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

8.13 Benson Lake

An Introduction to Benson Lake

Benson Lake, Vilas County, is a shallow lowland drainage lake with a maximum depth of 15 feet, a mean depth of 7 feet, and a surface area of approximately 33 acres. Benson Lake is considered to be mesotrophic and its watershed encompasses approximately 147,950 acres. In 2017, 31 native aquatic plant species were found in the lake, of which wild celery (*Vallisneria americana*) is the most common. One non-native plant, reed canary grass, was found during surveys.

Field Survey Notes

Primarily sandy and rocky substrate observed during the 2017 point-intercept survey. The lake has abundant emergent and floating-leaf communities (Photo 8.13).

Photo 8.13. Benson Lake, Vilas County

Lake at a Glance* – Benson Lake

Morphology	
Acreage	33
Maximum Depth (ft)	15
Mean Depth (ft)	7
Volume (acre-feet)	237
Shoreline Complexity	2.1
Vegetation	
Curly-leaf Survey Date	June 28, 2017
Comprehensive Survey Date	August 2, 2017
Number of Native Species	31
Threatened/Special Concern Species	-
Exotic Plant Species	Reed canary grass
Simpson's Diversity	0.88
Average Conservatism	29.3
Water Quality	
Wisconsin Lake Classification	Shallow, Lowland Drainage
Trophic State	Upper Mesotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	4,513:1

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

8.13.1 Benson Lake Water Quality

Water quality data was collected from Benson Lake on three occasions in 2017. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen. Please note that the data in these graphs represent concentrations and depths taken during the growing season (April-October), summer months (June-August) or winter (February-March) as indicated with each dataset. Furthermore, unless otherwise noted the phosphorus and chlorophyll-*a* data represent only surface samples. In addition to sampling efforts completed in 2017, any historical data was researched and are included within this report as available.

Benson Lake is located on the Manitowish River downstream of the Rest Lake Dam. As such, it is more like a river than a natural lake. Because of the very short hydrologic residence time, water quality likely reflects concentrations in the river.

No historical data exist for two water quality parameters of interest – total phosphorus and chlorophyll-*a*. In 2017, average summer phosphorus concentrations (23.2 µg/L) were similar to the median value (21.0 µg/L) for other shallow lowland drainage lakes in the state and lower than the median value (33.0 µg/L) for other lakes within the Northern Lakes and Forests ecoregion (Figure 8.13.1-1). The 2017 average summer phosphorus concentration falls in the *excellent* category for shallow lowland drainage lakes in the state.

In 2017, the average summer chlorophyll-*a* concentration (5.1 µg/L) was slower than the median value (9.4 µg/L) for other lakes of this type (Figure 8.13.1-2). This value is similar to the median value (5.6 µg/L) for other lakes within the Northern Lakes and Forests ecoregion. The 2017 average summer chlorophyll-*a* concentration falls in the *excellent* category for shallow lowland drainage lakes in the state.

Both of these parameters, total phosphorus and chlorophyll-*a*, rank within a TSI category of *excellent*, indicating the lake has enough nutrients for production of aquatic plants, algae, and other organisms but not so much that a water quality issue is present.

The clarity of Benson Lake's water can be described as *excellent* during the summer months in which data has been collected (Figure 8.13.1-3). A weighted average over this timeframe (8.5 feet) exceeds the median value for other shallow lowland drainage lakes in the state (5.6 feet) and is similar to the regional median (8.9 feet). Secchi disk clarity is influenced by many factors, including plankton production and suspended sediments, which themselves vary due to several environmental conditions such as precipitation, sunlight, and nutrient availability. In many lakes in the Manitowish Waters Chain of Lakes, a natural staining of the water plays a role in light penetration, and thus water clarity, as well. The waters of Benson Lake may contain naturally occurring organic acids that are washed into the lake from nearby wetlands. The acids are not harmful to humans or aquatic species; they are by-products of decomposing terrestrial and wetland plant species. This natural staining may reduce light penetration into the water column, which reduces visibility and also reduces the growing depth of aquatic vegetation within the lake. *True color* measures the dissolved organic materials in water; however, true color was not measured in Benson Lake and it is unknown if the lake's water clarity is primarily influenced by staining from organic acids.

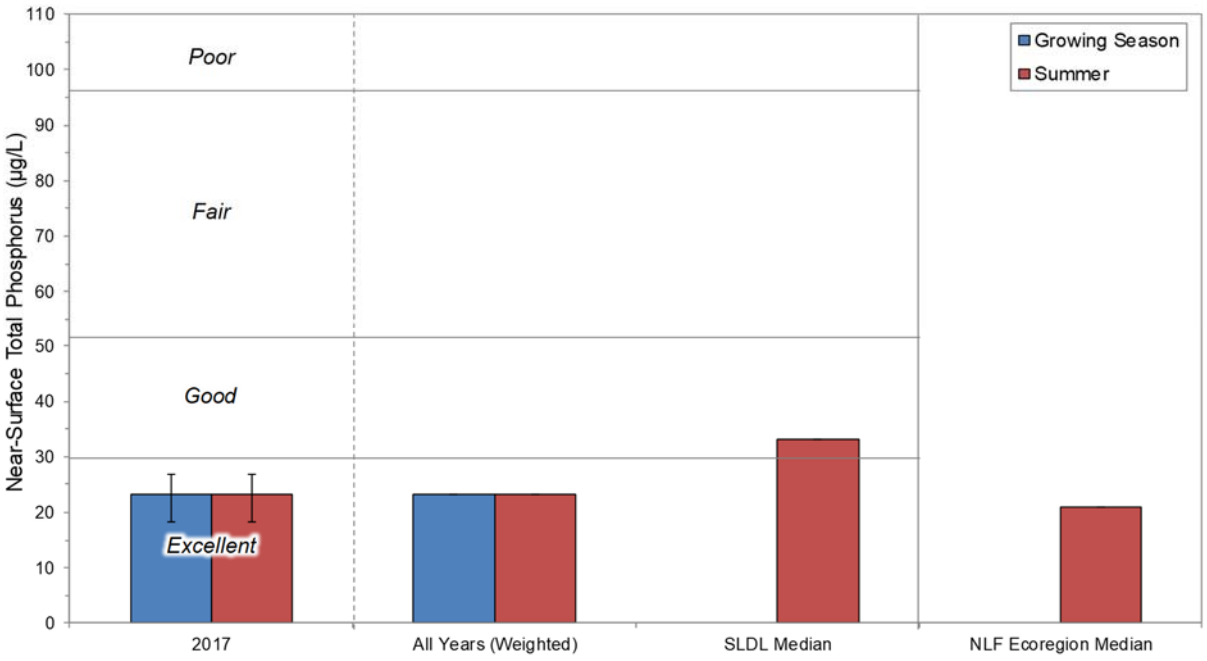


Figure 8.13.1-1. Benson Lake, state-wide shallow lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

