

Whitney Lake 2018 Lake Assessment Report

Prepared by
Vilas County Land & Water Conservation

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Assessment Type	Metric	Metric Context	Whitney Lake Results
Water Quality	Total Phosphorus	FAL ¹ & REC ² : 40 ug/L in shallow headwater drainage lakes	13.57 ug/L average July-Sep 2018
	Chlorophyll a	FAL ¹ : 27 ug/L in shallow headwater drainage lakes REC ² : >20 ug/L more than 30% of days	6.23 ug/L average July, Sep 2018 >20 ug/L in 0 of 2 sampling events (0%)
Aquatic Plant Point-Intercept	Floristic Quality Index	24.3 median for Northern Lakes and Forest Lakes Ecoregion	33.05
	Average Value of Conservatism	6.7 median for Northern Lakes and Forest Lakes Ecoregion	7.05
Shoreland Habitat	Docks/Mile	>16 docks/mile density correlated with less fish diversity	1.5

¹Fish and aquatic life; ²Recreation; ³Frequency of Occurrence

Metrics & Contexts sourced from: WisCALM 2018; Hauxwell et al 2010; Nichols 1999; and Jacobson et. al. 2016.

Additional Data		
Water Quality	Secchi Depth	8.33 ft average
Aquatic Plant Point-Intercept Survey	Max Depth of Plants	11.0 ft
	FOO ³ shallower than max depth	85.91%
	Simpson's Diversity Index	0.86
	Rare Plants	Robbin's spikerush (<i>Eleocharis robbinsii</i>)
AIS Early Detection	Verified & New AIS Found	Chinese mystery snail New AIS: None
Shoreland Habitat	% Natural Cover	99%
	% Impervious	1%
	Parcels With Runoff Concerns	3 of 19 parcels (16%)
	Coarse Woody Habitat	68.8 logs/mile (anecdotally considered low)

Executive Summary

Whitney Lake is shallow headwaters drainage lake in Vilas County. Of the 3 water quality sampling events, Total Phosphorus and Chlorophyll a measured within the thresholds set by 2018 WISCALM and is indicative of good water quality. Five plants make up the bulk of the macrophyte aquatic plant community, however biodiversity hot-spots were located behind bog mats around the lake. Freshwater sponges were prevalent with a littoral frequency of occurrence of over 12%. The lake's floristic quality (33.05) is much higher than average for the region (24.3). No new aquatic invasive species (AIS) were found, however; the invasive Chinese mystery snails found were previously verified with DNR. The coarse woody habitat survey resulted in 68.8 logs/mile of shoreline. Most of the vegetative cover within the 35 ft. shoreland buffer area is natural (99%), however 1% is impervious. Pier density is at 1.5 docks/mile, which is much less than the 16.0 docks/mile threshold where negative impacts to fish diversity are seen. Additional littoral structures could add to this impact. Highlighted recommendations include water quality monitoring, continuation of shoreline conservation practices, maintaining coarse woody habitat, and AIS monitoring.

Introduction

Lakes are a vital natural resource to the economy and way of life in Vilas County. With over 75% of property taxes coming from lake front properties (based on 2016 tax roll), and tourism estimated to bring



Figure 1. Whitney Lake Map courtesy of Vilas County Online Mapping

in an additional \$212.5 million annually (*Total Tourism Impacts*), it is in the county's best interest to keep these lakes attractive. Vilas County sits at a headwaters region, meaning that this area's lakes and rivers are dependent on precipitation and groundwater. This area does not glean significant water from upstream waterways, so local conservation practices often protect our waters directly as well as maintain the water quality as it heads downstream out of Vilas County. With these ideas in mind, the Vilas County Land & Water Conservation Department successfully applied for a grant to assess lake health through the DNR's Directed Lakes program.

The purposes of the study of Whitney Lake are to: 1) fill data gaps by collecting data; and 2) identify any negative lake health issues for future focus. This data can also be used by the Vilas County Land & Water Conservation Department in the future with its planned watershed assessments.

Whitney Lake is a 225 acre Shallow Headwaters Drainage Lake located in the Town of Boulder Junction in Vilas County. Whitney Lake's maximum depth is 8 feet and is made up of 40% sand, 0% gravel, 0% rock, 60% muck (*Whitney Lake*). There are no inlets, but an unnamed stream drains the lake to Island Creek

which then flows to the Manitowish River. The lake is ringed by bogs on the south and west side with a shallow but navigable channel along the lake's west shore. No bathymetry map is publicly available.

The adjacent riparian land is owned by the Northern Highland American Legion State Forest (about 87% of shoreline) and private landowners (about 13% of shoreline). The ground cover is primarily forests and bogs, however there is some development on the lake. Pondered histosols are largely present around lake and are indicative of wetlands. Other predominant surrounding soils are sandy soils (primarily Rubicon Sand, Sayner-Rubicon Sand, or Keweenaw-Sayner-Vilas complex) with slopes ranging from 0-35%. These soils are rates "well drained" or "excessively drained". (*Web Soil Survey*).

Whitney Lake is represented by the Boulder Junction Lakes Alliance. This organization works with the Town of Boulder Junction to support lake conservation, and the Town has received DNR Surface Water Grants in the past related to Clean Boats Clean Waters projects for other lakes.



Figure 2. Soils of Whitney Lake. Pondered histosols (Hp), Rubicon sand (RoB), Keweenaw-Sayner-Vilas complex (KeC), and Sayner-Rubicon sand (SaD) predominate the riparian area. Courtesy Soil Web Survey, NRCS.

Results and Discussion

Note – See Appendix 1 for Methods

Water Quality

Whitney Lake is a 225 acre and 8 ft “shallow headwaters drainage lake”. Water quality assessments reference WisCALM Shallow Headwaters Lake criteria. It is not on the 2018 Impaired Waters list.

The total phosphorus criteria for fish & aquatic life and recreation for shallow headwaters drainage lakes is 40 ug/L. The total phosphorus sampled on Whitney Lake did not exceed the criteria any of the 3 sampling events in 2018. The mean total phosphorus reading from the 3 sampling events in 2018 was 13.57 ug/L, with a minimum reading of 12.6 ug/L and a maximum reading of 14.7 ug/L.

The chlorophyll a criteria for Fish and Aquatic Life for shallow headwater drainage lakes is 27 ug/L and for Recreation is 30% of days where chlorophyll a is >20 ug/L. While chlorophyll a was sampled in August 2018, the sample tube was contaminated before it could be analyzed, so chlorophyll a data is not available for August 2018. The chlorophyll a results at the July & Sep 2018 sampling events averaged to be 6.23 ug/L, with a minimum reading of 6.2 ug/L and a maximum reading of 6.26 ug/L. These figures never exceed 20 ug/L chlorophyll a (0% of days).

Water in Whitney Lake was reported blue & clear in July & Sep; and yellow & clear in July. Secchi depths averaged 8.3 ft, and is indicative of good to fair water quality. The pH (7.59) indicated slightly basic (vs. acidic) water. Alkalinity (22.6 mg/L) was low and indicates it is a softwater lake and has little buffering capacity for acid rain events. Calcium concentrations are relatively low (6.68 mg/L) as is the conductivity (53.5 uS/cm), reflecting that it would be very unlikely to support a reproducing zebra mussel population (Cohen). For perspective, WI DNR recommends zebra mussel monitoring at concentrations of 10 mg/L calcium and above, correlated with a conductivity of 99 uS/cm threshold (Hein and Ferry).

Temperature and dissolved oxygen monitoring showed that Whitney Lake was well mixed. “Warm water” fish need dissolved oxygen levels of at least 5 mg/L (Shaw et.al.). More than 5 mg/L dissolved oxygen was found on Whitney Lake down to the lake bottom. See Appendix 2 for water quality raw data and temperature and dissolved oxygen profiles.

Aquatic Plant Point-Intercept Survey

The Point-Intercept survey was done from July 5-19, 2018. Of the 413 point-intercept (PI) locations, 301 were visited – see Appendix 3 Figure 14. Those that were not visited were skipped because either they were non-navigable or terrestrial. Although the lake is listed as 8 ft deep, plants were found growing down to 11 ft deep, and only 4 points on the lake appeared to be too deep for plant growth.

Robbin’s spikerush (*Eleocharis robbinsii*) was found on Whitney Lake and is considered rare by DNR Natural Heritage Inventory (*Wisconsin’s Rare Plants*). See Appendix 3 for photos of highlighted plants.

Table 1. Whitney Lake 2018 Aquatic Plant Point-Intercept Statistics. Values sourced from UW-Extension Lakes Aquatic Plant Survey Data Workbook formulas.

Whitney Lake 2018 Point-Intercept Summary

Total number of sites visited	301
Total number of sites with vegetation	256
Total number of sites shallower than maximum depth of plants	298
Frequency of occurrence at sites shallower than maximum depth of plants	85.91
Simpson Diversity Index	0.86
Maximum depth of plants (ft.)**	11.00
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	301
Average number of all species per site (shallower than max depth)	1.51
Average number of all species per site (veg. sites only)	1.76
Average number of native species per site (shallower than max depth)	1.51
Average number of native species per site (veg. sites only)	1.76
Species Richness	23
Species Richness (including visuals)	26
Floristic Quality Index	33.05
Average Value of Conservatism	7.05

The Species Richness for Whitney Lake is 23. This figure includes only those species collected with the rake, and does not include visual sightings. Whitney Lake has much more species on average than other lakes: average Species Richness for the Northern Lakes and Forests Ecoregion is 13 and the state of Wisconsin average is 13 (Nichols). See Appendix 5 for Species Richness Map.

The Average Value of Conservatism for Whitney Lake of 7.05 is higher than the Northern Lakes and Forest Lakes Ecoregion average of 6.7 and the state of Wisconsin average of 6.0 (Nichols). This shows that there are higher quality types of plants that represent the region in Whitney Lake.

The Floristic Quality Index weighs both the species richness and the average value of Conservatism. The Floristic Quality for Whitney Lake is 33.05. This value is much higher than the Northern Lakes and Forest Lakes Ecoregion of 24.3 and the state of Wisconsin of 22.2 (Nichols).

The Simpson Diversity Index for Whitney Lake is 0.86. This indicates an above average number of species and more even distribution of those species in Whitney Lake compared with other lakes in the Northern Lakes and Forest Lakes Ecoregion (where 0 = no diversity and 1 = infinite diversity).

