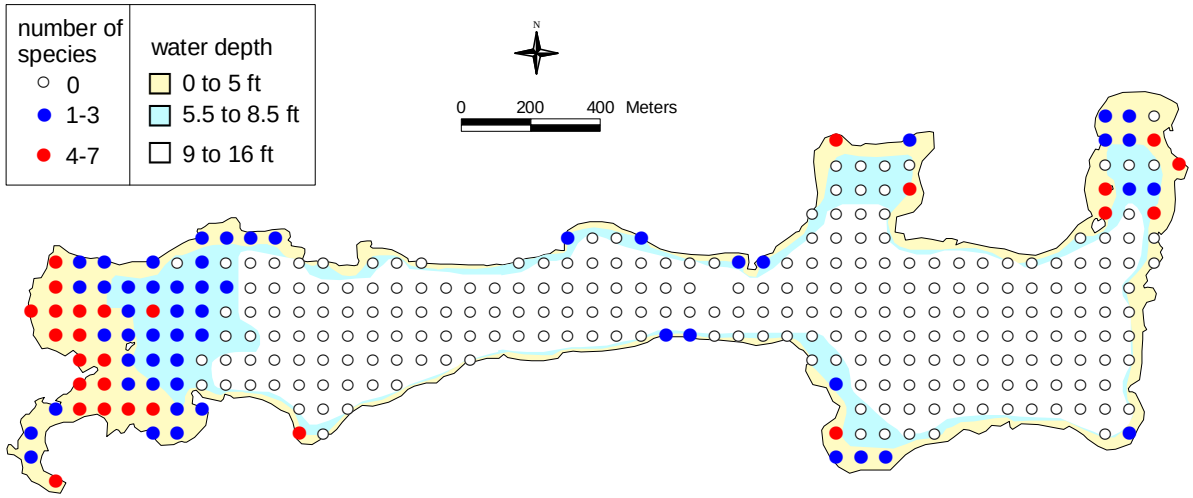


Figure 7. Percent of sites with vegetation vs. water depth
Ban Lake (69-0742-00), August 3-4, 2004.

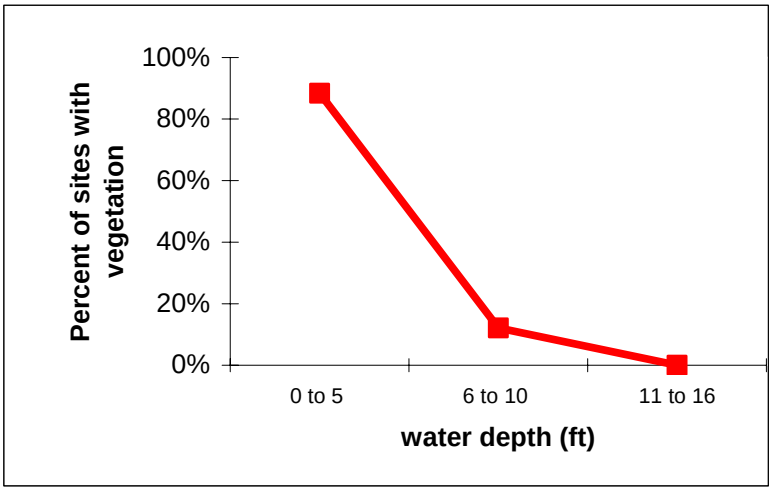
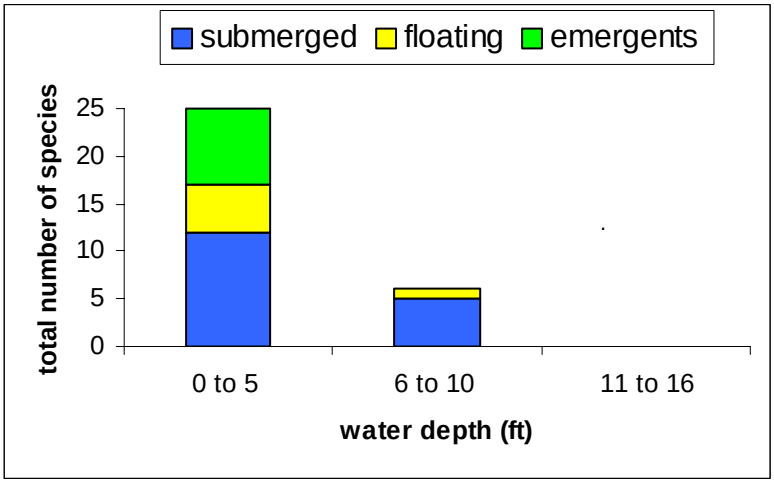


Figure 8.Types of aquatic plants vs. water depth
Ban Lake (69-0742-00), August 3-4, 2004.



