Little John Lake
2017-2018 Lake Assessment Report

Prepared by
Vilas County Land & Water Conservation
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Assessment Type	Metric	Metric Context	Little John Lake Results
Water Quality	Total Phosphorus	FAL[1] & REC[2]: 40 ug/L in shallow headwater drainage lakes	35.4 ug/L average July-Sep 2017 & 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	11.43 ug/L average July, Sep 2017 & July, Aug, Sep 2018 >20 ug/L in 0 of 5 sampling events (0%)
Aquatic Plant Point-Intercept	Floristic Quality Index	24.3 median for Northern Lakes and Forest Lakes Ecoregion	18.7
	Average Value of Conservatism	6.7 median for Northern Lakes and Forest Lakes Ecoregion	5.6
Shoreland Habitat	Docks/Mile	>16 docks/mile density correlated with less fish diversity	2.42

[1]Fish and aquatic life; [2]Recreation; [3]Frequency 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	6.6 ft average
Aquatic Plant Point-Intercept Survey	Max Depth of Plants	12.0 ft
	FOO[3] shallower than max depth	64.6%
	Simpson's Diversity Index	0.70
	Rare Plants	none
AIS Early Detection	Verified & **New** AIS Found	Banded mystery snail, Chinese mystery snail **New AIS: Narrow leaved cattail (*Typha angustifolia*)**
Shoreland Habitat	% Natural Cover	88%
	% Impervious	4%
	Parcels With Runoff Concerns	7 of 10 parcels (70%)
	Coarse Woody Habitat	46.4 logs/mile (anecdotally considered low)

Executive Summary

Little John Lake is shallow headwaters drainage lake in Vilas County. Of the 6 water quality sampling events, Total Phosphorus and Chlorophyll a measured more than the amounts set by 2018 WISCALM at least once. Three plants make up the bulk of the macrophyte aquatic plant community, however biodiversity hot-spots were located in the lake. The lake's floristic quality (18.7) is lower than average for the region (24.3). Narrow leaved cattail (Typha angustifolia) was a new invasive species found during the study, however; previously verified aquatic invasives listed with DNR are: banded mystery snail, Chinese mystery snail, and rusty crayfish. The coarse woody habitat survey resulted in 46.4 logs/mile of shoreline. Most of the vegetative cover within the 35 ft. shoreland buffer area is natural (88%), however 2% is lawn. Pier density is at 2.42 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 continuation of water quality monitoring, address nearshore stormwater & erosion concerns by assisting willing landowners to establish no-mow or native plantings, maintaining and increasing coarse woody habitat, and considering manual control of the invasive narrow leaved cattail.

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 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.

Figure 1. Little John Lake Map courtesy of Vilas County Online Mapping

Little John Lake has few private landowners, and most of its shores are managed by the Northern Highlands American Legion State Forest. The purposes of the study of Little John 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.

Little John Lake is a 151 acre Shallow Headwater Drainage Lake located in the Town of Boulder Junction in Vilas County. Little John Lake's maximum depth is 19 feet and is made up of 70% sand, 20% gravel, 10% rock, 0% muck (*Little John Lake*). The lake is spring-fed, and there is one unnamed outlet west of the boat

launch that flows to Allequash Creek, and from there to Trout Lake. There are no operational dams on record within Little John Lake's sub-watershed which reaches downstream to include Trout Lake (*Surface Water Data Viewer)*.

The majority (94%) adjacent riparian shoreline is owned by the Northern Highland American Legion State Forest. Private landownership accounts for 6% of the shoreline. The ground cover is primarily forests and wetlands, and development is contained to a small area on the south shore. Surrounding soils are indicated as sandy soils (primarily Sayner-Rubicon Sandy Loam) with slopes ranging from 0-15% (SaB or SaC). These soils are rated "excessively drained" and are listed as a low runoff class. Wetland soils are Loxley & Dawson peats (Lo) with slopes ranging from 0-1% (*Web Soil Survey*).

Little John Lake is represented by the Boulder Junction Lakes Alliance. This organization works with the Town of Boulder Junction to apply for grants, with the Town as the grant sponsor. Clean Boats Clean Waters monitoring at the public boat landing has been a DNR grant-funded activity coordinated by the Lakes Alliance in the past. The lake does not have a current management plan.

Figure 2. Soils adjacent to Little John Lake. Sayner-Rubicon Complex with 6-15% slopes (SaC) rings the lake. Courtesy Natural Resources Conservation Service Soil Web Survey tool.

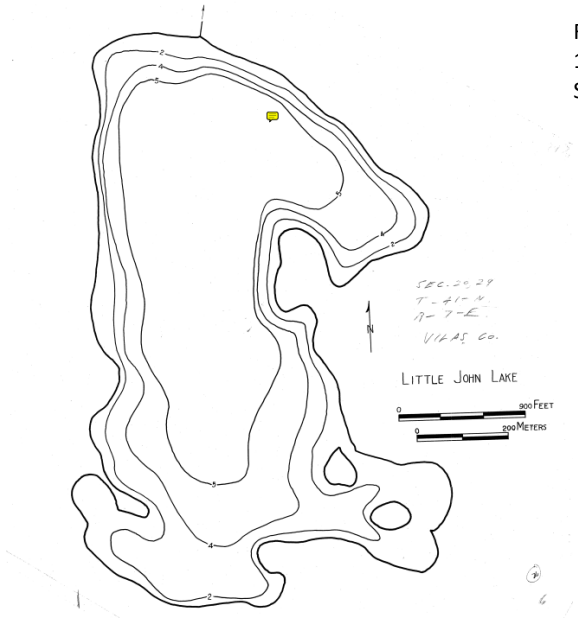


Figure 3. Little John Lake bathymetry map. Note measurements are in meters. Courtesy WI DNR.

Results and Discussion

Note – See Appendix 1 for Methods

Water Quality

Little John Lake is a 151 acre and 19 ft deep "shallow headwaters drainage lake". Water quality assessments reference WisCALM Shallow Headwaters Drainage Lake criteria. It does not appear on the 2018 WI DNR Impaired Waters listing for any impairment.

The total phosphorus criteria for fish & aquatic life and recreation for shallow headwater drainage lakes is 40 ug/L. The total phosphorus sampled on Little John Lake exceeded the criteria on 2 of the 6 sampling events 2017-2018. The mean total phosphorus reading from the 6 sampling events was 35.4 ug/L, with a minimum reading of 24.9 ug/L and a maximum reading of 62.8 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. The chlorophyll a results exceeded 27 ug/L once; however that particular value is likely erroneous, and will be considered an outlier for the purposed of this report. It is likely that this value should have been less, due to an assumed volume of being filtered for the sample. Chlorophyll a measurements averaged to be 11.43 ug/L, with a minimum reading of 6.63 ug/L and a maximum reading of 13.0 ug/L (outlier excluded). Little John Lake exceeded 20 ug/L chlorophyll a at 0 of the 5 sampling events (0%, outlier excluded).

Using statistical formulas, DNR staff will determine whether Little John Lake should be considered for the Impaired Waters list. The Impaired Waters list is published by DNR every other year, with the new listing expected in 2020.

Water in Little John Lake was reported to be green & murky in July, Aug, & Sep 2017; blue & clear in July, & August 2018; and green & clear in Sep 2018. Secchi depths averaged 6.6 ft, and is indicative of fair to poor water quality. The higher pH (8.89) and alkalinity (51.7 mg/L) show Little John Lake is a hardwater lake, and can buffer against acid rain events. Calcium concentrations are relatively low (14.4 mg/L) as is the conductivity (110 uS/cm), reflecting that it would be unlikely to support a reproducing zebra mussel population (Cohen). However, 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 Little John Lake was mixed (not stratified) 5 out of 6 sampling events. The lake was documented to stratify once in Aug 2018. "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 Little John Lake down to 9-12 ft. deep, depending on the time of sampling. At 0 mg/L dissolved oxygen, chemical processes differ in this anoxic environment and certain nutrients like phosphorus can be converted to bio-available forms and released lake-wide during turnover events, fueling algae and plant growth. 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 August 2 - 3, 2017. Of the 363 point-intercept (PI) locations, 149 were visited – see Appendix 3 Figure 20. Those that were not visited were skipped because either they were deeper than the maximum depth of plants, or the points were non-navigable, terrestrial, or a temporary obstacle was encountered.

No plants found in Little John Lake were considered rare by DNR Natural Herritage Inventory (*Wisconsin's Rare Plants*). See Appendix 3 for photos of highlighted plants.

Table 1. Little John Lake 2017 Aquatic Plant Point-Intercept Statistics. Values sourced from UW-Extension Lakes Aquatic Plant Survey Data Workbook formulas.

Little John Lake 2017 Point-Intercept Summary

Total number of sites visited	**149**
Total number of sites with vegetation	**93**
Total number of sites shallower than maximum depth of plants	**144**
Frequency of occurrence at sites shallower than maximum depth of plants	**64.58**
Simpson Diversity Index	**0.70**
Maximum depth of plants (ft.)**	**12.00**
Number of sites sampled using rake on Rope (R)	**107**
Number of sites sampled using rake on Pole (P)	**42**
Average number of all species per site (shallower than max depth)	**1.17**
Average number of all species per site (veg. sites only)	**1.82**
Average number of native species per site (shallower than max depth)	**1.17**
Average number of native species per site (veg. sites only)	**1.82**
Species Richness	**11**
Species Richness (including visuals)	**19**
Floristic Quality Index	**18.69**
Average Value of Conservatism	**5.6**

rake, and does not include visual sightings. Little John Lake has less 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 Little John Lake of 5.6 is less than the Northern Lakes and Forest Lakes Ecoregion average of 6.7 and less than the state of Wisconsin average of 6.0 (Nichols). This shows that there are just lower than average types of plants that represent the region in Little John Lake.

The Floristic Quality Index weighs both the species richness and the average value of Conservatism. The Floristic Quality for Little John Lake is 18.69. This value is below the Northern Lakes and Forest Lakes Ecoregion average of 24.3 and the state of Wisconsin of 22.2 (Nichols).

