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

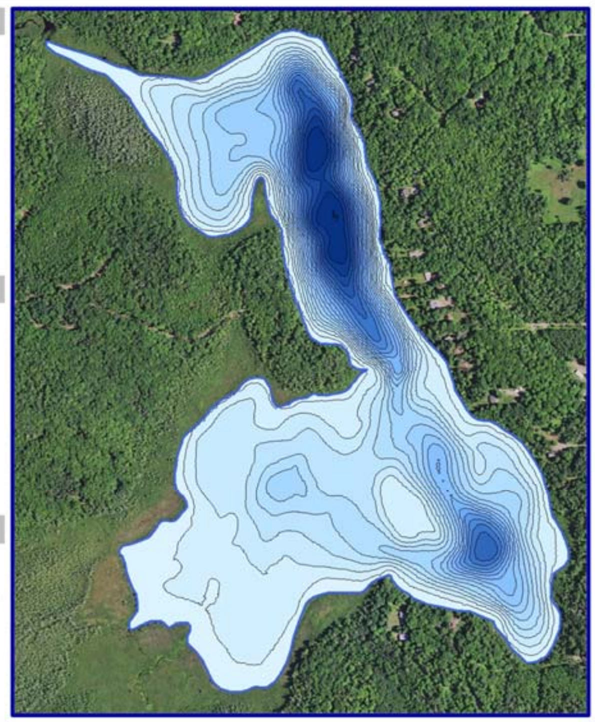
8.5 Rainbow Lake

An Introduction to Rainbow Lake

Rainbow Lake, Vilas County, is a 148-acre deep lowland, brown-water, meso-eutrophic drainage lake with a maximum depth of 39 feet and a mean depth of 9 feet (Rainbow Lake – Map 1). Its surficial watershed encompasses approximately 6,737 acres within the Flambeau River Watershed and is comprised mainly of intact forests and wetlands. Rainbow Lake is fed by upstream Tamarack Lake through Rainbow Creek from the south, and water leaves Rainbow Lake through Rainbow Creek to the north and flows into downstream North Turtle Lake. In 2016, 45 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 Rainbow Lake in 2016, and no other non-native species have been documented within the lake.

Lake at a Glance - Rainbow Lake

Morphology	
LakeType	Deep Lowland Drainage
Surface Area (Acres)	148
Max Depth (feet)	39
Mean Depth (feet)	9
Perimeter (Miles)	3.5
Shoreline Complexity	4.0
Watershed Area (Acres)	6,737
Watershed to Lake Area Ratio	43:1
Water Quality	
Trophic State	Meso-eutrophic
Limiting Nutrient	Phosphorus
Avg Summer P (μg/L)	24.4
Avg Summer Chl-α (μg/L)	10.3
Avg Summer Secchi Depth (ft)	6.6
Summer pH	7.5
Alkalinity (mg/L as $CaCO_3$)	30.1
Vegetation	
Number of Native Species	45
NHI-Listed Species	Vasey's pondweed (*Potamogeton vaseyi*)
Exotic Species	None
Average Conservatism	7.2
Floristic Quality	40.7
Simpson's Diversity (1-D)	0.93



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

8.5.1 Rainbow 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 33 Rainbow Lake riparian property owners. Fourteen (42%) of these 33 surveys were completed and returned. Given the relatively low response rate, the results of the stakeholder survey cannot be interpreted as being statistically representative of the population sampled. At best, the results may indicate possible trends and opinions about the stakeholder perceptions of Rainbow Lake but cannot be stated with statistical confidence. The full survey and results can be found in Appendix B. When asked about Rainbow Lake's current water quality 100% of the respondents indicated the water quality is *excellent* or *good* (Figure 8.5.1-1). When asked how water quality has changed in Rainbow Lake since they first visited the lake, 92% of respondents indicated water quality has *remained the same* and 8% indicated they were *unsure* (Figure 8.5.1-1).

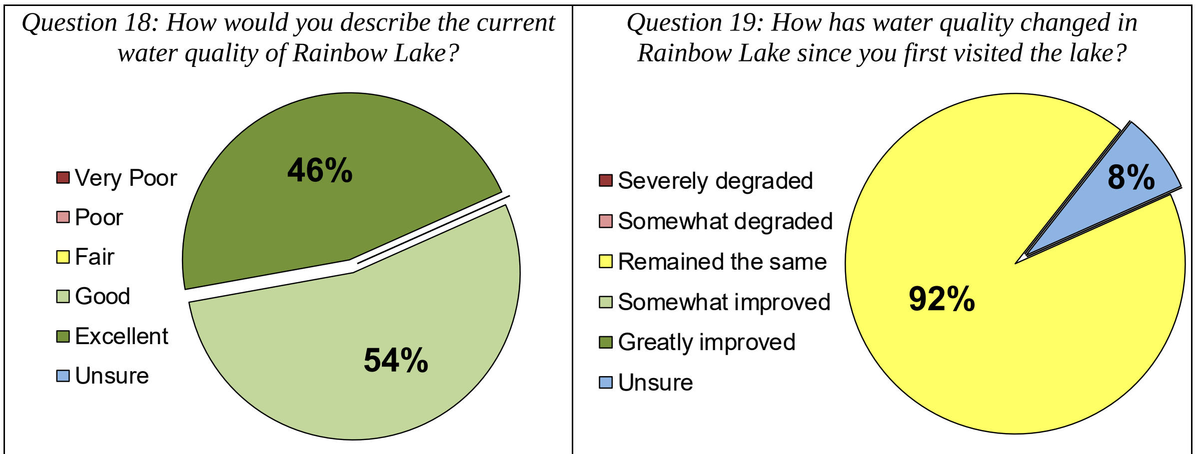


Figure 8.5.1-1. Rainbow Lake stakeholder survey responses regarding the lake's current and historical water quality. Created using responses from 14 (42%) respondents of 33 surveys distributed.

The total phosphorus data collected from Rainbow Lake in 2016 represent the first time this parameter has been measured from the lake. The average summer total phosphorus concentration measured in Rainbow Lake in 2016 was 24.4 µg/L which falls into the *good* category for deep lowland drainage lakes in Wisconsin (Figure 8.5.1-2). This average summer total phosphorus concentration is relatively similar to 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). As is discussed further within the Rainbow Lake Watershed Assessment Section (Section 8.5.2), the total phosphorus concentrations measured in Rainbow Lake align with predicted values generated based upon the lake's watershed size and land cover composition. While a determination of how phosphorus concentrations have changed over time cannot be made given the lack of historical data, given the minimal human development within the watershed it is likely that phosphorus concentrations have not changed significantly in Rainbow Lake since European settlement.

One historical chlorophyll-*a* concentration measurement is available from Rainbow Lake from August of 1984 with a concentration of 6.0 µg/L. In 2016, chlorophyll-*a* concentrations in Rainbow Lake ranged from 0.92 µg/L in late-October to 19.2 µg/L in late-July. The average summer chlorophyll-*a* concentration in 2016 was 11.8 µg/L, falling on the line between *good* and *fair* for Wisconsin's deep lowland drainage lakes (Figure 8.5.1-2). Rainbow Lake's 2016 summer chlorophyll-*a* concentration is higher than the median concentration for other deep lowland drainage lakes in Wisconsin (7.0 µg/L) and the median concentration for all lakes within the NLF ecoregion (5.6 µg/L).

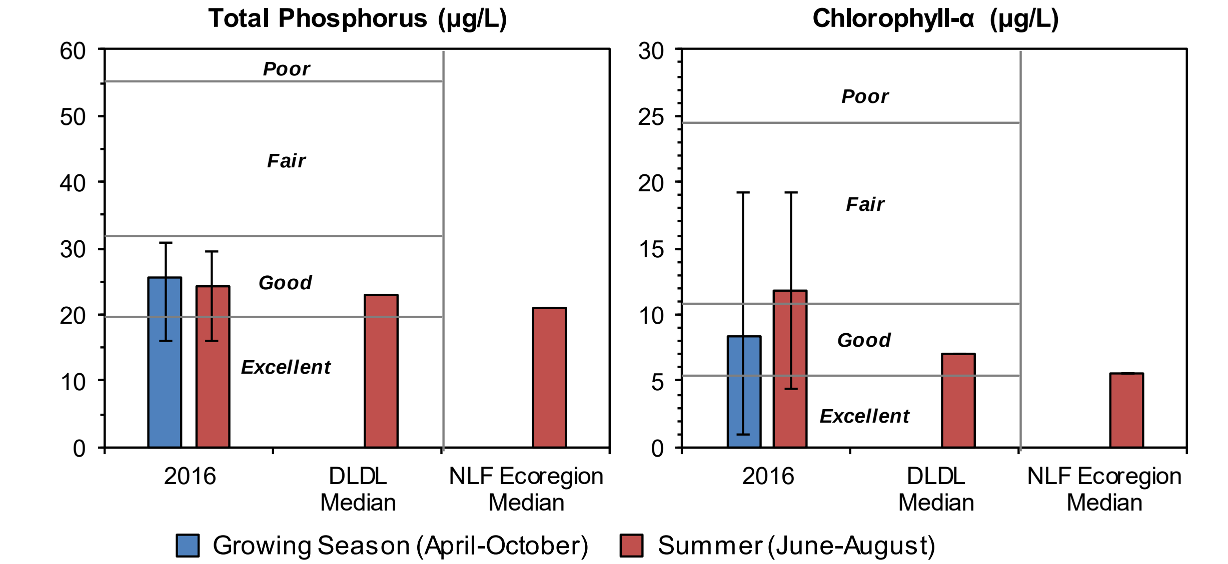


Figure 8.5.1-2. Rainbow Lake 2016 average growing season and summer total phosphorus and chlorophyll-α concentrations compared to median values for Wisconsin deep lowland drainage lakes (DLDL) and Northern Lakes and Forests (NLF) ecoregion lakes. Water Quality Index values adapted from WDNR PUB WT-913. Error bars represent maximum and minimum values.

Secchi disk transparency data from Birch Lake are available annually from 2005-2016 with the exception of 2008 (Figure 8.5.1-3). These data indicate that water clarity in Rainbow Lake can be variable from year to year, but the weighted summer average Secchi disk depth is 6.6 feet, falling into the *good* category for Wisconsin's deep lowland drainage lakes. Rainbow Lake's average summer Secchi disk depth falls lightly below the median values for deep lowland drainage lakes in Wisconsin and for all lake types within the NLF ecoregion. Water clarity in Rainbow Lake is lower than expected based upon the low chlorophyll-*a* concentrations, and is an indication that a factor other than phytoplankton is influencing water clarity.

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 Rainbow Lake in 2016 indicating minimal amounts of suspended material within the water. While suspended particles are minimal in Rainbow 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 Rainbow Lake in 2016 averaged 70 SU (standard units), indicating the lake's water is *tea-colored*. The high concentrations of dissolved organic acids in the lake reduce the water's clarity. It is important to note that the tea-colored water in Rainbow Lake is natural, and is not an indication of degraded conditions.

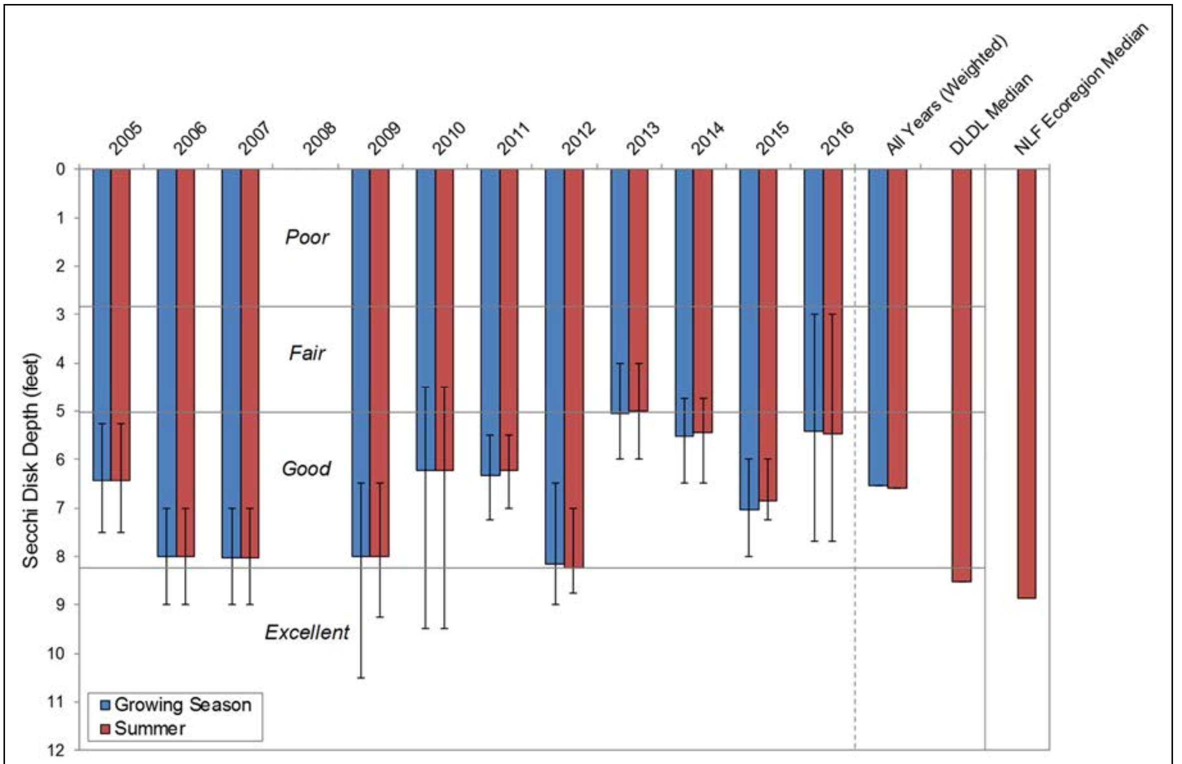


Figure 8.3.1-3. Rainbow Lake average annual Secchi disk depths and median Secchi disk depths for state-wide deep lowland drainage lakes (DLDL) and Northern Lakes and Forests (NLF) ecoregion lakes. Water Quality Index values adapted from WDNR PUB WT-913. Error bars represent maximum and minimum values.

The Secchi disk transparency data indicate that water clarity since 2013 has been lower when compared to previous measurements going back to 2005. The average growing season Secchi disk depth from 2005-2012 was 7.3 feet compared to an average of 5.8 feet from 2013-2016. When water clarity declines, typically lake managers first look to see if chlorophyll-*a* concentrations have increased. Unfortunately, neither chlorophyll-*a* nor total phosphorus concentrations are available over this time period. However, Harris, Hiawatha, and Birch lakes have all shown a similar a pattern of lower water clarity over this most recent period despite no measured increase in total phosphorus or chlorophyll-*a*. It is believed the recent decline in water clarity in these lakes and Rainbow Lake is the result of an increase in annual precipitation.

Precipitation data obtained from nearby Hurley, WI indicate that annual precipitation has been above average each year since 2013 (Figure 8.5.1-4). This increase in precipitation likely flushed a greater amount of dissolved organic compounds from coniferous forests and wetlands in Rainbow Lake's watershed into the lake, resulting in reduced water clarity. Given the large areas of coniferous wetlands in Rainbow Lake's watershed, it is to be expected that larger amounts of these dissolved compounds will be delivered to the lake during years with higher precipitation.

