Pearl Lake

Waushara County, Wisconsin

Comprehensive Lake Management Plan

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Stantec

WISCONSIN DEPT. OF NATURAL RESOURCES

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1.0 INTRODUCTION

Pearl Lake, located in the Town of Leon in central Waushara County, is a 101-acre seepage lake with a maximum depth of 45 feet (Figure 1) and a shoreline length of 2.21 miles. It drains a lake-direct watershed of approximately 901 acres. (Figure 2). Most of the shoreline is lined with residential homes. Year-round public access is provided via a boat launch.

Pearl Lake's direct watershed is relatively small, with a watershed to lake area ratio of approximately 9:1. However, surrounding residential and agricultural land uses make it vulnerable to excess phosphorus inputs. Excess nutrients could trigger several detrimental effects that may diminish the lake's ecological, recreational, and aesthetic potential. Local residents and lake users, the Pearl Lake Protection and Rehabilitation District (PRD), the Pearl Lake Property Owners Association, the Wisconsin Department of Natural Resources (WDNR) and other partners have been engaged in ongoing studies, fish habitat improvement projects, aquatic invasive species (AIS) management, and lake management planning over the years, which has resulted in a wealth of data for Pearl Lake.

This Pearl Lake Management Plan ("the Plan") is being developed to build on previous plans and studies, and to recommend on-the-ground conservation measures within the watershed and provide a framework to implement these measures. The Plan includes additional data collection, modeling of nutrient loading, and will establish target objectives for watershed and water quality improvements for Pearl Lake. The Plan will work to create alliances and partnerships between community members, lake users, landowners, scientists, and agencies to leverage funding and implement strategic conservation practices. The desired outcomes will include benefits to these stakeholders, and success will be built on collaboration among a wide range of local community members.

2.0 BACKGROUND

Prior to European settlement, the Pearl Lake watershed, like most of Waushara County, consisted of a largely forested landscape. The original, pre-European settlement vegetation within the watershed was a blend of oak forests, oak openings, sedge meadows, and prairies. The topography and drainage patterns of the Pearl Lake watershed are largely the result of glaciation, and are characterized by undulating ground moraines, with small glacial lakes and wetland depressions in outwash areas. Hydrology inputs include groundwater seepage through predominantly sandy soils, in addition to surface water runoff.

The current landscape maintains much of its forested area, but residential development has taken place around shoreland areas and a small amount of land has been converted to agriculture, which may be influencing the nutrient dynamics of the lake. Historical images from the USDA taken in 1937 show a watershed dominated by agriculture. This likely contributed to runoff and excess nutrient loading in the lake. Similar photos taken in 1992 demonstrate a shift to residential development, with increases in impervious surfaces along the shoreline and in the watershed.

Figure 3. 1937 Historic Aerial of the Pearl Lake Watershed

Figure 4. 1992 Historic Aerial of the Pearl Lake Watershed

Urban and agricultural development has increased in the watershed over the years, but nutrient inputs to the lake have remained relatively stable.

Today, Pearl Lake is characterized as an oligotrophic state, with low turbidity and excellent water clarity, and is fully meeting its designated uses for fish and aquatic life and recreation. However, stakeholders have observed excess plant and algae growth which may be related to phosphorus inputs from both internal phosphorus cycling and external sources in the watershed.

In particular, Eurasian Watermilfoil has been observed along all sides of the shoreline and continued to persist despite treatment efforts. Curly-leaf pondweed has also been observed.

2.1 LOCAL PARTNERS

The Pearl Lake PRD is a public inland lake district that was developed to preserve, promote, and enhance the general welfare of Pearl Lake and its watershed. PRD is committed to connecting members, volunteers, and anyone interested in improving Pearl Lake. PRD initiated this planning effort with support from the Pearl Lake Property Owners Association, Town of Leon, Waushara County, Golden Sands Resource Conservation and Development (RC&D), WDNR and Lake & Pond Resource LLC (WLPR).

The Pearl Lake Property Owners Association connects residents living around Pearl Lake, raises funds, and works collaboratively towards a better lake experience for all stakeholders.

The Town of Leon encompasses the northeast portion of the Pearl Lake watershed, which is primarily rural. The Town of Leon routinely works with the County to enforce Shoreland Zoning regulations and local permitting.

Waushara County Land Conservation Department has been actively engaged in water quality efforts within the Pearl Lake watershed for decades. Their work includes coordination with local farmers to provide incentives for conservation practices on agricultural land, lake planning, and enforcement of shoreland zoning and septic system regulations.

Golden Sands Resource Conservation & Development (RC&D) Council Inc. is a community-based nonprofit founded in 1972 to work between counties to address widespread environmental issues in the region. They have done extensive work to support aquatic invasive species planning for Pearl Lake.

WDNR provides technical and financial support for fish population studies and stocking, aquatic invasive species monitoring and control, and water quality monitoring on Pearl Lake. WDNR biologists advise on many of the management activities on Pearl Lake. WDNR Surface Water Management grants support ongoing efforts to monitor aquatic invasive species and water quality on Pearl Lake.

Wisconsin Lake and Pond Resource (WLPR) is an aquatic resources consulting company with over 75 years of experience in lake management across the state of Wisconsin. They used their expertise to assist Stantec with aquatic invasive species recommendations for Pearl Lake.

2.2 STAKEHOLDERS AND PUBLIC PARTICIPATION

A public survey was made available to residents and visitors of the Pearl Lake watershed to engage the public in the planning process and determine priorities for management. The online survey was available at www.mypearllake.org from July 13th, 2022 until August 30th, 2022. 131 people participated in the survey, the majority of which own shoreline property and are seasonal residents. Water quality, high water levels, AIS control, and fish habitat improvement appear to be the highest priorities for survey respondents.

Water quality was addressed through a number of questions, including a few that were specific to the existing septic systems. It appears the majority of respondents have conventional systems, and 63% of respondents would be receptive of a public sewerage system if funding assistance were provided. There is also concern related to high water levels and flooding.

A large majority of survey respondents (76%) are either fairly concerned or very concerned about aquatic plant growth, including algae and invasive species, in Pearl Lake. Nearly 15% of survey respondents feel that their use of Pearl Lake is negatively impacted by aquatic plant growth, either sometimes or often. Over 60% of respondents support continued AIS control, even if chemical treatment is necessary to control populations of Eurasian watermilfoil. However, the majority of respondents are at least fairly concerned, if not very concerned, about potential impacts of chemical control to native aquatic plants, aquatic invertebrates, lake wildlife, and human health.

Regarding high water levels in Pearl Lake, a majority of respondents had concerns, with nearly 67% concerned about future high water levels and over 70% stating that their property has been affected by high water levels in Pearl Lake.

The largest changes to Pearl Lake that respondents noted were increased algae, the amount of aquatic plants, and the amount of shoreline development. The majority of respondents say that these have "somewhat increased." The majority of respondents also noted that quality of fishing has either somewhat or greatly declined. A small majority of respondents stated that water quality and clarity has stayed the same, with most other respondents stating that it has somewhat declined.

Survey results are included in Appendix A.

2.3 PUBLIC OUTREACH

The following outreach activities were used to gather opinions, comments and suggestions on the proposed Plan from agency partners, local stakeholders, partner organizations, research and educational institutions and the general public:

- The Pearl Lake PRD board met on Saturday, May 28th 2022 and announced their plans to update their lake management plan. There was concern among members regarding Eurasian watermilfoil and zebra mussels.
- The Pearl Lake PRD board met again on Saturday, July 2nd 2022. Lake residents expressed concern about poor water quality and Eurasian watermilfoil.
- The Pearl Lake PRD Annual Meeting was held on September 3rd, 2022. Dr. Susan Solarz and Nick Thomas with PRD discussed Eurasian watermilfoil treatment options including hand pulling, chemical treatment (on hold for 2022), and weevils. They also addressed WDNR plans for adjusting limits on the Pearl Lake fishery.
- Dr. Susan Solarz hosted a seminar on weevils on Sunday, August 28th, 2022 at Pearl Lake to discuss potential benefits of a rearing program.
- The Pearl Lake PRD met on October 21st, 2022 and discussed recommendations in the draft Plan and next steps, including the public comment period. Aquatic plant management and EWM was discussed in detail and members requested additional information and recommendations for 2023 treatment.

3.0 PREVIOUS MANAGEMENT ACTIONS

Pearl Lake stakeholders have been vigilant in protecting the lake's health and aesthetic value. Over the last 20-30 years, surveys and studies of the lake have been performed, identifying impairments and establishing the need for improving water quality and the fishery of the lake.

- In 1996, Pearl Lake was included in a statewide Eurasian watermilfoil weevil study by the University of Wisconsin Stevens Point (UWSP) to evaluate the effect of supplemental enhancement of weevil populations to control Eurasian Watermilfoil in Pearl Lake (Jester, Bozek, & Helsel, 1999).
- In 2004, The Pearl Lake Rehabilitation District did an Aquatic Invasive Species Study to survey the aquatic plants in Pearl Lake, especially invasives such as curly-leaf pondweed, Eurasian watermilfoil, and purple loosestrife. (Provost, Pearl Lake Aquatic Plant Survey, 2004)
- In 2009, the first comprehensive survey of Pearl Lake was conducted on behalf of the Pearl Lake Rehabilitation District to gather baseline information on Pearl Lake's chemistry, biology, and hydrology, and to address concerns about aquatic invasive species and water quality (Cason and Associates, 2011-2015)
- In 2014, UWSP published the Waushara County Lake Study for Pearl Lake (Haney, Turyk, & Rupp, 2014).
- In 2015, the Golden Sands Resource Conservation and Development Council sponsored a Clean Boats, Clean Waters project on Pearl Lake to control the spread of aquatic invasive species. This program is ongoing.
- In 2016, the UWSP Center for Watershed Science and Education developed a Lake Management Plan for Pearl Lake (Center for Watershed Science and Education, 2016)

4.0 NATURAL RESOURCE APPRAISALS, OBJECTIVES AND STRATEGY

To achieve water quality improvements within Pearl Lake, and improve habitat and ecological processes across the watershed, a set of objectives and strategies are presented below for each natural resource category.

4.1 WATER QUALITY – WATERSHED, TRIBUTARIES & LAKE

4.1.1 Watershed and Tributaries

A watershed is an area of land in which water drains to a common point such as a stream, lake or wetland. Pearl Lake is located within a 901-acre lake-direct catchment. This lake-direct catchment is in turn located within the Bruce Creek-Willow Creek HUC 12 watershed, which lies within the Willow Creek-Frontal Lake Poygan Watershed (Figure 5).

The nearest river or stream is Willow Creek (WBIC 243700), which flows through Waushara County, originating near Wild Rose and flowing east to Lake Poygan in Winnebago County.

4.1.2 Lake Water Quality

Pearl Lake has been the subject of numerous studies by the Pearl Lake PRD beginning in the early 1990s.

A wide variety of studies have examined the aquatic plant distribution, chemistry, hydrology, and shoreline development, among other factors. Water quality monitoring began in 1976 and has continued through 2022. The general condition of Pearl Lake is considered by the DNR to be “excellent,” although there are some concerns about the aquatic plant population in the lake, as referenced in the survey data included in Appendix B. Increased nutrient loading is known to promote aquatic plant growth and can offset lake ecosystem balance and the fishery. The Pearl Lake PRD seeks to evaluate septic systems around the lake, surface water runoff, and high water levels while continuing to monitor water quality and track changes in the local fishery and aquatic plants.

Nonpoint source contributions that may impact the lake and its watershed include erosion, animal waste, fertilizers, and leaf/grass litter, all of which result in sediment increases and nutrient enrichment. Sediment is a primary carrier of phosphorus. Phosphorus readily attaches to soil particles and is transported to the water body through the erosion process. When soil erodes, some or most of it, eventually reaches a water body. Once in the water, the sediment increases the turbidity of the water (the water looks muddy) and this turbidity can have adverse effects on fish and other aquatic organisms.

Nutrient enrichment, primarily from animal waste and commercial fertilizer, is detrimental to surface and groundwater quality. Surface water and groundwater contaminated by animal waste can cause serious illnesses if consumed by humans. Animal waste can also be hazardous to aquatic life. Phosphorus from manure enters waterbodies and acts as a fertilizer, stimulating massive algal and aquatic plant growth. When these organisms die, they are broken down by aquatic organisms, and this decomposition process leads to High Biologic Oxygen Demand, which consumes nearly all the oxygen in lakes and streams,

causing fish kills. Ammonia in manure is toxic and can kill aquatic life. Phosphorus in manure causes long-term eutrophication in lakes and streams.

Perhaps the greatest single pathway for phosphorus into the lake is via dissolved phosphorus picked up in rainwater and snowmelt, and overland runoff. Phosphorus from manure or chemical fertilizers, if not incorporated into the soil, quickly dissolves and can be mobilized by excess precipitation or runoff. A critical factor in phosphorus runoff is the level of phosphorus in the soil. When phosphorus levels in the soil are high, the element is easily dissolved by rainwater and removed from the land by runoff. Once in the runoff, it easily enters streams and lakes causing algae blooms and eutrophication. Thus, high levels of legacy soil phosphorus built up in the watershed from decades of agricultural use can be a persistent source of phosphorus inputs (Motew, et al. 2017).

Phosphorus, chlorophyll-*a* and Secchi disk transparency are common water quality parameters evaluated in lakes. Monitoring and evaluating concentrations of phosphorus within the lake permits a better understanding of current and potential aquatic plant growth rates.

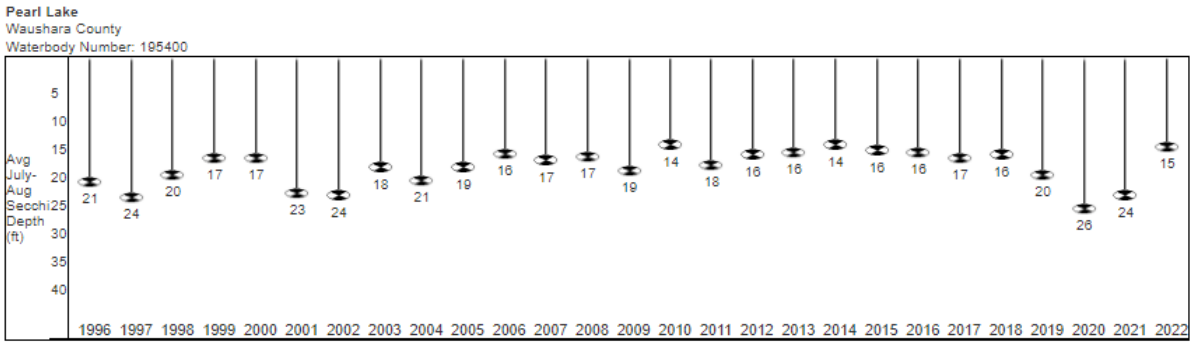
Chrolophyll-*a* is the green pigment in plants and algae used in photosynthesis and serves as an indicator of algal biomass chlorophyll-*a* concentrations are directly related to the abundance of free-floating algae in the lake, and chlorophyll-*a* is a useful measurement of the intensity of algal blooms.

Secchi disk transparency is a measurement of water clarity and is perhaps the most used and easiest to understand and interpret. Furthermore, measuring Secchi disk transparency over long periods of time is one of the simplest methods of monitoring the health of a lake.

Wisconsin bases its General Condition Assessment for lakes on the Carlson Trophic State Index (TSI). The Carlson TSI is the most commonly used index of lake productivity. It provides separate, but relatively equivalent TSI calculations based on chlorophyll-*a,* total phosphorus concentrations or Secchi depth. TSI values range from low (less than 30), representing very clear, nutrient-poor lakes, to high (greater than 70) for extremely productive, nutrient-rich lakes. Total phosphorus, chlorophyll-a and water clarity values are directly related to the trophic state of a lake. As nutrients, primarily phosphorus, accumulate within a lake, its productivity increases and the lake progresses through the following three trophic states:

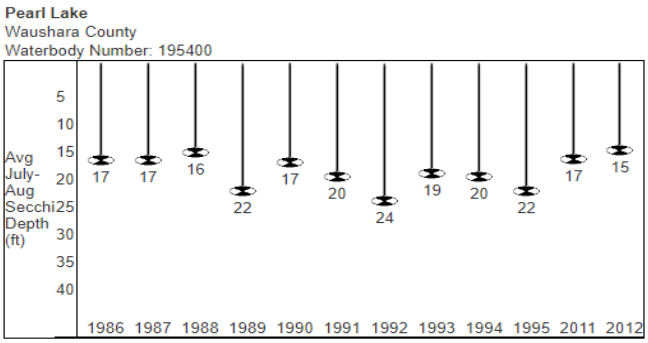
- Oligotrophic (low nourishment and productivity) — Oligotrophic lakes tend to be very clear with low phosphorus levels and low production of biological material.
- Mesotrophic (moderate nourishment and productivity) — Mesotrophic lakes are more fertile with higher phosphorus levels, and moderately clear water. Biological productivity is elevated including fish production.
- Eutrophic (high nourishment and productivity) — Eutrophic lakes are very fertile, supporting high productivity of algae, aquatic plants, and abundant quantities of fish. However, extremely eutrophic (hypertrophic) conditions, often due to excessive phosphorus inputs from agricultural runoff, urban stormwater, or leaking septic systems, lead to a variety of impairments to lake water quality. Problems can include excessive aquatic vegetation, frequent and severe algae blooms, low oxygen, winter fish kills, and reduced usability for recreational boating and swimming.

Water quality parameters within Pearl Lake have been monitored annually by volunteers since 1976. The West Basin of the Lake was monitored multiple times throughout the year in 1979, and from 1996 to the present, while the East Lobe of the lake was monitored between 1986-1995, in 1997, and during the period between 2010-2012. Volunteers monitor Secchi disk transparency (Figure 6 and 7), total phosphorus, total nitrogen chlorophyll-a, and other parameters, which are sent to the Wisconsin State Lab of Hygiene for analysis.



Past secchi averages in feet (July and August only).

Figure 6. 1996-2022 Secchi disk measurements from Pearl Lake- West Basin



Past secchi averages in feet (July and August only).

Figure 7. 1986– 2012 Secchi disk measurements from Pearl Lake- East Basin

Summer Secchi depth measurements taken from 1996-2022 in the west basin and from 1986-2012 in the east basin suggest the lake has maintained good to very good water clarity throughout that period. However, water clarity at the west lobe monitoring station has declined in recent years, from a record high of 26 feet in 2020 to 15 feet in 2022. According to the UW-Extension's Guide to Understanding Lake Data, Secchi depths lower than seven feet are considered poor or very poor, Secchi depths between seven and ten feet are considered fair, and depths exceeding 10 are good to excellent (Shaw, 2004) (Table 1).

Table 1 Water Clarity Index

Water Clarity	Secchi Depth (ft)
Very Poor	3
Poor	5
Fair	7
Good	10
Very good	20
Excellent	32

In 2022, water quality parameters were sampled within Pearl Lake in the West Lobe during four different days in late spring and early summer. The average summer chlorophyll-a was 2.4 µg/l (compared to a Southeast Georegion summer average of 25.4 µg/l). Summer chlorophyll-a concentrations are included in Figure 8. Concentrations have remained relatively stable over time but have experienced a downward trend since record high measurements were taken in the late 1990s and early 2000s.

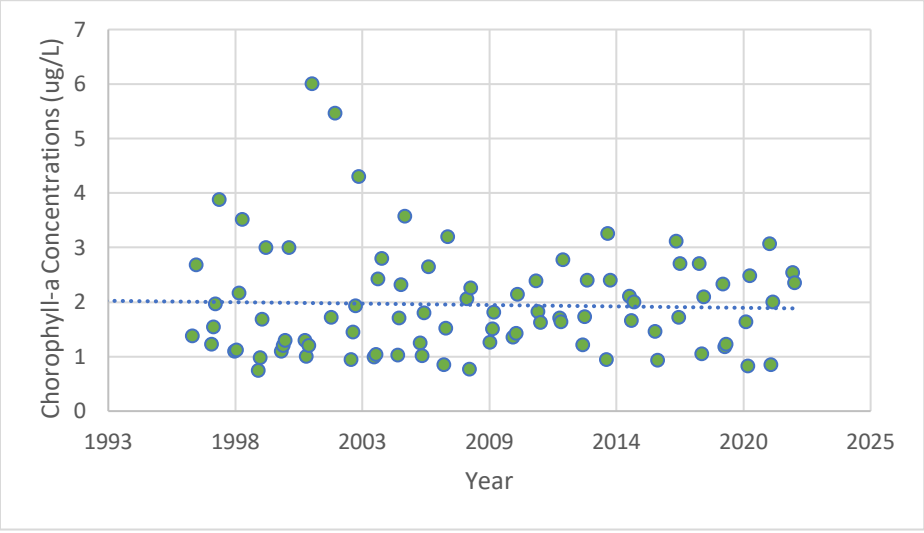
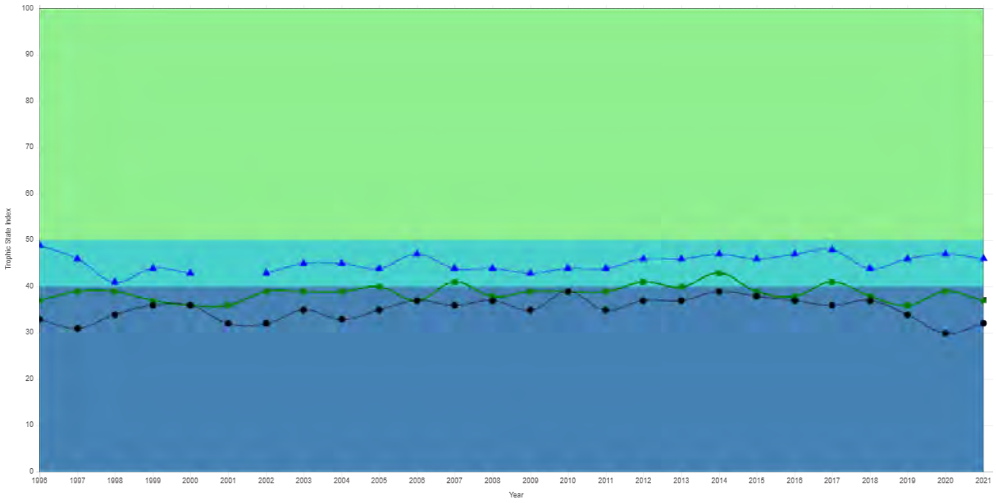


Figure 8. Summer Chlorophyll-a Measurements- Deep Hole (1996-2022).

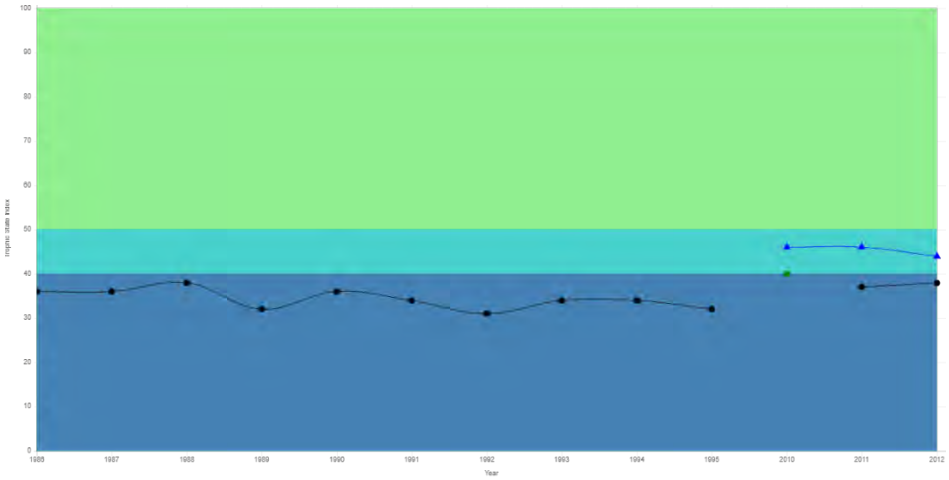
The overall Phosphorus TSI for Pearl Lake based on 2022 data was 46.5, suggesting a continued mesotrophic state (Figure 9 and 10). The average summer trophic state for the last 5 years, based on

chlorophyll TSI, was 38.7, which is excellent for a seepage lake (Table 2). Lakes with TSI values between 40 and 50 are considered mesotrophic. While characterized by good water clarity, as TSI increases within mesotrophic lakes, there is an increasing risk of low dissolved oxygen in the hypolimnion of the lake during the summer months.



- Secchi TSI ▲ Total Phosphorus TSI ■ Chlorophyll TSI

Figure 9. 1990 – 2012 TSI results from Pearl Lake- West Basin



- Secchi TSI ▲ Total Phosphorus TSI ■ Chlorophyll TSI

Figure 10. 1990 – 2012 TSI results from Pearl Lake- East Basin

Table 2. Trophic Status Index (TSI) thresholds – general assessment of lake Natural Communities.

Condition Level	Shallow			Deep			
	Headwater	Lowland	Seepage	Headwater	Lowland	Seepage	Two-Story
Excellent	< 53	< 53	< 45	< 48	< 47	< 43	< 43
Good	53 – 61	53 – 61	45 – 57	48 – 55	47 – 54	43 – 52	43 – 47
Fair	62 – 70	62 – 70	58 – 70	56 – 62	55 – 62	53 – 62	48 – 52
Poor	≥ 71	≥ 71	≥ 71	≥ 63	≥ 63	≥ 63	≥ 53

Dissolved oxygen is another important indicator of lake health. Levels of dissolved oxygen below five parts per million can result in die-offs of cold-water fish species and other bottom-dwelling organisms, and levels below three parts per million can threaten the survival of warm-water fish species as well. Dissolved oxygen is produced by plants and algae, but it gets consumed by bacteria when these organisms die and decompose. Levels of dissolved oxygen are influenced by factors such as water temperature, atmospheric pressure, and biological productivity.

Dissolved oxygen measurements taken in the summer from 2014-2022 show dissolved oxygen decreasing with depth up to the bottom of the lake at 45 feet (Figure 11). In 2014, 2015, 2017, 2019, 2021, and 2022, measurements show dissolved oxygen concentrations less than 1 mg/L at 40 feet, and in 2018 and 2020, measurements below 1 mg/L were observed at 35 feet.

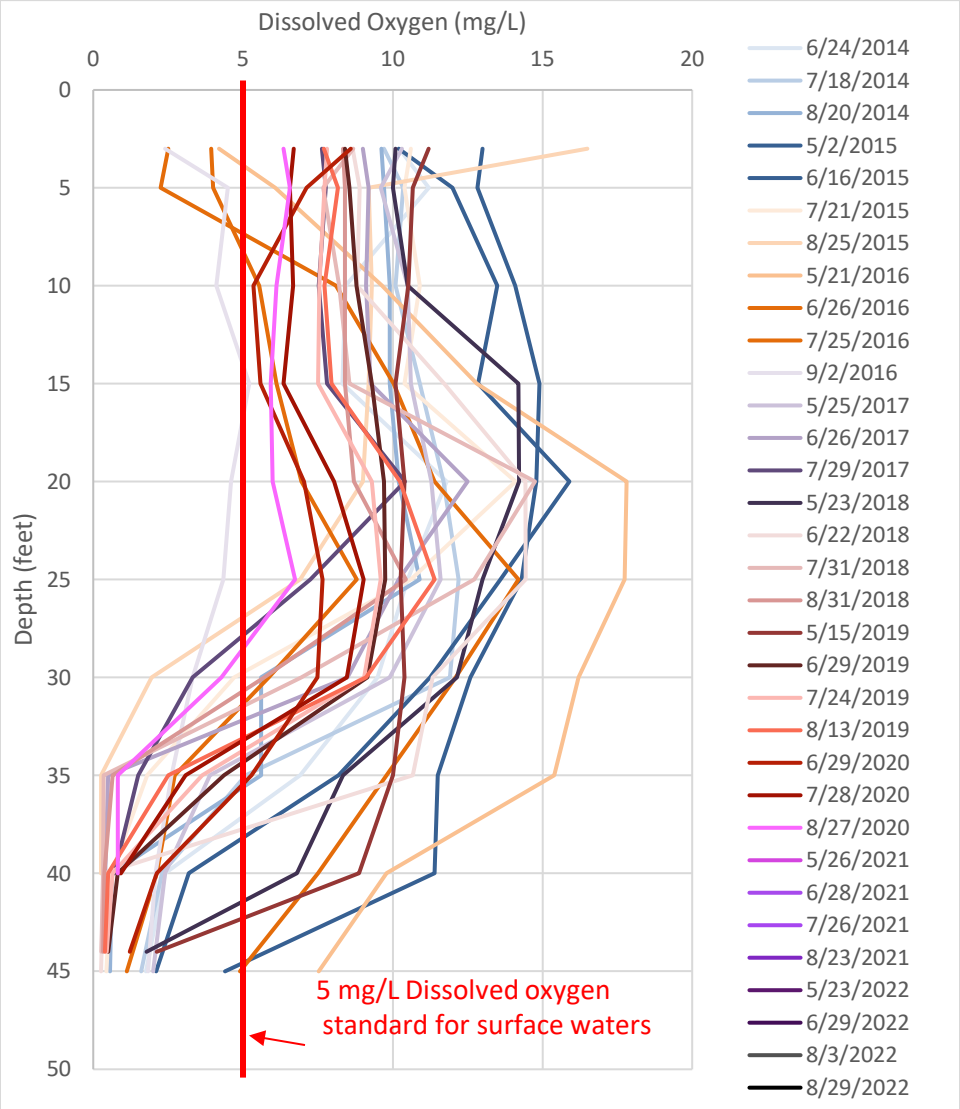


Figure 11. Dissolved oxygen measurements taken in the West Lobe of Pearl Lake (2014-2022)

Low dissolved oxygen at the bottom of the lake can be caused by a process called internal loading. Internal phosphorus loading describes the movement and recycling of phosphorus between the bottom sediments of the lake and the water column. Decomposer bacteria that break down detritus and sediments at the bottom of lakes consume oxygen in the process. This low-oxygen condition can trigger geochemical reactions that dissolve the previously insoluble phosphorus in the bottom sediments, allowing it to resuspend into the water column.

There are many factors that influence this process. One is temperature. During summer, lakes deeper than 20 feet tend to stratify, trapping nutrients in the bottom sediments, but in fall and spring, turnover events can re-suspend those nutrients in the water column.

The re-suspension of phosphorus from bottom sediments to the water column can be problematic because excess nutrients can cause algal blooms and excessive plant growth in the lake, contributing to eutrophication and impacting the ecological and recreational potential of the lake. Further studies are needed to determine the extent of internal loading in Pearl Lake.

Detailed water quality data from 1976 to 2022 can be found on the WDNR Pearl Lake citizen monitoring web site:

Pearl Lake (wi.gov)

Phosphorus is a limiting nutrient for algae, thus the amount of phosphorus is a critical driver in controlling lake fertility. Simply put, the more phosphorus entering the lake, the more plant growth, both aquatic macrophytes and algae. Excessive plant/algae growth in turn leads to problems including low oxygen and winterkills, which have resulted in a loss of desirable fish species from the lake (Surendonk, 1999). Many of the strategies in this Plan are focused on controlling phosphorus inputs. This is not the only nutrient concern; however, it is currently the most important for water quality protection. A confounding issue is that the phosphorus in the lake bottom sediments will continue to be resuspended into the water column for decades to come.

Although phosphorus TSI levels indicate oligotrophic conditions, total phosphorus measurements taken between 1976 and 2022 indicate that phosphorus concentrations have remained comfortably below the 20 ug/L standard for stratified, seepage lakes (Figure 12). Controlling phosphorus inputs to remain below this standard is important to maintaining good water clarity and controlling excess plant growth.

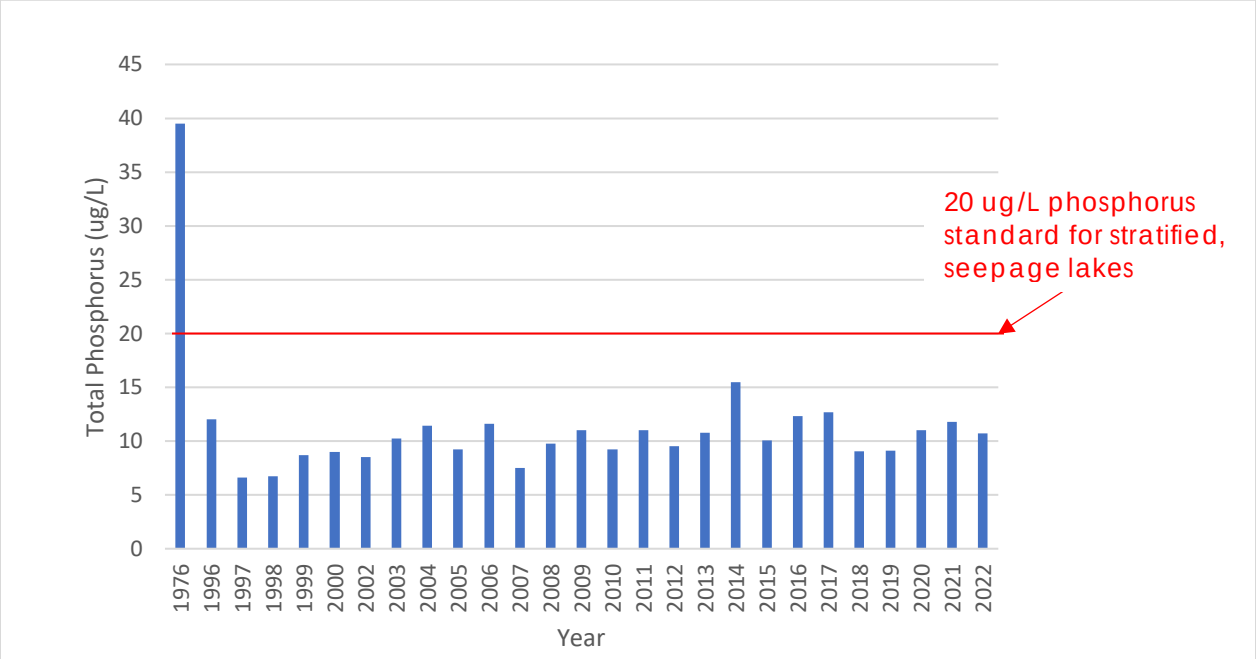


Figure 12. Average Yearly Total Phosphorus Measurements from the West Lobe of Pearl Lake (1976-2022)

POINT SOURCE LOADINGS

Point source discharges to waterways are regulated under the Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NDPES). It is implemented at the state level by Wisconsin's National Pollution Discharge Elimination System (WPDES), which grants dischargers permits to discharge pollutants at a certain level. There are no known WPDES point source dischargers in the Pearl Lake subbasin.

NONPOINT SOURCE LOADINGS

Phosphorus and sediment loadings to Pearl Lake are from nonpoint sources. Most lands contribute some type of nonpoint source pollution from the runoff that flows over them, but different land surfaces contribute different types of pollution.

Urban Area Sources

One main cause of nonpoint source pollution in urban areas is the amount of impervious surface. Surfaces such as asphalt and concrete do not allow for infiltration into the land, and water runs off these surfaces, carrying stormwater and its pollutants to surrounding soils and waterways. This urban runoff often contains pollutants such as road salts, vehicle wastes, and heavy metals. Construction sites also can contribute sediment and nutrient pollution from disturbed soils and construction materials. In addition, lawn areas in urban and suburban areas can contain fertilizers and pesticides that can cause water pollution, and lawn and leaf clippings can contribute to nutrient pollution as well.

The many septic systems in the watershed are a potential source of nonpoint source runoff to Pearl Lake. If not properly maintained, septic systems can leach nutrients and bacteria from human wastes into nearby waterbodies via groundwater contamination. The Wisconsin DNR's shoreland zoning guidance notes the potential of septic systems within 1000 feet of lakes to discharge pollutants into the nearby waterbody. These systems are a water quality concern and should be assessed to ensure that failing systems are identified and repaired.

Waushara County requires septic systems to be visually inspected every 3 years for signs of leaking and ponding. Pumping is required by be done by a licensed plumber, and certified soil testers must test soils prior to issuing a septic permit.

Compliance to these guidelines is necessary to ensure that septic seepage is not occurring.

Agricultural Area Sources

In agricultural areas, nutrients applied to farmland such as fertilizers, animal manure, and sludge often contribute a large amount of nutrient pollution to surrounding waterways. Crop residues, sediment losses from farmland, and irrigation water also contribute to this problem.

4.2 NONPOINT SOURCE WATERSHED MODELING

Stantec conducted two nonpoint source watershed models to estimate phosphorus and sediment loading in the Pearl Lake watershed.

STEPL MODEL

The first model is the Spreadsheet Tool for Estimating Pollutant Loads (STEPL) model, which was conducted using publicly available watershed data and assistance from Sheboygan County and the WDNR. The STEPL model was developed by the Environmental Protection Agency (EPA) to evaluate loading and potential load reductions from the utilization of best management practices (BMPs) on a variety of land types. Inputs to the model include weather data, land use, agricultural animal counts, Universal Soil Loss Equation values, manure spreading rates, septic system information, and other pertinent watershed information. This data is used to calculate loadings based on the runoff volume and the pollutant concentrations in runoff. BMPs and their estimated efficiencies are taken into account and additional BMPs can be added to achieve target load reductions.

Land Use

One major input to the STEPL model was land use data. To support the modeling efforts, National Land Cover Database (NLCD) system from 2019 was obtained. NLCD mapping is conducted and published by a consortium of federal government agencies and covers the entire United States in one consistent system. According to the 2019 NLCD mapping, general land use is the Pearl Lake watershed is distributed as shown in the following Table 3. This land use data was adjusted based on aerial survey and information provided by Waushara County, and those adjustments are included in the table. Some additional land use subcategories were used for the detailed phosphorus modeling. STEPL uses the simplified land use of cropland, pastureland, urban, forest, feedlot, and “user defined” categories to estimate pollutant loadings from each land type (Table 4). For this study, the “user defined” category encompassed shrublands and grasslands and was given low runoff values to reflect these land uses. For accuracy, the “feedlot” category only encompasses feedlots that drain to waterways within the basin. There were no feedlots identified that drain to waterways in the Pearl Lake watershed.

