8.5 DOG LAKE

8.5.1 An Introduction to Dog Lake

Dog Lake, Oneida County, is a lowland drainage lake with a maximum depth of 22 feet and a surface area of 216 acres. This eutrophic lake has a relatively large watershed when compared to the size of the lake. Dog Lake contains 32 native plant species, of which wild celery was the most common plant. No exotic plants were observed during the 2011 lake surveys.

Field Survey Notes

Unusually large community of water horsetail (Equisetum fluviatile) encountered during aquatic plant surveys (pictured at right).

Photo 8.5.1-1 Dog Lake, Oneida County

Lake at a Glance – Dog Lake

Morphology	
Acreage	216
Maximum Depth (ft)	22
Mean Depth (ft)	8
Volume (acre-feet)	1,710
Shoreline Complexity	3.2
Vegetation	
Curly-leaf Survey Date	June 21, 2011
Comprehensive Survey Date	August 9, 2011
Number of Native Species	32
Threatened/Special Concern Species	-
Exotic Plant Species	-
Simpson's Diversity	0.88
Average Conservatism	6.7
Water Quality	
Wisconsin Lake Classification	Shallow, lowland drainage
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	210:1

8.5.2 Dog Lake Watershed Assessment

Dog Lake's watershed is 45,631 acres in size. Compared to Dog Lake's size of 216 acres, this makes for an incredibly large watershed to lake area ratio of 210:1.

Exact land cover calculation and modeling of nutrient input to Dog Lake will be completed towards the end of this project (in 2015-2016). By this time, the latest satellite imagery (and thus the most accurate land cover delineation) will be available. Additionally, when water quality sampling of the upper reaches of the chain is completed, these results will be input to predictive models and thus make the modeling of nutrient input to the entire chain more accurate.

As mentioned previously in the Chain-wide Watershed Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In late summer of 2011, Dog Lake's immediate shoreline was assessed in terms of its development. Dog Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 2.0 miles of natural/undeveloped and developed-natural shoreline (54% of the entire shoreline) were observed during the survey (Figure 8.5.2-1). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 1.0 miles of urbanized and developed–unnatural shoreline (26% of the total shoreline) was observed. If restoration of the Dog Lake shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. The Dog Lake Map 1 displays the location of these shoreline lengths around the entire lake.

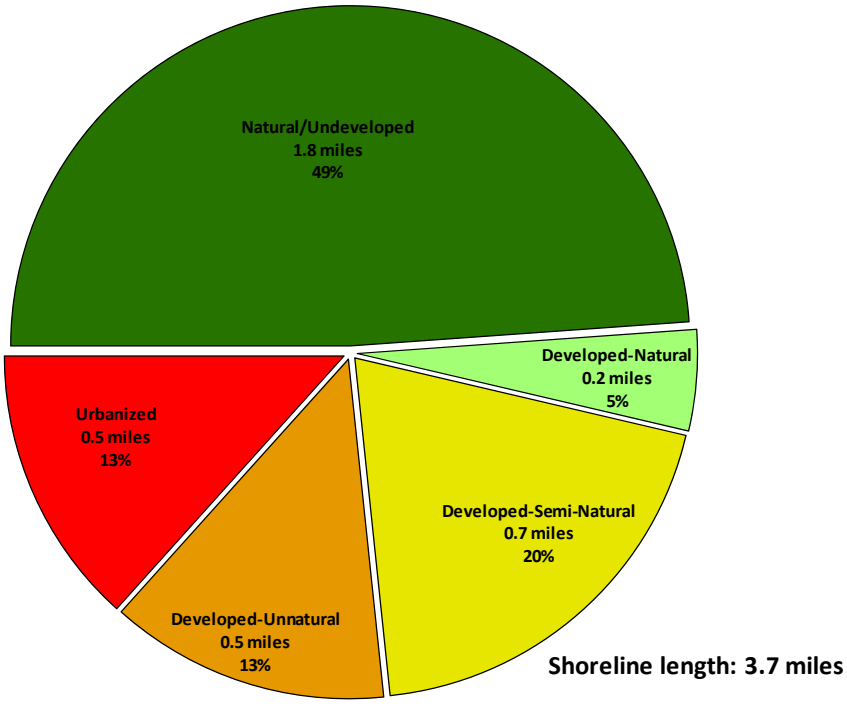

Figure 8.5.2-1. Dog Lake shoreland categories and total lengths. Based upon a late summer 2011 survey. Locations of these categorized shorelands can be found on the Dog Lake Map 1.

