Aquatic Vegetation of Blueberry Lake
Wadena County, Minnesota
(DOW 80-0034-00)

June 15-16, 2005

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Summary

Blueberry Lake is a shallow lake located south of Park Rapids, in Wadena County, Minnesota. Vegetation surveys were conducted in June 2005 to assess the aquatic plant community and provide quantitative estimates of the frequency at which the common submerged plant species occur.

A total of 23 native aquatic plant species were recorded in Blueberry Lake, including three emergent, two floating-leaved, three free-floating and 15 submerged species. However, the submerged plant community is dominated by the non-native species, curly-leaf pondweed (*Potamogeton crispus*). Vegetation occurred in 59 percent of the sample sites in Blueberry Lake but native species were found in only 25 percent of the sites.

Curly-leaf pondweed occurred in 43 percent of the sample sites. It was most abundant in depths of four to nine feet where it occurred in 72 percent of the sample sites. It occurred throughout the lake to the maximum depth of 15 feet and was the only species found in depths greater than nine feet. Curly-leaf pondweed formed surface mats over approximately 25 percent of the lake.

Narrow-leaf pondweed (*Potamogeton freisii*) was the most common native submerged plant and was found in 17 percent of the sample sites to a maximum depth of nine feet. Yellow waterlily (*Nuphar variegata*) occurred in seven percent of the sites and was primarily found in shallow water of the north bay. All other native species were present in less than five percent of the sample sites and were restricted to water depths less than six feet.

Introduction

Blueberry Lake (DOW 29-0250-00) is located about nine miles south of Park Rapids in Wadena County, Minnesota within the ecological region called the Laurentian Mixed Forest Province (Fig. 1).

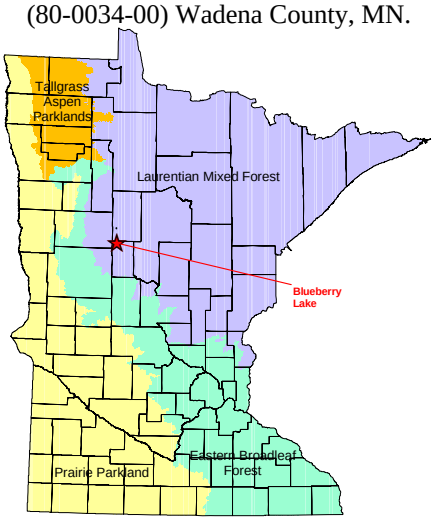


Figure 1. Location of Blueberry Lake (80-0034-00) Wadena County, MN.

The lake lays at the northern edge of the Crow Wing River Watershed. The Blueberry River and the Shell River enter the lake on the southwest end. The outlet of Blueberry Lake is the Shell River that flows through Upper and Lower Twin Lakes and then east to the Crow Wing River (Fig. 2).

Much of the uplands near Blueberry Lake remain forested but large areas have been converted to

Figure 2: Location of Blueberry Lake within Crow Wing River Watershed.