Types of aquatic plants found

A total of 25 native aquatic plant species were found in Ban Lake including 12 submerged, five floating-leaf, and eight emergent (Table 1). An additional four native wetland emergent species were recorded but a thorough survey of the adjacent wetlands was not conducted. The number of species found per site ranged from zero to seven and sites with water depths less than six feet had more species than deeper sites (Fig. 6).

Emergent and floating-leaf species

The emergent plants found in Ban Lake and along the adjacent shoreline include bog shrubs like leather leaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*), a variety of sedges and other "reed-like" species, and a few showy flowering plants such as pickerelweed (*Pontederia cordata*), arrowhead (*Sagittaria rigida*), and water lobelia (*Lobelia dortmanna*). Emergents were restricted to depths less than five feet (Fig. 8) and within that shallow zone, seven percent of the sites contained at least one emergent.

Floating-leaf species were found in depths of six feet and less (Fig. 8). Within the depth zone from shore to five feet, 38 percent of the sample sites contained at least one floating-leaf species. Common species were Watershield (*Brasenia schreberi*), White waterlily (*Nymphaea odorata*), and floating-leaf burreed (*Sparganium angustifolium*). As a group, waterlilies (white, yellow and watershield) were found in 29 percent of the shallow water (shore to five feet) sites (Fig. 9).

Table 1. Aquatic Plants of Ban Lake, St. Louis County (69-0742-00)
August 3-4, 2004

Frequency = percent of sites in which species occurred

Life Form	Common Name	Scientific Name	Frequency	
			0 to 8.5 ft	0 to 16 ft
			120 sites	309 sites
SUBMERGED These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants may be rooted or loosely anchored to the lake bottom.	Stonewort	*Nitella sp. (v)*	37	14
	Small pondweed	*Potamogeton pusillus**(v)*	23	9
	Wild celery	*Vallisneria americana (v)*	12	5
	Quillwort	*Isoetes sp. (v)*	10	4
	Greater bladderwort	*Utricularia vulgaris (v)*	9	4
	Humped bladderwort	*Utricularia gibba (v)*	9	4
	Farwell's watermilfoil	*Myriophyllum farwellii (v)*	8	3
	Water bulrush	*Scirpus subterminalis*	4	2
	Hornwort	*Ceratophyllum echinatum (v)*	4	2
	Bushy pondweed	*Najas flexilis (v)*	3	1
	Ribbon-leaf pondweed	*Potamogeton epihydrus*	3	1
	Flat-leaved bladderwort	*Utricularia intermedia (v)*	2	1
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface. Many have colorful flowers that extend above the water	Floating-leaf burreed	*Sparganium angustifolium (v)*	8	3
	White waterlily	*Nymphaea odorata (v)*	8	3
	Watershield	*Brasenia schreberi (v)*	8	3
	Floating-leaf pondweed	*Potamogeton natans (v)*	2	1
	Yellow waterlily	*Nuphar variegata (v)*	2	1
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Wild Rice	*Zizania palustris*	2	1
	Stiff Arrowhead	*Sagittaria rigida*** (v)*	1	<1
	Spikerush	*Eloecharis sp. (v)*	1	<1
	Swamp horsetail	*Equisetum fluviatile (v)*	1	<1
	Water lobelia	*Lobelia dortmana*	present*	
	Three-way sedge	*Dulichium arundinaceum (v)*	present	
	Blue flag iris	*Iris versicolor*	present	
	Pickerelweed	*Pontederia cordata*	present	
WETLAND EMERGENTS These plants grow along shore in wet soils and may extend into the lake	Sedge	*Carex sp. (v)*	present present	
	Leather leaf	*Chamaedaphne calyculata*	present	
	Sweet gale	*Myrica gale (v)*	present	
	Pitcher plant	*Sarracenia purpurea*	present	