The Simpson Diversity Index for Little John Lake is 0.70. This indicates a lower number of species and/or uneven distribution of those species in Little John 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, Common Waterweed (*Elodea canadensis)* Coontail (*Ceratophyllum demersum)*, and Flatstem Pondweed (*Potamogeton zosteriformis)* were the most prevalent, with a littoral frequency of occurrence of 57%, 26%, and 23% respectively.

Table 2. Little John Lake 2017 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
Elodea canadensis	Common Waterweed	3	57.17%
Ceratophyllum demersum	Coontail	3	26.39%
Potamogeton zosteriformes	Flat-stem pondweed	6	22.92%

Six 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. Little John Lake 2017 Aquatic Plant Point-Intercept Additional Species Visually Encountered

Species – Visuals	Common Name
Carex eutriculata	Common beaked sedge
Nuphar variegata	Spatterdock
Sagittaria latifolia	Common arrowhead
Sparganium eurycarpum	Common bur-reed
Typha angustifolia	Narrow leaf cattail
Typha latifolia	Broad leaf cattail

Of all the sampling points on Little John Lake, the most species rich areas occurred in the southwest bay where the private parcels exist as well as the southeast bay. See Appendix 3 Figure 26.

For Little John 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: *Carex sutriculata, Ceratophyllum demersum, Chara sp., Eleocharis palustris, Elodea canadensis, Equisetum fluviatile, Najas flexilis, Nuphar variegata, Potamogeton amplifolius, Potamogeton foliosus, Potamogeton robinsii, Potamogeton zosteriformis, Schoenoplectus tabernaemontani, Sparganium eurycarpum, Typha angustifolia, Typha latifolia, and Vallisneria americana.* Plants not photographed or pressed were *Sagittaria latifolia.*

AIS Early Detection Survey:

On August 9, 2017, the AIS Early Detection Survey was completed. Targeted sites included: the public boat landing; the north island's south shoreline; the south island's north shoreline; the southwest bay; and a point on the western shoreline. A meander survey around the perimeter of the lake was conducted. The water was quite murky, so D-nets and rakes were used for sampling in lieu of snorkeling. Multiple species were searched for (see Methods section in Appendix 1 for species list), only one previously unverified species was detected – narrow leaf cattail (*Typha angustifolia*). Chinese mystery snails and banded mystery snails were found during the survey, both of which were previously documented as in SWIMS as "Verified". Rusty crayfish are also listed a verified species in SWIMS. No AIS are listed as "Observed".

Veliger tows were sampled on August 9, 2017. Results were analyzed by DNR staff in Madison. No zebra mussel veligers were found in the Little John Lake samples (SWIMS).

A sediment sample was taken on August 9, 2017 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 May 4, 2017 when the water was fairly clear and easy to detect submerged logs. 153 logs were counted between the ordinary high water mark and the 2 ft depth contour along the 3.3 miles of shoreline, giving the density of 46.4 logs/mile of shoreline – see Appendix 4.

73 logs (48%) crossed the ordinary high water mark, providing a habitat "bridge" between the water and land. 4 logs (3%) were submerged with the full tree crown, providing more complex structure to the Coarse Woody Habitat.

Shoreline Assessment

The shoreline of Little John Lake consists of 10 parcels – some are privately owned and some are state owned and managed as part of the Northern Highlands American Legion State Forest.

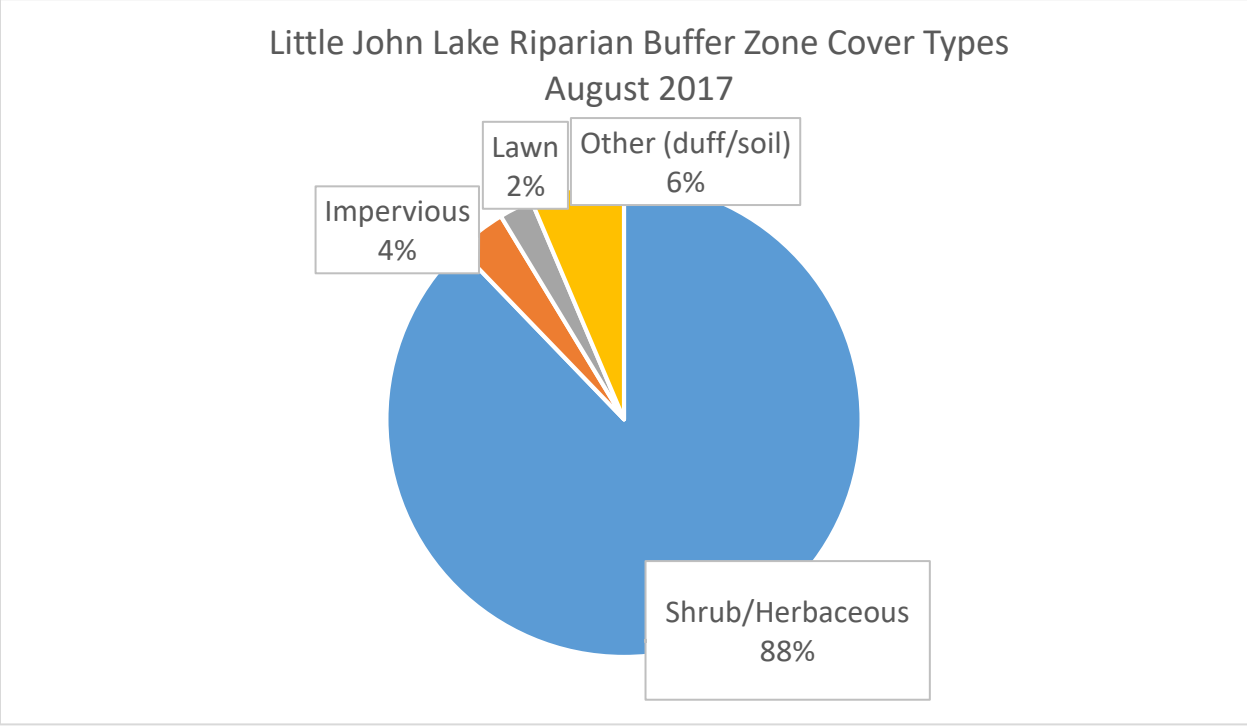


Figure 4. Ground cover type in Riparian Buffer Area (35 ft. inland from shore) on Little John Lake, 2017.

Lake-wide, 88% of the riparian area (35 ft. inland from ordinary high water mark) was covered by a shrub/herbaceous layer. Lawn made up 2% of the riparian area, and Impervious surfaces made up 4%.

The "other" category was comprised of mostly duff along with some bare soil, and covered 6 % of riparian buffer zone. See Appendix 5 for Riparian Buffer Zone Cover Types.

Figure 5. Pier density on Little John Lake was low at 2.42 docks/mile. Having a lake-wide dock density greater than 16 docks/mile has been shown to have negative effects on fish diversity (Jacobsen et.al).

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. Little John Lake exceeds this statistic having 88% covered with shrub/herbaceous cover.

A few human structures or modifications were noted in the Riparian, Bank, and Littoral Zones. See Figure 8 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 Little John Lake, boats on shore were the most common human structure. 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). Little John Lake is below this figure at 2.42 docks/mile. Additional littoral structures such as boat lifts, swim rafts, etc. would intuitively seem to add to this stress.

Figure 6. 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.

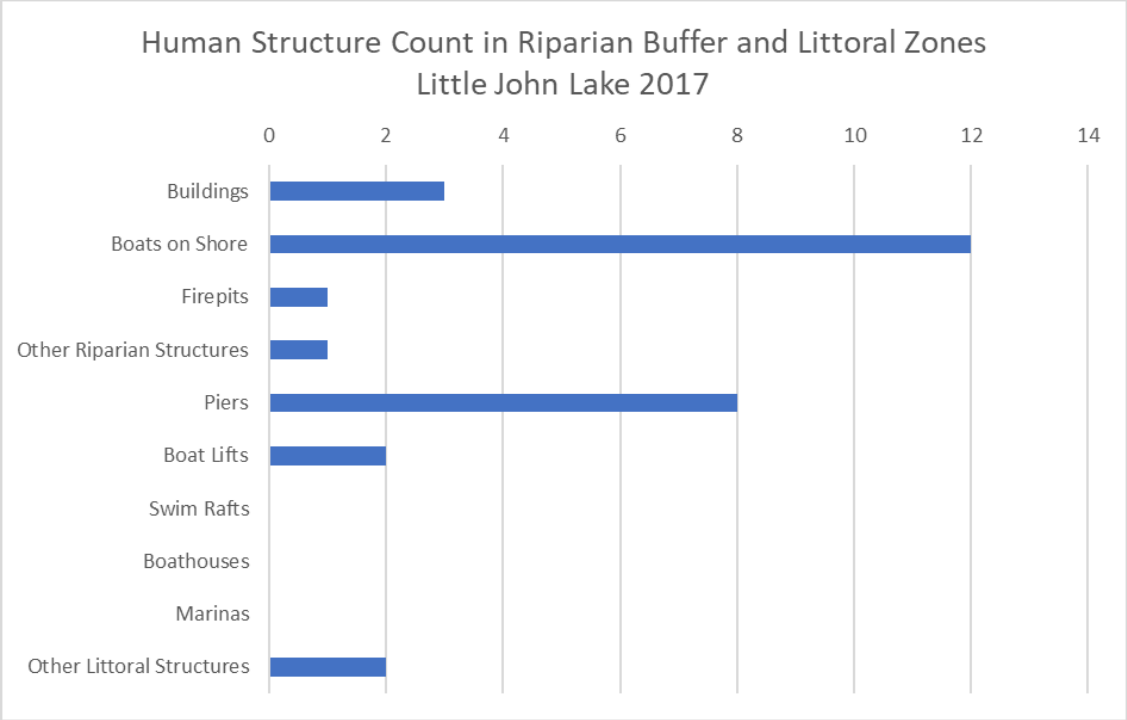
Within the Bank Zone, of erosion concerns, riprap, erosion control structures, artificial beaches, or seawalls, only 10 ft of riprap was observed.

