Note: Methodology, explanation of analysis and biological background on Clear Lake studies are contained within the Manitowish Waters Chain of Lakes-wide Management Plan document.

8.4 Clear Lake

An Introduction to Clear Lake

Clear Lake, Vilas County, is a spring lake with a maximum depth of 45 feet, a mean depth of 16 feet, and a surface area of approximately 568 acres. The lake empties into downstream Fawn Lake. The lake is in a mesotrophic state, and its watershed encompasses approximately 3,046 acres. In 2013, 55 native aquatic plant species were located in the lake, of which fern pondweed (*Potamogeton robbinsii*) was the most common. No aquatic invasive plant species were observed growing in or along the shorelines of Clear Lake in 2013.

Field Survey Notes

Abundance of native plants in this clear-watered, minimally developed lake. No exotic plant species found during surveys.

Photo 8.4. Clear Lake, Vilas County

Lake at a Glance* – Clear Lake

Morphology	
Acreage	568
Maximum Depth (ft)	45
Mean Depth (ft)	16
Volume (acre-feet)	9,055
Shoreline Complexity	6.5
Vegetation	
Curly-leaf Survey Date	June 25, 2013
Comprehensive Survey Date	July 31, 2013
Number of Native Species	55
Threatened/Special Concern Species	Vasey's pondweed (*Potamogeton vaseyi*)
Exotic Plant Species	-
Simpson's Diversity	0.90
Average Conservatism	6.7
Water Quality	
Wisconsin Lake Classification	Deep, Seepage
Trophic State	Mesotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	4:1

**These parameters/surveys are discussed within the Chain-wide portion of the management plan.*

8.4.1 Clear Lake Water Quality

Water quality data was collected from Clear Lake on six occasions in 2013/2014. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen. Please note that the data in these graphs represent concentrations and depths taken during the growing season (April-October), summer months (June-August) or winter (February-March) as indicated with each dataset. Furthermore, unless otherwise noted the phosphorus and chlorophyll-*a* data represent only surface samples. In addition to sampling efforts completed in 2013/2014, any historical data was researched and are included within this report as available.

Note that in this report, Clear Lake is compared against water quality variables for deep, seepage lakes. Technically, Clear Lake may be considered a spring lake because of its hydrology; it has no surface inlet stream but does flow to the south into Fawn Lake, so has an outlet stream. For the purposes of the water quality analysis however, Clear Lake will be categorized as a seepage lake as it most closely aligns to this lake type within WisCALM (2014).

A fair amount of historical data is available for Clear Lake due to the efforts of volunteers through Wisconsin's Citizens Lake Monitoring Network. The datasets include nearly 15 years of non-continuous total phosphorus data. In 2013, average summer phosphorus concentrations averaged 14.9 µg/L, which is comparable to the median value (15.0 µg/L) for other deep, lowland drainage lakes in the state (Figure 8.4.1-1). This value is also lower than the value for other lakes within the Northern Lakes and Forests ecoregion. A weighted value from all available data ranks as *Good* for a deep, lowland drainage lake. The 2013 data is similar to phosphorus concentrations measured during the late 1990's and 2000's. From the available data, no changes in annual total phosphorus concentrations can be observed.

Total phosphorus surface values from 2013 are compared with bottom-lake samples collected during this same time frame in Figure 8.4.1-2. As displayed in this figure, during spring and fall turnovers (lake vertical mixing) surface and bottom total phosphorus concentrations were similar. However, during the summer and winter, the bottom phosphorus concentrations were greater than the relatively low surface concentrations. During these periods, anoxic conditions were recorded near the bottom of the lake through measurement of dissolved oxygen (refer to Figure 8.4.1-6 and associated text). This is an indication of hypolimnetic nutrient recycling, or internal nutrient loading, which is a process discussed further in the Manitowish Waters Chain of Lakes-wide document. This is a natural process that most lakes have. While the hypolimnetic concentrations are higher than surface water concentrations, these relatively higher levels are not high enough to negatively impact Clear Lake's surface water quality. Typically, lake managers do not become concerned unless these concentrations near 200 µg/L)

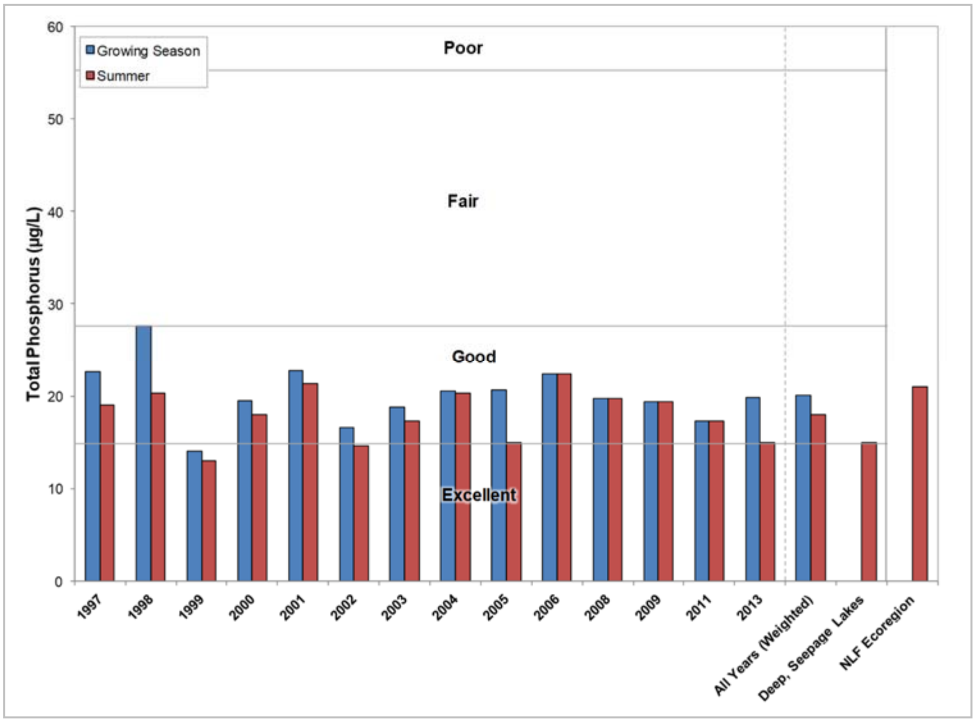


Figure 8.4.1-1. Clear Lake, state-wide deep seepage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

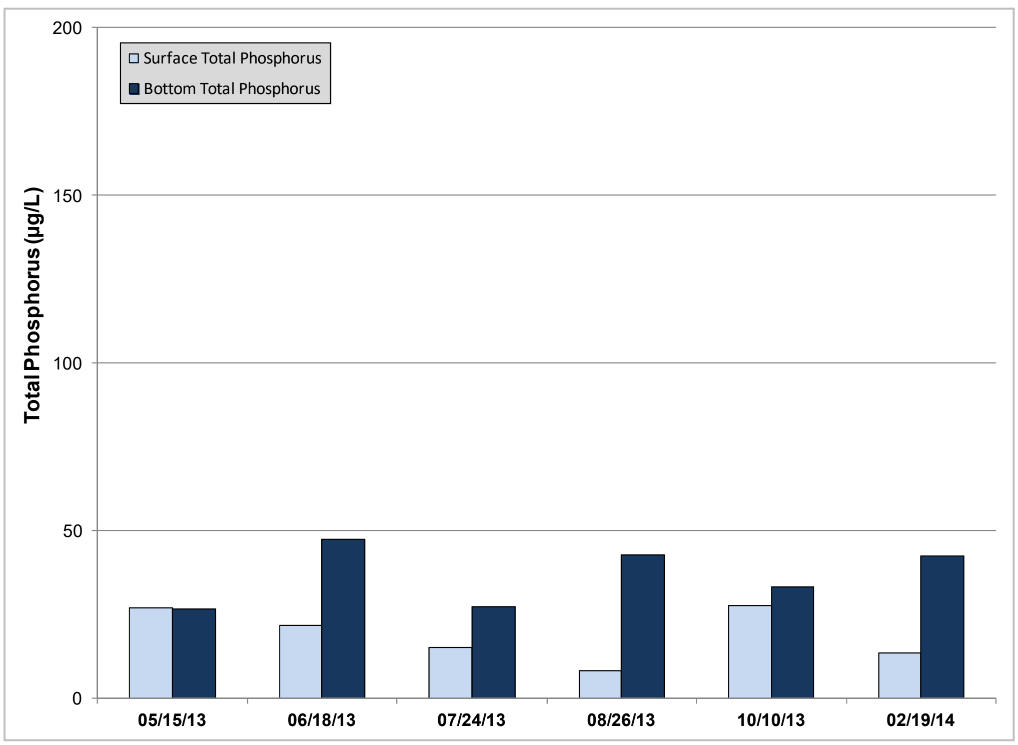


Figure 8.4.1-2. Clear Lake surface and bottom total phosphorus values, 2013-2014. Anoxia was observed in the hypolimnion of the lake during June, July, August and February sampling visits.