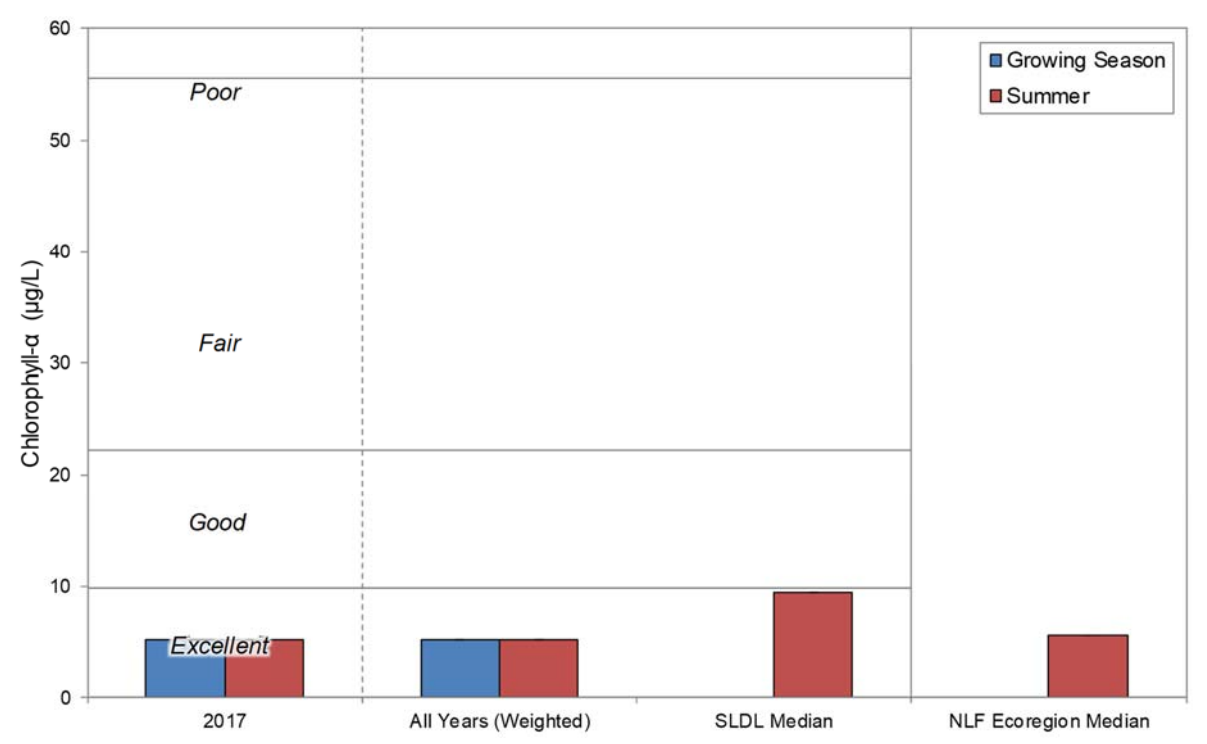


Figure 8.13.1-2. Benson Lake, state-wide shallow lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

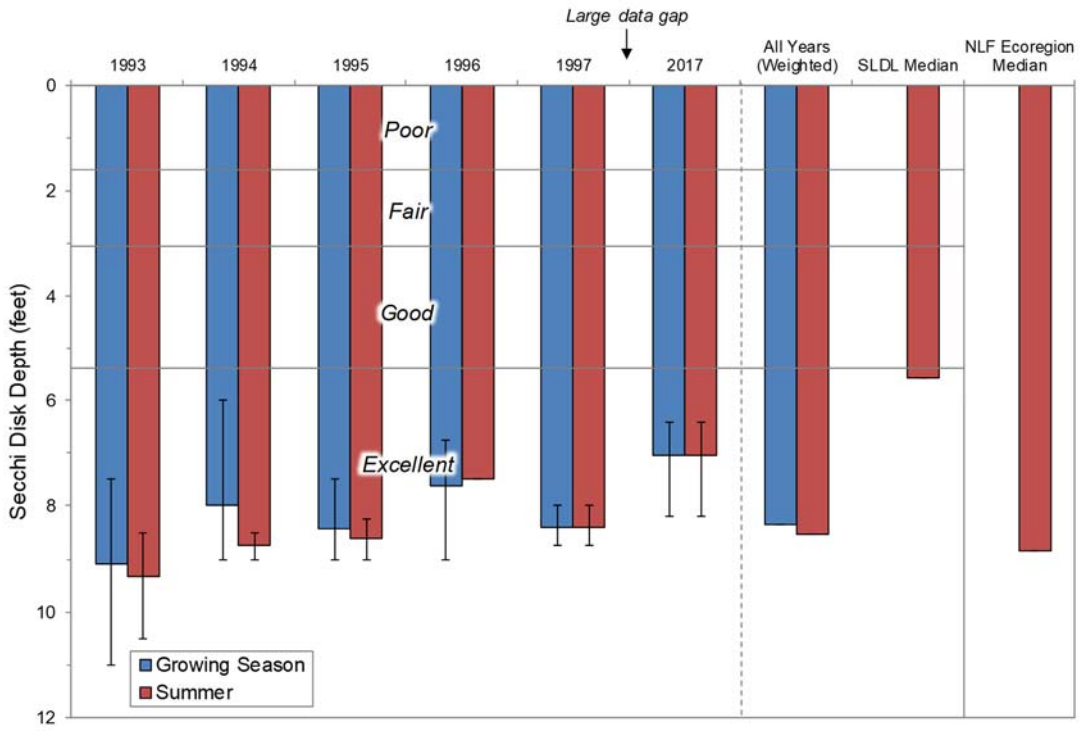


Figure. 8.13.1-3. Benson Lake, state-wide shallow lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Benson Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values are displayed in Figure 8.13.1-4. In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Benson Lake is in an upper-mesotrophic state.