Table 3. NLCD Land Use Distribution in Pearl Lake Direct Watershed

Land Use Description	NLCD Acres	Adjustment
Open Space in Developed Areas	64	64
Low Intensity Development	25	25
Medium Intensity Development	3	3
High Intensity Development	0	0
Cultivated Crops	82	10
Pasture/Hay	16	68
Grassland/Herbaceous	6	6
Open Water	108	108

Land Use Description	NLCD Acres	Adjustment
Barren Land	1	1
Forest	452	452
Shrub/Scrubland	9	29
Wetlands	135	135
Total	**901**	**901**

Table 4. Land Use Categories for STEPL Modeling

Land use major category	Area (acres)	Percent of total
Cropland	10	16%
Forest	452	21%
Pastureland	52	9%
Urban / road right of way	92	29%
Grassland/Wetland	187	7%
Open water	108	18%
Total	**901**	**100%**

Septic Systems

Waushara County reports that most, if not all, of the residences around Pearl Lake are serviced by private onsite wastewater treatment systems (POWTS). A survey of parcels around the lake shows that there are approximately 290 residences within 1000 feet of Pearl Lake with the potential of discharging to Pearl Lake in the event of septic failure (Figure 13). Given an average septic failure rate of 2% as provided by the STEPL model, there would be 5.8 failing septic systems in the lake-direct watershed, discharging 986 gallons per day, and contributing 70.6 pounds of phosphorus per year.

However, it should be noted that Waushara County requires visual inspection of these systems, so loadings of this magnitude may be an overestimate. A full septic survey is recommended to ensure that septic systems are not leaching nutrients to the lake.

Results

By inputting the general subbasin and BMP information into the STEPL model, the model provided estimates on the amount of loading occurring in the subbasin. Due to its simplicity and calibration using edge of field monitoring, the STEPL model tends to overestimate nutrient loadings as compared to a more detailed model, such as SWAT. However, these loadings can be used as a baseline by which to compare the efficiencies of BMPs. These estimates are included below.

The baseline loadings in the Pearl Lake subbasin, as determined by the STEPL model, are as follows:

Phosphorus – 148 pounds/year

Sediment – 19 tons/year

Nitrogen - 604 pounds/year

According to the STEPL model, the two largest sources of phosphorus in the subbasin are runoff from urban (26%) and cropland (10%) areas. Septic discharges are also shown as a large source of phosphorus (48%), however estimates are estimated based on a 2% failure rate (as provided by the STEPL model) and are likely an overestimate (Figure 14). Septic system inputs can be refined via septic surveys, as discussed above.

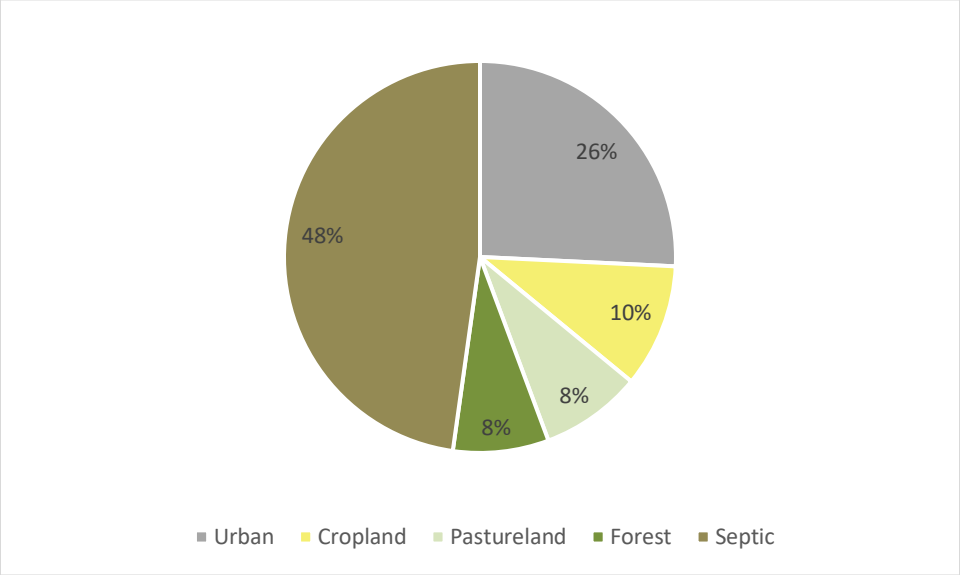


Figure 14. Phosphorus Loading in the Pearl Lake Subbasin by Land Use and Source

WiLMs/PRESTO Model

Because the STEPL tends to overestimate nonpoint source pollutant loadings, the Unit Area Loading model was also used to give a more accurate representation of the nonpoint source loadings in the watershed.

The model is based upon watershed land uses and phosphorus export coefficients. This method is consistent with the approach used to model nonpoint watershed phosphorus loading in the DNR's Wisconsin Lake Modeling Suite (WiLMS). It is also one of the procedures in the DNR's PRESTO (Pollutant Load Ratio Estimation Tool) model.

To use the Unit Area Loading model, the following categories of data were required:

- Total watershed area, from Geographic Information System (GIS) mapping and analysis
- Land use, from GIS data
- Phosphorus export coefficients (database)

Phosphorus Export Coefficients

For the WDNR WiLMS/PRESTO model, the major input required is phosphorus export coefficients. A database of phosphorus export coefficients from the DNR's PRESTO and WiLMS models were used in this study. This database was obtained from the PRESTO Documentation Manual (Version 1.1, published by Wisconsin DNR, March 2013) and is shown below (Table 5).

One benefit of the DNR's database is that three estimates of phosphorus exports coefficients are given: a low value, a most likely value, and a high value. This recognizes the wide variability and uncertainty in phosphorus loads and concentrations for any given watershed. Rather than a single number, phosphorus model results should be viewed as a range of likely loads. Using the variability in phosphorus export coefficients, possible variation in total watershed phosphorus loads can be reported.

Table 5. Phosphorus Export Coefficients for Modeling

Land Use Description	Export Coefficient (lbs of phosphorus / square mile / year)		
	Low	Most Likely	High
Open Space in Developed Areas	57	171	286
Low Intensity Development	29	57	143
Medium Intensity Development	171	286	457
High Intensity Development	571	856	1,142
Cultivated Crops	286	571	1,713
Pasture/Hay	57	171	286
Grassland/Herbaceous	57	97	143
Open Water	0	0	0
Barren Land	0	0	0
Forest	29	54	103
Shrub/Scrubland	43	74	123
Wetlands	0	0	0

Results

Using the methods described above, estimated total phosphorus loads to Pearl Lake from nonpoint sources in the upstream watershed were also calculated. The loading estimates are included in Table 6 below.

Table 6. Total Nonpoint Phosphorus Loads from Watershed

Estimate Range	Total P (lbs/average year)
Low end	41
Most Likely	90
High end	173

Table 7. Total Phosphorus Loads by Land Use

Land Use Description	Average nonpoint phosphorus load, lbs/ac/yr
Open Space in Developed Areas	17
Low Intensity Development	2
Medium Intensity Development	1
High Intensity Development	0
Cultivated Crops	9
Pasture/Hay	18
Grassland/Herbaceous	1
Open Water	0
Barren Land	0
Forest	38
Shrub/Scrubland	3
Wetlands	0
Total	**138**

Note that the loads shown in the tables are not cumulative loads but represent the incremental load to each the outlet from direct runoff from the subbasin.

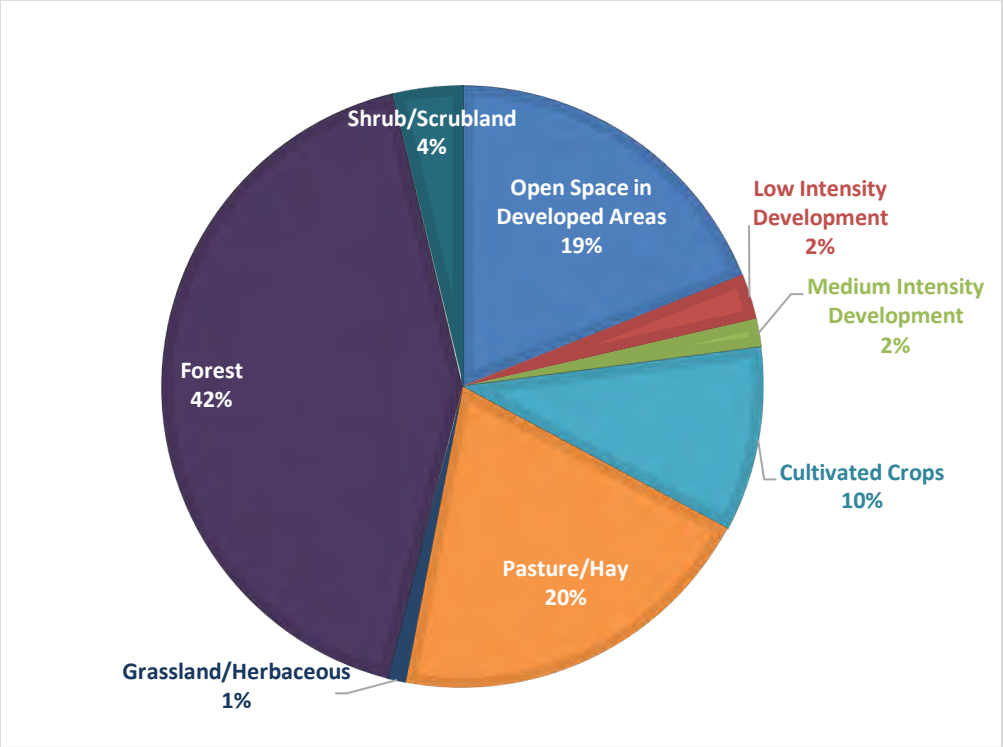


Figure 15. Unit Area Loadings by Land Use in the Pearl Lake Watershed

The results of the STEPL and PRESTO/WiLMS models show that the majority of the nonpoint source pollutant loading in the Pearl Lake watershed originates from runoff from urban areas. The PRESTO/WiLMS model is likely to reflect the nonpoint source pollutant loadings more accurately in the watershed relative to the STEPL model. The STEPL model was used in order to quantify BMP reductions to the nonpoint source loadings. In addition, the STEPL was able to provide an estimate of septic loadings to the lake, and demonstrates that there may be considerable nutrient pollution originating from septic systems around the lake.

WATER QUALITY STRATEGIES AND OBJECTIVES

Water quality improvement strategies and objectives for Pearl Lake include:

1. Monitoring: Continue volunteer-led water quality sampling on Pearl Lake. If nutrient levels rise, consider expanding to year-round dissolved oxygen measurements to evaluate potential for internal phosphorus loading from bottom sediments.

2. Septic Inventory: STEPL results estimated that the loading from septic tanks near Pearl Lake is contributing approximately 70.6 pounds of phosphorus annually. This is approximately 46% of the estimated annual contribution from nonpoint sources in the watershed. While Waushara County visually inspects these systems for leakage, the condition of most septic systems in the watershed is unknown and therefore, a high degree of uncertainty exists when estimating potential loadings. This estimate could be refined with additional data on population, residence usage, site soil conditions, and age/condition of septic systems.

3. Phosphorus Reduction: To preserve the excellent water clarity of Pearl Lake, total phosphorus inputs to the lake should be controlled. A TMDL for the Bruce Creek- Willow Creek watershed will establish appropriate phosphorus reduction goals to limit phosphorus runoff in the watershed. According to the Waushara County Land and Water Resource Management Plan, published in 2021, the County approved a 10-year phosphorus reduction goal of 10% for agricultural lands every year from 2024 to 2034 for all watersheds in Waushara County. This Plan proposes at least a 20% phosphorus reduction goal by 2024, with actions proposed to achieve greater than 20% phosphorus reduction by 2026.

   Due to the high density of single-family urban development in the Pearl Lake watershed, several urban BMPs were modeled in STEPL and their phosphorus efficiencies are included in Table 8.

Table 8. Phosphorus Removal Estimates for BMPs on Single-Family Residences

Description	Total phosphorus load (lbs/yr)	Estimated removal efficiency	Phosphorus removal (lbs/yr)
Rain Barrels/Cisterns (100% of Drainage Area)	29	25%	10
Bioretention (100% of Drainage Area)	30	24%	9

Description	Total phosphorus load (lbs/yr)	Estimated removal efficiency	Phosphorus removal (lbs/yr)
Rain Barrels/Cisterns (50% of Drainage Area)	36	6%	2
Bioretention (50% of Drainage Area)	34	12%	5
Grass swales (100% of Drainage Area)	39	7%	3
Grass swales (50% of Drainage Area)	37	4%	1
Weekly Street-Sweeping (100% of Drainage Area)	38	2%	1

4. Restore and Protect Habitat Quality: Restore and/or improve stream and shoreline habitat, riparian and watershed wetlands and uplands to improve water quality within Pearl Lake (Figure 16). Restoration activities will improve resilience of the lake ecosystem as it relates to the frequency and magnitude of flood or drought events. Resilience of the ecosystem will come from wetland preservation, restoration and possible construction of new wetlands, as well as enhancement of BMPs. These enhancements could include BMP (retention basins, artificial wetlands, stormwater management systems, rain gardens, buffers) construction, reconstruction, or modifications to accommodate more flooding events.

   Protecting or enhancing the ecological integrity of the wetlands in Pearl Lake watersheds is critical to filtering surface water flows and reducing phosphorus inputs to Pearl Lake. Where feasible, wetland restoration should be considered on marginal/fallow agricultural lands.

   At present, there are three critical habitat zones around the lake (Figure 17). These sites, designated by the WDNR in 2004, have significant value as habitat and provide crucial ecosystem services for the lake, such as water filtration and flood protection. These areas should be protected from any shoreline modifications or native species removal unless permitted by the WDNR (Provost, Pearl Lake Sensitive Area Designation Report, 2004).

POTENTIAL FUTURE ANALYSIS

The modeling conducted for this Plan is envisioned as the first step in a process of adaptive analysis, planning and implementation. As scoped in the WDNR grant, watershed sediment and phosphorus loads were estimated using unit area loading techniques and a STEPL modeling approach. As resources, time, and funding permit, there are numerous analysis and planning tasks that can be undertaken to refine the analysis of existing conditions and enhance management planning.

Detailed Assessment of Current Watershed Management Measures

This initial nonpoint pollutant loading analysis is based primarily on land uses, drainage areas, and typical phosphorus contributions from average Wisconsin agricultural areas. Predicted phosphorus loads do not account for existing management measures that may already be implemented in the watershed. In the future, management measures already being implemented on individual farms could be reviewed with stakeholders, to credit these existing practices in the analysis.

4.3 HYDROLOGY

As a seepage lake fed primarily through groundwater inputs, Pearl Lake is not currently connected by surface level hydrology to other surrounding waterbodies. The lake is lined with single-family residences and is bordered on the north, west, and east by Pearl Lake Road and on the east by County Road EE. The lack of a lake outlet leaves lakeside property owners susceptible to flood damages when water levels are high.

Waushara County has monitored lake levels from 1975 to 2021, recording an average lake elevation of 817.81 MSL over that time period (Figure 18). Recent data shows that in July of 2020, lake elevations reached a record high level of 820.08 MSL. There are some anecdotal reports of this period of high lake levels resulting in property damage around the lake shoreline, including damage to homes and boating infrastructure. The high water levels also cause erosion issues, such as washout under Pearl Lake Road.

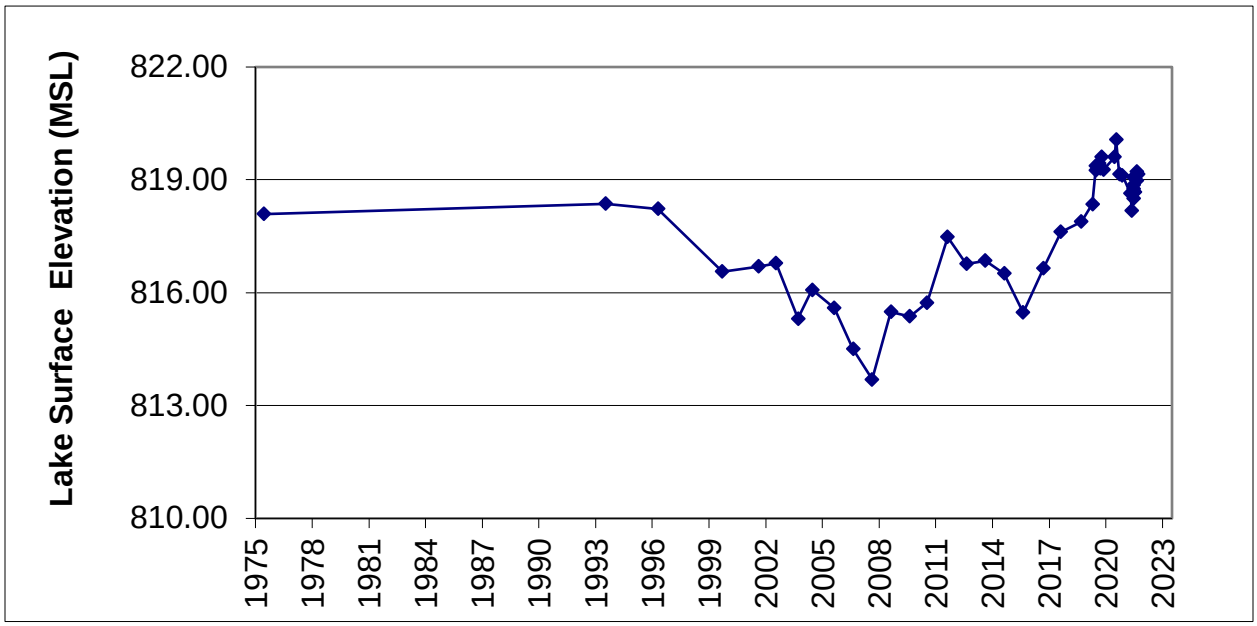


Figure 18. Water Surface Elevation Readings (1975-2021)

HYDROLOGY STRATEGIES AND OBJECTIVES

Stantec was contracted to investigate possible solutions to these problems and began work on a hydrology study to do so. One possible solution put forward by a group of stakeholders was to investigate whether there was a historical outlet on the west side of the lake that drained through a wetland area to nearby Willow Creek, and if so, to re-establish this connection. Historical data was insufficient to confirm a historic surface water connection, but Stantec suggested several solutions to the high-water level problem including gravity flow and pumping options, as described below.

1. **Establish a gravity outflow from the lake to the wetland on the west side of the lake which is tributary to Willow Creek.** One way to accomplish this would be to construct a short culvert through a property on the west side of the lake under Pearl Lake Road, to provide a surface water connection to the marsh west of Pearl Lake Road. The culvert could potentially be widened, which would allow for fish passage and enhanced aquatic habitat. This would require cooperation from the landowner, ground disturbance, tree removal, and an existing shed to be relocated. The gravity flow option is shown in green in Figure 19 below.

2. **Install a long gravity sewer from the northwest corner of the lake to west of 24th Road.** The sewer would run through the properties of cooperating landowners in the northwest corner of the lake. This would result in a much longer length of pipe, approximately 2,200 feet. To allow for a continuous slope for gravity flow of water, this pipe would have to be installed at depths of up to 60 feet, under the hilly high ground along the route. Trench excavation and surface installation of a pipe at this depth is not feasible and tunneling would have to be used to install the pipe. This would be a very costly project, with an estimated construction cost of at least $3 million. However, it avoids the need to install a culvert and relocate structures on private property and it also avoids the operation and maintenance costs of a pumping station. Possible locations for this sewer are shown in blue and yellow in Figure 19 below.

Figure 19. Potential Gravity Sewer Locations

3. **Install a pump outflow from the lake.** Another option would be to install a pump station near the lake shoreline, and pump water to a discharge pipe. The discharge pipe would be routed to Pearl Lake Road, and then along the road to the western marsh. The pump station, and pipe connecting the lake to Pearl Lake Road, could be installed at multiple locations, depending on open land availability and landowner cooperation. There also appears to be a public right-of way to the lake that could potentially serve as a location for a pumping station. Waushara County confirms that this is public land, but a surveyor and/or attorney would need to be retained to analyze further details about the exact boundaries and status of this land.

Alternatively, a pump station and pipeline could be installed on private property of a cooperating landowner. One benefit of pumping is that the pipeline can be installed at a shallower depth, because water does not need to flow by gravity the entire way. So, the pipe could be installed by surface trenching, at depths of 8 to 10 feet, and the need for costly tunneling would be eliminated or reduced.

Instead of constructing a permanent pump station, a temporary pumping system can be rented and operated, each time the lake level needs to be lowered. This type of system is typically delivered on a large trailer, so truck access to a location near the lake shoreline would need to be established. They are typically diesel-fuel powered. A temporary pipeline, probably some sort of flexible hosing, would also be installed.

The hydrology study for Pearl Lake was suspended as water levels dropped down to average levels in 2021. However, if water levels rise and become problematic again, these options can be reconsidered.

These options all require consideration of potential impacts to wetlands and surrounding waterbodies. These options would need to be considered by the DNR. Additional studies would likely be required for the applicant to provide enough detail for the department to make permitting decisions.

4.4 FISHERY

Pearl Lake supports natural populations of panfish, Largemouth bass, and Northern Pike.

A Fyke netting survey conducted in March and April of 2021 by the WDNR measured a high abundance and density of lower-sized Northern Pike, with estimates of the population at 348 fish. The size structure of the population is low, with a proportional stock density of 4, which is in the 2nd percentile compared to other Wisconsin lakes. Overall, the Northern Pike population in Pearl Lake is below average, having 3.5 adult Northern Pike per acre.

Electrofishing surveys conducted in 2021 (Appendix E) documented a moderately high abundance of Largemouth Bass, with a moderate size structure. The proportional stock density has increased significantly since the last survey in 2012. However, only 6% of fish larger than 8 inches were also of legal size. Limited optimal habitat for Largemouth Bass has been observed in Pearl Lake.

Healthy populations of panfish were also observed in this survey, with an abundance of bluegill of adult sizes, and a presence of Black Crappie, Yellow Perch, Green Sunfish, White Suckers, Yellow Bullhead and Horneyhead Chubs.

Despite supporting a healthy fishery, slower growth rates of Northern Pike and Largemouth Bass suggest a decline in optimal habitat for these species. Woody debris and aquatic vegetation support crucial habitat for fish. Woody material along shorelines may have been removed over the years. It is recommended that woody debris such as fish sticks be restored along shorelines to support this critical habitat for fish.

FISHERY STRATEGIES AND OBJECTIVES

1. Ensure the protection and maintenance of sensitive areas for nursery, feeding, shelter through support of cross strategies for aquatic plants and water quality.
2. Provide additional woody debris and emergent plants to improve fish habitat. Improve shoreline habitat by planting native plants along shorelines. Allow trees near the shoreline to drop naturally into the littoral zone of the lake to provide additional habitat.
3. Conduct routine sampling to assure the health of the fishery.
4. Work with WDNR to adjust stocking strategies and regulations to balance the fishery.
5. Enhance existing wetland connections to the lake (Figure 16) to provide additional spawning and rearing habitat for fish. Enhancements should include removal of invasive herbaceous and shrub species within the wetland area, re-establishment of native vegetation and recontouring of wetland topography to facilitate spawning.

4.5 SHORELINE HABITAT

Shorelands are very beneficial in terms of nutrient retention and filtration. Shorelands are also important for habitat for native species, and shoreline stabilization. Research has shown that coarse woody habitat, often within natural or undeveloped shorelines, provides many ecosystem benefits in a lake. Coarse woody habitat describes habitat consisting of trees, limbs, branches, roots and wood fragments at least four inches in diameter that occur along the shoreline. Coarse woody habitat provides shoreland erosion control, a carbon source for the lake, prevents suspension of sediments, provides a surface for algal growth which is important for aquatic macroinvertebrates, and perhaps most importantly, provides crucial habitat for fish. Shoreline development, land conversion, cleared and mowed vegetation, pier development and removal of trees and logs have collectively removed important shore structure that would otherwise support habitat for fish and wildlife, increase biodiversity, and improve water quality and general aesthetics.

Pearl Lake shoreline development began sometime after the late 1930s. Shoreline mowing and maintenance as lawn decreases water quality by increased inputs of phosphorus and sediments into the lake. Removal of native plants and deadwood from shallow, near-shore areas, most often to allow for boating and swimming, negatively impacts habitat for fish, mammals, birds, insects and amphibians, while leaving the bottom and shoreline sediments vulnerable to wave actions. The protection of biologically and structurally diverse shoreline areas and adjacent wetland/upland interface is critical for sustaining a healthy lake.

Waushara County Land Conservation Department conducted a shoreline survey in 2022. Shoreline zones were assessed for quality based on the degree of natural vegetation, human influence, erosion, and presence of structures. The results are shown in Figure 20.

In 2011, the University of Wisconsin-Steven's Point's Center for Land Use Education conducted a similar shoreline survey (Figure 21).

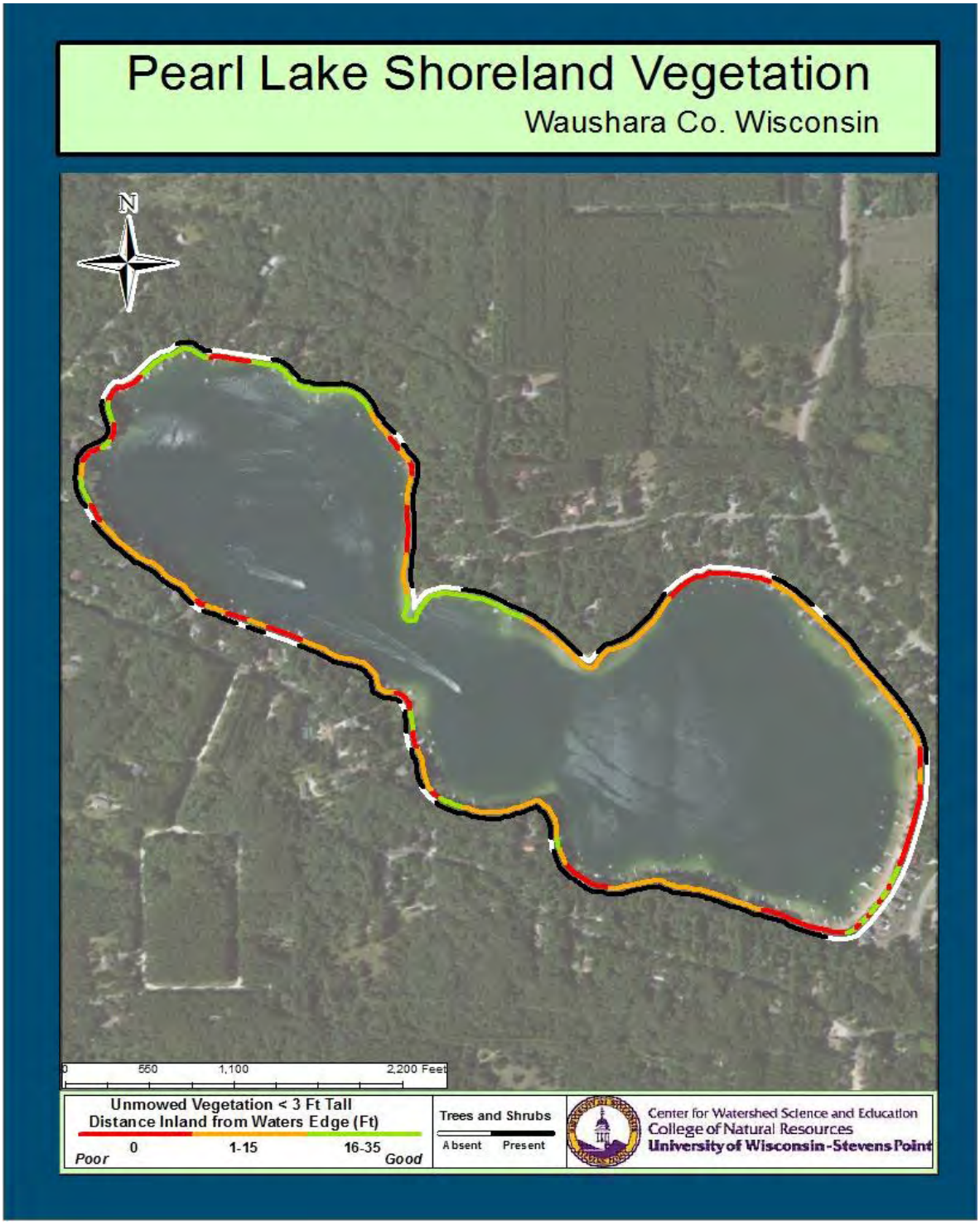


Figure 21. Pearl Lake Shoreline Survey Results (2011)

Compared to 2022 survey results, there has been a deterioration of many shoreline zones. The 2011 survey results show large areas of good to excellent shoreline quality, particularly along the south shore of the lake. Much of this area received lessor scores in the most recent survey. In addition, a large stretch of shoreline on the northern side of the western lobe has degraded. Shoreline protection is crucial to lake health, and these areas should be targeted for restoration in order to sustain a balanced lake ecosystem.

LAKE AND SHORELINE HABITAT STRATEGIES AND OBJECTIVES

1. Encourage natural, undeveloped or unmanicured views of the shoreline, with abundant coarse woody habitat, native shoreline vegetation, and diverse submergent, emergent, and floating-leaf plant communities.
2. Target areas of shoreline deterioration for potential shoreline improvement projects combine with fish habitat projects, where applicable.

4.6 AQUATIC PLANTS

Aquatic plants have a very important role within lake and wetland ecosystems. Not only do they produce oxygen for other organisms, but they also provide necessary habitat to sustain healthy organism populations. They help to keep water clean within lakes and wetlands by absorbing excess nutrients such as phosphorus and nitrogen. Excess phosphorus and nitrogen in waterbodies can lead to excessive algae blooms, which can in turn harm fish and microorganisms. Aquatic plants can also help in controlling wave height, thus limiting the amount of erosion caused by waves hitting the shoreline. Aquatic plants are also essential for providing food for fish, micro-invertebrates and other aquatic organisms. Healthy, diverse aquatic plant communities are also important for keeping non-native or invasive species in check. By giving the invasive plants competition for space, this helps to keep invasive plants from flourishing, and allows people more time to respond to an infestation of non-native plants.

Aquatic invasive species (AIS) are organisms that are introduced to an ecosystem that can disrupt the ecosystem function. They typically thrive in new ecosystems as they lack the predators, they encounter in their native habitat ranges. They can also typically tolerate a wide range of living conditions, making them harder to eradicate over a large area. They also have a competitive edge over native species, meaning they begin growing earlier in the season, thus out competing native species. Eurasion Water Milfoil (*Myriophyllum spicatum*), Curly Leaf Pondweed (*Potamogeton crispus*), and Yellow Iris (*Iris chrysophylla*) are examples of aquatic invasive species that are present in Pearl Lake. Additional plant growth may assist in reducing phosphorus and nitrogen levels during the growing season, however once the plants begin to die off these excess nutrients are re-released back into the environment. These excess nutrients can cause oxygen levels to drop, thus choking out native species and depriving organisms of necessary oxygen. Curly leaf pondweed begins growing in the late stages of winter, giving it an advantage over the native plants. Once the plant disperses its turions, it begins to die off. If the curly leaf pondweed is dominant and over abundant, this large die off can be detrimental to native species as this can create eutrophic conditions. In a healthy ecosystem, each plant serves a specific function, and can be part of a symbiotic relationship with other species within the ecosystem. Invasive species can be detrimental to these relationships between native species.

Pearl Lake has been impacted by stressors, including introduction of AIS that are currently spreading in Wisconsin lakes and having an impact on fisheries and aquatic habitats. Eurasian Water Milfoil (EWM) was identified by the WDNR in 1994. Curly-Leaf Pondweed was discovered in 1977. Eurasian water milfoil is currently the dominant AIS concern in the lake. Nuisance aquatic vegetation exists, in part, because of this species abundance and distribution in the lake.

EWM and Hybrid Watermilfoil (HWM) have been surveyed almost every year in Pearl Lake since 2009. Distribution maps for years 2018-2021 are included in Figures 22 through 25. In 2018, (Figure 22), EWM was observed as scattered, small groups, with one small area of moderately dense grouping on the western shoreline. That year, three acres were treated with Navigate (granular 2, 4-D). In 2019 (Figure 23), EWM and HWM spread, with more areas of scattered growth, two areas of moderately dense growth, and one area of dense growth on the south side of the lake. In 2019, one acre was treated with Navigate. In 2020, EWM and HWM growth appeared to die back, with several areas of scattered growth, but no areas of moderate or dense growth (Figure 24). That June, two acres were treated with a combination of Aquastrike, Pondilla Pro Adjuvant, Aquasticker Adjuvant, and Polyan Weighting agent. A fall survey in 2021 (Figure 25) shows a significant increase in EWM and HWM that fall, with the majority of the shoreline covered with EWM or HWM, and moderately dense to dense clusters of the plants in many areas along the shoreline. Hand pulling was performed in June 2021.

The most recent aquatic vegetation surveys of Pearl Lake were conducted by Golden Sands RC&D in July and August of 2022. Golden Sands RC&D conducted a Point Intercept (PI) Aquatic Plant Survey on July 26-27, 2022. The survey was completed according to the point-intercept sampling method defined in the WDNR draft guidance entitled “Aquatic Plant Management in Wisconsin” (Wisconsin Department of Natural Resouces, 2005). This survey repeated sampling identical to past whole-lake surveys and at established sample points.

The native plants identified during the 2022 survey were found to be diverse, but mostly concentrated along the shallow edges of the lake. The two most common types of vegetation identified were muskgrass (*Chara sp*.) and Nitella (*Nitella sp.*) both of which are macro-algae. The most common true plant identified was Southern naiad (*Najas guadalupensis*), with a 16.6 % littoral frequency of occurrence. The native plant population was found to be diverse, yet relatively sparse. The species richness was given a value of 17, which is close to but exceeding the statewide average of 16.8. The Floristic Quality Index (FQI), which measures the plant community’s closeness to an undisturbed condition, was 25, which is almost one point higher than the statewide average, indicating that the native plant community in Pearl Lake is of decent quality compared to other lakes in the state. The FQI reported in 2019 was 23, which indicates that the diversity of native plant populations has improved from 2019 to 2022 (Golden Sands, 2019).

The top six native species in abundance were:

1) Muskgrasses
2) Nitella
3) Aquatic Moss
4) Variable Pondweed (*Potamogeton gramineus*)
5) Slender Naiad (*Najas flexilis*)
6) Wild Celery (*Vallisneria americana*)

The 2022 PI survey found EWM/HWM to have a 6.32% littoral frequency of occurrence, compared to 2.91% in 2019. 2022 EWM/HWM sites and densities are shown in Figure 26. Although there is a scattering of EWM/HWM around the lake, most observations were visual only or had a rake fullness of 1. This indicates low to moderate densities of EWM/HWM within the littoral zone of Pearl Lake, as represented by the PI grid. No curly-leaf pondweed was identified, likely because of its tendency to die back as the lake warms in the summer. The Golden Sands RC&D Point Intercept Aquatic Plant Survey is included in Appendix D.

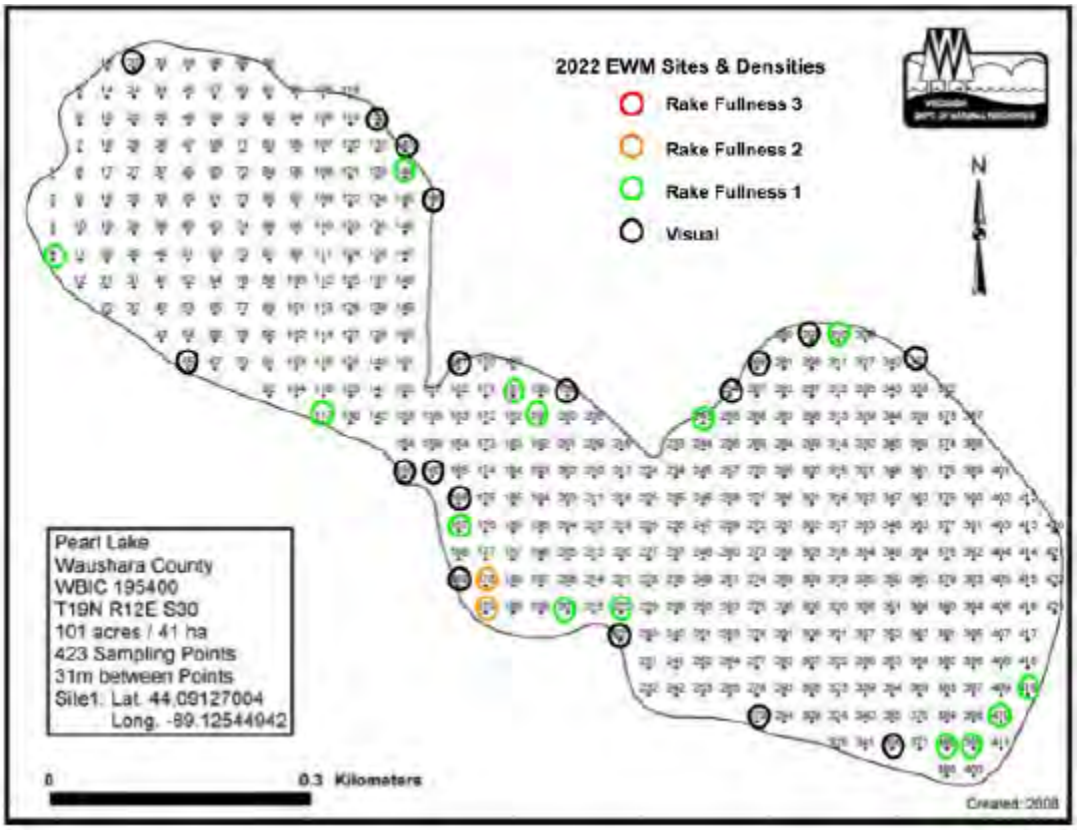


Figure 26. Density of Eurasian Watermilfoil in Littoral Zone of Pearl Lake (Golden Sands RC&D, 2022)

Golden Sands RC&D also conducted an EWM/HWM survey on August 23, 2022 to document distribution and acreage of EWM/HWM on Pearl Lake. The purpose of this study was to guide management recommendations for EWM/HWM. Figure 27 shows the results of the survey and shows areas of moderate to high density EWM/HWM over an area of approximately 9.3 acres. The Golden Sands RC&D EWM Survey Report is included in Appendix D.