Similar to what has been observed with the total phosphorus dataset, summer average chlorophyll-*a* concentrations (3.9 µg/L) were comparable to the median value (3.6 µg/L) for other lakes of this type and are lower than the median for all lakes in the ecoregion (Figure 8.4.1-3). Both of these parameters, total phosphorus and chlorophyll-*a*, rank within a TSI category of *Good*, indicating the lake has enough nutrients for production of aquatic plants, algae, and other organisms but not so much that a water quality issue is present. During 2013 visits to the lake, Onterra ecologists recorded field notes describing very good water conditions.

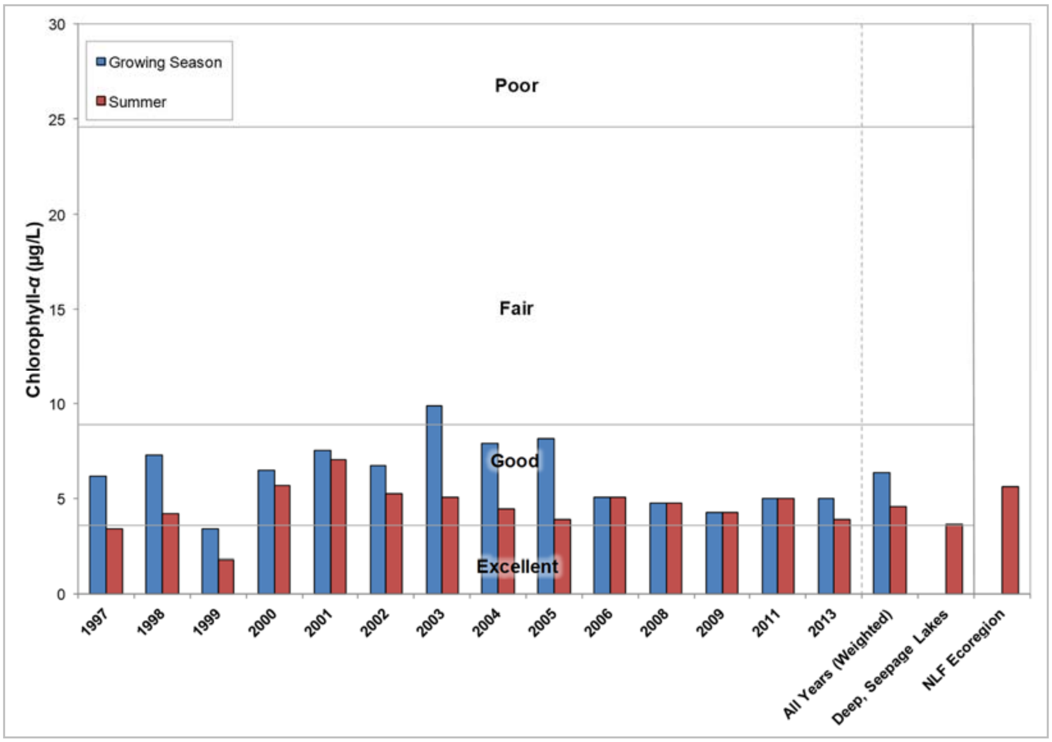


Figure 8.4.1-3. Clear Lake, state-wide deep seepage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

From the examination of the available Secchi disk clarity data, several conclusions can be drawn. First, the clarity of Clear Lake's water can be described as *Good* to *Excellent* during the summer months in which data has been collected (Figure 8.4.1-4). A weighted average over this timeframe is slightly greater than the median value for other deep seepage lakes in the state and is also greater than the regional median. Secondly, there is no apparent trend in the clarity of the water in Clear Lake; the data indicate that clarity may differ from one year to the next, but has not gotten "worse" or "better" over this time period.

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 Clear Lake as well as the other lakes in the Manitowish Waters Chain of Lakes, a natural staining of the water plays a role in light penetration, and thus water clarity, as well. The waters of Clear Lake contain naturally occurring 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 terrestrial and wetland plant species. This natural staining may reduce light penetration into the water column, which reduces visibility and also reduces the growing depth of aquatic vegetation within the lake. Because of its smaller watershed relative to the other Manitowish Waters Chain of Lakes, Clear Lake's water may be less stained.

"True color" measures the dissolved organic materials in water. Water samples collected in April and July of 2013 were measured for this parameter, and were found to be 20 and 10 Platinum-cobalt units (Pt-co units, or PCU), respectively. Lillie and Mason (1983) categorized lakes with 0-40 PCU as having "low" color, 40-100 PCU as "medium" color, and >100 PCU as high color.

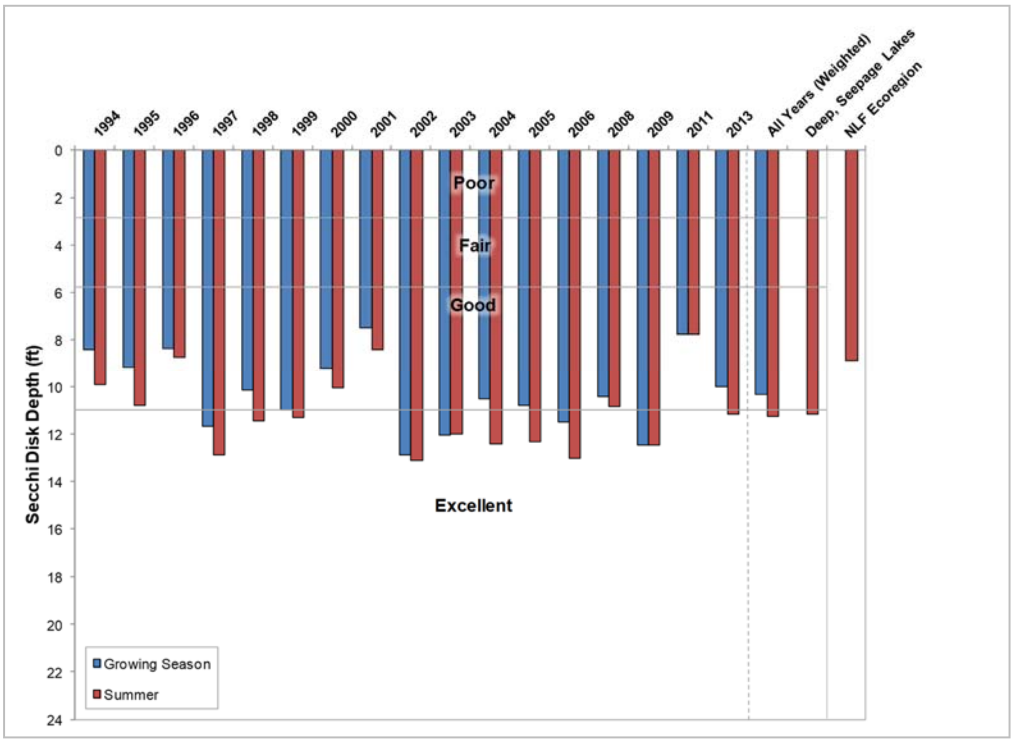


Figure 8.4.1-4. Clear Lake, state-wide deep seepage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Clear 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 8.4.1-5). 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 Clear Lake is in a mesotrophic state.

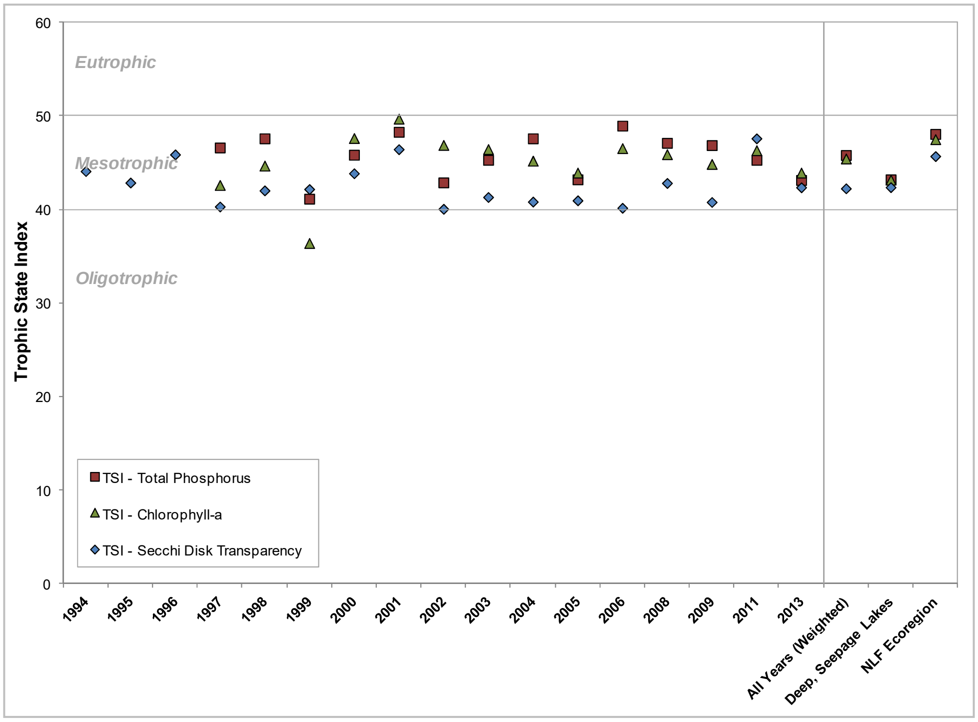


Figure 8.4.1-5. Clear Lake, state-wide deep seepage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Clear Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Clear Lake by Onterra staff. Graphs of those data are displayed in Figure 8.4.1-6 for all sampling events.

