Mamie Lake
2017-2018 Lake Assessment Report

Prepared by
Vilas County Land & Water Conservation

April 16, 2019

Assessment Type	Metric	Metric Context	Mamie Lake Results
Water Quality	Total Phosphorus	FAL[1] & REC[2]: 40 ug/L in shallow lowland drainage lakes	43.5 ug/L average
	Chlorophyll a	FAL[1]: 27 ug/L in shallow lowland drainage lakes REC[2]: >20 ug/L more than 30% of days	27.8 ug/L average >20 ug/L in 5 of 6 sampling events (80%)
Aquatic Plant Point-Intercept	Floristic Quality Index	24.3 median for Northern Lakes and Forest Lakes Ecoregion	37.18
	Average Value of Conservatism	6.7 median for Northern Lakes and Forest Lakes Ecoregion	6.68
Shoreland Habitat	Docks/Mile	>16 docks/mile density correlated with less fish diversity	16.8 docks/mile

[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	Average 4.75 ft
Aquatic Plant Point-Intercept Survey	Max Depth of Plants	7.0 ft
	FOO[3] shallower than max depth	67%
	Simpson's Diversity Index	0.82
	Rare Plants	None
AIS Early Detection	Verified & **New** AIS Found	Curly leaf pondweed; banded mystery snail; Chinese mystery snail **New AIS: None**
Shoreland Habitat	% Natural Cover	84%
	% Impervious	6%
	Parcels With Runoff Concerns	34 of 40 (85%)
	Coarse Woody Habitat	148 logs/mile

Executive Summary

Mamie Lake is one of fifteen lakes on the Cisco Chain spanning Wisconsin and Michigan. Chlorophyll a and total phosphorus data collected throughout this study were sometimes just above and sometimes just below the established thresholds. Four plants made up the bulk of the aquatic plant community, however biodiversity hot-spots were located in 3 areas. The lake's floristic quality (37.18) is much higher than average for the region (24.3). No new aquatic invasive species (AIS) were found, however; previously verified AIS listed with DNR were: banded mystery snail, Chinese mystery snail, curly leaf pondweed, and rusty crayfish. Several terrestrial invasive species were seen on shorelines, some that still need verification. Coarse woody habitat survey resulted in 148 logs/mile of shoreline. Most of the vegetative cover within the 35 ft. shoreland buffer area was natural (84%), however 10% zone was lawn. Pier density is at 16.8 docks/mile, which just exceeds the 16.0 docks/mile threshold where negative impacts to fish diversity are seen. Highlighted recommendations include outreach on and installation of erosion control best practices, facilitating habitat improvements in the shoreland buffer area, protecting biodiversity hot-spots, discouraging any additional pier installations, and continuation of water quality and AIS monitoring.

Introduction

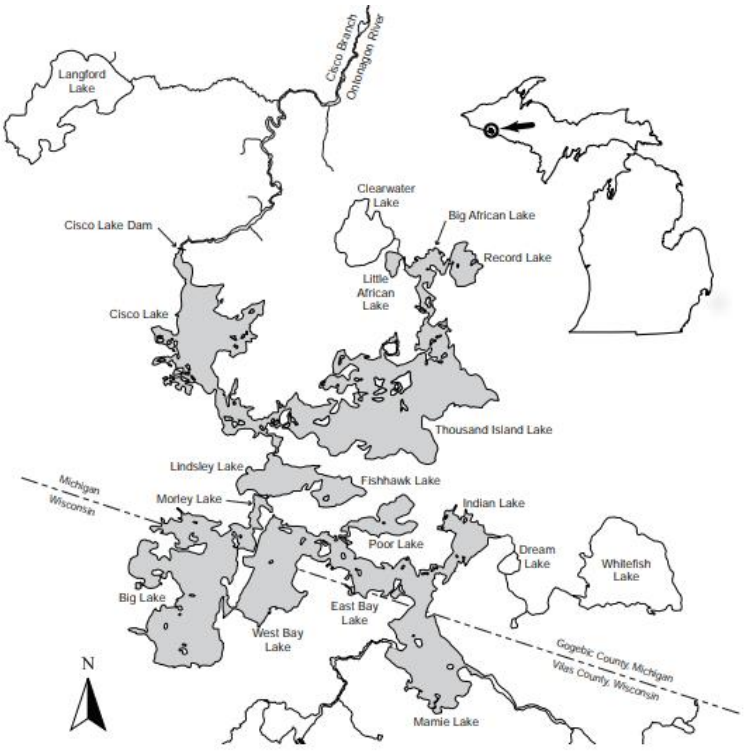

Figure 1. Cisco Chain Map courtesy of MI DNR.

Lakes are a vital natural resources 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.

Mamie Lake is part of the Cisco Chain of Lakes that runs along the Wisconsin-Michigan border. The purposes of the study of Mamie 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.

Mamie Lake is a 337 acre Shallow Lowland Drainage Lake located in the Towns of Land O'Lakes (WI) and Watersmeet (MI). Mamie Lake's maximum depth is 15 feet and is made up of 60% sand, 25% gravel, 10% rock, 5% muck (*Mamie Lake*). It is one of the 15 different lakes that make up the Cisco Chain. This Chain was created by a dam constructed at the outlet of the West Branch of the Ontonagon River out of Cisco Lake during the early 1900's logging era. Today, the Upper Peninsula Power Company (UPPCO) owns and operates this dam.

The adjacent riparian land is owned by private landowners, including resort properties. The ground cover is primarily forests and bogs, however there is moderate development on the lake. Surrounding soils are indicated as sandy soils (primarily Gogebic-Fence-Pence complex, Gogebic-Pence Complex, or Gogebic sandy substratum-Pence-Cathro Complex) with slopes ranging from 0-35%. These soils are moderately well to well drained, but are listed in a high to very high runoff class. Wetland soils are primarily Seelyeville & Markey mucks or Loxley & Dawson peats with slopes ranging from 0%-1% (*Web Soil Survey*). In 2018, Vilas County Land & Water Conservation ran erosion susceptibility modeling for all watersheds within the county. Highly susceptible areas were located around Mamie Lake -see Appendix 6.

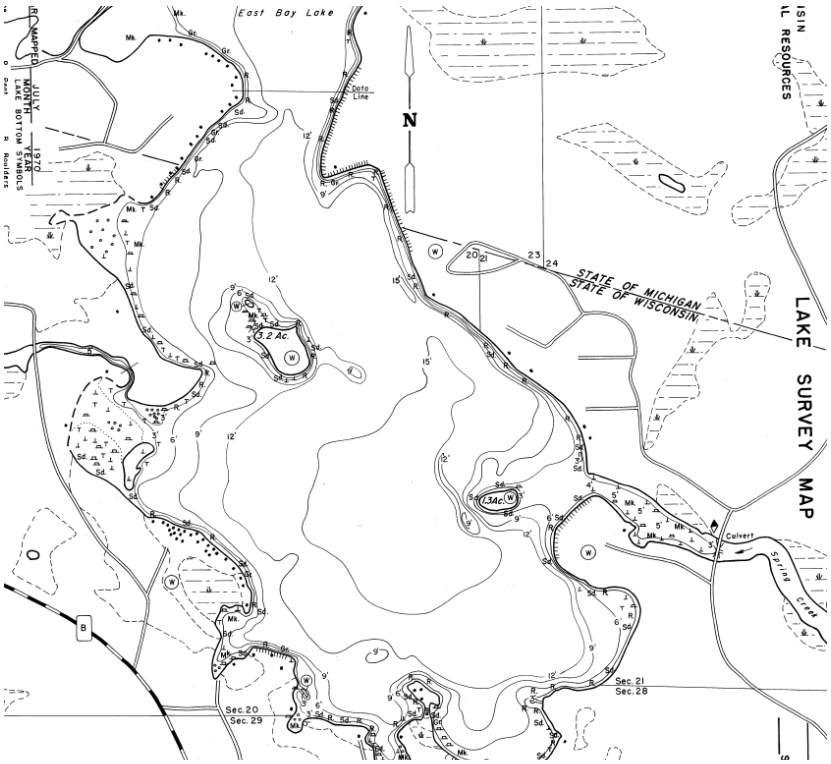

Figure 2. Mamie Lake bathymetry map. Courtesy WI DNR.

Mamie Lake is represented by the Cisco Chain Riparian Owners Association. This organization is comprised of Wisconsin and Michigan property owners. The group had succeeded in passing a Special Assessment tax on the Michigan side in 2018 (similar to a Lake District in WI). As of the writing of this report, no Lake District exists on the WI side, however the Cisco Chain of Riparian Owners Association is investigating this option.

Results and Discussion

Note – See Appendix 1 for Methods

Water Quality

Mamie Lake is a 337 acre and 15 ft deep "shallow lowland drainage lake". Water quality assessments reference WisCALM Shallow Lowland Drainage Lake criteria. It is not listed on the 2018 WI DNR Impaired Waters listing.

The total phosphorus criteria for fish & aquatic life and recreation is 40 ug/L. The total phosphorus sampled on Mamie Lake exceeded the criteria 3 times in 2017 and was just below the criteria 3 times in 2018. The mean total phosphorus reading from the 6 sampling events over the 2 years was 43.5 ug/L, with a minimum reading of 38.1 ug/L and a maximum reading of 54.3 ug/L.

The chlorophyll a criteria for Fish and Aquatic Life is 27 ug/L and for Recreation is 30% of days where chlorophyll a is >20 ug/L. The chlorophyll a results at each sampling event were averaged to be 27.8 ug/L, with a minimum reading of 16.4 ug/L and a maximum reading of 45.1 ug/L. Mamie Lake appears to exceed the Recreation criteria for total phosphorus in 5 of our 6 sampling events (80%).

Using statistical formulas, DNR staff will determine whether or Mamie Lake should be added or not added to the Impaired Waters list. The Impaired Waters list is published by DNR every other year, with the new listing expected in 2020.

Water in Mamie Lake was reported brown in color at all sampling events in 2017, while in 2018 it ranged from brown to yellow to blue. In 2017 reports listed the water as murky while in 2018 all reports listed the water as "clear". Secchi depths averaged 4.75 ft, and is indicative of fair to poor water quality. The higher pH (8.47) and alkalinity (45.7 mg/L) show Mamie Lake is a hardwater lake. Calcium concentrations are relatively low (13.1 mg/L) as is the conductivity (95.8 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 Mamie Lake was not stratified. "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 Mamie Lake up to 12 ft. deep with one exception: the August 2018 sampling found dissolved oxygen concentrations at <5mg/L at only 9 feet deep. 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 July 24-July 28, 2017. Of the 498 point-intercept (PI) locations, 160 were visited – see Appendix 3 Figure 15. 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.

No plants found in Mamie Lake were considered rare by DNR Natural Herritage Inventory (*Wisconsin's Rare Plants*). However, there were a few plants worth highlighting. Spiny hornwort (*Ceratophyllum echinatum*) was found on 1 site. Blunt-leaf pondweed (*Potamogeton obtusifolius*) was found at 2 sites. Small bladderwort (*Utricularia minor*) was found at 1 site. Northern wild rice (*Zinzania palustris*) was found at 1 site. See Appendix 3 for photos of highlighted plants.

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

Mamie Lake 2017 Point-Intercept Summary

Total number of sites visited	**160**
Total number of sites with vegetation	**85**
Total number of sites shallower than maximum depth of plants	**126**
Frequency of occurrence at sites shallower than maximum depth of plants	**67.46**
Simpson Diversity Index	**0.82**
Maximum depth of plants (ft.)**	**7.00**
Number of sites sampled using rake on Rope (R)	**65**
Number of sites sampled using rake on Pole (P)	**70**
Average number of all species per site (shallower than max depth)	**1.38**
Average number of all species per site (veg. sites only)	**2.05**
Average number of native species per site (shallower than max depth)	**1.37**
Average number of native species per site (veg. sites only)	**2.04**
Species Richness	**32**
Species Richness (including visuals)	**33**
Floristic Quality Index	**37.18**
Average Value of Conservatism	**6.68**

The Species Richness for Mamie Lake is 32. This figure includes only those species collected with the rake, and does not include visual sightings. Mamie Lake has more than twice as many 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 Mamie Lake of 6.68 is just less 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 "average" types of plants that represent the region in Mamie Lake – not trending towards high or low quality systems.

The Floristic Quality Index weighs both the species richness and the average value of Conservatism. The Floristic Quality for Mamie Lake is 37.18. 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 Mamie Lake is 0.82. This indicates an average number of species and distribution of those species in Mamie 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, wild celery (*Vallisneria americana)* was by far the most prevalent, with a littoral frequency of occurrence of 53% and was found at 67 of the 85 sites with vegetation.

