Please note that study methods and explanations of analyses for Tamarack Lake can be found within the Town of Winchester Town-wide Management Plan document.

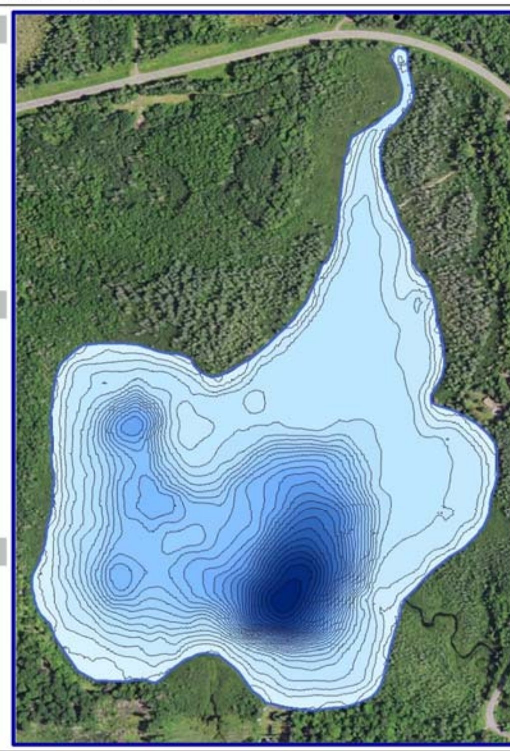
8.4 Tamarack Lake

An Introduction to Tamarack Lake

Tamarack Lake, Vilas County, is a 63-acre deep lowland, brown-water, meso-eutrophic drainage lake with a maximum depth of 27 feet and a mean depth of 7 feet (Tamarack Lake – Map 1). Its surficial watershed encompasses approximately 5,114 acres within the Flambeau River Watershed and is comprised mainly of intact forests and wetlands. Tamarack Lake is fed by upstream Birch Lake through Tambier Creek and upstream Deer Lake through Deer Creek. Water from Tamarack Lake flows into downstream Rainbow Lake through Rainbow Creek. In 2016, 31 native aquatic plant species were located within the lake, of which fern-leaf pondweed (*Potamogeton robbinsii*) was the most common. Non-native aquatic plant species were not located in Tamarack Lake in 2016, and no other non-native species have been documented within the lake.

Lake at a Glance - Tamarack Lake

Morphology	
LakeType	Deep Lowland Drainage
Surface Area (Acres)	63
Max Depth (feet)	27
Mean Depth (feet)	7
Perimeter (Miles)	1.7
Shoreline Complexity	2.1
Watershed Area (Acres)	5,114
Watershed to Lake Area Ratio	77:1
Water Quality	
Trophic State	Meso-eutrophic
Limiting Nutrient	Phosphorus
Avg Summer P (μg/L)	32.2
Avg Summer Chl-α (μg/L)	5.6
Avg Summer Secchi Depth (ft)	5.9
Summer pH	7.3
Alkalinity (mg/L as $CaCO_3$)	31.6
Vegetation	
Number of Native Species	32
NHI-Listed Species	None
Exotic Species	None
Average Conservatism	7.3
Floristic Quality	34.1
Simpson's Diversity (1-D)	0.83



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

8.4.1 Tamarack Lake Water Quality

It is often difficult to determine the status of a lake's water quality purely through observation. Anecdotal accounts of a lake "getting better" or "getting worse" can be difficult to judge because a) a lake's water quality may fluctuate from year to year based upon environmental conditions such as precipitation, and b) differences in observation and perception of water quality can differ greatly from person to person. It is best to analyze the water quality of a lake through scientific data as this gives a concrete indication as to the health of the lake, and whether its health has deteriorated or improved. Further, by looking at data for similar lakes regionally and statewide, the status of a lake's water quality can be made by comparison.

In 2016, a stakeholder survey was sent to five Tamarack Lake riparian property owners. Four of these five (80%) surveys were completed and returned. The full survey and results can be found in Appendix B. When asked about Tamarack Lake's current water quality, 100% of the respondents indicated the water quality is *good* (Figure 8.4.1-1). When asked how water quality has changed in Tamarack Lake since they first visited the lake, 75% of respondents indicated water quality has *remained the same* and 25% indicated they were *unsure* (Figure 8.4.1-1).

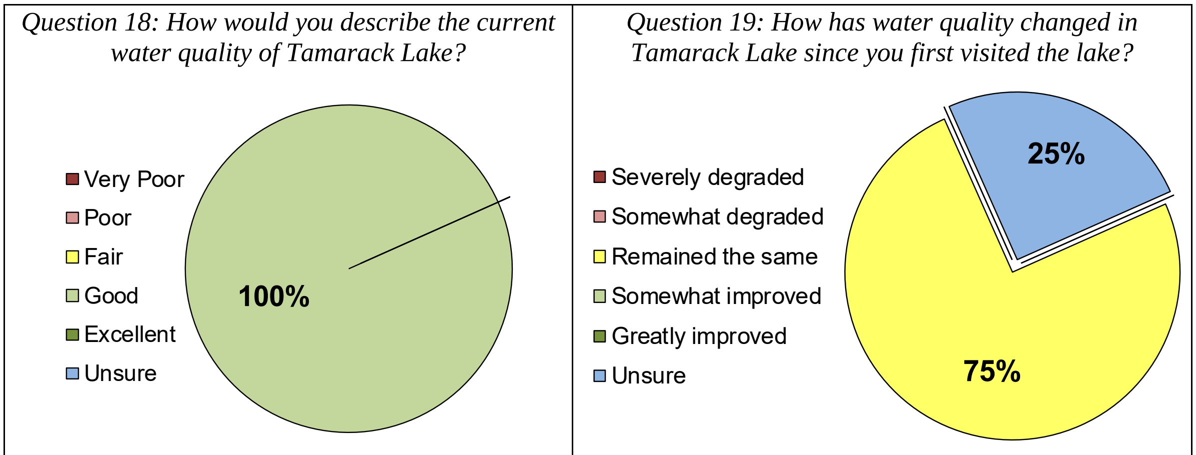


Figure 8.4.1-1. Tamarack Lake stakeholder survey responses regarding the lake's current and historical water quality. Created using responses from 4 (80%) respondents of 5 surveys distributed.

The water quality data collected in 2016 represent the first time data have been collected from Tamarack Lake. Given historical data are not available, it cannot be said if or how water quality in Tamarack Lake has changed over time. However, the 2016 data provide information on the current condition of Tamarack Lake's water quality. The average summer total phosphorus concentration measured in Tamarack Lake in 2016 was 32.2 µg/L which straddles the threshold between the *good* and *fair* categories for deep lowland drainage lakes in Wisconsin (Figure 8.4.1-2). This average summer phosphorus concentration exceeds the median concentration for other deep lowland drainage lakes in Wisconsin (23.0 µg/L) and for all lake types within the NLF ecoregion (21.0 µg/L).

The average growing season total phosphorus concentration measured in Tamarack Lake in 2016 was approximately 37% higher than the predicted phosphorus concentration generated by watershed modeling. As is discussed in further detail within the Tamarack Lake Watershed Assessment Section (Section 8.4.2), it is believed the higher-than-predicted phosphorus concentrations are not the result of human activity and are likely the result of the model underestimating phosphorus input from Tamarack Lake's direct watershed. While phosphorus concentrations were higher than expected, chlorophyll-*a* concentrations were lower than expected given the level of phosphorus within the lake. As is discussed further, phytoplankton production in Tamarack Lake is likely light-limited due to the dark-stained water found in the lake.

The average summer chlorophyll-*a* concentration measured in Tamarack Lake in 2016 was 5.6 µg/L, falling on the threshold between *excellent* and *good* for deep lowland drainage lakes in Wisconsin (Figure 8.4.1-2). The summer average chlorophyll-*a* concentration in Tamarack Lake is lower than the median concentration for other deep lowland drainage lakes in Wisconsin (7.0 µg/L) and the same as the median concentration for all lake types within the NLF ecoregion (5.6 µg/L). As mentioned, the measured chlorophyll-*a* concentrations from Tamarack Lake are lower than expected given the measured concentrations of phosphorus. This is an indication that another factor other than phosphorus is limiting phytoplankton production. It is likely that the phytoplankton are light-limited due to the dark-stained water found in Tamarack Lake. The sources of Tamarack Lake's stained water are discussed further in this section.

The average summer Secchi disk depth measured in Tamarack Lake in 2016 was 5.9 feet, falling in the *good* category for Wisconsin's deep lowland drainage lakes. Tamarack Lake's average summer Secchi disk depth falls below the median depth for other deep lowland drainage lakes in Wisconsin (8.5 feet) and the median depth for all lake types within the NLF ecoregion (8.9 feet). The measured Secchi disk depth in Tamarack Lake is lower than predicted based on measured chlorophyll-*a* concentrations, and is an indication that a factor other than phytoplankton is influencing water clarity in Tamarack Lake.

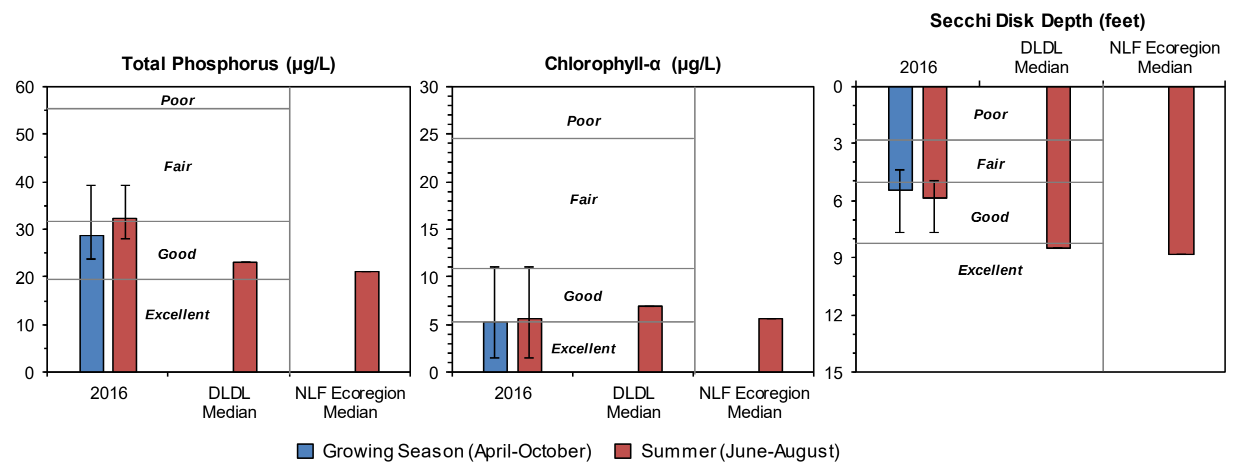


Figure 8.4.1-2. Tamarack Lake 2016 average growing season and summer total phosphorus, chlorophyll-α, and Secchi disk depth compared to median values for Wisconsin deep lowland drainage lakes (DLDL) and Northern Lakes and Forests (NLF) ecoregion lakes. Water Quality Index values adapted from WDNR PUB WT-913. Error bars represent maximum and minimum values.

Abiotic suspended particulates, such as sediment, can also cause a reduction in water clarity. However, *total suspended solids*, a measure of both biotic and abiotic suspended particles within the water, were low in Tamarack Lake in 2016 indicating minimal amounts of suspended material within the water. While suspended particles are minimal in Tamarack Lake, water clarity can also be influenced by dissolved compounds within the water. Many lakes in the northern region of Wisconsin contain higher concentrations of natural dissolved organic acids that originate from decomposing plant material within wetlands in the lake's watershed. In higher concentrations, these dissolved organic compounds give the water a tea-like color or staining and decrease water clarity.

A measure of water clarity once all of the suspended material (i.e. phytoplankton and sediments) have been removed, is termed *true color*, and measures how the clarity of the water is influenced by dissolved components. True color values measured from Tamarack Lake in 2016 averaged 65 SU (standard units), indicating the lake's water is *tea-colored*. Based on Tamarack Lake's chlorophyll-*a* concentrations measured in 2016, Secchi disk transparency was predicted to be approximately 8.0 feet; however, the high concentrations of dissolved organic acids in the lake reduce the water's clarity to the measured growing season average of 5.9 feet. It is important to note that the tea-colored water in Tamarack Lake is natural, and is not an indication of degraded conditions.

To determine if internal nutrient loading (discussed in Town-Wide Section of management plan) is a significant source of phosphorus in Tamarack Lake, near-bottom phosphorus concentrations are compared against those collected from the near-surface. Near-bottom total phosphorus concentrations were measured on five occasions from Tamarack Lake in 2016 (Figure 8.4.1-3). Near-bottom total phosphorus concentrations were relatively similar to those measured at the surface on all sampling occasions with the exception of samples collected in late-July. Near-bottom total phosphorus concentrations measured during this sampling event were approximately two times higher than those measured at the surface; however, the near-bottom total phosphorus concentration was well below 200 µg/L. While internal phosphorus loading occurs to some degree during summer stratification, there is no indication that that this near-bottom phosphorus is mobilized to surface waters during the summer. Additionally, even if this phosphorus was mobilized to surface waters, the amount is not at a level which would significantly impact water quality.

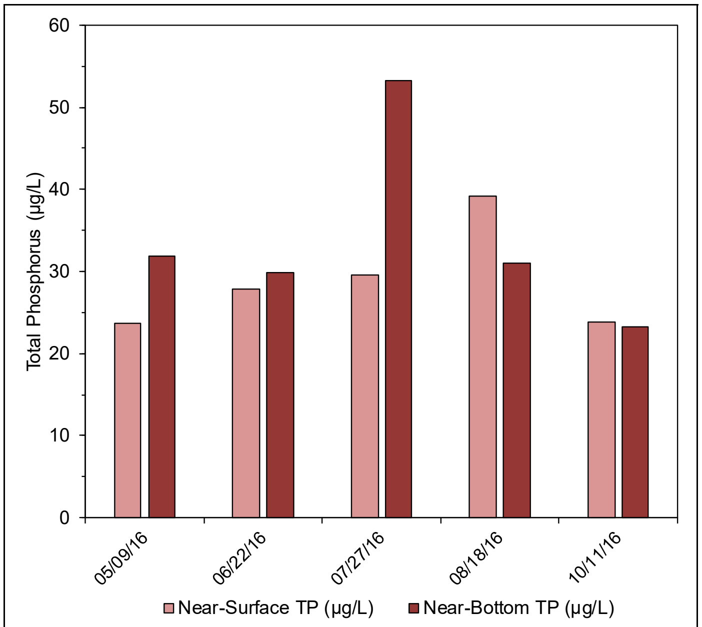


Figure 8.4.1-3. Tamarack Lake near-bottom total phosphorus concentrations and corresponding near-surface total phosphorus concentrations measured in 2016.

Tamarack Lake Trophic State

Figure 8.4.1-4 contains the Trophic State Index (TSI) values for Tamarack Lake calculated from the data collected in 2016. These TSI values are calculated using summer near-surface total phosphorus, chlorophyll-*a*, and Secchi disk transparency 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 the calculated TSI values for these three parameters are to one another indicates a higher degree of correlation.

The weighted TSI values for total phosphorus and chlorophyll-*a* (and Secchi disk depth) in Tamarack Lake indicate the lake is at present in meso-eutrophic state. Tamarack Lake's productivity is similar to the productivity of other deep lowland drainage lakes throughout Wisconsin and slightly higher when compared to the productivity of all lake types within the NLF ecoregion.

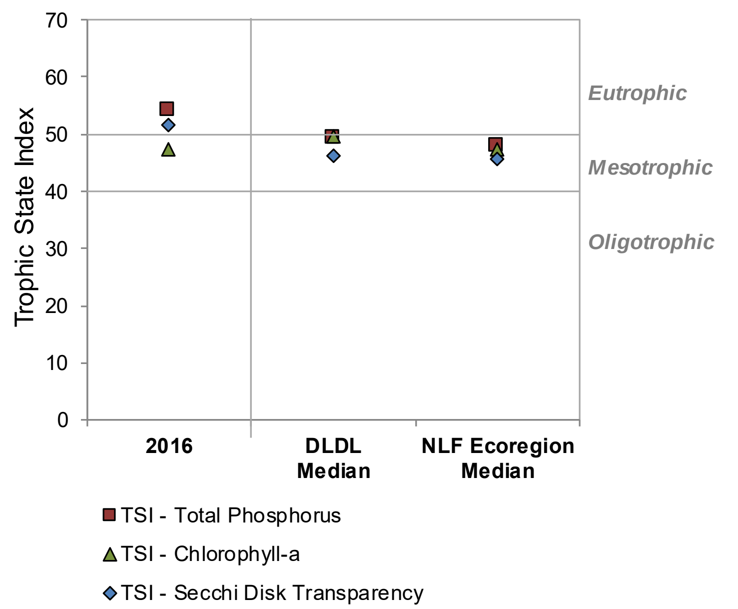


Figure 8.4.1-4. Tamarack Lake, statewide deep lowland drainage lakes (DLDL), and Northern Lakes and Forests (NLF) ecoregion lakes Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Tamarack Lake

Dissolved oxygen and temperature profile data were collected during each water quality sampling event conducted by Onterra ecologists. These data are displayed in Figure 8.4.1-5. The temperature and dissolved oxygen data collected in 2016 indicate that the lake remains stratified throughout the summer and develops anoxia from 6.0 feet and deeper by mid-summer. By October, surface temperatures had cooled and the lake had mixed as indicated by relatively uniform temperature and dissolved oxygen throughout the water column. An attempt was made to collect water quality data through the ice in February 2017 on Tamarack Lake, but this sampling was not conducted due to unsafe ice conditions.

