Aquatic vegetation of Little Pine and Daggett Lakes

June, 2010

ID# 18-0266-00 and 18-0271-00

Crow Wing County, Minnesota

Blue flag iris, sedges and waterlilies in southwest arm of Little Pine Lake, 2010.

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This report should be cited as:
Simon, S and D. Perleberg. 2010. Aquatic vegetation of Little Pine Lake (ID# 18-0266-00) and Daggett Lake (ID# 18-0271-00), Crow Wing County, Minnesota, 2010. Minnesota Department of Natural Resources, Division of Ecological and Water Resources, 1601 Minnesota Dr., Brainerd, MN 56401. 28 pp.

Summary

An early summer 2010 vegetation survey was conducted in the eastern-most waterbodies of the Whitefish Chain of Lakes: Little Pine Lake and Daggett Lake. The survey assessed the distribution and abundance of native aquatic plants and the non-native plant, curly-leaf pondweed (*Potamogeton crispus*). Information on vegetation and water depth was recorded at 174 sample sites in Little Pine Lake and at 140 sites in Daggett Lake.

A total of 39 native aquatic plant species were recorded in these lakes including 8 emergent, 4 floating-leaved, 3 free-floating, and 24 submerged species. A partial list of wetland plants was also recorded. A total of 99 acres of emergent and floating-leaf plant beds were mapped including extensive areas of floating bog, 31 acres of waterlilies (*Nymphaea odorata* and *Nuphar variegata*) and 14 acres of wild rice (*Zizania palustris)*.

Submerged plants were commonly found to a depth of 15 feet in both lakes and scattered submerged plants occurred to 20 feet in Daggett Lake. Within the 0-20 feet depth zone, 78% of the Little Pine Lake sites and 57% of the Daggett Lake sites contained plants. The majority of vegetated sites contained at least one native plant. Coontail (*Ceratophyllum demersum*) was the most common submerged plant and was found in at least 30% of the survey sites in each lake. Other common submerged species included flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*), star duckweed (*Lemna trisulca*), white-stem pondweed (*Potamogeton praelongus*), Canada waterweed (*Elodea canadensis*), and greater bladderwort (*Utricularia vulgaris*).

One non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was documented during the survey and occurred with a frequency of 24% in Little Pine Lake and 17% in Daggett Lake. It was present at scattered locations around the lakes and often co-occurred with native plants. The abundance of curly-leaf pondweed in these lakes in 2010 was similar to that found during a 2009 survey.

Introduction

Little Pine and Daggett lakes are located in Crow Wing County, north central Minnesota (Figure 1). These lakes are the eastern-most waterbodies in the Whitefish Chain of Lakes. This chain of 14 waterbodies was connected in 1886 when the Pine River Dam was completed and raised water levels making channels between the set of lakes. Most of the lakes are connected by the Pine River as it flows east through the chain. Daggett Brook connects Little Pine Lake and Daggett Lake to the chain as it flows south through them and into Cross Lake (Figure 2). The Pine River drains the system to the southeast and eventually meets the Mississippi River.

Figure 1. Location of Little Pine and Daggett Lakes in Crow Wing County.

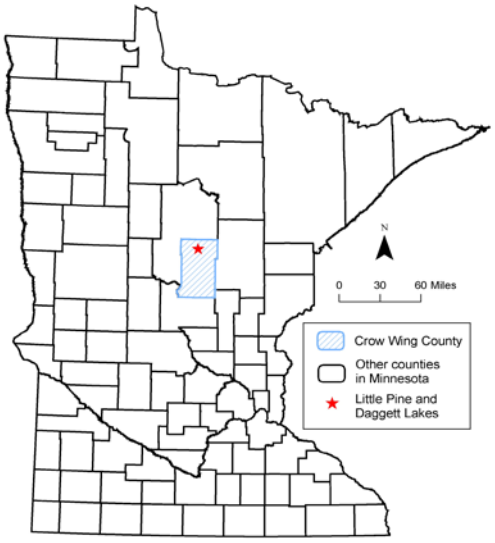
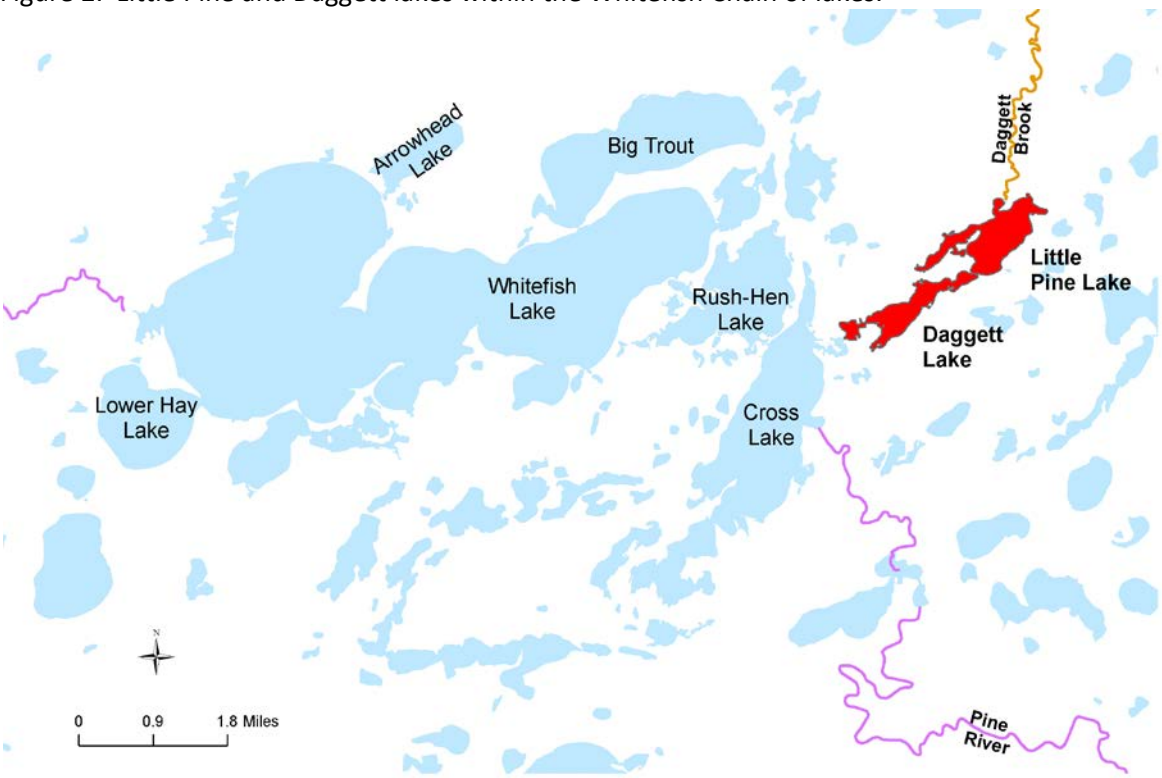


Figure 2. Little Pine and Daggett lakes within the Whitefish Chain of lakes.