Of the plant species found, Large-leaf pondweed (*Potamogeton amplifolius*), Slendar naiad (*Najas flexilis*), Flat-leaf bladderwort (*Utricularia intermedia*), Muskgrass (*Chara contraria*), and White water lily (*Nymphaea odorata*) were the most prevalent. See Table 2.

Table 2. Whitney Lake 2018 Aquatic Plant Point-Intercept Species Collected Via Rake, Coefficients of Conservatism, and Littoral Frequency of Occurrence if > or = 10%

Species – Collected via Rake	Common Name	Coefficient of Conservatism	Littoral Frequency of Occurrence
<i>Potamogeton amplifolius</i>	Large-leaf pondweed	7	38.93%
<i>Najas flexilis</i>	Slendar naiad	6	30.87%
<i>Chara contraria</i>	Muskgrass	7	18.46%
<i>Nymphaea odorata</i>	White water lily	6	10.40%
<i>Utricularia intermedia</i>	Flat-leaf bladderwort	9	10.40%

Three additional species were visually encountered within 6 ft. of a PI point, but not captured on a rake. These plants are not factored into Diversity calculations.

Table 3. Whitney Lake 2018 Aquatic Plant Point-Intercept Additional Species Visually Encountered

Species – Visuals	Common Name
<i>Eleocharis erythropoda</i>	Bald spikerush
<i>Sparganium natans</i>	Small bur-reed
<i>Lemna minor</i>	Small duckweed

Of all the sampling points on Whitney Lake, the most species rich areas occurred in 5 areas where a bog mat within the lake boundary buffered a near-shoreline area. See Appendix 3 Figure 24.

For Whitney Lake, a sample specimen of most of the plants were collected, photographed, and pressed. Pressed specimens were verified and are housed at the Freckmann Herbarium at UW-Steven Point including: *Acorus americanus*, *Brasenia schreberi*, *Chara contraria*, *Eleocharis erythropoda*, *Elocharis robinsii*, *Elodea canadensis*, *Isoetes sp.*, *Najas flexilis*, *Nitella flexilis*, *Nymphaea odorata*, *Potamogeton amplifolius*, *Potamogeton gramineus*, *Potamogeton natans*, *Potamogeton obtusifolius*, *Sagittaria latifolia*, *Potamogeton spirillus*, *Schoenoplectus subterminalis*, *Sparganium angustifolium*, *Sparganium natans*, *Utricularia gibba*, *Utricularia intermedia*, *Utricularia minor*, *Utricularia minor*, *Utricularia purpurea*, *Utricularia vulgaris*, and *Vallisneria americana*. Plants not photographed or pressed were *Nuphar variegata* and *Lemna minor*.

AIS Early Detection Survey

On June 16, 2018, the AIS Early Detection Survey was completed. Targeted sites included: the public boat landing; the area just south of the private parcels; the creek outlet; and the open water area behind the bog on the northwest shore. A meander survey around the perimeter of the lake was conducted. The water had good visibility, so the sites were snorkeled. Although multiple species were searched for (see Methods section in Appendix 1 for species list), **no new targeted AIS were found** during the survey. Chinese mystery snails were found during the survey, which were previously documented as in SWIMS as “Verified”. No AIS are listed as “Observed”.

Zebra mussel veliger tows were not done because calcium concentrations were below the threshold of 10 mg/L and conductivity was below the threshold 99 uS/cm to necessitate sampling. Whitney Lake water would be considered unsuitable for sustaining a reproducing zebra mussel population. (SWIMS).

A sediment sample was taken on August 15, 2018 and analyzed by DNR staff in Madison for spiny waterfleas. No evidence of spiny waterfleas was found in the sample (SWIMS).

Coarse Woody Habitat

Coarse woody habitat was mapped on June 12, 2018 when the water was fairly clear and easy to detect submerged logs. A follow up canoe survey was done on August 14, 2018 to get behind the bogs on the west shore – the water still had very good clarity (secchi averaging 8 ft). 227 logs were counted between the ordinary high water mark and the 2 ft depth contour along the 6.6 miles of shoreline, giving the density of 68.8 logs/mile of shoreline – see Appendix 4.

127 logs (56%) crossed the ordinary high water mark, providing a habitat “bridge” between the water and land. 14 logs (6%) were submerged with the full tree crown, providing more complex structure to the Coarse Woody Habitat.

Shoreline Assessment

The shoreline of Whitney Lake consists of 19 parcels – some are privately owned and some are state owned and managed as part of the Northern Highlands American Legion State Forest.

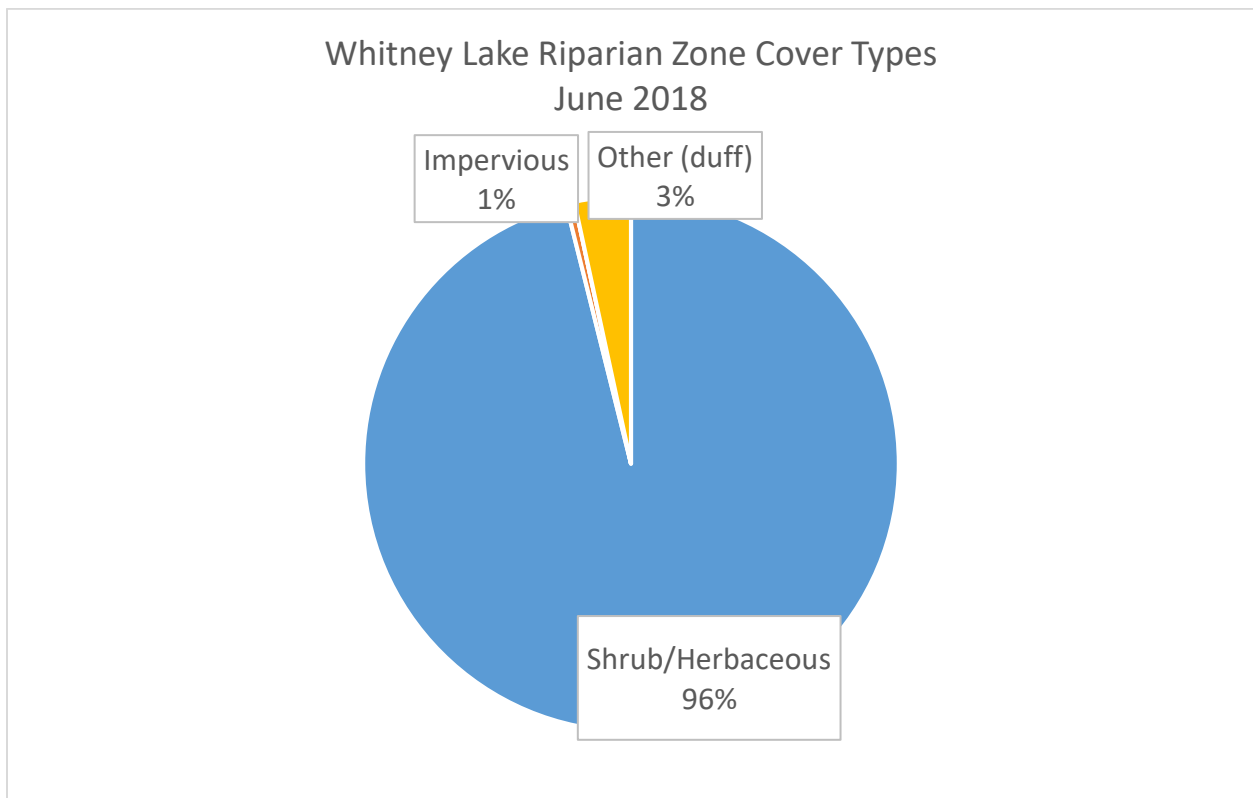


Figure 3. Ground cover type in Riparian Buffer Area (35 ft. inland from shore) on Whitney Lake, 2018.

Lake-wide, 96% of the riparian area (35 ft. inland from ordinary high water mark) was covered by a shrub/herbaceous layer. Lawn made up 0% of the riparian area, and Impervious surfaces made up 1%. See Appendix 5 for Riparian Buffer Zone Cover Types.

Since Wisconsin now allows 100 ft. frontage lake parcels, and each parcel (or each 100 ft.) is allowed a 35 ft. viewing corridor through the Riparian Buffer Zone (Vilas County Shoreland Zoning Ordinance), 65% native vegetation remaining in the Riparian Buffer Zone is the lake-wide standard target. This rate does not reflect a biological or ecological best practice. Whitney Lake exceeds this statistic having 96% covered with shrub/herbaceous cover.

Some human structures or modifications were noted in the Riparian and Littoral Zones. See Figure 6 for Human Structures in Riparian Buffer and Littoral Zones Charts.

Because of their ecological importance, these areas are typically protected by County Zoning and DNR regulations and permits are often required to modify or place new structures in these areas. In Whitney Lake, boats on shore were the most common structure.



Figure 5. Landowners experiencing minor-moderate erosion issues may find that Healthy Lakes practices such as native plantings are enough to reduce runoff. Contact Land & Water Conservation for an assessment. Photo courtesy of Healthy lakes WI.

Ten docks or less per kilometer (16 docks/mile) of shoreline has been shown to be a threshold of maintaining high quality fish diversity in Minnesota (Jacobsen et. al). Whitney Lake is below this figure at 1.5 docks/mile. Additional littoral structures such as boat lifts, swim rafts, etc. would intuitively seem to add to this stress. Other major categories for structures were: boats on shore (46); buildings (38); boat lifts (32); and other riparian structures (20).



Figure 4. Dock density on Whitney Lake was low, and disturbance to riparian areas appeared minimal. Lake-wide, there were 1.5 docks/mile on Whitney Lake. Having a lake-wide dock density greater than 16 docks/mile has been shown to have negative effects on fish diversity (Jacobsen et.al).

Within the Bank Zone, no modifications or erosion concerns were observed.

A few runoff and erosion concerns were documented within the riparian area: 3 parcels had a straight stairs/trail/road to the lake. See Figure 7 for Number of Parcels with Erosion or Runoff Concerns.

Aquatic plant removal was observed on 2 parcels.

Photos of the riparian area and data from the shoreline assessment are housed with the Vilas County Land & Water Conservation Department and will be shared with the Department of Natural Resources.

