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

8.3 Spider Lake

An Introduction to Spider Lake

Spider Lake, Vilas County, is a deep, lowland drainage lake with a maximum depth of 43 feet, a mean depth of 20 feet, and a surface area of approximately 283 acres. The lake is fed via Island Lake to the east and Manitowish Lake to the south, and empties into downstream Stone Lake. The lake is currently in a mesotrophic state, and its watershed encompasses approximately 134,039 acres. In 2012, 40 native aquatic plant species were located in the lake, of which wild celery (*Vallisneria americana*) was the most common. Three non-native plants, curly-leaf pondweed, purple loosestrife, and common forget-me-not were observed growing in or along the shorelines of Island Lake in 2012.

Field Survey Notes

Fairly dense curly-leaf pondweed observed between Spider and Island Lakes, within a narrow channel.

Photo 8.3. Spider Lake, Vilas County

Lake at a Glance* – Spider Lake

Morphology	
Acreage	283
Maximum Depth (ft)	43
Mean Depth (ft)	20
Volume (acre-feet)	5,660
Shoreline Complexity	6.5
Vegetation	
Curly-leaf Survey Date	May 30, 2012
Comprehensive Survey Date	July 25, 2012
Number of Native Species	40
Threatened/Special Concern Species	Vasey's pondweed (*Potamogeton vaseyi*)
Exotic Plant Species	Curly-leaf pondweed; Purple loosestrife; Common forget-me-not
Simpson's Diversity	0.92
Average Conservatism	6.6
Water Quality	
Wisconsin Lake Classification	Deep, Lowland Drainage
Trophic State	Mesotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	472:1

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

8.3.1 Spider Lake Water Quality

Water quality data was collected from Spider Lake on six occasions in 2012/2013. 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 2012/2013, any historical data was researched and are included within this report as available.

Unfortunately, very limited data exists for two water quality parameters of interest – total phosphorus and chlorophyll-*a* concentrations. In 2012, average summer phosphorus concentrations (11.7 μg/L) were less than the median value (23.0 μg/L) for other deep, lowland drainage lakes in the state (Figure 8.3.1-1). 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 *Excellent* for a deep, lowland drainage lake.

Total phosphorus surface values from 2012 are compared with bottom-lake samples collected during this same time frame in Figure 8.3.1-2. As displayed in this figure, on several occasions surface and bottom total phosphorus concentrations were similar. However, on some occasions, namely during July and August of 2012, the bottom phosphorus concentrations were much 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 8.3.1-6 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. While this process may be contributing some phosphorus to Spider Lake's water column, the impacts of nutrient loading are not apparent in the lake's overall water quality; as previously mentioned, Spider Lake's surface water total phosphorus values are slightly lower than the median value for comparable lakes in Wisconsin, and rank as *Excellent* overall.

Similar to what has been observed with the total phosphorus dataset, summer average chlorophyll-*a* concentrations (4.3 μg/L) were slightly lower than the median value (7.0 μg/L) for other lakes of this type (Figure 8.3.1-3), as well as lower than the median for all lakes in the ecoregion. Both of these parameters, total phosphorus and chlorophyll-*a*, rank within a TSI category of *Excellent*, 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 2012 visits to the lake, Onterra ecologists recorded field notes describing very good water conditions.

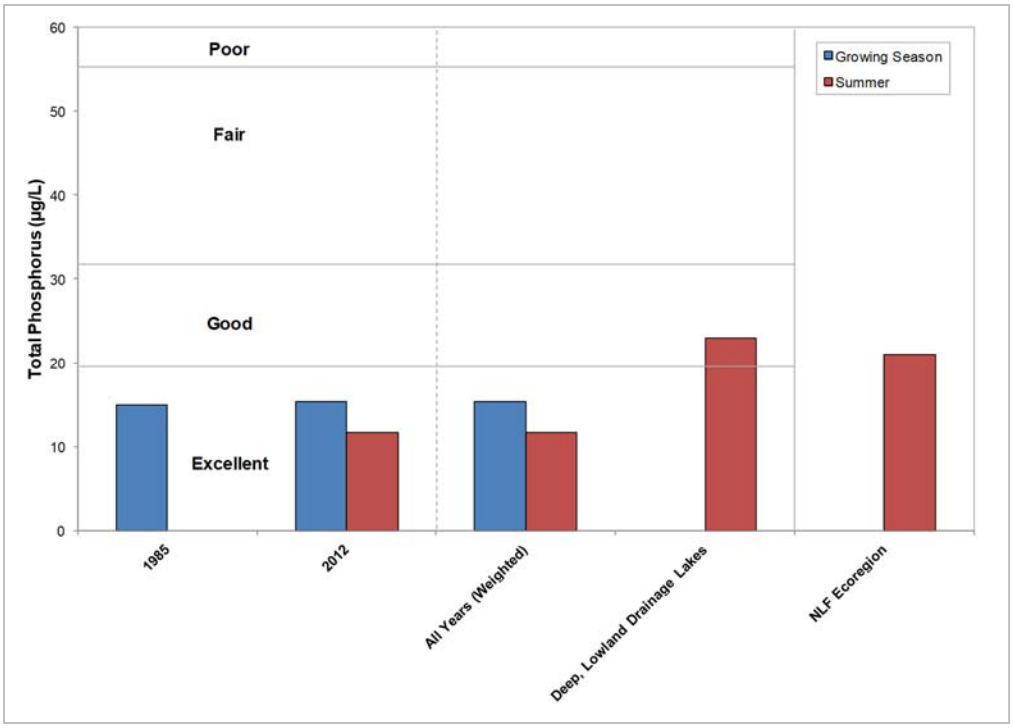


Figure 8.3.1-1. Spider Lake, state-wide deep, lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

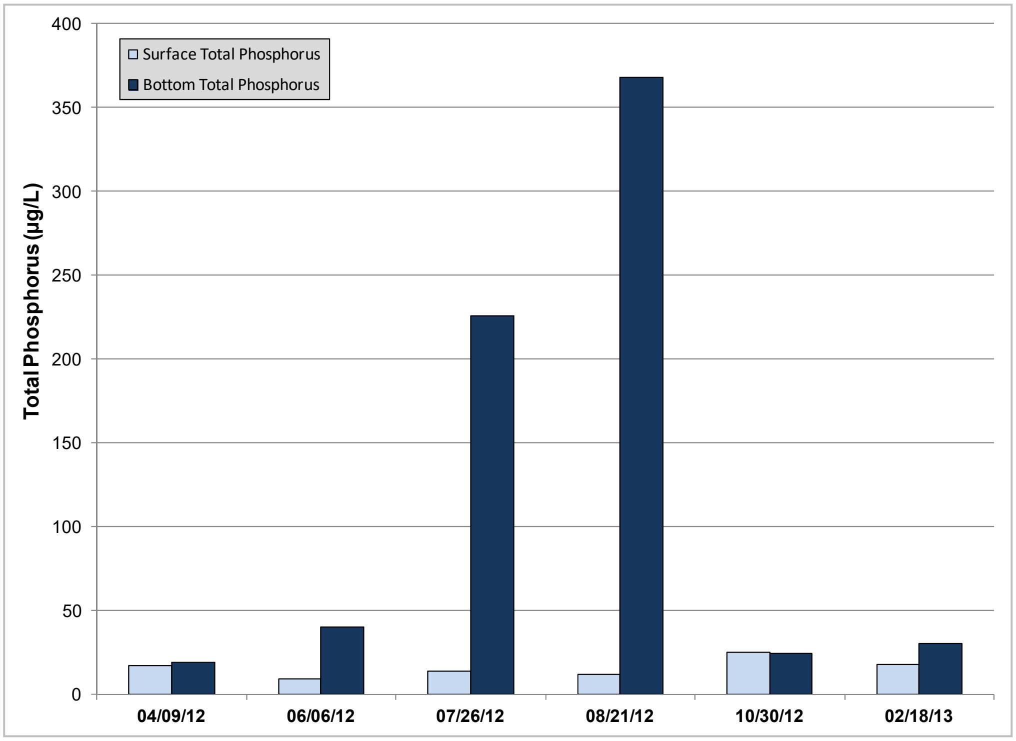


Figure 8.3.1-2. Spider Lake surface and bottom total phosphorus values, 2012-2013. Anoxia was observed in the hypolimnion of the lake during July and August sampling visits.

