8.10 Razorback Lake

An Introduction to Razorback Lake

Razorback Lake, Vilas County, is a 381-acre deep seepage lake with a maximum depth of 35 feet and a mean depth of 15 feet (Razorback Lake – Map 1). Its watershed encompasses approximately 876 acres within the St. Germain River Watershed and is comprised mainly of intact forests and wetlands. In 2019, 46 native aquatic plant species were located within the lake, of which stoneworts and slender naiad (*Najas flexilis*) were the most common.

Lake at a Glance - Razorback Lake

Morphometry	
Lake Type	Deep Seepage Lake
Surface Area (Acres)	381
Max Depth (feet)	35
Mean Depth (feet)	15
Perimeter (Miles)	6.3
Shoreline Complexity	5.2
Watershed Area (Acres)	876
Watershed to Lake Area Ratio	1:1

Water Quality	
Trophic State	Oligo-Mesotrophic
Limiting Nutrient	Phosphorus
Avg Summer P (μg/L)	11.3
Avg Summer Chl-α (μg/L)	4.7
Avg Summer Secchi Depth (ft)	13.5
Summer pH	7.7
Alkalinity (mg/L as $CaCO_3$)	22.5

Vegetation	
Number of Native Species	46
NHI-Listed Species	Vasey's pondweed (*Potamogeton vaseyi*)
Exotic Species	Reed canary grass (*Phalaris arundinacea*), Narrow-leaved cattail (*Typha angustifolia*)
Average Conservatism	7.0
Floristic Quality	35.0
Simpson's Diversity (1-D)	0.88

8.10.1 Razorback Lake Water Quality

Water quality data was collected from Razorback Lake on six occasions in 2019-2020. Onterra staff sampled the lake for water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen. Please note that the data in these graphs represent concentrations and depths taken during the growing season (April-October), summer months (June-August) or winter (February-March) as indicated with each dataset. Furthermore, unless otherwise noted the phosphorus and chlorophyll-*a* data represent only near-surface samples. In addition to sampling efforts completed in 2019-2020, any historical data were researched and are included within this report as available.

Near-surface total phosphorus data from Razorback Lake are available from 1989 and 2019 (Figure 8.10.1-1). The weighted summer average total phosphorus concentration is 11.3 μg/L and falls into the *excellent* category for deep seepage lakes in Wisconsin. Razorback Lake's summer average total phosphorus concentrations are lower than the median value for deep seepage lakes in the state (15.0 μg/L) and almost one half the median value for all lake types in the Northern Lakes and Forests (NLF) ecoregion (21.0 μg/L).

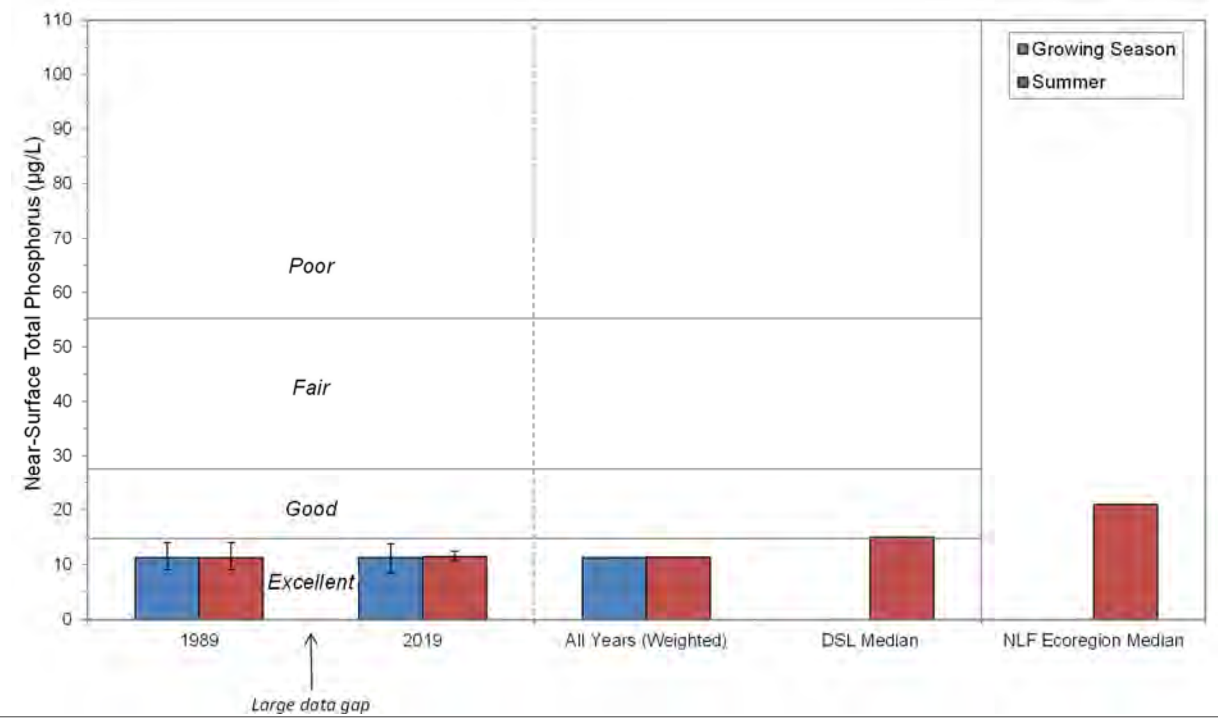


Figure 8.10.1-1. Razorback Lake, statewide deep seepage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Chlorophyll-*a* data are available from Razorback Lake from 1979, 1989 and 2019 (Figure 8.10.1-2). Razorback Lake's weighted summer average chlorophyll-*a* concentration is 4.7 µg/L and falls into the *good* category for deep seepage lakes in Wisconsin. Razorback Lake's weighted summer average chlorophyll-*a* concentration is slightly higher than the median value for deep seepage lakes in the state (3.6 µg/L) and lower than the median value of 5.6 µg/L for all lake types in the NLF ecoregion. As described in the Town-wide Water Quality Section (3.1), two suspect results (9.0 µg/L and 7.0 µg/L), which are considerably higher than other values from Razorback Lake were reported during August 1989. As discussed below, Razorback is phosphorus limited, so that nutrient controls the growth of algae within the lake. Correspondingly high phosphorus values were not recorded in August 1989, so the validity of the chlorophyll-*a* results is suspect. However, one possible factor, as reported by long-time Razorback resident and former National Weather Service Meteorologist, Mr. Jeff Raberding, the area was experiencing a severe drought during 1989, so that may have somehow played into higher-than-normal chlorophyll-*a* levels in the lake.

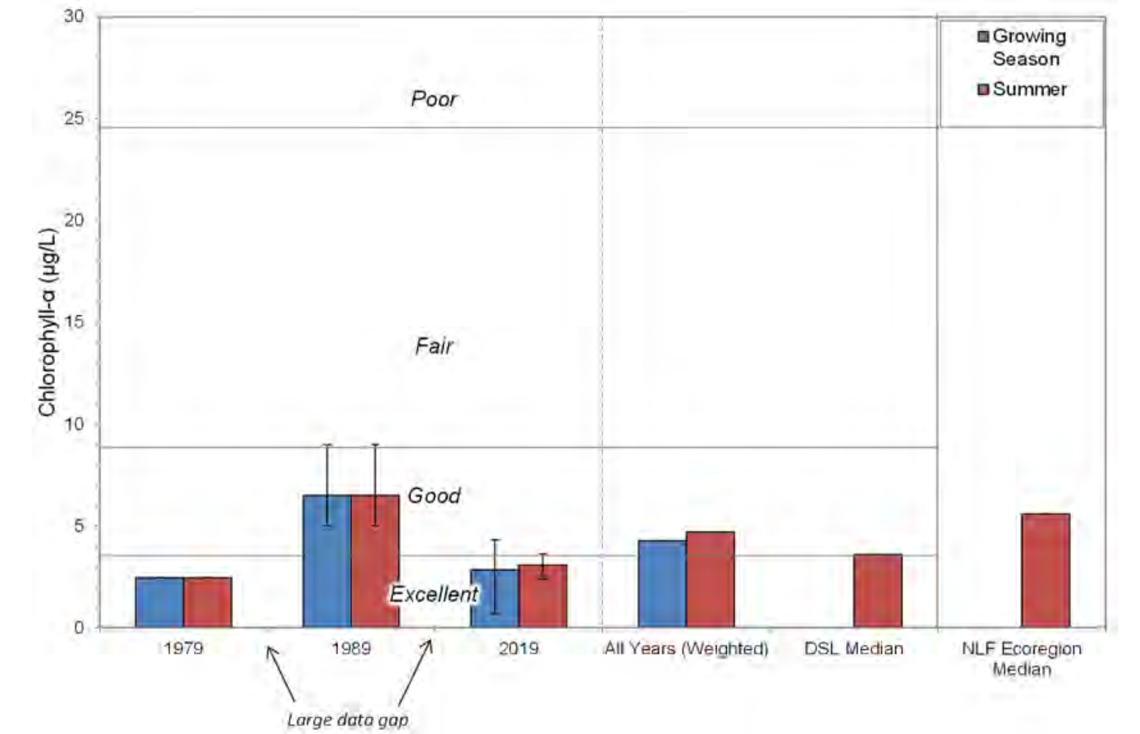


Figure 8.10.1-2. Razorback Lake, statewide deep seepage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Secchi disk transparency data are available from Razorback Lake from 1979 and 2019 (Figure 8.10.1-3). The weighted summer average Secchi disk depth is 13.5 feet and falls into the *excellent* category for deep seepage lakes in Wisconsin. Razorback Lake's weighted summer average Secchi disk depth is deeper than the median value of 11.2 feet for deep seepage lakes in the state and much better than the median value of 8.9 feet for all lake types in the NLF ecoregion.

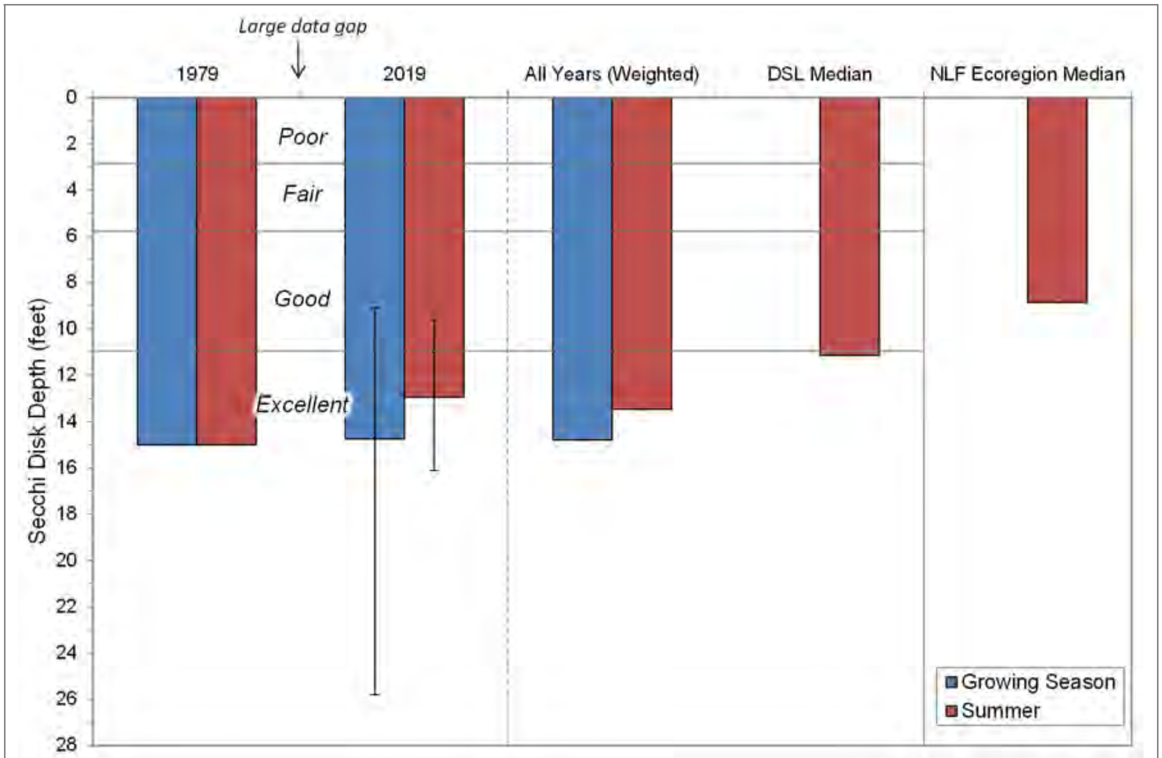


Figure 8.10.1-3. Razorback Lake, statewide deep seepage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Limiting Plant Nutrient of Razorback Lake

Using midsummer nitrogen and phosphorus concentrations from Razorback Lake, a nitrogen:phosphorus ratio of 31:1 was calculated. This finding indicates that Razorback Lake is indeed phosphorus limited as are the vast majority of Wisconsin lakes. In general, this means that cutting phosphorus inputs may limit plant growth within the lake.

Razorback Lake Trophic State

Figure 8.10.1-4 contains the Trophic State Index (TSI) values for Razorback Lake. These TSI values are calculated using summer near-surface total phosphorus, chlorophyll-*a*, and Secchi disk transparency data collected as part of this project along with available historical data. In general, the best values to use in assessing a lake's trophic state are chlorophyll-*a* and total phosphorus, as water clarity can be influenced by other factors other than phytoplankton such as dissolved organic compounds. The closer the calculated TSI values are 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 transparency) in Razorback Lake indicate the lake is on the border between oligotrophic and mesotrophic states. Razorback Lake's productivity is lower when compared to other deep seepage lakes in Wisconsin and all lake types within the NLF ecoregion.

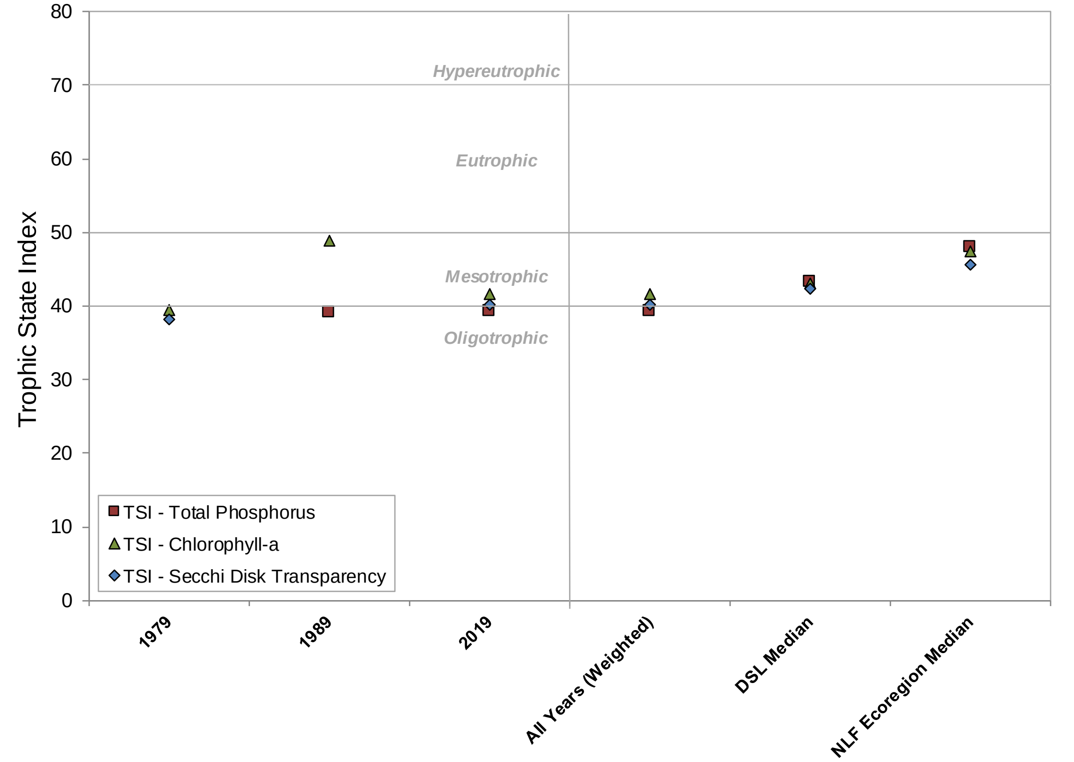


Figure 8.10.1-4. Razorback Lake, statewide deep seepage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Razorback Lake

Dissolved oxygen and temperature were measured during water quality sampling visits to Razorback Lake by Onterra staff. Profiles depicting these data are displayed in Figure 8.10.1-5.