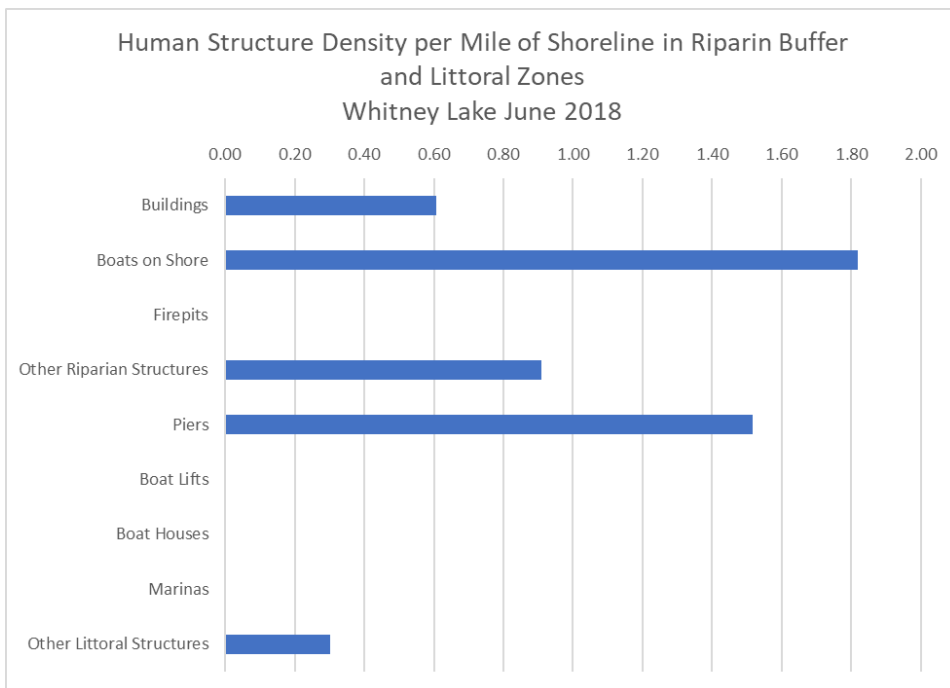
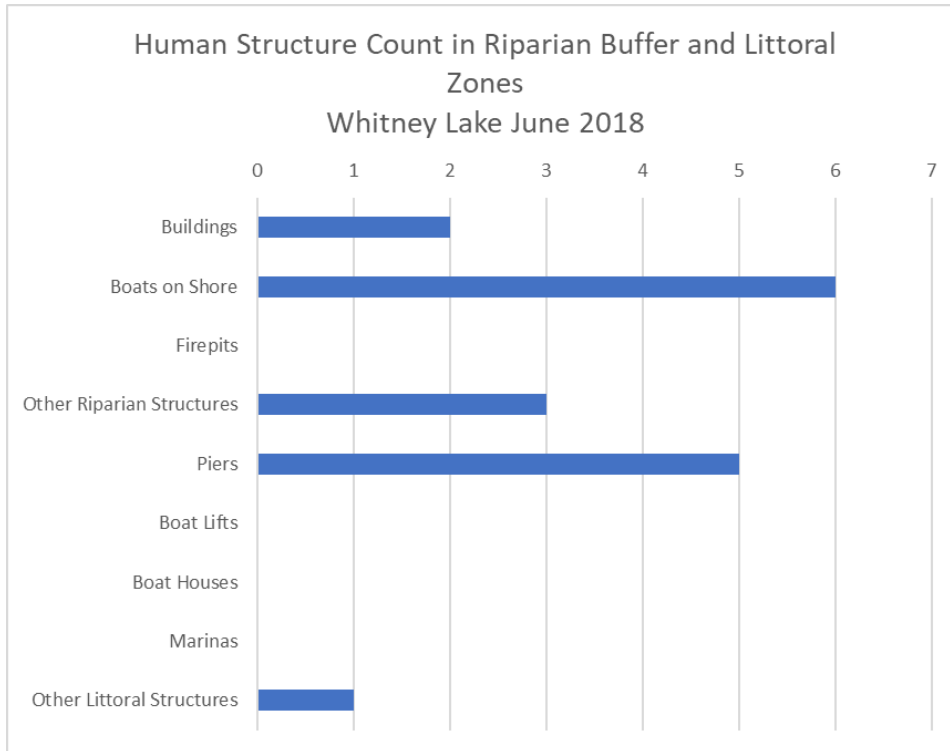


Figure 6. Number and density per mile of shoreline of human structures documented in the Riparian Buffer and Littoral Zones on Whitney Lake 2018.

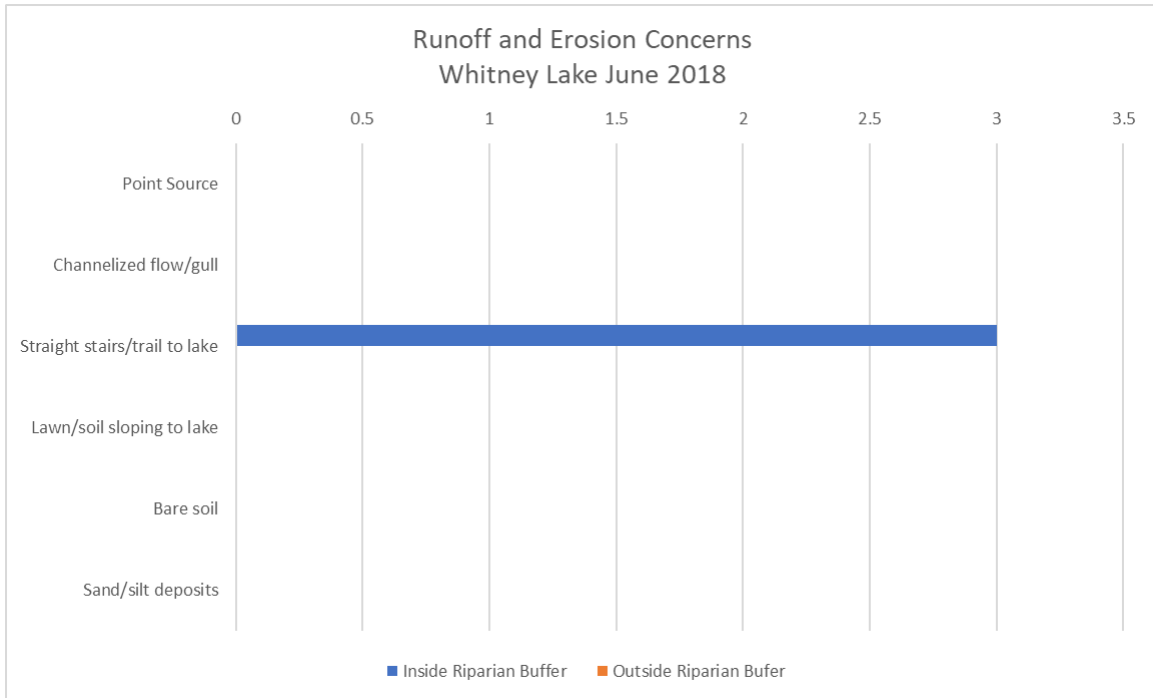


Figure 7. Number of parcels with runoff and erosion concerns in Riparian Zone and Outside Riparian Zone on Whitney Lake 2018. Of the 19 parcels, 3 had erosion or runoff concerns (16%).



Figure 8. Minimizing impervious surfaces in and around lake access paths, maintaining vegetation, and curving the trail across the slope keeps shoreland erosion in check.



Figure 9. Impervious surfaces and straight trail access make a site even more prone to erosion. This site (not on Whitney Lake) was augmented with a water infiltration pit to minimize runoff into the lake.

Observations

Anecdotally, lake residents indicated there was a winter fish kill the winter of 2017-2018.

Freshwater sponges were found at 12% of littoral area points sampled in the aquatic plant point intercept survey.

Trumpeter swans as well as much of the diversity of aquatic plants took refuge in the navigable waterway behind the bog mats on the lake.



Figure 10. Freshwater sponges were found at over 12% of littoral points surveyed.



Figure 11. Quiet areas of the lake were protected by bog mats.

Recommendations

The Boulder Junction Lake Alliance partners with the Town of Boulder Junction and could facilitate if desired:

- **Monitor water quality regularly:**
 - While it seems apparent that Whitney Lake has good water quality, it may be helpful to have year-round dissolved oxygen information to correlate with any future winter fish kills. Contact Sandy Wickman from WI DNR 715-365-8951 or Sandra.wickman@wisconsin.gov for additional assistance.
- **Maintain native vegetation to grow in the 35 ft. shoreland buffer areas:**
 - The shoreland owners of Whitney Lake have done an excellent job of creating minimal impact to their shorelines. Encourage this leaving native plants, shrubs, and trees within the 35 ft buffer zone. Roots of turf grasses are not as well equipped as the existing native shoreline plants at holding down soil and reducing runoff. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance or question in preserving native shorelines.
- **Protect areas of biodiversity hotspots, expanses of intact shorelines, and areas rich in coarse woody habitat:**
 - Share species richness, shrub/herbaceous, and coarse woody habitat maps widely with riparian owners, including the Northern Highlands State Forest.
 - Encourage landowners of the “biodiversity hotspots” (see p. 6), shrub/herbaceous cover >80% (see page 27), and dense coarse woody habitat areas (see p. 25) to protect their natural areas. This could be done through nominating landowners for VCLRA’s Blue Heron Award, or the Vilas County Land & Water Conservation Stewardship Award. Contact Tom Ewing of VCLRA for further information 630-251-0247.
 - Maintain motorless designation.
- **Maintain Coarse Woody Habitat:**
 - Encourage leaving down wood where it falls to maintain fish habitat. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.
- **Maintain awareness of stormwater management and resources for private landowners:**
 - The number of parcels with erosion concerns was low (3), but landowners should be encouraged to seek assistance as needed with stormwater concerns. Stormwater management (gutters, infiltrations, curved/vs. straight access paths, etc.) outside the 35 ft. buffer zone should also be addressed with willing landowners. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Encourage recognition, prevention, and control of invasive species as appropriate:**
 - Maintain boat landing aquatic invasive species signage as needed.
 - Encourage lake residents to become familiar with invasive species ID. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance with aquatic invasives.