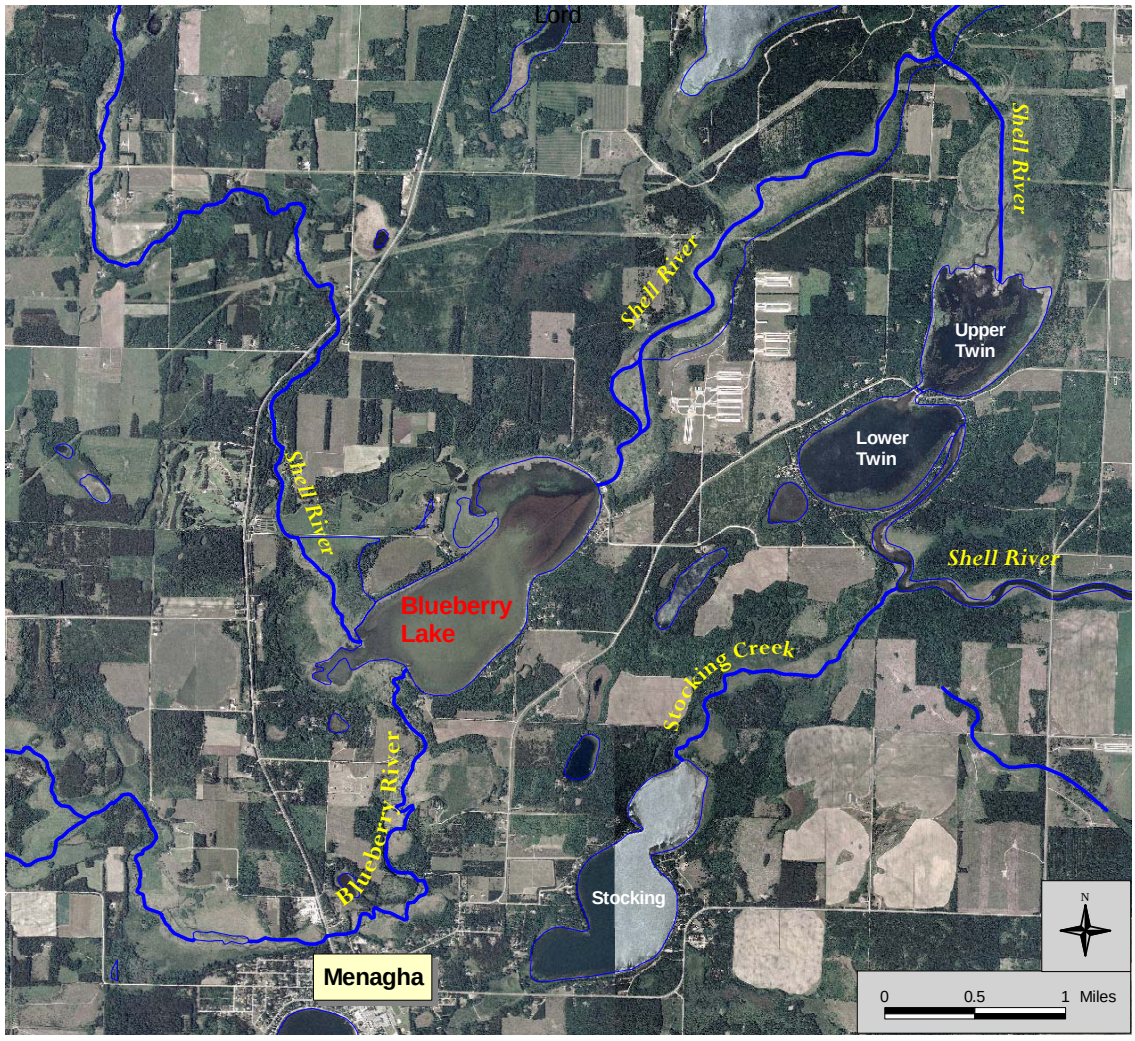
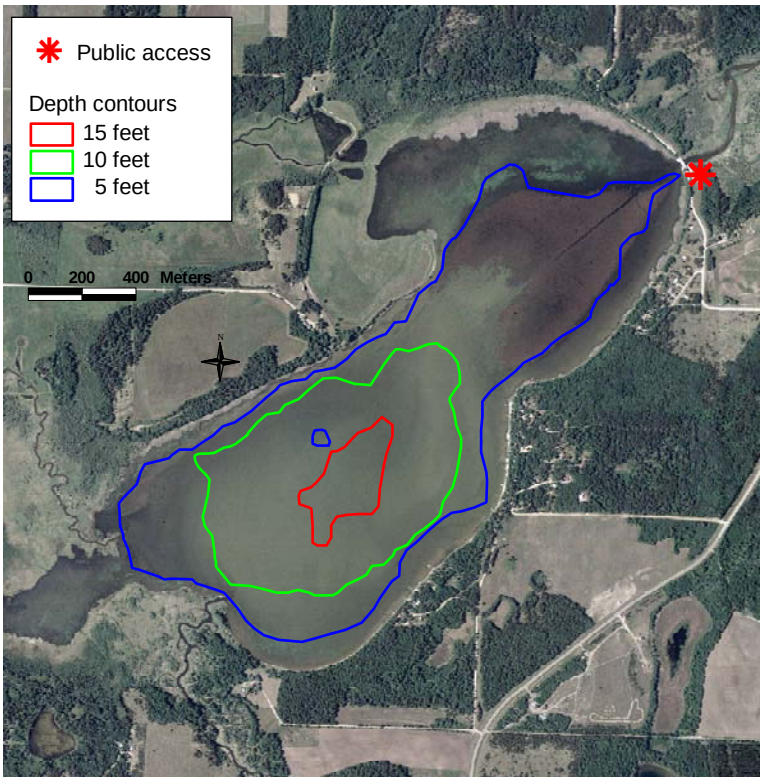


Figure 3. Depth contours of Blueberry Lake (80-0034-00) based on 2005 survey. Aerial photograph source: Farm Service Agency, 2003.



agriculture (Fig. 2). Residential homes are primarily located on the southeast half of the lake and a public boat launch is located on the northeast side of the lake, at the outlet channel to the Shell River (Fig. 3).

Blueberry is a shallow lake with a surface area of about 522 acres and a maximum depth of 15.0 feet (Fig. 3). Water quality data are limited but clarity can be low as indicated by a mean summer Secchi depth of 3.6 feet between 1995 and 1997 (MPCA 2005). Heavy algae blooms are common during summer months and a high carp population in the lake also stirs up bottom sediments (MnDNR 2005).

Previous vegetation surveys of Blueberry Lake were conducted in 1963, 1975, 1987 and 1992 (MnDNR Lake Files). Historically, wild rice (*Zizania aquatica*), and hard-stem bulrush (*Scirpus acutus*) were the common emergent plants and yellow waterlily (*Nuphar variegata*) and white waterlily (*Nymphaea odorata*) were also present near shore. Submerged vegetation was recorded to seven to 10 feet and native species included Canada waterweed (*Elodea canadensis*), muskgrass (*Chara* sp.)., native pondweeds (*Potamogeton* spp.), and coontail (*Ceratophyllum demersum*). In 1963, surveyors reported difficulty mapping submerged vegetation due to high turbidity. Subsequent surveys also reported mid-summer algal blooms in the lake.

Blueberry Lake is one of several lakes in this watershed where the non-native plant, curly-leaf pondweed (*Potamogeton crispus*) has invaded. Curly-leaf pondweed was not recorded in any previous survey, but MnDNR Fisheries staff report that it has been in the lake for at least the past three years.

Vegetation Survey Objectives

The purpose of vegetation survey of Blueberry Lake was 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 distribution maps for the common species