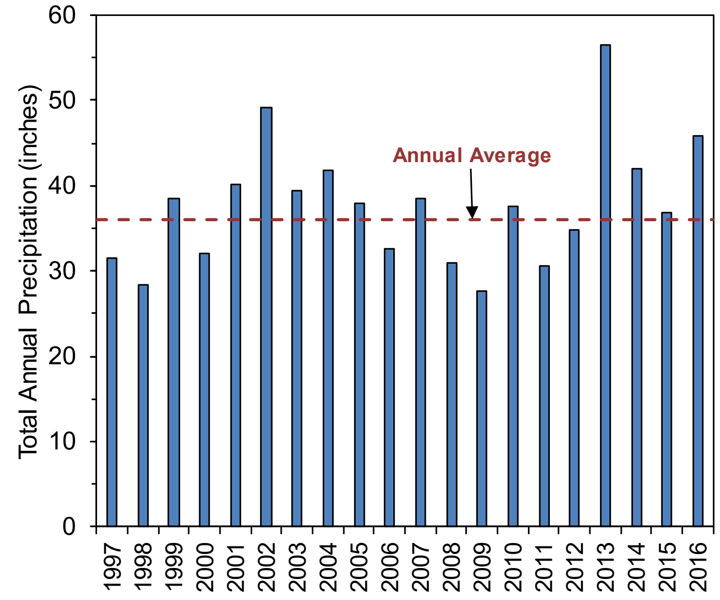


Figure 8.5.1-5. Total annual precipitation measured in Hurley, WI. Data obtained from Midwestern Regional Climate Center (2016).

To determine if internal nutrient loading (discussed in town-wide section of management plan) is a significant source of phosphorus in Rainbow 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 Rainbow Lake in 2016 and once in 2017 (Figure 8.3.1-6). Near-bottom total phosphorus concentrations increased over the course of the growing season from 52 µg/L in May to 226 µg/L in August. As is discussed in the Dissolved Oxygen subsection, Rainbow Lake maintained stratification over the course of the summer and an anoxic hypolimnion. This allowed phosphorus to be released from bottom sediments into the overlying water within the hypolimnion.

While the near-bottom total phosphorus concentrations measured in Rainbow Lake in 2016 indicate the internal release of phosphorus from bottom sediments is occurring during summer stratification, near-surface total phosphorus concentrations indicate the majority of this phosphorus remains within the hypolimnion and is not being mobilized to surface waters. Following fall mixing in October, there was a small increase in near-surface total phosphorus concentrations likely due to near-bottom phosphorus being mixed throughout the water column. While internal phosphorus loading occurs in Rainbow Lake, the lake's morphology prevents this phosphorus from being mixed to the surface during the growing season and it does not appear to be effecting phosphorus concentrations at the surface.

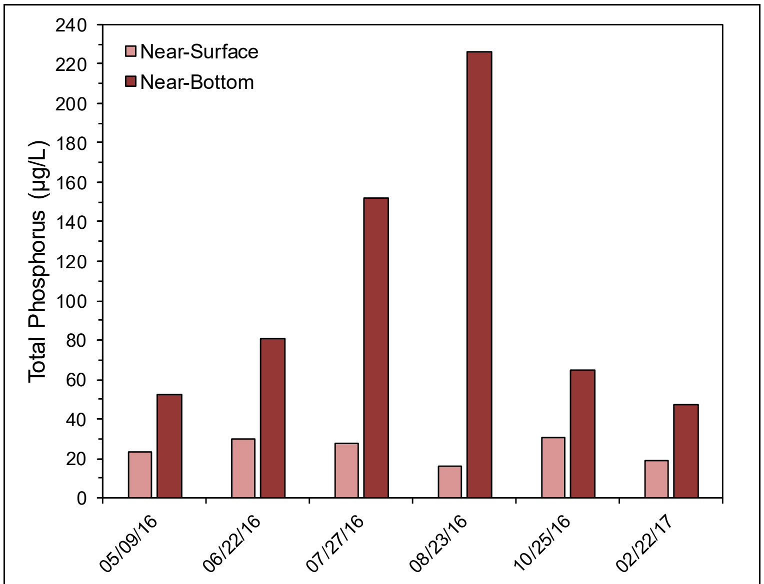


Figure 8.5.1-6. Rainbow Lake near-bottom total phosphorus concentrations and corresponding near-surface total phosphorus concentrations measured in 2016.

Rainbow Lake Trophic State

Figure 8.5.1-7 contains the Trophic State Index (TSI) values for Rainbow Lake calculated from the data collected in 2016 along with historical data. 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 Rainbow Lake indicate the lake is at present in a meso-eutrophic state. Rainbow 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.

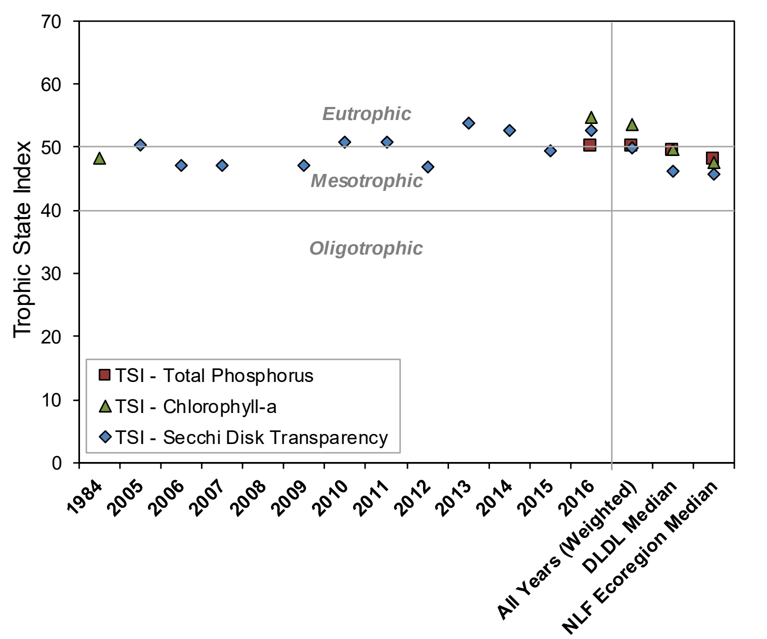


Figure 8.5.1-7. Rainbow Lake, statewide deep lowland drainage lakes (DLDL), and Northern Lakes and Forests (NLF) ecoregion lakes Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Rainbow 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 8.5.1-8. The temperature and dissolved oxygen data collected in 2016 indicate that the lake remained stratified throughout the summer and develops anoxia from 15.0 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. Dissolved oxygen collected under the ice in February 2017 indicated sufficient oxygen throughout most of the water column for aquatic life, indicating winter fish kills are likely not an issue for Rainbow Lake.

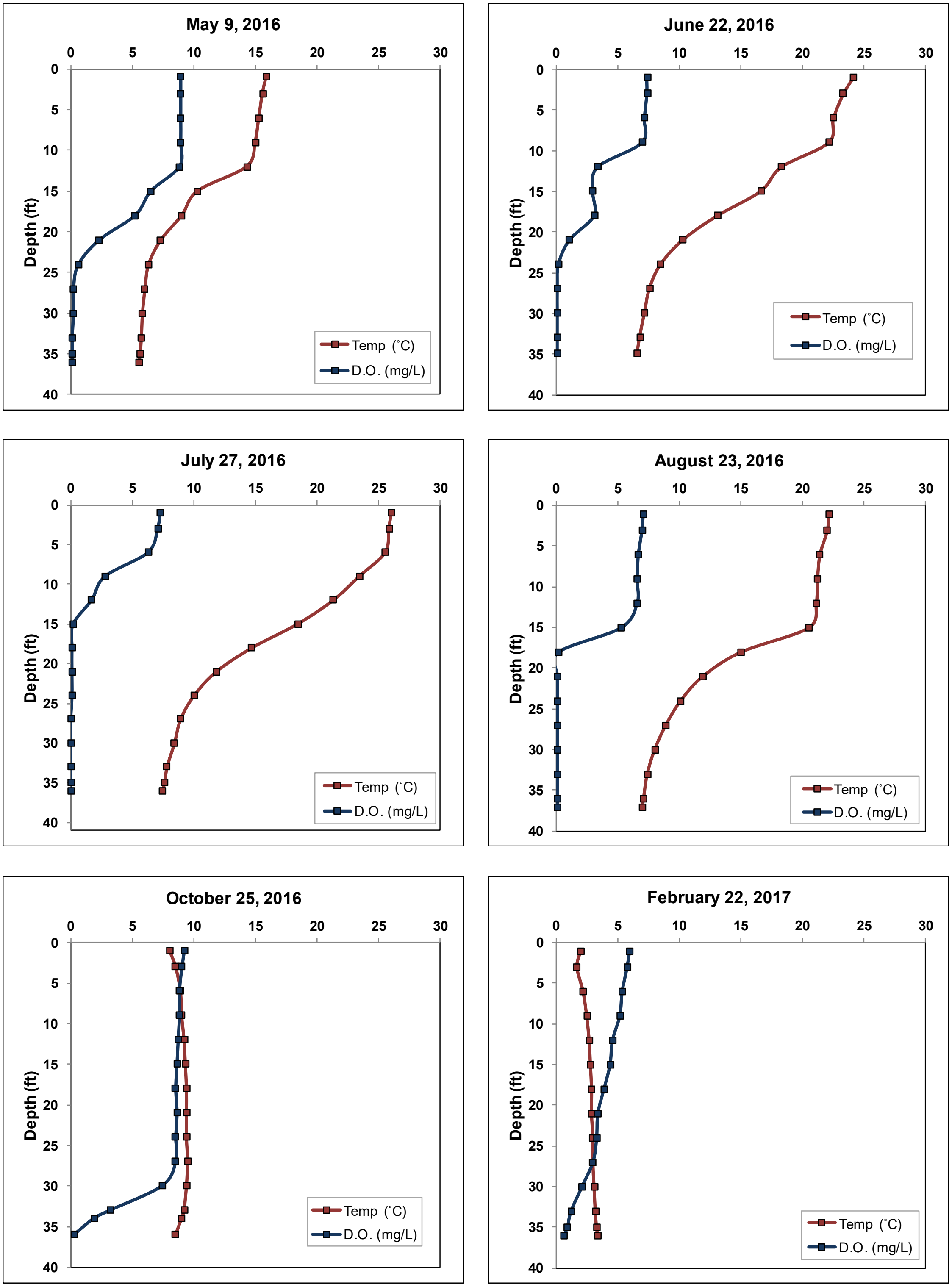


Figure 8.5.1-8. Rainbow Lake 2016/17 dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected from Rainbow Lake

The previous section is centered on parameters relating to Rainbow 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 Rainbow 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. Rainbow Lake's mid-summer surface water pH was measured at 7.5 in 2016. This value indicates Rainbow 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. Rainbow Lake's average alkalinity measured in 2016 was 30.1 mg/L as $CaCO_3$. This value falls within the expected range for northern Wisconsin lakes, and indicates that while Rainbow Lake is considered a softwater lake, it is not sensitive to fluctuations in pH from acid rain.

Water quality samples collected from Rainbow 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 Rainbow Lake's pH falls within this range. Rainbow Lake's calcium concentration in 2016 was 9.3 mg/L, indicating the lake has *very low susceptibility* to zebra mussel establishment. Plankton tows were completed by Onterra ecologists at three locations in Rainbow 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.

8.5.2 Rainbow Lake Watershed Assessment

Rainbow Lake's surficial watershed encompasses approximately 6,737 acres (Figure 8.5.2-1 and Rainbow Lake – Map 2) yielding a watershed to lake area ratio of 43:1. For modeling, the watershed was divided between the Tamarack Lake subwatershed and the Rainbow Lake direct watershed. Rainbow Lake's direct watershed is comprised of land cover types including forests (50%), wetlands (32%), pasture/grass (9%), the lake's surface itself (9%), and rural residential areas (<1%) (Figure 8.5.2-1). Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Rainbow Lake's residence time is approximately 0.18 years, or the water within the lake is completely replaced approximately 5.5 times per year.

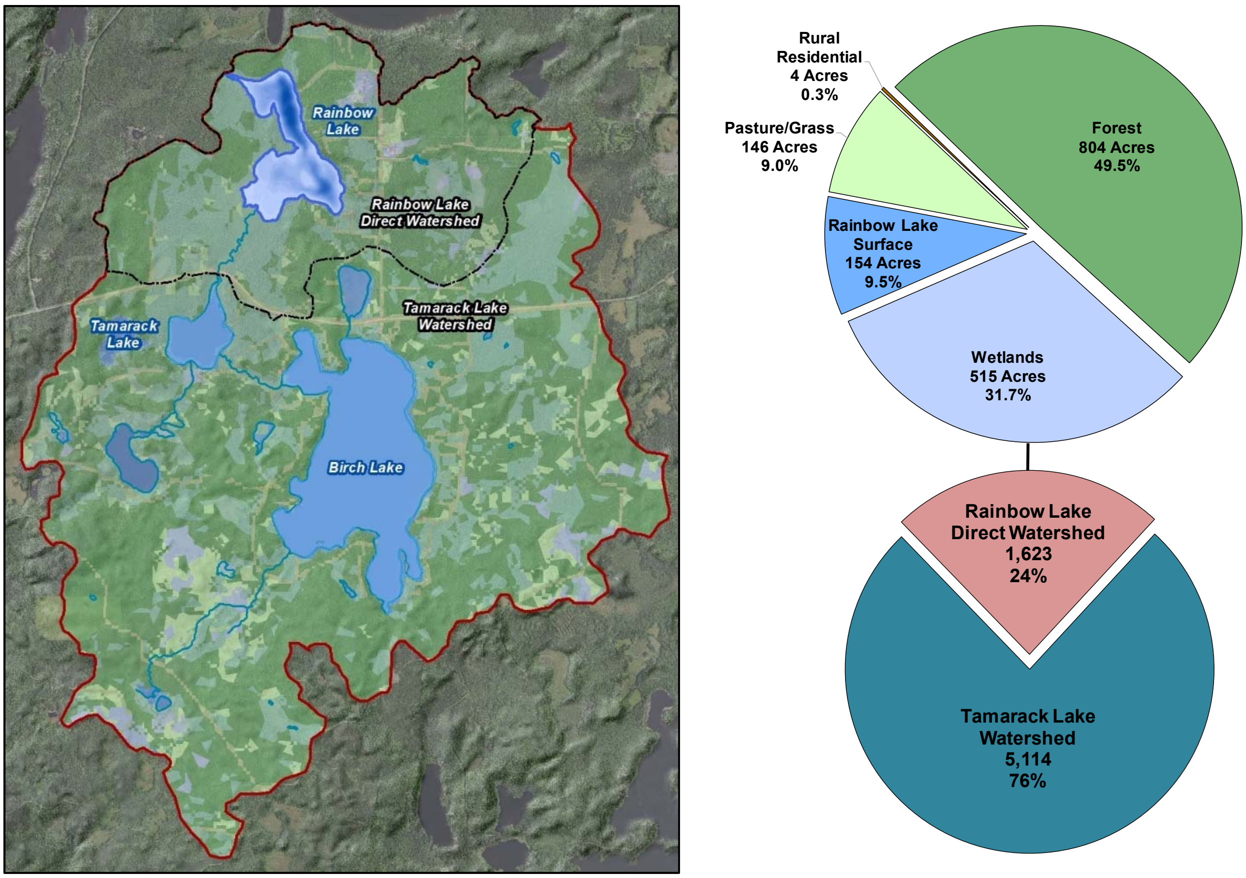


Figure 8.5.2-1. Rainbow Lake watershed boundary (red line) and proportion of land cover types. Rainbow Lake direct watershed is indicated by black dashed line. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

Using the land cover types within Rainbow Lake's direct watershed and phosphorus data from upstream Tamarack Lake, WiLMS was utilized to estimate the annual potential phosphorus load delivered to Rainbow Lake from its watershed. In addition, data obtained from a stakeholder survey sent to Rainbow 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 approximately 610 pounds of phosphorus are delivered to Rainbow Lake from its watershed on an annual basis (Figure 8.5.2-2).