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Appendices

Appendix 1: Methods

Appendix 2: Water Quality Raw Data and Temperature & Dissolved Oxygen Profiles

Appendix 3: Aquatic Plant Point-Intercept Sampling Point Map, Plant Photos, and Species Richness Map

Appendix 4: Coarse Woody Habitat Map

Appendix 5: Shoreland Data Maps

Appendix 6: Erosion Susceptibility

Appendix 1: Methods

All surveys mentioned below were completed following the WI DNR's Directed Lakes protocols May 3, 2016 revision (Hein and Ferry, 2016). Any deviations from the protocols are mentioned within each section here. Decontamination of the boat and equipment via the DNR's bleach method or hot pressure washing method occurred before a new body of water was entered (*Boat, Gear, and Equipment Decontamination and Disinfection Manual Code 9183.1*).

Water Quality Sampling

Water quality sampling was done on three occasions and scheduled with the Lansat Satellite schedule Path 25, with one exception due to an equipment error where sampling on that day was not possible. Temperature and dissolved oxygen profiles were measured at the deep hole using a YSI ProODO meter.

Lake water for chemistry analysis was collected with a 2 meter Integrating Sampler from the deep hole. Samples were analyzed by the WI State Lab of Hygiene in Madison, WI. "Blank" and "duplicate" samples were also included for quality assurance. Sampling parameters varied by date:

2018

- July: Temperature and dissolved oxygen profile; Secchi; total phosphorus; chlorophyll a; alkalinity, pH, and conductivity
- August: Temperature and dissolved oxygen profile; Secchi; total phosphorus; chlorophyll a; calcium
- September: Temperature and dissolved oxygen profile; Secchi; total phosphorus; and chlorophyll a

Total phosphorus and chlorophyll a results were compared to the 2018 WisCALM criteria for shallow headwater drainage lakes.

Aquatic Plant Point Intercept Survey

WI DNR staff created a grid-based map consisting of 413 point-intercept (PI) sampling points for Whitney Lake and shared the resulting shapefile. Using the Minnesota DNR GPS Application software and a Garmin 76CX unit, the PI points were downloaded. As indicated in the Directed Lakes protocols, the standard WI Point-Intercept methods were used (Hauxwell et. al.). Land & Water staff navigated to each point that was shallower than the maximum depth for aquatic plants (determined during sampling) and identified each macrophyte collected on a double headed rake. A rake on a pole was used for sites shallower than 15 ft., and while a rake on a rope would have been used for sites deeper than 15 feet, no areas of the lake were this deep. Species that were seen within 6 ft. from the boat that were not collected on the double headed rake were recorded as "visuals".

Plants were identified using several resources: *Aquatic Plants of the Upper Midwest 2nd Edition* (Skawinski), *Through the Looking Glass 2nd Edition* (Borman et. al.), *Manual of Vascular Plants of the Northeastern United States and Canada 2nd Edition* (Gleason and Cronquist), and "Identifying Pondweeds – A Brief Summary" (Knight).

Results were entered on the Aquatic Plant Survey Data Workbook (*Aquatic Plant Management in WI*). Statistics including Simpson's Diversity Index, Species Richness, Floristic Quality, and Average Value of Conservatism are sourced from this workbook's imbedded formulas.

Ideally, a representative aquatic plant for each species located would be collected, photographed, and pressed. Most plants found were treated as above, however a few were not – see the Results for more details. All pressed plants were verified and are now housed with the UW-Stevens Point Freckmann Herbarium.

AIS Early Detection Surveys

Staff snorkeled around the lake in search of aquatic invasive species. Boat launches, inlets, outlets, high use areas, and changes in habitat are typically targeted areas, and Whitney Lake's target sites included 4 areas: the public boat landing; the area just south of the private parcels; the creek outlet; and the open water area behind the bog on the northwest shore. A boat meander survey around the lake edge that included riparian visual surveys was also done to increase aquatic and riparian invasive species detection.

AIS visually searched for included: hydrilla, water hyacinth, European frogbit, curly leaf pondweed, water lettuce, yellow floating heart, fanwort, Eurasian water-milfoil, Brazilian waterweed, parrot feather, didymo, water chestnut, purple loosestrife, yellow iris, flowering rush, Japanese knotweed, Phragmites, Japanese hops, faucet snails, zebra/quagga mussels, Chinese & banded mystery snails, Asian clams, rusty crayfish, swamp crayfish, New Zealand mudsnails, spiny waterfleas, and starry stonewort.

Veliger tows using a 50 cm opening plankton net were taken at 3 different locations to detect zebra mussels. Results were analyzed by WI DNR staff.

Sediment samples using an Ekman Dredge were taken to detect spiny waterfleas at 1 location at the deep hole on the lake. Results were analyzed by WI DNR staff.

Coarse Woody Habitat

Coarse woody habitat was surveyed according to the existing 2016 draft of the Lake Shoreland & Shallows Habitat Monitoring Field Protocol (Hein et. al.). Coarse woody habitat situated between the ordinary high water mark and the 2 ft. depth contour at least 4 inches in diameter and 5 ft. long was documented and mapped. A Garmin 76CX was used to mark each piece of wood. Certain features about the wood were manually noted: "Branchiness" (no branches; a few branches; full crown); does the wood cross the ordinary high water mark (touch shore; not touch shore); and is 5 ft. of the wood currently submerged (in water; not in water).

Data was downloaded using BaseCamp software, and a map was created in ArcMap.

Shoreland Assessment

This survey collected information per land parcel. A shapefile was created that contained the parcel boundaries around Whitney Lake with a centroid in each parcel pushed out 50 ft. into the lake. A 35 ft. boundary inland was drawn around the lake to designate the Riparian Zone. This data was downloaded onto a Trimble Nomad data logger. The centroid and parcels lines and gave a target and boundaries to work with while on the lake assessing the parcels.

The Shoreland Assessment protocols call for documenting the condition of the Riparian Buffer Zone 35 ft. inland from shore, the bank zone, and the littoral zone – see Figure 12. If it was uncertain if structures were located within the 35 ft. riparian buffer zone, a rangefinder was used to measure distances.

Data collected on the Riparian Buffer Zone were percent cover (canopy, shrubs, herbaceous, impervious surfaces, manicured lawn, agriculture, and other); human structures (buildings, boats on shore, fire pits, and other); runoff concerns (point source, channelized flow/gully, straight stair/trail/road to lake, lawn/soil sloping to lake, bare soil, sand/silt deposits, and other).

Data collected on the Bank Zone were horizontal lengths of the following: vertical sea wall; rip rap; other erosion control structures; artificial beach; bank erosion >1 ft. face; and bank erosion < 1ft. face.

Data collected on the Littoral Zone were the number human structures: piers, boat lifts, swim rafts/water trampolines, boathouses, and marinas. Presence/absence of aquatic emergent and floating plants were noted. Signs of aquatic plant removal were also noted.

Photos of the 35 ft. Riparian Buffer Zone were taken at approximately 50 ft. from shore.

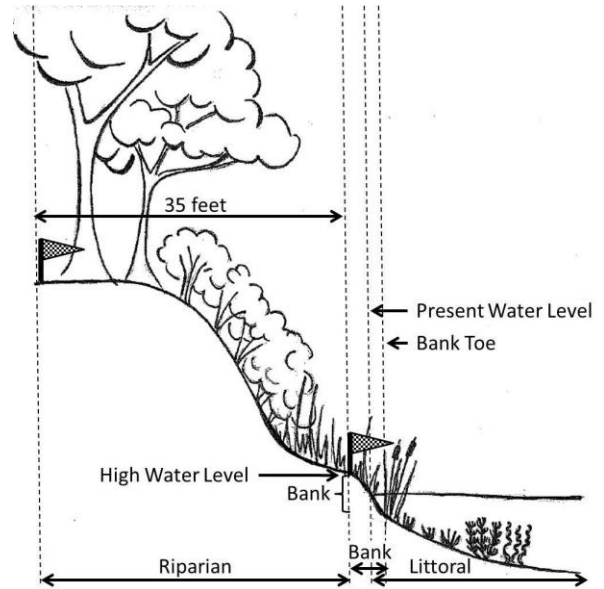


Figure 12. Shoreland areas assessed included the Riparian Buffer Zone, Bank Zone, and Littoral Zone. Graphic courtesy of WI DNR.

Appendix 2: Water Quality Raw Data and Temperature and Dissolved Oxygen Profiles

Table 4. Results of 2018 Whitney Lake water quality testing. Testing occurred on 7/16/18; 8/15/2018; 8/23/2018; and 9/17/2018.

	July 2018	Aug 2018	Sep 2018	Average
Secchi average (ft.)	8.0	8.0	9.0	8.33
Total Phosphorus (ug/L)	12.6	14.7	13.4	13.57
Chlorophyll a (ug/L)	6.20	Error	6.26	6.23
Calcium (mg/L)	6.68	n/a	n/a	6.68
Alkalinity (mg/L)	22.6	n/a	n/a	22.6
pH	7.59	n/a	n/a	7.59
Conductivity (uS/cm)	53.5	n/a	n/a	53.5

The July, August, and September temperature and dissolved oxygen profiles show the lake was mixed and did not stratify.

