8.2 WHITEFISH LAKE

8.2.1 An Introduction to Whitefish Lake

Whitefish Lake, Oneida County, is a drainage lake with a maximum depth of 33 feet and a surface area of 205 acres. This mesotrophic lake has a relatively large watershed when compared to the size of the lake. Whitefish Lake contains 49 native plant species, of which wild celery is the most common plant. No exotic plants were observed during the 2010 lake surveys.

Field Survey Notes

Difficulty accessing lake via Throoughfare in mid-April, due to lower water levels. Access was possibly later in month.

Many (49) aquatic plant species encountered during poin-intercept survey. Very large muskellunge spotted in shallow waters of isolated eastern bay.

Photo 8.2.1-1 Whitefish Lake, Oneida County

Lake at a Glance – Whitefish Lake

Morphology	
Acreage	205
Maximum Depth (ft)	33
Mean Depth (ft)	16
Volume (acre-feet)	3,252
Shoreline Complexity	3.1
Vegetation	
Curly-leaf Survey Date	June 17, 2010
Comprehensive Survey Date	August 10, 2010
Number of Native Species	49
Threatened/Special Concern Species	-
Exotic Plant Species	-
Simpson's Diversity	0.93
Average Conservatism	7.1
Water Quality	
Wisconsin Lake Classification	Deep, lowland drainage
Trophic State	Mesotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	95:1

8.2.2 Whitefish Lake Watershed Assessment

Whitefish Lake's watershed is 19,630 acres in size. Compared to Whitefish Lake's size of 205 acres, this makes for an incredibly large watershed to lake area ratio of 95:1.

Exact land cover calculation and modeling of nutrient input to Whitefish 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 2010, Whitefish Lake's immediate shoreline was assessed in terms of its development. Whitefish Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.1 miles of natural/undeveloped and developed-natural shoreline (33% of the entire shoreline) were observed during the survey (Figure 8.2.2-1). 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, about 0.9 miles of urbanized and developed–unnatural shoreline (27% of the total shoreline) was observed. If restoration of the Whitefish 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. Whitefish Lake Map 1 displays the location of these shoreline lengths around the entire lake.

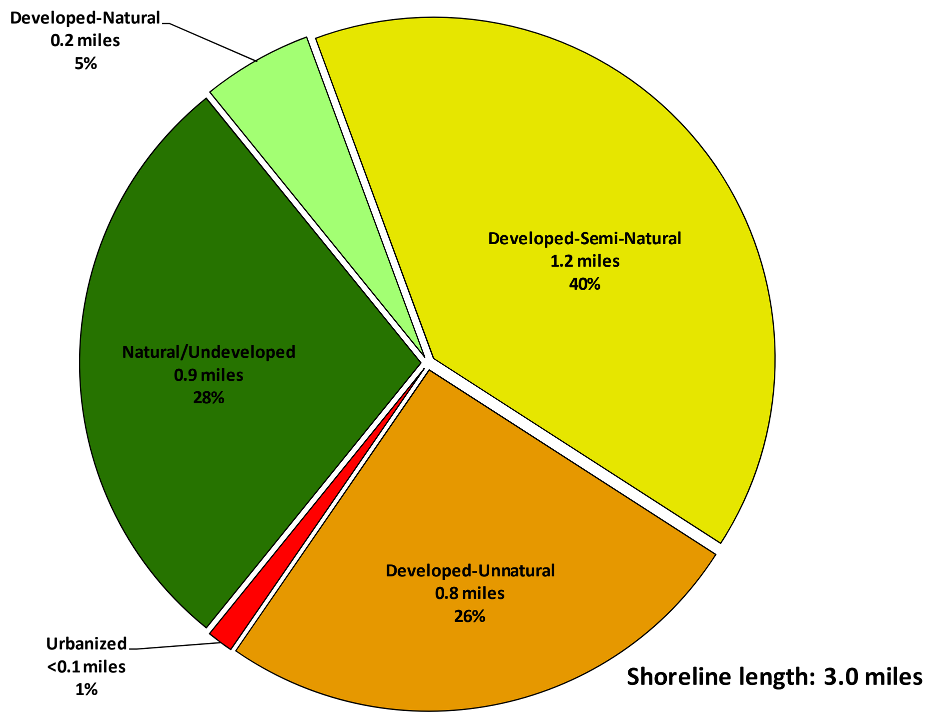

Figure 8.2.2-1. Whitefish Lake shoreland categories and total lengths. Based upon a late summer 2010 survey. Locations of these categorized shorelands can be found on Whitefish Lake Map 1.