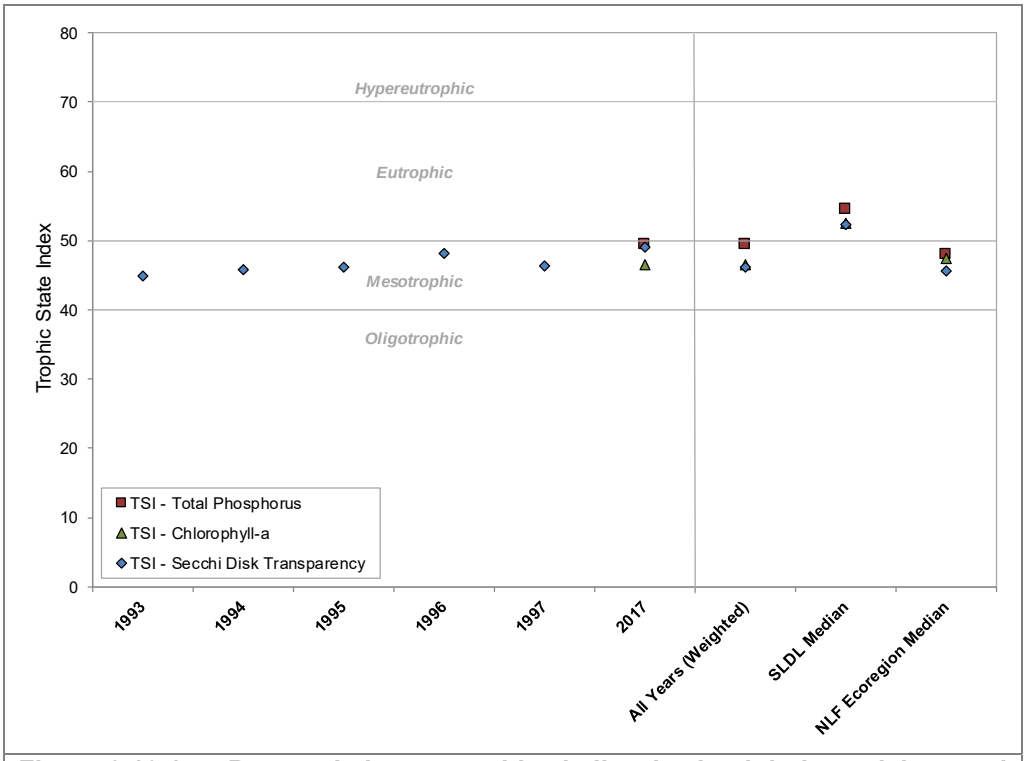


Figure 8.13.1-4. Benson Lake, state-wide shallow lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Benson Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Benson Lake by Onterra staff. Graphs of those data are displayed in Figure 8.13.1-5 for all sampling events.

Benson Lake remained thoroughly mixed throughout the summer months in 2017 (Figure 8.13.1-5). This is not uncommon in lakes that are moderate in size and fairly shallow. Energy from the wind and flow from the Manitowish River is sufficient to mix the lake from top to bottom, distributing oxygen throughout the epilimnion and hypolimnion and keeping water temperatures fairly constant within the water column.

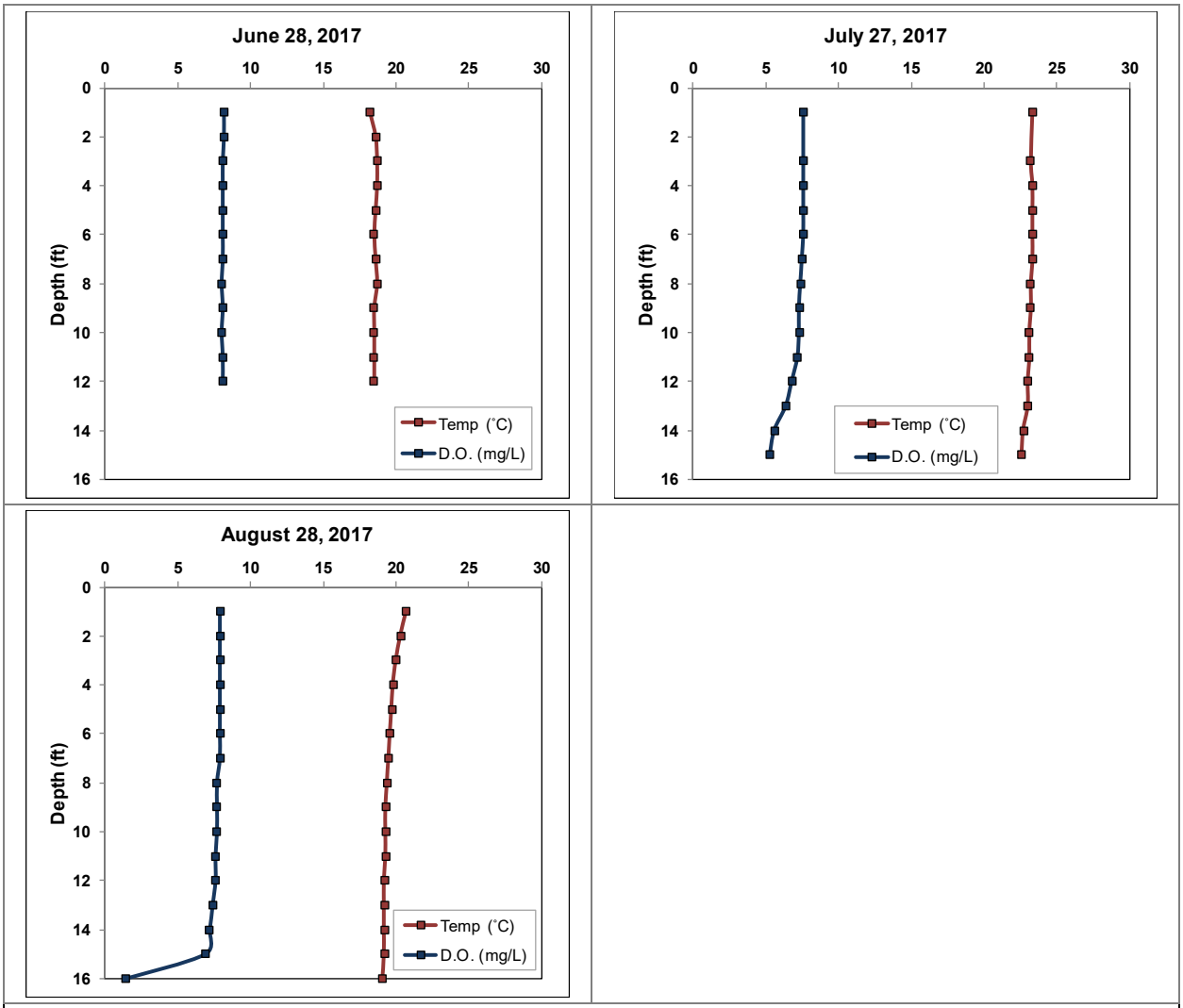


Figure 8.13.1-5. Benson Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Benson Lake

The water quality section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Benson Lake's water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include; pH, alkalinity, and calcium.