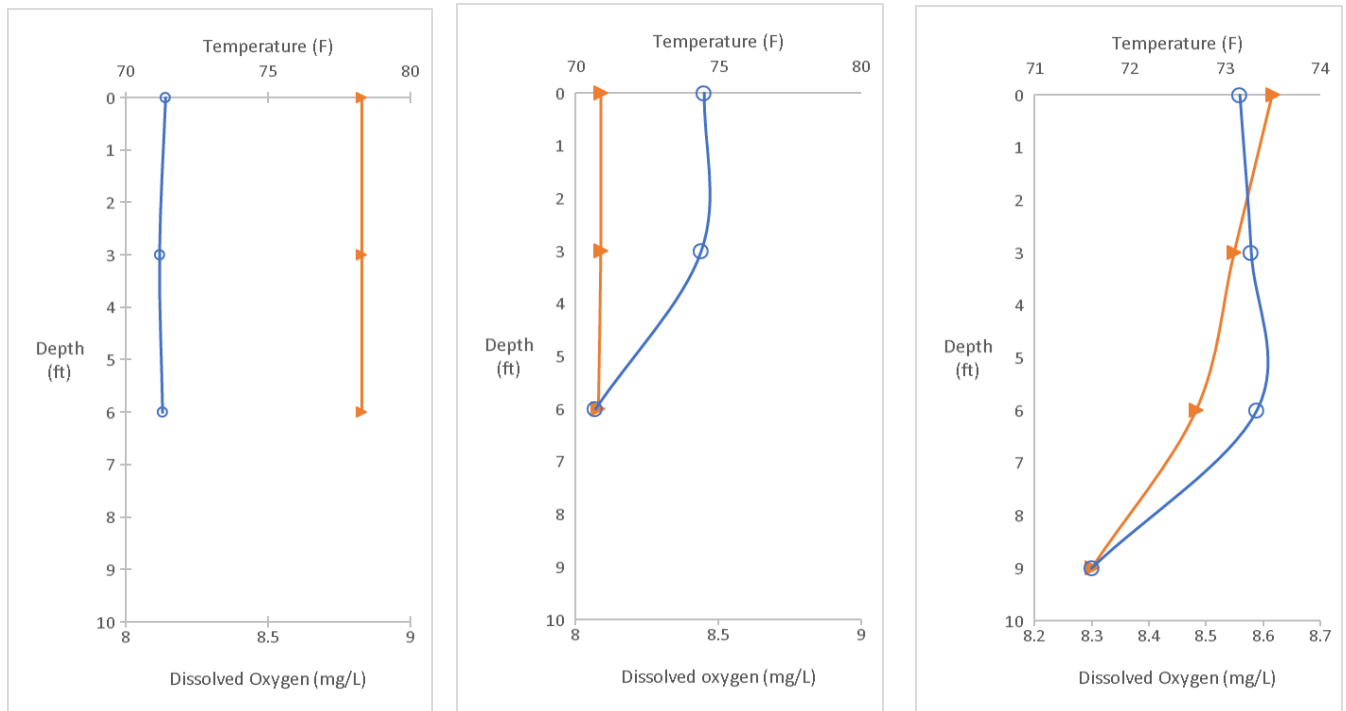


Figure 13. July, Aug, and Sep 2018 dissolved and temperature profiles for Whitney Lake.

Appendix 3: Aquatic Plant Point-Intercept Sampling Point Map, Plant Photos, and Species Richness Map

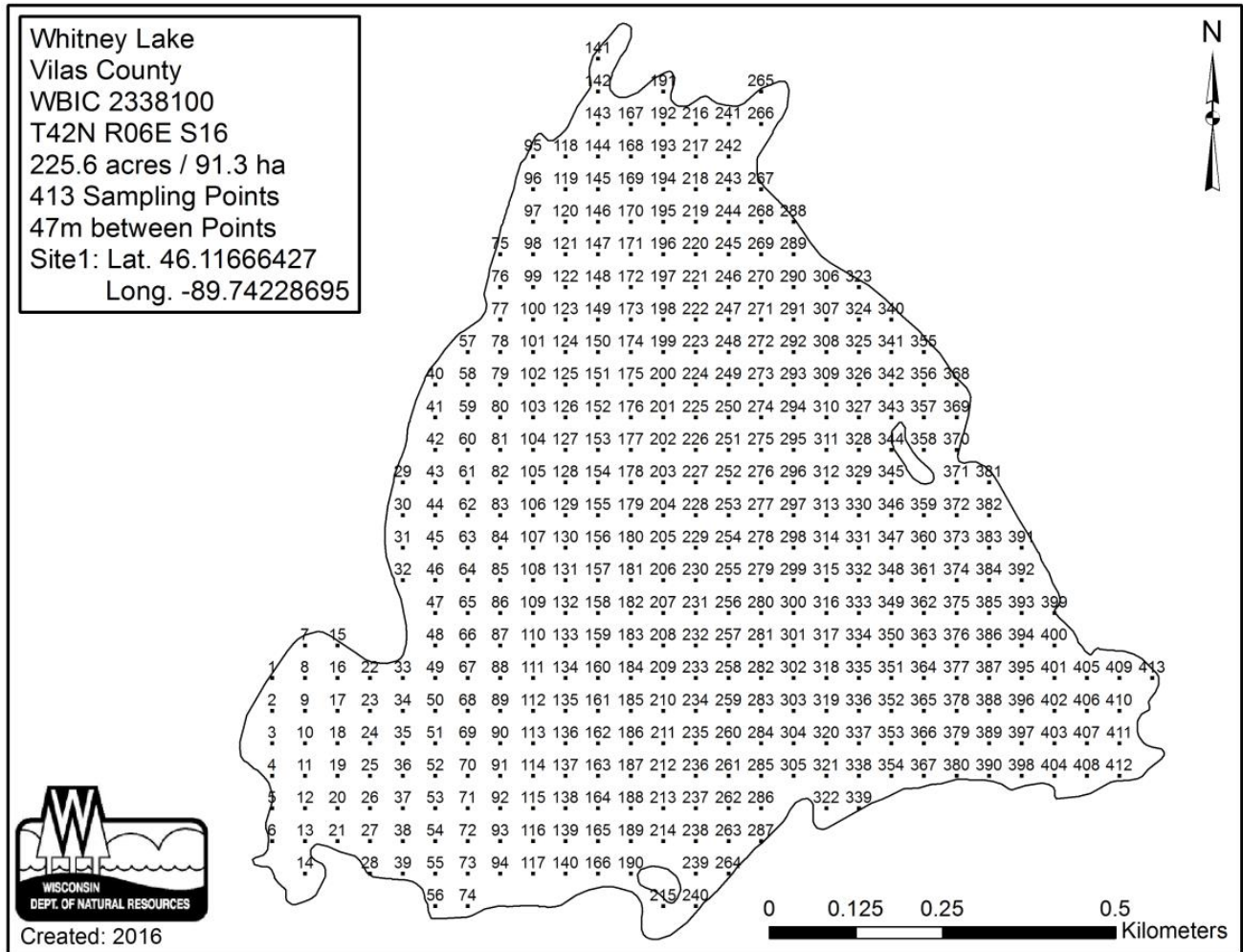


Figure 14. Aquatic plant point-intercept map for Whitney Lake. Courtesy of WI DNR.



Figure 15. Flat-leaf bladderwort (*Utricularia intermedia*) found in Whitney Lake 2018 point-intercept survey. This plant occurred in over 10% of littoral sites surveyed.



Figure 16. White water lily (*Nymphaea odorata*) found in Whitney Lake 2018 point-intercept survey. This plant occurred in over 10% of littoral sites surveyed.



Figure 17. Slender naiad (*Najas flexilis*) found in Whitney Lake 2018 point-intercept survey. This plant occurred in over 30% of littoral sites surveyed.



Figure 18. Large leaf pondweed (*Potamogeton amplifolius*) found in Whitney Lake 2018 point-intercept survey. This plant occurred in over 38% of littoral sites surveyed.



Figure 19. Muskgrass (*Chara contraria*) found in Whitney Lake 2018 point-intercept survey. This plant occurred in over 18% of littoral sites surveyed.



Figure 20. Robbin's spikerush (*Eleocharis robbinsii*) found in Whitney Lake 2018 point-intercept survey. This plant is considered rare and occurred in over 7% of littoral sites surveyed.

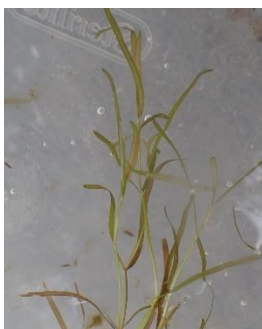


Figure 21. Blunt Pondweed (*Potamogeton obtusifolius*) found in Whitney Lake 2018 point-intercept survey.



Figure 22. Common waterweed (*Elodea canadensis*) found in Whitney Lake 2018 point-intercept survey.



Figure 23. Spiral fruited pondweed (*Potamogeton spirillus*) found in Whitney Lake 2018 point-intercept survey.

Species Richness

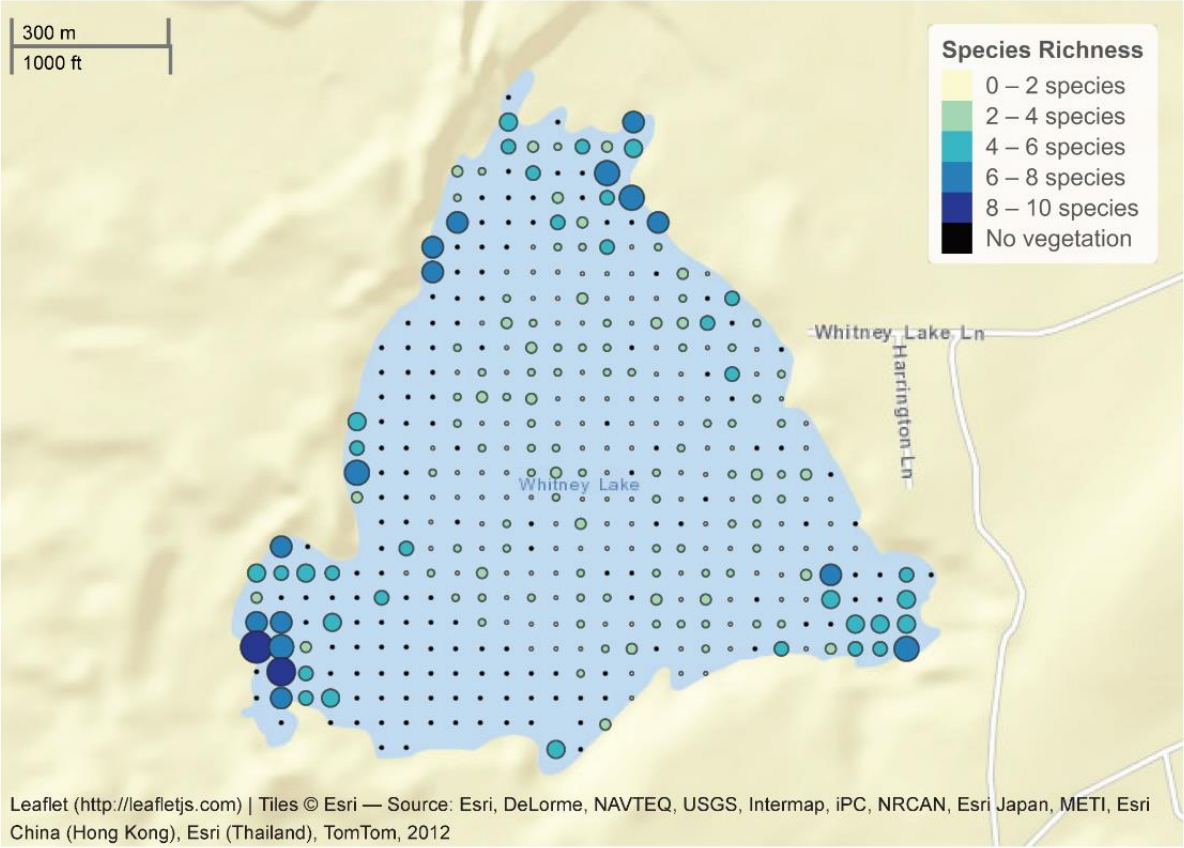


Figure 24. Whitney Lake species richness by sampling point. Diversity hot spots occurred primarily in the quiet bays protected by bog mats. Map courtesy of WI DNR.