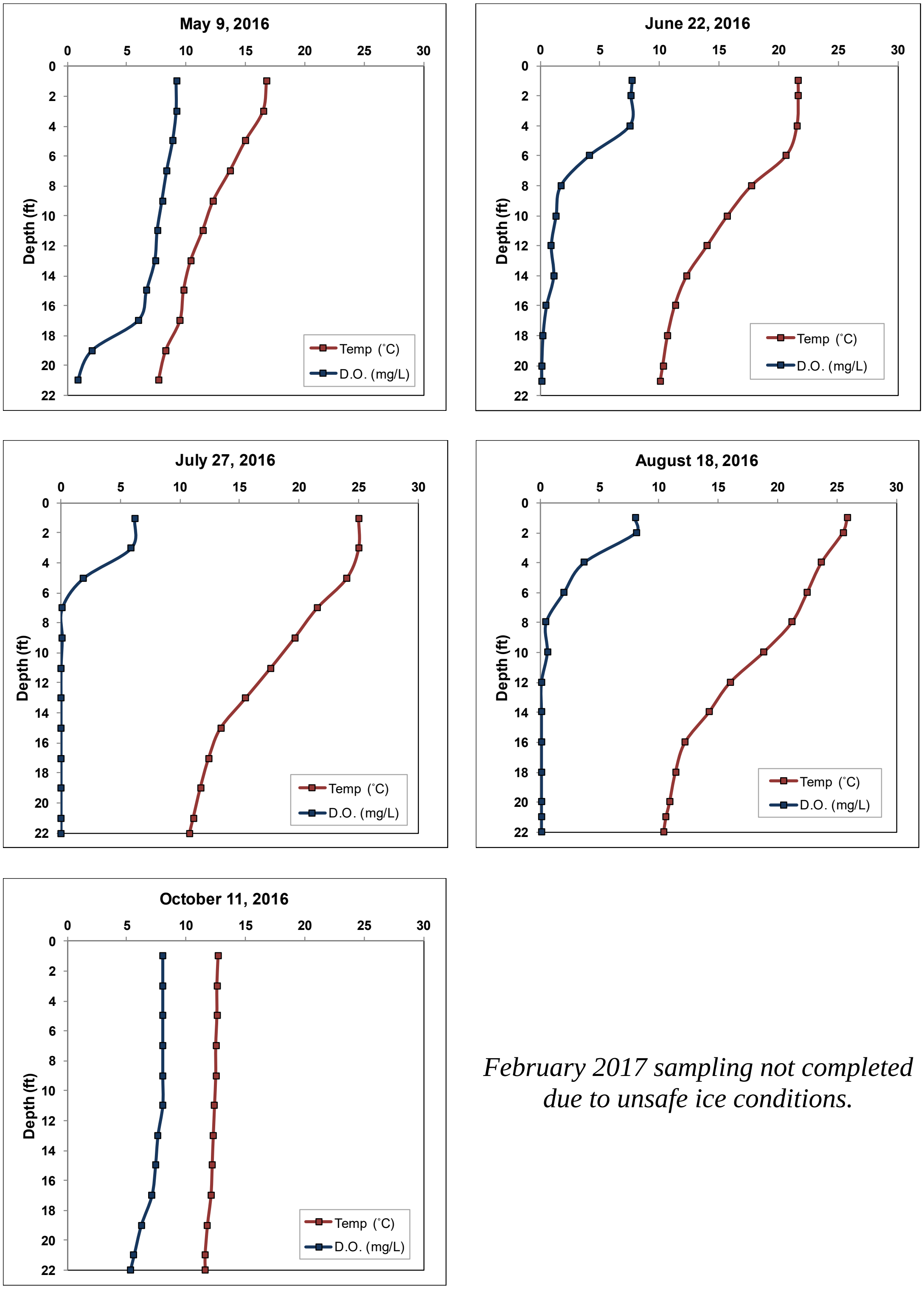


Figure 8.4.1-5. Tamarack Lake 2016/17 dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected from Tamarack Lake

The previous section is centered on parameters relating to Tamarack Lake's trophic state. 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 Tamarack 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 Town-wide 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. Tamarack Lake's mid-summer surface water pH was measured at 7.3 in 2016. This value indicates Tamarack Lake's water is alkaline and falls within the normal range for Wisconsin lakes. Fluctuations in pH with respect to seasonality are common; in-lake processes such as photosynthesis by plants act to reduce acidity by carbon dioxide removal while decomposition of organic matter adds carbon dioxide to water, thereby increasing acidity. A lake's pH is primarily determined by the water's alkalinity, or a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. Tamarack Lake's average alkalinity measured in 2016 was 31.6 mg/L as $CaCO_3$. This value falls within the expected range for northern Wisconsin lakes, and indicates that while Tamarack Lake is considered a softwater lake, it is not sensitive to fluctuations in pH from acid rain.

Water quality samples collected from Tamarack Lake in 2016 were also analyzed for calcium. Calcium concentrations, along with pH, are currently being used to determine if a waterbody is suitable to support the invasive zebra mussel, as these animals require calcium for the construction of their shells. Zebra mussels typically require higher calcium concentrations than Wisconsin's native mussels, and lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The accepted suitable pH range for zebra mussels is 7.0 – 9.0, and Tamarack Lake's pH falls within this range. Tamarack Lake's calcium concentration in 2016 was 9.9 mg/L, indicating the lake has *very low susceptibility* to zebra mussel establishment. Plankton tows were completed by Onterra ecologists at three locations in Tamarack Lake in 2016 that underwent analysis for the presence of zebra mussel veligers, their planktonic larval stage. Analysis of these samples were negative for zebra mussel veligers, and Onterra ecologists did not observe any adult zebra mussels during the 2016 surveys.

8.4.2 Tamarack Lake Watershed Assessment

Tamarack Lake's surficial watershed encompasses approximately 5,114 acres (Figure 8.4.2-1 and Tamarack Lake – Map 2) yielding a watershed to lake area ratio of 77:1. The watershed is comprised of the Birch Lake subwatershed (4,178 acres) and the Tamarack Lake direct watershed (936 acres). For the watershed modeling, phosphorus data collected from Birch Lake were used along with the land cover types within the Tamarack Lake direct watershed. Tamarack Lake's direct watershed is comprised of land cover types including forests (44%), wetlands (37%), pasture/grass (12%), and the lake's surface itself (7%) (Figure 8.4.2-1). Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Tamarack Lake's residence time is approximately 0.08 years, or the water within the lake is completely replaced approximately 13 times per year.

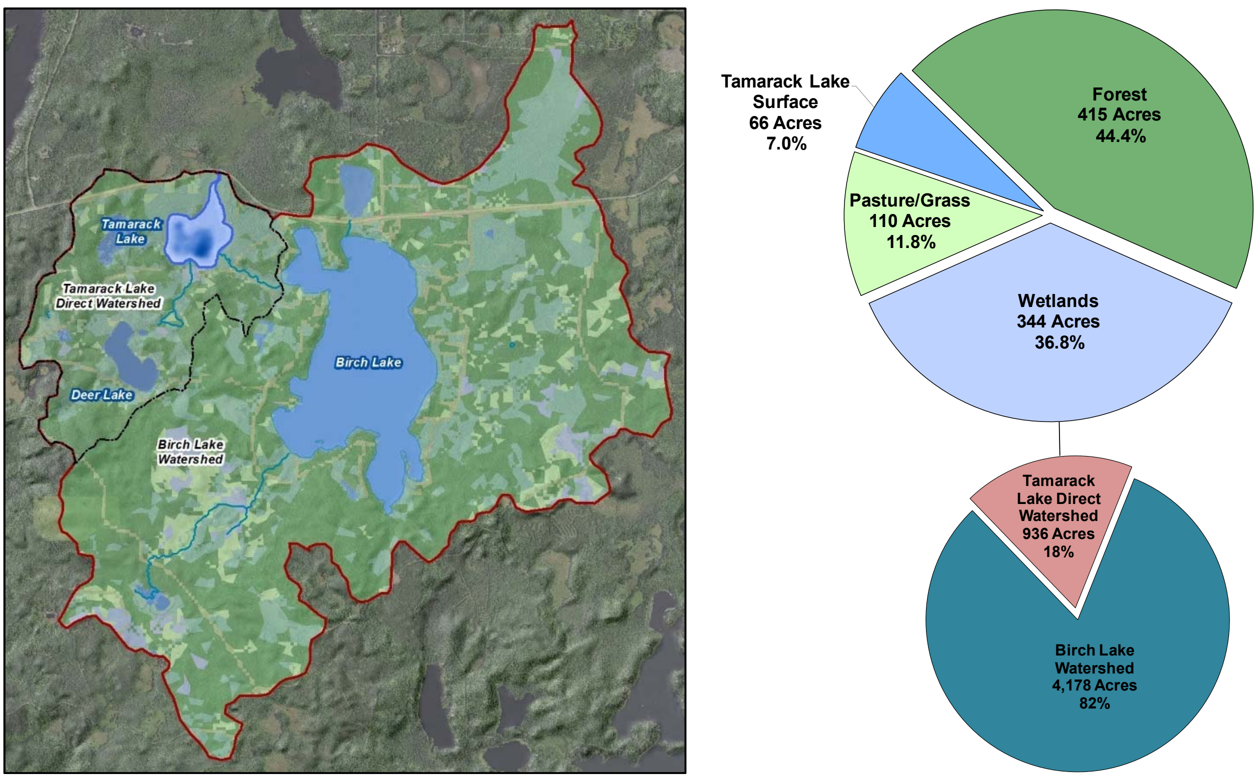


Figure 8.4.2-1. Tamarack Lake watershed boundary (red line) and proportion of land cover types. Tamarack Lake direct watershed is indicated by black dashed line. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

Using the land cover types within Tamarack Lake's direct watershed and phosphorus data from Birch Lake, WiLMS was utilized to estimate the annual potential phosphorus load delivered to Tamarack Lake from its watershed. In addition, data obtained from a stakeholder survey sent to Tamarack Lake riparian property owners in 2016 was also used to estimate the amount of phosphorus loading to the lake from riparian septic systems. The model estimated that a total of approximately 328 pounds of phosphorus are delivered to Tamarack Lake from its watershed on an annual basis (Figure 8.4.2-2).

Of the estimated 328 pounds of phosphorus being delivered to Tamarack Lake on an annual basis, approximately 218 pounds (66%) originates from the Birch Lake subwatershed while the remaining 110 pounds (34%) originates from Tamarack Lake's direct watershed. Within the direct watershed, 33 pounds (10%) originate from forests, 31 pounds (10%) originate from wetlands, 29 pounds (9%) originate from areas of pasture/grass/rural open space, 18 pounds (5%) originate from direct atmospheric deposition onto the lake surface, and a negligible amount was estimated to originate from riparian septic systems (Figure 8.4.2-2). Using the estimated annual potential phosphorus load, WiLMS predicted an in-lake growing season average total phosphorus concentration of 19 µg/L. The 2016 measured growing season total phosphorus concentration in Tamarack Lake was 28.8 µg/L, approximately 37% higher than the WiLMS predicted concentration. The higher concentration of phosphorus measured in Tamarack Lake is an indication that approximately 200 additional pounds of phosphorus are entering the lake each year that was not accounted for within the model.

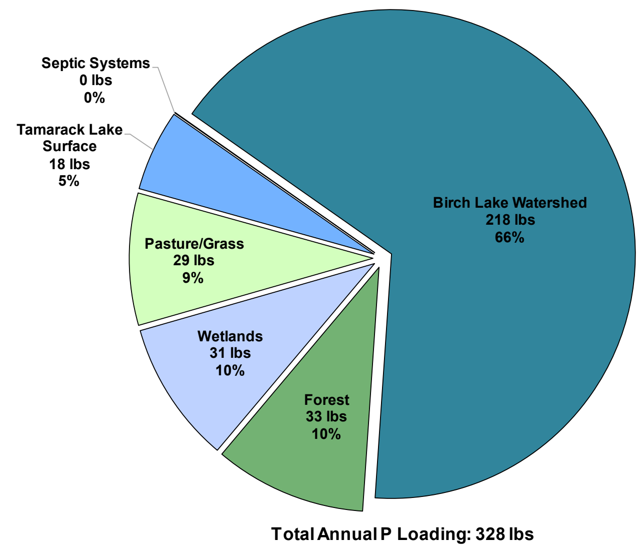


Figure 8.4.2-2. Tamarack Lake estimated potential annual phosphorus loading. Please note WiLMS estimated approximately 328 pounds of phosphorus are delivered to Tamarack Lake annually. However, based upon measured phosphorus concentrations, it is estimated approximately 526 pounds of phosphorus are loaded to the lake annually. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

In most instances in northern Wisconsin lakes when the measured phosphorus concentration is higher than that predicted by the model, it is an indication of internal nutrient loading. However, as is discussed in the Tamarack Lake Water Quality Section (Section 8.4.1), the data indicate that internal nutrient loading is not a significant source of phosphorus to Tamarack Lake and suggests that the unaccounted phosphorus is originating externally from the watershed. Given measured phosphorus concentrations from Birch Lake were used in the modeling, it is likely the predicted phosphorus loading from the Birch Lake subwatershed is highly accurate and it is not probable that the unaccounted phosphorus is originating from the Birch Lake subwatershed.

It is believed the unaccounted phosphorus resulting in higher than predicted phosphorus concentrations in Tamarack Lake is originating from the lake's direct watershed. Tamarack Lake's direct watershed is almost entirely comprised of natural land cover types, and it is likely that phosphorus export from the direct watershed is naturally higher than model predictions. It is also possible that the data collected from Tamarack Lake in 2016 represent a year with higher than average phosphorus concentrations as a result of increased precipitation. Regardless, the higher than predicted phosphorus concentrations in Tamarack Lake are not the result of anthropogenic activity and are believed to be the result of underestimation by the WiLMS model.

8.4.3 Tamarack Lake Shoreland Condition

Shoreland Development

As is discussed within the Town-wide Section, one of the most sensitive areas of a lake's watershed is the immediate shoreland zone. This transition zone between the aquatic and terrestrial environment is the last source of protection for the lake against pollutants originating from roads, driveways, and yards above, and is also a critical area for wildlife habitat and overall lake ecology. In the late-summer of 2016, the immediate shoreland of Tamarack Lake was assessed in terms of its development, and the shoreland zone was characterized with one of five shoreland development categories ranging from urbanized to completely undeveloped.

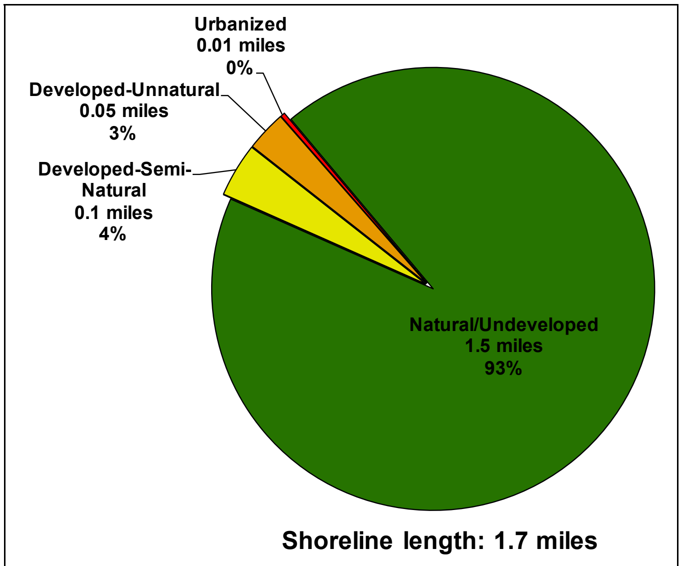


Figure 8.4.3-1. Tamarack Lake shoreland categories and total lengths. Based upon a late-summer 2016 survey. Locations of these categorized shorelands can be found on Tamarack Lake - Map 3.

The 2016 survey revealed that Tamarack Lake has stretches of shoreland that fit four of the five shoreland assessment categories (Figure 8.4.3-1). In total, 1.5 miles (93%) of the 1.7-mile shoreland zone were categorized as natural/undeveloped or shoreland types that provide the most benefit to the lake and should be left in their natural state if possible. Approximately 0.06 miles (3%) of the shoreland was categorized as developed-unnatural or urbanized, shorelands which provide little benefit to and may actually adversely impact the lake. If restoration of Tamarack Lake's shoreland is to occur, primary focus should be placed on these shoreland areas. Tamarack Lake – Map 3 displays the locations of these shoreland categories around the entire lake.

Coarse Woody Habitat

A survey for coarse woody habitat was conducted in conjunction with the shoreland assessment (development) survey on Tamarack Lake in 2016. Coarse woody habitat was identified, and classified in several size categories (2-8 inches diameter, >8 inches diameter and cluster) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed in the Town-wide Section, research

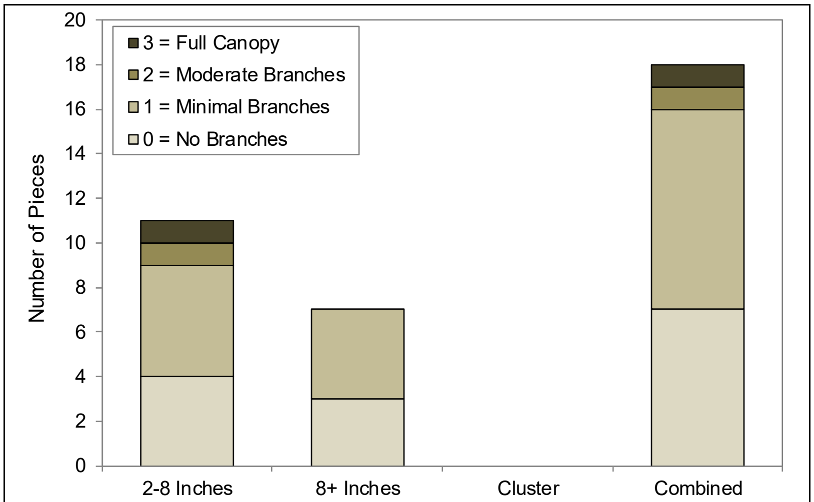


Figure 8.4.3-2. Tamarack Lake coarse woody habitat survey results. Based upon a late-summer 2016 survey. Locations of Tamarack Lake coarse woody habitat can be found on Tamarack Lake – Map 4.

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 the coarse woody habitat survey on Tamarack Lake, a total of 18 pieces were observed along 1.7 miles of shoreline, yielding a coarse woody habitat to shoreline mile ratio of 11:1 (Figure 8.4.3-2). Onterra ecologists have been completing these surveys on Wisconsin's lakes for five years, and Tamarack Lake falls in the 16th percentile for the number of coarse woody habitat pieces per shoreline mile of 75 lakes studied. While the majority of the shoreland zone around Tamarack Lake is natural, the lower number of coarse woody habitat pieces is due to non-forested wetlands which surround most of the lake and lack larger trees. Refraining from removing these woody habitats from the shoreland area will ensure this high-quality habitat remains in these lakes. The locations of these coarse woody habitat pieces are displayed on Tamarack Lake – Map 4.