Of the estimated 610 pounds of phosphorus being delivered to Rainbow Lake on an annual basis, approximately 415 pounds (68%) originates from the Tamarack Lake subwatershed while the remaining 195 pounds originates from the lake's direct watershed (Figure 8.5.2-2). Within Rainbow Lake's direct watershed, forests account for 64 pounds (10%), wetlands account for 46 pounds (8%), atmospheric deposition onto the lake surface accounts for 42 pounds (7%), pasture/grasslands account for 40 pounds (6%), and riparian septic systems were estimated to account for 4 pounds (1%) (Figure 8.5.2-2). Using the estimated annual potential phosphorus load, WiLMS predicted an in-lake growing season average total phosphorus concentration of 23 µg/L. The 2016 measured growing season total phosphorus concentration in Rainbow Lake was very similar to the predicted at 25.5 µg/L. This indicates that the lake's watershed was modeled accurately and that there are no significant sources of unaccounted phosphorus entering the lake.

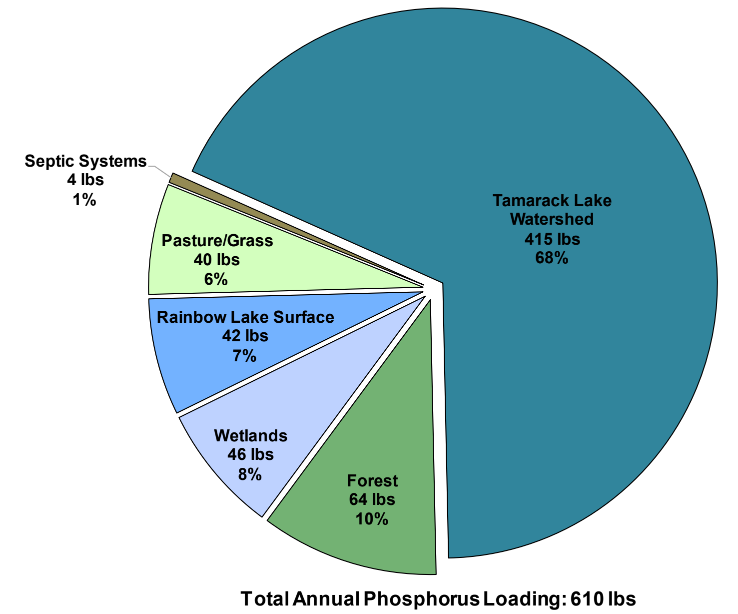


Figure 8.5.2-2. Rainbow Lake estimated potential annual phosphorus loading. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Rainbow Lake Water Levels

Lake water levels can fluctuate naturally over varied timescales due to changes in precipitation and/or changes in human land use. Natural seasonal and long-term changes in water levels in lakes are beneficial as they generally create more diverse plant and animal communities. Water level fluctuations in drainage lakes, like Rainbow Lake, tend to be more moderate when compared to seepage lakes which lack input from streams or rivers and are largely tied to the level of the groundwater aquifer. Even during drier periods, rivers and streams still provide a source of water to drainage lakes. However, drainage lakes may show increases in water levels relatively quickly following large rain events.

Beginning in 2010, the NLDC and Rainbow Lake volunteers began monitoring Rainbow Lake's water levels annually during the open water season (Figure 8.5.2-3). Over the course of this monitoring, Rainbow Lake's water levels fluctuated a maximum of approximately 20 inches, with a minimum water level recorded in 2012 and a maximum water level recorded in 2014. The average intra-annual water level variation from 2010-2017 was 9.7 inches. Water levels in 2016 were approximately 1.0 inches above the 2010-2017 average while water levels in 2017 were 0.7 inches below average. The data collected from Rainbow Lake indicate that water levels tend to fluctuate both intra- and interannually with changes in precipitation levels. Ongoing collection of water level data at Rainbow Lake will allow for a better understanding of longer-term changes in water levels.

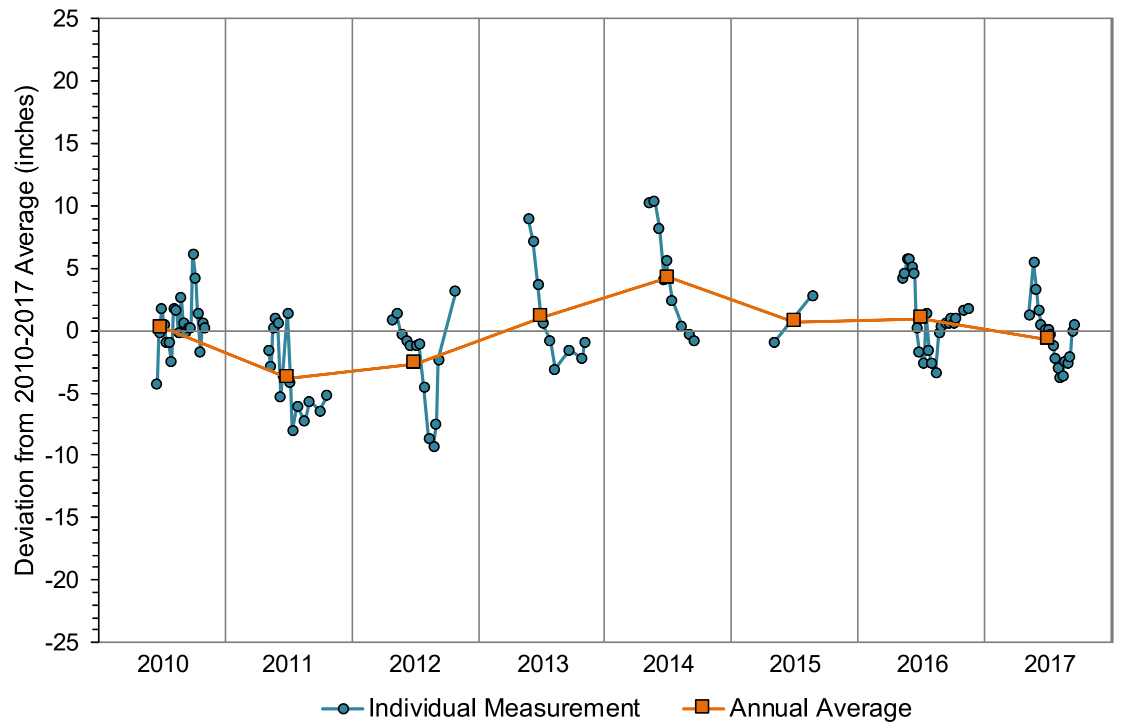


Figure 8.5.2-3. Rainbow Lake 2010-2017 water levels. Created using data provided by NLDC.

8.5.3 Rainbow 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 Rainbow 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.

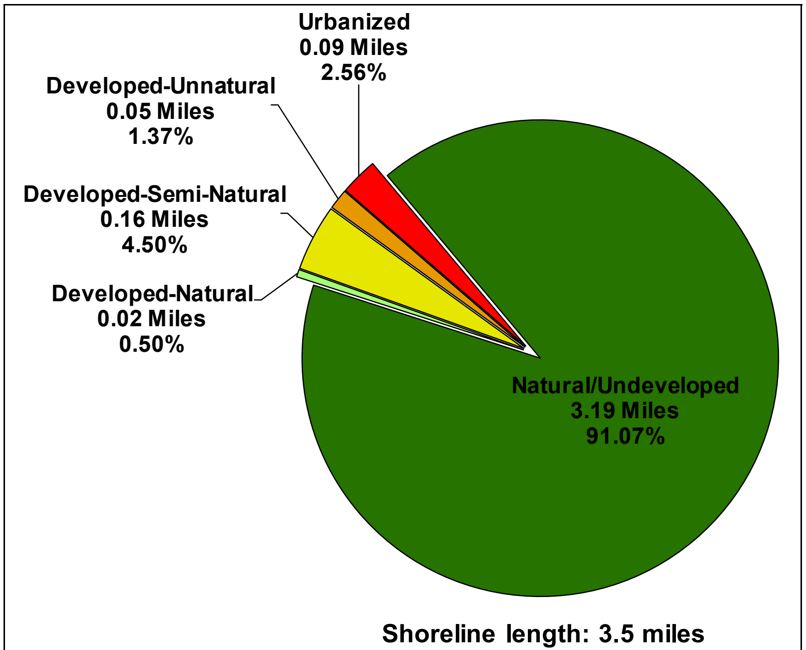


Figure 8.5.3-1. Rainbow Lake shoreland categories and total lengths. Based upon a late-summer 2016 survey. Locations of these categorized shorelands can be found on Rainbow Lake - Map 3.

The 2016 survey revealed that Rainbow Lake has stretches of shoreland that fit all five shoreland assessment categories (Figure 8.5.3-1). In total, 3.22 miles (91.5%) of the 3.5-mile shoreland zone were categorized as natural/undeveloped or developed-natural or shoreland types that provide the most benefit to the lake and should be left in their natural state if possible. Approximately 0.15 miles (3.5%) of the shoreland was categorized as developed-unnatural or urbanized, shoreland areas which provide little benefit to and may actually adversely impact the lake. If restoration of Rainbow Lake's shoreland is to occur, primary focus should be placed on these highly developed shoreland areas. Rainbow 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 Rainbow 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 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 Rainbow Lake, a total of 55 pieces were observed along 3.5 miles of shoreline, yielding a coarse woody habitat to shoreline mile ratio of 16:1 (Figure 8.5.3-2). Onterra ecologists have been completing these surveys on Wisconsin's lakes for five years, and Rainbow Lake falls in the 29th percentile for the number of coarse woody habitat pieces per shoreline mile of 75 lakes studied. While the majority of the shoreland zone around Rainbow Lake is natural, the lower number of coarse woody habitat pieces is due to non-forested wetlands which surround a large portion 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 Rainbow Lake – Map 4.

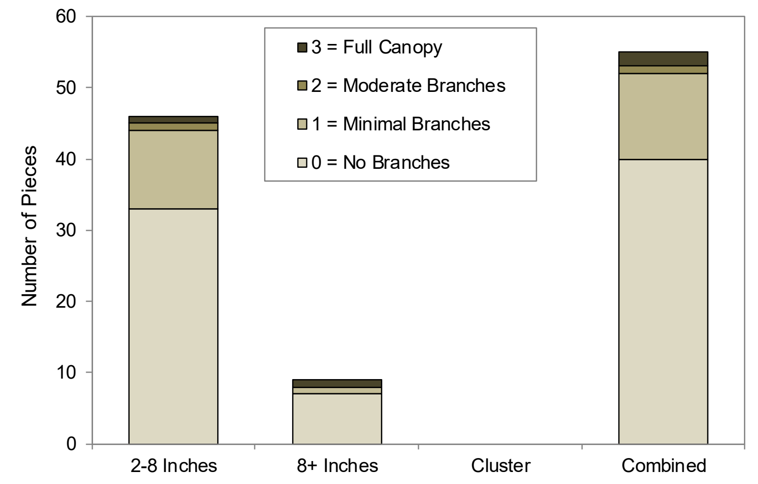


Figure 8.5.3-2. Rainbow Lake coarse woody habitat survey results. Based upon a late-summer 2016 survey. Locations of Rainbow Lake coarse woody habitat can be found on Rainbow Lake – Map 4.

8.5.4 Rainbow Lake Aquatic Vegetation

An Early-Season Aquatic Invasive Species (ESAIS) Survey was conducted by Onterra ecologists on Rainbow 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 Rainbow Lake in 2016, and it is believed that curly-leaf pondweed is not present within the lake or exists at an undetectable level. Rainbow 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.

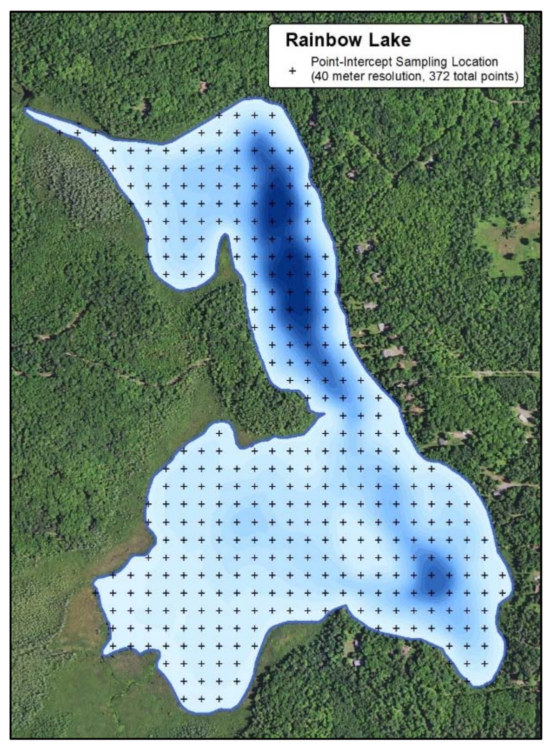


Figure 8.5.4-1. Rainbow Lake whole-lake point-intercept survey sampling locations.

The whole-lake aquatic plant point-intercept survey and emergent and floating-leaf aquatic plant community mapping survey were conducted on Rainbow Lake by Onterra ecologists on July 20, 2016 (Figure 8.5.4-1). During these surveys, a total of 45 aquatic plant species were located, none of which are considered to be non-native, invasive

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species (Table 8.5.4-1). The species list also contains the 30 species recorded from Rainbow Lake during a survey completed by the WDNR in 2009. Most of the species located in 2009 were relocated in 2016 along with other species which were not recorded in 2009.

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 Rainbow Lake (bathymetric results on Rainbow 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 Rainbow 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 Rainbow Lake with both the hardest and softest substrates in the lake occurring within 1.0-6.0 feet of water (Figure 8.5.4-2). The softer substrates occurred near the mouth of Rainbow Creek and in areas of adjacent wetlands while shallower areas within eastern and northern portions of the lake had the hardest substrates. 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.

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 8.5.4-3 and Rainbow 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 8 feet. However, the majority of aquatic plant growth occurs within 3.0-5.0 feet of water. The 2016 acoustic survey indicated approximately 49% of Rainbow Lake's area contains aquatic vegetation, while the remaining 51% of the lake is too deep and light-limited to support aquatic plant growth.