8.1.3 Whitefish Lake Water Quality

During 2011/2012, water quality data was collected from Whitefish 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 Secchi disk clarity since 2006, with advanced monitoring (total phosphorus and chlorophyll-*a*) beginning in 2007. These efforts provide consistent, reliable data on which a comparable database may be built. Monitoring should be continued in order to understand trends in the water quality of Whitefish Lake for years to come.

During this time, summer average total phosphorus concentrations have ranged consistently between 14.5 and 19.7 µg/L (Figure 8.2.3-1). Some of these average annual concentrations rank within the TSI category of *Good*, with most ranking as *Excellent*. A weighted value across all years is lower than the median for deep, lowland drainage lakes in the state of Wisconsin. As with the total phosphorus values, average summer chlorophyll-*a* concentrations also rank within categories of *Good* and mostly *Excellent*, and a weighted average is less than the median concentration for similar lakes across the state (Figure 8.2.3-2).

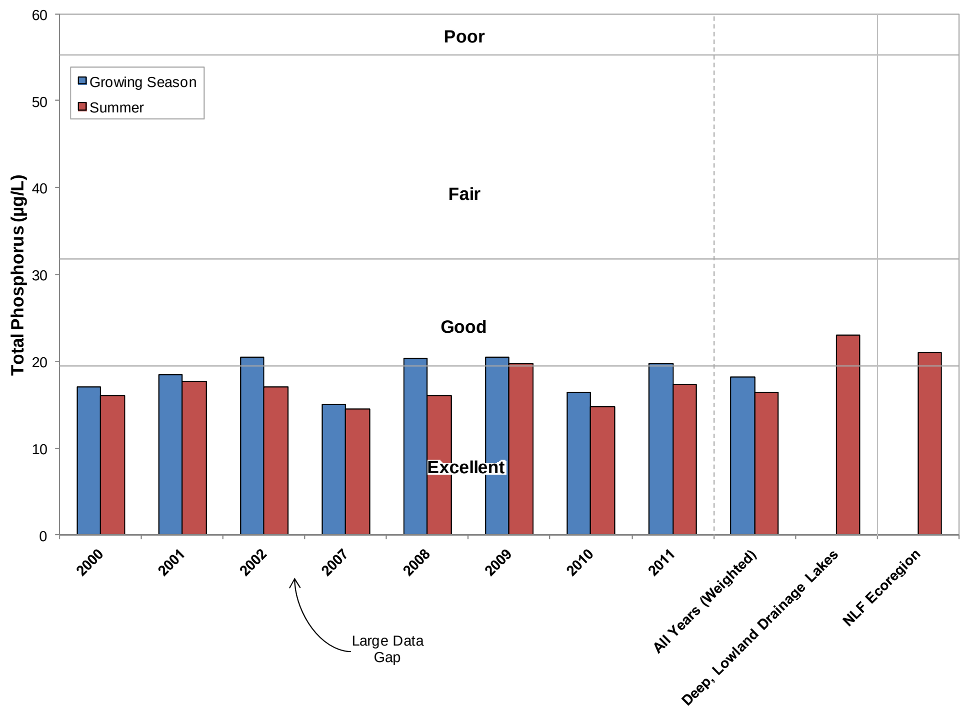

Figure 8.2.3-1. Whitefish Lake, state-wide deep, lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