8.4.4 Tamarack Lake Aquatic Vegetation

An Early-Season Aquatic Invasive Species (ESAIS) Survey was conducted by Onterra ecologists on Tamarack Lake on June 28, 2016. 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 the non-native curly-leaf pondweed which should be at or near its peak growth at this time. Fortunately, no curly-leaf pondweed was located in Tamarack Lake in 2016, and it is believed that curly-leaf pondweed is not present within the lake or exists at an undetectable level. Tamarack Lake users should familiarize themselves with curly-leaf pondweed and its identification as nearby Harris Lake contains a population of curly-leaf pondweed that was discovered in 2008.

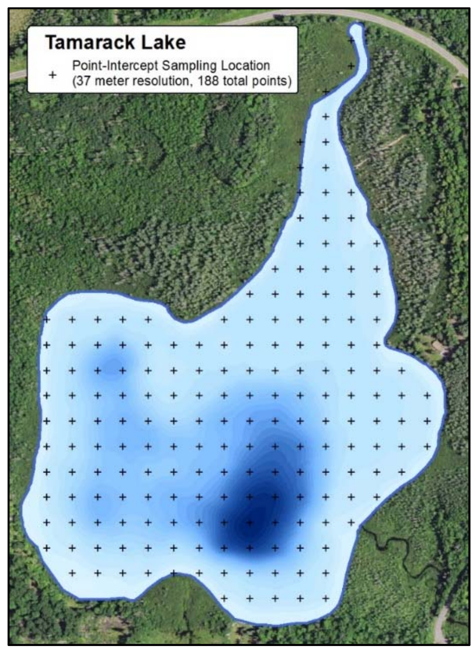


Figure 8.4.4-1. Tamarack Lake whole-lake point-intercept survey sampling locations.

The whole-lake aquatic plant point-intercept survey and emergent and floating-leaf aquatic plant community mapping survey were conducted on Tamarack Lake by Onterra ecologists on July 20, 2016 (Figure 8.4.4-1). During these surveys, a total of 32 aquatic plant species were located, none of which are considered to be non-native, invasive species (Table 8.4.4-1). Lakes in Wisconsin vary in their morphometry, water chemistry, and substrate composition, and all of these factors influence aquatic plant community composition. In early August of 2016, Onterra ecologists completed an acoustic survey on Tamarack Lake (bathymetric results on Tamarack Lake – Map 1). The sonar-based technology records aquatic plant bio-volume, or the percentage of the water column that is occupied by aquatic plants at a given location. Data pertaining to Tamarack Lake's substrate composition were also recorded during this survey. The sonar records substrate hardness, ranging from the hardest substrates (i.e. rock and sand) to the more flocculent, softer organic sediments.

Data regarding substrate hardness collected during the 2016 acoustic survey showed that substrate hardness varies widely in shallow areas of Tamarack Lake with both the hardest and softest substrates in the lake occurring within 1.0-5.0 feet of water (Figure 8.4.4-2). The softer substrates occurred near the mouths of inlet creeks and in areas of adjacent wetlands while areas of harder substrates mainly occurred along the lake's northern shorelines. Average substrate hardness increased between 6.0-11.0 feet before declining slightly and remaining relatively constant to 27.0 feet. Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in soft 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 of the different habitat types that are available.

Table 8.4.4-1. List of aquatic plant species located in Tamarack Lake during Onterra 2016 aquatic plant surveys.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2016 (Onterra)
Emergent	*Dulichium arundinaceum*	Three-way sedge	9	I
Emergent	*Eleocharis palustris*	Creeping spikerush	6	I
Emergent	*Pontederia cordata*	Pickerelweed	9	X
Emergent	*Schoenoplectus acutus*	Hardstem bulrush	5	I
Emergent	*Sparganium americanum*	American bur-reed	8	I
Emergent	*Typha latifolia*	Broad-leaved cattail	1	I
FL	*Brasenia schreberi*	Watershield	7	X
FL	*Nuphar variegata*	Spatterdock	6	X
FL	*Nymphaea odorata*	White water lily	6	X
FL	*Sparganium fluctuans*	Floating-leaf bur-reed	10	X
Submergent	*Bidens beckii*	Water marigold	8	X
Submergent	*Ceratophyllum demersum*	Coontail	3	X
Submergent	*Chara* spp.	Muskgrasses	7	X
Submergent	*Elodea canadensis*	Common waterweed	3	I
Submergent	*Eriocaulon aquaticum*	Pipewort	9	X
Submergent	*Isoetes* spp.	Quillwort spp.	8	X
Submergent	*Myriophyllum sibiricum*	Northern watermilfoil	7	X
Submergent	*Najas flexilis*	Slender naiad	6	X
Submergent	*Potamogeton amplifolius*	Large-leaf pondweed	7	X
Submergent	*Potamogeton berchtoldii*	Slender pondweed	7	X
Submergent	*Potamogeton epihydrus*	Ribbon-leaf pondweed	8	X
Submergent	*Potamogeton gramineus*	Variable-leaf pondweed	7	X
Submergent	*Potamogeton praelongus*	White-stem pondweed	8	I
Submergent	*Potamogeton richardsonii*	Clasping-leaf pondweed	5	I
Submergent	*Potamogeton robbinsii*	Fern-leaf pondweed	8	X
Submergent	*Potamogeton spirillus*	Spiral-fruited pondweed	8	X
Submergent	*Potamogeton zosteriformis*	Flat-stem pondweed	6	X
Submergent	*Utricularia minor*	Small bladderwort	10	X
Submergent	*Utricularia vulgaris*	Common bladderwort	7	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	I
FF	*Lemna minor*	Lesser duckweed	5	I
FF	*Lemna trisulca*	Forked duckweed	6	X

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

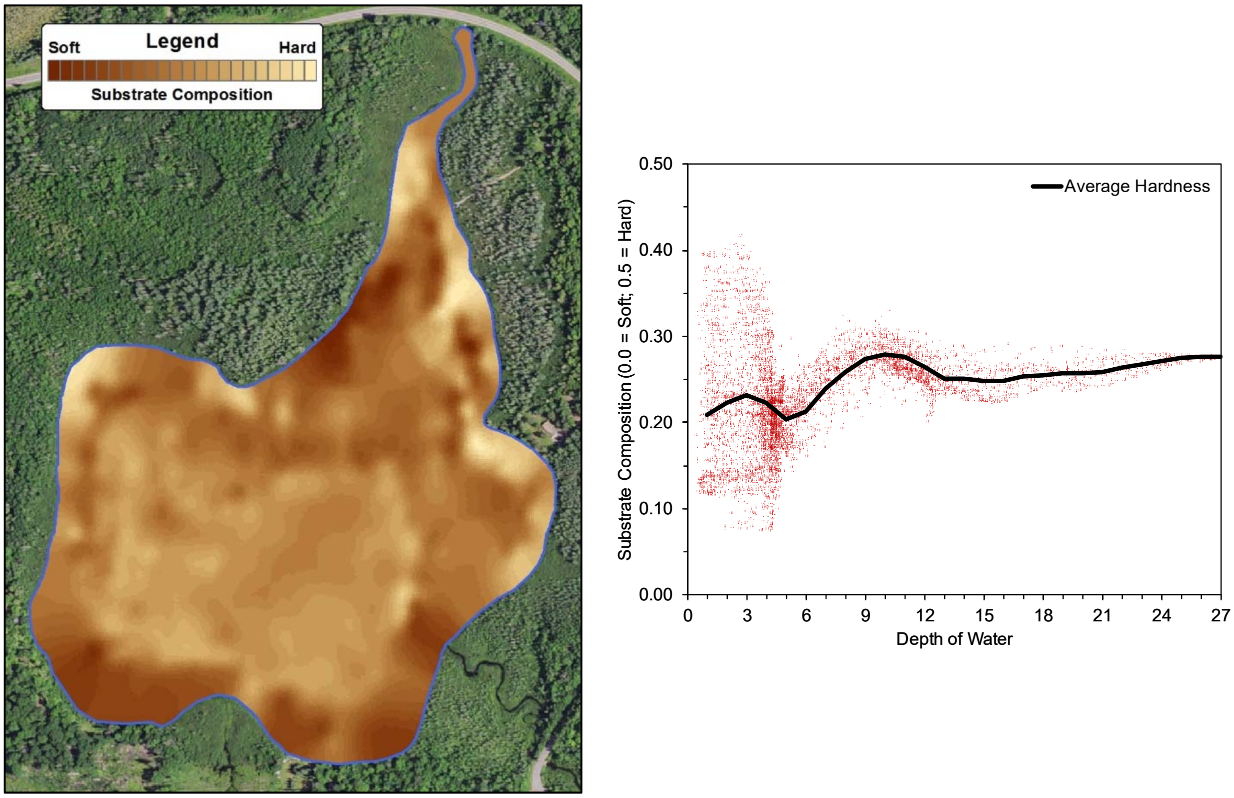


Figure 8.4.4-2. Tamarack Lake spatial distribution of substrate hardness (left) and substrate hardness across water depth (right). Individual data points are displayed in red. Creating using data from August 2016 acoustic survey.

The acoustic survey also recorded aquatic plant bio-volume throughout the entire lake. As mentioned earlier, aquatic plant bio-volume is the percentage of the water column that is occupied by aquatic plants. The 2016 aquatic plant bio-volume data are displayed in Figure 8.4.4-3 and Tamarack Lake – Map 6. Areas where aquatic plants occupy most or all of the water column are indicated in red while areas of little to no aquatic plant growth are displayed in blue. The 2016 whole-lake point-intercept survey found aquatic plants growing to a maximum depth of 10 feet. However, the majority of aquatic plant growth occurs within 2.0-6.0 feet of water. The 2016 acoustic survey indicated approximately 75% of Tamarack Lake's area contains aquatic vegetation, while the remaining 25% of the lake is too deep and light-limited to support aquatic plant growth.

While the acoustic mapping is an excellent survey for understanding the distribution and levels of aquatic plant growth throughout the lake, this survey does not determine what aquatic plant species are present. Whole-lake point-intercept surveys are used to quantify the abundance of individual species within the lake. As mentioned, aquatic plants were recorded growing to a maximum depth of 10 feet in 2016. Of the 145 point-intercept sampling locations that fell at or shallower than the maximum depth of plant growth (littoral zone), approximately 89% contained aquatic vegetation. Aquatic plant rake fullness data collected in 2016 indicates that 15% of the 145 littoral sampling locations contained vegetation with a total rake fullness rating (TRF) of 1, 21% had a TRF rating of 2, and 53% had a TRF rating of 3 (Figure 8.4.4-5). These data indicate that aquatic plant density in Tamarack Lake is high throughout most areas where plants occur.

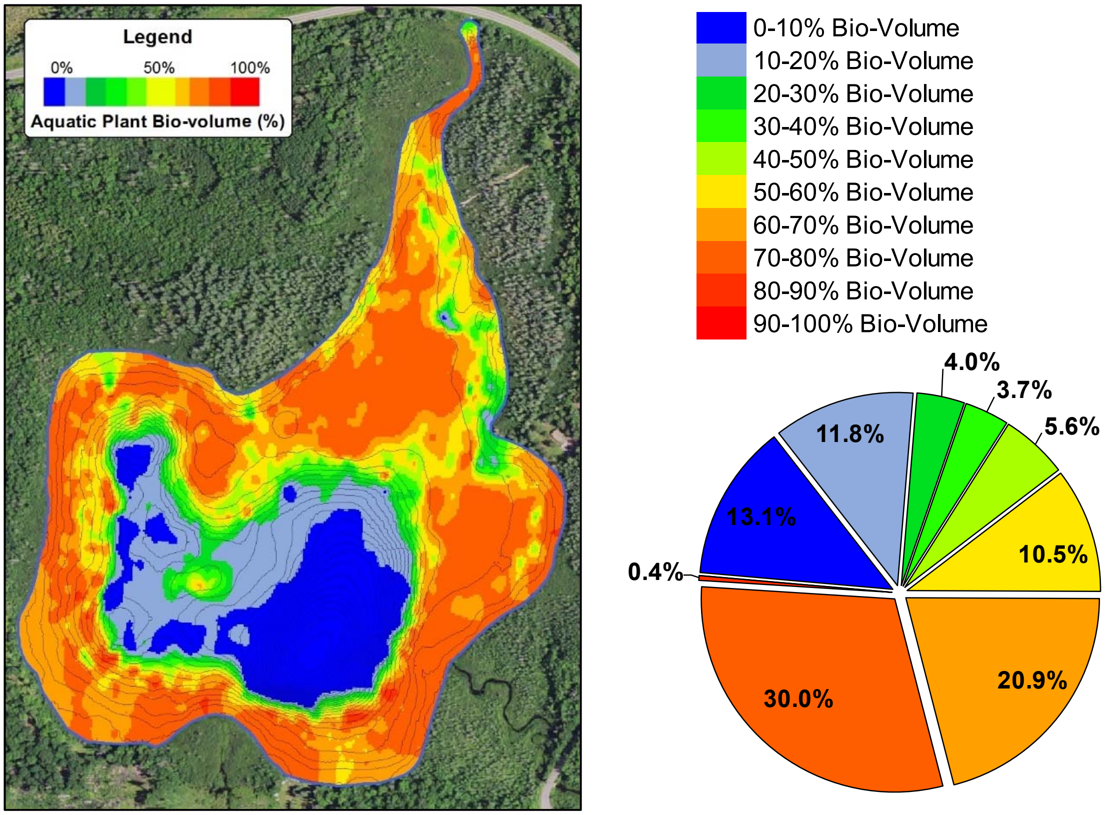


Figure 8.4.4-4. Tamarack Lake 2016 aquatic plant bio-volume. Created using data from August 2016 acoustic survey data. Contour lines represent one-foot increments.

Of the 32 aquatic plant species located in Tamarack Lake in 2016, 22 were encountered directly on the rake during the whole-lake point-intercept survey (Figure 8.4.4-6). The remaining 10 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 22 species directly sampled with the rake during the point-intercept survey, fern-leaf pondweed, white water lily, and common bladderwort were the three-most frequently encountered aquatic plant species (Figure 8.4.4-6).

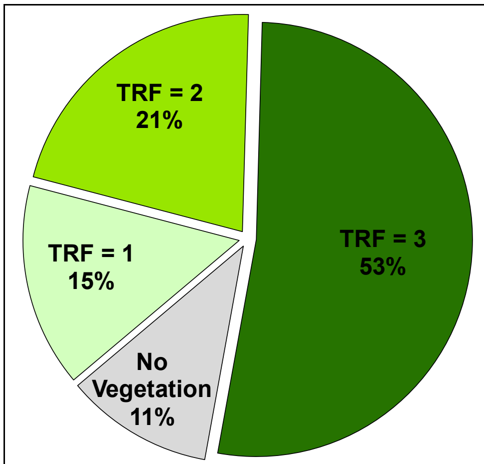


Figure 8.4.4-5. Tamarack Lake 2016 aquatic vegetation total rake fullness ratings (TRF). Created from data collected during the 2016 whole-lake point-intercept survey (N = 145).

Fern-leaf pondweed was the most frequently encountered aquatic plant species in Tamarack Lake in 2016 with a littoral frequency of occurrence of 67% (Figure 8.4.4-6). Fern-leaf pondweed is a common plant in softwater lakes in northern Wisconsin, and is often one of the most abundant. It can be found in shallow to deep water typically over soft sediments. Large beds of fern-leaf pondweed provide excellent structural habitat for aquatic wildlife and help to prevent the suspension of the soft bottom sediments in which they grow. In Tamarack Lake, fern-leaf pondweed was most abundant between 4.0 and 8.0 feet of water.

White water lily was the second-most frequently encountered aquatic plant species in Tamarack Lake during the 2016 point-intercept survey with a littoral frequency of occurrence of 19% (Figure 8.4.4-6). White water lily is a common water lily species that can be found in quiet waters of lakes and rivers throughout Wisconsin. This plant possesses a rhizome which is buried in the sediment and produces large circular leaves which float on the surface. Large, showy, and fragrant white flowers are produced which open in the morning and close by afternoon. In Tamarack Lake, a ring of white water lily around the lake in 2.0-4.0 feet of water was observed (Photo 8.4.4-1 and Map 7). Like other aquatic plants, white water lily provides valuable structural habitat and reduces sediment resuspension and shoreland erosion.

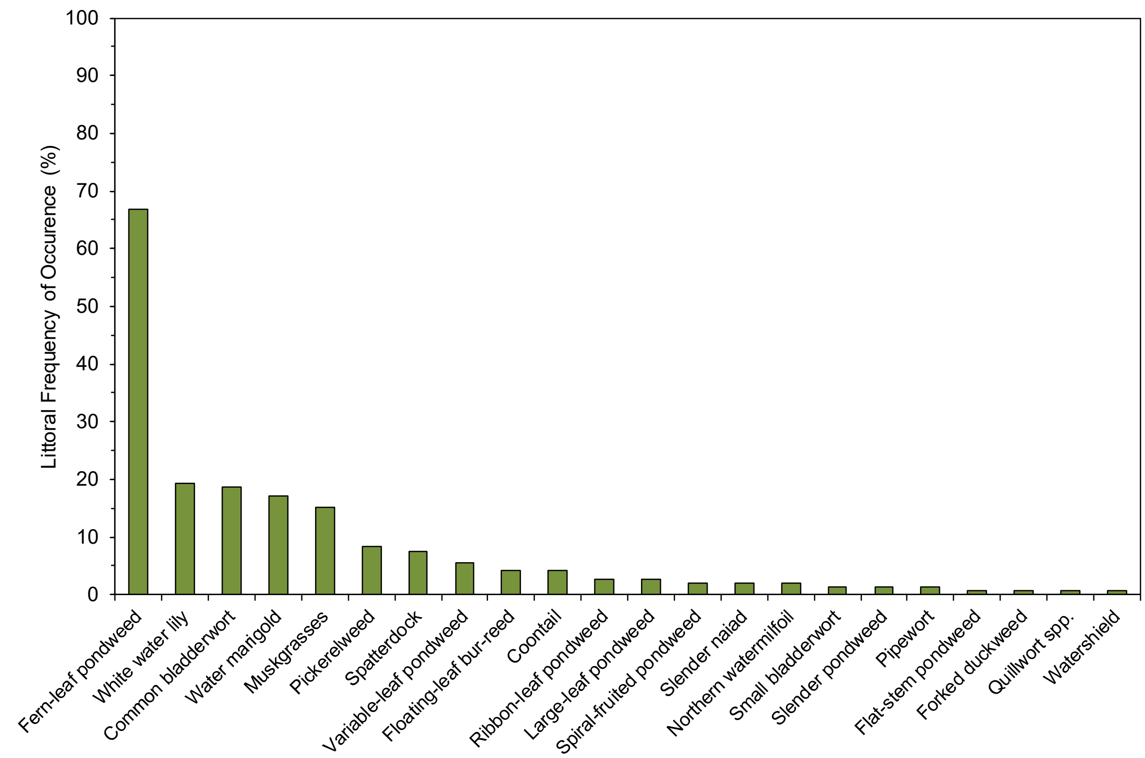


Figure 8.4.4-6. Tamarack Lake 2016 littoral frequency of occurrence of aquatic plant species. Created using data from 2016 whole-lake point-intercept survey.

