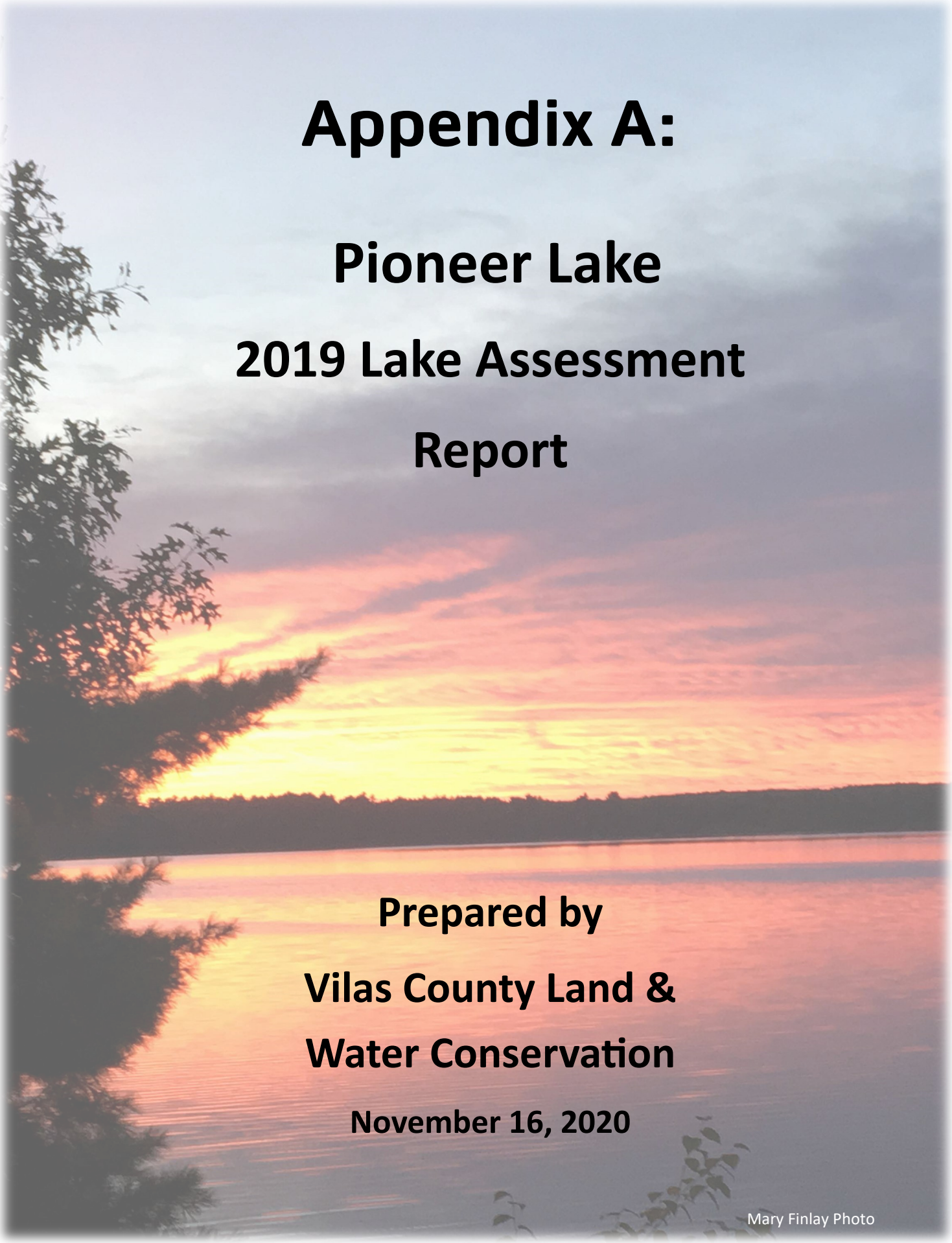

Appendix A:

Pioneer Lake

2019 Lake Assessment

Report

Prepared by

Vilas County Land &

Water Conservation

November 16, 2020

Mary Finlay Photo

Pioneer Lake
2019 Lake Assessment Report

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Assessment Type	Metric	Metric Context	Pioneer Lake Results
Water Quality	Total Phosphorus	FAL[1] & REC[2]: 40 ug/L in shallow lowland drainage lakes	19.43 ug/L average July-Sep 2019
	Chlorophyll a	FAL[1]: 27 ug/L in shallow lowland drainage lakes REC[2]: >20 ug/L more than 30% of days	9.65 ug/L average July-Sep 2019 >20 ug/L in 0 of 3 sampling events (0%)
Aquatic Plant Point-Intercept	Floristic Quality Index	24.3 median for Northern Lakes and Forest Lakes Ecoregion	29.24
	Average Value of Conservatism	6.7 median for Northern Lakes and Forest Lakes Ecoregion	6.38
Shoreland Habitat	Docks/Mile	>16 docks/mile density correlated with less fish diversity	25.20

Additional Data		
Water Quality	Secchi Depth	9.08 ft average
Aquatic Plant Point-Intercept Survey	Max Depth of Plants	14.0 ft
	FOO[3] shallower than max depth	86.78%
	Simpson's Diversity Index	0.90
	Rare Plants	Species is unverified - either Water-thread pondweed *Potamogeton diversifolius* or Vasey's pondweed *Potamogeton vaseyi* (both are considered rare plants)
AIS Early Detection	Previously Verified & **Newly Verified** AIS	Previously verified AIS: Chinese mystery snail **New AIS: Banded mystery snail; Narrow leaf cattail**
Shoreland Habitat	% Natural Cover	81%
	% Impervious	6%
	Parcels With Runoff Concerns	53 of 80 parcels (66%)
	Coarse Woody Habitat	46.49 logs/mile (anecdotally considered low)

[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.

Executive Summary

Pioneer Lake is shallow lowland 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. Potamogeton robbinsii (fern pondweed) was by far the most common aquatic plant in the lake, but a diverse mix of other native plants make up the remaining macrophyte aquatic plant community. The lake's floristic quality (29.24) is higher than average for the region (24.3), and its species richness (21) is well above the Northern Lakes and Forests regional average of 13. New aquatic invasive species (AIS) verified were banded mystery snails and narrow leaf cattail. Previously verified invasive species were Chinese mystery snails. While Eurasian watermilfoil was not found on Pioneer Lake, one rooted plant was found on the Twin River at the Monheim Rd. crossing. The coarse woody habitat survey resulted in 46.49 logs/mile of shoreline, which is anecdotally considered low. Most of the vegetative cover within the 35 ft. shoreland buffer area is natural (81%), however 6% is impervious and 13% is lawn. Pier density is at 25.2 docks/mile, which is much more than the 16.0 docks/mile threshold where negative impacts to fish diversity are seen. Additional littoral structures could add to this impact. Over 12% of the lake was riprapped, including areas that appear to be low energy sites. Highlighted recommendations include AIS monitoring, native plant monitoring, water quality monitoring, implementing shoreline conservation practices, increasing coarse woody habitat, and new property owner campaigns.

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. Pioneer Lake Map courtesy of Vilas County Online Mapping.

The purposes of the study of Pioneer Lake are to: 1) fill data gaps by collecting data; 2) identify any negative lake health issues for future focus; 3) assist the lake organization collect field data for their lake management plan. This data can also be used by the Vilas County Land & Water Conservation Department in the future with its planned watershed assessments.

Pioneer Lake is a 429 acre Shallow Lowland Drainage Lake located in the Town of Conover in Vilas County. Pioneer Lake's maximum depth is 27 feet and is made up of 30% sand, 10% gravel, 5% rock, and 55% muck (*Pioneer Lake*). There is a forked inlet on the east side, the Twin River, which drains South Twin Lake. Pioneer Creek outlets on the west side of Pioneer Lake and connects to the Wisconsin River. A dam

operated by the Wisconsin Valley Improvement Company exists on the Twin River at South Twin Lake, upstream of Pioneer Lake. The lake is primarily forested with wetlands around the inlets and outlet.

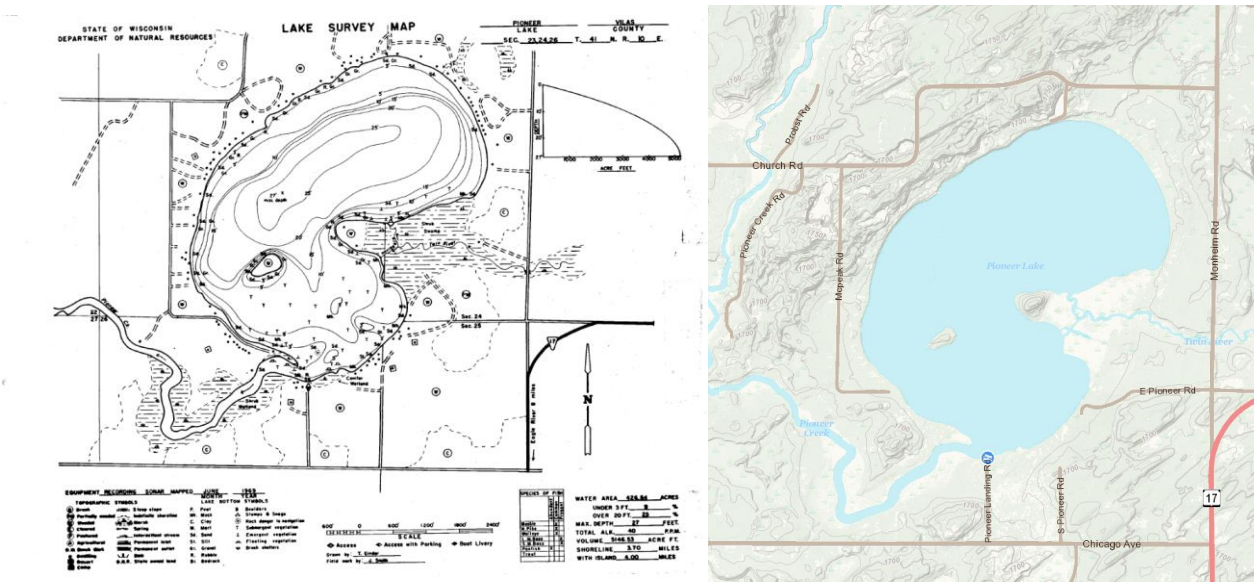


Figure 2. On left Pioneer Lake bathymetry map courtesy of WI DNR; and on right Pioneer Lake area topography map image courtesy of Vilas County Online Mapping.

A bathymetry map shows the area south of the island is shallow, while north of the island, the lake gets much deeper. A topographic map shows most of the area around the lake is fairly flat. However, there are some steep shores on the northwestern side of the lake.

Apart from the boat launch area, there is no public land on the lakeshore and most parcels are developed. The ground cover is primarily forests and wetland. Seelyeville and Markey mucks predominate the inlet and outlet areas and are indicative of wetlands. Other predominant surrounding soils are sandy soils with slopes ranging from 0-35%: primarily Sayner-Rubicon Complex (SaC & SaD), Rubicon Sand (RoB), and Croswell sand CrA. The steeper soils (SaC and SaD) are located on the northwest side of the lake (*Web Soil Survey*).

Figure 3. Soils of Pioneer Lake. Seelyeville and Markey mucks (Se), Sayner-Rubicon complex (SaC &SaD), Rubicon sand (RoB), Croswell sand (CrA), and predominate the riparian area. Courtesy Soil Web Survey, NRCS.

Pioneer Lake is represented by the Pioneer Lake Association. The Pioneer Lake Association has been active in the past in response to property damage from high water, especially in 2017. They will be using the data from this plan to create a lake management plan with their lake consultant. The Pioneer Lake Association has also been active with the newly formed Conover Town Lakes Committee.

Results and Discussion

Note – See Appendix 1 for Methods

Water Quality

Pioneer Lake is a 439 acre and 27 ft deep "shallow lowland drainage lake". Water quality assessments reference WisCALM Shallow Lowland Drainage Lake criteria. It is listed on the 2018 Impaired Waters list for mercury contaminated fish tissue. This listing occurred in 1998. However, this report does not address this listing as it is likely from atmospheric deposition.

The total phosphorus criteria for fish & aquatic life and recreation for shallow lowland drainage lakes is 40 ug/L. The total phosphorus sampled on Pioneer Lake did not exceed the criteria on any of the 3 sampling events in 2019. The mean total phosphorus reading from the 3 sampling events in 2019 was 19.43 ug/L, with a minimum reading of 17.4 ug/L and a maximum reading of 22.3 ug/L.

The chlorophyll a criterion for Fish and Aquatic Life for shallow lowland drainage lakes is 27 ug/L and for Recreation is 30% of days where chlorophyll a is >20 ug/L. The chlorophyll a results from 3 sampling events in 2019 averaged to be 9.65 ug/L, with a minimum reading of 4.65 ug/L and a maximum reading of 14.4 ug/L. These figures never exceed 20 ug/L chlorophyll a (0% of days).

Nitrogen data was collected as Nitrate + Nitrite and Total Kjeldahl Nitrogen. Nitrate + Nitrite are inorganic forms of nitrogen. Total Kjeldahl Nitrogen (TKN) measures organic nitrogen as well as ammonia (also inorganic). Combining these values gives a total Nitrogen measure for the lake. In Pioneer Lake, Nitrate + Nitrite were not detected. TKN measured 0.469 mg/L, so Total Nitrogen is also 0.469 mg/L.

The Total Nitrogen results can be compared to the Total Phosphorus results to determine which nutrient limits plant and algae growth in the lake. Ratios of N:P of <10:1 indicate a lake is nitrogen limited; between 10:1 – 15:1 indicate a transitional lake; and > 15:1 indicate a phosphorus limited lake (Shaw et.al.). Using the average 2019 total phosphorus value Pioneer Lake's N:P ratio is 24:1, so Pioneer Lake is phosphorus limited. This means that inputs of phosphorus (soil erosion, garden fertilizers, etc.) would be likely increase production of plant and algae growth.

Water in Pioneer Lake was reported brown & clear in July & Sep; and blue & clear in July. Secchi depths averaged 9.08 ft, and is indicative of good water quality. The pH (8.22) indicated slightly basic (vs. acidic) water. Alkalinity (39.7 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 (10.3 mg/L) as is the conductivity (102 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 Pioneer Lake was stratified in July and August, and mixed in September. "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 in the epilimnion in July (18 ft) & August (15 ft), and in September when the lake was not stratified the entire water column had more than 5 mg/L. 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 1-13, 2019. Of the 437 point-intercept (PI) locations, 252 were visited – see Appendix 3 Figure 24. Those that were not visited were skipped because either they were too deep or a dock blocked access.

Table 1. Pioneer Lake 2019 Aquatic Plant Point-Intercept Statistics. Values sourced from UW-Extension Lakes Aquatic Plant Survey Data Workbook formulas.

Pioneer Lake 2019 Point-Intercept Summary

Total number of sites visited	**252**
Total number of sites with vegetation	**210**
Total number of sites shallower than maximum depth of plants	**242**
Frequency of occurrence at sites shallower than maximum depth of plants	**86.78**
Simpson Diversity Index	**0.90**
Maximum depth of plants (ft.)**	**14.00**
Number of sites sampled using rake on Rope (R)	**1**
Number of sites sampled using rake on Pole (P)	**251**
Average number of all species per site (shallower than max depth)	**2.49**
Average number of all species per site (veg. sites only)	**2.87**
Average number of native species per site (shallower than max depth)	**2.49**
Average number of native species per site (veg. sites only)	**2.87**
Species Richness	**21**
Species Richness (including visuals)	**24**
Floristic Quality Index	**29.24**
Average Value of Conservatism	**6.38**

A *Potamogeton* species was found that could not be Identified to species, but is either *Potamogeton diversifolius* (water-thread pondweed) or *Potamogeton vaseyi* (Vasey's pondweed) (Freckmann). Both are considered rare plants and are listed as Special Concern by DNR Natural Heritage Inventory (*Wisconsin's Rare Plants*). To identify this to species, another specimen is needed. See Appendix 3 for photos of highlighted plants.

The Species Richness for Pioneer Lake is 21. This figure includes only those species collected with the rake, and does not include visual sightings. Pioneer Lake has 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 Pioneer Lake of 6.38 is just lower than the Northern Lakes and Forest Lakes Ecoregion average of 6.7, but is just greater than the state of Wisconsin average of 6.0 (Nichols). This shows that there are just below average quality types of plants that represent the region in Pioneer Lake.

The Floristic Quality Index weighs both the species richness and the average value of Conservatism. The Floristic Quality for Pioneer Lake is 29.24. This value is 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 Pioneer Lake is 0.90. This indicates an above average number of species and more even distribution of those species in Pioneer Lake compared with other lakes in the Northern Lakes and Forest Lakes Ecoregion (where 0 = no diversity and 1 = infinite diversity).

Table 2. Pioneer Lake 2019 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
Potamogeton robbinsii	Fern pondweed	8	47.11%
Vallisneria americana	Water celery	6	34.71%
Potamogeton zosteriformis	Flat-stem pondweed	6	26.86%
Potamogeton pusillis	Small pondweed	7	21.49%
Myriophyllum sibericum	Northern water-milfoil	6	16.94%
Elodea canadensis	Common waterweed	3	15.29%
Najas flexilis	Slender naiad	6	14.88%
Ceratophyllum demersum	Coontail	3	12.40%
Potamogeton gramineus	Variable pondweed	7	11.98%
Potamogeton amplifolius	Large-leaf pondweed	7	10.74%
Potamogeton richardsonii	Clasping-leaf pondweed	5	10.74%

Of the plant species found, Fern pondweed (*Potamogeton robbinsii,)* Water celery (*Vallisneria americana)*, Flat-stem pondweed *(Potamogeton zosteriformis)*, and Small pondweed (*Potamogeton pusillis*) were the most prevalent. See Table 2.

