8.4 Little Star Lake

An Introduction to Little Star Lake

Little Star Lake, Vilas County, is a 101-acre shallow headwater, eutrophic drainage lake with a maximum depth of 9 feet and a mean depth of 4 feet (Little Star Lake – Map 1). Its watershed encompasses approximately 516 acres within the St. Germain River Watershed and is comprised mainly of intact forests and wetlands. Water leaves Little Star Lake to the south and flows into Star Lake. In 2017, 18 native aquatic plant species were located within the lake, of which water celery (*Vallisneria americana*) was the most common. One non-native plant, Eurasian watermilfoil (*Myriophyllum spicatum*), was found during the surveys.

Lake at a Glance - Little Star Lake

Morphometry	
Lake Type	Shallow Headwater Drainage Lake
Surface Area (Acres)	101
Max Depth (feet)	9
Mean Depth (feet)	4
Perimeter (Miles)	1.7
Shoreline Complexity	1.5
Watershed Area (Acres)	516
Watershed to Lake Area Ratio	4:1

Water Quality	
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Avg Summer P (µg/L)	52
Avg Summer Chl-α (µg/L)	26
Avg Summer Secchi Depth (ft)	2.1
Summer pH	-
Alkalinity (mg/L as $CaCO_3$)	-

Vegetation	
Number of Native Species	18
NHI-Listed Species	-
Exotic Species	Eurasian watermilfoil (*Myriophyllum spicatum*)
Average Conservatism	6.5
Floristic Quality	22.5
Simpson's Diversity (1-D)	0.8

Descriptions of these parameters can be found within the town-wide portion of the management plan

8.4.1 Little Star Lake Water Quality

Water quality data was collected from Little Star Lake on four occasions in 2017 with reduced water quality monitoring due to the size of the lake, depth of the lake, the level of development. Onterra staff sampled the lake for 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 2017 any historical data was researched and are included within this report as available.

Near-surface total phosphorus data from Little Star Lake are available from 1979, 2007, and 2017 (Figure 8.4.1-1). The weighted summer average total phosphorus concentration is 52 µg/L and falls just into the *fair* category for shallow headwater drainage lakes in Wisconsin. Little Star Lake's summer average total phosphorus concentrations are over 1.5 times higher than the median value for shallow headwater drainage lakes in the state and are almost 2.5 times higher than the median value for all lake types in the Northern Lakes and Forests (NLF) ecoregion.

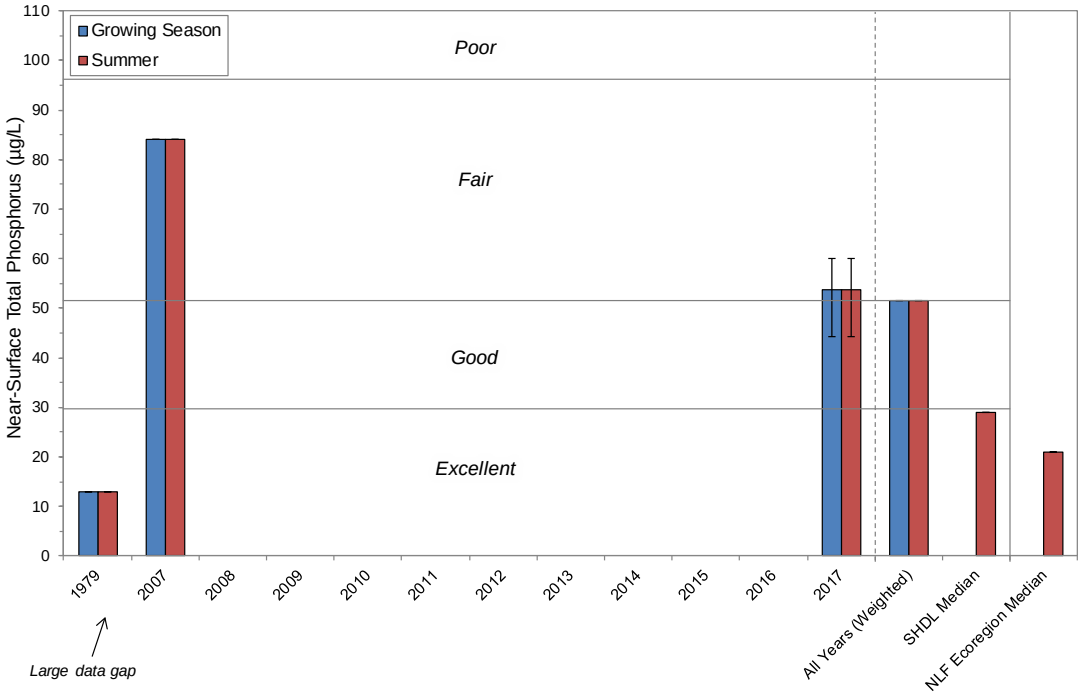


Figure 8.4.1-1. Little Star Lake, statewide shallow headwater drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Internal nutrient loading is likely occurring in Little Star Lake. As discussed in the Town-Wide Paleoecology Section (3.2), internal nutrient loading is likely the result of activities associated with logging around the beginning of the twentieth century. The logging activities would have resulted in increased nutrient loading to the lake.

Chlorophyll-*a* data are available from Little Star Lake from 1979, 2007, and from 2017 (Figure 8.4.1-2). Average summer chlorophyll-*a* concentrations ranged from 5 µg/L in 1979 to 32 µg/L in 2017; however, only one chlorophyll-*a* measurement was taken in 1979 and may not be representative of the summer average. Little Star Lake's summer average chlorophyll-*a* concentration is 26 µg/L and falls into the *fair* category for shallow headwater drainage lakes in Wisconsin. Little Star Lake's summer average chlorophyll-*a* concentrations are almost 3.5 times higher than the median value for shallow headwater drainage lakes in the state and over 4.5 times higher than the median value for all lake types in the NLF ecoregion.

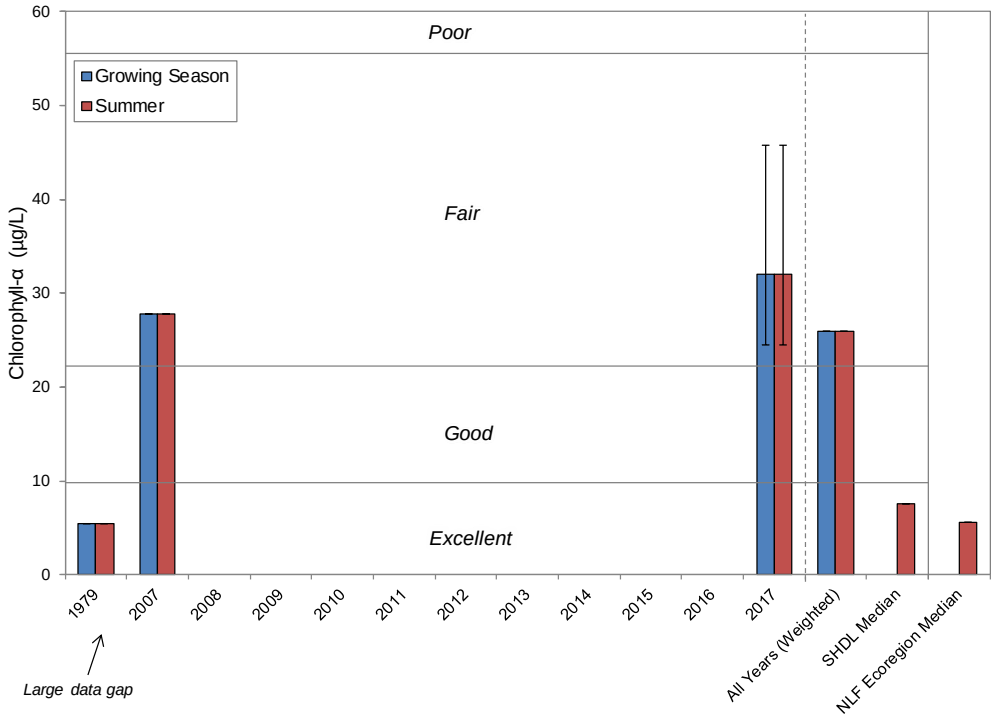


Figure 8.4.1-2. Little Star Lake, statewide shallow headwater drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Secchi disk transparency data are available from Little Star Lake from 1979 and from 2017 (Figure 8.4.1-3). The weighted summer average Secchi disk depth is 2.1 feet and falls into the *fair* category for shallow headwater drainage lakes in Wisconsin. Little Star Lake's weighted summer average Secchi disk depth is approximately 2.6 feet shallower than the median value for shallow headwater drainage lakes in the state and is approximately 4.2 feet shallower than the median value for all lakes types in the NLF ecoregion.

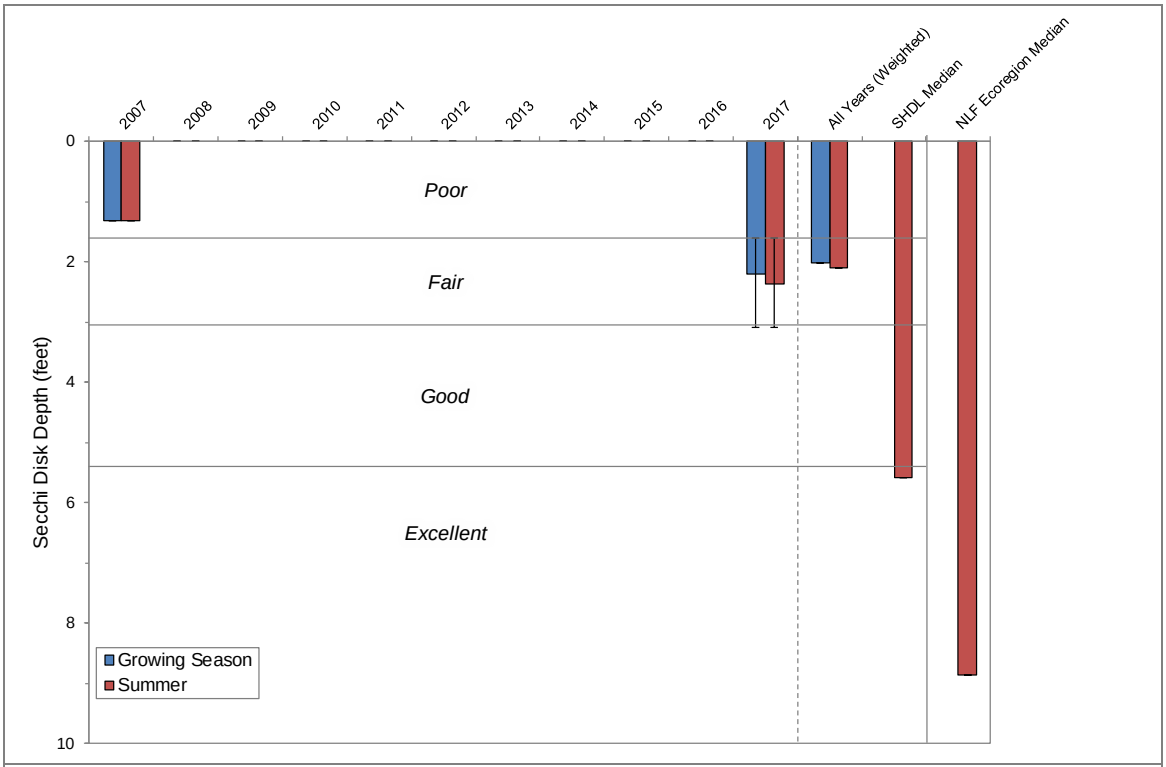


Figure 8.4.1-3. Little Star Lake, statewide shallow headwater drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Limiting Plant Nutrient of Little Star Lake

Using midsummer nitrogen and phosphorus concentrations from Little Star Lake, a nitrogen:phosphorus ratio of 17:1 was calculated. This finding indicates that Little Star Lake is indeed phosphorus limited as are the vast majority of Wisconsin lakes. In general, this means that cutting phosphorus inputs may limit plant growth within the lake.

Little Star Lake Trophic State

Figure 8.4.1-4 contains the Trophic State Index (TSI) values for Little Star Lake. These TSI values are calculated using summer near-surface total phosphorus, chlorophyll-*a*, and Secchi disk transparency data collected as part of this project along with available historical data. In general, the best values to use in assessing a lake's trophic state are chlorophyll-*a* and total phosphorus, as water clarity can be influenced by other factors other than phytoplankton such as dissolved organic compounds. The closer together these three TSI values are indicates a higher degree of correlation between the parameters.

The weighted TSI values for total phosphorus and chlorophyll-*a* (and Secchi disk transparency) in Little Star Lake indicate the lake is at present in a eutrophic state. Star Lake's productivity is much higher when compared to other shallow headwater drainage lakes in Wisconsin and all lake types within the NLF ecoregion.

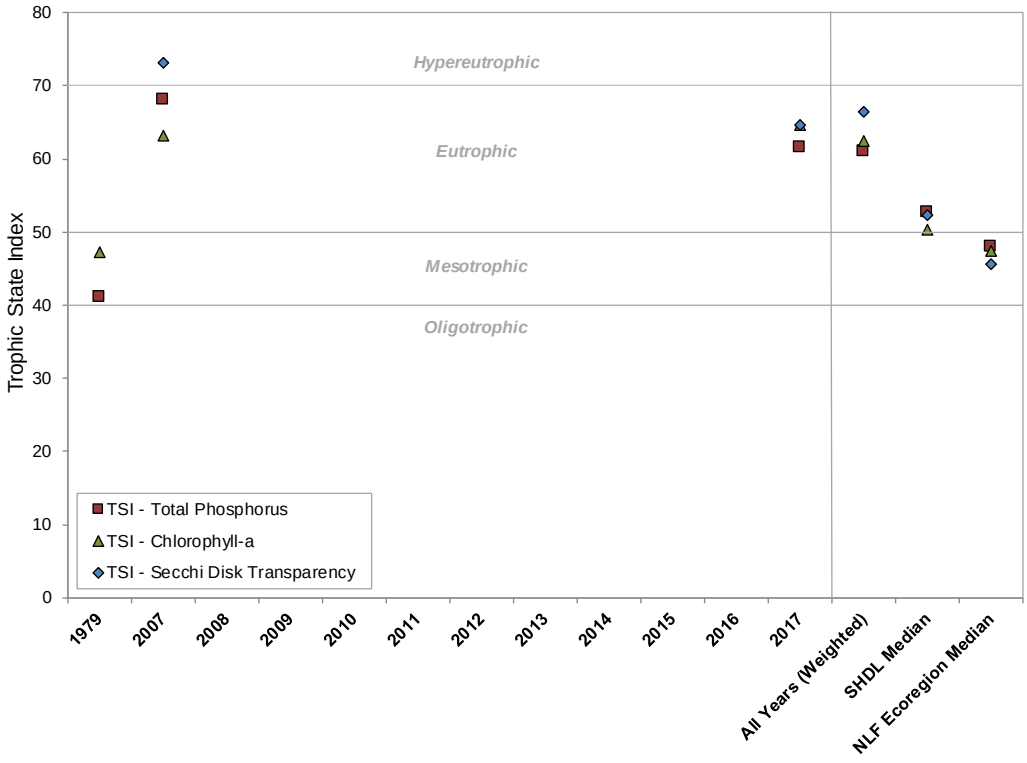


Figure 8.4.1-4. Little Star Lake, statewide shallow lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Little Star Lake

Dissolved oxygen and temperature were measured during water quality sampling visits to Little Star Lake by Onterra staff. Profiles depicting these data are displayed in Figure 8.4.1-5.

Little Star Lake is *polymictic* [lakes that are too shallow to thermally stratify and can mix throughout the growing season] and the temperature at the bottom was over 20°C in July 2017, indicating that the lake frequently mixes (Figure 8.4.1-5).