Table 2. Mamie Lake 2017 Aquatic Plant Point-Intercept Species Collected Via Rake, Coefficients of Conservatism, and Littoral Frequency of Occurrence if > or = 5%

Species – Collected via Rake	Common Name	Coefficient of Conservatism	Littoral Frequency of Occurrence
Vallisneria americana	Wild celery	6	53%
Potamogeton zosteriformes	Flat-stem pondweed	6	17%
Lemna trisulca	Forked duckweed	6	12%
Certatphyllum demersum	Coontail	3	11%
Bidens beckii	Water marigold	6	5%

One additional species was 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. Mamie Lake 2017 Aquatic Plant Point-Intercept Additional Species Visually Encountered

Species – Visuals	Common Name
Typha latifolia	Broad leaved cattail

Of all the sampling points on Mamie Lake, the most species rich areas occurred in the small bay just south of Bent's Camp Resort (southwest side of lake), Spring Creek as it empties into Mamie Lake (southeast side of lake), and Helen Creek as is leaves Mamie Lake (west side of lake). See Appendix 3 Figure 23.

For Mamie Lake, the plants with more difficult ID were collected, photographed, and pressed. Pressed specimens were verified and are housed at the Freckmann Herbarium including: *Ceratophyllum demersum, Ceratophyllum echinatum, Chara sp., Eleocharis acicularis, Elodea nuttallii, Heteranthera dubia, Najas flexilis, Pontederia cordata, Potamogeton amplipholius, Potamogeton berchtoldii* (listed under PI worksheet as *Potamogeton pusillus,* as *P. berchtoldii* is not an option on the worksheet*), Potamogeton crispus, Potamogeton natans, Potamogeton obtusifolius, Potamogeton robinsii, Potamogeton spirillus, Sparganium emersum, Spirodela polyrrhiza, Utricularia minor, Utricularia vulgaris,* and *Zizania palustris.* Plants not photographed or pressed were *Bidens beckii, Elodea canadansis, Lemna trisulca, Myriophullum sibericum, Nitella sp., Nuphar variegata, Nymphaea odorata, Potamogeton foliosus, Potamogeton praelongus, Potamogeton richardsonii, Potamogeton zosteriformes, Typha latifolia,* and *Vallisneria americana.*

AIS Early Detection Survey

On July 20, 2017, the AIS Early Detection Survey was completed. Targeted sites included: Spring Creek Thousand Island Lake Rd. boat launch, Helen Creek access area, Bent's Camp Resort, Spring Creek Inlet, Helen Creek Outlet, as well as a meander survey around the perimeter of the lake. The water was borderline clear enough to look for AIS while snorkeling, so most sites were snorkeled. Exceptions were

the Spring Creek Inlet – that area was generally very shallow (1-2 ft depth) and could effectively be searched visually while wading. The area near Bent's Camp Resort was snorkeled, however that area was too murky to effectively see. Rake tosses and D-net sweeps were done as a follow-up to assure nothing was missed. Although multiple species were searched for, **no new targeted AIS were found** during the survey. AIS previously documented as in SWIMS as "Verified" are banded mystery snail, Chinese mystery snail, curly leaf pondweed, and rusty crayfish. No AIS are listed as "Observed".

While it cannot be confirmed because it was not in flower, yellow iris (*Iris psuedacorus*) is suspected near the Spring Creek Thousand Island Lake Dr boat launch area and on 2 developed properties during the meander survey. Several wetland/terrestrial species that are listed on NR40 were seen and suspected but not verified because they were growing on private lands and could not be legally accessed. However, they are not specifically targeted with the Directed Lakes protocols: aquatic forget-me-nots (*Myosotis scorpioides*), Eurasian honeysuckles (*Lonicera sp.)*, Acacia rose *(Robinia hispida*), creeping bellfower (*Campanula rapunculoides)* and Japanese barberry (*Berberis thunbergii*). Yellow foxglove (*Digitalis grandiflora*) is not listed on NR40, but is a non-native seen and suspected (not verified) during the meander survey in forested areas.

Veliger tows were sampled on July 20, 2017. Results were analyzed by DNR staff in Madison. No zebra mussel veligers were found in the Mamie Lake sample (Kail).

Sediment samples were taken on July 24, 2017 and analyzed by DNR staff in Madison for spiny waterfleas. No evidence of spiny waterfleas was found in the samples (Kail).

Coarse Woody Habitat

Coarse woody habitat was mapped on June 6, 2017 when the water was fairly clear and easy to detect submerged logs. 828 logs were counted between the ordinary high water mark and the 2 ft depth contour along the 5.6 miles of shoreline, giving the density of 148 logs/mile of shoreline – see Appendix 4. Note that not all logs were completely submerged on this day due to the water being below the ordinary high water mark.

391 logs crossed the ordinary high water mark, providing a habitat "bridge" between the water and land. 56 logs were submerged with the full tree crown, providing more complex structure to the Coarse Woody Habitat.

Shoreline Assessment

The shoreline of Mamie Lake consists of 40 parcels, all of which are owned by private landowners. The northern boundary of Mamie Lake extends just over the border of Michigan, so some data included in the survey is reflective of Michigan parcels.

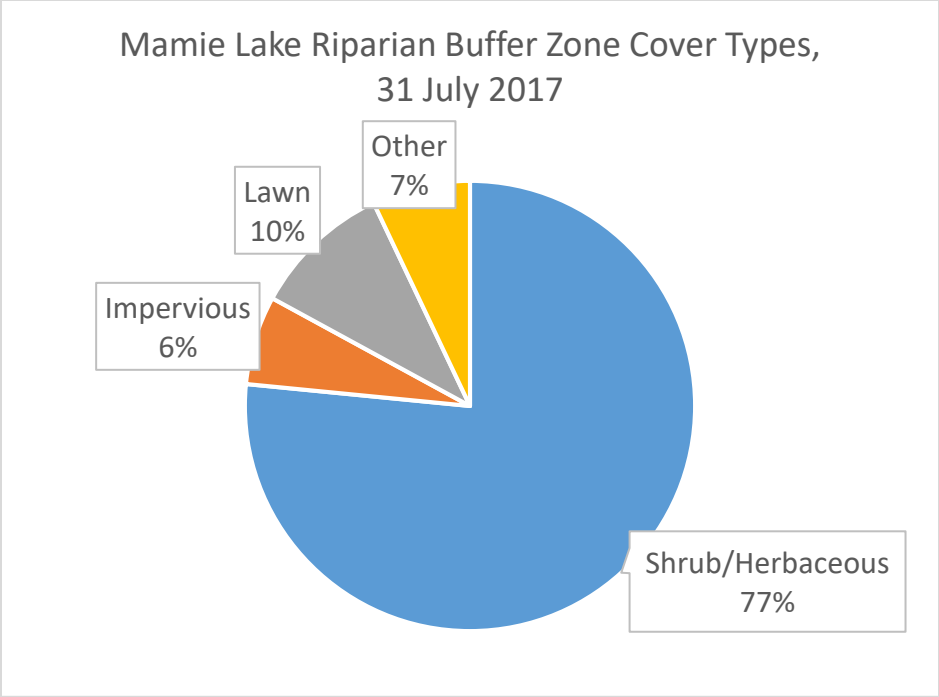

Figure 3. Ground cover type in Riparian Buffer Area (35 ft. inland from shore) on Mamie Lake, 2017. "Other" category includes duff.

Lake-wide, 77% of the riparian area (35 ft. inland from ordinary high water mark) was covered by a shrub/herbaceous layer. Lawn made up 10% of the riparian area, and Impervious surfaces made up 6%. The "other" category was comprised of duff, bare soil, and mulch and covered 7% of riparian buffer zone. See Appendices 7-9 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), so 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. Mamie Lake exceeds this statistic having 77% covered with shrub/herbaceous cover.

Many human structures or modifications were noted in the Riparian, Bank, and Littoral Zones. See Figure 8 for Human Structures in Riparian Buffer, Bank 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 Mamie Lake, piers were the most common 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). Mamie Lake just exceeds this figure at 16.8 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: boat lifts (41); boats on shore (37); and buildings within the riparian area (34).

Figure 4. Some areas of Mamie Lake showed denser dock placement. Lake-wide, there were 16.8 docks/mile on Mamie 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, modifications included riprap and artificial beaches. There was 630 ft of riprap noted, which would comprise 2% of the lake. Note that Mamie Lake is naturally quite rocky, and many shoreline areas could have been riprapped many years ago, but vegetation has been growing in. Riprap was not noted unless it was obvious. Artificial beaches totaled 70 feet of shoreline (less than 1% of the total shoreline). Bank erosion with a greater than 1 ft face was noted across 12 ft of shoreline. No seawalls, erosion control structures, or bank erosion less than 1 ft face was noted. See Figure 9.

Figure 5. Erosion on steep slopes with natural vegetation was often seen on Mamie Lake properties.

Several runoff and erosion concerns were documented: 1 parcel had a point source; 26 parcels had stairs/trail/road to the lake; 17 had lawn/soil sloping to the lake; 14 had bare soil; and 1 had sand/silt deposits. See Figure 10 for Number of Parcels with Erosion or Runoff Concerns.

Aquatic plant removal was observed on only 1 parcel.

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. A point source was found on 1 property.

Figure 7. Erosion near Spring Creek Inlet crossing on Thousand Island Lake Rd.

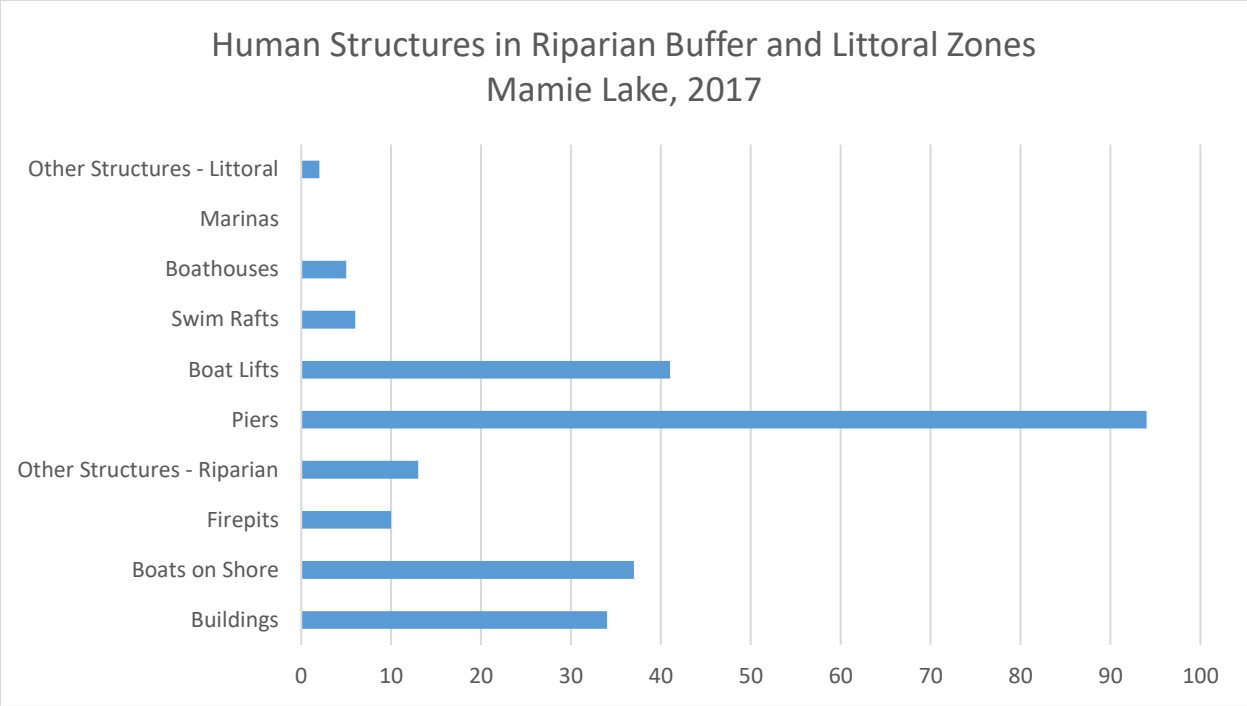

Figure 8. Number of human structures documented in the Riparian Buffer and Littoral Zones on Mamie Lake 2017.