Common bladderwort was the third-most frequently encountered aquatic plant species in Tamarack Lake during the 2016 point-intercept survey with a littoral frequency of occurrence of 19% (Figure 8.4.4-6). Common bladderwort is one of seven species of bladderwort that occur in Wisconsin and one of two species located in Tamarack Lake. Bladderworts are a genus of carnivorous plants which produce bladder-like traps that are used to capture aquatic invertebrates. Common bladderwort is the most prevalent species in Wisconsin and can be found across a wider range of water quality within areas of quiet water. In summer, common bladderwort produces yellow snapdragon-like flowers on stalks held above the water's surface (Photo 8.4.4-1). In Tamarack Lake, common bladderwort was most abundant between 4.0 and 8.0 feet of water.

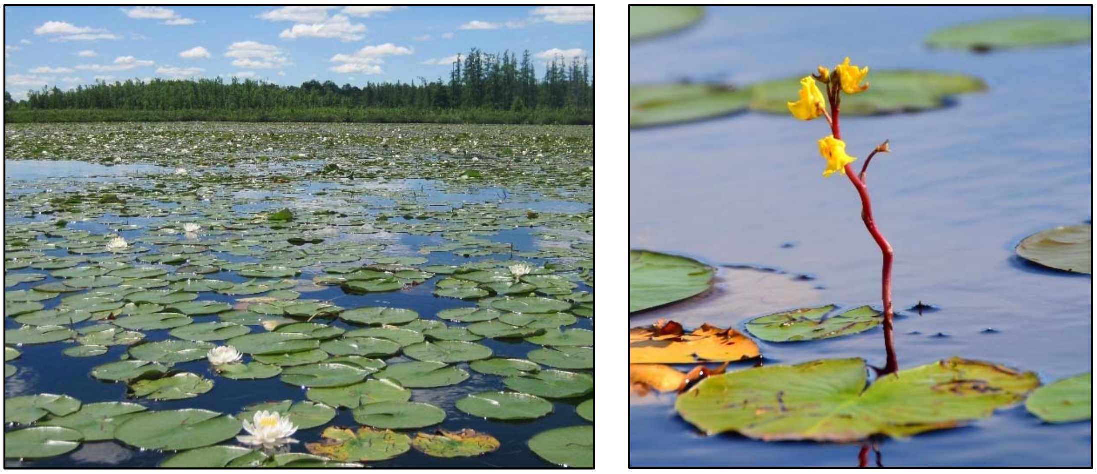


Photo 8.4.4-1. Large white water lily (*Nymphaea odorata*) community in Tamarack Lake (left) and flowers of common bladderwort (*Utricularia vulgaris*) from Rainbow Lake (right). Photo credit Onterra, 2016.

Submersed aquatic plants can be grouped into one of two general categories based upon their morphological growth form and habitat preferences. These two groups include species of the *isoetid* growth form and those of the *elodeid* growth form. Plants of the isoetid growth form are small, slow-growing, inconspicuous submerged plants (Photo 8.4.4-2). These species often have evergreen, succulent-like leaves and are usually found growing in sandy/rocky soils within near-shore areas of a lake (Boston and Adams 1987, Vestergaard and Sand-Jensen 2000).

In contrast, aquatic plant species of the elodeid growth form have leaves on tall, erect stems which grow up into the water column, and are the plants that lake users are likely more familiar with (Photo 8.4.4-2). It is important to note that the definition of these two groups is based solely on morphology and physiology and not on species' relationships. For example, dwarf-water milfoil (*Myriophyllum tenellum*) is classified as an isoetid, while all of the other milfoil species in Wisconsin such as northern water milfoil (*Myriophyllum* sibiricum) are classified as elodeids.

Alkalinity, as it relates to the amount of bicarbonate within the water, is the primary water chemistry factor for determining a lake's aquatic plant community composition in terms of isoetid versus elodeid growth forms (Vestergaard and Sand-Jensen 2000). Most aquatic plant species of the elodeid growth form cannot inhabit lakes with little or no alkalinity because their carbon demand for photosynthesis cannot be met solely from the dissolved carbon dioxide within the water and must be supplemented from dissolved bicarbonate.

On the other hand, aquatic plant species of the isoetid growth form can thrive in lakes with little or no alkalinity because they have the ability to derive carbon dioxide directly from the sediment, and many also have a modified form of photosynthesis to maximize their carbon storage (Madsen et al. 2002). While isoetids are able to grow in lakes with higher alkalinity, their short stature makes them poor competitors for space and light against the taller elodeid species. Thus, isoetids are most prevalent in lakes with little to no alkalinity where they can avoid competition from elodeids. However, in lakes with moderate alkalinity, like Tamarack Lake Lake, the aquatic plant community can be comprised of isoetids growing beneath a scattered canopy of the larger elodeids. Isoetid communities are vulnerable to sedimentation and eutrophication (Smolders et al. 2002), and a number are listed as special concern (e.g. northeastern bladderwort) or threatened in Wisconsin due to their rarity and susceptibility to environmental degradation.


Photo 8.4.4-2. Lake quillwort (*Isoetes lacustris*) of the isoetid growth form (left) and variable pondweed (*Potamogeton gramineus*) and fern pondweed (*P. robbinsii*) of the elodeid growth form (right).

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 2016 point-intercept survey on Tamarack Lake and their conservatism values were used to calculate the FQI of Tamarack Lake's aquatic plant community (equation shown below).

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

Figure 8.4.4-7 compares the 2016 FQI components of Tamarack Lake to median values of lakes within the Northern Lakes and Forests Lakes (NLFL) ecoregion and lakes throughout Wisconsin. The native species richness, or number of native aquatic plant species located on the rake in 2016 (22) falls above the median species richness values for lakes in the NLFL ecoregion (21) and for lakes throughout Wisconsin (19) (Figure 3.3.4-7). The average conservatism of the 22 native aquatic plant species located in Tamarack Lake in 2016 was 7.3, exceeding the median average conservatism values for lakes within the NLFL ecoregion (6.7) and lakes throughout Wisconsin (6.3) (Figure 3.3.4-7). This indicates that a higher proportion of Tamarack Lake's aquatic plant community is comprised of environmentally-sensitive species, or species with higher conservatism values.

Using Tamarack Lake's native aquatic plant species richness and average conservatism yields a high FQI value of 34.1 (Figure 3.3-4-7). Tamarack Lake's FQI value exceeds the median value for lakes within the NLFL ecoregion (30.8) and the median value for lakes throughout Wisconsin (27.2). Overall, the FQI analysis indicates that the aquatic plant community found in Tamarack Lake is of higher quality than the majority of lakes within the NLFL ecoregion and lakes throughout the state.

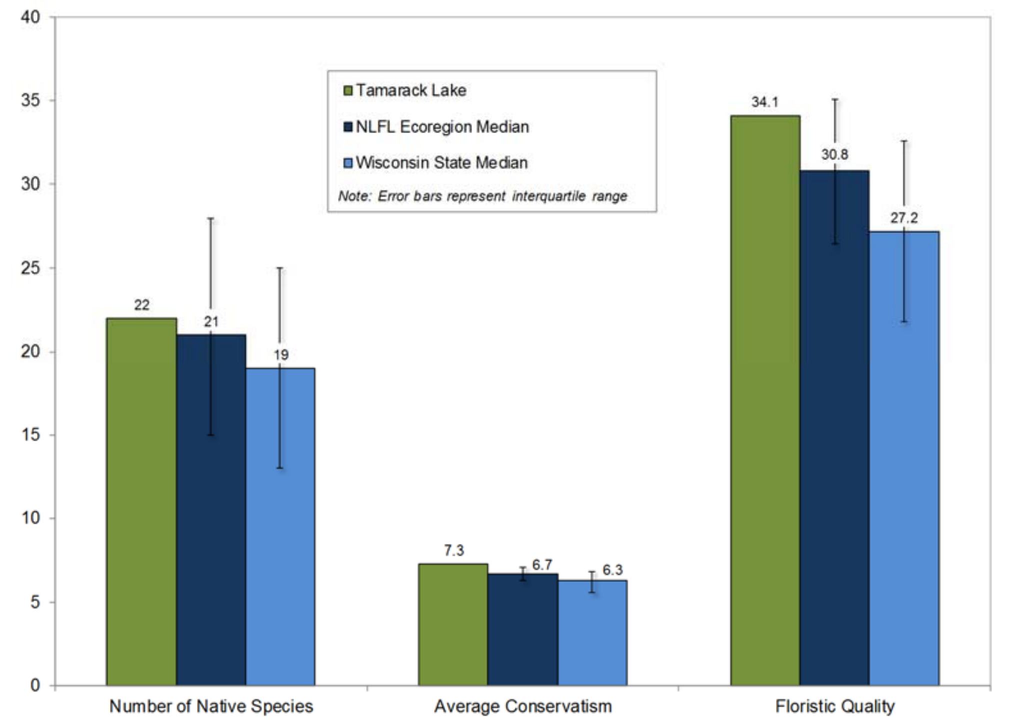


Figure 8.4.4-7. Tamarack Lake Floristic Quality Assessment. Created using data from Onterra 2016 whole-lake point-intercept survey. Analysis follows Nichols (1999).

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 Tamarack Lake contains a high number of native aquatic plant species, one may assume the aquatic plant community has high 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 Tamarack Lake's diversity value ranks. Using data collected by Onterra and WDNR Science Services, quartiles were calculated for 212 lakes within the NLFL ecoregion (Figure 8.4.4-8). Using the data collected from the 2016 point-intercept survey, Tamarack Lake's aquatic plant was found to have low species diversity with a Simpson's Diversity Index value of 0.83. In other words, if two individual aquatic plants were randomly sampled from Tamarack Lake in 2016, there would be an 83% probability that they would be different species. Tamarack Lake's Simpson's Diversity value falls near the lower quartile for lakes in the NLFL ecoregion and below the median for lakes throughout Wisconsin.

One way to visualize Tamarack Lake's lower species diversity is to look at the relative occurrence of aquatic plant species. Figure 8.4.4-9 displays the relative frequency of occurrence of aquatic plant species created from the 2016 whole-lake point-intercept survey. While Tamarack Lake contains a higher number of species, approximately 73% of the plant community is comprised of five species. The remaining 17 species occur in relatively low abundance. Explained another way, if 100 plants were randomly sampled from Tamarack Lake, 36 would be fern-leaf pondweed, 10 would be white water lily, etc. The uneven distribution of aquatic plant species within the community and dominance by a small number of species yields lower species diversity. However, the low species diversity of Tamarack Lake's aquatic plant community is not an indication of degraded conditions. Rather, the combination of the lake's primarily soft substrates in the littoral areas and low-light conditions reduce the number of habitat types available. Fern-leaf pondweed competes against other species well under these conditions which leads to a dominance of this plant within the community.

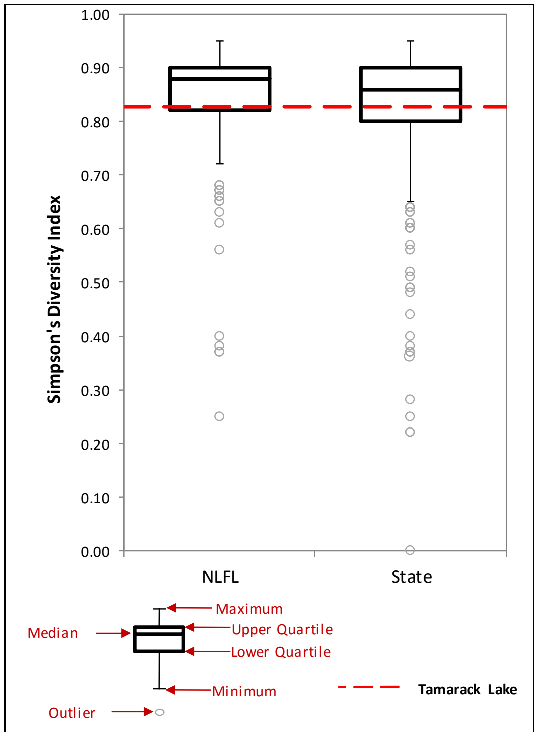


Figure 8.4.4-8. Tamarack Lake species diversity index. Created using data from Onterra 2016 point-intercept survey.

In 2016, Onterra ecologists also conducted a survey aimed at mapping emergent and floating-leaf aquatic plant communities in Tamarack Lake. This survey revealed Tamarack Lake contains approximately 20 acres of these communities comprised of 10 different aquatic plant species (Tamarack Lake – Map 7 and Table 8.4.4-2). The majority of these communities are comprised of pickerelweed and white water lily. 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. 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 Tamarack Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development.

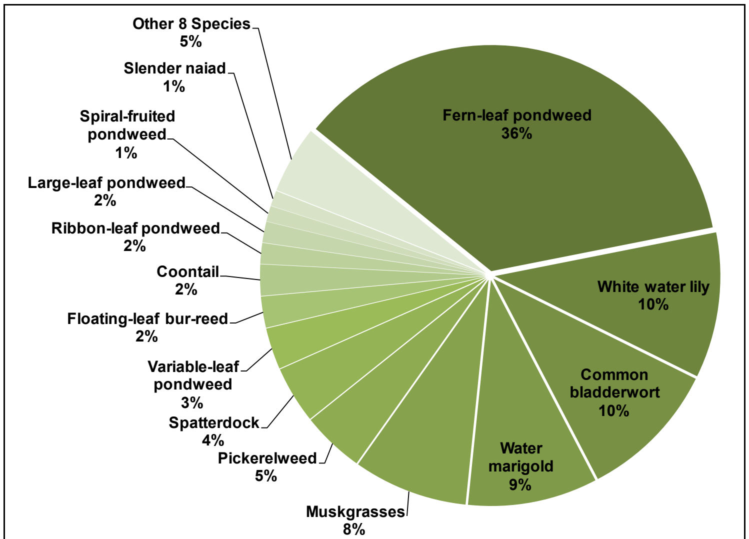


Figure 8.4.4-9. Tamarack Lake 2016 relative frequency of occurrence of aquatic plant species. Created using data from 2016 point-intercept survey.

Table 8.4.4-2. Tamarack Lake 2016 acres of emergent and floating-leaf aquatic plant communities. Created using data from 2016 aquatic plant community mapping survey.

Plant Community	Acres
Emergent	7.8
Floating-leaf	12.3
Mixed Emergent & Floating-leaf	0.0
Total	**20.0**

8.4.5 Aquatic Invasive Species in Tamarack Lake

As of 2016, no aquatic invasive species have been confirmed in Tamarack Lake. However, the non-native Chinese (*Cipanogopaludina chinensis*) and banded (*Viviparus georgianus*) mystery snails and rusty crayfish (*Orconectes rusticus*) have been documented in upstream Birch Lake and it is possible that these species are present in Tamarack Lake. One study conducted in northern Wisconsin lakes found that the Chinese mystery snail did not have strong negative effects on native snail populations (Solomon et al. 2010). However, researchers did detect negative impacts to native snail communities when both Chinese mystery snails and the rusty crayfish were present (Johnson et al. 2009).

Rusty crayfish were introduced to Wisconsin from the Ohio River Basin in the 1960's likely via anglers' discarded bait. In addition to displacing native crayfish (*O. virilis* and *O. propinquus*), rusty crayfish also degrade the aquatic habitat by reducing aquatic plant abundance and diversity and have also been shown to consume fish eggs. While there is currently no control method for eradicating rusty crayfish from a waterbody, aggressive trapping and removal has been shown to significantly reduce populations and minimize their ecological impact. While it is possible these species are present in Tamarack Lake, their presence has not been officially verified.

8.4.6 Tamarack Lake Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a summary of available data is included here as 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 the lake. The goal of this section is to provide an overview 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 2017) and personal communications with DNR Fisheries Biologists Steve Gilbert and Hadley Boehm.

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 Birch 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 phytoplankton. 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 piscovorous 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.

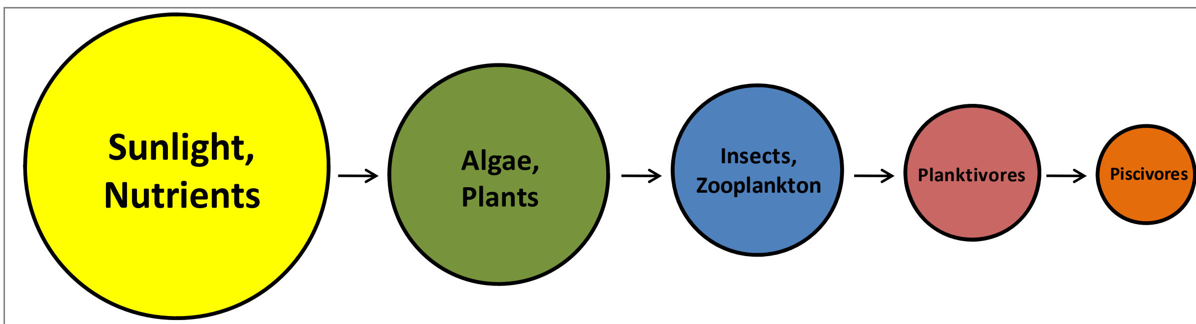


Figure 8.4.6-1 Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Tamarack Lake is a meso-eutrophic system, meaning it has a moderate amount of nutrients and thus a moderate amount of primary productivity. This is relative to an oligotrophic system, which contains fewer nutrients (less productive) and a eutrophic system, which contains more nutrients (more productive). Simply put, this means Tamarack Lake should be able to support an appropriately sized population of predatory fish (piscovores) when compared to eutrophic or oligotrophic systems. Table 8.4.6-1 shows the popular game fish present in Tamarack Lake.