8.5.3 Dog Lake Water Quality

During 2011/2012, water quality data was collected from Laurel Lake on six occasions. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen. Additionally, historical databases were searched for any prior data that may have been collected on Dog Lake. Unfortunately, Secchi disk clarity data had been collected only sporadically on Dog Lake in the past, making a long term trend analysis difficult. However, it is possible to make some comparisons from recent data to that which was collected years ago.

Dog Lake total phosphorus and chlorophyll-*a* values can be found in Table 8.5.3-1. In 2011, summer total phosphorus concentrations averaged 31.7 µg/L, which is slightly lower than the median value for other shallow, lowland drainage lakes in the state of Wisconsin (33.0 µg/L). The 2011 average summer chlorophyll-*a* concentration (8.8 µg/L) is somewhat lower than the average for other shallow, lowland drainage lakes statewide (median = 9.4 µg/L). The total phosphorus average ranks as *Good* in the Trophic State Index, while the chlorophyll-*a* average value ranks as *Excellent*.

Table 8.5.3-1. Dog Lake, state-wide shallow, lowland drainage lakes, and regional values for water quality parameters. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

	Secchi (feet)				Chlorophyll-*a* (µg/L)				Total Phosphorus (µg/L)			
	Growing Season		Summer		Growing Season		Summer		Growing Season		Summer	
Year	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1979	1	4.0	1	4.0	1	3.6	1	3.6	1	43.0	1.0	43.0
1990	5	5.2	5	5.2								
1991	6	3.0	6	3.0								
1994	6	4.2	4	4.2								
1995	8	4.6	8	4.6								
1996	11	4.3	8	4.4								
2011	5	2.5	3	2.5	5	8.0	3	8.8	5	34.6	3.0	31.7
All Years (Weighted)		4.0		4.1		7.3		7.5		36.0		34.5
Shallow, Lowland Drainage Lakes				5.6				9.4				33.0
NLF Ecoregion				8.9				5.6				21.0

In addition to data collected during 1979 and the 1990's, measurements of Secchi disk clarity were taken in Dog Lake during 2011 field visits as well. A weighted average across all summers ranks as *Good*, however is slightly below the median value for other shallow, lowland drainage lakes in Wisconsin. During the aquatic plant surveys that took place on Dog Lake in 2011, plants were found growing to a maximum depth of six feet; however, the vast majority of plants grew to only five feet of depth. This is an added testament to the low water clarity in Dog Lake.

Secchi disk clarity is influenced by many factors, including plankton production and suspended sediments, which themselves vary due to several environmental conditions such as precipitation, sunlight, and nutrient availability. In lakes such as the Three Lakes Chain of lakes, a natural staining of the water plays a role in light penetration, and thus water clarity, as well. The darker waters of Dog Lake contain many organic acids that are washed into the lake from nearby wetlands. The acids are not harmful to humans or aquatic species; they are by-products of decomposing wetland plant species. This natural staining reduces light penetration into the water column, which reduces visibility but also reduces the growing depth of aquatic vegetation within the lake.

Dog Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from upper mesotrophic to eutrophic (Figure 8.5.3-1). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Dog Lake is in a eutrophic state.