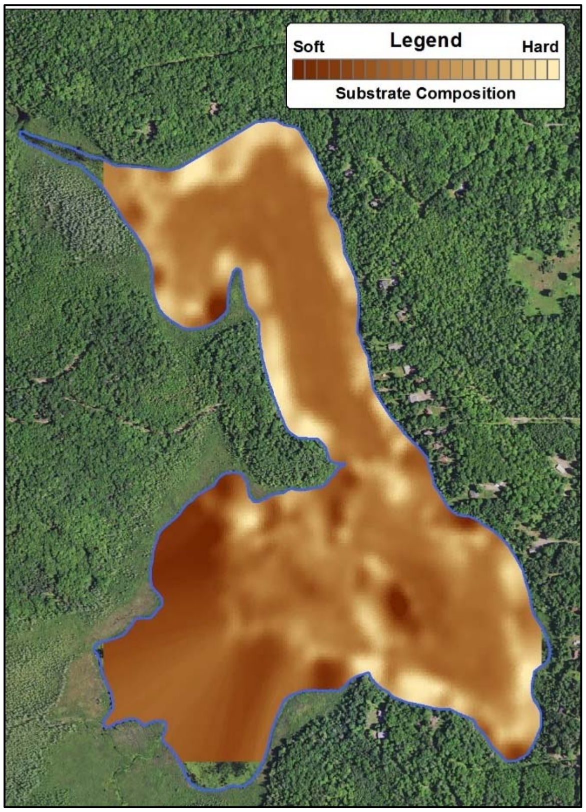
As mentioned, aquatic plants were recorded growing to a maximum depth of 8 feet in 2016. Of the 172 point-intercept sampling locations that fell at or shallower than the maximum depth of plant growth (littoral zone), approximately 88% contained aquatic vegetation. Aquatic plant rake fullness data collected in 2016 indicates that 22% of the 172 littoral sampling locations contained vegetation with a total rake fullness rating (TRF) of 1, 46% had a TRF rating of 2, and 20% had a TRF rating of 3 (Figure 8.5.4-5). These data indicate that aquatic plant density in Rainbow Lake is relatively high throughout most areas where plants occur.

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. Of the 45 aquatic plant species located in Rainbow Lake in 2016, 32 were encountered directly on the rake during the whole-lake point-intercept survey (Figure 8.5.4-6). The remaining 13 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 32 species directly sampled with the rake during the point-intercept survey, fern-leaf pondweed, common bladderwort, and muskgrasses were the three-most frequently encountered aquatic plant species (Figure 8.5.4-6).

Table 8.5.4-1. List of aquatic plant species located in Rainbow Lake during Onterra 2016 aquatic plant surveys.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2009 (WDNR)	2016 (Onterra)
Emergent	*Carex lacustris*	Lake sedge	6		I
	Carex lasiocarpa	Narrow-leaved woolly sedge	9		I
	Carex stricta	Common tussock sedge	7		I
	Carex utriculata	Common yellow lake sedge	7		I
	Dulichium arundinaceum	Three-way sedge	9		I
	Eleocharis palustris	Creeping spikerush	6		X
	Iris versicolor	Northern blue flag	5		I
	Phragmites australis subsp. *americanus*	Common reed	5		I
	Pontederia cordata	Pickerelweed	9	X	X
	Sagittaria sp.	Arrowhead sp.	N/A	X	
	Schoenoplectus acutus	Hardstem bulrush	5	X	X
	Typha latifolia	Broad-leaved cattail	1	X	I
FL	*Brasenia schreberi*	Watershield	7	X	X
	Nuphar variegata	Spatterdock	6	X	X
	Nymphaea odorata	White water lily	6	X	X
	Sparganium fluctuans	Floating-leaf bur-reed	10	X	X
FL/E	*Sparganium* sp. (sterile)	Sterile Bur-reed sp.	N/A		I
Submergent	*Bidens beckii*	Water marigold	8	X	X
	Ceratophyllum demersum	Coontail	3	X	
	Ceratophyllum echinatum	Spiny hornwort	10		X
	Chara spp.	Muskgrasses	7	X	X
	Elodea canadensis	Common waterweed	3	X	X
	Elodea nuttallii	Slender waterweed	7		X
	Eriocaulon aquaticum	Pipewort	9	X	
	Heteranthera dubia	Water stargrass	6	X	X
	Isoetes spp.	Quillwort spp.	8	X	X
	Myriophyllum sibiricum	Northern watermilfoil	7	X	X
	Najas flexilis	Slender naiad	6	X	X
	Nitella spp.	Stoneworts	7	X	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	X	I
	Potamogeton gramineus	Variable-leaf pondweed	7	X	X
	Potamogeton natans	Floating-leaf pondweed	5	X	X
	Potamogeton obtusifolius	Blunt-leaved pondweed	9		I
	Potamogeton praelongus	White-stem pondweed	8	X	X
	Potamogeton pusillus	Small pondweed	7		X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X	X
	Potamogeton robbinsii	Fern-leaf pondweed	8	X	X
	Potamogeton spirillus	Spiral-fruited pondweed	8		X
	*Potamogeton vaseyi**	Vasey's pondweed	10		X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X	X
	Utricularia gibba	Creeping bladderwort	9		I
	Utricularia intermedia	Flat-leaf bladderwort	9		X
	Utricularia minor	Small bladderwort	10		X
	Utricularia vulgaris	Common bladderwort	7	X	X
	Vallisneria americana	Wild celery	6	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	X	
	Juncus pelocarpus	Brown-fruited rush	8	X	
	Schoenoplectus subterminalis	Water bulrush	9		X

FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent
X = Located on rake during point-intercept survey; I = Incidental Species
** = Species listed as special concern by Wisconsin Natural Heritage Inventory*



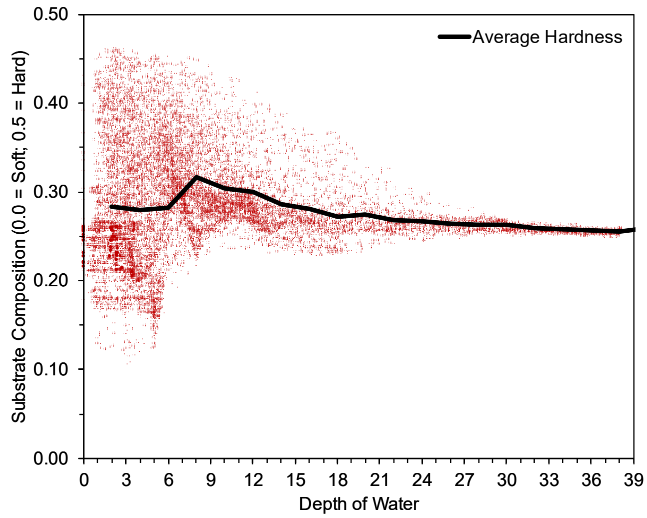


Figure 8.5.4-2. Rainbow Lake spatial distribution of substrate hardness (left) and substrate hardness across water depth (right). Individual data points are displayed in red. Creating using data from August 2016 acoustic survey.

Fern-leaf pondweed was the most frequently encountered aquatic plant species in Rainbow Lake in 2016 with a littoral frequency of occurrence of 51% (Figure 8.5.4-6). 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 Rainbow Lake, fern-leaf pondweed was most abundant between 3.0 and 5.0 feet of water.

Common bladderwort was the second-most frequently encountered aquatic plant species in Rainbow Lake during the 2016 point-intercept survey with a littoral frequency of occurrence of 22% (Figure 8.5.4-6). Common bladderwort is one of seven species of bladderwort that occur in Wisconsin and one of four species located in Rainbow 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 8.5.4-1). In Rainbow Lake, common bladderwort was most abundant between 2.0 and 4.0 feet of water.

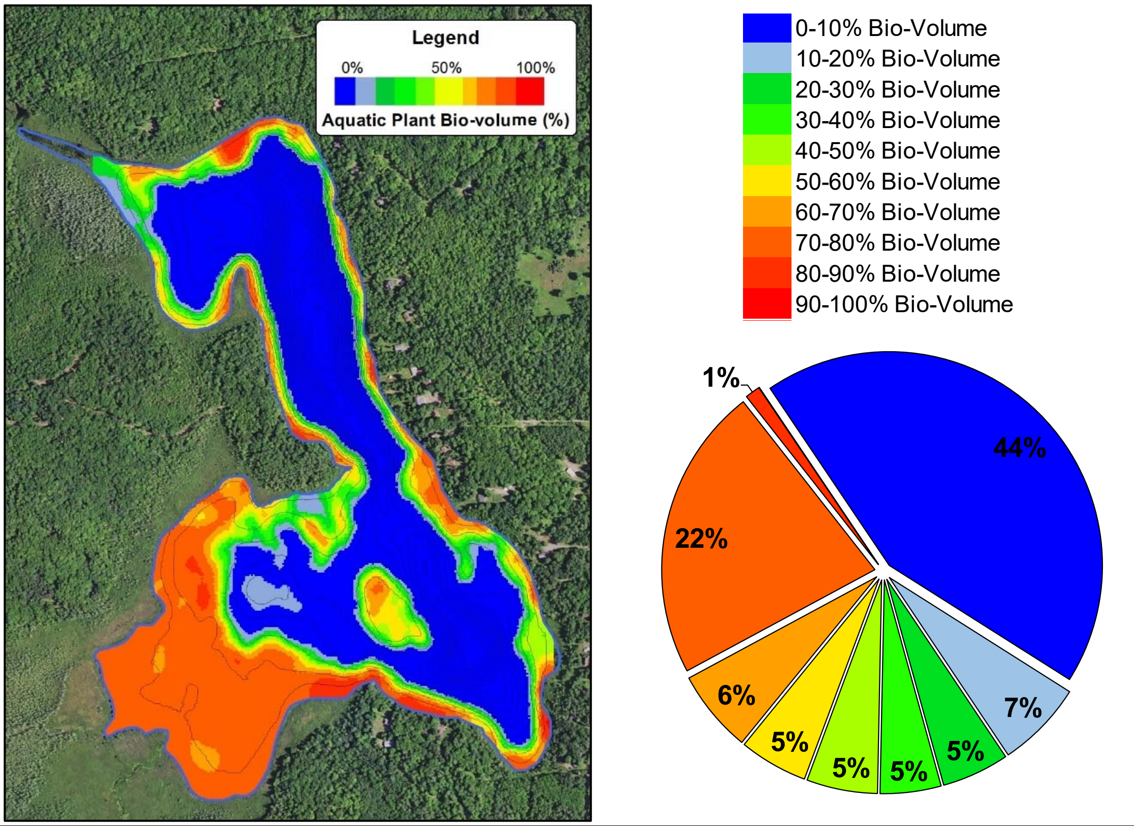


Figure 8.5.4-4. Rainbow Lake 2016 aquatic plant bio-volume. Created using data from August 2016 acoustic survey data. Contour lines represent one-foot increments.

Muskgrasses were the third-most frequently encountered aquatic plant in Rainbow Lake in 2016 with a littoral frequency of occurrence of 18% (Figure 8.5-4-6). Muskgrasses are a genus of macroalgae of which there are seven species in Wisconsin. Muskgrasses tend to be most prevalent in hardwater lakes rich in calcium, but some species can also be found in softwater lakes like Rainbow Lake. In Rainbow Lake, muskgrasses were located in shallow water mainly from 2.0-4.0 feet over areas of sandy substrate.

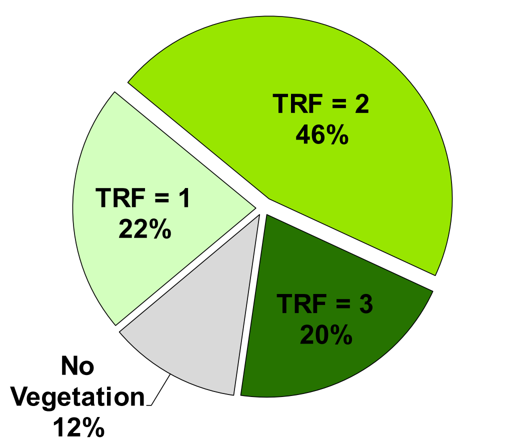


Figure 8.5.4-5. Rainbow Lake 2016 aquatic vegetation total rake fullness ratings (TRF). Created from data collected during the 2016 whole-lake point-intercept survey (N = 172).

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 8.5.4-2). 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).

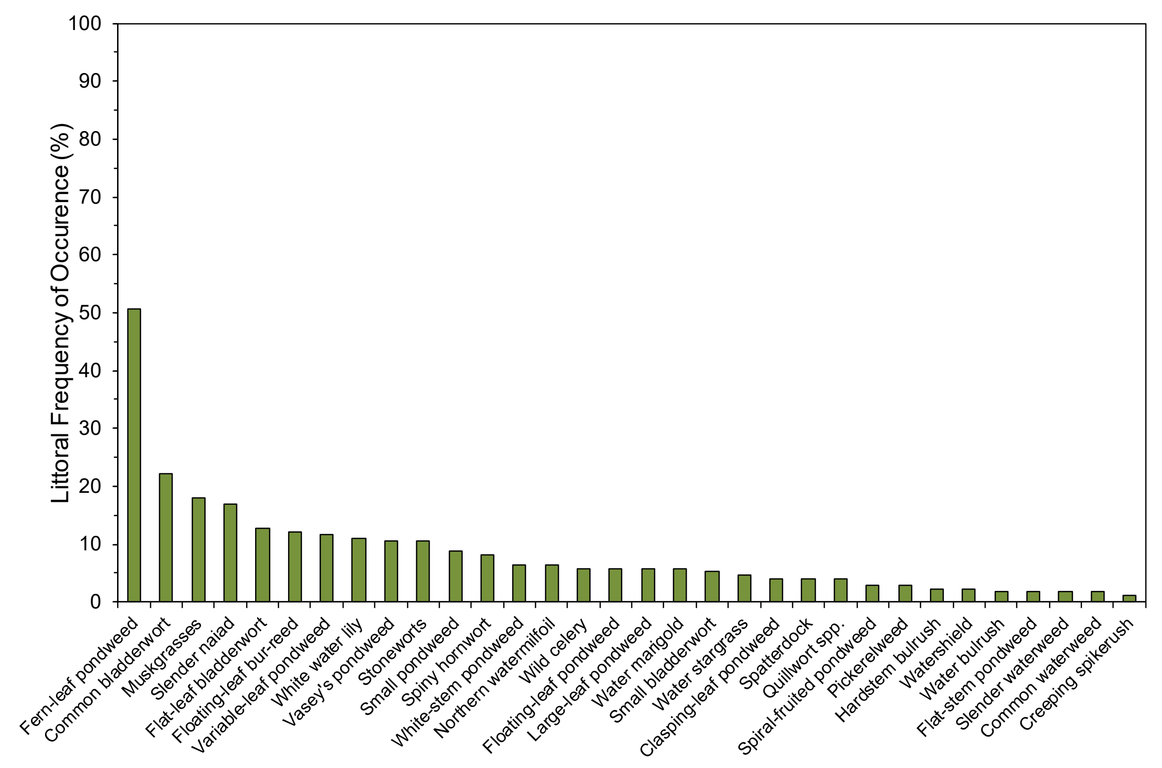


Figure 8.5.4-6. Rainbow Lake 2016 littoral frequency of occurrence of aquatic plant species. Created using data from 2016 whole-lake point-intercept survey.

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 8.5.4-2). 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.

Photo 8.5.4-1. Flowers of common bladderwort (*Utricularia vulgaris*) from Rainbow Lake. Photo credit Onterra, 2016.

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.


Photo 8.5.4-2. 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).

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 Rainbow 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.

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 Rainbow Lake and their conservatism values were used to calculate the FQI of Rainbow Lake's aquatic plant community (equation shown below).