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. Pioneer Lake 2019 Aquatic Plant Point-Intercept Additional Species Visually Encountered

Species – Visuals	Common Name
Nymphaea odorata	White water lily
Schoenoplectus tabernaemontani	Softstem bulrush
Sparganium eurocarpus	Common bur-reed

A few additional native species were found on Pioneer Lake that were not associated with a sampling point. *Ceratophyllum echinatum* (Spiny hornwort); *Nuphar variegata* (Spatterdock); *Potamogeton epihydrus* (Ribbon-leaf pondweed); and *Persicaria amphibia* (Water smartweed) were found near the north outlet of the Twin River. *Brasenia schreberi* (Watershield) was found near the boat launch.

Of all the sampling points on Pioneer Lake, the most species rich areas occurred in 6 areas: northwest of the Pioneer Creek; the northwest side of the island; the west shore between Pine Log Drive and Toboggan Trail; near the north outlet of Twin River; near the south outlet of the Twin River; and just east of the boat launch. See Appendix 3 Figure 34.

Total Rake Fullness is a measure of how dense plant material grows at a particular sampling point. A double headed rake is used to sample points and the amount of plant material on the rake is recorded from 1 (a few plants) to 3 (rake tines are completely covered with plants). Pioneer Lake averaged 1.61 aquatic plant density where plants were found. Many points south of the island had dense plant growth – 29 points within that area had a Total Rake Fullness of 3. These plants were all native species; however, when these plants are growing in shallow water boaters may find this less desirable particularly in the lake's southeastern bay where there is shallow water and dense plant growth. Note that the Twin River's south outlet, near this bay, is an area of greater species richness for the lake.

For Pioneer 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: *Bidens beckii, Ceratophyllum demersum, Ceratophyllum echinatum, Chara braunii, Chara contraria, Eleocharis acicularis, Elodea canadensis, Heteranthera dubia, Isoetes echinospora, Myriophyllum sibericum, Najas flexilis, Nymphaea odorata, Nuphar variegata, Persicaria amphibia, Potamogeton amplifolius, Potamogeton epihydrus, Potamogeton friesii, Potamogeton gramineus, Potamogeton illinoensis, Potamogeton praelongus, Potamogeton pusillis, Potamogeton richardsonii, Potamogeton robbinsii, Potamogeton zosteriformis, Sagittaria cuneata, Schoenoplectus tabernaemontani, Sparganium eurycarpum, Typha angustifolia,* and *Utricularia vulgaris.* Plants that were not housed at the UW- Stevens Point Herbarium were *Brasenia schreberi, Vallisneria americana* and *Potamogeton sp.* (either *P. diversifolius* or *P.* vaseyi).

AIS Early Detection Survey

On July 8, 2019, the AIS Early Detection Survey was completed. Targeted sites included: the public boat landing; the outlet to Pioneer Creek; the Maple View Resort shoreline; the north side of the island; the shoreline near the church; and both the north and south inlets from the Twin River. A meander survey around the perimeter of the lake was conducted. The water had good visibility, so the sites were snorkeled. Previous to this survey, only invasive Chinese mystery snails were known to be in Pioneer Lake. Multiple species were searched for (see Methods section in Appendix 1 for species list), and 2 new AIS were found that were not previously listed: Narrow leaf cattail (*Typha angustifolia)* (Freckmann) and Banded mystery snails (*Viviparus georgianus)* (Wirt). Previously verified Chinese mystery snails were also found during the survey. Yellow iris is suspected on the northeast shoreline just north of Bauer Lane, but cannot be verified because it was not flowering at the time of the survey – native blue flag iris can look quite similar. Several crayfish were found living in the rocky substrate near the island. A sample was collected, and verified as a native Northern Clearwater Crayfish (*Orconectes propinquus).* Invasive Eurasian watermilfoil (*Myriophyllum spicatum)* was found and verified on the downstream side of the Twin River – Monheim Rd crossing. No other AIS are listed as "Observed" in the DNR's lakes pages listing for Pioneer Lake.

Figure 4. Native Northern Clearwater crayfish found on Pioneer Lake.

Figure 5. Example photo of invasive yellow iris. This plant is suspected but not verified on Pioneer Lake. Photo courtesy of Oneida County Land & Water Conservation.

To detect reproducing zebra mussels in the lake, veliger (juvenile mussels) tows were done July 8, 2019. Zebra mussel veligers were not detected. (Wirt 2020).

A sediment sample was taken on August 8, 2019 and analyzed by the State Lab of Hygiene for spiny waterfleas. Spiny waterfleas were not detected (Wirt 2020).

Figure 6. Verified invasives of Pioneer Lake and nearby Twin River (clockwise from top left): narrow leaf cattail area on Pioneer Lake; narrow-leaf cattail flower; Chinese mystery snail photo courtesy of Amy Benson; USGS, Banded mystery snail; and Eurasian water-milfoil found on the Twin River-Monheim Rd. crossing.

A suspicious floating leaf fragment was found during the aquatic plant point-intercept survey. The UW-Stevens Point Herbarium staff suspected invasive yellow floating heart and sent it for genetic testing. The specimen was actually a native spatterdock *Nuphar variegata* (Wirt).

Due to the verified Eurasian watermilfoil in the Twin River, the suspected yellow floating heart, and narrow leaf cattail, AIS Early Detection Sampling was repeated in summer 2020 on Pioneer Lake, the Twin River up to the Monheim Rd. crossing, and on Pioneer Creek down to the obstacle located about ¾ of the way to the Church Rd. crossing. No new AIS were detected. Dredge samples for spiny waterfleas and plankton tows for zebra mussel veligers were also repeated in 2020 but results are not yet available.

Invasive yellow iris is suspected but not verified on Pioneer Lake. A flower is needed to differentiate invasive yellow iris from native blue flag iris. It would be recommended for residents of Pioneer Lake to be watchful of Yellow Iris on their shorelines during late May to early June when blooms – see Figure 5.

Coarse Woody Habitat

Coarse woody habitat was mapped on May 16, 2019 when the water was clear and easy to detect submerged logs. 192 logs were counted between the ordinary high water mark and the 2 ft depth contour along the 4.13 miles of shoreline, giving the density of 46.49 logs/mile of shoreline – see Appendix 4.

77 logs (40%) crossed the ordinary high water mark, providing a habitat "bridge" between the water and land. 12 logs (6%) were submerged with the full tree crown, providing more complex structure to the Coarse Woody Habitat.

The rate of 46.49 logs/miles is considered low. Riparians that are interested in increasing wood in the lake should work with either Vilas County Land & Water Conservation or the DNR Fisheries Biologist for recommendations.

Shoreline Assessment

The shoreline of Pioneer Lake consists of 80 privately owned parcels. Within the 35 ft. buffer zone, 61% of the area was covered by a canopy (trees taller than 16 ft.). In many cases, parcels with lower canopy

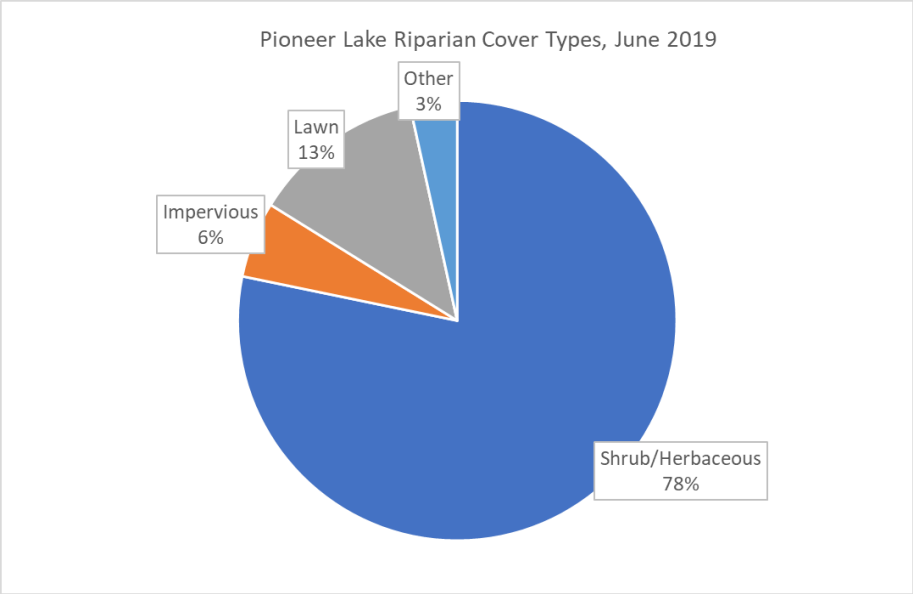


Figure 7. Ground cover type in Riparian Buffer Area (35 ft. inland from shore) on Pioneer Lake, 2019.

percentages correlated with higher percentages of lawn, however; the wetland area at the Twin River outlet naturally has very little canopy. See Figure 37 for a map of percent canopy cover.

Lake-wide, 78% of the riparian area (35 ft. inland from ordinary high water mark) was covered by a shrub-herbaceous layer. Lawn made up 13% of the riparian area, and impervious surfaces made up 6%. 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. Pioneer Lake exceeds this statistic having 78% covered with shrub/herbaceous cover.

Figure 8. Dock density on Pioneer Lake was fairly high at 25.20 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).

Several human structures or modifications were noted in the Riparian and Littoral Zones. See Figure 12 for Human Structures in Riparian Buffer and Littoral Zones Charts.

Figure 9. 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.

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 Pioneer Lake, piers were the most common structure. Ten docks or less per kilometer (16 docks/mile) of shoreline, as a reflection of shoreline development, has been shown to be a threshold of maintaining high quality fish diversity in Minnesota (Jacobsen et. al). Pioneer Lake's pier density was 25.20 docks/mile of shoreline, much more than the suggested threshold. Additional littoral

structures such as boat lifts, swim rafts, etc. would intuitively seem to add to this stress. Other major categories for structure density were: boats on shore (18.90/mile); boat lifts (12.60/mile); buildings (5.57/mile); and other riparian structures (5.57/mile).

Within the Bank Zone, several parcels had human modifications of riprap, other erosion control structures, or artificial beaches. 465 ft. of artificial beaches was documented. Some parcels had bank erosion with a greater than 1 ft. face (more than 1 foot vertical face of bank is eroded for a certain length of shoreline). Shoreland length of these human modifications and bank erosion appear in Figure 17. Notice that over 2,700 ft. (over 12%) of the shoreline of Pioneer Lake is rock riprapped. While riprap can protect shorelines from erosion resulting from wave and wake energy, some energy will be transferred to the edges of the non-riprapped areas and lake bottom, resulting in possible erosion on adjacent shorelines and lake bottom (Basco). See Figures 10 and 11.

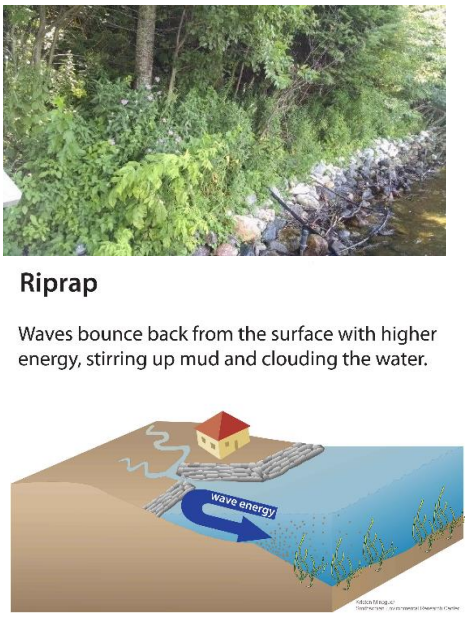


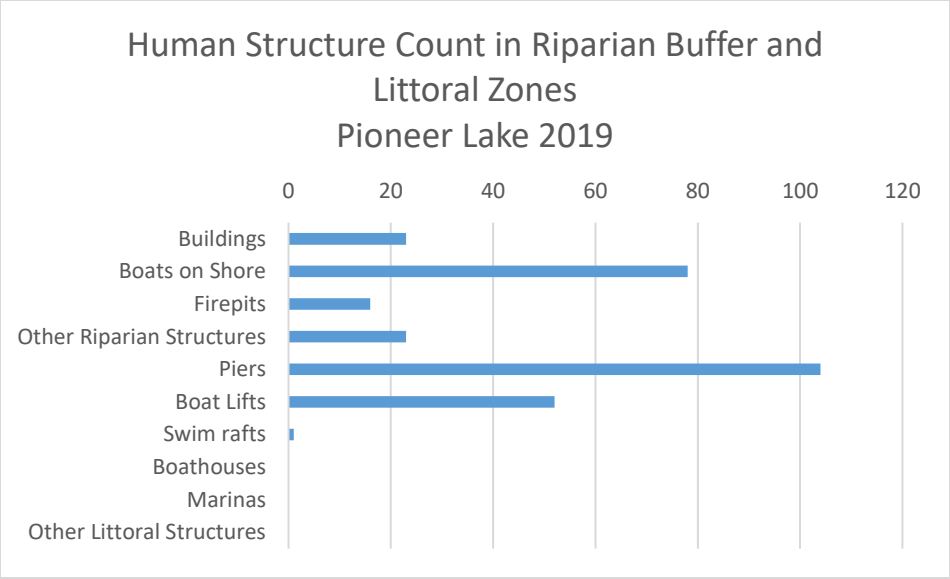
Figure 10. Top: Rock riprap photo. Bottom: Wave energy is "bounced" or transferred from riprap to adjacent shoreline and lake bottom. While the armored section is protected, the adjacent shoreline and lake bottom are now the target of higher wave energy, making them further susceptible to erosion. Kristen Minogue, Smithsonian Environmental Research Center.

Several runoff and erosion concerns were documented within the riparian area: 36 parcels had areas of lawn or soil sloping to the lake; 34 parcels had a straight stairs/trail/road to the lake; 24 parcels had bare soil (not sloping); and 2 parcels contained a point source (pipe draining directly into the lake). See Figure 13 for Number of Parcels with Erosion or Runoff Concerns.

Emergent or floating plants were observed in the littoral zone adjacent to 13 of the 80 parcels. There was no evidence of aquatic plant removal on Pioneer Lake.

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 11. Bank erosion on Pioneer Lake likely caused by flank erosion from the adjacent riprapped area.



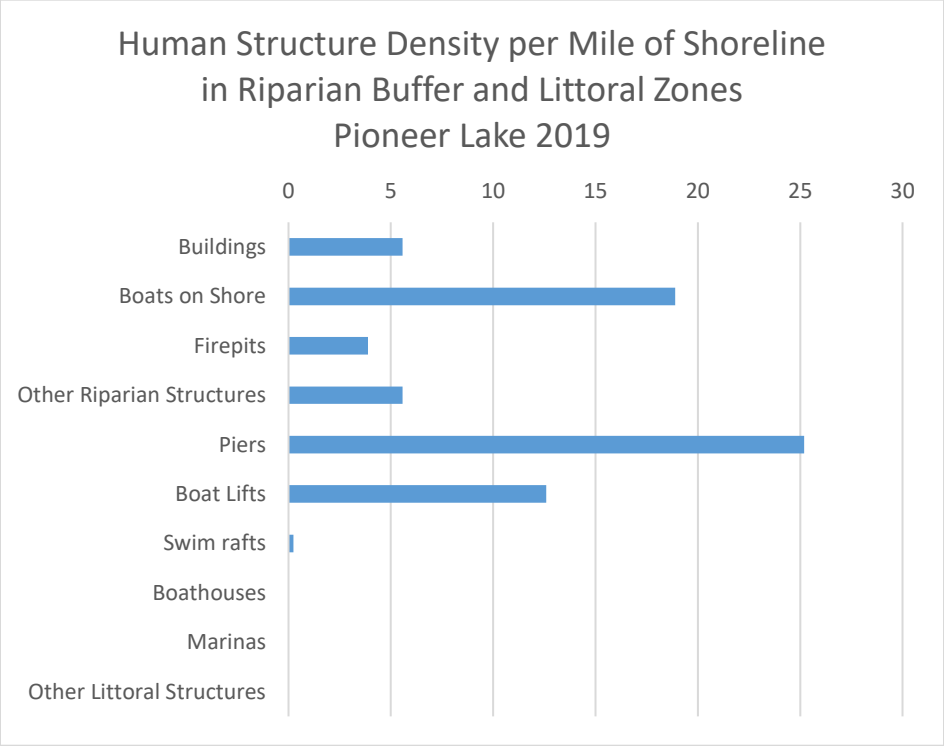


Figure 12. Number and density per mile of shoreline of human structures documented in the Riparian Buffer and Littoral Zones on Pioneer Lake 2019.

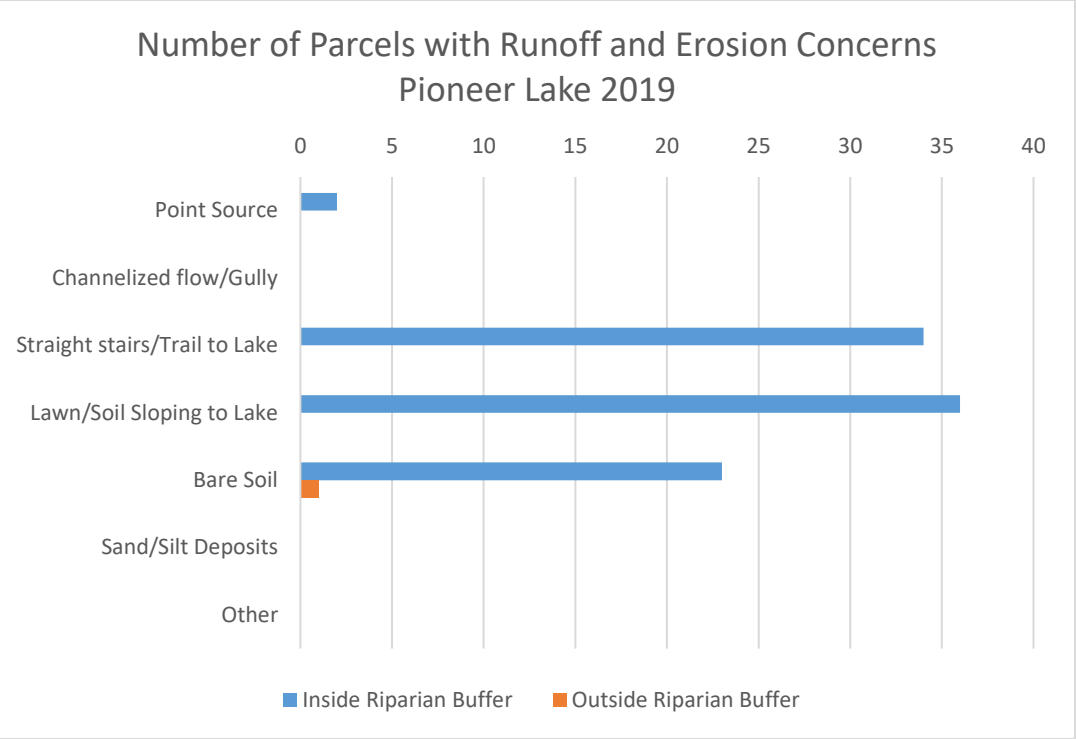


Figure 13. Number of parcels with runoff and erosion concerns in Riparian Zone and Outside Riparian Zone on Pioneer Lake 2019. Of the 80 parcels, 53 had erosion or runoff concerns (66%).