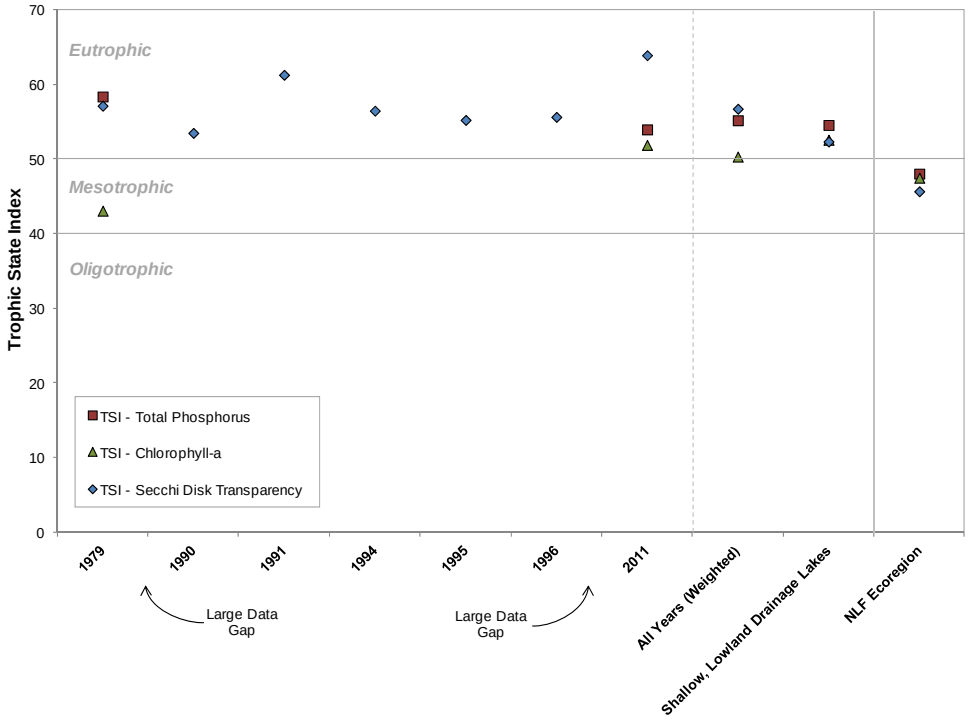

Figure 8.5.3-1. Dog Lake, state-wide shallow, lowland drainage lakes, and regional Wisconsin Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Dog Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Dog Lake by Onterra staff. Graphs of those data are displayed in Figure 8.5.3-2 for all sampling events.

Dog Lake remained thoroughly mixed throughout most of the summer months in 2011, though a small amount of stratification likely occurs periodically in the deeper portions of the lake. This is not uncommon in lakes that are moderate in size and depth. Energy from the wind is sufficient to mix the lake from top to bottom, distributing oxygen throughout the epilimnion and hypolimnion and keeping water temperatures fairly constant within the water column. Decomposition of organic matter along the lake bottom is likely the cause of the slight decrease in dissolved oxygen observed in July. Despite this late summer dip, dissolved oxygen levels remained sufficient in the upper ~12 feet of the water column to support most aquatic life found in northern Wisconsin lakes. Dissolved oxygen was also ample during the winter months of 2012, when oxygen may decrease due to ice cover on the lake and lack of oxygen production from plants and algae.