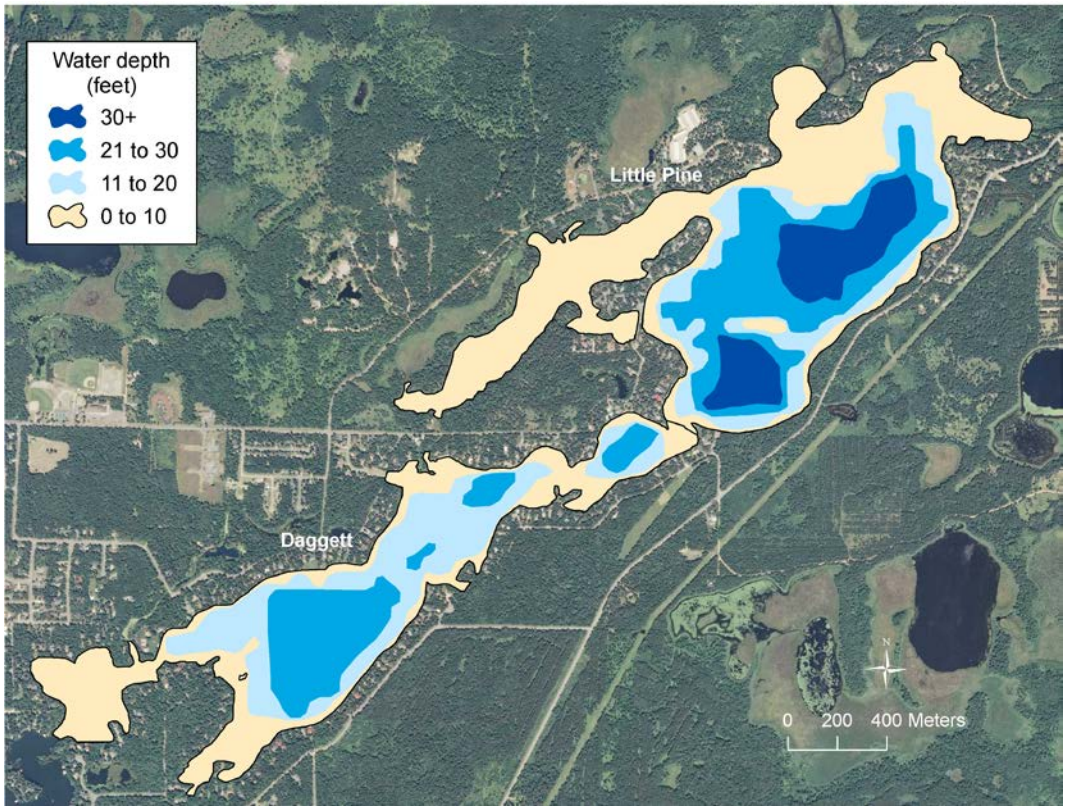
Lake Characteristics

Little Pine and Daggett lakes are narrow, elongated basins at the mouth of Daggett Brook. Together, the lakes are about three miles in length with an average width of about half of a mile. They have about 14 miles of shorelines with numerous small embayments. These lakes

are among the smallest waterbodies in the Whitefish Chain of lakes, with a combined surface area of 612 acres (Little Pine, 387 acres and Daggett, 225 acres). The majority of the shoreline of these lakes is privately owned and developed with residential homes. Public access is available by boating from the public ramp on Cross Lake.

These basins are relatively shallow lakes with maximum depths of 36 feet in Little Pine and 23 feet in Daggett (Figure 3). Fifty eight percent of both lakes are less than 15 feet in depth.

Figure 3. Little Pine and Daggett lakes depth contours (Based on 2010 data).



Both waterbodies are described as eutrophic (high nutrients). The Secchi disk 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. In 2009, mean summer (July through September) water clarity, as measured by Secchi disc readings, was 10 feet in Little Pine and Daggett Lakes (MPCA, 2010). As a general rule, sunlight can penetrate to a depth of two times the Secchi depth and aquatic plants can grow to a depth of one and half times the Secchi depth. Based on Secchi disk measurements alone, aquatic plants are expected to be restricted to depths of 15 feet and less in these lakes.

Historic aquatic plant community

Previous vegetation surveys recorded a diversity of native plants in these lakes with more than 28 types of lake plants. Bulrush (*Schoenoplectus* spp.) an important emergent plant for fish and

invertebrate habitat, was common in past surveys (DNR Fisheries lake files). Submerged plants, such as sago pondweed (*Stuckenia pectinata*), coontail (*Ceratophyllum demersum*) and northern watermilfoil (*Myriophyllum sibiricum*), were commonly found to a depth of 10 feet in Little Pine and Daggett lakes.

The non-native plant, curly-leaf pondweed (*Potamogeton crispus*), has been present in these lakes since at least the 1990's (DNR Fisheries lake files). A Spring 2009 plant survey was conducted to assess the distribution and abundance of curly-leaf pondweed. It was found at scattered locations in both lakes and occurred with a frequency of 21% in Little Pine Lake and 15% in Daggett Lake (Loso and Perleberg 2009). Information on native plants was also collected in 2009 but was incomplete because many native plants do not reach peak growth until mid to late summer.

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2010 plant population of Little Pine and Daggett Lakes. Specific objectives included:

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

Methods

Mapping floating-leaf and emergent vegetation beds

Beds of floating-leaf and emergent plants occur in near-shore areas of Little Pine and Daggett lakes. Waterlilies and cattails were mapped using 2008 Farm Service Administrative (FSA) true color aerial photographs. Field surveys were conducted in September 2010 to verify photo-interpretations and to map bulrush beds that are difficult to detect on aerial photos. Surveyors mapped bulrush beds by motoring around the perimeter of each bed and recording their track with a handheld Global Positioning System (GPS). Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage.

Lakewide vegetation survey

Lakewide vegetation surveys of both lakes were conducted using a point-intercept survey method (Madsen 1999, MnDNR 2008). Survey waypoints were created using a GIS computer program and downloaded into a handheld GPS. 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 20 feet or less. To minimize damage to vegetation, surveyors did not survey sites if they occurred in dense beds of emergent or floating-leaf plants. Surveyors sampled a total of 174 sites in Little Pine Lake and 143 sites in Daggett Lake (Table 1, Figure 4).

Figure 4. 2010 vegetation survey sites on Little Pine and Daggett Lakes.

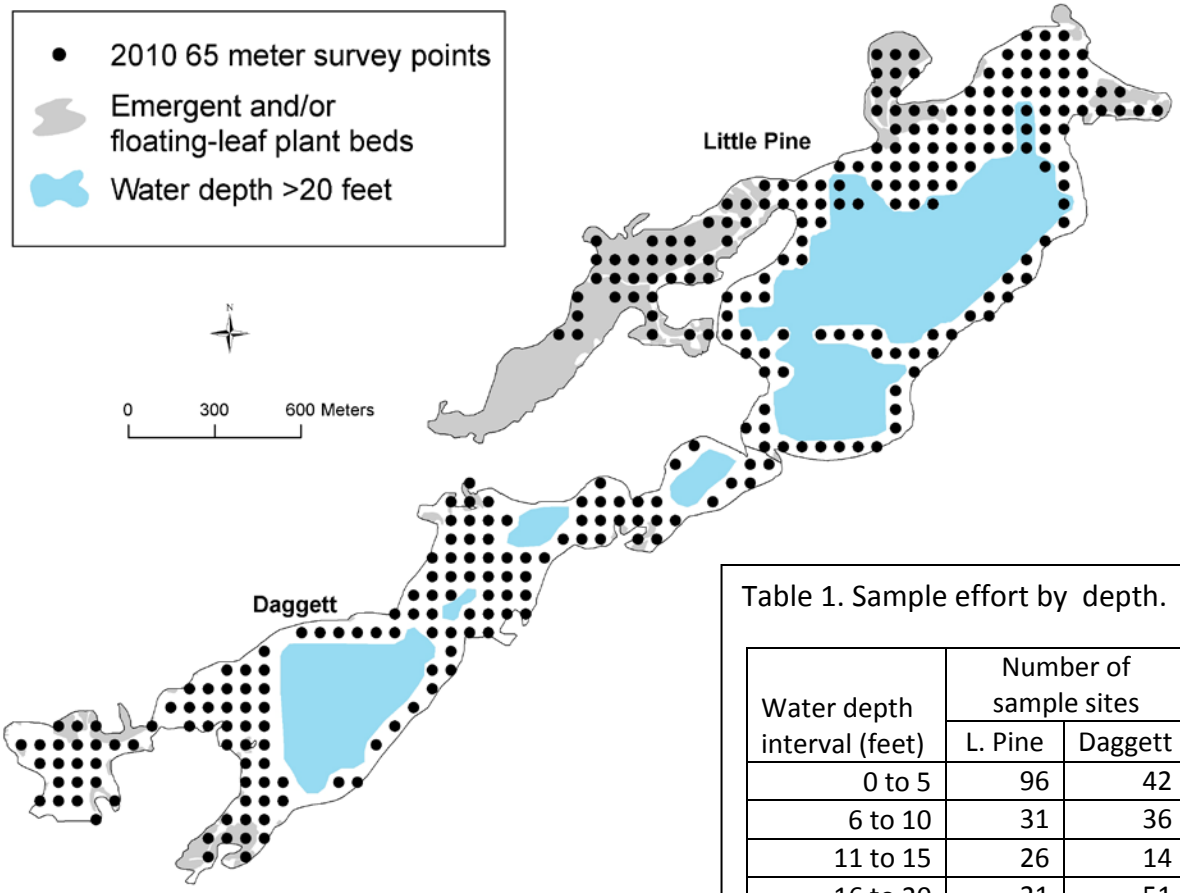


Table 1. Sample effort by depth.