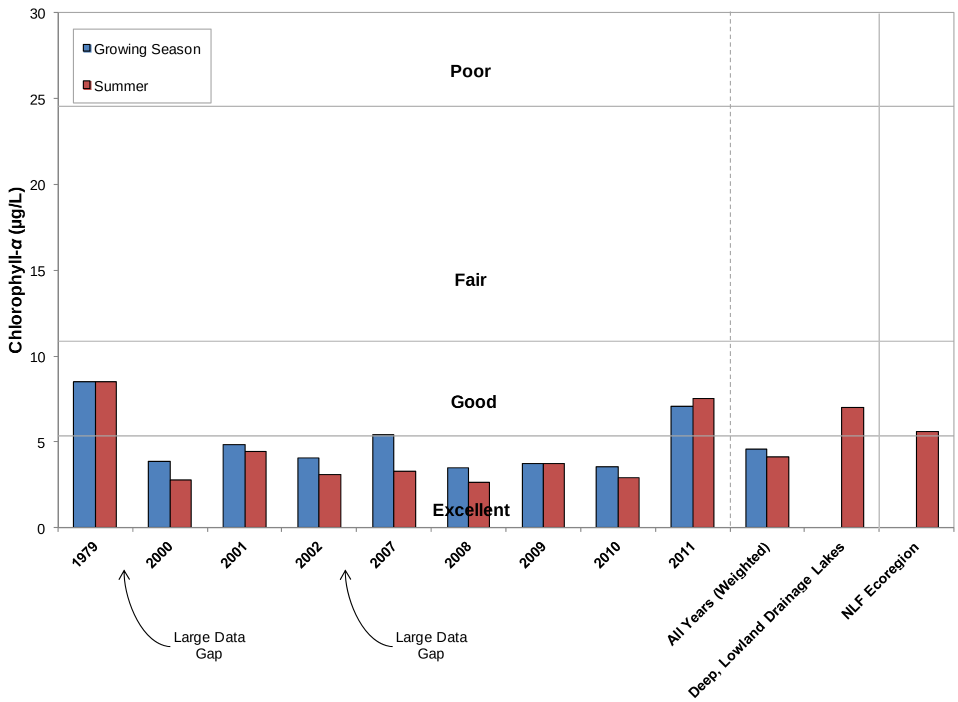

Figure 8.2.3-2. Whitefish Lake, state-wide deep, lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span a longer timeframe than the other two primary water quality parameters (Figure 8.1.3-3). Summer averages lie mostly within the *Excellent* category. A weighted average across all years is slightly greater than the average for deep, 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. Comparing the chlorophyll-*a* dataset with the Secchi disk clarity dataset, it is apparent that during most years the two parameters do indeed have an inverse relationship. For example, in 2010 chlorophyll-*a* concentrations were relatively low in the lake, and in that same year Secchi disk depth averages are fairly high. On the other hand, in 2011 average chlorophyll-*a* concentrations were particularly high for Whitefish Lake and, as a result, the average Secchi disk depth was fairly low during that time.

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 also plays a role in light penetration, and thus water clarity, as well. The darker waters of Whitefish 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.