Appendix 4: Coarse Woody Habitat Map

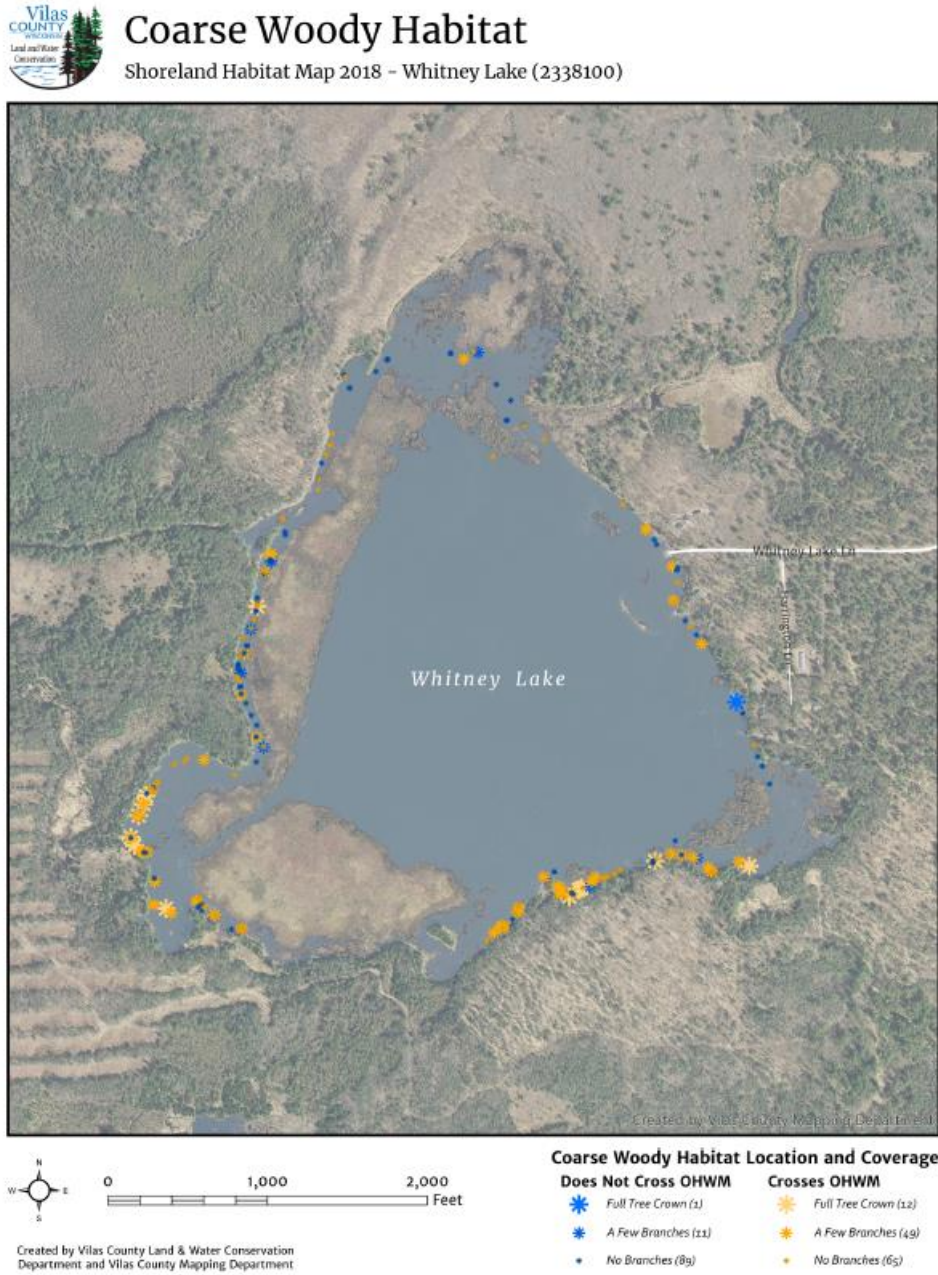


Figure 25. Coarse Woody Habitat Characterization for Whitney Lake, 2018. 68.8 logs/mile were documented.

Appendix 5: Shoreland Survey Maps



Percent Canopy

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Percent Canopy
0-20% 21-40% 41-60% 61-80% 81-100% County Parcels

0 1,000 2,000 Feet



Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 26. Canopy cover percent per parcel within 35 ft buffer area on Whitney Lake 2018.



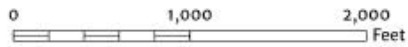
Percent Shrub/Herbaceous

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Percent Shrub/Herbaceous

- 0-20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%
- County Parcels



Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 27. Percent shrub/herbaceous cover per parcel within 35 ft buffer area on Whitney Lake 2018.



Percent Lawn

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Percent Lawn
0-20% 21-40% 41-60% 61-80% 81-100% County Parcels

0 1,000 2,000 Feet



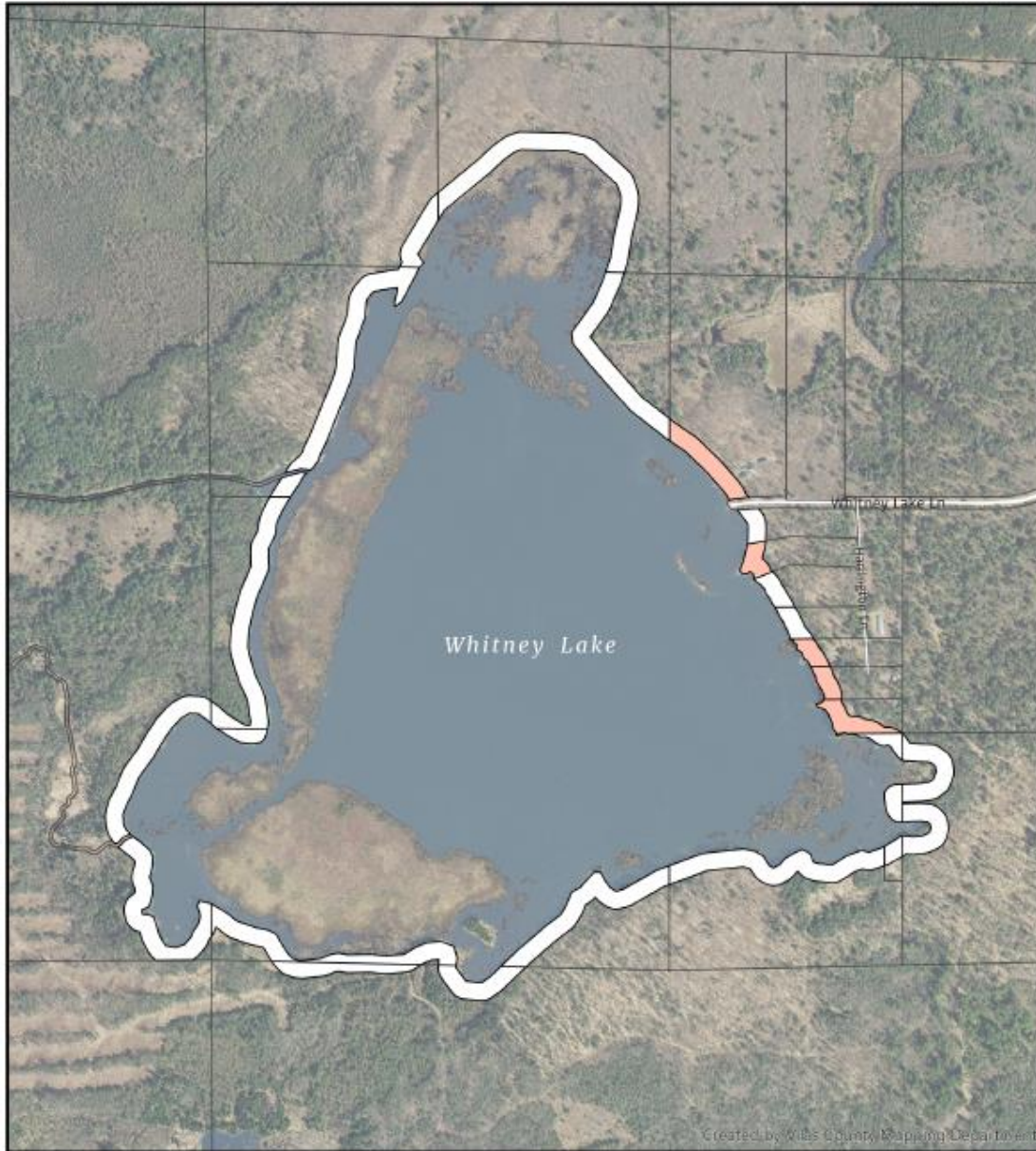
Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 28. Percent lawn cover per parcel within 35 ft buffer area on Whitney Lake 2018.



