8.7 DEER LAKE

8.7.1 An Introduction to Deer Lake

Deer Lake, Oneida County, is a drainage lake with a maximum depth of 20 feet and a surface area of 177 acres. This eutrophic lake has a relatively large watershed when compared to the size of the lake. Deer Lake contains 38 native plant species, of which white water lily was the most common plant. No exotic plants were observed during the 2011 lake surveys.

Field Survey Notes

Navigation tricky on west side of lake, where shallow water and thick floating-leaf aquatic plants were commonly encountered. Dark, stained water observed during surveys.

Photo 8.7.1-1 Deer Lake, Oneida County

Lake at a Glance – Deer Lake

Morphology	
Acreage	177
Maximum Depth (ft)	20
Mean Depth (ft)	10
Volume (acre-feet)	1,794
Shoreline Complexity	9.7
Vegetation	
Curly-leaf Survey Date	June 21, 2011
Comprehensive Survey Date	August 4 & 9, 2011
Number of Native Species	38
Threatened/Special Concern Species	-
Exotic Plant Species	-
Simpson's Diversity	0.89
Average Conservatism	6.3
Water Quality	
Wisconsin Lake Classification	Shallow, lowland drainage
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	306:1

8.7.2 Deer Lake Watershed Assessment

Deer Lake's watershed is 54,378 acres in size. Compared to Deer Lake's size of 177 acres, this makes for an incredibly large watershed to lake area ratio of 306:1.

Exact land cover calculation and modeling of nutrient input to Deer 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, Deer Lake's immediate shoreline was assessed in terms of its development. Deer Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 2.9 miles of natural/undeveloped and developed-natural shoreline (50% of the entire shoreline) were observed during the survey (Figure 8.7.2-1). 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 mile of urbanized and developed–unnatural shoreline (17% of the total shoreline) was observed. If restoration of the Deer 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. Deer Lake Map 1 displays the location of these shoreline lengths around the entire lake.

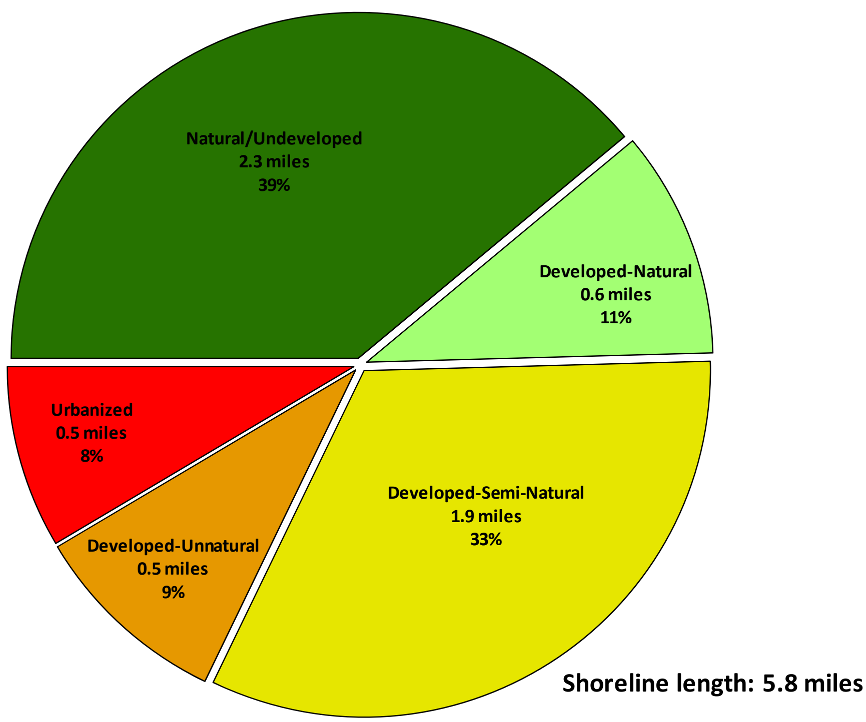

Figure 8.7.2-1. Deer Lake shoreland categories and total lengths. Based upon a late summer 2011 survey. Locations of these categorized shorelands can be found on the Deer Lake Map 1.