Razorback Lake is a dimictic lake, meaning it mixes thoroughly during the spring and fall, when changing air temperatures and gusty winds help to mix the water column. During summer the lake is stratified and the very bottom of the lake becomes void of oxygen. During this time, bacteria break down organic matter that has collected at the bottom of the lake and in doing so utilize any available oxygen. (Figure 8.10.1-5).

During the winter months, the coldest temperatures are found just under the overlying ice, while oxygen gradually diminishes once again towards the bottom of the lake. In February of 2020, oxygen levels remained sufficient throughout most of the water column to support most aquatic life in northern Wisconsin lakes.

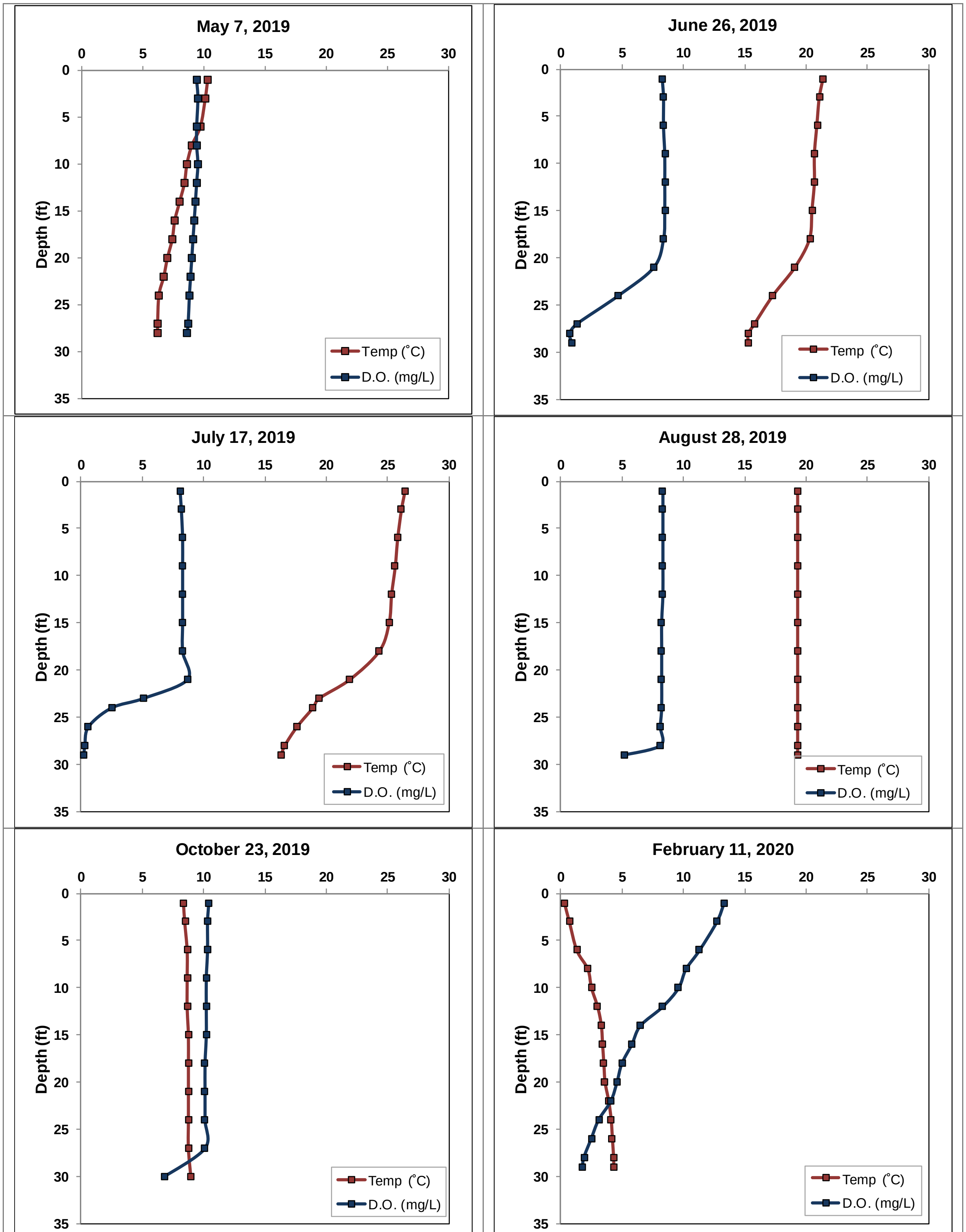


Figure 8.10.1-5. Razorback Lake 2019-2020 dissolved oxygen and temperature profiles.

8.10.2 Razorback Lake Watershed Assessment

The Upper Wisconsin watershed is approximately 1,714,568 acres (2,679 square miles) and includes portions of six counties. The watershed originates at Lac Vieux Desert, which is located in the upper Michigan peninsula and Vilas County in Wisconsin. Approximately 139 miles of the Wisconsin river flows through the Upper Wisconsin watershed before leaving the headwater basin approximately four miles south of Merrill. The Upper Wisconsin watershed is subdivided into seventeen sub-watersheds, with Razorback Lake and its watershed being located in the Saint Germain River sub-watershed (Figure 8.10.2-1 and Razorback Lake Map 2).

Code	Name	Acres
UW30	Prairie River	168,955
UW31	Copper River	65,949
UW32	New Wood River	74,070
UW33	Noisy and Pine Creeks	114,783
UW34	Spirit River	108,175
UW35	Somo River	90,435
UW36	Lower Tomahawk River	85,676
UW37	Middle Tomahawk River	149,313
UW38	Upper Tomahawk River	119,569
UW39	Woodboro	39,671
UW40	Pelican River	169,524
UW41	Rhinelander Flowage	76,610
UW42	Sugar Camp Creek	120,316
UW43	St Germain River	44,872
UW44	Eagle River	116,286
UW45	Tamarack Pioneer River	133,954
UW46	Deerskin River	36,410
Total		**1,714,568**

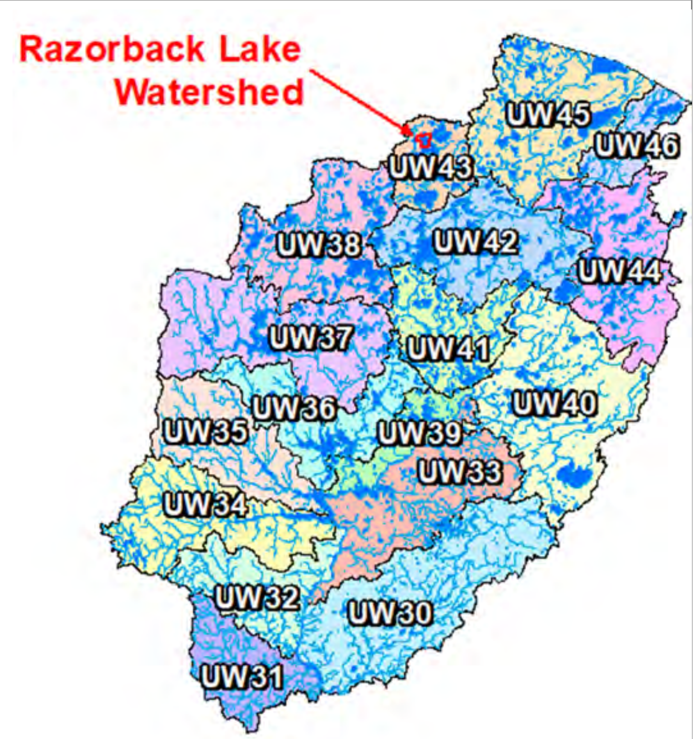


Figure 8.10.2-1. Upper Wisconsin River Watershed.

Razorback Lake's watershed encompasses an area of approximately 876 acres, yielding a very small watershed to lake area ratio of 2:1 (Figure 8.10.2-2, Razorback Lake Map 2). According to WiLMS modeling, the lake's water residence time is 7.4 years, meaning the lake water is replaced approximately 0.13 times per year (flushing rate).

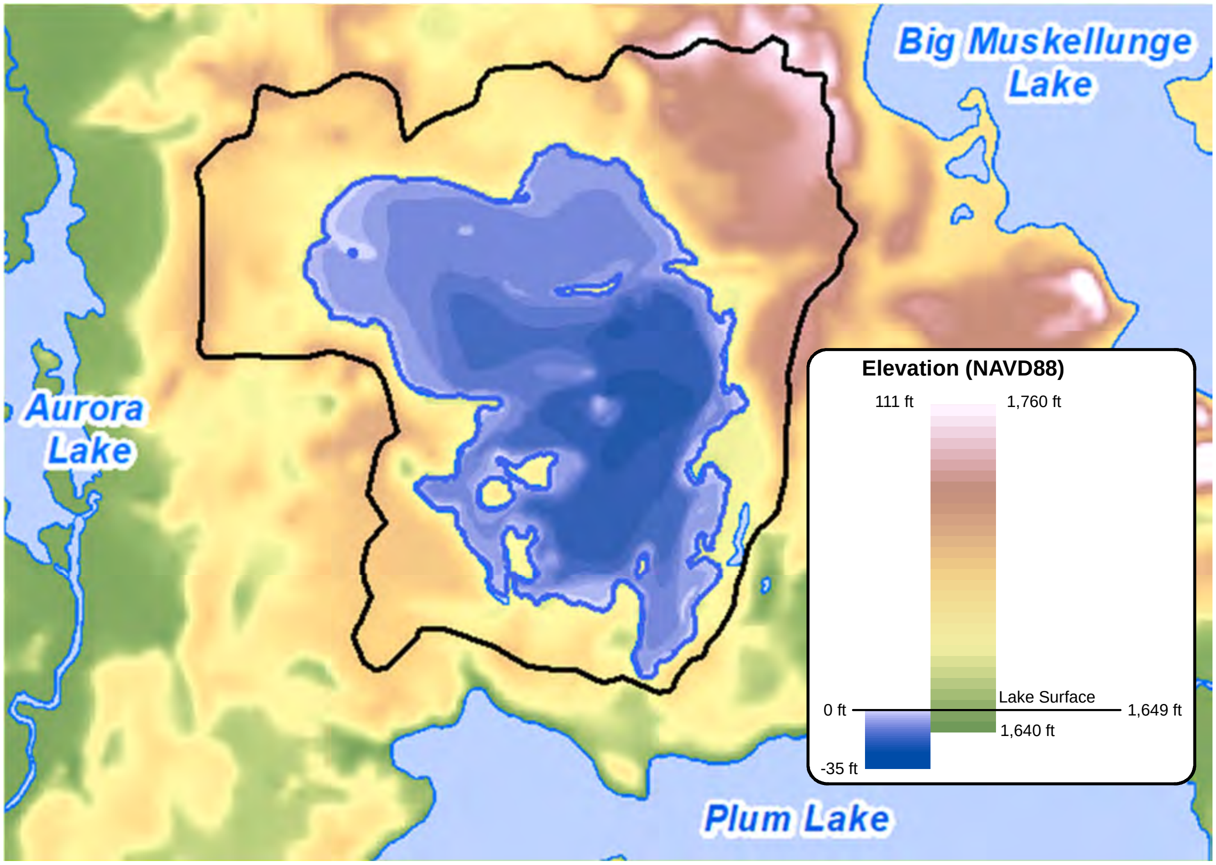


Figure 8.10.2-2. Razorback Lake watershed outline (black) with elevation.

Approximately 43% of Razorback Lake's watershed is composed of the lake's surface itself, 42% of forest, 9% of wetlands, and 6% of pasture/grass (Figure 8.10.2-3).

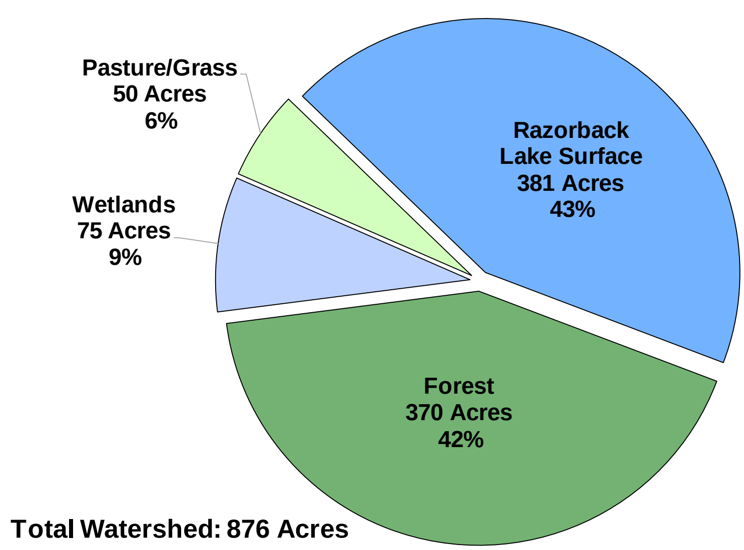


Figure 8.10.2-3. Razorback Lake watershed land cover types in acres. Based upon National Land Cover Database (NLCD – Fry et. al 2016).

Using the land cover data described above, WiLMS was utilized to estimate the annual potential phosphorus load from Razorback Lake's watershed. It was estimated that approximately 111 pounds of phosphorus is delivered to Razorback Lake from its watershed on an annual basis (Figure 8.10.2-4).

Of the estimated 111 pounds of phosphorus being delivered annually to Razorback Lake, 59 pounds (54%) is estimated to originate from direct atmospheric deposition onto the lake surface, 29 pounds (26%) from forests, 13 pounds (12%) from grasslands, 7 pounds (6%) from wetlands, and 3 pounds (2%) is from lakeshore septic systems (Figure 8.10.2-4).

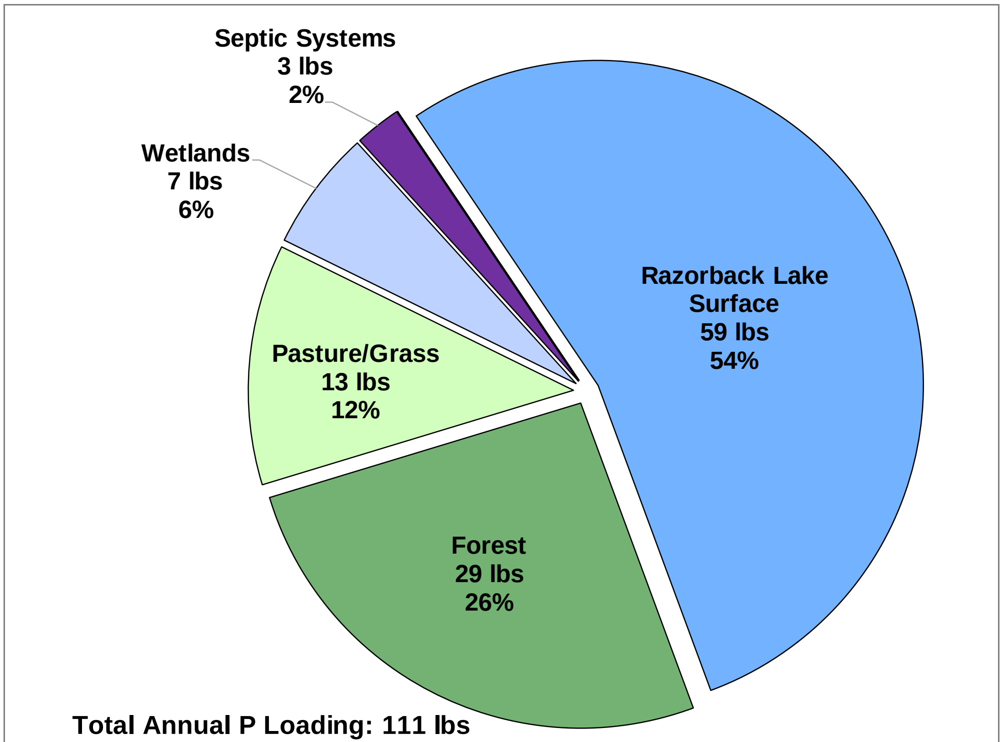


Figure 8.10.2-4. Razorback Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Using predictive equations, WiLMS estimated that based on the 111 pounds of phosphorus which are loaded to Razorback Lake annually, the lake should have an in-lake growing season mean (GSM) total phosphorus concentration of approximately 17 µg/L. This predicted GSM total phosphorus concentration is higher than the measured GSM concentration of 11 µg/L. The discrepancy between predicted and measured total phosphorus concentrations likely means that either less phosphorus is entering the lake than estimated or that some of the phosphorus is being incorporated into the macrophytes, e.g. wild rice. The latter is most likely the reason since Razorback Lake has a substantial wild rice population most years. There is a significant benthic algal community associated with the rice which would remove phosphorus from the water column.