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

Figure 8.5.4-7 compares the 2016 FQI components of Rainbow 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 (32) falls above the upper quartile for lakes in the NLFL ecoregion (21) and for lakes throughout Wisconsin (19) (Figure 3.3.4-7). The average conservatism of the 32 native aquatic plant species located in Rainbow Lake in 2016 was 7.2, 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 Rainbow Lake's aquatic plant community is comprised of environmentally-sensitive species, or species with higher conservatism values.

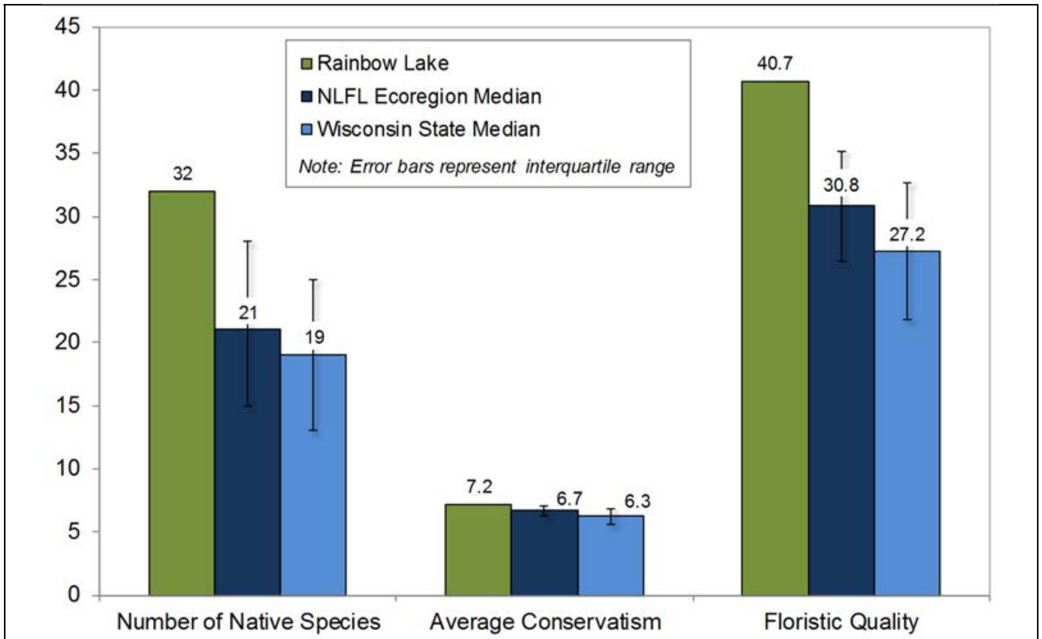


Figure 8.5.4-7. Rainbow Lake Floristic Quality Assessment. Created using data from Onterra 2016 whole-lake point-intercept survey. Analysis follows Nichols (1999).

Using Rainbow Lake's native aquatic plant species richness and average conservatism yields a high FQI value of 40.7 (Figure 3.3-4-7). Rainbow Lake's FQI value exceeds the upper quartile 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 Rainbow Lake is of higher quality than the majority of lakes within the NLFL ecoregion and lakes throughout the state.

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 Rainbow 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.

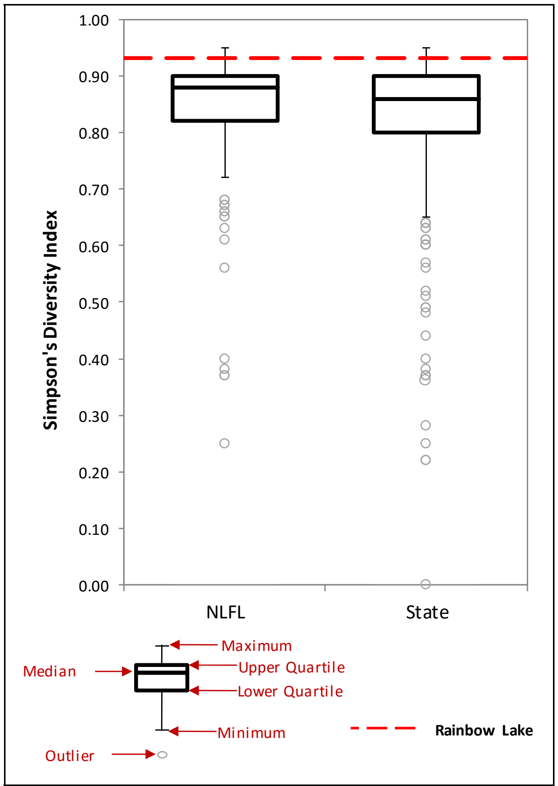


Figure 8.5.4-8. Rainbow Lake species diversity index. Created using data from Onterra 2016 point-intercept survey.

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 Rainbow 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 8.5.4-8). Using the data collected from the 2016 point-intercept survey, Rainbow Lake's aquatic plant was found to have high species diversity with a Simpson's Diversity Index value of 0.93. In other words, if two individual aquatic plants were randomly sampled from Rainbow Lake in 2016, there would be a 93% probability that they would be different species. Rainbow Lake's Simpson's Diversity value exceeds the upper quartiles for lakes in the NLFL ecoregion and lakes throughout Wisconsin.

One way to visualize Rainbow Lake's high species diversity is to look at the relative occurrence of aquatic plant species. Figure 8.1.4-9 displays the relative frequency of occurrence of aquatic plant species created from the 2016 whole-lake point-intercept survey and illustrates the relatively even distribution of aquatic plant species within the community. A plant community that is dominated by just a few species yields lower species diversity. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while fern-leaf pondweed was found at 51% of the littoral sampling locations in Rainbow Lake in 2016, its relative frequency of occurrence was 19%. Explained another way, if 100 plants were randomly sampled from Rainbow Lake in 2016, 19 of them would be muskgrasses. Rainbow Lake contains a wide array of habitat types in terms of substrate composition and sheltered versus open water. The variety of habitat types in Rainbow Lake allows the lake to support a higher number of species and also increases diversity.

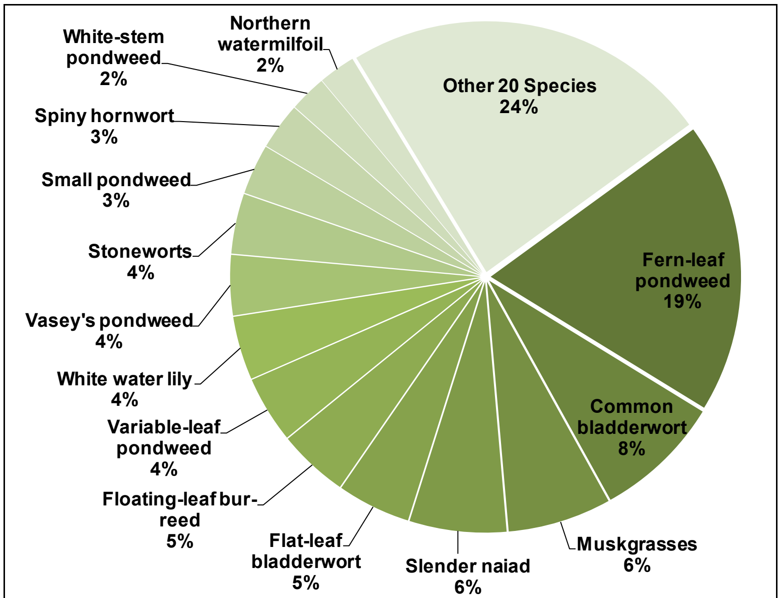


Figure 8.5.4-9. Rainbow Lake 2016 relative frequency of occurrence of aquatic plant species. Created using data from 2016 point-intercept survey.

In 2016, Onterra ecologists also conducted a survey aimed at mapping emergent and floating-leaf aquatic plant communities in Rainbow Lake. This survey revealed Rainbow Lake contains approximately 47 acres of these communities comprised of 16 different aquatic plant species (Rainbow Lake – Map 7 and Table 8.5.4-2). These native emergent and floating-leaf plant communities provide valuable fish and wildlife habitat that is important to the ecosystem of the lake. These areas are particularly important during times of fluctuating water levels, since structural habitat of fallen trees and other forms of course-woody habitat can be quite sparse along the shores of receding water lines. 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 Rainbow Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development.

Table 8.5.4-2. Rainbow 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	3.0
Floating-leaf	22.5
Mixed Emergent & Floating-leaf	21.6
Total	**47.1**

8.5.5 Aquatic Invasive Species in Rainbow Lake

As of 2016, no aquatic invasive species have been confirmed in Rainbow 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 Rainbow 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 Rainbow Lake, their presence has not been officially verified.

8.5.6 Rainbow 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 8.5.6-1.

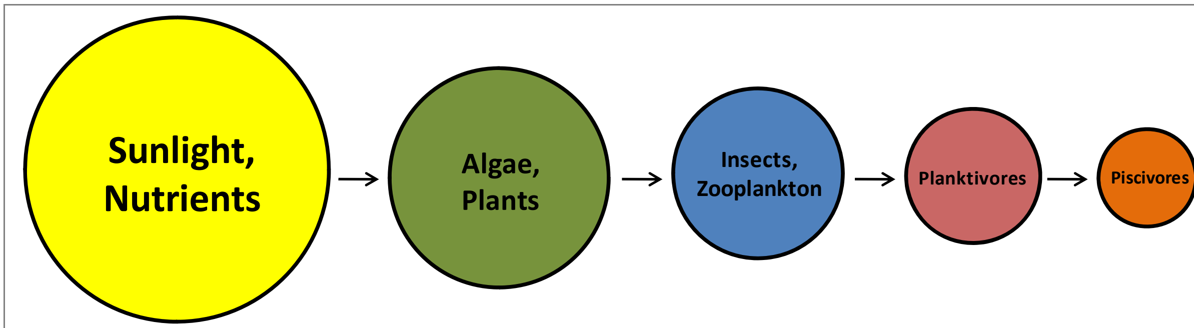


Figure 8.5.6-1 Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Rainbow Lake is a meso-eutrophic system, meaning it has high nutrient content and thus relatively high primary productivity. Simply put, this means Rainbow Lake should be able to support sizable populations of predatory fish (piscivores) because the supporting food chain is relatively robust. Table 8.5.6-1 shows the popular game fish present in Rainbow Lake.

Table 8.5.6-1. Gamefish present in Rainbow Lake with corresponding biological information (Becker, 1983).

Common Name (*Scientific Name*)	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Largemouth Bass (*Micropterus salmoides*)	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Muskellunge (*Esox masquinongy*)	30	Mid April - Mid May	Shallow bays over muck bottom with dead vegetation, 6 - 30 in.	Fish including other muskies, small mammals, shore birds, frogs
Northern Pike (*Esox lucius*)	25	Late March - Early April	Shallow, flooded marshes with emergent vegetation with fine leaves	Fish including other pike, crayfish, small mammals, water fowl, frogs
Panfish (*Lepomis*)	11	May - August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
Smallmouth Bass (*Micropterus dolomieu*)	13	Mid May - June	Nests more common on north and west shorelines over gravel	Small fish including other bass, crayfish, insects (aquatic and terrestrial)
Walleye (*Sander vitreus*)	18	Mid April - Early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish

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 8.5.6-1). 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 8.5.6-1). 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 8.5.6-1. 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 8.4.6-3). 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 Rainbow Lake have included muskellunge and are displayed in Table 8.5.6-2.

Photo 8.5.6-3. Fingerling Muskellunge.

Table 8.5.6-2. WDNR stocking data of fish species available for Rainbow Lake (1972-1990).

Year	Species	Age Class	# Fish Stocked	Avg Fish Length (in)
1972	Muskellunge	Fingerling	300	11
1974	Muskellunge	Fingerling	300	11

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.

Rainbow 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, 77% of the substrate sampled in the littoral zone of Rainbow Lake was soft sediments and 23% was 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 55 pieces of coarse woody along the shores of the Rainbow Lake, resulting in a ratio of approximately 16 pieces per mile of shoreline.

Regulations and Management

Current (2016-2017) regulations for Rainbow Lake gamefish species are displayed in Table 8.5.6-3. 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 8.5.6-3. WDNR fishing regulations for Rainbow 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 8.5.6-2. 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 8.5.6-2. 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/)

Rainbow 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.

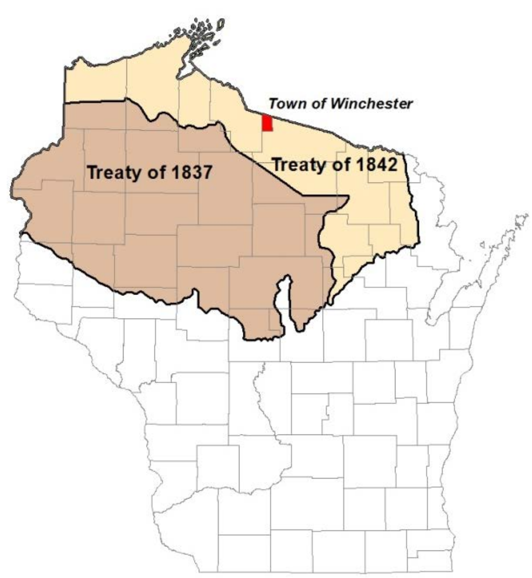


Figure 8.5.6-3. Location of the Town of Winchester within the Native American Ceded Territory (GLIFWC 2016). This map was digitized by Onterra; therefore it is a representation and not legally binding.

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, Rainbow Lake has not experienced a spearfishing harvest. A declaration for walleye harvest has been listed for Rainbow Lake in recent years, however no spearing efforts have been undertaken likely due to limited access.

8.5.7 Rainbow Lake Implementation Plan

The Implementation Plan presented in this section was created through the collaborative efforts of the Rainbow Lake Association (RLA) Planning Committee, Onterra ecologists, and North Lakeland Discovery Center (NLDC) and WDNR staff. It represents the path the RLA will follow in order to meet their lake management goals. 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 Rainbow Lake stakeholders as portrayed by the members of the Planning Committee 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 Rainbow Lake's water quality through the WDNR Citizens Lake Monitoring Network (CLMN).

Timeframe: Continuation of current effort

Facilitator: Ron Menozzi (current 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 Section, Rainbow Lake's water quality was good to excellent in all parameters measured. Continued monitoring can lead to early detection of potential negative trends and may lead to the reason 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 RLA have been measuring Secchi disk transparency in Rainbow Lake annually since 2005. The RLA realizes the importance of continuing this effort which will supply them with valuable data about their lake. Funding from the WDNR for advanced water quality monitoring (addition of total phosphorus and chlorophyll-*a*) has been increasingly difficult to acquire. It was suggested at the planning meetings that the Town of Winchester Town Lakes Committee may be able to provide funding to lakes within the township to process samples for total phosphorus and chlorophyll-*a*. The RLA should work with members of the Town Lakes Committee to determine if funding will be available to collect total phosphorus and chlorophyll-*a* data in addition to Secchi disk transparency on Rainbow Lake 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 temperature/dissolved oxygen probe for their use.

Nearby Trout Lake Research Station may also lend water quality equipment to water quality monitoring volunteers.

Ron Menozzi is currently the CLMN volunteer collecting Secchi disk transparency data from Rainbow Lake, and the RLA Board of Directors will appoint a water quality monitor at each annual meeting as needed. 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. Ron Menozzi and RLA Board of Directors appoints/recruits new volunteer(s) as needed at annual meeting.
2. New volunteer(s) contact Sandy Wickman (715.365.8951) as needed.
3. Volunteer(s) reports results to WDNR SWIMS database and to RLA members during annual meeting.