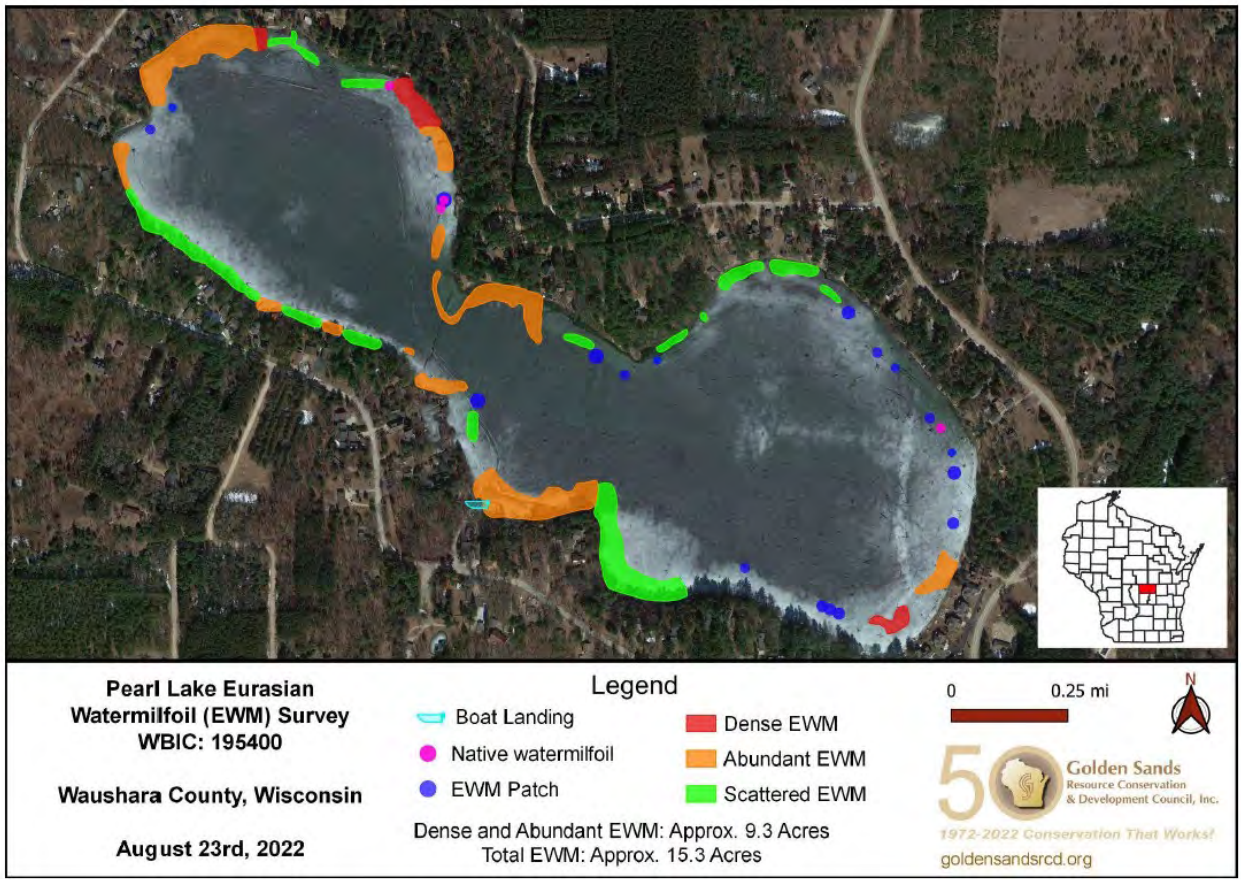


Figure 27. Distribution of Eurasian Watermilfoil in Littoral Zone of Pearl Lake (Golden Sands RC&D, 2022)

WLPR was contracted to evaluate the results of previous studies and 2022 surveys and provide recommendations for aquatic plant management. WLPR compared surveys from 2019 and 2022 to determine changes in plant communities in recent years. As shown in Figure 28, eight species saw an increase in occurrence and two species decreased. EWM populations more than doubled from 2019 to 2022, and total coverage in August 2022 was estimated at 15.3 acres (Figure 27, Golden Sands RC&D).

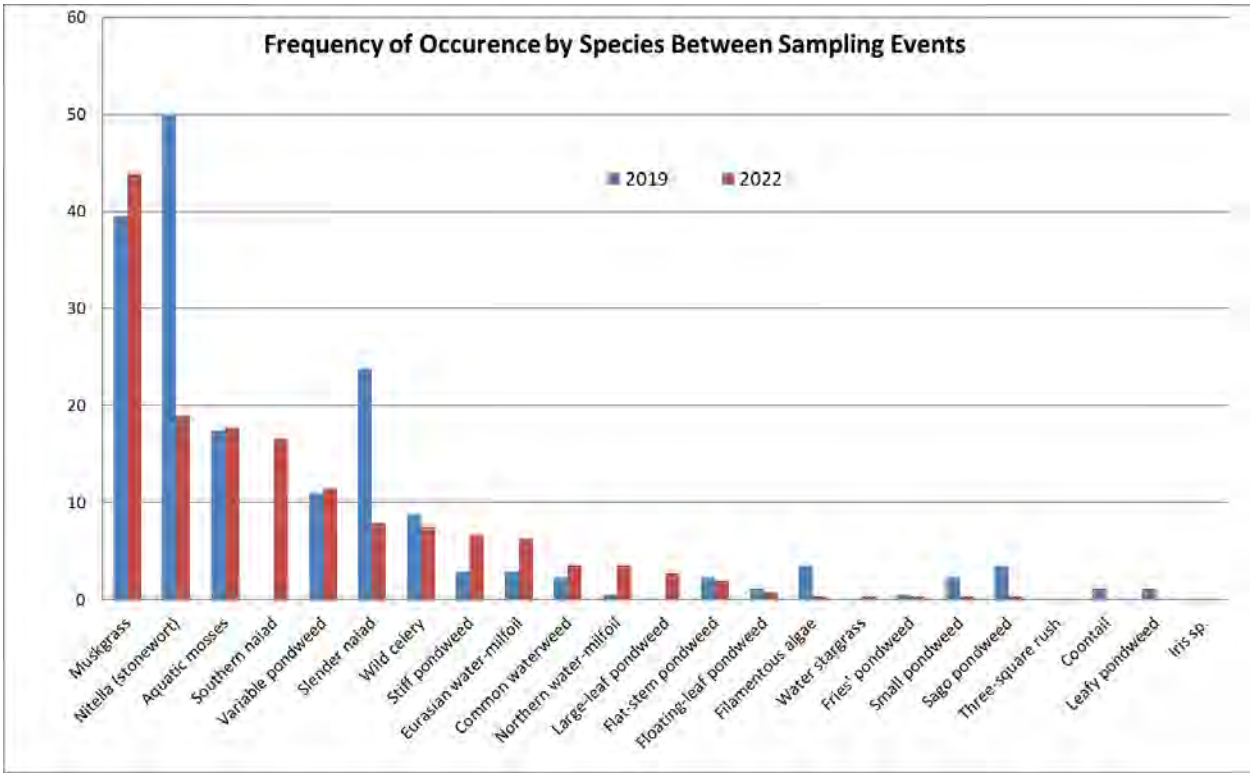


Figure 28. Frequency of Occurrence by Species Between Sampling Event (WLRP, 2022)

While EWM population densities are primarily scattered to abundant, they have reached a level where active management is a viable option. Management recommendations for EWM are therefore focused active monitoring and limiting impacts to non-target species.

Management recommendations are summarized below, and details are provided in the attached WLPR Pearl Lake Aquatic Plant Management Plan (Appendix E).

AQUATIC PLANT STRATEGIES AND OBJECTIVES

1. An adaptive management approach to aquatic plant management is recommended. Conditions and trends in native and AIS populations should be assessed by completing PI plant surveys and aerial coverage surveys as frequently as possible. These should be completed between June 15th and September 15th. If PRD intends to seek AIS Control Grants, PI surveys should be conducted the same year as the intended grant application is being planned for submission. In years where a point intercept survey is not feasible, conduct a meander survey to observe changes in the plant community. Management actions should be reassessed annually in response to changes in plant populations.
2. Management actions for AIS control can vary depending upon a number of variables, as listed below:

a. Frequency and abundance of each individual AIS population. For example: if AIS is present within the littoral zone but relative abundance is low and there are no user conflicts, it may not be necessary to manage populations.

b. Native plant assemblages and their proximity to AIS. It is important to consider specific native plants and their tolerance to chemical application. For example: where chemical treatment is expected to have a negative effect on native populations, it is preferable to explore alternative options.

c. Lake user conflicts and navigational corridors. These conflicts typically rank higher in priority for treatment options.

d. Likelihood of long-term success. Work with your WDNR contacts, partners, and contractor to explore variables and determine the best strategy for treatment.

3. The following guidance can be applied in response to growing populations of EWM, per the attached WLPR Pearl Lake Aquatic Plant Management Plan (Appendix E):

- EWM areas less than 0.25 acres can be left to naturalize, if populations are stable. In areas where EWM is problematic, it can be controlled via hand-pulling and/or Diver Assisted Suction Harvesting (DASH). Chemical control is not recommended for populations of this size.
- EWM areas between 0.25-0.50 acres can be controlled using hand-pulling or DASH, but can also be considered for fast-acting, selective chemical control for stands of moderate dominance or more.
- If coverage of EWM continues to exceed 20% of littoral zone, larger scale approaches can be considered, targeting areas mapped as abundant or dense for EWM by the most recent survey.
- Mechanical control should be utilized early in the season before EWM reaches the surface. Early season control is recommended to clear navigation channels.

4. Historically, herbicide treatments for EWM control on Pearl Lake were completed using 2,4-D products. 2,4-D resistance within aquatic plant communities may contribute to limited success for repeated applications in lakes. Recent research also suggests that 2,4-D herbicide applications in aquatic ecosystems has the potential to reduce survival of multiple species of freshwater fish in the early development phases (Gavin K. Dehnert, 2021). Where herbicide treatments are deemed necessary, per the guidelines above and future coordination with WDNR, consider the following guidelines:

a. Herbicide treatments should be limited to one chemical at a time to determine the effectiveness of individual treatments on plant species populations. Thorough records of treatments, including treatment areas, should be kept in order to study the effectiveness of these treatments.

b. Partial treatments in specific areas are recommended. Avoid application in too many locations at once to minimize impacts on the native plant community.

c. Following any spot treatments, conduct EWM aerial coverage survey again and compare to pre-treatment density and evaluate early-season and late-season PI surveys of natives in the area to evaluate impact on native species.

5. Continue to monitor water quality and staff monitors at the public boat landing trained by the Clean Boats Clean Waters program. Continue to offer boat washing station.
6. Consult with WDNR, Golden Sands RCD, and consulting partners on an annual basis, at a minimum, to discuss strategies for maintaining a healthy lake system.

4.7 CLIMATE CHANGE

Climate change is a controversial and highly charged topic. When developing long-term planning goals and practices, an approach that takes into account potential future conditions based on the best available science is recommended. Climate trends indicate increasing average temperatures, greater frequency and magnitude of flooding, and longer droughts. Some considerations for Pearl Lake and the region are outlined below.

- **Temperature Increase:** As the average seasonal temperature increases, duration of lake ice cover will be reduced. Fewer days of ice on the lake will allow for greater light penetration into the water. Instead of reflecting light off the ice, it will be absorbed by the water, which will increase the heat the lake absorbs. As a result, water temperature increases, which impacts the fishery. Additionally, intensity and duration of light penetration for plant growth will affect timing, quantity and quality of the lake plants.

- **Increased Precipitation:** As average temperatures increase, the atmosphere can hold more water as vapor, resulting in more frequent and intensive rainfall. Increased intensity of storm events has already been observed in recent years in Wisconsin. Heavy rainfall events result in large pulses of water carrying increased sediment loads which enter the lake in a short period of time. Studies suggest that heavy precipitation events are responsible for the majority of phosphorus entering lakes (Motew et al, 2017; Carpenter et al, 2014). Increasing frequency of heavy rainfall is expected to mobilize more soil phosphorus from the watershed. Planning for the next several decades may have to take into account longer growing seasons, greater volumes of runoff, and increasing frequency of 10-year, 100-year or greater flood events.

For further information on climate change in Wisconsin refer to the website “Wisconsin Initiative on Climate Change Impacts (UW WI, 2010): http://www.wicci.wisc.edu/

CLIMATE CHANGE STRATEGIES AND OBJECTIVES

1. Promote innovation and resiliency in existing and future BMP construction
2. Enhance the Education and Outreach program to include local understanding of climate change effects.
3. Encourage robust, native and diverse wetland, riparian, and aquatic plant communities within the entire watershed

4. Ensure future watershed development meets existing design standards or better, in anticipation of climate change induced flooding in the watershed. This would pertain to storm water structures, agriculture and new development.

4.8 EDUCATION AND OUTREACH

There are numerous regional education and outreach organizations, comprised of environmental advocacy groups, associations and friends' groups, which citizens can utilize for information about water quality. These groups have provided consistent leadership and cooperation with the lake community. Newsletters, community events and educational forums are focused on the fishery, recreation opportunities, ecology, aquatic invasive species, natural history, land stewardship, and more.

EDUCATION AND OUTREACH STRATEGIES AND OBJECTIVES

1. Public Education: Per Waushara County Soils and Water Department 10-Year Land and Water Plan (Waushara County Land Conservation & Zoning Department, 2021), new education and outreach programs shall focus on: improving groundwater and surface water quality, creating awareness of conservation stewardship efforts being implemented, County Ordinance requirements, State Standards for compliance of Farmland Preservation Program income tax credit, incentives and cost share availability for installation of conservation practices and many other environmental topics to enhance the quality of our natural resources. Where water quality improvement projects are implemented on Pearl Lake, host an event to highlight success and educate the public.
2. Environmental Monitoring: Continue to monitor the lakes water quality using WisCALM protocols and expand the network of volunteer participation.
3. Evaluation of BMPs: Employ USGS or similar methodology to evaluate efficacy of implementation. To meet current criteria for receiving grants from federal or State programs, evaluation of objectives achieved and successes and failures, are required. This will be completed on 2 levels;
    - Level 1 – Longer range general lake condition appraisals that will show macro trends. On-going lake and tributary monitoring by WDNR and volunteers are examples. Further watershed modeling, if needed, would also fall into this category.
    - Level 2 – Focused evaluations specific to the site where BMP employed. Can involve upstream vs. downstream studies, biotic indexing, physical surveys (Bank Erosion Hazard Index (BEHI), sediment transport modeling, geomorphic modeling, etc.), or other appropriate methods characterizing the before and after conditions, and how it might affect the lake. Other evaluations could involve modeled nutrient and sediment loadings, wetland restoration, anecdotal evidence, images, and other acceptable modifications.
4. Educational Materials: Create educational material or packets of information regarding new or existing educational programs and continue to publish lake and watershed trends and monitoring results (newsletters, web sites, radio, newspapers).

5. Aquatic Invasive Species: Conduct quarterly review of AIS activity and update plan to reflect changed in control needs and those of the lake ecosystem. Integrate all partners with Pearl Lake AIS actions and regional efforts. Encourage education partners to be part of the AIS program execution.

4.9 PROJECT MANAGEMENT

Local leadership from the County and local nonprofits has been strong and the engagement by all partners has been exemplary. A challenge for the lake community and its leadership is maintenance of management capacity. Proper attention to management capacity involves all partners, including the general public.

Because multiple interests are involved, clarity of responsibility is critical. There are many stakeholders, in addition to the principal management units such the County, NRCS and WDNR. The challenge for the partnership will be to act on, and promote, continued integration, while improving the public's understanding about management structure.

All individuals on a team must be equipped with good working skills to effectively represent themselves and their respective management unit. Working on cooperative projects and being on a team with common objectives requires knowledge of human nature, consensus building, and team process. Building these skills is not an easy task. Advanced learning for maintaining a long-range strong partnership is necessary.

PROJECT MANAGEMENT STRATEGIES AND OBJECTIVES

1. Provide a clear description of management unit responsibilities and interaction with partners. This can be partially completed via existing Education and Outreach vehicles including partner's newsletters and annual meetings. Develop professional publications which list all the organizations, what they do, how they do it, and how they work together.
2. Identify working committees to carry out the following:
    - Define and identify critical areas.
    - Prepare a site-specific financial incentive package utilizing existing Federal and State programs as well as partner funds. Leverage key progressive farmers in the watershed that are well-respected in the watershed.
    - Present the financial incentive package to the landowner during "one on one" meetings.
    - Assist the landowner with any and all program signup paperwork, and permit requirements.
    - Assist the landowner with securing resources for the installation of the appropriate BMPs. Harvested buffers are recommended (they function well, do not grow up in brushy vegetation, and the harvesting actually removes some phosphorus).
    - Track accomplishments through GIS.
    - Utilize enforcement tools as necessary for non-cooperating landowners with critical sites

3. Hold annual meeting (with all partners in attendance) to assess the status of the lake and in the implementation of all strategic initiatives. As appropriate changes to the plans will be discussed and a one- page summation will be written describing the year's relevant events and decisions.
4. Form an AIS steering team for Pearl Lake (combined with regional effort) to manage lake inventory and monitoring, reporting, grant writing, contracting and rapid response treatments as needed.

5.0 FUNDING SOURCES

The following funding source should be consulted for implementing the lake and watershed improvement strategies outline above.

6.1.1.1 Wisconsin Department of Agricultural, Trade, and Consumer Protection (DATCP)

Soil and Water Resource Management Cost-Share Funds: DATCP allocates cost-share dollars for conservation practices in Manitowoc County. The Soil and Water Conservation Department administers cost sharing for applicants and helps farmers implement conservation practices.

6.1.1.2 Wisconsin Department of Natural Resources

Targeted Runoff Management Grant: The runoff management grant provides funding and authorizes cost-share reimbursement for practices installed to cure a notice of discharge violation. The Soil and Water Conservation Department administers grants and provides technical assistance under the runoff management grant program.

Well Abandonment: Financial assistance for individuals to properly abandon unused private wells. Unused wells are a direct line for contamination into clean ground water.

Wisconsin Wetland Conservation Trust in Lieu Fee Mitigation Program (WWCT): Land trusts, conservation groups, government organizations, or Wisconsin landowners may apply for a WWCT grant to preserve, enhance, and restore wetland resources in Wisconsin.

Knowles-Nelson Stewardship Program (K-N): Funds are provided to local units of government and nonprofit conservation organizations for land acquisition and recreational development statewide.

Surface Water Grants:

- AIS Prevention and Control Grants - share the costs of aquatic invasive species education programs that teach about the threats posed by invasive species and how to prevent and control them. These grants also help with projects that prevent new introductions, control existing populations, and restore habitat.
- Lake Protection Grants - assist eligible applicants with implementation of lake protection and restoration projects that protect or improve water quality, habitat or the elements of lake ecosystems.

6.1.1.3 United States Fish and Wildlife Service

Partners for Wildlife Program: The U.S. Fish and Wildlife Services provides technical and financial assistance to private landowners with a desire to provide suitable habitat for wildlife on their property.

Coastal Program: Provide funds for restoring and protecting fish and wildlife habitat on public and privately-owned lands.

6.1.1.4 United States Department of Agriculture: Natural Resource Conservation Service (NRCS)

Conservation Technical Assistance: NRCS assists land-users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. These conservation systems reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands. NRCS provides conservation planning to landowners.

Environmental Quality Incentive Program (EQIP): EQIP provides technical and financial help to farm and forest landowners for conservation practices that protect soil and water quality. Grassed waterways, stream fencing, critical area planting, manure management systems including storage structures and barnyard runoff protection, and many other conservation practices are eligible.

Great Lakes Restoration Initiative (EQIP-GLRI): To improve the health of the Great Lakes, the Natural Resource Conservation Service provides financial and technical resources to Manitowoc County landowners to improve water quality in the region. Through this Initiative, the Natural Resource Conservation Service focuses on helping farmers implement conservation practices that reduce erosion, improve water quality, and maintain agricultural productivity in selected watersheds.

Conservation Stewardship Program (CSP): CSP is a voluntary conservation program that encourages producers to continue to improve and maintain existing conservation activities as well as undertake additional conservation activities.

Conservation Reserve Program (CRP): CRP can reduce erosion, increase wildlife habitat, improve water quality, and increase forestland. Landowners set aside cropland with annual rental payments based on a bid. Tree planting, wildlife ponds, grass cover, and other environmental practices are eligible practices.

Conservation Reserve Enhancement Program (CREP): The Conservation Reserve Enhancement Program is an offshoot of the Conservation Reserve Program, the country's largest private-land conservation program. CREP targets high-priority conservation issues identified by local, state or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and introducing conservation practices, land owners are paid an annual rental rate, along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary and the contract period is typically 10-15 years. Typical practices include filter strips and riparian buffers.

Agricultural Conservation Easement Program (ACEP): ACEP provides financial and technical assistance to help conserve agricultural lands and restore wetlands. Under the Agricultural Land Easements component, the Natural Resource Conservation Service helps state and local governments, Native American tribes, and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance wetlands that have been altered for agriculture.

6.0 GRANT-FUNDED RECOMMENDATIONS

Pursuant to WDNR guidelines, this Plan must specify which actions are to be paid for with WDNR and/or other grant funds. This Plan shall be used to implement the recommendations as outlined in Table 9 below.

The proposed actions included within the Plan will be subject to ongoing monitoring and evaluation against objectives and target achievements. Investments of time, resources and effort will be evaluated for success, and may be reallocated as part of an adaptive management approach. Modifications of approach, based on new data or changing understandings of the underlying systems, will be integrated as the Project proceeds. Projects not identified in the list above may be funded by WDNR as long as they meet the objectives and strategies of this Plan.

Table 9. Grant-Funded Recommendations, Timeline, and Funding Sources

Management Plan Recommendations	Timeline	Funding Sources
Conduct a septic system inventory to identify failing septic systems for repair. Evaluate feasibility for sewerage system installation around Pearl Lake.	2022-2025	Wisconsin Fund
Continue to monitor the lake water quality at all sites using WisCALM protocols. Sample all inlets and outfalls around the lake to identify all sources of pollutant loadings.	2022+- Ongoing	WDNR Citizen Lake Monitoring Network (CLMN) program. Additional equipment purchase can be funded by WDNR Surface Water Grants program.
Encourage urban BMPs for single-family residences in watershed, including rain barrels, cisterns, bioretention, grass swales, and improved street sweeping practices.	2022+- Ongoing	Waushara County Water Quality Improvement Program
Work with partners and property owners to preserve and protect sensitive properties and restore and/or enhance shoreline, wetland, and terrestrial habitat within the Pearl Lake watershed to improve water quality within Pearl Lake.	2022+- Ongoing	Long-term preservation can be accomplished through conservation easements, coordinated by local land trusts. Funding sources for conservation easements include WDNR Knowles-Nelson Stewardship Program and NRCS Agricultural Conservation Easement Program (ACEP). Shoreline restoration and enhancement funding is provided by The WDNR Surface Water Grants – Health Lakes and Rivers subprogram.
Continue WDNR fish survey efforts and work with WDNR to adjust fishing regulations to accommodate a thriving fishery on Pearl Lake.	2022+- Ongoing	Funded and implemented by WDNR Fisheries staff.
Implement fish habitat improvement projects within the littoral zone along undeveloped	2022+- Ongoing	Funding for fish sticks installation can be provided

Management Plan Recommendations	Timeline	Funding Sources
shoreline in Pearl Lake. Prioritize areas where high quality shoreline habitat has been compromised in recent years.		by the WDNR Surface Water Grants – Healthy Lakes and Rivers subprogram.
Encourage natural shoreline with woody habitat and diverse natural plant communities. Target areas of shoreline deterioration for shoreline improvement projects.	2022+-Ongoing	WDNR Surface Water Grants – Healthy Lakes and Rivers subprogram.
Appraise conditions and trends in native and AIS populations by completing PI plant surveys as frequently as possible. Surveys should be conducted between June 15th and September 15th. Update the current aquatic plant management plan and implement actions proposed to accommodate notable changes within AIS populations within Pearl Lake.	2023 and at least once every two years thereafter	WDNR Surface Water Grants – AIS Prevention and Management program.
Use an adaptive management approach to AIS Management, taking into account AIS survey data, consulting with partners, and considering variables such as EWM density, lake-user conflicts, affects on native species, treatment area, and likelihood of success in determining whether chemical treatment is suitable.	2023+- Ongoing	WDNR Surface Water Grants– AIS Prevention and Management program.
In regard to growing populations of EWM, the following guidance can be applied. EWM areas less than 0.25 acres can be controlled via hand-pulling and/or DASH. EWM areas between 0.25-0.50 acres can be controlled using hand-pulling or DASH, but can also be considered for fast-acting, selective chemical control for stands of moderate dominance or more. The active ingredients florpyrauxifen-benzyl, diquat, endothall, and/or flumioxazin may be used at appropriate label rates. Areas of EWM greater than 0.5 acres should be controlled via	2022+- Ongoing	WDNR Surface Water Grants– AIS Prevention and Management program.

Management Plan Recommendations	Timeline	Funding Sources
fast-acting, selective chemical control for abundant stands of moderate or more density.		
If coverage of EWM continues to exceed 20% of littoral zone, whole-lake approaches can be pursued. Active ingredients such as fluridone and florpyrauxifen-benzyl can be dosed according to the information provided in Appendix E. The EWM is likely tolerant to 2,4-D due to past use.	2022+-Ongoing	WDNR Surface Water Grants– AIS Prevention and Management program.
Herbicide treatments should be limited to one chemical at a time to determine the effectiveness of individual treatments on plant species populations. Thorough records of treatments, including treatment areas, should be kept in order to study the effectiveness of these treatments. Partial treatments in specific areas are recommended. Avoid application in too many locations at once to minimize impacts on the native plant community. Following any spot treatments, conduct EWM delineation again and compare to pre-treatment density and evaluate early-season and late-season PI surveys of natives in the area to evaluate impact on native species.	2022+-Ongoing	WDNR Surface Water Grants– AIS Prevention and Management program.
Mechanical control should be utilized early in the season before EWM reaches the surface. Early season control is recommended to clear navigation channels.	2022+-Ongoing	WDNR Surface Water Grants– AIS Prevention and Management program.
Continue to monitor water quality and staff monitors at the public boat landing trained by the Clean Boats Clean Waters program. Continue to offer boat washing station.	2022+- Ongoing	Funding for CBCW is provided by the WDNR Surface Water Grants – AIS Prevention and Management program.

Management Plan Recommendations	Timeline	Funding Sources
Consult with WDNR, Golden Sands RCD, and consulting partners on an annual basis, at a minimum, to discuss strategies for maintaining a healthy lake system.	2022+-Ongoing	WDNR Surface Water Grants– AIS Prevention and Management program.
Continue to support efforts by partners at Waushara County Planning and Conservation and NRCS to implement no till, cover crop, and other conservation practices on agricultural lands.	2022+ -Ongoing	County Water Quality Improvement Program (Buffer Strips, Nutrient Management, Shoreline Protection, Wetland Restoration, Rain Gardens) and NRCS Environmental Quality Incentives Program (EQIP) for BMPs.
Educate the public on conservation stewardship practices in the Pearl Lake watershed. Assist landowners with securing resources for BMPs. Hold meetings to engage stakeholders in lake protection efforts.	2022+-Ongoing	Waushara County Water Quality Improvement Program
Promote climate awareness and resiliency through educational programs, innovative BMP design, and critical area protection.	2022+-Ongoing	Waushara County Water Quality Improvement Program

7.0 REFERENCES

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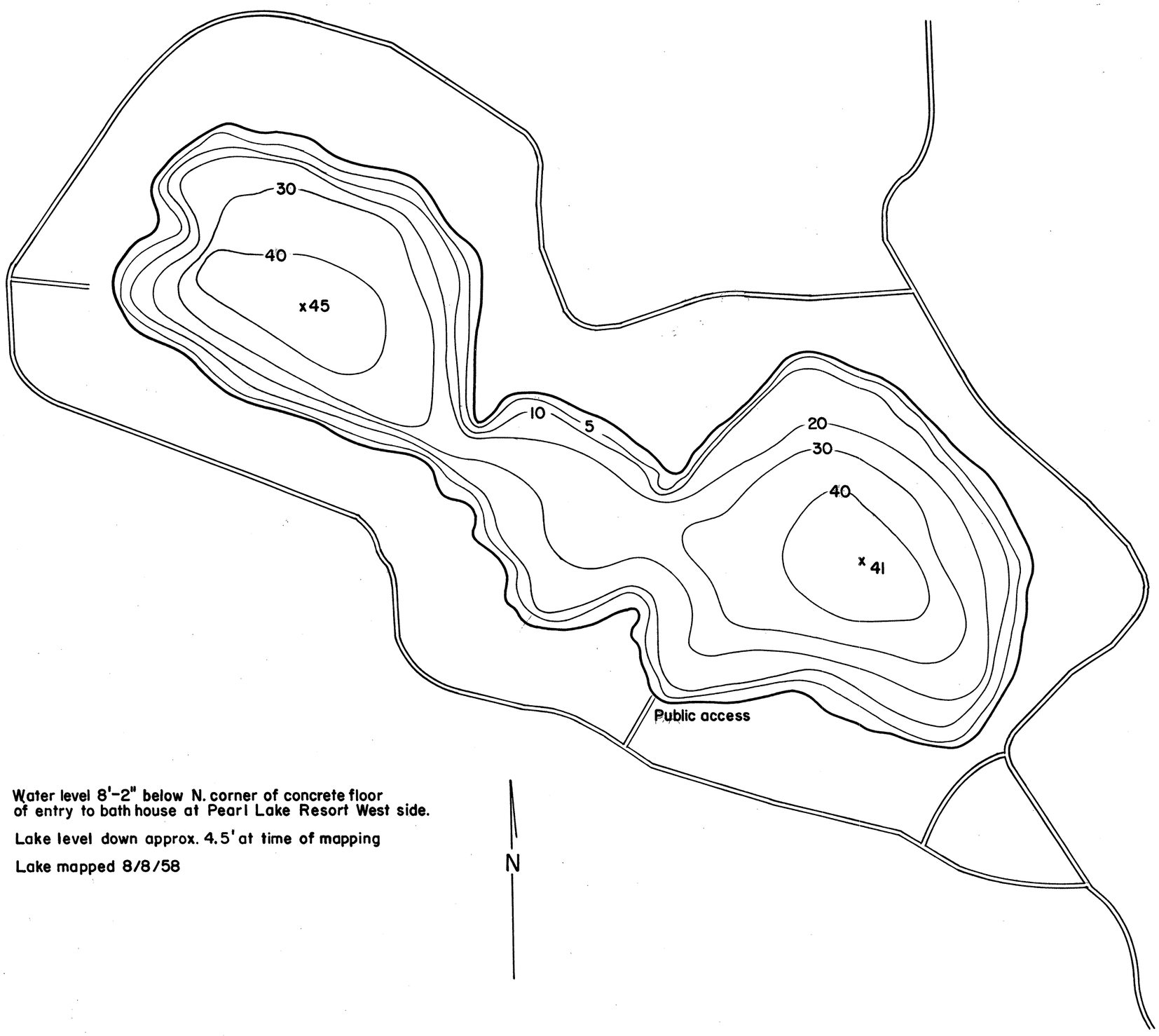
Appendix A FIGURES

Figure 1
Bathymetric Map

WISCONSIN CONSERVATION DEPARTMENT

LAKE SURVEY MAP

LAKE PEARL
SECTION 30
TOWNSHIP T. 19 N.
RANGE R. 12 E.
TOWN LEON
COUNTY WAUSHARA



Water level 8'-2" below N. corner of concrete floor of entry to bath house at Pearl Lake Resort West side.

Lake level down approx. 4.5' at time of mapping

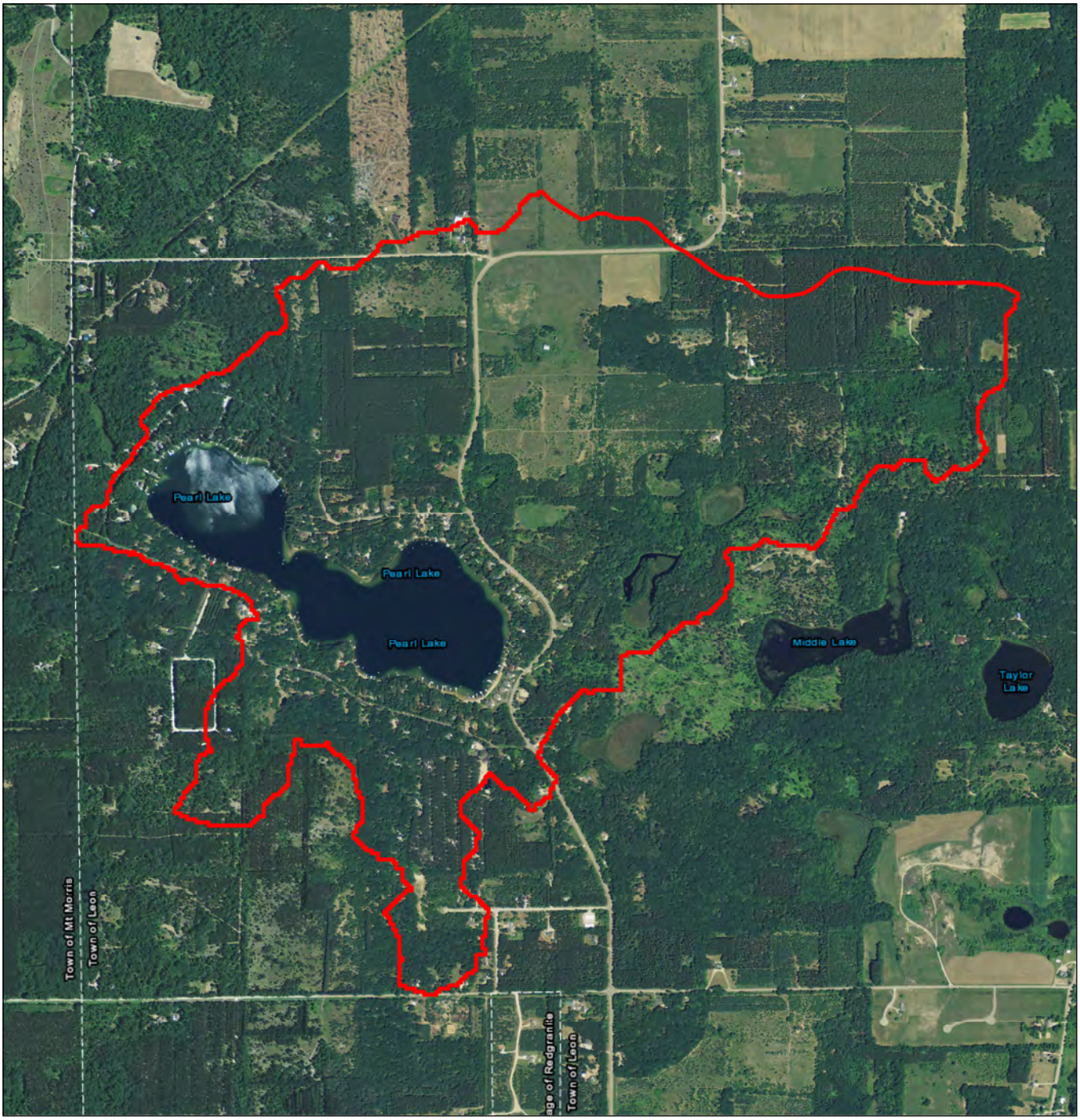
Lake mapped 8/8/58

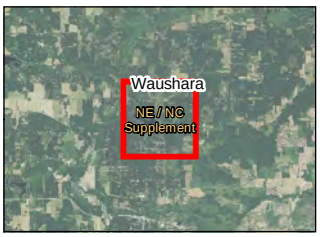
Source: Wisconsin Department of Natural Resources

AREA 101 Acres
TOTAL SHORELINE 2.2 Miles
MAX. DEPTH 45'

SCALE: 1"=400'

Source: Wisconsin Department of Natural Resources 608-266-2621
Pearl Lake – Waushara County, Wisconsin DNR Lake Map
Date – Aug 1958 - Historical Lake Map - Not for Navigation
A Public Document - Please Identify the Source when using it.