Clear Lake mixes thoroughly during the spring and fall, when changing air and water temperatures as well as gusty winds help to mix the water column. During the summer months, the bottom of the lake becomes void of oxygen and temperatures remain fairly cool as they were in the spring months. This occurrence is not uncommon in deep Wisconsin lakes; the sun's warmth is only able to penetrate the upper layer of the water column and wind energy is not sufficient to mix the entire water column either. Dissolved oxygen is mixed within the upper water column through plant respiration and atmospheric exchange. Oxygen may decrease in the hypolimnion, as the oxygenated upper water column is not able to exchange with this region. Additionally, during this time bacteria break down organic matter that has collected at the bottom of the lake and in doing so utilize any available oxygen.

The lake mixes completely again in the fall, re-oxygenating the water in the lower part of the water column. During the winter months, the coldest temperatures are found just under the overlying ice, while oxygen gradually diminishes once again towards the bottom of the lake. In February of 2013, oxygen levels remained sufficient throughout most of the water column to support most aquatic life in northern Wisconsin lakes.

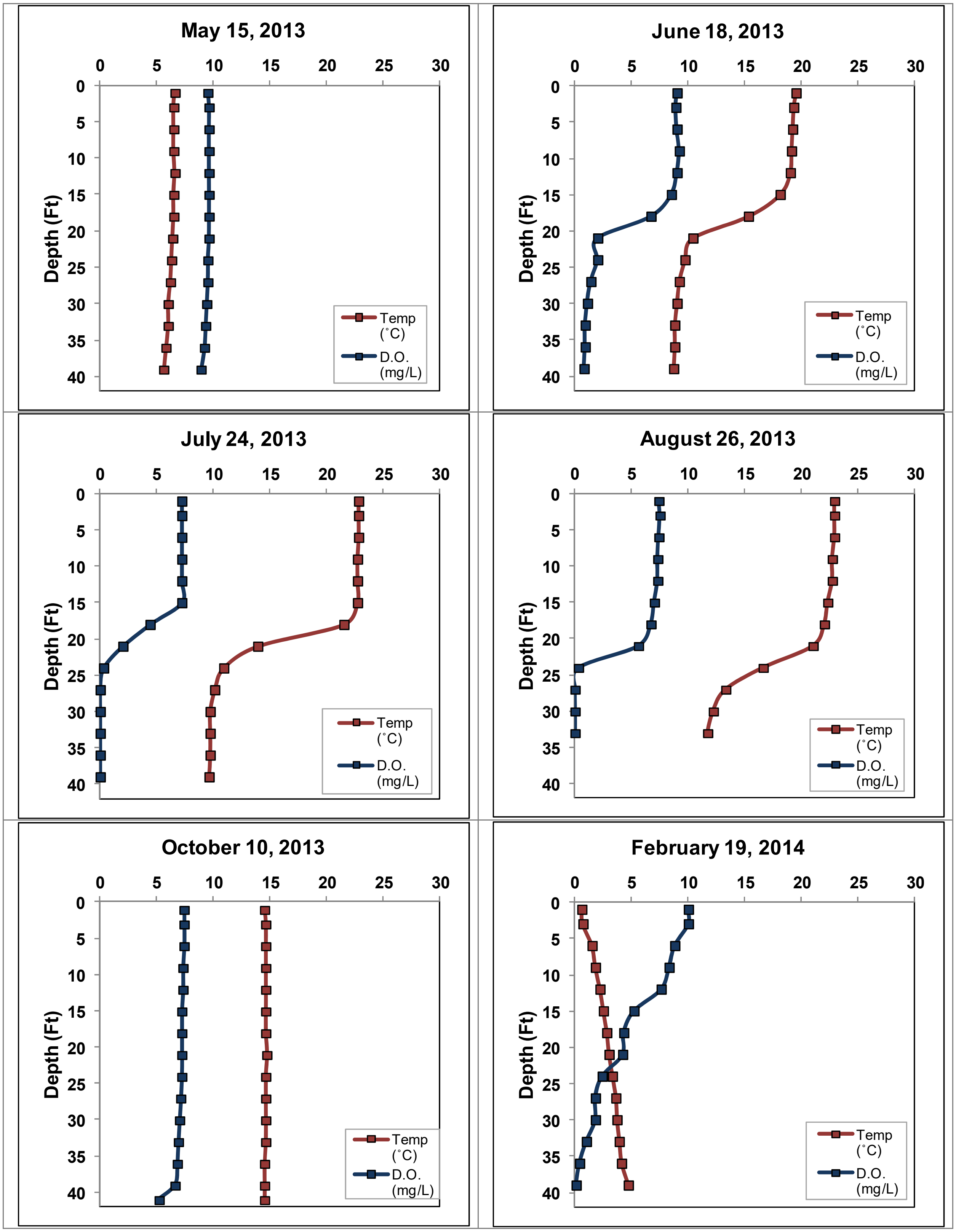


Figure 8.4.1-6. Clear Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Clear 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 Clear 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 Chain-wide 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. Clear Lake's surface water pH was measured at roughly 7.5 during May and 7.8 during July of 2013. These values are near or slightly above neutral and fall within the normal range for Wisconsin lakes. Fluctuations in pH with respect to seasonality is common; in-lake processes such as photosynthesis by plants act to reduce acidity by carbon dioxide removal while decomposition of organic matter add carbon dioxide to water, thereby increasing acidity.

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 carbonate form is better at buffering acidity, so lakes with higher alkalinity are less sensitive to acid rain than those with lower alkalinity. The alkalinity in Clear Lake was measured at 41.8 and 42.3 mg/L as $CaCO_3$ in May and July of 2013, respectively. This indicates 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 Clear Lake during 2013. Calcium is commonly examined because invasive and native mussels use the element for shell building 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 Clear Lake's pH of 7.5 – 7.8 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 Clear Lake was found to be 11.7 mg/L in August of 2013, which is at the bottom end of the optimal range for zebra mussels. Plankton tows were completed by Onterra staff during the summer of 2013 and these samples were processed by the WDNR for larval zebra mussels. No veligers (larval stage of zebra mussels) were observed within these samples.

8.4.2 Clear Lake Watershed Assessment

Clear Lake's watershed is 3,046 acres in size. Compared to Clear Lake's size of 568 acres, this makes for a small watershed to lake area ratio of 4:1. The watershed is comprised of land cover types including forest (53%), the lake surface itself (19%), wetlands (16%), pasture/grass/rural open space (12%), rural residential areas (<1%), and urban-medium density (<1%), (Figure 8.4.2-1). Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Clear Lake's residence time is approximately 2.9 years, or the water within the lake is completely replaced 0.35 times per year.

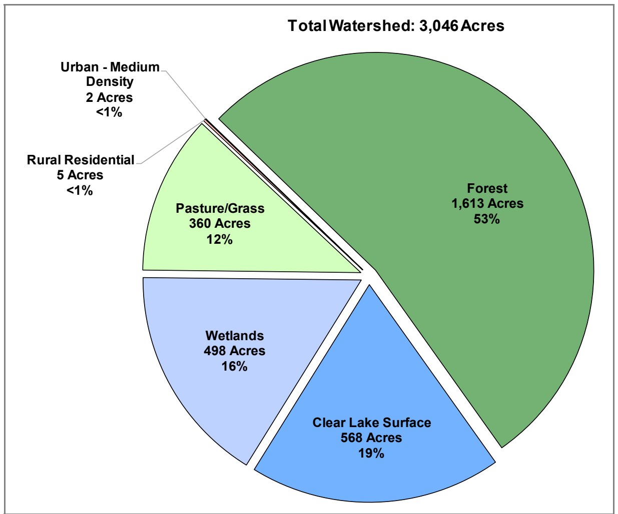


Figure 8.4.2-1. Clear Lake watershed boundary (red line) and proportion of land cover types. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

Of the estimated 423 pounds of phosphorus being delivered to Clear Lake on an annual basis, approximately 152 pounds (36%) originates through direct atmospheric deposition onto the lake, 130 pounds (31%) from forests, 97 pounds (23%) from areas of pasture/grass/rural open space, and 44 pounds (10%) from wetlands (Figure 8.4.2-2). Using the estimated annual potential phosphorus load, WiLMS predicted an in-lake growing season average total phosphorus concentration of 18 µg/L, which is essentially the same as the measured growing season average total phosphorus concentration of 20 µg/L. The similarity between the predicted and measured total phosphorus concentrations in Clear Lake is an indication that this is an accurate model of the lake's watershed and that there are no significant, unaccounted sources of phosphorus entering the lake.