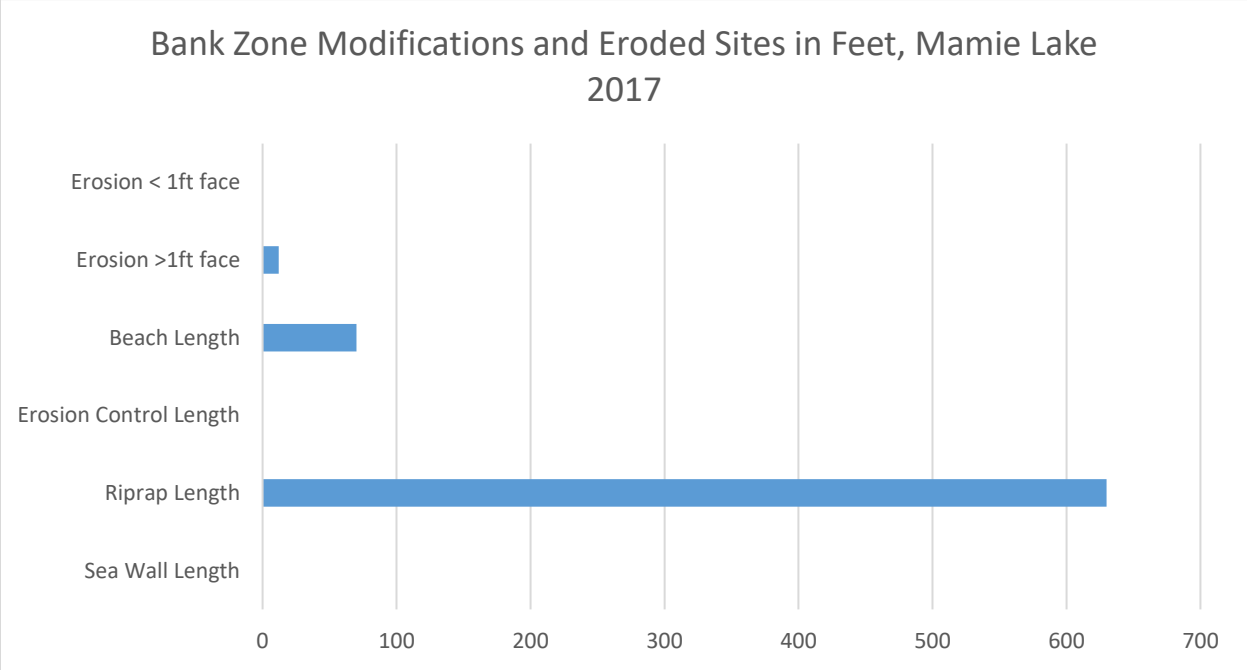

Figure 9. Length in feet of human modifications to Bank Zone on Mamie Lake 2017.

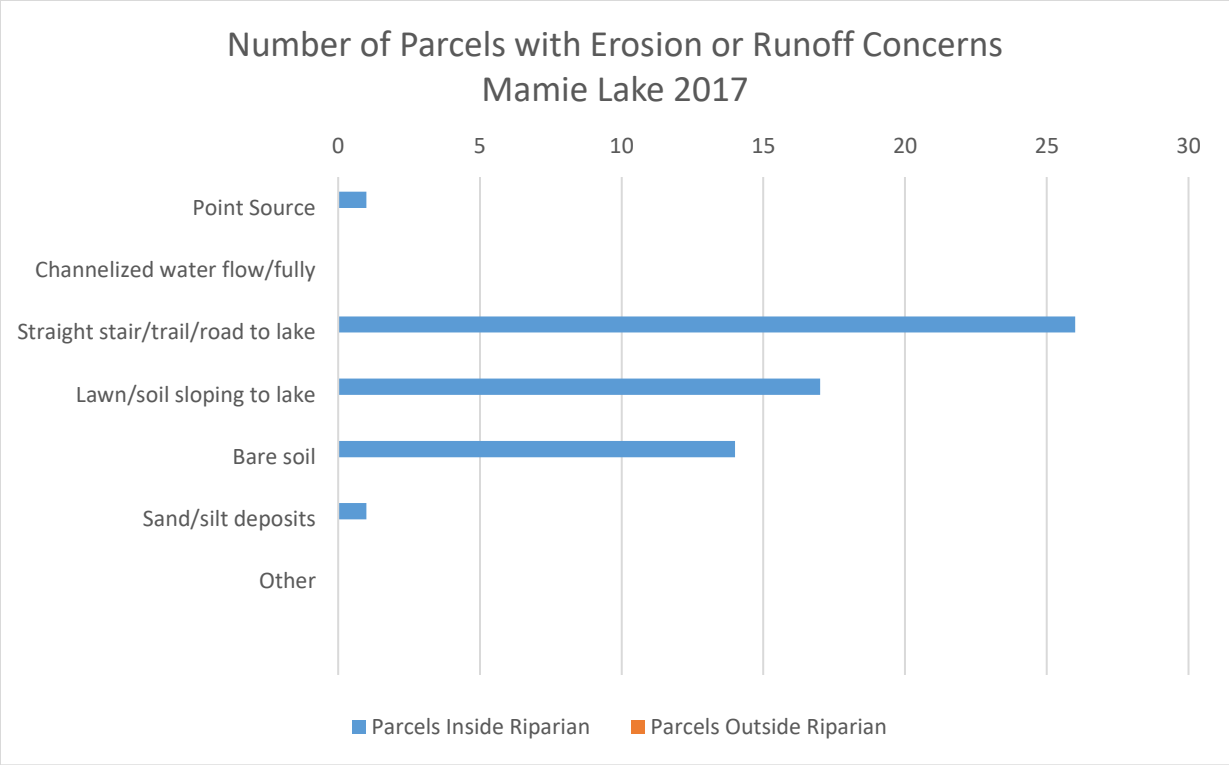

Figure 10. Number of parcels with runoff and erosion concerns in Riparian Zone and Outside Riparian Zone on Mamie Lake 2017.

Observations

While working on Mamie Lake, there were a few noteworthy observations not related to the Directed Lakes protocols.

The Mamie Lake riparian area seems to have its fair share of terrestrial invasives in the riparian areas – these are listed in more detail in the AIS Survey section.

Swamp milkweed appeared to be abundant on Mamie Lake. This plant looks similar to invasive purple loosestrife.

Figure 11. Swamp milkweed prior to flowering on Mamie Lake. This particular plant seemed to be popular with dragonfly nymphs – several cast skins are attached.

Bryozoans were found in several spots on the lake.

Freshwater were sponges found in particular near the Helen Creek Rd access (west side of lake).

Blue green algae was noted blooming in spots on the lake in 2017. While the zebra mussel veliger samples were negative, DNR staff analyzing the sample noted the presence of an algae bloom of *Dolichospermum* within the submitted sample – this is a blue green algae that is capable of producing toxins (SWIMS).

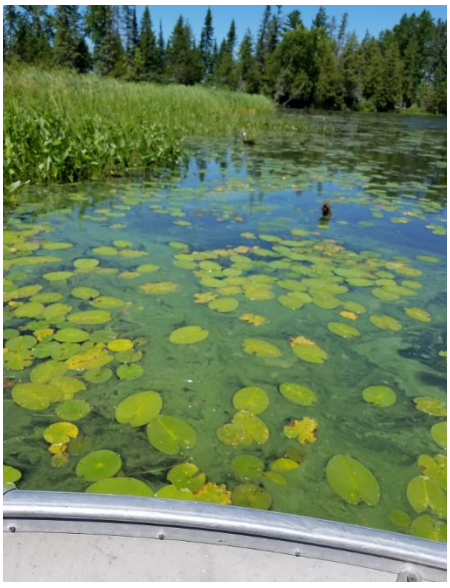

Figure 12. Blue green algae bloom on Mamie Lake July 24, 2017.

Recommendations

The Cisco Chain of Riparian Owners Association is active in protecting lakes within the Cisco Chain, including Mamie Lake. If desired, this group could facilitate:

- **Monitor water quality regularly**
  - Mamie Lake's water quality was sometimes just below and sometime just above standards. Establishing a volunteer monitoring program for secchi, cholorophyll a, and total phosphorus would allow for further data to watch these trends. 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 assistance.

- **Initiate a campaign on erosion awareness to varied lake users (riparians, resort guests, public access boaters, etc.)**:
  - Boat wake and shoreland erosion
  - Impervious surfaces impacts to water quality, habitat, fish, and wildlife
  - County cost sharing programming opportunities
  - DNR Healthy Lakes best practices and funding opportunities
  - Create connections on how smaller land parcels often lead to less native vegetation and more runoff – encourage keeping established parcels whole
    - The water level in Mamie Lake is higher than historic due to the construction of the dam on Cisco Lake in the early 1900's. The surrounding soils on the "new" banks and slopes are sandy, and often steep and fragile. In some instances, whole slopes were slumping into the lake. 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)**:
  - Lead Healthy Lakes campaign on Mamie Lake
  - Provide materials and serve as a point-of-contact for landowners to increase native vegetation and install erosion control practices within 35 ft. buffer zones and beyond
    - The number of parcels with erosion concerns was fairly high (85%), and much work could be done on Mamie Lake. Addressing these issues with willing private landowners will take a coordinated effort, ideally with a well versed ripairan being locally available for those interested. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Maintain and Increase Coarse Woody Habitat**:
    - The Cisco Chain appears to be a productive fishery. 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.

- **Encourage native vegetation to grow in the 35 ft. shoreland buffer areas:**
    - 10% of the 35 ft buffer zone was lawn. Encourage willing landowners remove turf grass in the buffer area and replace with native vegetation. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Discourage additional piers/docks on Mamie Lake:**
    - Mamie Lake is already over the 16 docks/mile threshold for impacting fish diversity (Jacobson et. al.). Consider the ability to share dock access in appropriate instances. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Protect the biodiversity of the aquatic plant community in diversity "hot-spots"**
    - Spring Creek channel from Thousand Island Lake Rd boat launch flowing into Mamie Lake
    - Helen Creek access from Helen Creek Rd flowing out of Mamie Lake
    - Small bay just south of the Bent's Camp resort
        - Four plants (Wild celery, flat stemmed pondweed, forked duckweed, and coontail) make up the bulk of the aquatic plants found on Mamie Lake. However, the above three areas are where biodiversity spiked. These areas should be protected from further littoral development/plant removals. 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:**
    - Target busiest boater traffic days for a volunteer Clean Boats Clean Waters campaign.
    - Continue routine monitoring of aquatic invasive species.
    - Ask residents to photograph Yellow Iris in flower.
    - Provide information to riparian owners on wetland and terrestrial plants on the shoreline: aquatic forget-me-nots (*Myosotis scorpioides*), Eurasian honeysuckles (*Lonicera sp.)*, Acacia rose *(Robinia hispida*), creeping bellflower (*Campanula rapunculoides)* and Japanese barberry (*Berberis thunbergii*).3
    - Continue to provide resources for landowners to control terrestrial invasive species.
        - The Mamie Lake boat launch has an informative sign. The launch does not seem to have heavy boat traffic; however, a volunteer Clean Boats Clean Waters Campaign during summer holiday weekends may be effective. Routine AIS monitoring, by volunteers or by a consultant will assist with finding any spread of the curly leaf pondweed, or any new AIS. Yellow Iris is likely on Mamie Lake, but

cannot be verified unless it is in flower. Have a lake resident capture a photo of Yellow Iris so it can be added to the DNR's AIS records. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance with aquatic species and Quita Sheehan for wetland and terrestrial species 715-479-3721 or mashee@vilascountywi.gov.

Sources

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

2018

- July: Temperature and dissolved oxygen profile; Secchi; total phosphorus; and chlorophyll a
- August: Temperature and dissolved oxygen profile; Secchi; total phosphorus; chlorophyll a;
- September: Temperature and dissolved oxygen profile; Secchi; total phosphorus; and chlorophyll a

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

Aquatic Plant Point Intercept Survey

WI DNR staff created a grid-based map consisting of 498 point-intercept (PI) sampling points for Mamie 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

Staff snorkeled and rake sampled at targeted sites 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 Mamie Lake's target sites included 5 areas: Spring Creek boat launch area (Thousand Island Lake Rd.), Helen Creek Rd bridge area, Bent's Camp Resort area, Spring Creek Inlet, and Helen Creek outlet. 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 (Gina LaLiberte).

Sediment samples using an Ekman Dredge were taken to detect spiny waterfleas at 3 different locations on the lake. Results were analyzed by WI DNR staff (Gina LaLiberte).

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

Coarse woody habitat was surveyed according to the existing 2016 draft of the Lake Shoreland & Shallows Habitat Monitoring Field Protocol (Hein et. al.). This survey collected information per land parcel. A shapefile was created that contained the parcel boundaries around Mamie 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.