Management Action: Continue monitoring Rainbow Lake's water levels through NLDC citizen science lake level monitoring program.

Timeframe: Continuation of current effort

Facilitator: Nancy and Jeff Johnson

Description: The NLDC currently administers a citizen-based lake level monitoring program which is supported by a WDNR grant 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, a staff gauge is installed on Rainbow Lake 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).

1. Current Rainbow 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. Nancy and Jeff Johnson recruit new volunteers as needed or notify RLA if new water level monitors are needed.

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

Timeframe: Initiate 2018

Facilitator: RLA Board of Directors

Description: The 2016 Shoreland Condition Assessment found that approximately 92% (3.2 miles) of Rainbow Lake's immediate shoreland zone contains little to no development, delineated as either *natural/undeveloped* or *developed-natural*, while approximately 4% (0.1 miles) contains a higher degree of development categorized 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 Rainbow Lake in terms of maintaining the lake's 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 Rainbow Lake's water quality and contribution to habitat loss.

The RLA 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 RLA in preserving and restoring Rainbow Lake's shoreland. 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 RLA 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 rainbow Lake's shoreland.

Action Steps:

1. RLA Board of Directors gathers appropriate information from entities listed above.
2. The RLA provides Rainbow 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 Water Department office for more information on shoreland restoration plans, financial assistance, and benefits of implementation.

Management Action:	Preserve natural land cover within Rainbow Lake's watershed beyond the immediate shoreland zone.
Timeframe:	Initiate in 2018
Facilitator:	RLA Board of Directors
Description:	As is discussed within the Watershed Section (8.5.2), changes in land use beyond the shoreland zone within a lake's watershed can impact water quality. Currently, Rainbow Lake's 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 RLA recognizes the importance of maintaining natural land cover within the watershed to maintain their water quality for future generations. As is discussed in the previous management action, one way the RLA 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 RLA can also reach out to land owners of property within these lakes' watersheds and provide them with information on the RLA'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 RLA and Birch 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 (Rainbow 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 RLA 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 RLA 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.

Action Steps:

1. See description above.

Management Goal 2: Increase Navigation Safety on Rainbow Lake

Management Action: Install signage at public carry-in access location on Rainbow Creek to inform lake users of watercraft regulations on Rainbow Lake.

Timeframe: Initiate in 2018

Facilitator: RLA Board of Directors

Description: Rainbow Lake does not possess a public boat launch on the lake and watercraft traffic was not listed as a top concern by respondents to the 2016 stakeholder survey. However, members of the Rainbow Lake Planning Committee felt it would be important to inform lake users of watercraft regulation areas on Rainbow Lake by placing signage at the public carry-in access point located where County Highway W crosses Rainbow Creek. This signage will 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 Rainbow Lake and reduce shoreline erosion/impacts to shoreline habitat.

Onterra will provide the RLA with a map similar to Rainbow Lake – Map 9 displaying these setback areas. The RLA 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 RLA will likely also need to obtain the necessary permission from the Town of Winchester to install new signage at this public access location.

Because the public access point on Rainbow Creek allows access to both Rainbow and Tamarack lakes, the RLA should work with Tamarack Lake stakeholders to develop signage that informs lake users of watercraft regulations on both of these lakes. Onterra will also be providing a watercraft regulation map for Tamarack Lake.

Action Steps:

1. Onterra provides RLA with Rainbow Lake watercraft regulation map similar to Rainbow Lake – Map 9.
2. Rainbow Lake works with sign/graphic design company to create sign for the public boat landing.

3. RLA obtains 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 Rainbow Lake Association with Rainbow Lake Stakeholders

Management Action: Promote stakeholder involvement, inform stakeholders on various lake issues, as well as the quality of life on Rainbow Lake.

Timeframe: Continuation of current effort

Facilitator: RLA Board of Directors

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 RLA will continue its effort to promote lake preservation and enhancement through a variety of educational efforts.

The RLA has published a newsletter for its membership in the past and would like to get this effort going again. Currently, the RLA does not have an individual or committee to head up the publishing and distribution of the newsletter. At the planning committee meetings, the RLA Planning Committee indicated that they will seek an RLA member to lead the redevelopment and distribution of an association newsletter. The RLA currently communicates with its membership via email, and the distribution of an electronic newsletter would be an excellent mode of communication and education for the RLA to its membership.

The RLA would also like to initiate the development of an association website and/or blog. The Birch Lake Association (BLA) currently maintains the Birch Lake Blog, a website where Birch Lake stakeholders can find information about the lake, meeting times, and an assortment of lake-related links. It was suggested during the planning meetings that the BLA could incorporate Rainbow Lake into their blog website seeing as the lakes are connected to each other. The development of a website/blog which incorporates information and lake-related issues from Birch, Tamarack, and Rainbow lakes would be an excellent avenue for interested stakeholders to gain information not only on how their actions impact their lake but lakes downstream as well. The RLA should reach out to the BLA in regards to joining the Birch Lake Blog.

The RLA would like to maintain its capacity to reach out to and educate association and non-association members regarding Rainbow 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 newly developed newsletter, distributed as separate educational materials, or posted on the association's future website. The RLA can also invite speakers to discuss lake-related topics or hold workshops for their members at their annual meetings. The RLA 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
- 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 Rainbow Lake
- Septic system maintenance
- Water levels
- Littering on the ice and year-round

Action Steps:

1. See description above.

Management Goal 4: Prevent New Aquatic Invasive Species Introductions to Rainbow Lake

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

Timeframe: Continuation of current effort.

Facilitator: RLA Board of Directors

Description: As of this writing, no aquatic invasive species have been documented in Rainbow Lake. The RLA understands 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, possible even eradication. Currently, RLA 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 RLA volunteer monitoring, NLDC staff completes AIS surveys on Rainbow Lake two times per year.

Action Steps:

1. RLA 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: Initiate aquatic invasive species rapid response plan upon discovery of new infestation.

Timeframe: Initiate upon invasive species discovery.

Facilitator: RLA Board of Directors

Description: In the event that an aquatic invasive species such as Eurasian watermilfoil is located by the trained volunteers, the areas would be marked using GPS and the RLA 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. RLA contact NLDC (877.543.2085) upon discovery of new invasive species in Birch Lake.

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

Timeframe: Initiate 2018

Facilitator: RLA Board of Directors

Description: Rainbow Lake contains a carry-in public access located on the northern side of the lake where County Highway 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. To request an AIS boat landing sign, the RLA should contact Tim Campbell (timothy.campbell@wisconsin.gov – 608.26.3531), WDNR AIS Education Specialist, to request a sign for the Rainbow Lake carry-in access. Lake users can also access Tamarack Lake from this launch site, and the RLA should work with Martin Plutowski from Tamarack Lake to coordinate obtaining this AIS signage.

Action Steps:

1. Please see above description.

Management Goal 5: Enhance the fishery of Rainbow Lake

Management Action: Continue work with WDNR fisheries managers to enhance the fishery of Rainbow Lake.

Timeframe: Continuation of current effort

Facilitator: RLA Board of Directors

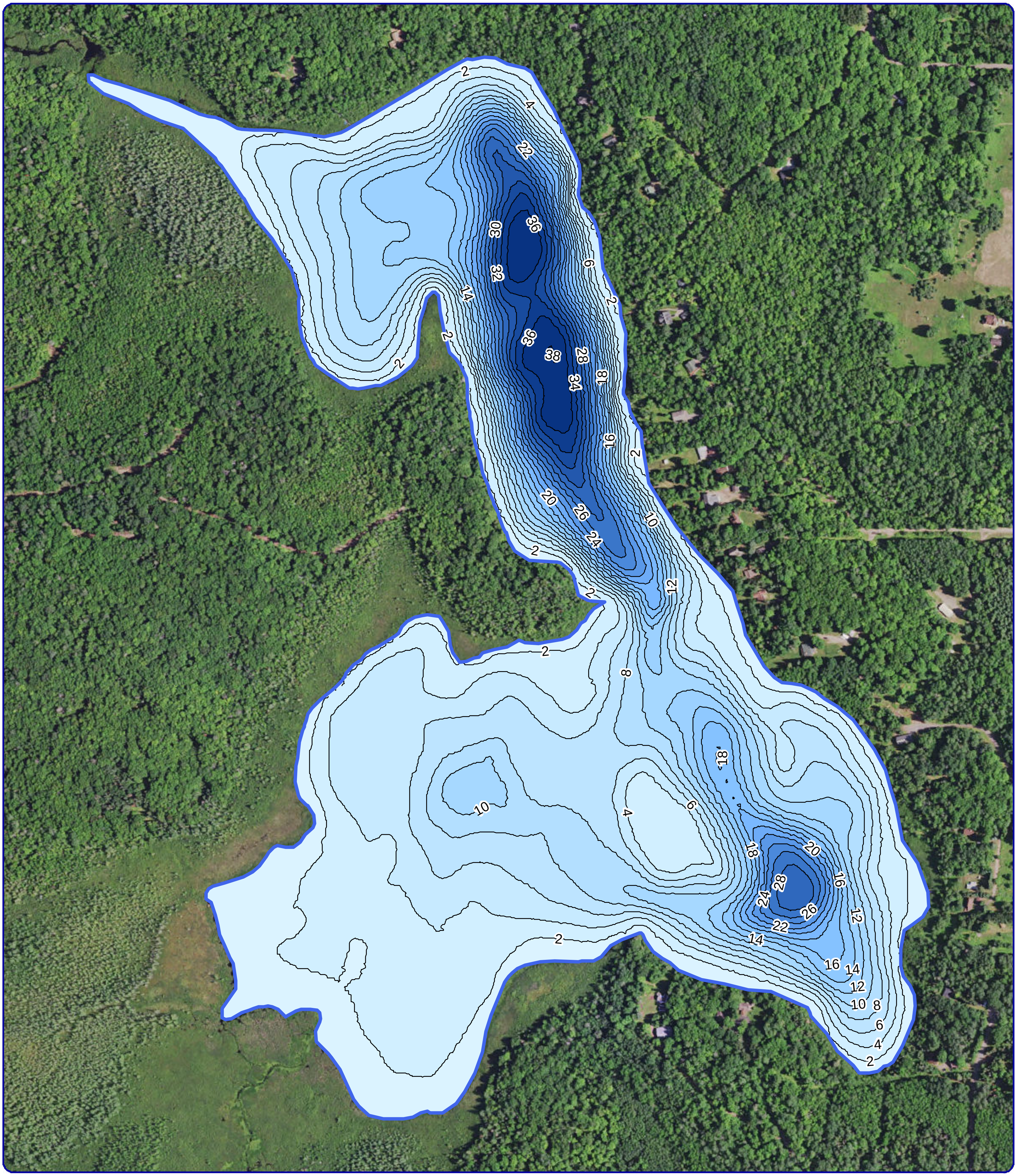
Description: In the 2016 stakeholder survey, fishing was ranked third behind relaxing/entertaining and nature viewing by respondents when asked to rank their top three activities that are important reasons for owning or renting their property on or near Rainbow Lake (Appendix B, Question 17). Respondents indicated that bluegill, crappie, northern pike, and muskellunge were the most sought-after fish by anglers in Rainbow Lake, and 67% of respondents rated the current fishing on Rainbow Lake as either good or excellent (Appendix B, Questions 11 and 12). Approximately 42% of respondents indicated the quality of fishing has gotten somewhat worse since they began fishing on Rainbow Lake, while 42% indicated the quality of fishing has remained the same (Appendix B, Question 13).

Rainbow Lake is currently listed as an Area of Special Natural Resource Interest (ASNRI) for harboring naturally reproducing populations of both walleye and muskellunge. The RLA and understands that a multitude of factors such as changes in habitat, water levels, and fishing pressure affect fish communities, and the RLA would like to take an active role in maintaining a healthy fishery to ensure Rainbow Lake remains a high-quality fishing lake for future generations.

Rainbow Lake is 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 RLA Board of Directors 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 RLA 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.



Sources:	
Orthophotography: NAIP 2015	
Bathymetric Survey: Onterra 2016	
Map Date: March 6, 2017	
Filename: Map1_Rainbow_Location.mxd	

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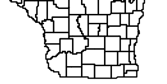