Water depth interval (feet)	Number of sample sites	
	L. Pine	Daggett
0 to 5	96	42
6 to 10	31	36
11 to 15	26	14
16 to 20	21	51
Total (0 to 20)	174	143
21 to 25	9	n/a
total	183	143

Little Pine Lake was surveyed on June 2 and 3, 2010 and Daggett Lake was surveyed on June 14, 2010. The surveys were conducted by boat and a GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments using a measured stick in water depths less than 7 feet and an electronic depth finder in deeper water.

Surveyors recorded all plant taxa found within a one square meter sample site at the pre- designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the water surface (Figure 5). 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 Hellquist and Crow (2000) and Flora of North America (1993+) and nomenclature followed MnTaxa (2010).

Figure 5. Sample rake.

At each sample site where water depth was seven feet or 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 sites 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.

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

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which the species occurred divided by the total number of sample sites. Frequency was calculated for the entire area from shore to 20 feet and sampling points were also grouped by water depth and separated into four depth zones for analysis (Table 1). Species frequency was also calculated for the entire lake area sampled (to 20 feet).

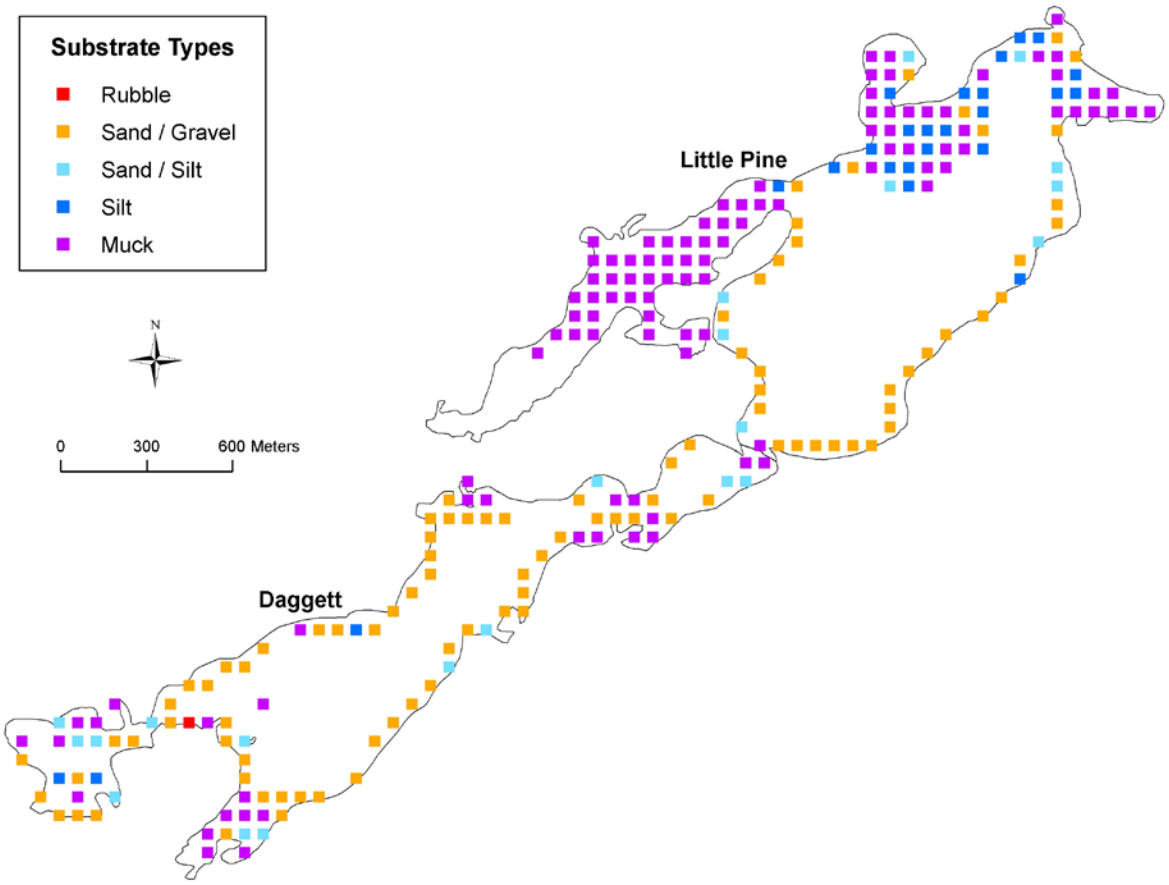
Example: In Little Pine Lake there were 174 samples sites in the 0-20 feet depth zone.
Coontail occurred in 99 sites.
Frequency of Coontail in 0 to 20 feet zone = (99 / 174)*100 = 57%

Results and Discussion

Shoal Substrates

The shoal substrates of Little Pine and Daggett Lakes were primarily hard substrates of sand, gravel, and rubble. Softer substrates of silt and muck were found in shallow, protected bays (Figure 6).

Figure 6. Shoal substrates of Little Pine and Daggett Lakes, June 2010.



Types of plants recorded

A total of 39 native aquatic plant species (types) were recorded in Little Pine and Daggett Lakes including 8 emergent, 4 floating-leaved, 3 free-floating, and 24 submerged species (Table 3). Submerged plants included macroalgae, and a diversity of rooted plants that can be grouped by leaf shape and size: dissected, small, narrow, broad and grass-leaved plants. Fifteen of these species were recorded for the first time in 2010 (Appendix 1). Clasping-leaf pondweed (*Potamogeton richardsonii*) was the only species found in earlier surveys that was not located in 2010.

One non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was documented in both lakes. The 2010 survey did not include an inventory of upland plants but surveyors did record the presence of several emergent wetland plants (Appendix 1).

Table 3. Frequency of submerged and free-floating aquatic plants in Little Pine and Daggett Lakes, June 2010.

[Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 20 ft water depth. It is also calculated for the entire depth zone sampled (to 20 feet)].

Life Form		Common Name	Scientific Name	Frequency	
				Little Pine (174 sites)	Daggett (143 sites)
SUBMERGED	Macroalgae	Muskgrass	*Chara* sp.	6	6
		Stonewort	*Nitella* sp.	2	---
		Watermoss	*Not identified to genus*	7	---
	Dissected-leaf rooted plants	Coontail	*Ceratophyllum demersum*	57	34
		Northern watermilfoil	*Myriophyllum sibiricum*	28	18
		Greater bladderwort	*Utricularia vulgaris*	14	---
		White water buttercup	*Ranunculus aquatilis*	8	1
		Water marigold	*Bidens beckii*	1	1
		Minor bladderwort	*Utricularia minor*	5	---
		Flat-leaved bladderwort	*Utricularia intermedia*	3	---
		Humped bladderwort	*Utricularia gibba*	1	---
	Small-leaf rooted plants	Canada waterweed	*Elodea canadensis*	11	5
		Bushy pondweed	*Najas flexilis*	3	6
		Southern naiad	*Najas guadalupensis*	1	2
	Narrow-leaf pondweeds	Narrow-leaf pondweed group	*Potamogeton friesii*	10	2
		Sago pondweed	*Stuckenia pectinata*	2	3
	Broad-leaf pondweeds	White-stem pondweed	*Potamogeton praelongus*	11	10
		Variable pondweed	*Potamogeton gramineus*	*Present	---
		Large-leaf pondweed	*Potamogeton amplifolius*	---	*Present
		Curly-leaf pondweed(I)	*Potamogeton crispus*	24	17
	Grass-leaf rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	28	22
		Water star-grass	*Heteranthera dubia*	5	3
		Robbins pondweed	*Potamogeton robbinsii*	3	1
		Wild celery	*Vallisneria americana*	2	5
		Water bulrush	*Schoenoplectus subterminalis*	*Present	---
Free-Floating		Star duckweed	*Lemna trisulca*	33	12
		Lesser duckweed	*Lemna* sp.	2	1
		Greater duckweed	*Spirodela polyhriza*	2	1

"---" = not found in that lake (I) = Introduced to Minnesota

*Present = Present in lake but not found in any survey sites

Table 3 continued. Frequency of floating-leaf and emergent aquatic plants in Little Pine and Daggett Lakes, June 2010.

[Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 20 ft water depth. It is also calculated for the entire depth zone sampled (to 20 feet)].