Piers

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Number of Piers
0 1 County Parcels

0 1,000 2,000 Feet



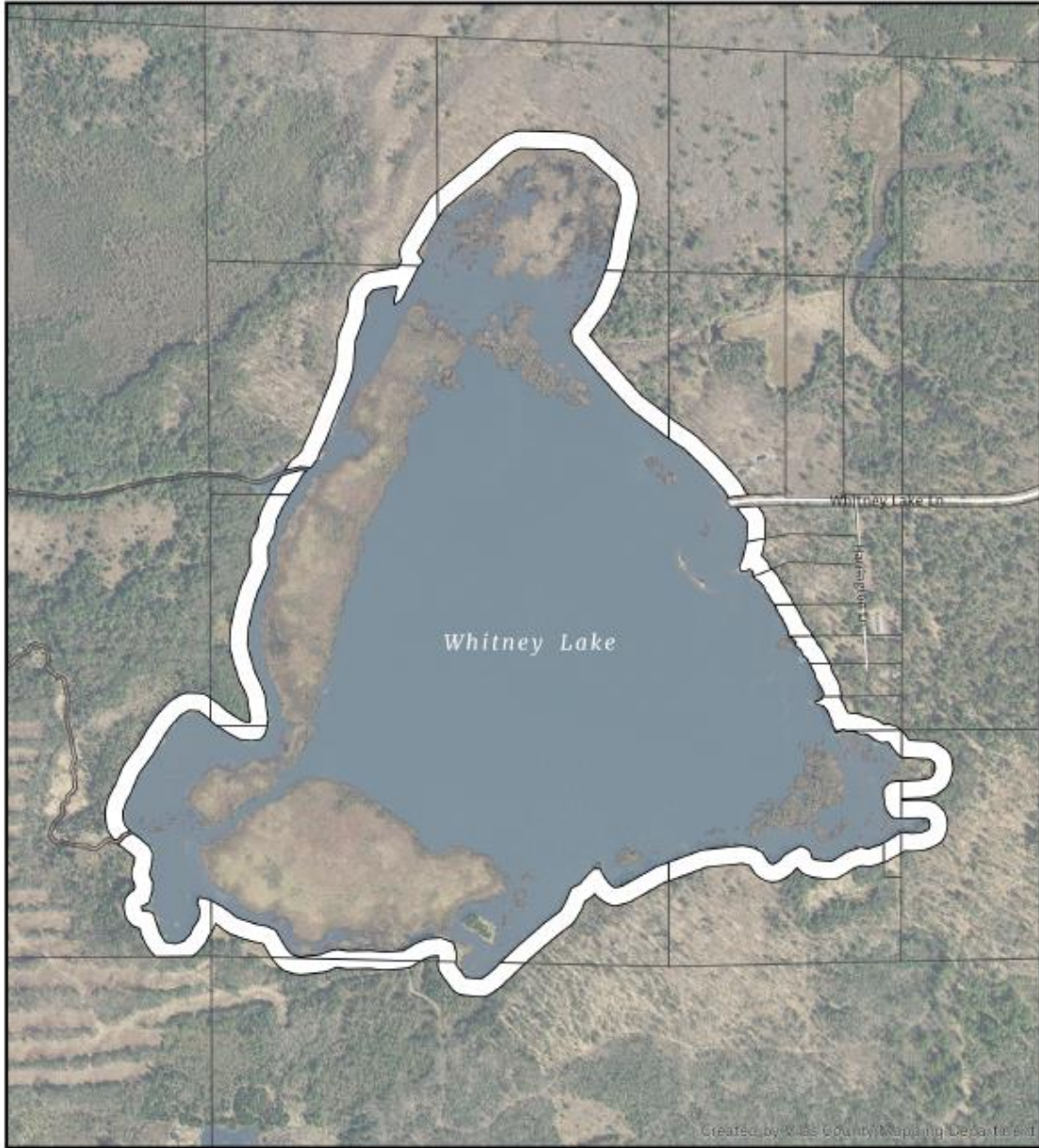
Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 29. Piers per parcel on Whitney Lake 2018.



Rip Rap

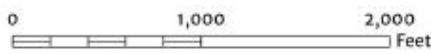
Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Created by Vilas County Mapping Department

Feet of Rip Rap

None County Parcels



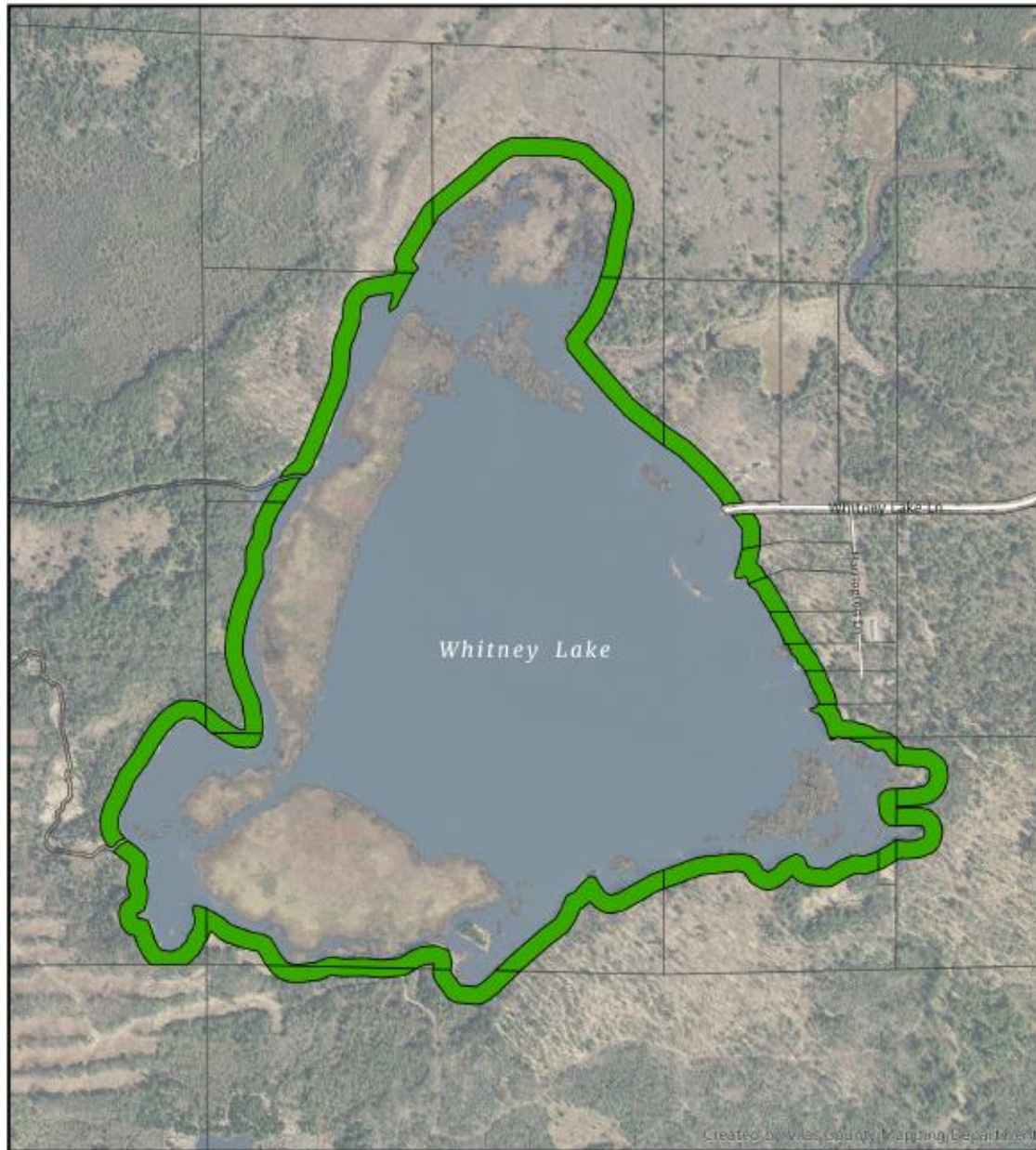
Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 30. No riprap was documented on Whitney Lake 2018.

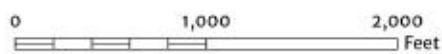


Bare Soil

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Bare Soil Presence
■ Absent □ County Parcels



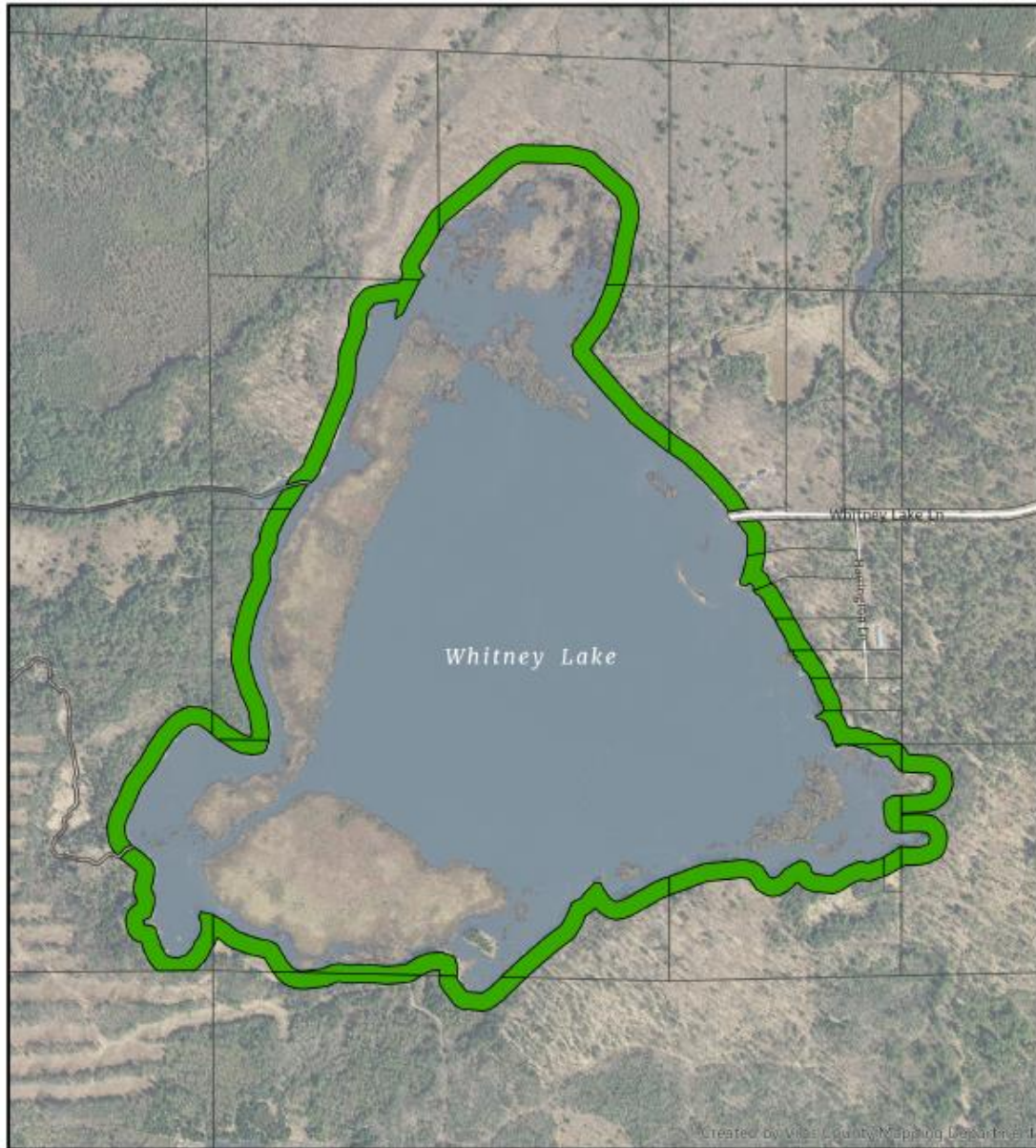
Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 31. Parcels where bare soil is present on Whitney Lake 2018 (none).