Runoff and erosion concerns were documented within the riparian area: 2 parcels had straight stairs/trail/road to the lake; 6 had lawn/soil sloping to the lake (6 of the 6 private parcels); and 9 had bare soil areas. No active erosion (channelized flow/gully or sand/silt deposits) or point sources were observed. See Figure 9 for Number of Parcels with Erosion or Runoff Concerns.

Aquatic plant removal was not observed on any 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 7. All of the privately-owned parcels had either lawn or bare soil area sloping to the lake. Stormwater and erosion can be managed in these areas by encouraging practices such as no-mow areas or low growing native plantings.



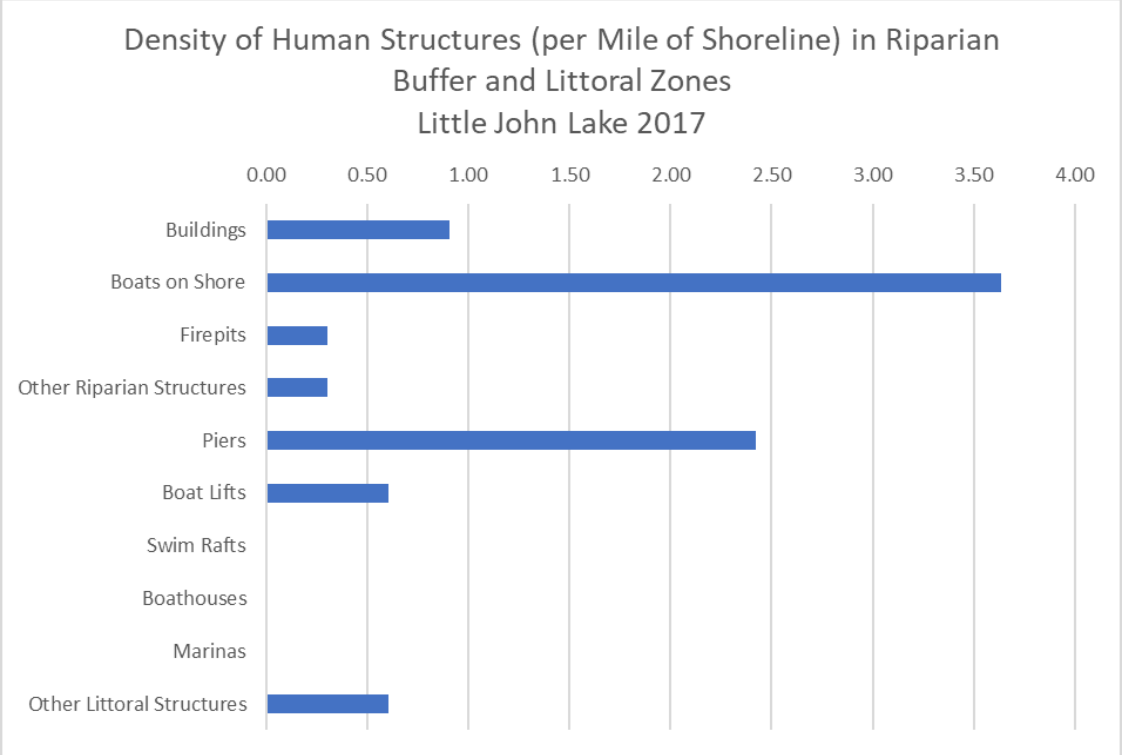


Figure 8. Number and density per mile of shoreline of human structures documented in the Riparian Buffer and Littoral Zones on Little John Lake 2017.

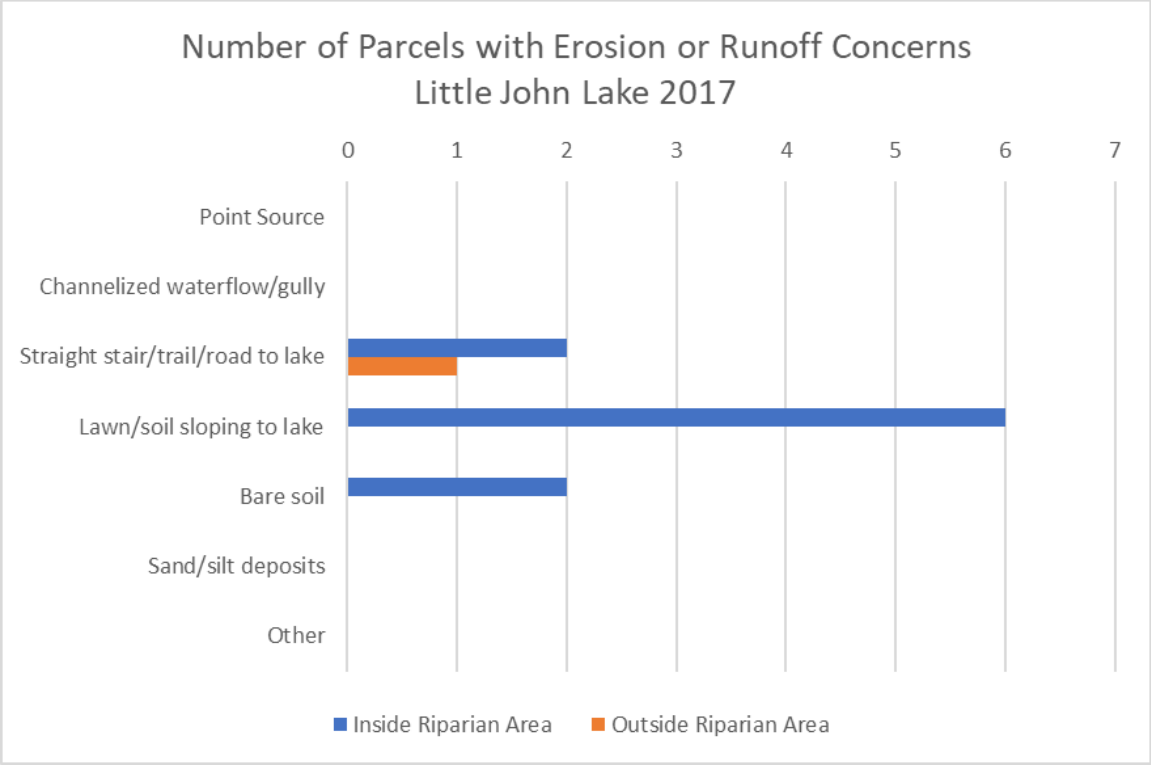


Figure 9. Number of parcels with runoff and erosion concerns in Riparian Zone and Outside Riparian Zone on Little John Lake 2017. Of the 75 parcels, 67 had erosion or runoff concerns (89%).

Figure 10. Minimizing impervious surfaces in and around lake access paths, maintaining vegetation, and curving the trail across the slope keeps shoreland erosion in check.

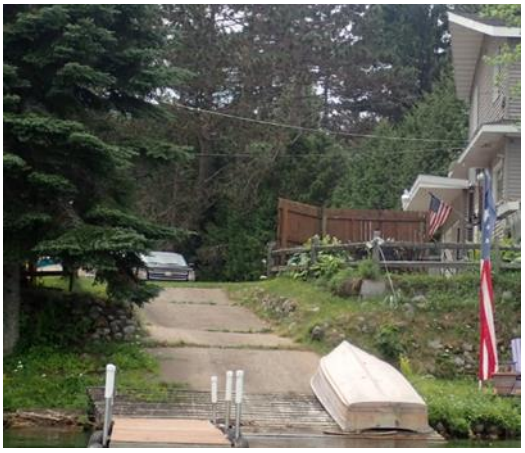


Figure 11. Impervious surfaces and straight trail access make a site even more prone to erosion. This site was augmented with a water infiltration pit to minimize runoff into the lake.

Observations

One dense blue-green algae bloom was observed and reported to the Vilas County Public Health Dept. on August 22, 2017. This bloom dissipated within 24 hours.

The southwest bay appeared to have a lighter colored substrate than the rest of the lake and marl is suspected. Note that calcium concentrations at the deep hole were low and calcium sampling was not done in the southwest bay, so this is not conclusive.

Thank you very much to Dick Jenks who assisted with the Shoreline Survey, water quality sampling, and has been working towards progressive lake conservation within Boulder Junction!

Figure 12. Blue-green algae bloom at the public landing on Little John Lake August 22, 2017.

Recommendations

The Boulder Junction Lakes Alliance works with the Town of Boulder Junction and Little John Lake residents. If desired this group could facilitate:

- **Continue to monitor water quality regularly:**
  - Having ongoing data for phosphorus, chlorophyll a, and Secchi depths will help determine Little John Lakes' water quality status. When water chemistry data is sampled, use a WI certified lab to process the results so they are usable for WI DNR as well (ex. WI State Lab of Hygiene) and can be compared from year to year. Contact Sandy Wickman from WI DNR 715-365-8951 or Sandra.wickman@wisconsin.gov for additional assistance.

- **Encourage awareness of blue-green algae bloom safety:**
  - Report blue-green algae blooms to Vilas County Public Health at 715-479-3656 for potential posting. Disperse information to riparian owners about safety during blue-green algae blooms. For questions contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov.

- **Encourage native vegetation to grow in the 35 ft. shoreland buffer areas:**
  - Most private properties had lawn within the 35 ft buffer zone. The roots of these turf grasses are not as well equipped as native shoreline plants at holding down soil and reducing runoff. Encourage willing landowners remove turf grass in the buffer area and replace with native vegetation or establish a no-mow area. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Protect areas 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, the Vilas County Land & Water Conservation Stewardship Award, or creating a BAVLA incentive program. With larger parcels, Northwoods Land Trust may be able to help with Conservation Easements. Contact Tom Ewing of VCLRA for further information 630-251-0247.