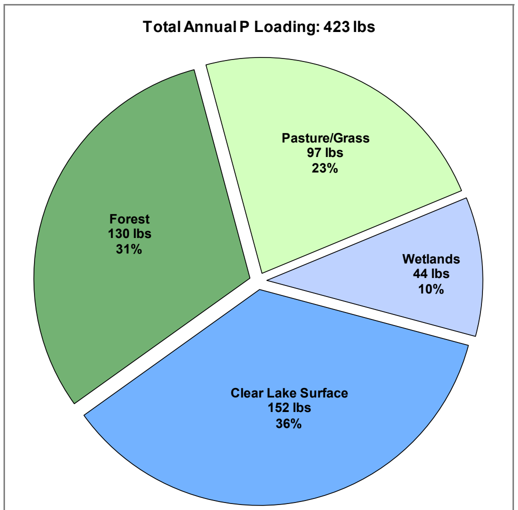


Figure 8.4.2-2. Clear Lake estimated potential annual phosphorus loading. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Using the WiLMS model for Clear Lake's watershed, scenarios can be run to determine how Clear Lake's water quality would change given alterations to its watershed. For example, if 25% of the forests within Clear Lake's watershed were converted to row crop agriculture, phosphorus concentrations would be predicted to increase from the current growing season concentration of 18 µg/L to 27 µg/L. This increase in total phosphorus would result in chlorophyll-*a* concentrations increasing from the current growing season average of 6 µg/L to 10 µg/L, and Secchi disk transparency is predicted to decline from the current growing season average of 9.2 feet to 6.2 feet. This modelling illustrates the importance of the natural land cover types within Clear Lake's watershed in maintaining the lake's excellent water quality.

8.4.3 Clear Lake Shoreland Condition

Shoreland Development

As mentioned previously in the Chain-wide Shoreland Condition 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 2013, Clear Lake's immediate shoreline was assessed in terms of its development. Clear Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 5.3 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.4.3-1). This constitutes about 85% of Clear Lake's shoreline. 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, 0.5 miles of urbanized and developed–unnatural shoreline (9%) was observed. If restoration of the Clear 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. Clear Lake Map 1 displays the location of these shoreline lengths around the entire lake.

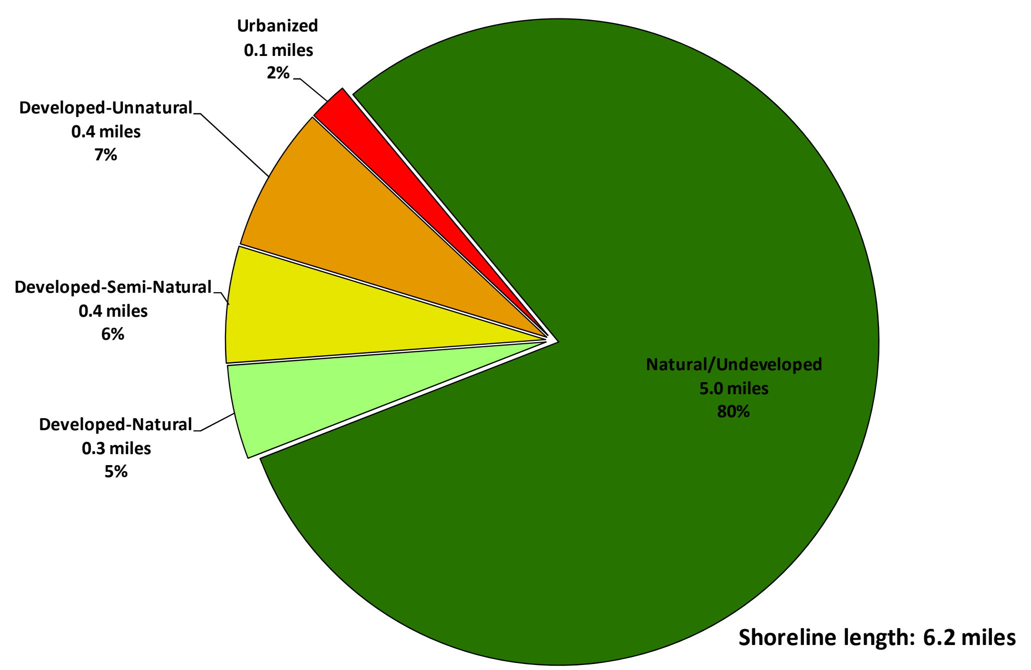


Figure 8.4.3-1. Clear Lake shoreland categories and total lengths. Based upon a late summer 2013 survey. Locations of these categorized shorelands can be found on Clear Lake Map 1.

Coarse Woody Habitat

As part of the shoreland condition assessment, Clear Lake was also surveyed to determine the extent of its coarse woody habitat. Coarse woody habitat was identified and classified in three size categories (2-8 inches in diameter, 8+ inches in diameter, or clusters of pieces) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed earlier, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance (Newbrey et al. 2005).

During this survey, 246 total pieces of coarse woody habitat were observed along 6.2 miles of shoreline (Clear Lake Map 2), which gives Clear Lake a coarse woody habitat to shoreline mile ratio of 40:1 (Figure 8.4.3-2). Only instances where emergent coarse woody habitat extended from shore into the water were recorded during the survey. Two hundred and one pieces of 2-8 inches in diameter pieces of coarse woody habitat were found, forty-one pieces of 8+ inches in diameter pieces of coarse woody habitat were found, and four instances of clusters of coarse woody habitat were found.

To put this into perspective, Wisconsin researchers have found that in completely undeveloped lakes, an average of 345 coarse woody habitat structures may be found per mile (Christensen et al. 1996). Please note the methodologies between the surveys done on Clear Lake and those cited in this literature comparison are much different, but still provide a valuable insight into what undisturbed shorelines may have in terms of coarse woody habitat.

Onterra has completed coarse woody habitat surveys on 98 lakes throughout Wisconsin since 2012, with the majority occurring in the NLF ecoregion on lakes with public access. The number of coarse woody habitat pieces per shoreline mile in Clear Lake falls above the 75th percentile of these 98 lakes (Figure 8.4.3-2).

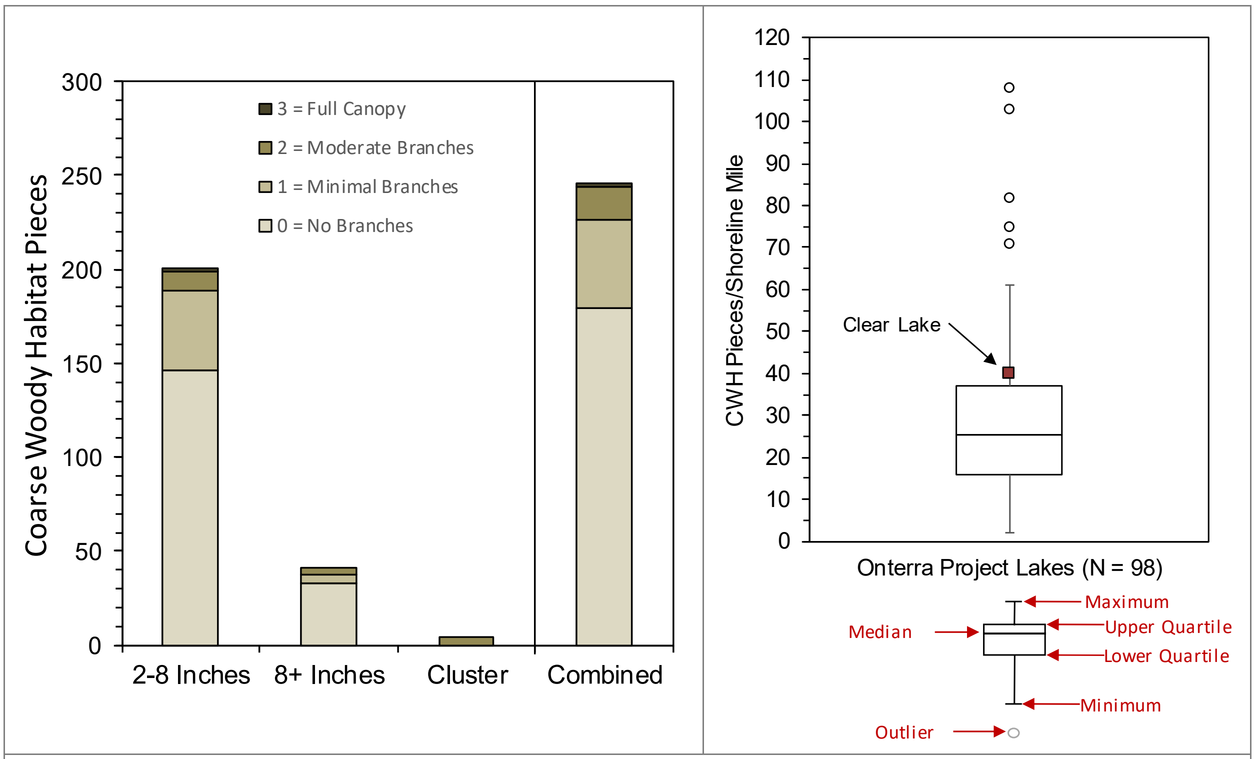


Figure 8.4.3-2. Clear Lake coarse woody habitat survey results. Based upon a late summer 2013 survey. Locations of the Clear Lake coarse woody habitat can be found on Clear Lake Map 2.