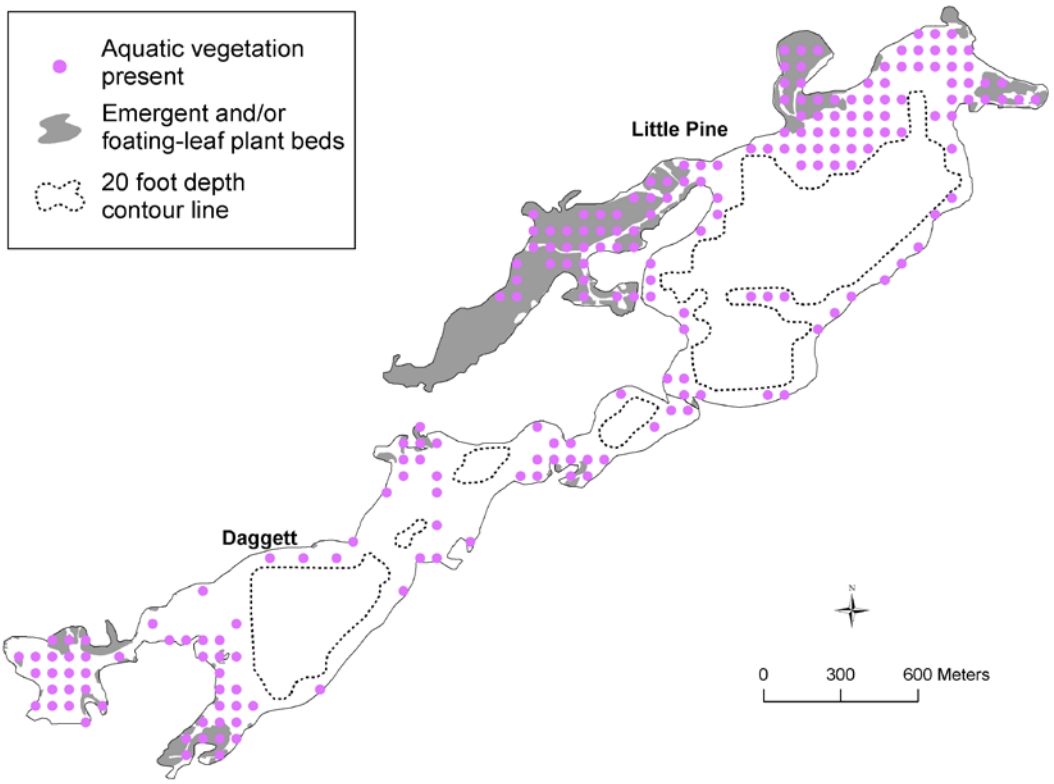
Life Form	Common Name	Scientific Name	Frequency	
			Little Pine (174 sites)	Daggett (143 sites)
Floating-leaf	White waterlily	*Nymphaea odorata*	9	4
	Yellow waterlily	*Nuphar variegata*	5	---
	Watershield	*Brasenia schreberi*	*Present	---
	Floating-leaf smartweed	*Persicaria amphibia*	*Present	---
Emergent	Wild rice	*Zizania palustris*	8	---
	Burreed	*Sparganium* sp.	1	2
	Narrow-leaf cattail	*Typha angustifolia*	1	1
	Bulrush	*Schoenoplectus* sp.	*Present	*Present
	Three-square bulrush	*Schoenoplectus pungens*	*Present	---
	Spikerush	*Eleocharis* sp.	*Present	---
	Arrowhead	*Sagittaria* sp.	---	1
	River bulrush	*Bolboschoenus fluviatilis*	---	*Present
Wetland emergents	Narrow-leaf sedge	*Carex* sp.	1	---
	Wide-leaf sedge	*Carex* sp.	1	---
	Bog Birch	*Betula pumila*	1	---
	Water arum	*Calla palustris*	*Present	*Present
	Blue flag iris	*Iris versicolor*	*Present	*Present
	Cottongrass	*Euriophorium gracilla*	*Present	---

"---" = not found in that lake (I) = Introduced to Minnesota
*Present = Present in lake but not found in any survey sites

Distribution of aquatic plants

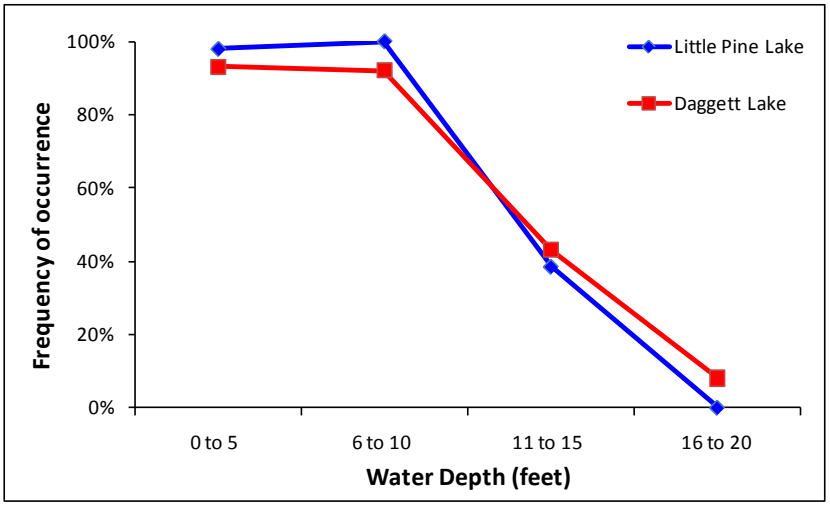
Plants occurred around the perimeter of both lakes but were concentrated in the shallow zones including the west half of Little Pine, the channel connecting the two lakes, and the southwest end of Daggett Lake (Figure 7). The most extensive beds of emergent and floating-leaf plants were in the southwest arm of Little Pine Lake. Submerged plants were abundant in the shallow protected areas, and were scattered in the main basins of both lakes.

Figure 7. Distribution of aquatic plants, Little Pine and Daggett Lakes, 2010.



Within the shore to 20 feet depth zone, 78% of the sites in Little Pine Lake and 53% of the sites in Daggett Lake contained plants. In both lakes, plants were most common in the 0-10 feet depth zone, where at least 98% of the Little Pine Lake sites and 92% of the Daggett Lake sites contained vegetation (Figure 8). Plant occurrence declined with increasing water depth. In depths greater than 15 feet depth, no plants were found in Little Pine Lake and only 4 sites in Daggett Lake contained plants.

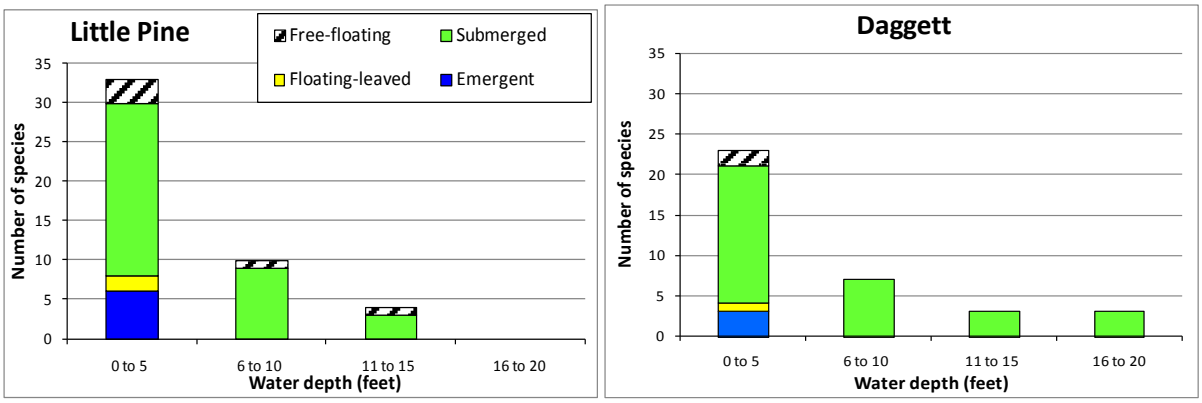
Figure 8. Aquatic plant frequency vs. water depth.