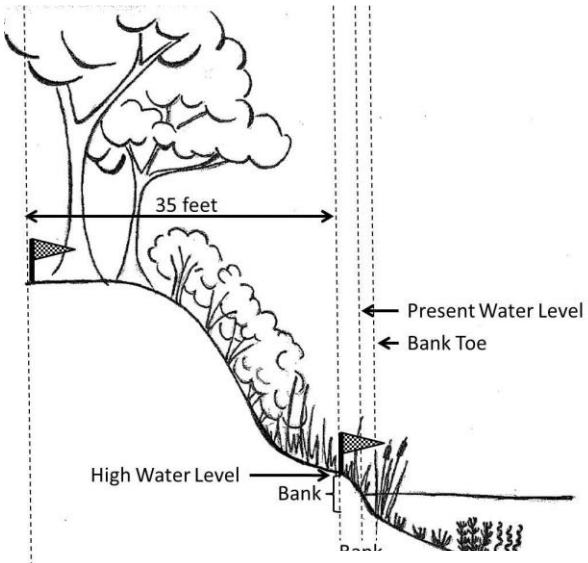


Figure 13. Shoreland areas assessed included the Riparian Buffer Zone, Bank Zone, and Littoral Zone. Graphic courtesy of WI DNR.

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.

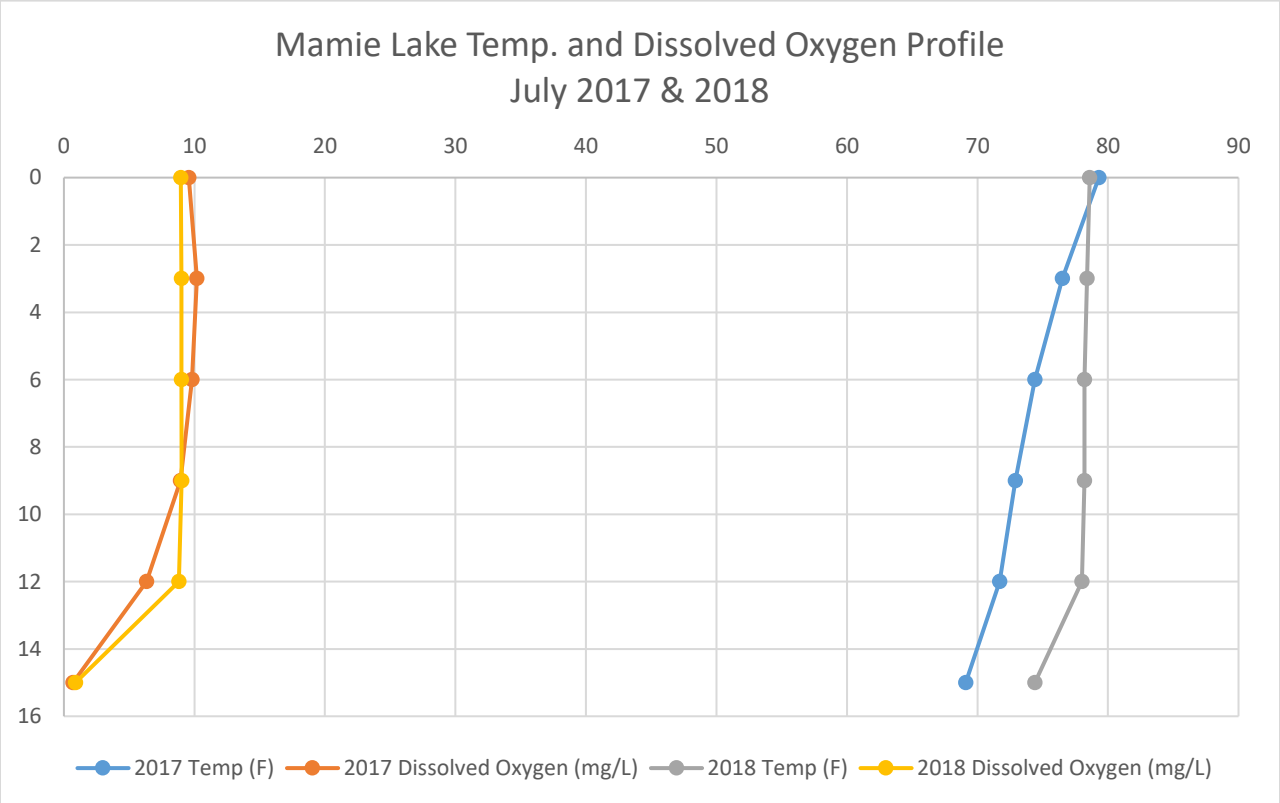
Photos of the 35 ft. Riparian Buffer Zone were taken at approximately 50 ft. from shore.

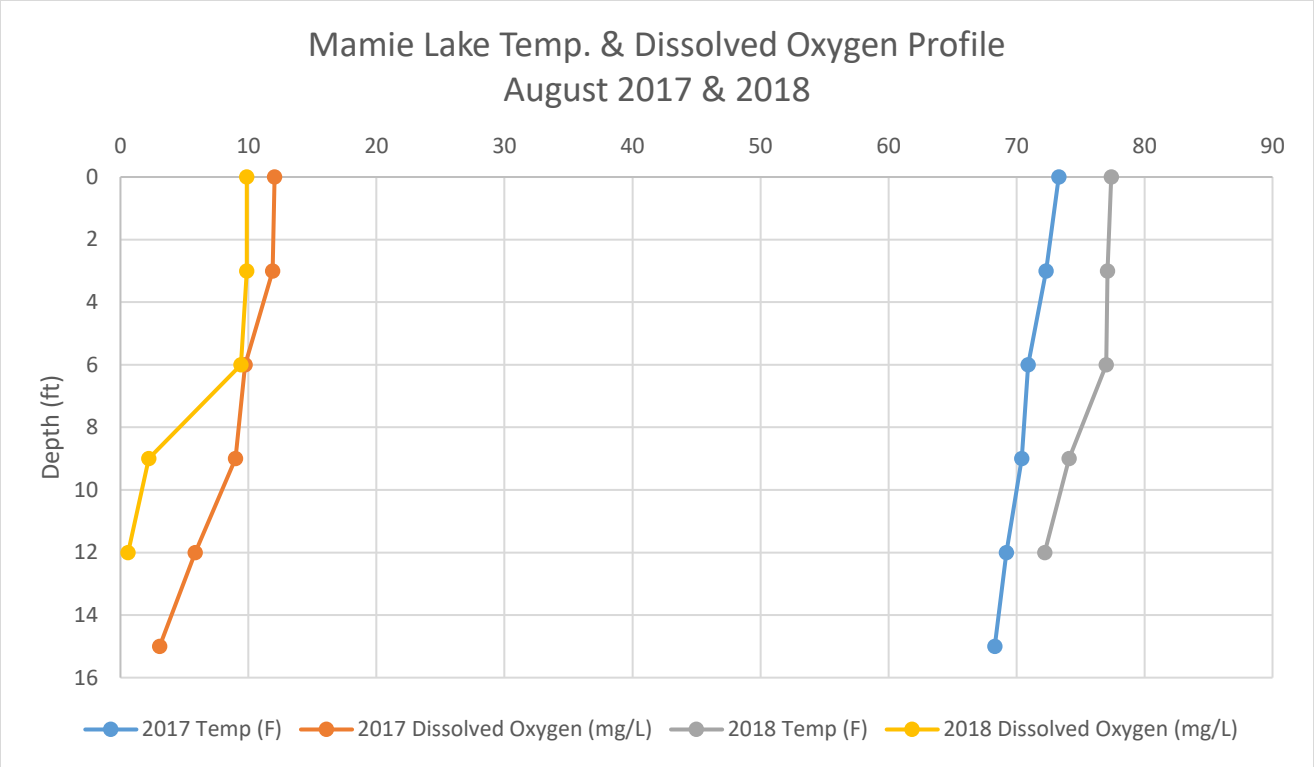
Appendix 2: Water Quality Raw Data and Temperature and Dissolved Oxygen Profiles

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

	July 2017	Aug 2017	Sep 2017	July 2018	Aug 2018	Sep 2018	Average
Secchi average (ft.)	5.75	3.0	3.75	4.5	4.5	7.25	4.75
Total Phosphorus (ug/L)	45.0	54.3	45.9	38.1	38.2	39.7	43.5
Chlorophyll a (ug/L)	16.4	45.1	29.1	23.7	27.7	24.7	27.7
Calcium (mg/L)	n/a	13.1	n/a	n/a	n/a	n/a	13.1
Alkalinity (mg/L)	n/a	45.7	n/a	n/a	n/a	n/a	45.7
pH	n/a	8.47	n/a	n/a	n/a	n/a	8.47
Conductivity (uS/cm)	n/a	95.8	n/a	n/a	n/a	n/a	95.8

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





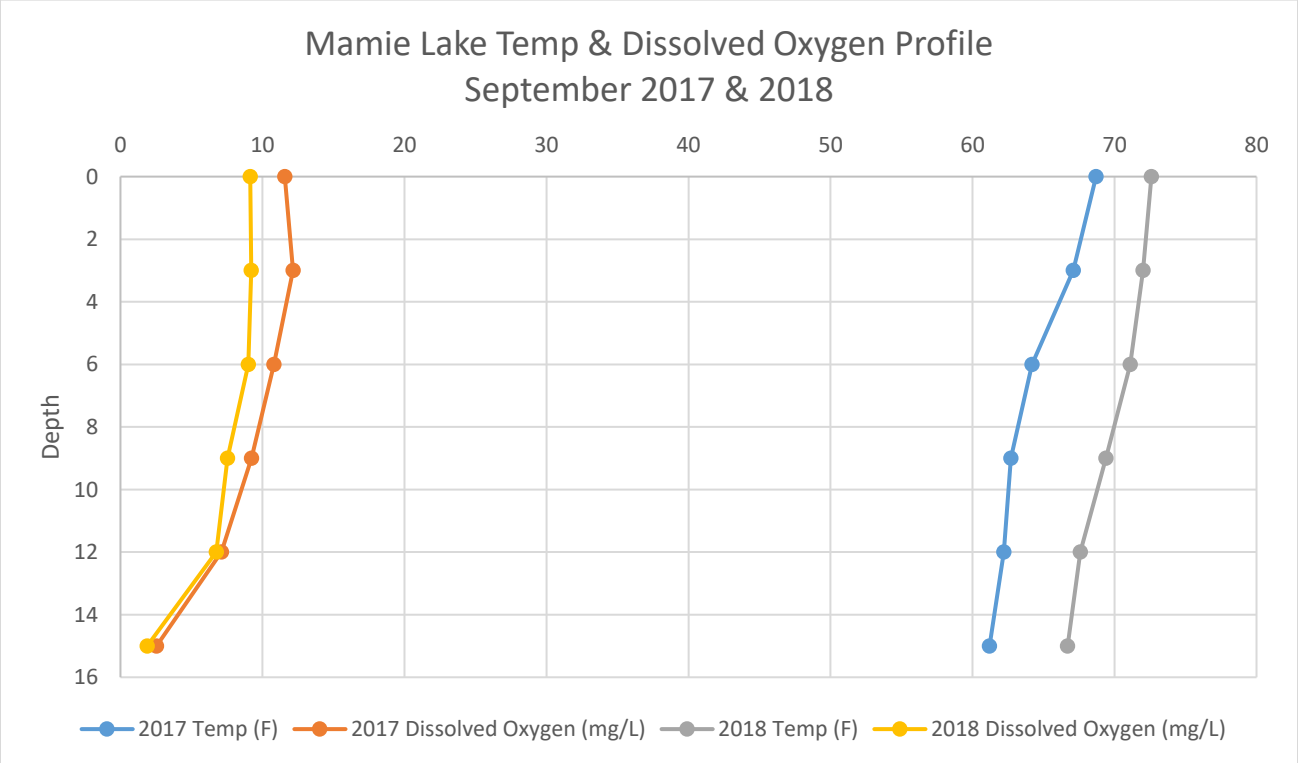


Figure 14. Temperature and dissolved oxygen profiles for Mamie Lake in 2017 and 2018. Sampling dates were: 7/19/2017; 8/21/2017; 9/13/2017; 7/16/2018; 8/15/2018; and 9/17/2018.