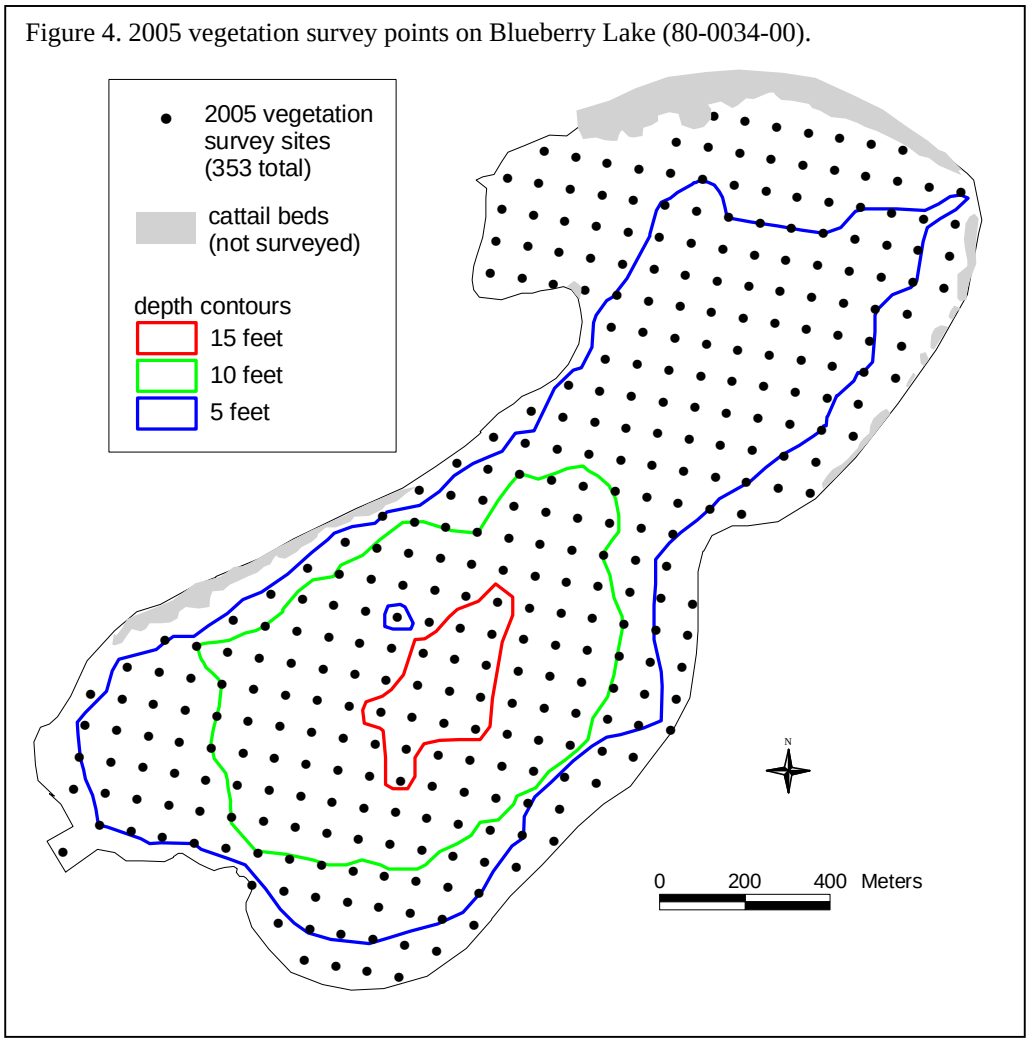
Methods

Aquatic Vegetation Survey Methods

A Point-Intercept vegetation survey of Blueberry Lake was conducted on June 15 and 16, 2005 following the methodology described by Madsen (1999). Sample points were established using a GIS software program using a 75 meter by 75 meter grid across the lake surface (Fig. 4). The cattail marsh at the far north edge of the lake and the shallow bay at the southwest end were not included in the survey. A total of 353 sites were sampled.

Survey waypoints were created and downloaded into a Global Positioning System (GPS) receiver. 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 eight feet and an electronic depth finder in water depths greater than eight feet. The surveyors recorded all plant species found within a one meter squared sample site at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Fig. 5). If curly-leaf pondweed was present at a site, surveyors recorded whether or not it formed surface mats at that site.

Figure 4. 2005 vegetation survey points on Blueberry Lake (80-0034-00).



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

Figure 5. Rake used to sample vegetation

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which a species occurred divided by the total number of sample sites.

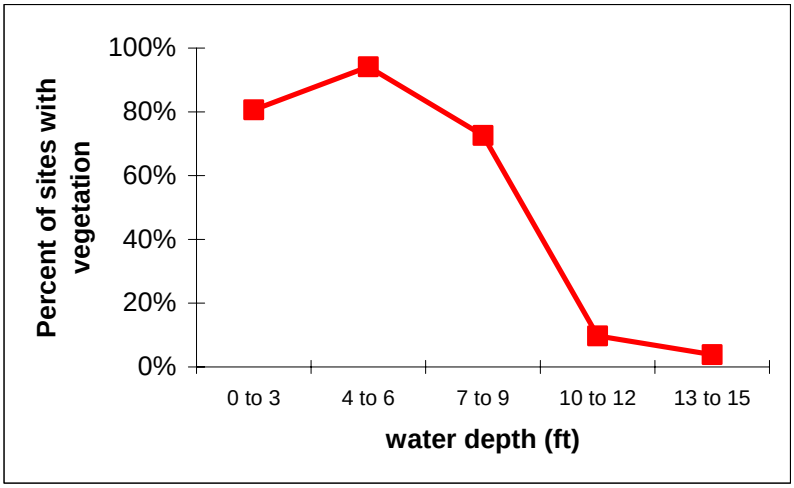
Example:
There were 353 samples sites.
In 2005, yellow waterlily occurred in 24 of those sample sites.
Frequency of yellow waterlily in 2005 = 24/353 (*100) = 7%

Frequency was calculated for the entire vegetated lake and sampling points were also grouped by water depth and separated into five depth zones for analysis: 0 to 3 feet, and 4 to 6 feet, 7 to 9 feet, 10 to 12 feet, 13 to 15 feet.

Results / Discussion

Maximum depth of vegetation and percent of lake with vegetation
In Blueberry Lake, 59 percent of the sample sites contained vegetation. Plants were found to a maximum depth of 15 feet but plants were most abundant in water depths of less than ten feet (Fig. 7). The four feet to six feet depth zone contained the most vegetation with plants occurring in 94 percent of the sites at this depth range. In depths greater than nine feet, only seven percent of sites contained plants.