Legend

Pearl Lake Watershed

0 500 1,000 Feet

(At original document size of 8.5x11)
1:19,646

N

Stantec

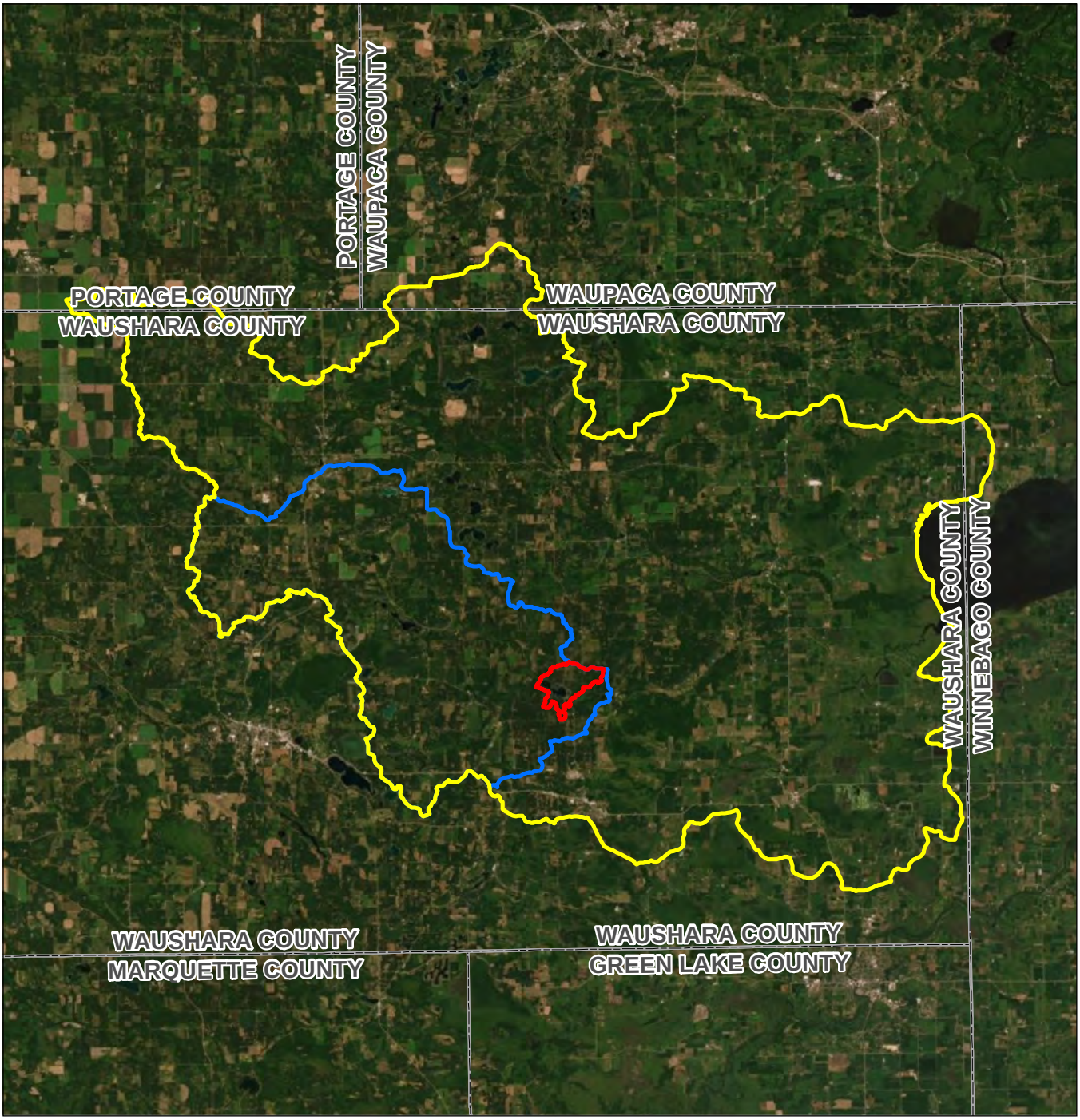
Project Location
Waushara County, WI

Client/Project 19370xxxx
Client Project Report *PRD Pearl Lake Comprehensive Management Plan*

Figure No. **2** **DRAFT**

Title
Pearl Lake Watershed

Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources:
3. Background:



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources:
3. Background:

Legend

- Pearl Lake Subbasin
- Bruce Creek-Willow Creek HUC 12 Watershed
- Willow Creek-Frontal Lake Poygan HUC 10 Watershed

0 5,000 10,000 Feet

(At original document size of 8.5x11)
1:272,042

N

Stantec

Project Location
Waushara County, WI

Client/Project 19370xxxx
Client Project Report *PRD Pearl Lake Comprehensive Management Plan*

Figure No.
5

DRAFT

Title
Pearl Lake Watersheds

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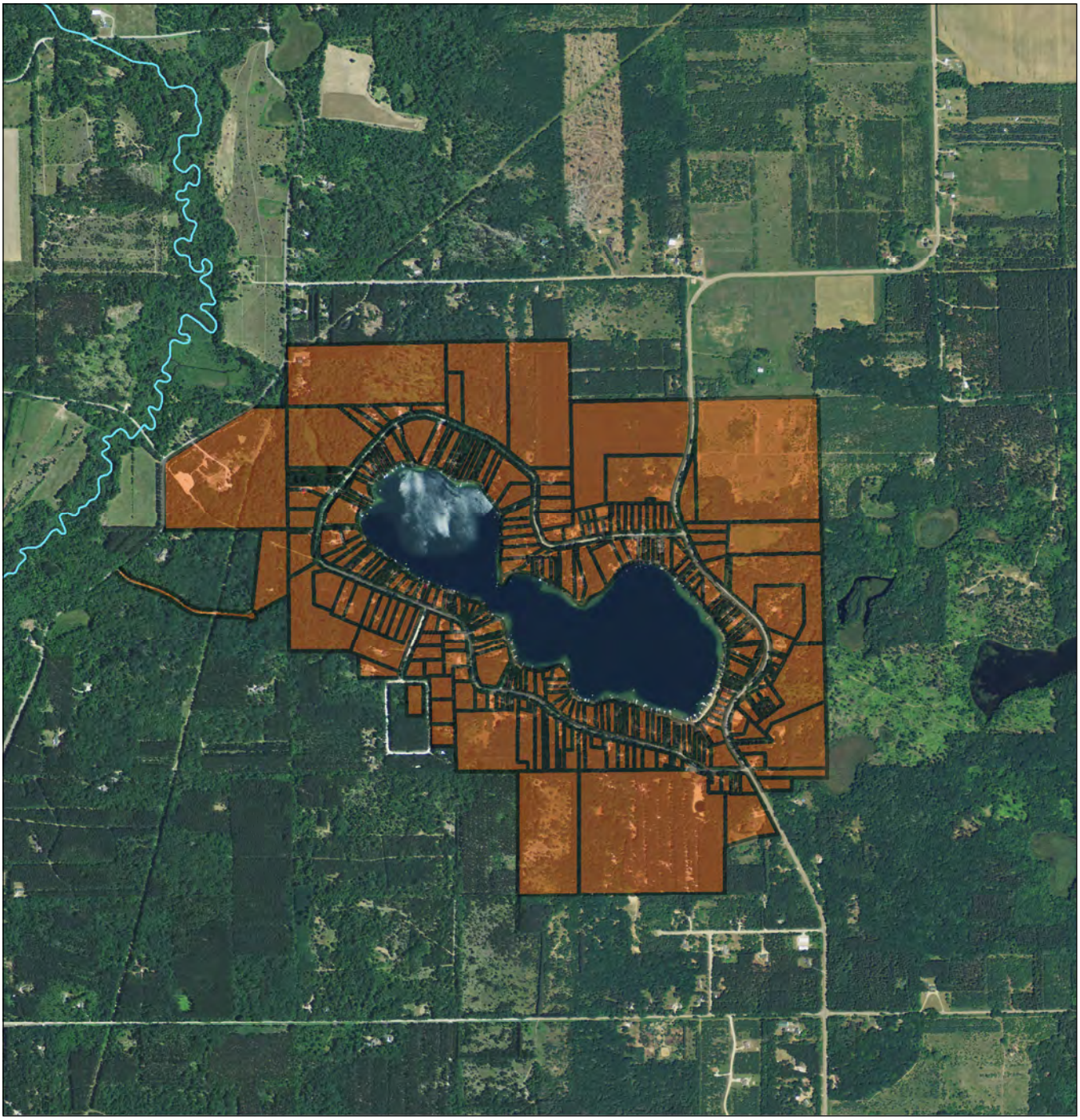

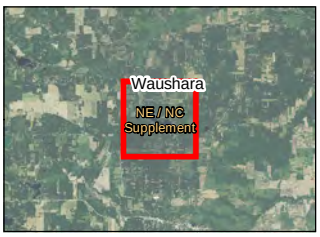

Legend

Parcels within 1000ft of Pearl Lake

0 500 1,000 Feet

(At original document size of 8.5x11)
1:19,646

N

Stantec

Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources:
3. Background:

Project Location
Waushara County, WI

Client/Project 19370xxxx
Client Project Report *PRD Pearl Lake Comprehensive Management Plan*

Figure No.
13

DRAFT

Title
Parcels with Potential of Septic Discharge to Pearl Lake

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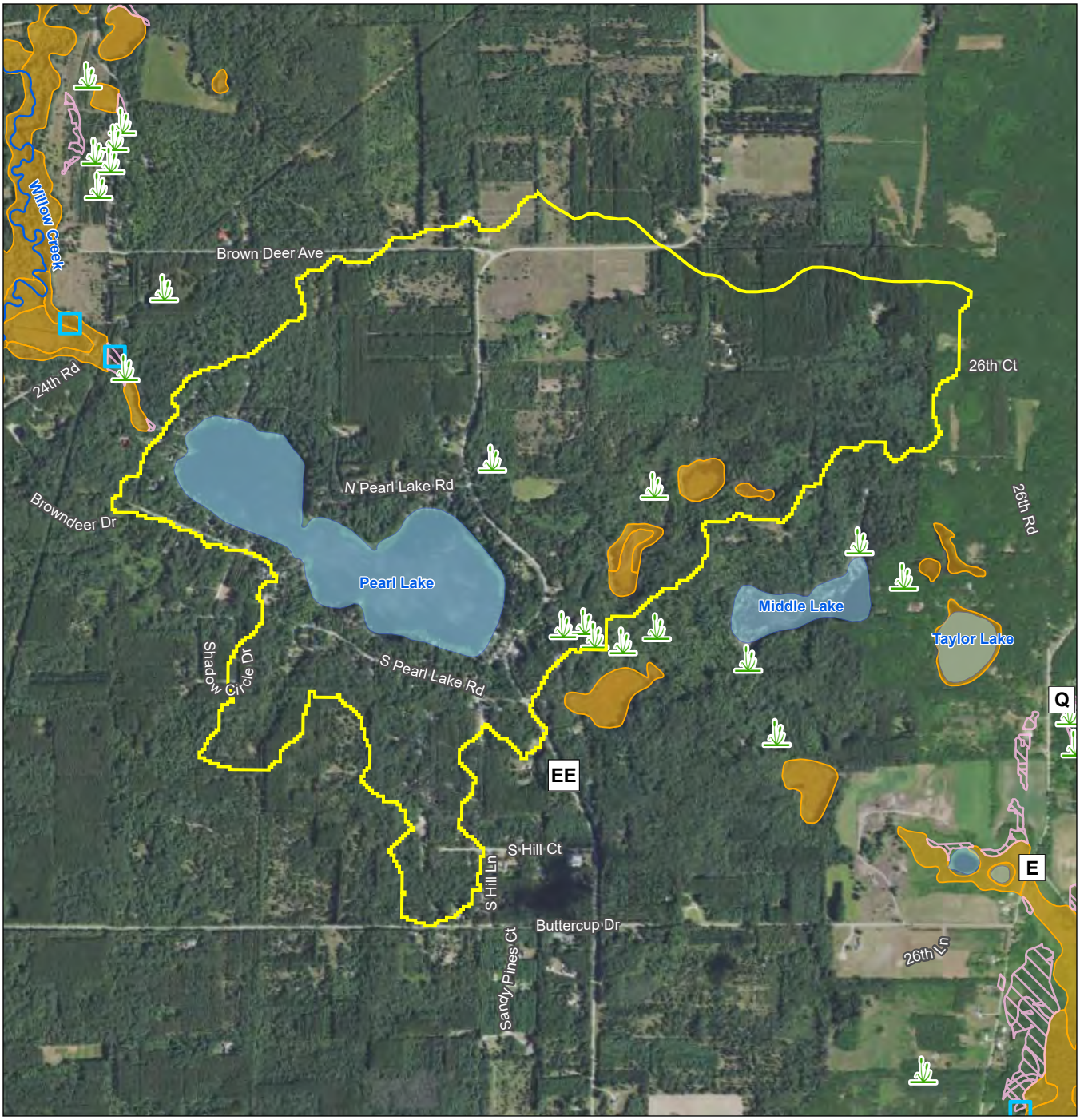

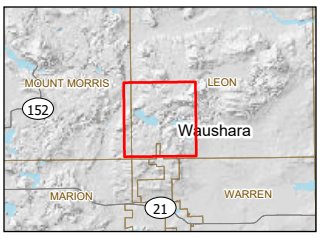

Notes

1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Data Sources: Stantec, Pearl Lake Protection and Rehabilitation District, Esri, WisDOT, WDNR
3. Background: NAIP 2020

Legend

- Pearl Lake Watershed Boundary
- WDNR Potentially Restorable Wetland

Wisconsin Wetland Inventory Data

- Excavated Pond
- Wetland Too Small to Delineate
- Wetland Area

DNR 24k Hydrography

- Perennial Stream
- Intermittent Stream
- Waterbody

0 1,250 2,500 Feet
(At original document size of 8.5x11)
1:30,000

N

Stantec

Project Location
T. of Leon
Waushara Co., WI

Client/Project 193708992
Pearl Lake Protection and Rehabilitation District
Pearl Lake Management Plan

Figure No.
16

DRAFT

Title
Wisconsin Wetland Inventory

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Figure 17. Sensitive Areas of Pearl Lake Shoreline

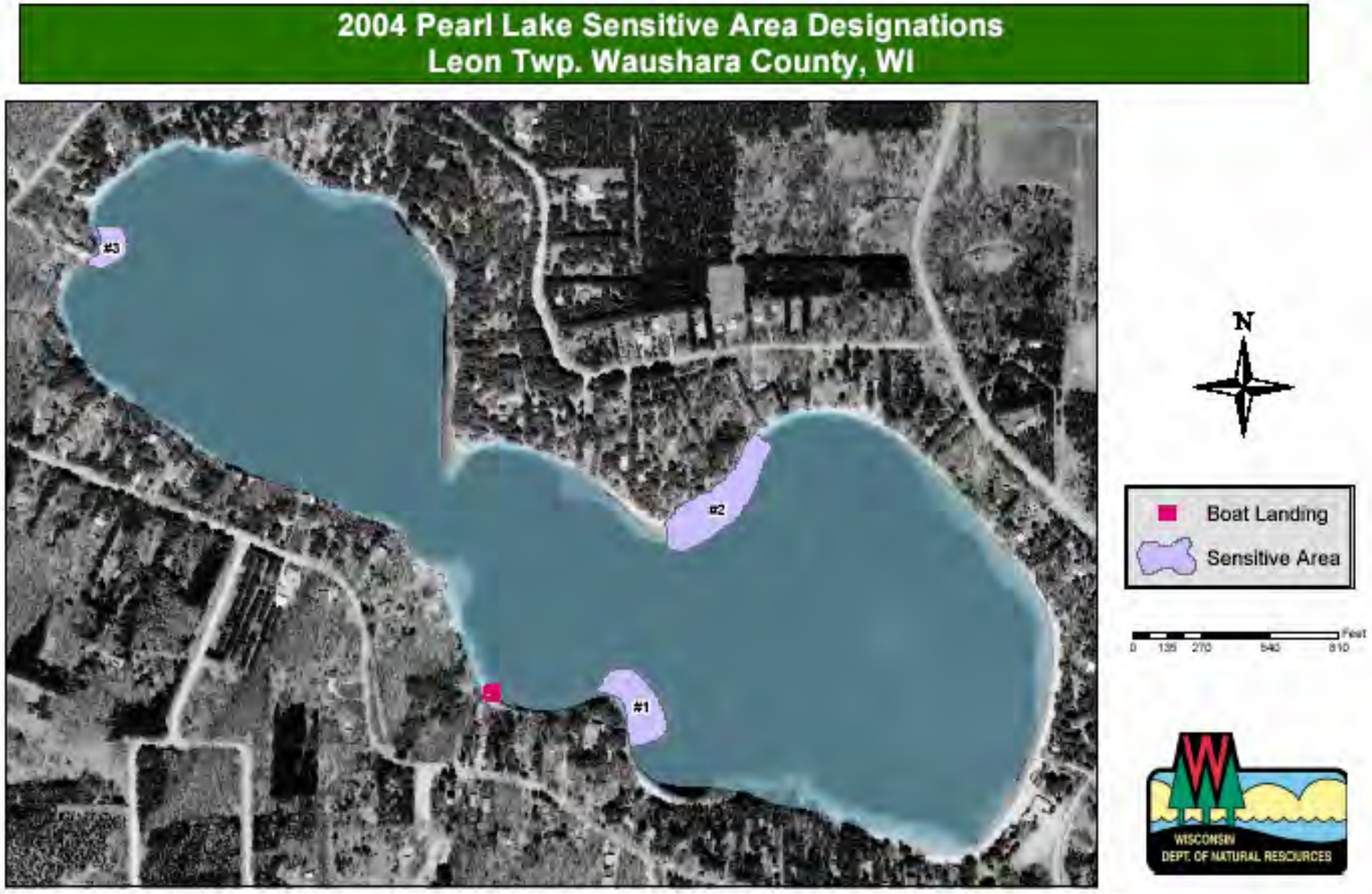
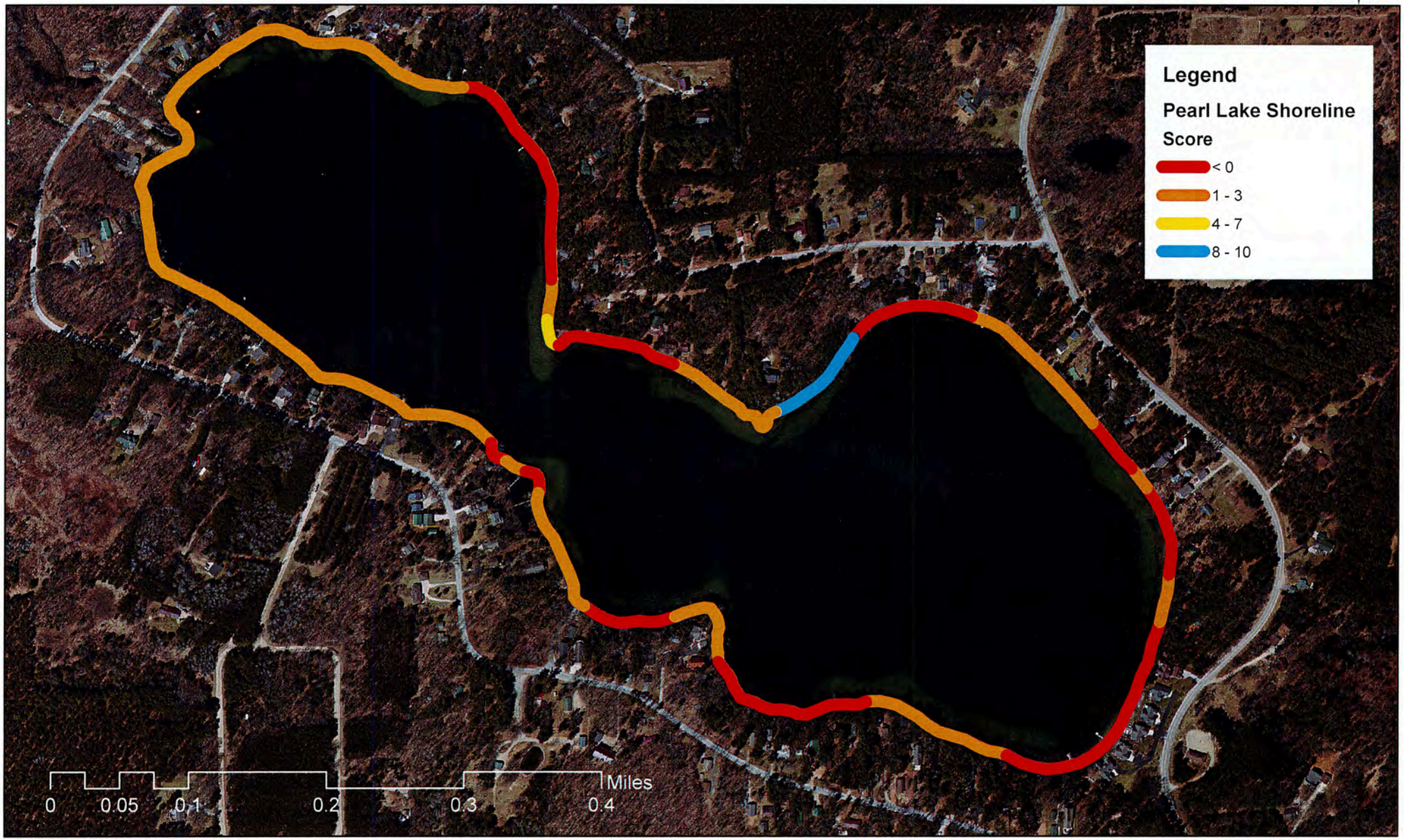


Figure 20

Pearl Lake Shoreline Assessment



Summary

Shorelines are color coded to show their overall health based on natural and physical characteristics. For example, shorelines shown in red indicate locations where management or mitigation may be warranted. Blue shorelines mark healthy riparian areas with natural vegetation and few human influences.

Caculating Shoreline Scores

Scores are based of the presence/absence of:

- Natural Vegetation
- Human Influence (Boathouses, Paths, Rip-Rap, etc)
- Erosion
- Structures

** Shoreline scores are grouped together and averaged.

Waushara County Est.1852

Map Created by Waushara County LCD (2022)

Figure 22
Pearl Lake EWM/HWM Distribution, 2018

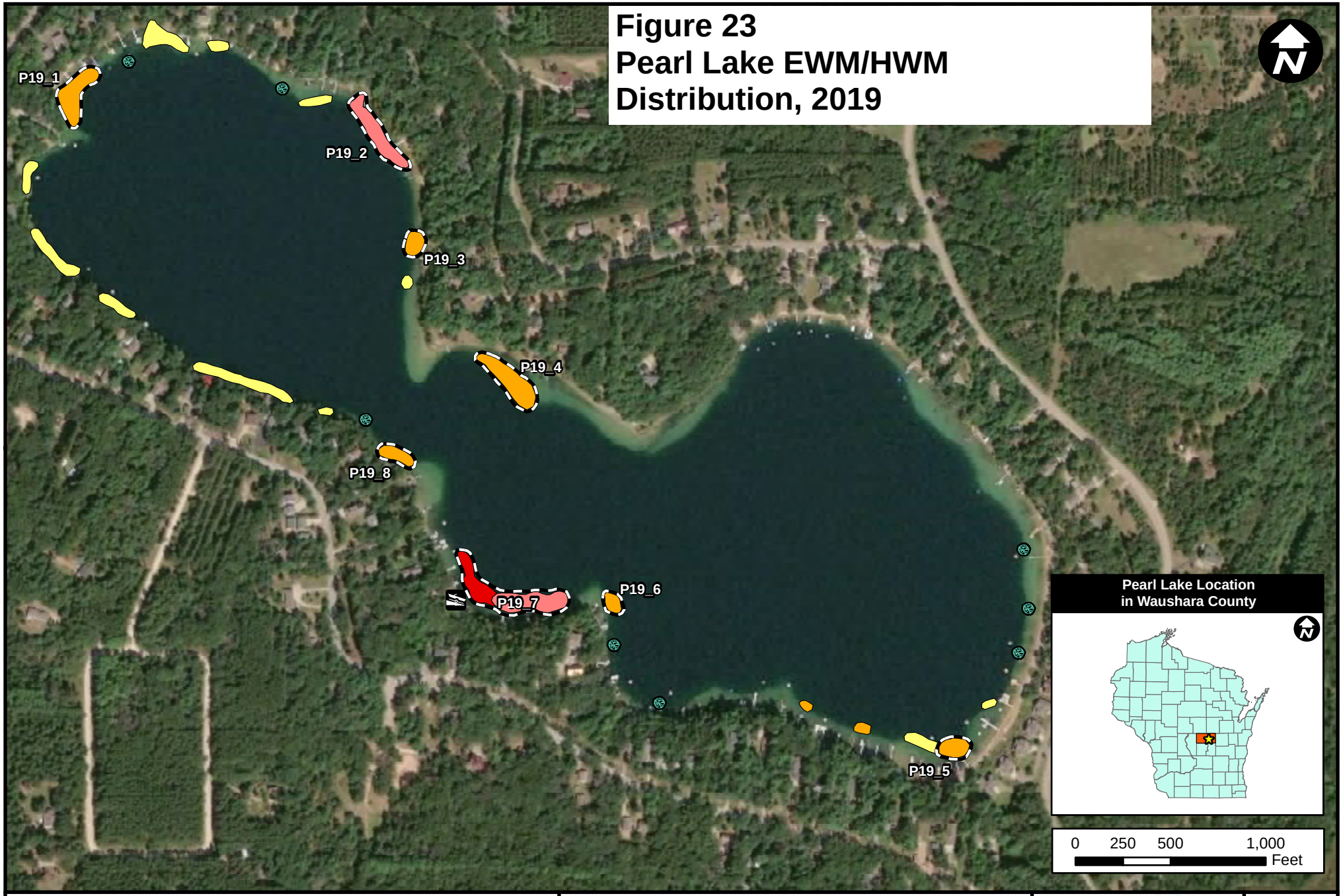
Pearl Lake EWM/HWM Distribution
October 23, 2018

- Individual plants/small groups of plants
- Scattered EWM/HWM
- Moderately Dense EWM/HWM

0 0.125 0.25 0.5 Kilometers

N
W E
S

Cason & ASSOCIATES, LLC
LAKE & POND MANAGERS



Legend

- Highly Scattered
- Scattered
- Moderately Dense
- Dense
- Small Clusters
- Possible Treatment Areas
- Boat Launch

Pearl Lake Aquatic Invasive Species Survey
Eurasian/Hybrid Watermilfoil

FIELD DATE(S):	CLIENT:	CITY:
9/30/2019	Pearl Lake Protec. & Rehab. District	Leon
DRAWN DATE:	**COUNTY:**	**STATE:**
12/11/2019	Waushara County	Wisconsin

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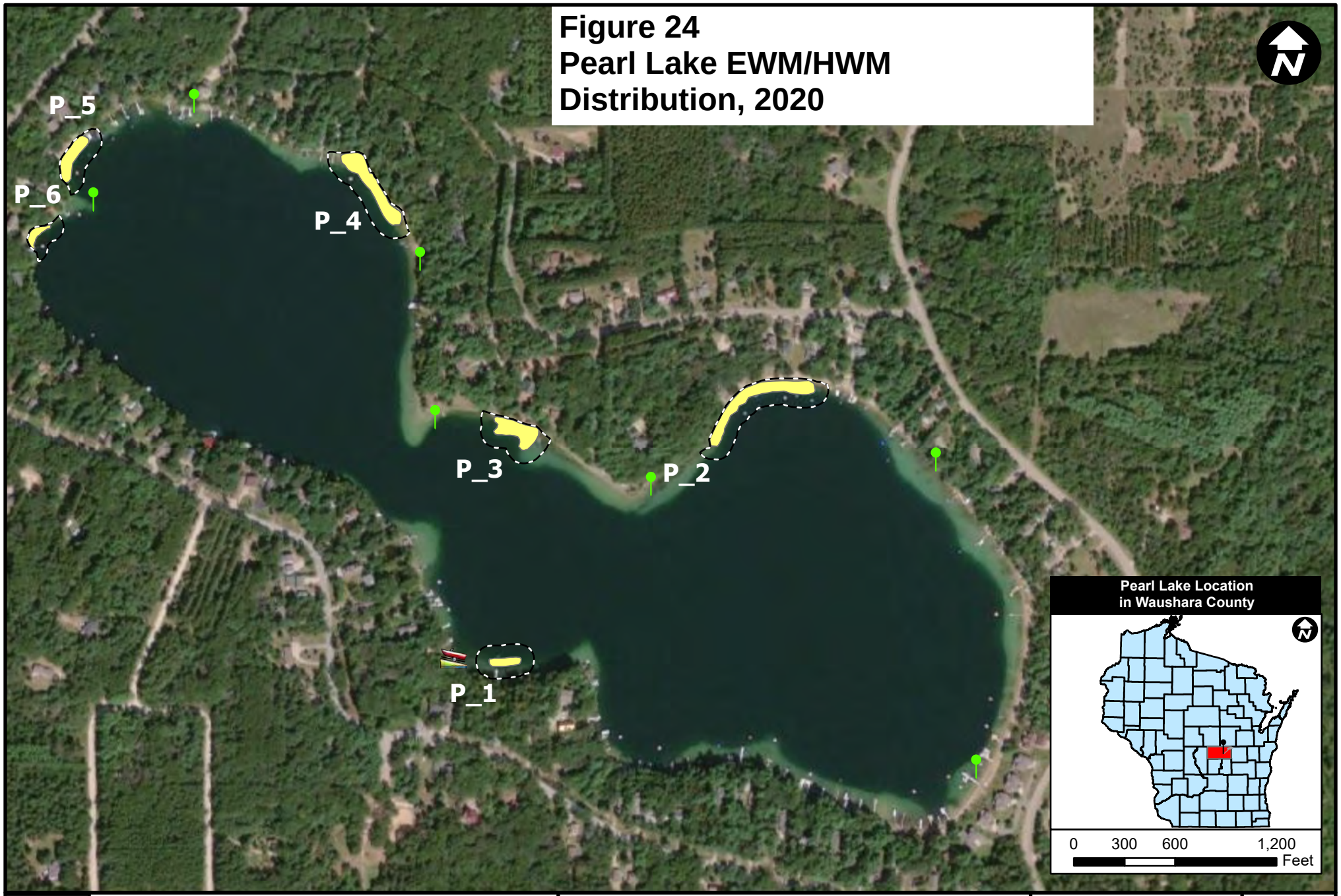
Figure 24
Pearl Lake EWM/HWM Distribution, 2020



Legend

- Highly Scattered
- Individual or Small Clusters
- Proposed Treatment Area
- Boat Launch

Aquatic Invasive Species Survey for Eurasian Watermilfoil

FIELD DATE(S):	CLIENT:	CITY:
09/29/2020	Pearl Lake P&R District	Leon
DRAWN DATE:	**COUNTY:**	**STATE:**
11/18/2020	Waushara County	Wisconsin

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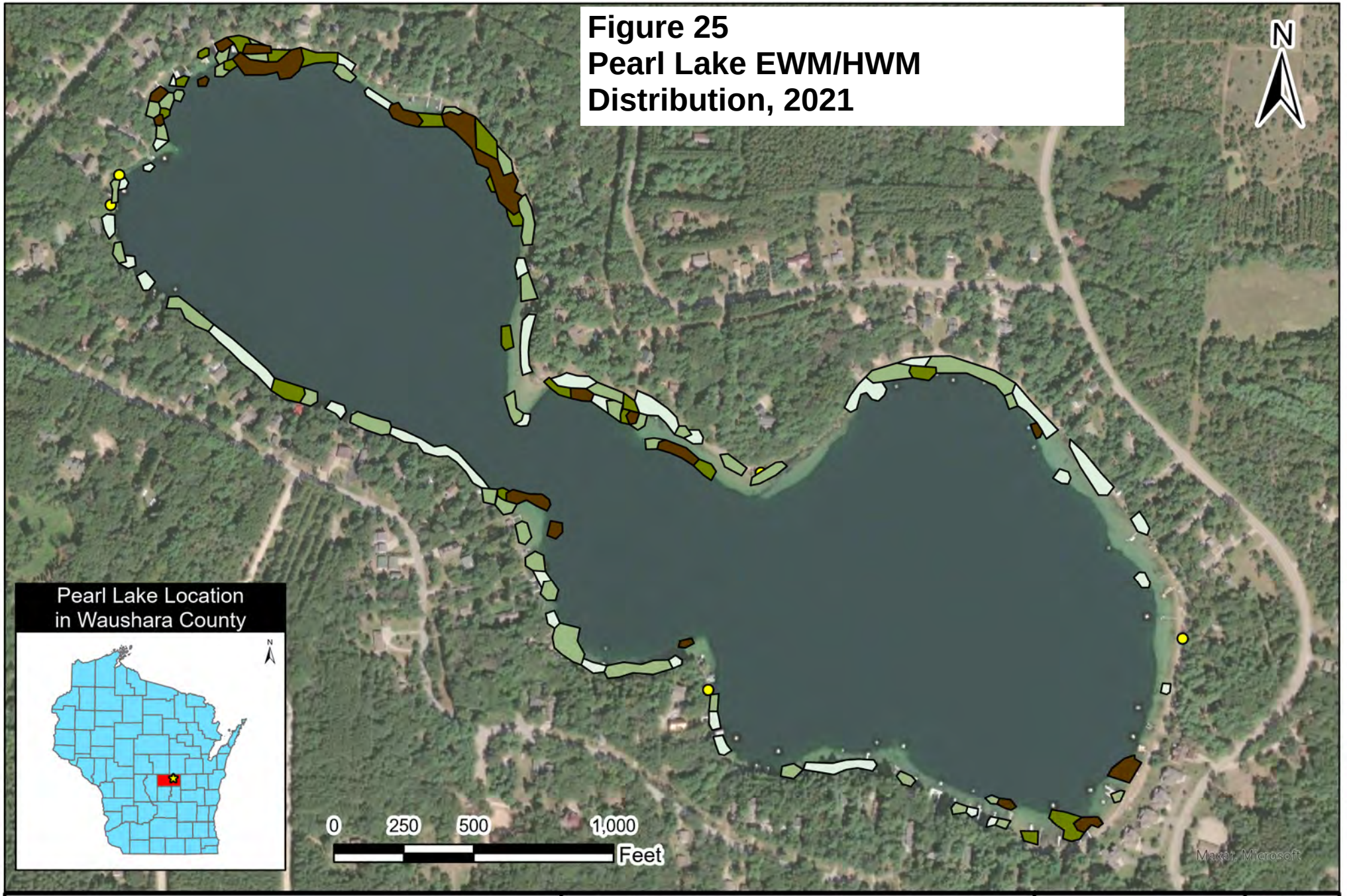
Figure 25
Pearl Lake EWM/HWM Distribution, 2021



Legend

- Dense
- Moderately Dense
- Scattered
- Highly Scattered
- Yellow_Iris

Hamilton Lake Aquatic Invasive Species Survey
Overview of Eurasian/Hybrid Watermilfoil

FIELD DATE(S):	CLIENT:	CITY:
9/22-23/2021	Pearl Lake Protection and Rehabilitation District	Redgranite
DRAWN DATE:	**COUNTY:**	**STATE:**
12/7/2021	Waushara County	Wisconsin

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MAP NUMBER: 1 of 1

Appendix B PUBLIC SURVEY RESULTS

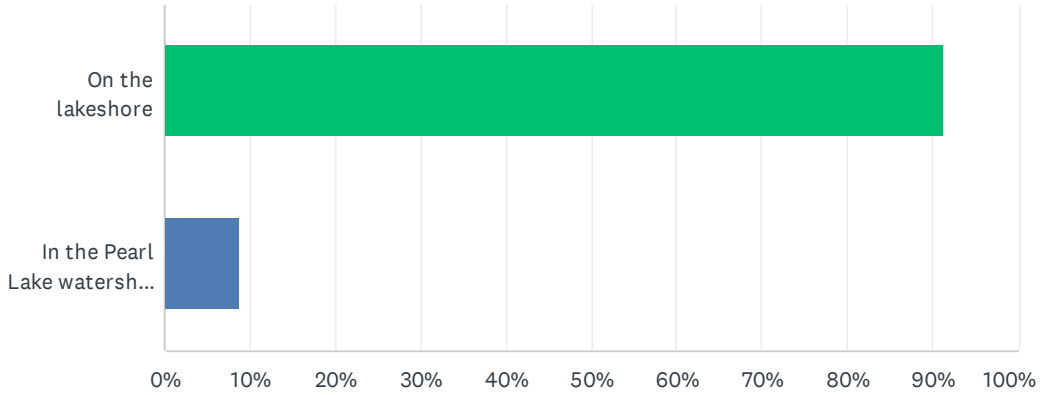
Q1 How many years have you lived on or in the Pearl Lake area?

Answered: 126 Skipped: 5

0-10 years	17%
11-30 years	26%
31-50 years	30%
Over 50 years	26%

Q2 What best describes where your property is located? Please choose one. If you own multiple properties, please keep in mind the one you have owned the longest.

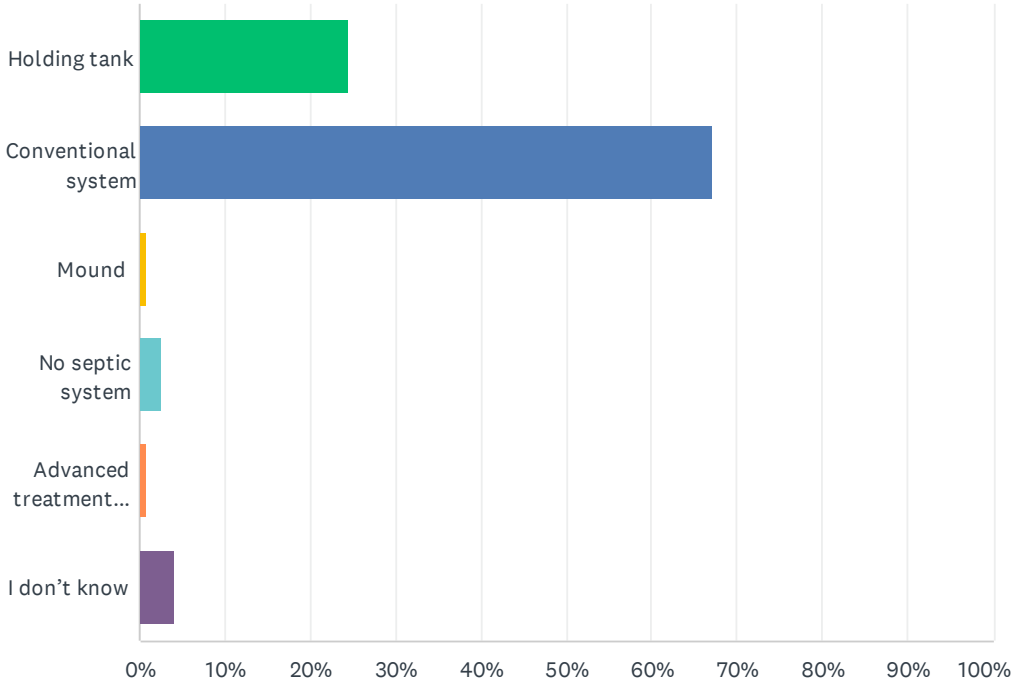
Answered: 127 Skipped: 4



ANSWER CHOICES	RESPONSES	
On the lakeshore	91.34%	116
In the Pearl Lake watershed – If watershed property, please skip ahead to question 5.	8.66%	11
TOTAL		127

Q3 What type of septic system does your property utilize?

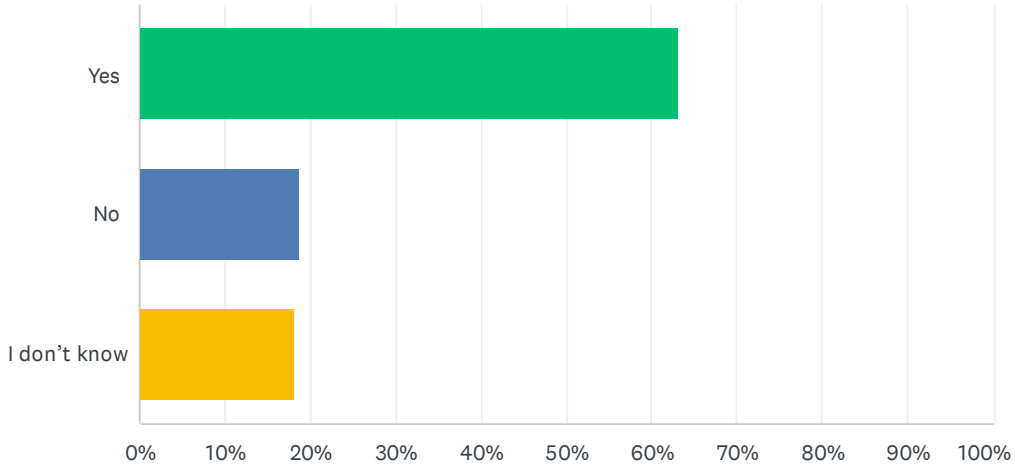
Answered: 122 Skipped: 9



ANSWER CHOICES	RESPONSES	
Holding tank	24.59%	30
Conventional system	67.21%	82
Mound	0.82%	1
No septic system	2.46%	3
Advanced treatment system	0.82%	1
I don't know	4.10%	5
TOTAL		122

Q4 Would you be receptive to a public sewerage system, if funded by grants?