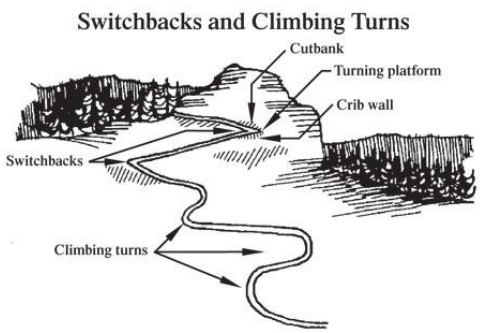


Figure 14. Minimizing impervious surfaces in the buffer zone, including on the access paths, maintaining vegetation, and curving the trail across the slope keeps shoreland erosion in check. Landowners should be mindful when curving or meandering an access path to comply with Zoning regulations on allowable access area width. Diagram courtesy of the US Forest Service.

Figure 15. Impervious surfaces and straight trail/road access allow runoff to speed up and brings phosphorus laden sediments to the lake. This site (not on Pioneer Lake) was augmented with a water infiltration pit to minimize runoff going into the lake.

Figure 16. Point source pipes were found on Pioneer Lake.

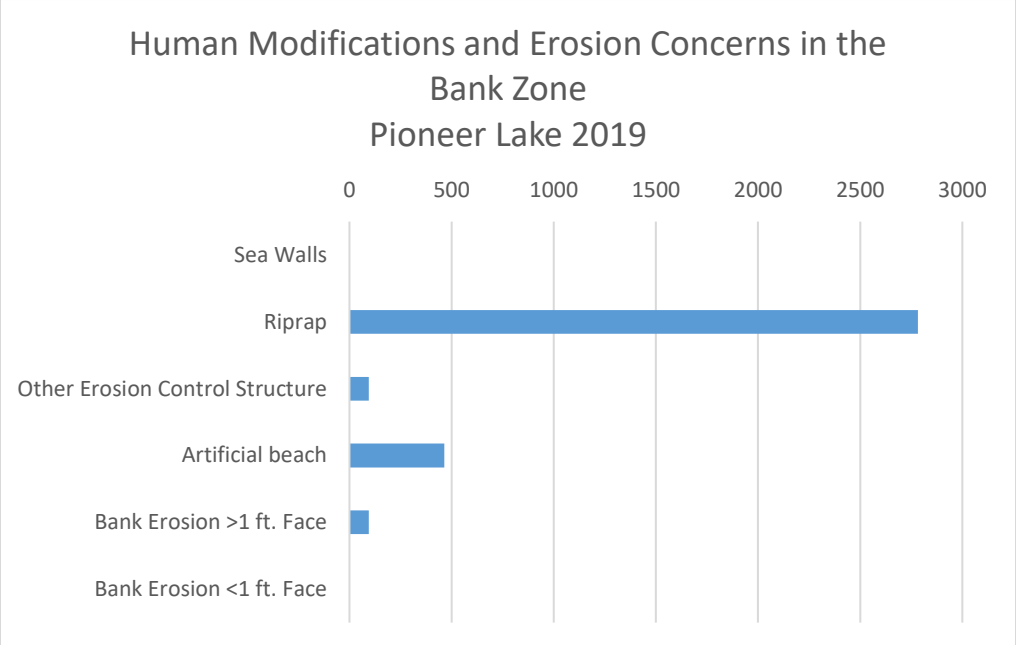


Figure 17. Length in feet of human modification and erosion concerns in Bank Zone on Pioneer Lake 2019. Riprap accounted for over 12% of the shoreline.

Observations

Pioneer Lakes has a public landing that does seem fairly popular. A new dock was installed in 2019.

Water levels seemed at or below the ordinary high water mark during the summer field work, however during a visit on Oct 2, 2019 the water levels seemed quite high.

During the field surveying, the upstream lake South Twin was doing a fluoridone treatment for their Eurasian Water Milfoil. While this project did not specifically sample for "burned/bleached" aquatic plants, no plant damage was noticed near the mouth of the Twin River.

And old snowmobile was found sunk into the lake's shoreland area. Residents indicate this had been there since the 1980's.

Figure 18. An old snowmobile has been reported to have been sunk into the shoreline since the 1980's.

Residents reported that historically, a landowner of the peninsula area near the Twin River outlet had attempted to upgrade the log road to a gravel road. Upon adding the heavy gravel, a whole section of the road and underlying wetland sunk into the lake. The utility poles around this area also seem a bit unstable. See Figure 19.

Figure 19. Air photo of the "sunken land" described by lake residents and photo of a leaning utility pole in same area.

It seemed several lake properties had "For Sale" signs. As properties change hands, more education about lake living may be needed.

Figure 20. Property for sale on Pioneer Lake.

The majority of the parcels on Pioneer Lake did not have steep banks. However there were some areas that were steep. Sandy dry soil in these areas are quite prone to erosion, and can be difficult to get vegetation established.

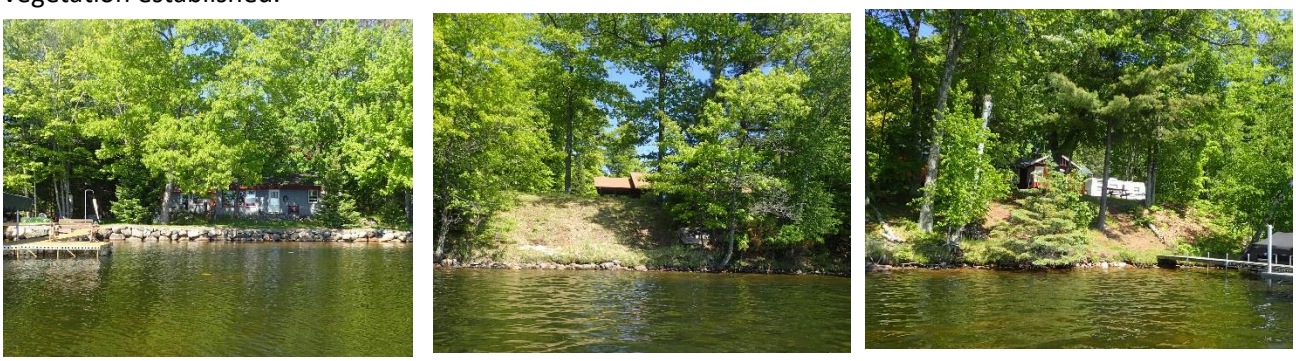


Figure 21. The photo on the left show the gentle grade of the majority of Pioneer Lake's parcels. The middle and right photos show steeper slopes. Runoff and erosion are more of a concern on steeper areas that occur primarily on the northwest side of the lake.

Recommendations

The Pioneer Lake Association could facilitate if desired:

- **Address point source sites:**
  - Follow up on the two point source discharges found for potential pollutants. If necessary/appropriate, encourage landowners to consider alternate ways to deal with their storm/waste water. Contact Melissa Yarrington of the WI DNR for assistance at 715-359-0192 or Melissa.yarrington@wisconsin.gov.

- **Maintain/create areas of native vegetation in the 35 ft. shoreland buffer areas:**
  - Leave/restore native plants, shrubs, and trees within the 35 ft buffer zone. The shoreland buffer zone consisted of 13% lawn; however, roots of turf grasses are not as well equipped as the existing native shoreline plants at holding down soil and reducing runoff. Because Pioneer Lakes is phosphorus limited, keeping soil (which naturally contains phosphorus) out of the lake can help maintain good water quality. These buffer zones also create fish and wildlife habitat. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance or questions with maintaining, creating, and funding 35 ft. shoreland buffers.
  - Minimize artificial beach areas. The Vilas County Shoreland Zoning does not allow creation of new beaches (Vilas County Shoreland Zoning Ordinance). When existing beaches need maintenance, a Shoreland Alternation Permit must be filed through the Vilas County Zoning Dept. Contact Vilas County Zoning at 715-479-3620 for assistance.

- **Address runoff and erosion concerns:**
  - Areas of bare soil in the riparian zone and bank erosion should be restored as they can add extra phosphorus into the water. Staff from Vilas County Land & Water Conservation are able to do site visits, recommend solutions, and in certain instances offer grant fund reimbursement for installing best practices. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance, questions, or possible funding.
  - Where lake access trails/driveways slope down to the lake, encourage riparian owners to curve their access trails across the slope rather than going straight down to the lake. This switchback approach will allow stormwater to infiltrate into the soil (vs. becoming runoff) better than a straight trail would. Landowners should be mindful when curving or meandering an access path to comply with Zoning regulations on allowable access area width. See Figure 14 as an example. For assistance with properly placing this type of lake access with the viewing corridor contact the Vilas County Zoning at 715-479-3620.

- **Consider other options before resorting to riprapping shorelines:**
  - While riprap can armor a shoreline suffering from wave erosion, it is not appropriate or effective in all shoreline erosion circumstances. Riprap can also make near-lake habitat unsuitable for animals such as turtles. Riprap "bounces" wave energy away, sometimes at the expense of the adjacent un-riprapped shoreline. In many instances, shorelines in low wave energy areas can be stabilized by other means such as biologs or native

plantings that continue to provide habitat. Vilas County Land & Water staff are available to address shoreland erosion concerns, have access to state engineering staff as needed, and in can provide some funding to manage eroding shorelines. Contact Quita Sheehan at 715-479-3721 or mashee@vilascountywi.gov to request a site visit.

- **Maintain/Increase Coarse Woody Habitat**:
  - Pioneer Lake had 46.49 logs/mile of shoreline, anecdotally a relatively low density. Encourage leaving down wood where it falls to maintain fish habitat. Increase coarse woody habitat through tree drops or installing Fish Sticks. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance and funding coordination.

- **Create a Clean Boats Clean Waters Campaign:**
  - Pioneer Lake's boat landing is busy enough to make an impact from Clean Boats Clean Waters education. This educational boat inspection program teaches boaters to comply with WI's invasive species laws and assisting willing boaters to do boat inspections before entering and after leaving the lake. This program can be volunteer or employee based. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for training and assistance.

- **Create an AIS monitoring group:**
  - Invasive Eurasian water milfoil was found in the Twin River at the Monheim Rd. crossing, and yellow iris is suspected but not yet confirmed. Monitoring for Eurasian water-milfoil and other AIS will be helpful so the association can respond in a timely manner if desired. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for training and guidance on forming a group.

- **Create a native plant monitoring group:**
  - Native plants create habitat for fish and other animals, are a food source, and are crucial for in-lake oxygen production. Create a group to monitor suspected rare plants and native plants. Contact Sandy Wickman from WI DNR 715-365-8951 or Sandra.wickman@wisconsin.gov for additional assistance.

- **Create a water level monitoring program:**
  - Pioneer Lake residents have had property damage from flooding in 2017, primarily due to high precipitation and upstream dam operations. Residents continue to report high water levels on occasion. Having quantitative data may be helpful if these water level issues will persist. Have a professional survey in a staff gauge and have a volunteer from the lake regularly report the water level. Contact Katie Hein from WI DNR at 608-267-2376 or catherine.hein@wisconsin.gov and Emily Heald from Discover Center at 715-543-2085 or water@discoverycenter.net to assist with creating a water level monitoring program.

- **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.
    - Encourage landowners adjacent to the "biodiversity hotspots" (see map on p. 29), dense coarse woody habitat areas (see p. 31), and those with shrub/herbaceous cover >80% (see page 33) to protect their natural areas. This could be done through nominating landowners for Vilas County Lakes & Rivers Association's Blue Heron Award, or the Vilas County Land & Water Conservation Stewardship Award. Contact Tom Ewing of VCLRA for further information 630-251-0247.
    - Large parcels with over 40 acres may be considered for conservation easements through the Northwoods Land Trust. Contact Ted Anchor, Executive Director of the Northwoods Land Trust at 715-479-2490 or ted@northwoodslandtrust.org for more information.

- **Maintain open communication with nearby lake representatives:**
    - Continue to send a representative at the Conover Town Lakes Committee meetings and maintain open communication with North-South Twin Lakes District and Riparian Owners Association as needed about upstream activities.

- **Build a science-based neighbor to neighbor shoreland stewardship program:**
    - Welcome new property owners and help with lake living, shoreland best practices such as Healthy Lake, and regulations.
    - Offer information on impacts of impervious surfaces, runoff & erosion, dock density, and development impacts.
    - Work with Vilas County Lakes & River Association to offer free/low cost materials on lake living to new owners and/or visitors. Contact Tom Ewing of VCLRA for further information 630-251-0247.

- **Continue to monitor water quality regularly:**
    - While it seems apparent that Pioneer Lake has good water quality, it will be helpful to have long term data for any future needs. Volunteers can do this through the Citizen Lake Network. Contact Sandy Wickman from WI DNR 715-365-8951 or Sandra.wickman@wisconsin.gov for additional assistance.

- **Consider control of invasive narrow leaf cattail site:**
    - Narrow leaf cattails can often be effectively managed with manual controls. If the Association and adjacent landowner are willing, try cutting live and dead 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 – broad leaf cattail is native and may also exist nearby. Contact Cathy Higley from Vilas County Land & Water Conservation 715-479-3738 or cahigl@vilascountywi.gov for assistance.

- **Recognize and encourage invested volunteers:**
    - With the acknowledgement that the Pioneer Lake Association has a long to-do list including many tasks outside of this report, it might be helpful to recognize volunteers who are invested in carrying work through the Pioneer Lake Association though formal or informal acts of appreciation.
    - Prioritize work to be done within Pioneer Lake Association's existing capacity.
    - Consider term limits on volunteer work, limiting Clean Boats Clean Waters shift times, and perhaps only twice/year AIS & native plant monitoring events would keep volunteer burnout at a minimum.
    - Contact Eric Olson at UW-Extension Lakes for lake organization capacity assistance at 715-346-2192 or eric.olson@uwsp.edu.

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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. Temperature and dissolved oxygen profiles were measured at the deep hole using a calibrated 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:

2019

- July: Temperature and dissolved oxygen profile; Secchi; total phosphorus; chlorophyll a; alkalinity, pH, and conductivity; and calcium
- August: Temperature and dissolved oxygen profile; Secchi; total phosphorus; chlorophyll a; nitrate + nitrite; and total Kjeldahl nitrogen
- 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 lowland drainage lakes.

Aquatic Plant Point Intercept Survey

WI DNR staff created a grid-based map consisting of 437 point-intercept (PI) sampling points for Pioneer 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 15 ft., and while a rake on a rope was used for sites deeper than 15 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 found more than 6 feet away from a PI point were recorded as a "boat survey".

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 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 Pioneer Lake's target sites included 7 areas: the public boat landing; the outlet to Pioneer Creek; the Maple View Resort shoreline; the north side of the island; the shoreline near the church; and both the north and south inlets from the Twin River. 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 the State Lab of Hygiene.

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 the State Lab of Hygiene.

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 Minnesota Garmin tool software, and a map was created in ArcPro.

Shoreland Assessment

This survey collected information per land parcel. A shapefile was created that contained the parcel boundaries around Pioneer 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 parcel lines 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 22. If it was uncertain that structures were located within the 35 ft. riparian buffer zone, a rangefinder was used to measure distances.

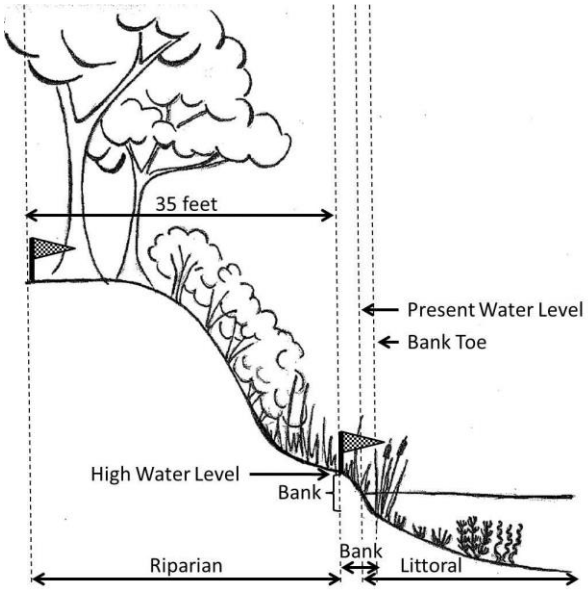


Figure 22. Shoreland areas assessed included the Riparian Buffer Zone, Bank Zone, and Littoral Zone. Graphic courtesy of WI DNR.

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 unless landowners requested their property not be photographed.

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

Table 4. Results of 2019 Pioneer Lake water quality testing. Testing occurred on 7/16/19; 8/19/19; and 9/18/2019.