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

Common Name (*Scientific Name*)	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
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
Largemouth Bass (*Micropterus salmoides*)	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
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
Panfish (*Lepomis*)	11	May - August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates

Survey Methods

In order to keep the fishery of a lake healthy and stable, fisheries biologists must assess the current fish populations and trends. To begin this process, the correct sampling technique(s) must be selected to efficiently capture the desired fish species. A common passive trap used is a fyke net (Photo 8.4.6-1). Fish swimming towards this net along the shore or bottom will encounter the lead of the net and be diverted into the trap and through a series of funnels which direct the fish further into the net. Once reaching the end, the fisheries technicians can open the net and sort the captured fish.

The other commonly used sampling method is electroshocking (Photo 8.4.6-1). This is done, often at night, by using a specialized boat fit with a generator and two electrodes installed on the front touching the water. Once a fish comes in contact with the electrical current produced, *galvanotaxis* stimulates their nervous system and involuntarily causes them to swim toward the electrodes. When the fish are in the vicinity of the electrodes, they undergo *narcosis* (stunned), making them easy for fisheries technicians to net and place into a livewell to recover. Contrary to what some may believe, electroshocking does not kill the fish and after being placed in the livewell, fish generally recover within minutes.

Once fish are captured using the appropriate method, data such as count, species, length, weight, sex, tag number, and aging structures may be recorded and the fish released. Fisheries biologists use this data to make recommendations and informed decisions on managing the future of the fishery.


Photo 8.4.6-1. Fyke net positioned in the littoral zone of a Wisconsin lake (right) and an electroshocking boat (left).

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 (Photo 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. Historical stocking efforts for Tamarack Lake have included muskellunge and are displayed in Table 8.4.6-2.

Photo 8.4.6-2. Fingerling Muskellunge.

Table 8.4.6-2. WDNR stocking data of fish species available for Tamarack Lake (1972-1990).

Year	Species	Age Class	# Fish Stocked	Avg Fish Length (in)
1972	Muskellunge	Fingerling	100	13.0
1973	Muskellunge	Fingerling	200	13.0
1988	Muskellunge	Fingerling	300	9.0
1990	Muskellunge	Fingerling	300	11.5

Fish Populations and Trends

Utilizing the above-mentioned fish sampling techniques and specialized formulas, WDNR fish biologists can estimate populations and determine trends of captured fish species. The data collected and calculated is then used by fish biologists to determine the best management plan for the lake or chain. One method that is used involves calculating abundance and size structure of the fish populations and comparing to area lakes with the same species.

Tamarack Lake Fish Habitat

Substrate Composition

Just as forest wildlife requires 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 2016, 97% of the substrate sampled in the littoral zone of Tamarack Lake was soft sediments, 2% was rock with the remaining 1% composed of sand substrate.

Coarse Woody Habitat & Fish Sticks Program

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).

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. 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. These projects are typically conducted on lakes lacking significant coarse woody habitat in the shoreland zone. A fall 2016 survey documented 18 pieces of coarse woody along the shores of the Tamarack Lake, resulting in a ratio of approximately 11 pieces per mile of shoreline.

Regulations and Management

Current (2016-2017) regulations for Tamarack Lake gamefish species 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 Tamarack Lake (2016-2017).

Species	Season	Regulation
Panfish	Open All Year	None, Daily bag limit 25
Largemouth bass and smallmouth bass	June 18, 2016 to March 5, 2017	14", Daily bag limit 5
Northern pike	May 7, 2016 to March 5, 2017	None, Daily bag limit 5
Walleye, sauger, and hybrids	May 7, 2016 to March 5, 2017	Only 1 fish over 14", Daily bag limit 3
Bullheads	Open All Year	None, Unlimited
Rough fish	Open All Year	None, Unlimited

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 8.4.6-2. 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 8.4.6-2. 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/)

Tamarack Lake Tribal 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 8.4.6-3). The Town of Winchester falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on specified systems. Determining how many fish are able to be taken from a lake, either by spear harvest or angler harvest, is a highly regimented and dictated process.

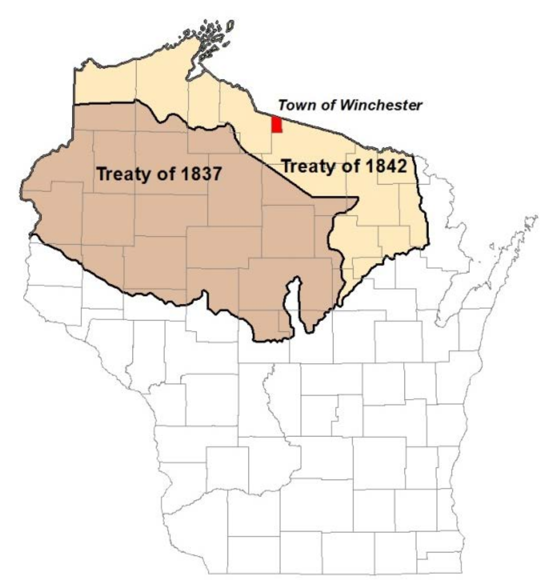


Figure 8.4.6-3. Location of the Town of Winchester within the Native American Ceded Territory (GLIFWC 2016). This map was digitized by Onterra; therefore it is a representation and not legally binding.

This highly structured procedure begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a *total allowable catch* is established, based upon estimates of a sustainable harvest of the fishing stock (age 3 to age 5 fish). This figure is usually about 35% (walleye) or 27% (muskellunge) of the lake's known or modeled population, but may vary on an individual lake basis due to other circumstances. In lakes where population estimates are out of date by three or more years, a standard percentage is used. The total allowable catch number may be reduced by a percentage agreed upon by biologists that reflects the confidence they have in their population estimates for the particular lake. This number is called the *safe harvest level*.

Often, the biologists overseeing a lake cannot make adjustments due to the regimented nature of this process, so the total allowable catch often equals the safe harvest level. The safe harvest is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest is then multiplied by the Indian communities claim percent. This result is called the *declaration*, and represents the maximum number of fish that can be taken by tribal spearers (Spangler, 2009). Daily bag limits for walleye are then reduced for hook-and-line anglers to accommodate the tribal declaration and prevent over-fishing. Bag limits reductions may be increased at the end of May on lakes that are lightly speared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

Spearers are able to harvest muskellunge, walleye, northern pike, and bass during the open water season; however, in practice, walleye and muskellunge are the only species harvested in significant numbers, so conservative quotas are set for other species. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2016). Creel clerks and tribal wardens are assigned to each lake at the designated boat landing. A catch report is completed for each boating party upon return to the boat landing. In addition to counting every fish harvested, the first 100 walleye (plus all those in the last boat) are measured and sexed. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the declaration is met or the season ends. In 2011, a new reporting requirement went into effect on lakes with smaller declarations. Starting with the 2011 spear harvest season, on lakes with a harvestable declaration of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake. While within the ceded territory, Tamarack Lake has not experienced a spearfishing harvest.

8.4.7 Tamarack Lake Implementation Plan

The Implementation Plan presented in this section was created through the collaborative efforts of the Birch Lake Association (BLA) and Tamarack Lake riparians Planning Committee, Onterra ecologists, North Lakeland Discovery Center (NLDC), and WDNR staff. It represents the path the BLA and Tamarack Lake riparians will follow in order to meet their lake management goals. Tamarack Lake has few riparian property owners and the BLA has included Tamarack Lake in their meetings, activities, and educational outreach. For this reason, the following Implementation Plan includes management goals and associated actions that both of these lakes will implement. This same Implementation Plan can also be found in the Birch Lake Individual Lake Report (Section 8.3).

The goals detailed within the plan are realistic and based upon the findings of the studies completed in conjunction with this planning project and the needs of the Birch and Tamarack lake stakeholders as portrayed by the members of the Planning Committees and the numerous communications between Planning Committee members and the lake stakeholders. The Implementation Plan is a living document in that it will be under constant review and adjustment depending on the condition of the lake, the availability of funds, level of volunteer involvement, and the needs of the stakeholders.

Management Goal 1: Maintain current water quality conditions

Management Action:	Continue monitoring of Birch and Tamarack lakes' water quality through the WDNR Citizens Lake Monitoring Network (CLMN).
Timeframe:	Continuation of current effort
Facilitator:	Glen Wildenberg (current Birch Lake CLMN volunteer) and Martin Plutowski (current Tamarack Lake CLMN volunteer)
Description:	Monitoring water quality is an import aspect of every lake management planning activity. Collection of water quality data at regular intervals aids in the management of the lake by building a database that can be used for long-term trend analysis. As discussed in the water quality sections, Birch and Tamarack lakes' water quality is good to excellent in all parameters measured. Continued monitoring will allow for early detection of potential negative trends and may lead to the reason as to why the trend is developing. The Citizen Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality information on their lake. Volunteers from the BLA have been measuring Secchi disk transparency in Birch Lake annually since 1997 and have been collecting samples for total phosphorus and chlorophyll-*a* annually since 2000. Volunteers from Tamarack Lake have been measuring Secchi disk transparency annually since 2016. Funding for advanced water quality monitoring (addition of total phosphorus and chlorophyll-*a*) has been increasing difficult to acquire, and it was suggested at the planning meetings that the Town of Winchester Lakes Committee may be able to provide funding for the collection

of total phosphorus and chlorophyll-*a* for the town's lakes in the future. Martin Plutowski (or the current Tamarack Lake volunteer) should work with the Town Lakes Committee to determine if funding would be available to conduct total phosphorus and chlorophyll-*a* monitoring on Tamarack Lake in addition to Secchi disk transparency in the future. Emily Heald, the current Water Program Coordinator at the NLDC, has indicated that the NLDC may be able to provide the water quality monitoring volunteers with a Secchi disk and temperature/dissolved oxygen probe for their use. Nearby Trout Lake Research Station may also lend water quality equipment to water quality monitoring volunteers.

The BLA and Tamarack Lake stakeholders realize the importance of continuing this monitoring effort which will supply them with valuable data about their lake. When a change in the collection volunteer occurs, Sandy Wickman (715.365.8951) or the appropriate WDNR/UW-Extension staff will need to be contacted to ensure the proper training occurs and the necessary sampling materials are received by the new volunteer. It is also important to note that as a part of this program, the data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS) by the volunteer.

Action Steps:

1. Glen Wildenberg and Martin Plutowski appoint/recruit new volunteer(s) as needed. If water quality equipment cannot be provided by WDNR, contact Emily Heald (715.543.2085) at the NLDC to inquire if the NLDC is able to lend equipment.
2. New volunteer(s) contact Sandy Wickman (715.365.8951) as needed.
3. Volunteer(s) reports results to WDNR SWIMS database.

Management Action: Continue monitoring Birch and Tamarack lakes' water levels through NLDC citizen science lake level monitoring program.

Timeframe: Continuation of current effort

Facilitator: Birch Lake: Joe and Dorla Osfar; Tamarack Lake: Martin Plutowski and available/interested Tamarack Lake stakeholders

Description: The NLDC currently administers a citizen-based lake level monitoring program where lake levels are monitored on area lakes. Seasonal and longer-term water level fluctuations are natural in Wisconsin's lakes and are often beneficial for lake health. Continued monitoring of lake levels provides for an understanding of what conditions lead to changes in water levels. Following ice-out in the spring, staff gauges are installed on Birch and Tamarack lakes and referenced to a fixed benchmark. Each week during the open-water season, volunteers record the current lake level. The staff gauges are removed in the fall and water level records are provided to NLDC staff. These lake level data are submitted to the WDNR's Surface

Water Integrated Monitoring System (SWIMS). The collection of lake level monitoring data must be a long-term, multiyear effort to accurately and precisely discern inter- and intra-annual patterns in water level fluctuations.

Action Steps:

1. Current BLA and Tamarack Lake volunteers record water level on staff gauges weekly during the open-water season.
2. Volunteers report water level data to NLDC at the end of each open-water season.
3. NLDC records water level data in WDNR SWIMS database.
4. Joe and Dorla Osfar and Martin Plutowski recruit new volunteers as needed or notify BLA if new water level monitors are needed.

Management Action: Preserve natural and restore highly developed shoreland areas on Birch and Tamarack lakes to improve habitat, reduce erosion, and protect water quality.

Timeframe: Initiate 2018

Facilitator: BLA Board of Directors and interested/available Tamarack Lake stakeholders

Description: The 2016 Shoreland Condition Assessment found that approximately 70% (4.5 miles) of Birch Lake's immediate shoreland zone contains little to no development, delineated as either *natural/undeveloped* or *developed-natural*, while approximately 16% (1.0 miles) contains a higher degree of development categorized as *developed-unnatural* or *urbanized*. On Tamarack Lake, approximately 93% (1.5 miles) of the lake's shoreland was delineated as *natural/undeveloped* while approximately 3% (0.05 miles) was delineated as *developed-unnatural* or *urbanized*. It is important that the owners of properties with little development become educated on the benefits their shoreland is providing to these lakes in terms of maintaining their water quality and habitat, and that these shorelands remain in a natural or semi-natural state. It is equally important that the owners of properties with developed shorelands become educated on the lack of benefits and possible harm their shoreland has to these lakes in terms of water quality and contribution to habitat loss.

The BLA board of directors will work with appropriate entities such as the NLDC and Vilas County Land and Water Department to research grant programs and other pertinent information that will aid the BLA and Tamarack Lake riparians in preserving and restoring the shoreland areas of these lakes. The NLDC has several restoration/rain/lakeshore/erosion gardens that can serve as examples and educational pieces for Birch and Tamarack Lake riparians to gather ideas for their properties. In addition, the NLDC can also help riparian property owners with planting ideas. This would be accomplished through education of property owners, or direct preservation of land through implementation of conservation easements or land trusts that the property owner would approve of. The BLA should contact Catherine Higley (cahigl@co.vilas.wi.us – 715.479.3738), Vilas County's Invasive Species Coordinator, to gather information on how to protect and restore areas of Birch Lake's shoreland.

Action Steps:

1. BLA Board of Directors gathers appropriate information from entities listed above.
2. The BLA provides Birch and Tamarack lake property owners with the necessary informational resources to protect or restore their shoreland should they be interested. Interested property owners may contact the NLDC and Vilas County Land and Conservation office for more information on shoreland restoration plans, financial assistance, and benefits of implementation.

Management Action: Preserve natural land cover within Birch and Tamarack lakes' watershed beyond the immediate shoreland zone.

Timeframe: Initiate in 2018

Facilitator: BLA Board of Directors and interested/available Tamarack Lake stakeholders

Description: As is discussed within the Watershed Section (8.3.2), changes in land use beyond the shoreland zone within a lake's watershed can impact water quality. Currently, Birch and Tamarack lakes' watershed is mainly comprised of natural land cover types, forests and wetlands. These natural land cover types export minimal amounts of phosphorus, retain soil, and maintain the good water quality found in these lakes. The BLA and Tamarack Lake stakeholders recognize the importance of maintaining natural land cover within the watershed of these lakes to maintain their water quality for future generations.

As discussed in the previous management action, one way the BLA and Tamarack Lake stakeholders can preserve land within the watershed is through the purchase of land and placement within a land trust. A number of land owners within the watershed have already put their land in a trust. The BLA can also reach out to land owners of property within these lakes' watersheds and provide them with information on the BLA's mission and why preserving their land in a more natural state is beneficial for water quality. In addition, because Birch, Tamarack, and Rainbow lakes share the same watershed, the BLA and Rainbow Lake Association may choose to work together to reach out to property owners throughout the entire watershed of these three lakes to provide them with information on how their land management can lead to the preservation of Birch, Tamarack, and Rainbow lakes.

As of 2017, approximately 40% of the land within the Birch-Tamarack-Rainbow lake watershed is owned by The Forestland Group's Heartwood Forestland Partnership (Birch Lake – Map 8). This land is managed for sustainable logging and is overseen by regional teams working with local forestry consulting firms. The Forestland Group forest management is based on natural regeneration as opposed to planted silvicultural systems, and they were one of three recipients of a Corporate Sustainable Standard Setter Award by the Rainforest Alliance for leadership in the movement toward sustainable certification (TFG website: http://www.forestlandgroup.com/conservation/). The land within the Birch-Tamarack-Rainbow lake watershed is part of the Great Lakes Region Chippewa East Property. Shawn Hagan is the Senior Director for Forestland Operations (906.487.7491) of the Great Lakes Region for The Forestland Group, and the BLA can contact Shawn for more information on how this property within the watershed is managed.

Approximately 3% of the land within the Birch-Tamarack-Rainbow lake watershed is owned by the Wisconsin Department of Natural Resources, while the remaining 57% is comprised of privately-owned parcels. In an effort to preserve natural land cover on these properties, the BLA can include information on the benefits of maintaining these properties in a natural state along with information on the benefits of maintaining a natural shoreline as discussed in the previous management action.

A valuable resource for land owners interested in putting their property in a trust in northern Wisconsin is the Northwoods Land Trust. For other available options, land owners should contact the Vilas County Land and Water Conservation Department. The websites for these groups can be found below:

- The Northwoods Land Trust Website: (www.northwoodslandtrust.org)
- Vilas County Land and Water Conservation Department Website: (http://www.vilasconservation.com/who_we_are.html)

Action Steps:

1. See description above.

Management Goal 2: Increase Navigation Safety on Birch and Tamarack Lakes

Management Action: Consider the placement of waterway markers (non-regulatory danger buoys) to indicate areas in Birch and Tamarack lakes that are hazardous to vessel operation.