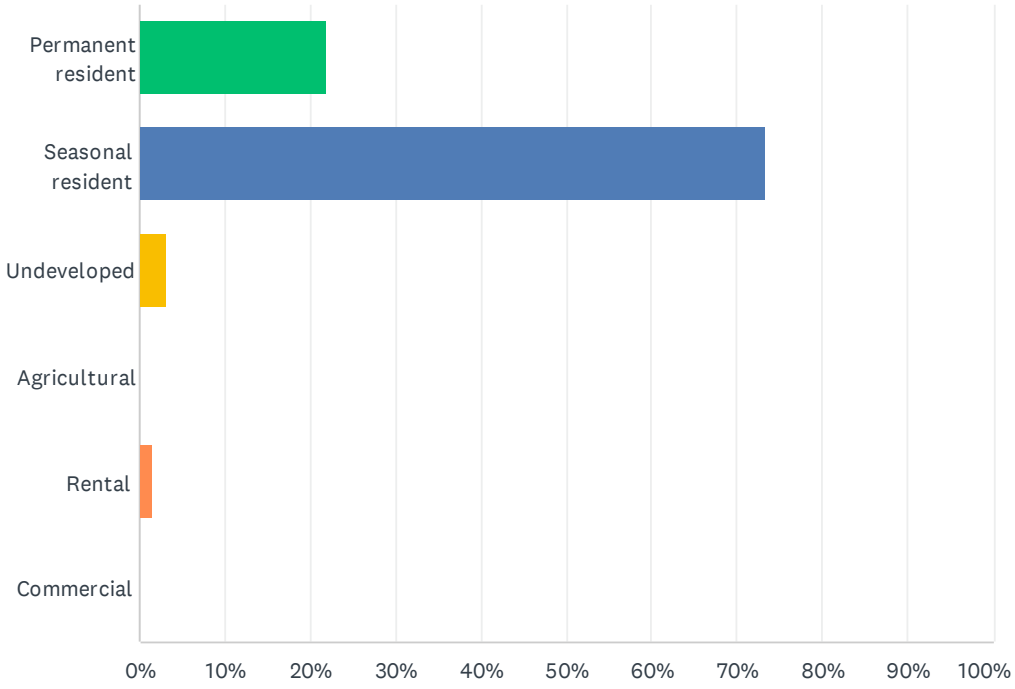
Answered: 122 Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	63.11%	77
No	18.85%	23
I don't know	18.03%	22
TOTAL		122

Q5 Which one best describes the primary use of the property that you indicated in question 2?

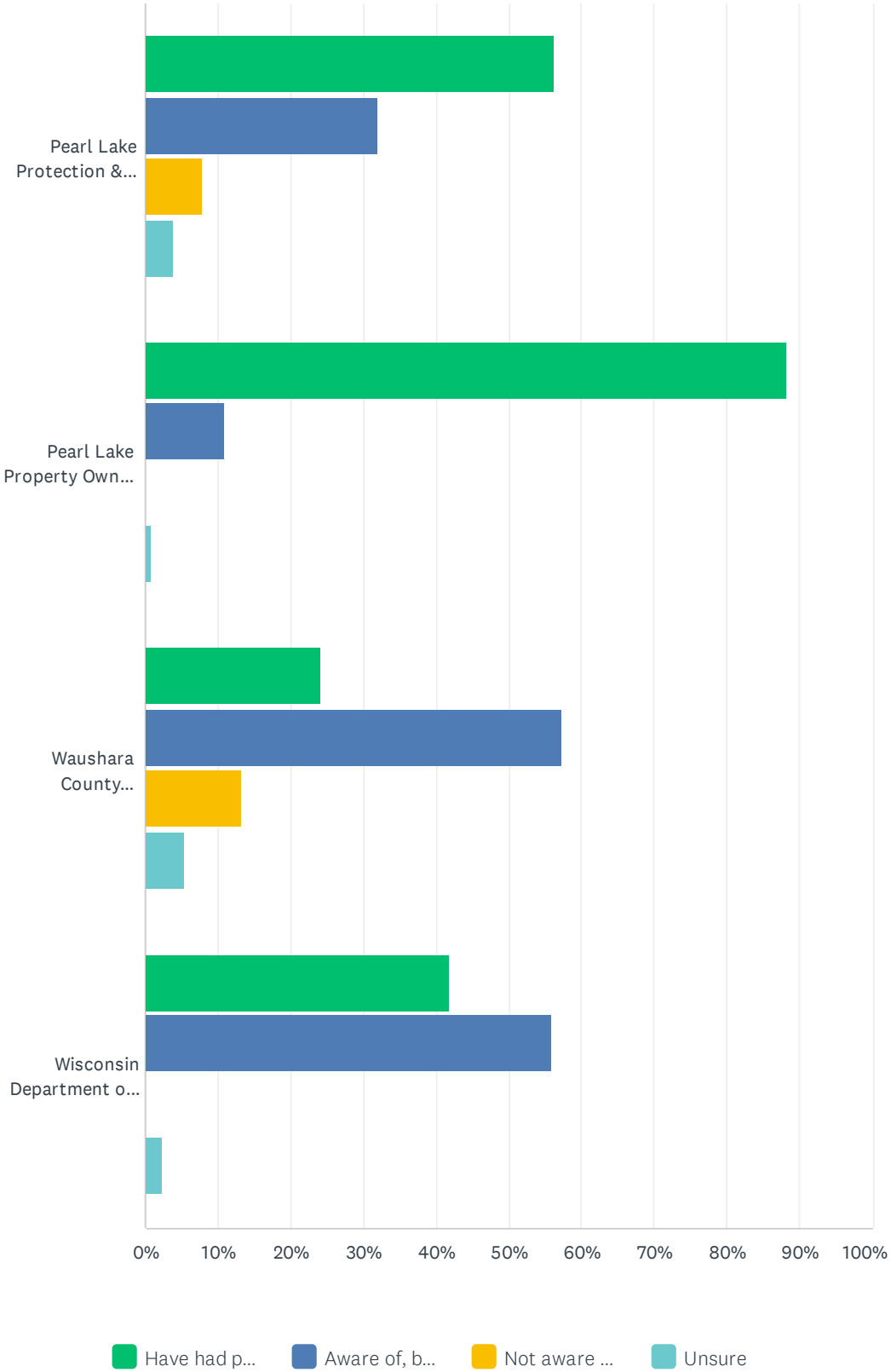
Answered: 128 Skipped: 3



ANSWER CHOICES	RESPONSES	
Permanent resident	21.88%	28
Seasonal resident	73.44%	94
Undeveloped	3.13%	4
Agricultural	0.00%	0
Rental	1.56%	2
Commercial	0.00%	0
TOTAL		128

Q6 How familiar are you with the roles that the following organizations and agencies play in Pearl Lake? Please mark one response for each entity.

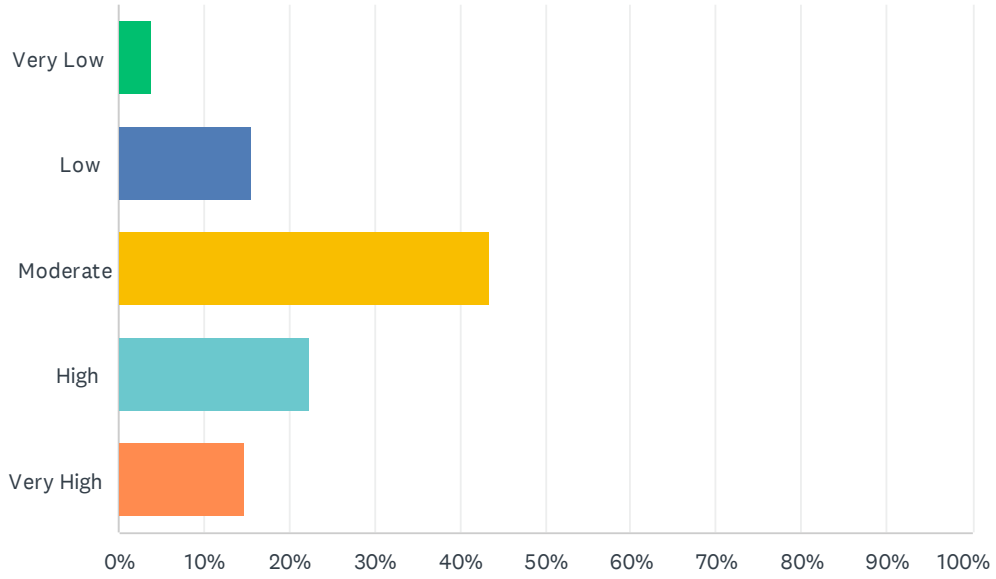
Answered: 129 Skipped: 2


Pearl Lake Protection &...
Pearl Lake Property Own...
Waushara County...
Wisconsin Department o...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Have had p...
Aware of, b...
Not aware ...
Unsure

	HAVE HAD PERSONAL CONTACT OR COMMUNICATION	AWARE OF, BUT HAVE HAD NO PERSONAL CONTACT OR COMMUNICATION	NOT AWARE OF AGENCY OR ORGANIZATION	UNSURE	TOTAL	WEIGHTED AVERAGE
Pearl Lake Protection & Rehabilitation District	56.25% 72	32.03% 41	7.81% 10	3.91% 5	128	1.59
Pearl Lake Property Owners Assoc.	88.37% 114	10.85% 14	0.00% 0	0.78% 1	129	1.13
Waushara County Conservation Dept.	24.03% 31	57.36% 74	13.18% 17	5.43% 7	129	2.00
Wisconsin Department of Natural Resources	41.86% 54	55.81% 72	0.00% 0	2.33% 3	129	1.63

Q7 Before receiving this survey, how would you rate your knowledge about efforts underway to protect, restore, and conserve Pearl Lake and its watershed?

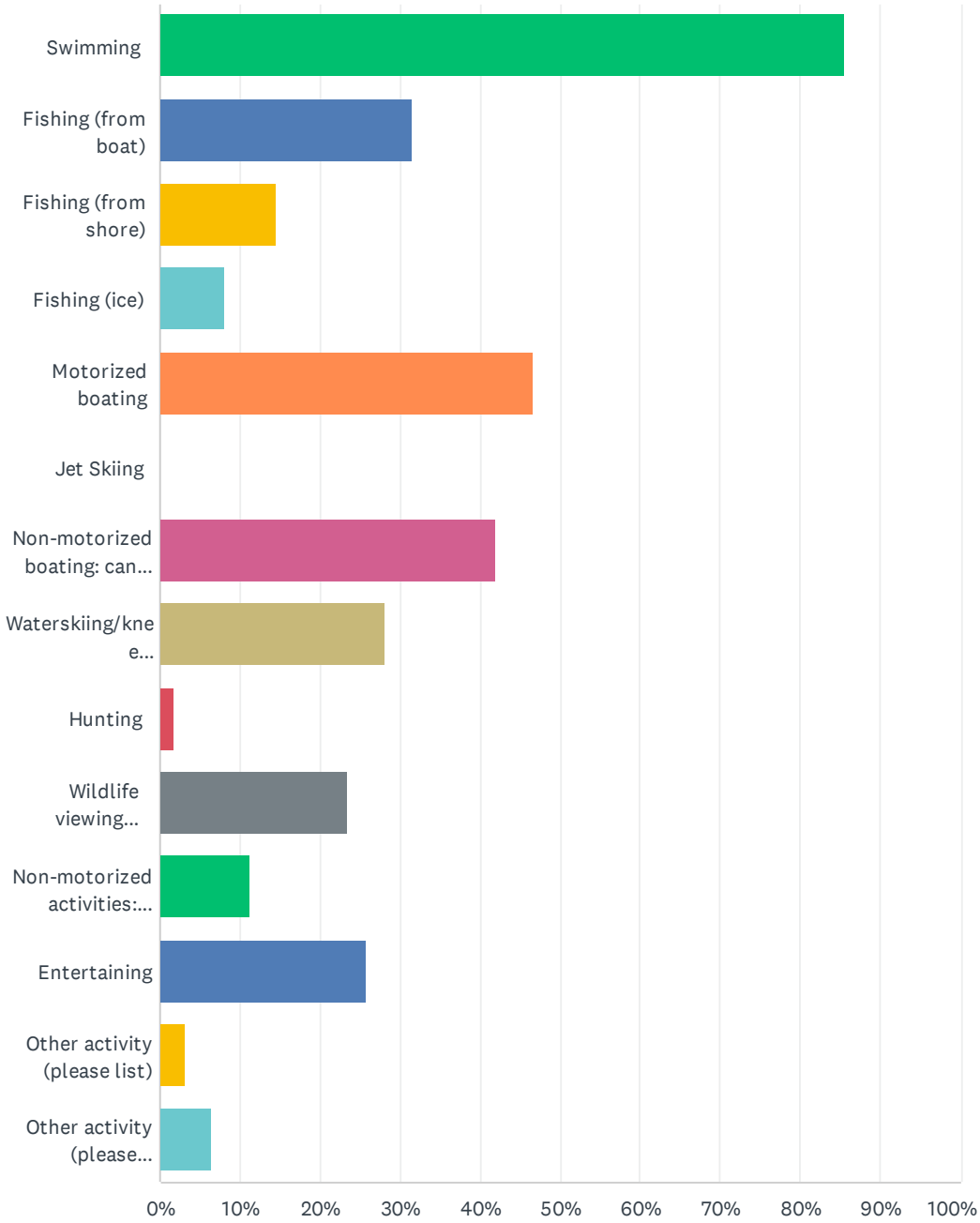
Answered: 129 Skipped: 2



ANSWER CHOICES	RESPONSES	
Very Low	3.88%	5
Low	15.50%	20
Moderate	43.41%	56
High	22.48%	29
Very High	14.73%	19
TOTAL		129

Q8 From the list below, please check up to three recreational activities that are most important reasons that you own property on/near Pearl Lake

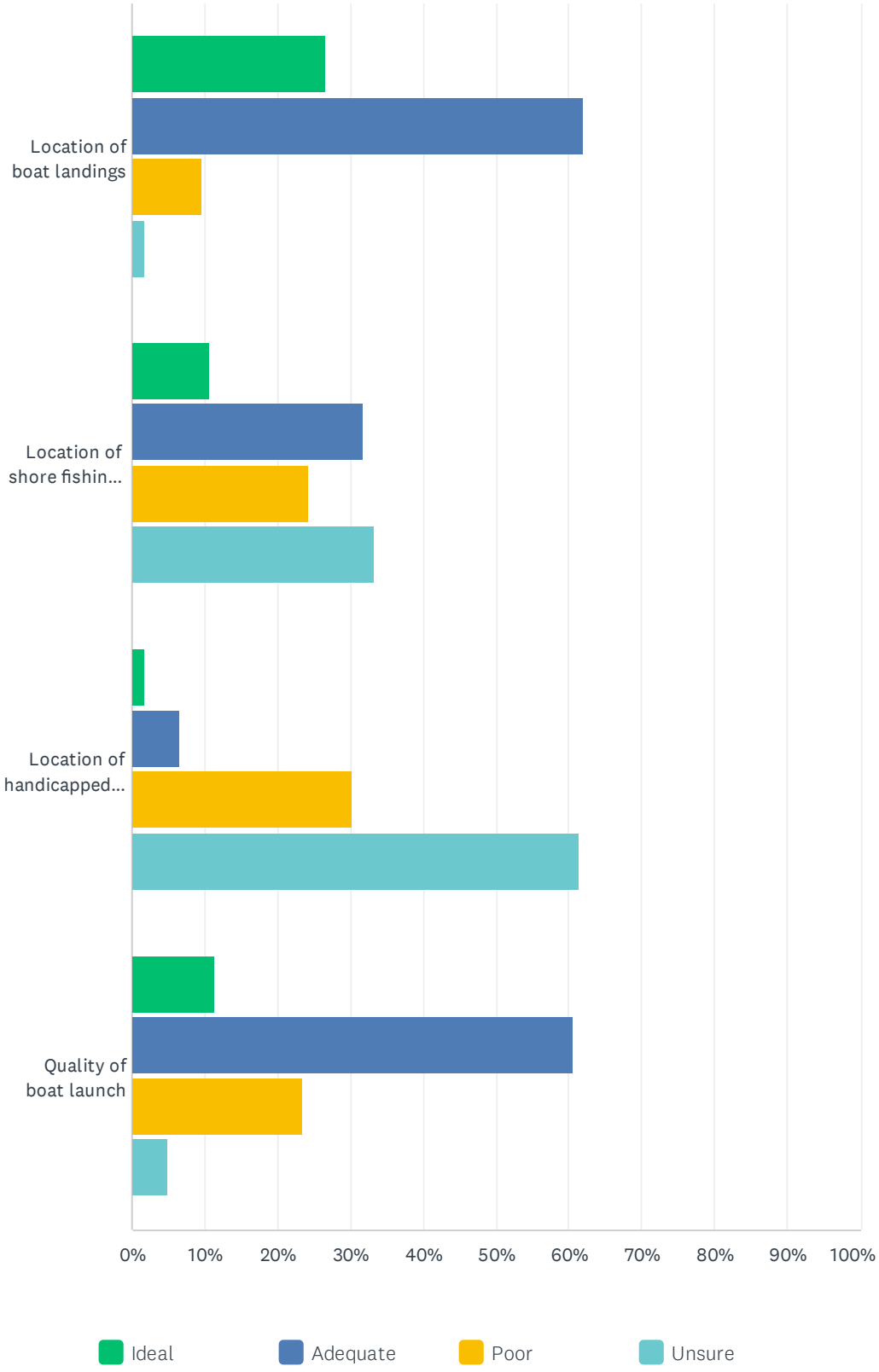
Answered: 124 Skipped: 7



ANSWER CHOICES	RESPONSES	
Swimming	85.48%	106
Fishing (from boat)	31.45%	39
Fishing (from shore)	14.52%	18
Fishing (ice)	8.06%	10
Motorized boating	46.77%	58
Jet Skiing	0.00%	0
Non-motorized boating: canoe, kayak, sailing, rowing	41.94%	52
Waterskiing/knee boarding/tubing	28.23%	35
Hunting	1.61%	2
Wildlife viewing including bird watching	23.39%	29
Non-motorized activities: running, biking, x-country skiing, snowshoeing	11.29%	14
Entertaining	25.81%	32
Other activity (please list)	3.23%	4
Other activity (please specify)	6.45%	8
Total Respondents: 124		

Q9 How do you feel about each of the following aspects of access sites to Pearl Lake? Check one per row.

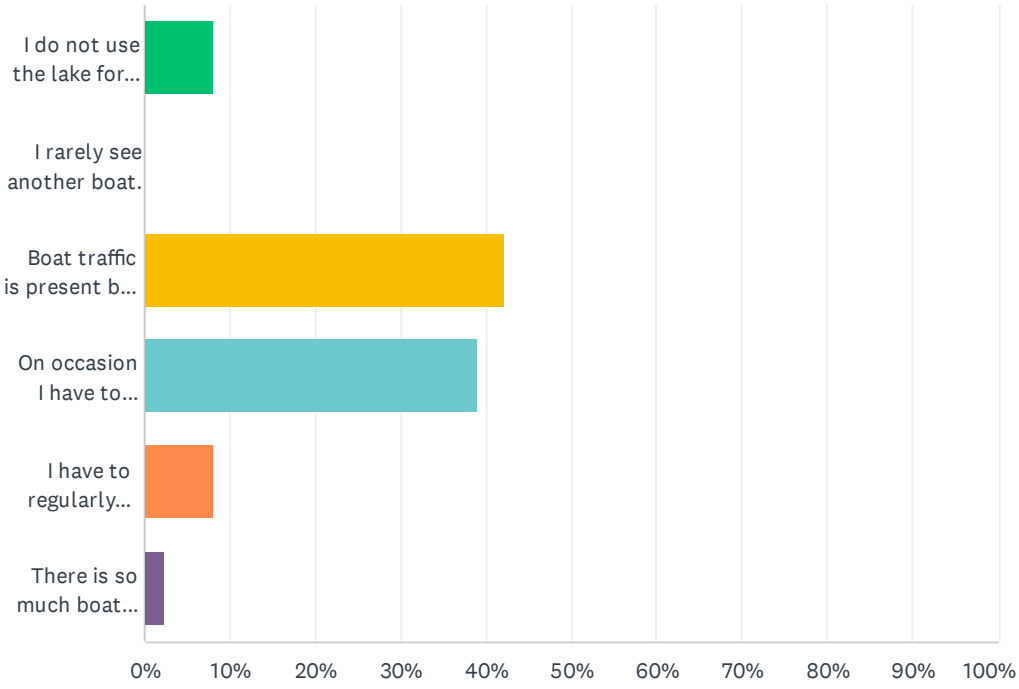
Answered: 124 Skipped: 7


Location of boat landings
Location of shore fishin...
Location of handicapped...
Quality of boat launch
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Ideal
Adequate
Poor
Unsure

	IDEAL	ADEQUATE	POOR	UNSURE	TOTAL	WEIGHTED AVERAGE
Location of boat landings	26.61% 33	62.10% 77	9.68% 12	1.61% 2	124	1.86
Location of shore fishing sites	10.57% 13	31.71% 39	24.39% 30	33.33% 41	123	2.80
Location of handicapped accessible fishing sites	1.64% 2	6.56% 8	30.33% 37	61.48% 75	122	3.52
Quality of boat launch	11.29% 14	60.48% 75	23.39% 29	4.84% 6	124	2.22

Q10 Which statement best describes your experience with boat traffic on Pearl Lake? Check one.

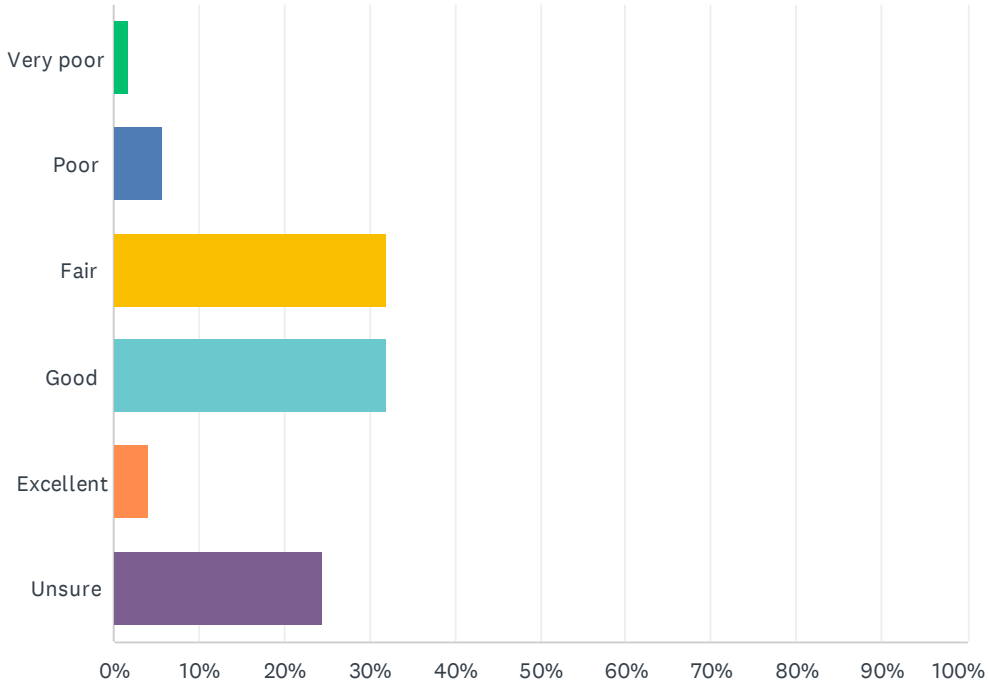
Answered: 123 Skipped: 8



ANSWER CHOICES	RESPONSES	
I do not use the lake for boating.	8.13%	10
I rarely see another boat.	0.00%	0
Boat traffic is present but not enough to bother me.	42.28%	52
On occasion I have to modify my plans because of boat traffic.	39.02%	48
I have to regularly change my plans because of boat traffic on the lake.	8.13%	10
There is so much boat traffic that I don't use the lake much anymore.	2.44%	3
TOTAL		123

Q11 How would you describe the current quality of fishing on Pearl Lake? Check one.

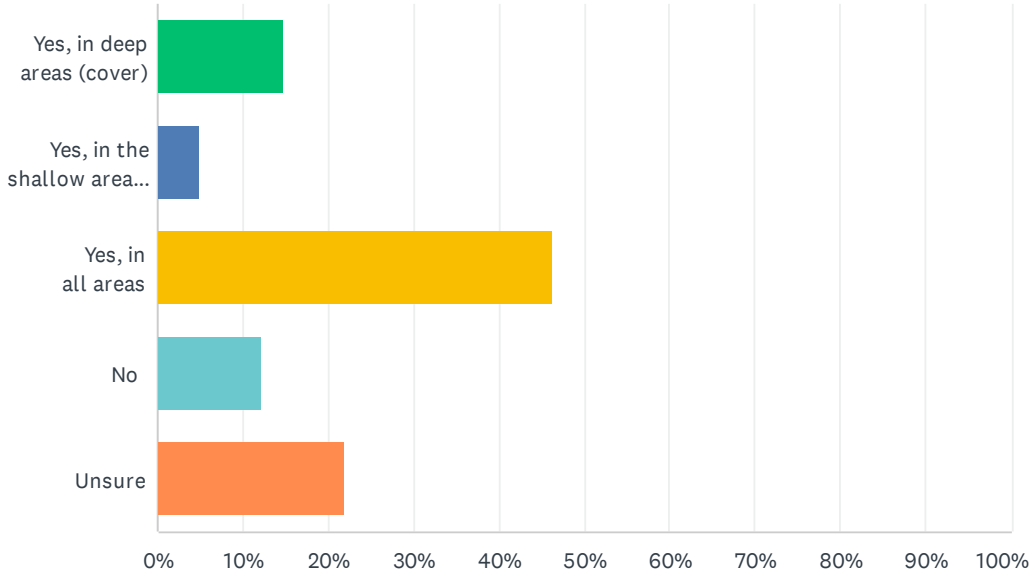
Answered: 122 Skipped: 9



ANSWER CHOICES	RESPONSES	
Very poor	1.64%	2
Poor	5.74%	7
Fair	31.97%	39
Good	31.97%	39
Excellent	4.10%	5
Unsure	24.59%	30
TOTAL		122

Q12 Would you support projects that improve fish habitat on Pearl Lake?

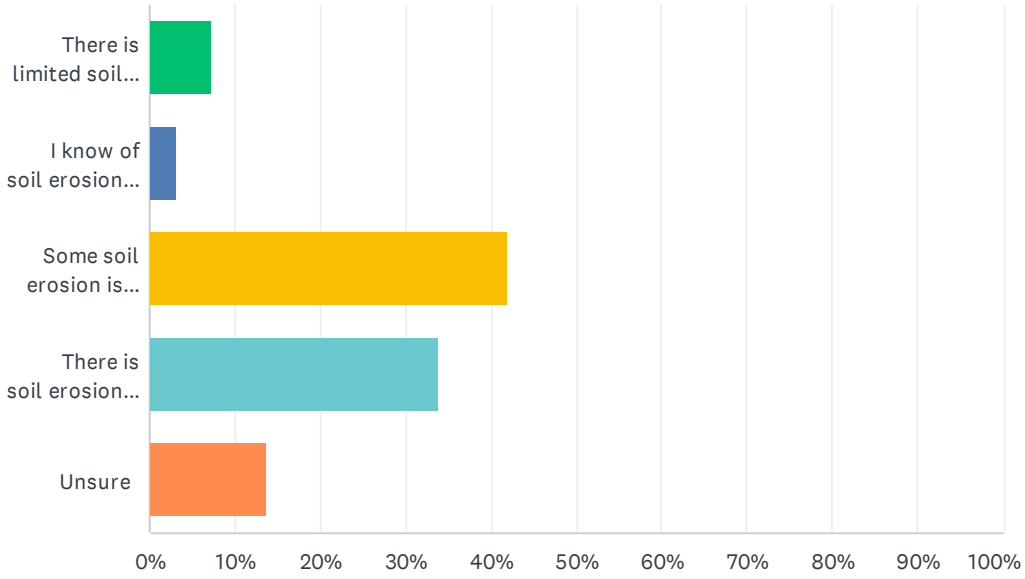
Answered: 123 Skipped: 8



ANSWER CHOICES	RESPONSES	
Yes, in deep areas (cover)	14.63%	18
Yes, in the shallow areas (spawning habit)	4.88%	6
Yes, in all areas	46.34%	57
No	12.20%	15
Unsure	21.95%	27
TOTAL		123

Q13 In your opinion, which statement best describes the shoreline of Pearl Lake?

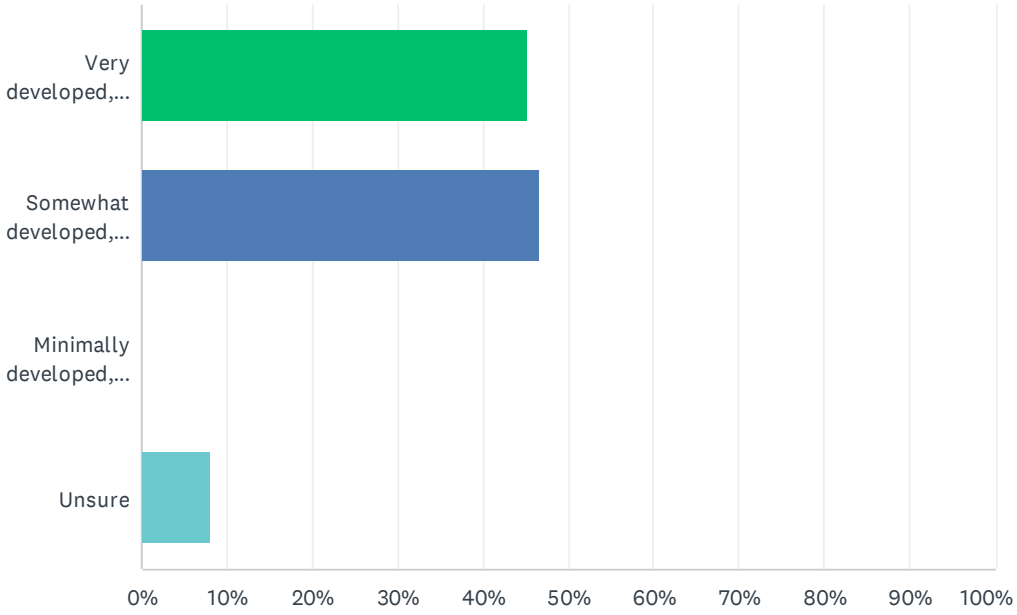
Answered: 124 Skipped: 7



ANSWER CHOICES	RESPONSES	
There is limited soil erosion along the shore.	7.26%	9
I know of soil erosion within the watershed, but it is not visible from the water.	3.23%	4
Some soil erosion is visible from the water, but only along parts of the shoreline.	41.94%	52
There is soil erosion along most of the shoreline that can be seen from the water.	33.87%	42
Unsure	13.71%	17
TOTAL		124

Q14 How would you rate shoreline development (residential, commercial, or otherwise) around Pearl Lake's shore?

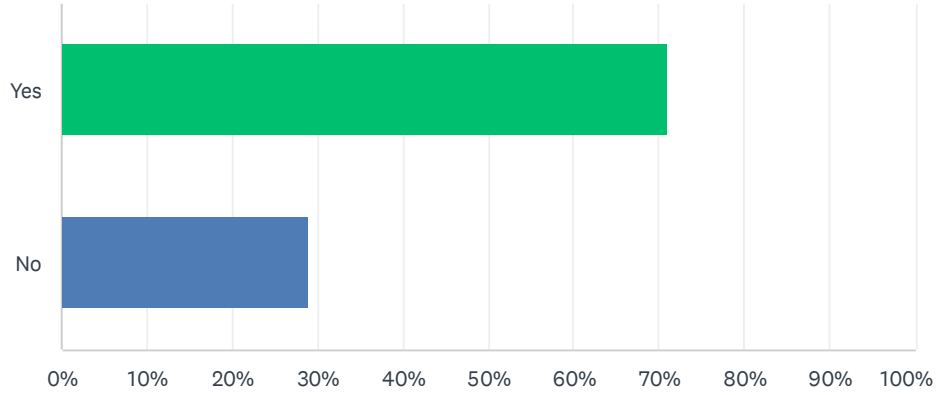
Answered: 124 Skipped: 7



ANSWER CHOICES	RESPONSES	
Very developed, buildings are too close together	45.16%	56
Somewhat developed, buildings are well spaced with natural areas	46.77%	58
Minimally developed, buildings are remote and natural areas are the dominant land use	0.00%	0
Unsure	8.06%	10
TOTAL		124

Q15 Has your property been affected by high water levels in Pearl Lake?

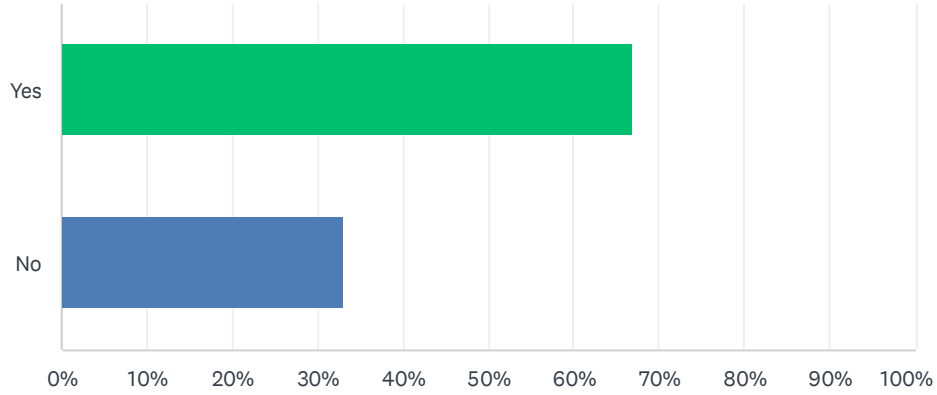
Answered: 124 Skipped: 7



ANSWER CHOICES	RESPONSES	
Yes	70.97%	88
No	29.03%	36
TOTAL		124

Q16 Are you concerned about future high water levels in Pearl Lake?

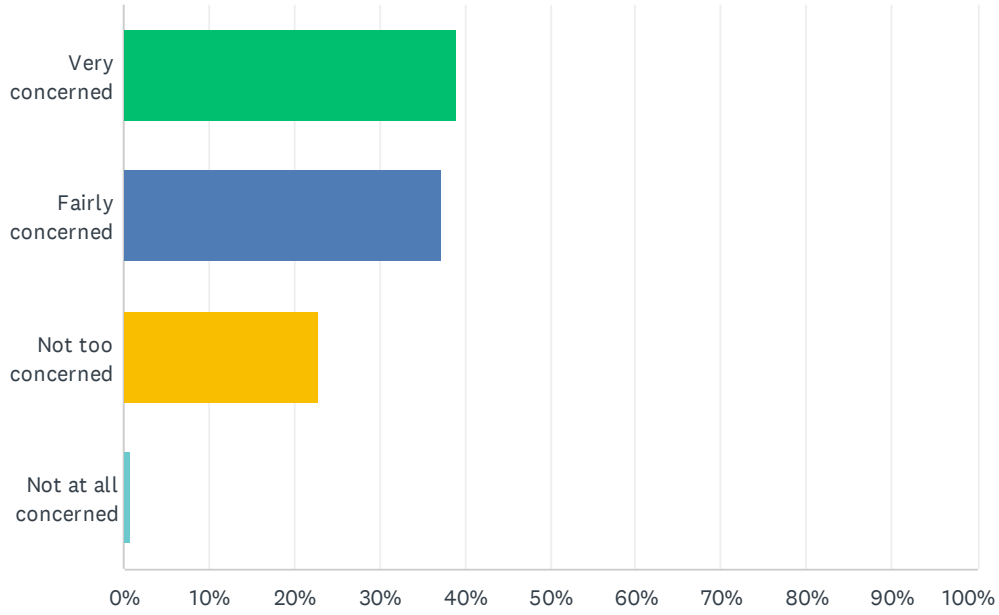
Answered: 124 Skipped: 7



ANSWER CHOICES	RESPONSES	
Yes	66.94%	83
No	33.06%	41
TOTAL		124

Q17 In a typical year, how much concern do you have about aquatic plant growth, including algae and invasive species, in Pearl Lake?

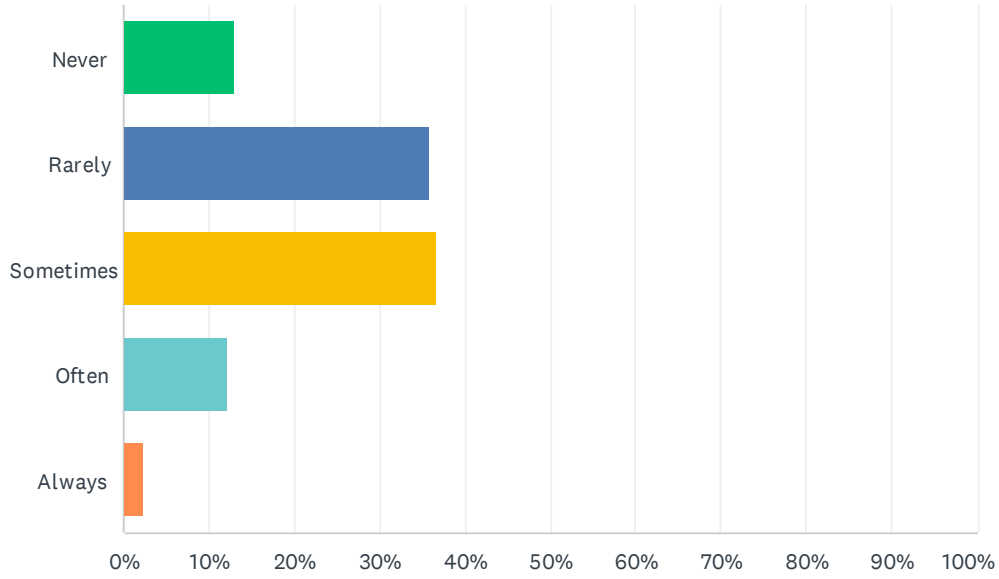
Answered: 123 Skipped: 8



ANSWER CHOICES	RESPONSES	
Very concerned	39.02%	48
Fairly concerned	37.40%	46
Not too concerned	22.76%	28
Not at all concerned	0.81%	1
TOTAL		123

Q18 In a typical year, how often does aquatic plant growth, including algae and invasive species, negatively impact your use of Pearl Lake?