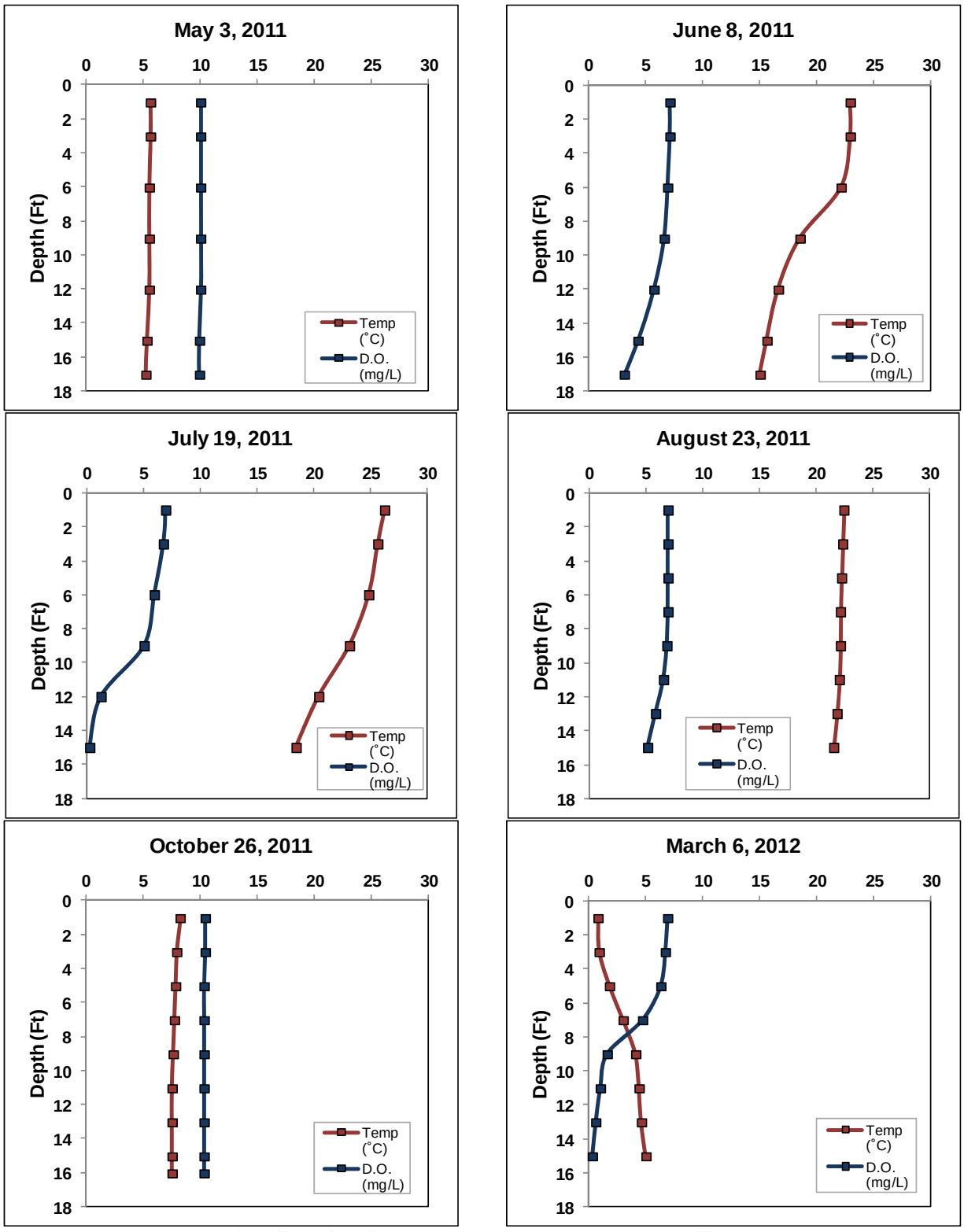

Figure 8.5.3-2. Dog Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Dog Lake

The water quality section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Dog Lake's water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include; pH, alkalinity, and calcium.

As the Chainwide Water Quality Section explains, the pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions (H^+) within the lake's water and is thus an index of the lake's acidity. Dog Lake's pH was measured at 7.0 during the summer months in 2011. This value is neutral and falls within the normal range for Wisconsin lakes.

A lake's pH is primarily determined by the amount of alkalinity that is held within the water. Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. Lakes with low alkalinity have higher amounts of the bicarbonate compound (HCO_3^-) while lakes with a higher alkalinity have more of the carbonate compound of alkalinity ($CO_3^=$). The bicarbonate form is better at buffering acidity, so lakes with higher alkalinity are less resistant to acid rain than those with lower alkalinity. The alkalinity in Dog Lake was measured at 17.6 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain.