- **Maintain and Increase Coarse Woody Habitat**:
  - Encourage leaving down wood where it falls to maintain fish habitat. Landowners may be interested in creating more coarse woody habitat along their shorelines by placing "fish sticks". Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Create a Shoreland Improvement Team to coordinate on-the-ground best practices for runoff and habitat concerns for interested landowners (liaison with County & DNR)**:
    - Provide informational materials and serve as a point-of-contact for landowners who would like to increase native vegetation and install erosion control practices within the 35 ft. buffer zones and beyond. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.
        - The number of private parcels with erosion concerns was 100%. Addressing these issues with willing private landowners will take a coordinated effort, ideally with a well versed riparian being locally available for those interested. Stormwater management (gutters, infiltrations, 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.

- **Continue to encourage recognition, prevention, and control of invasive species as appropriate:**
    - Continue Clean Boats Clean Waters campaign as well as routine monitoring for aquatic invasive species. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance with aquatic invasives.

- **Consider management of invasive Narrow Leaf Cattail:**
    - Narrow leaf cattail can be managed by cutting live and dead the stems at least 3 inches below the water level in late summer or early fall. It is preferred if this can be accomplished for the entire growing season. Dispose of any cattail seedheads by bagging, labeling, and disposing in a landfill. Be aware of cattail identification – native broad leaf cattail also exists on the lake. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

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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 or 24. 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:

2017

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

2018

- July: Temperature & dissolved oxygen profile; Secchi; total phosphorus; and chlorophyll a.
- August: Temperature & dissolved oxygen profile; Secchi; total phosphorus; and chlorophyll a.
- 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 636 point-intercept (PI) sampling points for Little John 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 that 5 ft., while a rake on a rope was used for sites deeper than 5 feet. 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

Due to low water clarity staff used D-nets and aquatic rakes 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 Little John Lake's target sites included 5 areas: the public boat landing; the north island's south shoreline; the south island's north shoreline; the southwest bay; and a point on the western shoreline. A boat meander survey around the lake edge that included littoral rake sampling and 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 on the deep hole of 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 Little John 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 13. A rangefinder was used to determine uncertain distances from the ordinary high water mark.

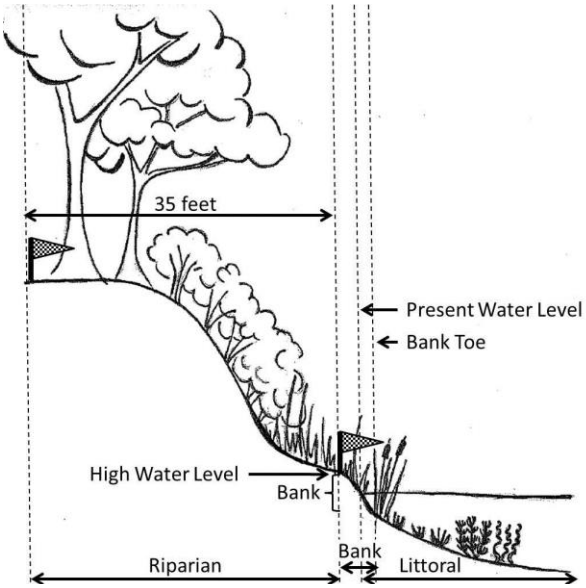

Figure 13. Shoreland areas assessed included the Riparian Buffer Zone, Bank Zone, and Littoral Zone. Graphic courtesy of WI DNR.

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.

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

Table 4. Results of 2017-2018 Little John Lake water quality testing. Testing occurred on 7/19/17; 8/21/17; 9/13/17; 7/16/18; 8/15/2018; and 9/17/2018.

	July 2017	Aug 2017	Sep 2017	July 2018	Aug 2018	Sep 2018	Average
Secchi average (ft.)	9.25	3.5	5.75	6.5	7.25	7.5	6.6
Total Phosphorus (ug/L)	26.2	62.8	43.5	25.6	24.9	29.2	35.4
Chlorophyll a (ug/L)	6.63	Error	15.9	9.62	12.0	13.0	11.4
Calcium (mg/L)	14.4	n/a	n/a	n/a	n/a	n/a	14.4
Alkalinity (mg/L)	n/a	51.7	n/a	n/a	n/a	n/a	51.7
pH	n/a	8.89	n/a	n/a	n/a	n/a	8.89
Conductivity (uS/cm)	n/a	110	n/a	n/a	n/a	n/a	110

The temperature and dissolved oxygen profiles show the lake was mixed most of the time, but stratified in Aug 2018.

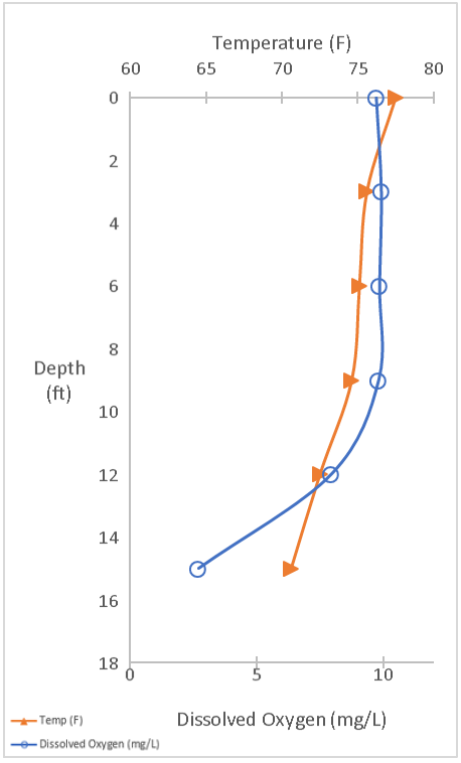

Figure 14. Temperature and dissolved oxygen profile for Little John Lake 7/19/17.

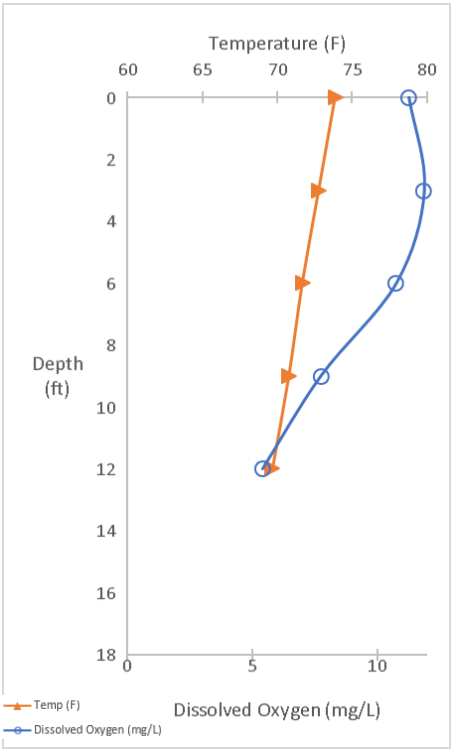

Figure 15. Temperature and dissolved oxygen profile for Little John Lake 8/21/17.

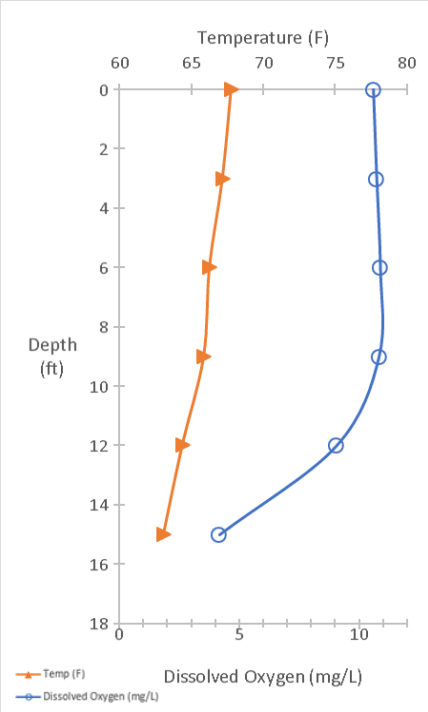

Figure 16. Temperature and dissolved oxygen Profile for Little John Lake 9/13/17.

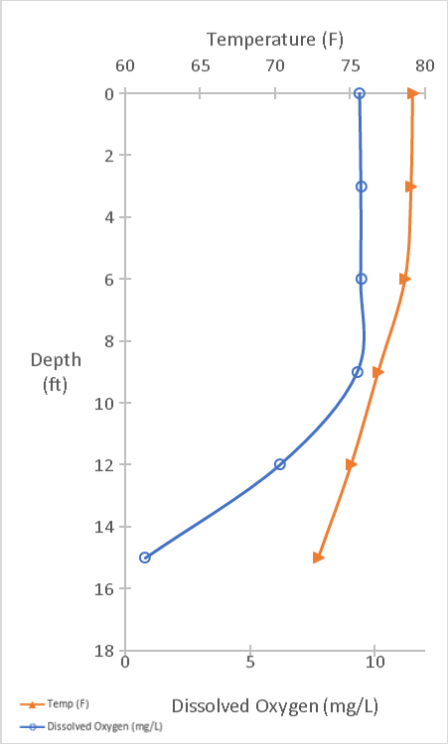

Figure 17. Temperature and dissolved oxygen profiles for Little John Lake 7/16/2018.

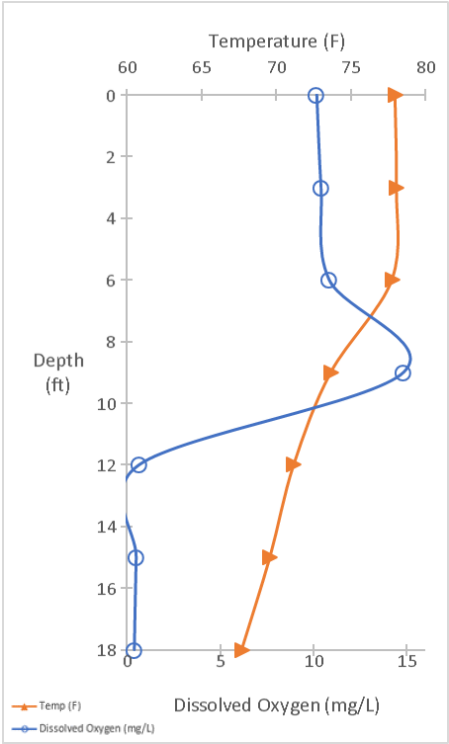

Figure 18. Temperature and dissolved oxygen profiles for Little John Lake 8/15/2018.