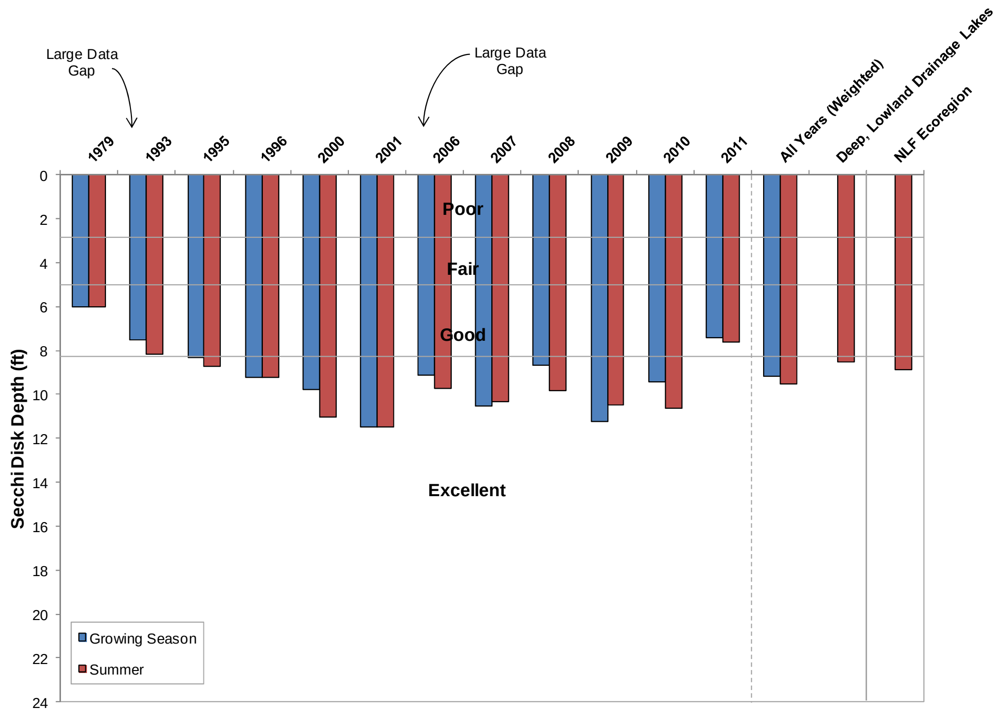

Figure 8.2.3-3. Whitefish Lake, state-wide deep, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Whitefish Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to eutrophic (Figure 8.2.3-4). 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 Whitefish Lake is in a mesotrophic state.

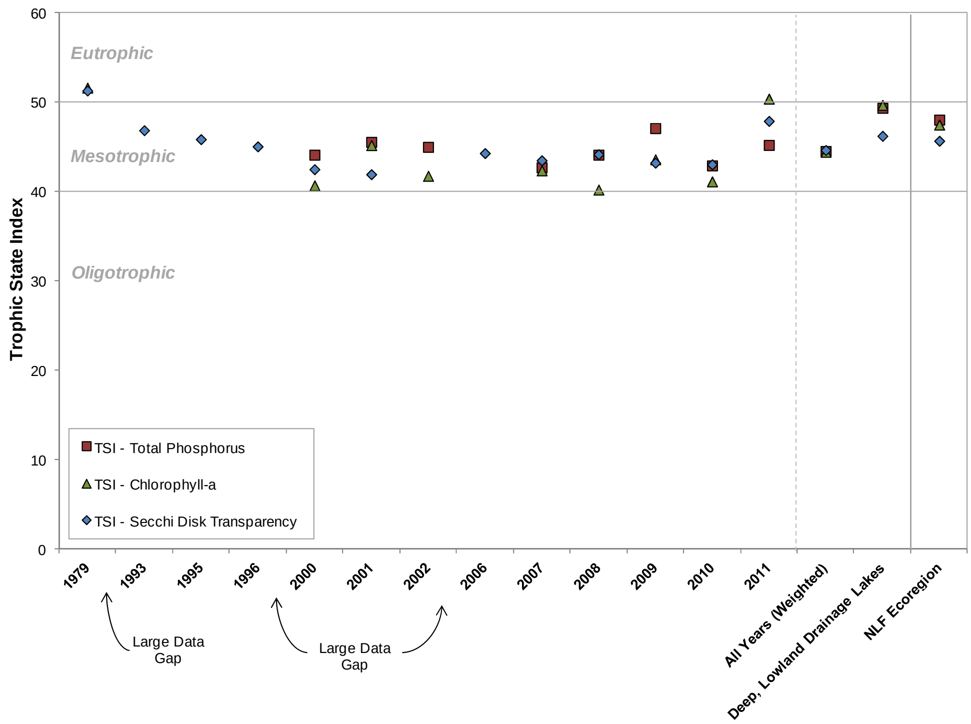

Figure 8.1.3-4. Whitefish Lake, state-wide deep, lowland drainage lakes, and regional Wisconsin Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Whitefish Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Whitefish Lake by Onterra staff. Graphs of those data are displayed in Figure 8.2.3-5 for all sampling events.