Timeframe: Initiate 2018

Facilitator: Birch Lake: BLA Board of Directors; Tamarack Lake: available/interested Tamarack Lake stakeholders

Description: Birch and Tamarack lakes are visited by a number of lake users that recreate on the lake in different ways. Like many lakes, both of these lakes contain some areas that present navigation hazards to lake users. While it is the responsibility of lake users to familiarize themselves with the waterbody and employ safe boating practices, the Birch and Tamarack lake stakeholders would like to deploy non-regulatory danger markers in areas of these lakes that present navigation hazards. Non-regulatory markers are used to mark navigational channels, hazards, and other dangerous areas or to provide general information to the boating public (WDNR PUB-LE-317-2016).

In Birch Lake, these markers would serve to warn lake users of the shallow water and/or rocks present in the area. The acoustic survey conducted in Birch Lake in 2016 identified three areas out from shore which were shallow (< 4 feet in depth) and may present navigation hazards to lake users (Birch Lake – Map 9). Marking these areas will likely also reduce direct impacts (i.e. bottom scarring) from motorboats to valuable native aquatic plant and benthic communities in these areas. Site 1 is a shallow rock bar in the southwest area of the lake approximately 1.0 acre in size. It is proposed that four non-regulatory danger markers be placed around the perimeter of this rock bar as illustrated on Birch Lake – Map 9. Site 2 and 3 are small areas of shallow water of approximately 0.05 acres in size each. It is proposed that a single non-regulatory danger buoy be placed in the center of each of these shallow areas.

Currently, the BLA places three markers in the southwest area of the lake near the small island to indicate the slow, no wake area. Given that these three markers are close to shore, they are readily installed and taken out each year using a small row boat by BLA volunteers. The proposal for adding an additional six markers within the offshore areas previously discussed will make it more logistically challenging for the BLA to get these markers installed and taken out annually. This management action is currently considered as a proposal for marking hazardous areas in Birch Lake, and prior to seeking a permit for these markers the BLA will need to have continued discussions regarding how many additional markers they would like placed in the lake, their location placement, and who and how these markers will be taken in and out of the lake annually.

In Tamarack Lake, one non-regulatory danger marker would be used to identify an area where large rocks are present near the surface and pose hazards to watercraft. It is proposed that one marker be placed at this location to notify lake users of the rocks in these areas (Tamarack Lake – Map 8). As with Birch Lake, Tamarack Lake stakeholders will need to discuss this further to determine sources of funding for the purchase of a marker and who will be responsible for taking this marker in and out of the lake annually.

These non-regulatory danger buoys would be placed in the lakes in spring following ice-out and removed in the fall prior to ice-on. If the BLA and/or Tamarack Lake stakeholder elect to move forward with placing these non-regulatory danger markers in their respective lakes, the initial installation of these markers involves the following requirements as listed in WDNR PUB-LE-317-2016 (http://dnr.wi.gov/files/PDF/pubs/le/LE0317.pdf):

- A WDNR Waterway Marker Application and Permit (Form 8700-58) must be completed.
- The "danger" buoy will be white with an orange diamond. Any information (e.g. "rock") will be printed on this buoy in black. It must by cylindrical in shape, a minimum of 36 inches above the waterline, with a minimum diameter of 7 inches.
- The buoys must be placed by individuals with authorization from the governing entity having jurisdiction over the waters involved.
- The permit must be accompanied by a map or diagram showing the proposed location of the markers (Birch Lake – Map 9 and Tamarack Lake – Map 8). Exact locations must be expressed in GPS coordinates or in specific feet distance from one or more fixed objects whose location is easily identifiable.
- Completed applications and information material should be sent to the WDNR Regional Recreational Safety Warden for Vilas County (Jeremy Cords – contact information below).

Action Steps:

1. The BLA and Tamarack Lake stakeholders have ongoing discussions regarding the addition of non-regulatory waterway markers in their respective lakes as discussed above.
2. If the BLA and/or Tamarack Lake holders elect to move forward with the addition of non-regulatory danger markers in their respective lakes, they would submit WDNR Waterway Marker Application and Permit (Form 8700-58) separately accompanied by Birch Lake – Map

9 and Tamarack Lake – Map 8 to Jeremy Cords (Jeremy.Cords@wi.gov; 920.366.1917), the WDNR Regional Recreational Safety Warden for Vilas County.

3. Following permit approval by the WDNR, the BLA and/or Tamarack Lake stakeholders would purchase non-regulatory danger markers that meet size, shape, and color regulations described for non-regulatory danger markers in WDNR PUB-LE-317-2016 (http://dnr.wi.gov/files/PDF/pubs/le/LE0317.pdf).
4. Individuals with proper authorization will place the markers in the lake following ice-out and will remove the markers prior to ice-on annually.

Management Action: Install signage at Birch and Tamarack lakes' public access location to inform lake users of watercraft regulations on these lakes.

Timeframe: Initiate in 2018

Facilitator: Birch Lake: BLA Board of Directors; Tamarack Lake: interested/available stakeholders

Description: As is discussed in the study results sections, of the 129 stakeholder surveys distributed to Birch Lake riparian property owners in 2016, 50 (39%) were completed. Given the lower response rate, the results of the survey cannot be interpreted as being statistically representative of the population sampled, and at best, the results may indicate possible trends and opinions about the stakeholder perceptions of Birch Lake. However, nearly 50% of respondents indicated that watercraft traffic is currently having a moderate to great negative impact on Birch Lake (Appendix B, Question 2). During the planning meetings, members of the Birch and Tamarack lakes Planning Committees expressed concern about motorboats and personal watercraft operating above slow, no wake speed within the designated setback from the shoreline (100 feet for boats and 200 feet for personal watercraft). The Planning Committee is concerned not only about recreational safety but about the impact to shoreland areas from watercraft operating above slow, no wake too close to shore.

In addition to informing Birch and Tamarack lake riparians on Wisconsin's watercraft regulations and responsible boating practices through their newsletter, a recommendation that no skiing/wakeboarding occur after 7:00 pm, the BLA and Tamarack Lake stakeholders will install signage at the public access point for each lake to provide lake users with a visual representation of the 100- and 200-foot slow, no wake setbacks in an effort to improve recreational safety on these lakes and reduce shoreline erosion/impacts to shoreline habitat. The access point for Tamarack Lake is a carry-in access location on Hwy W that is owned by the Town of Winchester. Members on the Tamarack Lake Planning Committee indicate that they will need to hold additional discussions with Tamarack Lake stakeholders to decide if they would like this type of signage at the carry-in access location.

Onterra will provide the BLA and Tamarack Lake stakeholders with a map similar to Birch Lake – Map 10 and Tamarack Lake – Map 9 displaying these setback areas. The BLA and Tamarack Lake stakeholders will need to provide this map to a sign/graphic design company to create a durable sign for outdoor use at the public access points. In addition, the BLA and Tamarack Lake stakeholders will likely also need to obtain the necessary permission from the Town of Winchester to install new signage at these public access locations.

Action Steps:

1. Onterra provides BLA and Tamarack Lake stakeholders with watercraft regulation maps.
2. Birch Lake and Tamarack Lake stakeholders work with sign/graphic design company to create sign for the public boat landing.
3. BLA and Tamarack Lake stakeholders obtain necessary permission from the Town of Winchester to install sign at the Birch Lake public boat landing.

Management Goal 3: Assure and Enhance the Communication and Outreach of the Birch Lake Association with Birch and Tamarack Lake Stakeholders

Management Action: Promote stakeholder involvement, inform stakeholders on various lake issues, as well as the quality of life on Birch and Tamarack lakes.

Timeframe: Continuation of current effort

Facilitator: BLA Board of Directors and interested/available Tamarack Lake stakeholders

Description: Education represents an effective tool to address lake issues like shoreline development, invasive species, water quality, lawn fertilizers, as well as other concerns such as community involvement and boating safety. The BLA will continue its effort to promote lake preservation and enhancement through a variety of educational efforts.

Currently, the BLA publishes four newsletter issues per year – a hard copy issue once per year which is distributed to all Birch Lake riparian property owners and three electronic issues which are sent to Birch Lake Association members. These newsletters provide members and non-members with association-related information including current projects and updates, meeting times, and educational topics. In addition, the BLA also maintains a website, the Birch/Tamarack Lake Blog (http://birchlake.blogspot.com/), where lake users can find information on Birch and Tamarack lake, meeting times, information on the Town of Winchester lakes, along with a host of lake-related links. During the planning meetings with the Phase II lakes' planning committees, it was suggested that the Rainbow Lake Association (RLA) be included to the Birch/Tamarack lakes blog website after gaining a better understanding on the connectivity between these three lakes. The inclusion of the RLA in the Birch/Tamarack blog will facilitate increased communication between these groups and improve conservation efforts for these three connected lakes.

Eighty-eight percent of Birch Lake stakeholder survey respondents indicated that the BLA keeps them either fairly well informed or highly informed regarding issues with Birch Lake and its management. The BLA would like to maintain its capacity to reach out to and educate association and non-association members regarding Birch Lake and its preservation. Education of lake stakeholders on all matters is important, and a list of educational topics that were discussed during the planning meetings can be found below. These topics can be included within the association's newsletter, distributed as separate educational materials, or posted on the association's website. The BLA has historically invited lake-related speakers to discuss lake topics at the annual Birch/Tamarack annual meeting on Labor Day weekend and they intend to continue to do so in the future in an effort to educate their membership on responsible lake stewardship. The BLA should also reach out to professionals from the NLDC, WDNR, Vilas County Lakes and Rivers Association, etc. to obtain educational pieces for their newsletter.

Example Educational Topics

- Shoreline restoration and protection
- Effect lawn fertilizers/herbicides have on the lake
- Importance of maintaining course woody habitat
- Fishing rules and regulations
- Tribal spear harvests
- Catch-and-release fishing
- Boating regulations and safety
- Pier regulations and responsible placement to minimize habitat disturbance
- Importance of maintaining a healthy native aquatic plant community
- Respect to and maintaining a safe distance from wildlife (e.g. loons) within the lake
- Aquatic invasive species (AIS) prevention
- Water quality monitoring updates from Birch and Tamarack lake
- Septic system maintenance
- Water levels

- Littering on the ice and year-round

In addition to publishing a quarterly newsletter, the BLA will also create a mailing to riparian property owners that includes a summary of the 2016 study results along with information on the BLA's role in the management of Birch Lake and the benefits of being a member. Every other year, the BLA updates and publishes their membership directory. The BLA will also be updating information on their introductory brochure that has been created for distribution to new association members.

Birch Lake Planning Committee members also expressed concern about the need to educate short-term renters on Birch Lake on responsible lake stewardship and watercraft use as these short-term users of the lake often have little vested interest in the lake beyond recreational activities. If the BLA is able to identify rental properties on Birch Lake, the BLA could reach out to these rental property owners to determine if they would be willing to include some type of BLA-created informational packet to their renters. This packet could include items such as the *Town of Winchester Lake User Guide* which provides information on common sense courtesies and watercraft regulations for lake users as well as steps to prevent AIS introductions. The packet could also include the watercraft regulation map for Birch Lake along with other interesting facts or figures about the lake.

The education of Birch Lake property owners who are not members of the BLA was also an issue brought forward by the Birch Lake Planning Committee. They indicated that while the BLA can readily inform its membership, the association has limited influence with non-members. The Town of Winchester Town Lakes Committee is currently having ongoing discussions regarding contracting the NLDC to conduct educational initiatives and monitoring. The Town Lakes Committee has been highly involved the Winchester Lakes Management Planning Project, and following the completing of this project, the committee will be looking to initiate new, smaller projects to help the Winchester lakes. The Town Lakes Committee can also host speakers at public events and publish newspaper and newsletter articles in an effort to maximize outreach to Winchester lakes' users.

Action Steps:

1. See description above.

Management Goal 4: Prevent New Aquatic Invasive Species Introductions to Birch and Tamarack Lake

Management Action: Continue volunteer aquatic invasive species monitoring using the shoreline monitors.

Timeframe: Continuation of current effort.

Facilitator: BLA Board of Directors and interested/available Tamarack Lake stakeholders

Description: As of this writing, four non-native, invasive species have been documented in Birch Lake: the rusty crayfish, banded mystery snail, Chinese mystery snail, and aquatic forget-me-not. No non-native species have been documented to date in Tamarack Lake. As is discussed in the Other Aquatic Invasive Species in the Town of Winchester Lakes section (section 3.5), in high numbers rusty crayfish have the capacity to reduce aquatic plant abundance while the non-native snails have been shown to displace native snail species. Data on Birch Lake's non-native crayfish and snail populations are not available, so it is not known to what extent these species may be adversely affecting Birch Lake's ecology. The studies completed in 2016 indicate that Birch Lake's native aquatic plant community is very healthy, and the crayfish population may be having limited impacts on the lake's plants. While aquatic forget-me-not was not documented by Onterra along shoreland areas of Birch Lake in 2016, NLDC staff and several BLA volunteers observed this plant in 2017.

The BLA and Tamarack Lake stakeholders understand that it important to prevent future introductions of non-native species such as Eurasian watermilfoil and curly-leaf pondweed. Nearby waterbodies such as Harris Lake and the Manitowish Chain of Lakes contain populations of curly-leaf pondweed, while Presque Isle Lake contains a population of Eurasian watermilfoil. In lakes without Eurasian watermilfoil and curly-leaf pondweed, early detection of these can often lead to successful control, and in instances with small infestations, possibly even eradication. Currently, Birch and Tamarack lakes volunteers have received aquatic invasive species identification and monitoring training and perform shoreline surveys in which volunteers are responsible for periodically monitoring specific areas of the lake. This methodology allows the entire lake to be monitored for the presence of non-native species. In addition to volunteer monitoring, NLDC staff completes AIS surveys on Birch and Tamarack lakes two times per year.

Action Steps:

1. Birch and Tamarack lakes volunteers updated their identification and monitoring skills by attending training sessions provided by the NLDC (877.543.2085).

2. Trained volunteers recruit and train additional association members.
3. Complete monitoring surveys following protocols.

Management Action: Install aquatic invasive species (AIS) signage at Tamarack/Rainbow lakes public carry-in access location.

Timeframe: Initiate 2018

Facilitator: Interested/available Tamarack Lake stakeholders

Description: Tamarack Lake contains a carry-in public access owned by the Town of Winchester located on the northern side of the lake where County Hwy W crosses Rainbow Creek. At present, this public access location does not contain an AIS awareness sign to inform lake users on AIS prevention. The WDNR is currently offering these signs, posts, and hardware free of charge. Tamarack Lake Planning Committee members indicated they would have to have continued discussion with Tamarack Lake stakeholders to determine if they would like AIS signage posted at this carry-in access point. Tamarack Lake stakeholders should also work with the Rainbow Lake Association (RLA) as Rainbow Lake can also be accessed by this carry-in location. To request an AIS boat landing sign, Tamarack Lake stakeholders and the RLA should contact Tim Campbell (timothy.campbell@wisconsin.gov – 608.26.3531), WDNR AIS Education Specialist, to request a sign for the Tamarack/Rainbow lakes carry-in access.

Action Steps:

1. Please see above description.

Management Action: Initiate aquatic invasive species rapid response plan upon discovery of new infestation.

Timeframe: Initiate upon invasive species discovery.

Facilitator: Birch Lake: BLA Board of Directors ; Tamarack Lake: interested/available stakeholders

Description: In the event that an aquatic invasive species such as Eurasian watermilfoil is located by the trained volunteers in Birch or Tamarack lake, the areas would be marked using GPS and the BLA or Tamarack Lake stakeholders should contact resource managers (NLDC) immediately. The areas marked by volunteers would serve as focus areas for professional ecologists, and these areas would be surveyed by professionals during the plant's peak growth phase and the results would be used to develop potential control strategies.

Action Steps:

1. BLA and/or Tamarack Lake stakeholders contact NLDC (877.543.2085) upon discovery of new invasive species in Birch or Tamarack lake.

Management Action: Continue Clean Boats Clean Waters watercraft inspections at Birch Lake's public access location.

Timeframe: Continuation of current effort

Facilitator: BLA Board of Directors

Description: The BLA has been periodically conducting watercraft inspections using volunteers at the public boat landing since 2007 through the Clean Boats Clean Waters (CBCW) program. In-kind time for watercraft inspections at Birch Lake is being provided through the WDNR grants as part of the four-year lake management planning project (2015-2018). However, the BLA would like to continue watercraft inspections beyond 2018. The intent of the boat inspections would not only be to prevent additional exotic species from entering the lake through the public access point, but also to prevent the infestation of other waterways with exotic species that originated in Birch Lake. The goal would be to monitor the during the busiest times (e.g. holiday weekends) in order to maximize contact with lake users, spreading the word about the negative impacts of AIS on our lakes and educating people about how they are the primary vector of their spread.

The BLA would like to continue watercraft inspections using volunteers. Often, it is difficult for lake groups to recruit and maintain a volunteer base to oversee CBCW inspections throughout the summer months. Recruitment outside of the BLA may be necessary in order to have sufficient coverage of the Birch Lake public access. Education efforts outside of the lake community help to not only raise awareness about the threat of AIS, but also potentially recruit new volunteers to participate in activities such as CBCW.

Members of the BLA, as well as other volunteers, will need to be trained on CBCW protocols in order to participate in public boat landing inspections. Fully understanding the importance of CBCW inspections, paid watercraft inspectors may be sought to ensure monitoring occurs at the public boat landing. These paid inspectors may be purchased alone or in conjunction with volunteers through the BLA or in the community.

Action Steps:

1. Members of the BLA periodically attend CBCW training sessions through the WDNR to update their skills to current standards.
2. Training of additional volunteers completed by those previously trained.
3. Begin inspections during high-use weekends.
4. Report results to WDNR and BLA.
5. Promote enlistment and training of new volunteers to keep program fresh.

Management Goal 5: Enhance the fishery of Birch and Tamarack Lakes

Management Action: Continue work with WDNR fisheries managers to enhance the fishery of Birch and Tamarack lakes.