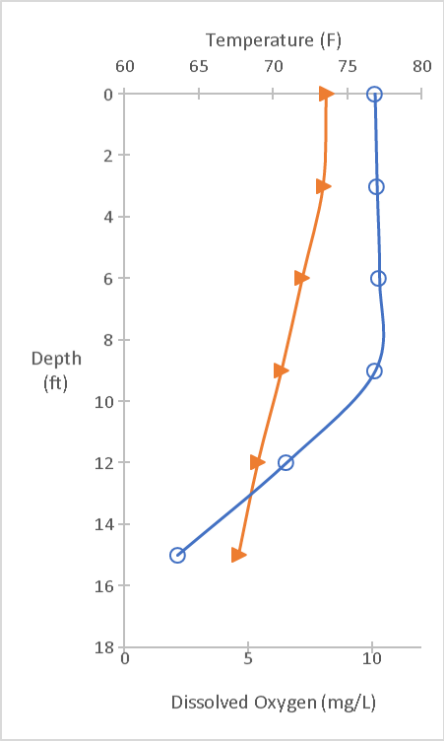

Figure 19. Temperature and dissolved oxygen Profiles for Little John Lake 9/17/18.

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

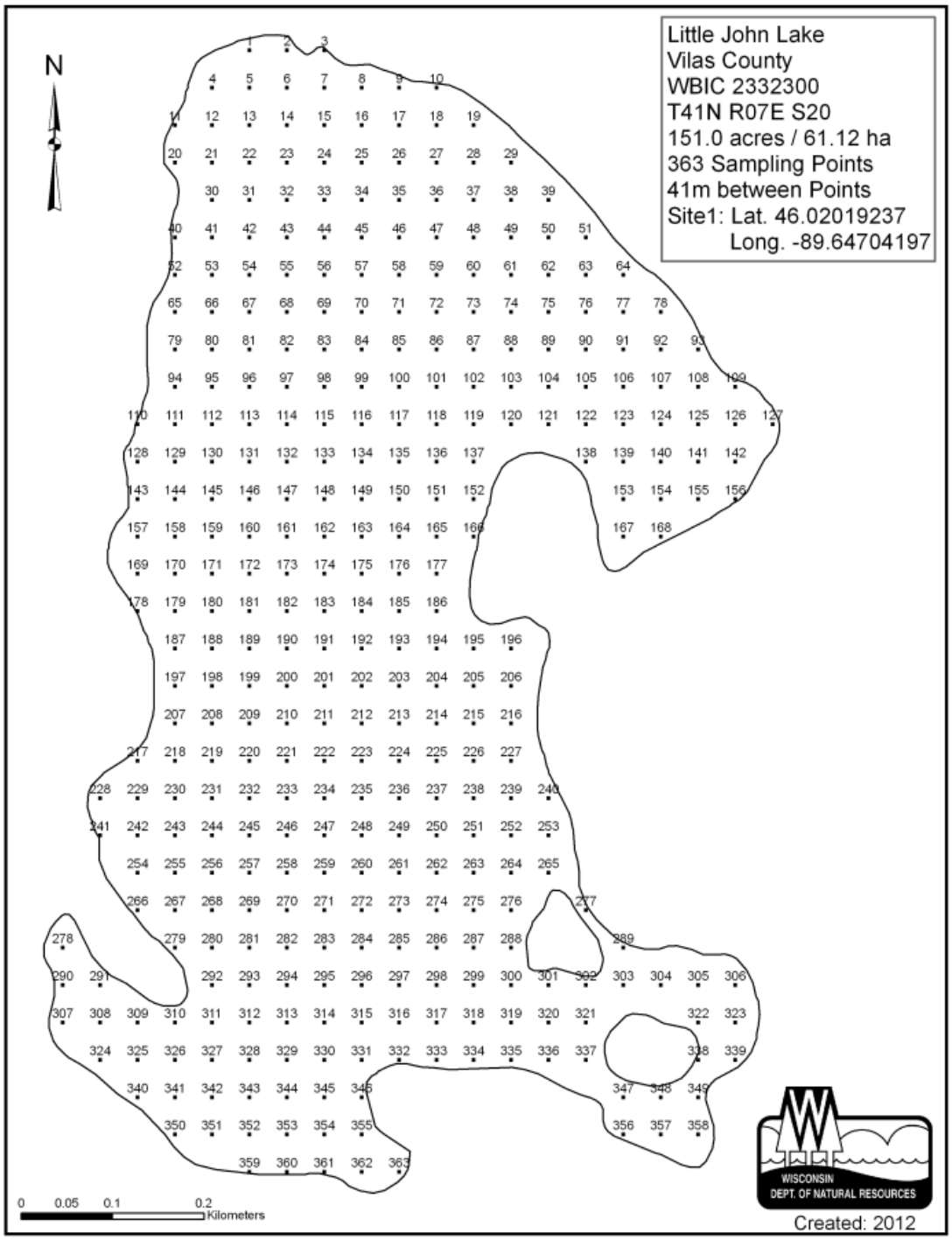

Figure 20. Aquatic plant point-intercept map for Little John Lake. Courtesy of WI DNR.

Figure 21. Coontail (*Ceratophyllum demersum)* found in Little John Lake 2017 point-intercept survey. This plant occurred in over 31% of littoral sites surveyed.

Figure 22. Common Waterweed (*Elodea canadensis)* was found in Little John Lake 2017 point-intercept survey. This plant occurred in over 35% of littoral sites surveyed.

Figure 23. Leafy Pondweed (*Potamogeton foliosus*) was found in the Little John Lake 2017 point-intercept survey.

Figure 24. Slender Naiad (*Najas flexilis*) found in the Little John Lake 2017 point-intercept survey.

Figure 25. Flat Stem Pondweed (*Potamogeton zosteriformis*) found in Little John Lake 2017 point-intercept survey. This plant occurred in over 25% of littoral sites surveyed.

Little John – species diversity by point

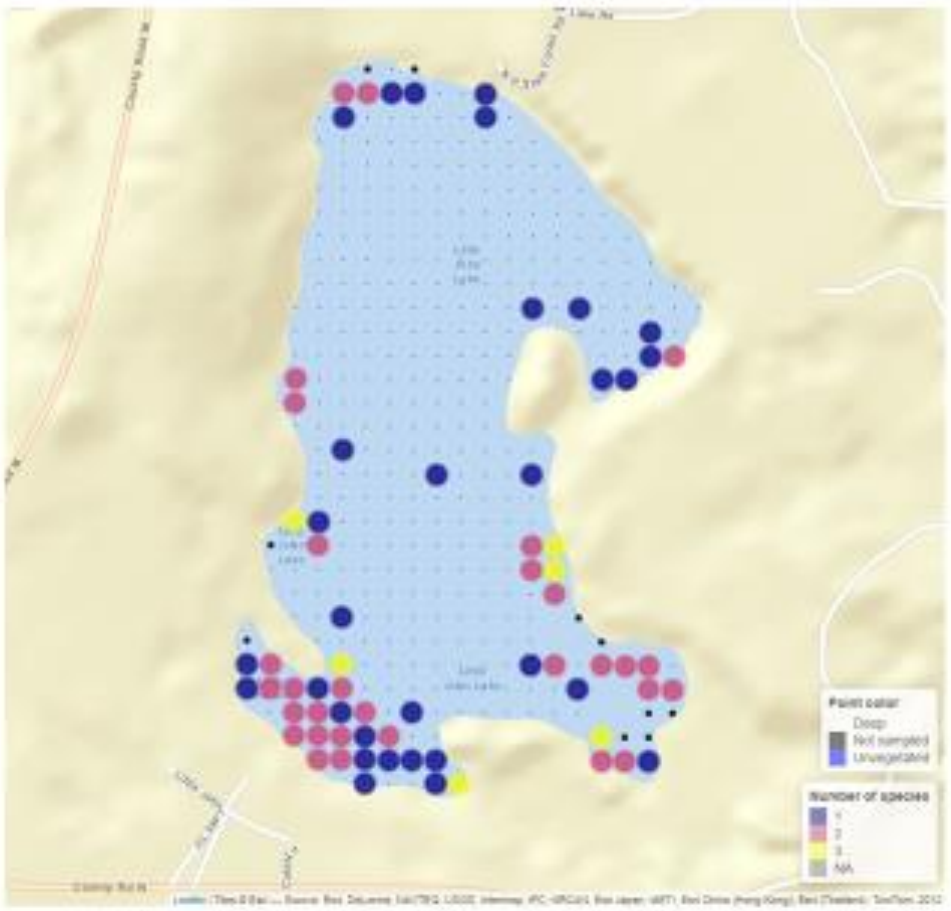

Figure 26. Little John Lake species richness by sampling point. Diversity hot spots occurred in the southwest bay and south east bay. Map courtesy of WI DNR.