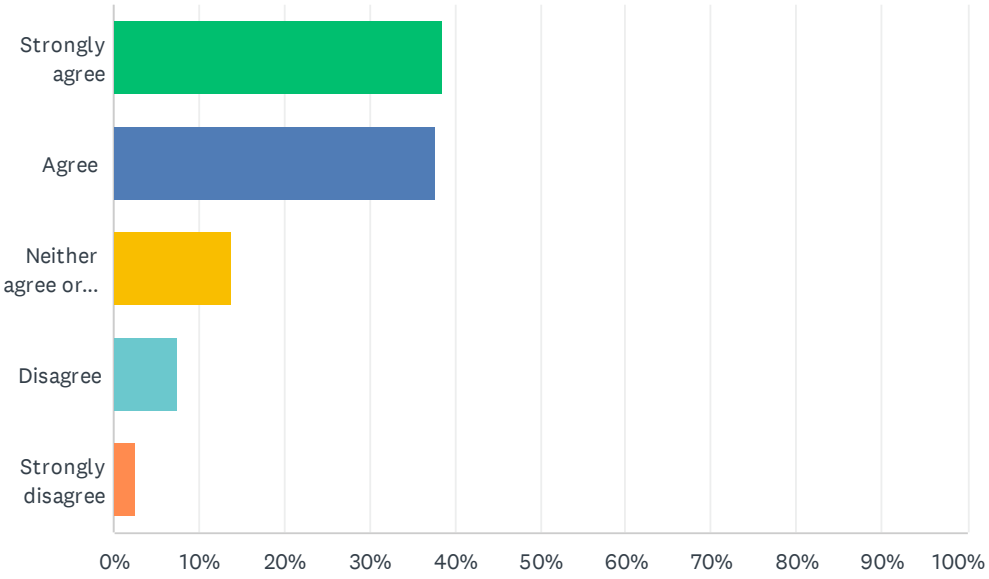
Answered: 123 Skipped: 8



ANSWER CHOICES	RESPONSES	
Never	13.01%	16
Rarely	35.77%	44
Sometimes	36.59%	45
Often	12.20%	15
Always	2.44%	3
TOTAL		123

Q19 How much do you agree or disagree that aquatic plants, including algae and invasive species, play an important role in maintaining the health of Pearl Lake?

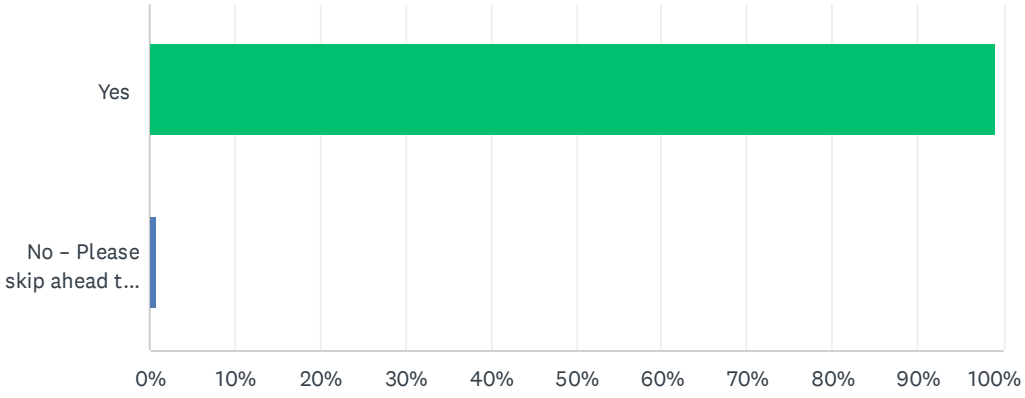
Answered: 122 Skipped: 9



ANSWER CHOICES	RESPONSES	
Strongly agree	38.52%	47
Agree	37.70%	46
Neither agree or disagree	13.93%	17
Disagree	7.38%	9
Strongly disagree	2.46%	3
TOTAL		122

Q20 Aquatic invasive species (AIS) are non-native plants and animals that are introduced into our lakes and streams and can potentially upset the natural balance of a lake ecosystem while decreasing recreational opportunities. Examples of AIS include animals such as carp, zebra mussels, rusty crayfish, round goby, and spiny waterflea and plants such as water milfoil, purple loosestrife, and curly-leaf pondweed. Before reading the statement above, had you ever heard of aquatic invasive species (AIS)?

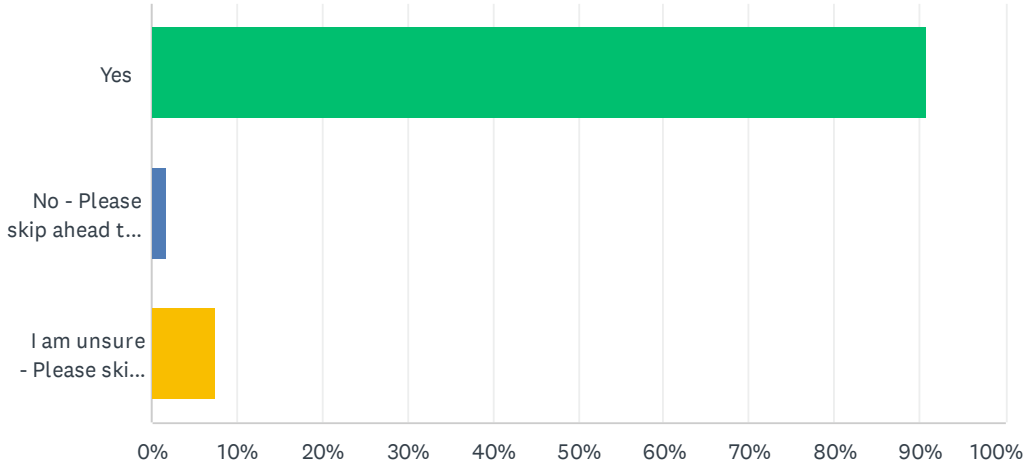
Answered: 123 Skipped: 8



ANSWER CHOICES	RESPONSES	
Yes	99.19%	122
No – Please skip ahead to the Water Quality section.	0.81%	1
TOTAL		123

Q21 Do you believe invasive species are present in Pearl Lake?

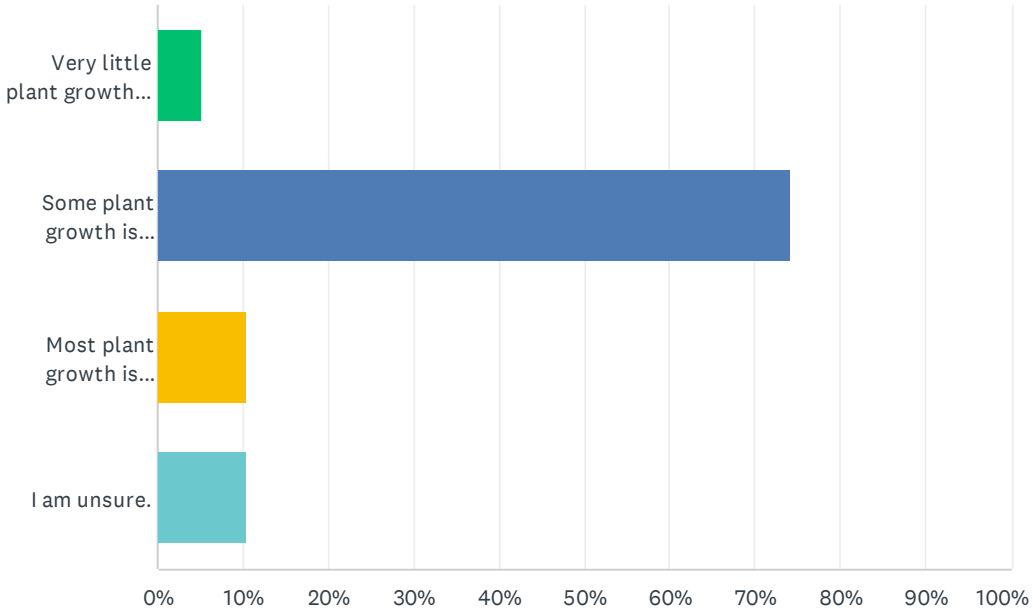
Answered: 121 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	90.91%	110
No - Please skip ahead to the Water Quality section.	1.65%	2
I am unsure - Please skip ahead to the Water Quality section.	7.44%	9
TOTAL		121

Q22 How much of Pearl Lake’s aquatic plant growth do you believe is invasive species?

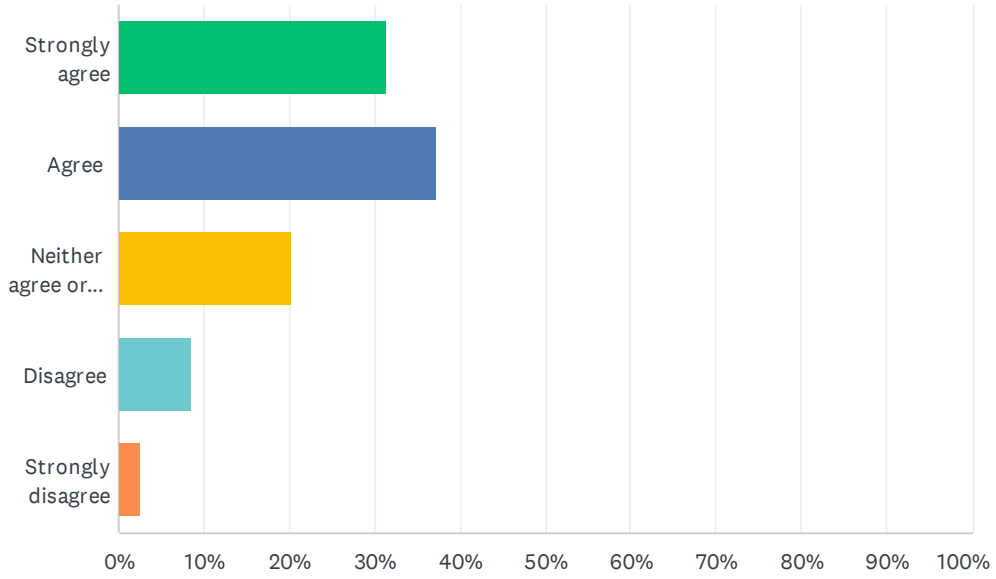
Answered: 116 Skipped: 15



ANSWER CHOICES	RESPONSES	
Very little plant growth is invasive.	5.17%	6
Some plant growth is invasive.	74.14%	86
Most plant growth is invasive.	10.34%	12
I am unsure.	10.34%	12
TOTAL		116

Q23 How much do you agree or disagree that chemical control is necessary to manage aquatic invasive species (AIS) in Pearl Lake?

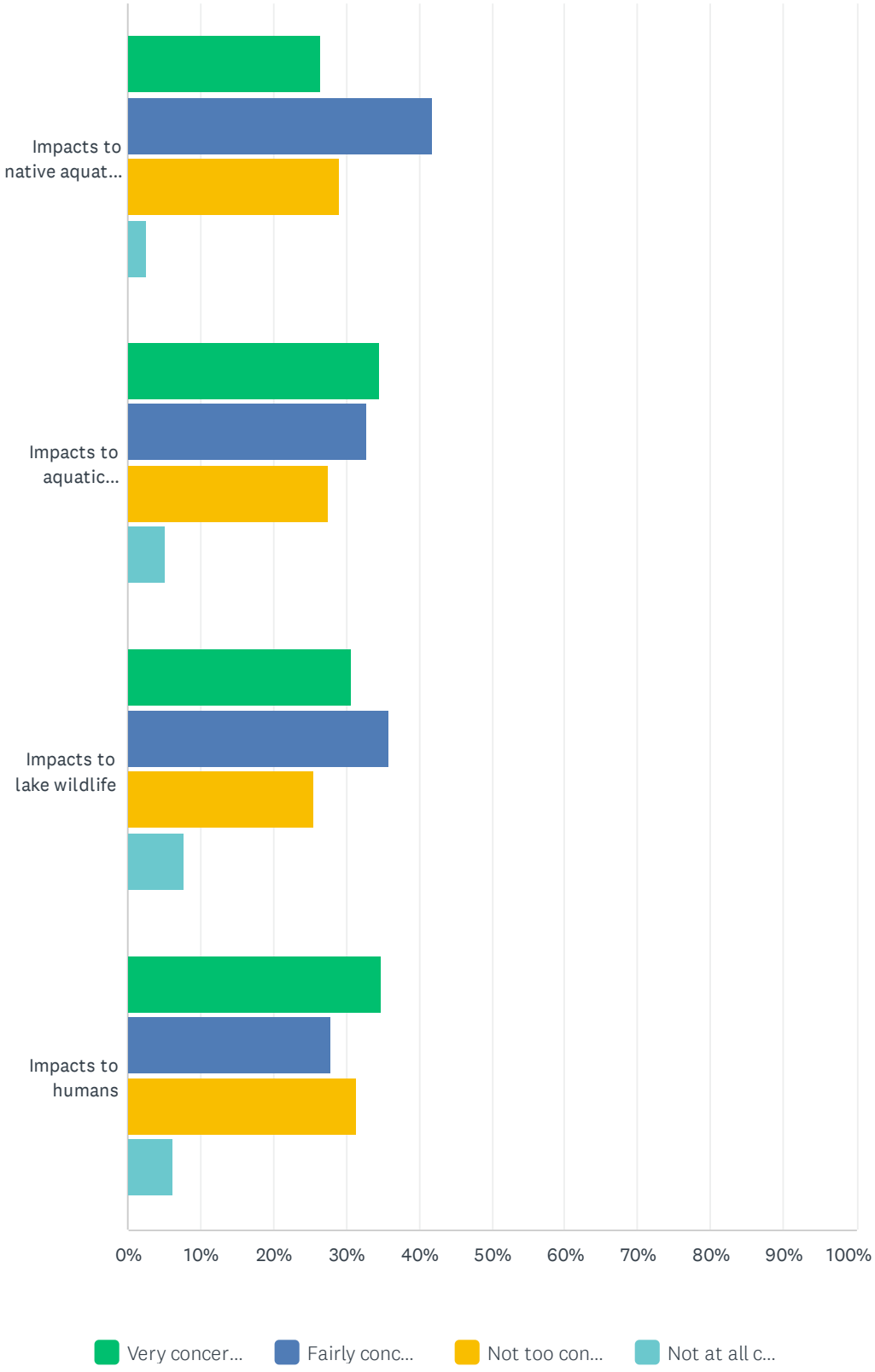
Answered: 118 Skipped: 13



ANSWER CHOICES	RESPONSES	
Strongly agree	31.36%	37
Agree	37.29%	44
Neither agree or disagree	20.34%	24
Disagree	8.47%	10
Strongly disagree	2.54%	3
TOTAL		118

Q24 How much concern, if any, do you feel for each of the following potential impacts of chemical control to manage aquatic invasive species in Peal Lake?

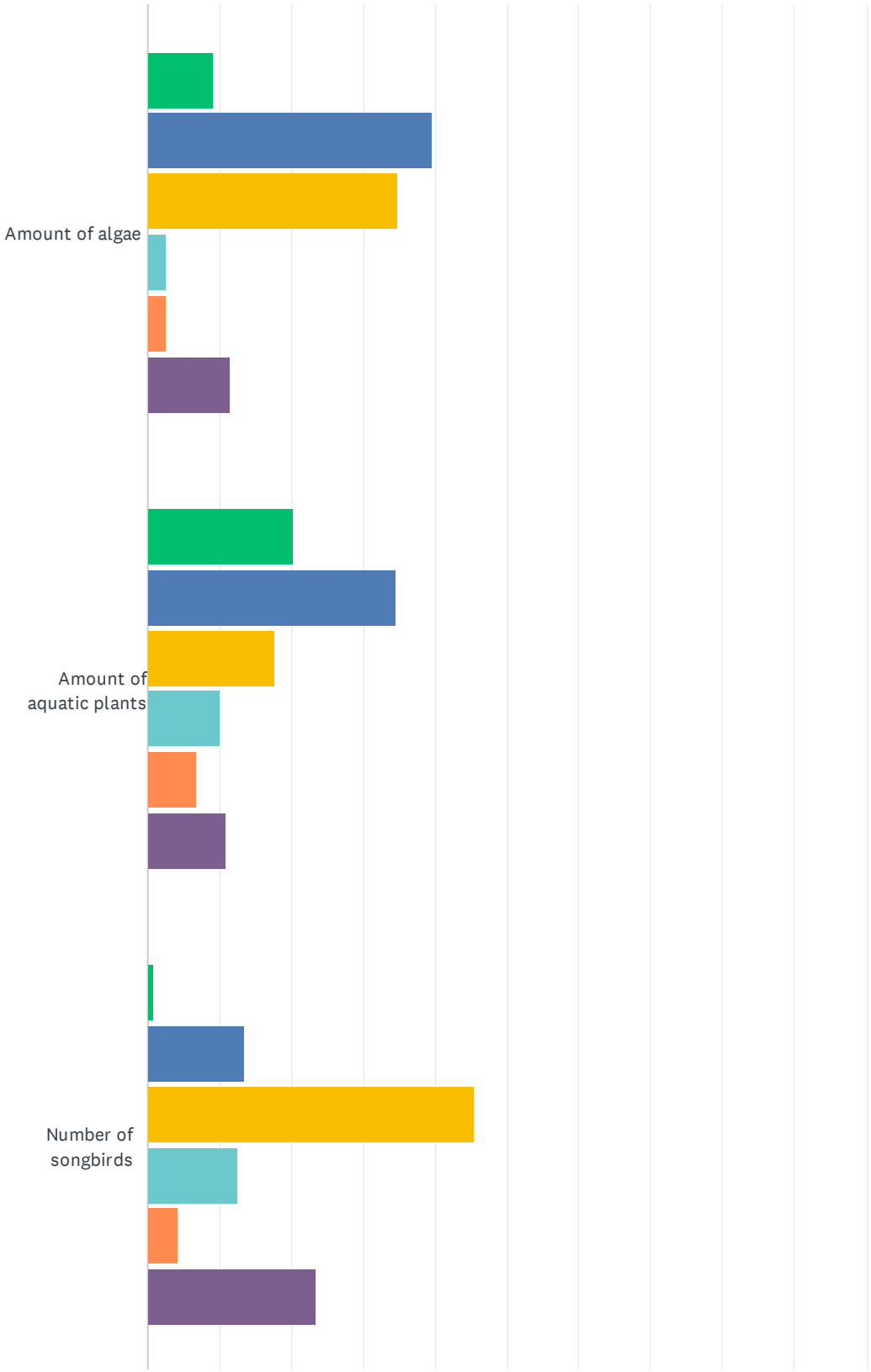
Answered: 117 Skipped: 14

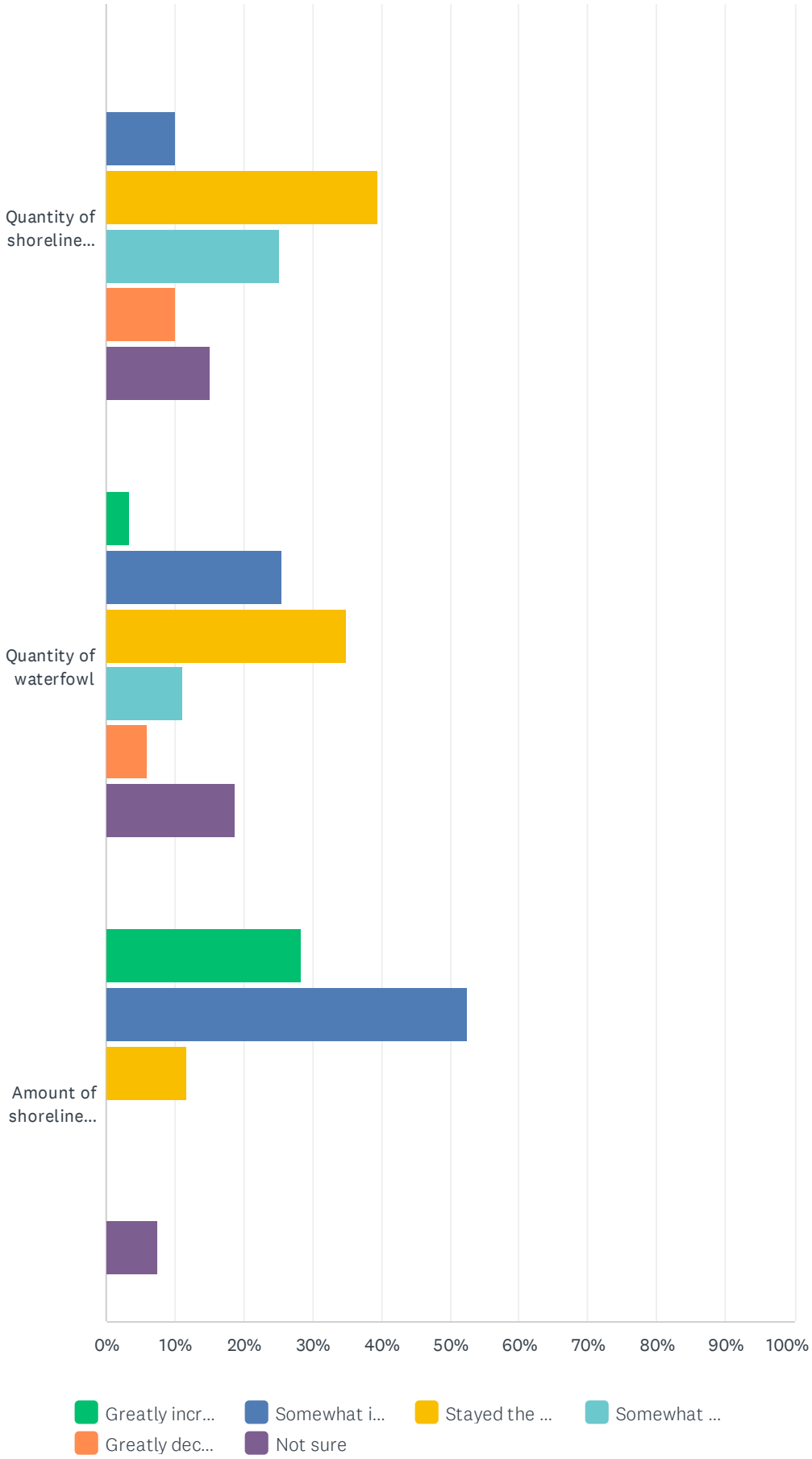

Impacts to native aquat...
Impacts to aquatic...
Impacts to lake wildlife
Impacts to humans
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Very concer...
Fairly conc...
Not too con...
Not at all c...

	VERY CONCERNED	FAIRLY CONCERNED	NOT TOO CONCERNED	NOT AT ALL CONCERNED	TOTAL
Impacts to native aquatic plants	26.50% 31	41.88% 49	29.06% 34	2.56% 3	117
Impacts to aquatic invertebrates and fish	34.48% 40	32.76% 38	27.59% 32	5.17% 6	116
Impacts to lake wildlife	30.77% 36	35.90% 42	25.64% 30	7.69% 9	117
Impacts to humans	34.78% 40	27.83% 32	31.30% 36	6.09% 7	115

Q25 Since you have lived on or near Pearl Lake, how do you feel each of the following have changed?

Answered: 121 Skipped: 10

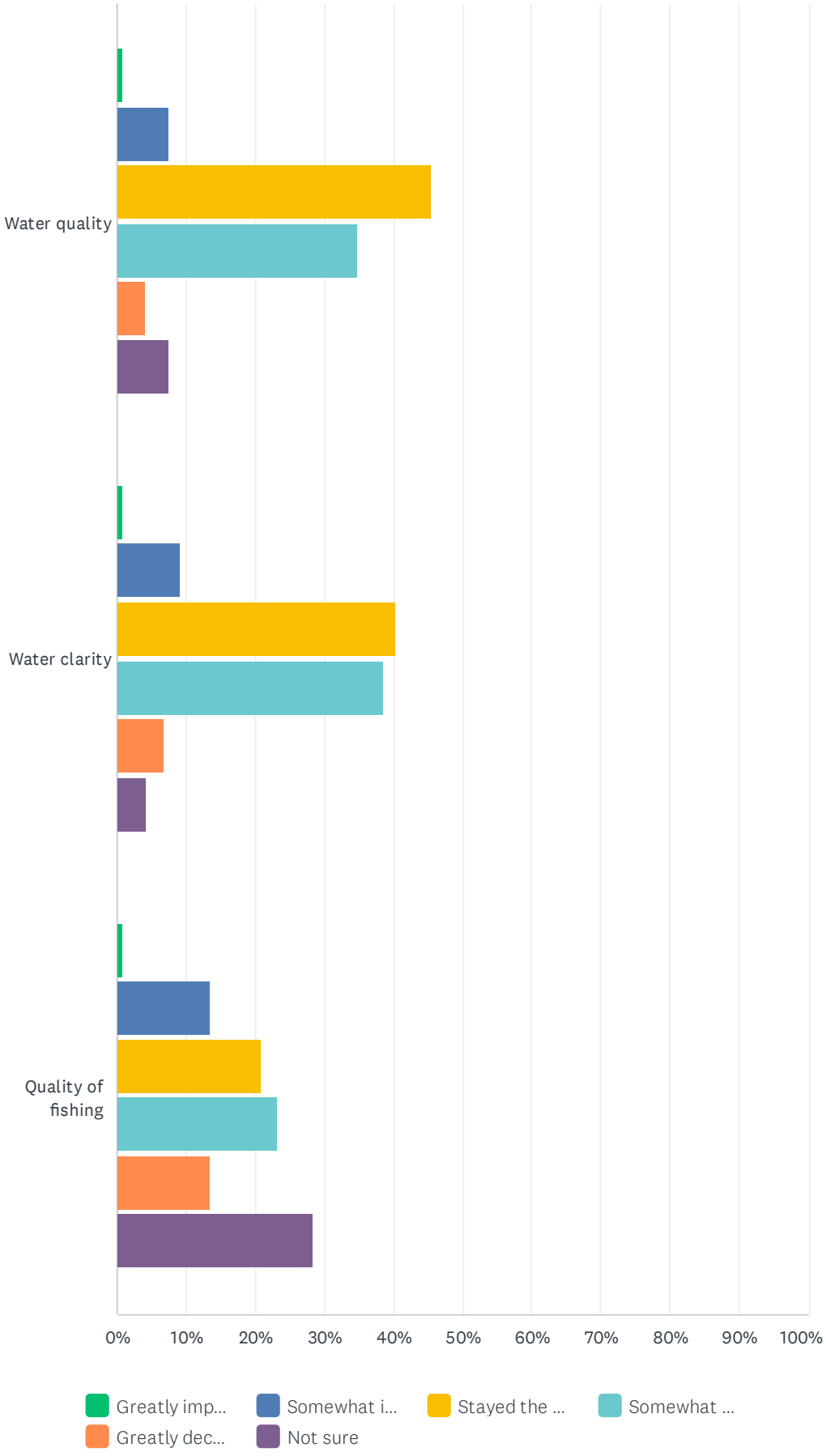



Quantity of shoreline...
Quantity of waterfowl
Amount of shoreline...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Greatly incr...
Somewhat i...
Stayed the ...
Somewhat ...
Greatly dec...
Not sure

	GREATLY INCREASED	SOMEWHAT INCREASED	STAYED THE SAME	SOMEWHAT DECREASED	GREATLY DECREASED	NOT SURE	TOTAL	WEIGHTED AVERAGE
Amount of algae	9.09% 11	39.67% 48	34.71% 42	2.48% 3	2.48% 3	11.57% 14	121	2.84
Amount of aquatic plants	20.17% 24	34.45% 41	17.65% 21	10.08% 12	6.72% 8	10.92% 13	119	2.82
Number of songbirds	0.84% 1	13.45% 16	45.38% 54	12.61% 15	4.20% 5	23.53% 28	119	3.76
Quantity of shoreline wildlife	0.00% 0	10.08% 12	39.50% 47	25.21% 30	10.08% 12	15.13% 18	119	3.81
Quantity of waterfowl	3.42% 4	25.64% 30	35.04% 41	11.11% 13	5.98% 7	18.80% 22	117	3.47
Amount of shoreline development	28.33% 34	52.50% 63	11.67% 14	0.00% 0	0.00% 0	7.50% 9	120	2.13

Q26 Since you have lived on or near Pearl Lake, how do you feel each of the following have changed?

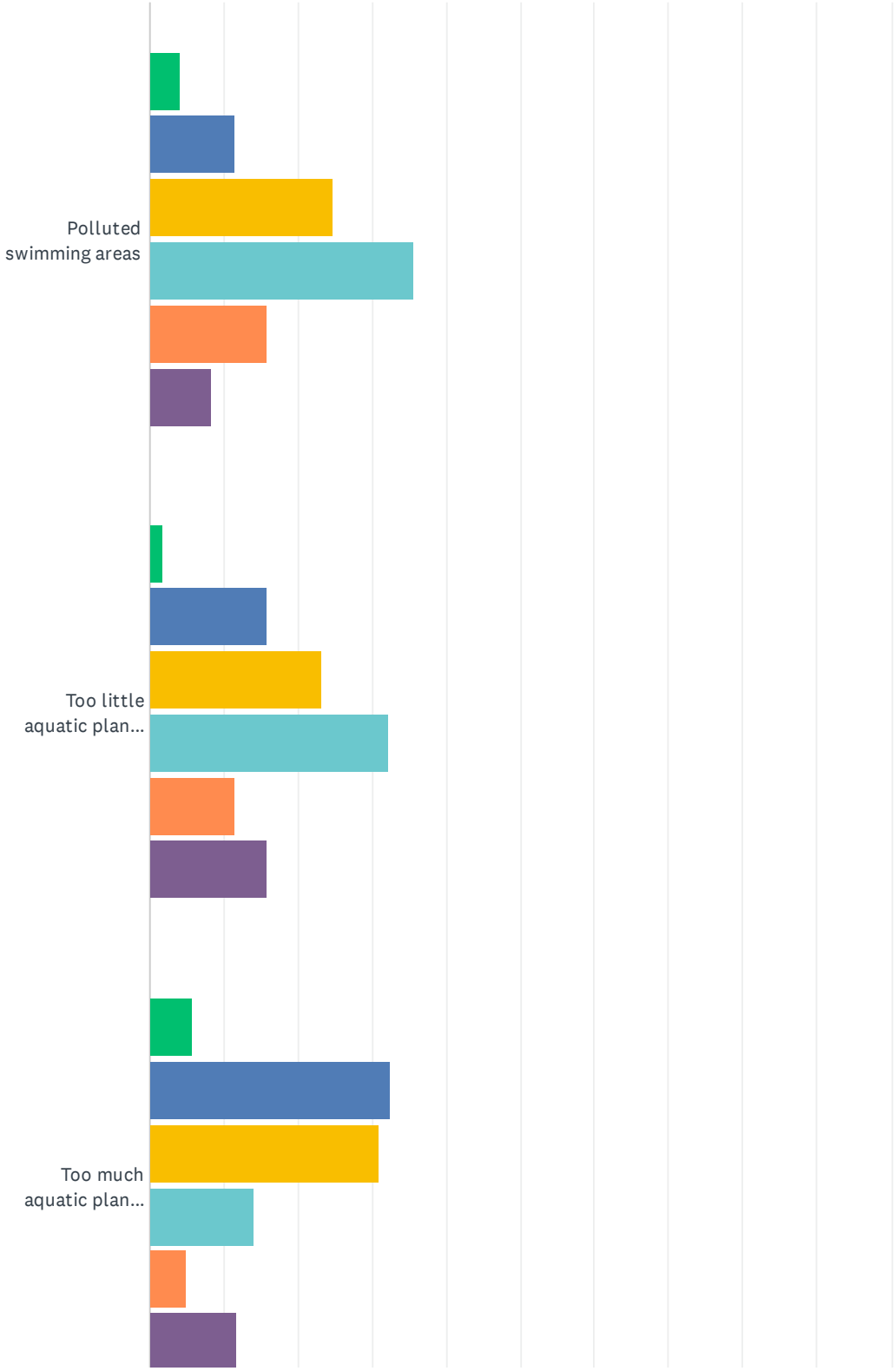
Answered: 121 Skipped: 10

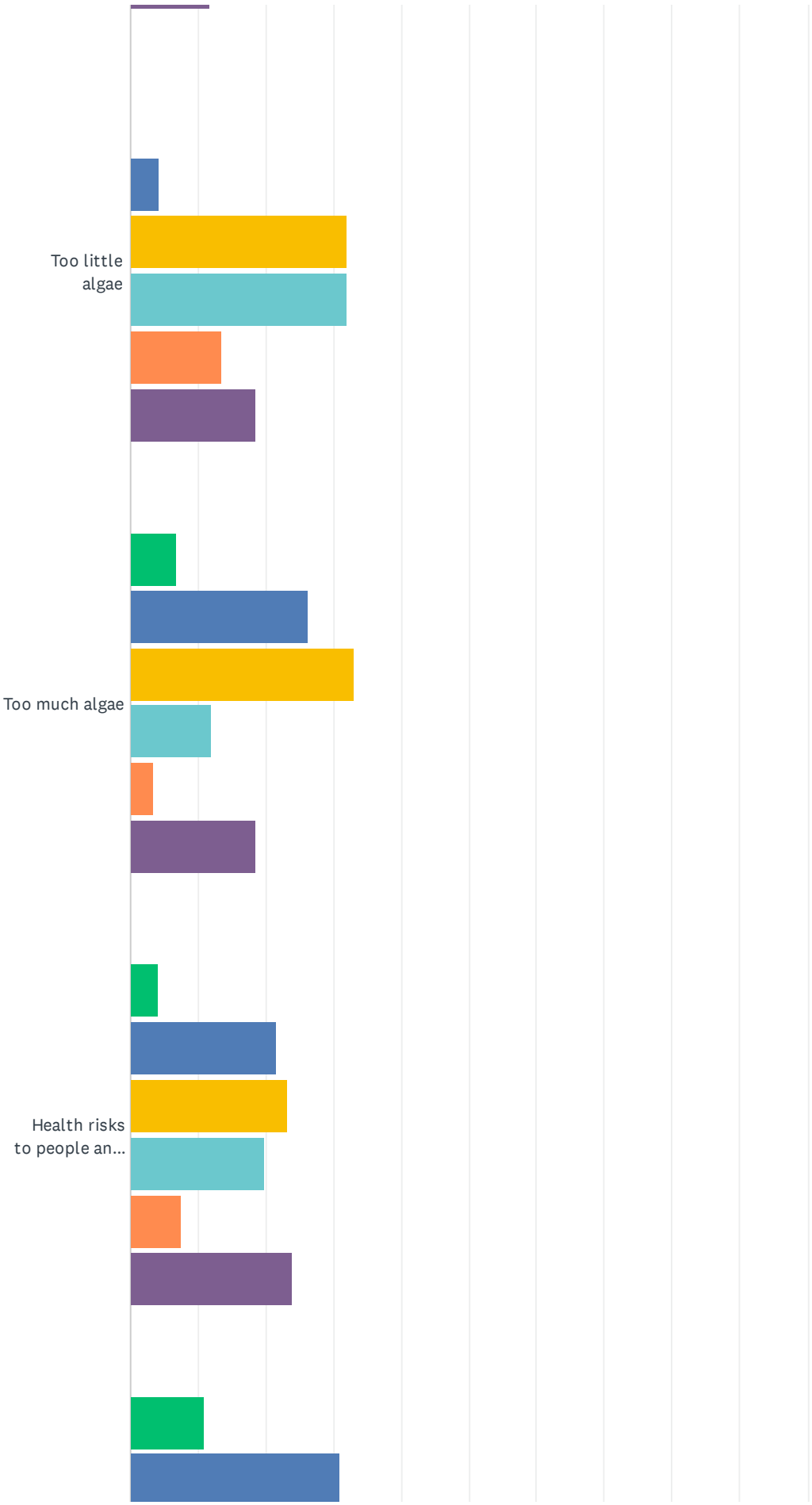

Water quality
Water clarity
Quality of fishing
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Greatly imp...
Somewhat i...
Stayed the ...
Somewhat ...
Greatly dec...
Not sure

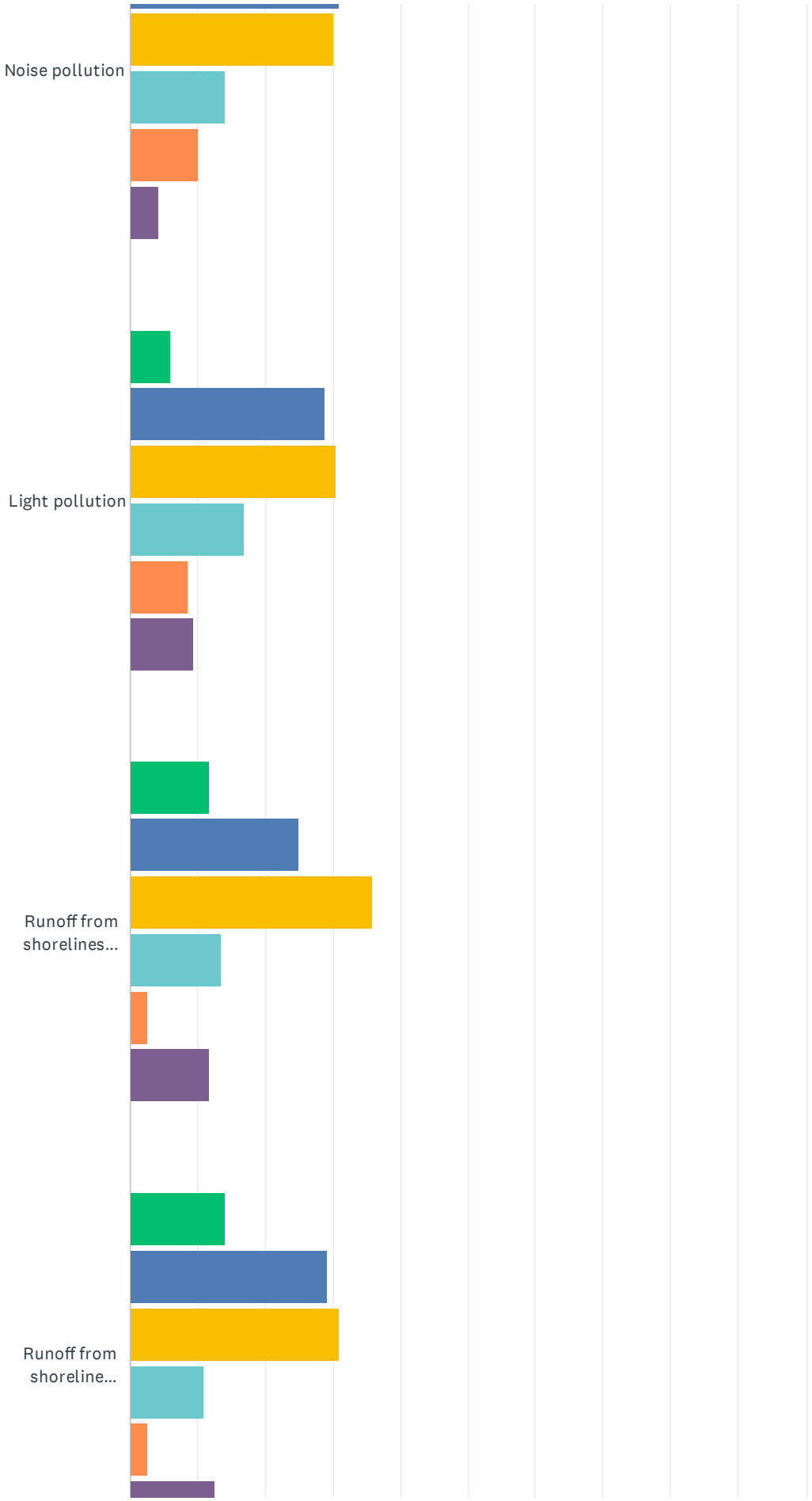
	GREATLY IMPROVED	SOMEWHAT IMPROVED	STAYED THE SAME	SOMEWHAT DECLINED	GREATLY DECLINED	NOT SURE	TOTAL	WEIGHTED AVERAGE
Water quality	0.83% 1	7.44% 9	45.45% 55	34.71% 42	4.13% 5	7.44% 9	121	3.56
Water clarity	0.84% 1	9.24% 11	40.34% 48	38.66% 46	6.72% 8	4.20% 5	119	3.54
Quality of fishing	0.83% 1	13.33% 16	20.83% 25	23.33% 28	13.33% 16	28.33% 34	120	4.20

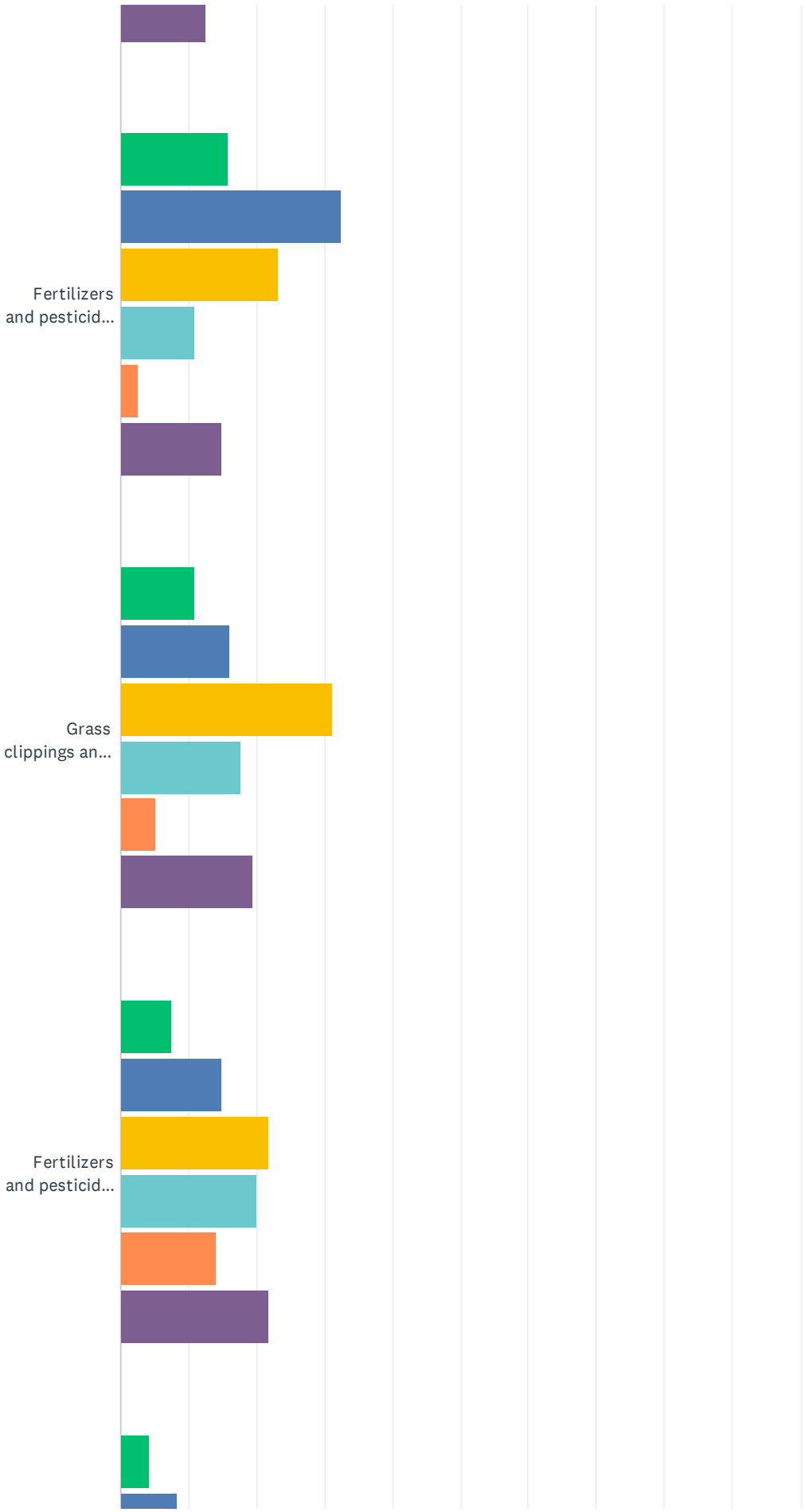
Q27 Below are potential problems for lakes in general. How much do you agree or disagree that each is a current issue regarding the quality of water in Pearl Lake?