8.4.4 Clear Lake Aquatic Vegetation

An early season aquatic invasive species survey was conducted on Clear Lake on June 25, 2013. While the intent of this survey is to locate *any* potential non-native species within the lake, the primary focus is to locate occurrences of curly-leaf pondweed which should be at or near its peak growth at this time. During this meander-based survey of the littoral zone, Onterra ecologists did not locate any occurrences of curly-leaf pondweed or any other submersed non-native aquatic plant species.

The aquatic plant point-intercept survey was conducted on Clear Lake on July 31, 2013 by Onterra. The floating-leaf and emergent plant community mapping survey was completed on that same day to map these community types. During all surveys, 55 species of native aquatic plants were located in Clear Lake (Table 8.4.4-1). 29 of these species were sampled directly during the point-intercept survey and are used in the analysis that follows, while 26 species were observed incidentally during visits to Clear Lake.

Aquatic plants were found growing to a depth of 21 feet. As discussed later on within this section, many of the plants found in this survey indicate that the overall community is healthy, diverse and in one species case somewhat rare. Of the 323 point-intercept locations sampled within the littoral zone, roughly 62% contained aquatic vegetation. Clear Lake Map 3 indicates that most of the point-intercept locations that contained aquatic vegetation are located in shallow bays that are more likely to hold organic substrates. Approximately 34% of the point-intercept sampling locations where sediment data was collected at were sand, 54% consisted of a fine, organic substrate (muck) and 12% were determined to be rocky (Chain-wide Fisheries Section, Table 3.5-5).

Table 8.4.4-1. Aquatic plant species located in Clear Lake during 2013 plant surveys.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2013 (Onterra)
Emergent	*Carex comosa*	Bristly sedge	5	*I*
	Carex vesicaria	Blister sedge	7	*I*
	Dulichium arundinaceum	Three-way sedge	9	*I*
	Eleocharis sp.	Spikerush sp.	N/A	*I*
	Equisetum fluviatile	Water horsetail	7	*X*
	Glyceria canadensis	Rattlesnake grass	7	*I*
	Iris versicolor	Northern blue flag	5	*I*
	Juncus effusus	Soft rush	4	*I*
	Scirpus cyperinus	Wool grass	4	*I*
	Sagittaria latifolia	Common arrowhead	3	*I*
	Schoenoplectus tabernaemontani	Softstem bulrush	4	*I*
	Schoenoplectus pungens	Three-square rush	5	*I*
	Sagittaria rigida	Stiff arrowhead	8	*I*
	Schoenoplectus acutus	Hardstem bulrush	5	*X*
	Typha spp.	Cattail spp.	1	*I*
	Zizania sp.	Wild rice Species	8	*I*
FL	*Brasenia schreberi*	Watershield	7	*I*
	Nuphar variegata	Spatterdock	6	*I*
	Nymphaea odorata	White water lily	6	*X*
	Polygonum amphibium	Water smartweed	5	*I*
FL/E	*Sparganium emersum*	Short-stemmed bur-reed	8	*I*
	Sparganium natans	Little bur-reed	9	*I*
	Sparganium androcladum	Shining bur-reed	8	*I*
Submergent	*Bidens beckii*	Water marigold	8	*X*
	Chara spp.	Muskgrasses	7	*X*
	Ceratophyllum demersum	Coontail	3	*X*
	Elatine minima	Waterwort	9	*I*
	Elodea nuttallii	Slender waterweed	7	*X*
	Elodea canadensis	Common waterweed	3	*X*
	Isoetes sp.	Quillwort species	N/A	*X*
	Myriophyllum verticillatum	Whorled watermilfoil	8	*I*
	Myriophyllum tenellum	Dwarf watermilfoil	10	*X*
	Myriophyllum sibiricum	Northern watermilfoil	7	*X*
	Najas flexilis	Slender naiad	6	*X*
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	*I*
	Potamogeton spirillus	Spiral-fruited pondweed	8	*X*
	Potamogeton friesii	Fries' pondweed	8	*X*
	Potamogeton praelongus	White-stem pondweed	8	*X*
	Potamogeton strictifolius	Stiff pondweed	8	*X*
	Potamogeton amplifolius	Large-leaf pondweed	7	*X*
	Potamogeton vaseyi	Vasey's pondweed	10	*X*
	Potamogeton gramineus	Variable pondweed	7	*X*
	Potamogeton richardsonii	Clasping-leaf pondweed	5	*X*
	Potamogeton pusillus	Small pondweed	7	*X*
	Potamogeton zosteriformis	Flat-stem pondweed	6	*X*
	Potamogeton robbinsii	Fern pondweed	8	*X*
	Ranunculus aquatilis	White water-crowfoot	8	*I*
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A	*X*
	Stuckenia pectinata	Sago pondweed	3	*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*
	Sagittaria cristata	Crested arrowhead	9	*I*
	Sagittaria cuneata	Arum-leaved arrowhead	7	*I*

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

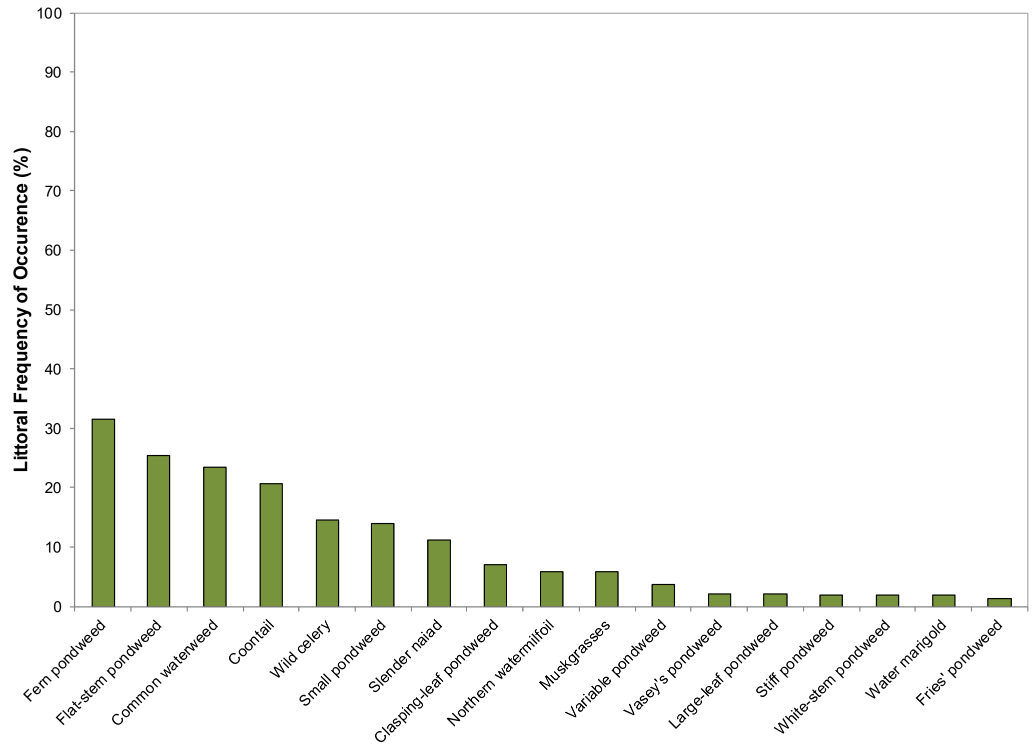


Figure 8.4.4-1. Clear Lake aquatic plant littoral frequency of occurrence analysis. Created using data from a 2013 point-intercept survey. Please note that only species with a frequency of occurrence greater than 2% are depicted.

Figure 8.4.4-1 (above) shows that fern pondweed, flat-stem pondweed and common waterweed were the most frequently encountered plants within Clear Lake. Fern pondweed is a low-growing plant that was likely named after its palm-frond or fern-like appearance. This plant is known to provide habitat for smaller aquatic animals that are used as food by larger, predatory fishes. Flat-stem pondweed, as its name implies, is a freely branched plant with strongly flattened stems and long, stiff leaves. Flat-stem pondweed lacks floating leaves, a feature many plants in the *Potamogeton* genus have. This plant can be a locally important food source to many aquatic and terrestrial organisms. Common waterweed is an interesting plant in that although it sometimes produces root-like structures that bury themselves into the sediment, it is largely an unrooted plant that can obtain nutrients directly from the water. As a result, this plant's location in a lake can be dependent upon water movement.

One species discovered during 2013 studies, Vasey's pondweed (*Potamogeton vaseyi*), is listed by the Wisconsin Natural Heritage Inventory as a species of special concern in Wisconsin due to uncertainty regarding its distribution and abundance in Wisconsin. Vasey's pondweed is typically found in bays of large soft-water lakes as well as in rivers and ponds.

During aquatic plant inventories, 55 species of native aquatic plants (including incidentals) were found in Clear Lake. 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 Clear Lake's plant community (0.90) lies above the Northern Lakes and Forest Lakes ecoregion value (0.86), indicating the lake holds exceptional diversity.