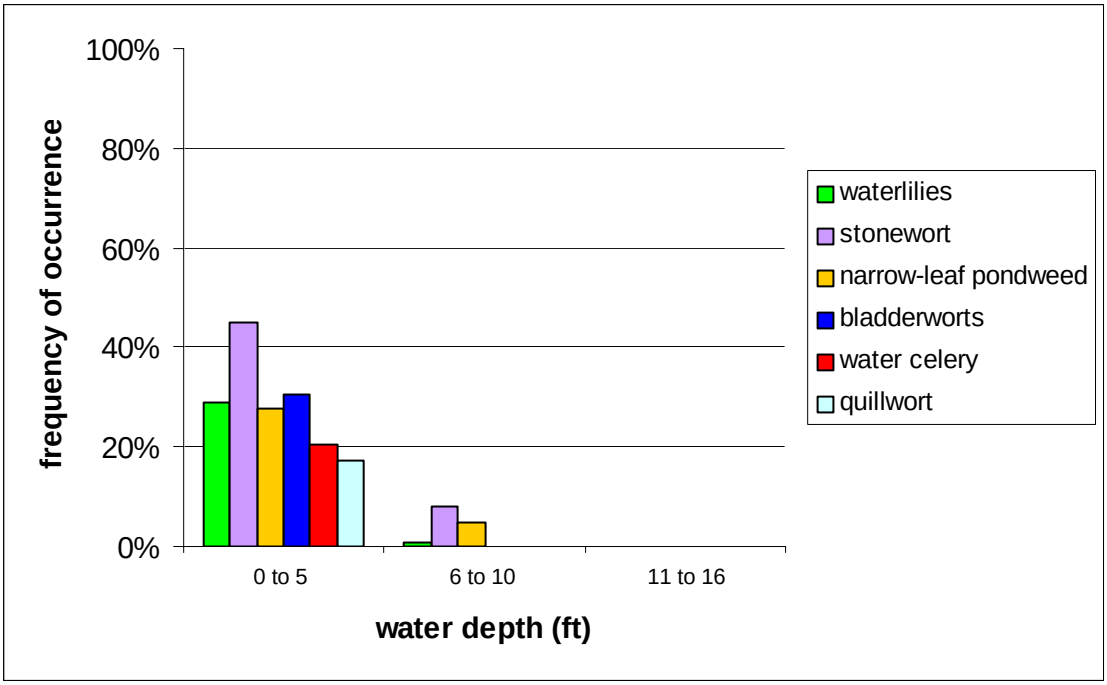
* present indicates plant was found during survey but did not occur within a specific sample site.

** *Potamogeton pusillus* (small pondweed) was identified but it is not known whether all "narrow-leaf" pondweed species occurred in the lake. Therefore, the general group "narrow-leaf pondweed" (*Potamogeton* sp.) was entered in the database.

*** *Sagittaria rigida* (stiff arrowhead) was identified but it is not known whether all arrowhead species observed in the lake were this species. Therefore, the general group "arrowhead species" (*Sagittaria* sp.) was entered in the database.

V = voucher specimen collected

Figure 9. Frequency of common aquatic plants vs. water depth.
Ban Lake, St. Louis County (69072199), August 3-4, 2004.