Appendix 4: Coarse Woody Habitat Map

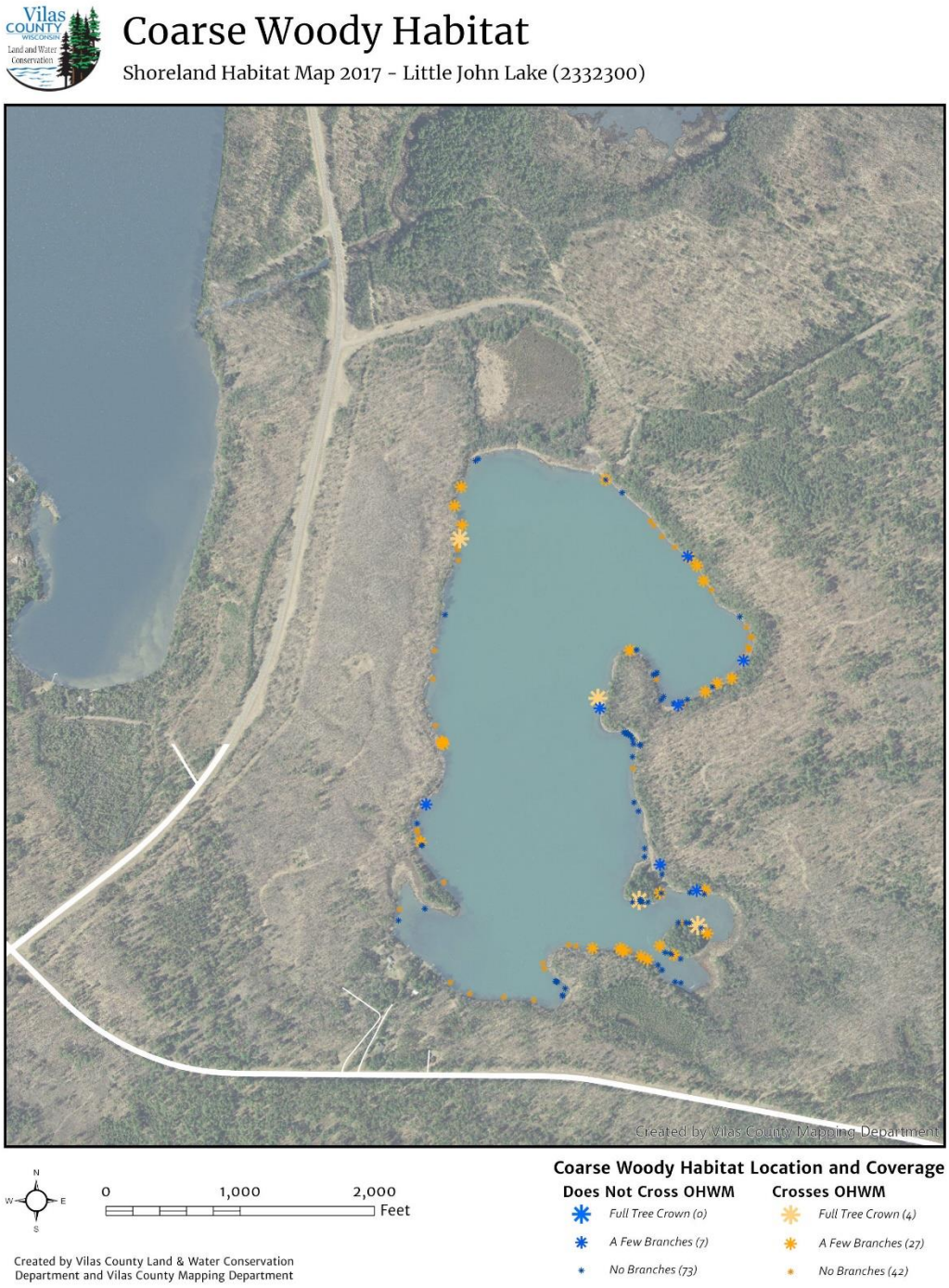

Figure 27. Coarse Woody Habitat Characterization for Little John Lake, 2017. 46.4 logs/mile were documented.

Appendix 5: Shoreland Survey Maps

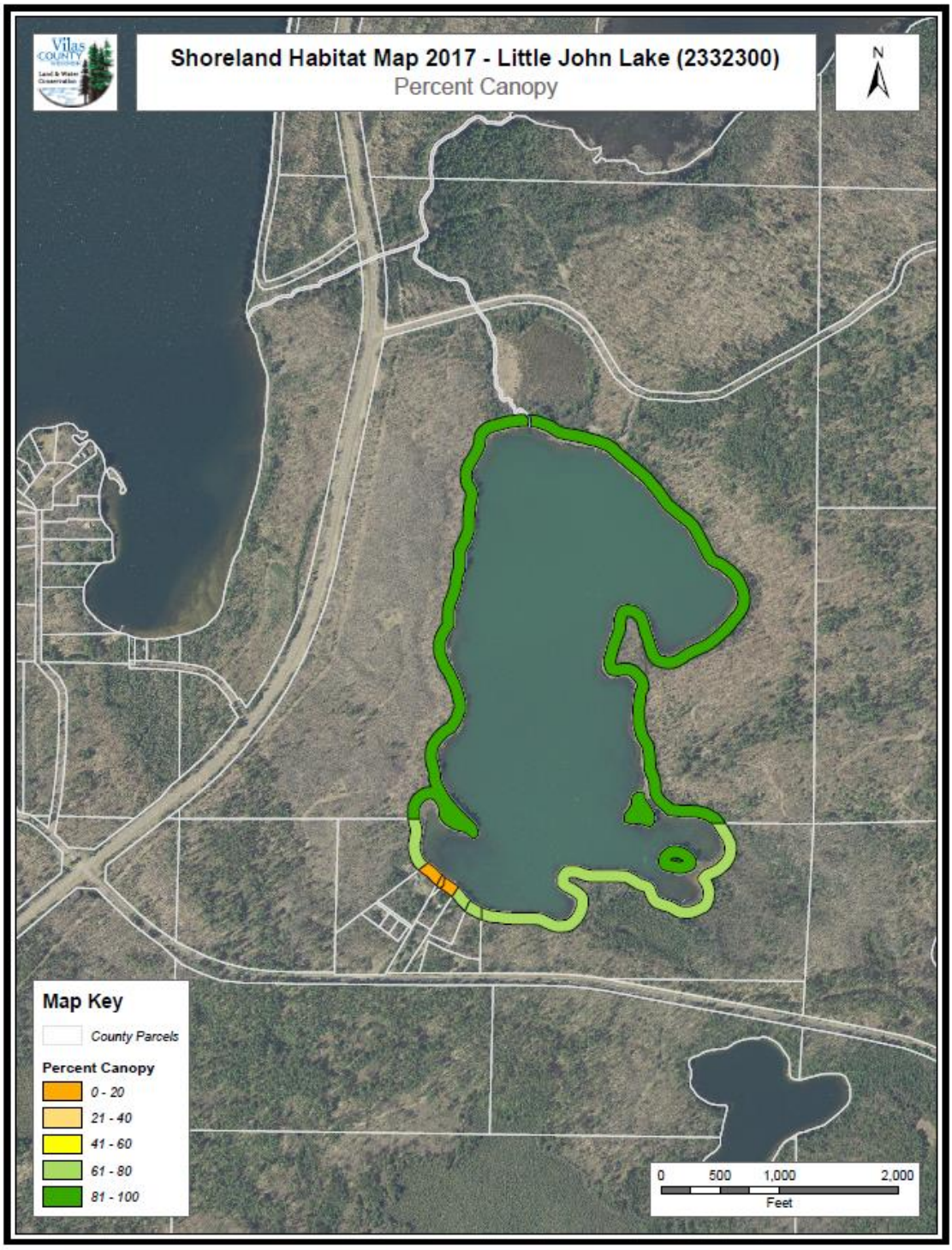

Figure 28. Canopy cover percent per parcel within 35 ft buffer area on Little John Lake 2017.

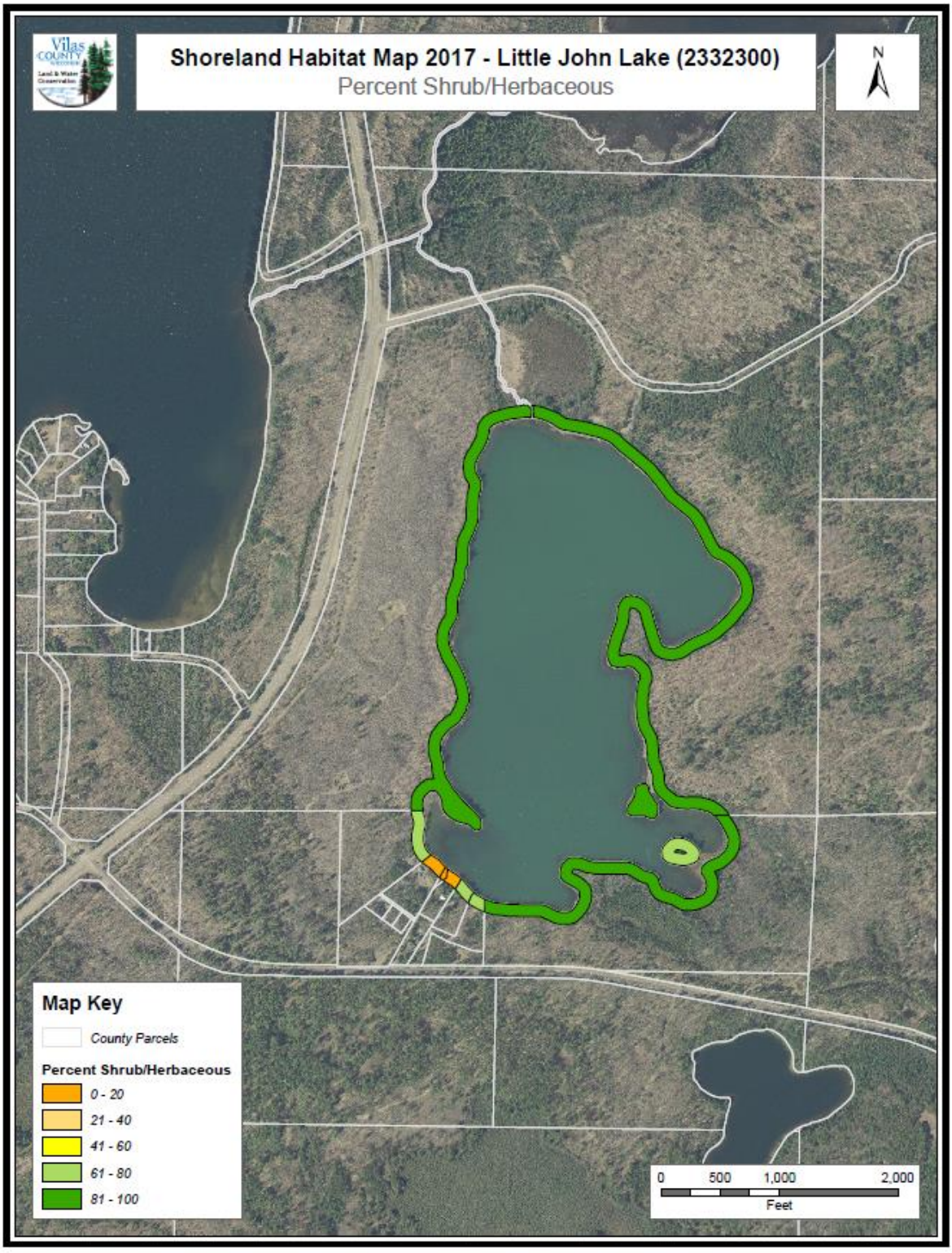

Figure 29. Percent shrub/herbaceous cover per parcel within 35 ft buffer area on Little John Lake 2017.