Figure 6. Frequency of vegetation vs. water depth, Blueberry Lake (80-0034-00), June 15-16, 2005



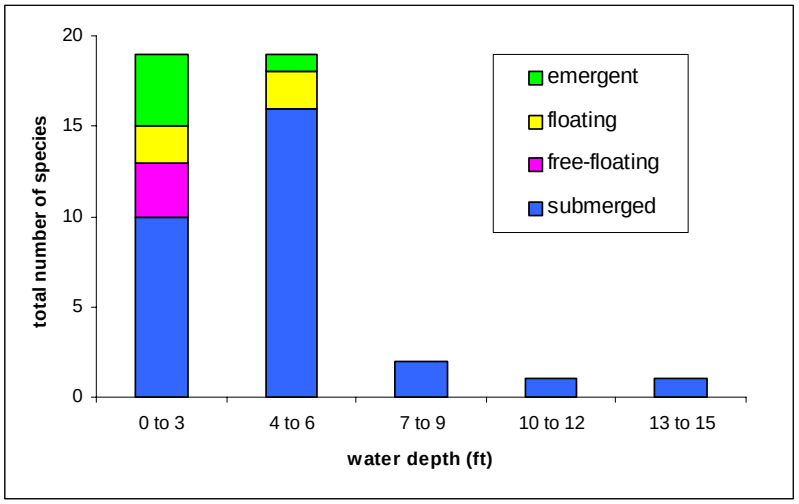
Number of species recorded

A total of 23 native aquatic plant species were recorded in Blueberry Lake, including three emergent, two floating-leaved, three free-floating and 15 submerged species (Table 1). Curly-leaf pondweed (*Potamogeton crispus*), a non-native, submerged aquatic plant species was documented in the lake.

Distribution of species by water depth

The highest number of plant species was found in the zone from shore to a depth of six feet (Fig. 7). Free-floating species were only found from shore to a depth of three feet and emergent and floating-leaved plants were not found beyond the five feet depth. Submerged species occurred at all water depths with the majority of species found in depths of four to six feet. Only four submerged species were found in depths greater than six feet and only one species, curly-leaf pondweed, occurred in depths greater than nine feet (Fig. 7).

Figure 7. Total number of species found at each depth zone. Blueberry Lake (80-0034-00). June 15-16, 2005



Emergent and Floating-leaf plants

Within the depth zone from shore to six feet, 20 percent of the surveyed sites contained at least one floating or emergent plant. Cattails (*Typha* sp.) were common along the north and northwest shores (Fig. 8) and bulrush (*Scirpus acutus*) and wild rice (*Zizania aquatica*) were present but not common. Waterlilies were concentrated in the northern end of the lake (Fig. 8) and Yellow waterlily (*Nuphar variegata*) was the most frequently occurring floating-leaf species, occurring in 14 percent of the sites from shore to six feet. White waterlily (*Nymphaea odorata*) was also present but occurred in only two percent of the shallow water sites.

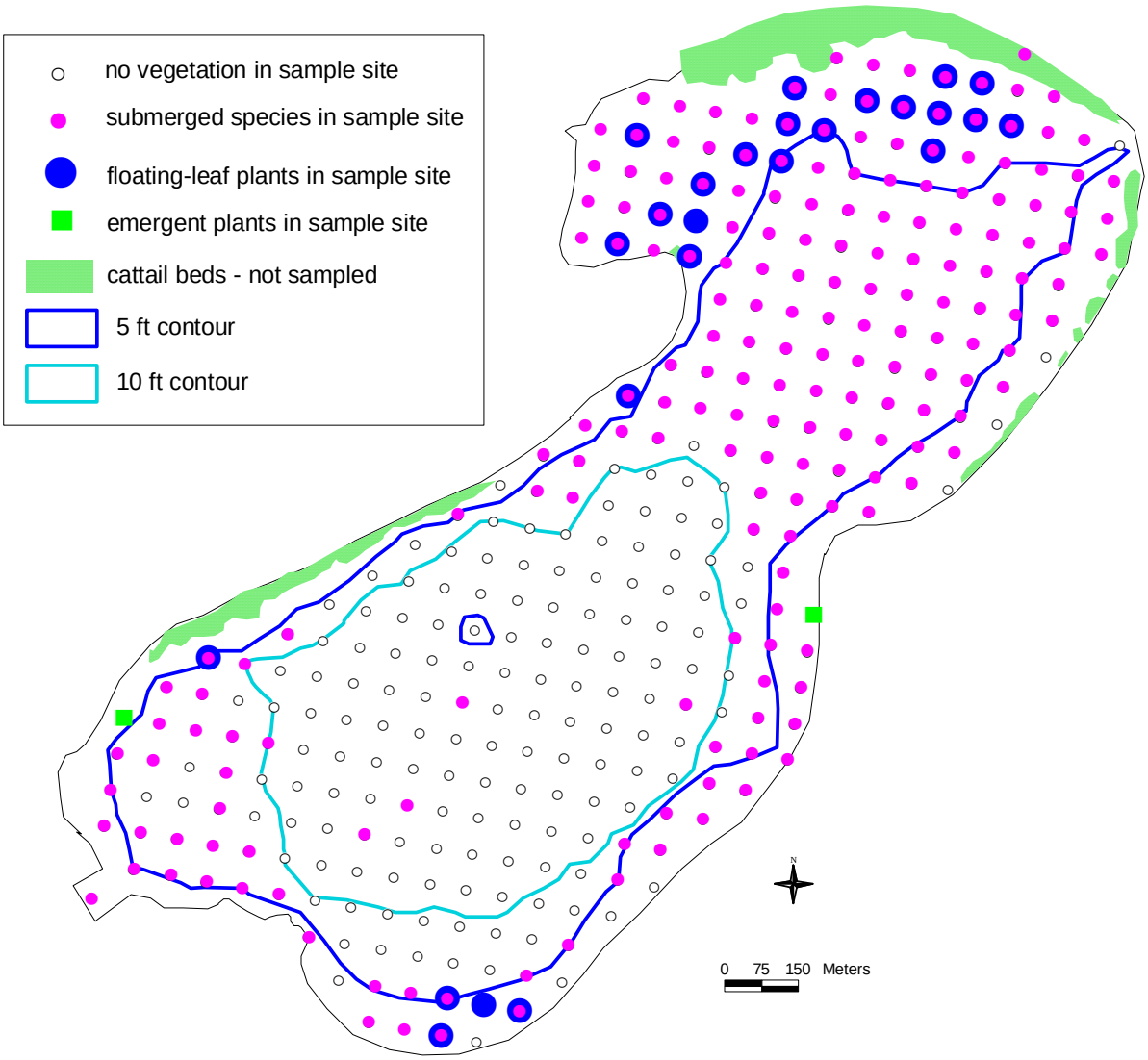
Table 1. Aquatic Plants of Blueberry Lake, Wadena County (80-0034-00)
June 15-16, 2005