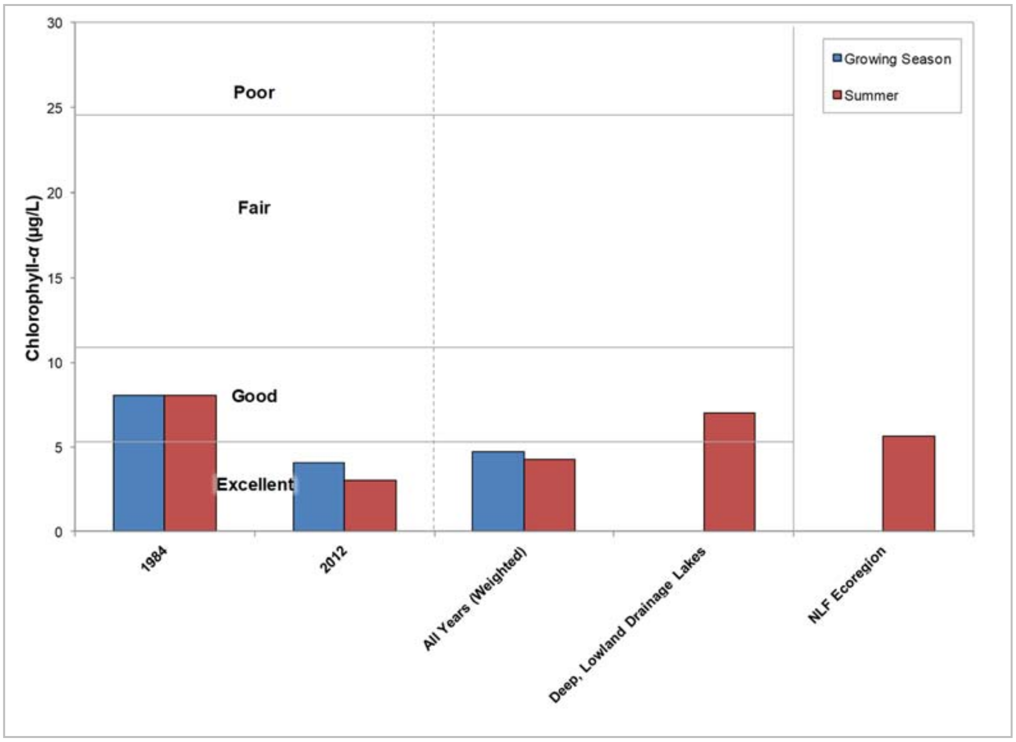


Figure 8.3.1-3. Spider Lake, state-wide deep, lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

From the examination of the available Secchi disk clarity data, several conclusions can be drawn. First, the clarity of Spider Lake's water can be described as *Excellent* during the summer months in which data has been collected (Figure 8.3.1-4). A weighted average over this timeframe is greater than the median value for other deep, lowland drainage lakes in the state and is also larger than the regional median. Secondly, there is no apparent trend in the clarity of the water in Spider 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 Spider 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 Spider 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.

"True color" measures the dissolved organic materials in water. Water samples collected in April and July of 2012 were measured for this parameter, and were found to be 15 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.

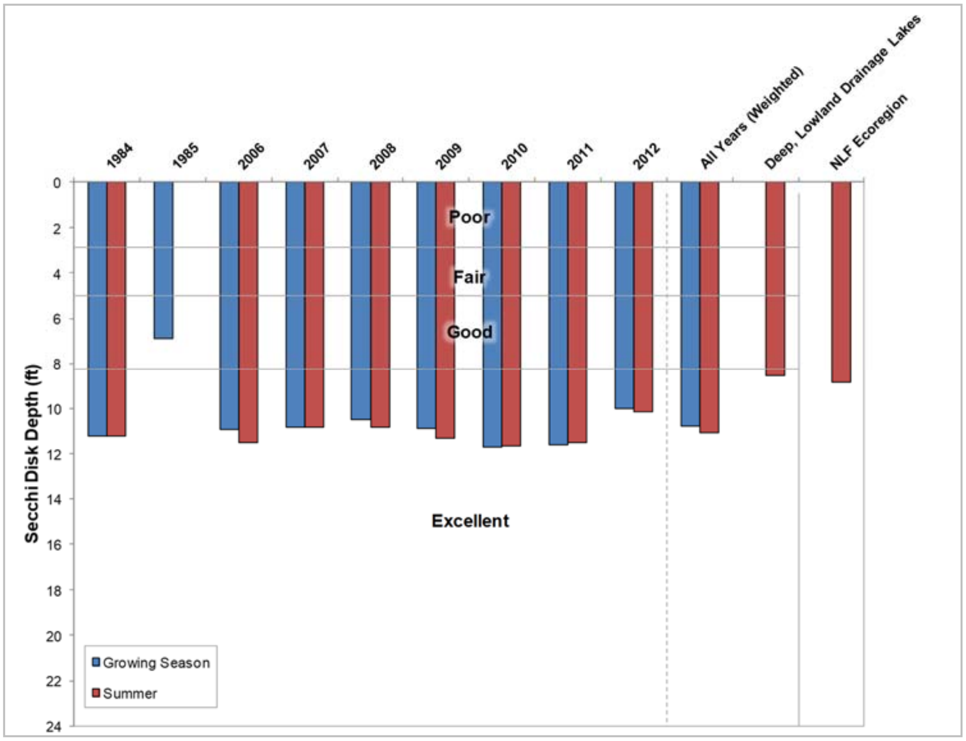


Figure 8.3.1-4. Spider Lake, state-wide deep, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Spider 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 8.3.1-5). 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 Spider Lake is in a mesotrophic state.

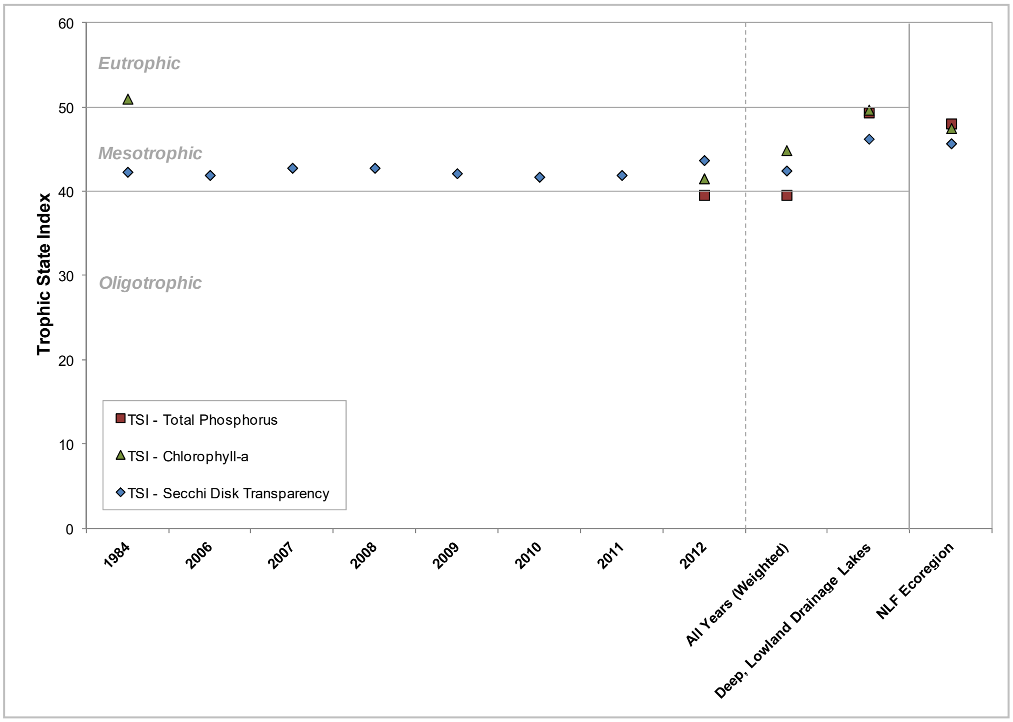


Figure 8.3.1-5. Spider Lake, state-wide deep, lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Spider Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Spider Lake by Onterra staff. Graphs of those data are displayed in Figure 8.3.1-6 for all sampling events.