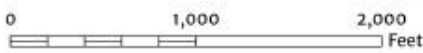
Lawn/Soil Sloping to Lake

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Lawn/Soil Sloping to Lake

Absent County Parcels



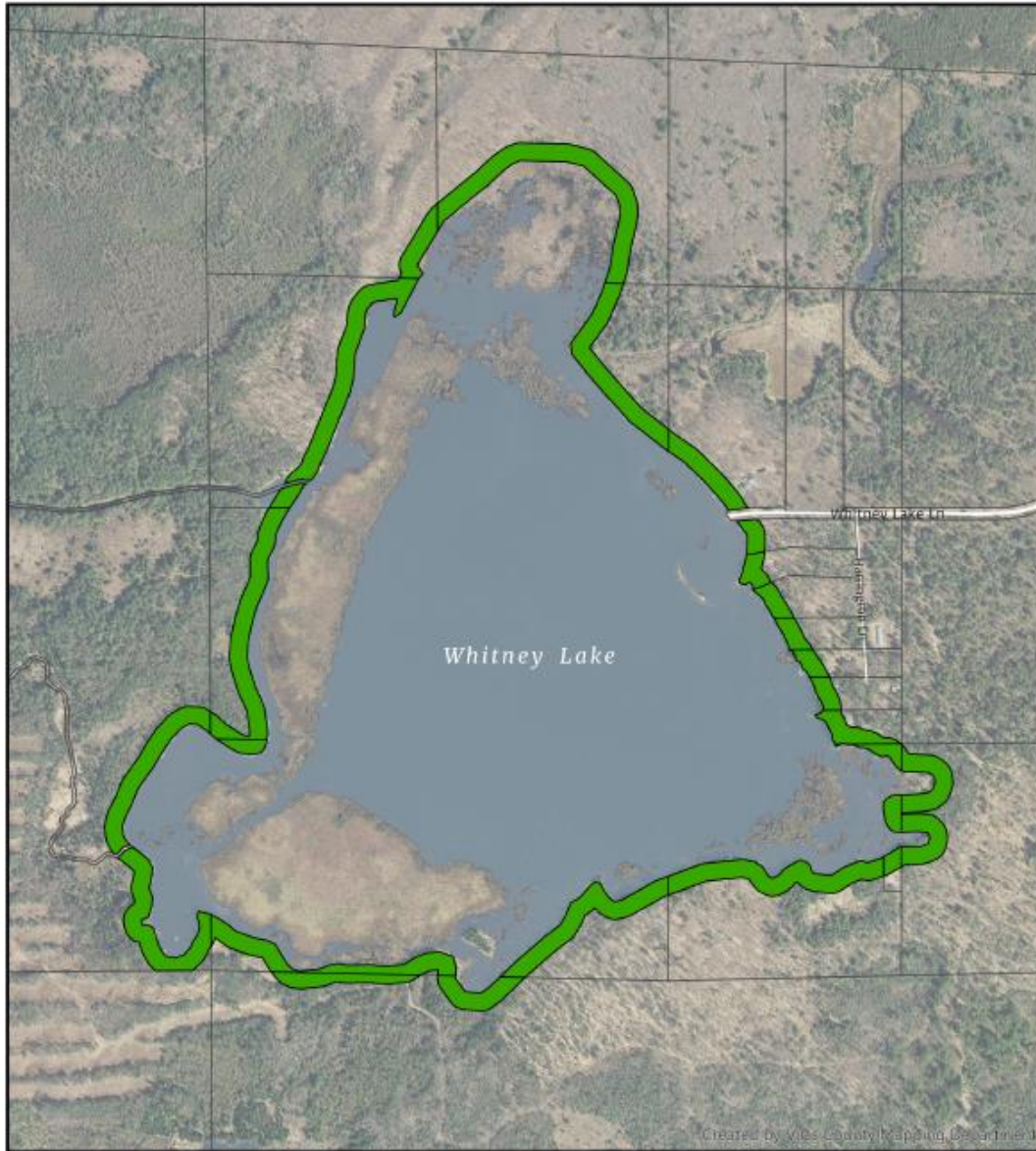
Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 32. Parcels where lawn or soil slopes to lakes on Whitney Lake 2018 (none).

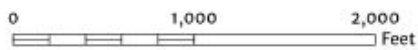


Bank Erosion

Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Bank Erosion with >1ft Face
None County Parcels



Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 33. Feet of bank erosion >1ft face per parcel on Whitney Lake 2018 (none).



Emergent and Floating Aquatic Plants


Shoreland Habitat Map 2018 - Whitney Lake (2338100)



Aquatic Plants

 Floating & Emergent Plants

 Plant Removal

 County Parcels

0 1,000 2,000 Feet



Created by Vilas County Land & Water Conservation Department and Vilas County Mapping Department

Figure 34. Floating and emergent plants, and aquatic plant removal observations on Whitney Lake 2018.

Appendix 18: Erosion Susceptibility

Areas Most Susceptible to Sheet, Rill and Gully Erosion

Island Lake-Manitowish River Subwatershed (070500020104)

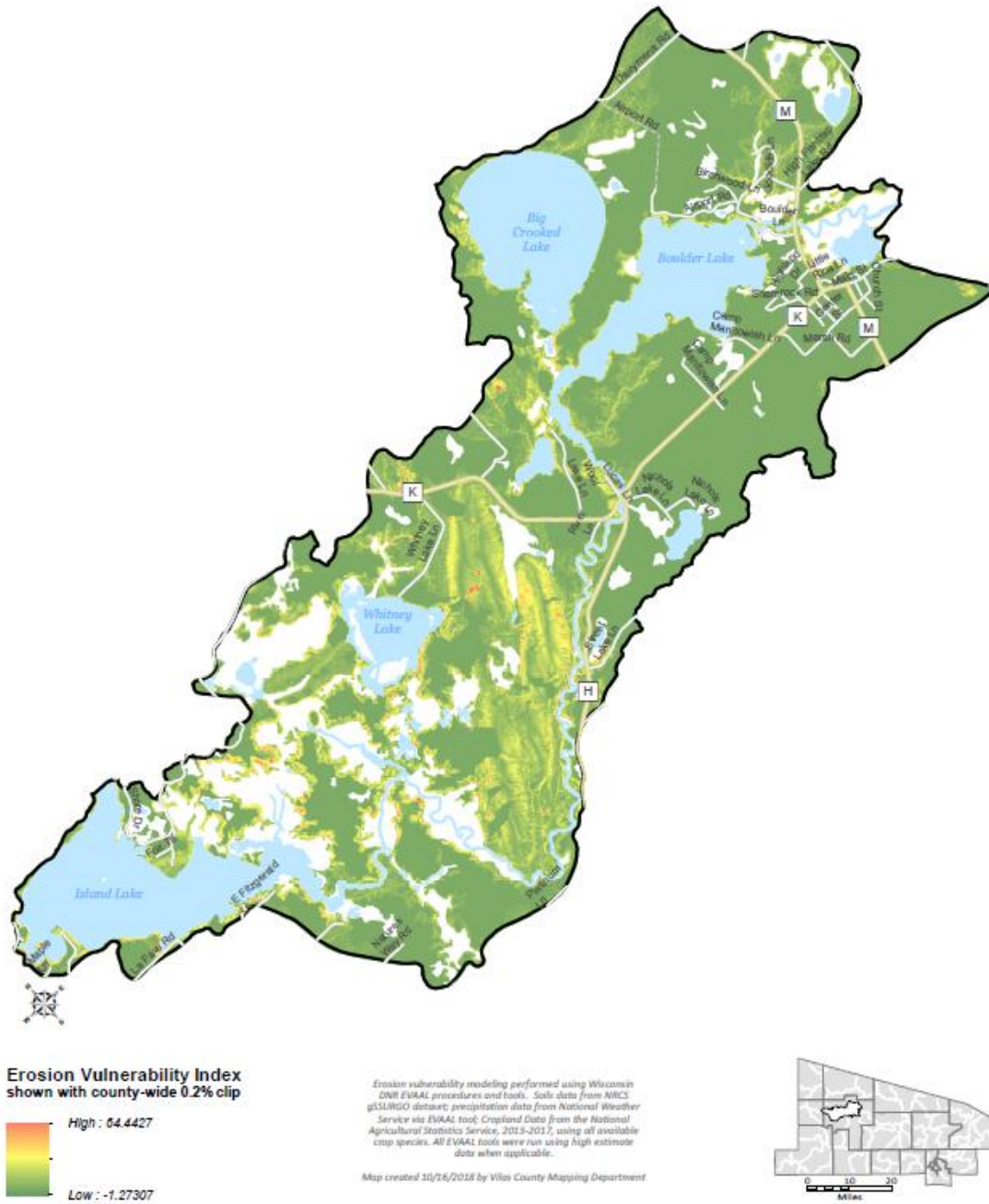


Figure 35. Areas susceptible to erosion in the Whitney Lakes subwatershed.