Project Location in Wisconsin

Legend

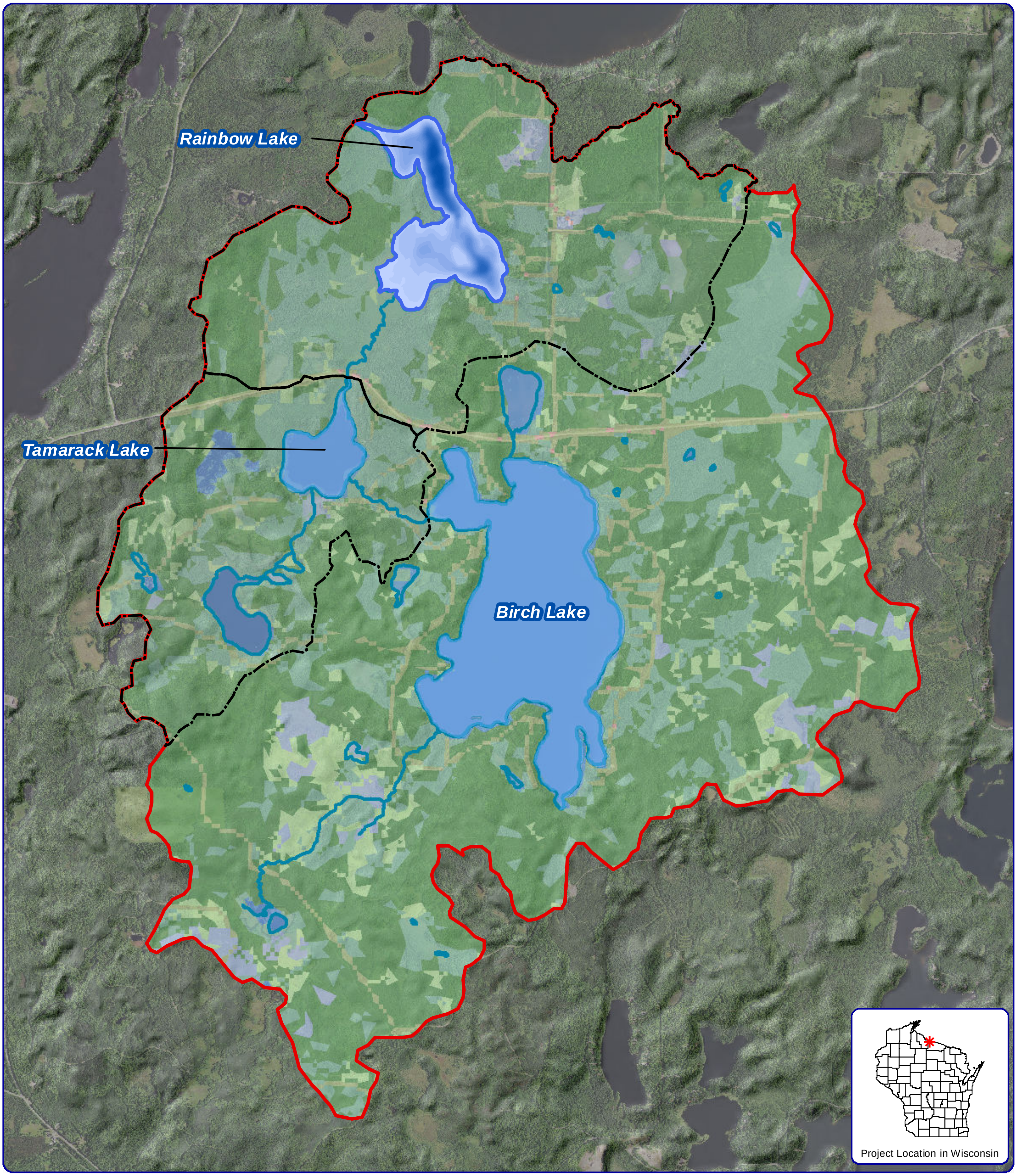
Rainbow Lake ~146 acres
WDNR Definition

Rainbow Lake - Map 1

Town of Winchester

Vilas County, Wisconsin

Project Location & Lake Boundaries



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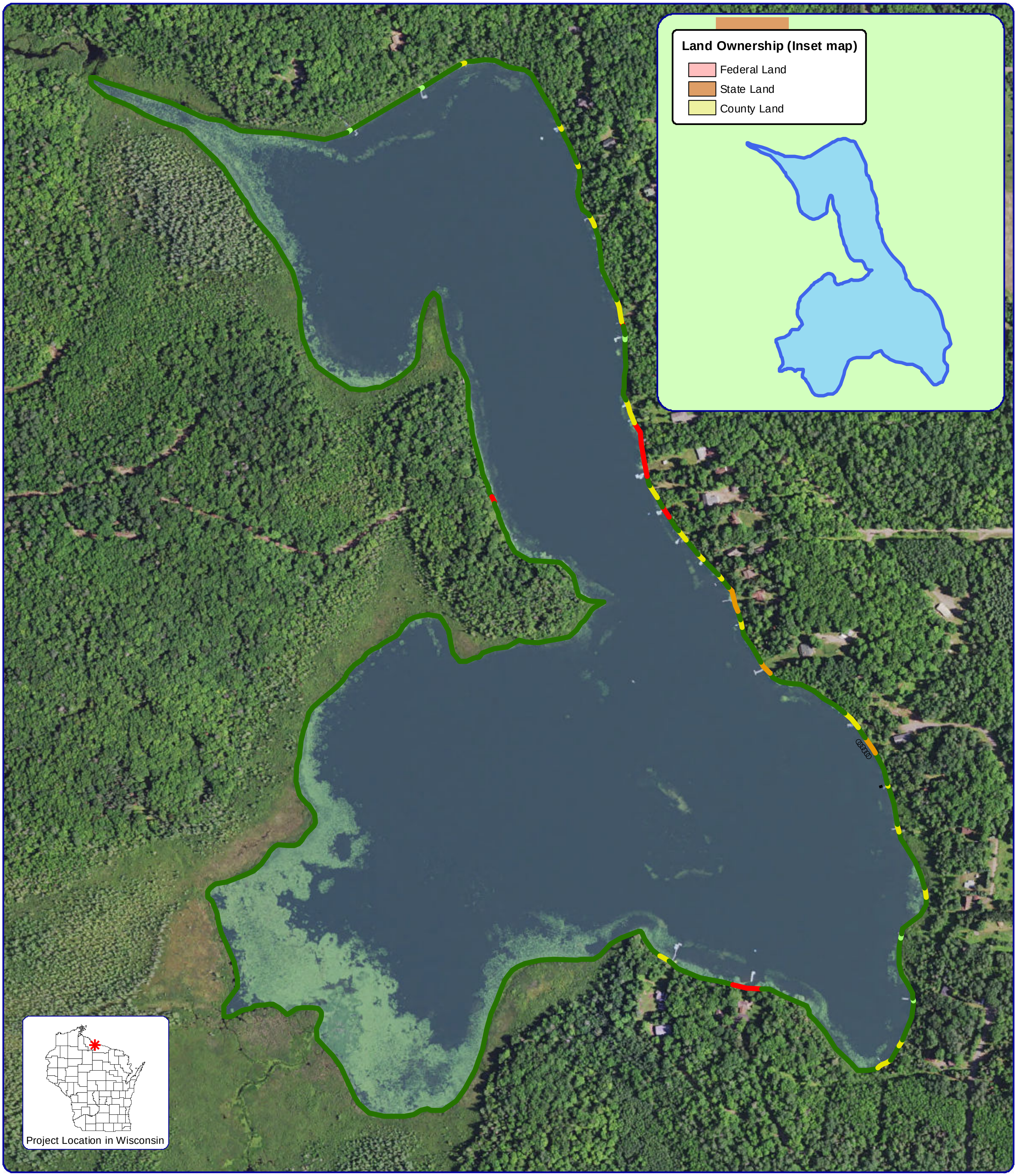
Sources:
Hydro: WDNR
Bathymetry: Onterra 2016
Orthophotography: NAIP 2015
Land Cover: NLCD 2011
Watershed Boundaries: Onterra 2016
Map Date: March 6, 2017
Filename: Map2_Rainbow_WS.mxd

Legend

- Rainbow Lake Entire Watershed
- Subwatershed Boundary
- Forest
- Forested Wetlands
- Pasture/Grass
- Rural Open Space
- Rural Residential
- Non-Forested Wetlands
- Open Water
- River/Stream

Rainbow Lake - Map 2
Town of Winchester
Vilas County, Wisconsin

Watershed Boundaries & Land Cover Types



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

Seawall

Masonry/Wood/Metal
Rip-Rap

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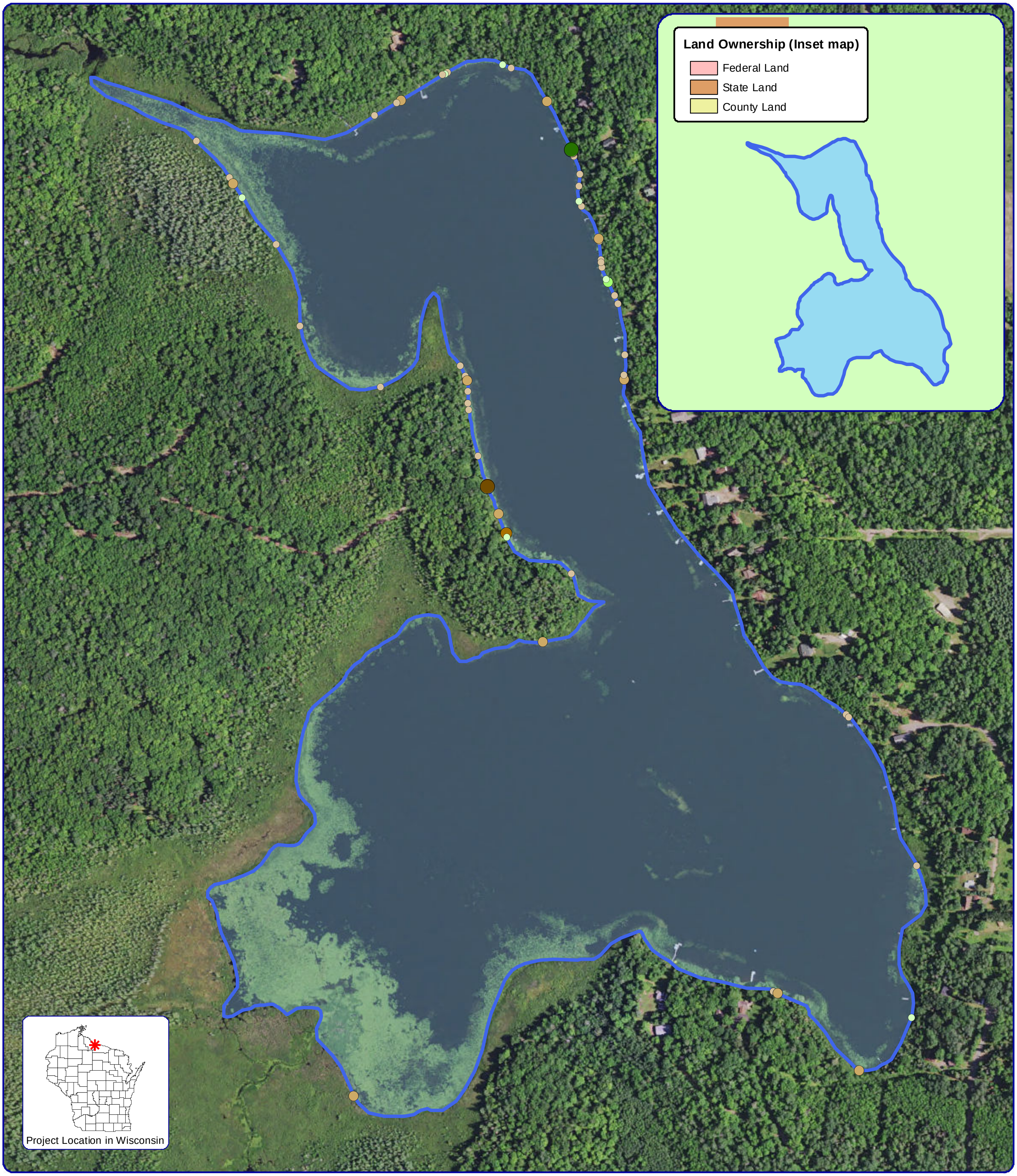
Sources:
Roads and Hyrdo: WDNR
Shoreland Condition: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map3_Rainbow_SA_2016.mxd

Rainbow Lake - Map 3

Town of Winchester
Vilas County, Wisconsin

2016 Shoreline Condition



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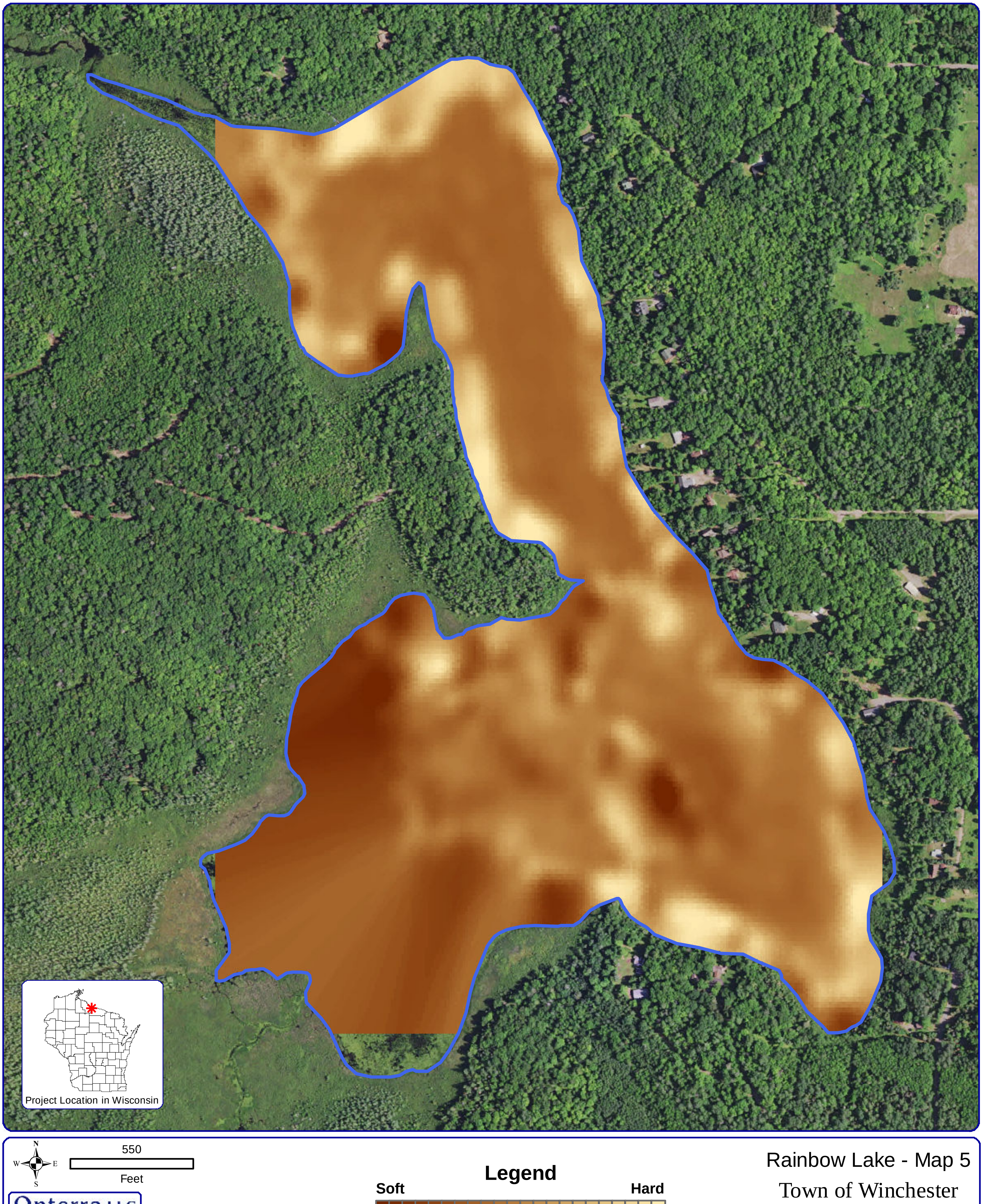
Sources:
Roads and Hyrdo: WDNR
Shoreland Condition: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map4_Rainbow_CWH_2016.mxd

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)

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



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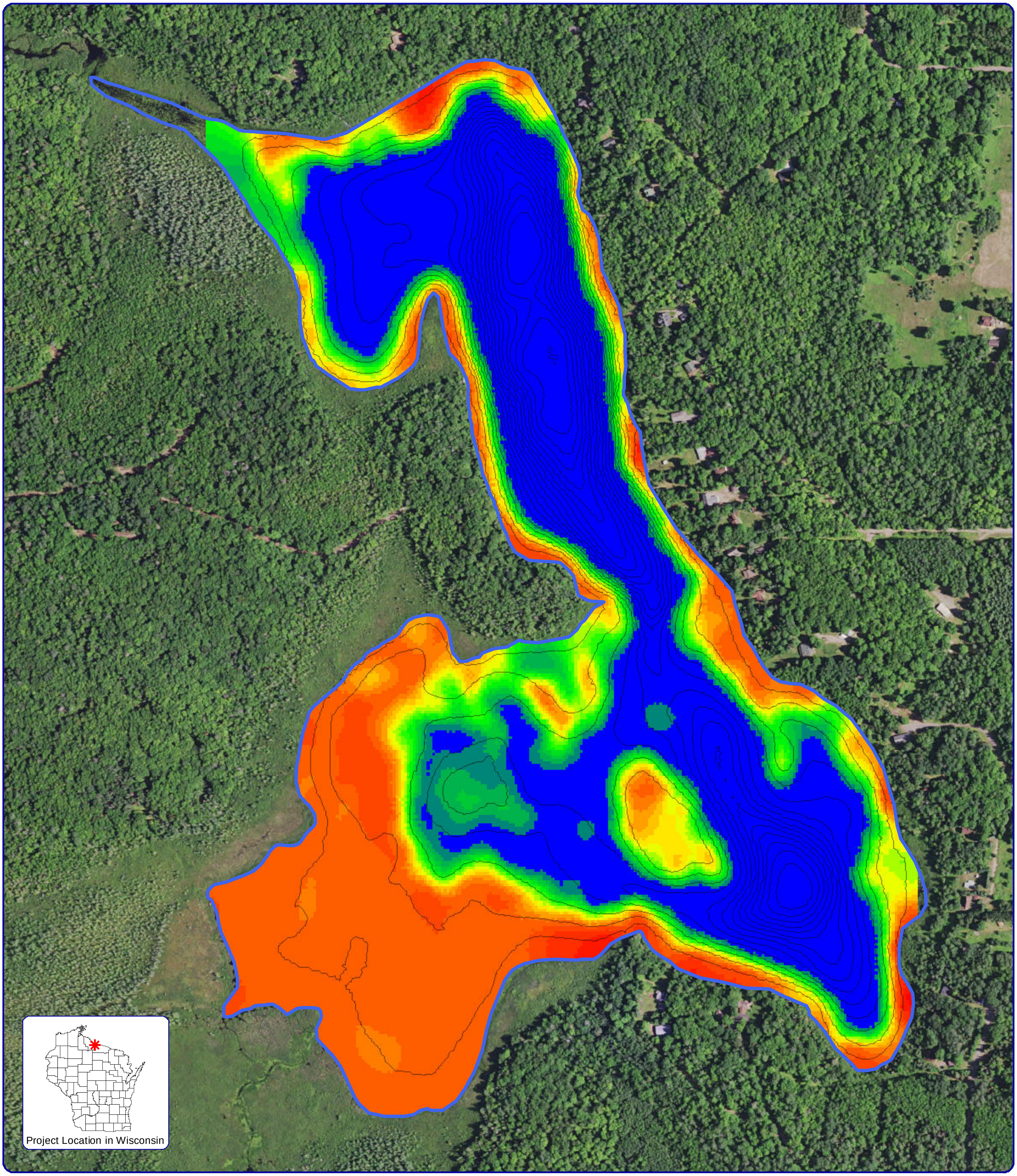
Sources:
Roads and Hyrdo: WDNR
Acoustic Survey: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map5_Rainbow_SubHard_2016.,mxd