Spider Lake mixes thoroughly during the spring and fall, when changing air temperatures and 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, where wind energy is not sufficient during the summer to mix the entire water column – only the upper portion. 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.

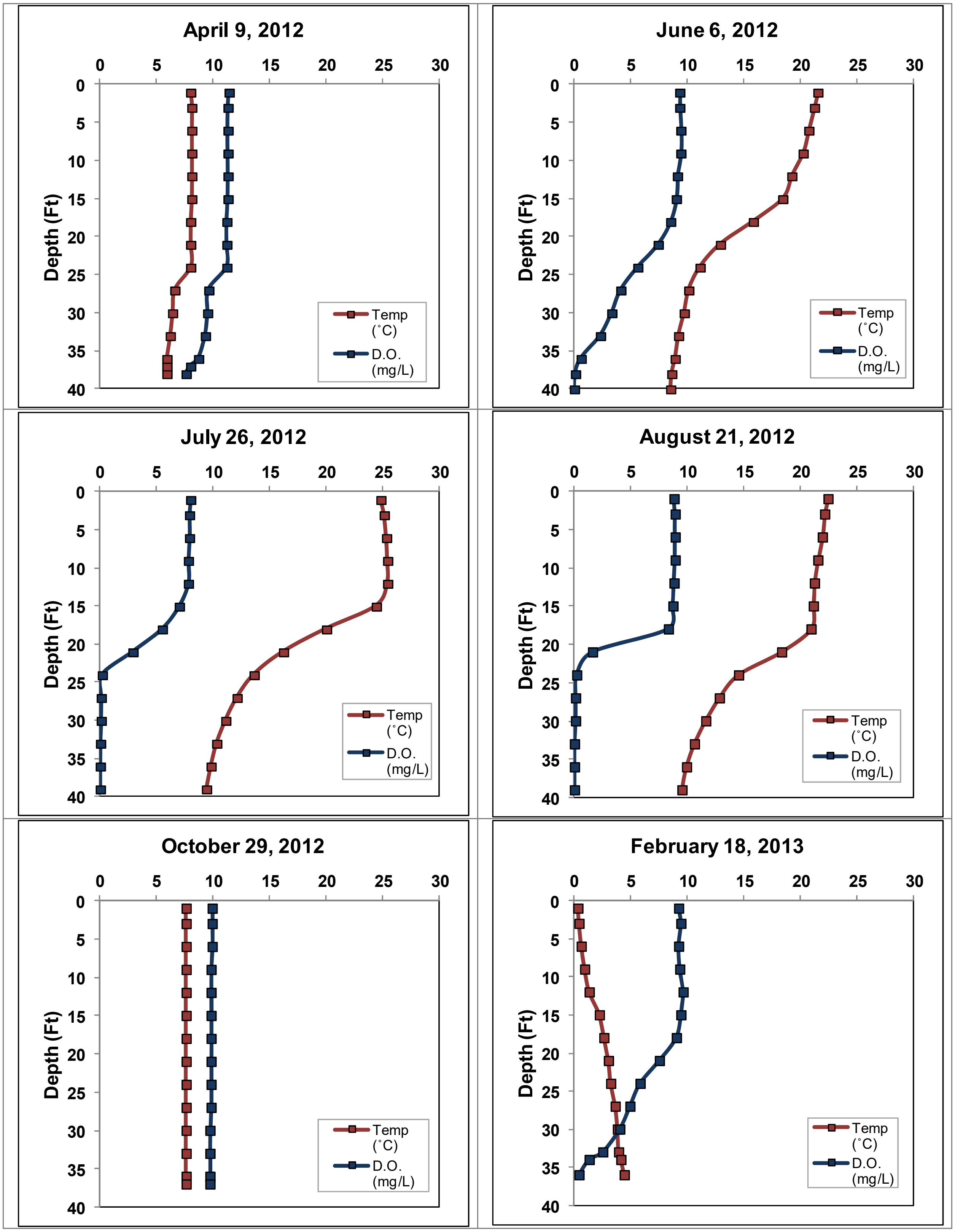


Figure 8.3.1-6. Spider Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Spider 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 Spider 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. Spider Lake's surface water pH was measured at roughly 8.8 during April and 7.7 during July of 2012. 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 Spider Lake was measured at 47 and 45 mg/L as $CaCO_3$ in April and July of 2012, 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 Spider Lake during 2012. 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 Spider Lake's pH of 7.7 – 8.8 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 Spider Lake was found to be 12.9 mg/L in April and 12.6 mg/L in July of 2012, which is at the bottom end of the optimal range for zebra mussels. Plankton tows were completed by Onterra staff during the summer of 2012 and these samples were processed by the WDNR for larval zebra mussels. No veligers (larval stage of zebra mussels) were observed within these samples.

8.3.2 Spider Lake Watershed Assessment

8.3.2 Spider Lake Watershed Assessment

Spider Lake's watershed is 134,041 acres in size. Compared to Spider Lake's size of 283 acres, this makes for a very large watershed to lake area ratio of 472:1. Similar to most lakes that are downstream of other lakes, the large majority of the lake's watershed consists of the lakes immediately upstream. For Spider Lake this means that 81.877 acres (61%) of the lake's watershed is the Island subwatershed and 51,048 acres (39%) of the watershed is the Manitowish Lake subwatershed. The rest of the Spider Lake's watershed is comprised of small amounts of various land cover types (Figure 8.3.2-1). Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Spider Lake's residence time is approximately 15 days, or the water within the lake is completely replaced 26 times per year.

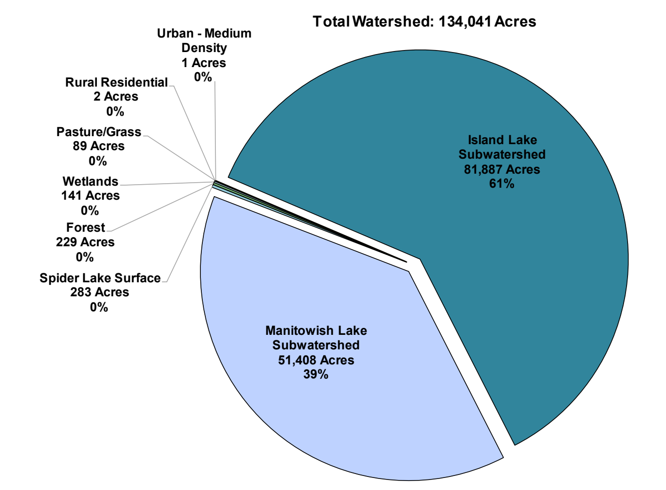


Figure 8.3.2-1. Island Lake watershed boundary (red line) and proportion of land cover types. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

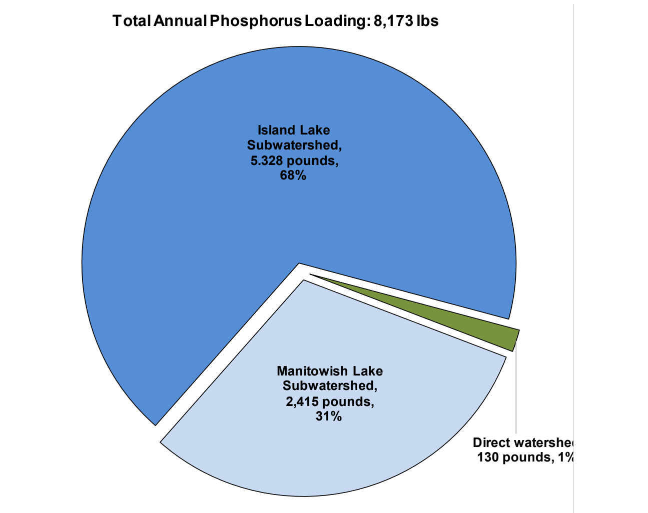


Figure 8.3.2-2. Spider Lake estimated potential annual phosphorus loading. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Of the estimated 8,173 pounds of phosphorus being delivered to Spider Lake on an annual basis, approximately 5.328 pounds (68%) originates from the Island Lake subwatershed, 2,415 pounds (31%) from the Manitowish Lake subwatershed, and the rest comes from the direct (Figure 8.3.2-2). Using the estimated annual potential phosphorus load, WiLMS predicted an in-lake growing season average total phosphorus concentration of 19 µg/L, which is essentially the same as the measured growing season average total phosphorus concentration of 12 µg/L. It is not clear why the model overestimates the phosphorus concentration in Spider Lake. This does indicate that internal loading is not an issue in the lake.