Timeframe: Continuation of current effort

Facilitator: BLA Board of Directors and interested/available Tamarack Lake stakeholders

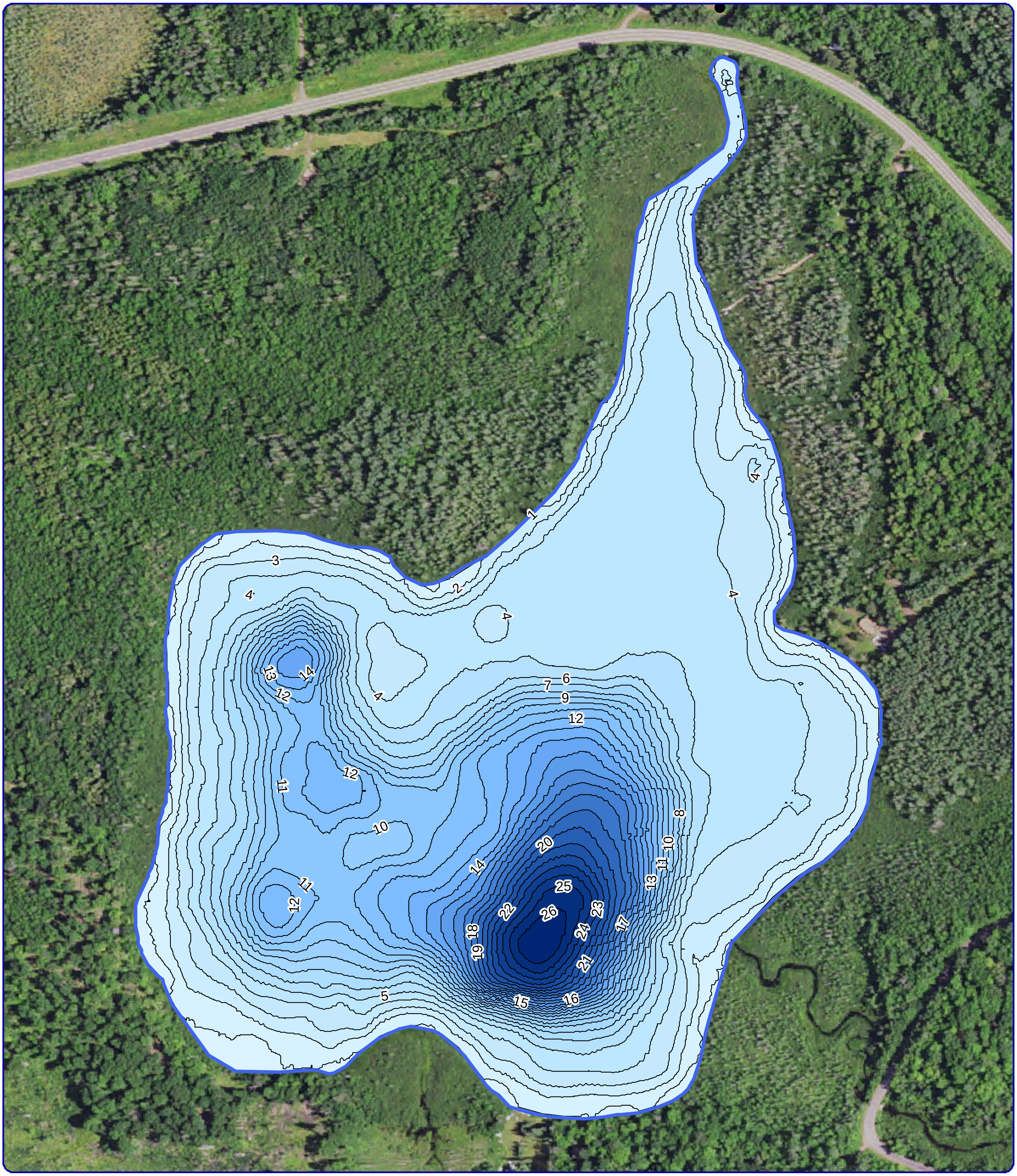
Description: In the 2016 stakeholder survey, fishing was ranked second behind relaxing/entertaining by respondents when asked to rank their top three activities that are important reasons for owning or renting their property on or near Birch Lake (Appendix B, Question 17). Respondents indicated that walleye, muskellunge, and smallmouth bass were the top three most sought-after fish by anglers in Birch Lake, and 79% of respondents rated the current fishing on Birch Lake as either fair or good (Appendix B, Questions 11 and 12). Approximately 44% of respondents indicated the quality of fishing has gotten somewhat worse since they began fishing on Birch Lake, while 39% indicated the quality of fishing has remained the same (Appendix B, Question 13).

Birch Lake is currently listed as an Area of Special Natural Resource Interest (ASNRI) for harboring naturally reproducing populations of both walleye and muskellunge, while Tamarack Lake has a ASNRI designation for a naturally reproducing muskellunge population. The BLA and Tamarack Lake stakeholders understand that a multitude of factors such as changes in habitat, water levels, and fishing pressure affect fish communities, and the BLA and Tamarack Lake stakeholders would like to take an active role in maintaining a healthy fishery to ensure Birch and Tamarack lakes remain high-quality fishing lakes for future generations.

Both Birch and Tamarack lake are currently overseen by WDNR fisheries biologist Hadley Boehm (715.356.5211). In an effort to remain informed on studies pertaining to fisheries in these lakes, the BLA Board of Directors and interested/available Tamarack Lake stakeholders should contact Hadley at least once per year (perhaps during the winter months when field work is not occurring) for a brief summary of activities. In addition, the BLA can discuss management options for maintaining and enhancing the lakes' fishery, which may include changes in angling regulations and/or habitat enhancements.

Action Steps:

See description above.



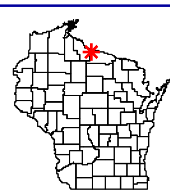
N
W E
S

340
Feet

Onterra LLC
Lake Management Planning

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

Sources:
Orthophotography: NAIP 2015
Bathymetric Survey: Onterra 2016
Map Date: March 6, 2017
Filename: Map1_Tamarack_Location.mxd


Project Location in Wisconsin

Legend

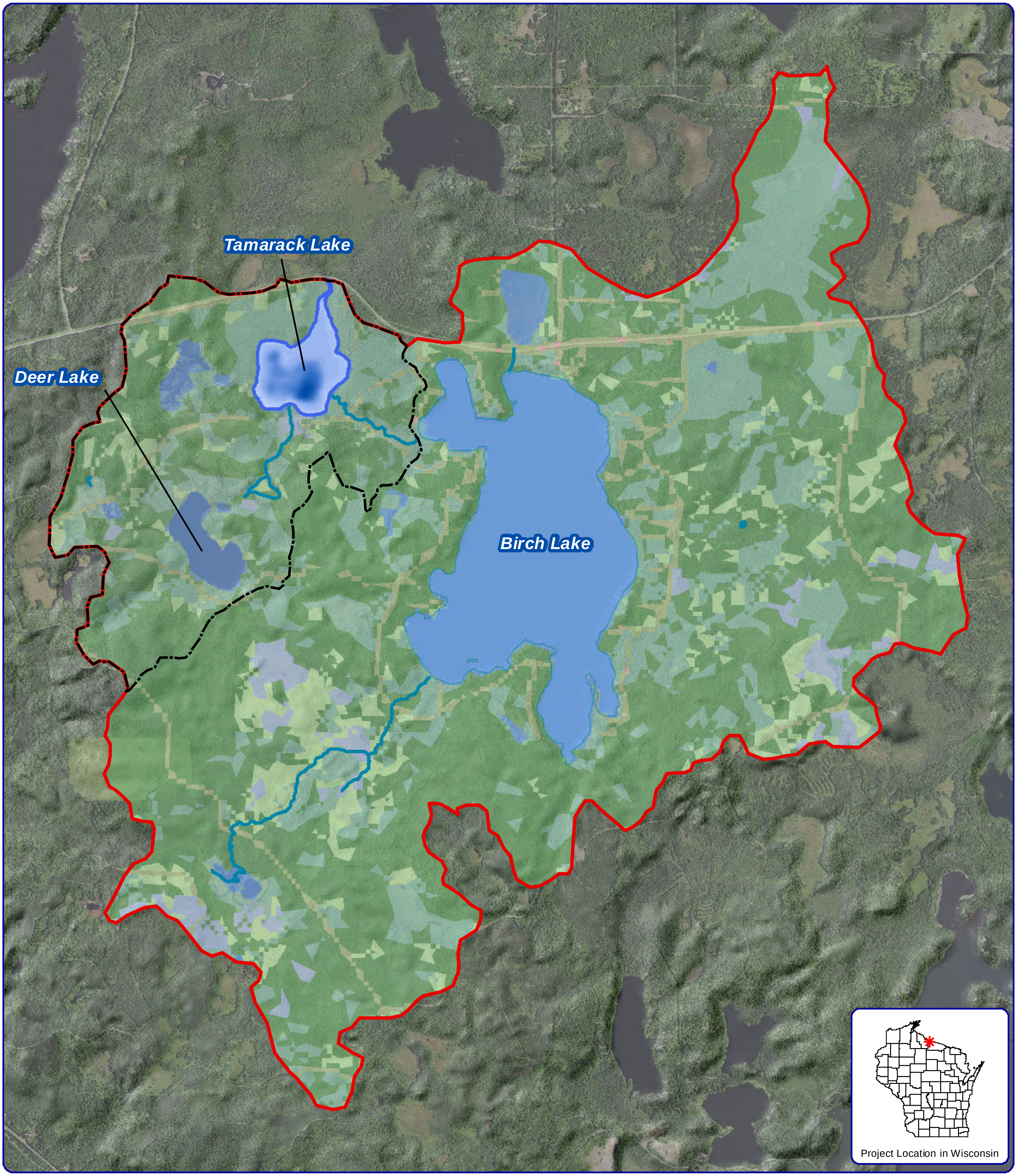
Tamarack Lake ~66 acres
WDNR Definition

Tamarack Lake - Map 1

Town of Winchester

Vilas County, Wisconsin

Project Location & Lake Boundaries



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2,600
Feet

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

Sources:
Hydro: WDNR
Bathymetry: Onterra 2016
Orthophotography: NAIP 2015
Land Cover: NLCD 2011
Watershed Boundaries: Onterra 2016
Map Date: March 6, 2017
Filename: Map2_Tamarack_WS.mxd

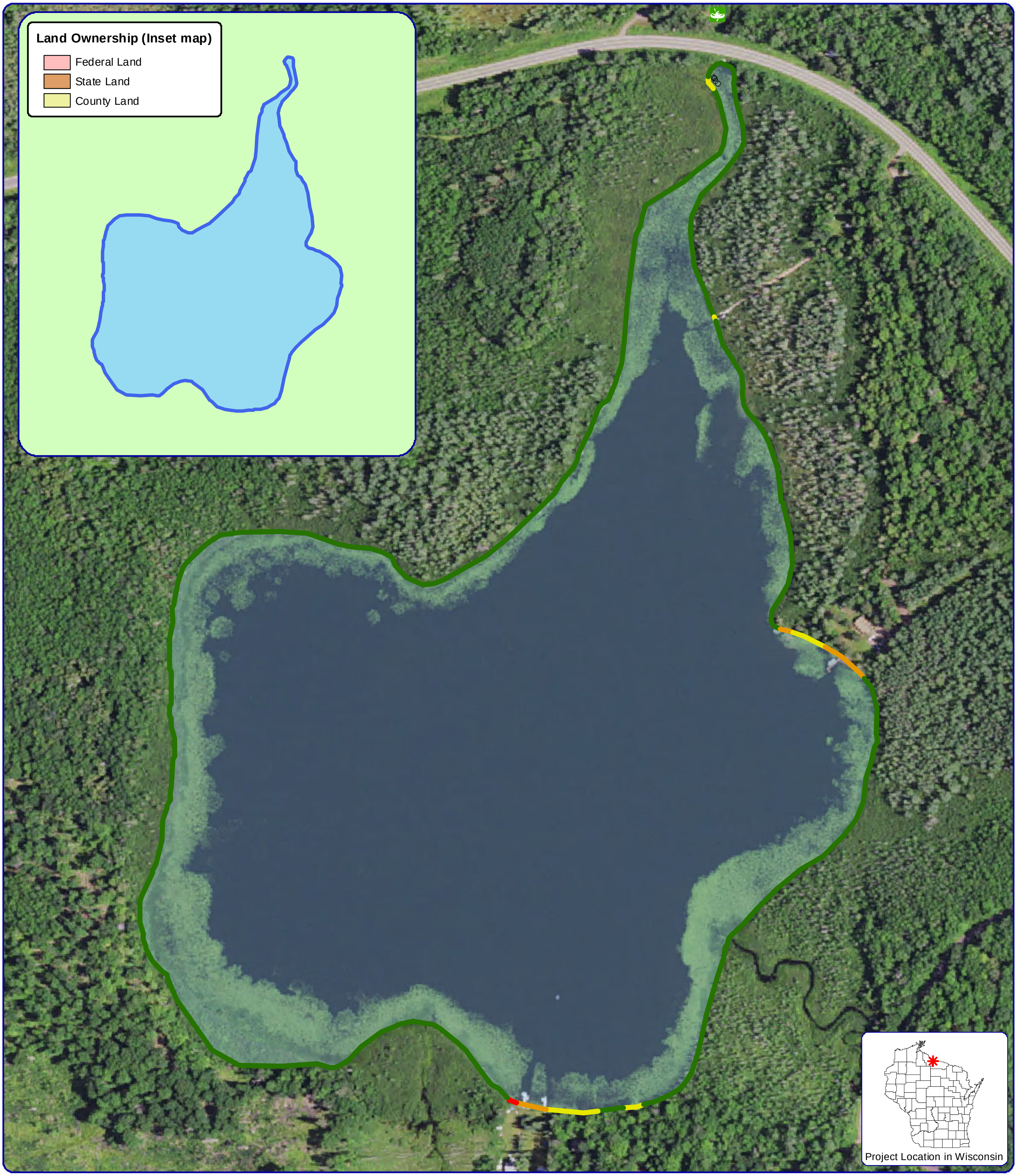
Legend

- Tamarack Lake Entire Watershed
- Tamarack Lake Direct Watershed
- Forest
- Forested Wetlands
- Pasture/Grass
- Rural Open Space
- Rural Residential
- Non-Forested Wetlands
- Open Water
- River/Stream

Tamarack Lake - Map 2

Town of Winchester
Vilas County, Wisconsin

Watershed Boundaries & Land Cover Types



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Feet

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Sources:
Roads and Hyrdo: WDNR
Shoreland Condition: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map3_Tamarack_SA_2016.mxd

Legend

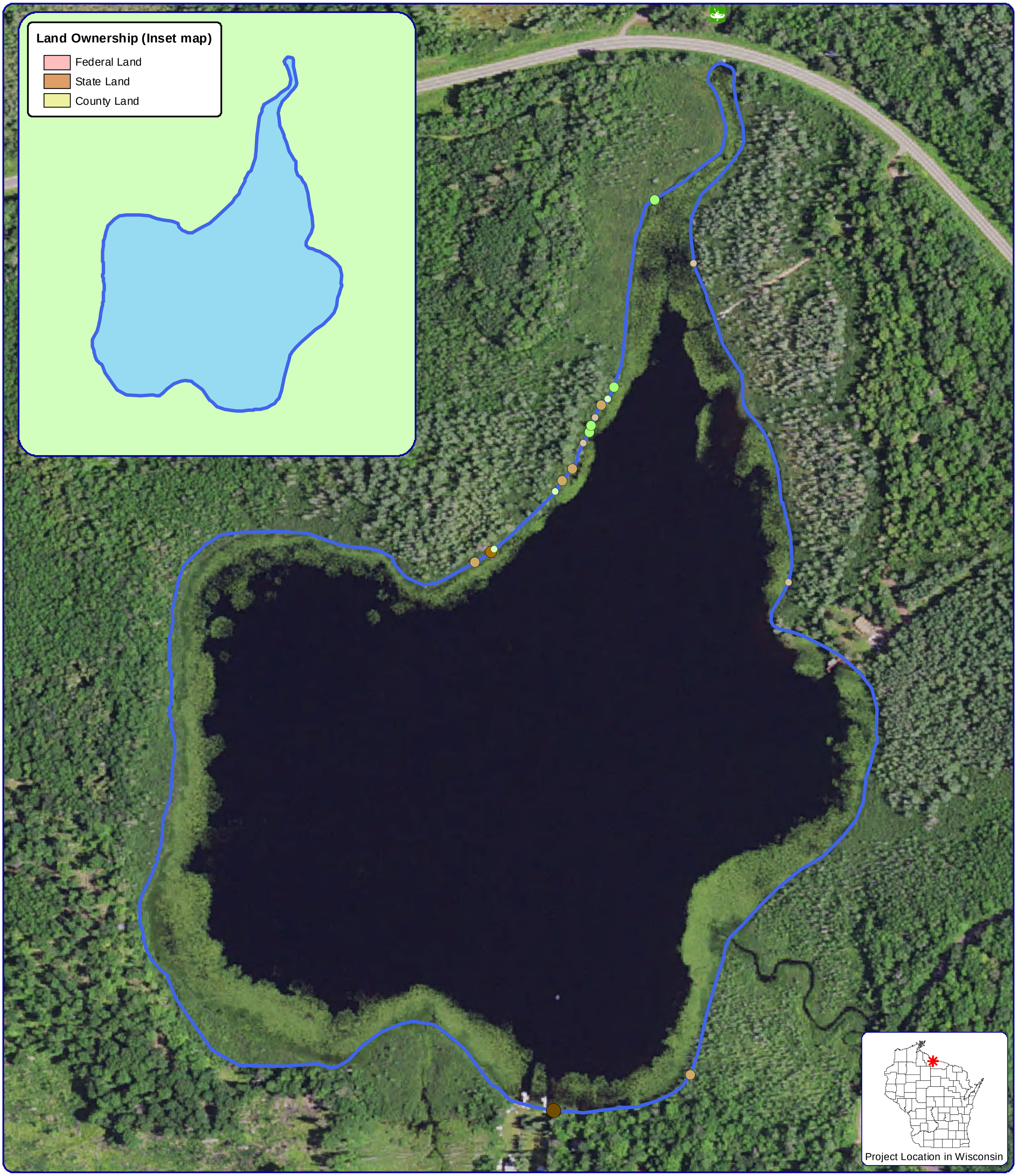
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized

Seawall
Masonry/Wood/Metal
Rip-Rap

Tamarack Lake - Map 3

Town of Winchester
Vilas County, Wisconsin

2016 Shoreline Condition



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W E
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350
Feet