8.10.3 Razorback Lake Shoreland Condition

Shoreland Development

As mentioned previously in the Town-wide Shoreland Condition Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In the fall of 2019, Razorback Lake's immediate shoreline was assessed in terms of its development. Razorback Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 5.7 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.10.3-1). This constitutes about 90% of Razorback Lake's shoreline. These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 0.3 miles of urbanized and developed–unnatural shoreline (5%) was observed. If restoration of the Razorback Lake shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. Razorback Lake - Map 3 displays the location of these shoreline lengths around the entire lake.

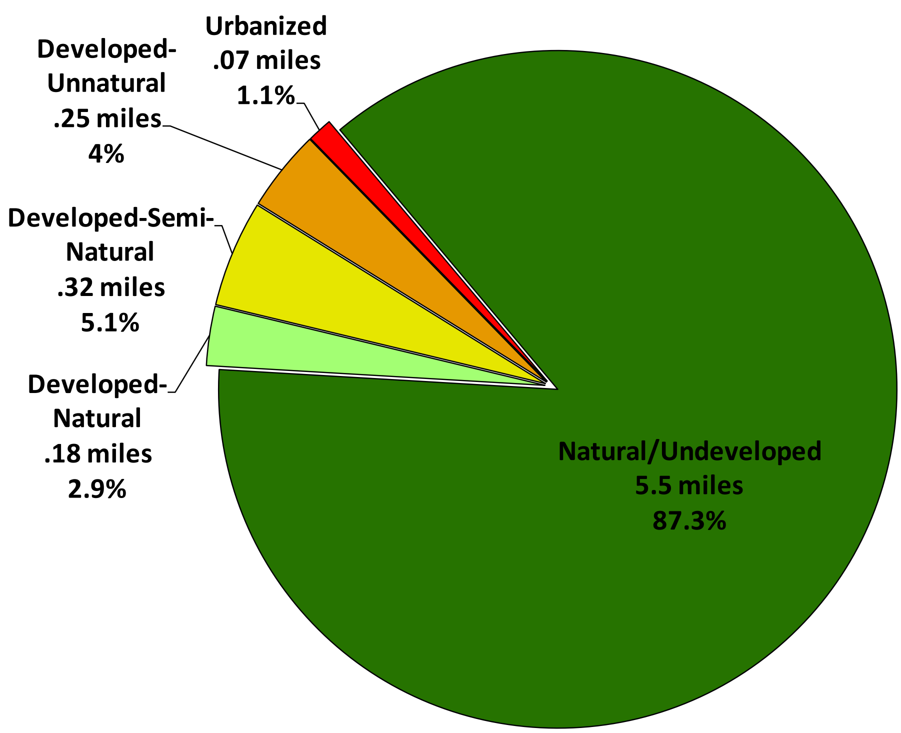


Figure 8.10.3-1. Razorback Lake shoreland categories and total lengths. Based upon a fall 2019 survey. Locations of these categorized shorelands can be found on Razorback Lake - Map 3.

Coarse Woody Habitat

A survey for coarse woody habitat was conducted in conjunction with the shoreland assessment (development) survey. Coarse woody habitat was identified, and classified in three size categories (2-8 inches in diameter, >8 inches in diameter, and cluster of pieces) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed earlier, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance (Newbrey et al. 2005).

During this survey, 420 total pieces of coarse woody habitat were observed along 6.3 miles of shoreline (Razorback Lake - Map 4), which gives Razorback Lake a coarse woody habitat to shoreline mile ratio of 66:1 (Figure 8.10.3-2). Only instances where emergent coarse woody habitat extended from shore into the water were recorded during the survey. Of the 420 total pieces of coarse woody habitat observed during the survey, 379 pieces were 2-8 inches in diameters, 41 were 8 inches in diameter or greater, and no clusters of pieces of coarse woody habitat were found.

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

Onterra has completed coarse woody habitat surveys on 111 lakes throughout Wisconsin since 2012, with the majority occurring in the NLF ecoregion on lakes with public access. The number of coarse woody habitat pieces per shoreline mile in Razorback Lake fell in the 95th percentile of these 111 lakes (Figure 8.10.3-2).

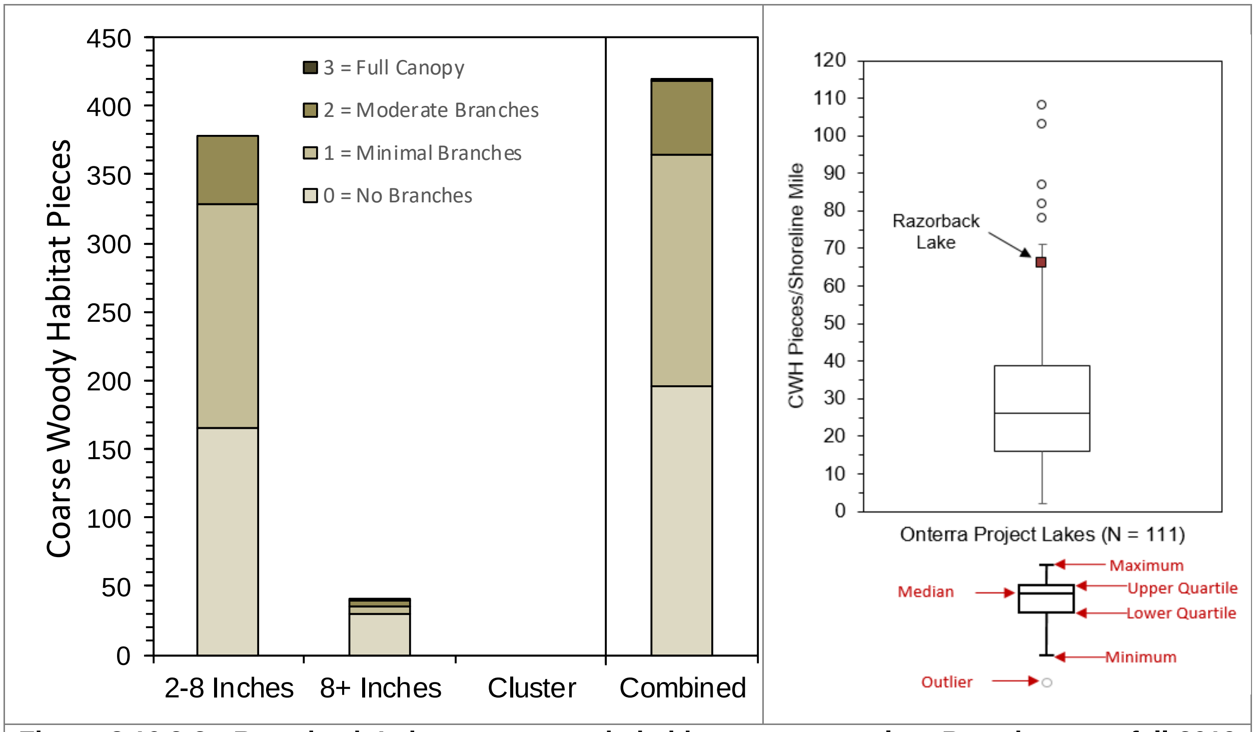


Figure 8.10.3-2. Razorback Lake coarse woody habitat survey results. Based upon a fall 2019 survey. Locations of Razorback Lake coarse woody habitat can be found on Razorback Lake - Map 4.

8.10.4 Razorback Lake Aquatic Vegetation

An Early-Season Aquatic Invasive Species (ESAIS) Survey was conducted by Onterra ecologists on Razorback Lake on June 25, 2019. While the intent of this survey is to locate any potential non-native species within the lake, the primary focus is to locate potential occurrences of the non-native curly-leaf pondweed, which should be at or near its peak growth at this time. No aquatic invasive species were located during this survey.

Photograph 8.10.4-1. Razorback Lake

The whole-lake aquatic plant point-intercept survey was conducted on Razorback Lake by Onterra ecologists on July 31, 2019. The emergent and floating-leaf aquatic plant community mapping survey was also completed by Onterra on July 31, 2019. During these surveys, a total of 46 native aquatic plant species were located (Table 8.10.4-1). Two species of exotic emergent plants were located as well – reed canary grass and narrow-leaved cattail. Information regarding these non-native species can be found in the following section, 8.10.5.

As discussed in the primer section, sediment data were collected at each sampling location within the littoral zone during the point-intercept survey. Approximately 50% of the point-intercept locations within littoral areas contained fine, organic sediments (muck), 32% contained sand, and 18% contained rock (Figure 8.10.4-1). All three substrate types were found around the perimeter of Razorback Lake (Razorback Lake - Map 5). Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in mucky substrates, others only in sandy areas, and some can be found growing in either. Lakes that have varying substrate types generally support a higher number of plant species because of the different habitat types that are available.

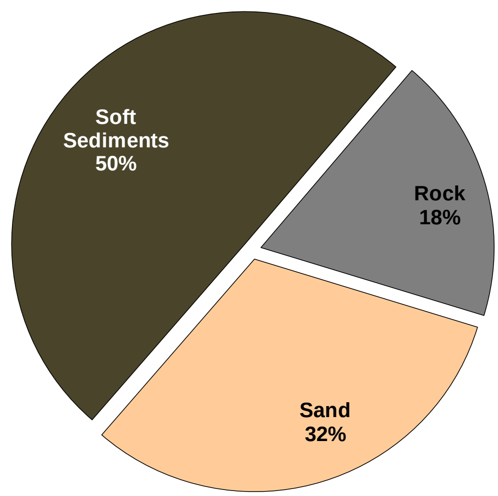


Figure 8.10.4-1. Razorback Lake 2019 proportion of substrate types. Created from data collected during the 2019 whole-lake point-intercept survey (N = 335).

Table 8.10.4-1. List of aquatic plant species located in Razorback Lake during Onterra 2019 aquatic plant surveys.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2019 (Onterra)
Emergent	*Calamagrostis canadensis*	Bluejoint grass	5	I
	Carex aquatilis	Long-bracted tussock sedge	7	I
	Carex comosa	Bristly sedge	5	I
	Carex crinita	Fringed sedge	6	I
	Carex hystericina	Porcupine sedge	3	I
	Carex utriculata	Common yellow lake sedge	7	I
	Cladium mariscoides	Smooth sawgrass	10	I
	Dulichium arundinaceum	Three-way sedge	9	X
	Equisetum fluviatile	Water horsetail	7	I
	Eleocharis palustris	Creeping spikerush	6	X
	Iris sp.	Iris sp.	N/A	I
	Iris versicolor	Northern blue flag	5	I
	Phalaris arundinacea	Reed canary grass	Exotic	I
	Phragmites australis subsp. americanus	Common reed	5	I
	Sagittaria latifolia	Common arrowhead	3	I
	Scirpus atrocinctus	Black-girdled wool grass	7	I
	Scirpus cyperinus	Wool grass	4	I
	Sparganium americanum	American bur-reed	8	I
	Sparganium androcladum	Shining bur-reed	8	I
	Schoenoplectus tabernaemontani	Softstem bulrush	4	X
	Typha latifolia	Broad-leaved cattail	1	I
	Typha angustifolia	Narrow-leaved cattail	Exotic	X
FL	*Nuphar variegata*	Spatterdock	6	X
	Nymphaea odorata	White water lily	6	X
	Persicaria amphibia	Water smartweed	5	I
Submergent	*Chara spp.*	Muskgrasses	7	X
	Elatine minima	Waterwort	9	X
	Eriocaulon aquaticum	Pipewort	9	X
	Elodea canadensis	Common waterweed	3	X
	Myriophyllum tenellum	Dwarf watermilfoil	10	X
	Najas gracillima	Northern naiad	7	X
	Najas flexilis	Slender naiad	6	X
	Nitella spp.	Stoneworts	7	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X
	Potamogeton berchtoldii	Slender pondweed	7	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	X
	Potamogeton foliosus	Leafy pondweed	6	X
	Potamogeton gramineus	Variable-leaf pondweed	7	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X
	Potamogeton robbinsii	Fern-leaf pondweed	8	X
	Potamogeton spirillus	Spiral-fruited pondweed	8	I
	*Potamogeton vaseyi**	Vasey's pondweed	10	X
	Ranunculus flammula	Creeping spearwort	9	X
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	N/A	I
	Utricularia vulgaris	Common bladderwort	7	I
	Vallisneria americana	Wild celery	6	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	X
	Juncus pelocarpus	Brown-fruited rush	8	X

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

Of the 517 point-intercept sampling locations that fell at or below the maximum depth of plant growth in 2019, approximately 48% contained aquatic vegetation. Razorback Lake – Map 6 displays the point-intercept locations that contained aquatic vegetation in 2019, and the total rake fullness ratings at those locations. Twenty-nine percent of the point-intercept locations had a total rake fullness (TRF) rating of 1, 12% had a total rake fullness rating of 2, and 7% had the highest total rake fullness rating of 3 (Figure 8.10.4-2). Fifty-two percent of the littoral zone had no vegetation. The large percentage of sampling points that had either no vegetation or the lowest TRF rating of 1 means that where plants are found on Razorback Lake, they are very sparse.

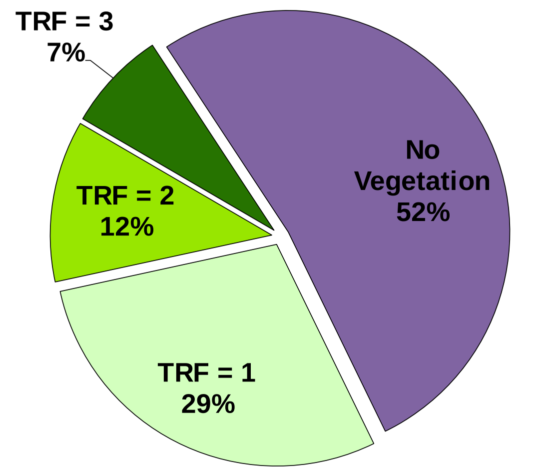


Figure 8.10.4-2. Razorback Lake 2019 aquatic vegetation total rake fullness ratings (TRF). Created from data collected during the 2019 whole-lake point-intercept survey (N = 517).

Of the 46 native aquatic plant species located in Razorback Lake in 2019, 25 were encountered directly on the rake (Figure 8.10.4-3). The remaining 21 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 25 species directly sampled with the rake during the point-intercept survey, stoneworts, slender naiad, clasping-leaf pondweed, and muskgrasses were the four most frequently encountered plants, respectively (Figure 8.10.4-3).

While not a true plant, but a type of macroalgae, stoneworts were the most commonly encountered species in Razorback Lake in 2019, with a littoral occurrence of 22.2% (Figure 8.10.4-3). Stoneworts have whorls of forked branches attached to its “stems” which are long, slender, smooth-textured algae. Because they lack roots, stoneworts remove nutrients directly from the water.

Slender naiad, the second most abundant aquatic plant in Razorback Lake in 2019 with a littoral occurrence of 17.6% (Figure 8.10.4-3), is one of three native naiads that can be found in Wisconsin. Being an annual, it produces numerous seeds on an annual basis and is considered to be one of the most important food sources for a number of migratory waterfowl species (Borman et al. 1997). In addition, slender naiad’s small, condensed network of leaves provide excellent habitat for aquatic invertebrates.

Clasping-leaf pondweed was the third-most frequently encountered aquatic plant in Razorback Lake in 2019 with a littoral frequency of occurrence of 14.7% (Figure 8.10.4-3). As its name indicates, the submersed leaves of clasping-leaf pondweed clasp or partially wrap around the stem. Clasping-leaf pondweed is often found growing over harder substrates and is tolerant of low-light conditions, often one of the more abundant plants in lakes with stained water in northern Wisconsin. Clasping-leaf pondweed superficially resembles the non-native curly-leaf pondweed and is often misidentified as such. However, the leaf margins of curly-leaf pondweed are serrated where the leaves of clasping-leaf pondweed lack serration. Like other native aquatic plants, clasping-leaf pondweed provides important structural habitat, stabilizes bottom sediments, and its fruits and rhizomes are important sources of food for wildlife.