	July 2019	**Aug 2019**	**Sep 2019**	**Average**
Secchi average (ft.)	10.0	7.75	9.5	9.08
Total Phosphorus (ug/L)	18.6	22.3	17.4	19.43
Chlorophyll a (ug/L)	4.65	14.4	9.9	9.65
Calcium (mg/L)	10.3	n/a	n/a	10.3
Alkalinity (mg/L)	39.7	n/a	n/a	39.7
pH	8.22	n/a	n/a	8.22
Conductivity (uS/cm)	102	n/a	n/a	102
Nitrate + Nitrite (mg/L)	n/a	None detected	n/a	None detected
Total Kjeldahl Nitrogen (mg/L)	n/a	0.469	n/a	0.469

The July, August, and September temperature and dissolved oxygen profiles show the lake was stratified in July & Aug, and mixed in Sep.

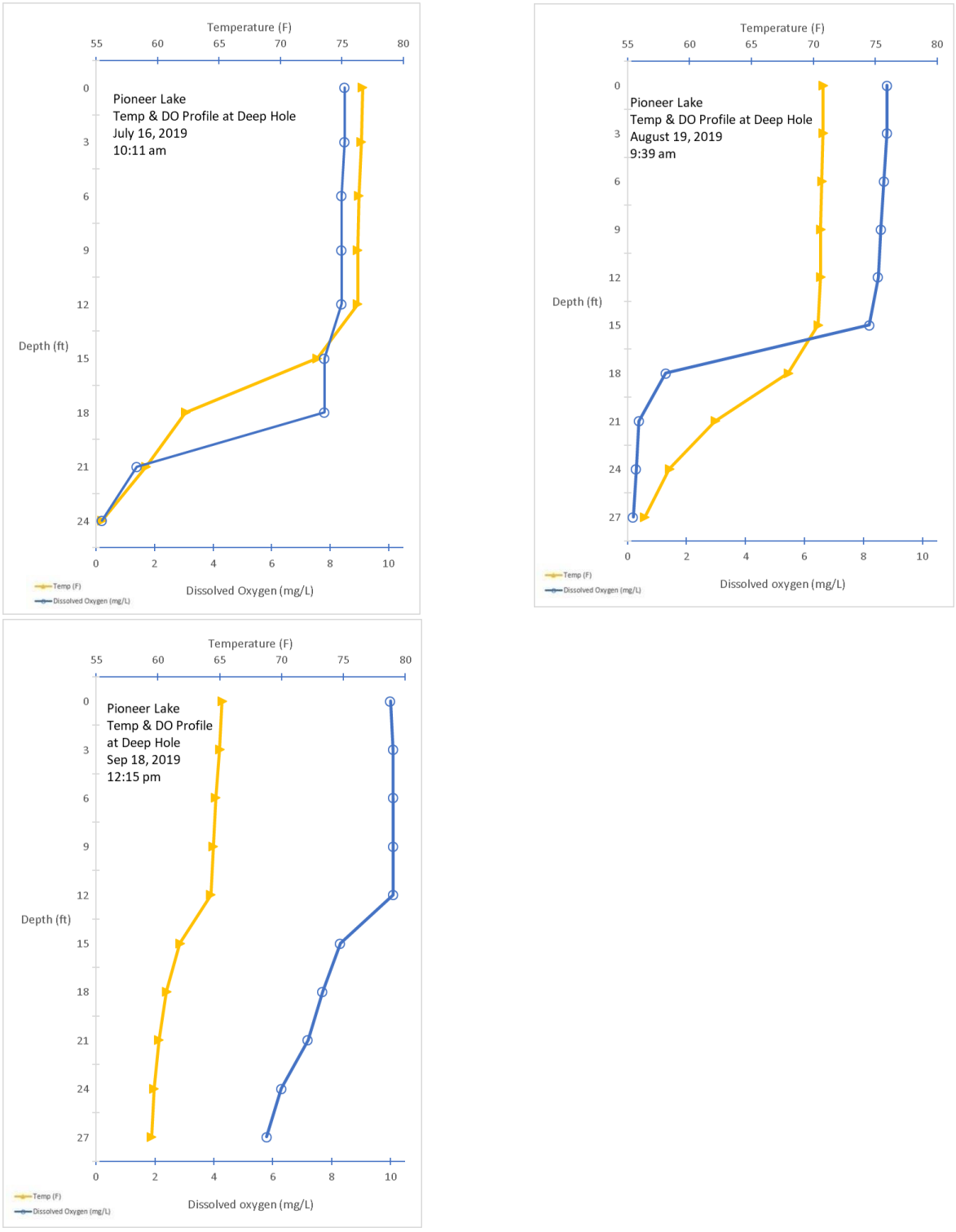


Figure 23. July, Aug, and Sep 2019 dissolved and temperature profiles for Pioneer Lake.

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

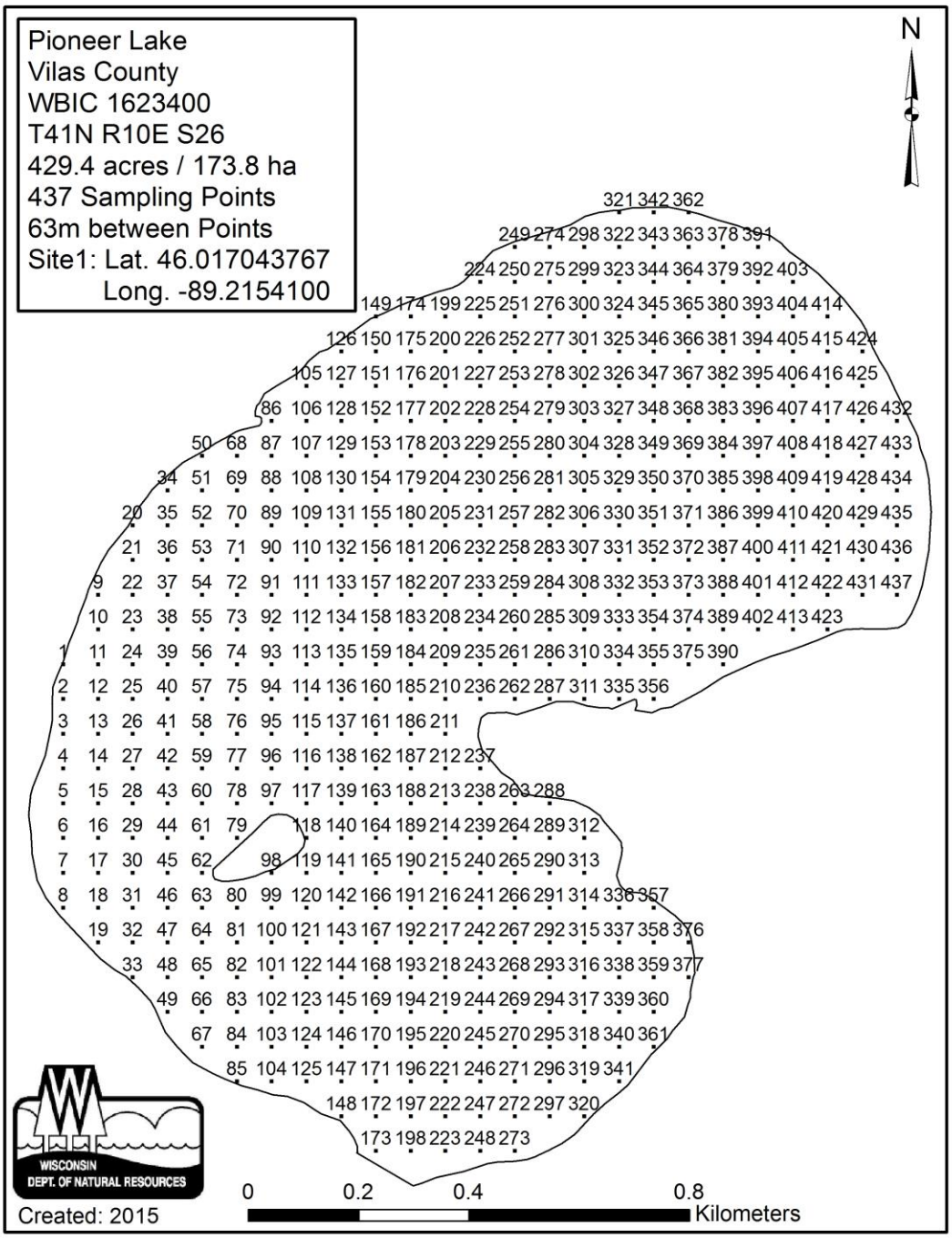


Figure 24. Aquatic plant point-intercept map for Pioneer Lake. Courtesy of WI DNR.

Figure 25. Fern pondweed (*Potamogeton robbinsii*) was found in Pioneer Lake 2019 point-intercept survey. This plant occurred in over 47% of littoral sites surveyed.

Figure 26. Water celery was found in the Pioneer Lake 2019 point-intercept survey. This plant occurred in over 34% of littoral sites surveyed.

Figure 27. Flat-stem pondweed (*Potamogeton zosteriformis*) found in Pioneer Lake 2019 point-intercept survey. This plant occurred in over 26% of littoral sites surveyed.

Figure 28. Northern water-milfoil (*Myriophyllum sibericum*) was found in the Pioneer Lake 2019 point-intercept survey. This plant occurred in over 16% of littoral sites surveyed.

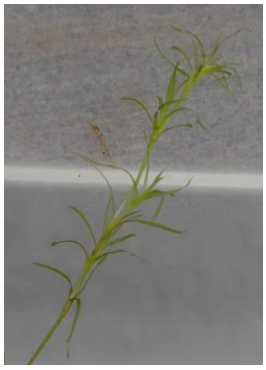


Figure 29. Slender naiad (*Najas flexilis*) was found in the Pioneer Lake 2019 point-intercept survey. This plant occurred in over 18% of littoral sites surveyed.

Figure 30. Common water weed (*Elodea canadensis)* was found in the Pioneer Lake 2019 point-intercept survey. This plant occurred in over 15% of littoral sites surveyed.

Figure 31. Small Pondweed (*Potamogeton pusillis*) was found in the Pioneer Lake 2019 point-intercept survey. This plant occurred in over 21% of littoral sites surveyed.

Figure 32. Common bur-reed (*Sparganium eurycarpum)* found in the Pioneer Lake 2019 point-intercept survey.

Figure 33. Special concern pondweed species, either water-thread pondweed or Vasey's pondweed (*Potamogeton diversifolius or vaseyi*) found in Pioneer Lake.

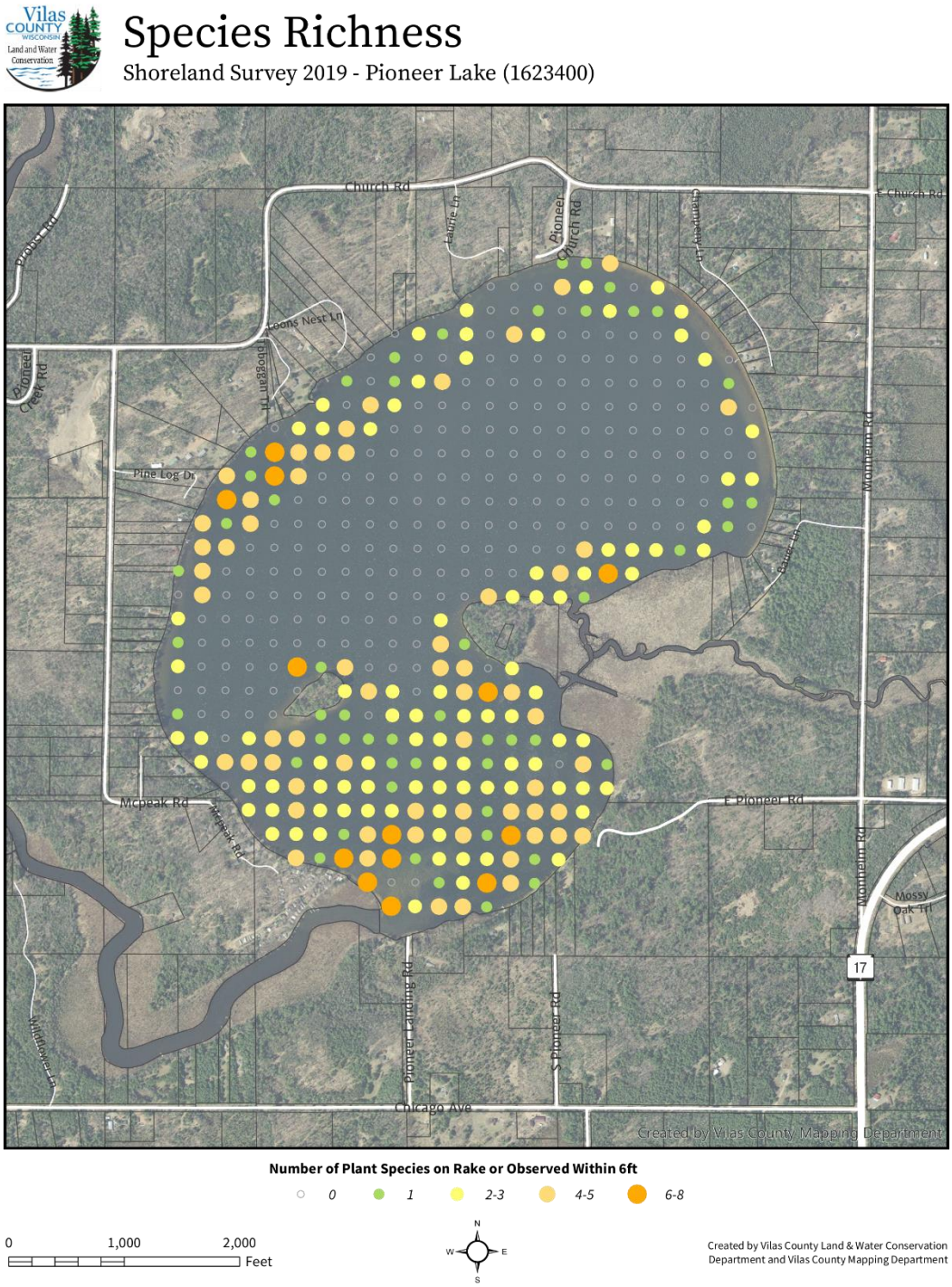


Figure 34. Pioneer Lake species richness by sampling point. Diversity hot spots occurred in 6 areas on the lake. Map courtesy of WI DNR.

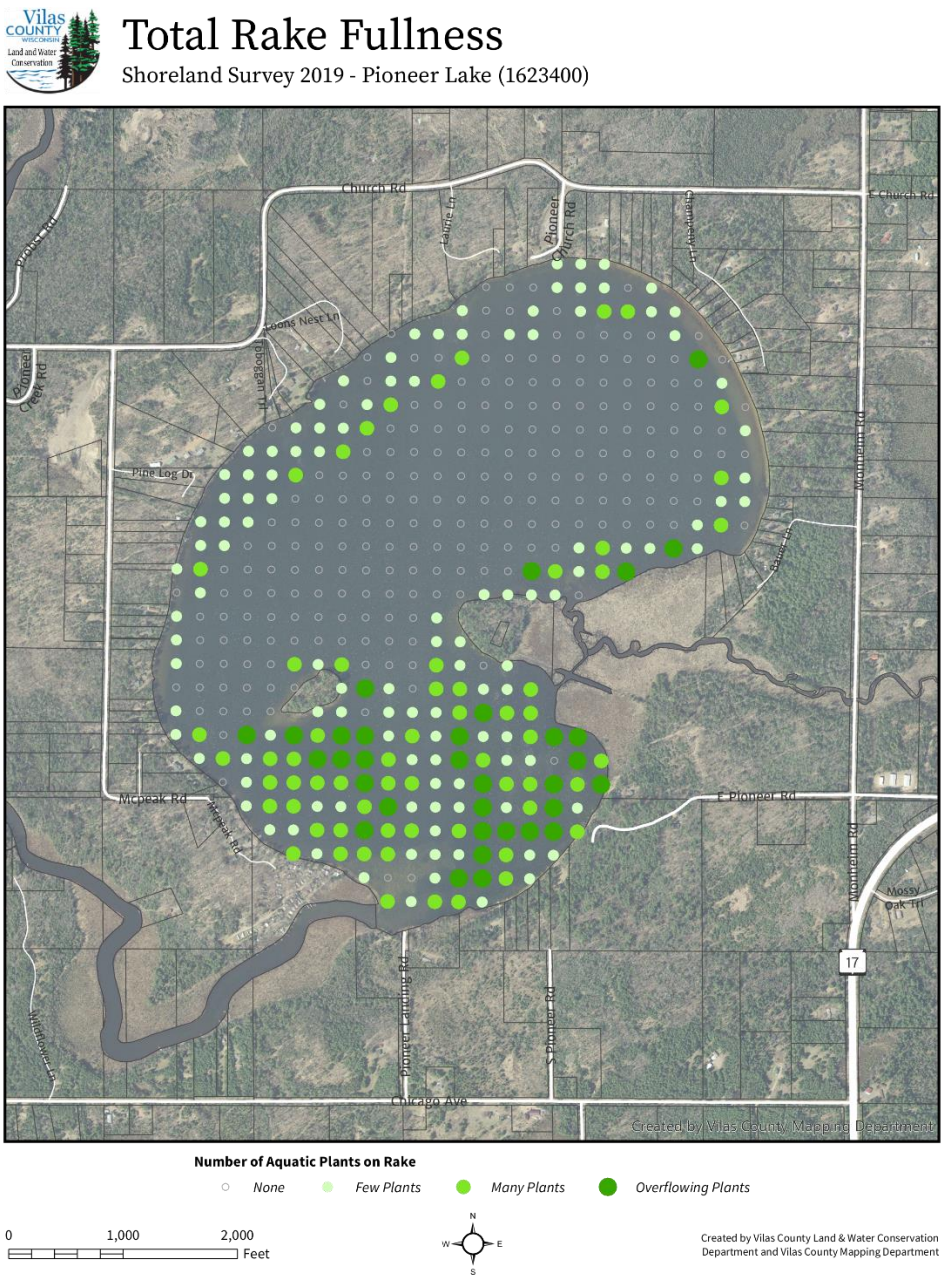
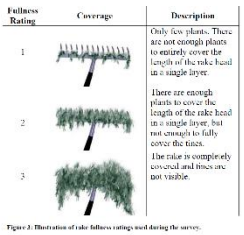


Figure 35. Pioneer Lake rake fullness by sampling point. Most of the dense plant growth is on the south side of the lake. See graphic for explanations of plant densities. Map and graphic courtesy of WI DNR.