Whitefish Lake was found to be thoroughly mixed during the spring, but quickly stratified once the weather warmed the uppermost layers of water in June. Throughout the summer months, the lake remained thermally stratified at about 15 feet. This is not uncommon in lakes that are moderate in size and fairly deep. Energy from the wind is sufficient to mix only the upper layer of water, allowing the cooler, denser water to remain below. Decomposition of organic matter along the lake bottom is the cause of the decrease in dissolved oxygen observed in the summer months. In October, the lake is mixed once again by fall winds and oxygen is restored throughout the water column. During the winter months, dissolved oxygen depletes within the lake because the water is not able to exchange oxygen with the air through the ice. Dissolved oxygen levels remained sufficient in the upper 15 feet of the water column year-round to support most aquatic life found in northern Wisconsin lakes.

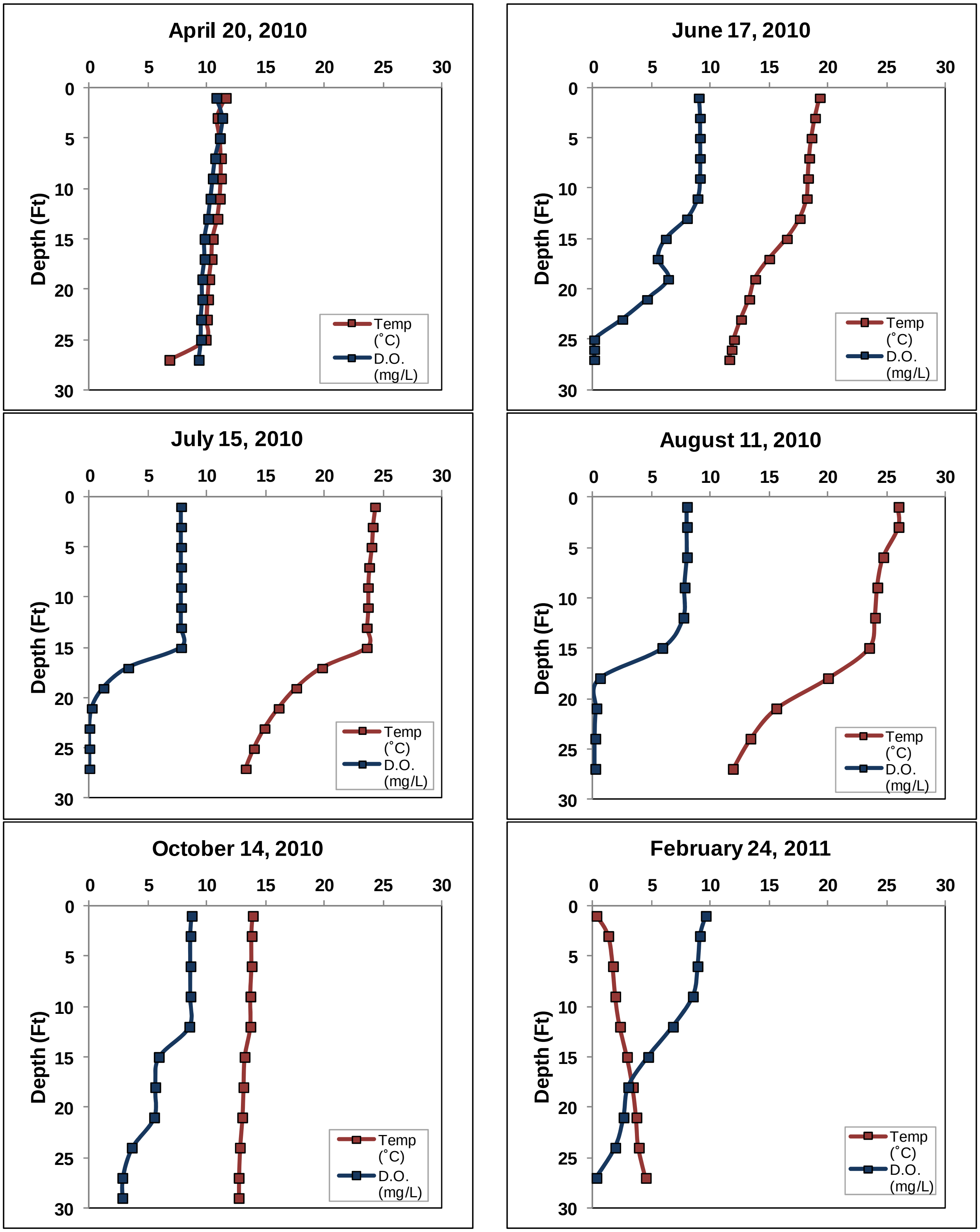

Figure 8.2.3-5. Whitefish Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Whitefish 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 Whitefish 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. Whitefish Lake's pH was measured at roughly 7.9 in the summer months of 2010. This value is above 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 Whitefish Lake was measured at 44.5 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and is not sensitive to acid rain.

Samples of calcium were also collected from Whitefish Lake during the summer of 2010. 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 Whitefish Lake's pH of 7.9 falls within 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 Whitefish Lake was found to be 11.3 mg/L, falling just below the optimal range for zebra mussels. Plankton tows were completed by Onterra staff during the summer of 2010 and these samples were processed by the WDNR for larval mussels. No veligers (larval mussels) were found within these samples.

8.2.4 Whitefish Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Whitefish Lake on June 17, 2010. 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 Whitefish Lake or is present at an undetectable level.

The aquatic plant point-intercept survey was conducted on Whitefish Lake on August 10, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was completed on August 11 to create the aquatic plant community map (Whitefish Lake Community Map). During all surveys, 49 species of native aquatic plants were located in Whitefish Lake (Table 8.2.4-1). 36 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 14 feet, which is deep relative to the other lakes within the Three Lakes Chain of lakes, where plants may be found growing to only six feet of water. As discussed later on within this section, the species found in this survey indicate that the overall aquatic plant community is healthy and diverse.