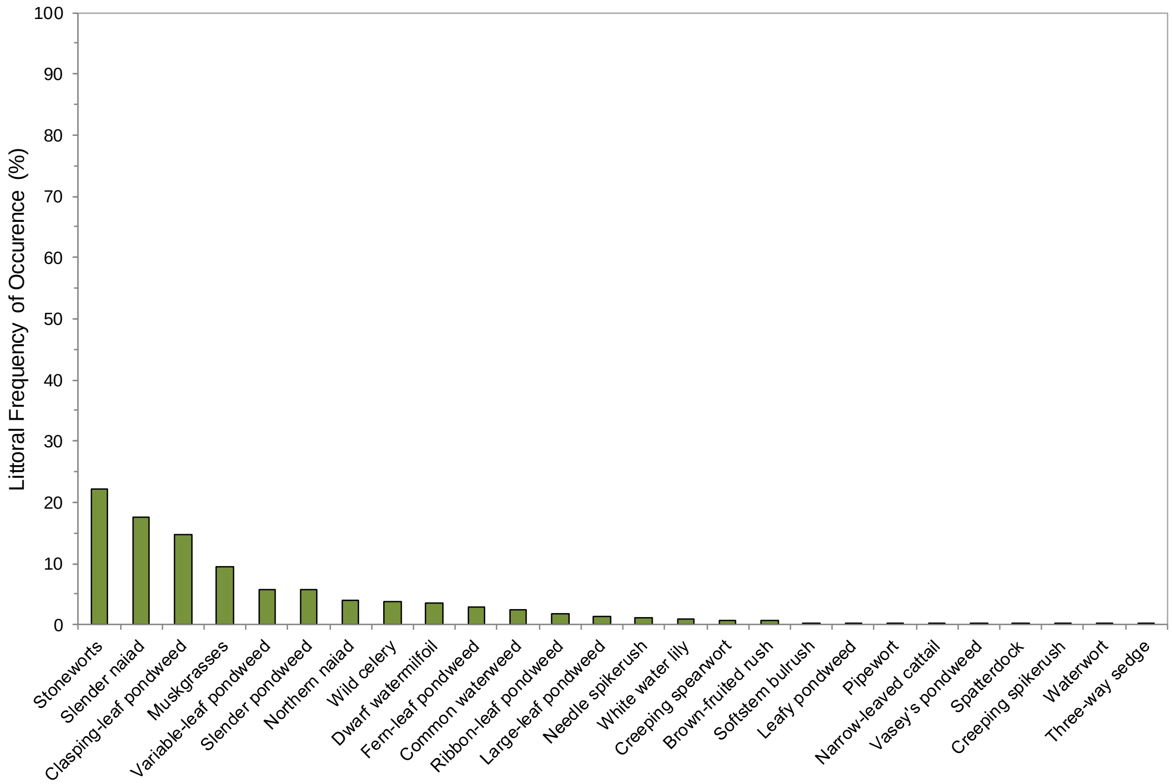


Figure 8.10.4-3. Razorback Lake 2019 littoral frequency of occurrence of aquatic plant species. Created using data from the 2019 whole-lake point-intercept survey.

Muskgrasses, like stoneworts, are a genus of macroalgae of which there are seven species in Wisconsin. In 2019, muskgrasses had a littoral frequency of occurrence of approximately 9.5% in Razorback Lake. Muskgrasses require lakes with good water clarity, and their large beds stabilize bottom sediments. Studies have also shown that muskgrasses sequester phosphorus in the calcium carbonate incrustations which from on these plants, aiding in improving water quality by making the phosphorus unavailable to phytoplankton (Coops 2002).

Vasey's pondweed (*Potamogeton vaseyi*), which is a special concern plant species in Wisconsin, was found on one point during the point-intercept survey in Razorback Lake. This species is listed by the Natural Heritage Inventory (NHI) due to uncertainty regarding its population and rarity in the state (WDNR PUBL-ER-001 2014). The locations of Vasey's pondweed are currently being tracked by the Wisconsin NHI to determine if it requires further listing as either threatened or endangered. Vasey's pondweed has very fine and slender leaves which alternate

Photograph 8.10.4-2. Flowers and floating-leaves of Vasey's pondweed. Photo credit Onterra.

on the stem (Photograph 8.10.4-2). Upon reaching the surface, the plant produces small oval-shaped floating-leaves which aid in holding the flower stalk above the surface. It prefers water with lower alkalinity and a moderate pH range (Nichols 1999). This delicate plant requires high-quality conditions to survive, and its presence within Razorback Lake is indicative of an environment with minimal disturbance.

As discussed in the Town-wide section, the calculations used to create the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and do not include incidental species. The native species encountered on the rake during the 2019 point-intercept survey and their conservatism values were used to calculate the FQI of Razorback Lake's aquatic plant community (equation shown below).

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

Figure 8.10.4-4 compares 2019 FQI components of Razorback Lake to median values of lakes within the Northern Lakes and Forests (NLF) ecoregion and lakes throughout Wisconsin. The number of native aquatic plant species encountered on the rake, or native species richness, was 25 for the 2019 survey. Razorback Lake's species richness is above the median value for lakes within the ecoregion and the state.

Razorback Lake's average conservatism in 2019 was 7.0 (Figure 8.10.4-4). This value is slightly higher than the median values for lakes in the ecoregion and throughout Wisconsin, which indicates Razorback Lake's aquatic plant community contains a higher than average number of aquatic plants that are considered to be sensitive to environmental degradation and require high-quality habitats. Given Razorback Lake's higher native species richness and conservatism values from 2019, Razorback Lake has a higher Floristic Quality Index value of 35. This FQI value is above the median values for lakes in the ecoregion and the state, and indicates that Razorback Lake's aquatic plant community is of higher quality than the majority of lakes throughout Wisconsin.

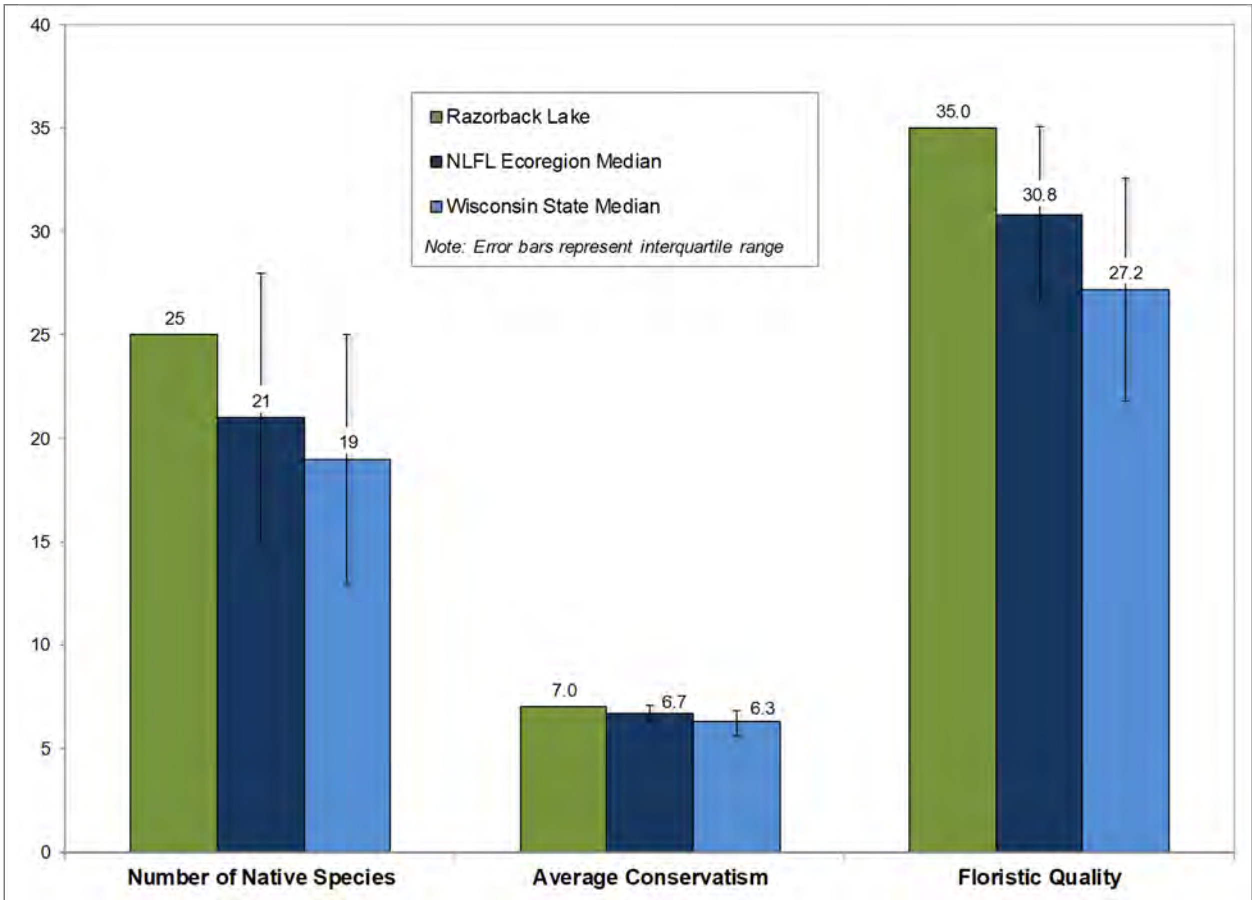


Figure 8.10.4-4. Razorback Lake Floristic Quality Assessment. Created using data from Onterra 2019 whole-lake point-intercept survey. Analysis follows Nichols (1999).

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

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Razorback Lake's diversity value ranks. Using data collected by Onterra and WDNR Science Services, quartiles were calculated for 212 lakes within the NLF ecoregion (Figure 8.10.4-5). Using the data collected from the 2019 point-intercept survey, Razorback Lake's aquatic plant community is shown to have an average species diversity with a Simpson's Diversity Index value of 0.88. In other words, if two individual aquatic plants were randomly sampled from Razorback Lake in 2019, there would be an 88% probability that they would be different species. This diversity value matches the median for the ecoregion and falls just slightly above the median for lakes throughout the state.

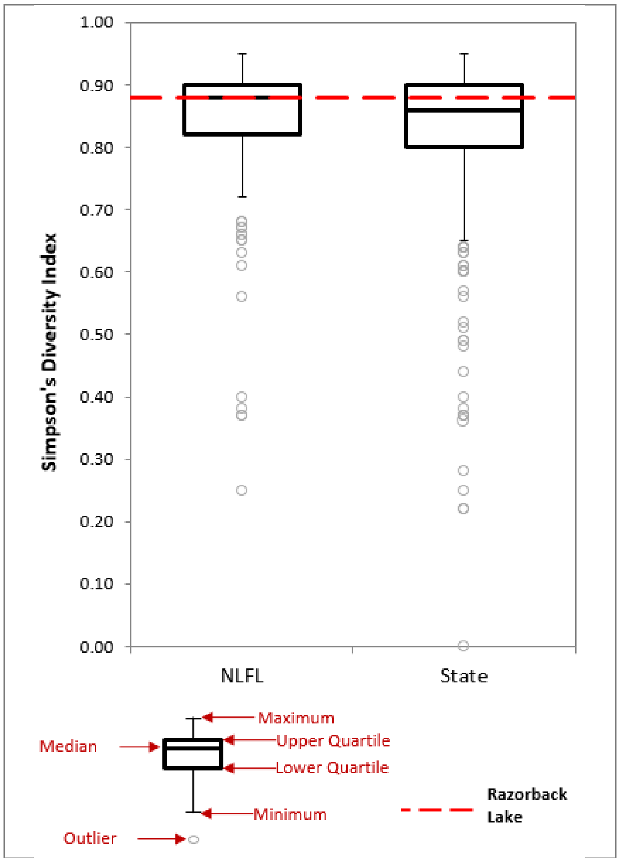


Figure 8.10.4-5. Razorback Lake species diversity index. Created using data from the Onterra 2019 point-intercept survey.

One way to visualize Razorback Lake's species diversity is to look at the relative occurrence of aquatic plant species. Figure 8.10.4-6 displays the relative frequency of occurrence of aquatic plant species created from the 2019 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 stoneworts were found at 22.2% of the littoral sampling locations in Razorback Lake in 2019, its relative frequency of occurrence is 21.9%.

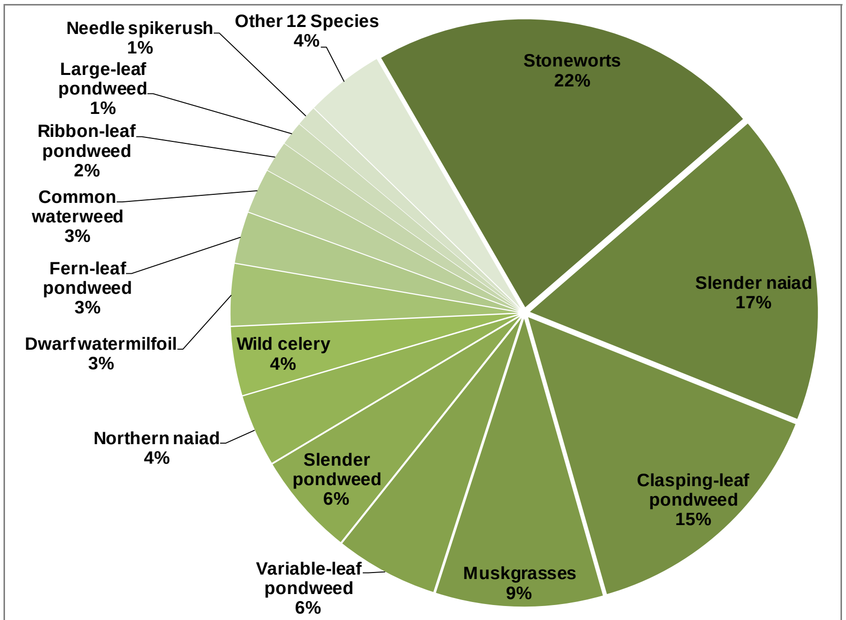


Figure 8.10.4-6. Razorback Lake 2019 relative frequency of occurrence of aquatic plant species. Created using data from 2019 point-intercept survey.

Explained another way, if 100 plants were randomly sampled from Razorback Lake in 2019, 22 of them would be stoneworts.

In 2019, Onterra ecologists also conducted a survey aimed at mapping emergent and floating-leaf aquatic plant communities in Razorback Lake. This survey revealed Razorback Lake contains approximately 7 acres of these communities comprised of 23 different aquatic plant species (Razorback Lake – Map 7 and Table 8.10.4-2). This accounts for less than 2% of the lake surface area. 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.

Photograph 8.10.4-3. A native iris, Northern blue flag, along the shoreline of Razorback Lake.

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

Table 8.10.4-2. Razorback Lake 2019 acres of emergent and floating-leaf aquatic plant communities. Created using data from 2019 aquatic plant community mapping survey.

Plant Community	Acres
Emergent	1.4
Floating-leaf	0.0
Mixed Emergent & Floating-leaf	5.7
Total	**7.2**

8.10.5 Aquatic Invasive Species in Razorback Lake

Onterra and the WDNR have confirmed five invasive species to be present in and around Razorback Lake (Table 8.10.5-1). Due to the small number of dwellings around Razorback Lake, no stakeholder survey was distributed for Phase III of this project, so no stakeholder perceptions of AIS will be included in this section as they were in previous phases.

Table 8.10.5-1. AIS present within Razorback Lake

Type	Common name	Scientific name	Location within the report
Plants	Giant reed	*Phragmites australis* subsp. *australis*	Section 8.10.5 - Below
	Reed canary grass	*Phalaris arundinacea*	Section 8.10.5 - Below
	Narrow-leaved cattail	*Typha angustifolia*	Section 8.10.5 - Below
Invertebrates	Banded Mystery Snail	*Viviparus georgianus*	Section 8.10.5 - Below
	Chinese Mystery Snail	*Cipangopaludina chinensis*	Section 8.10.5 - Below
	Freshwater Jellyfish	*Craspedacusta sowerbyi*	Section 8.10.5 - Below

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

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

Giant Reed (aka Phragmites)

Giant reed (*Phragmites australis* subsp. *australis*) is a tall, perennial grass that was introduced to the United States from Europe. Giant reed forms towering, dense colonies that overtake native vegetation and replace it with a monoculture that provides inadequate sources of food and habitat for wildlife. A native strain (*P. australis* subsp. *americanus*) of this species also exists in Wisconsin. Giant reed was found in one area of Razorback Lake in 2021. Currently, the best control method for this species is to pull it. Vilas County and GLIFWC have been monitoring and hand-pulling giant reed near the boat landing on Razorback Lake.