Plant communities richness

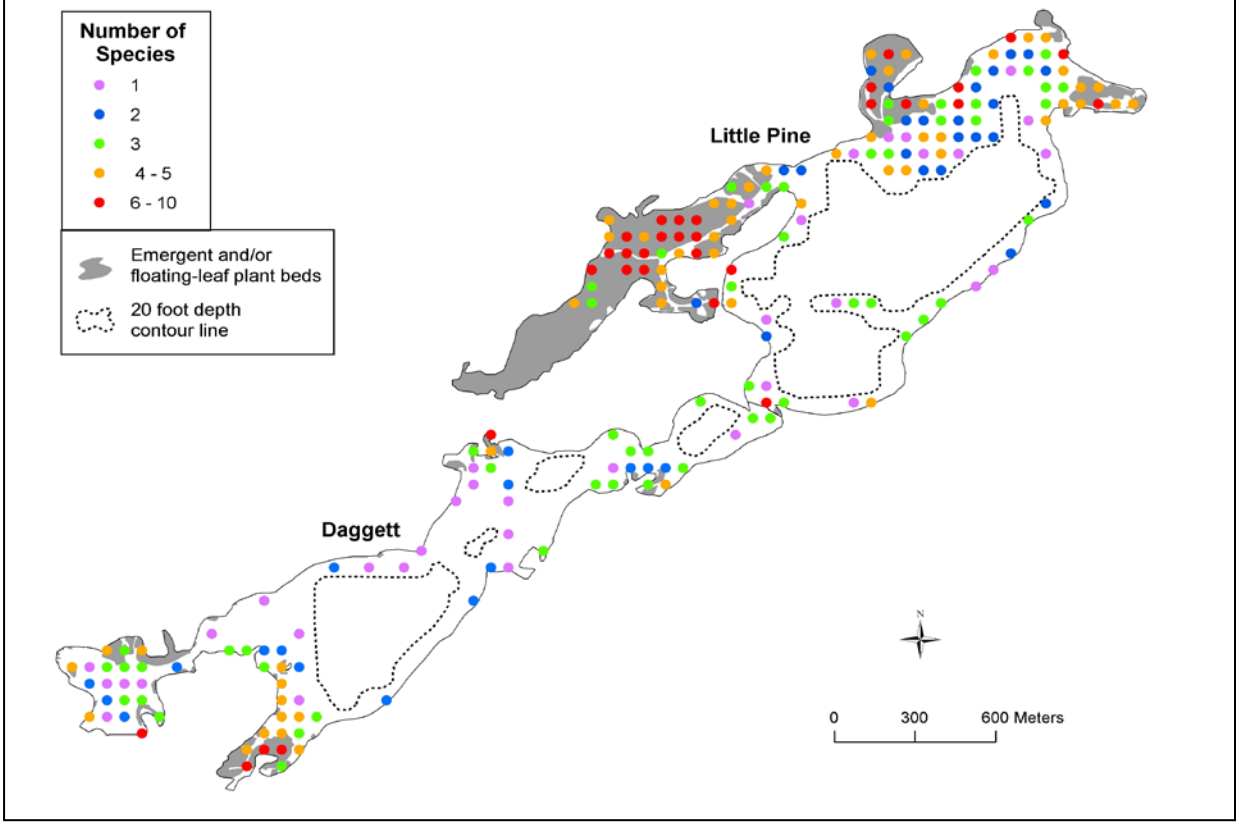
The highest number of plant species was found in shallow water, from 0 to 5 feet (Figure 9). Emergent and floating-leaf plants were restricted to water depths of 5 feet and less. Submerged plants were found to a depth of 15 feet in Little Pine and 20 feet in Daggett.

Figure 9. Number of plant species vs. water depth. Little Pine and Daggett Lakes, 2010



The number of plant species found at each one square meter sample site ranged from 0 to 10 (Figure 10) and most sites contained at least one species. The greatest number of species was found in protected bays and channels of Little Pine and Daggett Lakes.

Figure 10. Number of plant species at each sample site, Little Pine and Daggett Lakes, 2010.

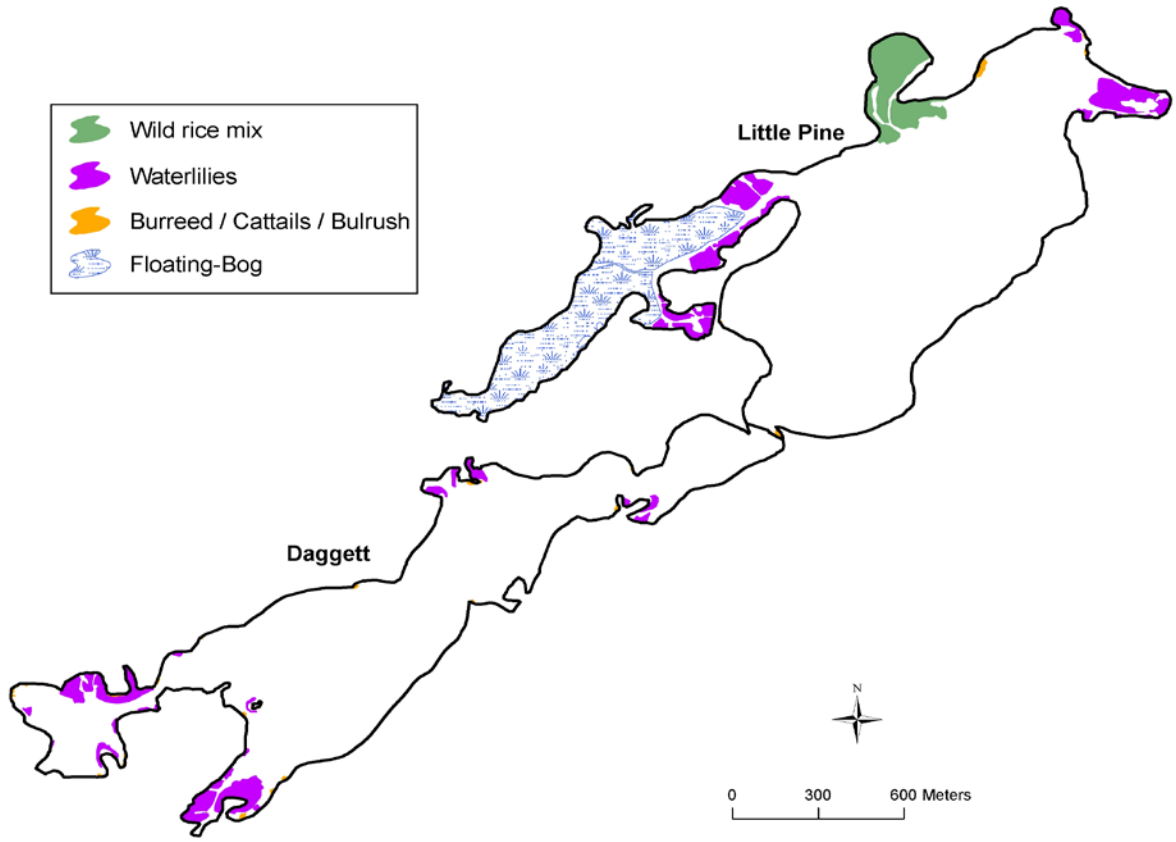


Major Emergent and Floating-leaf Plant Beds

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

Approximately 83 acres of emergent and floating-leaf plant beds were mapped in Little Pine and 16 acres in Daggett. Major plant bed types were, floating bog, waterlilies and wild rice (Figure 11).

Figure 11. Emergent and floating-leaf plant beds, 2010.



Floating bogs are mats of aquatic plants that are not firmly rooted to the lakebed and may rise and fall with variations in lake level. They are part of a natural plant community succession as open water areas fill with vegetation. Floating bogs are often dominated by emergent aquatic and wetland plants, including sedges, shrubs and flowering herbs.

About 51 acres of floating bog were delineated in the southwest arm of Little Pine Lake (Figure 12). These emergent plant beds provide important water quality and wildlife habitat benefits.

Figure 12. Floating bog in Little Pine Lake

Wild rice (*Zizania palustris*) was the most frequent emergent in Little Pine and within the 0 to 5 feet depth zone it occurred in 15% of the sites. It frequently co-occurred with bulrush, waterlilies or other emergent vegetation. Wild rice prefers soft substrates (Lee 1986, Nichols 1999) and generally requires moving water for growth (MnDNR 2008). In Little Pine Lake, 14 acres of wild rice were mapped and it was concentrated in the northwest bay of the lake (Figure 11) where there is inflow from Daggett Brook (Figure 2). Wild rice was not found in Daggett Lake.

Figure 13. Floating stage of Wild Rice

Figure 14. Emergent stage of Wild Rice

Wild rice is an annual plant that germinates each year from seed that fell to the lake bottom in the previous fall. The plant begins growth underwater and then forms a floating-leaf stage (Figure 13) before becoming fully emergent (Figure 14). Wild rice is susceptible to disturbance because it is weakly rooted to the lake bottom. In addition to its ecological value as habitat and food for wildlife, wild rice has important cultural and economic values in Minnesota (MnDNR 2008). This valuable plant is increasingly threatened by factors such as lakeshore development and increased water recreational use (MnDNR 2008).