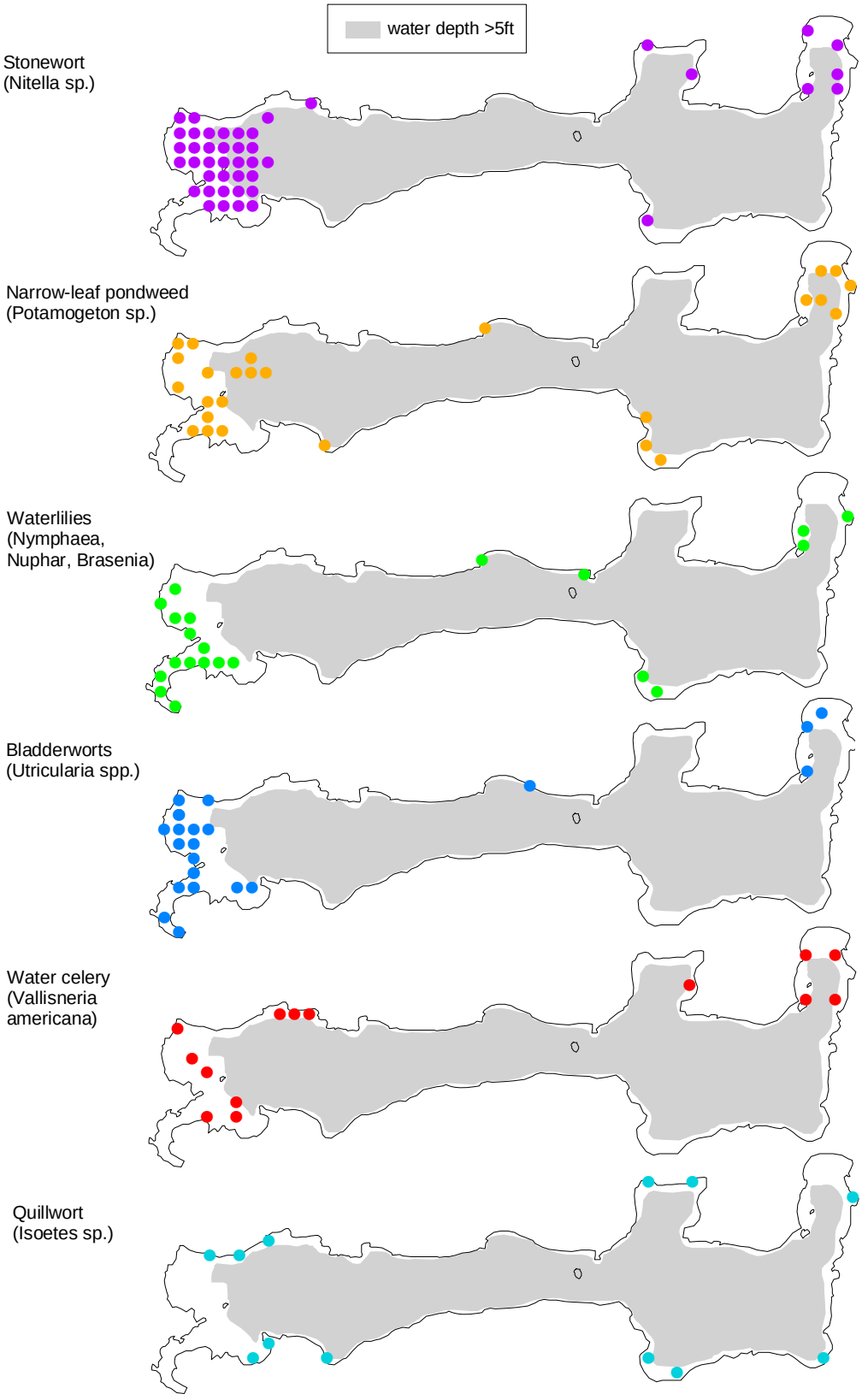
Submerged species

Submerged plants were the most common type found within the sample sites but occurred in only 25 percent of all sites. They were found from shore to 8.5 feet, but were most frequent in the shore to five feet depth zone where 81 percent of the sites contained at least one submerged species. In depths greater than five feet, only five species were found and their frequencies of occurrence were less than 10 percent (Fig. 9). Most submerged species were concentrated in the western end of the lake and the shallow bays at the east end (Fig. 10).

Stonewort (*Nitella* sp.) was the most frequently occurring species in Ban Lake and within the vegetated zone (shore to 8.5 feet) it was found in 37 percent of the sites (Table 1). Stonewort is a large algae that resembles higher plant species but does not form true roots, stems or leaves. It is primarily found in lakes of northeast Minnesota, including St. Louis County lakes. It is often found on soft sediments in deeper zone of lakes (Borman et al.1997). In Ban Lake, it did occur to a depth of 7.5 feet but was most common in shallower depths (Fig. 9).