8.7.3 Deer Lake Water Quality

During 2011/2012, water quality data was collected from Deer 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.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored water clarity since 2006, and various volunteers and agencies have taken Secchi readings on Deer Lake in the late 1980's and mid 1990's also (Figure 8.7.3-1). These efforts provide a database of historical clarity data which may be compared against recent data in an effort to detect any trends that may be occurring in the water quality of the lake. These efforts should be continued in order to understand trends in the water quality of Laurel Lake. Unfortunately, only Secchi disk clarity has been monitored in the past, as monitoring for total phosphorus and chlorophyll-*a* requires additional sampling and funding and has not been sampled besides dates in 1979 and 2011.

In 2011, summer total phosphorus concentrations averaged 32.3 μg/L, which is slightly higher than the median value for other shallow, lowland drainage lakes in the state of Wisconsin (33.0 μg/L). As with the total phosphorus values, 2011 average summer chlorophyll-*a* concentrations (11.0 μg/L) are also somewhat higher than the average for other shallow, lowland drainage lakes statewide (median = 9.4 μg/L). Both the total phosphorus and chlorophyll-*a* average concentrations rank as *Good* in the Trophic State Index.

Measurements of Secchi disk clarity span a longer timeframe than the other two primary water quality parameters, and show some variance between years (Figure 8.7.3-1). Summer averages fall mostly within categories of *Fair* and *Good*, and a weighted average across all years is less than the average for shallow, lowland drainage lakes statewide. Secchi disk clarity is often tied to algal abundance – the more algae in the water column, the less clear the water will be. However Secchi disk clarity is influenced by many other factors which themselves vary due to several environmental conditions such as precipitation, sunlight, and nutrient availability. In Deer Lake and the rest of 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 Deer 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. In 2011, aquatic plants were found growing to a depth of only six feet within the lake.

Deer 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 8.7.3-2). 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 Deer Lake is in a eutrophic state.

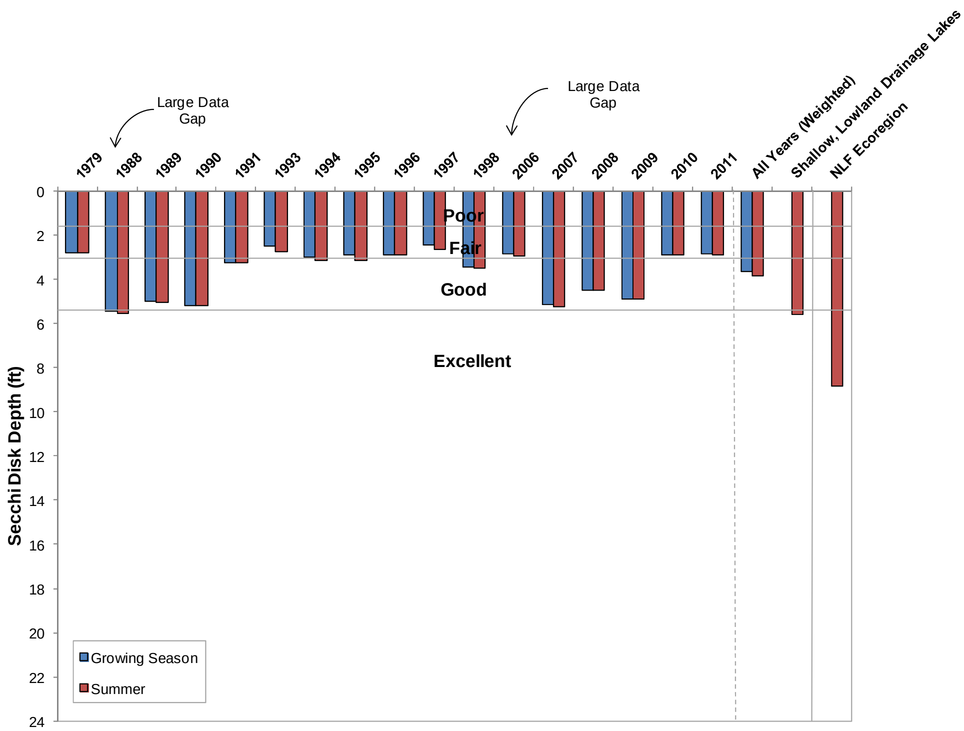

Figure 8.7.3-1. Deer Lake, state-wide shallow, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