Because the large majority of the phosphorus that enters Spider Lake comes from the upstream lakes, especially Island Lake, efforts to reduce phosphorus levels in Spider Lake should concentrate on reducing phosphorus inputs to the upstream lakes.

8.3.3 Spider 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 2012, Spider Lake's immediate shoreline was assessed in terms of its development. Spider Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.0 mile of natural/undeveloped and developed-natural shoreline was observed during the survey (Figure 8.3.3-1). This constitutes about 17% of Spider 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, 2.0 miles of urbanized and developed–unnatural shoreline (34%) was observed. If restoration of the Spider 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. Spider Lake Map 1 displays the location of these shoreline lengths around the entire lake.

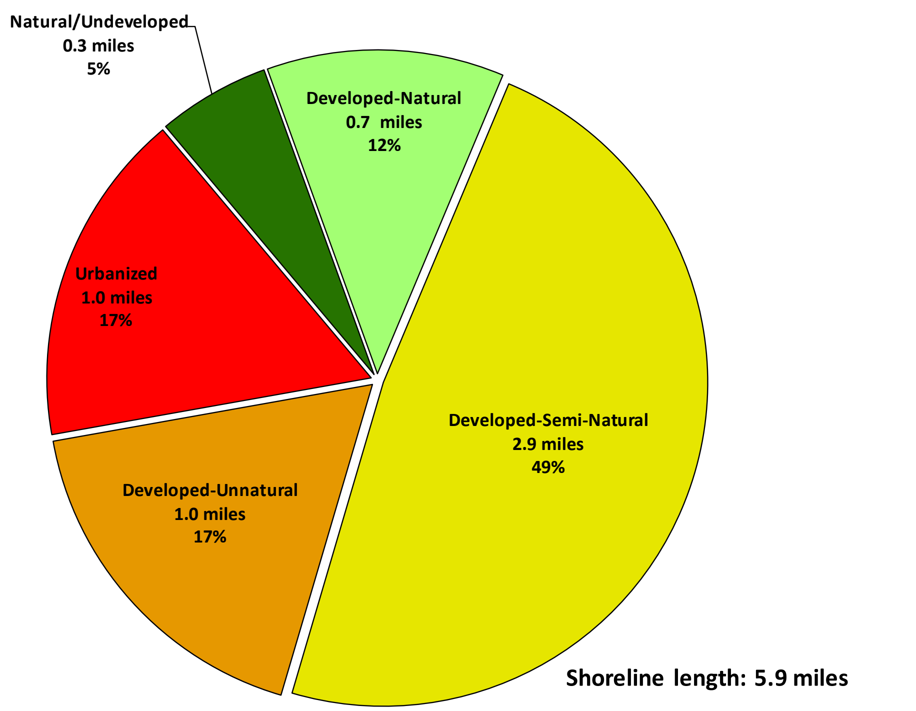


Figure 8.3.3-1. Spider Lake shoreland categories and total lengths. Based upon a late summer 2012 survey. Locations of these categorized shorelands can be found on Spider Lake Map 1.

Coarse Woody Habitat

As part of the shoreland condition assessment, Spider 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, 27 total pieces of coarse woody habitat were observed along 5.9 miles of shoreline (Spider Lake Map 2), which gives Spider Lake a coarse woody habitat to shoreline mile ratio of 5:1 (Figure 8.3.3-2). Only instances where emergent coarse woody habitat extended from shore into the water were recorded during the survey. Twenty-four pieces of 2-8 inches in diameter pieces of coarse woody habitat were found, three pieces of 8+ inches in diameter pieces of coarse woody habitat were found, and no 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 Spider 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 Spider Lake falls well below the 25th percentile of these 98 lakes (Figure 8.3.3-2).

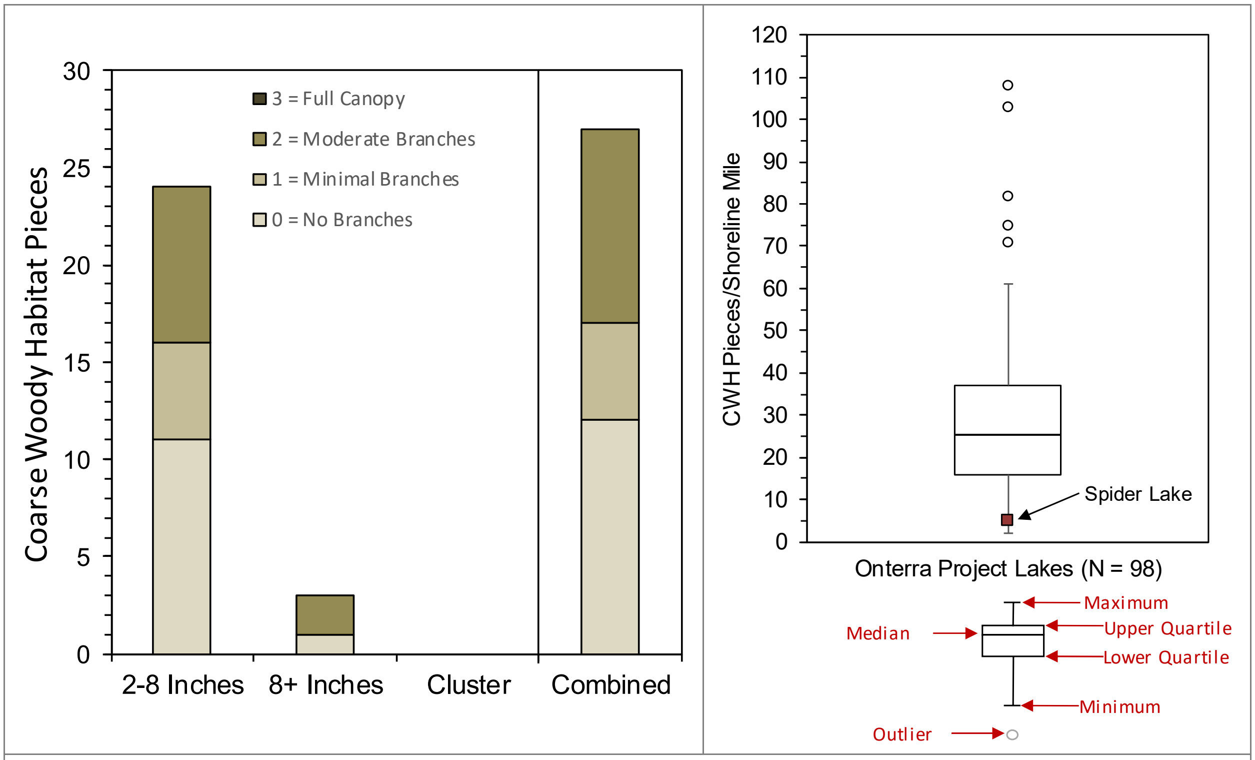


Figure 8.3.3-2. Spider Lake coarse woody habitat survey results. Based upon a late summer 2012 survey. Locations of the Spider Lake coarse woody habitat can be found on Spider Lake Map 2.