Other emergent plants found were bulrush (*Schoenoplectus* sp.; Figure 15) Cattail (*Typha* spp. Figure 16), and burreed (*Sparganium* sp. Figure 17). These other emergents often occurred in narrow bands along shore and covered less than one acre.

Figure 15. Bulrush

Figure 16. Cattails in Little Pine Lake

Figure 17. Burreed

Floating-leaf plants included yellow waterlily (*Nuphar variegata*; Figure 18), and white waterlily (*Nymphaea odorata*; Figure 19). Waterlily beds often contained scattered bulrush plants, and submerged plants. Waterlily beds, or mixed beds of waterlilies and emergent plants, covered about 17 acres in Little Pine and about 14 acres in Daggett (Figure 11).

Figure 18. Yellow waterlily

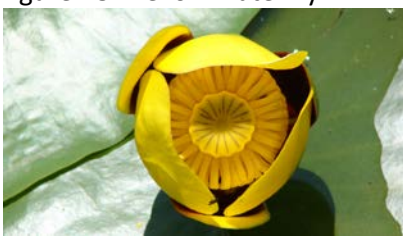


Figure 19. White waterlily

Submerged native aquatic vegetation

Submerged native plants occurred in 75% of the Little Pine sample sites and 54% of the Daggett sample sites. The most frequently occurring species were coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), northern watermilfoil (*Myriophyllum sibiricum*), star duckweed (*Lemna trisulca*), white-stem pondweed (*Potamogeton praelongus*), Canada waterweed (*Elodea canadensis*), and greater bladderwort (*Utricularia vulgaris),* these species all occurred at a frequency of at least 10% (Table 3). Distribution maps for these species are shown in Figures 20 and 21. These species varied in their depth distribution in each lake (Figure 22).

Figure 20. Distribution of common aquatic plants in Little Pine and Daggett lakes.

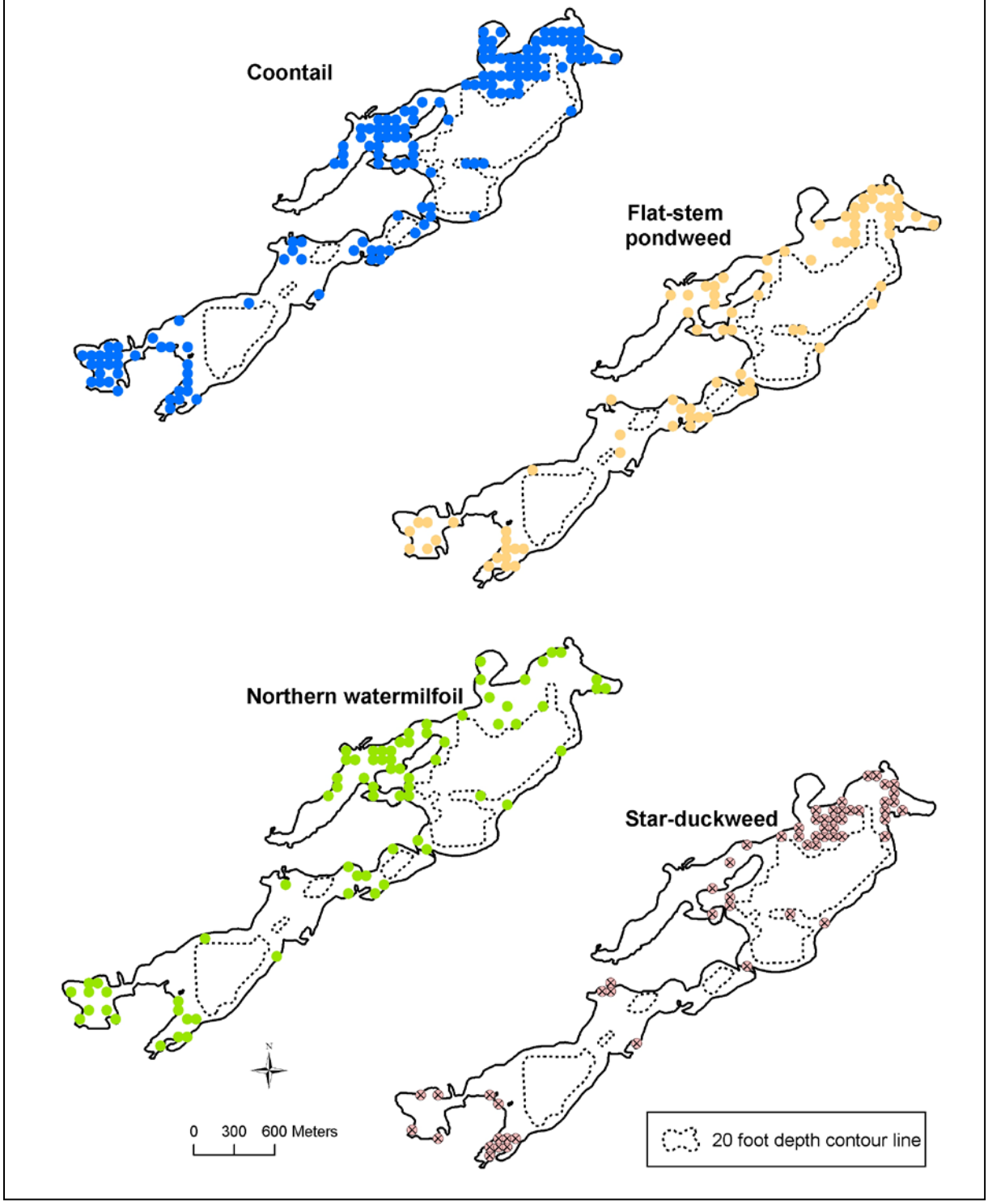


Figure 21 Distribution of common aquatic plants in Little Pine and Daggett lakes.