As the Chain-wide Water Quality Section explains, the pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions (H^+) within the lake's water and is thus an index of the lake's acidity. Benson Lake's surface water pH was measured at roughly 7.7 July of 2017. This value is slightly above neutral and falls within the normal range for Wisconsin lakes. Fluctuations in pH with respect to seasonality is common; in-lake processes such as photosynthesis by plants act to reduce acidity by carbon dioxide removal while decomposition of organic matter adds carbon dioxide to water, thereby increasing acidity.

A lake's pH is primarily determined by the amount of alkalinity that is held within the water. Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. Lakes with low alkalinity have higher amounts of the bicarbonate compound (HCO_3^-) while lakes with a higher alkalinity have more of the carbonate compound of alkalinity ($CO_3^=$). The carbonate form is better at buffering acidity, so lakes with higher alkalinity are less sensitive to acid rain than those with lower alkalinity. The alkalinity in Benson Lake was measured at 39.1 in July of 2017 and indicates that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain.

While samples of calcium were not collected from Benson Lake in 2017, calcium is commonly examined because invasive and native mussels use the element for shell building and in reproduction. Invasive mussels typically require higher calcium concentrations than native mussels. The commonly accepted pH range for zebra mussels is 7.0 to 9.0, so Benson Lake's pH of 7.7 falls within this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. Plankton tows were completed by Onterra staff during the summer of 2017 and these samples were processed by the WDNR for larval zebra mussels. No veligers (larval zebra mussels) were found within these samples.

8.13.2 Benson Lake Watershed Assessment

Benson Lake's watershed is 147,950 acres in size. Compared to Benson Lake's size of 33 acres, this makes for an incredibly large watershed to lake area ratio of 4513:1. Similar to most lakes that are downstream of other lakes, the large majority of the lake's watershed consists of the lake immediately upstream. For Benson Lake this means that 147,704 acres (>99%) of Benson Lake's watershed is the Sturgeon Lake subwatershed. The direct watershed of Benson Lake is a very small part of the lake's total watershed (Figure 8.13.2-1). Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Benson Lake's residence time is approximately one-half day, or that the water within the lake is completely replaced 672 times per year.

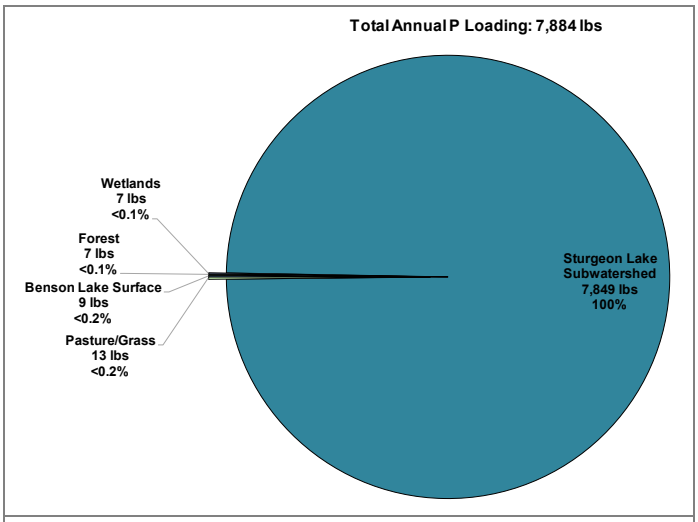


Figure 8.13.2-1. Benson Lake watershed proportion of land cover types. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

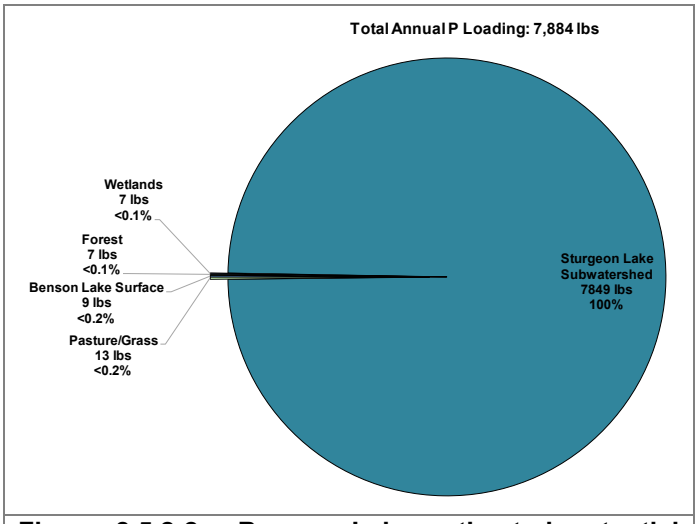


Figure 8.5.2-2. Benson Lake estimated potential annual phosphorus loading. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Of the estimated 7,884 pounds of phosphorus being delivered to Benson Lake on an annual basis, nearly all of it originates from Sturgeon Lake which is the lake immediately upstream of Benson Lake (Figure 8.13.2-2). Using the estimated annual potential phosphorus load, WiLMS similar to the measured growing season phosphorus concentration of 23 µg/L. This means the model works fairly well for Benson Lake.

Because the nearly all of the phosphorus that enters Benson Lake comes from the upstream Sturgeon Lake, efforts to reduce phosphorus levels in Benson Lake should concentrate on reducing phosphorus inputs to Sturgeon Lake.

8.13.3 Benson Lake Shoreland Condition

Shoreland Development

As mentioned previously in the Chain-wide Shoreland Condition Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In fall of 2017, Benson Lake's immediate shoreline was assessed in terms of its development. Benson Lake has stretches of shoreland that three of the five shoreland assessment categories. In all, 1.1 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.13.3-1). This constitutes about 93% of Benson Lake's shoreline. This shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, less than one tenth of a mile of developed–unnatural shoreline (1%) was observed. If restoration of the Benson Lake shoreline is to occur, primary focus should be placed on this shoreland area as they currently provide little benefit to, and actually may harm, the lake ecosystem. Benson Lake Map 1 displays the location of these shoreline lengths around the entire lake.