Samples of calcium were also collected from Dog Lake during the summer of 2011. Calcium is commonly examined because invasive and native mussels use the element to build shells and in reproduction. Invasive mussels typically require higher calcium concentrations than native mussels. The commonly accepted pH range for zebra mussels is 7.0 to 9.0, so Dog Lake's pH of 7.0 is at the bottom end of this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The calcium concentration of Dog Lake was found to be 5.5 mg/L, falling well below the optimal range for zebra mussels. Plankton tows were completed by Onterra staff during the summer of 2011 and these samples were processed by the WDNR for larval zebra mussels. No veligers (larval zebra mussels) were found within these samples.

8.5.4 Dog Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Dog Lake on June 21, 2011. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Dog Lake or is present at an undetectable level.

The aquatic plant point-intercept survey was conducted on Dog Lake on August 9, 2011 by Onterra. The floating-leaf and emergent plant community mapping survey was completed on August 9 & 10 to create the aquatic plant community map (Dog Lake Map 2). During all surveys, 32 species of native aquatic plants were located in Dog Lake (Table 8.5.4-1). 21 of these species were sampled directly during the point-intercept survey and are used in the analysis that follows. Aquatic plants were found growing to a depth of six feet, which is common within the Three Lakes Chain of lakes. As discussed later on within this section, many of the plants found in this survey indicate that the overall community is healthy and fairly diverse.

Of the 116 point-intercept locations sampled within the littoral zone, approximately 56% contained aquatic vegetation. Approximately 75% of the point-intercept sampling locations where sediment data was collected at were sand, 24% consisted of a fine, organic substrate (muck) and no areas of rocky substrate were encountered (Chain-wide Fisheries Section, Figure 3.4-5).

Table 8.5.4-1. Aquatic plant species located in the Dog Lake during the 2011 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2011 (Onterra)
Emergent	Acorus calamus	Sweetflag	7	I
	Dulichium arundinaceum	Three-way sedge	9	I
	Decodon verticillatus	Water-willow	7	I
	Equisetum fluviatile	Water horsetail	7	X
	Eleocharis palustris	Creeping spikerush	6	X
	Iris versicolor	Northern blue flag	5	I
	Juncus effusus	Soft rush	4	I
	Pontederia cordata	Pickerelweed	9	X
	Sagittaria latifolia	Common arrowhead	3	I
	Schoenoplectus tabernaemontani	Softstem bulrush	4	I
	Scirpus cyperinus	Wool grass	4	I
	Typha spp.	Cattail spp.	1	I
	Zizania palustris	Northern wild rice	8	X
FL	Nymphaea odorata	White water lily	6	X
	Nuphar variegata	Spatterdock	6	X
FL/E	Sparganium emersum	Short-stemmed bur-reed	8	I
	Sparganium eurycarpum	Common bur-reed	5	X
	Sparganium fluctuans	Floating-leaf bur-reed	10	X
Submergent	Elodea canadensis	Common waterweed	3	X
	Isoetes sp.	Quilwort species	N/A	X
	Myriophyllum sibiricum	Northern water milfoil	7	I
	Najas flexilis	Slender naiad	6	X
	Potamogeton pusillus	Small pondweed	7	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	X
	Potamogeton robbinsii	Fern pondweed	8	X
	Potamogeton gramineus	Variable pondweed	7	X
	Potamogeton spirillus	Spiral-fruited pondweed	8	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X
	Utricularia vulgaris	Common bladderwort	7	X
	Vallisneria americana	Wild celery	6	X
SE	Eleocharis acicularis	Needle spikerush	5	X

FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent;
X = Located on rake during point-intercept survey; I = Incidental Species