Reed canary grass

Reed canary grass (*Phalaris arundinacea*) is a large, coarse perennial grass that can reach three to six feet in height. Often difficult to distinguish from native grasses, this species can form dense, highly productive stands that outcompete native species. Unlike native grasses, few wildlife species utilize the grass as a food source, and the stems grow too densely to provide cover for small mammals and waterfowl. It grows best in moist soils such as wetlands, marshes, stream banks and lake shorelines. It is difficult to eradicate and is quite resilient to herbicide applications.

Narrow-leaved cattail

Narrow-leaved cattail (*Typha angustifolia*) is a perennial wetland plant that is found throughout Wisconsin, and is listed by the WDNR as restricted. It can grow very aggressively and outcompete and displace native plants, decreasing biodiversity. The easiest way to tell this species apart from the native variety (broad-leaved cattail) is the space between the male and female portions of the flowers which is not usually visible on the native cattail. The best method of control for invasive narrow-leaved cattail is manual removal.

Aquatic Animals

Mystery snails

There are two types of mystery snails found within Wisconsin waters, the Chinese mystery snail (*Cipangopaludina chinensis*) and the banded mystery snail (*Viviparus georgianus*). Both snails can be identified by their large size, thick hard shell and hard operculum (a trap door that covers the snail’s soft body). These traits also make them less edible to native predators. These species thrive in eutrophic waters with very little flow. They are bottom-dwellers eating diatoms, algae and organic and inorganic bottom materials. 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). Both Banded and Chinese mystery snails were verified in Razorback Lake in 2005.

Freshwater jellyfish

Freshwater jellyfish (*Craspedacusta sowerbyi*) are believed to have been introduced to the Great Lakes region around 1933 with the first Wisconsin sightings dating back to 1969. They are quite small, growing to about one inch in diameter. These jellyfish are ephemeral, living for only six to seven weeks and then disappearing, sometimes forever. While there is not yet a thorough understanding of how freshwater jellyfish affect their ecosystems, it is thought that they may outcompete other native species for zooplankton. Crayfish are a natural predator of freshwater jellyfish.

8.10.6 Razorback Lake Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as a reference. The following section is not intended to be a comprehensive plan for the lake's fishery, as those aspects are currently being conducted by the fisheries biologists overseeing Razorback Lake. The goal of this section is to provide an overview of some of the data that exists. Although current fish data were not collected as a part of this project, the following information was compiled based upon data available from the Wisconsin Department of Natural Resources (WDNR) the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and personal communications with DNR Fisheries Biologist Eric Wegleitner (WDNR 2020 & GLIFWC 2019).

Razorback Lake Fishery

Energy Flow of a Fishery

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

A concept called energy flow describes how the biomass of piscivores is determined within a lake. Because algae and plant matter are generally small in energy content, it takes an incredible amount of this food type to support a sufficient biomass of zooplankton and insects. In turn, it takes a large biomass of zooplankton and insects to support planktivorous fish species. And finally, there must be a large planktivorous fish community to support a modest piscivorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 8.10.6-1.

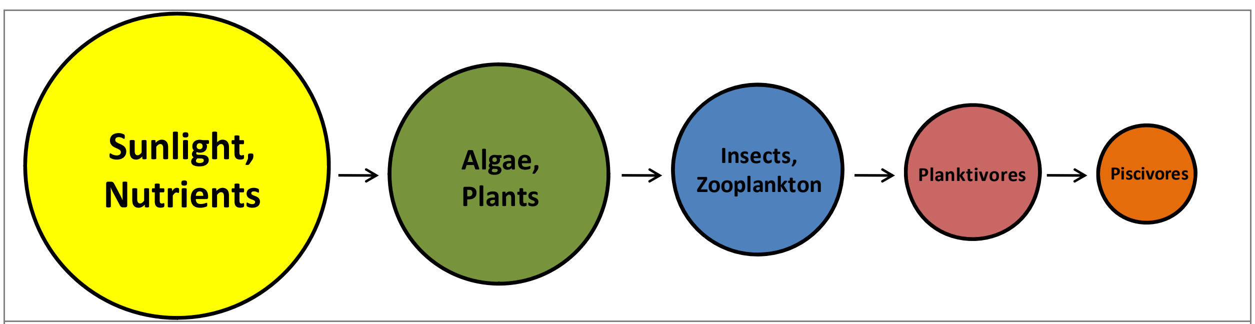


Figure 8.10.6-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Razorback Lake is on the border of being an oligotrophic or mesotrophic system, meaning it has high to moderate amount of water clarity, but a moderate to low amount of nutrients and thus low primary productivity. Simply put, this means it may be difficult for the lake to support a large population of predatory fish (piscivores) because the supporting food chain could be relatively small. Table 8.10.6-1-1 shows the popular game fish present in the system. Although not an exhaustive list of fish species in the lake, additional fish species found in the 2014 WDNR survey of Razorback Lake include white sucker (*Catostomus commersonii*) and the burbot (*Lota lota*).

Table 8.10.6-1. Gamefish present in Razorback Lake with corresponding biological information (Be 1983).

Common Name (*Scientific Name*)	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Bluegill *(Lepomis macrochirus)*	11	Late May - Early August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
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
Rock bass *(Ambloplites rupestris)*	13	Late May - Early June	Bottom of course sand or gravel, 1 cm - 1 m deep	Crustaceans, insect larvae, 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)
Yellow Perch *(Perca flavescens)*	13	April - Early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

Survey Methods

In order to keep the fishery of a lake healthy and stable, fisheries biologists must assess the current fish populations and trends. To begin this process, the correct sampling technique(s) must be selected to efficiently capture the desired fish species. A commonly used passive trap is a fyke net (Photograph 8.10.6-1). Fish swimming towards this net along the shore or bottom will encounter the lead of the net, 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, record biological characteristics, mark (usually with a fin clip), and then release the captured fish.

The other commonly used sampling method is electrofishing (Photograph 8.10.6-1). 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, the fish involuntarily swims toward the electrodes. When the fish is in the vicinity of the electrodes, they become stunned making them easier to net and place into a livewell to recover. Contrary to what some may believe, electrofishing does not kill the fish and after being placed in the livewell fish generally recover within minutes. As with a fyke net survey, biological characteristics are recorded and any fish that has a mark (considered a recapture from the earlier fyke net survey) are also documented before the fish is released.

The mark-recapture data collected between these two surveys is placed into a statistical model to calculate the population estimate of a fish species. Fisheries biologists can then use this data to make recommendations and informed decisions on managing the future of the fishery.


Photograph 8.10.6-1. Fyke net positioned in the littoral zone of a Wisconsin Lake (left) and an electroshocking boat (right).

Fish Stocking

Photograph 8.10.6-2. Fingerling Muskellunge.

To assist in meeting fisheries management goals, the WDNR may permit the stocking of fry, fingerling or adult fish in a waterbody that were raised in permitted hatcheries (Photograph 8.10.6-2). Stocking of a lake may be done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Razorback Lake has been stocked periodically from 1982-2008 with walleye, and from 1973 to 1995 with muskellunge (Tables 8.10.6-2 and 8.10.6-3). Largemouth and smallmouth bass have each been stocked once in 1972 and 1974, respectively (Table 8.10.6-4). Stocking on Razorback Lake was stopped after 2008 after DNR biologists determined natural recruitment was occurring.

Table 8.10.6-2. Stocking data for walleye in Razorback Lake (1982-2008).

Year	Species	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1982	WALLEYE	UNSPECIFIED	FINGERLING	18,000	3
1985	WALLEYE	UNSPECIFIED	FINGERLING	18,000	2
1987	WALLEYE	UNSPECIFIED	FINGERLING	54,000	3
1989	WALLEYE	UNSPECIFIED	FINGERLING	20,550	2
1991	WALLEYE	UNSPECIFIED	FINGERLING	18,791	2.35
1992	WALLEYE	UNSPECIFIED	FINGERLING	9,590	1
1994	WALLEYE	UNSPECIFIED	FINGERLING	18,390	2
1996	WALLEYE	UNSPECIFIED	FINGERLING	22,454	1.75
1997	WALLEYE	UNSPECIFIED	LARGE FINGERLING	10,200	2.1
1998	WALLEYE	UNSPECIFIED	SMALL FINGERLING	78,803	1.93
2000	WALLEYE	LAC COURTE OREILLES	SMALL FINGERLING	18,100	1.7
2002	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	18,100	1.5
2004	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	30,900	1.7
2006	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	12,663	1.4
2008	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	12,670	1.6

Table 8.10.6-3. Stocking data for muskellunge in Razorback Lake (1973-1995).

Year	Species	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1973	MUSKELLUNGE	UNSPECIFIED	FINGERLING	400	13
1977	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,000	7
1979	MUSKELLUNGE	UNSPECIFIED	FINGERLING	627	8
1995	MUSKELLUNGE	UNSPECIFIED	FRY	100,000	0.4

Table 8.10.6-4. Stocking data for bass in Razorback Lake (1972-1974).

Year	Species	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1972	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	1,000	3
1974	SMALLMOUTH BASS	UNSPECIFIED	FINGERLING	8,000	3

Gamefish

The gamefish present in Razorback Lake represent different population dynamics depending on the species. In May 2014, a comprehensive fishery survey was done to assess the health of the fishery. A brief summary of the survey results for common gamefish species is below.

Walleyes are a highly valued sportfish in Wisconsin. A mark-recapture survey was conducted in an effort to calculate a population estimate for adult walleyes in Razorback Lake in 2014. 1,095 adult fish were captured and subsequently marked through fyke netting efforts. Then, during a night of electrofishing, 217 walleyes were captured. Based on these results, the Razorback Lake adult walleye population is estimated at 3,082 fish, or 8.5 fish/acre. This is an increase from a 1999 estimate of 6.5 fish/acre (Table 8.10.6-5). Juvenile walleye were not included in these population estimates. The largest fish captured in 2014 was a 27.7-inch female (Figure 8.10.6-2).

Table 8.10.6-5. WDNR Adult Walleye Population Estimate for Razorback Lake.

Year	Primary Recruitment Source	Population Estimate	Lower 95 C.I.	Number / Acre	# Adults <12 Inches / Acre	# Adults 12-15 Inches / Acre	# Adults 15-20 Inches / Acre	# Adults >20 Inches / Acre
1999	Stocked	2,369	2,172	6.5	0.2	4.6	1.7	0
2014	Natural	3,082	2,528	8.5	0.5	4.9	3.2	0

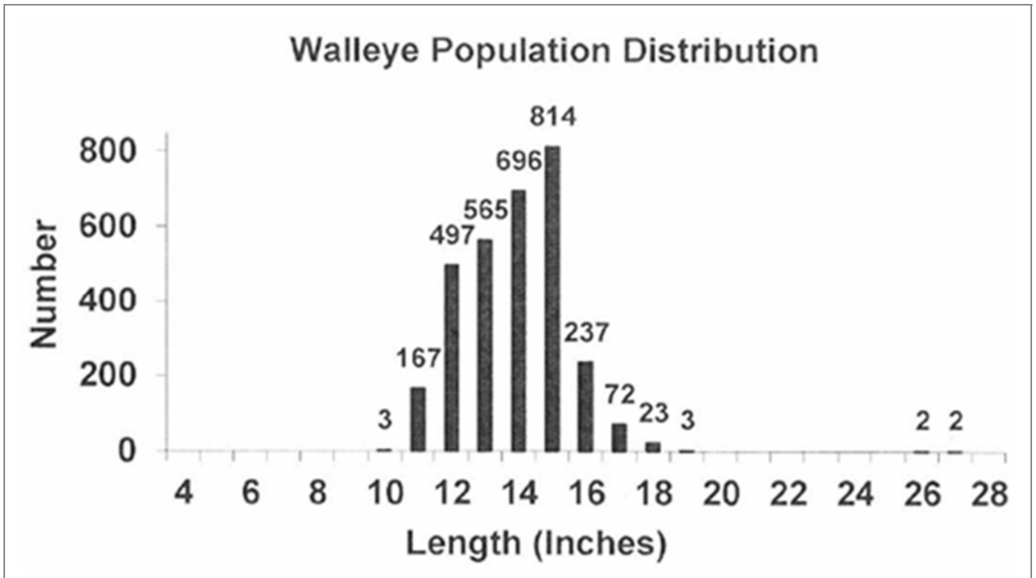


Figure 8.10.6-2. Walleye Population Distribution in Razorback Lake. (2014).

Muskellunge, similar to walleye, are another valued sportfish in Wisconsin. In this survey, 5 muskellunge were captured and marked with a fin clip. These fish ranged in size from 38-46.8 inches. No attempts were made to calculate a population estimate for adult muskellunge in Razorback Lake.

Northern pike were a common catch in the 2014 survey. In 2014, 213 pike were captured with no attempt to calculate a population estimate. The average length of the pike captured, however, was poor, with only 2% measuring greater than 20 inches long (Figure 8.10.6-3).

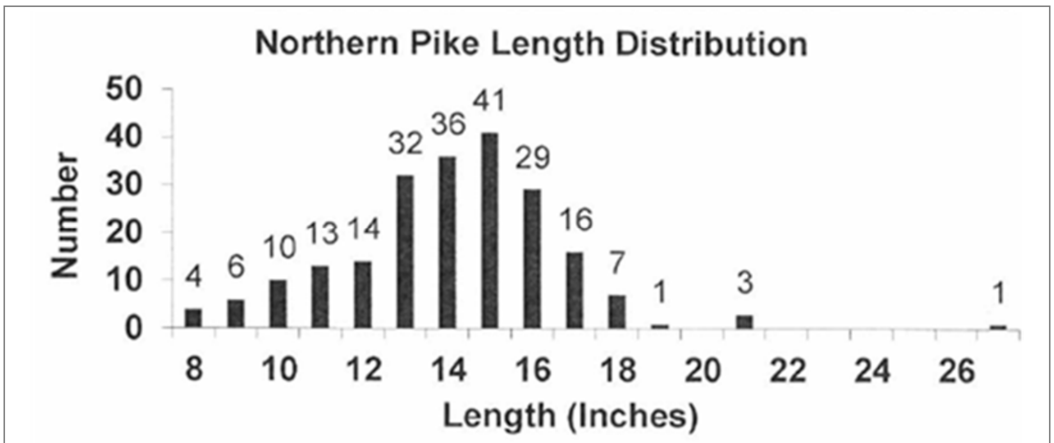


Figure 8.10.6.3. Northern Pike Population Distribution in Razorback Lake. (2014).

Smallmouth bass are common in Razorback Lake. In 2014, 222 smallmouth were captured, with 31% of these fish measuring 14 inches or greater. The chance at a trophy-sized smallmouth is possible in Razorback Lake, as 17 fish measuring 18 inches or greater were captured (Figure 8.10.6-4).

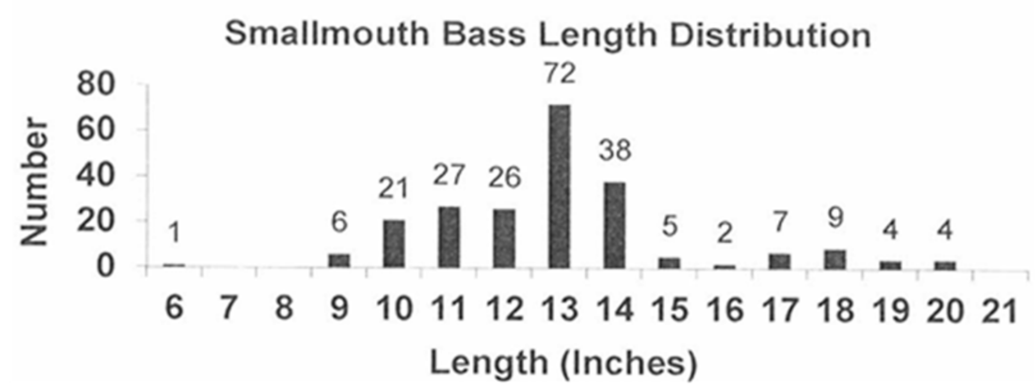


Figure 8.10.6.4. Smallmouth Bass Population Distribution in Razorback Lake. (2014).