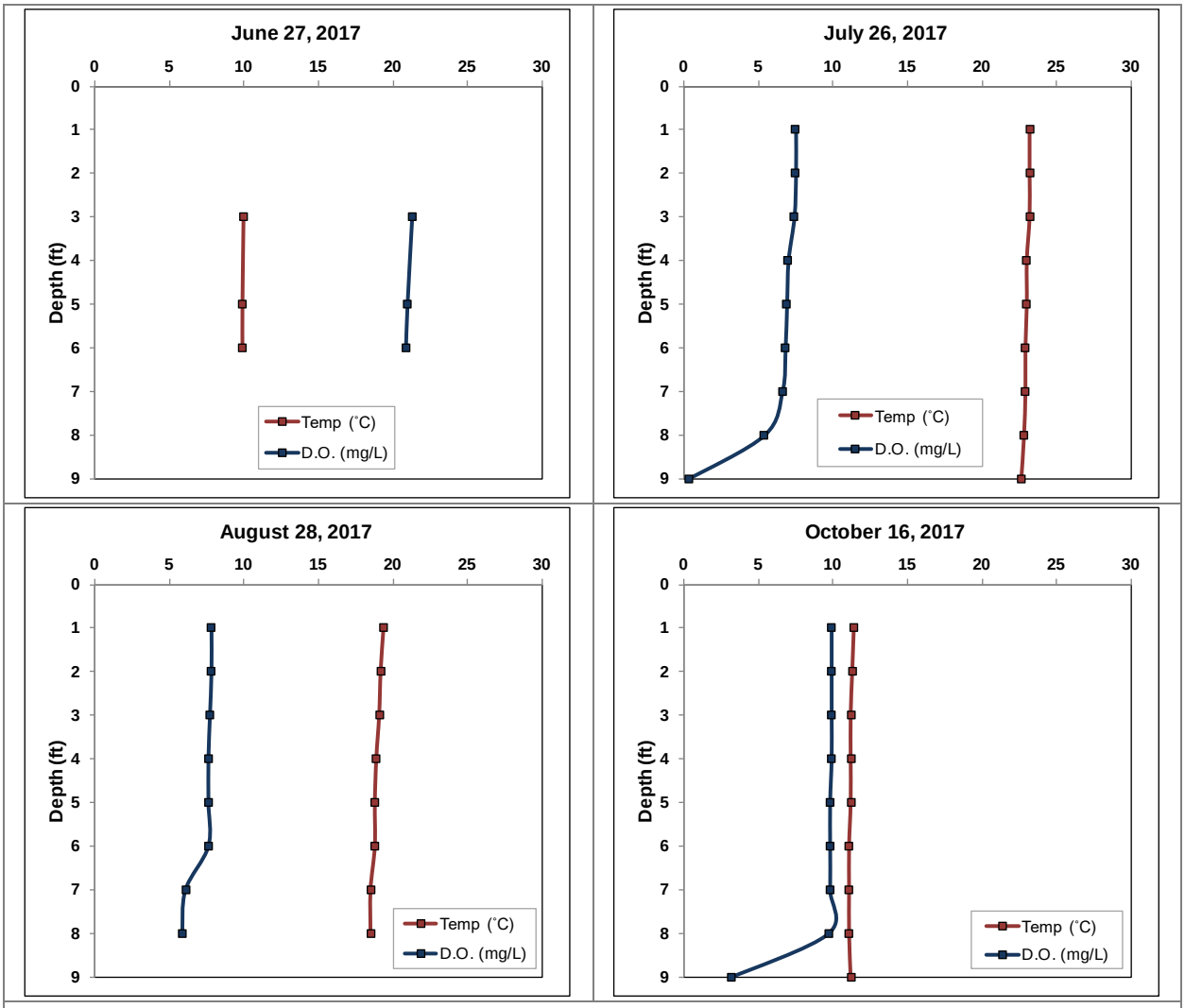


Figure 8.4.1-5. Little Star Lake 2017 dissolved oxygen and temperature profiles.

8.4.2 Little Star Lake Watershed Assessment

Little Star Lake's watershed encompasses an area of approximately 516 acres, yielding a small watershed to lake area ratio of 4:1 (Figure 8.4.2-1, Little Star Lake – Map 2). According to WiLMS modeling, the lake's water is completely replaced every 306 days (residence time) or approximately 1.2 times per year (flushing rate).

Approximately 48% of Little Star Lake's watershed is composed of forest, 22% of wetlands, 20% of the lake's surface, 9% of pasture/grass, and 1% of rural residential areas (Figure 8.4.2-1).

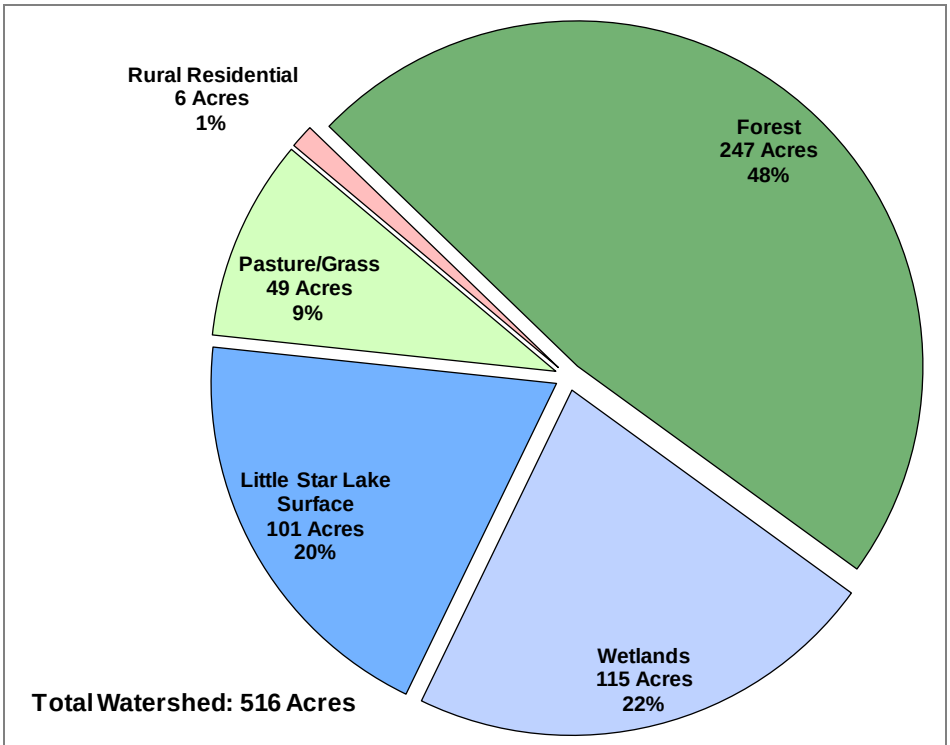


Figure 8.4.2-1. Little Star Lake watershed land cover types in acres. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

Using the land cover data described above, WiLMS was utilized to estimate the annual potential phosphorus load from Little Star Lake's watershed. It was estimated that approximately 71 pounds of phosphorus is delivered to Little Star Lake from its watershed on an annual basis (Figure 8.4.2-2).

Of the estimated 71 pounds of phosphorus being delivered annually to Little Star Lake, 37% is estimated to originate from direct atmospheric deposition into the lake, 28% from forest, 19% from pasture/grass, 15% from wetlands, and 1% from riparian septic systems (Figure 8.2.2-2).

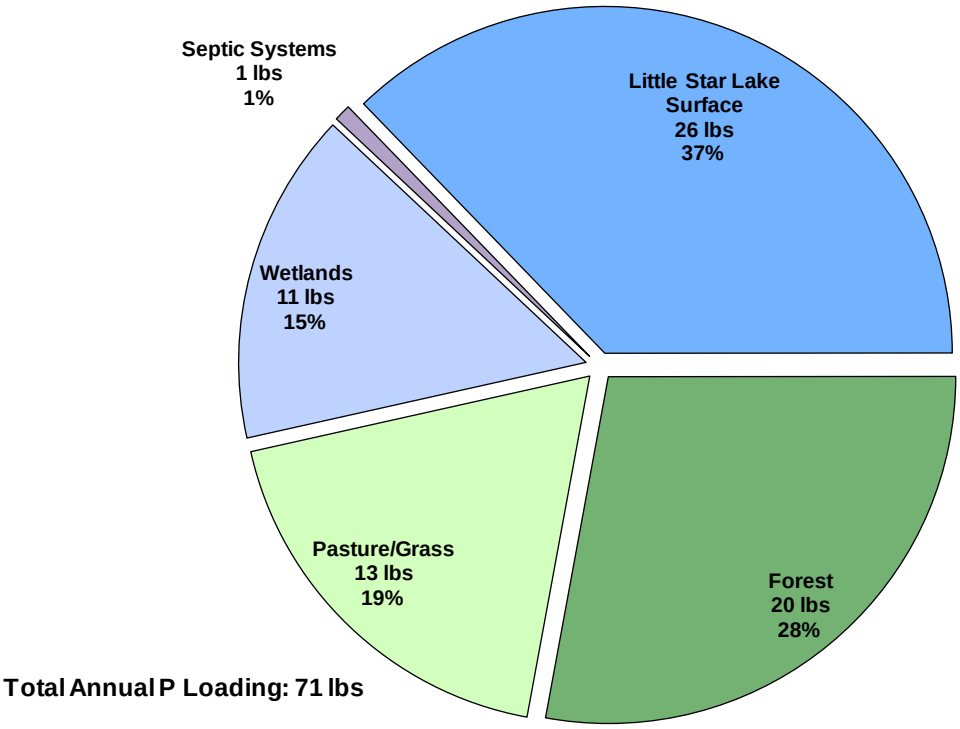


Figure 8.4.2-2. Little Star Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Using predictive equations, WiLMS estimated that based on the 71 pounds of phosphorus which are estimated to be loaded to Little Star Lake annually, the lake should have an in-lake growing season mean (GSM) total phosphorus concentration of approximately 26 µg/L. This predicted GSM total phosphorus concentration almost two times lower than the measured GSM concentration of 51.7 µg/L. The discrepancy between predicted and measured total phosphorus concentrations may be explained, in part, by internal nutrient loading occurring in Little Star Lake. The model may have also underestimated the amount of phosphorus loaded to Little Star Lake on an annual basis from the lake's watershed.

8.4.3 Little Star Lake Shoreland Condition

Shoreland Development

As mentioned previously in the Town-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 the fall of 2017, Little Star Lake's immediate shoreline was assessed in terms of its development. Little Star Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.5 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.4.3-1). This constitutes about 80% of Little Star 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, <0.1 miles of urbanized and developed–unnatural shoreline (1%) was observed. If restoration of the Little Star 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. Little Star Lake - Map 3 displays the location of these shoreline lengths around the entire lake.

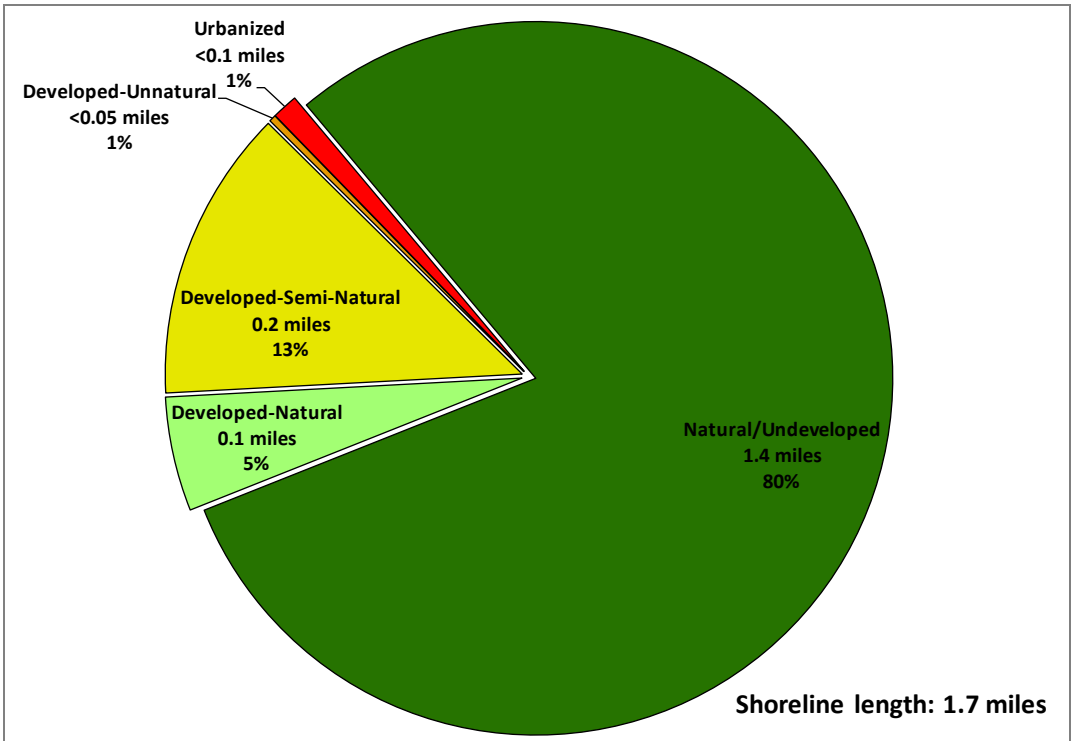


Figure 8.4.3-1. Little Star Lake shoreland categories and total lengths. Based upon a fall 2017 survey. Locations of these categorized shorelands can be found on Little Star Lake - Map 3.

Coarse Woody Habitat

A survey for coarse woody habitat was conducted in conjunction with the shoreland assessment (development) survey. Coarse woody habitat was identified, and classified in three size categories (2-8 inches in diameter, >8 inches in diameter, and cluster 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, 130 total pieces of coarse woody habitat were observed along 1.7 miles of shoreline (Little Star Lake - Map 4), which gives Little Star Lake a coarse woody habitat to shoreline mile ratio of 75:1 (Figure 8.4.3-2). Only instances where emergent coarse woody habitat extended from shore into the water were recorded during the survey. Of the 130 total pieces of coarse woody habitat observed during the survey, 111 pieces were 2-8 inches in diameters, 19 were 8 inches in diameter or greater, and no clusters of pieces 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 Little Star 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 75 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 Little Star Lake fell well above the 75th percentile of these 75 lakes (Figure 8.4.3-2).

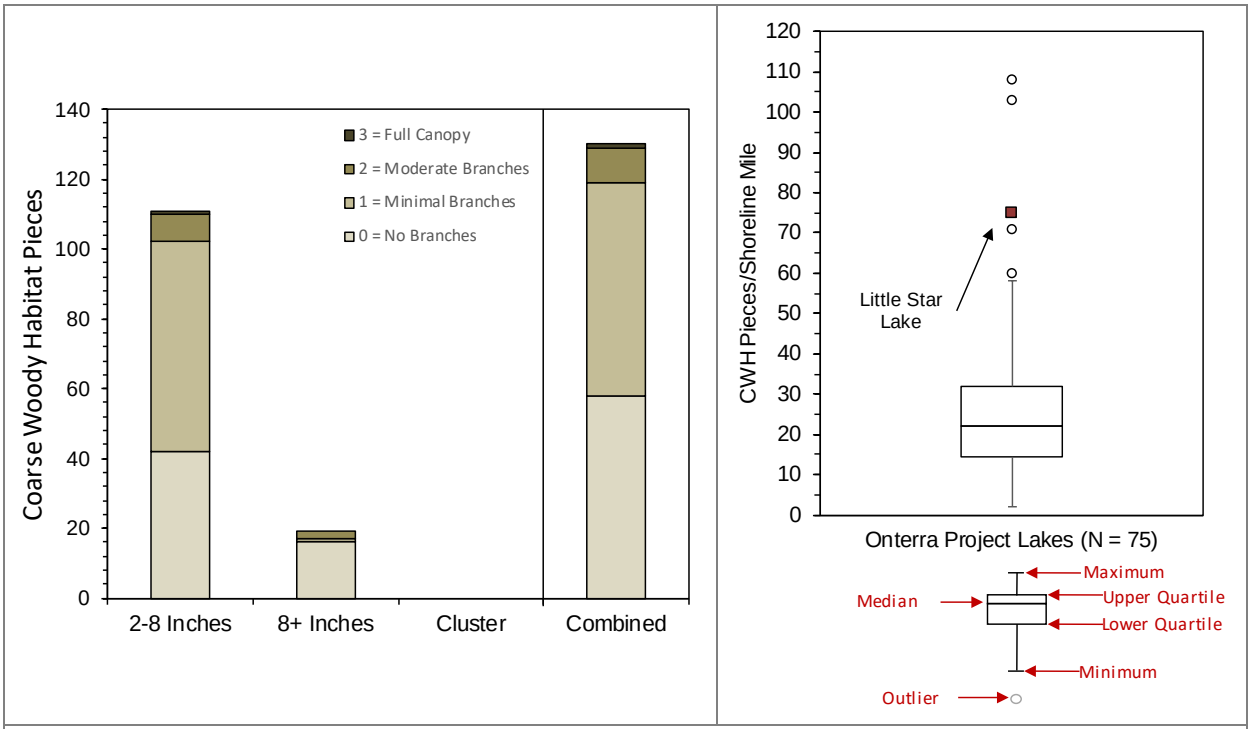


Figure 8.4.3-2. Little Star Lake coarse woody habitat survey results. Based upon a fall 2017 survey. Locations of Little Star Lake coarse woody habitat can be found on Little Star Lake - Map 4.