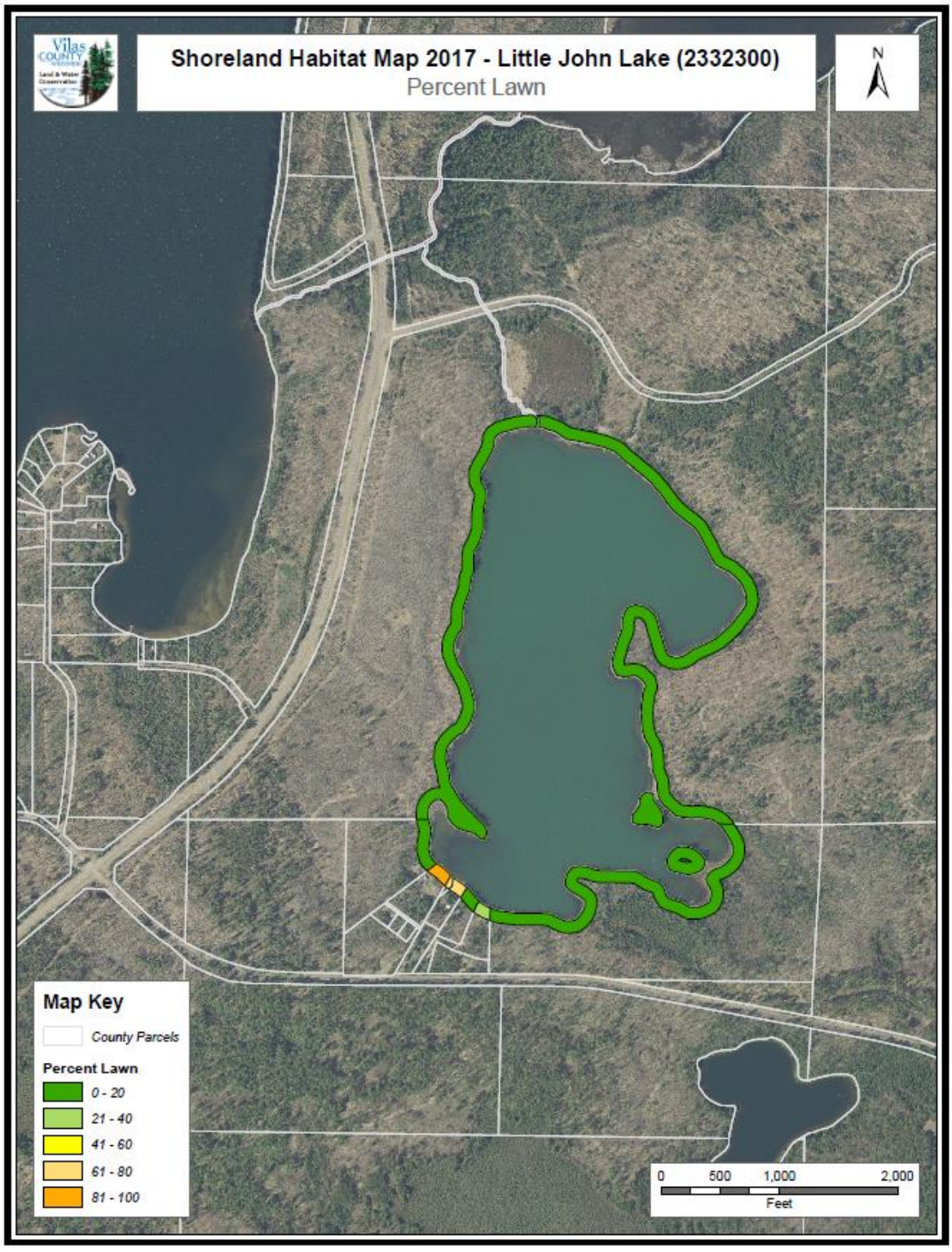

Figure 30. Percent lawn cover per parcel within 35 ft buffer area on Little John Lake 2017.

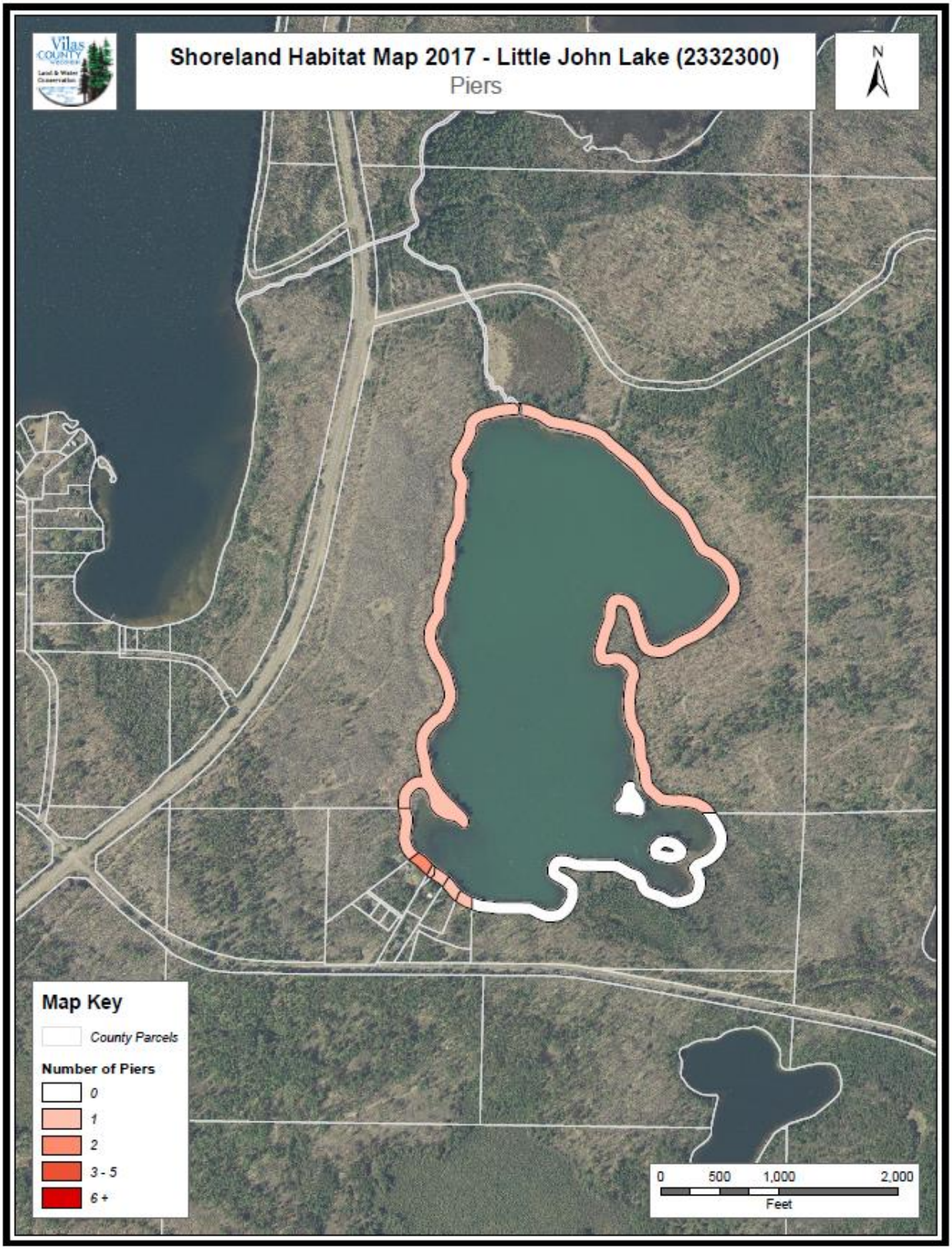

Figure 31. Piers per parcel on Little John Lake 2017.