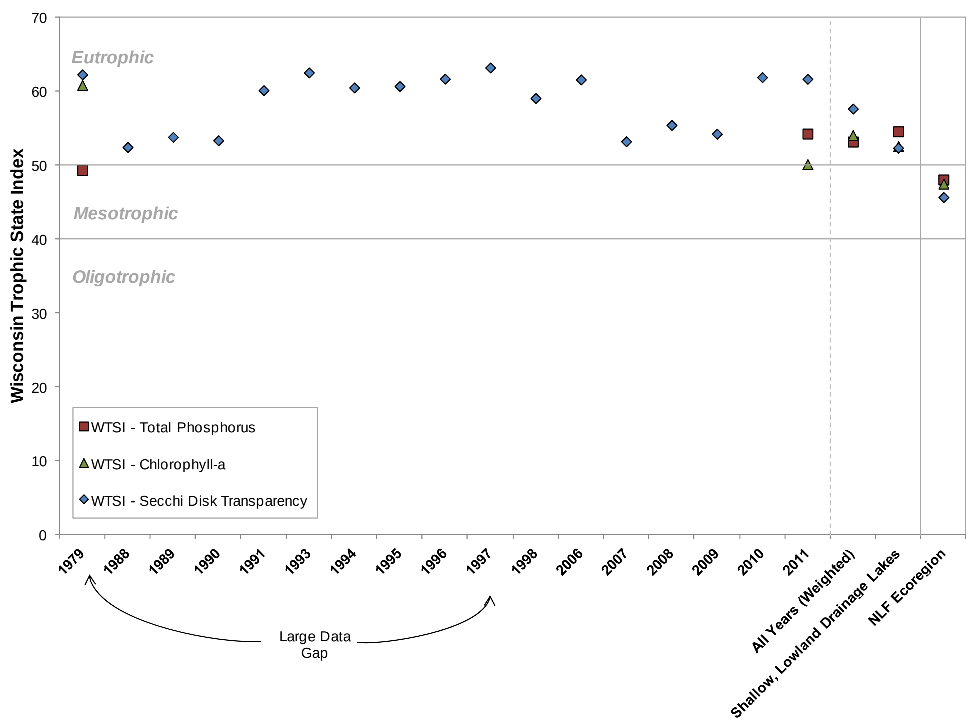

Figure 8.7.3-2. Deer Lake, state-wide shallow, lowland drainage lakes, and regional Wisconsin Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Deer Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Deer Lake by Onterra staff. Graphs of those data are displayed in Figure 8.7.3-3 for all sampling events.

Deer 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 the summer months. Despite this late summer dip, dissolved oxygen levels remained sufficient in the upper ~13 feet of the water column to support most aquatic life found in northern Wisconsin lakes. In the winter months, when ice cover and limited oxygen production from plants reduces oxygen content of the water, there is often concern that the levels of oxygen may dip below what is necessary for fish in the lake. Although oxygen concentrations decreased near the bottom of Deer Lake, levels remained high enough in the upper half of the water column.