As explained earlier in the Manitowish Waters Chain of Lakes-wide document, 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 fern pondweed was found at 32% of the sampling locations, its relative frequency of occurrence is 18%. Explained another way, if 100 plants were randomly sampled from Clear Lake, 16 of them would be fern pondweed. This distribution can be observed in Figure 8.4.4-2, where together 11 native species account for 91% of the aquatic plant population within Clear Lake, while the other 18 species account for the remaining 11%. 26 additional native species were located from the lake but not from of the point-intercept survey, and are indicated in Table 8.4.4-1 as incidentals.

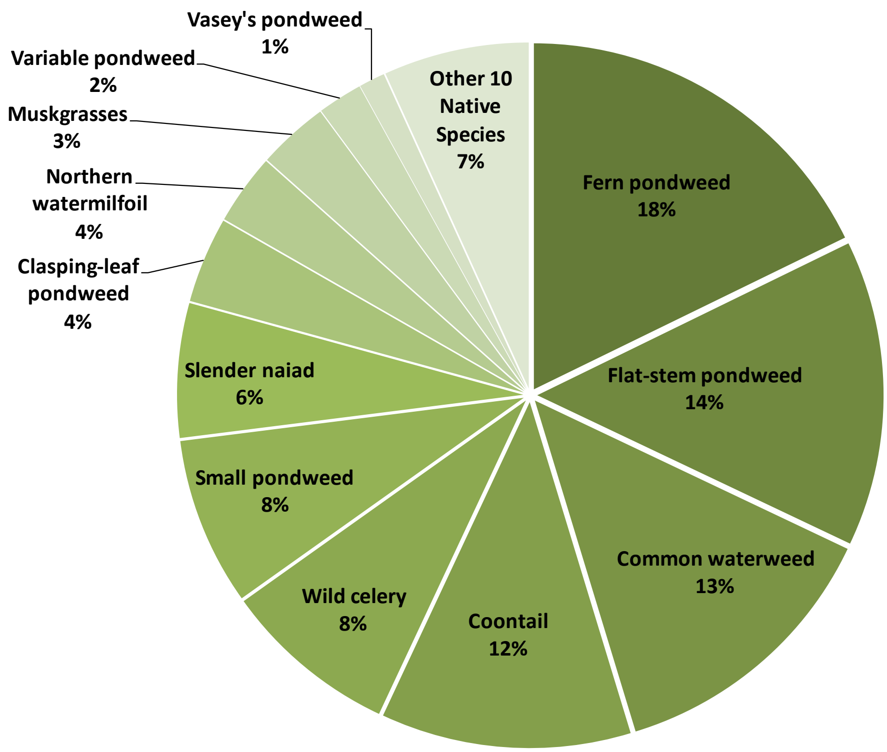


Figure 8.4.4-2. Clear Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2013 point-intercept survey.

Clear Lake's average conservatism value (6.7) is higher than the state (6.0) and equal to the Northern Lakes and Forests ecoregion (6.7) median. This indicates that the plant community of Clear Lake is indicative of a very moderately disturbed system. Combining Clear Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in a value of 36.1 which is above the median values of the ecoregion and state.

The quality of Clear Lake is also indicated by the high incidence of emergent and floating-leaf plant communities that occur in many areas. The 2013 community map indicates that approximately 62.2 acres of the lake contains these types of plant communities (Clear Lake Map

4, Table 8.4.4-2). 23 floating-leaf and emergent species were located on Clear Lake (Table 8.4.4-1), all of which provide valuable wildlife habitat.

Table 8.4.4-2. Clear Lake acres of emergent and floating-leaf plant communities from the 2013 community mapping survey.

Plant Community	Acres
Emergent	58.1
Floating-leaf	3.6
Mixed Floating-leaf and Emergent	0.5
Total	62.2

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 Clear 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 found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

8.4.5 Clear Lake Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here and within each lake's individual report section as a reference. The following section is not intended to be a comprehensive plan for the lake's fishery, as those aspects are currently being conducted by the fisheries biologists overseeing Clear Lake. The goal of this section is to provide an overview of some of the data that exists. Although current fish data were not collected as a part of this project, the following information was compiled based upon data available from the Wisconsin Department of Natural Resources (WDNR) the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and personal communications with DNR Fisheries Biologist Hadley Boehm (WDNR 2018 & GLIFWC 2017).

Fish Stocking

To assist in meeting fisheries management goals, the WDNR may stock fry, fingerling or adult fish in a waterbody that were raised in nearby permitted hatcheries (Photograph 8.4.5-1). Stocking of a lake may be done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Clear Lake has been stocked from 1973 to 2016 with muskellunge and walleye (Table 8.4.5-1).

Photograph 8.4.5-1. Fingerling Muskellunge.

Table 8.4.5-1. Stocking data available in Clear Lake (1976-2016).

Lake	Year	Species	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
Clear Lake	1976	Walleye	Unspecified	Fingerling	26,000	3
Clear Lake	1973	Muskellunge	Unspecified	Fingerling	2,562	11
Clear Lake	1977	Muskellunge	Unspecified	Fingerling	1,000	7
Clear Lake	1981	Muskellunge	Unspecified	Fingerling	415	12
Clear Lake	1983	Muskellunge	Unspecified	Fingerling	250	11
Clear Lake	1985	Muskellunge	Unspecified	Fingerling	500	11
Clear Lake	1988	Muskellunge	Unspecified	Fingerling	500	11
Clear Lake	1989	Muskellunge	Unspecified	Fingerling	200	9
Clear Lake	1990	Muskellunge	Unspecified	Fingerling	500	9
Clear Lake	1991	Muskellunge	Unspecified	Fingerling	250	11.5
Clear Lake	1992	Muskellunge	Unspecified	Fingerling	250	11
Clear Lake	1993	Muskellunge	Unspecified	Fingerling	500	10
Clear Lake	1997	Muskellunge	Unspecified	Large Fingerling	64	10.5
Clear Lake	1999	Muskellunge	Unspecified	Large Fingerling	250	11.8
Clear Lake	2002	Muskellunge	Unspecified	Large Fingerling	400	10.1
Clear Lake	2004	Muskellunge	Unspecified	Large Fingerling	400	10.5
Clear Lake	2006	Muskellunge	Upper Wisconsin River	Large Fingerling	400	9.9
Clear Lake	2008	Muskellunge	Upper Wisconsin River	Large Fingerling	400	10.1
Clear Lake	2010	Muskellunge	Upper Wisconsin River	Large Fingerling	243	12.5
Clear Lake	2012	Muskellunge	Upper Wisconsin River	Large Fingerling	400	10.2
Clear Lake	2014	Muskellunge	Upper Wisconsin River	Large Fingerling	396	10.4
Clear Lake	2016	Muskellunge	Upper Wisconsin River	Large Fingerling	360	10.9

Clear Lake Spear Harvest Records

Walleye open water spear harvest records are provided in Figure 8.4.5-1 from 1999 to 2017. As many as 192 walleye have been harvested from the lake in the past (2015), but the average harvest is roughly 116 fish in a given year. Spear harvesters on average have taken 99% of the declared quota. Additionally, on average 6% of walleye harvested have been female.

Muskellunge open water spear harvest records are provided in Figure 8.4.5-2 from 1999 to 2017. As many as 8 muskellunge have been harvested from the lake in the past (2010), however the average harvest is 4 fish in a given year. Spear harvesters on average have taken 53% of the declared quota.

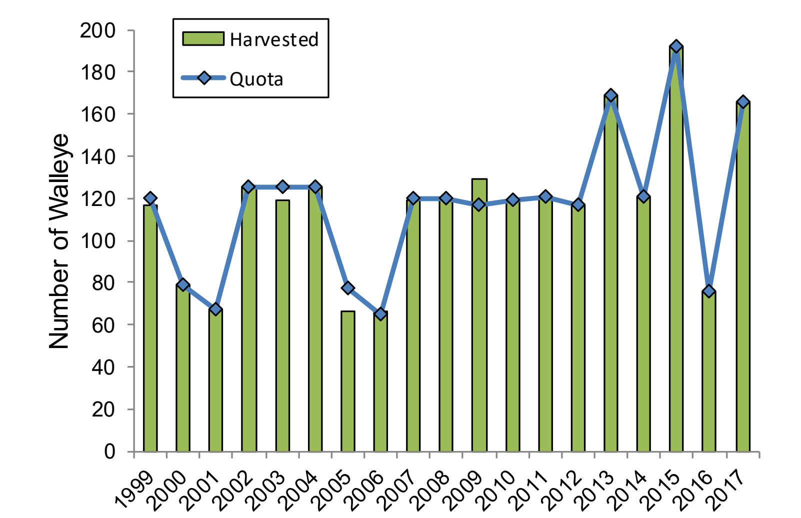


Figure 8.4.5-1. Clear Lake walleye spear harvest data. (GLIFWC 1999-2017).