Frequency calculated for entire lake (shore to 15 feet depth)
Frequency = percent of sites in which species occurred
353 sample sites

Life Form	Common Name	Scientific Name	Frequency
SUBMERGED-ANCHORED These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are often rooted or anchored to the lake bottom.	Curly-leaf pondweed	*Potamogeton crispus (v)*	43
	Fries pondweed	*Potamogeton freisii**	17
	Muskgrass	*Chara sp. (v)*	6
	White water buttercup	*Ranunculus longirostris (v)*	4
	Canada waterweed	*Elodea canadensis (v)*	3
	Coontail	*Ceratophyllum demersum (v)*	2
	Sago pondweed	*Stuckenia pectinata (v)*	2
	Flat-stem pondweed	*Potamogeton zosteriformis (v)*	1
	Marestail	*Hippuris vulgaris (v)*	1
	Bushy pondweed	*Najas flexilis*	1
	Large-leaf pondweed	*Potamogeton amplifolius (v)*	< 1
	Northern watermilfoil	*Myriophyllum sp. (v)*	< 1
	Wild celery	*Vallisneria americana*	< 1
	Clasping-leaf pondweed	*Potamogeton richardsonii (v)*	Present*
	Illinois pondweed	*Potamogeton illinoensis (v)*	present
	American brooklime	*Veronica americana (v)*	present
FREE-FLOATING These plants float on the water and drift with water currents.	Water liverwort	*Riccia fluitans (v)*	present
	Greater duckweed	*Spirodela polyrhiza*	Present
	Lesser duckweed	*Lemna minor*	Present
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	Yellow waterlily	*Nuphar variegata (v)*	7
	White waterlily	*Nymphaea odorata*	1
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Hardstem bulrush	*Scirpus acutus (v)*	1
	Wild Rice	*Zizania palustris*	Present
	Cattail	*Typha sp.*	present

* Potamogeton freisii was confirmed in the lake but other narrow-leaf pondweeds (*Potamogeton* spp.) may also have been present. All narrow-leaf pondweeds were grouped together for analysis.
**present indicates plant was found during survey but did not occur within a specific sample site.
V = voucher specimen collected
Highlite = non-native species

Figure 8. Distribution of emergent, floating and submerged species in Blueberry Lake (80-0034-00) June 15-16, 2005.



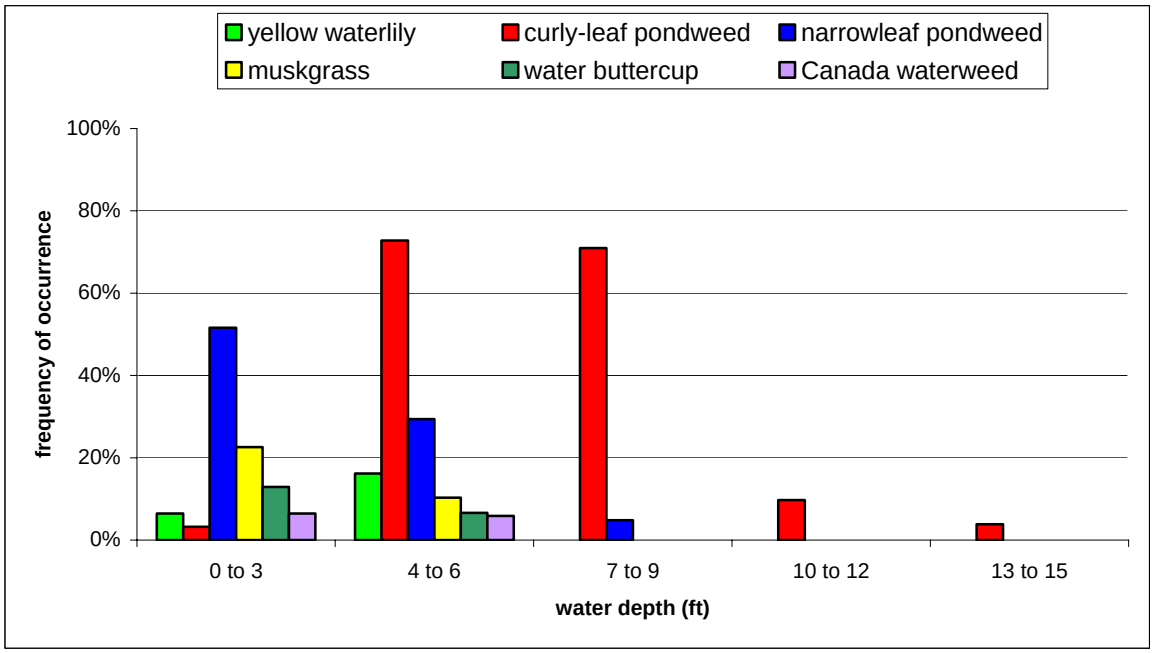
Submerged and free-floating plant species

Submerged species were present in 58 percent of the sample sites (Fig. 8) and free-floating species were not located within sample sites. Although 19 different submerged and free-floating species were found in Blueberry Lake, only a few species were commonly occurring.