Of the 174 point-intercept locations sampled within the littoral zone, approximately 86% contained aquatic vegetation. Approximately 74% of the point-intercept sampling locations where sediment data was collected at were sand, 24% consisted of a fine, organic substrate (muck) and 3% were determined to be rocky (Chain-wide Fisheries Section, Figure 3.4-5).

Table 8.2.4-1. Aquatic plant species located in the Whitefish Lake during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2010 (Onterra)
Emergent	*Carex comosa*	Bristly sedge	5	I
	Carex utriculata	Northwest Territory sedge	7	I
	Calla palustris	Water arum	9	I
	Dulichium arundinaceum	Three-way sedge	9	I
	Decodon verticillatus	Water-willow	7	I
	Iris versicolor	Northern blue flag	5	I
	Pontederia cordata	Pickerelweed	9	X
	Sagittaria latifolia	Common arrowhead	3	I
	Schoenoplectus acutus	Hardstem bulrush	5	I
	Scirpus cyperinus	Wool grass	4	I
	Schoenoplectus subterminalis	Water bulrush	9	X
	Typha spp.	Cattail spp.	1	X
	Zizania palustris	Northern wild rice	8	X
FL	*Brasenia schreberi*	Watershield	7	I
	Nymphaea odorata	White water lily	6	X
	Nuphar variegata	Spatterdock	6	X
FL/E	*Sparganium eurycarpum*	Common bur-reed	5	I
	Sparganium angustifolium	Narrow-leaf bur-reed	9	X
	Sparganium emersum	Short-stemmed bur-reed	8	X
	Sparganium fluctuans	Floating-leaf bur-reed	10	X
Submergent	*Chara spp.*	Muskgrasses	7	X
	Ceratophyllum demersum	Coontail	3	X
	Elodea canadensis	Common waterweed	3	X
	Heteranthera dubia	Water stargrass	6	X
	Isoetes lacustris	Lake quillwort	8	X
	Megalodonta beckii	Water marigold	8	X
	Myriophyllum sibiricum	Northern water milfoil	7	X
	Nitella sp.	Stoneworts	7	X
	Najas flexilis	Slender naiad	6	X
	Potamogeton natans	Floating-leaf pondweed	5	I
	Potamogeton strictifolius	Stiff pondweed	8	I
	Potamogeton illinoensis	Illinois pondweed	6	X
	Potamogeton spirillus	Spiral-fruited pondweed	8	X
	Potamogeton obtusifolius	Blunt-leaf pondweed	9	X
	Potamogeton foliosus	Leafy pondweed	6	X
	Potamogeton praelongus	White-stem pondweed	8	X
	Potamogeton gramineus	Variable pondweed	7	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X
	Potamogeton friesii	Fries' pondweed	8	X
	Potamogeton robbinsii	Fern pondweed	8	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X
	Potamogeton pusillus	Small pondweed	7	X
	Ranunculus aquatilis	White water-crowfoot	8	X
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A	X
	Utricularia intermedia	Flat-leaf bladderwort	9	X
	Utricularia vulgaris	Common bladderwort	7	X
	Vallisneria americana	Wild celery	6	X
S/E	*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