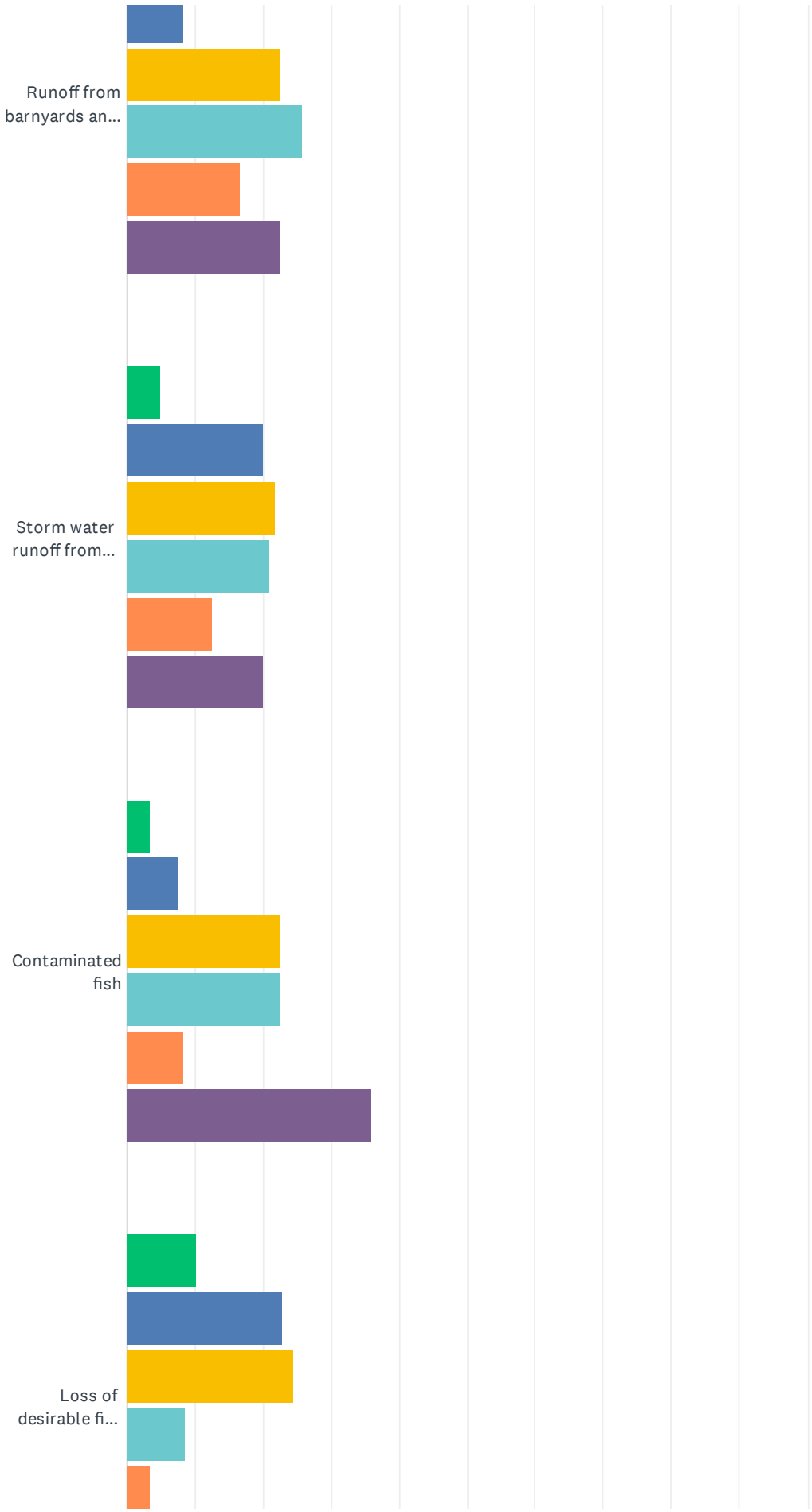
Answered: 121 Skipped: 10

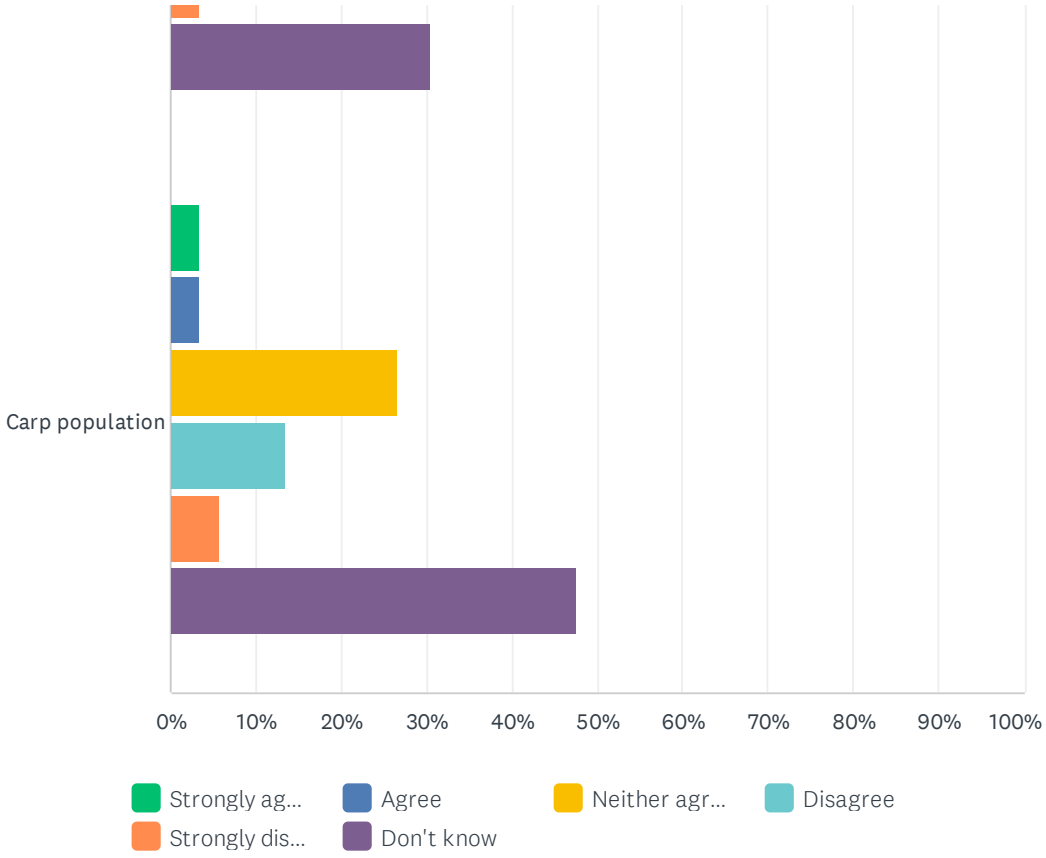



Too little algae
Too much algae
Health risks to people an...


Noise pollution
Light pollution
Runoff from shorelines...
Runoff from shoreline...


Fertilizers and pesticid...
Grass clippings an...
Fertilizers and pesticid...

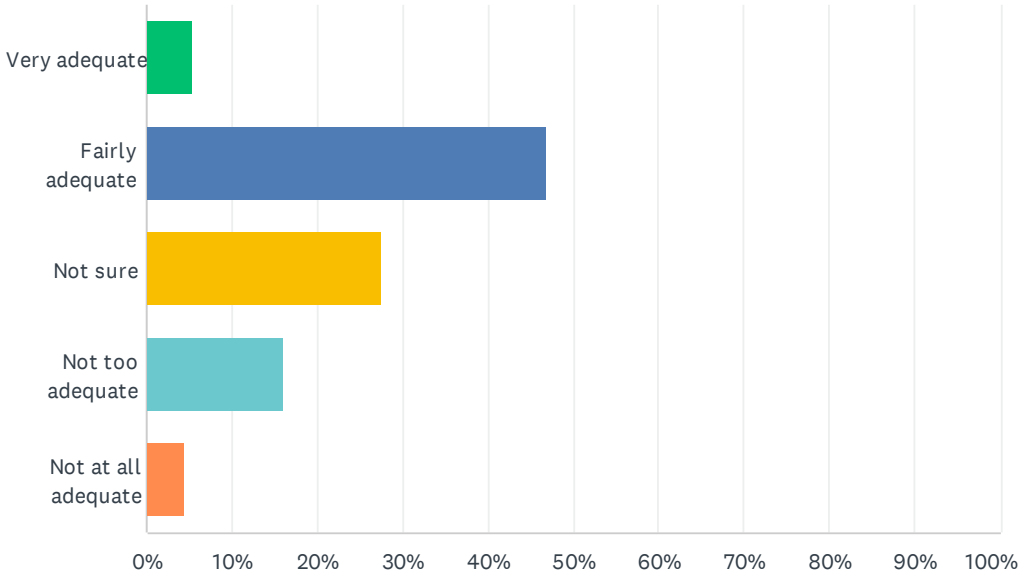

Runoff from barnyards an...
Storm water runoff from...
Contaminated fish
Loss of desirable fi...


Carp population
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Strongly ag...
Agree
Neither agr...
Disagree
Strongly dis...
Don't know

	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	DON'T KNOW	TOTAL	WEIGHTED AVERAGE
Polluted swimming areas	4.13% 5	11.57% 14	24.79% 30	35.54% 43	15.70% 19	8.26% 10	121	3.72
Too little aquatic plant growth	1.65% 2	15.70% 19	23.14% 28	32.23% 39	11.57% 14	15.70% 19	121	3.83
Too much aquatic plant growth	5.83% 7	32.50% 39	30.83% 37	14.17% 17	5.00% 6	11.67% 14	120	3.15
Too little algae	0.00% 0	4.20% 5	31.93% 38	31.93% 38	13.45% 16	18.49% 22	119	4.10
Too much algae	6.78% 8	26.27% 31	33.05% 39	11.86% 14	3.39% 4	18.64% 22	118	3.35
Health risks to people and pets from algae blooms	4.13% 5	21.49% 26	23.14% 28	19.83% 24	7.44% 9	23.97% 29	121	3.77
Noise pollution	10.83% 13	30.83% 37	30.00% 36	14.17% 17	10.00% 12	4.17% 5	120	2.94
Light pollution	5.93% 7	28.81% 34	30.51% 36	16.95% 20	8.47% 10	9.32% 11	118	3.21
Runoff from shorelines and/or stream banks	11.67% 14	25.00% 30	35.83% 43	13.33% 16	2.50% 3	11.67% 14	120	3.05
Runoff from shoreline development and clearing	14.17% 17	29.17% 35	30.83% 37	10.83% 13	2.50% 3	12.50% 15	120	2.96
Fertilizers and pesticides from residential runoff	15.83% 19	32.50% 39	23.33% 28	10.83% 13	2.50% 3	15.00% 18	120	2.97
Grass clippings and leaves from near shore and/or city storm drains	10.92% 13	15.97% 19	31.09% 37	17.65% 21	5.04% 6	19.33% 23	119	3.48
Fertilizers and pesticides from farm fields	7.50% 9	15.00% 18	21.67% 26	20.00% 24	14.17% 17	21.67% 26	120	3.83
Runoff from barnyards and animal feedlots	4.17% 5	8.33% 10	22.50% 27	25.83% 31	16.67% 20	22.50% 27	120	4.10
Storm water runoff from city roads and streets	5.00% 6	20.00% 24	21.67% 26	20.83% 25	12.50% 15	20.00% 24	120	3.76
Contaminated fish	3.33% 4	7.50% 9	22.50% 27	22.50% 27	8.33% 10	35.83% 43	120	4.33
Loss of desirable fish species	10.17% 12	22.88% 27	24.58% 29	8.47% 10	3.39% 4	30.51% 36	118	3.64
Carp population	3.33% 4	3.33% 4	26.67% 32	13.33% 16	5.83% 7	47.50% 57	120	4.58

Q28 How adequately do you feel the present land use regulations protect habitat and water quality in the lake?

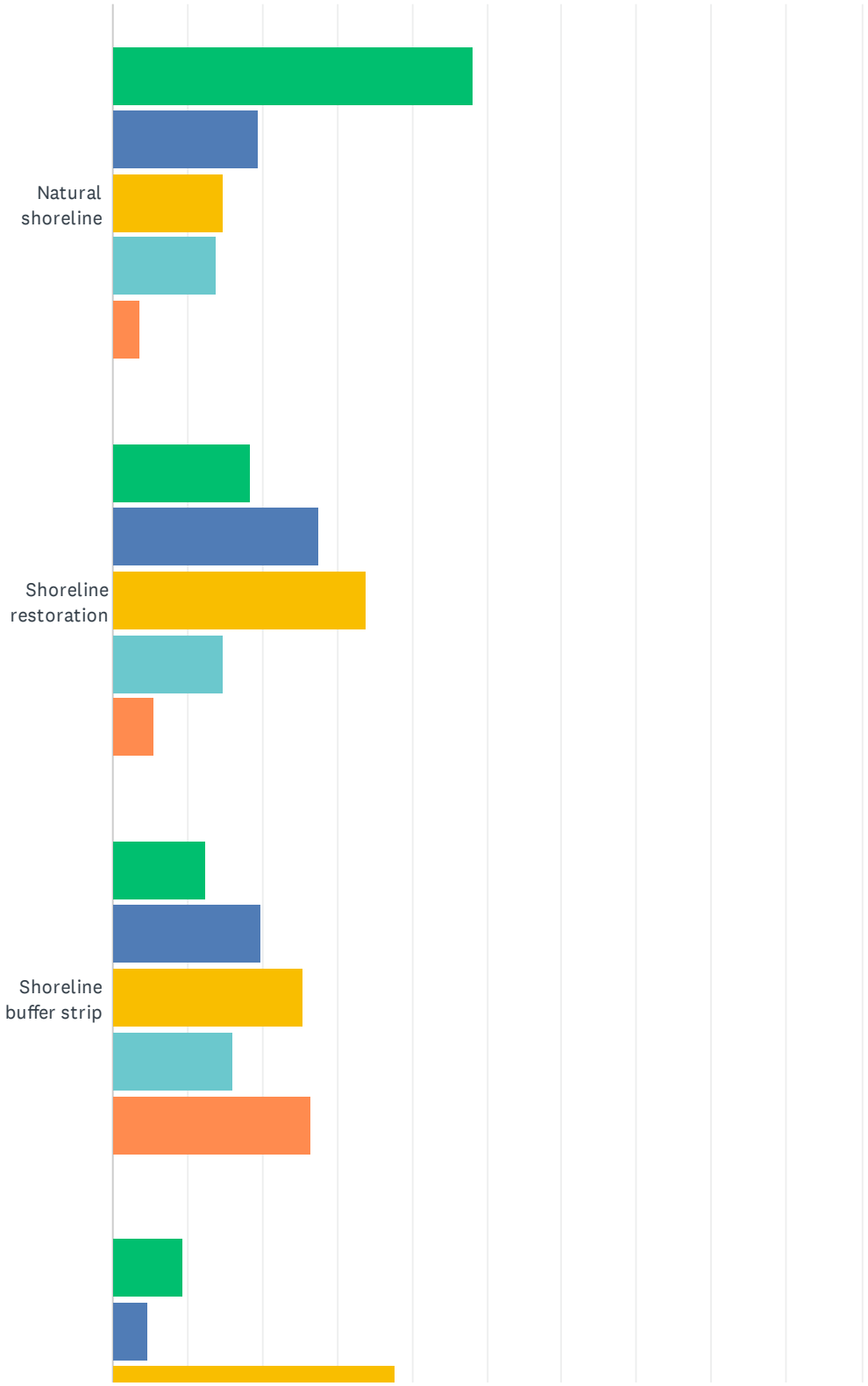
Answered: 113 Skipped: 18

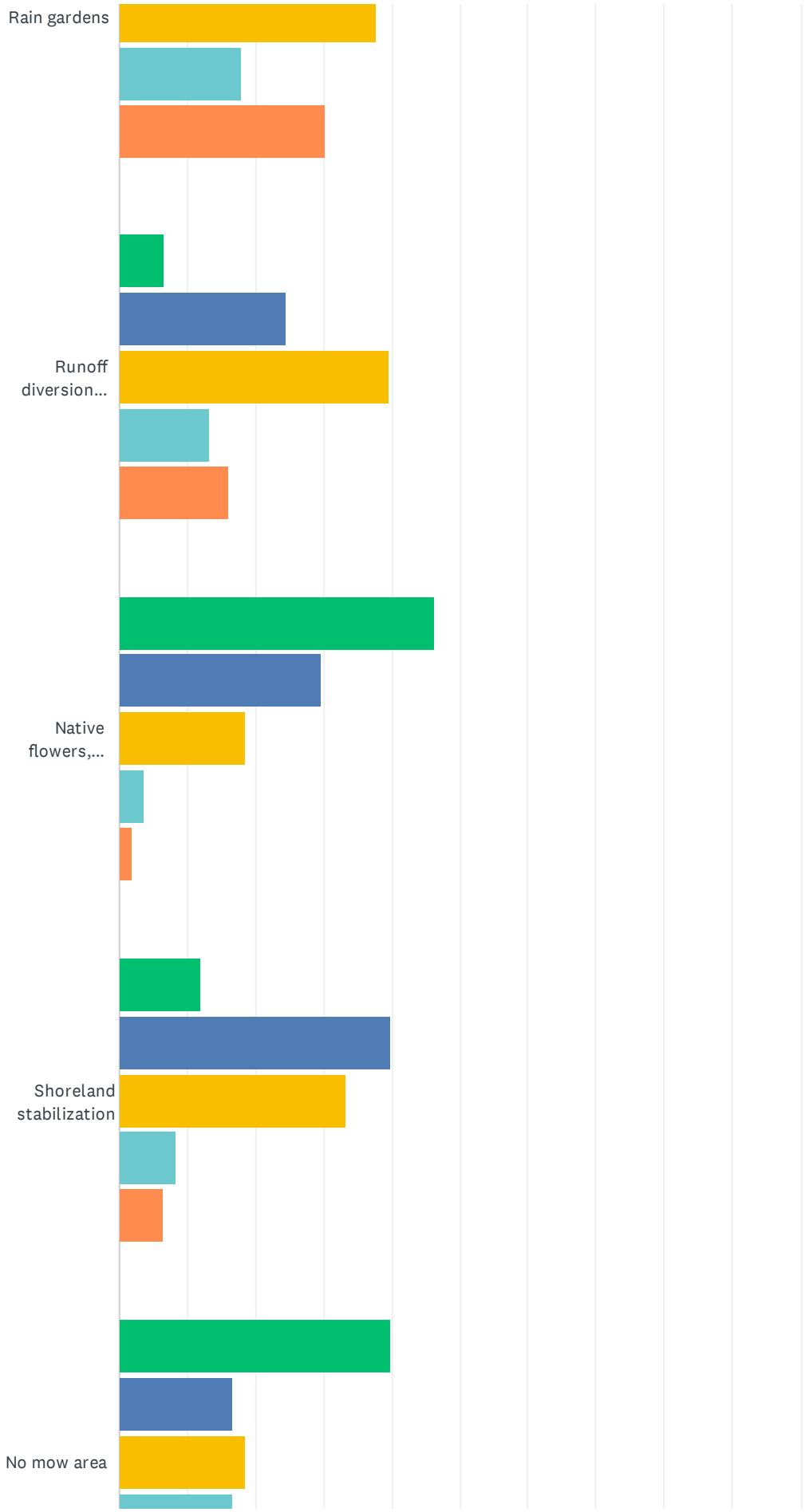


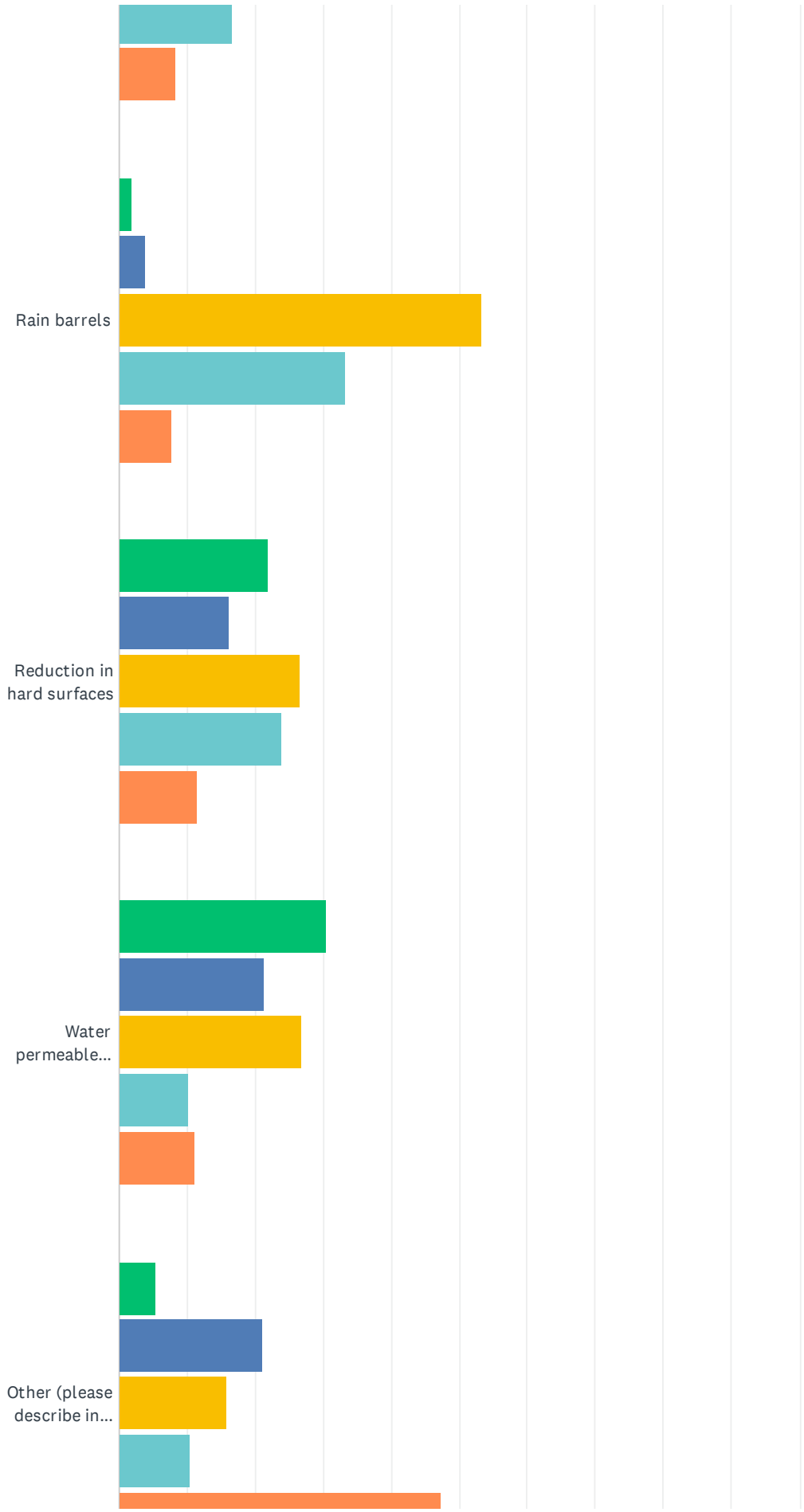
ANSWER CHOICES	RESPONSES	
Very adequate	5.31%	6
Fairly adequate	46.90%	53
Not sure	27.43%	31
Not too adequate	15.93%	18
Not at all adequate	4.42%	5
TOTAL		113

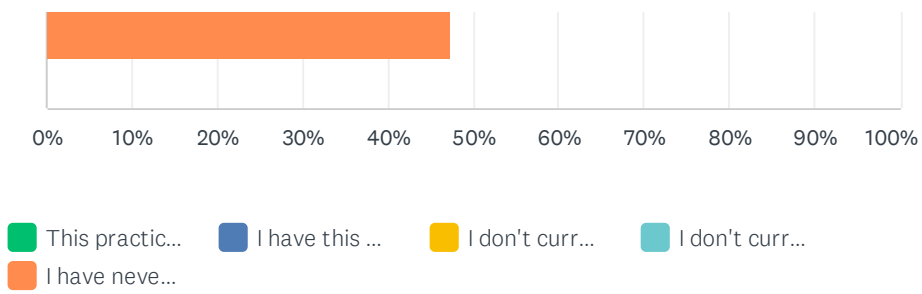
Q29 The following landscaping practices can be used to protect and improve water quality. Please tell us your experience with each of the below practices on your property.

Answered: 111 Skipped: 20




Rain gardens
Runoff diversion...
Native flowers,...
Shoreland stabilization
No mow area

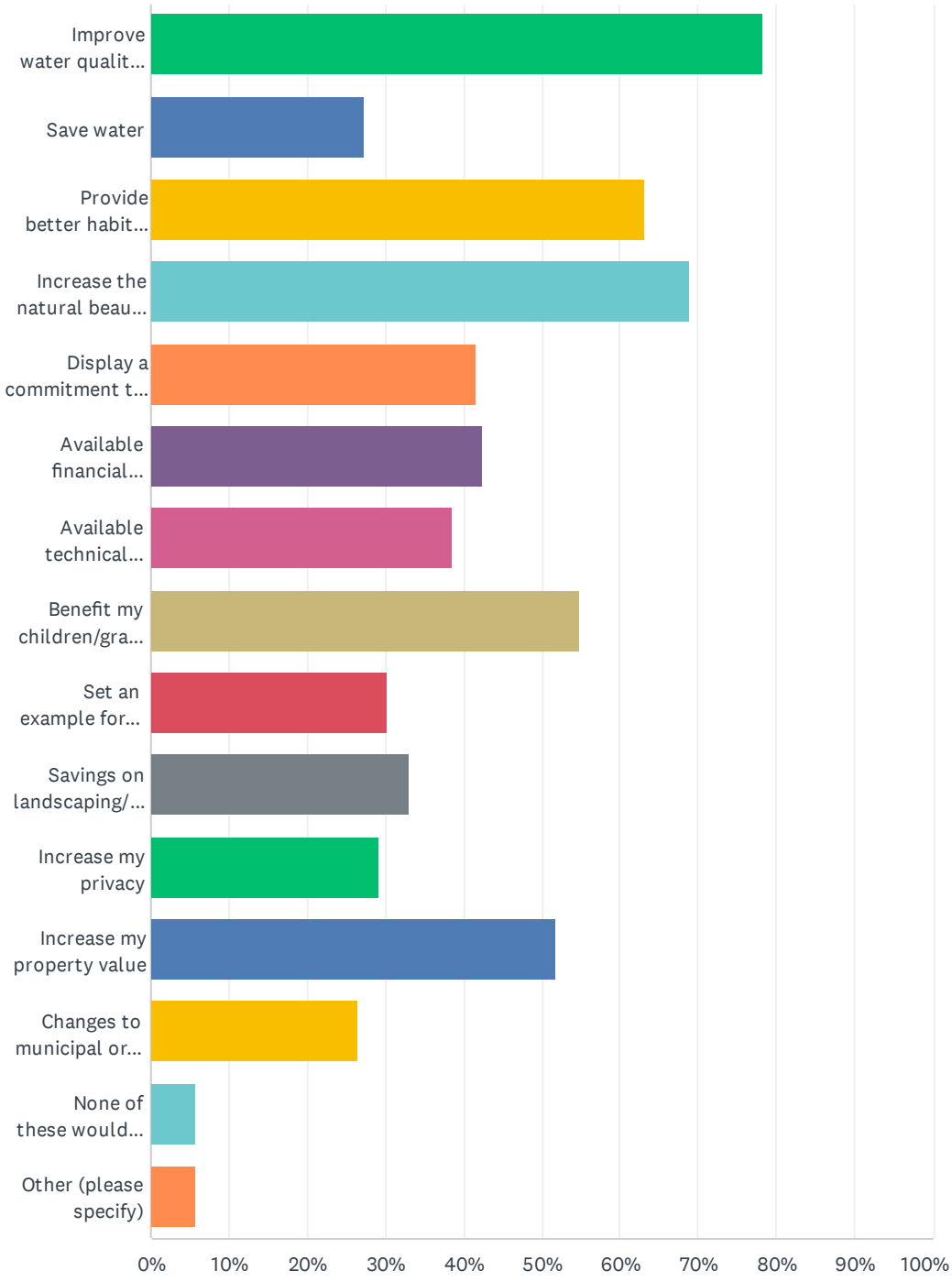

Rain barrels
Reduction in hard surfaces
Water permeable...
Other (please describe in...



	THIS PRACTICE EXISTS NATURALLY ON MY PROPERTY	I HAVE THIS PRACTICE INSTALLED ON MY PROPERTY	I DON'T CURRENTLY HAVE THIS PRACTICE BUT WOULD CONSIDER INSTALLING IT ON MY PROPERTY	I DON'T CURRENTLY HAVE THIS PRACTICE BUT WOULD NOT CONSIDER INSTALLING IT ON MY PROPERTY	I HAVE NEVER HEARD OF THIS PRACTICE BEFORE	TOTAL	WEIGHTED AVERAGE
Natural shoreline	48.15% 52	19.44% 21	14.81% 16	13.89% 15	3.70% 4	108	2.06
Shoreline restoration	18.35% 20	27.52% 30	33.94% 37	14.68% 16	5.50% 6	109	2.61
Shoreline buffer strip	12.26% 13	19.81% 21	25.47% 27	16.04% 17	26.42% 28	106	3.25
Rain gardens	9.43% 10	4.72% 5	37.74% 40	17.92% 19	30.19% 32	106	3.55
Runoff diversion practices	6.60% 7	24.53% 26	39.62% 42	13.21% 14	16.04% 17	106	3.08
Native flowers, shrubs, and trees	46.30% 50	29.63% 32	18.52% 20	3.70% 4	1.85% 2	108	1.85
Shoreland stabilization	12.04% 13	39.81% 43	33.33% 36	8.33% 9	6.48% 7	108	2.57
No mow area	39.81% 43	16.67% 18	18.52% 20	16.67% 18	8.33% 9	108	2.37
Rain barrels	1.90% 2	3.81% 4	53.33% 56	33.33% 35	7.62% 8	105	3.41
Reduction in hard surfaces	21.90% 23	16.19% 17	26.67% 28	23.81% 25	11.43% 12	105	2.87
Water permeable surfaces	30.56% 33	21.30% 23	26.85% 29	10.19% 11	11.11% 12	108	2.50
Other (please describe in text box)	5.26% 1	21.05% 4	15.79% 3	10.53% 2	47.37% 9	19	3.74

Q30 What might motivate you to change how you manage your property? Please check all that apply.