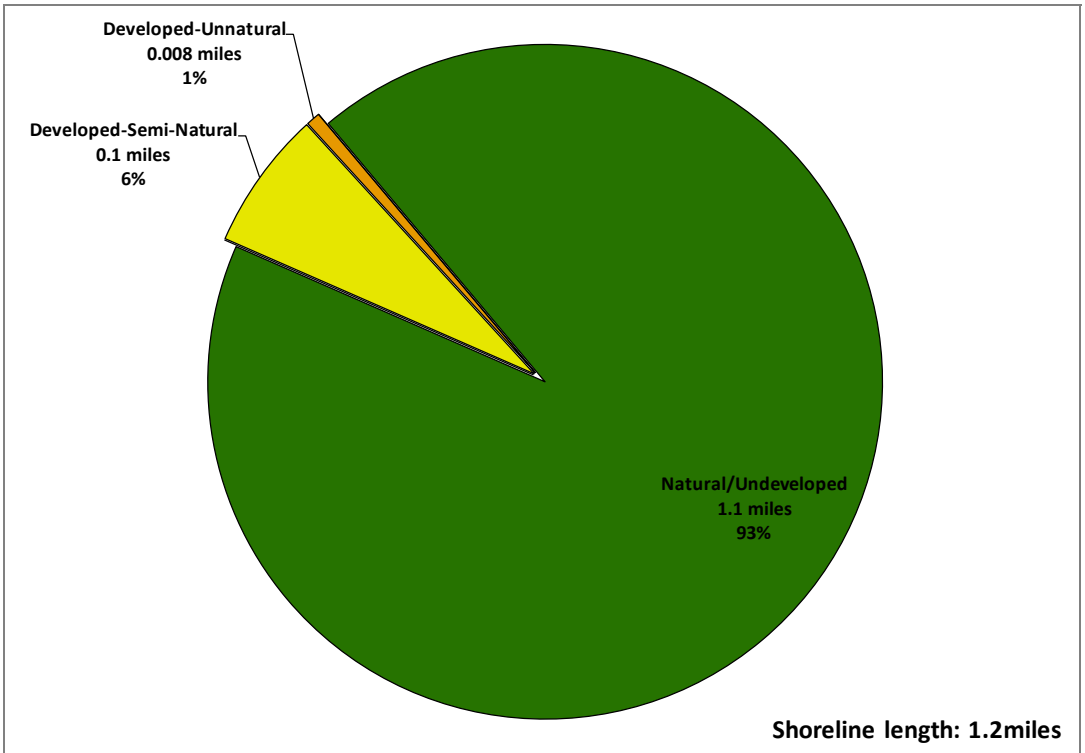


Figure 8.13.3-1. Benson Lake shoreland categories and total lengths. Based upon a fall 2017 survey. Locations of these categorized shorelands can be found on Benson Lake Map 1.

Coarse Woody Habitat

As part of the shoreland condition assessment, Benson Lake was also surveyed to determine the extent of its coarse woody habitat. Coarse woody habitat was identified, and classified in three size categories (2-8 inches in diameter, 8+ inches in diameter, or clusters of pieces) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed earlier, research indicates that fish species prefer some branching as opposed to no

branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance (Newbrey et al. 2005).

During this survey, 33 total pieces of coarse woody habitat were observed along 1.2 miles of shoreline (Benson Lake Map 2), which gives Benson Lake a coarse woody habitat to shoreline mile ratio of 28:1 (Figure 8.13.3-2). Only instances where emergent coarse woody habitat extended from shore into the water were recorded during the survey. Twenty-two pieces of 2-8 inches in diameter pieces of coarse woody habitat were found, 11 pieces of 8+ inches in diameter pieces of coarse woody habitat were found, and no instances of clusters of coarse woody habitat were found.

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

Onterra has completed coarse woody habitat surveys on 98 lakes throughout Wisconsin since 2012, with the majority occurring in the NLF ecoregion on lakes with public access. The number of coarse woody habitat pieces per shoreline mile in Benson Lake falls just above the median of these 98 lakes (Figure 8.13.3-2).

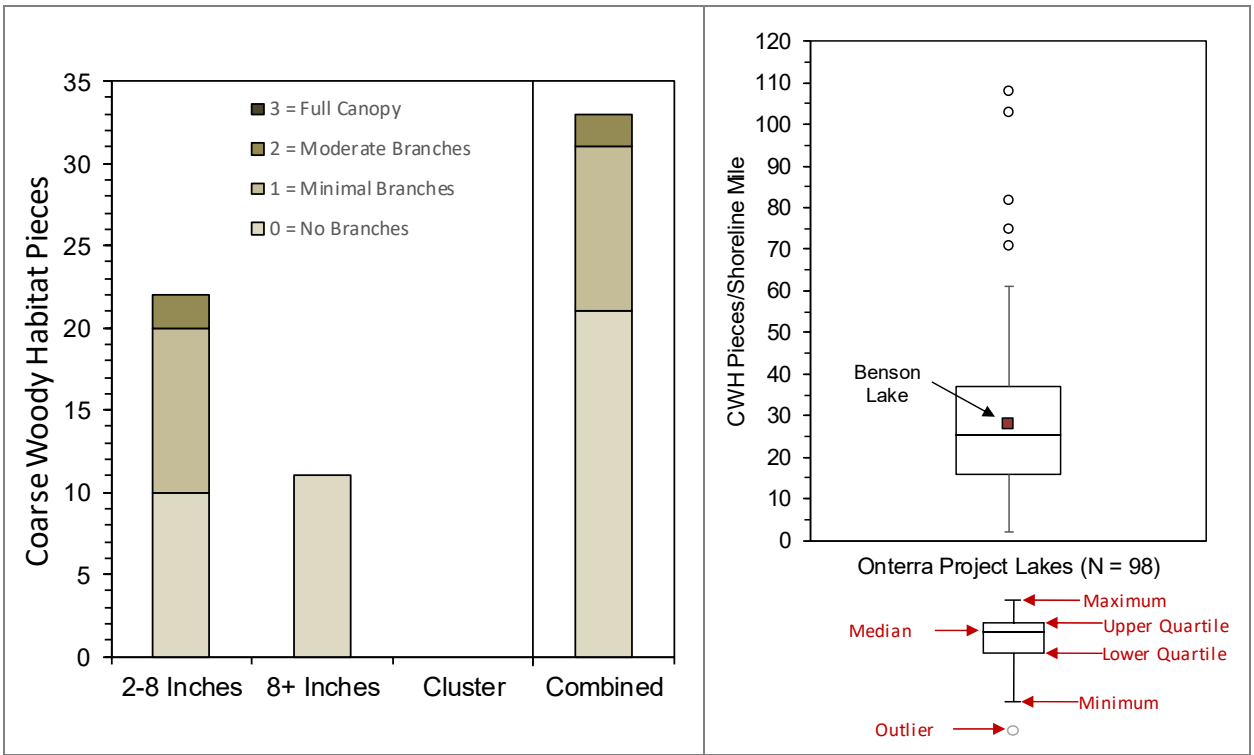


Figure 8.13.3-2. Benson Lake coarse woody habitat survey results. Based upon a fall 2017 survey. Locations of the Benson Lake coarse woody habitat can be found on Benson Lake Map 2.