8.3.4 Spider Lake Aquatic Vegetation

An early season aquatic invasive species survey was conducted on Spider Lake on May 30, 2012. 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. While curly-leaf pondweed was not located during May 30, 2012 survey, earlier and subsequent surveys completed by professionals and volunteers did locate this exotic. This is elaborated on at the end of this section.

The aquatic plant point-intercept survey was conducted on Spider Lake on July 25, 2012 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, 40 species of native aquatic plants were located in Spider Lake (Table 8.3.4-1). 32 of these species were sampled directly during the point-intercept survey and are used in the analysis that follows, while eight species were observed incidentally during visits to Spider Lake. Four exotic species, purple loosestrife (*Lythrum salicaria*), common forget-me-not (*Myosotis scorpioides*) and curly-leaf pondweed (*Potamogeton crispus*) were observed within and along Spider Lake also. Exotic species inventories and management actions are discussed within the Chain-wide plan document.

Aquatic plants were found growing to a depth of 14 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 281 point-intercept locations sampled within the littoral zone, roughly 45% contained aquatic vegetation. Spider 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 63% of the point-intercept sampling locations where sediment data was collected at were sand, 17% consisted of a fine, organic substrate (muck) and 20% were determined to be rocky (Chain-wide Fisheries Section, Table 3.5-5).

Table 8.3.4-1. Aquatic plant species located in Spider Lake during 2012 plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2012 Onterra
Emergent	*Carex retrorsa*	Retrorse sedge	6	I
	Carex crinita	Fringed sedge	6	I
	Carex vesicaria	Blister sedge	7	I
	Eleocharis palustris	Creeping spikerush	6	X
	Equisetum fluviatile	Water horsetail	7	X
	Juncus effusus	Soft rush	4	I
	Lythrum salicaria	Purple loosestrife	Exotic	I
	Myosotis scorpioides	Common forget-me-not	Exotic	I
	Scirpus cyperinus	Wool grass	4	I
	Sagittaria rigida	Stiff arrowhead	8	X
	Schoenoplectus acutus	Hardstem bulrush	5	X
	Schoenoplectus tabernaemontani	Softstem bulrush	4	X
	Typha spp.	Cattail spp.	1	I
	Zizania sp.	Wild rice Species	8	I
FL	*Nuphar variegata*	Spatterdock	6	X
	Nymphaea odorata	White water lily	6	X
FL/E	*Sparganium fluctuans*	Floating-leaf bur-reed	10	I
	Sparganium eurycarpum	Common bur-reed	5	X
Submergent	*Bidens beckii*	Water marigold	8	X
	Callitriche palustris	Common water starwort	8	X
	Chara spp.	Muskgrasses	7	X
	Ceratophyllum demersum	Coontail	3	X
	Elatine minima	Waterwort	9	X
	Elodea canadensis	Common waterweed	3	X
	Heteranthera dubia	Water stargrass	6	X
	Myriophyllum sibiricum	Northern watermilfoil	7	X
	Nitella sp.	Stoneworts	7	X
	Najas flexilis	Slender naiad	6	X
	Potamogeton pusillus	Small pondweed	7	X
	Potamogeton spirillus	Spiral-fruited pondweed	8	X
	Potamogeton vaseyi	Vasey's pondweed	10	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X
	Potamogeton crispus	Curly-leaf pondweed	Exotic	X
	Potamogeton strictifolius	Stiff pondweed	8	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X
	Potamogeton gramineus	Variable pondweed	7	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X
	Potamogeton robbinsii	Fern pondweed	8	X
	Sagittaria cristata	Crested arrowhead	9	X
	Utricularia vulgaris	Common bladderwort	7	X
	Vallisneria americana	Wild celery	6	X
SE	*Eleocharis acicularis*	Needle spikerush	5	X
	Sagittaria cuneata	Arum-leaved arrowhead	7	X

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

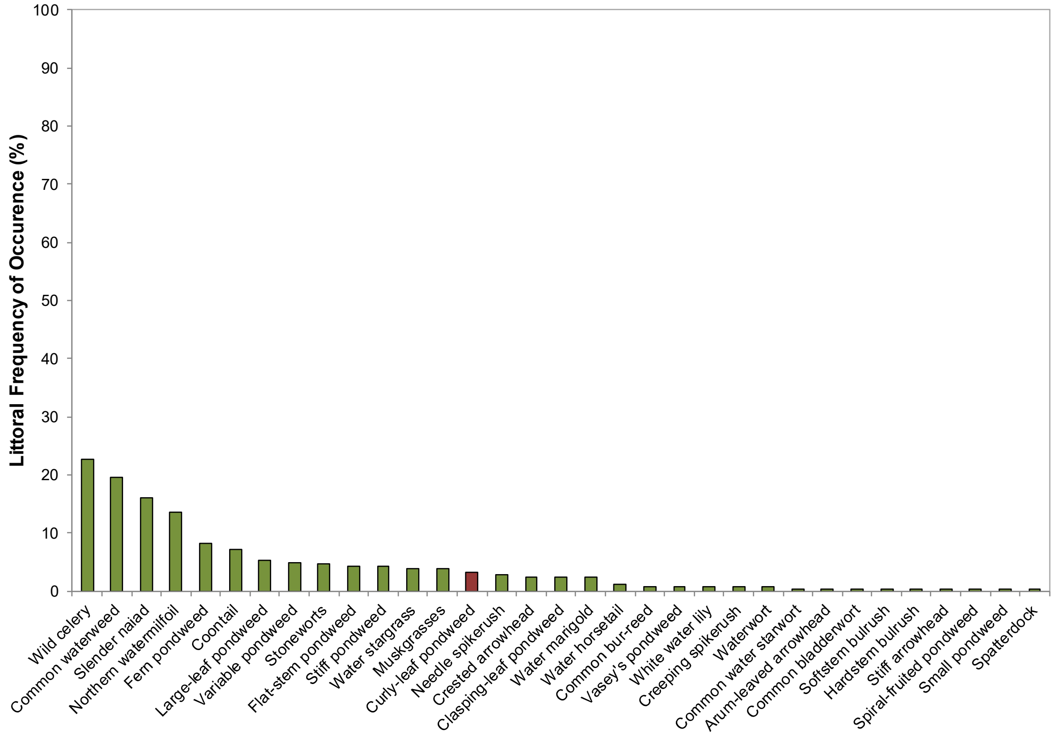


Figure 8.3.4-1. Spider Lake aquatic plant littoral frequency of occurrence analysis. Created using data from a 2012 point-intercept survey. Exotic species indicated in red.

Figure 8.3.4-1 (above) shows that wild celery, common waterweed and slender naiad were the most frequently encountered plants within Spider 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 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. Naiad species are branching plants that are eaten by waterfowl and provides excellent shelter for aquatic insects and small fish. As its name implies, slender naiad is a slender, low-growing species with narrow, short pale green leaves.

One species discovered during 2011 and 2012 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, 40 species of native aquatic plants (including incidentals) were found in Spider Lake, along with three non-native plant species. 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 Spider Lake's plant community (0.92) 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 wild celery was found at 23% of the sampling locations, its relative frequency of occurrence is 16%. Explained another way, if 100 plants were randomly sampled from Spider Lake, 16 of them would be wild celery. This distribution can be observed in Figure 8.3.4-2, where together 15 native (and one non-native) species account for 89% of the aquatic plant population within Spider Lake, while the other 18 species account for the remaining 10%. Eight additional native and two non-native species were located from the lake but not from of the point-intercept survey, and are indicated in Table 8.3.4-1 as incidentals.