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

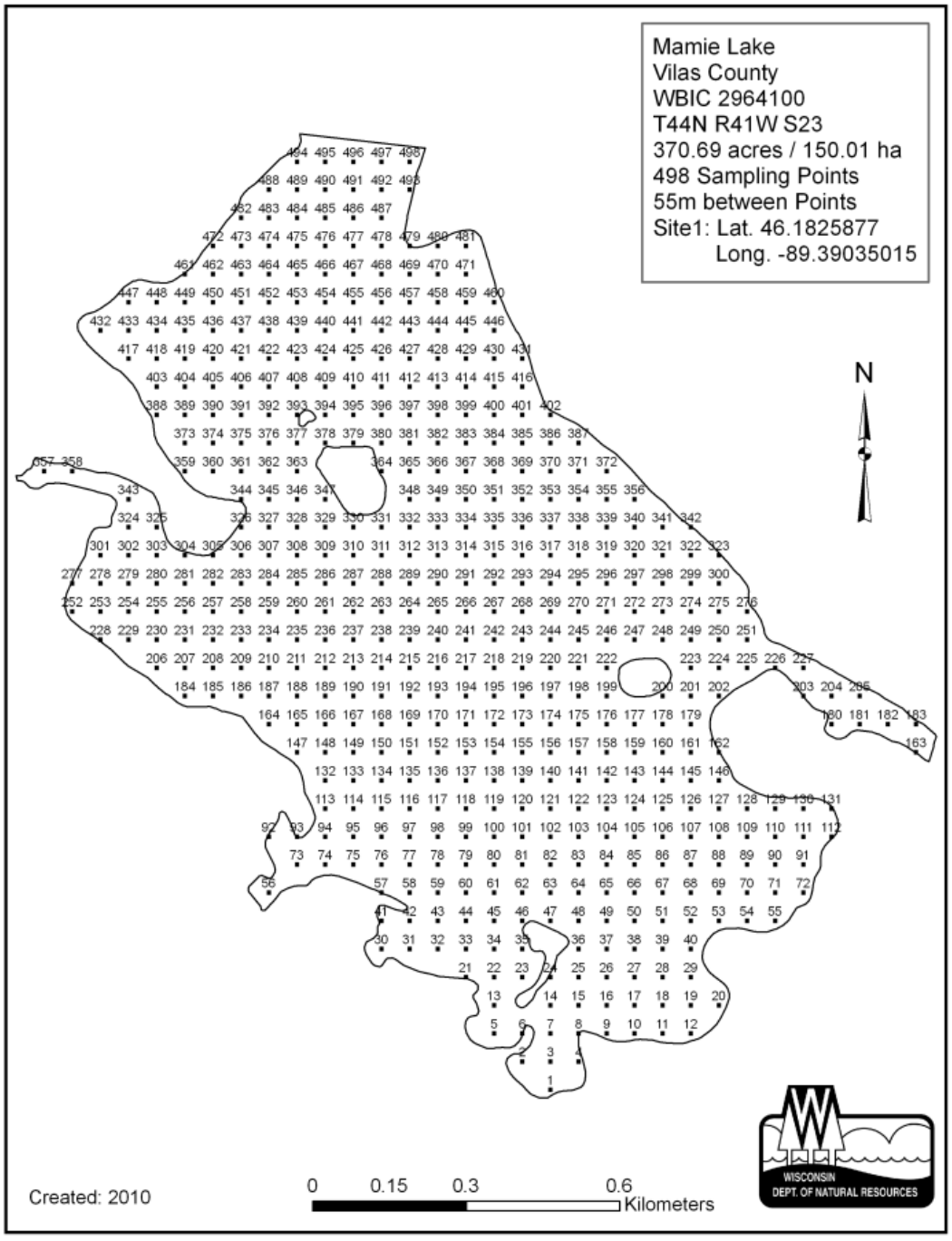


Figure 15. Mamie Lake Point Intercept Map. Courtesy of WI DNR.

Figure 16. Spiny hornwort (*Ceratophyllum echinatum)* found in Mamie Lake 2017 point-intercept survey.

Figure 17. Blunt Pondweed (*Potamogeton obtusifolius)* found in Mamie Lake 2017 point-intercept survey.

Figure 18. Small bladderwort (Utricularia *minor*) found on Mamie Lake 2017 point-intercept survey.

Figure 19. Spiral-fruited pondweed (*Potamogeton spirillus*) found in Mamie Lake 2017 point-intercept survey.

Figure 20. Pickerelweed (*Potenderia cordata*) found in Mamie Lake 2017 point-intercept survey.

Figure 21. Common bladderwort (*Utricularia vulgaris)* found in Mamie Lake 2017 point-intercept survey.

Figure 22. Large-leaf pondweed (*Potamogeton amplifolius*) found during Mamie Lake 2017 point-intercept survey.

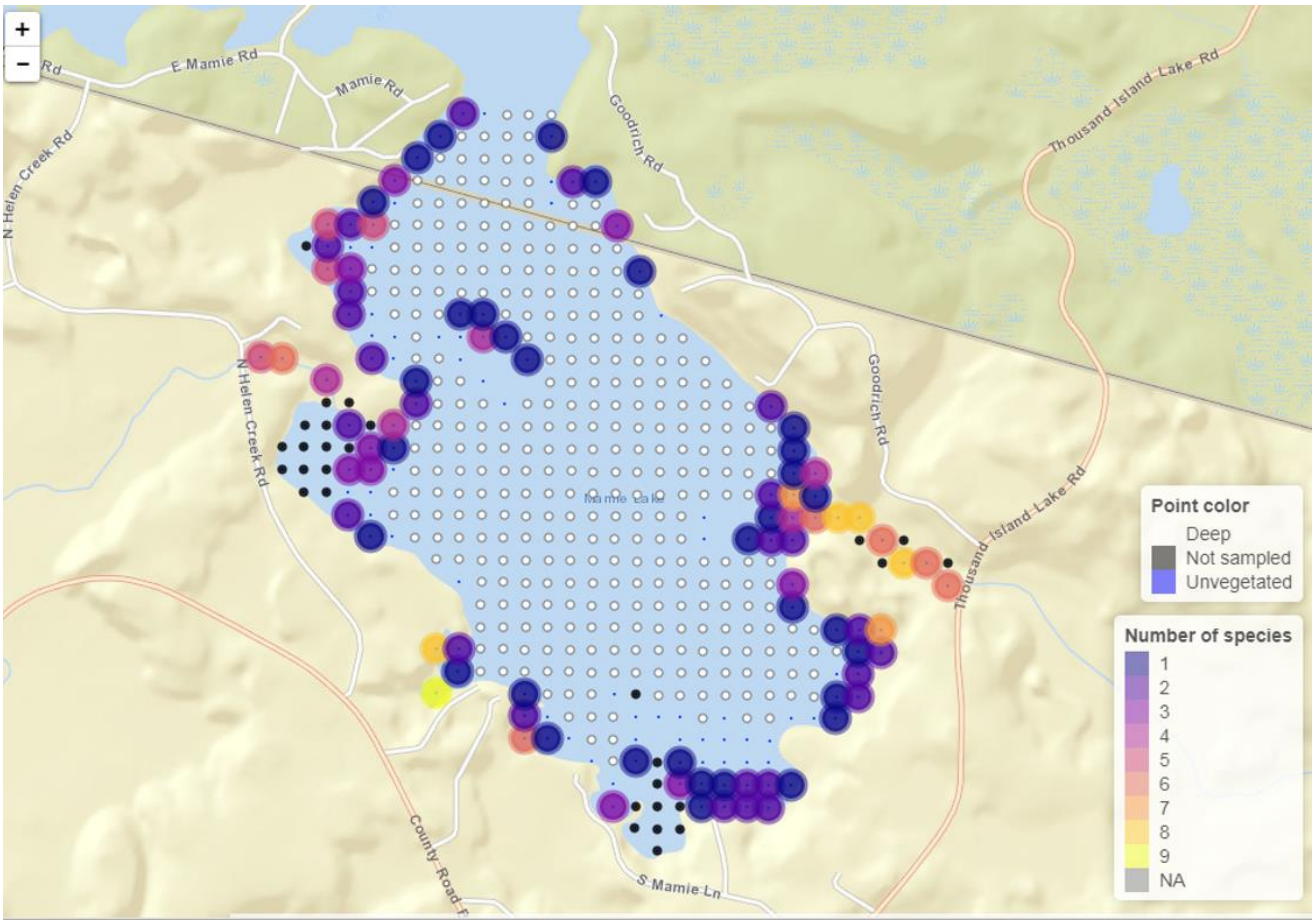


Figure 23. Mamie Lake species richness by sampling point. Map courtesy of WI DNR.

Appendix 4: Coarse Woody Habitat Map

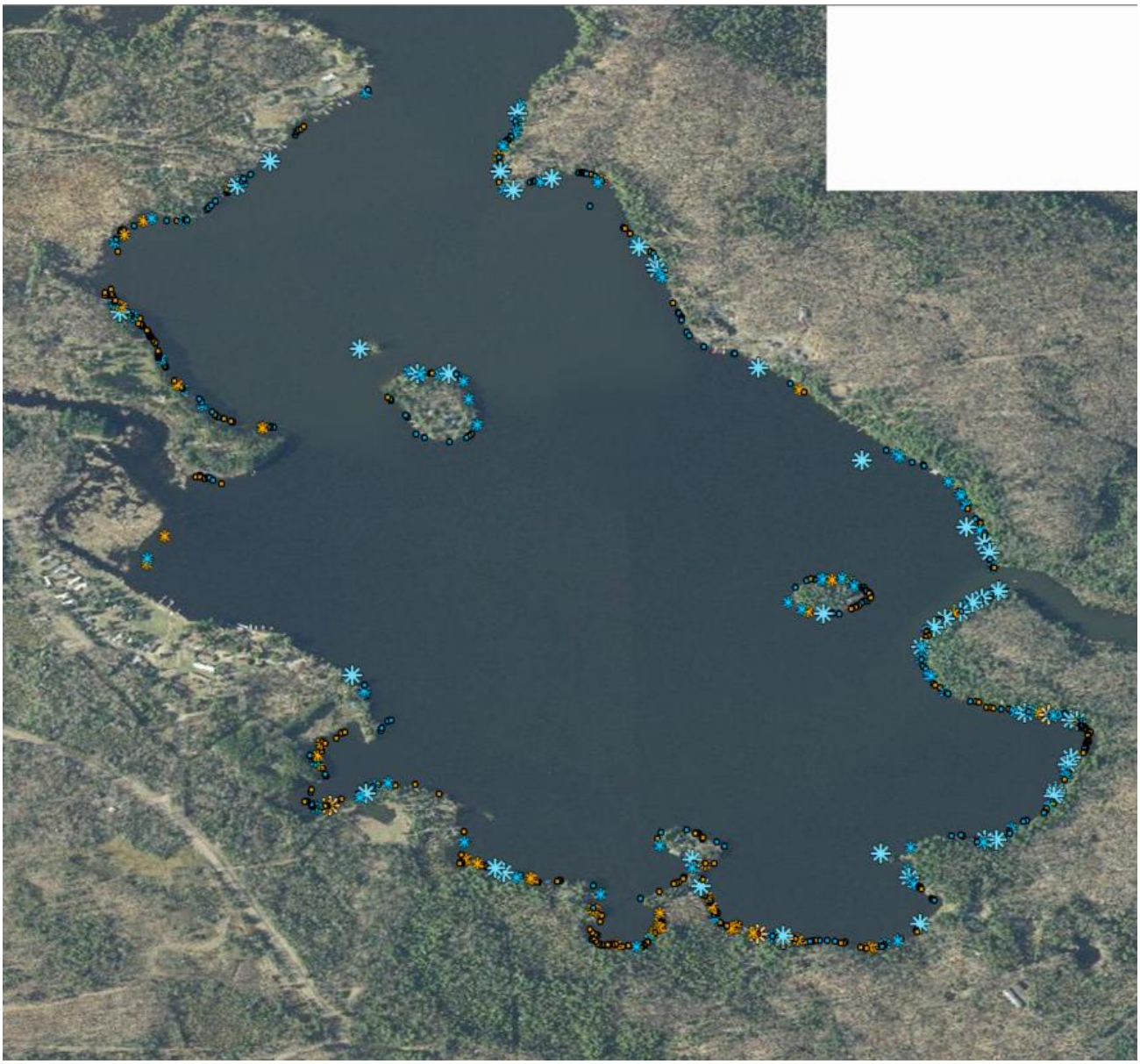


Figure 24. Coarse Woody Habitat Characterization for Mamie Lake, 2017. 148 logs/mile were documented.