Onterra LLC
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De Pere, WI 54115
920.338.8860
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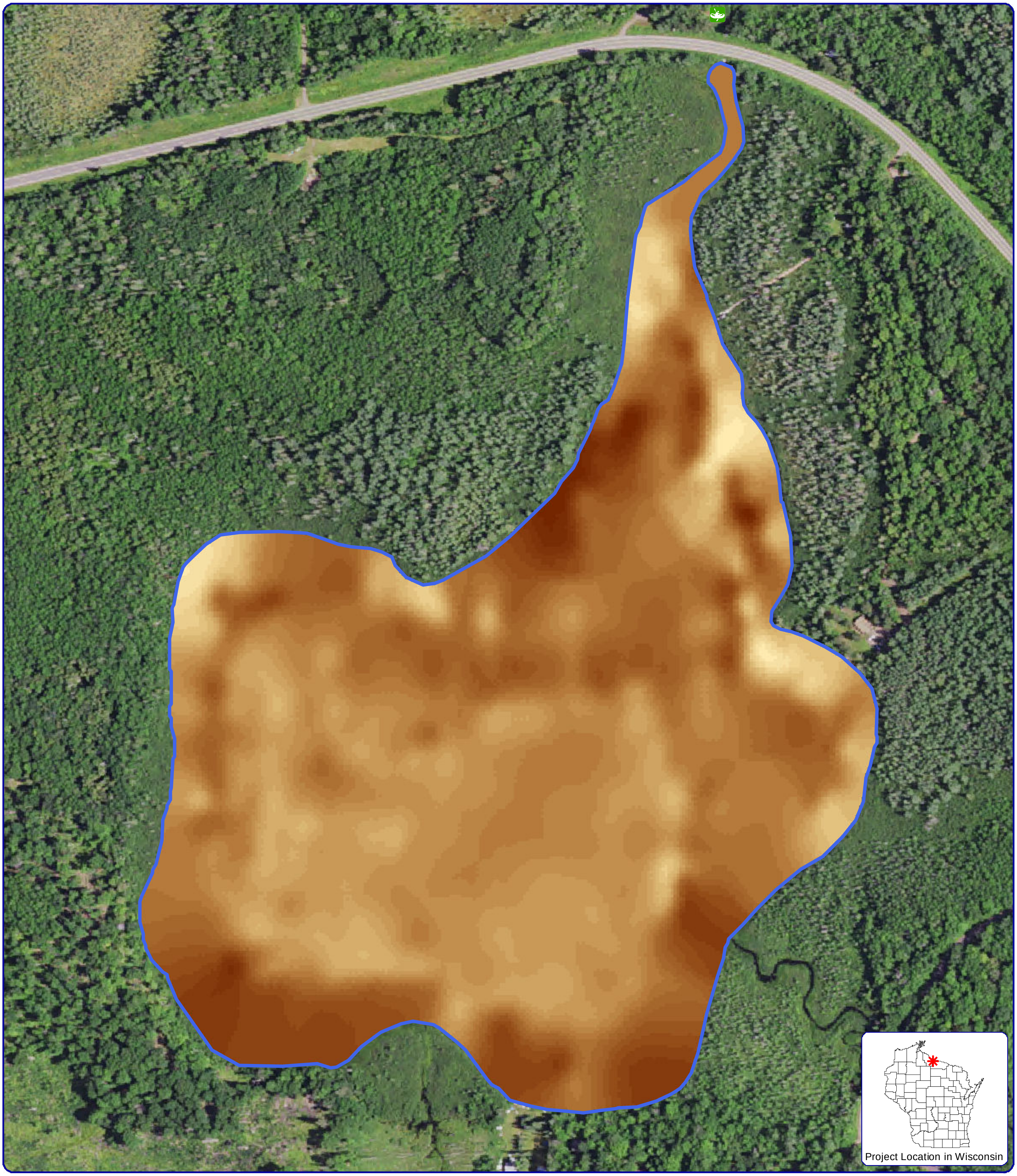
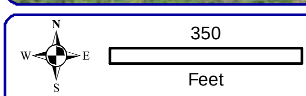
Sources:
Roads and Hyrdo: WDNR
Shoreland Condition: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map4_Tamarack_CWH_2016.mxd

Legend

2-8 Inch Pieces	8+ Inch Pieces	Cluster of Pieces
No Branches	No Branches	No Branches (none)
Minimal Branches	Minimal Branches	Minimal Branches (none)
Moderate Branches	Moderate Branches	Moderate Branches (none)
Full Canopy	Full Canopy	Full Canopy (none)

Tamarack Lake - Map 4
Town of Winchester
Vilas County, Wisconsin
2016 Coarse Woody Habitat





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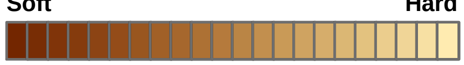
Sources:
Roads and Hyrdo: WDNR
Acoustic Survey: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map5_Tamarack_SubHard_2016.mxd

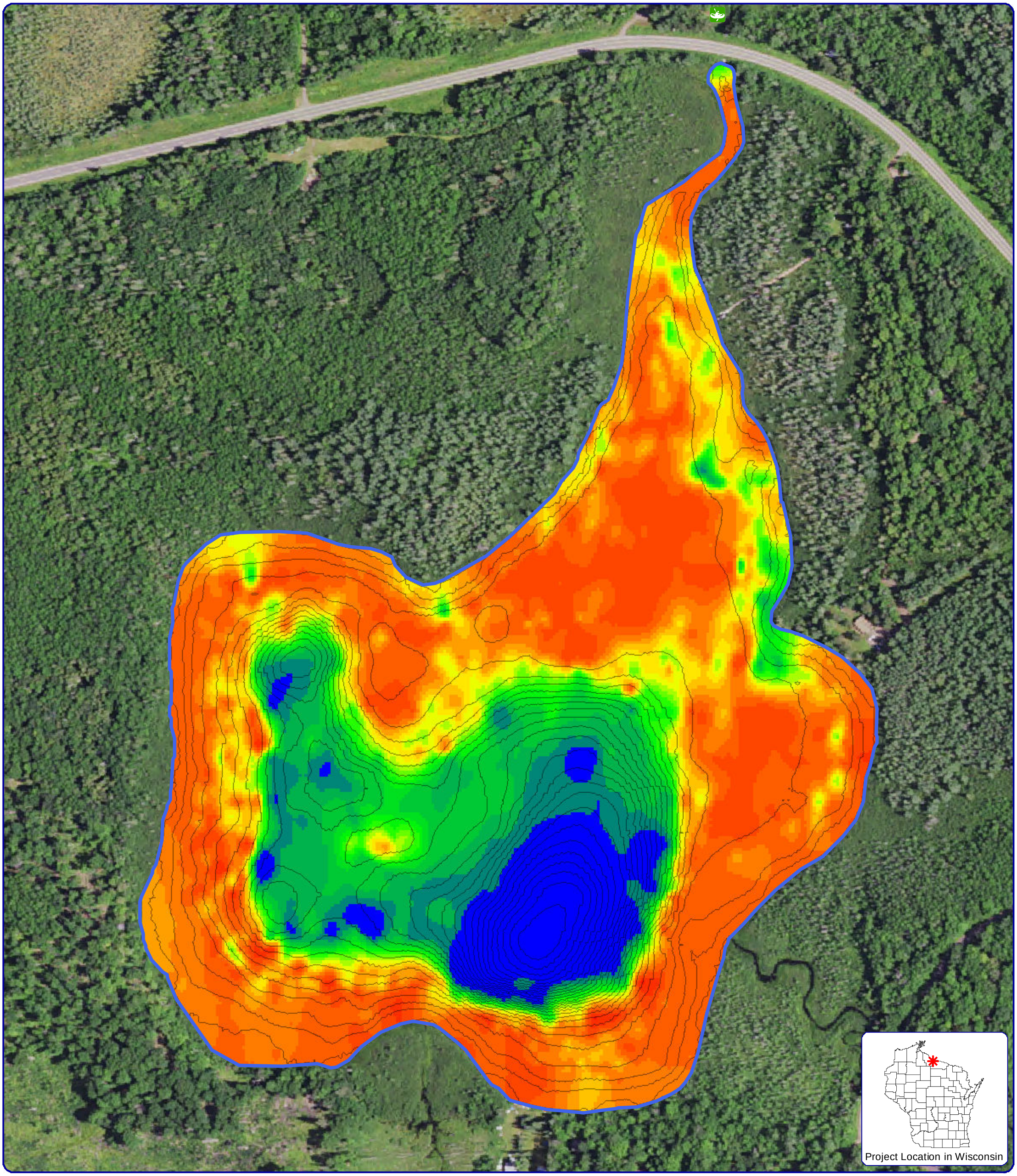
Legend



Tamarack Lake - Map 5

Town of Winchester
Vilas County, Wisconsin

2016 Acoustic Survey: Substrate Hardness



350
Feet

Legend

0% 50% 100%

Aquatic Plant Bio-volume (%)

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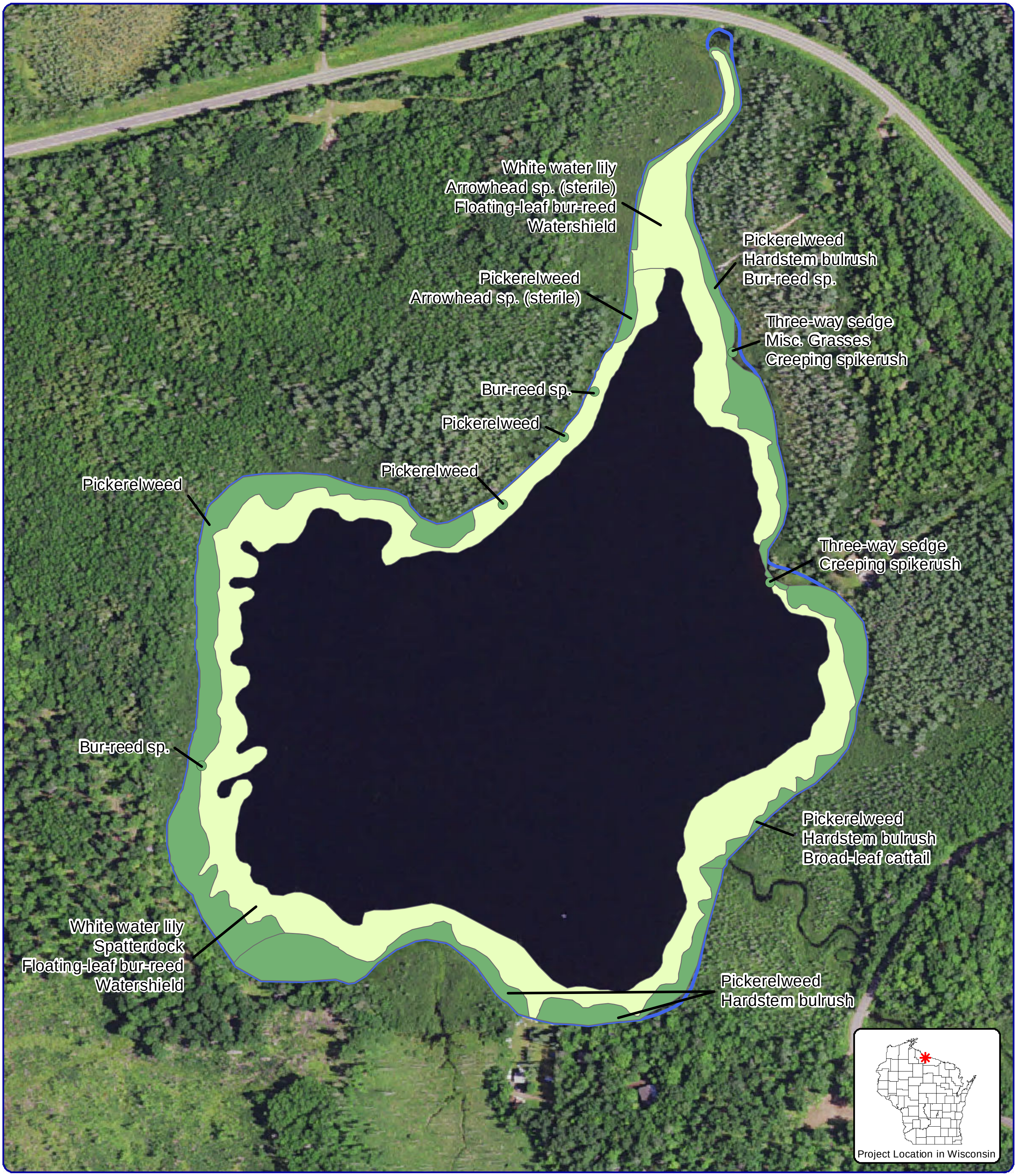
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hyrdo: WDNR
Acoustic Survey: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map6_Tamarack_BioVol_2016.mxd

Tamarack Lake - Map 6
Town of Winchester
Vilas County, Wisconsin

2016 Acoustic Survey: Aquatic Plant Bio-Volume



N
W E
S
350
Feet

Legend

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

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

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

Sources:
Roads and Hyrdo: WDNR
Aquatic Plants: Onterra, 2016
Map Date: October 20, 2016
Filename: Map7_Tamarack_Comm_2016.mxd

Tamarack Lake - Map 7

Town of Winchester

Vilas County, Wisconsin

2016 Emergent & Floating-leaf Plant Communities

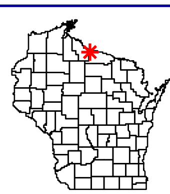
N
W E
S

340
Feet

Onterra LLC
Lake Management Planning

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

Sources:
Orthophotography: NAIP 2015
Map Date: October 5, 2017
Filename: Map8_Tamarack_NavHazards.mxd



Project Location in Wisconsin

Legend

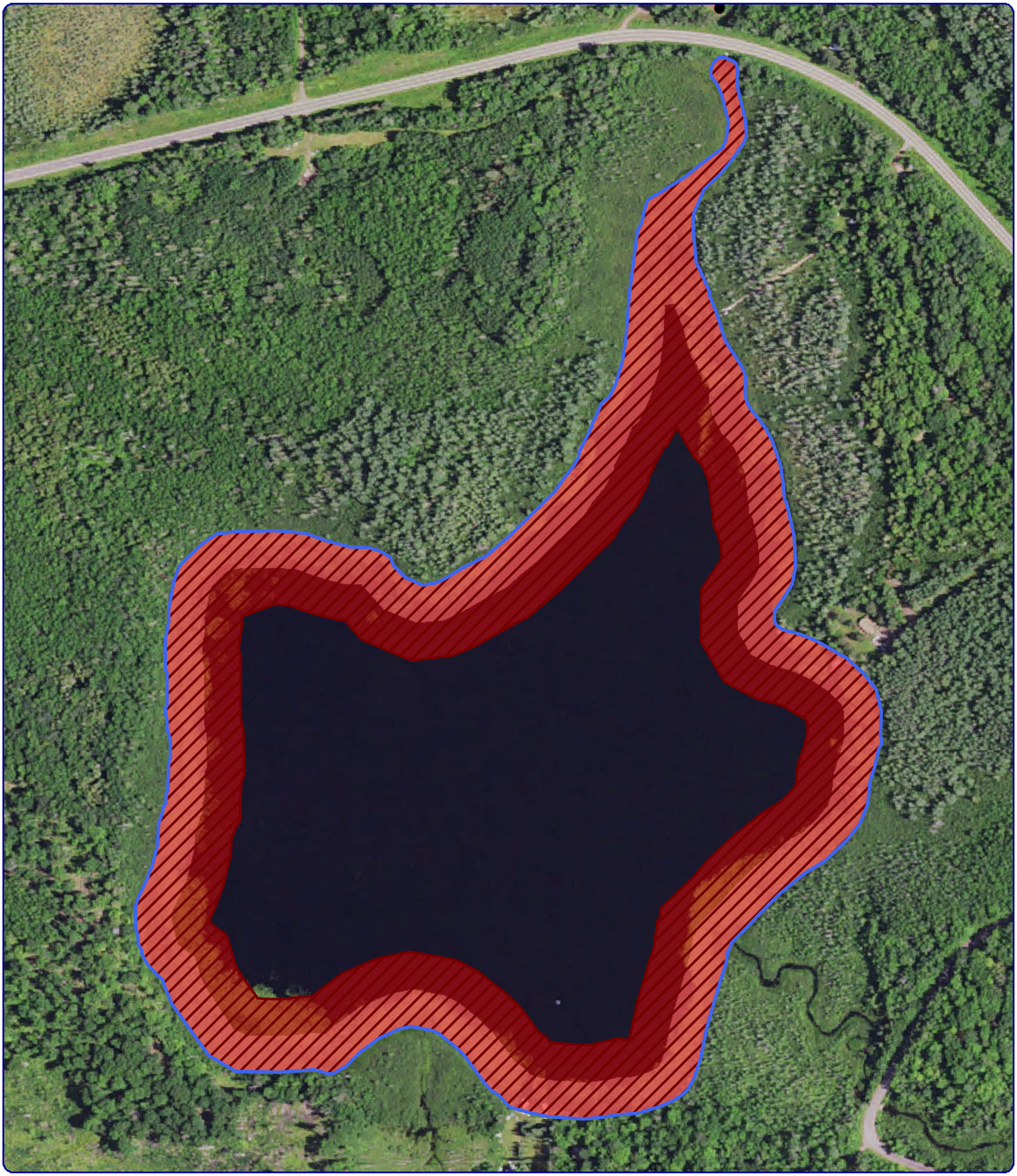
♦ Proposed Regulatory Danger Marker Location

Tamarack Lake - Map 8

Town of Winchester

Vilas County, Wisconsin

Proposed Non-Regulatory Danger Marker Placement Location



340
Feet

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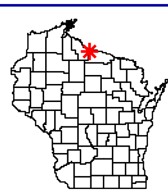
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP 2015
Map Date: October 5, 2017
Filename: Map9_Tamarack_WatercraftRegs.mxd


Project Location in Wisconsin

Legend

Boating
Slow/No Wake Area (100 feet)

Personal Watercraft
Slow/No Wake Area (200 feet)

Tamarack Lake - Map 9

Town of Winchester
Vilas County, Wisconsin

Watercraft Regulation Areas