Largemouth bass are not common in Razorback Lake, but were present in the 2014 survey. Six fish were captured, ranging in size from 13-18 inches.

Panfish

Bluegill were the most commonly encountered panfish in 2014, however, only 24 individuals were captured (Figure 8.10.6-5). The average size of fish captured was below the quality size requirement of seven inches.

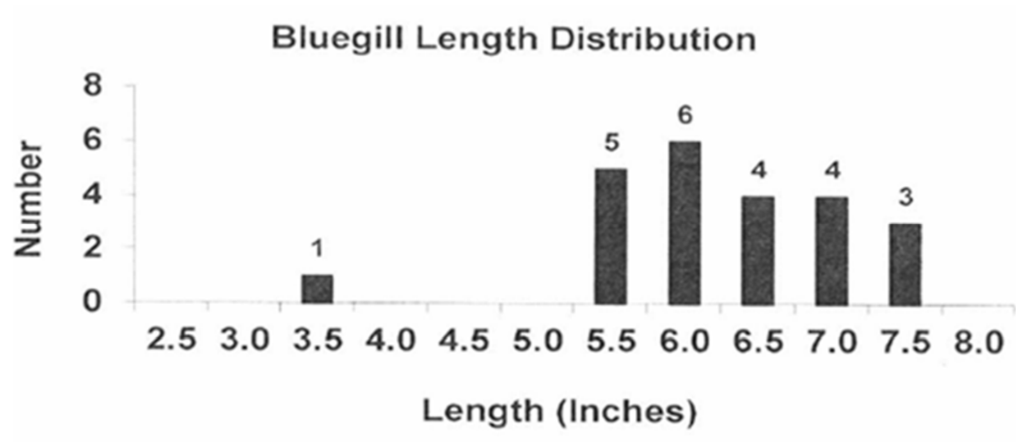


Figure 8.10.6-5. Walleye Population Distribution in Razorback Lake. (2014).

Yellow perch and **rock bass** were also captured, but in low numbers. Exact numbers and size of these fish were not recorded.

Razorback Lake Spear Harvest Records

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 8.10.6-6). Razorback Lake falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on lakes located within the Ceded Territory. Determining how many fish are able to be taken from a lake by tribal harvest is a highly regimented and dictated process. This highly structured procedure begins with bi-annual meetings between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" (TAC) is established, based upon estimates of a sustainable harvest of the fishing stock. The TAC is the number of adult walleye or muskellunge that can be harvested from a lake by tribal and recreational anglers without endangering the population. A "safe harvest" value is calculated as a percentage of the TAC each year for all walleye lakes in the ceded territory. The safe harvest represents the number of fish that can be harvested by tribal members through the use of high efficiency gear such as spearing or netting without influencing the sustainability of the population. This does not apply to angling harvest which is considered a low-efficiency harvest regulated statewide by season length, size and bag limits. The safe harvest limits are set through either recent population estimates or a statistical model that ensure there is less than a 1 in 40 chance that more than 35% of the adult walleye population will be harvested in a lake through high efficiency methods. By March 15th of each year the relevant Native American communities may declare a proportion of the total safe harvest on each lake; this declaration represents the maximum number of fish that can be harvested by tribal members annually. Prior to 2015, annual walleye bag limits for anglers were adjusted in all Ceded Territory lakes based upon the percent of the safe harvest levels determined for the Native American spearfishing season. Beginning in 2015, new regulations for walleye were created to stabilize regional walleye angler bag limits. The daily bag limits for walleye in lakes located partially or wholly within the ceded territory is three. The state-wide bag limit for walleye is five. Anglers may only remove three walleye from any individual lake in the ceded territory but may fish other waters to full-fill the state bag limit (WDNR 2017).

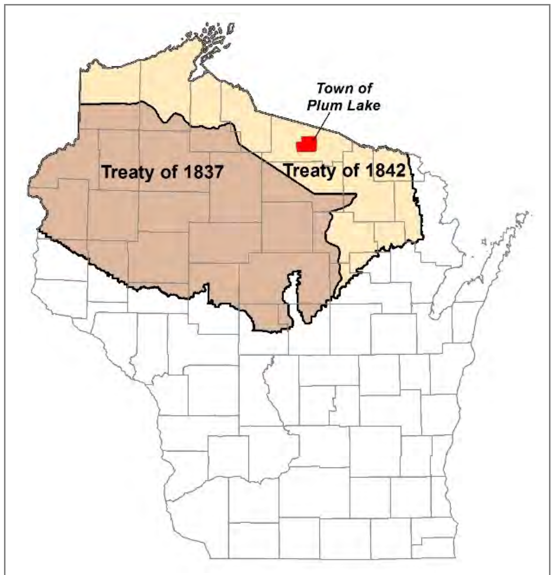


Figure 8.10.6-6. Location of Razorback Lake within the Native American Ceded Territory (GLIFWC 2017). This map was digitized by Onterra; therefore, it is a representation and not legally binding.

Tribal members may 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. Tribal spearers may only take two walleyes over twenty inches per nightly permit; one between 20 and

24 inches and one of any size over 20 inches (GLIFWC 2016). This regulation limits the harvest of the larger, spawning female walleye. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Spearfishing of a particular species ends once the declared harvest is reached in a given lake. 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.

Razorback Lake receives moderate spearing pressure from the Lac Du Flambeau Tribe. On average, 123 walleyes are speared each year, but as many as 392 fish have been taken in one year (2015). Muskellunge harvest has also been recorded, with an average of about one fish per year. As many as three have been harvested in one year (2012). Figures 8.10.6-7 and 8.10.6-8 show the spear harvest for both walleye and muskellunge from 2000-2019.

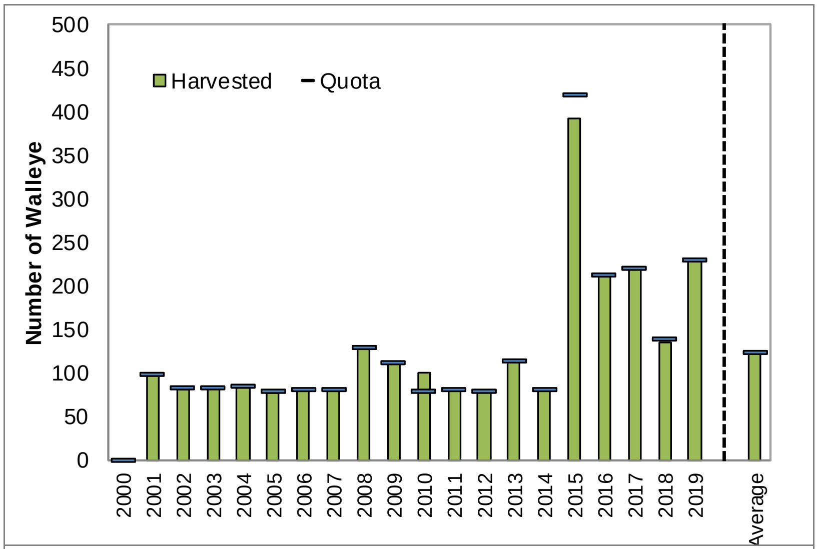


Figure 8.10.6.7. Razorback Lake walleye spear harvest data. (GLIFWC 2000-2019).

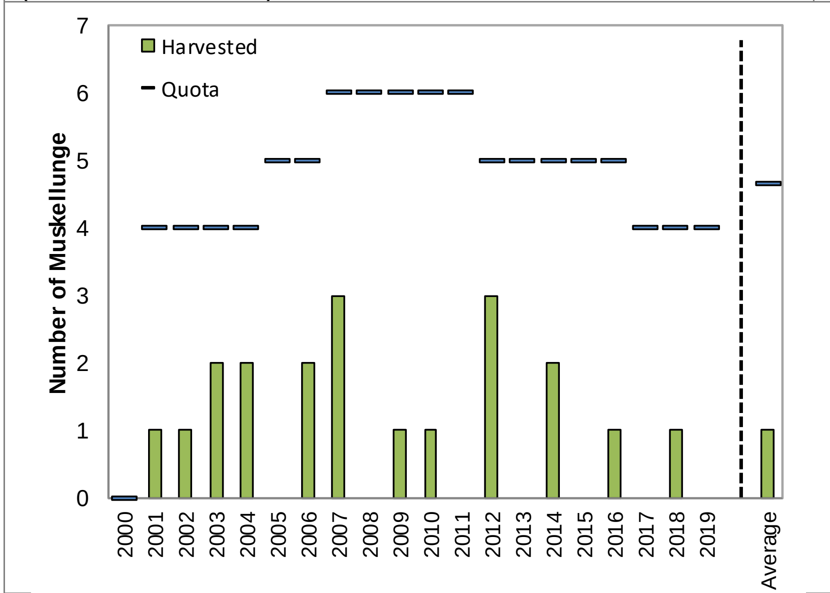


Figure 8.10.6.8. Razorback Lake muskellunge spear harvest data. (GLIFWC 2000-2019).

Razorback Lake Fish Habitat

Substrate Composition

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

Substrate and habitat are critical to fish species that do not provide parental care to their eggs. Northern pike is one species that does not provide parental care to its eggs (Becker 1983). Northern pike broadcast their eggs over woody debris and detritus, which can be found above sand or muck. This organic material suspends the eggs above the substrate, so the eggs are not buried in sediment and suffocate as a result. Walleye are another species that does not provide parental care to its eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn and care for their eggs in muck as well.

According to the point-intercept survey conducted by Onterra in 2019, 50% of the substrate sampled in the littoral zone of Razorback Lake were soft sediments, 32% composed of sand sediments, and 18% composed of rock sediment.

Woody Habitat

As discussed in the Shoreland Condition Section, the presence of coarse woody habitat is important for many stages of a fish's life cycle, including nesting or spawning, escaping predation as a juvenile, and hunting insects or smaller fish as an adult. Unfortunately, as development has increased on Wisconsin lake shorelines in the past century, this beneficial habitat has often been the first to be removed from the natural shoreland zone. Leaving these shoreland zones barren of coarse woody habitat can lead to decreased abundances and slower growth rates in fish (Sass 2006). A fall 2019 survey documented 420 pieces of coarse woody along the shores of Razorback Lake, resulting in a ratio of approximately 66 pieces per mile of shoreline.

Fish Habitat Structures

Some fisheries managers may look to incorporate fish habitat structures on the lakebed or littoral areas extending to shore for the purpose of improving fish habitats. These projects are typically conducted on lakes lacking significant coarse woody habitat in the shoreland zone. The "Fish sticks" program, outlined in the WDNR best practices manual, adds trees to the shoreland zone restoring fish habitat to critical near shore areas. Typically, every site has 3 – 5 trees which are partially or fully submerged in the water and anchored to shore (Photograph 8.10.6-3). The WDNR recommends placement of the fish sticks during the winter on ice when possible to prevent adverse impacts on fish spawning or egg incubation periods. The program requires a WDNR permit and can be funded through many different sources including the WDNR, County Land & Water Conservation Departments or partner contributions.


Photograph 8.10.6-3. Examples of fish sticks (left) and half-log habitat structures. (Photos by WDNR)

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

Half-logs are another form of fish spawning habitat placed on the bottom of the lakebed (Photograph 8.10.6-3). Smallmouth bass specifically have shown an affinity for overhead cover when creating spawning nests, which half-logs provide (Wills 2004). If the waterbody is exempt from a permit or a permit has been received, information related to the construction, placement and maintenance of half-log structures are available online.

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

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

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

If a project does not meet all of the conditions listed on the checklist, a permit application may be sent in to the WDNR and an exemption requested. The Town of Plum Lakes may work with their local WDNR fisheries biologist to determine if the installation of fish habitat structures should be considered in aiding fisheries management goals for Razorback Lake.

Regulations

Regulations for Razorback Lake gamefish species as of March 2020 are displayed in Table 8.10.6-6. Only one bass of at least 18 inches in length may be kept in an effort to increase trophy bass numbers. New to 2020, open season for muskellunge has been extended to December 31, 2020, however muskellunge fishing may only be done in open water. 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 8.10.6-6. WDNR fishing regulations for Razorback Lake (As of March 2020).

Species	Daily bag limit	Length Restrictions	Season
Panfish (bluegill, pumpkinseed, sunfish, crappie and yellow perch)	25	None	Open All Year
Largemouth bass and smallmouth bass	1	18"	June 20, 2020 to March 7, 2021
Smallmouth bass	1	18"	June 20, 2020 to March 7, 2021
Largemouth bass	1	18"	May 2, 2020 to March 7, 2020
Muskellunge and hybrids	1	40"	May 23, 2020 to December 31, 2020
Northern pike	5	None	May 2, 2020 to March 7, 2021
Walleye, sauger, and hybrids	3	The minimum length is 15", but walleye, sauger, and hybrids from 20" to 24" may not be kept, and only 1 fish over 24" is allowed.	May 2, 2020 to March 7, 2021
Bullheads	Unlimited	None	Open All Year
Cisco and whitefish	10 fish	None	Open All Year

General Waterbody Restrictions: Motor Trolling is allowed with 1 hook, bait, or lure per angler, and 2 hooks, baits, or

Mercury Contamination and Fish Consumption Advisories

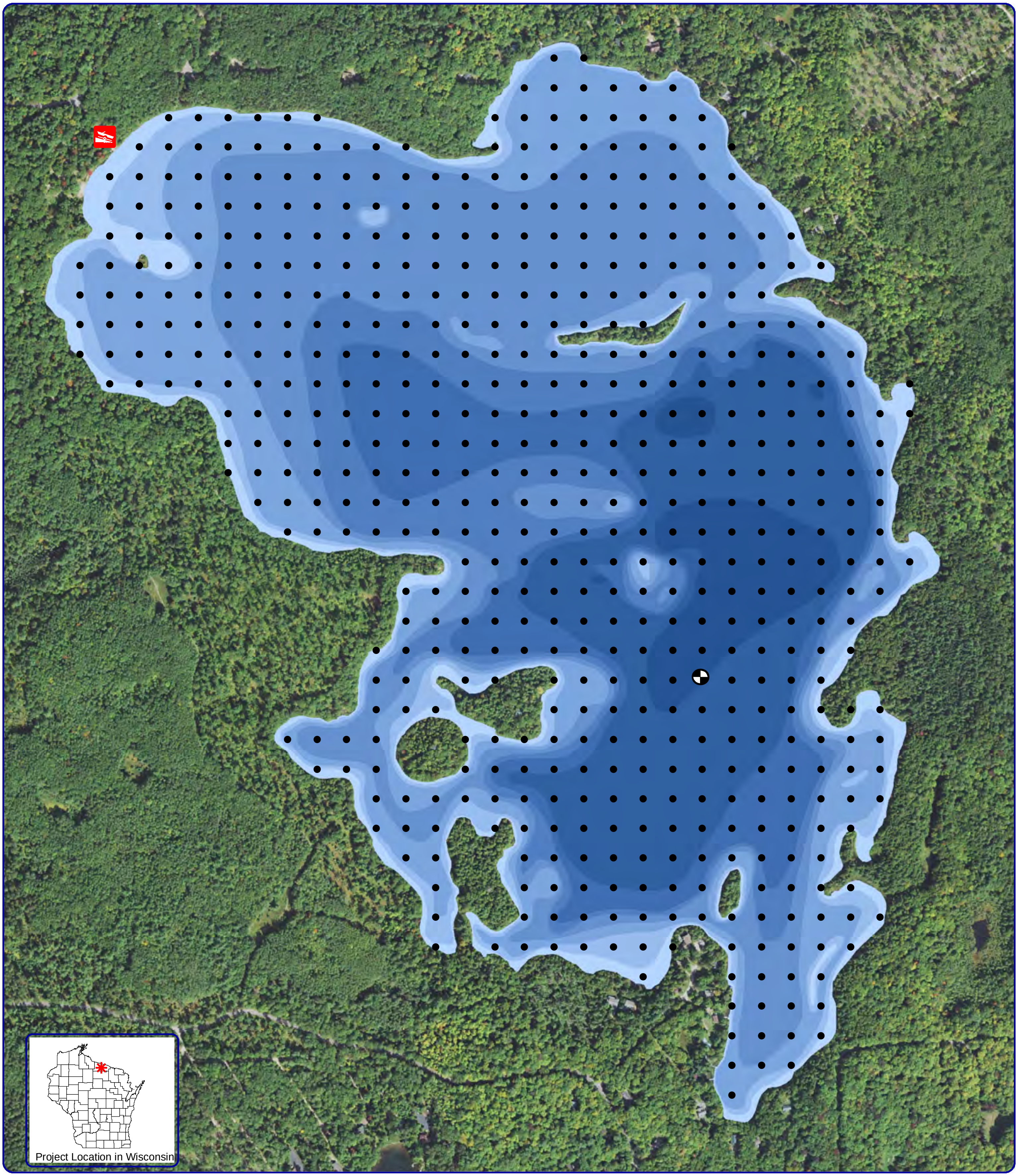
Freshwater fish are amongst the healthiest of choices you can make for a home-cooked meal. Unfortunately, fish in some regions of Wisconsin are known to hold levels of contaminants that are harmful to human health when consumed in great abundance. The two most common contaminants are polychlorinated 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 8.10.6-9. 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	-