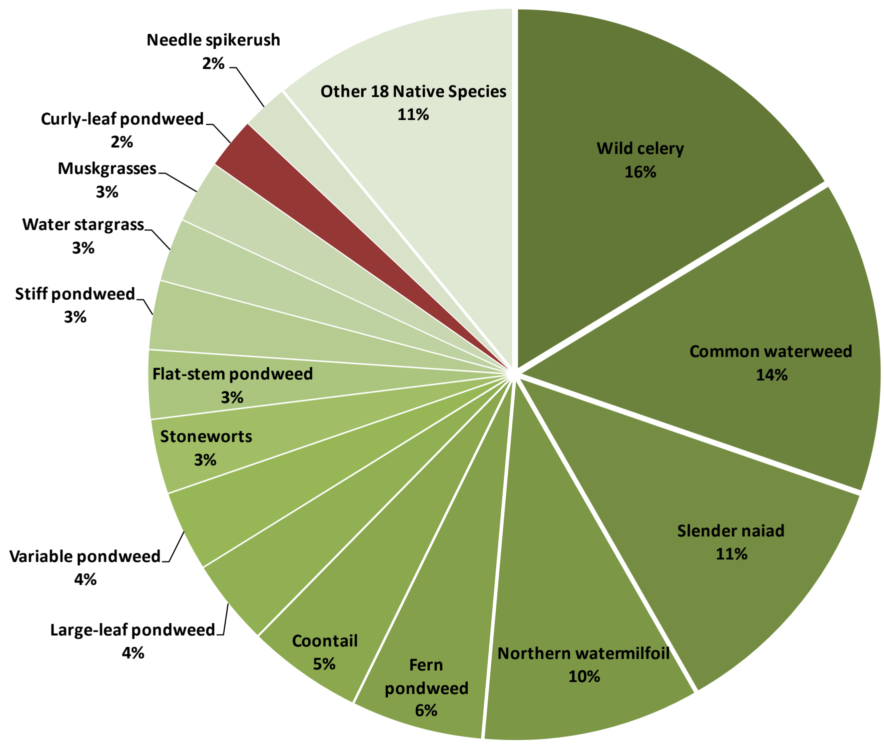


Figure 8.3.4-2. Spider Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2012 point-intercept survey.

Spider Lake's average conservatism value (6.5) is higher than the state (6.0) but slightly under the Northern Lakes and Forests ecoregion (6.7) median. This indicates that the plant community of Spider Lake is indicative of a moderately disturbed system. Combining Spider Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in a value of 36.9 which is above the median values of the ecoregion and state.

The quality of Spider Lake is also indicated by the high incidence of emergent and floating-leaf plant communities that occur in many areas. The 2012 community map indicates that approximately 2.4 acres of the lake contains these types of plant communities (Spider Lake Map 4, Table 8.3.4-2). Eighteen floating-leaf and emergent species were located on Spider Lake (Table 8.3.4-1), all of which provide valuable wildlife habitat.

Table 8.3.4-2. Spider Lake acres of emergent and floating-leaf plant communities from the 2012 community mapping survey.

Plant Community	Acres
Emergent	1.4
Floating-leaf	-
Mixed Floating-leaf and Emergent	1.0
Total	2.4

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 Spider 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.

Non-Native Aquatic Plants in Spider Lake

Purple loosestrife

Purple loosestrife (*Lythrum salicaria*) is a perennial herbaceous plant native to Europe and was likely brought over to North America as a garden ornamental. This plant escaped from its garden landscape into wetland environments where it is able to out-compete our native plants for space and resources. First detected in Wisconsin in the 1930's, it has now spread to 70 of the state's 72 counties. Purple loosestrife largely spreads by seed, but also can vegetatively spread from root or stem fragments.

In Spider Lake, purple loosestrife was located along the shoreline of the lake in several locations (Spider Lake – Map 4). There are a number of effective control strategies for combating this aggressive plant, including herbicide application, biological control by native beetles, and manual hand removal. Due to the low occurrence and distribution of plants, hand removal by volunteers is likely the best option as it would decrease costs significantly. Additional purple loosestrife monitoring would be required to ensure the eradication of the plant from the shorelines and wetland areas around Spider Lake.

Common Forget-me-not

Common forget-me-not (*Myosotis scorpioides*) is a relatively small, semi-aquatic wetland plant that produces clusters of small bluish flowers. Native to Eurasia, like pale-yellow iris, common forget-me-not has escaped cultivation and invaded wetland habitats across Wisconsin and creates a monotypic ground cover. A small colony of common forget-me-not was located by Onterra on the far western shoreline of Spider Lake's southern basin (Spider Lake – Map 4). Manual removal by pulling the plants and their roots is likely the best option for control of this plant at this time on Spider Lake.

Curly-leaf Pondweed

Curly-leaf pondweed (*Potamogeton crispus*) is discussed in detail at the end of the Aquatic Plant Section 3.4. Monitoring results, control actions, and a description of the plant's lifecycle are contained in that section.

Curly-leaf pondweed was first discovered in Spider Lake during 2010. Through 2019, the infrequent occurrences of this exotic, in Spider Lake proper, were managed through volunteer and professional hand-harvesting. A more significant population located in the Spider-Island channel was closely monitored and managed with a combination of herbicide treatments and hand-harvesting. This is described in Section 3.4. As a part of the Manitowish Waters Comprehensive Management Plan, Spider Lake's curly-leaf pondweed population will be monitored by volunteers and professionals with control actions being implemented as appropriate.

8.3.5 Spider 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 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 Spider 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 8.3.5-1). 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. Spider Lake has been stocked from 1991 to 2016 with muskellunge (Table 8.3.5-1).

Photograph 8.3.5-1. Fingerling Muskellunge.

Table 8.3.5-1. Stocking data available for <u>muskellunge</u> in Spider Lake (1991-2016).

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1991	Unspecified	Fingerling	250	11
1992	Unspecified	Fingerling	250	10
1993	Unspecified	Fingerling	500	10
1997	Unspecified	Large Fingerling	268	10.5
1999	Unspecified	Large Fingerling	250	11.8
2002	Unspecified	Large Fingerling	400	10.1
2004	Unspecified	Large Fingerling	400	10.5
2006	Upper Wisconsin River	Large Fingerling	400	10.5
2008	Upper Wisconsin River	Large Fingerling	400	10.1
2010	Upper Wisconsin River	Large Fingerling	240	12.5
2012	Upper Wisconsin River	Large Fingerling	400	10.2
2014	Upper Wisconsin River	Large Fingerling	400	10.4
2016	Upper Wisconsin River	Large Fingerling	438	11.07

Spider Lake Spear Harvest Records

Walleye open water spear harvest records are provided in Figure 8.3.5-1 from 1999 to 2017. As many as 66 walleye have been harvested from the lake in the past (2014), but the average harvest is roughly 31 fish in a given year. Spear harvesters on average have taken 58% of the declared quota. Additionally, on average 12% of walleye harvested have been female.

Muskellunge open water spear harvest records are provided in Figure 8.3.5-2 from 1999 to 2017. As many as two muskellunge have been harvested from the lake in the past (1999, 2007 and 2008), however the average harvest is zero fish in a given year. Spear harvesters on average have taken 7% of the declared quota.

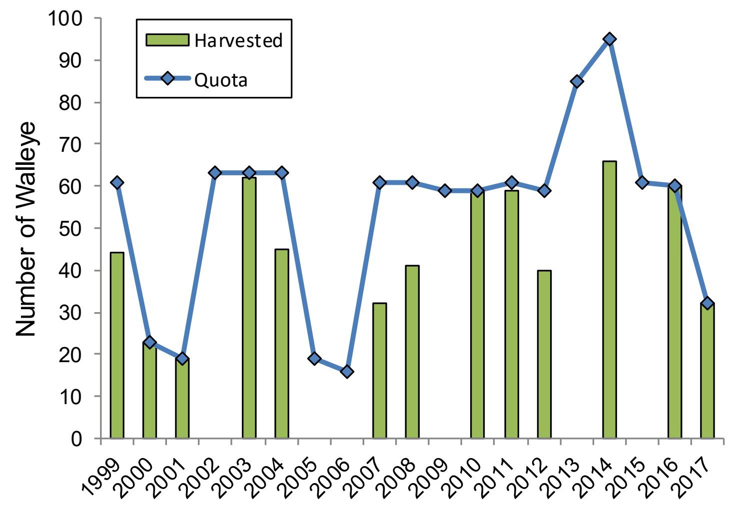


Figure 8.3.5-1. Spider Lake walleye spear harvest data. (GLIFWC 1999-2017).