Curly-leaf pondweed (*Potamogeton crispus*) dominated the submerged plant community of Blueberry Lake and was found in 43 percent of the sample sites (Table 1). It occurred at all water depths and was the only species found in depths greater than nine feet (Fig. 9). It was most abundant in depths of four to nine feet where it occurred in 72 percent of the sample sites.

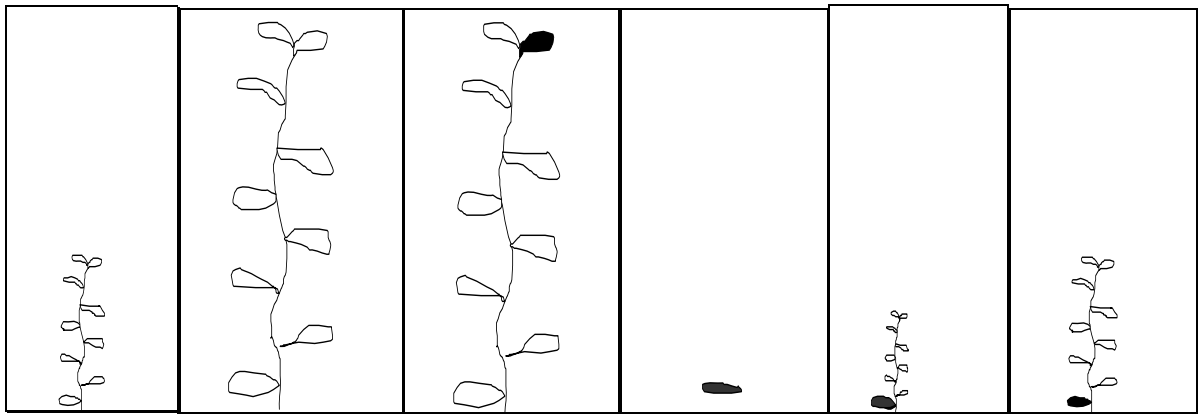
Curly-leaf pondweed is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in at least 700 Minnesota lakes

Figure 9. Frequency of common species vs. water depth. Blueberry Lake (80-0034-00) June 15-16, 2005.



(Invasive Species Program 2005). Like many native submerged plants, it is perennial but it has a unique life cycle that may provide a competitive advantage over native species. Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall (Fig. 10). 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.

Figure 10. Life cycle of Curly-leaf pondweed (*Potamogeton crispus*).



Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson, 1985).

During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats (Fig. 11). During the spring of 2005 in Blueberry Lake, curly-leaf formed surface mats in 28 percent of the sample sites (Fig 12). Surface mats occurred in depths from four to nine feet and covered an estimated 25 percent of the lake.

Figure 11. Surface mats of curly-leaf pondweed in Blueberry Lake (80-0034-00) June 15-16, 2005.