Figure 8.10.6-9. 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/)

**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.*



N W E S

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Feet

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

Sources
Roads and Hydro: WDNR
Map Date: February 18, 2020 HAL
Filename: *Map1_Razorback_Location.mxd*

Legend

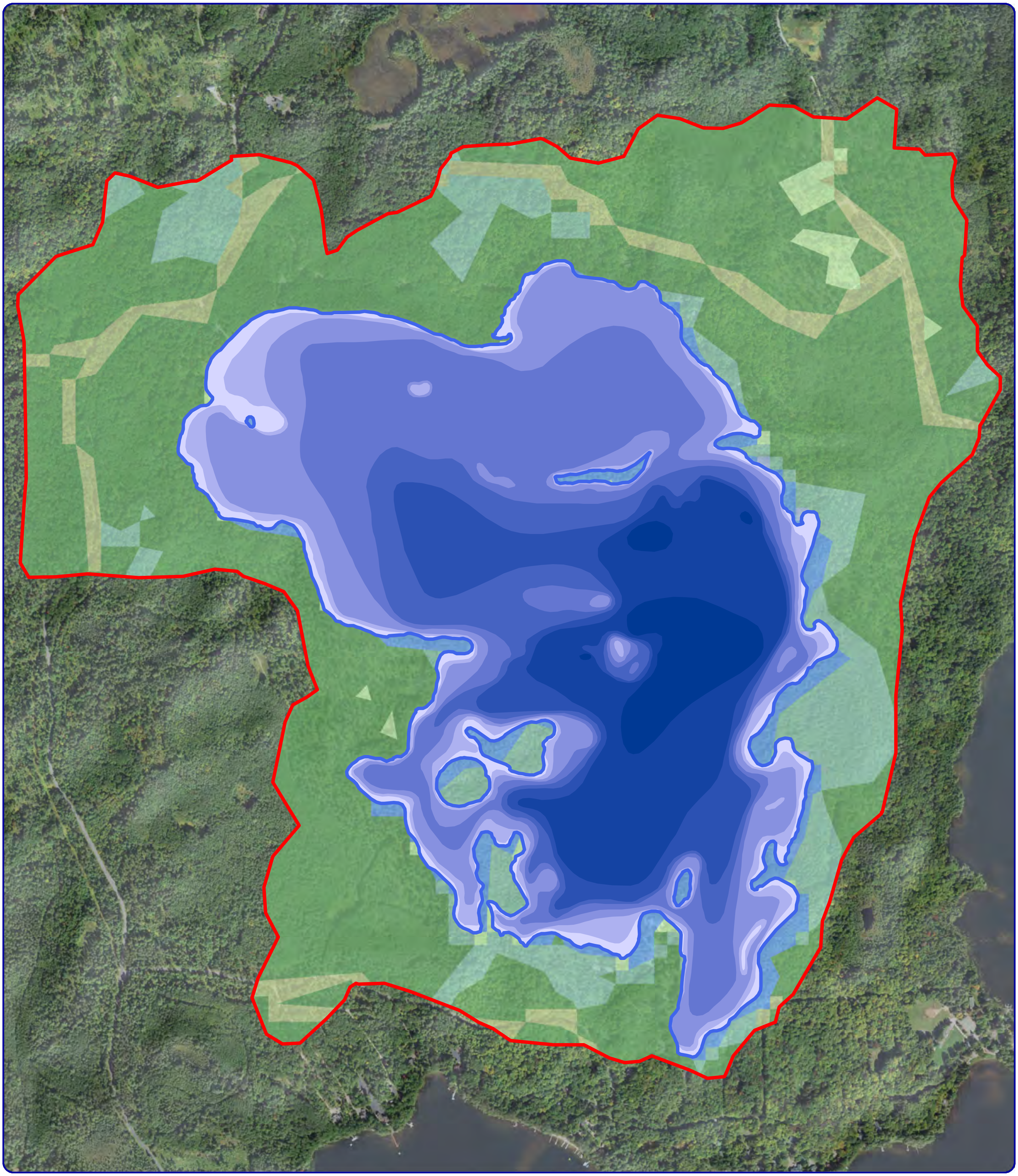
Razorback Lake ~ 381 acres
WDNR Definition

Point-intercept Sample Location
51-meter spacing, 587 points

Water Quality
Sampling Location

Public Access

Map 1
Razorback Lake
Vilas County, Wisconsin
Project Location & Lake Boundaries



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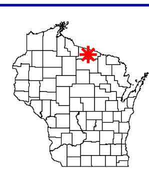
Sources:
Hydro: WDNR
Land Cover: NLCD, 2016
Watershed Boundaries: Onterra, 2019
Map Date: December 30, 2019 JMB
File Name: Razorback_Watershed_2019.mxd



Extent of large map shown in red.

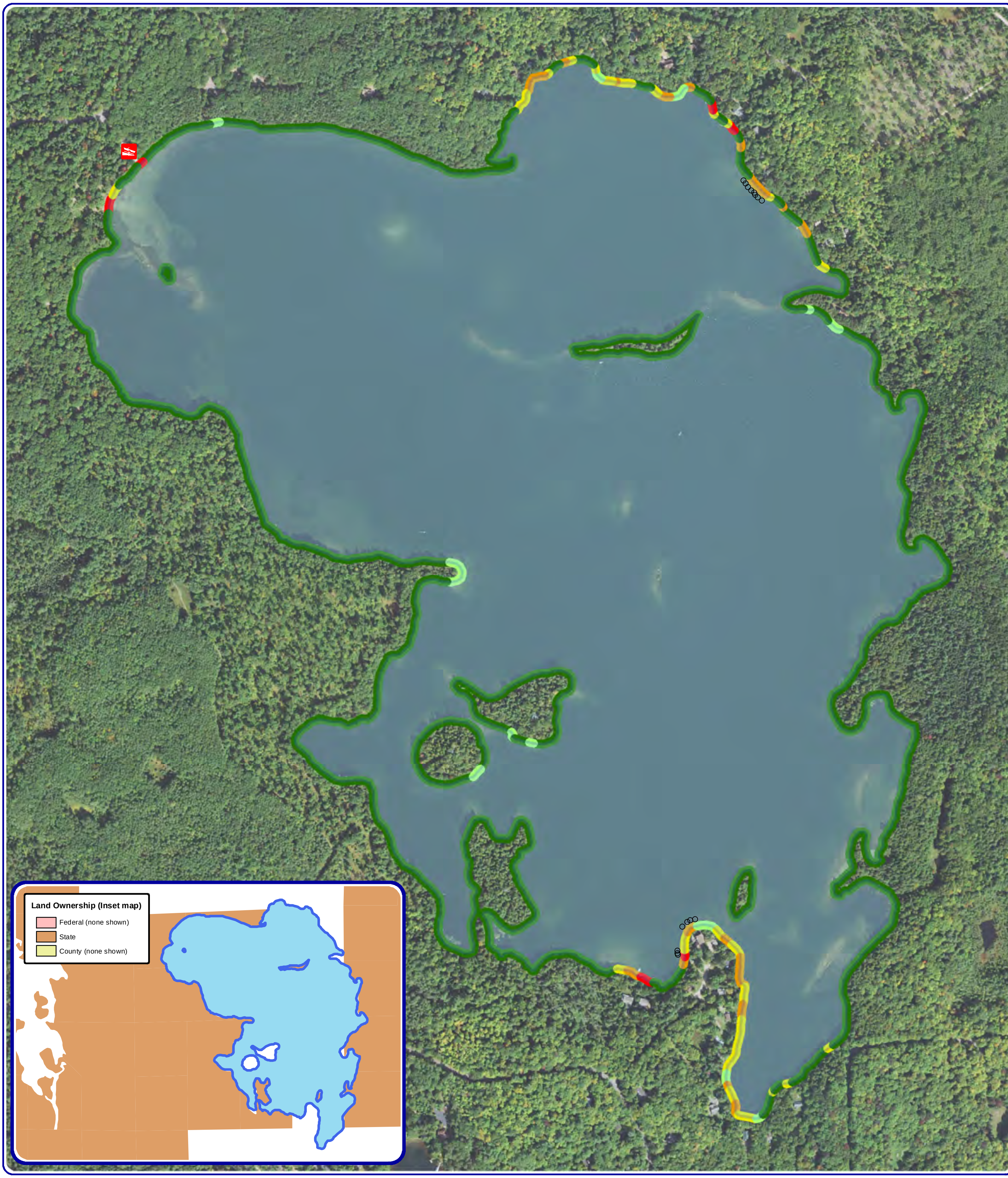
Legend

- Forest
- Forested Wetlands
- Pasture/Grass
- Open Water
- Wetland
- Row Crop Agriculture
- Rural Open Space
- Rural Residential
- Urban - High Density
- Urban - Medium Density
- Razorback Lake Watershed Boundary

Razorback Lake - Map 2

Vilas County, Wisconsin

Watershed Boundaries & Land Cover Types



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Sources
Hydro: WDNR
Shoreland Assessment: Onterra, 2019
Orthophotography: NAIP, 2017
Map date: November 21, 2019 AMS
Filename: Razorback_SA_2019.mxd

Legend

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

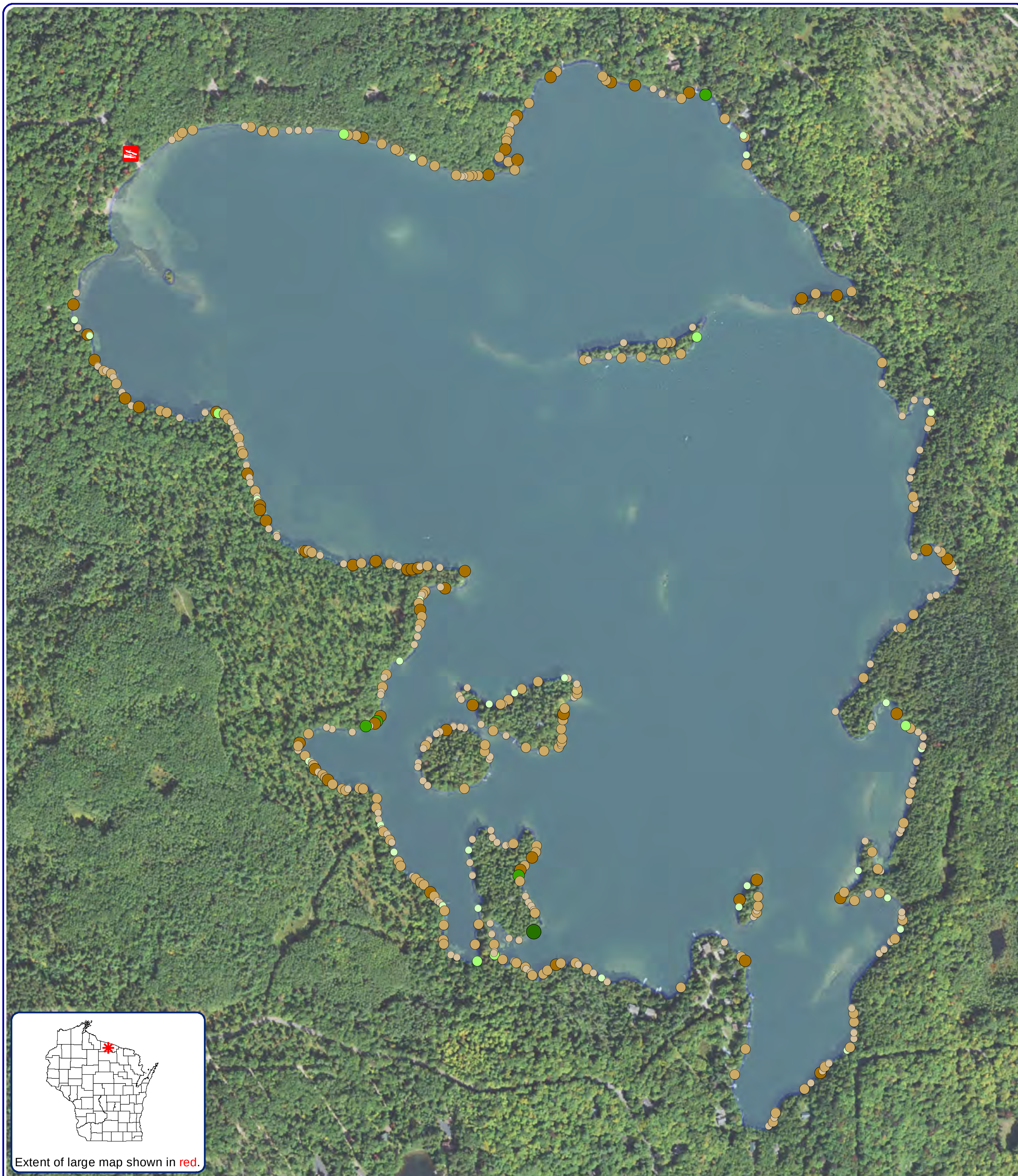
Seawall Modifier

Masonary/Wood Seawall
Rip-Rap

Razorback Lake - Map 3

Vilas County, Wisconsin

2019 Shoreland Condition Assessment



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Feet

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Sources
Hydro: WDNR
CWH Survey: Onterra, 2019
Orthophotography: NAIP, 2017
Map date: November 21, 2019 AMS
Filename: Razorback_CWH_2019.mxd

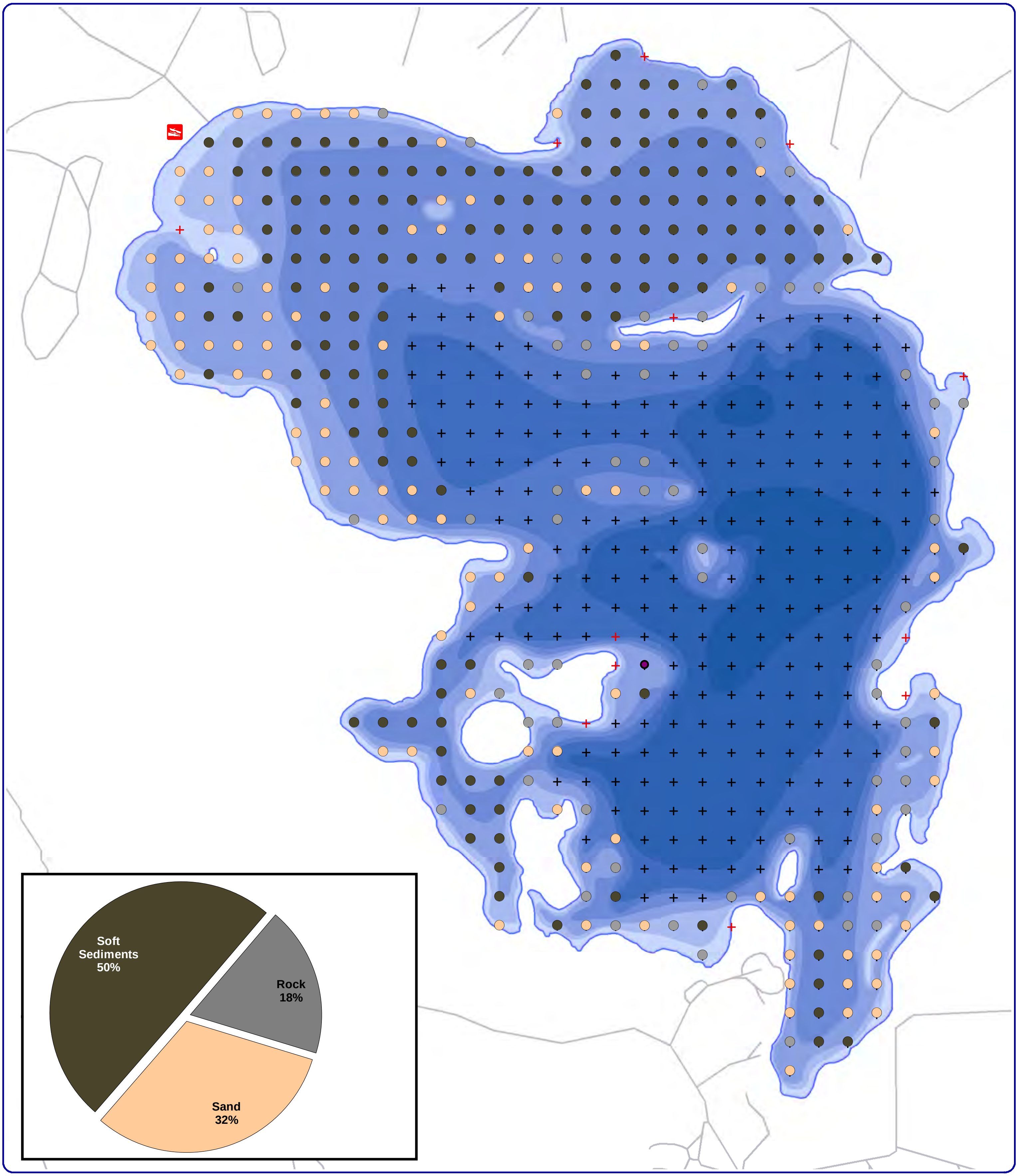
Legend

2-8 Inch Pieces	8+ Inch Pieces	Cluster of Pieces
No Branches	No Branches	No Branches
Minimal Branches	Minimal Branches	Minimal Branches
Moderate Branches	Moderate Branches	Moderate Branches
Full Canopy	Full Canopy	Full Canopy