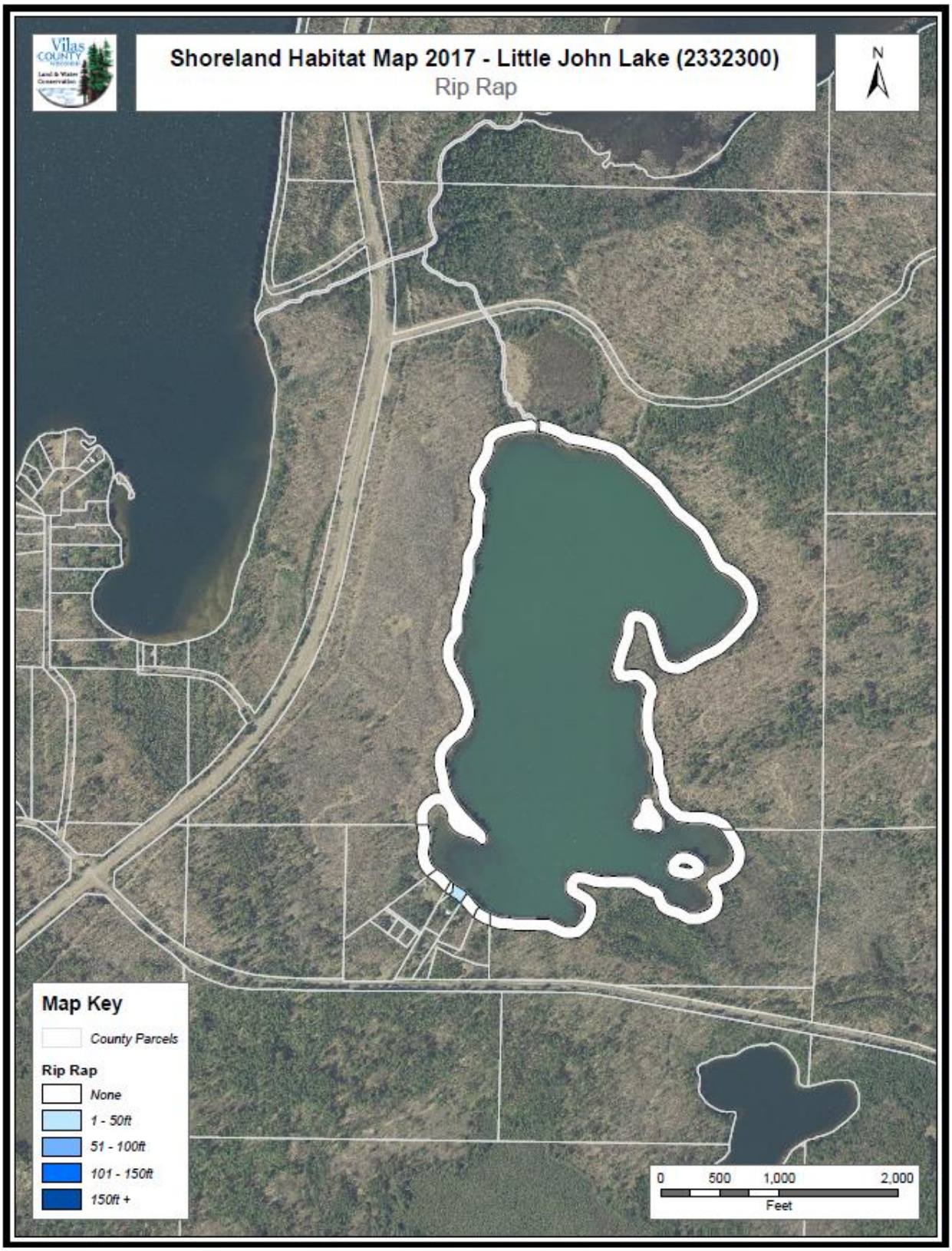

Figure 32. Riprap feet per parcel on Little John Lake 2017.

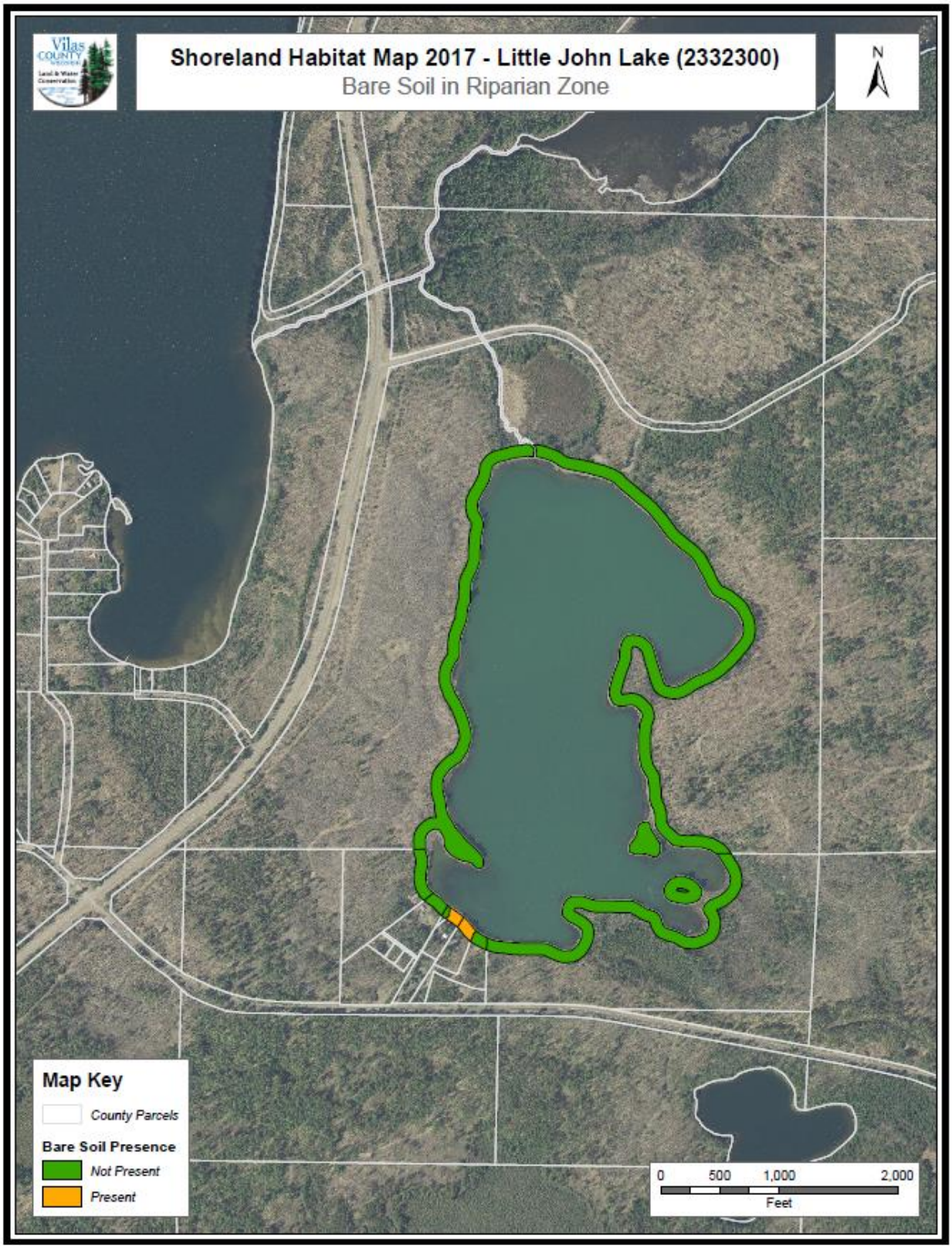

Figure 33. Parcels where bare soil is present on Little John Lake 2017.

Figure 34. Parcels where lawn or soil slopes to lakes on Little John Lake 2017.

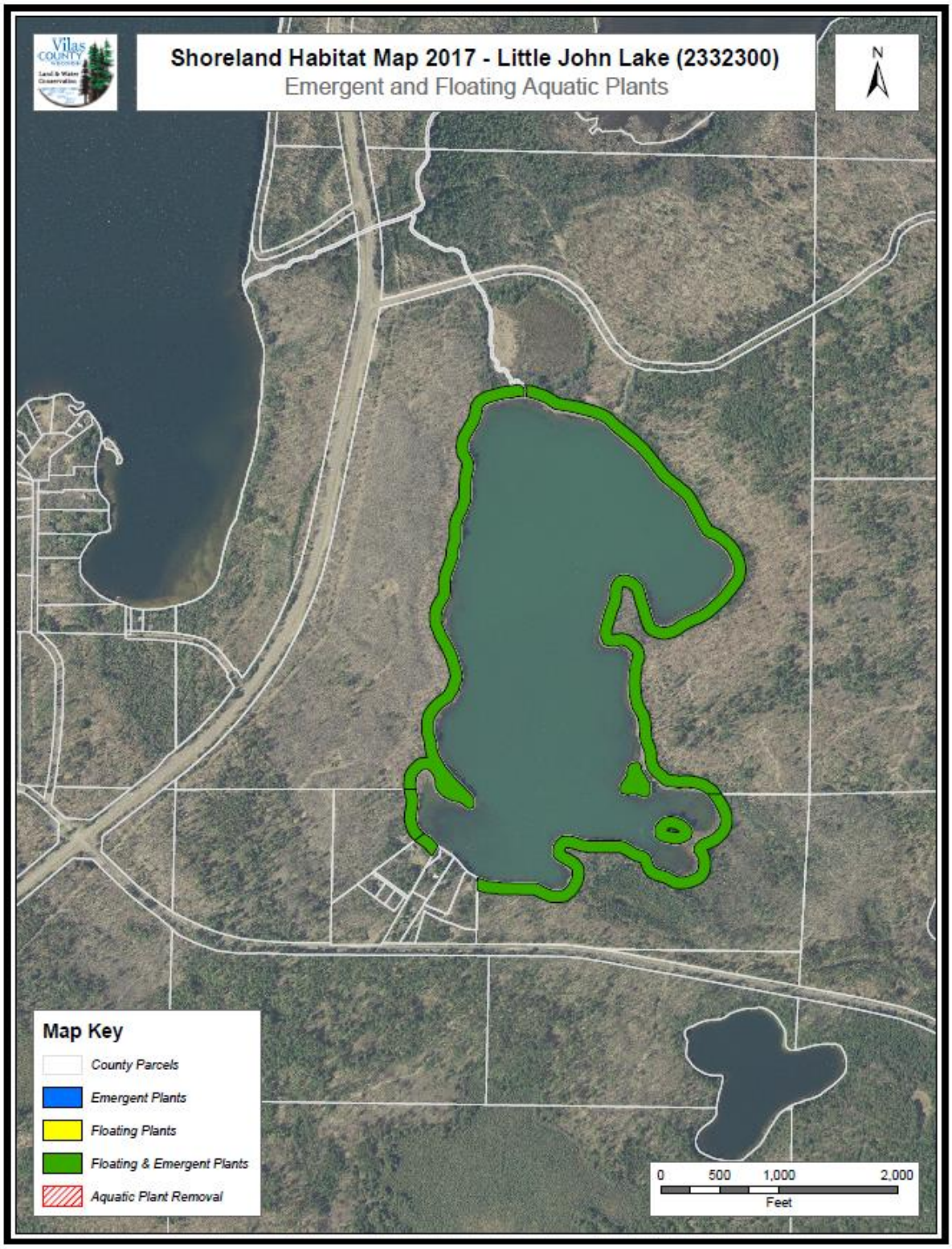

Figure 35. Floating and emergent plants on Little John Lake 2017.

Appendix 18: Erosion Susceptibility

Figure 36. Areas susceptible to erosion in the Trout Lake subwatershed.