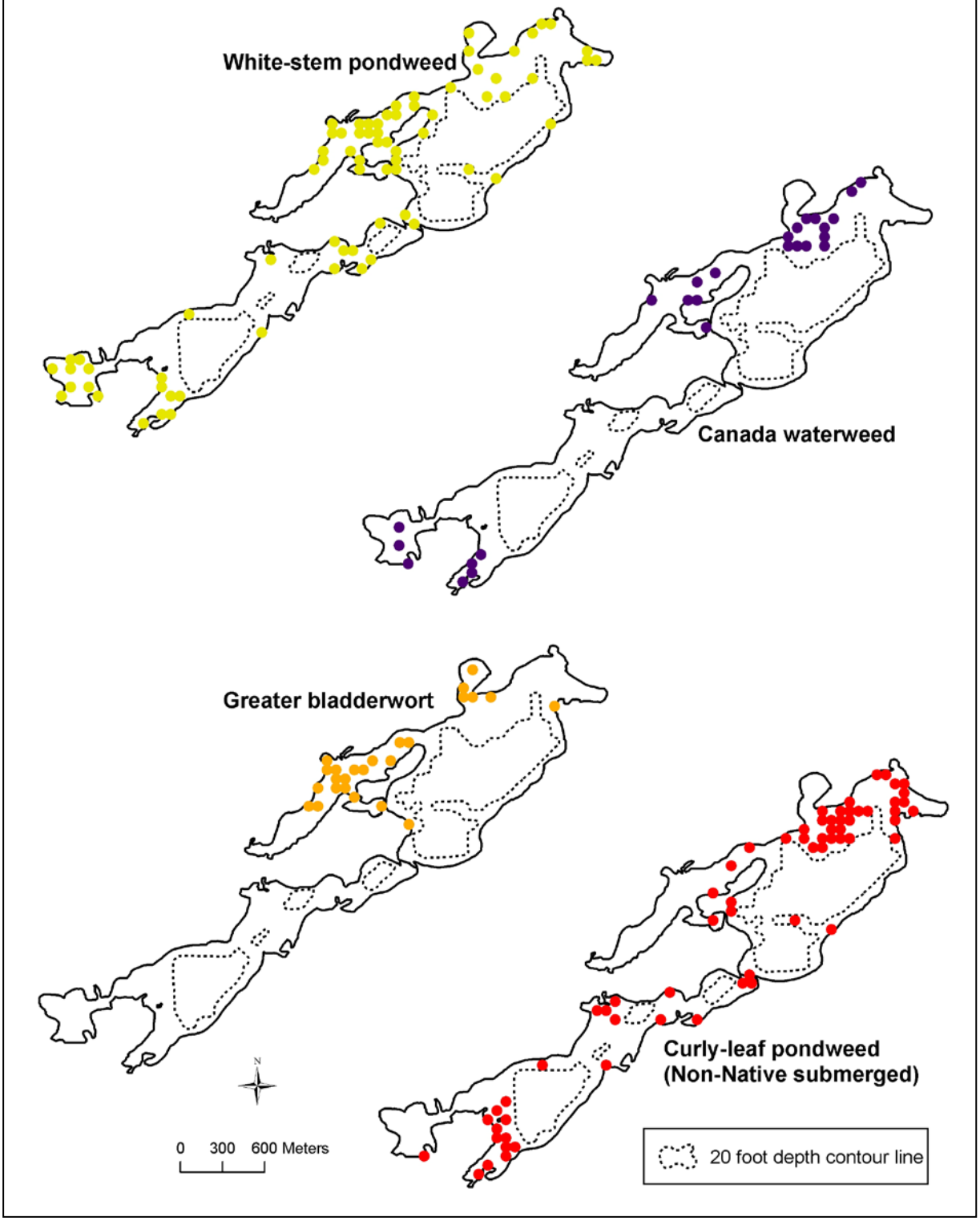
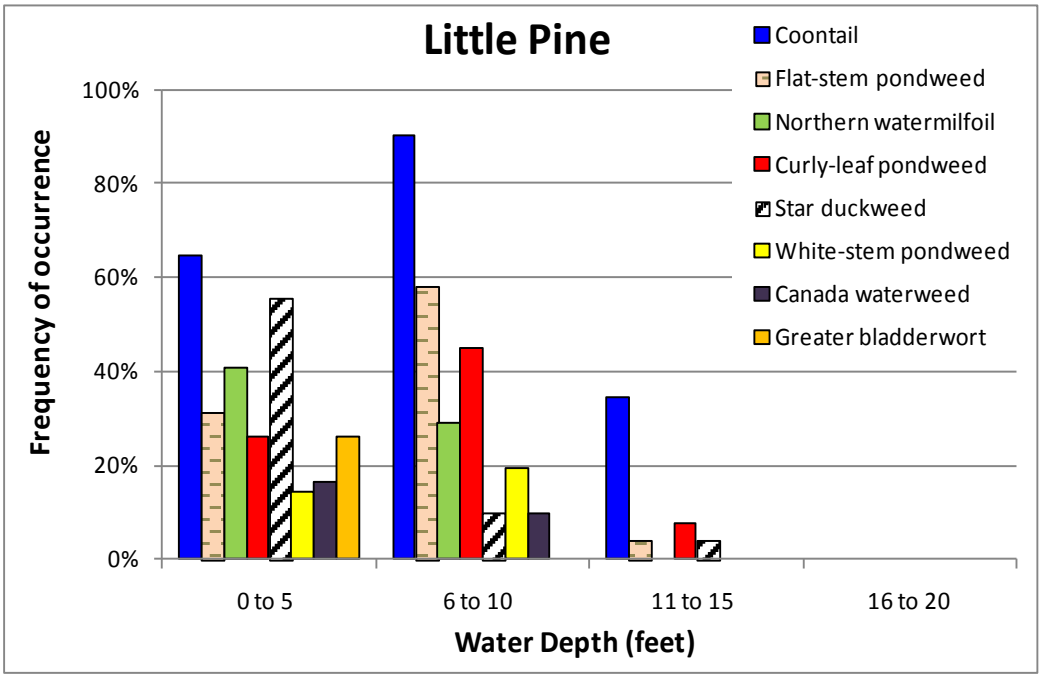
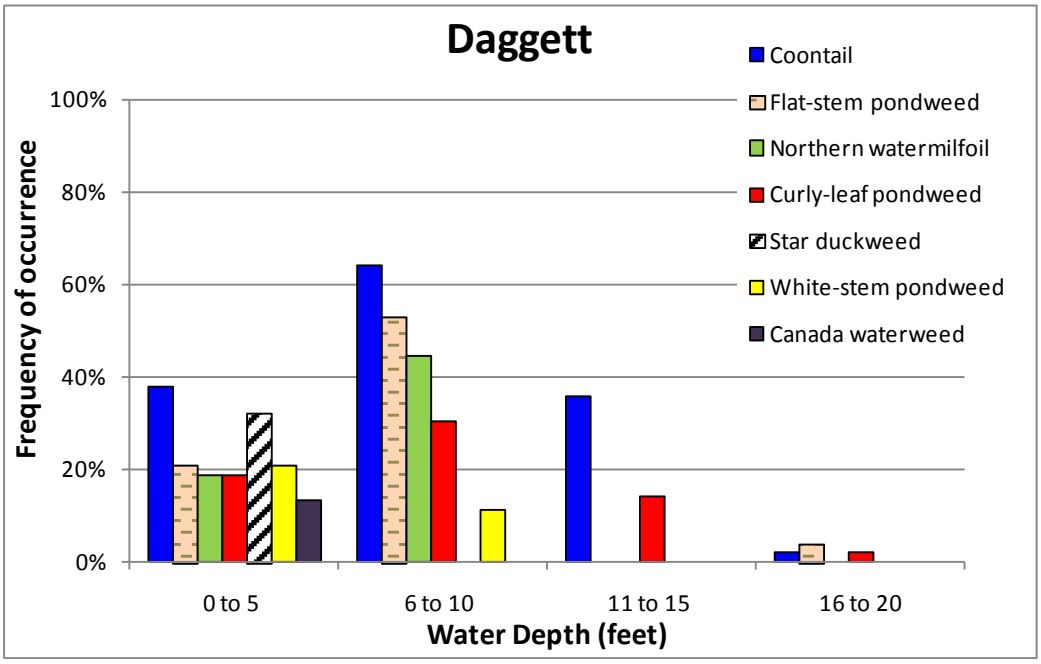


Figure 22. Frequency of common plants by water depth interval.





Coontail (Figure 23) grows entirely submerged and its roots are only loosely anchored to the lake bottom. It is adapted to a broad range of lake conditions and is tolerant of higher turbidity and can grow in muck substrates. Coontail is perennial and can over winter as a green plant under the ice and then begins new growth early in the spring, spreading primarily by stem fragmentation. The finely divided leaves of this plant provide a home for insects valuable as fish food.

Coontail was the most common species found in both lakes and occurred in 57% of the Little Pine sites and 34% of the Daggett sites (Table 3). It was the dominant plant at most depth zones and was most common in 6-10 ft (Figure 22). Coontail was abundant throughout both lakes, but was frequently found in shallow mucky sites.

Figure 23. Coontail

Flat-stem pondweed (Figure 24) is named for its flattened, grass-like leaves. Flat-stem pondweed is a perennial plant that is 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. These pondweeds are anchored to the lake bottom by rhizomes and over winter by winter buds. Flat-stem pondweed occurred in 28% of the Little Pine sites and 22% of the Daggett sites (Table 3). It was found to a depth of 11 feet in Little Pine and 20 feet in Daggett. It was most often found in water depths of 10 feet and less (Figure22) and was common throughout both lakes (Figure 17).

Figure 24. Flat-stem pondweed

Northern watermilfoil (Figure 25) is a native, submerged plant. It is a rooted perennial with finely dissected leaves. Particularly in depths less than ten feet, this plant may reach the water surface and its flower stalk will extend above the water surface. It spreads primarily by stem fragments and over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes. For information on how to distinguish the native northern watermilfoil from the non-native, Eurasian watermilfoil, click here: identification. Northern watermilfoil was found in 28% of the Little Pine sites and 18% of the Daggett sites (Table 3; Figure 22).

Figure 25. Northern watermilfoil in flower

Photo by John Maunder

Star duckweed (Figure 26) is a free-floating species that often occurs submerged near the lake bottom but it does not anchor to the substrate and can float freely with the current. This plant was present in 33% of the Little Pine sites and 12% of the Daggett lake survey sites (Table 3). It was most often found in water depths of five feet and less (Figure 22) and was found on the northwest shores of Little Pine and the south shores of Daggett (Figure 20).

Figure 26. Star duckweed (photo by Robert Freckman- UW - Stevens Point)

White-stem pondweed (Figure 27) is a broadleaf plant that is sometimes called “cabbage” by anglers. This species is not tolerant of turbidity (Nichols, 1999) and is often one of the first

species to decline if water clarity declines. White-stem pondweed was found in 11% of the Little Pine sites and 10% of the Daggett sites (Table 3; Figure 22) and was most common in depths less than ten feet. White-stem pondweed was found at scattered locations throughout both lakes (Figure 21).