Appendix 4: Coarse Woody Habitat Map

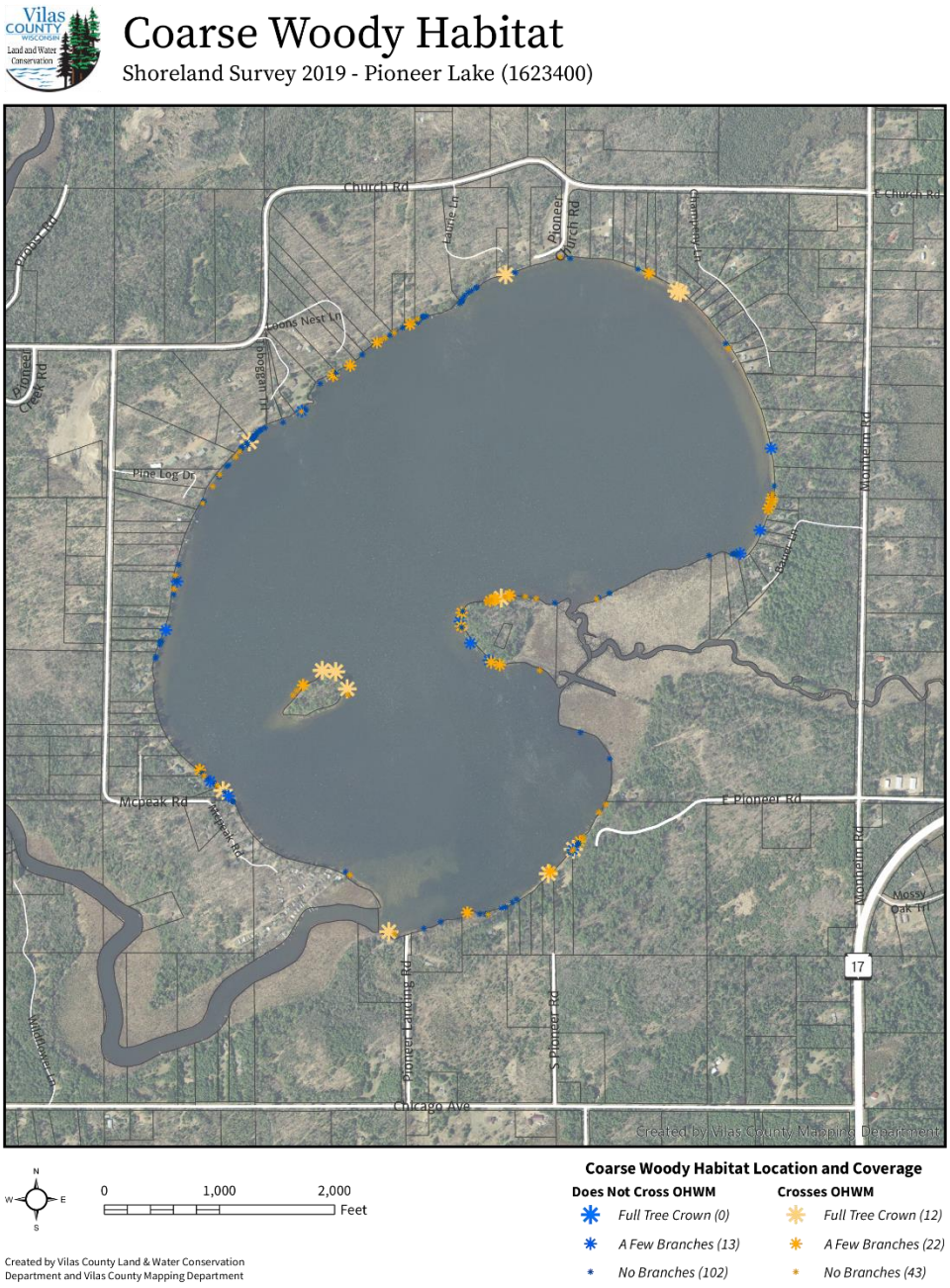


Figure 36. Coarse Woody Habitat Characterization for Pioneer Lake, 2019. 46.49 logs/mile were documented.

Appendix 5: Shoreland Survey Maps

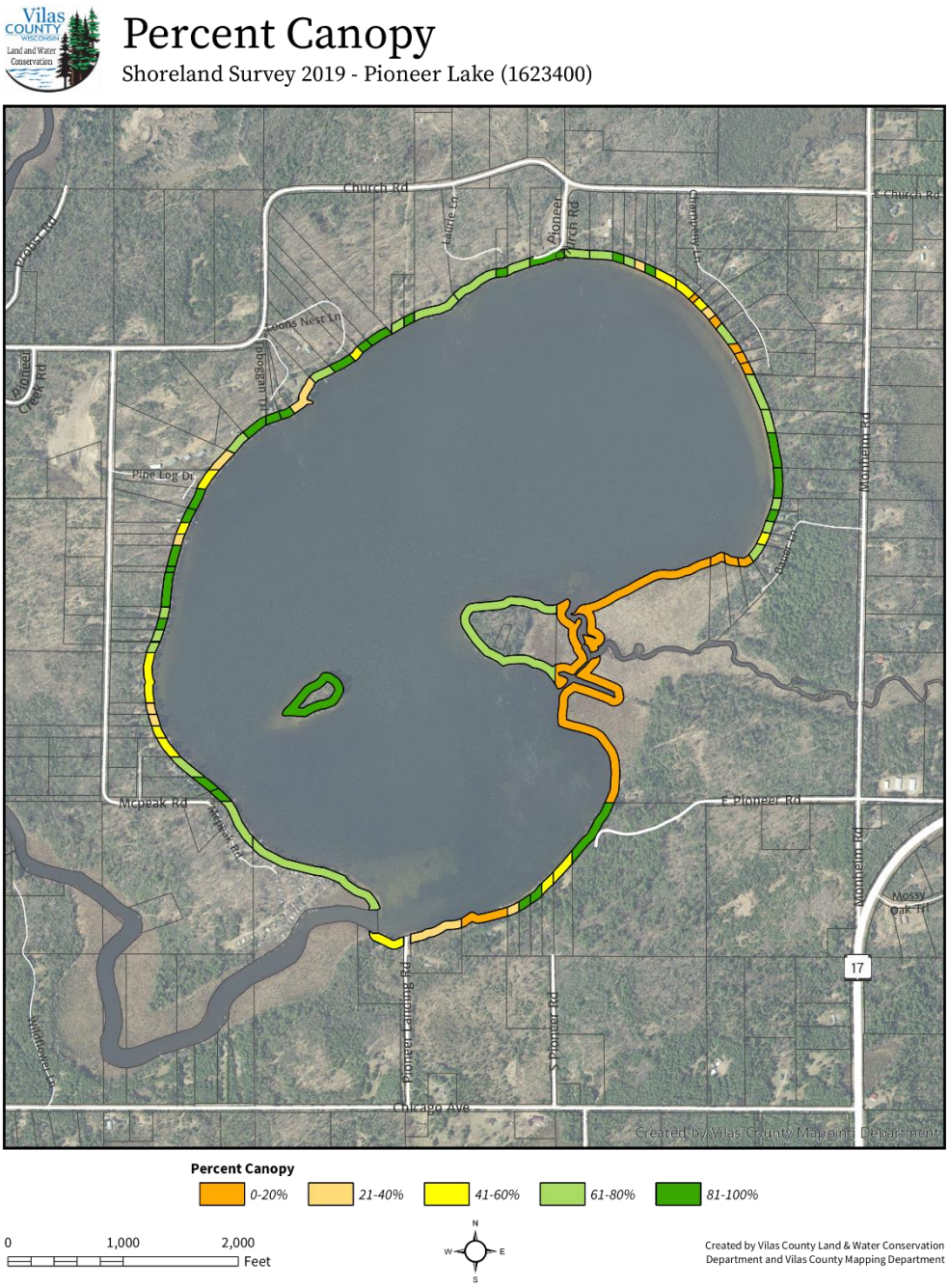


Figure 37. Canopy cover percent per parcel within 35 ft buffer area on Pioneer Lake 2019.

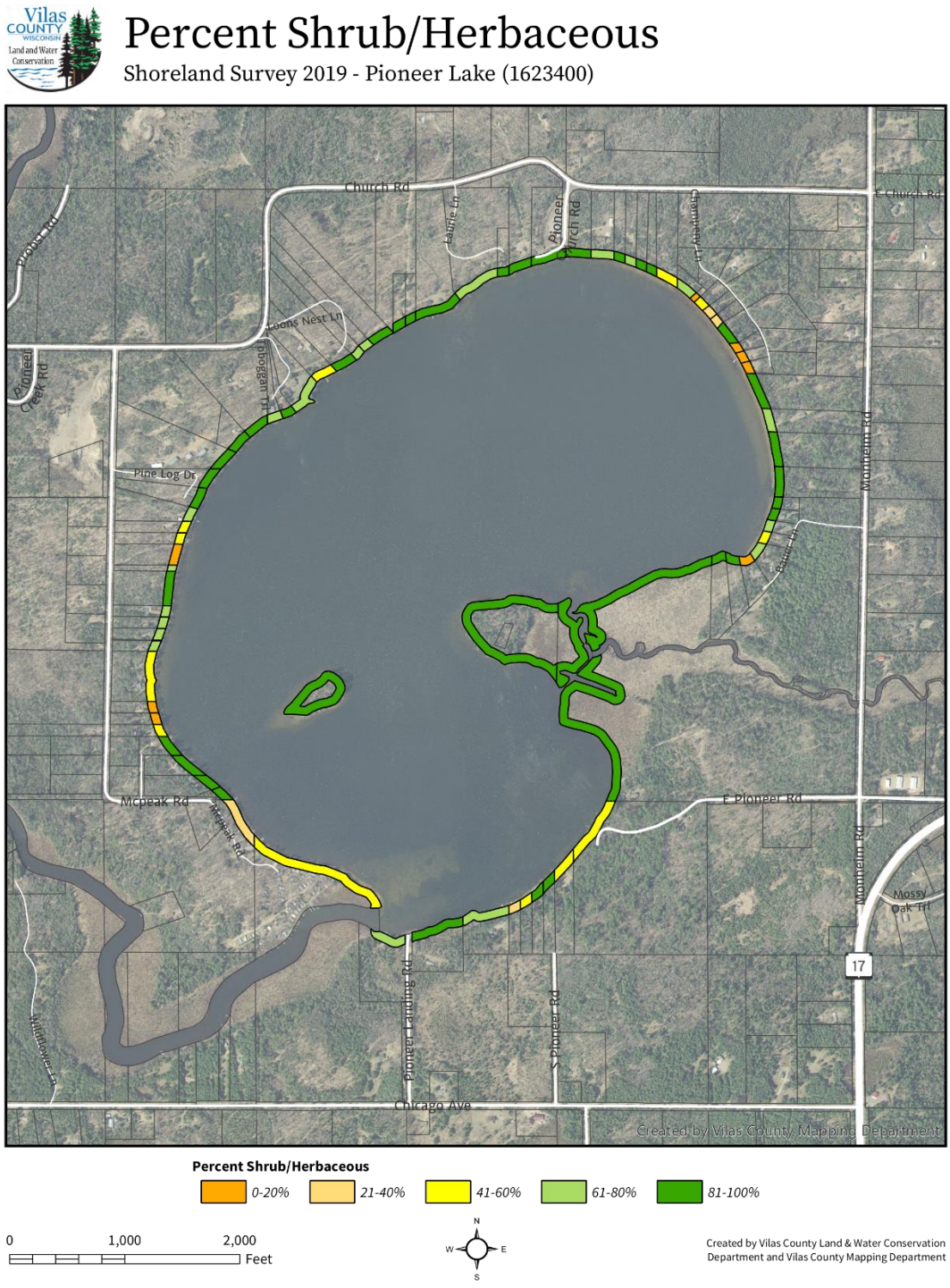


Figure 38. Percent shrub/herbaceous cover per parcel within 35 ft buffer area on Pioneer Lake 2019.

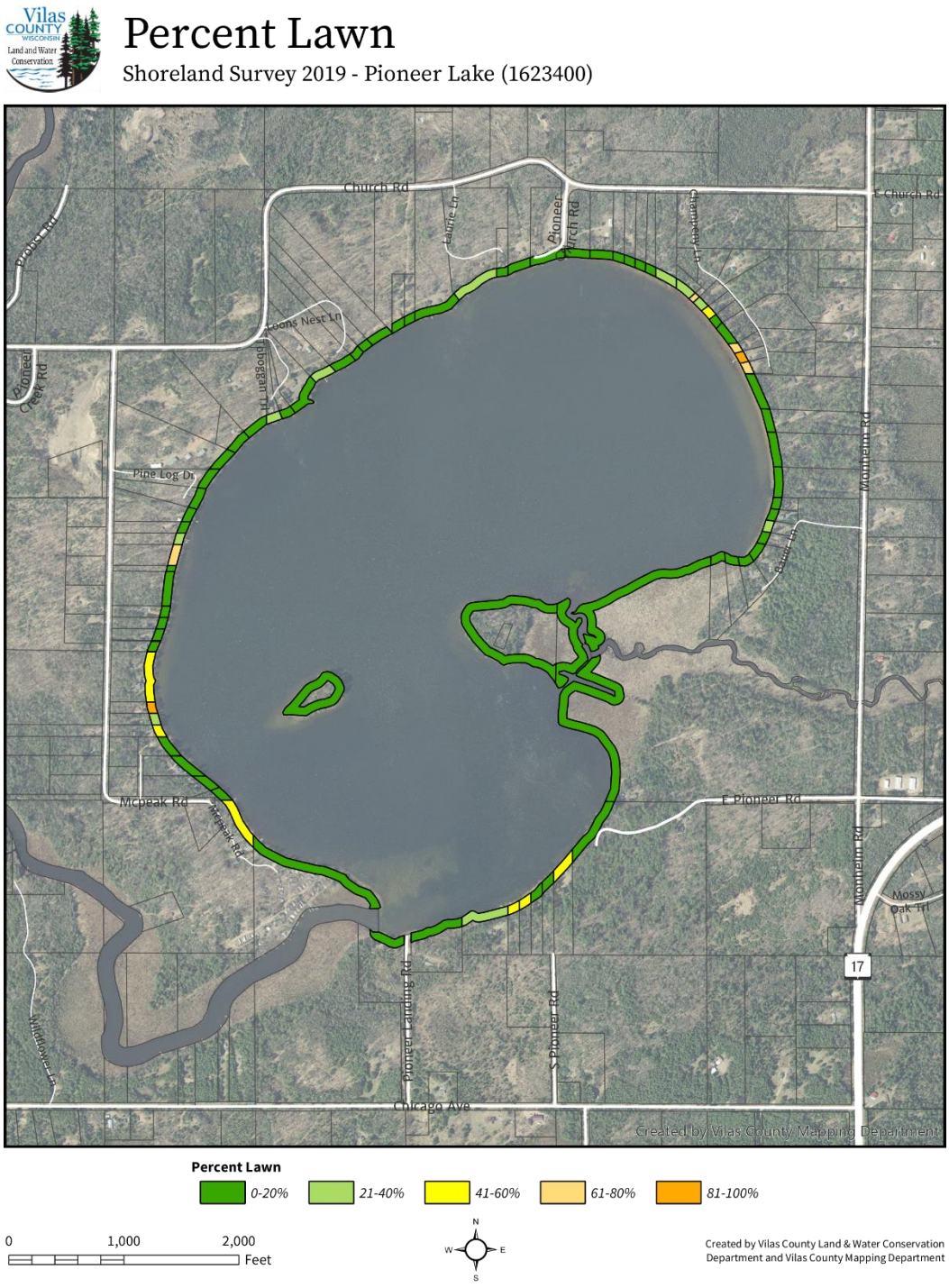


Figure 39. Percent lawn cover per parcel within 35 ft buffer area on Pioneer Lake 2019.

Figure 40. Percent impervious surfaces within 35 ft. riparian buffer zone per parcel on Pioneer Lake 2019.