8.4.4 Little Star Lake Aquatic Vegetation

An Early-Season Aquatic Invasive Species (ESAIS) Survey was conducted by Onterra ecologists on Little Star Lake on June 29, 2017. While the intent of this survey is to locate any potential non-native species within the lake, the primary focus is to locate potential occurrences of the non-native curly-leaf pondweed, which should be at or near its peak growth at this time. No curly-leaf pondweed was located during the survey.

Photograph 8.4.4-1. Little Star Lake

The whole-lake aquatic plant point-intercept survey and emergent and floating-leaf aquatic plant community mapping survey were conducted on West Plum by Onterra ecologists on August 3, 2017. During these surveys, a total of 19 aquatic plant species were located, one of which is considered to be a non-native, invasive species: Eurasian watermilfoil (Table 8.4.4-1). One native aquatic plant species present in Little Star Lake, Vasey's pondweed, is listed by the Wisconsin Natural Heritage Inventory Program as a species of 'special concern' because it is rare or uncommon in Wisconsin and there is uncertainty regarding its abundance and distribution within the state.

As discussed in the primer section, sediment data were collected at each sampling location within the littoral zone during the point-intercept survey. Approximately 91% of the point-intercept locations within littoral areas contained fine, organic sediments (muck), 8% contained sand, and 1% contained rock (Figure 8.4.4-1). The majority of the shallow, near-shore areas contained sand and/or rock, while the deeper areas of the littoral zone were comprised of muck (Little Star Lake - Map 5). Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in mucky substrates, others only in sandy areas, and some can be found growing in either. Lakes that have varying substrate types generally support a higher number of plant species because the different habitat types that are available.

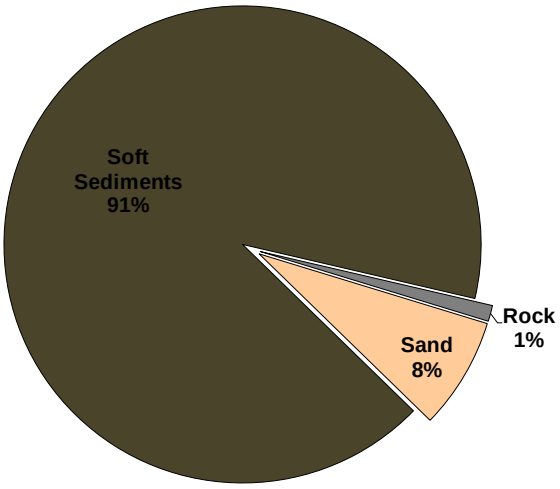


Figure 8.4.4-1. Little Star Lake 2017 proportion of substrate types. Created from data collected during the 2017 whole-lake point-intercept survey (N = 178).

Table 8.4.4-1. List of aquatic plant species located in Little Star Lake during Onterra 2017 aquatic plant surveys.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2017 (Onterra)
Emergent	*Eleocharis palustris*	Creeping spikerush	6	I
	Iris versicolor	Northern blue flag	5	I
	Schoenoplectus acutus	Hardstem bulrush	5	I
	Sparganium americanum	American bur-reed	8	I
	Typha spp.	Cattail spp.	1	I
FL	*Nuphar variegata*	Spatterdock	6	X
	Nymphaea odorata	White water lily	6	X
Submergent	*Chara* spp.	Muskgrasses	7	X
	Elodea canadensis	Common waterweed	3	X
	Heteranthera dubia	Water stargrass	6	I
	Myriophyllum spicatum	Eurasian watermilfoil	Exotic	I
	Najas flexilis	Slender naiad	6	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X
	Potamogeton foliosus	Leafy pondweed	6	X
	Potamogeton pusillus	Small pondweed	7	X
	Potamogeton robbinsii	Fern-leaf pondweed	8	X
	*Potamogeton vaseyi**	Vasey's pondweed	10	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X
	Vallisneria americana	Wild celery	6	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
** = Species listed as special concern by WI Natural Heritage Inventory*

Of the 178 point-intercept sampling locations that fell at or below the maximum depth of plant growth in 2017, approximately 22% contained aquatic vegetation. Little Star Lake – Map 6 displays the point-intercept locations that contained aquatic vegetation in 2017, and the total rake fullness ratings at those locations. The aquatic vegetation found in 2017 was found lake-wide. Seven percent of the point-intercept locations had a total rake fullness (TRF) rating of 1, 7% had a total rake fullness rating of 2, and 8% had the highest total rake fullness rating of 3 (Figure 8.4.4-2). Seventy-eight percent of the littoral zone had no vegetation meaning that where plants are found, they are sparse.

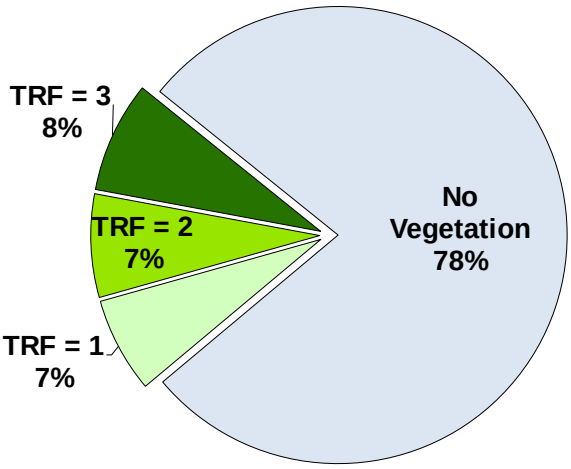


Figure 8.4.4-2. Little Star Lake 2017 aquatic vegetation total rake fullness ratings (TRF). Created from data collected during the 2017 whole-lake point-intercept survey (N = 178).

Of the 18 native aquatic plant species located in Little Star Lake in 2017, 12 were encountered directly on the rake during the whole-lake point-intercept survey (Figure 8.4.4-3). The remaining six plants were located incidentally, meaning they were observed by Onterra ecologists while on the lake but they were not directly sampled on the rake at any of the point-intercept sampling locations. Incidental species typically include emergent and floating-leaf species that are often found growing on the fringes of the lake and submersed species that are relatively rare within the

plant community. Of the 12 species directly sampled with the rake during the point-intercept survey, wild celery, slender naiad, stoneworts, and muskgrasses were the four-most frequently encountered plants, respectively (Figure 8.4.4-3).

Wild celery, the most abundant aquatic plant in Little Star Lake in 2017 with a littoral occurrence of 11% (Figure 8.4.4-3), has bundles of long submersed leaves that are flat and ribbon-like which emerge from a basal rosette and provide excellent structural habitat for aquatic organisms. Spreading rapidly via rhizomes, wild celery is often found growing in large colonies where their extensive root systems stabilize bottom sediments. In mid- to late-summer, the coiled flower stalks of wild celery can be observed at or near the surface, and following pollination, large banana-shaped seed pods can also be seen. These seed pods have been shown to be an important food source for waterfowl (Borman et al. 1997).

Slender naiad, the second-most abundant aquatic plant in Little Star Lake in 2017 with a littoral occurrence of 8% (Figure 8.4.4-3), is one of three native naiads that can be found in Wisconsin. Being an annual, it produces numerous seeds on an annual basis and is considered to be one of the most important food sources for a number of migratory waterfowl species (Borman et al. 1997). In addition, slender naiad's small, condensed network of leaves provide excellent habitat for aquatic invertebrates.

Stoneworts were the third-most abundant aquatic plant encountered in 2017 in Little Star Lake, with a littoral occurrence of 7% (Figure 8.4.4-3). Stoneworts are a species of macro-algae rather than a vascular plant. Whorls of forked branches are attached to the "stems" of the plant, which are long, slender, smooth-textured algae. Because they lack roots, stoneworts remove nutrients directly from the water.

Muskgrasses, like stoneworts, are a genus of macroalgae of which there are seven species in Wisconsin (Photograph 8.4.4-2). In 2017, muskgrasses had a littoral frequency of occurrence of approximately 7% (Figure 8.4.4-3). Dominance of the aquatic plant community by muskgrasses is common in hardwater lakes and these macroalgae have been found to be more competitive against vascular plants (e.g. pondweeds, milfoils, etc.) in lakes with higher concentrations of calcium carbonate in the sediment (Kufel and Kufel 2002; Wetzel 2001). Muskgrasses require lakes with good water clarity, and their large beds stabilize bottom sediments. Studies have also shown that muskgrasses sequester phosphorus in the calcium carbonate incrustations which from on these plants, aiding in improving water quality by making the phosphorus unavailable to phytoplankton (Coops 2002).

Photograph 8.4.4-2. The aquatic macroalgae muskgrasses (*Chara* spp.) Photo credit Onterra.

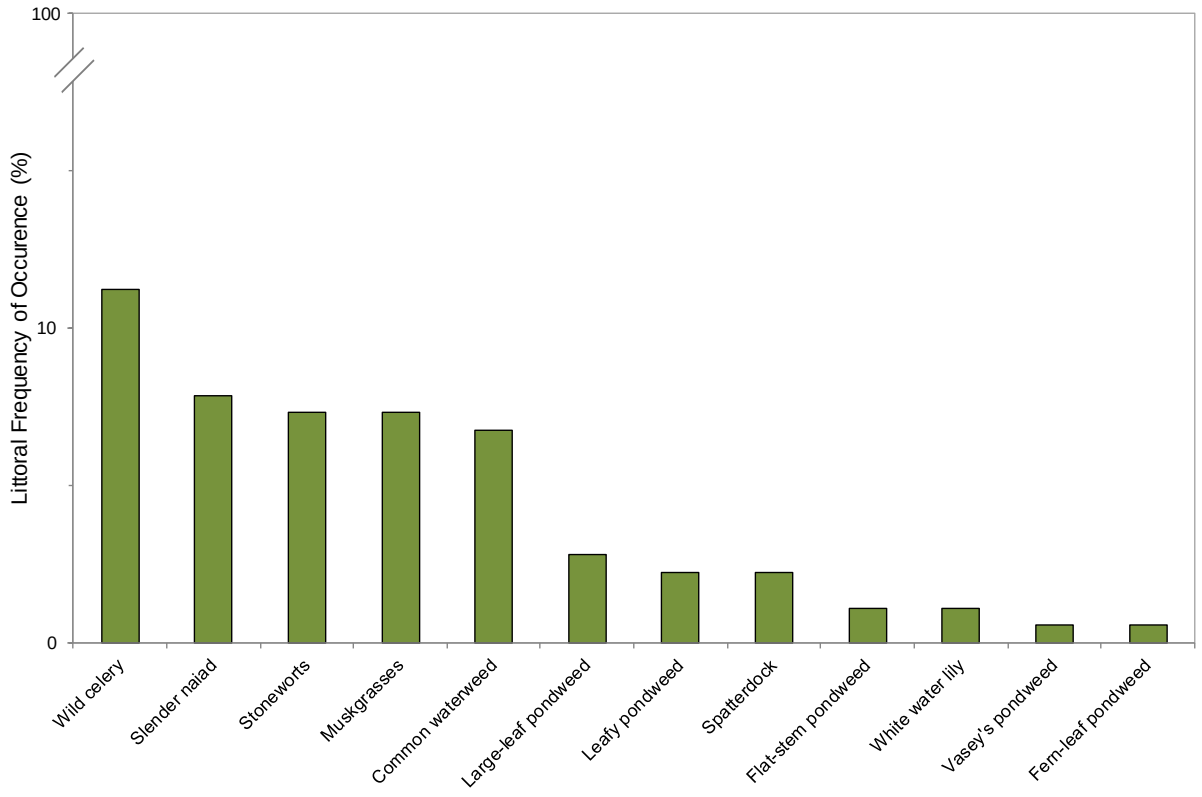


Figure 8.4.4-3. Little Star Lake 2017 littoral frequency of occurrence of aquatic plant species. Created using data from 2017 whole-lake point-intercept survey.

As discussed in the Town-wide section, the calculations used to create the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and do not include incidental species. The native species encountered on the rake during the 2017 point-intercept survey and their conservatism values were used to calculate the FQI of West Plum's aquatic plant community (equation shown below).

$$\text{FQI} = \text{Average Coefficient of Conservatism} * \sqrt{\text{Number of Native Species}}$$

Figure 8.4.4-4 compares 2017 FQI components of Little Star Lake to median values of lakes within the Northern Lakes and Forests (NLF) ecoregion and lakes throughout Wisconsin. The number of native aquatic plant species encountered on the rake, or native species richness, was 12 for the 2017 survey. Little Star Lake's species richness is below the lower quartile value for lakes within the ecoregion and the state.

Little Star Lake's average conservatism in 2017 was 6.5 (Figure 8.4.4-4). Little Star Lake's average conservatism is below the median values for lakes in the ecoregion but above the median for lakes throughout Wisconsin, which indicates Little Star Lake's aquatic plant community contains an average number of aquatic plants that are considered to be sensitive to environmental degradation and require high-quality habitats. Given Little Star Lake's lower native species richness and average conservatism values from 2017, Little Star Lake has a higher Floristic Quality Index value of 22.5. This FQI value is below the median values for lakes in the ecoregion and for

the state, and indicates that Little Star Lake's aquatic plant community is of lesser quality than the majority of lakes throughout Wisconsin.

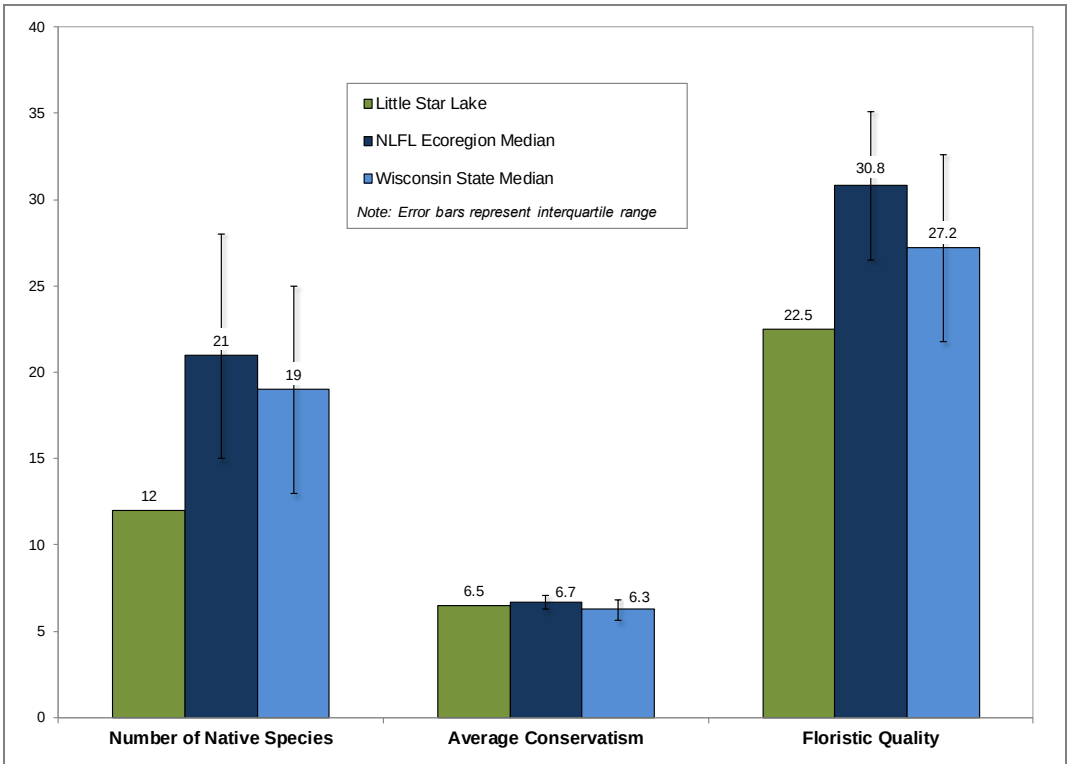


Figure 8.4.4-4. Little Star Lake Floristic Quality Assessment. Created using data from Onterra 2017 whole-lake point-intercept survey. Analysis follows Nichols (1999).