8.13.4 Benson Lake Aquatic Vegetation

An early season aquatic invasive species survey was conducted on Benson Lake on June 28, 2017. While the intent of this survey is to locate any potential non-native species within the lake, the primary focus is to locate occurrences of curly-leaf pondweed which should be at or near its peak growth at this time. During this meander-based survey of the littoral zone, Onterra ecologists did not locate any occurrences of curly-leaf pondweed or any other submersed non-native aquatic plant species.

The aquatic plant point-intercept survey and floating-leaf and emergent plant community mapping were conducted on Benson Lake on August 2, 2017 by Onterra. During all surveys, 32 species of aquatic plants were located in Benson Lake (Table 8.13.4-1). Twenty-two of these species were sampled directly during the point-intercept survey and are used in the analysis that follows, while 10 species were observed incidentally during visits to Benson Lake. One non-native species, red canary grass (*Phalaris arundinacea*) was observed along the Benson Lake shoreline.

Aquatic plants were found growing to a depth of 14 feet. As discussed later on within this section, many of the plants found in this survey indicate that the overall community is healthy, diverse and in one species case somewhat rare. Of the 106 point-intercept locations sampled within the littoral zone, roughly 29% contained aquatic vegetation. Benson Lake Map 3 indicates that most of the point-intercept locations that contained aquatic vegetation are located in the northern bay of the lake. Approximately 46% of the point-intercept sampling locations where sediment data was collected at were sand, 41% consisted of a fine, organic substrate (muck) and 12% were determined to be rocky (Chain-wide Fisheries Section, Table 3.5-5).

Table 8.13.4-1. Aquatic plant species located in Benson Lake during 2017 plant surveys.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2017 (Onterra)
Emergent	*Carex pseudocyperus*	Cypress-like sedge	8	I
	Eleocharis palustris	Creeping spikerush	6	I
	Iris versicolor	Northern blue flag	5	I
	Phalaris arundinacea	Reed canary grass	Exotic	I
	Phragmites australis subsp. *americanus*	Common reed	5	I
	Pontederia cordata	Pickerelweed	9	X
	Schoenoplectus tabernaemontani	Softstem bulrush	4	I
	Sparganium eurycarpum	Common bur-reed	5	X
FL	*Nuphar variegata*	Spatterdock	6	X
	Nymphaea odorata	White water lily	6	X
Submergent	*Bidens beckii*	Water marigold	8	X
	Ceratophyllum demersum	Coontail	3	X
	Chara spp.	Muskgrasses	7	X
	Elodea canadensis	Common waterweed	3	X
	Myriophyllum sibiricum	Northern watermilfoil	7	I
	Najas flexilis	Slender naiad	6	X
	Potamogeton amplifolius	Large-leaf pondweed	7	I
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	I
	Potamogeton friesii	Fries' pondweed	8	X
	Potamogeton gramineus	Variable-leaf pondweed	7	X
	Potamogeton nodosus	Long-leaf pondweed	5	X
	Potamogeton pusillus	Small pondweed	7	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X
	Potamogeton robbinsii	Fern-leaf pondweed	8	X
	Potamogeton spirillus	Spiral-fruited pondweed	8	X
	*Potamogeton vaseyi**	Vasey's pondweed	10	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	N/A	X
	Stuckenia pectinata	Sago pondweed	3	X
	Utricularia vulgaris	Common bladderwort	7	I
	Vallisneria americana	Wild celery	6	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	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*

Figure 8.13.4-1 shows that wild celery, slender naiad, coontail, and flat-stem pondweed were the most frequently encountered plants within Benson Lake. Wild celery is a long, limp, ribbon-leaved turbidity-tolerant species that is a premiere food source for ducks, marsh birds, shore birds and muskrats. Animals may eat the entire plant, including the tubers that reside within the sediment. Slender naiad, a common annual species in Wisconsin, is considered to be one of the most important food sources for a number of migratory waterfowl species (Borman et al. 1997). Their numerous seeds, leaves, and stems all provide sources of food. The small, condensed network of leaves provide excellent habitat for aquatic invertebrates. Coontail is largely un-rooted (although do sometimes possess structures that function similar to roots or become partially buried in the sediment) and its location can be largely a product of water movement. Flat-stem pondweed, as its name implies, is a freely branched plant with strongly flattened stems and long, stiff leaves. Flat-stem pondweed lacks floating leaves, a feature many plants in the *Potamogeton* genus have. This plant can be a locally important food source to many aquatic and terrestrial organisms.