Razorback Lake - Map 4

Vilas County, Wisconsin

Coarse Woody Habitat



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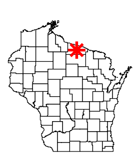
Sources
Hydro: WDNR
Plants: Onterra, 2019
Orthophotography: NAIP, 2017
Map date: February 17, 2020 AMS
Filename: Razorback_SA_2019.mxd



Project Location in Wisconsin

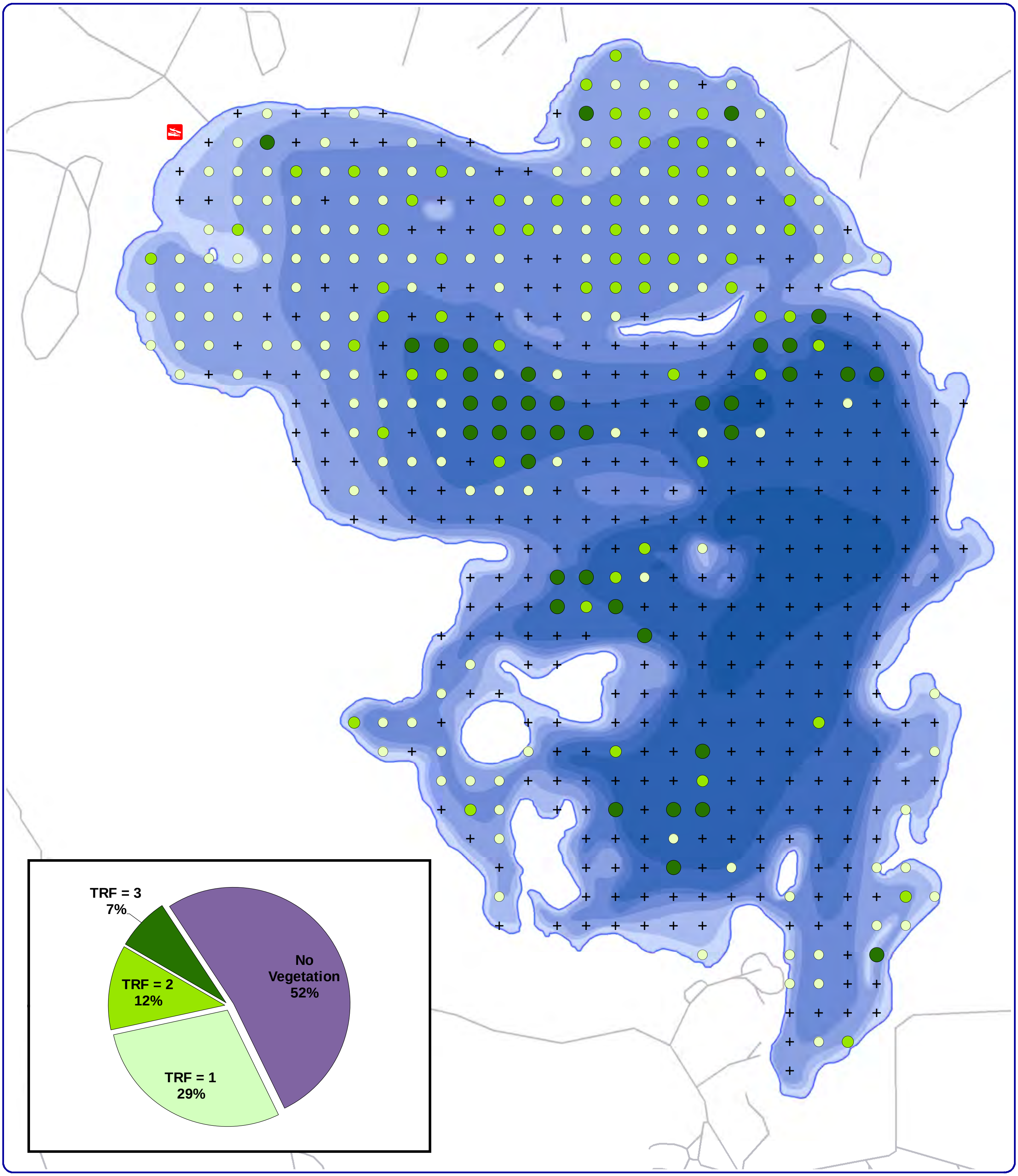
Legend

- Soft/Organic Sediments
- Rock
- Sand
- + Sampled
- + Non-navigable

Razorback Lake- Map 5

Vilas County, Wisconsin

2019 PI Survey: Substrate Types



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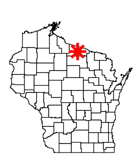
Sources
Hydro: WDNR
Plants: Onterra, 2019
Orthophotography: NAIP, 2017
Map date: February 17, 2020 AMS
Filename: MapX_Razorback_TRFPI_2019.mxd



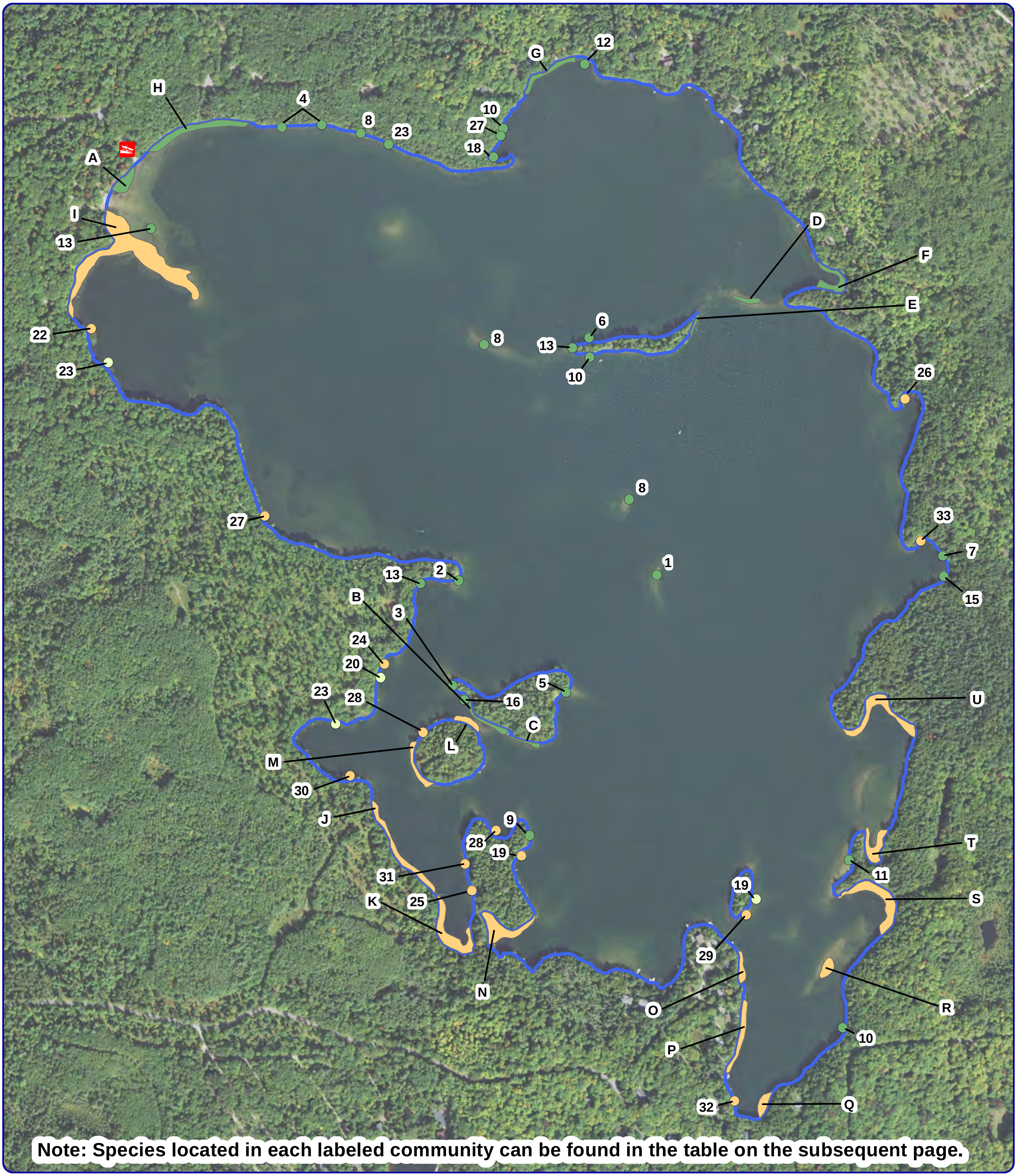
Project Location in Wisconsin

Legend

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

Razorback Lake - Map 6
Vilas County, Wisconsin

2019 PI Survey: Aquatic Vegetation Distribution



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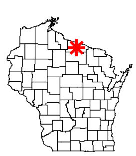
Sources
Hydro: WDNR
Aquatic Plants: Onterra, 2019
Orthophotography: NAIP, 2017
Map date: December 6, 2019 AMS
Filename: Razorback_Comm_2019.mxd


Project Location in Wisconsin

Legend

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

Razorback Lake - Map 7

Vilas County, Wisconsin

Emergent & Floating-leaf Aquatic Plant Communities

Razorback Lake 2019 Emergent & Floating-Leaf Plant Species

Corresponding Community Polygons and Points are displayed on Razorback Lake - Map 7

Large Plant Community (Polygons)									
Emergent	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**	**Acres**
A	Smooth sawgrass	Creeping spikerush	Three-way sedge	Wool-grass	Porcupine sedge	Common arrowhead			0.21
B	Three-way sedge	Bur-reed sp	Reed canary grass	Creeping spikerush					0.13
C	Three-way sedge	Creeping spikerush	Iris sp						0.06
D	Softstem bulrush	Three-way sedge	Narrow leaf cattail	Creeping spikerush					0.09
E	Softstem bulrush	Creeping spikerush							0.04
F	American bur-reed	Three-way sedge	Wool-grass	Softstem bulrush	Bristly sedge				0.24
G	Softstem bulrush	Creeping spikerush	Narrow Leaf cattail	Three-way sedge					0.20
H	Creeping spikerush	Cattail sp.	Softstem bulrush	Three-way sedge	Wool-grass	Bristly sedge			0.48
Floating-leaf & Emergent	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**	**Acres**
I	Smooth sawgrass	Creeping spikerush	Three-way sedge	Softstem bulrush	Spatterdock	American bur-reed	Common reed	Wool-grass	2.03
J	Three-way sedge	American bur-reed	Spatterdock	White water lily	Porcupine sedge	Softstem bulrush			0.39
K	Three-way sedge	White water lily	Spatterdock	Wool-grass	Reed canary grass	Arrowhead sp. (sterile)	American bur-reed		0.50
L	Spatterdock	Three-way sedge	American bur-reed	White water lily					0.12
M	Creeping spikerush	Spatterdock	White water lily	Iris sp					0.17
N	White water lily	Three-way sedge	Broadfruit bur-reed	Spatterdock	Creeping spikerush	Bristly sedge	Wool-grass		0.46
O	White water lily	Three-way sedge	Creeping spikerush						0.12
P	White water lily	Three-way sedge	Wool-grass	Iris sp	Spatterdock				0.27
Q	Spatterdock	White water lily	Arrowhead sp (sterile)	Wool-grass	Water smartweed	Smooth sawgrass			0.15
R	Three-way sedge	White water lily	Softstem bulrush	Wool-grass					0.15
S	Smooth sawgrass	White water lily	Softstem bulrush	Creeping spikerush	Three-way sedge				0.55
T	White water lily	Three-way sedge	Bur-reed sp.	Wool Grass	Creeping spikerush	Smooth sawgrass			0.30
U	Three-way sedge	Softstem bulrush	Creeping spikerush	American bur-reed	Arrowhead sp (sterile)	Wool-grass	White water lily	Spatterdock	0.52

Small Plant Community (Points)								
Emergent	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**
1	Creeping spikerush	Narrow leaf Cattail	Softstem bulrush					
2	Creeping spikerush	Softstem bulrush	Three-way sedge	Wool-grass				
3	Creeping spikerush	Softstem bulrush	Three-way sedge					
4	Creeping spikerush	Softstem bulrush						
5	Creeping spikerush	Three-way sedge	Softstem bulrush	Wool-grass	Porcupine sedge			
6	Creeping spikerush	Three-way sedge						
7	Iris sp							
8	Softstem bulrush	Creeping spikerush						
9	Softstem bulrush	Three-way sedge	Iris sp	Creeping spikerush				
10	Softstem bulrush	Three-way sedge						
11	Softstem bulrush	Three-way sedge	Iris sp.					
12	Softstem bulrush	Three-way sedge	Wool-grass					
13	Softstem bulrush							
14	Three-way sedge	Softstem bulrush	Iris sp					
15	Three-way sedge	Softstem bulrush	Cattail sp	Iris sp				
16	Three-way sedge	Bur-reed sp.						
17	Wool-grass	Arrowhead sp (sterile)	Bur-reed sp.	Softstem bulrush				
18	Wool-grass	Softstem bulrush	Three-way sedge	Arrowhead sp (sterile)	Bristly sedge			
Floating-leaf	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**
19	Iris sp	Three-way sedge	Spatterdock	Smooth sawgrass	Softstem bulrush			
20	Spatterdock	White water lily						
21	Spatterdock							
22	White water lily	Creeping spikerush	Softstem bulrush	Spatterdock				
23	White water lily							
Floating-leaf & Emergent	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**
24	Bluejoint reedgrass	Three-way sedge	Wool-grass	Iris sp.	Softstem bulrush	Water sedge		
25	Cattail sp.	Spatterdock	Three-way sedge					
26	American bur-reed	White water lily	Narrow leaf cattail	Softstem bulrush	Wool-grass	Porcupine sedge	Arrowhead sp (sterile)	
27	Broadfruit bur-reed	American bur-reed	Softstem bulrush	Three-way sedge				
28	Spatterdock	Three-way sedge	Iris sp.					
29	Spatterdock	Three-way sedge						
30	Spatterdock	White water lily	American bur-reed	Three-way sedge				
31	White water lily	Three-way sedge						
32	White water lily	Water smartweed	Softstem bulrush	Arrowhead sp (sterile)	Wool-grass			
33	Wool-grass	White water lily	Bur-reed sp.	Iris sp	Reed Canary	Water horsetail		

Species are listed in order of dominance within the community; Scientifc names can be found in the species list in Table 8.10.4-1