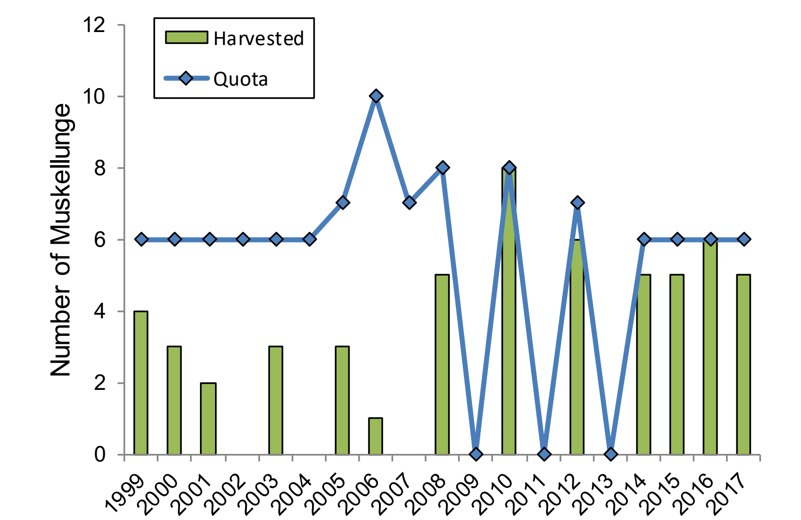
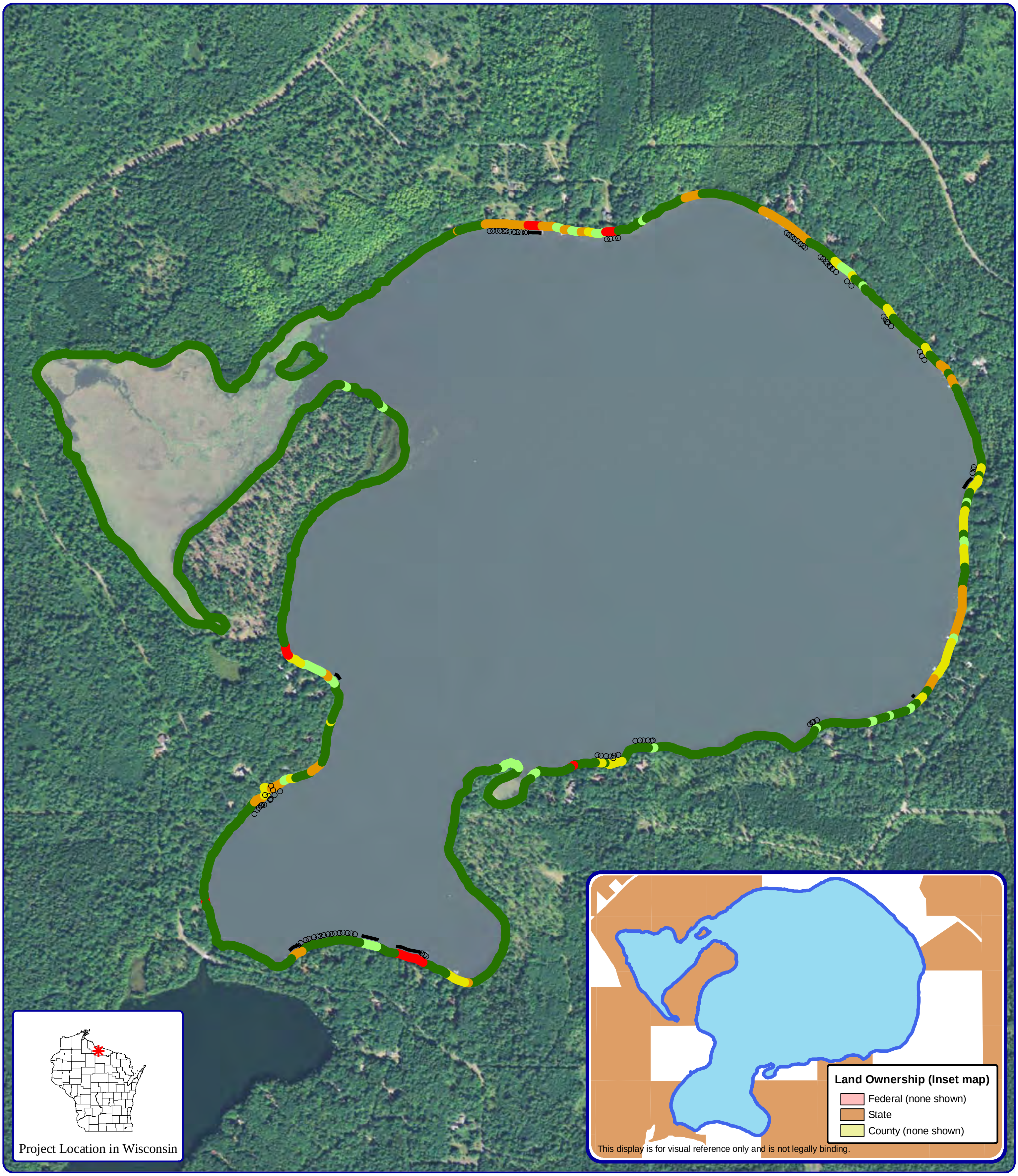


Figure 8.4.5-2. Clear Lake muskellunge spear harvest data. (GLIFWC 1999-2017).



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Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Hydro, State Land and Roads: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2013
Map date: October 14, 2014
Filename: *Clear_ShorelandCondition_2014.mxd*