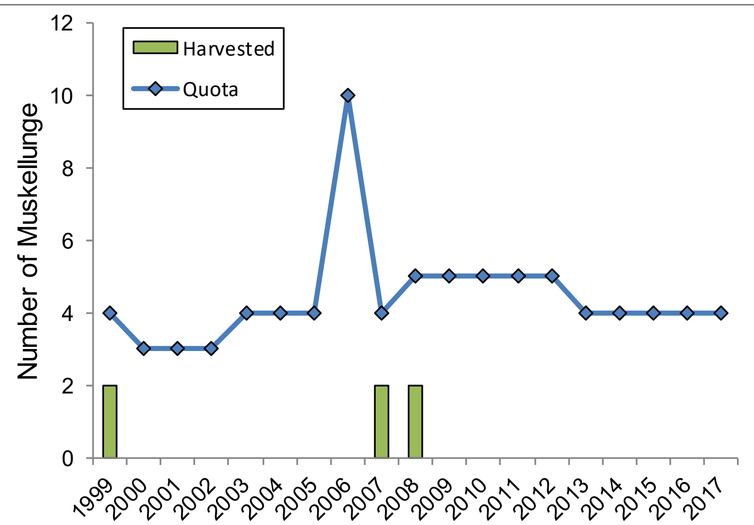
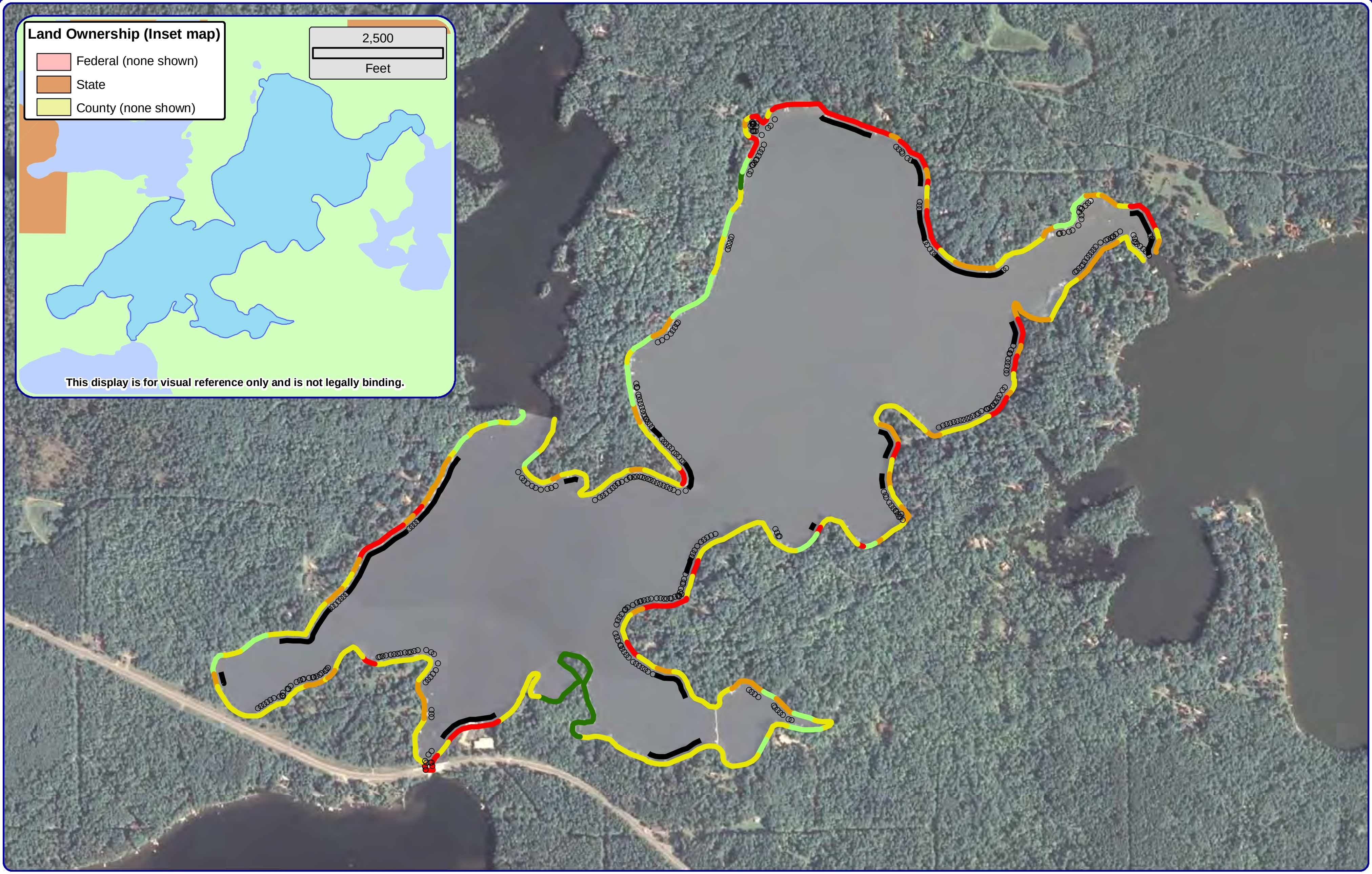


Figure 8.3.5-2. Spider Lake muskellunge spear harvest data. (GLIFWC 1999-2017).



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Onterra LLC
Lake Management Planning
815 Prosper Road
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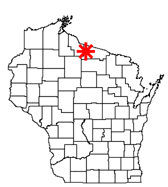
Sources:
Shoreline Assessment: Onterra, 2012
Orthophotography: NAIP, 2010
Map Date: September 24, 2013
Filename: Spider_Map1_SA_2012.mxd