As explained in the Town-wide section, lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. In addition, a plant community with a mosaic of species with differing morphological attributes provides zooplankton, macroinvertebrates, fish, and other wildlife with diverse structural habitat and various sources of food. Because Little Star Lake contains a lower number of native aquatic plant species, one may assume the aquatic plant community has low species diversity. However, species diversity is also influenced by how evenly the plant species are distributed within the community.

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Little Star Lake's diversity value ranks. Using data collected by Onterra and WDNR Science Services, quartiles were calculated for 212 lakes within the NLF ecoregion (Figure 8.4.4-5). Using the data collected from the 2017 point-intercept survey, Little Star Lake's aquatic plant community is shown to have average species diversity with a Simpson's Diversity Index value of 0.86. In other words, if two individual aquatic plants were randomly sampled from Little Star Lake in 2017, there would be an 86% probability that they would be different species. This diversity value falls below the median for the ecoregion and at the median for lakes throughout the state.

One way to visualize Little Star Lake's species diversity is to look at the relative occurrence of aquatic plant species. Figure 8.4.4-6 displays the relative frequency of occurrence of aquatic plant species created from the 2017 whole-lake point-intercept survey and illustrates the relatively even distribution of aquatic plant species within the community. A plant community that is dominated by just a few species yields lower species diversity. 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 11% of the littoral sampling locations in Little Star Lake in 2017, its relative frequency of occurrence is 22%. Explained another way, if 100 plants were randomly sampled from Little Star Lake in 2017, 22 of them would be wild celery. When a lake is dominated by just a few species, the diversity is affected, which would cause the lake to have a lower Simpson's diversity index.

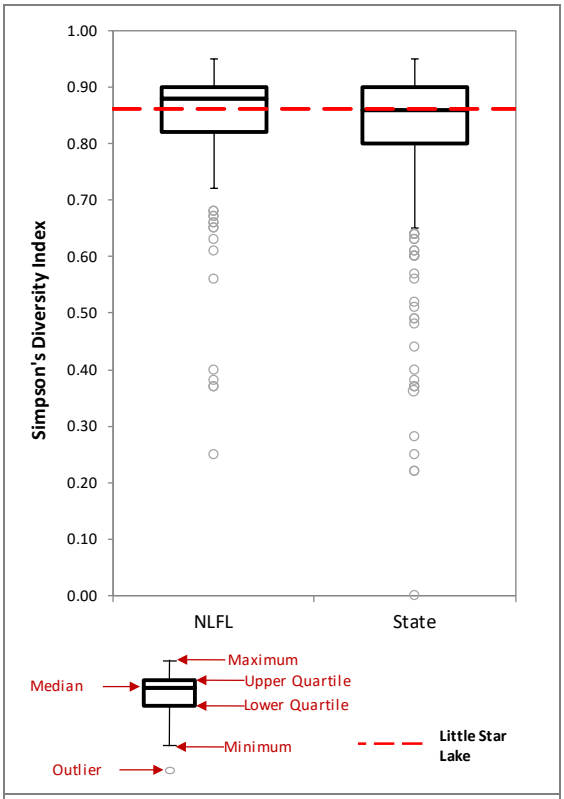


Figure 8.4.4-5. Little Star Lake species diversity index. Created using data from the Onterra 2017 point-intercept survey.

In 2017, Onterra ecologists also conducted a survey aimed at mapping emergent and floating-leaf aquatic plant communities in Little Star Lake. This survey revealed Little Star Lake contains approximately 16 acres of these communities comprised of seven different aquatic plant species (Little Star Lake – Map 7 and Table 8.4.4-2). These native emergent and floating-leaf plant communities provide valuable fish and wildlife habitat that is important to the ecosystem of the lake. These areas are particularly important during times of fluctuating water levels, since structural habitat of fallen trees and other forms of course-woody habitat can be quite sparse along the shores of receding water lines.

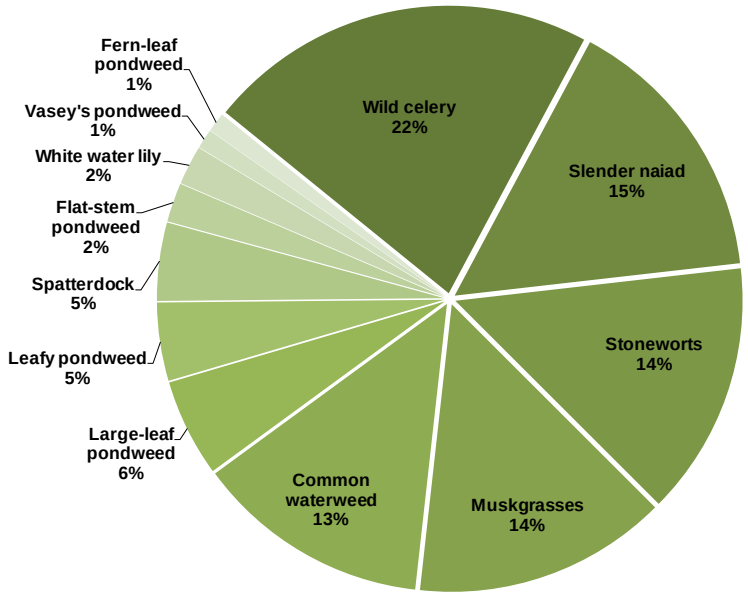


Figure 8.4.4-6. Little Star Lake 2017 relative frequency of occurrence of aquatic plant species. Created using data from 2017 point-intercept survey.

The community map represents a 'snapshot' of the important emergent and floating-leaf plant communities, and a replication of this survey in the future will provide a valuable understanding of the dynamics of these communities within

Little Star Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development.

Table 8.4.4-2. Little Star Lake 2017 acres of emergent and floating-leaf aquatic plant communities. Created using data from 2017 aquatic plant community mapping survey.

Plant Community	Acres
Emergent	0.0
Floating-leaf	16.1
Mixed Emergent & Floating-leaf	0.0
Total	**16.1**

Non-native Aquatic Plants in Little Star

Eurasian watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*; EWM; Photograph 8.4.4-3) is a non-native aquatic plant that has invaded over 400 waterbodies in Wisconsin. The plant may outcompete other native aquatic vegetation with its dominating, aggressive growth and reach the point where its populations form dense mats on the surface of a lake's littoral zone. These dense mats impact recreation as well as the ecology of the lake.

Photograph 8.4.4-3. Eurasian watermilfoil, a non-native, invasive aquatic plant. Photo credit Onterra.

Eurasian watermilfoil was first discovered in Little Star Lake in 2017 by Onterra ecologists. The population was reassessed during the whole-lake point-intercept survey and remained at point-based data for the summer of 2017. Following this discovery, the Town of Plum Lake hired a professional firm to conduct hand-harvesting of EWM on the lake in August 2017. The Town of Plum Lake received a Lake Planning Grant from the WDNR to fund a portion of the Phase III management planning project. The project includes funding for monitoring of EWM on Little Star Lake through 2019.

A pair of annual EWM mapping surveys were used within this project to coordinate and qualitatively monitor the professional hand-harvesting efforts. In late-spring/early summer, an Early Season Aquatic Invasive Species Survey (ESAIS) is completed from which the hand-harvesting strategy is finalized. Following the conclusion of harvesting efforts, Onterra ecologists complete the Late-Summer EWM Mapping Survey, the results of which serve to evaluate the hand-harvesting strategy. During the mapping surveys, the EWM population was mapped by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *Highly Scattered* to *Surface Matting*. Point-based techniques were applied to EWM locations that were considered as *Small Plant Colonies* (<40 feet in diameter), *Clumps of Plants*, or *Single or Few Plants*. While EWM is usually not at its peak growth at this time of year, the water is typically clearer during the early summer allowing for more effective viewing of

submersed plants, and EWM is often growing higher in the water column than many of the native aquatic plants at that time of year. In Little Star Lake, the EWM has been often found growing to the water's surface in both the ESAIS and Late-Summer mapping surveys, making for relatively easy mapping with the visual surveys.

Figure 8.4-4-7 displays the results of the two EWM mapping surveys that were completed during 2020. During the June ESAIS survey, all EWM occurrences consisted of single or few plants. After the hand harvesting efforts, the September 2020 mapping survey found the EWM population to be slightly greater than the June survey however; overall, of a similar distribution as other recent late-summer surveys. All EWM occurrences that were mapped in the September 2020 mapping survey consisted of single or few plants or clumps of plants and no large contiguous colonies that would require area-based mapping were located anywhere in the lake.

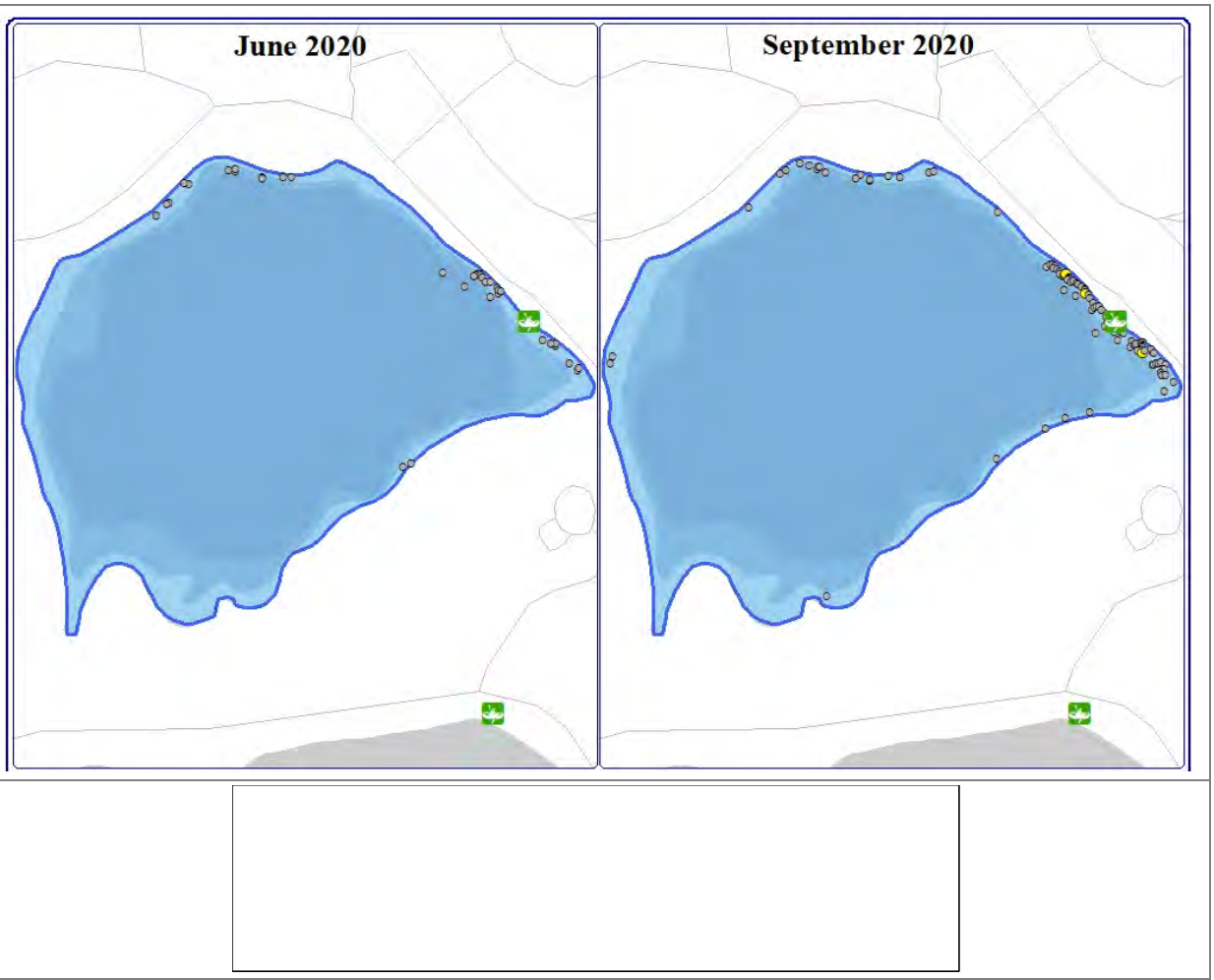


Figure 8.4.4-7. June 2020 and September 2020 EWM Mapping Survey Results in Little Star Lake.

Hand-Harvesting Management Actions

The Town of Plum Lakes has contracted with a professional hand harvesting company in recent years to manage the EWM population in Little Star Lake. Onterra provides the spatial data from the mapping surveys to a professional hand-harvesting firm to aid the control efforts. In each year from 2017-2020, Aquatic Plant Management, LLC (APM) has conducted hand-harvesting services

on Little Star Lake. Table 8.4-4-3 displays a summary of the professional hand harvesting efforts that have taken place in Little Star Lake from 2017-2020. The largest EWM harvest yield was in 2019 during which a total of 12 cubic feet of EWM was harvested over the course of four dive days (Table 8.4-4-3). Details of the professional hand-harvesting efforts are included in annual Dive Summary Reports authored by APM, LLC.

Table 8.4-4-3. Summary of Professional Hand Harvesting Efforts in Little Star Lake from 2017-2020. 2020 harvest data to be included in final report.

Year	EWM Harvest (cubic ft)
2017	7.65
2018	2.30
2019	12.00
2020	

Since EWM was discovered in 2017, annual monitoring has tracked the EWM population during a period of active management spanning four years (Figure 8.4.4-8). During this time period, the EWM population has generally been consistently comprised of low-density occurrences (single plants, clumps of plants, or small plant colonies), in approximately the same locations around the lake. In each survey, the greatest concentration of EWM plants has been located along the northeast shoreline of the lake on either side of the public carry-in access location. At no point over the course of the monitoring has EWM been found to increase in size and density to a point where large and contiguous colonies were present. Additionally, EWM has not become established in new areas of the lake during the course of the active management (hand harvesting) and monitoring that has taken place since 2017.

Whether it be due to targeted hand harvesting efforts, environmental factors such as water clarity, or a combination the two, the EWM population in Little Star Lake has been kept at a very low level in the years since its initial discovery in 2017. Continued monitoring will be valuable going forward in managing this invasive species as well as in determining whether active management efforts are prudent.