Appendix 5: Shoreland Survey Maps

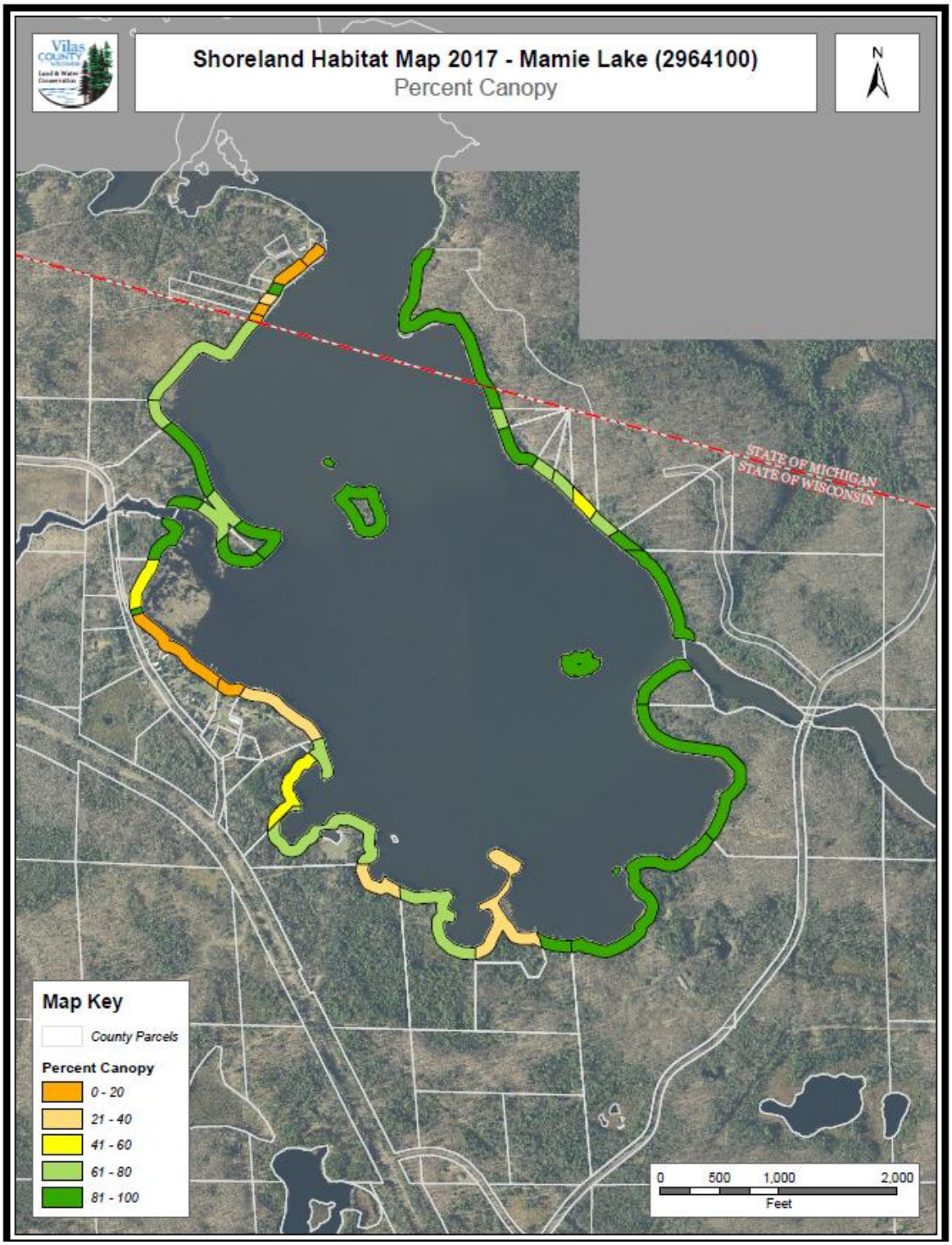


Figure 25. Canopy cover percent per parcel within 35 ft buffer area on Mamie Lake 2017.

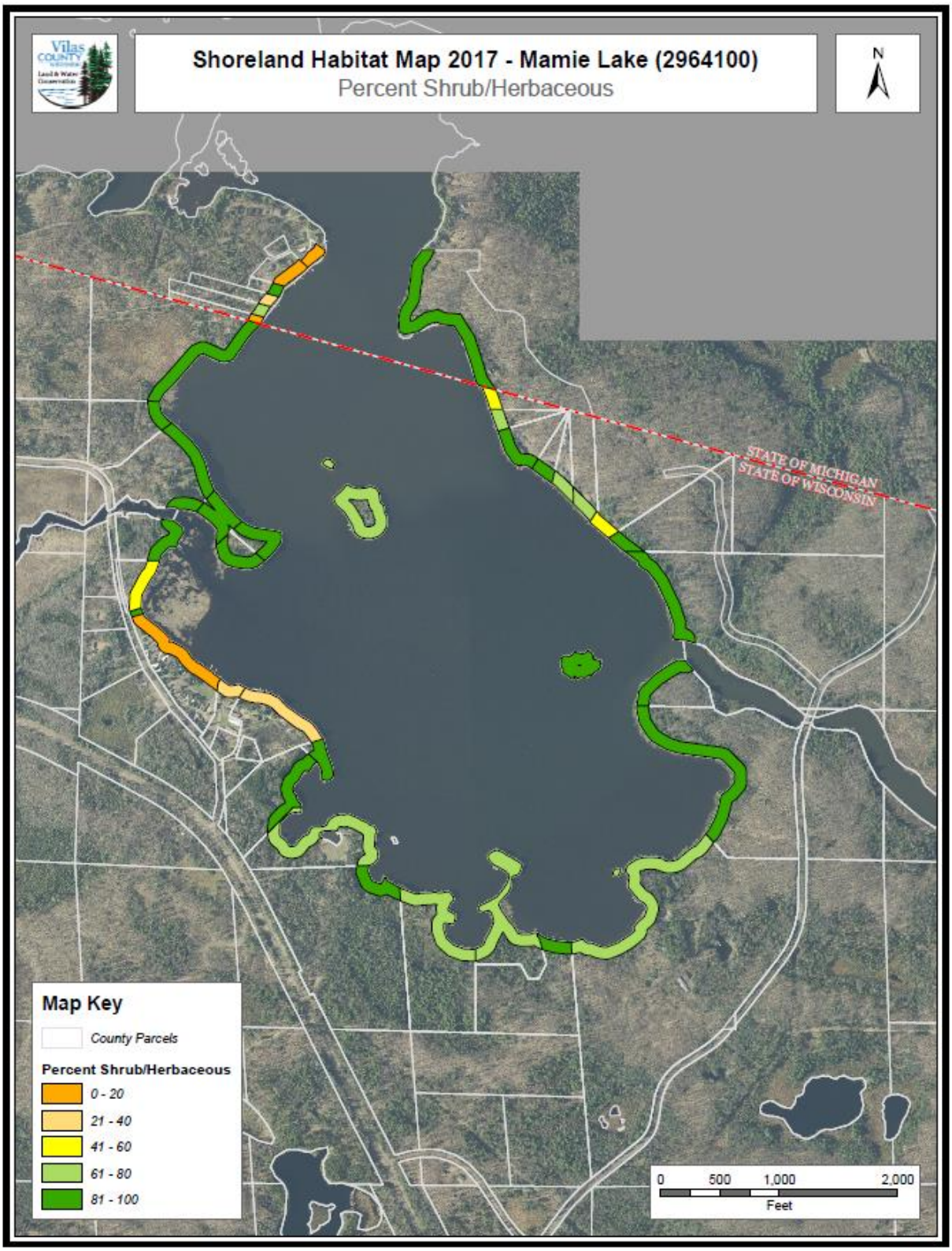


Figure 26. Percent shrub/herbaceous cover per parcel within 35 ft buffer area on Mamie Lake 2017.

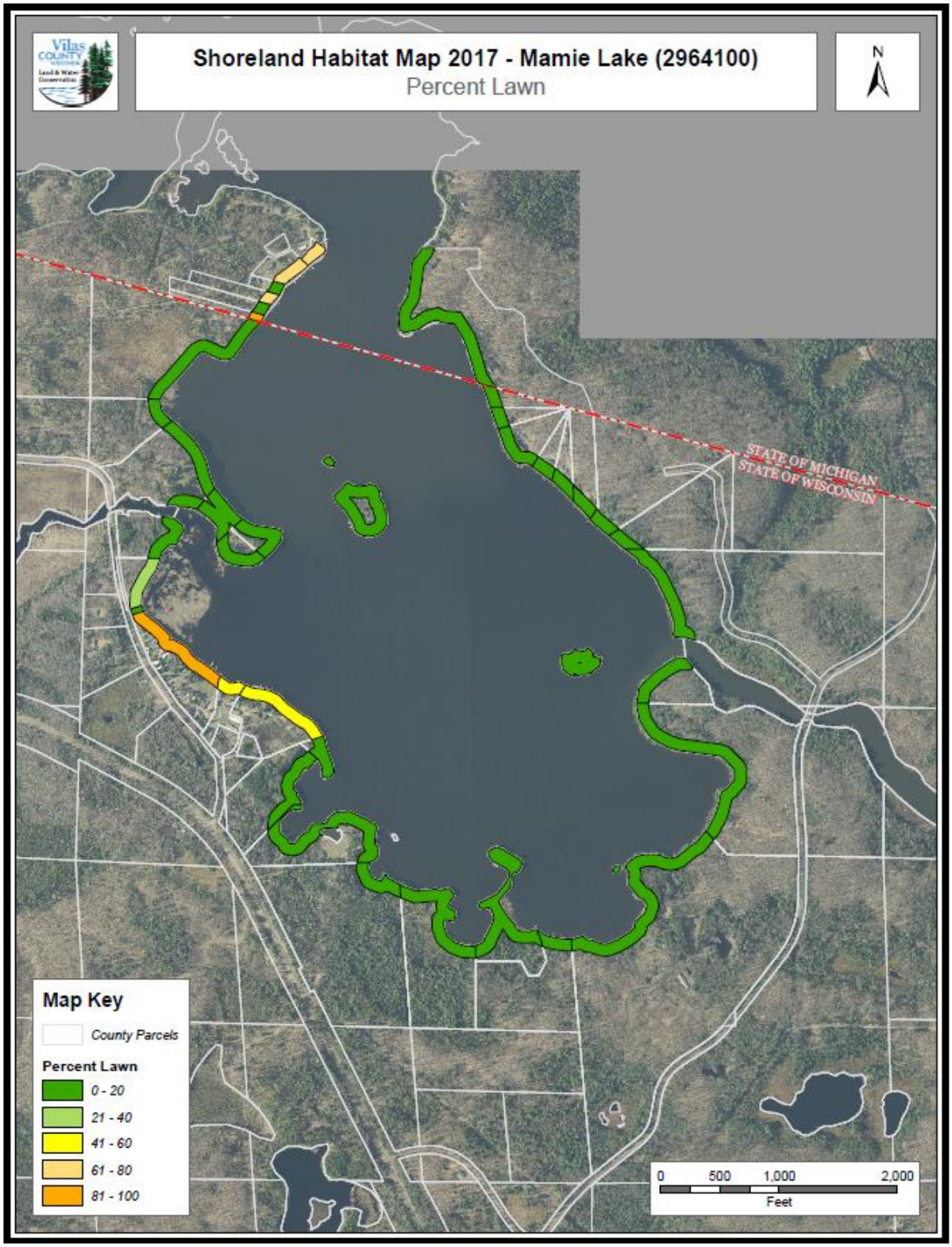


Figure 27. Percent lawn cover per parcel within 35 ft buffer area on Mamie Lake 2017.

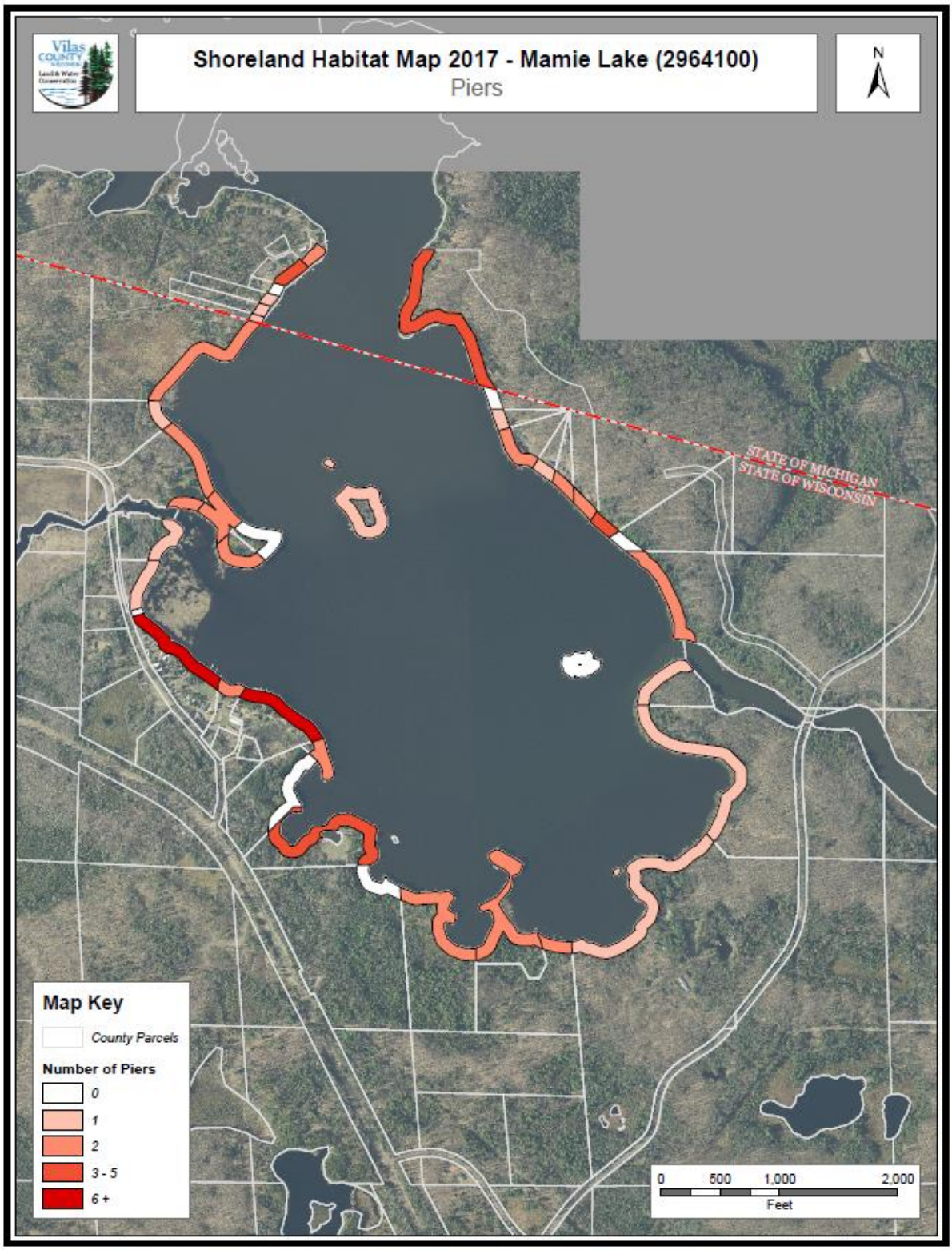


Figure 28. Piers per parcel on Mamie Lake 2017.