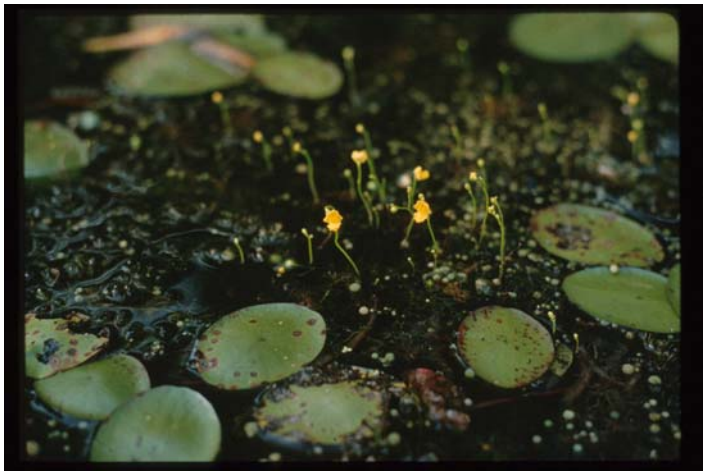
Narrow-leaf pondweed (*Potamogeton pusillus*) was the second most frequent species and was found in 23 percent of the sites within the vegetated zone (Table 1). It was found to a maximum depth of eight feet but reached its maximum frequency in depths less than six feet (Fig. 9). This species is widespread in Minnesota (Ownbey and Morley 1991) and is tolerant of lower light levels (Nichols 1999).

Figure 10. Distribution of common aquatic plant species in Ban Lake (69-0742-00), Aug 2-3, 2004.



Several bladderwort species were found in Ban Lake. Bladderworts are named for the tiny air sacs or bladders that allow them to float near the water surface and also act to trap insects which are digested by the plants. Bladderworts are submerged species that produce showy flowers that emerge above the water (Fig. 11). They prefer soft substrates (Nichols 1999) but also float freely in the water column and may be found in protected areas such as waterlily beds. Greater bladderwort *(Utricularia vulgaris)* is the largest bladderwort found in Ban Lake and was present in nine percent of ths sites within the vegetated zone (shore to five feet depth). Two smaller species, humped bladderwort (*Utricularia gibba*) and flat-leaved bladderwort (*U. intermedia)* were found in nine and four percent of the sites, respectively (Table1). These smaller bladderworts are often confused as algae because of their fine stems and leaves. Within the shore to five feet depth zone, 30 percent of the sites contained at least one bladderwort species (Fig. 9).

Fig. 11. Bladderwort flowers among the floating leaves of watershield.



Water celery (*Vallisneria americana*) is a rooted submerged species and within the shore to 8.5 feet depth zone it occurred in 12 percent of the sites (Table 1). This species is widespread in Minnesota lakes and its tubers provide an important source of food for waterfowl. In Ban Lake, water celery grew to a depth of five feet (Fig. 9).

Quillwort (*Isoetes* sp.) occurred in 10 percent of the sample sites within the shore to 8.5 feet depth zone and was only found in depths less than five feet (Fig. 9). This species is primarily found in softwater lakes (Nichols 1999) of northeastern Minnesota (Ownbey and Morley 1991). These plants are not flowering plants and are named for their leaf-like structures that resemble "quills". Quillworts are among a specialized group of aquatic plants that are compact, slow-growing and ever-green and capable of surviving in low nutrient habitats (Madsen 1991).

All other species were found in less than 10 percent of the sites within the vegetated zone and they were restricted to depths less than six feet. Some of the other unique species found include Farwell's milfoil (*Myriophyllum farwellii*), hornwort (*Ceratophyllum echinatum*), water lobelia (*Lobelia dortmana*), water bulrush *(Scirpus subterminalis),* and ribbon pondweed *(Potamogeton epihydrus).* These species are uncommon in Minnesota and are generally restricted to soft-water lakes of northeastern Minnesota.

Recently, researchers analyzed lake vegetation survey data from over 2000 lakes in Minnesota and found that the aquatic plant community of Ban Lake was very unique, with only one other lake in the state (White Oak Lake in Cass County) having a similar plant composition (Reschke 2005). The distinct composition of plant species may be limited to boggy wetlands or low

alkalinity ponds. They concluded that there may be other lakes of this type but because some of the characteristic plant species are difficult to identify in the field, and because their analysis was based on frequently occurring species, those lakes may have been grouped differently.

Monitoring changes in aquatic plant community

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity and water chemistry. 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 from the 2004 vegetation survey can also be used to monitor annual changes in the native and non-native plant species composition.

The unique aquatic plant community of Ban Lake is largely influenced by the water chemistry of the lake. Increased turbidity and/or other changes in water chemistry could lead to a shift in the plant community. Low water clarity is natural in Ban Lake but further reductions in clarity by human impacts could be detrimental to the current plant community.

Other factors that influence aquatic plant communities include annual changes in water temperatures and/or snow and ice cover that may lead to longer or shorter growing seasons, natural fluctuations in plant species, and herbivores and aquatic plant management activities.

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