Figure 27. White-stem pondweed
Photo: ©2006 Wm. Dean Taylor

Canada waterweed (Figure 28) is a perennial submerged species that is widespread throughout Minnesota. It is adapted to a variety of conditions and is tolerant of low light and prefers soft substrates. Canada waterweed can overwinter as an evergreen plant and spreads primarily by fragments. Canada waterweed was found in 11% of the Little Pine sites (Table 3; Figure 22). Canada waterweed was most frequent in the northwest shore of Little Pine and the south shore of Daggett (Figure 21).

Figure 28. Canada waterweed

Greater bladderwort is an entirely submerged plant except during bloom when its small, showy yellow flower extends above the water (Figure 29). Bladderwort often floats freely in the water column and is tolerant of turbid water. It reproduces by fragments and winter buds that can float to new areas of the lake. This plant has finely dissected leaves with small "bladders" that trap invertebrates. It is Minnesota's version of a "Venus flytrap" and feeds on the nitrogen it obtains from insects. Greater bladderwort was found in 14% of Little Pine Lake sites (Table 3). It was most common in depths of five feet and less (Figure 22). Greater bladderwort was not found in Daggett Lake (Figure 21).

Figure 29. Flowers of Greater bladderwort.

In addition to the commonly occurring native submerged plants in Little Pine and Daggett Lakes, there were several unique plants located during the survey including water bulrush (*Schoenoplectus subterminalis*), and several species of bladderworts (*Utricularia* spp.). These species are not widespread in Minnesota but are usually associated with undisturbed areas in clear water lakes of northern Minnesota.

Submerged non-native aquatic vegetation

Curly-leaf pondweed (*Potamogeton crispus*) (Figure 30) was found in 24% of the survey sites in Little Pine, and 17% of the survey sites in Daggett (Table 3). In both lakes it was most commonly found in the 6 to 10 feet depth zone (Figure 22). Curly-leaf pondweed was found at scattered locations throughout both lakes, but was concentrated in the northwest part of Little Pine and the southern bay of Daggett (Figure 21).

Figure 30. Curly-leaf pondweed.

This is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in more than 700 Minnesota lakes (Invasive Species Program 2010). Like many native submerged plants, it is perennial but 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. Winter foliage is produced and continues to grow under ice (Wehrmeister and Stuckey 1978). Curly-leaf reaches its maximum growth in May and June, when water temperatures are still too low for most native plant growth. In late spring and early summer, curly-leaf plants form structures called "turions" which are hardened stem tips that break off and fall to the substrate. Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson 1985).

The foliage of curly-leaf pondweed does provide some fish and wildlife habitat, but it may also create problems in some lakes, or in areas of some lakes. During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats. These dense growths may compete with native vegetation and can also cause problems for recreational lake users.

Change in aquatic plant communities

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

- Change in water clarity
  If water clarity in Little Pine and Daggett Lakes increases, submerged vegetation may be more common at depths greater than 15 feet.

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

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

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

The abundant and diverse aquatic plant communities found in Little Pine and Daggett Lakes 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. History and current plants of Little Pine and Daggett Lakes

Submerged plants

Common Name	Scientific Name	1950	1987	1990	2009	2010
Water marigold	*Bidens beckii*	P D				P D
Coontail	*Ceratophyllum demersum*	P D	P D	P D	P D	P D
Muskgrass	*Chara* sp.				P D	P D
Canada waterweed	*Elodea canadensis*			P	P D	P D
Water star-grass	*Heteranthera dubia*					P D
Northern watermilfoil	*Myriophyllum sibiricum*	P D	P D	P D	P D	P D
Bushy pondweed	*Najas flexilis*			P	D	P D
Southern naiad	*Najas guadalupensis*					P D
Stonewort	*Nitella* sp.					P
Large-leaf pondweed	*Potamogeton amplifolius*			P	D	D
Curly-leaf pondweed (I)	*Potamogeton crispus*			P	P	P D
Fries' pondweed	*Potamogeton friesii*					P
Variable pondweed	*Potamogeton gramineus*	P D				P
White-stem pondweed	*Potamogeton praelongus*		D	D	P	P D
Clasping leaf pondweed	*Potamogeton richardsonii*	P D	D	P D		
Robbin's pondweed	*Potamogeton robbinsii*				P	P D
Narrow-leaved pondweed	*Potamogeton* sp.					P
Flat-stem pondweed	*Potamogeton zosteriformis*	P D	P	P	P D	P D
White water buttercup	*Ranunculus aquatilis*		P D	P D	P D	P D
Water bulrush	*Schoenoplectus subterminalis*					P
Sago pondweed	*Stuckenia pectinata*	P D	P D	P D	P	P D
Greater bladderwort	*Utricularia vulgaris*	P D				P
Lesser bladderwort	*Utricularia minor*					P
Flat-leaf bladderwort	*Utricularia intermedia*					P
Humped bladderwort	*Utricularia gibba*					P
Wild celery	*Vallisneria americana*		P	P		P D
Watermoss	*Not identified to genus*					P
	Total Little Pine	8	6	11	10	25
	Total Daggett	8	6	6	8	16
	Total species in both lakes	8	8	12	12	26

Floating-leaved plants

Common Name	Scientific Name	1950	1987	1990	2009	2010
Watersheild	*Brasenia schreberi*					P
Yellow waterlily	*Nuphar variegata*	P D	D	P D	P	P D
White waterlily	*Nymphaea odorata*	P D	P D	P D		P D
Floating-leaf smartweed	*Persicaria amphibia*					P
	Total Little Pine	2	1	2	1	4

	Total Daggett	2	2	2	0	2
	Total species in both lakes	2	2	2	1	4

Free-floating plants

Common Name	Scientific Name	1950	1987	1990	2009	2010
Lesser duckweed	*Lemna* sp.		P	P		P D
Star duckweed	*Lemna trisulca*		P	P	P D	P D
Greater duckweed	*Spirodela polyrhiza*	P D				P D
	Total Little Pine	1	2	2	1	3
	Total Daggett	1	0	0	1	3
	Total species in both lakes	1	2	2	2	3

Emergent plants

Common Name	Scientific Name	1950	1987	1990	2009	2010
River bulrush	*Bolboschoenus fluviatilis*					D
Spikerush	*Eleocharis* sp.					P
Arrowhead	*Sagittaria* sp.					P D
Bulrush	*Schoenoplectus* sp.	P D				P D
Three-square bulrush	*Schoenoplectus pungens*					P
Giant burreed	*Sparganium eurycarpum*		P D	D		P D
Cattail	*Typha* sp.	P D	P D	P D		P D
Wild rice	*Zizania palustris*		P	P		P
	Total Little Pine	2	3	2	0	7
	Total Daggett	2	2	2	0	5
	Total species in both lakes	2	3	3	0	8

Wetland emergent plants

Common Name	Scientific Name	1950	1987	1990	2009	2010
Alder	*Alnus sp.*					P
Bog Birch	*Betula pumila*					P
Sedge – Narrow-leaf	*Carex sp.*					P
Sedge – Broad-leaf	*Carex sp.*					P
Water arum	*Calla palustris*					P D
Cottongrass	*Eriophorum gracilla*					P
St. John's wort	*Hypericum sp.*					P
Blue flag iris	*Iris versicolor*			P		P D
Tufted loosestrife	*Lysimachia thyrsiflora*					P
Reed canary grass (I)	*Phalaris arundinaceae*			P		P
Water dock	*Rumex sp.*					P
Water parsnip	*Sium suave*					P
	Total Little Pine	0	0	2	0	12

	Total Daggett	0	0	0	0	2
	Total species in both lakes	0	0	2	0	12

P = present in Little Pine Lake
D = present in Daggett Lake

I = introduced species in Minnesota

1950 (July 5-6): DNR Fisheries survey

1987 (July 7-10, 24): Dale Lockwood, Michael Patrick; Brainerd DNR Fisheries survey

1990 (July 16 – 20): Wayne Mueller; Brainerd DNR Fisheries survey

2009 (May 5, 7 and June 2): Dan Swanson, Rich Rezanka, Ben Burggraff, Adam Rollins; MnDNR Ecological Resources Division – Invasive Species Program

2010 (June 2-3, 14): Simon, Perleberg, Van Dyne; MnDNR Ecological and Water Resources Division