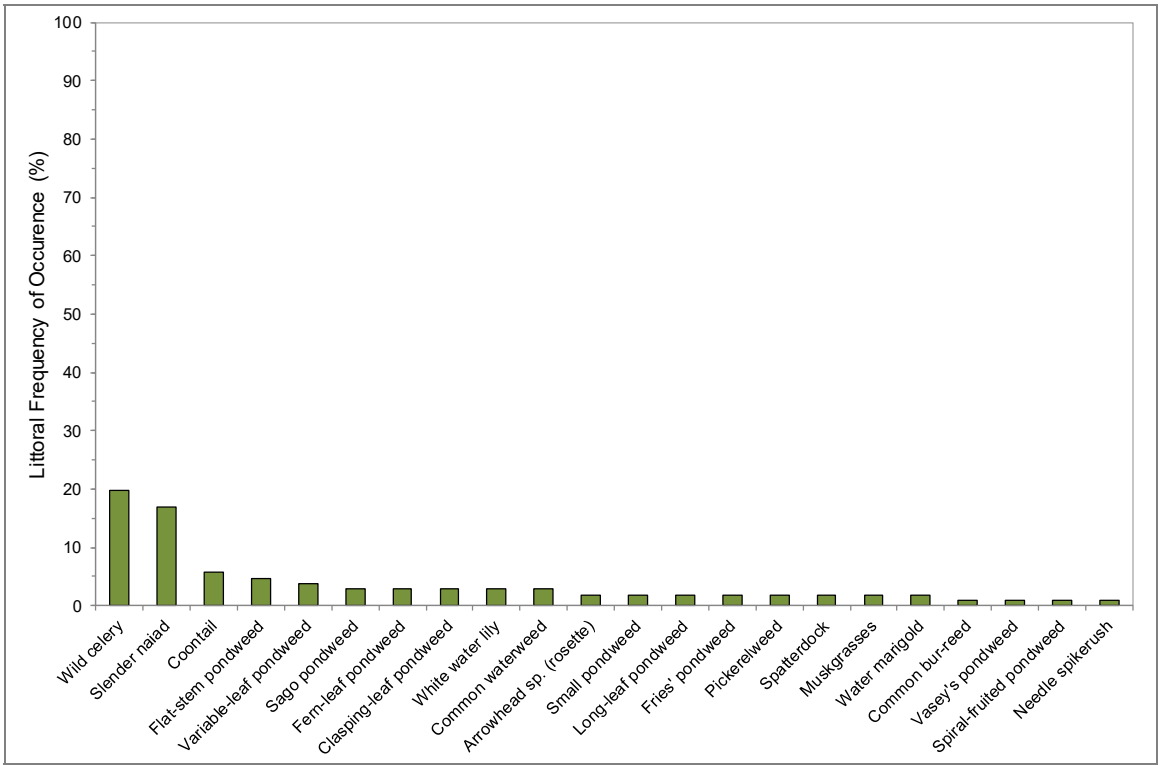


Figure 8.13.4-1. Benson Lake aquatic plant littoral frequency of occurrence analysis. Created using data from a 2017 point-intercept survey. .

During aquatic plant inventories, 31 species of native aquatic plants (including incidentals) were found in Benson Lake. Because of this, one may assume that the system would also have a high diversity. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Benson Lake's plant community (0.88) lies at the Northern Lakes and Forest Lakes ecoregion value (0.88), indicating the lake holds diversity similar to the lakes in the same ecoregion.

As explained earlier in the Manitowish Waters Chain of Lakes-wide document, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while wild celery was found at 20% of the sampling locations, its relative frequency of occurrence is 24%. Explained another way, if 100 plants were randomly sampled from Benson Lake, 24 of them would be wild celery. This distribution can be observed in Figure 8.13.4-2, where together four native species account for 57% of the aquatic plant population within Benson Lake, while the other 18 species account for the remaining 43%. Nine additional native species were found incidentally from the lake but not from of the point-intercept survey, and are indicated in Table 8.13.4-1 as incidentals.

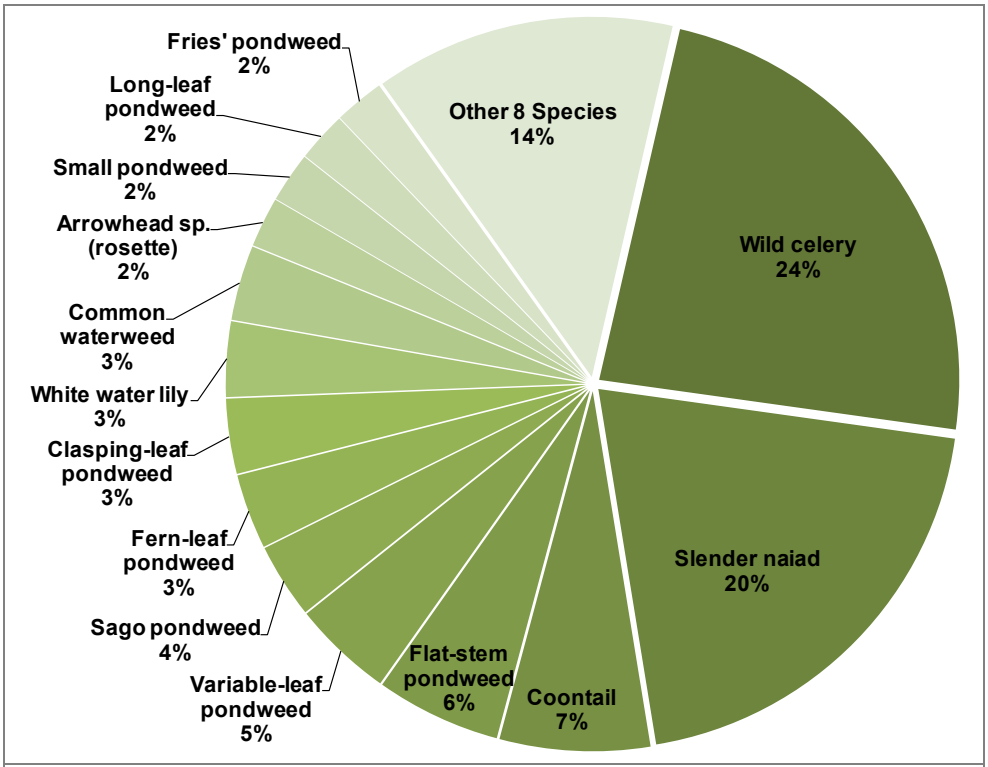


Figure 8.13.4-2. Benson Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2017 point-intercept survey.

Benson Lake's average conservatism value (6.2) is below the state median (6.3) and the Northern Lakes and Forests ecoregion median (6.7). This indicates that the plant community of Benson Lake is indicative of a slightly below average system within Wisconsin. Combining Benson Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in a value of 29.3 which is below the median values of the ecoregion (30.8) but above the median for the state (27.2).

The Benson Lake 2017 community map indicates that approximately 5.5 acres of the lake contains these types of plant communities (Benson Lake Map 4, Table 8.8.4-2). Ten floating-leaf and emergent species were located on Benson Lake (Table 8.8.4-1), all of which provide valuable wildlife habitat.

Table 8.13.4-2. Benson Lake acres of emergent and floating-leaf plant communities from the 2017 community mapping survey.

Plant Community	Acres
Emergent	0.5
Floating-leaf	0.9
Mixed Emergent & Floating-leaf	4.2
Total	**5.5**

The community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Benson Lake. This is important, because these communities are often

negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

Non-Native Aquatic Plants in Benson Lake

Reed canary grass

Reed canary grass (*Phalaris arundinacea*) is a large, coarse perennial grass that can reach six feet in height. Often difficult to distinguish from native grasses, this species forms dense, highly productive stands that vigorously 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. Reed canary grass was observed along the eastern shore of Benson Lake (Benson Lake – Map 4). Reed canary grass is difficult to eradicate; at the time of this writing there is no commonly accepted control method. This plant is quite resilient to herbicide applications. Small, discrete patches have been covered by black plastic to reduce growth for an entire season. However, the species must be monitored because rhizomes may spread out beyond the plastic.