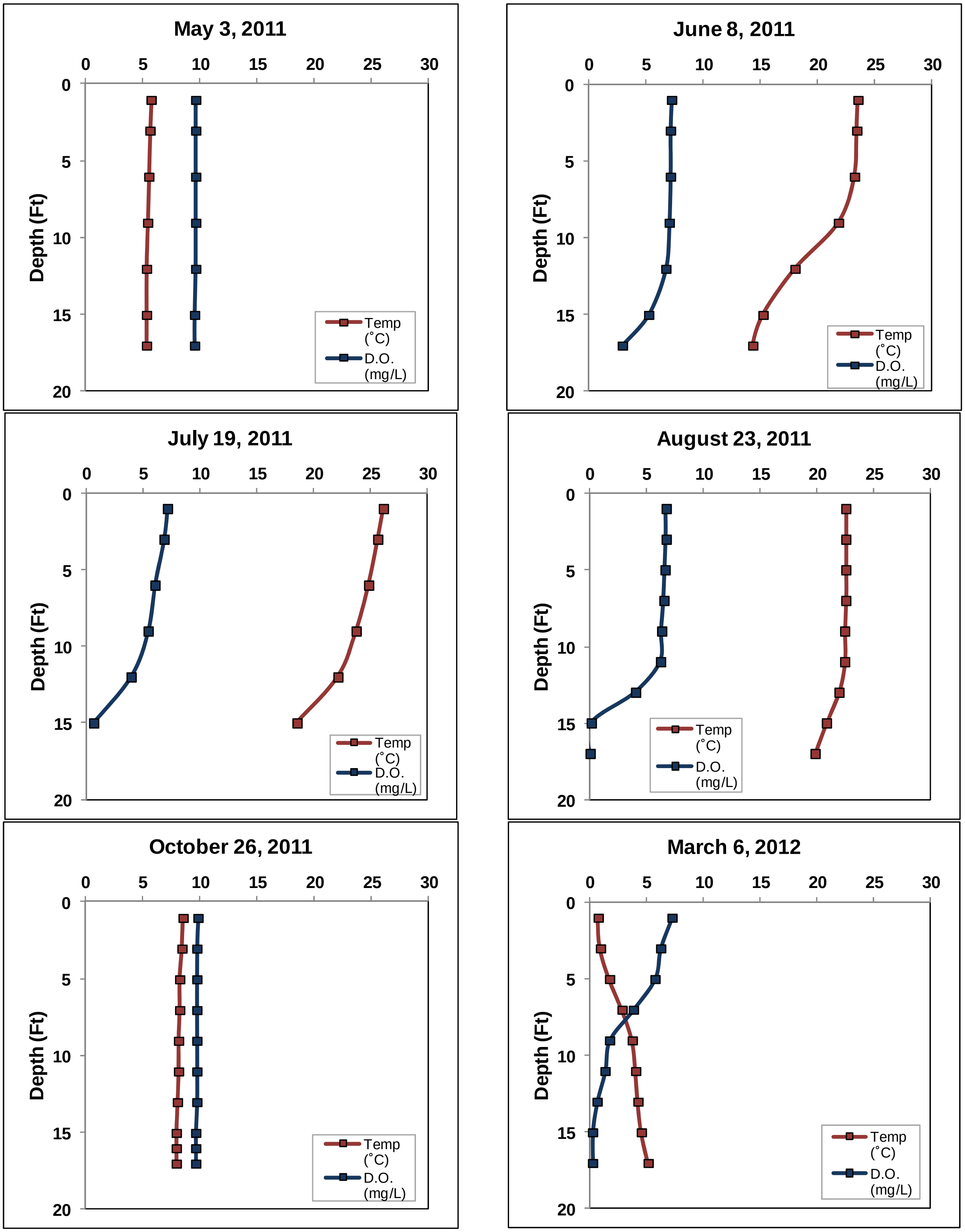

Figure 8.7.3-3. Deer Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Deer 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 Deer 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. Deer 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 Deer Lake was measured at 18.1 (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 Deer 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 Deer 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 Deer Lake was found to be 5.6 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.

8.7.4 Deer Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Deer 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 Deer Lake or is present at an undetectable level.

The aquatic plant point-intercept survey was conducted on Deer Lake on August 4 & 9, 2011 by Onterra. The floating-leaf and emergent plant community mapping survey was completed on August 8 & 9 to create the aquatic plant community map (Deer Lake Map 2). During all surveys, 38 species of native aquatic plants were located in Deer Lake (Table 8.7.4-1). 26 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 comparable to the other lakes 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 149 point-intercept locations sampled within the littoral zone, approximately 64% contained aquatic vegetation. Approximately 39% of the point-intercept sampling locations where sediment data was collected at were sand, 60% consisted of a fine, organic substrate (muck) and only 1% were determined to be rocky (Chain-wide Fisheries Section, Figure 3.4-5).

Table 8.7.4-1. Aquatic plant species located in the Deer Lake during the 2011 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2011 (Onterra)
Emergent	*Calla palustris*	Water arum	9	*I*
	Dulichium arundinaceum	Three-way sedge	9	*I*
	Decodon verticillatus	Water-willow	7	*I*
	Eleocharis palustris	Creeping spikerush	6	*X*
	Iris versicolor	Northern blue flag	5	*I*
	Juncus effusus	Soft rush	4	*X*
	Pontederia cordata	Pickerelweed	9	*X*
	Sagittaria latifolia	Common arrowhead	3	*I*
	Scirpus cyperinus	Wool grass	4	*I*
	Typha spp.	Cattail spp.	1	*X*
	Zizania palustris	Northern wild rice	8	*X*
FL	*Nuphar variegata*	Spatterdock	6	*X*
	Nymphaea odorata	White water lily	6	*X*
FL/E	*Sparganium emersum*	Short-stemmed bur-reed	8	*I*
	Sparganium fluctuans	Floating-leaf bur-reed	10	*X*
Submergent	*Chara spp.*	Muskgrasses	7	*X*
	Ceratophyllum demersum	Coontail	3	*X*
	Elodea canadensis	Common waterweed	3	*I*
	Elodea nuttallii	Slender waterweed	7	*X*
	Isoetes sp.	Quilwort species	N/A	*X*
	Myriophyllum sibiricum	Northern water milfoil	7	*I*
	Myriophyllum verticillatum	Whorled water milfoil	8	*I*
	Najas flexilis	Slender naiad	6	*X*
	Potamogeton amplifolius	Large-leaf pondweed	7	*X*
	Potamogeton natans	Floating-leaf pondweed	5	*X*
	Potamogeton spirillus	Spiral-fruited pondweed	8	*X*
	Potamogeton pusillus	Small pondweed	7	*X*
	Potamogeton robbinsii	Fern pondweed	8	*X*
	Potamogeton gramineus	Variable pondweed	7	*X*
	Potamogeton zosteriformis	Flat-stem pondweed	6	*X*
	Potamogeton epihydrus	Ribbon-leaf 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*
FF	*Lemna turionifera*	Turion duckweed	2	*I*
	Lemna trisulca	Forked duckweed	6	*X*
	Spirodela polyrhiza	Greater duckweed	5	*I*