Project Location in Wisconsin

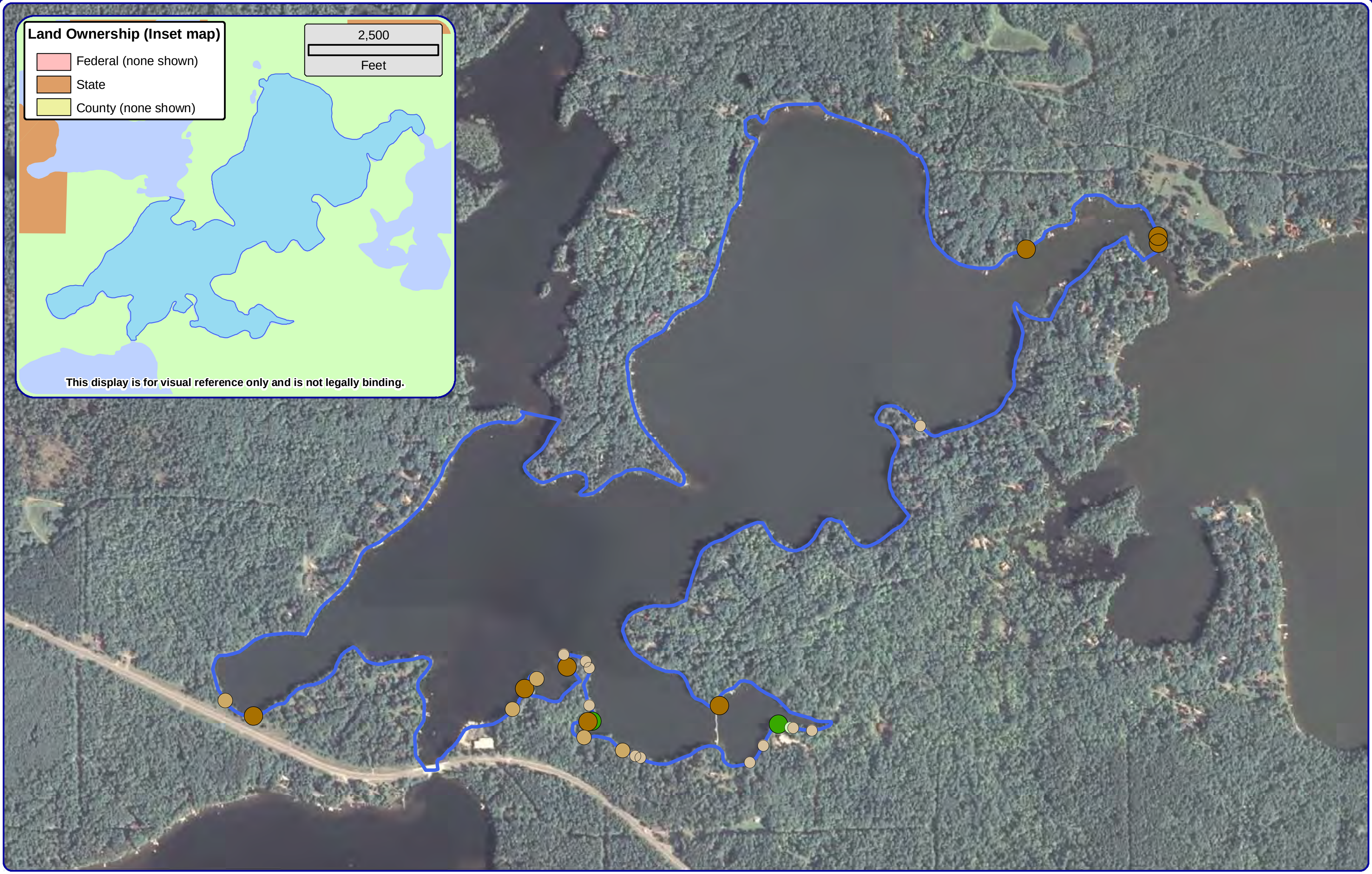
Legend

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

Seawall

- Masonary/Metal/Wood
- Rip-Rap

Spider Lake - Map 1
Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin
Shoreline Condition



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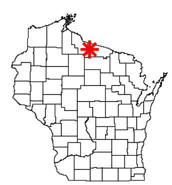
Sources:
Shoreline Assessment: Onterra, 2012
Orthophotography: NAIP, 2010
Map Date: September 24, 2013
Filename: Spider_Map2_CWH_2012.mxd



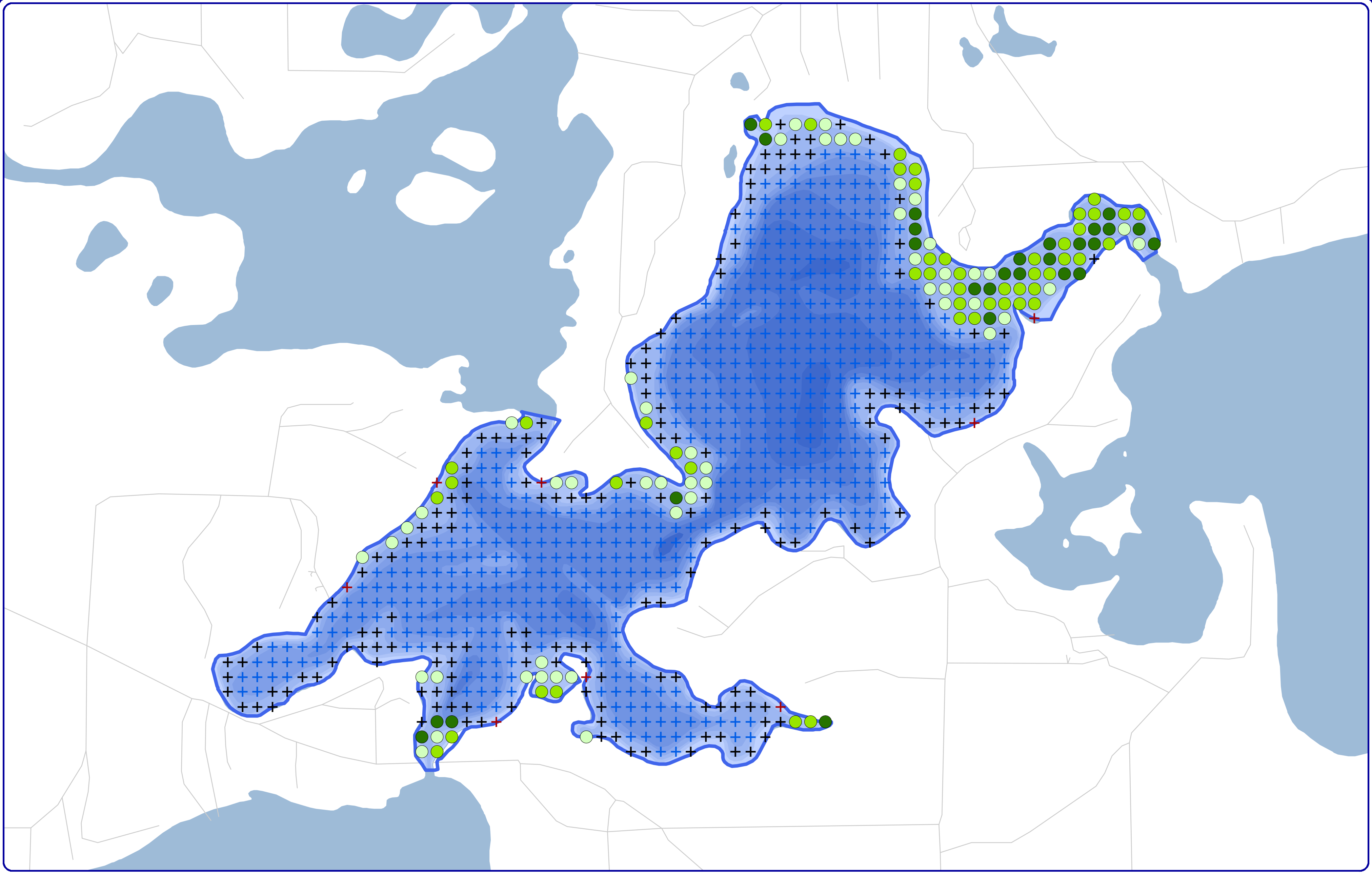
Project Location in Wisconsin

Legend

- 2-8 Inches, No Branches
- 2-8 Inches, Minimal Branches
- 2-8 Inches, Moderate Branches
- 2-8 Inches, Full Canopy (none)
- >8 Inches, No Branches
- >8 Inches, Minimal Branches (none)
- >8 Inches, Moderate Branches
- >8 Inches, Full Canopy
- Cluster

Spider Lake - Map 2
Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin

Course Woody Habitat



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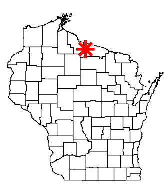
Sources:
Aquatic Plant Surveyt: Onterra, 2012
Roads and Hydro: WDNR
Map Date: September 24, 2013
Filename: Spider_Map3_TRFPI_2012.mxd



Project Location in Wisconsin

Legend

2012 Point-intercept Survey

- + No Vegetation
- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- + Too Deep (Below Max Depth of Plants)
- + Non-navigable

Spider Lake - Map 3
Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin

Aquatic Plant Distribution

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Sources:
Aquatic Plants: Onterra, 2012
Orthophotography: NAIP, 2010
Map date: December 11, 2012
Filename: Spider_Map4_Comm_2012.mxd

Legend

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

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- Adjacent Wetland Habitat

Exotic Plant Communities
- Purple loosestrife
- Common forget-me-not

Spider Lake - Map 4
Manitowish Waters
Chain of Lakes
Vilas County, Wisconsin
Emergent & Floating-leaf
Aquatic Plant Communities