8.13.5 Benson 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 and within the chain wide report section 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 Benson Lake. The goal of this section is to provide an overview of some of the data that exists. Although current fish data were not collected as a part of this project, the following information was compiled based upon data available from the Wisconsin Department of Natural Resources (WDNR) the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and personal communications with DNR Fisheries Biologist Hadley Boehm (WDNR 2018 & GLIFWC 2017).

Fish Stocking

To assist in meeting fisheries management goals, the WDNR may stock fry, fingerling or adult fish in a waterbody that were raised in nearby permitted hatcheries. 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. Benson Lake has no historical stocking records.

Benson Lake Spear Harvest Records

Although Benson Lake has been declared as a spear harvest lake, it has not historically seen a harvest. It is possible that spearing efforts have been concentrated on other larger lakes in the region, which would potentially have a higher estimated safe harvest for both walleye and muskellunge.

N
W E
S

300
Feet

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

Sources:
Hydro: WDNR
Orthophotography: NAIP, 2017
Shoreline Assessment: Onterra, 2017
Map Date: October 9, 2017
Filename:Benson_Map1_ShorelandCondition_2017.mxd


Project Location in Wisconsin

Legend

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

Seawall
- Rip-Rap
- Wood/Masonary/Metal

Map 1
Benson Lake
Vilas County, Wisconsin
2017 Shoreland Condition

N
W E
S

300
Feet

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

Sources:
Hydro: WDNR
Orthophotography: NAIP, 2017
Coarse Woody Habitat Survey: Onterra, 2017
Map Date: October 9, 2017
Filename:Benson_Map2_CWH_2017.mxd

Project Location in Wisconsin

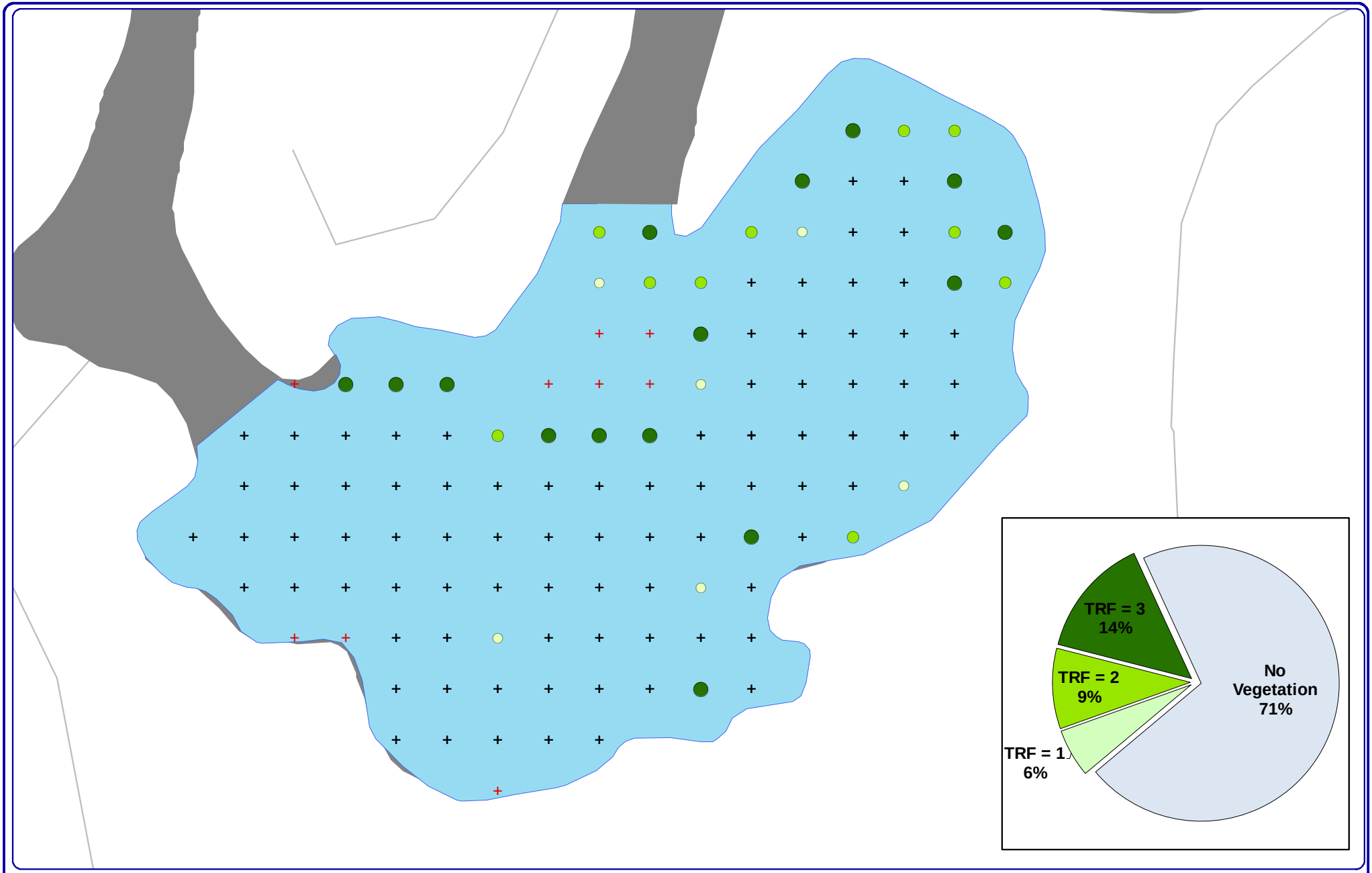
Legend

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

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

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

Map 2
Benson Lake
Vilas County, Wisconsin
Coarse Woody Habitat



N
W E
S

250
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
Plant Survey: Onterra, 2017
Map Date: November 17, 2017
Filename: *MapX_Benson_TRFPI_2017.mxd*


Project Location in Wisconsin

Legend

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

Map 3
Benson Lake
Vilas County, Wisconsin
2017 PI Survey:
Aquatic Vegetation Distribution

N
W E
S

250
Feet

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Sources:
Aquatic Plants: Onterra, 2017
Orthophotography: NAIP, 2017
Map date: November 3, 2017
Filename: Benson_Comm_2017.mxd

Project Location in Wisconsin

Legend

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

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

Map 4

Benson Lake

Vilas County, Wisconsin

Emergent & Floating-leaf Aquatic Plant Communities