Legend

- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

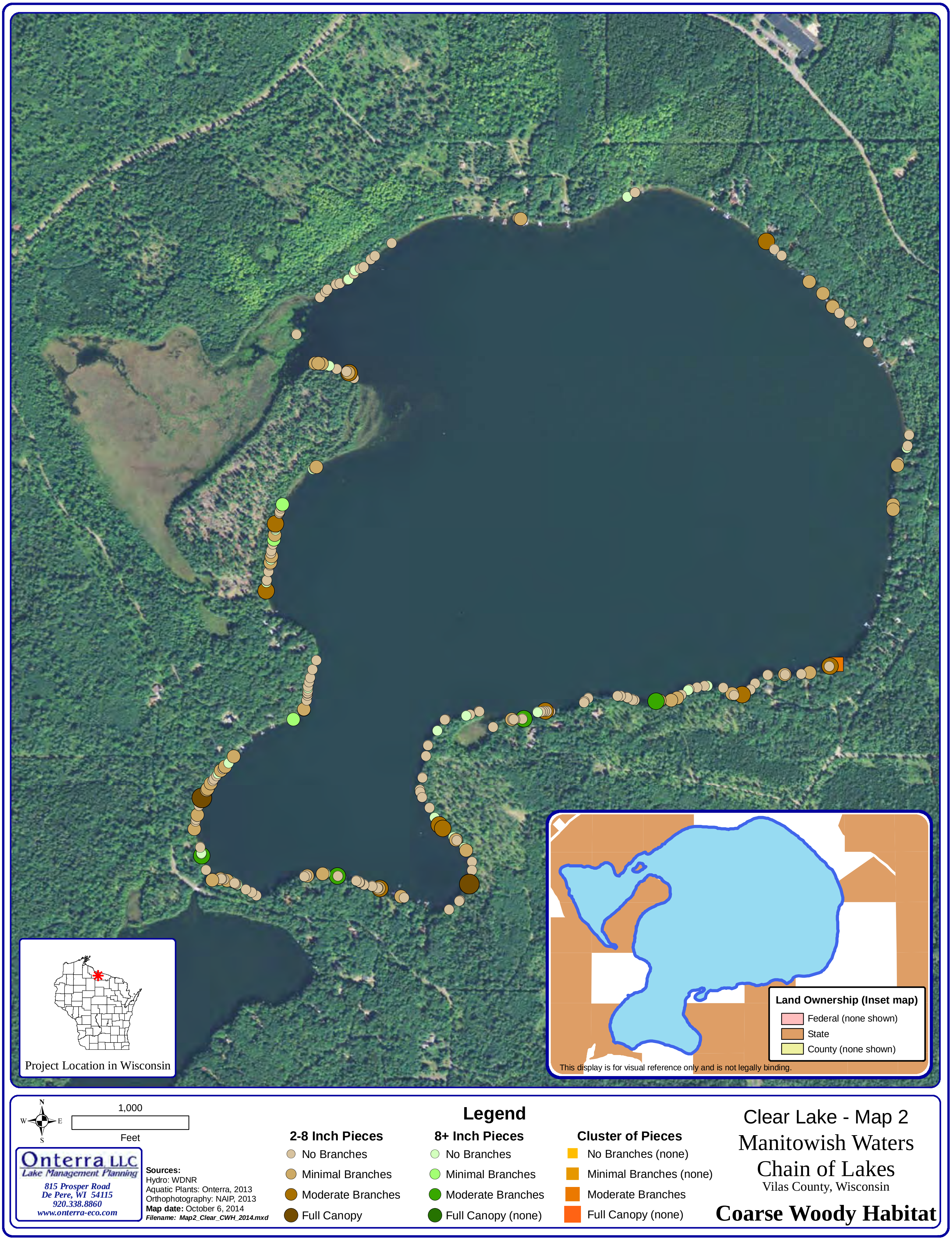
Seawall

- Masonary/Metal/Wood
- Rip-Rap

Clear Lake - Map 1

Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin

Shoreland Condition



Project Location in Wisconsin
Land Ownership (Inset map)
Federal (none shown)
State
County (none shown)
This display is for visual reference only and is not legally binding.
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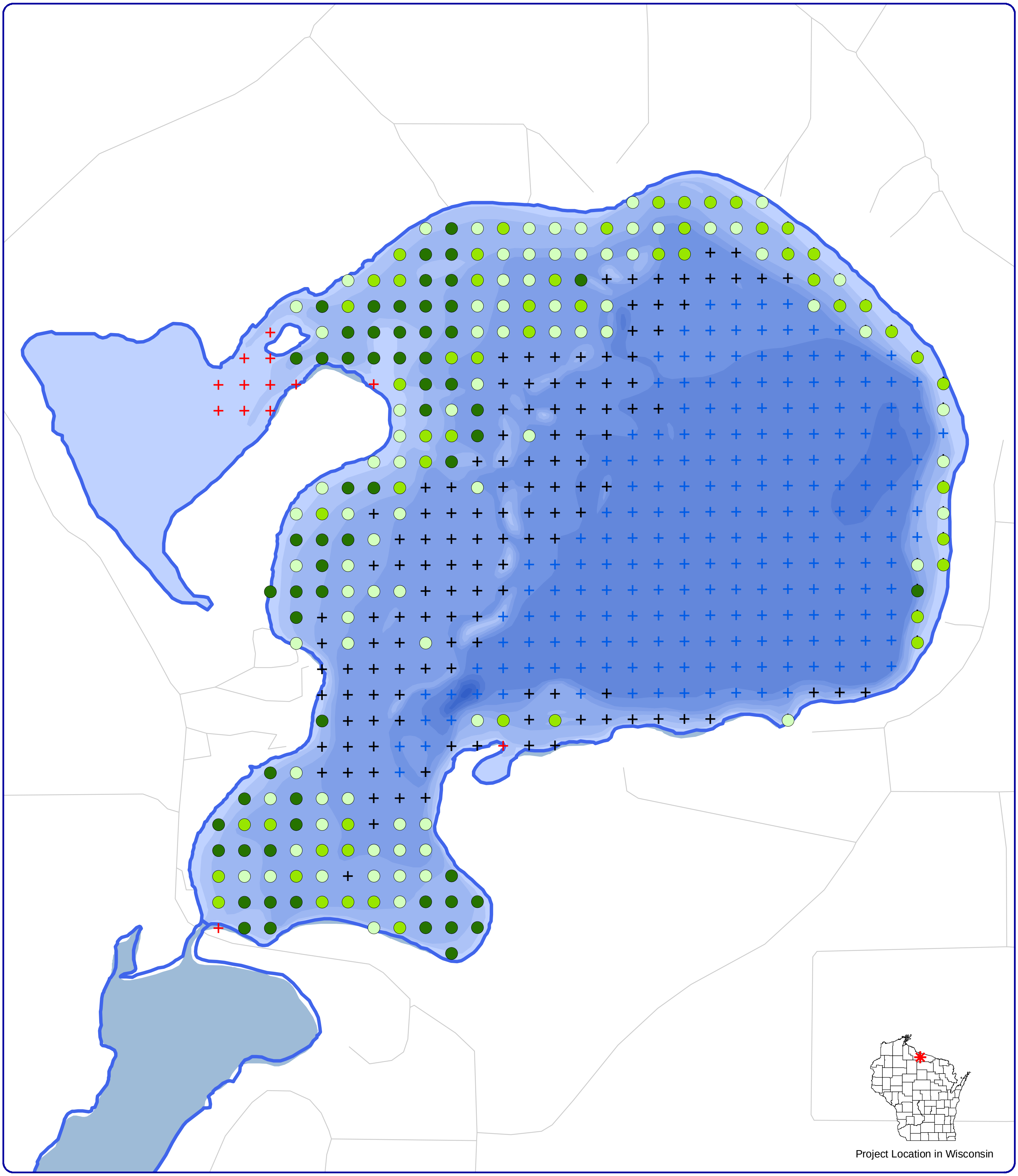
Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com
Sources:
Hydro: WDNR
Aquatic Plants: Onterra, 2013
Orthophotography: NAIP, 2013
Map date: October 6, 2014
Filename: Map2_Clear_CWH_2014.mxd
Legend
2-8 Inch Pieces
No Branches
Minimal Branches
Moderate Branches
Full Canopy
8+ Inch Pieces
No Branches
Minimal Branches
Moderate Branches
Full Canopy (none)
Cluster of Pieces
No Branches (none)
Minimal Branches (none)
Moderate Branches
Full Canopy (none)
Clear Lake - Map 2
Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin
Coarse Woody Habitat



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Legend

2013 Point-intercept Survey

- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- No Vegetation
- Non-navigable
- Deep

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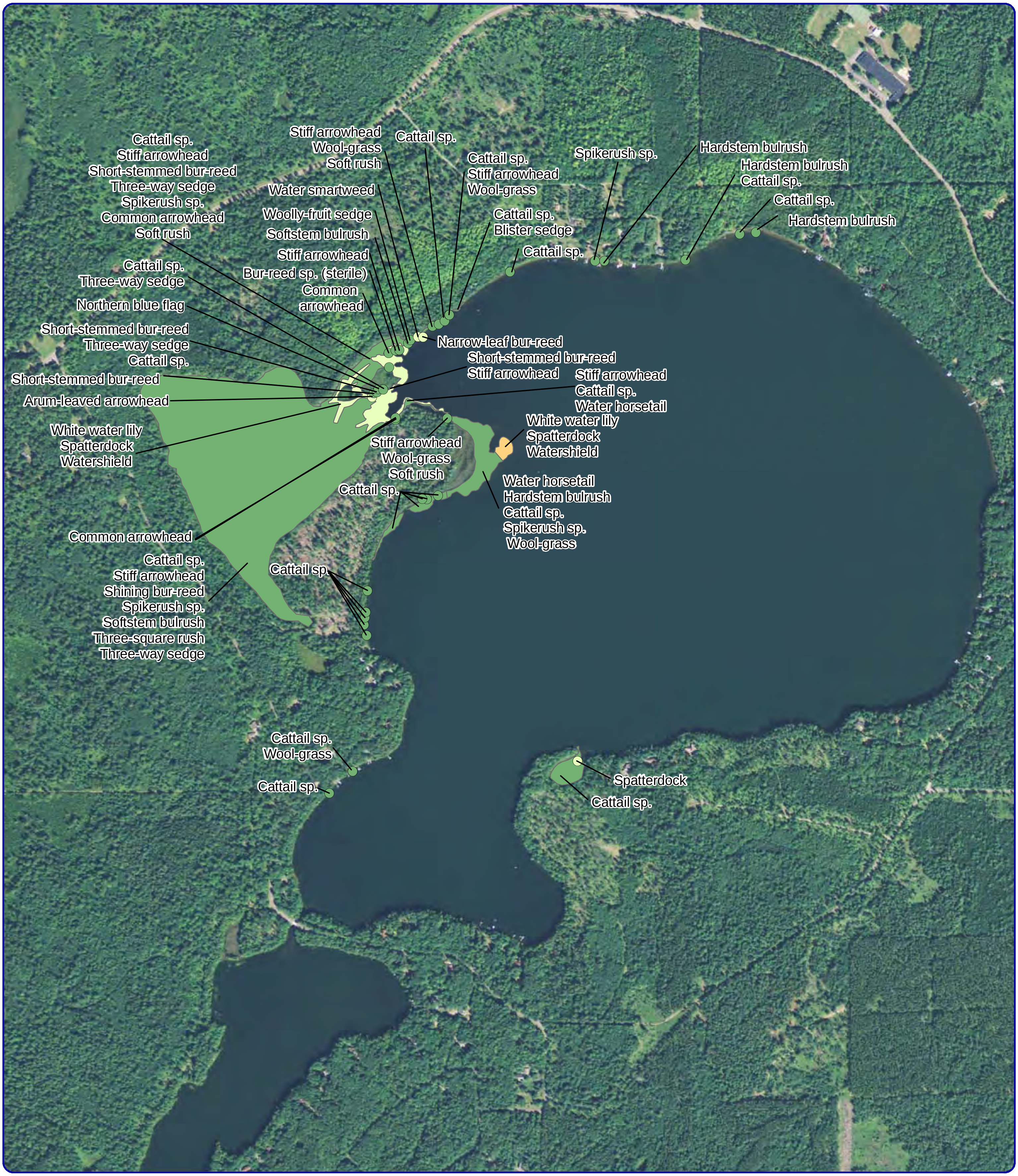
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Map Date: December 16, 2014
Filename: Clear_TRFPI_2013.mxd

Clear Lake - Map 3

Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin

Aquatic Plant Distribution



N W E S

1,100

Feet

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Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Hydro: WDNR
Aquatic Plants: Onterra, 2013
Orthophotography: NAIP, 2010
Map date: Month Day Year
Filename: *Clear_Map4_Comm_2013.mxd*

Project Location in Wisconsin

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Map 4
Clear Lake
Vilas County, Wisconsin

Aquatic Plant Communities