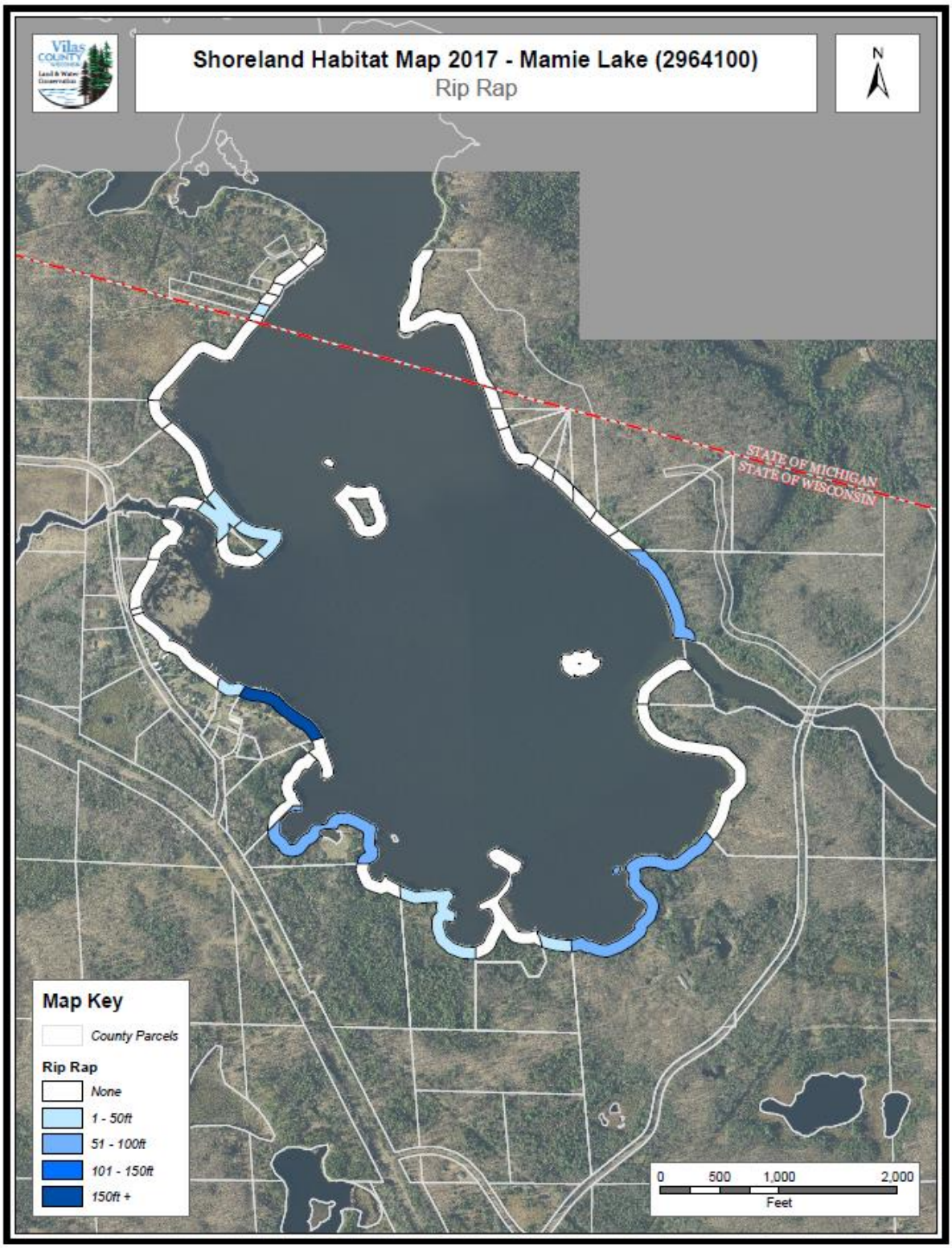


Figure 29. Riprap feet per parcel on Mamie Lake 2017.

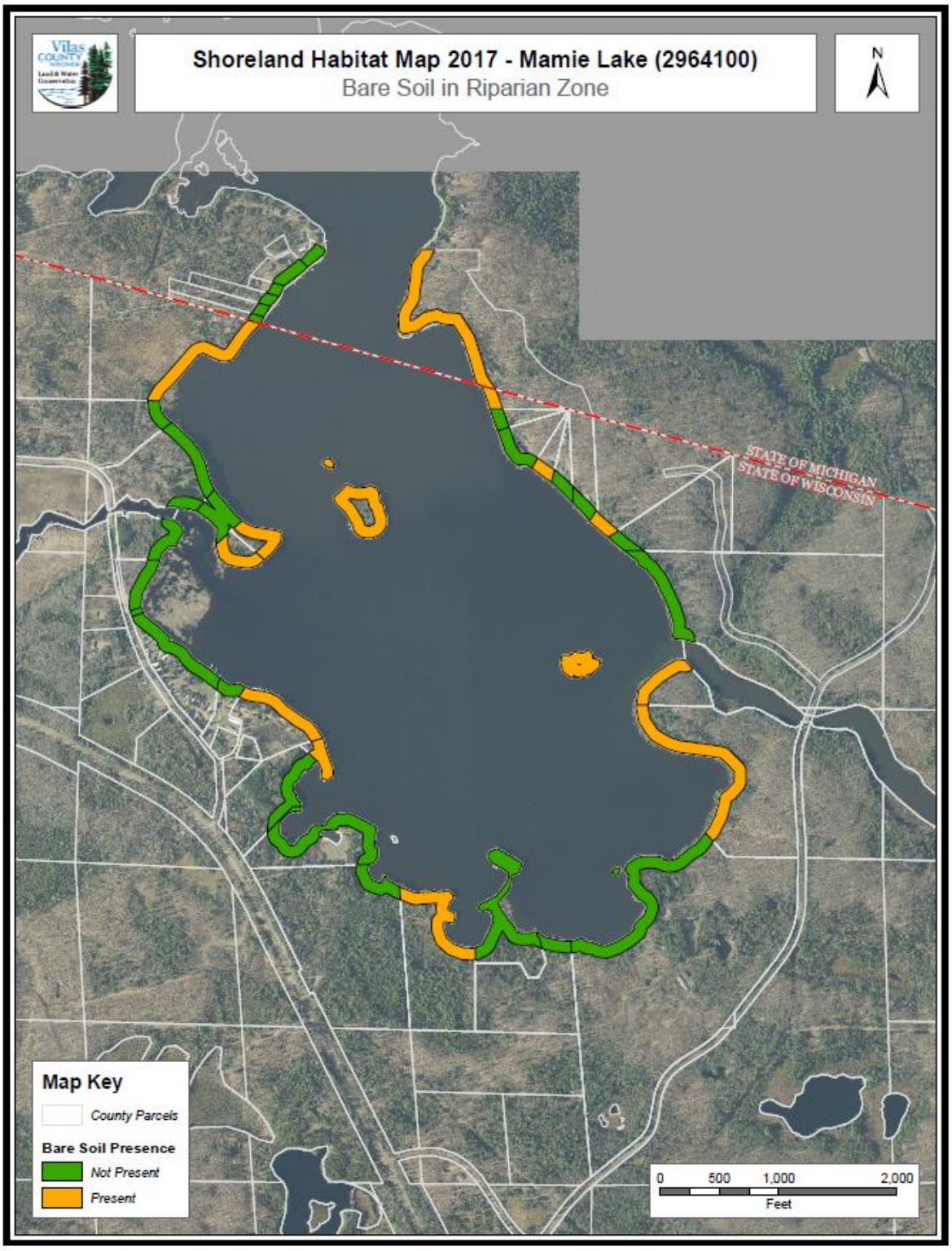


Figure 30. Parcels where bare soil is present on Mamie Lake 2017.

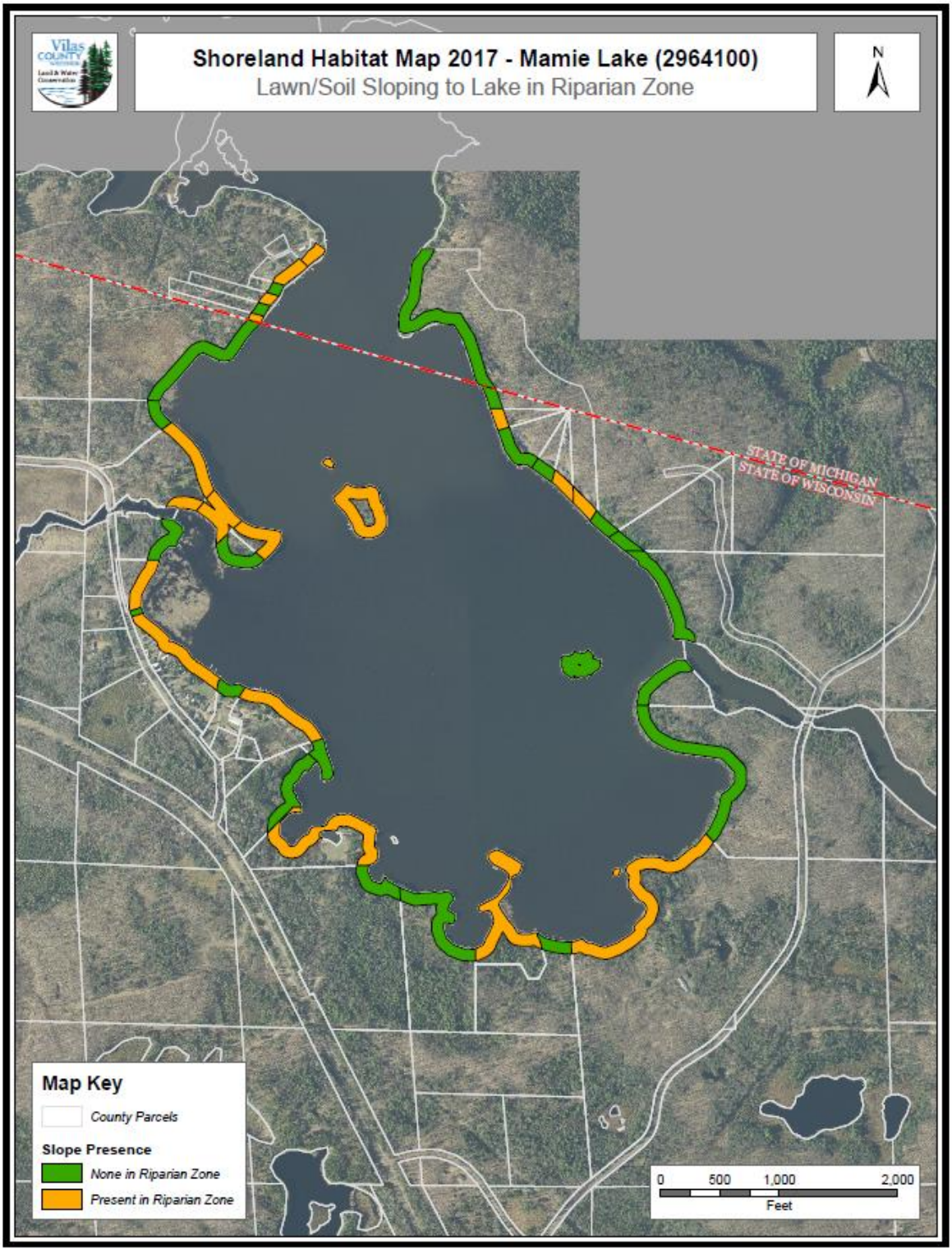


Figure 31. Parcels where lawn or soil slopes to lakes on Mamie Lake 2017.