Piers

Shoreland Survey 2019 - Pioneer Lake (1623400)

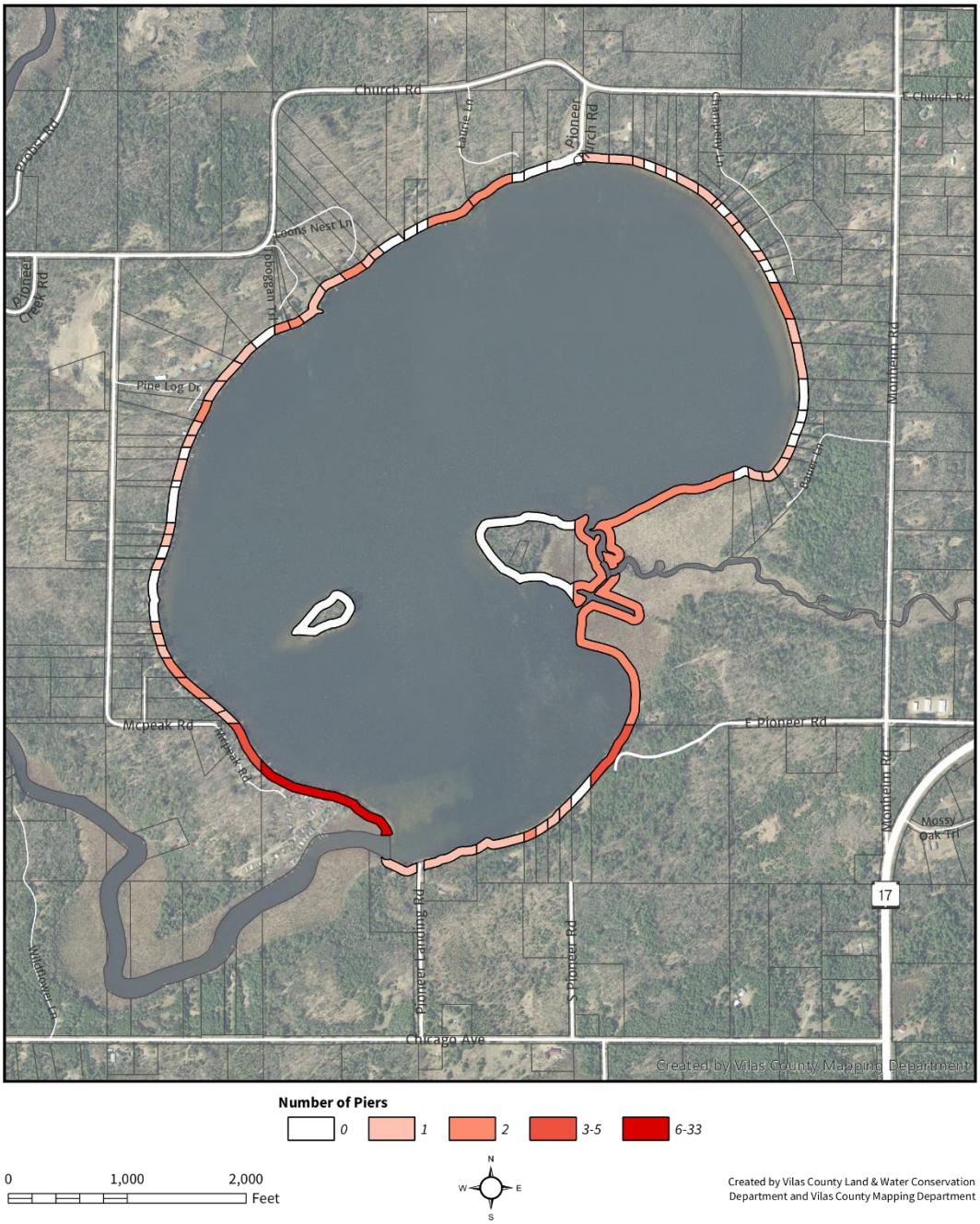


Figure 41. Piers per parcel on Pioneer Lake 2019.

Figure 42. Feet of riprap per parcel on Pioneer Lake 2019. Over 12% of the shoreline was riprapped.

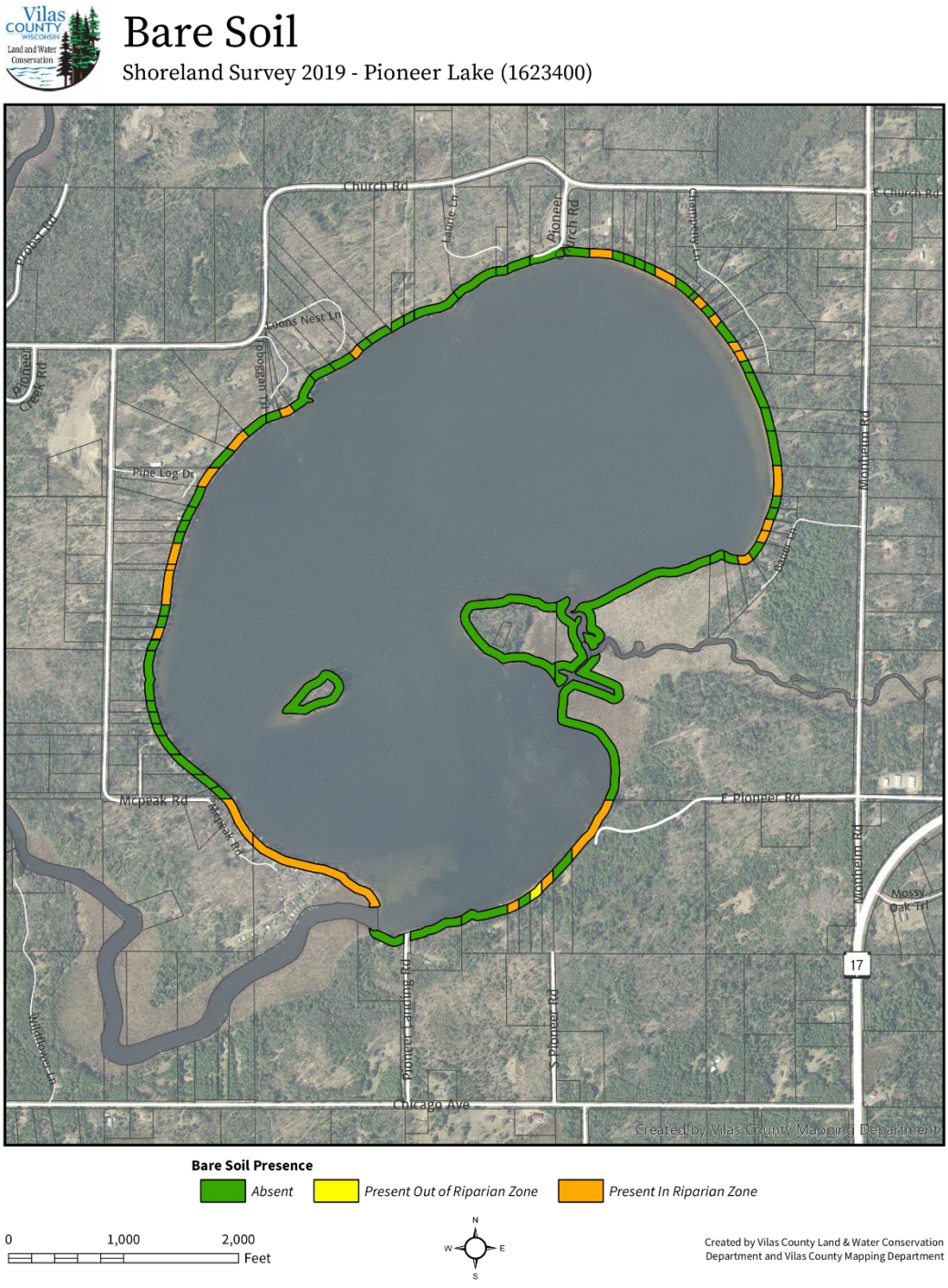


Figure 43. Parcels where bare soil was present inside or outside of the 35 ft. riparian buffer zone on Pioneer Lake 2019.

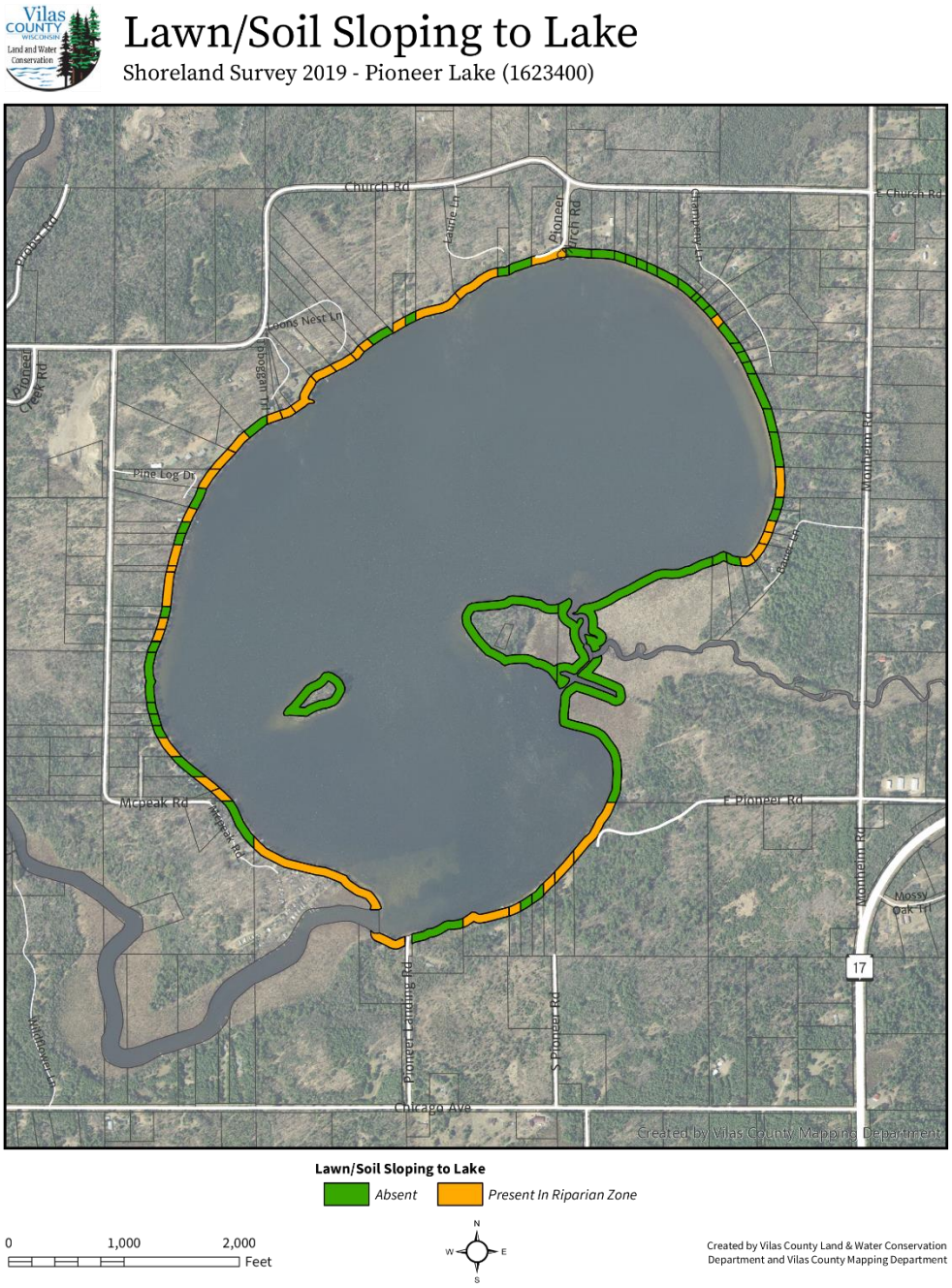


Figure 44. Parcels where lawn or soil slopes to lake on Pioneer Lake 2019.

Figure 45. Parcels where point sources were documented on Pioneer Lake 2019.

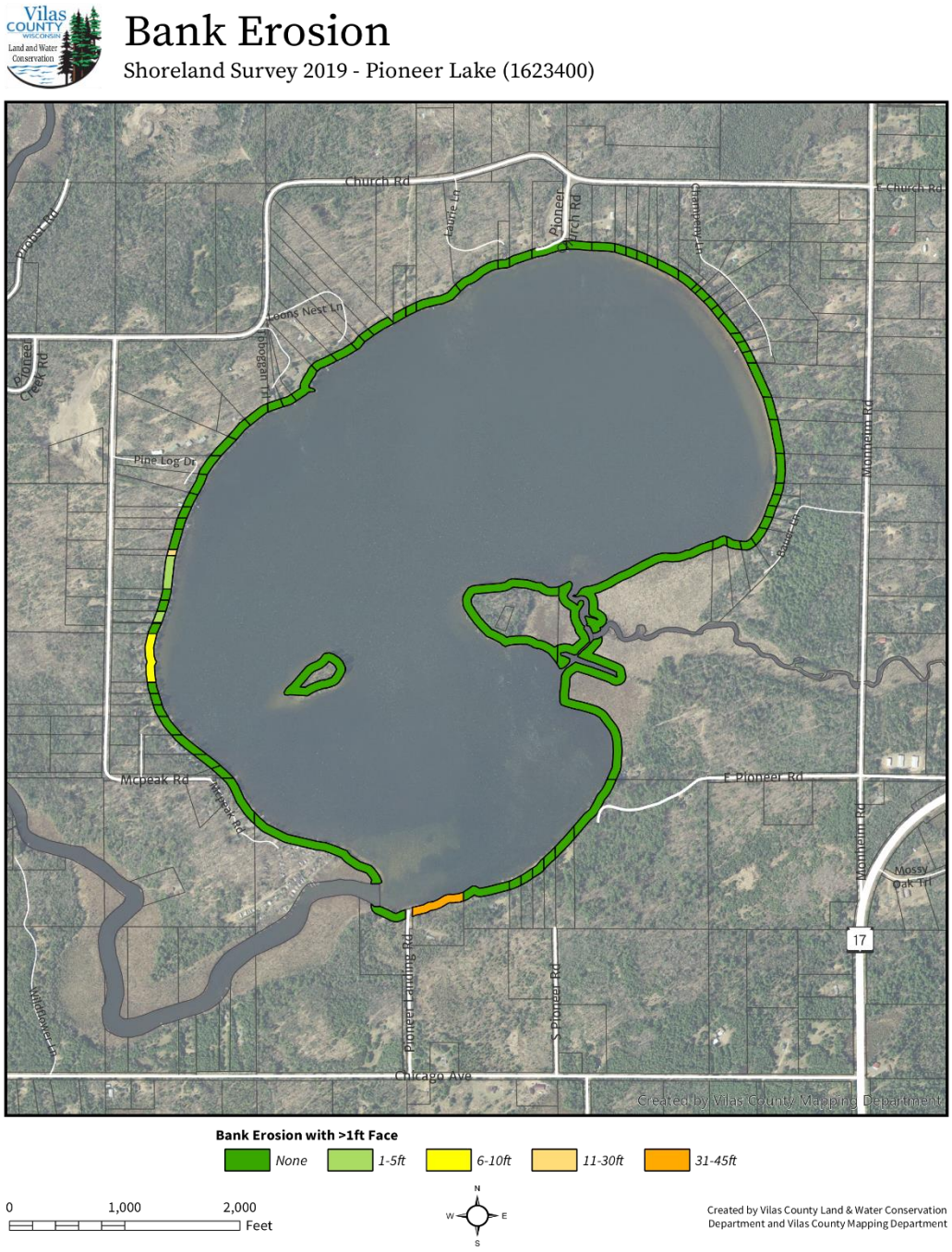


Figure 46. Feet of bank erosion >1ft face per parcel on Pioneer Lake 2019.

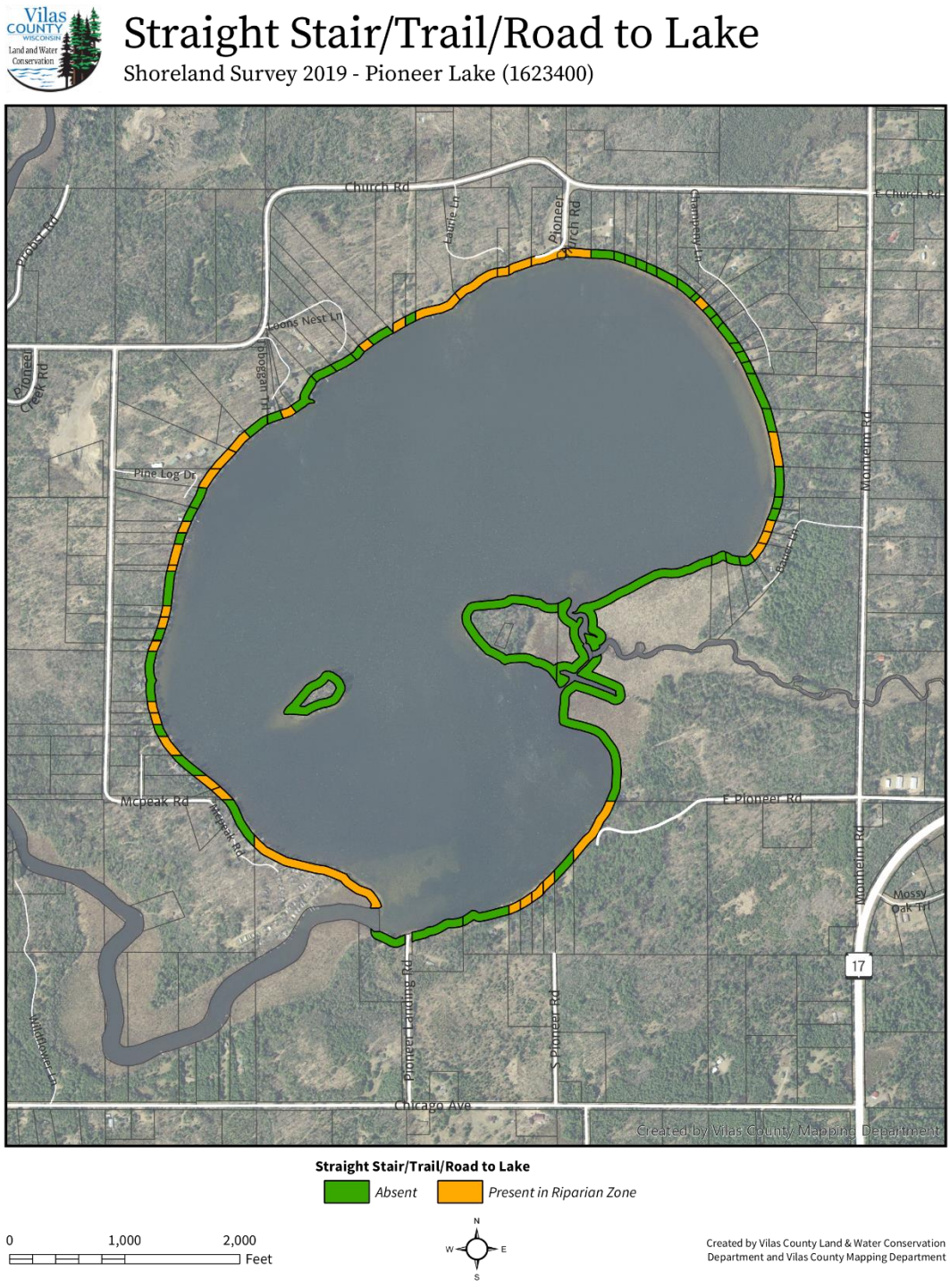


Figure 47. Parcels where straight stairs, trail, or road lead to the lake on Pioneer Lake 2019.