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

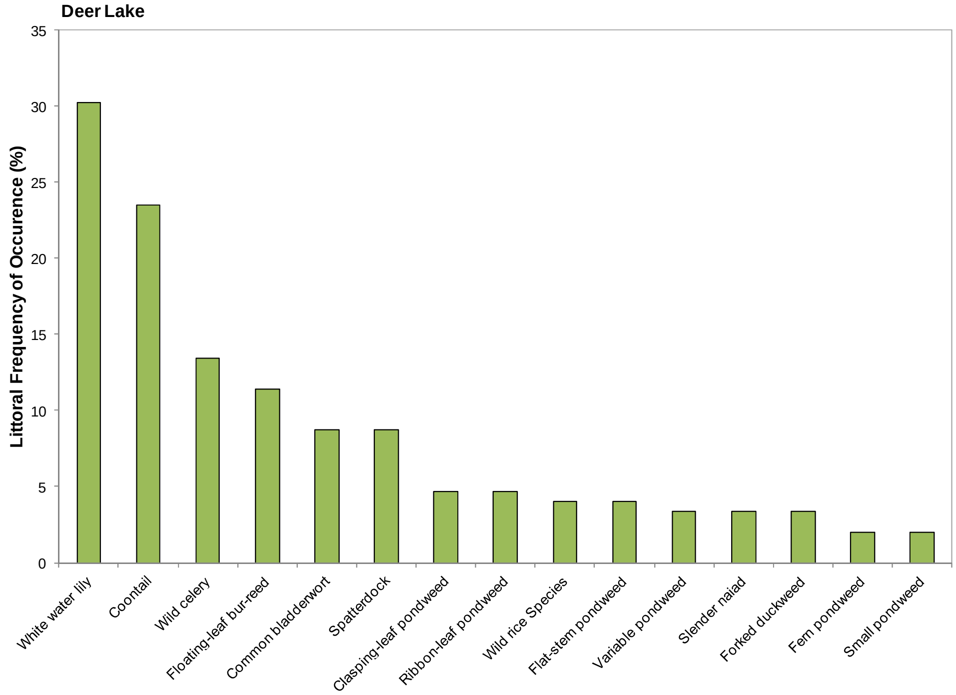

Figure 8.7.4-1 Deer Lake aquatic plant littoral frequency of occurrence analysis. Chart includes species with a frequency occurrence greater than 1.0% only. Created using data from a 2011 point-intercept survey.

Figure 8.7.4-1 (above) shows that white water lily, coontail and wild celery were the most frequently encountered plants within Deer Lake. White water lily is a floating-leaf species that produces broad, round leaves and a white flower. This plant is common in Wisconsin lakes around the shoreline, and in addition to creating shade for aquatic organisms it also serves as a food source. Able to obtain the majority of its essential nutrients directly from the water, coontail does not produce extensive root systems, making it susceptible to uprooting by water-action and water movement. When this occurs, uprooted plants float and aggregate on the water's surface where they can continue to grow and form dense mats. Coontail is tolerant to low-light conditions. 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.