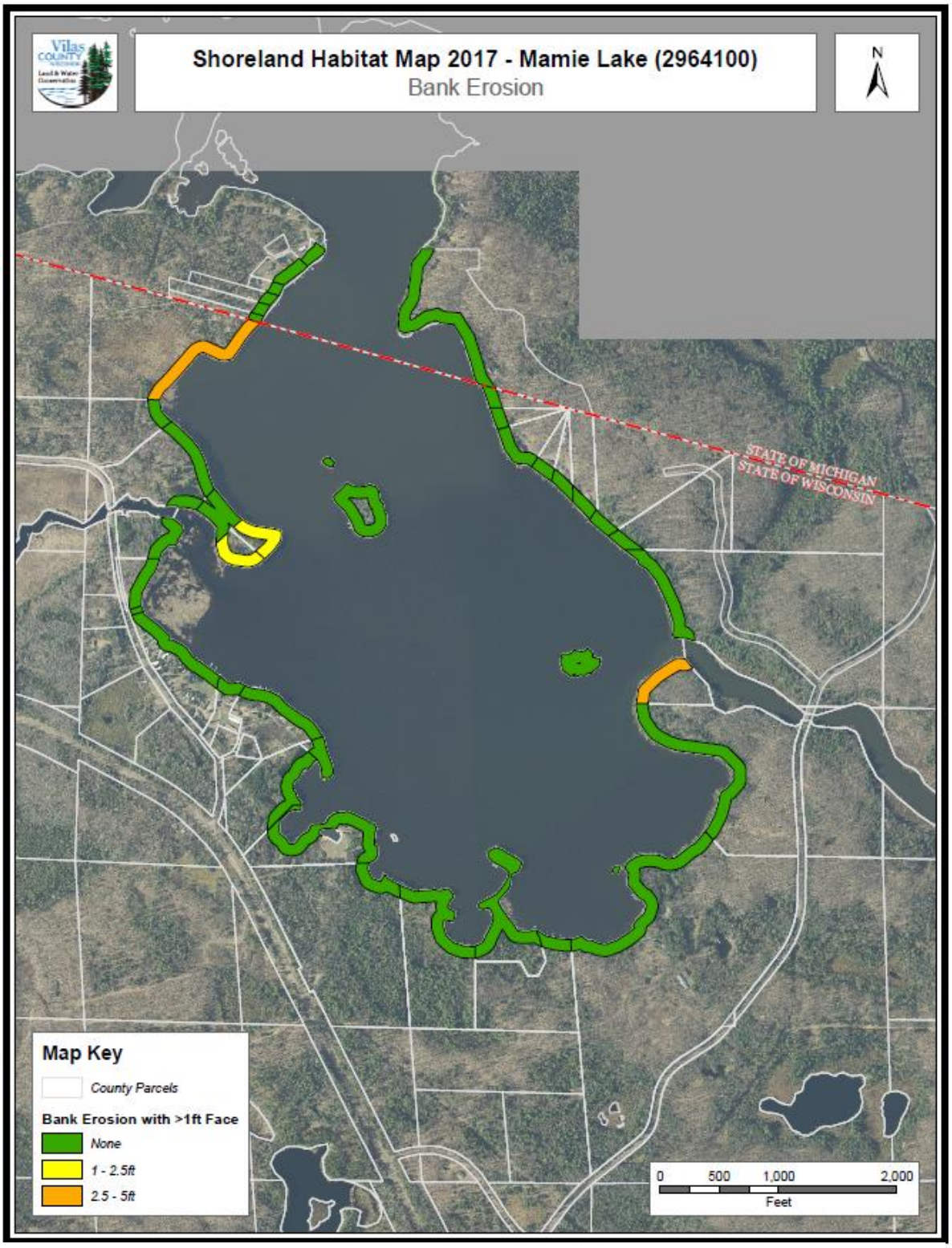


Figure 32. Shoreland length of bank erosion with >1 ft. face per parcel on Mamie Lake 2017.

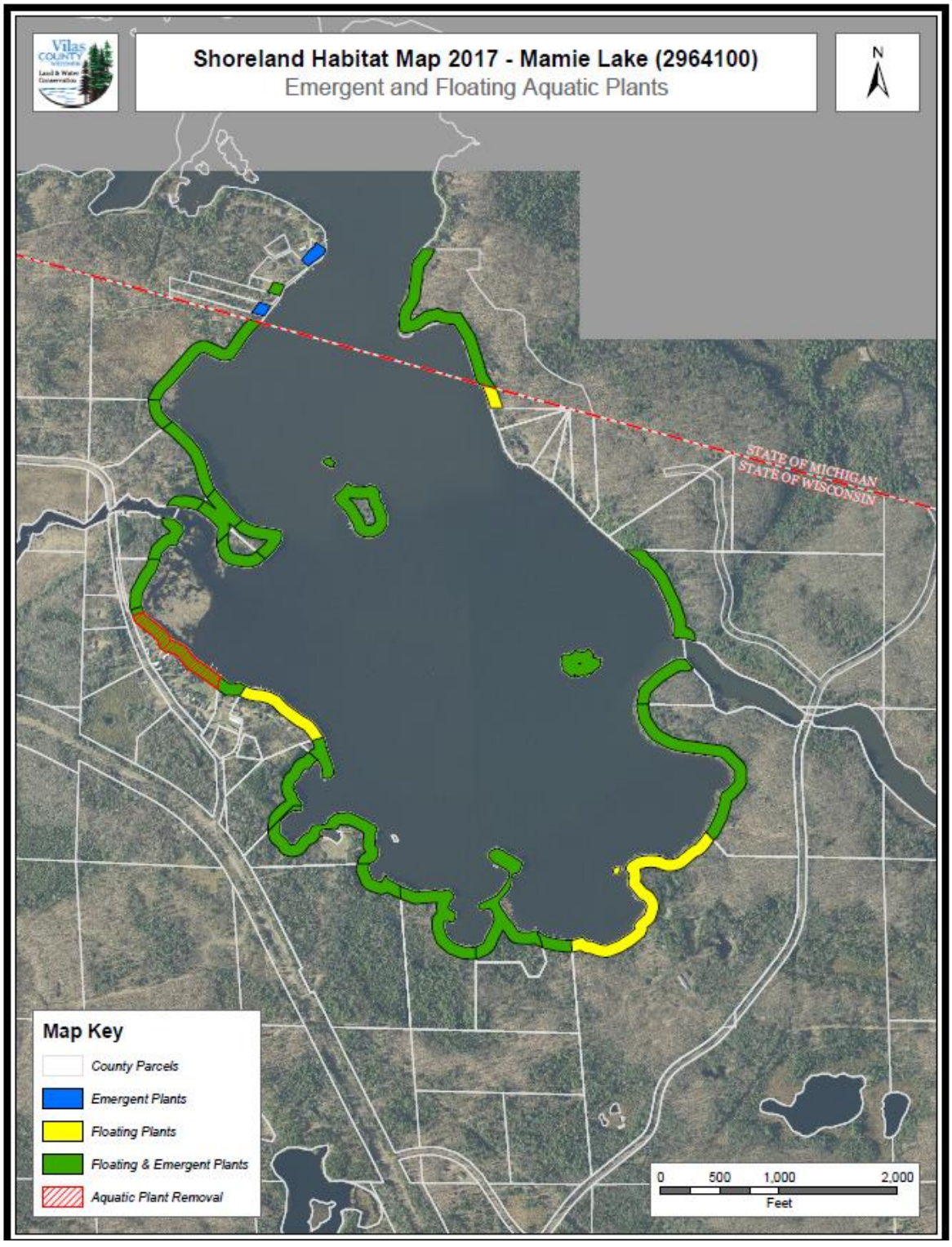
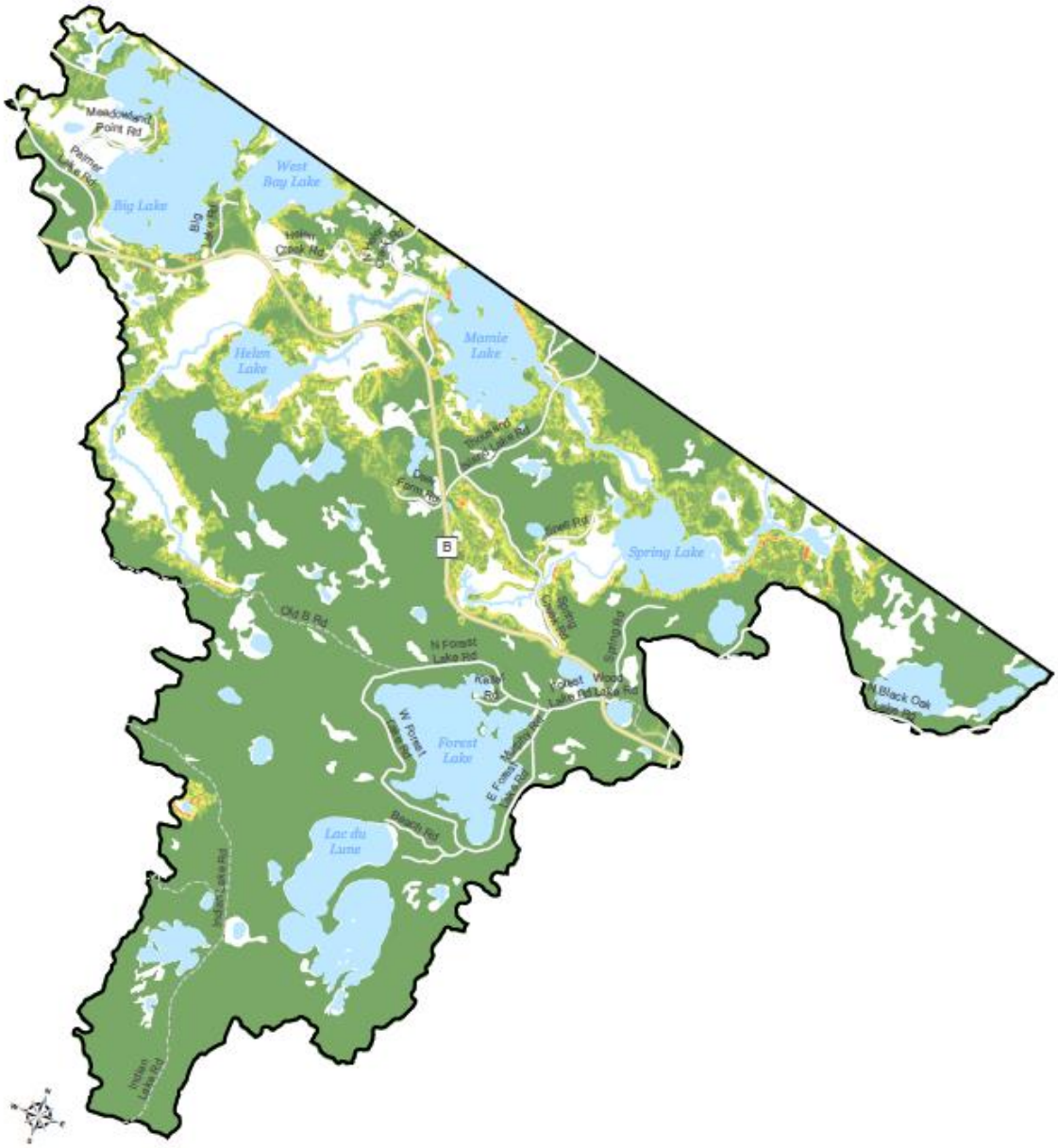


Figure 33. Emergent and floating aquatic plants and aquatic plant removal observations on Mamie Lake 2017.

Appendix 18: Erosion Susceptibility

Areas Most Susceptible to Sheet, Rill and Gully Erosion

Cisco Lake-Cisco Branch Ontonagon River Subwatershed (040201020101)



Erosion Vulnerability Index
shown with county-wide 0.2% clip

High : 64.4427

Low : -1.27307

Erosion vulnerability modeling performed using Wisconsin DNR EVAAL procedures and tools. Soils data from NRCS gSSURGO dataset; precipitation data from National Weather Service via EVAAL tool; Cropland Data from the National Agricultural Statistics Service, 2013-2017, using all available crop species. All EVAAL tools were run using high estimate data when applicable.

Map created 10/16/2018 by Vilas County Mapping Department