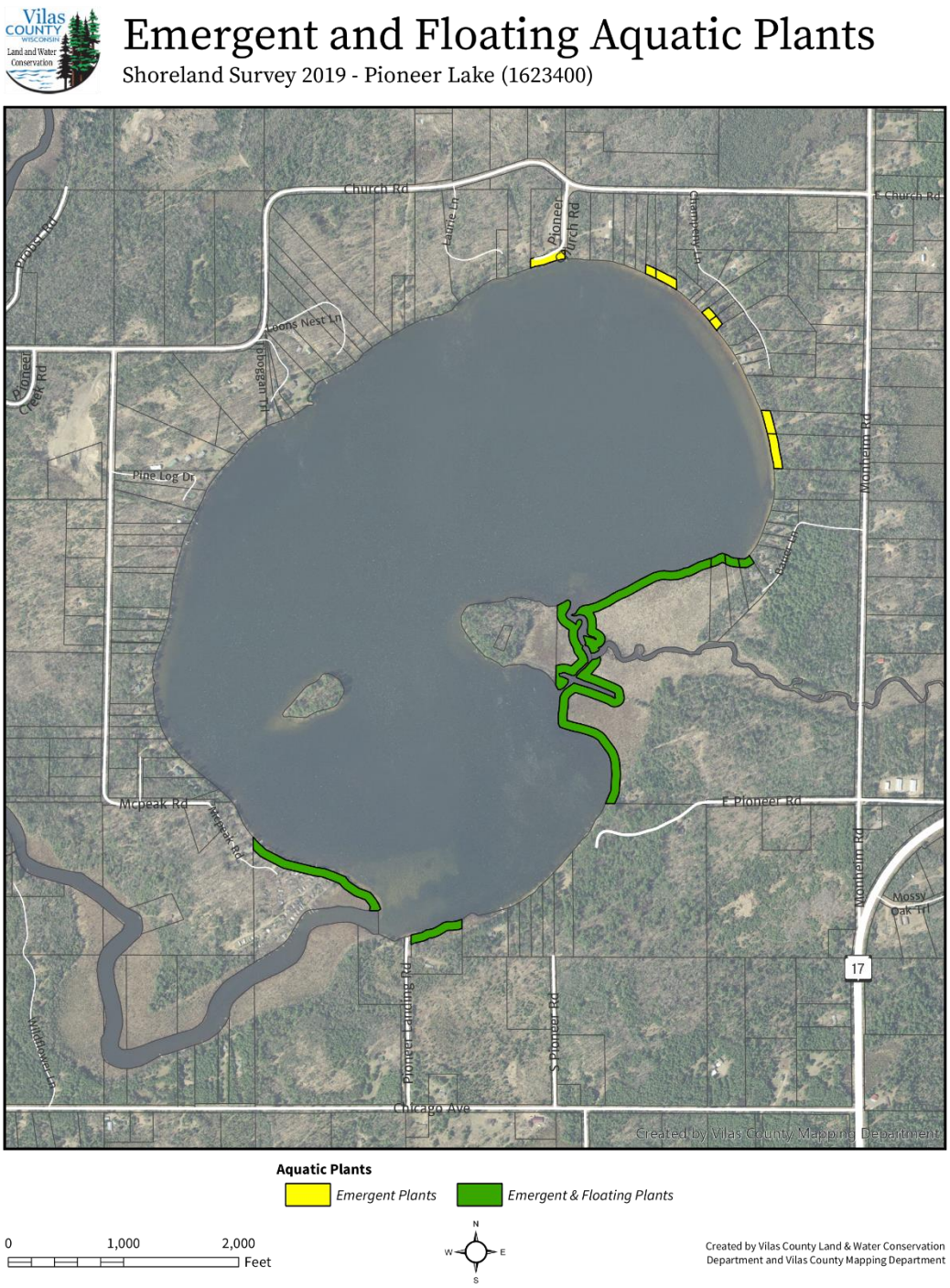


Figure 48. Parcels where emergent or emergent and floating plants were observed on Pioneer Lake 2019. No plant removal was observed.

Appendix 5: Erosion Susceptibility

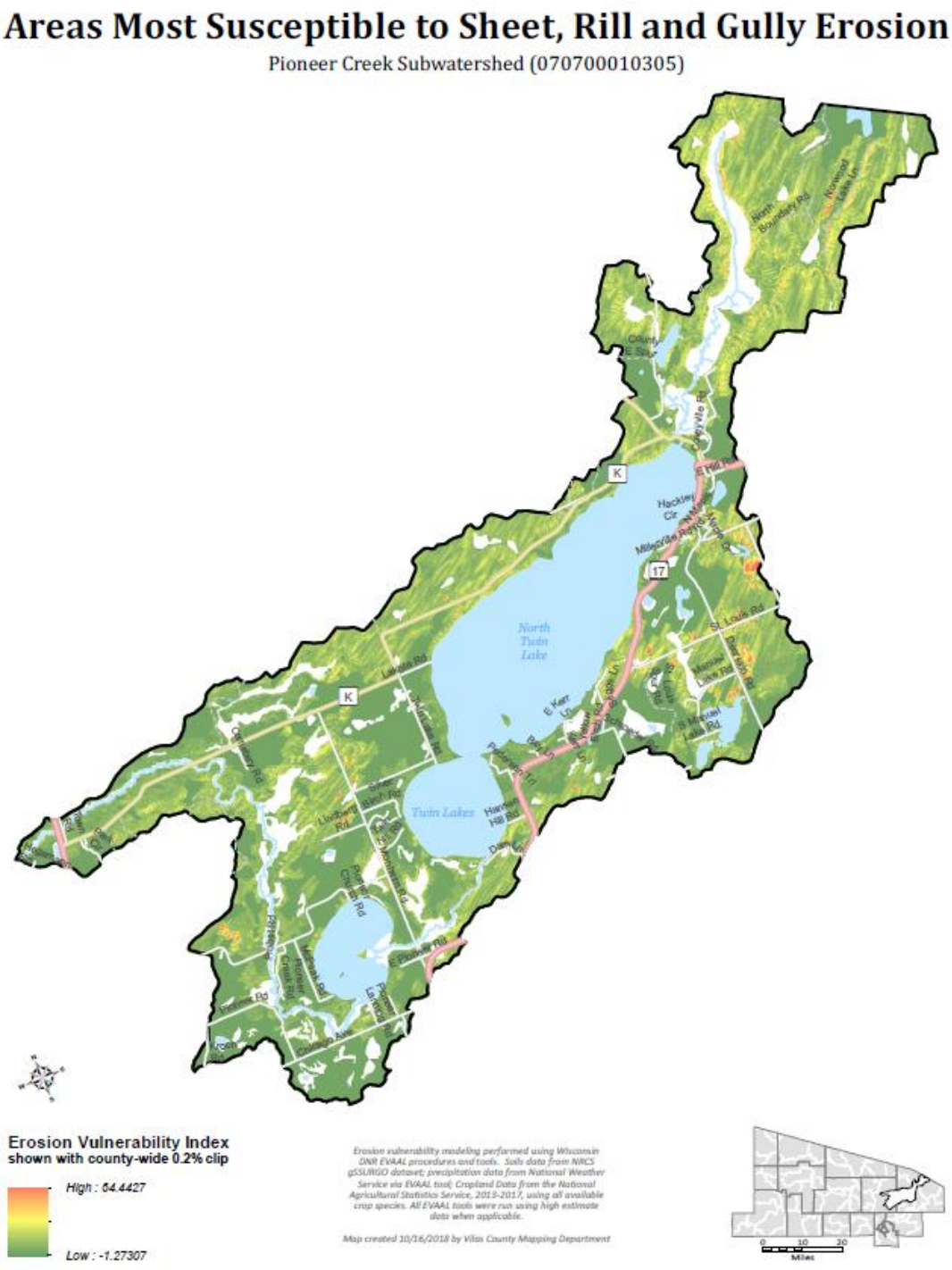
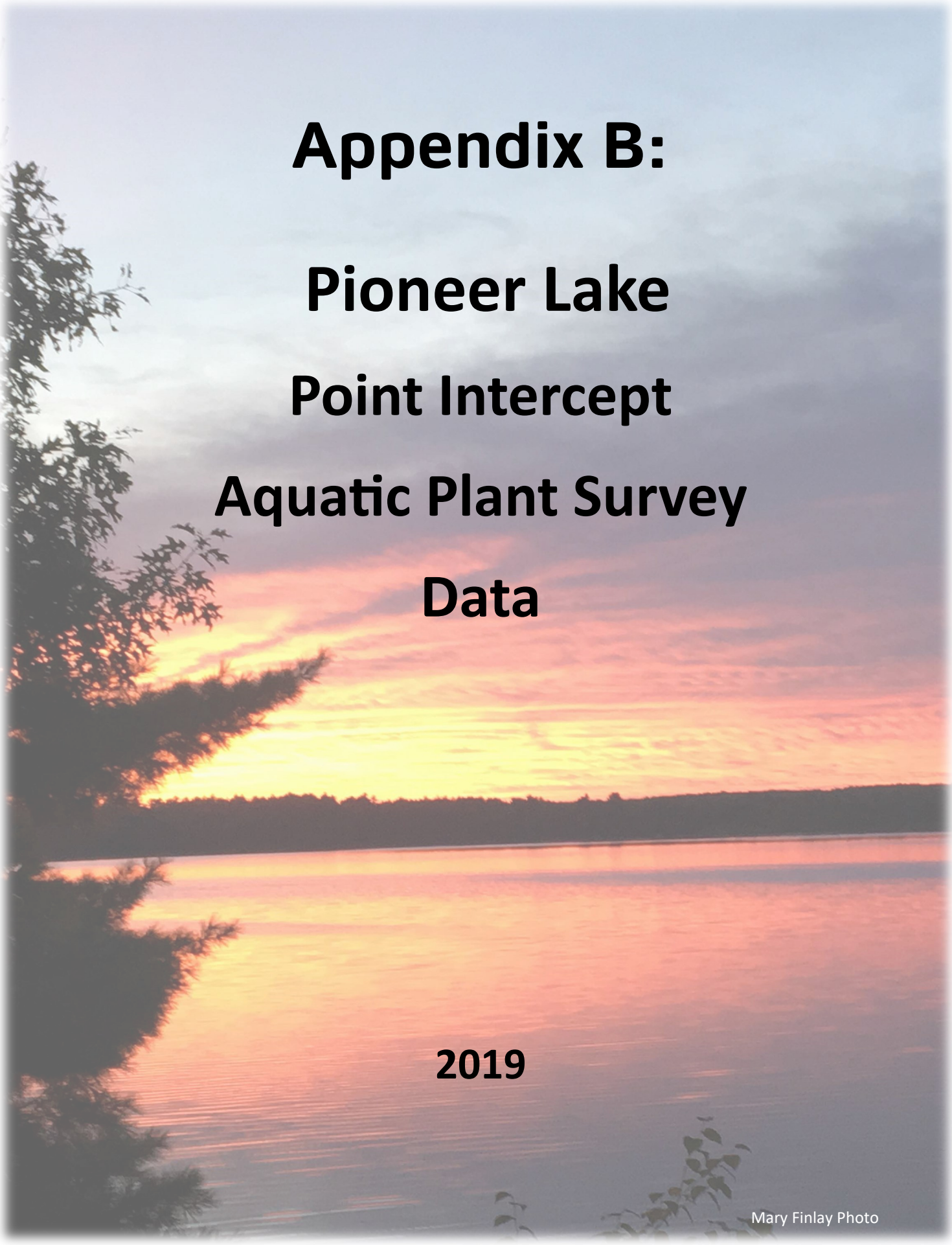


Figure 49. Areas susceptible to erosion in the Pioneer Creek subwatershed.



Appendix B:

Pioneer Lake

Point Intercept

Aquatic Plant Survey

Data

2019

	A	B	C
1	**Boat Survey**		
2	**Lake**	Pioneer Lake	
3	**County**	Vilas	
4	**WBIC**	1623400	
5	**Date of Survey**	Aug 1-13, 2019	
6	**Field Crew**	Cathy Higley	
7		Derek Thorn	
8			
9			
10	**Nearest Point**	**Species seen, habitat information**	
11	377	*Typha angustifolia*	
12	356	*Ceratophullum echinatum*	
13		*Potamogeton epihydrus*	
14		*Persicaria amphibia*	
15		*Nuphar variegata*	

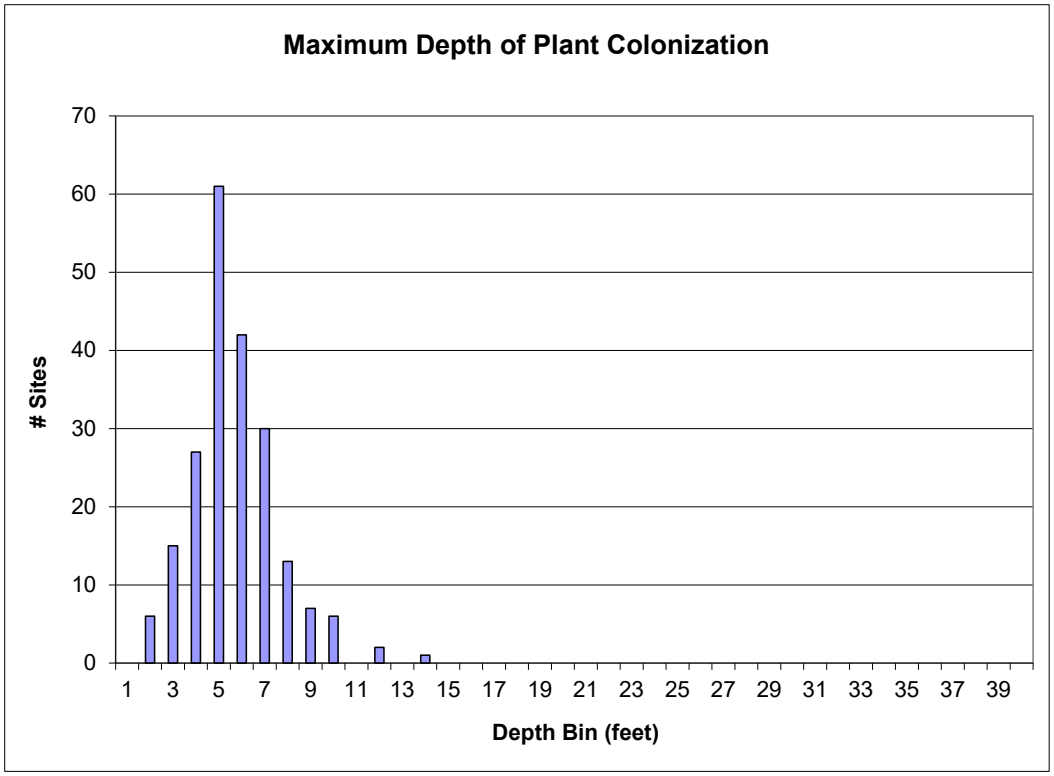
STATS	Total vegetation	*Myriophyllum spicatum,Eurasian water milfoil*	*Potamogeton crispus,Curly-leaf pondweed*	Bidens beckii (formerly Megalodonta), Water marigold	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Eleocharis acicularis, Needle spikerush	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton friesii, Fries' pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton praelongus, White-stem pondweed	Potamogeton pusillus, Small pondweed	Potamogeton richardsonii, Clasping-leaf pondweed
Pioneer Lake																			
Vilas County																			
1623400																			
Aug 1-13, 2019																			
INDIVIDUAL SPECIES STATS:																			
Frequency of occurrence within vegetated areas (%)				11.43	14.29	0.95	1.90	17.62	0.48	19.52	17.14		12.38	1.90	13.81	4.29	7.14	24.76	12.38
Frequency of occurrence at sites shallower than maximum depth of plants				9.92	12.40	0.83	1.65	15.29	0.41	16.94	14.88		10.74	1.65	11.98	3.72	6.20	21.49	10.74
Relative Frequency (%)				4.0	5.0	0.3	0.7	6.1	0.2	6.8	6.0		4.3	0.7	4.8	1.5	2.5	8.6	4.3
Relative Frequency (squared)	0.10			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.01	0.00
Number of sites where species found				24	30	2	4	37	1	41	36		26	4	29	9	15	52	26
Average Rake Fullness	1.61			1.13	1.00	1.00	1.00	1.11	1.00	1.32	1.03		1.00	1.00	1.03	1.00	1.13	1.12	1.04
#visual sightings												1	1					1	1
present (visual or collected)				present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present

	STATS	Total vegetation	Potamogeton robbinsii, Fern pondweed	Potamogeton vaseyi, Vasey's pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Sagittaria cuneata, Arum-leaved arrow-head	Schoenoplectus tabernaemontani, Softstem bulrush	Sparganium eurycarpum, Common bur-reed	Utricularia vulgaris, Common bladderwort	Vallisneria americana, Wild celery	Aquatic moss
Lake	Pioneer Lake										
County	Vilas County										
WBIC	1623400										
Survey Date	Aug 1-13, 2019										
	INDIVIDUAL SPECIES STATS:										
	Frequency of occurrence within vegetated areas (%)		54.29		30.95	0.95			0.48	40.00	0.48
	Frequency of occurrence at sites shallower than maximum depth of plants		47.11		26.86	0.83			0.41	34.71	0.41
	Relative Frequency (%)		18.9		10.8	0.3			0.2	13.9	
	Relative Frequency (squared)	0.10	0.04		0.01	0.00			0.00	0.02	
	Number of sites where species found		114		65	2			1	84	1
	Average Rake Fullness	1.61	1.49		1.05	1.00			1.00	1.17	1.00
	#visual sightings				1		1	1		1	
	present (visual or collected)		pre-sent		pre-sent	pre-sent	pre-sent	pre-sent	pre-sent	pre-sent	pre-sent

SUMMARY STATS:

Total number of sites visited	**252**
Total number of sites with vegetation	**210**
Total number of sites shallower than maximum depth of plants	**242**
Frequency of occurrence at sites shallower than maximum depth of plants	**86.78**
Simpson Diversity Index	**0.90**
Maximum depth of plants (ft)**	**14.00**
Number of sites sampled using rake on Rope (R)	**1**
Number of sites sampled using rake on Pole (P)	**251**
Average number of all species per site (shallower than max depth)	**2.49**
Average number of all species per site (veg. sites only)	**2.87**
Average number of native species per site (shallower than max depth)	**2.49**
Average number of native species per site (veg. sites only)	**2.87**
Species Richness	**21**
Species Richness (including visuals)	**24**
****SEE "MAX DEPTH GRAPH" WORKSHEET TO CONFIRM**	
Kept max depth of 14 ft. because **2** different species of plants were found 2ft. Deeper	
than other plants	

DEPTH BIN (FT)	# SITES (NO ENTRY)
1	0
2	6
3	15
4	27
5	61
6	42
7	30
8	13
9	7
10	6
11	0
12	2
13	0
14	1
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
32	0
33	0
34	0
35	0
36	0
37	0
38	0
39	0
40	0



Note: The X-axis (Depth Bin) can be scaled to better fit the plant distribution data.
Click on the outermost portion of the graph, and adjust the selection box in Column A.