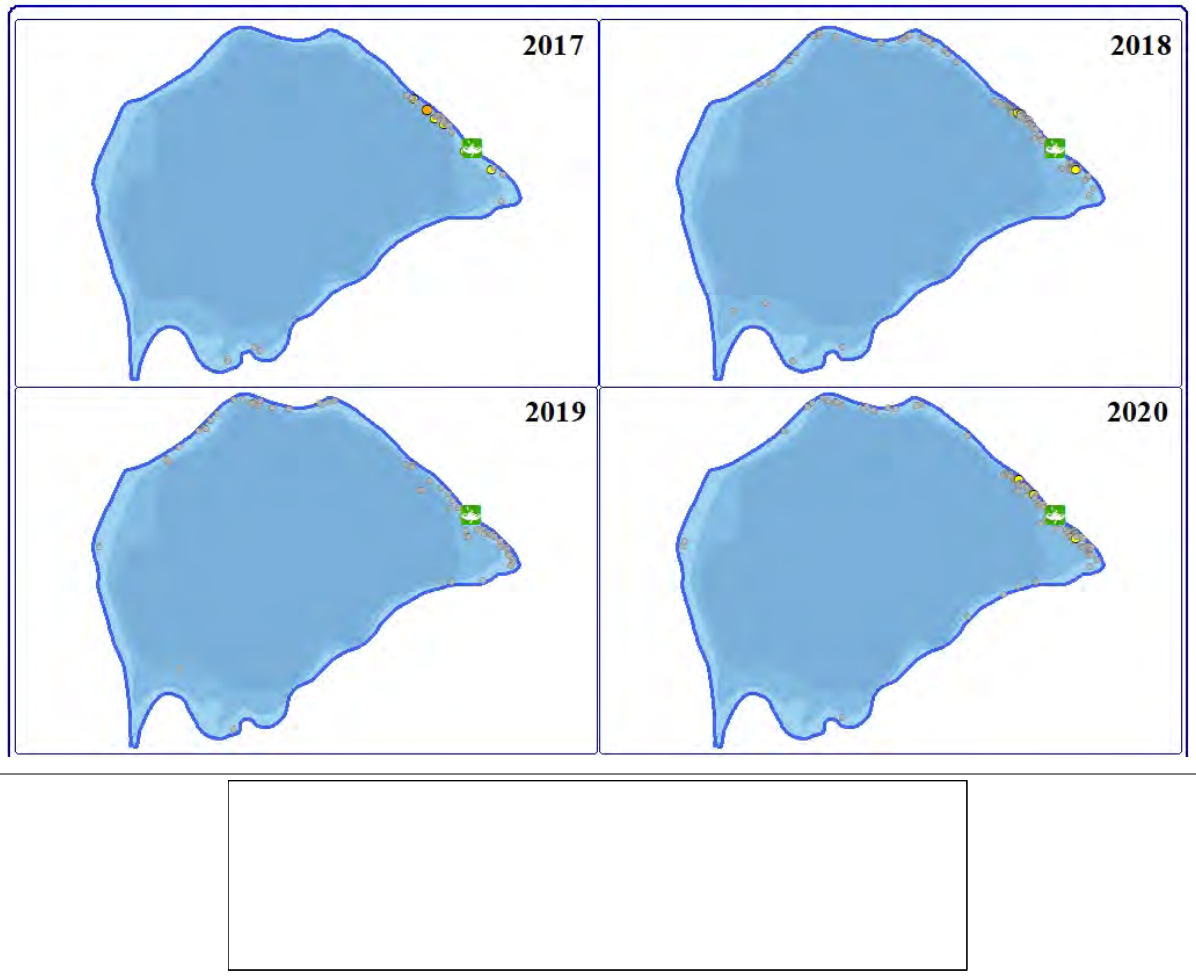


Figure 8.4.4-8. EWM Population Progression from 2017-2020 in Little Star Lake. Data from Onterra EWM Mapping Surveys.

8.4.5 Aquatic Invasive Species in Little Star Lake

As is discussed in section 2.0 Stakeholder Participation, the lake stakeholders were asked about aquatic invasive species (AIS) and their presence in Little Star Lake within the anonymous stakeholder survey. Onterra and the WDNR have confirmed that there are two AIS present (Table 8.4.5-1).

Table 8.4.5-1. AIS present within Star Lake

Type	Common name	Scientific name	Location within the report
Plants	Eurasian watermilfoil	*Myriophyllum spicatum*	Section 8.3.4 – Little Star Lake Aquatic Plants
Invertebrates	Rusty crayfish	*Orconectes rusticus*	Section 8.3.5 – Aquatic Invasive Species in Little Star Lake

More information on these invasive species or any other AIS can be found at the following links:

- http://dnr.wi.gov/topic/invasives/
- https://nas.er.usgs.gov/default.aspx
- https://www.epa.gov/greatlakes/invasive-species

Aquatic Animals

Rusty Crayfish

Rusty crayfish (*Orconectes rusticus*) are originally from the Ohio River basin and are thought to have been transferred to Wisconsin through bait buckets. These crayfish displace native crayfish and reduce aquatic plant abundance and diversity. Rusty crayfish can be identified by their large, smooth claws, varying in color from grayish-green to reddish-brown, and sometimes visible rusty spots on the sides of their shell. They are not eaten by fish that typically eat crayfish because they are more aggressive than the native crayfish. Rusty crayfish reproduce quickly but with intensive harvesting their populations can be greatly reduced within a lake.

8.4.6 Little Star 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 Little Star 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 2017 & GLIFWC 2017).

Little Star Lake Fishery

Energy Flow of a Fishery

When examining the fishery of a lake, it is important to remember what drives that fishery, or what is responsible for determining its mass and composition. The gamefish in Little Star Lake are supported by an underlying food chain. At the bottom of this food chain are the elements that fuel algae and plant growth – nutrients such as phosphorus and nitrogen, and sunlight. The next tier in the food chain belongs to zooplankton, which are tiny crustaceans that feed upon algae and plants, and insects. Smaller fish called planktivores feed upon zooplankton and insects, and in turn become food for larger fish species. The species at the top of the food chain are called piscivores and are the larger gamefish that are often sought after by anglers, such as bass and walleye.

A concept called energy flow describes how the biomass of piscivores is determined within a lake. Because algae and plant matter are generally small in energy content, it takes an incredible amount of this food type to support a sufficient biomass of zooplankton and insects. In turn, it takes a large biomass of zooplankton and insects to support planktivorous fish species. And finally, there must be a large planktivorous fish community to support a modest piscivorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 8.4.6-1.

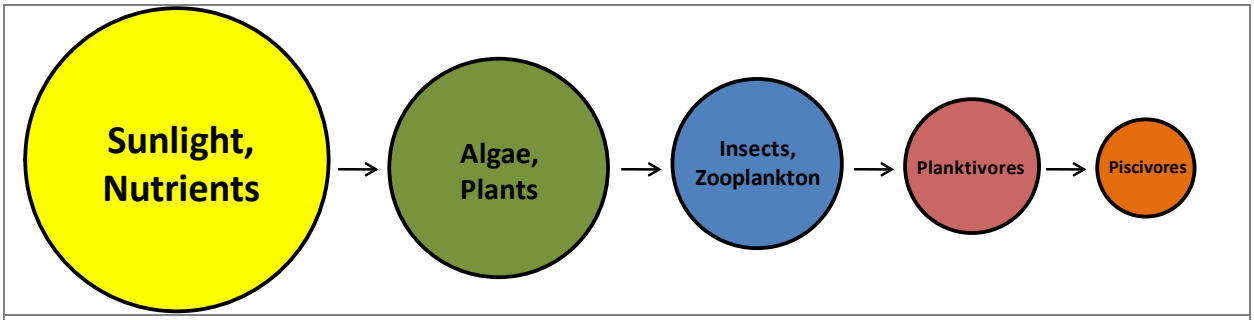


Figure 8.4.6-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Little Star Lake is a eutrophic system, meaning it has high nutrient content and thus relatively high primary productivity. Simply put, this means Little Star Lake should be able to support sizable populations of predatory fish (piscivores) because the supporting food chain is relatively robust. Table 8.4.6-1 shows the popular game fish present in

the system. Although not an exhaustive list of fish species in the lake, additional fish species found in past surveys of Little Star Lake include panfish (*Lepomis*).

Table 8.4.6-1. Gamefish present in Little Star Lake with corresponding biological information (Becker, 1983).

Common Name (*Scientific Name*)	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Largemouth Bass (*Micropterus salmoides*)	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Muskellunge (*Esox masquinongy*)	30	Mid April - Mid May	Shallow bays over muck bottom with dead vegetation, 6 - 30 in.	Fish including other muskies, small mammals, shore birds, frogs
Northern Pike (*Esox lucius*)	25	Late March - Early April	Shallow, flooded marshes with emergent vegetation with fine leaves	Fish including other pike, crayfish, small mammals, water fowl, frogs

Fish Stocking

To assist in meeting fisheries management goals, the WDNR may permit the stocking of fry, fingerling or adult fish in a waterbody that were raised in permitted hatcheries (Photograph 8.4.6-2). 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. Little Star Lake was stocked from 1974 to 1989 with muskellunge (Table 8.4.6-2).

Photograph 8.3.6-2. Fingerling Muskellunge.

Table 8.4.6-2. Stocking data available for muskellunge in Little Star Lake (1974-1989).

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1974	Unspecified	Fingerling	250	11
1976	Unspecified	Fingerling	100	13
1989	Unspecified	Fingerling	160	9

Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the first most important reason for owning property on or near Little Star Lake (Question #18). Figure 8.4.6-2 displays the fish that Little Star Lake stakeholders enjoy catching the most, with crappie being the most popular. Approximately 85% of these same respondents believed that the quality of fishing on the lake was either good or fair (Figure 8.4.6-3). Approximately 72% of respondents who fish Little Star Lake believe the quality of fishing has remained the same or is somewhat worse since they first started fishing the lake (Figure 8.4.6-4).

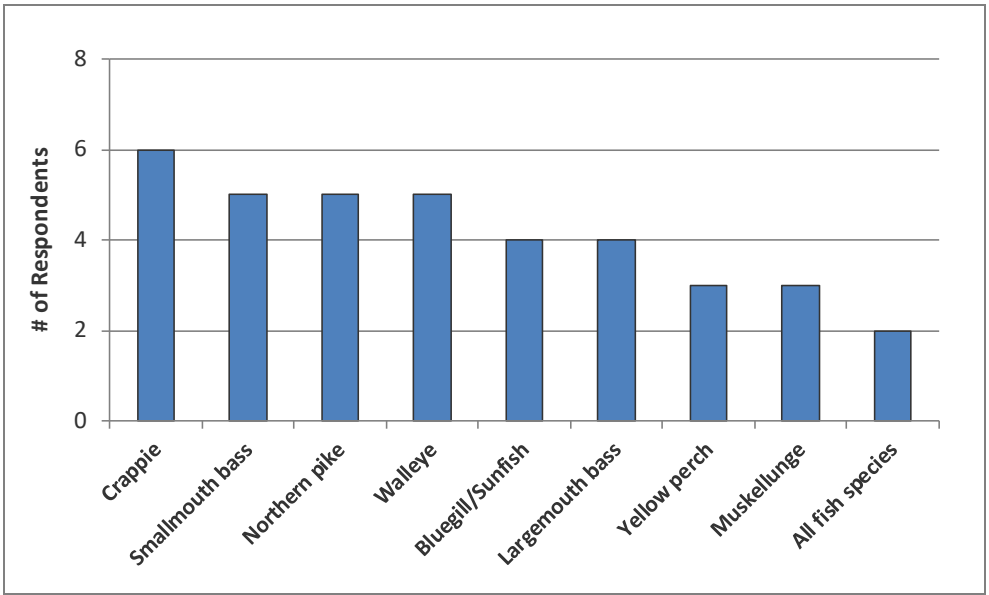


Figure 8.4.6-2. Stakeholder survey response Question #12. What species of fish do you like to catch on Little Star Lake?

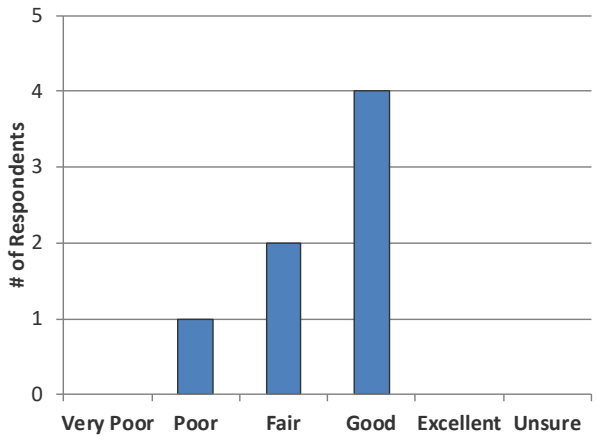


Figure 8.4.6-3. Stakeholder survey response Question #13. How would you describe the current quality of fishing on Little Star Lake?

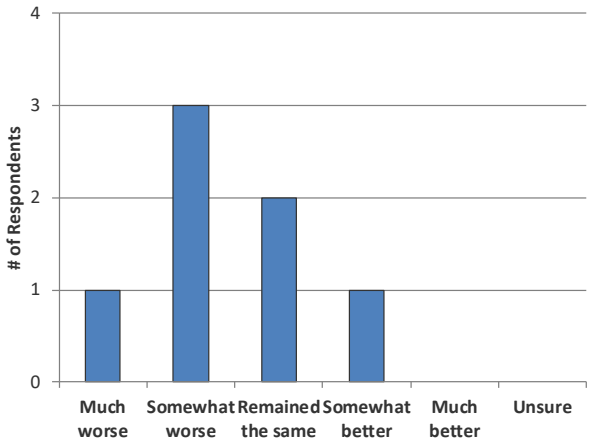


Figure 8.4.6-4. Stakeholder survey response Question #14. How has the quality of fishing changed on Little Star Lake since you started fishing the lake?

Little Star Lake Spear Harvest Records

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 8.4.6-5). Little Star Lake falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on lakes located within the Ceded Territory.

While within the ceded territory, Little Star Lake has not experienced a spearfishing harvest.

Figure 8.4.6-5. Location of Little Star Lake within the Native American Ceded Territory (GLIFWC 2017). This map was digitized by Onterra; therefore, it is a representation and not legally binding.

Little Star Lake Fish Habitat

Substrate Composition

Just as forest wildlife require proper trees and understory growth to flourish, fish require certain substrates and habitat types to nest, spawn, escape predators, and search for prey. Lakes with primarily a silty/soft substrate, many aquatic plants, and coarse woody debris may produce a completely different fishery than lakes that are largely sandy/rocky, and contain few aquatic plant species or coarse woody habitat.

Substrate and habitat are critical to fish species that do not provide parental care to their eggs. Northern pike is one species that does not provide parental care to its eggs (Becker 1983). Northern pike broadcast their eggs over woody debris and detritus, which can be found above sand or muck. This organic material suspends the eggs above the substrate, so the eggs are not buried in sediment and suffocate as a result. Walleye are another species that does not provide parental care to its

eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn and care for their eggs in muck as well.

According to the point-intercept survey conducted by Onterra in 2017, 91% of the substrate sampled in the littoral zone of Little Star Lake were soft sediments, 8% composed of sand and 1% composed of rock sediments.

Woody Habitat

As discussed in the Shoreland Condition Section, the presence of coarse woody habitat is important for many stages of a fish's life cycle, including nesting or spawning, escaping predation as a juvenile, and hunting insects or smaller fish as an adult. Unfortunately, as development has increased on Wisconsin lake shorelines in the past century, this beneficial habitat has often been the first to be removed from the natural shoreland zone. Leaving these shoreland zones barren of coarse woody habitat can lead to decreased abundances and slower growth rates in fish (Sass 2006). A fall 2017 survey documented 130 pieces of coarse woody along the shores of Little Star Lake, resulting in a ratio of approximately 75 pieces per mile of shoreline.

Fish Habitat Structures

Some fisheries managers may look to incorporate fish habitat structures on the lakebed or littoral areas extending to shore for the purpose of improving fish habitats. These projects are typically conducted on lakes lacking significant coarse woody habitat in the shoreland zone. The "Fish sticks" program, outlined in the WDNR best practices manual, adds trees to the shoreland zone restoring fish habitat to critical near shore areas. Typically, every site has 3 – 5 trees which are partially or fully submerged in the water and anchored to shore (Photograph 8.4.6-3). The WDNR recommends placement of the fish sticks during the winter on ice when possible to prevent adverse impacts on fish spawning or egg incubation periods. The program requires a WDNR permit and can be funded through many different sources including the WDNR, County Land & Water Conservation Departments or partner contributions.

Photograph 8.4.6-3. Examples of fish sticks (left) and half-log habitat structures. (Photos by WDNR)

Fish cribs are a fish habitat structure that is placed on the lakebed. Installing fish cribs may be cheaper than fish sticks; however some concern exists that fish cribs can concentrate fish, which in turn leads to increased predation and angler pressure.

Half-logs are another form of fish spawning habitat placed on the bottom of the lakebed (Photograph 8.4.6-3). Smallmouth bass specifically have shown an affinity for overhead cover when creating spawning nests, which half-logs provide (Wills 2004). If the waterbody is exempt from a permit or a permit has been received, information related to the construction, placement and maintenance of half-log structures are available online.

An additional form of fish habitat structure is spawning reefs. Spawning reefs typically consist of small rubble in a shallow area near the shoreline for mainly walleye habitat. Rock reefs are sometimes utilized by fisheries managers when attempting to enhance spawning habitats for some fish species. However, a 2004 WDNR study of rock habitat projects on 20 northern Wisconsin lakes offers little hope the addition of rock substrate will improve walleye reproduction (WDNR 2004).