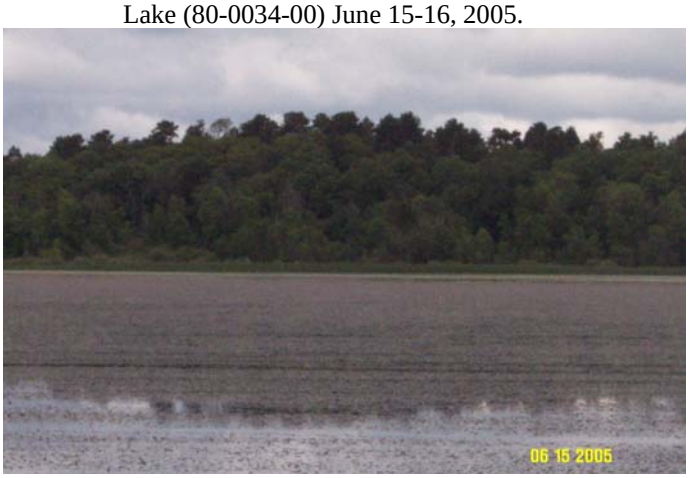
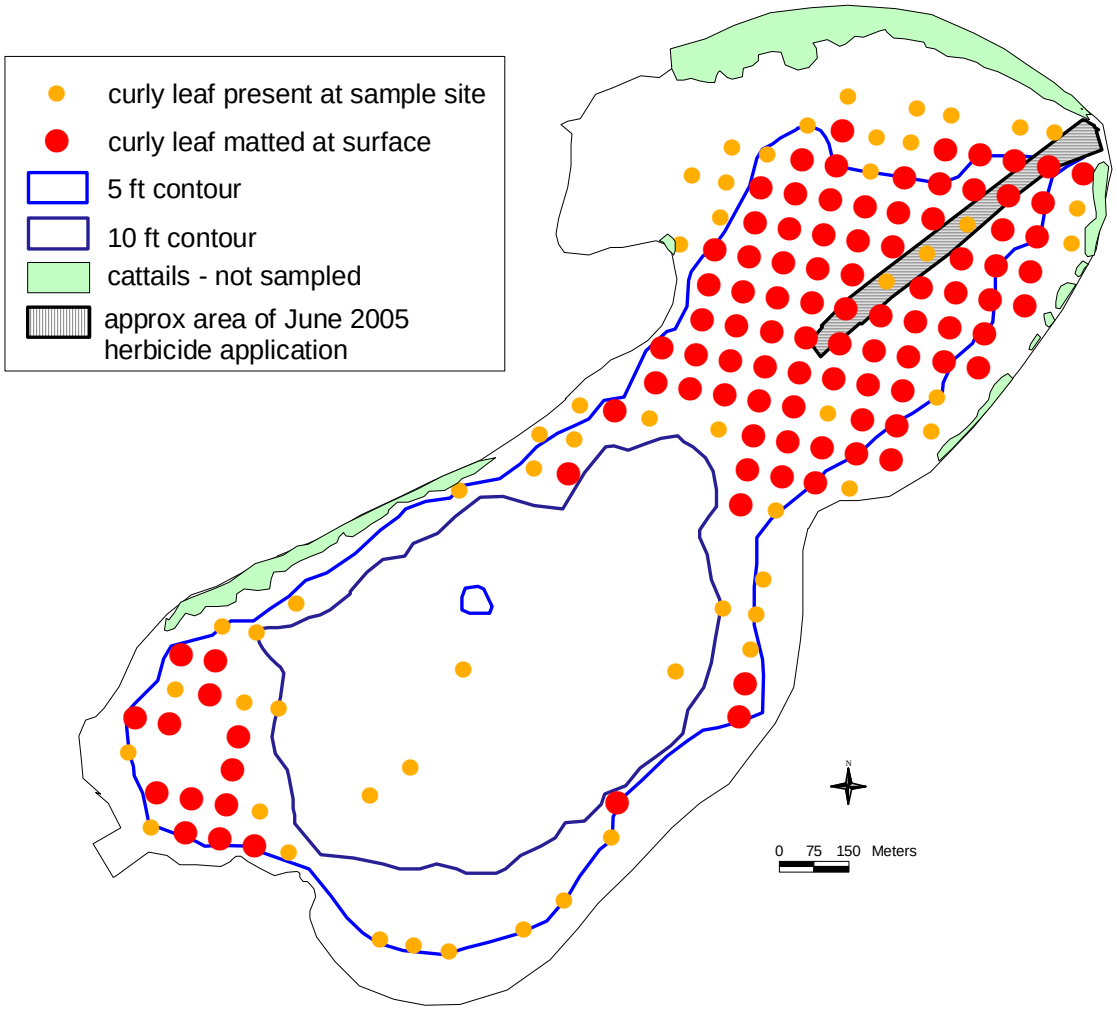


Figure 12. Distribution of curly-leaf pondweed (*Potamogeton crispus*) including sample sites where surface mats occurred in Blueberry Lake (80-0034-00) June 15-16, 2005.



Curly-leaf was absent or sparse in the waterlily beds of the north shore, along the southeast shore, and in water depths greater than nine feet (Fig. 12).

In June, 2005, approximately 10 acres of Blueberry Lake was treated with herbicide to control curly-leaf pondweed (Fig. 12). This application was conducted under a permit from the MnDNR. During the June 15-16 vegetation survey, curly-leaf pondweed within the treatment area appeared less dense than areas outside the treatment. The treatment area, however, was located along the outlet flowage channel of the Shell River, which historically appears to remain free of matted vegetation as seen in the 2003 aerial photo of Blueberry Lake (Fig. 3). It is difficult, therefore, to determine whether the lack of matted curly leaf in this area was due to the herbicide application, boat traffic, flow of the Shell River through the lake, or a combination of these factors.

Native submerged species occurred in only 25 percent of the sample sites.

Narrow-leaf pondweeds (*Potamogeton* spp.) were the most common group of native submerged species found in Blueberry Lake. There are several species of narrow-leaf pondweeds and they can be difficult to identify if not found in flower or fruit. Freis pondweed (*Potamogeton freisii*) 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. Narrow-leaf pondweeds are rooted, perennial submerged plants with flowers that extend above the water surface. Narrow-leaf pondweeds were present in 17 percent of the sample sites (Table 1) and were found in depths from three to nine feet. This group was most abundant in the shallowest water zone where it occurred in 52 percent of the sample sites (Fig. 9). Narrow-leaf pondweeds were primarily found in the north end of the lake and along the southeast shore (Fig. 13.)

Muskgrass (*Chara* sp.) occurred in six percent of the sample sites (Table 1). Muskgrass is a macroscopic algae that is common in many hardwater Minnesota lakes. It is named for its characteristic musky odor. Because this species does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low “carpets” on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to invade open areas of lake bottom where it can act as a sediment stabilizer. In Blueberry Lake, muskgrass was restricted to depths from three to five feet (Fig. 9) and was found along the southeast shore and in the north end of the lake (Fig. 13). Muskgrass and curly-leaf pondweed were never found occurring within the same sample site.

White water buttercup (*Ranunculus longirostris*) was found in four percent of the sample sites (Table 1) and occurred in depths of three to four feet (Fig. 9). It was found at several locations around the lake (Fig. 13) and formed dense stands with narrow-leaf pondweed in the shallow southwest bay.

Canada waterweed (*Elodea canadensis*) was present in only three percent of the sample sites (Table 1) and was found in three to five feet of water (Fig. 9). Canada waterweed was found at a few sites at both the north and south ends of Blueberry Lake (Fig. 13).

All other submerged species were present in less than three percent of the sample sites (Table 1)

Figure 13. Distribution of common aquatic plant species in Blueberry Lake (80-0034-00) June 15-16, 2005.