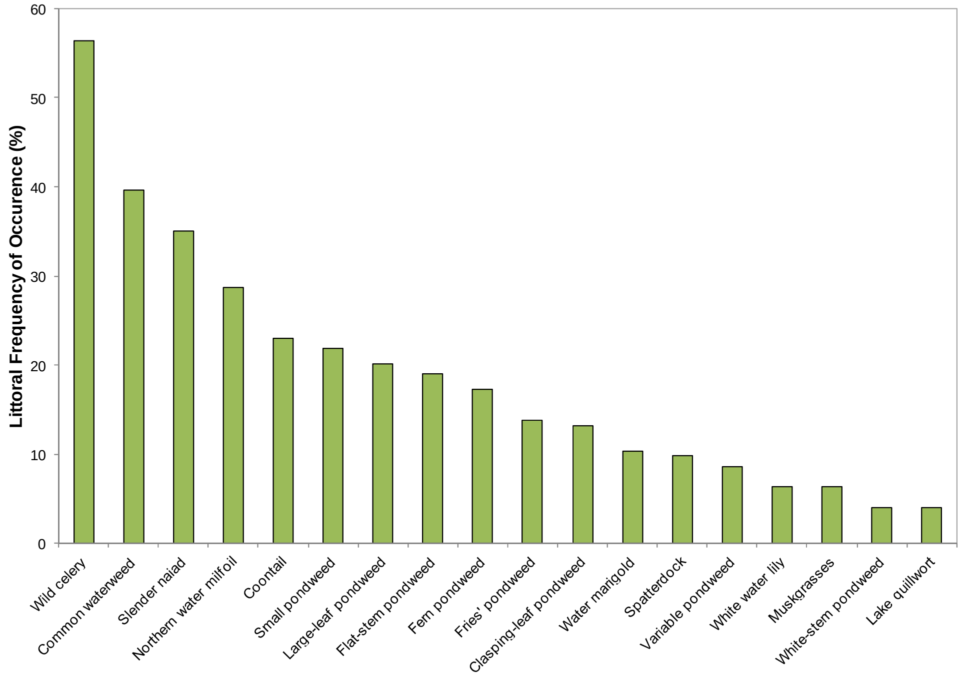

Figure 8.2.4-1 Whitefish Lake aquatic plant littoral frequency of occurrence analysis. Chart includes species with a frequency occurrence greater than 3.0% only. Created using data from a 2010 point-intercept survey.

Figure 8.2.4-1 (above) shows that wild celery, common waterweed, and slender naiad were the most frequently encountered plants within Whitefish Lake. Wild celery is a submerged aquatic plant with ribbon-shaped floating leaves that may grow to as long as two meters, depending on water depth. It is a preferred food choice by numerous species of waterfowl and aquatic invertebrates. Common waterweed is able to obtain most of its nutrients through the water and thus does not produce extensive root systems. Sometimes, this plant may produce structures similar to roots (rhizoids) or become partially buried in the sediment. Because of this, the plant is susceptible to being easily uprooted and migrated by water-action and movement. As its name implies, slender naiad is a slender, low-growing species with narrow, short pale green leaves. This submerged plant provides habitat for small aquatic organisms and is a food source of waterfowl.