Of the seven milfoil species (genus *Myriophyllum*) found in Wisconsin, two (northern water milfoil and whorled water milfoil) were located from Deer 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. Whorled water milfoil is a submerged milfoil plant with leaves in whorls of 4 to 5. As with northern water milfoil, the leaves of this plant have somewhat of a feathery appearance. It is often mistaken for northern water milfoil or the invasive Eurasian water milfoil. This plant is most readily distinguished from other milfoils by its overall size (whorled water milfoil is typically larger and more robust) and the length between leaf nodes, which is less than other species of milfoil (about 1 cm apart). Additionally, leaflet counts are helpful in identification – whorled water milfoil typically has 9-13 leaflet segments on each side of the midrib of the leaflet, while northern water milfoil has 5-10 and Eurasian water milfoil 12-24 leaflets.

38 species of aquatic plants (including incidentals) were found in Deer 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 Deer Lake's plant community (0.89) lies above the Northern Lakes and Forests Lakes ecoregion value (0.86), indicating the lake holds great diversity.

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 coontail was found at 23% of the sampling locations, its relative frequency of occurrence is 17%. Explained another way, if 100 plants were randomly sampled from Deer Lake, 17 of them would be coontail. This distribution can be observed in Figure 8.7.4-2, where together 10 species account for 83% of the population of plants within Deer Lake, while the other 16 species account for the remaining 17%. Twelve additional species were located from the lake but not from of the point-intercept survey, and are indicated in Table 8.7.4-1 as incidentals.

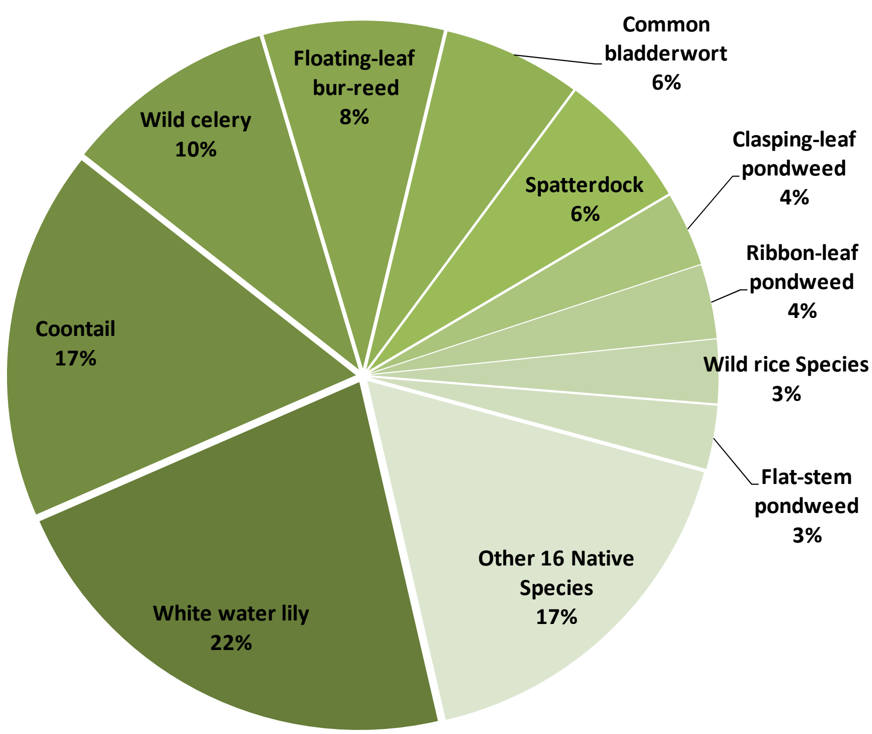

Figure 8.7.4-2 Deer Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2011 point-intercept survey.

Deer Lake's average conservatism value (6.3) is slightly higher than the state median value, but lower than the ecoregion median. This indicates that the plant community of Deer Lake is indicative of a moderately disturbed system. This is not surprising considering Deer Lake's plant community has moderate diversity and species richness. Combining Deer Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 32.2 which is above the median values of the ecoregion and state.

The quality of Deer 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 70.2 acres of the lake contains these types of plant communities (Deer Lake Map 2, Table 8.7.4-2). Fifteen floating-leaf and emergent species were located on Deer Lake (Table 8.2.4-1), all of which provide valuable wildlife habitat.

Table 8.7.4-2. Deer Lake acres of emergent and floating-leaf plant communities from the 2011 community mapping survey.

Plant Community	Acres
Emergent	23.2
Floating-leaf	13.9
Mixed Floating-leaf and Emergent	33.1
Total	70.2

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 Deer 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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