Placement of a fish habitat structure in a lake does not require a permit if the project meets certain conditions outlined by the WDNR's checklists available online:

(https://dnr.wi.gov/topic/waterways/Permits/Exemptions.html)

If a project does not meet all of the conditions listed on the checklist, a permit application may be sent in to the WDNR and an exemption requested.

The TPL should work with the local WDNR fisheries biologist to determine if the installation of fish habitat structures should be considered in aiding fisheries management goals for Little Star.

Regulations

Regulations for Little Star Lake gamefish species as of April 2018 are displayed in Table 8.4.6-3. For specific fishing regulations on all fish species, anglers should visit the WDNR website (*www.http://dnr.wi.gov/topic/fishing/regulations/hookline.html)* or visit their local bait and tackle shop to receive a free fishing pamphlet that contains this information.

Table 8.4.6-3. WDNR fishing regulations for Little Star Lake (As of April 2018).

Species	Daily bag limit	Length Restrictions	Season
Panfish (bluegill, pumpkinseed, sunfish, crappie and yellow perch)	25	None	Open All Year
Smallmouth bass (Early Season)	Catch and release only	None	May 5, 2018 to June 15, 2018
Smallmouth bass	5	14"	June 16, 2018 to March 3, 2019
Largemouth bass	5	14"	May 5, 2018 to March 3, 2019
Muskellunge and hybrids	1	40"	May 26, 2018 to November 30, 2018
Northern pike	5	None	May 5, 2018 to March 3, 2019
Walleye, sauger, and hybrids	3	The minimum length is 15", but walleye, sauger, and hybrids from 20" to 24" may not be kept, and only 1 fish over 24" is allowed.	May 5, 2018 to March 3, 2019
Bullheads	Unlimited	None	Open All Year

General Waterbody Restrictions: Motor Trolling is allowed with 1 hook, bait, or lure per angler, and 3 hooks, baits, or lures maximum per boat.

Mercury Contamination and Fish Consumption Advisories

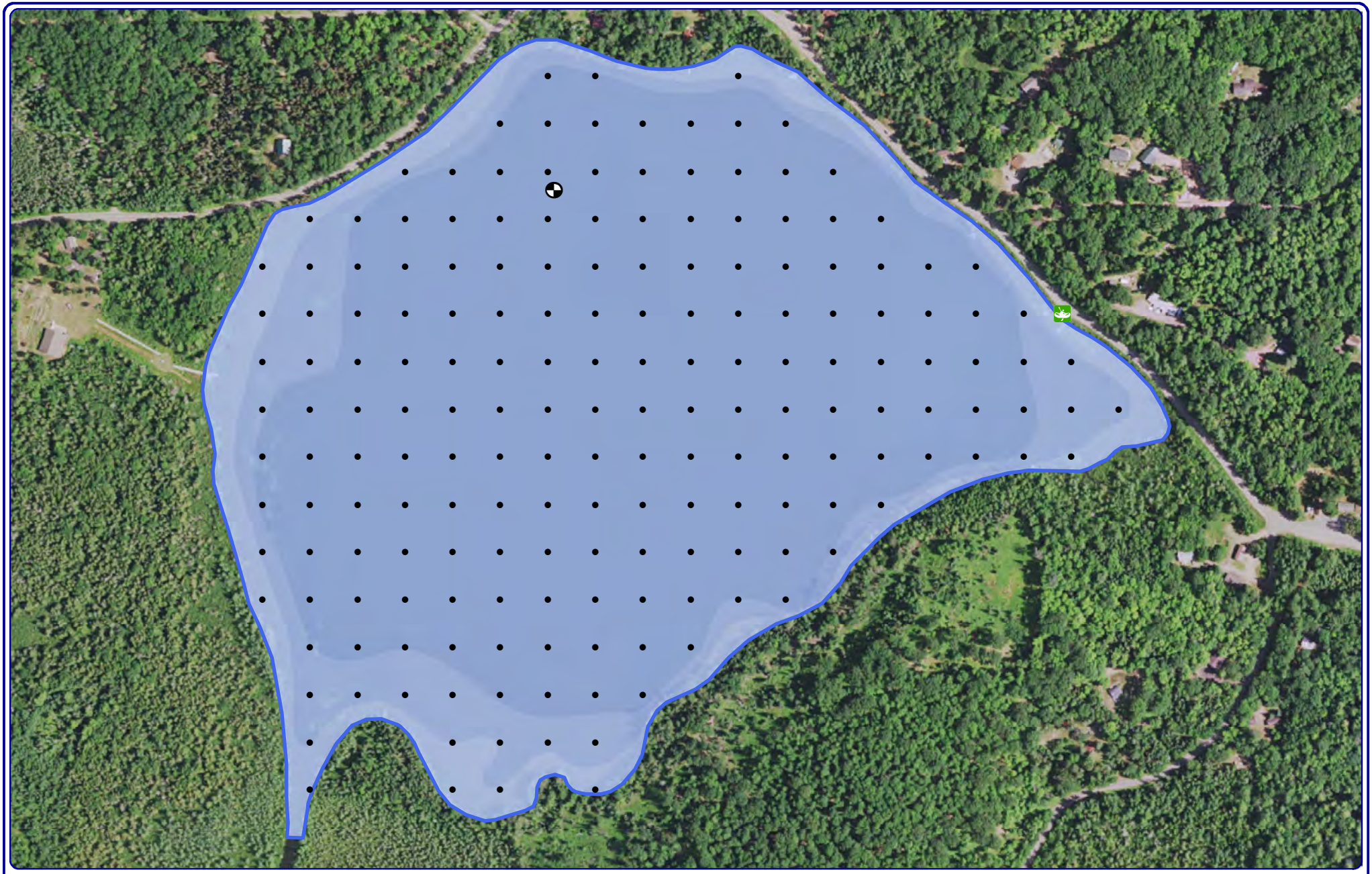
Freshwater fish are amongst the healthiest of choices you can make for a home-cooked meal. Unfortunately, fish in some regions of Wisconsin are known to hold levels of contaminants that are harmful to human health when consumed in great abundance. The two most common contaminants are polychlorinated biphenyls (PCBs) and mercury. These contaminants may be found in very small amounts within a single fish, but their concentration may build up in your body over time if you consume many fish. Health concerns linked to these contaminants range from poor balance and problems with memory to more serious conditions such as diabetes or cancer. These contaminants, particularly mercury, may be found naturally to some degree. However, the majority of fish contamination has come from industrial practices such as coal-burning facilities, waste incinerators, paper industry effluent and others. Though environmental regulations have reduced emissions over the past few decades, these contaminants are greatly resistant to breakdown and may persist in the environment for a long time. Fortunately, the human body is able to eliminate contaminants that are consumed however this can take a long time depending upon the type of contaminant, rate of consumption, and overall diet. Therefore, guidelines are set upon the consumption of fish as a means of regulating how much contaminant could be consumed over time.

General fish consumption guidelines for Wisconsin inland waterways are presented in Figure 8.4.6-6. There is an elevated risk for children as they are in a stage of life where cognitive development is rapidly occurring. As mercury and PCB both locate to and impact the brain, there are greater restrictions on women who may have children or are nursing children, and also for children under 15.

Fish Consumption Guidelines for Most Wisconsin Inland Waterways		
	Women of childbearing age, nursing mothers and all children under 15	**Women beyond their childbearing years and men**
Unrestricted*	-	Bluegill, crappies, yellow perch, sunfish, bullhead and inland trout
1 meal per week	Bluegill, crappies, yellow perch, sunfish, bullhead and inland trout	Walleye, pike, bass, catfish and all other species
1 meal per month	Walleye, pike, bass, catfish and all other species	Muskellunge
Do not eat	Muskellunge	-

**Doctors suggest that eating 1-2 servings per week of low-contaminant fish or shellfish can benefit your health. Little additional benefit is obtained by consuming more than that amount, and you should rarely eat more than 4 servings of fish within a week.*

Figure 8.4.6-6. Wisconsin statewide safe fish consumption guidelines. Graphic displays consumption guidance for most Wisconsin waterways. Figure adapted from WDNR website graphic (http://dnr.wi.gov/topic/fishing/consumption/)



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Feet

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

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Orthophotography: NAIP, 2015
Map Date: April 17, 2018
Filename: *Map1_LittleStar_Location.mxd*

Project Location in Wisconsin

Legend

- Little Star Lake ~95 acres
  WDNR Definition
- Carry-In Access
- Water Quality Sampling Location
- Point-intercept Sample Location
  45 meter points

Little Star Lake - Map 1

Town of Plum Lake
Vilas County, Wisconsin

Project Location & Lake Boundaries

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1,000
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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
Bathymetry: WDNR, digitized by Onterra
Orthophotography: NAIP 2015
Land Cover: NLCD 2011
Watershed Boundaries: Onterra 2017
Map Date: October 31, 2017
Filename: *Map2_LittleStar_WS.mxd*

Project Location in Wisconsin

Legend

Land Cover Types

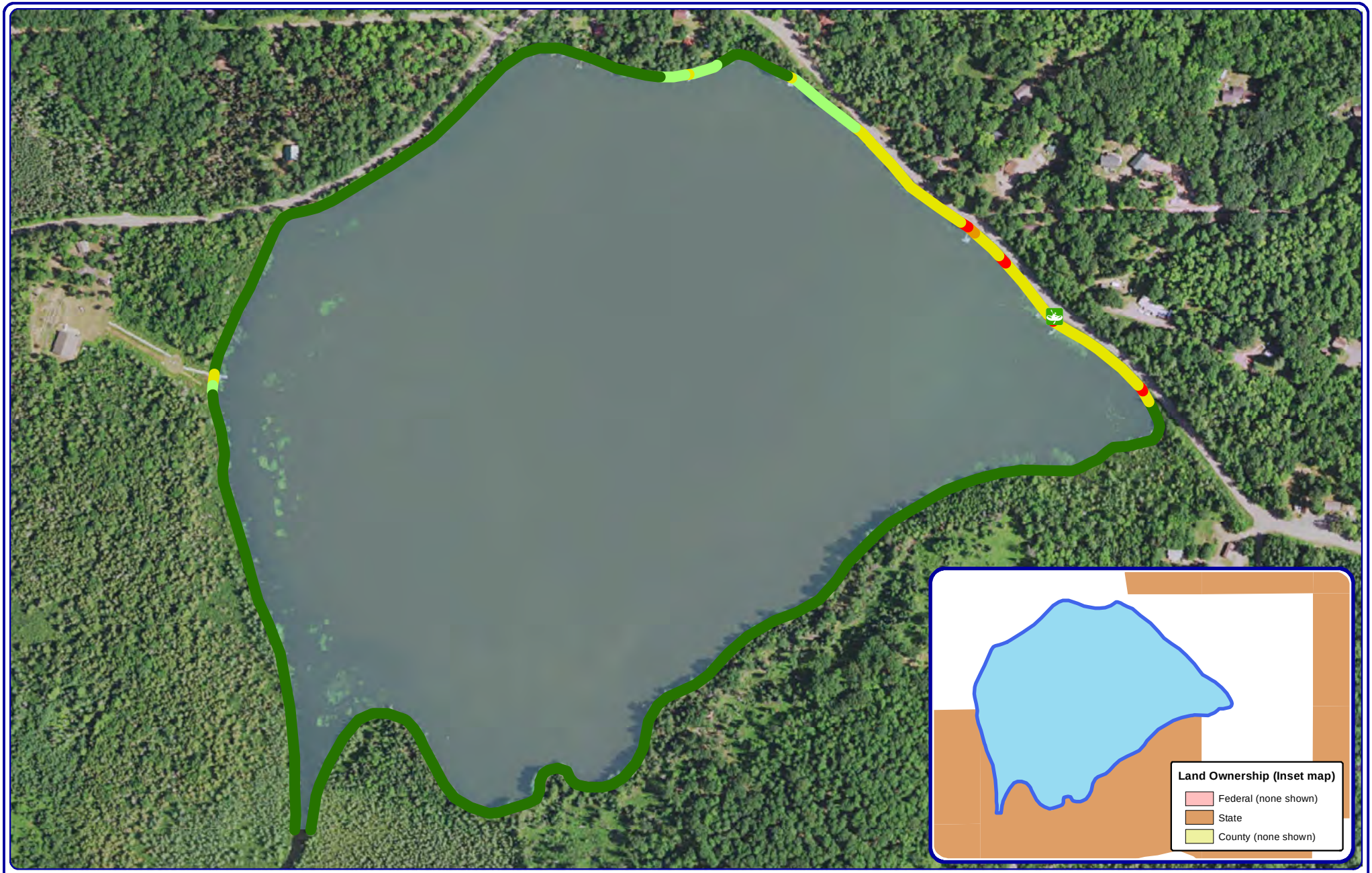
- Forest
- Forested Wetlands
- Wetlands
- Open Water
- Rural Open Space
- Pasture/Grass
- Rural Residential

- Little Star Lake Watershed Boundary
- River/Stream

Little Star Lake - Map 2

Town of Plum Lake
Vilas County, Wisconsin

Watershed Boundaries & Land Cover Types



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Onterra LLC
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920.338.8860
www.onterra-eco.com

Sources:
Hydro: WDNR
Orthophotography: NAIP, 2015
Shoreline Assessment: Onterra, 2017
Map Date: November 1, 2017
Filename:Map3_LittleStar_ShorelandCondition_2017.mxd

Project Location in Wisconsin

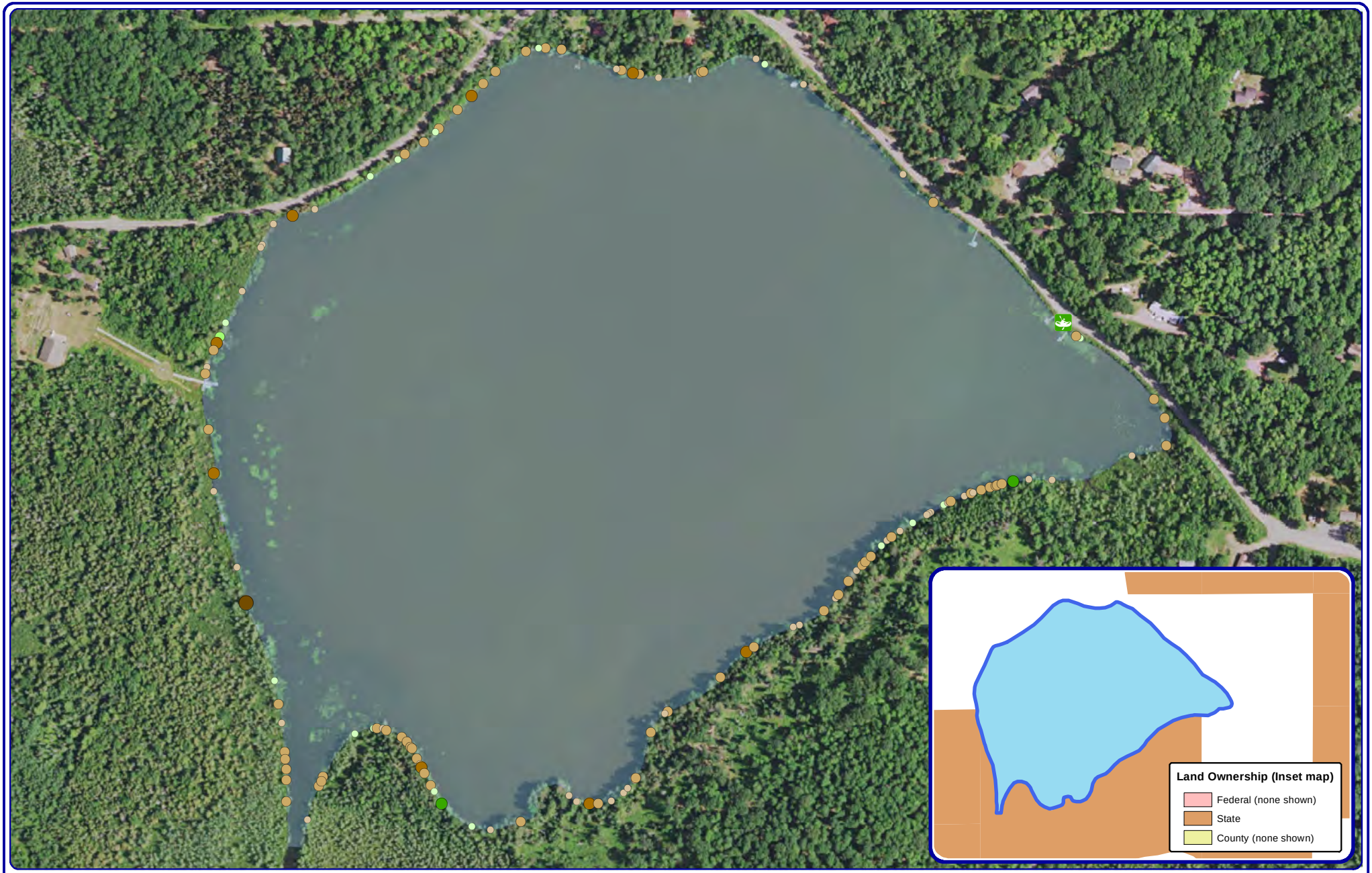
Legend

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

Little Star Lake - Map 3

Town of Plum Lake
Vilas County, Wisconsin

2017 Shoreland Condition



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

Sources:
Hydro: WDNR
Orthophotography: NAIP, 2015
Coarse Woody Habitat Survey: Onterra, 2017
Map Date: November 1, 2017
Filename: Map4_LittleStar_CWH_2017.mxd