Of the seven milfoil species (genus *Myriophyllum*) found in Wisconsin, only one (northern water milfoil) was located from Whitefish 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.

An incredible 49 species of aquatic plants (including incidentals) were found in Whitefish 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 Whitefish Lake's plant community (0.93) lies above the Northern Lakes and Forests Lakes ecoregion value (0.86), indicating the lake holds exceptional 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 wild celery was found at 56% of the sampling locations, its relative frequency of occurrence is 15%. Explained another way, if 100 plants were randomly sampled from Whitefish Lake, 15 of them would be wild celery. This distribution can be observed in Figure 8.2.4-2, where together nine species account for 72% of the population of plants within Whitefish Lake, and the other 27 species account for the remaining 28%. Thirteen additional species were found incidentally within the lake (not from of the point-intercept survey), and are indicated in Table 8.2.4-1 as incidentals.

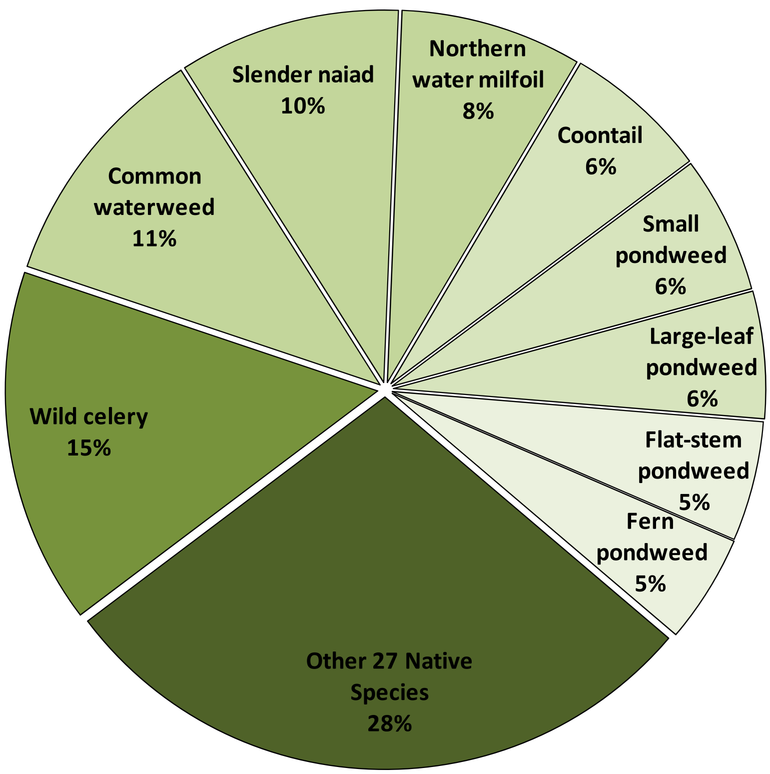

Figure 8.2.4-2 Whitefish Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Whitefish Lake's average conservatism value (7.1) is higher than both the state (6.0) and ecoregion (6.7) median. This indicates that the plant community of Whitefish Lake is indicative of an undisturbed system. This is not surprising considering Whitefish Lake's plant community has great diversity and high species richness. Combining Whitefish Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 42.5 which is well above the median values of the ecoregion and state.

The quality of Whitefish Lake is also indicated by the high incidence of emergent and floating-leaf plant communities that occur in many areas. The 2010 community map indicates that approximately 15.4 acres of the lake contains these types of plant communities (Whitefish Lake Map 2, Table 8.2.4-2). 18 floating-leaf and emergent species were located on Whitefish Lake (Table 8.2.4-1), all of which provide valuable wildlife habitat.

Table 8.2.4-2. Whitefish Lake acres of emergent and floating-leaf plant communities from the 2010 community mapping survey.

Plant Community	Acres
Emergent	0.1
Floating-leaf	1.2
Mixed Floating-leaf and Emergent	14.1
Total	15.4

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 Whitefish 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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