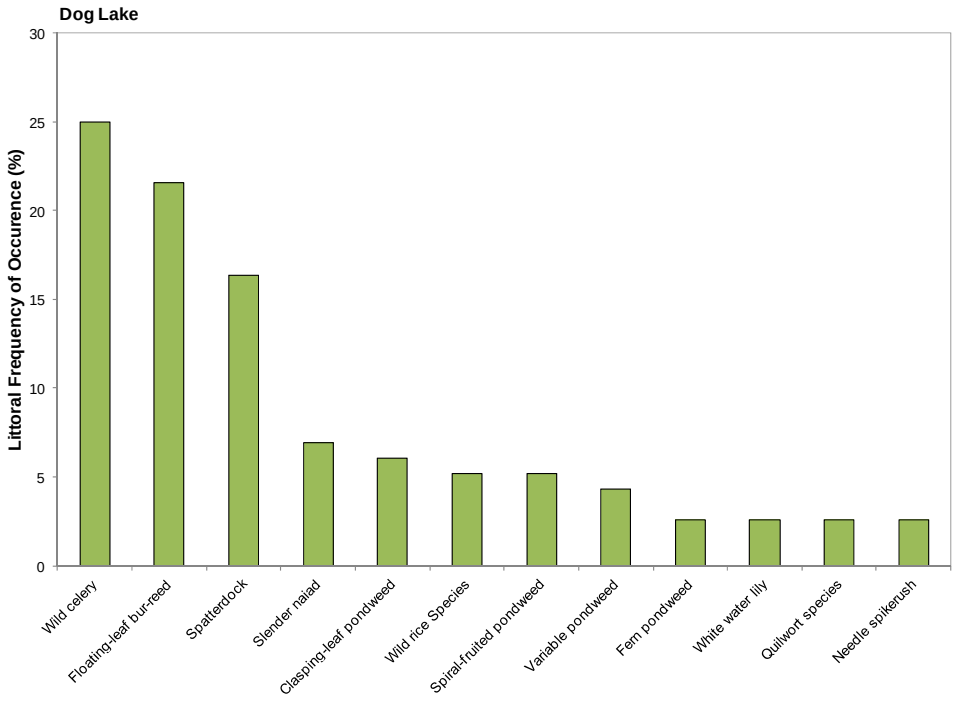

Figure 8.5.4-1 Dog Lake aquatic plant littoral frequency of occurrence analysis. Chart includes species with a frequency occurrence greater than 2.5% only. Created using data from a 2011 point-intercept survey.

Figure 8.5.4-1 (above) shows that wild celery, floating-leaf bur-reed and spatterdock were the most commonly encountered species during the point-intercept survey. Wild celery is a long, limp, ribbon-leaved turbidity-tolerant species that is a premiere food source for ducks, marsh birds, shore birds and muskrats. Animals may eat the entire plant, including the tubers that reside within the sediment. Floating-leaf bur-reed is an aquatic plant which includes long (2.5 to 5 ft) stems and long (2 to 3.25 ft) linear, ribbon-like leaves. Several species of bur-reed exist in Wisconsin, and while some differences exist in the leaves of these plants, the best way to differentiate between them is by the characteristics of their fruits. Spatterdock is a rooted, floating-leaved plant with heart-shaped leaves and a bright yellow roundish flower in the summer months. This plant provides shade, cover from predators, and a source of food for several species of mammals such as waterfowl, muskrat, beaver, and deer.

Of the seven milfoil species (genus *Myriophyllum*) found in Wisconsin, only one (northern water milfoil) was found within Dog Lake. Northern water milfoil, arguably the most common milfoil species in Wisconsin lakes, is frequently found growing in soft sediments and higher water clarity. Northern water milfoil is often falsely identified as Eurasian water milfoil, especially since it is known to take on the reddish appearance of Eurasian water milfoil as the plant reacts to sun exposure as the growing season progresses. The feathery foliage of northern water milfoil traps filamentous algae and detritus, providing valuable invertebrate habitat. Because northern water milfoil prefers high water clarity, its populations are declining state-wide as lakes are becoming more eutrophic.

32 species of aquatic plants (including incidentals) were found in Dog Lake and because of this, one may assume that the system would also have a high diversity. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Dog Lake's plant community (0.88) lies slightly above the Northern Lakes and Forests Lakes ecoregion value (0.86), indicating the lake has good diversity in its plant community.