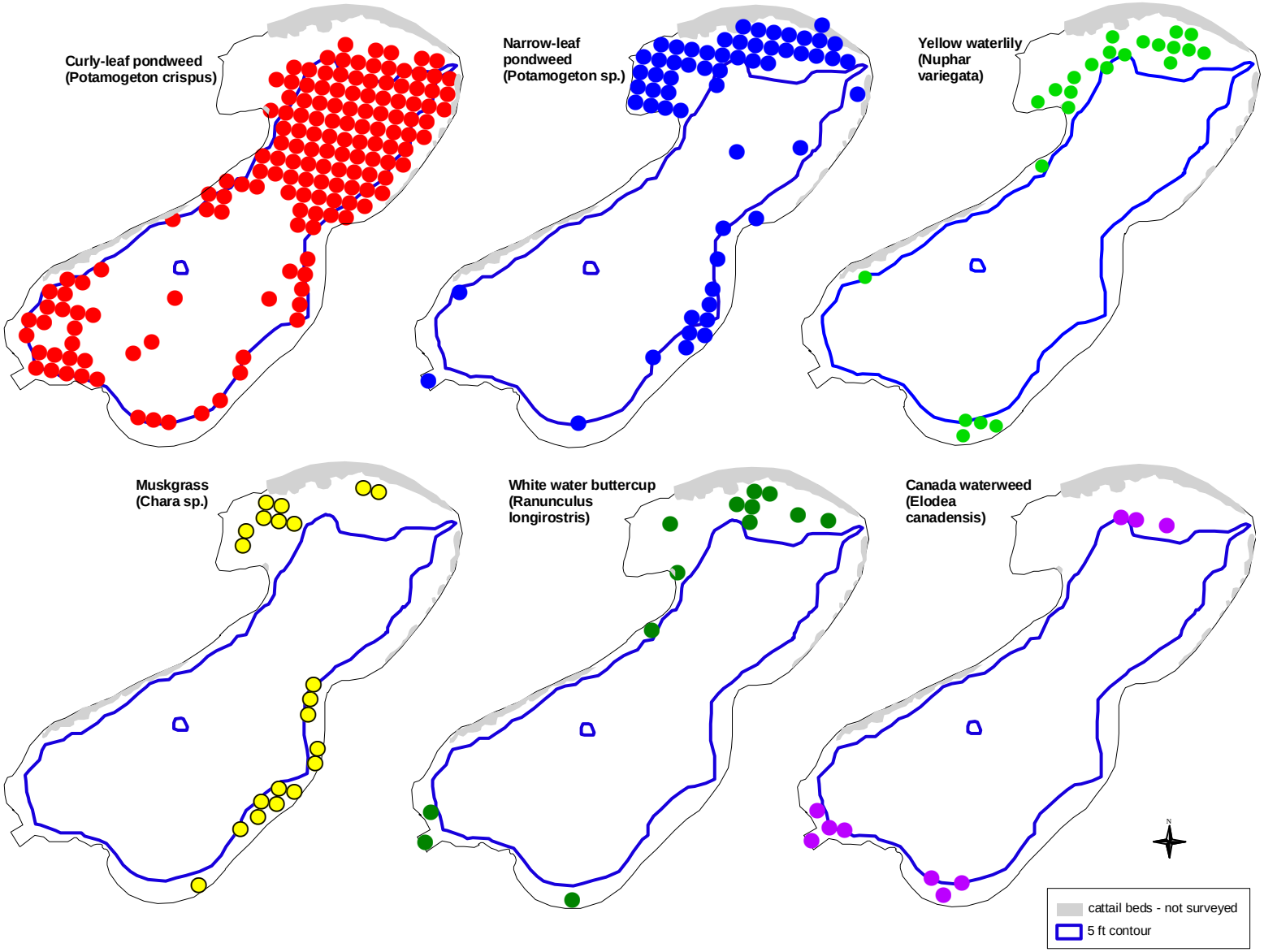
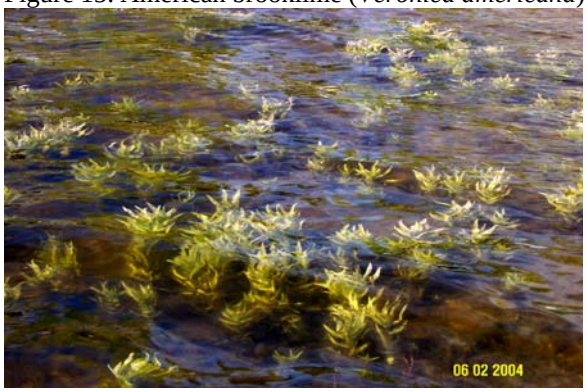


Figure 14. Marestail (*Hippuris vulgaris*) in Blueberry Lake (80-0034-00) June 15-16, 2005.

Figure 15. American brooklime (*Veronica americana*)



and were restricted to depths less six feet. Most of these species were found at the north and/or south ends of the lake.

Several unique native species were located in Blueberry Lake including marestail (*Hippuris vulgaris*) (Fig. 14) and American brooklime (*Veronica americana*) (Fig 15). Both species are often associated with cold water streams or springs and may be present in Blueberry Lake because the river flowage through the lake provides the habitat conditions required for their growth. Neither species was common in the lake.

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 2005 vegetation survey can also be used to monitor annual changes in the native and non-native plant species composition. In general, factors that may lead to change in native and non-native aquatic plant communities include:

- Change in water clarity
  If Blueberry Lake clarity increases, native submerged vegetation may be more common at depths greater than five 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.
- Natural fluctuation in plant species.
  Many submerged plants are perennial and regrow in similar locations each year. However, a few species such as wild rice (*Zizania aquatica*) and bushy pondweed (*Najas flexilis*) are annuals and are dependant on the previous years seed set for regeneration.
- Aquatic plant management activities

Herbicide and mechanical control of aquatic plants can directly impact the aquatic plant community. Monitoring these control activities can help insure that non-target species are not negatively impacted.

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