Rainbow Lake - Map 5

Town of Winchester
Vilas County, Wisconsin

2016 Acoustic Survey: Substrate Hardness



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Sources:
Roads and Hyrdo: WDNR
Acoustic Survey: Onterra, 2016
Orthophotograph: NAIP 2015
Map Date: December 1, 2016
Filename: Map6_Rainbow_BioVol_2016.mxd

Legend

0% 50% 100%

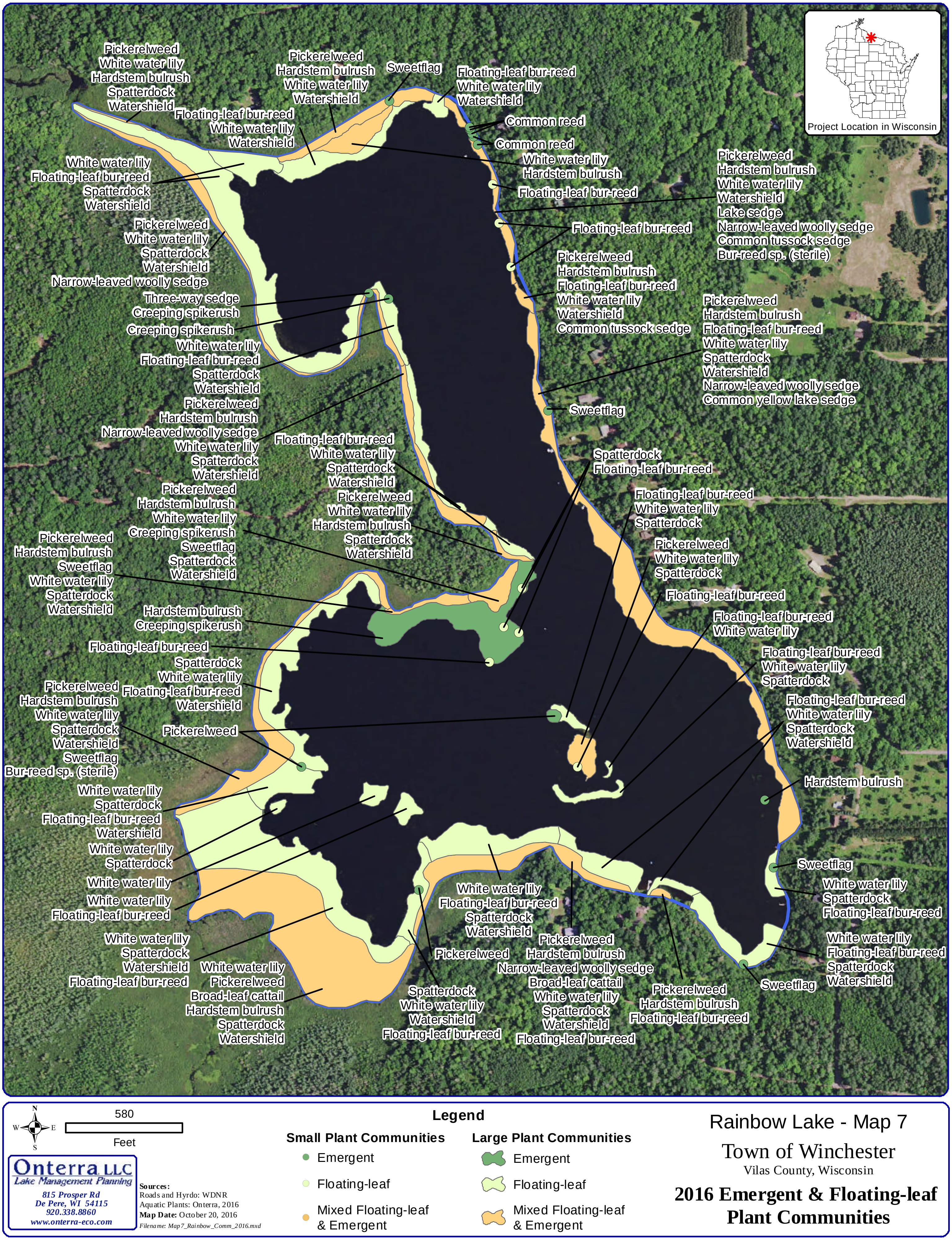
Aquatic Plant Bio-volume (%)

Rainbow Lake - Map 6

Town of Winchester

Vilas County, Wisconsin

2016 Acoustic Survey: Aquatic Plant Bio-Volume



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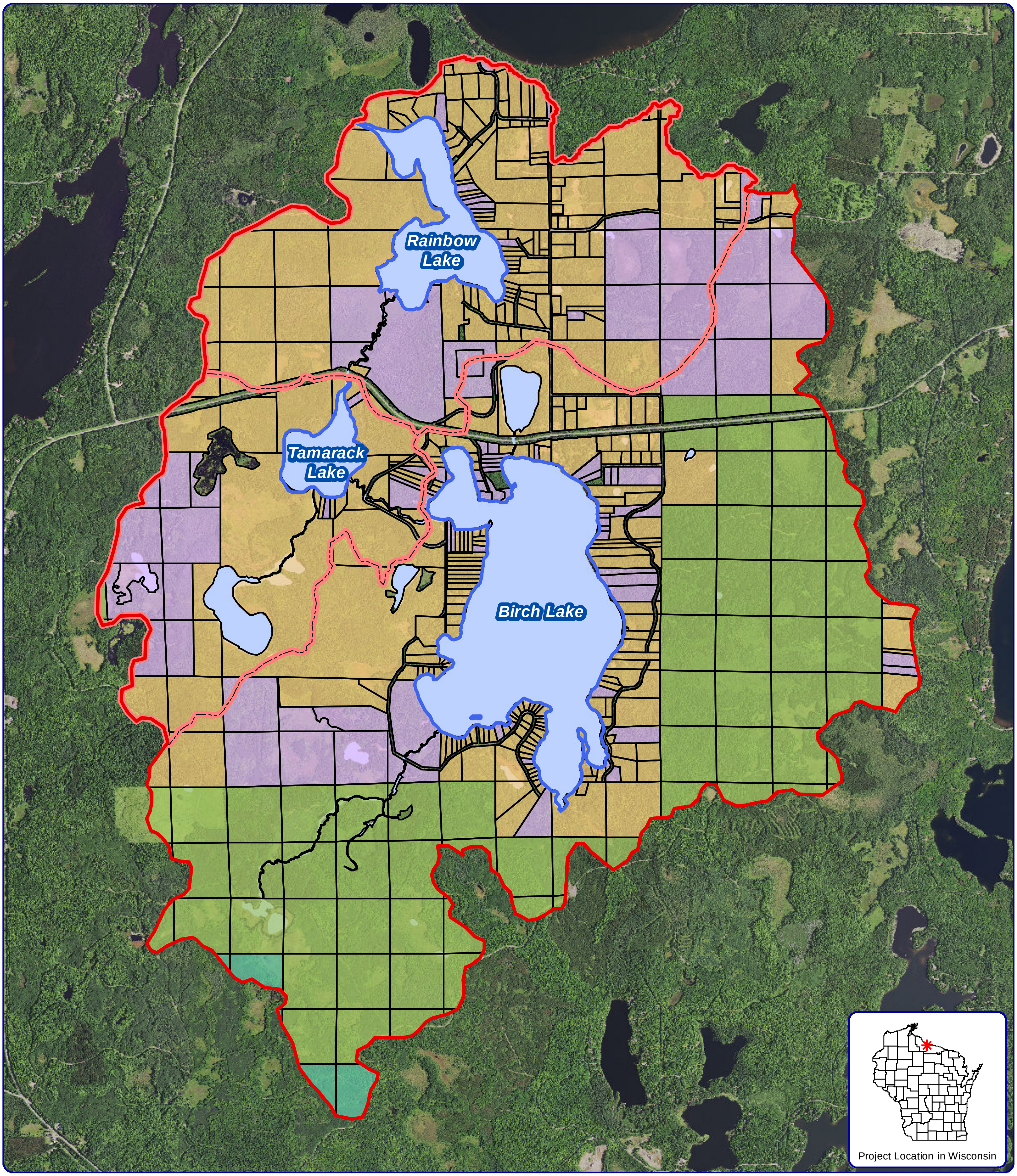
Sources:
Roads and Hyrdo: WDNR
Aquatic Plants: Onterra, 2016
Map Date: October 20, 2016
Filename: Map7_Rainbow_Comm_2016.mxd

Rainbow Lake - Map 7
Town of Winchester
Vilas County, Wisconsin
2016 Emergent & Floating-leaf Plant Communities



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Sources:
Hydro: WDNR
Orthophotography: NAIP 2015
Watershed Boundaries: Onterra 2016
Map Date: October 12, 2017
Filename: Map8_Rainbow_WS_LandOwnership.mxd

Phase II Lakes Watershed Boundary

Individual Lake Subwatershed Boundary

Legend

Privately-Owned Land

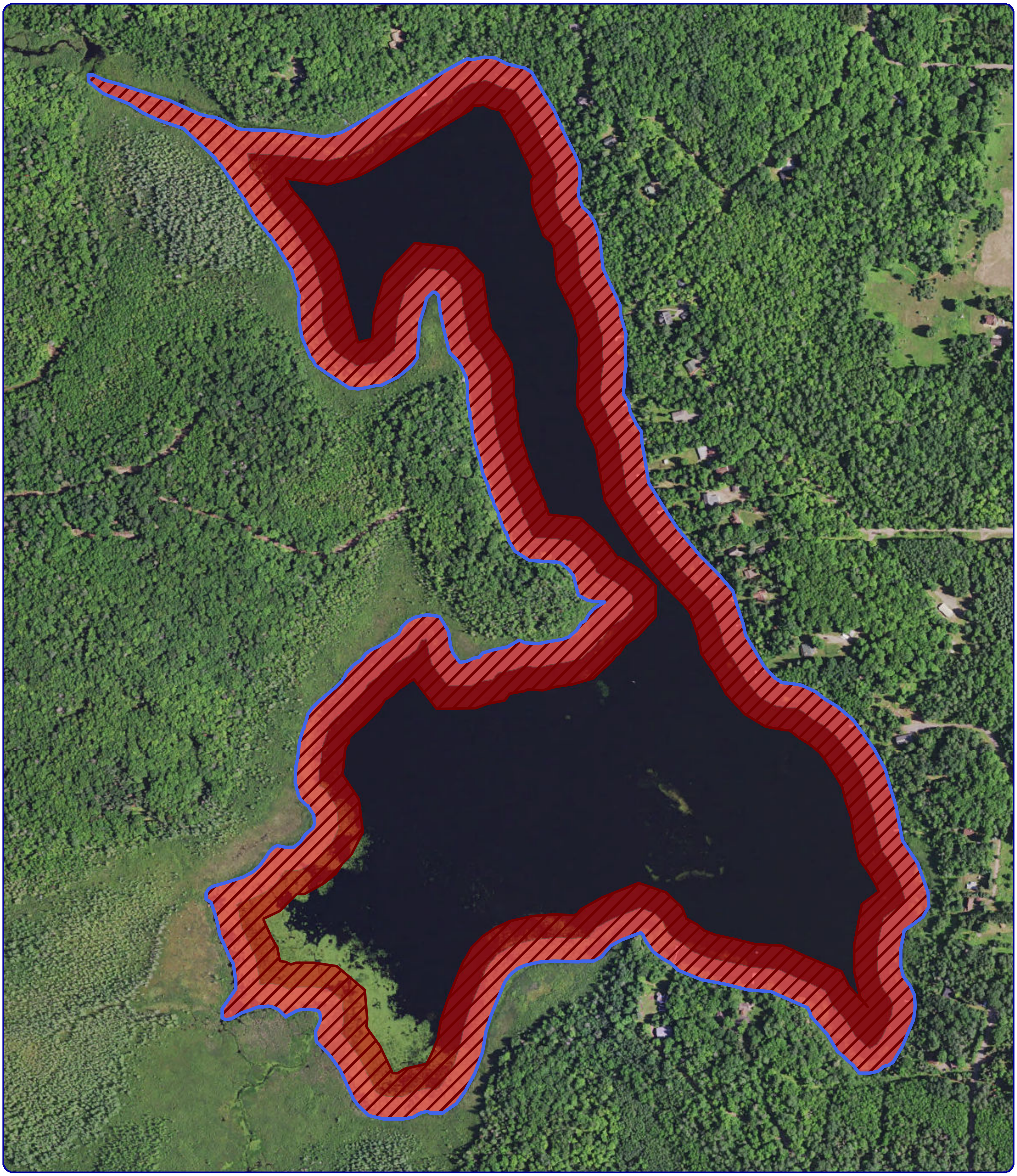
Privately-Owned Land Trust

The Forestland Group Heartwood Forestland Partnership

State-Owned Land

Rainbow Lake - Map 8
Town of Winchester
Vilas County, Wisconsin

Birch-Tamarack-Rainbow Lake Watershed Land Ownership



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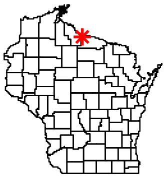
Sources:
Orthophotography: NAIP 2015
Map Date: October 5, 2017
Filename: Map9_Rainbow_WatercraftRegs.mxd



Project Location in Wisconsin

Legend

Boating
Slow/No Wake Area (100 feet)

Personal Watercraft
Slow/No Wake Area (200 feet)

Rainbow Lake - Map 9

Town of Winchester

Vilas County, Wisconsin

Watercraft Regulation Areas