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while wild celery was found at 25% of the sampling locations, its relative frequency of occurrence is 23%. Explained another way, if 100 plants were randomly sampled from Dog Lake, 23 of them would be wild celery. This distribution can be observed in Figure 8.5.4-2, where together 10 species account for 71% of the population of plants within Dog Lake, while the other 23 species account for the remaining 29%. Fifteen additional species were located from the lake but not from of the point-intercept survey, and are indicated in Table 8.5.4-1 as incidentals.

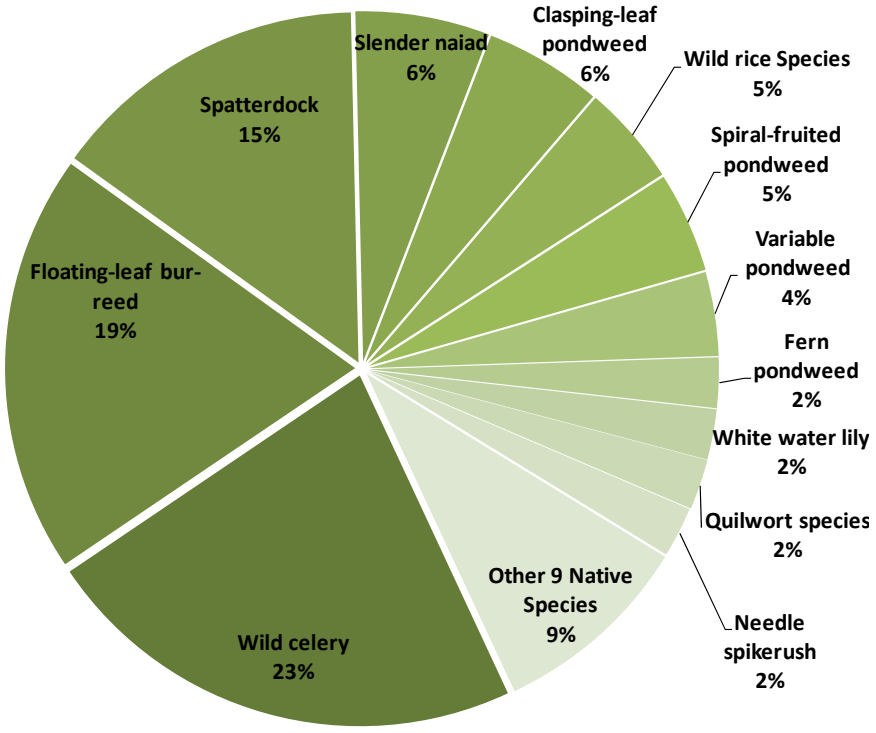

Figure 8.5.4-2 Dog Lake aquatic plant relative frequency of occurrence analysis.
Created using data from 2011 point-intercept survey.

Dog Lake's average conservatism value (6.7) is equal to the ecoregion but larger than the state-wide median. This indicates that the plant community of Dog Lake is indicative of a moderately undisturbed system. This is not surprising considering Dog Lake's plant community has good

diversity and high species richness. Combining Dog Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in a value of 30.5 which is above the median values of the ecoregion and state.

The quality of Dog Lake is also indicated by the high incidence of emergent and floating-leaf plant communities that occur in many areas. The 2011 community map indicates that approximately 41.6 acres of the lake contains these types of plant communities (Dog Lake Map 2, Table 8.5.4-2). Seventeen floating-leaf and emergent species were located on Dog Lake (Table 8.2.4-1), all of which provide valuable wildlife habitat.

Table 8.5.4-2. Dog Lake acres of emergent and floating-leaf plant communities from the 2011 community mapping survey.

Plant Community	Acres
Emergent	6.3
Floating-leaf	15.0
Mixed Floating-leaf and Emergent	20.3
Total	41.6

The community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Dog Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also Lost a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

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