0

Lake	Pioneer Lake
County	Vilas
Date	Aug 1-13, 2019
Township	
Range	
Section	

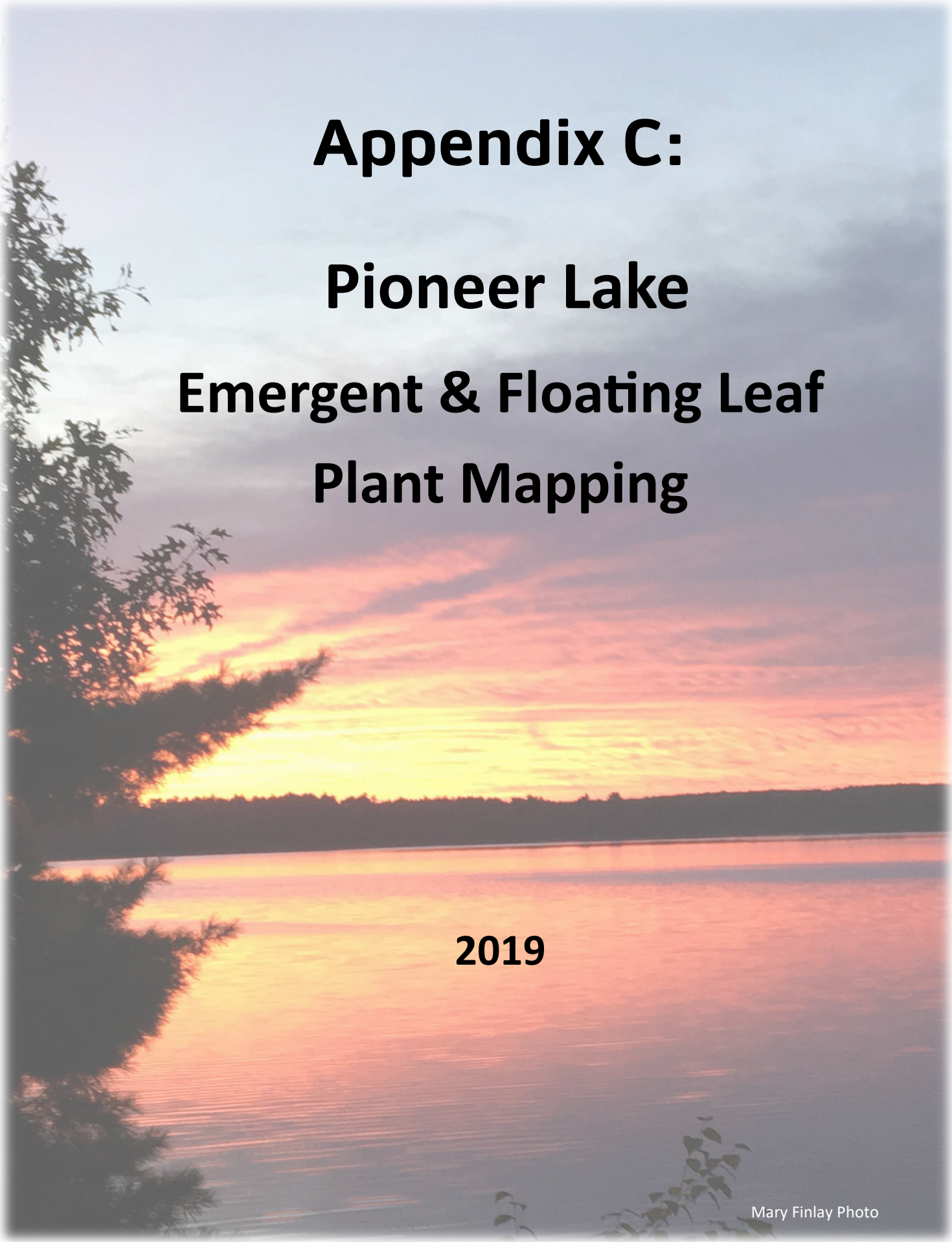
Species	Common Name	C	species pre-sent=1	
Acorus americanus	Sweet-flag	7	0	0
Alisma triviale	Northern water-plantain	4	0	0
Bidens beckii	Water marigold	8	1	8
Bolboschoenus fluviatilis	River bulrush	6	0	0
Brasenia schreberi	Watershield	6	0	0
Calla palustris	Wild calla	9	0	0
Callitriche hermaphroditica	Autumnal water-starwort	9	0	0
Callitriche heterophylla	Large water-starwort	9	0	0
Callitriche palustris	Common water-starwort	8	0	0
Carex comosa	Bottle brush sedge	5	0	0
Catabrosa aquatica	Brook grass	10	0	0
Ceratophyllum demersum	Coontail	3	1	3
Ceratophyllum echinatum	Spiny hornwort	10	0	0
Chara	Muskgrasses	7	1	7
Dulichium arundinaceum	Three-way sedge	9	0	0
Elatine minima	Waterwort	9	0	0
Elatine triandra	Greater waterwort	9	0	0
Eleocharis acicularis	Needle spikerush	5	1	5
Eleocharis erythropoda	Bald spikerush	3	0	0
Eleocharis palustris	Creeping spikerush	6	0	0
Elodea canadensis	Common waterweed	3	1	3
Elodea nuttallii	Slender waterweed	7	0	0
Equisetum fluviatile	Water horsetail	7	0	0
Eriocaulon aquaticum	Pipewort	9	0	0
Glyceria borealis	Northern manna grass	8	0	0
Gratiola aurea	Golden hedge-hyssop	10	0	0
Heteranthera dubia	Water star-grass	6	1	6
Isoetes echinospora	Spiny-spored quillwort	8	1	8
Isoetes lacustris	Lake quillwort	8	0	0
Isoetes sp.	Quillwort	8	0	0
Juncus pelocarpus f. submersus	Brown-fruited rush	8	0	0
Juncus torreyi	Torrey's rush	4	0	0
Lemna minor	Small duckweed	4	0	0
Lemna perpusilla	Least duckweed	10	0	0
Lemna trisulca	Forked duckweed	6	0	0
Littorella uniflora	Littorella	10	0	0
Lobelia dortmanna	Water lobelia	10	0	0
Ludwigia palustris	Marsh purslane	4	0	0
Myriophyllum alterniflorum	Alternate-flowered water-milfoil	10	0	0
Myriophyllum farwellii	Farwell's water-milfoil	8	0	0
Myriophyllum heterophyllum	Various-leaved water-milfoil	7	0	0
Myriophyllum sibiricum	Northern water-milfoil	6	1	6
Myriophyllum tenellum	Dwarf water-milfoil	10	0	0

Myriopyllum verticillatum	Whorled water-milfoil	8	0	0
Najas flexilis	Slender naiad	6	1	6
Najas gracillima	Northern naiad	7	0	0
Najas guadalupensis	Southern naiad	8	0	0
Nelumbo lutea	American lotus	7	0	0
Nitella	Nitella	7	0	0
Nuphar advena	Yellow pond lily	8	0	0
Nuphar microphylla	Small pond lily	9	0	0
Nuphar X rubrodisca	Intermediate pond lily	9	0	0
Nuphar variegata	Spatterdock	6	0	0
Nymphaea odorata	White water lily	6	0	0
Phragmites australis	Common reed	1	0	0
Polygonum amphibium	Water smartweed	5	0	0
Polygonum punctatum	Dotted smartweed	5	0	0
Pontederia cordata	Pickerelweed	8	0	0
Potamogeton alpinus	Alpine pondweed	9	0	0
Potamogeton amplifolius	Large-leaf pondweed	7	1	7
Potamogeton bicupulatus	Snail-seed pondwwed	9	0	0
Potamogeton confervoides	Algal-leaved pondweed	10	0	0
Potamogeton diversifolius	Water-thread pondweed	8	0	0
Potamogeton epihydrus	Ribbon-leaf pondweed	8	0	0
Potamogeton foliosus	Leafy pondweed	6	0	0
Potamogeton friesii	Fries' pondweed	8	1	8
Potamogeton gramineus	Variable pondweed	7	1	7
Potamogeton hillii	Hill's pondweed	9	0	0
Potamogeton illinoensis	Illinois pondweed	6	1	6
Potamogeton natans	Floating-leaf pondweed	5	0	0
Potamogeton nodosus	Long-leaf pondweed	7	0	0
Potamogeton oakesianus	Oakes' pondweed	10	0	0
Potamogeton obtusifolius	Blunt-leaf pondweed	9	0	0
Potamogeton praelongus	White-stem pondweed	8	1	8
Potamogeton pulcher	Spotted pondweed	10	0	0
Potamogeton pusillus	Small pondweed	7	1	7
Potamogeton richardsonii	Clasping-leaf pondweed	5	1	5
Potamogeton robbinsii	Fern pondweed	8	1	8
Potamogeton spirillus	Spiral-fruited pondweed	8	0	0
Potamogeton strictifolius	Stiff pondweed	8	0	0
Potamogeton vaseyi	Vasey's pondweed	10	0	0
Potamogeton zosteriformis	Flat-stem pondweed	6	1	6
Ranunculus aquatilis	White water crowfoot	8	0	0
Ranunculus flabellaris	Yellow water crowfoot	8	0	0
Ranunculus flammula	Creeping spearwort	9	0	0
Riccia fluitans	Slender riccia	7	0	0
Ruppia cirrhosa	Ditch grass	8	0	0
Sagittaria brevirostra	Midwestern arrowhead	9	0	0
Sagittaria cuneata	Arum-leaved arrowhead	7	1	7
Sagittaria graminea	Grass-leaved arrowhead	9	0	0
Sagittaria latifolia	Common arrowhead	3	0	0

Sagittaria rigida	Sessile-fruited arrowhead	8	0	0
Schoenoplectus acutus	Hardstem bulrush	6	0	0
Schoenoplectus heterochaetus	Slender bulrush	10	0	0
Schoenoplectus pungens	Three-square bulrush	5	0	0
Schoenoplectus subterminalis	Water bulrush	9	0	0
Schoenoplectus tabernaemontani	Softstem bulrush	4	0	0
Sparganium americanum	American bur-reed	8	0	0
Sparganium androcladum	Branched bur-reed	8	0	0
Sparganium angustifolium	Narrow-leaved bur-reed	9	0	0
Sparganium emersum	Short-stemmed bur-reed	8	0	0
Sparganium eurycarpum	Common bur-reed	5	0	0
Sparganium fluctuans	Floating-leaf bur-reed	10	0	0
Sparganium natans	Small bur-reed	9	0	0
Spirodela polyrhiza	Large duckweed	5	0	0
Stuckenia filiformis	Fine-leaved pondweed	8	0	0
Stuckenia pectinata	Sago pondweed	3	0	0
Stuckenia vaginata	Sheathed pondweed	9	0	0
Typha angustifolium	Narrow-leaved cattail	1	0	0
Typha latifolia	Broad-leaved cattail	1	0	0
Typha sp.	Cattail	1	0	0
Utricularia cornuta	Horned bladderwort	10	0	0
Utricularia geminiscapa	Twin-stemmed bladderwort	9	0	0
Utricularia gibba	Creeping bladderwort	9	0	0
Utricularia intermedia	Flat-leaf bladderwort	9	0	0
Utricularia minor	Small bladderwort	10	0	0
Utricularia purpurea	Large purple bladderwort	9	0	0
Utricularia resupinata	Small purple bladderwort	9	0	0
Utricularia vulgaris	Common bladderwort	7	1	7
Vallisneria americana	Wild celery	6	1	6
Wolffia borealis	Northern watermeal	6	0	0
Wolffia columbiana	Common watermeal	5	0	0
Zannichellia palustris	Horned pondweed	7	0	0
Zizania aquatica	Southern wild rice	8	0	0
Zizania palustris	Northern wild rice	8	0	0
Zizania sp.	Wild rice	8	0	0
N			21	
mean C				6.38095238
FQI				29.2411973

CITATION: **Nichols, SA. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management, 15(2):133-141.**

CITATION: **University of Wisconsin-Madison, 2001. Wisconsin Floristic Quality Assessment (WFQA). Retrived October 27, 2009 from: http://www.botany.wisc.edu/WFQA.asp**



Appendix C:

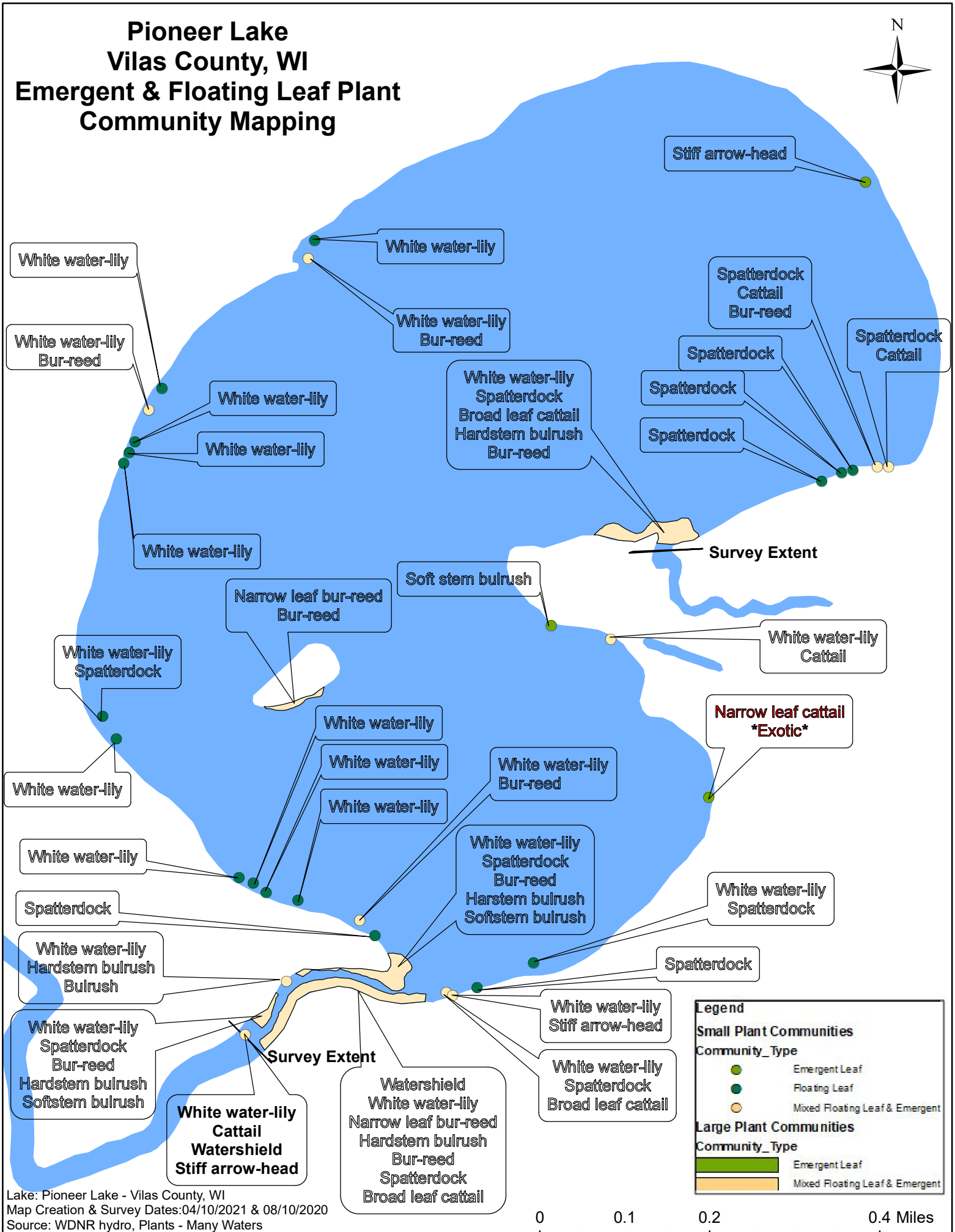
Pioneer Lake

Emergent & Floating Leaf Plant Mapping

2019

Mary Finlay Photo

Pioneer Lake
Vilas County, WI
Emergent & Floating Leaf Plant Community Mapping



Lake: Pioneer Lake - Vilas County, WI
Map Creation & Survey Dates:04/10/2021 & 08/10/2020
Source: WDNR hydro, Plants - Many Waters
File: Pioneer_EFL_2020