Project Location in Wisconsin

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)

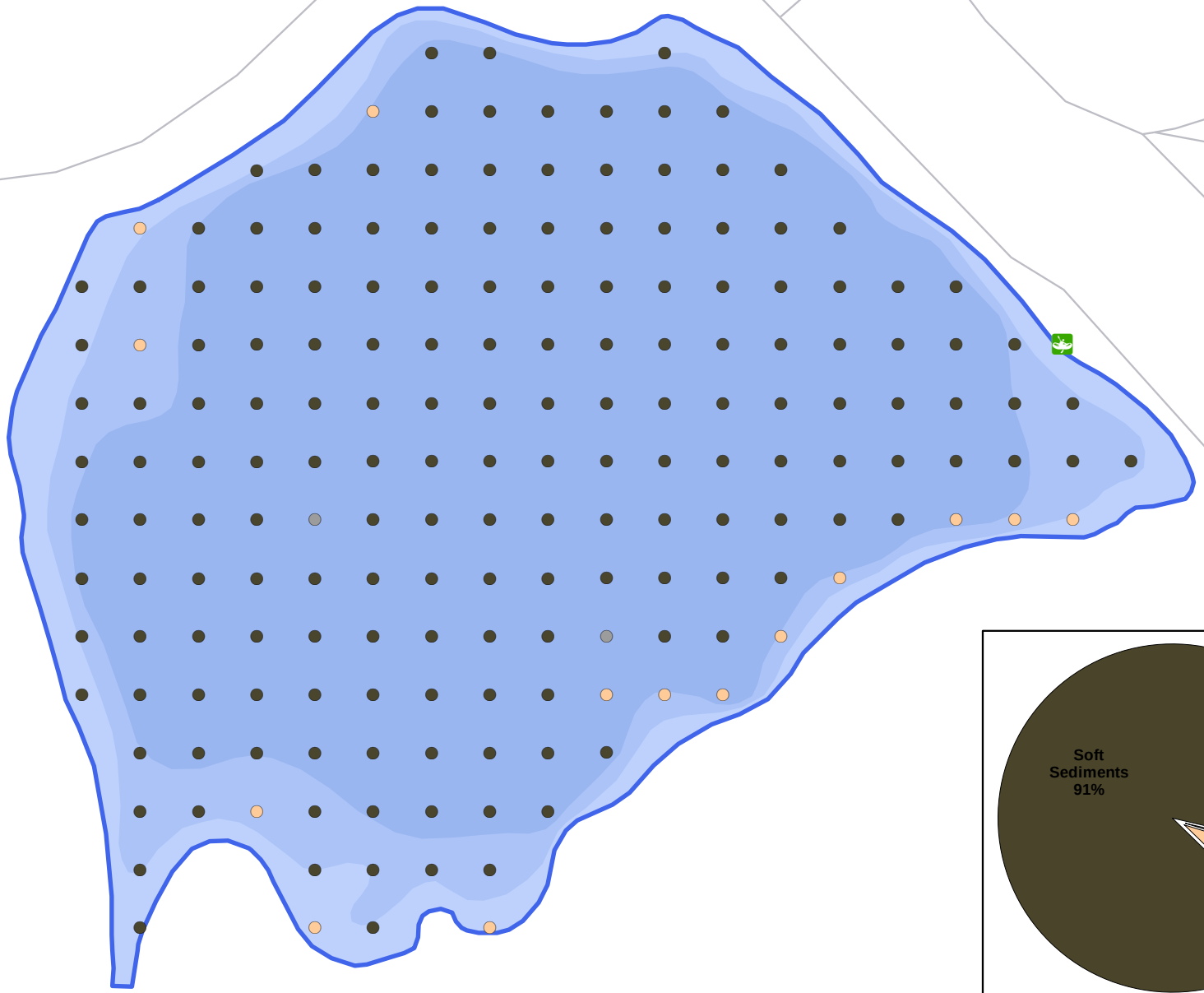
Cluster of Pieces
- No Branches (none)
- Minimal Branches (none)
- Moderate Branches (none)
- Full Canopy (none)

Little Star Lake - Map 4

Town of Plum Lake

Vilas County, Wisconsin

Coarse Woody Habitat



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Feet

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

Sources:
Hydro and Roads: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2017
Map Date: November 17, 2017
Filename: Map5_LittleStar_SubstratePI_2017.mxd


Project Location in Wisconsin

Legend

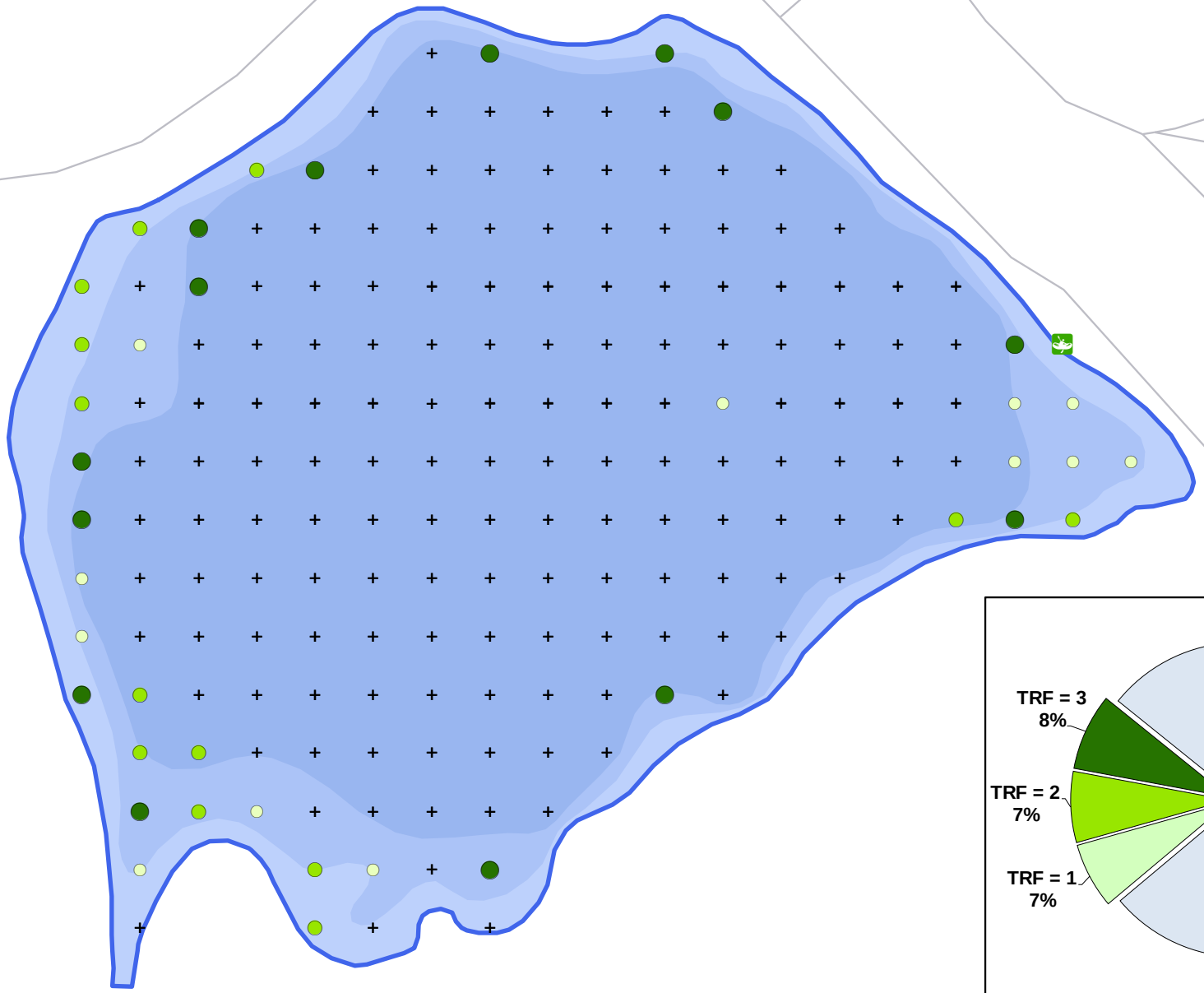
- Soft/Organic Sediments
- Rock
- Sand
- \+ Too Deep
- \+ Non-navigable

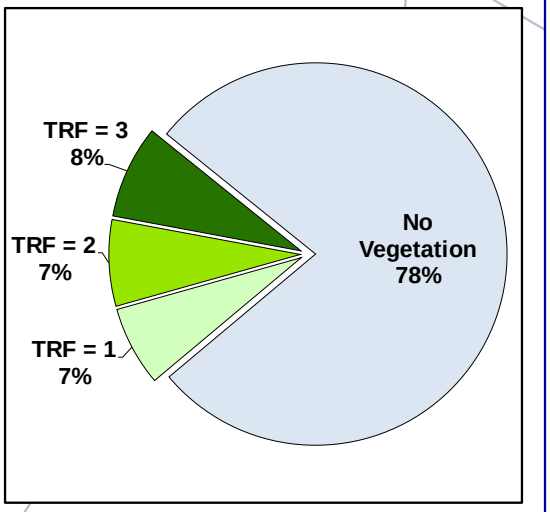
Little Star Lake - Map 5

Town of Plum Lake

Vilas County, Wisconsin

2017 PI Survey: Substrate Types





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Feet

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

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2017
Map Date: November 17, 2017
Filename: *Map6_LittleStar_TRFPI_2017.mxd*


Project Location in Wisconsin

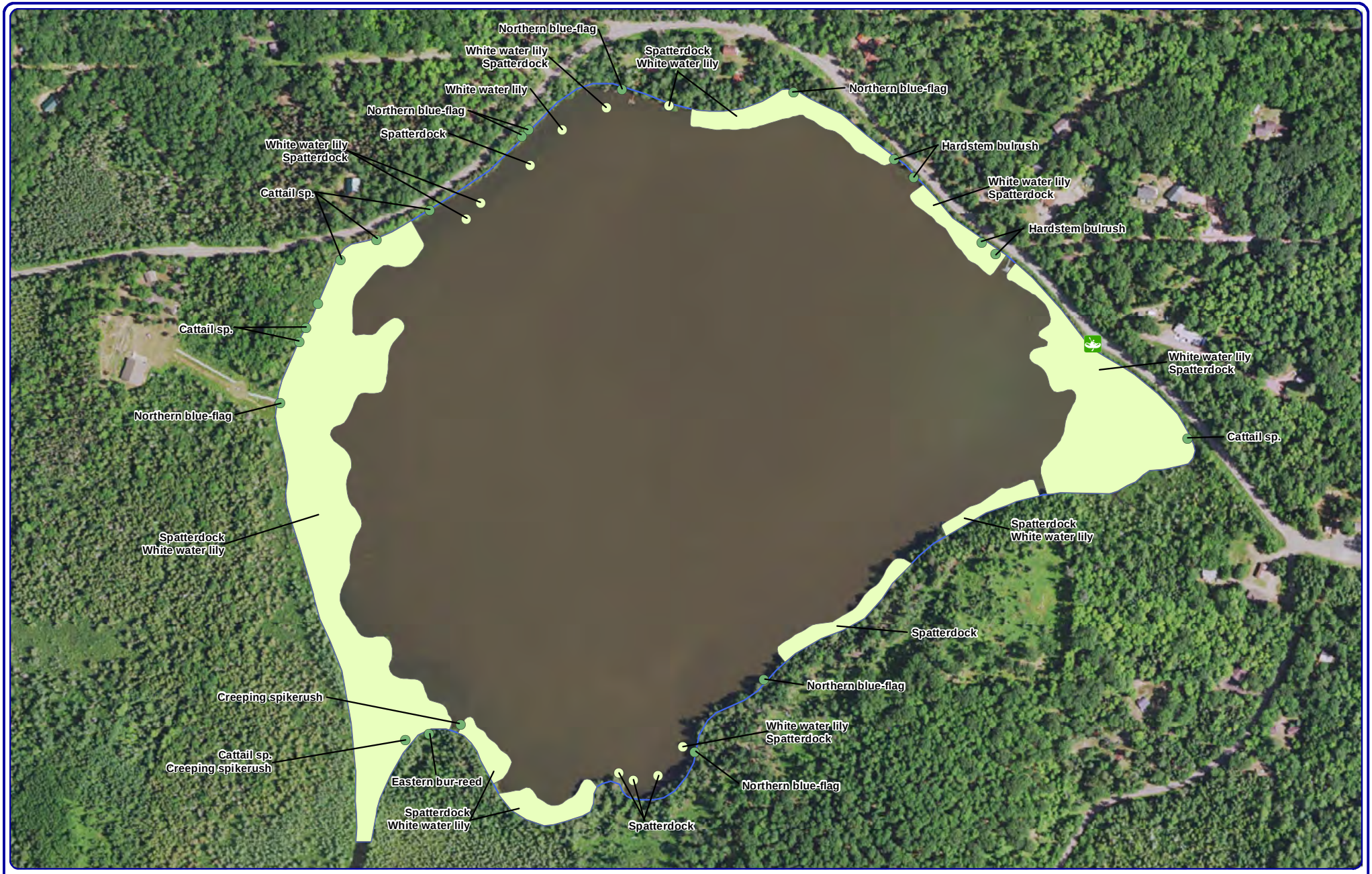
Legend

- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- \+ No Vegetation
- \+ Non-Navigable

Little Star Lake - Map 6

Town of Plum Lake
Vilas County, Wisconsin

2017 PI Survey: Aquatic Vegetation Distribution



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De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Hydro: WDNR
Aquatic Plants: Onterra, 2017
Orthophotography: NAIP, 2015
Map date: August 17, 2017
Filename: Map6_LittleStar_Comm_2017.mxd

Project Location in Wisconsin

Legend

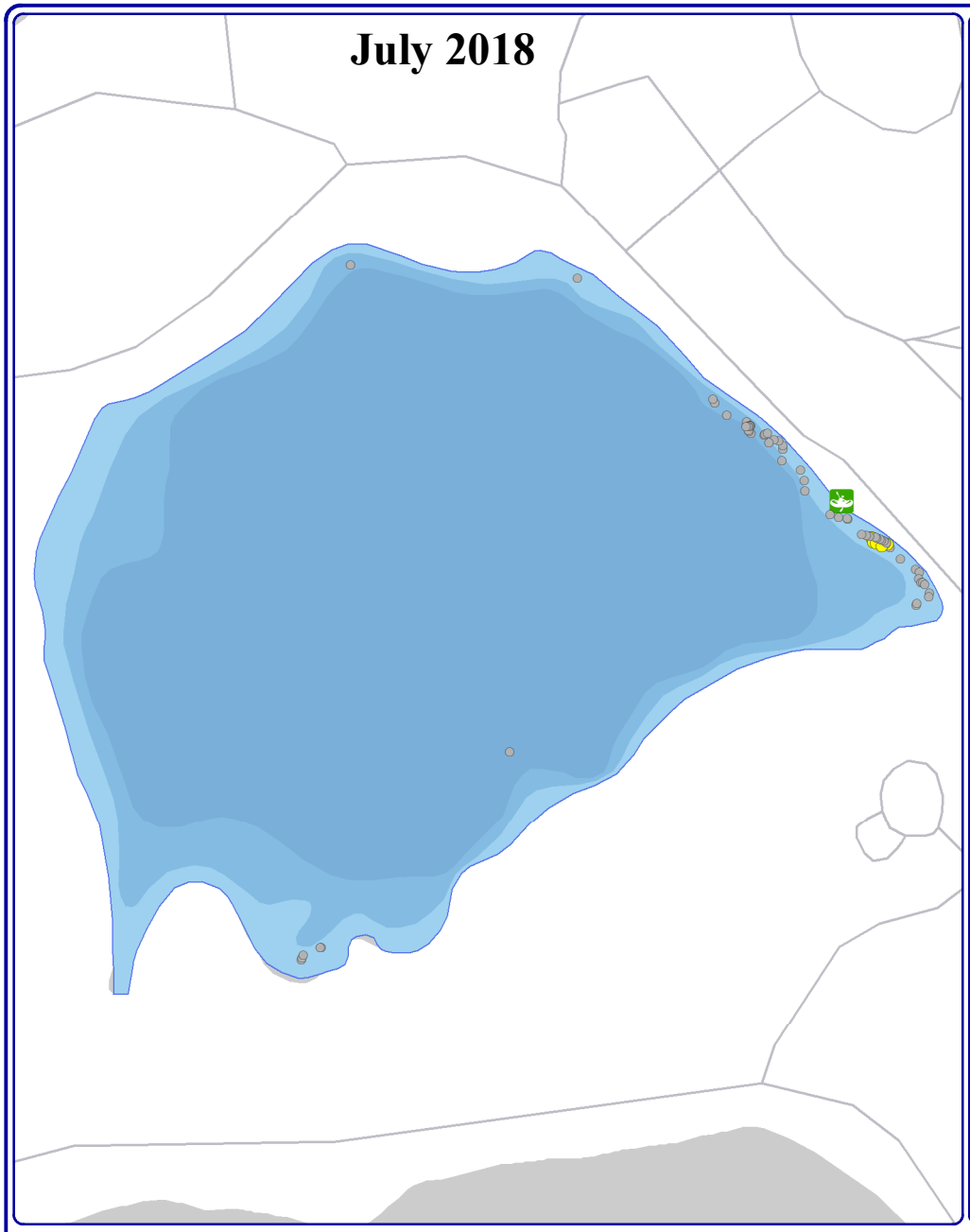
Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

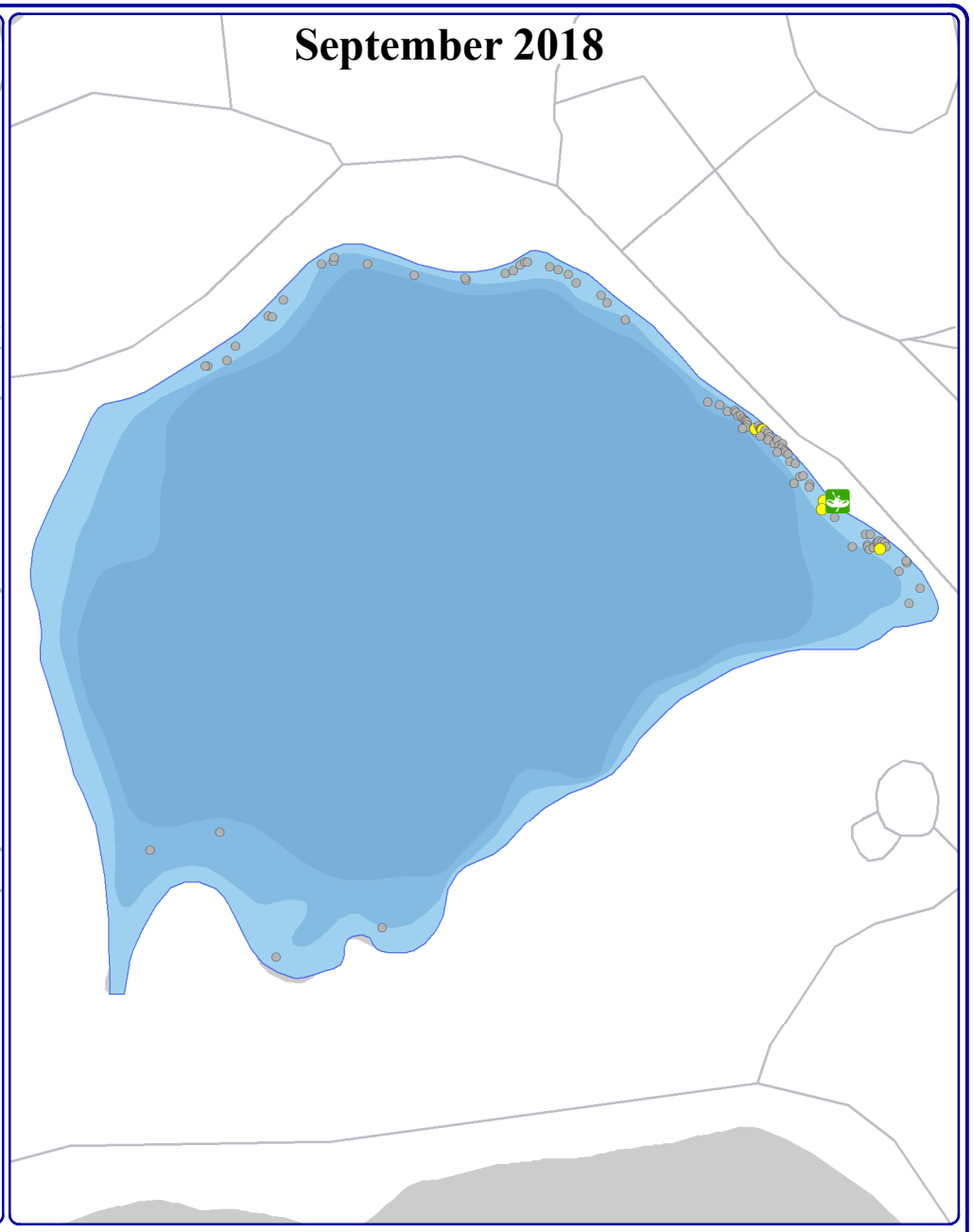
Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Little Star Lake - Map 7

Town of Plum Lake
Vilas County, Wisconsin

Emergent & Floating-leaf Aquatic Plant Communities





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

Sources:
Roads and Hydro: WDNR
Orthophotograph: NAIP, 2017
Bathymetry: WDNR, digitized by Onterra
Aquatic Plants: Onterra, 2018
Map Date: May 10, 2019 TWH
Filename: LittleStar_EWM_July-Sept18.mxd

Project Location in Wisconsin

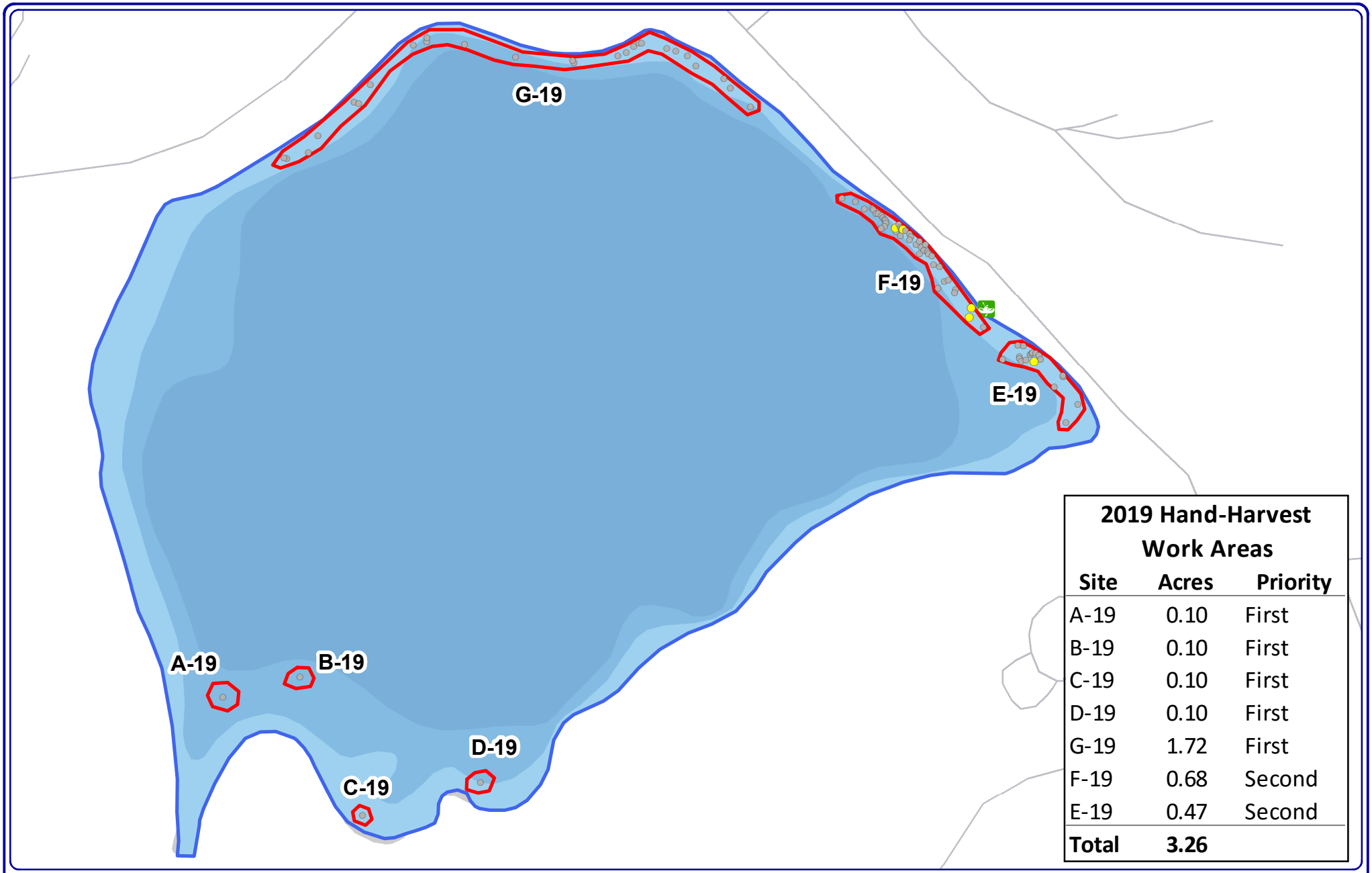
Legend

- Highly Scattered *(None found)*
- Scattered *(None found)*
- Dominant *(None found)*
- Highly Dominant *(None found)*
- Surface Matting *(None found)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony *(None found)*
- Carry-In Access

Little Star Lake - Map 8

Vilas County, Wisconsin

July & September 2018 Eurasian Watermilfoil Survey Results



2019 Hand-Harvest Work Areas

Site	Acres	Priority
A-19	0.10	First
B-19	0.10	First
C-19	0.10	First
D-19	0.10	First
G-19	1.72	First
F-19	0.68	Second
E-19	0.47	Second
Total	**3.26**	

N W E S

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Feet

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

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plants: Onterra, September 2018

Map Date: May 17, 2019 TWH
Filename: LittleStar_EWM_Sept18_2019HH Prelim.mxd

Project Location in Wisconsin

Legend

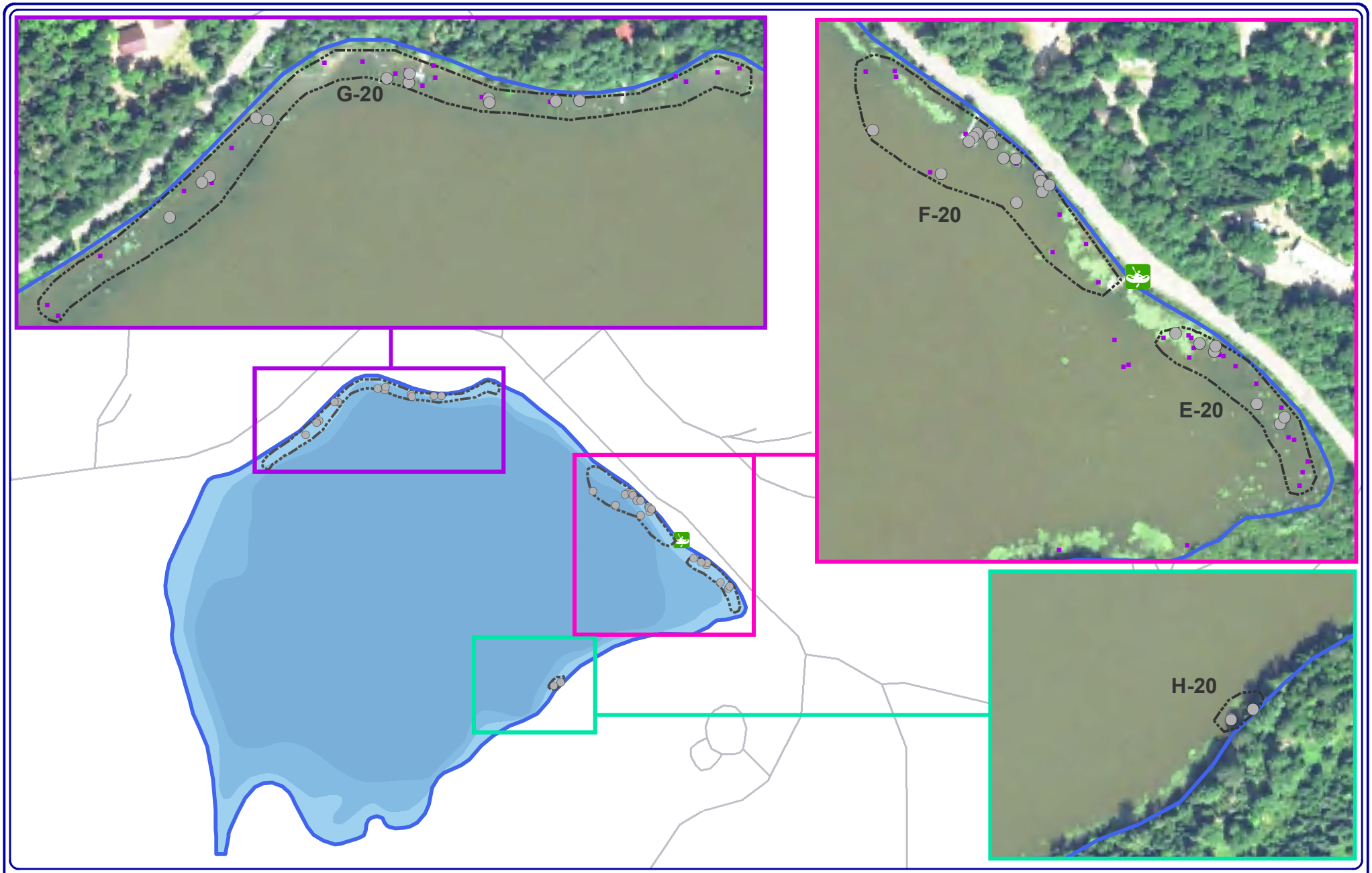
September 17, 2018 EWM Survey Results

- Single or Few Plants
- Clumps of Plants
- Small Plant Colony *(None found)*
- Carry-In Access
- 2019 Hand-Harvesting Work Areaa

Little Star Lake - Map 9

Vilas County, Wisconsin

Preliminary 2019 Hand-Harvesting Work Areas



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815 Prosper Road
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www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plants: Onterra, 2019-2020
Orthophotography: NAIP, 2018
Map Date: June 30, 2020 - EJH

Project Location in Wisconsin

Legend

- Single or Few Plants
- Clumps of Plants *(None found)*
- Small Plant Colony *(None found)*
- September 2019 EWM Location *(Shown within insets only)*
- Carry-In Access
- 2020 Hand-Harvesting Work Area

Little Star Lake
Vilas County, Wisconsin

June 2020 EWM Survey Results & Final Hand-Harvesting Work Areas