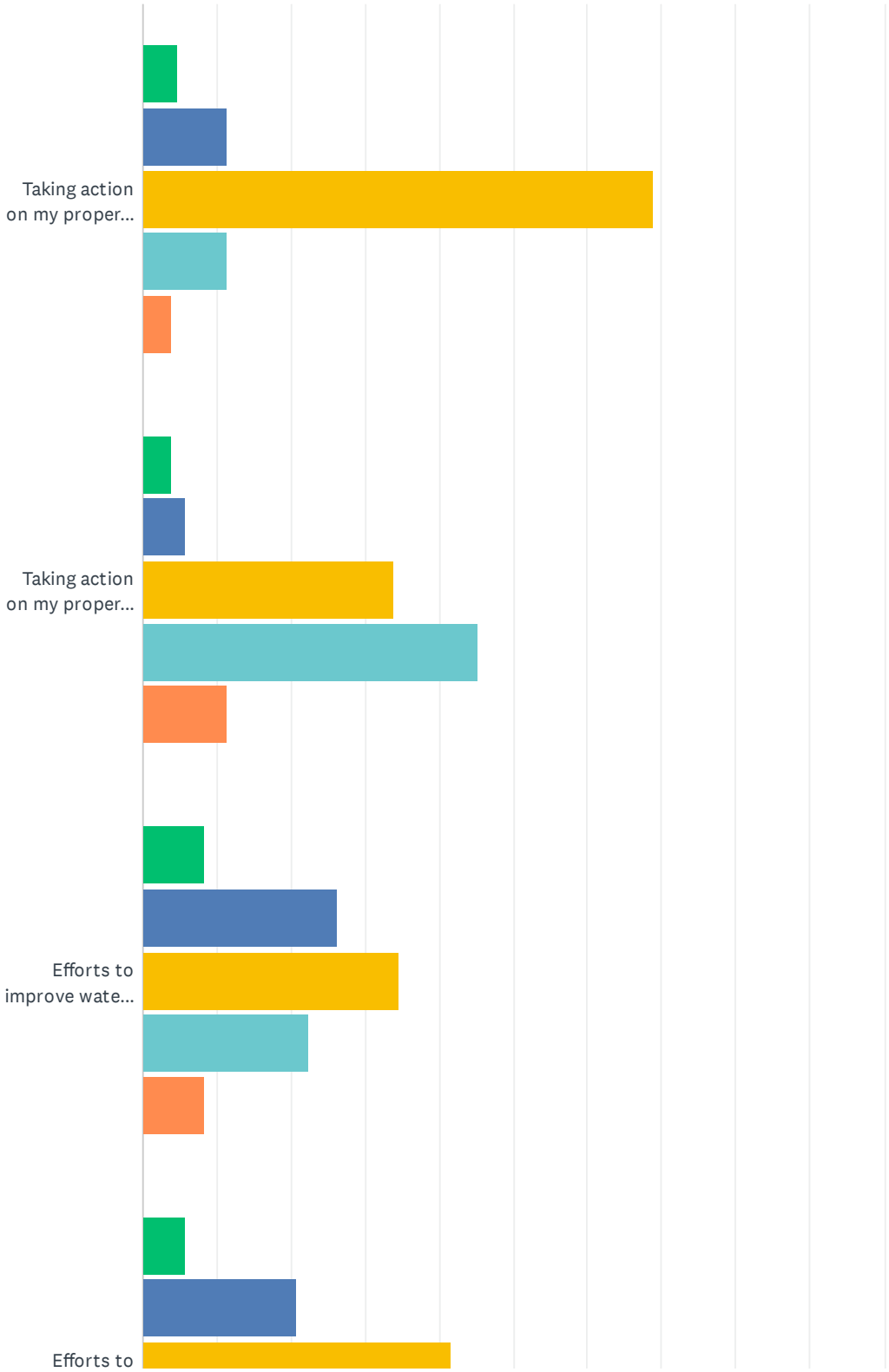
Answered: 106 Skipped: 25

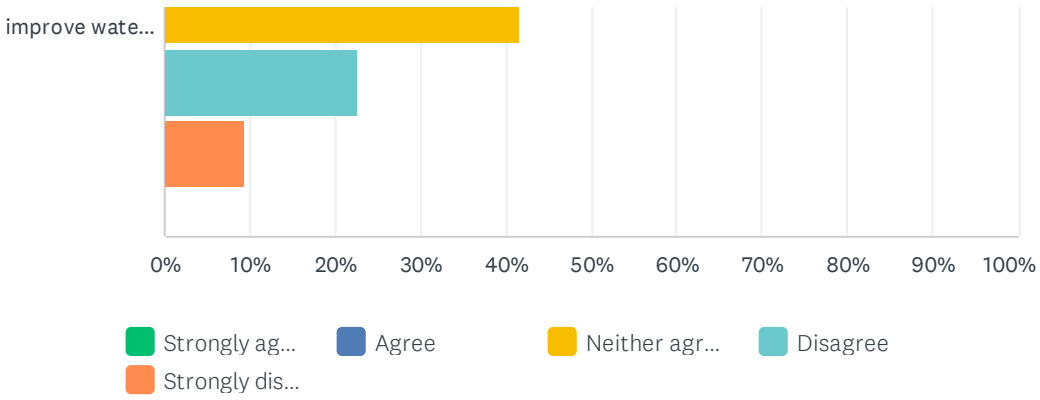


ANSWER CHOICES	RESPONSES	
Improve water quality in Pearl Lake	78.30%	83
Save water	27.36%	29
Provide better habitat for fish and wildlife	63.21%	67
Increase the natural beauty of my property	68.87%	73
Display a commitment to the environment	41.51%	44
Available financial assistance	42.45%	45
Available technical assistance	38.68%	41
Benefit my children/grandchildren	54.72%	58
Set an example for community members	30.19%	32
Savings on landscaping/maintenance costs	33.02%	35
Increase my privacy	29.25%	31
Increase my property value	51.89%	55
Changes to municipal or county ordinances which require utilizing some of these practices.	26.42%	28
None of these would motivate me.	5.66%	6
Other (please specify)	5.66%	6
Total Respondents: 106		

Q31 How much do you agree or disagree with the following statements regarding land use and management of Pearl Lake as it relates to improving water quality in Pearl Lake?

Answered: 108 Skipped: 23

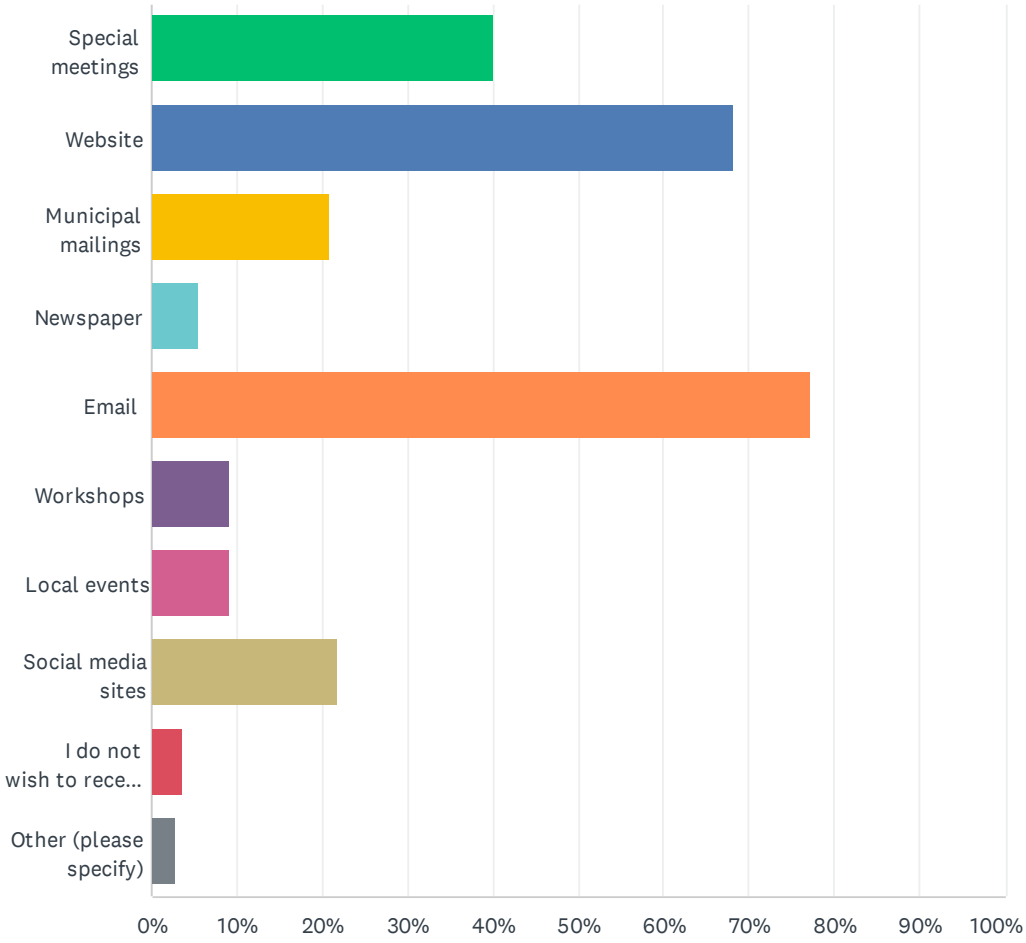




	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE	TOTAL	WEIGHTED AVERAGE
Taking action on my property to improve water quality is too expensive for me	4.72% 5	11.32% 12	68.87% 73	11.32% 12	3.77% 4	106	2.98
Taking action on my property to improve water quality is not a priority for me	3.77% 4	5.66% 6	33.96% 36	45.28% 48	11.32% 12	106	3.55
Efforts to improve water quality in Pearl Lake must be voluntary	8.41% 9	26.17% 28	34.58% 37	22.43% 24	8.41% 9	107	2.96
Efforts to improve water quality in Pearl Lake must include governmental regulations	5.66% 6	20.75% 22	41.51% 44	22.64% 24	9.43% 10	106	3.09

Q32 How would you like to receive information about activities related to Pearl Lake? Please check all that apply.

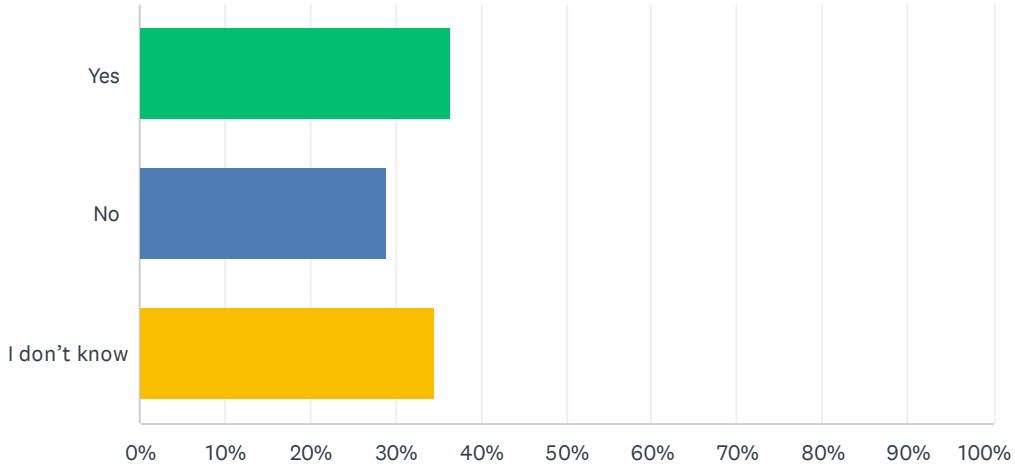
Answered: 110 Skipped: 21



ANSWER CHOICES	RESPONSES	
Special meetings	40.00%	44
Website	68.18%	75
Municipal mailings	20.91%	23
Newspaper	5.45%	6
Email	77.27%	85
Workshops	9.09%	10
Local events	9.09%	10
Social media sites	21.82%	24
I do not wish to receive information	3.64%	4
Other (please specify)	2.73%	3
Total Respondents: 110		

Q33 Would you be interested in volunteering for programs centered around preservation and conservation of Pearl Lake natural resources? This isn't a formal commitment but helps us understand potential interest in volunteering among the community.

Answered: 110 Skipped: 21



ANSWER CHOICES	RESPONSES	
Yes	36.36%	40
No	29.09%	32
I don’t know	34.55%	38
TOTAL		110

Appendix C WDNR FISH STUDY

2021 Comprehensive Fish Survey Summary Report

Pearl Lake (WBIC 195400)

Waushara County

Introduction and Objectives

In 2021, the Department of Natural Resources conducted a comprehensive fish survey of Pearl Lake in order to provide insight and direction for the future fisheries management of this lake. Comprehensive fish surveys include both spring fyke netting and electrofishing surveys. Primary sampling objectives of these surveys are to characterize species composition, relative abundance, and size structure. The following report is a brief summary of the activities conducted, general status of fish populations and future management options for Pearl Lake.

Combined Acres: 101
Lake Type: Seepage
Regulations: Statewide Default Regulations

Shoreline Miles: 2.1
Public Access: 1 Public Boat Launch

Maximum Depth (feet): 45

Survey Methods

- Pearl Lake was sampled according to SNI and SEII protocols as outlined in the statewide lake protocol. The primary objective of the SN1 survey is to count, measure, and mark adult Northern Pike to estimate abundance along with understanding the age structure in the lake. The primary objective of the SEII survey is to count and measure adult largemouth bass and panfish. Other species of fish may be sampled during each survey, but are considered by-catch as part of that survey.
- Spring fyke netting takes place shortly after ice out when the Northern Pike begin to spawn. Fyke Nets were deployed in areas of the lake that contained spawning habitat or were likely travel areas for Northern Pike. All the fish caught were measured except the White Suckers which were caught on occasion. The northern pike were weighed and age structures (fin rays) collected from a subsample for age and growth analysis. All newly captured pike were given a top caudal fin clip in order to calculate a population estimate and better understand the population.
- Spring electrofishing takes place later in the spring when water temperatures warm to at least 55F and largemouth bass and panfish move to shallow water in order to spawn. The entire shoreline was electroshocked as part of this survey. All fish captured were identified to species and were measured for length. A subsample of Bluegill and Largemouth Bass were taken from the lake for the collection of otoliths for age and growth determination.
- Fish metrics used to describe fish populations include catch per unit effort, total abundance, length frequency distribution, and mean age at length.

Wisconsin DNR Contact Info.

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Trevor Hoheisel - LTE Fish Tech
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Wautoma, WI. 54982

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Adam.Nickel@wisconsin.gov
Scott Bunde: 920-295-7020
Scott.Bunde@wisconsin.gov

FKYE NETTING SURVEY INFORMATION - SNI

Site Location	Survey Dates	Water Temperature (°F)	Target Species	Gear	Number of Nets	Net Nights
Pearl Lake	3/25/2021 - 4/2/2021	41 - 42	Northern Pike	Fyke Net	5	45

SPRING ELECTROFISHING II SURVEY INFORMATION

Site Location	Survey Date	Water Temperature (°F)	Target Species	Total Miles Shocked	Number of Stations	Gear	Number of Netters
Pearl Lake	5/20/2021	65	Bass and Panfish	2.1	4	Boom shocker	2

Fish Metric Descriptions

Catch per unit effort (CPUE) is an index used to measure fish population relative abundance, which simply refers to the number of fish captured per unit of distance or time. For netting surveys, we typically quantify CPUE by the number and size of fish per net night. For electrofishing surveys, we typically quantify CPUE by the number and size of fish captured per mile of shoreline. CPUE indexes are compared to statewide data by percentiles and within lake trends. For example, if a CPUE is in the 90th percentile, it is higher than 90% of the other CPUEs in the state.

Total abundance is a metric that describes population size and is estimated by mark and recapture. In the fyke netting survey, all Northern Pike that were captured were examined for a partial caudal fin (i.e., tail fin) clip. If a partial fin clip was not observed, one was given and the fish was released. If a partial caudal fin clip was observed, it was noted on the data sheet and the fish was released. When the Northern Pike were nearly done spawning, the fyke nets are pulled. The number of Northern Pike captured, the number marked and number that are recaptured are used in a formula to estimate Northern Pike abundance in Pearl Lake.

Proportional Stock Density (PSD) is an index used to describe size structure of fish populations. It is calculated by dividing the number of quality size fish by the number of stock size fish for a given species. PSD values between 40 - 60 generally describe a balanced fish population.

Length frequency distribution (LFD) is a graphical representation of the number or percentage of fish captured by half inch or one inch size intervals. Smaller fish (or younger age classes) may not always be represented in the length frequency due to different habitat usage or sampling gear limitations.

Mean Length at Age is an index used to assess fish growth. Calcified structures (e.g., otoliths, spines, or scales) were attempted to be collected from each inch bin for Northern Pike and Bluegill. Mean age is compared to statewide data by percentile with growth characterized by the following benchmarks: slow (<33rd percentile); moderate (33rd to 66th percentile); and fast (>66th percentile).

Northern Pike

- Fyke netting is the preferred sampling gear for Northern Pike when it's ice out. All results presented for Northern Pike are from spring fyke netting surveys.

2021 NORTHERN PIKE SIZE STRUCTURE METRICS

Total Number Measured	Average Length (inches)	Length Range (inches)	Stock and Quality Size (inches)	Stock Number	Quality Number	PSD	Percentile Rank	Size Rating
185	16.9	9.0 - 22.7	14.0 and 21.0	166	6	4	2nd	Low

NORTHERN PIKE SIZE STRUCTURE (PSD) TRENDS

PSD by Year		Historical Median
2004	2021	
0.0	4.0	2.0

NORTHERN PIKE RELATIVE ABUNDANCE (CPUE = NUMBER PER NET NIGHT)

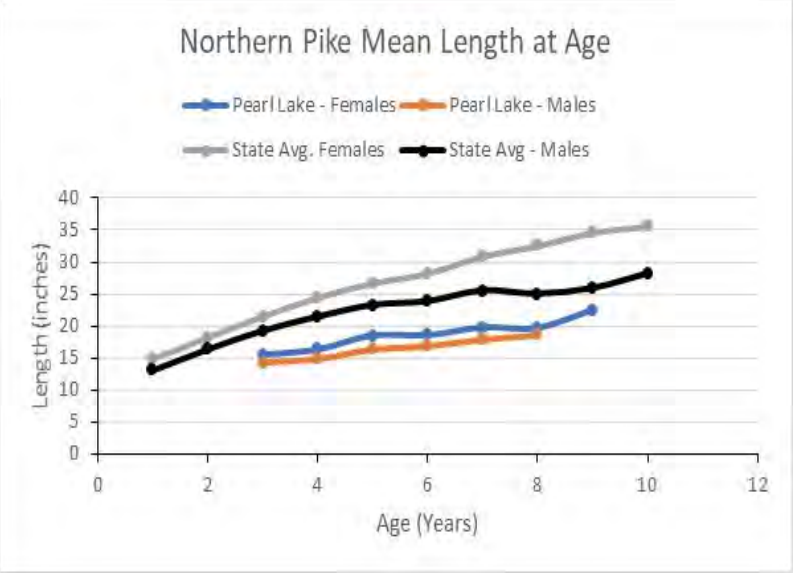
2021 Total Sampled	2004	2021	Historical Median	2021 Statewide Percentile Rank	2021 Abundance Rating
185	4.7	5.5	5.1	82nd	High

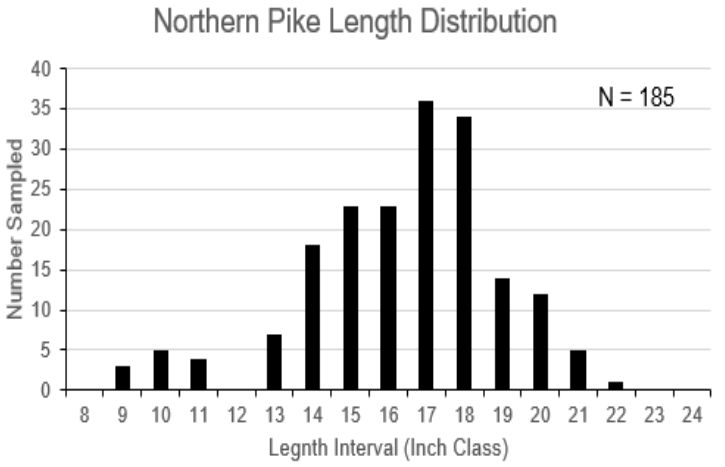
2021 NORTHERN PIKE GROWTH METRICS

Sex	Number Measured	Length Bin (inches)	Mean Age	Age Range	Growth Rating
Male	10	18.0 –18.9	5.7	4 –8	Low
Female	12	18.0 -18.9	5.2	4 –6	Low
Combined	22	18.0 -18.9	5.4	4 –8	Low

NORTHERN PIKE ADULT ABUNDANCE (POPULATION ESTIMATE)

Marked	Captured	Recaptures	Population Estimate (95% CI)	Number per Acre	Abundance Rating
185	246	60	348	3.5	Moderate





Northern Pike Summary

- Pearl Lake supports a high density Northern Pike population, with catch rates being 5.5 per net night in the 2021 fyke netting survey. A catch rate of 5.5 ranks out in the 82nd percentile when compared to lakes throughout Wisconsin. Catch rates of Northern Pike in historical fyke netting surveys have been similar, ranging from 4.7 - 5.5 per net night.
- Size structure of Northern Pike in the 2021 fyke netting survey was low with a PSD of 4 which ranks out in the 2nd percentile when compared to lakes throughout Wisconsin. Size structure in 2021 was slightly above previous fyke netting survey in 2004, PSD=0. No legal fish ≥ 26 inches were sampled in either survey.
- Population estimates of Northern Pike have stayed relatively unchanged over the last 2 surveys in Pearl Lake and show a below average fishery while having 3.5 adult Northern Pike per acre.
- Growth rates are well below average for Northern Pike in Pearl Lake with it taking 8+ years to reach 20 inches in length.

Largemouth Bass

- Electrofishing is the preferred sampling gear for Largemouth Bass. All results presented for largemouth bass are from spring electrofishing II surveys.

2021 LARGEMOUTH BASS SIZE STRUCTURE METRICS

Total Number Sampled	Average Length (inches)	Length Range (inches)	Stock and Quality Size (inches)	Stock Number	Quality Number	PSD	Percentile Rank	Size Rating	RSD 14
329	10.3	4.1 - 21.3	8.0 and 12.0	265	134	51	60th	Moderate	6

2021 LARGEMOUTH BASS RELATIVE ABUNDANCE (CPUE = NUMBER PER MILE)

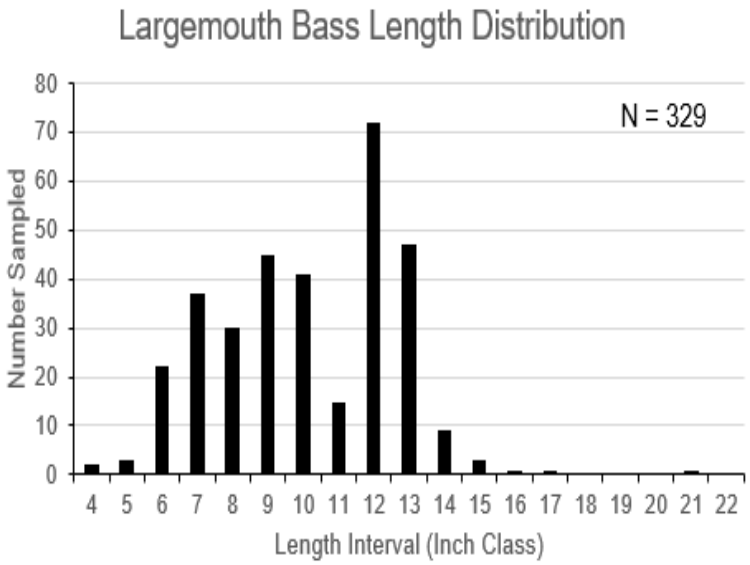
CPUE ≥ 8 inches	Percentile Rank	Overall Abundance Rating	Length Index	Length Index CPUE	Length Index Percentile Rank	Length Index Abundance Rating
126	99th	High	≥ 14.0 inches	7.14	76th	Moderately High

LARGEMOUTH BASS SIZE STRUCTURE TRENDS (PSD)

PSD by Year			Historical Median
2004	2012	2021	
48	12	51	37

LARGEMOUTH BASS RELATIVE ABUNDANCE TRENDS (CPUE ≥ 8 INCHES NUMBER PER MILE)

CPUE by Year			Historical Median
2004	2012	2021	
128	52	126	102



2021 LARGEMOUTH BASS GROWTH METRICS

Number Measured	Length Bin (inches)	Mean Age	Age Range	Growth Rating
10	12.0 –12.9	6.8	5 - 10	Low -Moderate
6	14.0 -14.9	8.3	7 –12	Low –Moderate

Largemouth Bass Summary

- Pearl Lake supports a high density population of Largemouth Bass. Catch rates of Largemouth Bass in the spring electrofishing survey were 126 Largemouth Bass ≥ 8 inches per mile of electrofishing, which ranks out in the 99th percentile when compared to lakes throughout Wisconsin. Catch rates over the last three spring electrofishing surveys fluctuated from 128 ≥ 8 inches in 2004 to 52 ≥ 8 inches in 2012. Catch rates in the range of 35-70 bass per mile 8 inches and larger seems to be a good range for lakes in this area of the state.
- Size structure of Largemouth Bass in 2021 was also fairly good with a PSD of 51. An RSD14 = 6 is of concern since only 6% of fish larger than 8 inches were also of legal size. The average size of bass was 10.3 inches with the largest one being a hefty 21 inches.
- Very little optimal habitat for Largemouth Bass is present in Pearl Lake. Recent interest and installation of nearshore woody habitat is encouraging. Lakeshore property owners should promote a diverse mix of native emergent, floating, submergent vegetation as well as tree drops and fish sticks.

Bluegill

- Electrofishing is the preferred sampling gear for Bluegill. All results presented for Bluegill are from spring electrofishing II surveys.

2021 BLUEGILL SIZE STRUCTURE METRICS

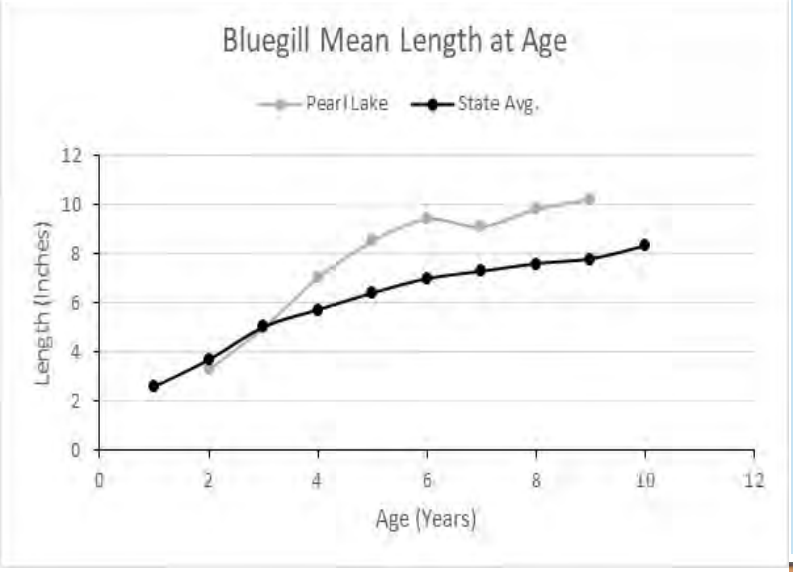
Gear	Number Measured	Average Length (inches)	Length Range (inches)	Stock and Quality Sizes (inches)	Stock Number	Quality Number	PSD	PSD 2012	Percentile Rank	Size Rating	RSD8	RSD 8 2012
Fyke Netting	21	6.4	3.6 - 10.2	3.0 and 6.0 inches	21	9	43	-	Too Few Fish	Too Few Fish	29	-
Electrofishing	200	5.4	1.6 - 9.8	3.0 and 6.0 inches	175	55	31	73	21st	Low	10	16

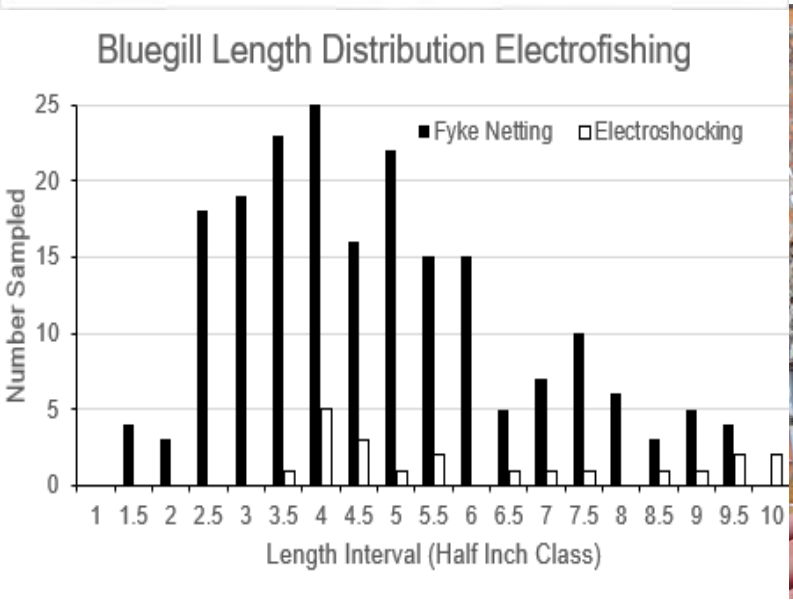
2021 BLUEGILL ELECTROFISHING CPUE (NUMBER PER MILE)

CPUE ≥ 3 inches	Percentile Rank	Overall Abundance Rating	Length Index	Length Index CPUE	Length Index Percentile Rank	Length Index Abundance Rating
175	81st	High	≥ 7.0 inches	35	88th	High

2021 BLUEGILL GROWTH METRICS

Number Measured	Length Bin (inches)	Mean Age	Age Range	Percentile Rank	Growth Rating
10	5.5 - 6.4	3.2	3 - 4	83rd	High
8	6.5 - 7.4	3.6	3 - 4	87th	High
10	7.5 - 8.4	4.3	4 - 5	96th	High





Panfish Summary

Bluegill:

- Catch rates of Bluegill were good for lakes in this area of the state. We typically like to see catch per unit effort of fish 3 inches and larger between 150—250 per mile.
- The size structure of the Bluegills sampled showed a low PSD with only 31 percent of the fish larger than 3 inches also larger than 6 inches.
- Growth rates were average to above average with fish reaching 6 inches in 3.6 years.

Black Crappie:

- The electrofishing boat is effective at catching Black Crappies, but the time of year this survey was done is not the best time of year to assess Black Crappies since they are done spawning and in deeper water where the boat is ineffective.
- Four fish were sampled rom 6.3 - 12.3 inches. Compared to similar surveys around the state Pearl Lake would rank in the 45th percentile. Fourteen crappies were sampled in 2012 (6.5-9.5 inches)

Yellow Perch:

- Only one Yellow Perch (4.6 in) was sampled in this survey (0 in 2012) Again this survey doesn't take place at the prime time of year to adequately asses Yellow Perch , but only one fish suggest a low population.

Green Sunfish:

- Green Sunfish have been common in the southern part of the state for some time, but we are encountering them more and more in our area as time goes by. We sampled 30 Green Sunfish in this survey (2.4 -6.7 inches) compared to 5 Green Sunfish in 2012. Their smaller size typically makes them less attractive to anglers, but fish that make harvestable size are good table fare.

Other fish sampled were White Suckers(30), Yellow Bullhead(6) and Horneyhead Chubs (1).

Final Summary and Management Recommendations

Northern Pike:

- Pearl Lake supports a high density Northern Pike population with growth rates below average
- With the high water there are some areas of Pearl lake that have some suitable spawning habitat. These areas would benefit from being protected or enhanced to ensure Northern Pike have spawning and nursery habitat in the future.
- The majority of Northern Pike that were caught in the fyke nets ranged between 14 and 20 inches with the largest being 22.7 inches. Average size = 16.9 inches.
- No fish larger than 26 inches were sampled. Currently the Northern Pike regulation is the southern zone state default of 2 northern pike greater then 26.
- Removing the 26 inch protective size limit should be pursued and replaced with the 5 fish no size limit regulation that is used up north.

Largemouth Bass:

- Pearl Lake supports a high density population of Largemouth Bass. Catch rates of Largemouth Bass in the spring electrofishing survey were 126 Largemouth Bass ≥ 8 inches per mile of electrofishing, Catch rates in the range of 35-70 bass per mile 8 inches and larger should be a good target for Pearl Lake.
- Size structure of Largemouth Bass in 2021 was also fairly good with a PSD of 51. An RSD14 = 6 is of concern since only 6% of fish larger than 8 inches were also of legal size.
- Growth rates of Largemouth Bass were below average with it taking 8.3 years to reach the legal size of 14 inches.
- Good habitat grows big bass and some of the new wood added, especially the nearshore trees should be very beneficial to the fishery.
- Removal of the size limit will be considered to reduce the number of bass down to the more desirable level of 35-70 bass per mile ≥ 8 inches. Bluegill growth should be considered as part of the regulation review process.

Bluegill:

- Bluegill catch rates have remained relatively unchanged from 2012 and are in the recommended range of 150-250 fish per mile 3 inches and larger.
- Size structure is somewhat low at 31% and should be closer to 50%.
- Growth rates were average to above average and like most clearwater lakes in the area, the population is likely susceptible to overharvest.

Black Crappie & Yellow Perch:

- This survey doesn't do an adequate job to assess these 2 species population but both species appear to be at low numbers and would benefit greatly from habitat improvements, especially nearshore wood. .

Other Management Recommendations:

- Like most of our developed lakes in the area, Pearl Lake is lacking optimal fish habitat in its shallow nearshore areas. It would be very beneficial to the fishery if more lakeshore owners promote a diverse mix of native emergent, submergent vegetation, as well as add wood in the form of fish sticks and tree drops along their shoreline. This would increase the amount of cover and habitat for a variety of organisms.
- The Department commends the residence of Pearl Lake for the efforts and progress they have made in addressing these habitat concerns. Keep up the good work!

Appendix D 2022 POINT INTERCEPT AQUATIC PLANT SURVEY & 2022 EURASIAN WATERMILFOIL SURVEY (GOLDEN SANDS RC&D)

GOLDEN SANDS
RESOURCE CONSERVATION & DEVELOPMENT COUNCIL, INC.
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Stevens Point, WI 54481
(715) 343-6215
https://www.goldensandsrcd.org/
a 501(c)3 non-profit conservation organization
Conservation That Works!

Pearl Lake, Waushara County WBIC #195400
Eurasian Watermilfoil (EWM) Survey
August 23, 2022

Pearl Lake Protection & Rehabilitation District,
Golden Sands Resource Conservation & Development Council, Inc (RC&D) completed an Eurasian watermilfoil (EWM) survey and mapping on Pearl Lake on August 23, 2022. The survey was completed by Golden Sands RC&D staff Chris Hamerla, Kendra Kundinger and Brian Zalay to show distribution and acreage of EWM throughout Pearl Lake. This survey was completed for the purpose of guiding potential management options.

The milfoil which was mapped appears to be hybrid EWM. Likely a cross between the native northern watermilfoil (*Myriophyllum sibericum*) and EWM (*Myriophyllum spicatum*). Genetic testing is needed to determine if these plants are a hybrid. Communication between Pearl Lake and the WDNR agreed that the samples should be tested. Samples from two locations were delivered to WDNR staff Chris Kolasinski in Oshkosh. Map 2 shows the two locations where the genetic samples were collected. In this summary, the term EWM will be used to describe any plants with EWM appearance which are shown on the map. This includes EWM and potential hybrid EWM.

EWM in Pearl Lake

According to the WDNR website, EWM was vouchered and verified in 1994. During the survey on August 23, 2022 many of the plants of interest appeared to be hybrid milfoil, a genetic cross of the native northern watermilfoil and the exotic invasive Eurasian watermilfoil.

When identifying milfoils as native or exotic/invasive, a good characteristic to use is the number of leaflets on each side of a leaf. The native milfoils may have up to 12 leaflets per side of leaf whereas EWM will typically have more than 12 leaflets per side of leaf. The picture below shows native, northern watermilfoil on the left and EWM on the right. The overall shape of the leaf can also be helpful as a soft characteristic towards whether the plant is native or not.

Every leaf that we looked at during the survey only had 10 - 12 leaflets per side. Typically EWM will have more than 12 leaflets per side of the leaf. Aside from that, the plants had the typical look of EWM. Many of the stems are pinkish, red in color, the shapes of the leaves are consistent with EWM. The picture below is milfoil samples taken from Pearl Lake for comparison. The specimen on the upper left is northern watermilfoil. The leaflets on the leaves are widely spaced and average 6-7 leaflets per side. The stem is a creamy-white color.

The lower right specimen is the suggested hybrid EWM. The leaflets are closely spaced and have a leaflet count of 10-12 per side. The whorl of leaves in the picture has 11-12 leaflets. The stem is a reddish color and the leaves are much more limp than the northern.

A word about hybrid EWM. Invasive species in WI are categorized as restricted or prohibited under NR 40. EWM is a restricted species. You can read more at the WDNR site, Invasive Species Rule - NR40 or click HERE. Hybrid EWM is categorized the same as EWM and management can be approached in similar methods.

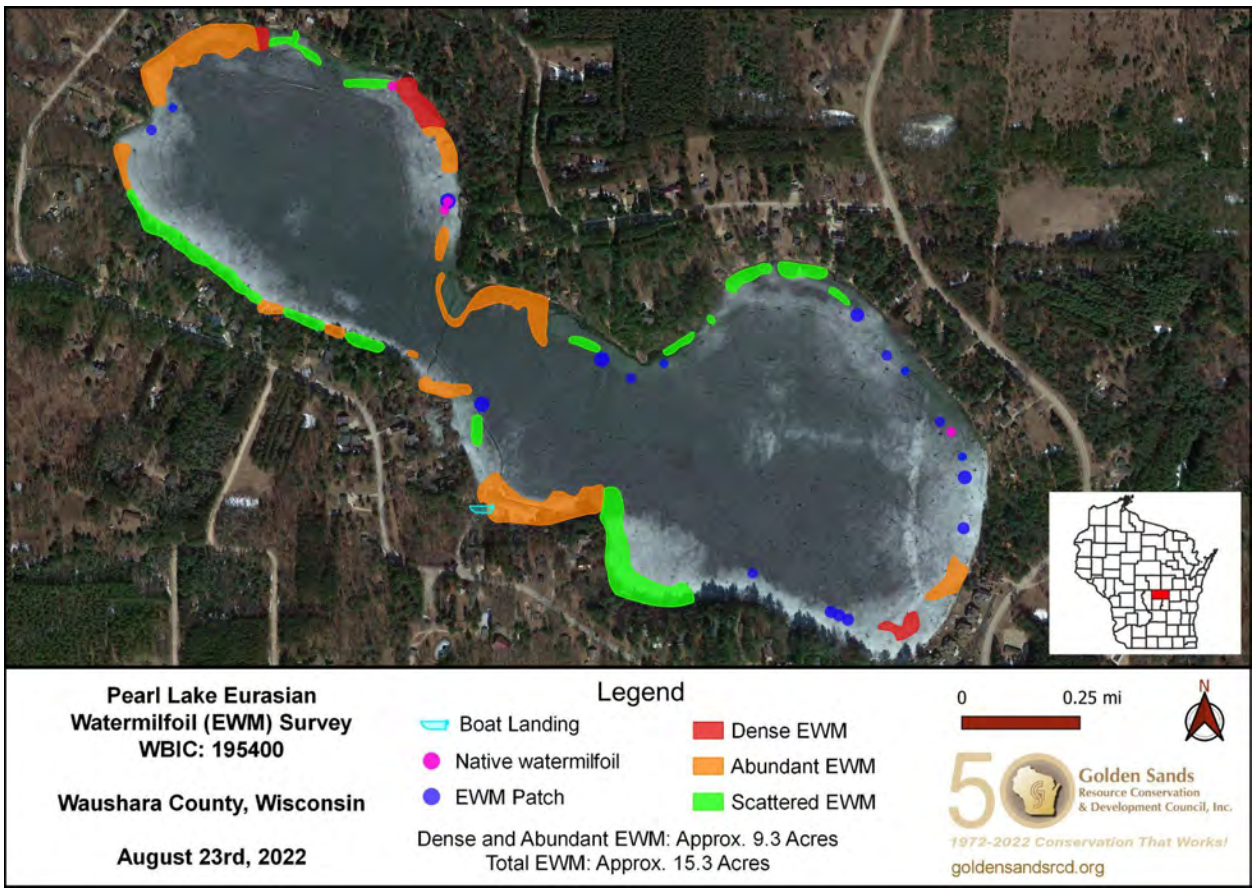
Native plants

The most common native aquatic plants which were observed while mapping the EWM were: southern naiad (*Najas guadalupensis*), variable pondweed (*Potamogeton gramineus*), slender naiad (*Najas flexilis*), wild celery (*Vallisneria americana*) and muskgrass (*Chara species*). During any type of management, unintended damage may occur to other non-targeted species. It is important to know what those species are when determining management options. A full list of Pearl Lake's plant community, as observed during the 2022 point intercept (PI) survey, can be found in the 2022 PI data and the PI summary report.

EWM Densities and Locations

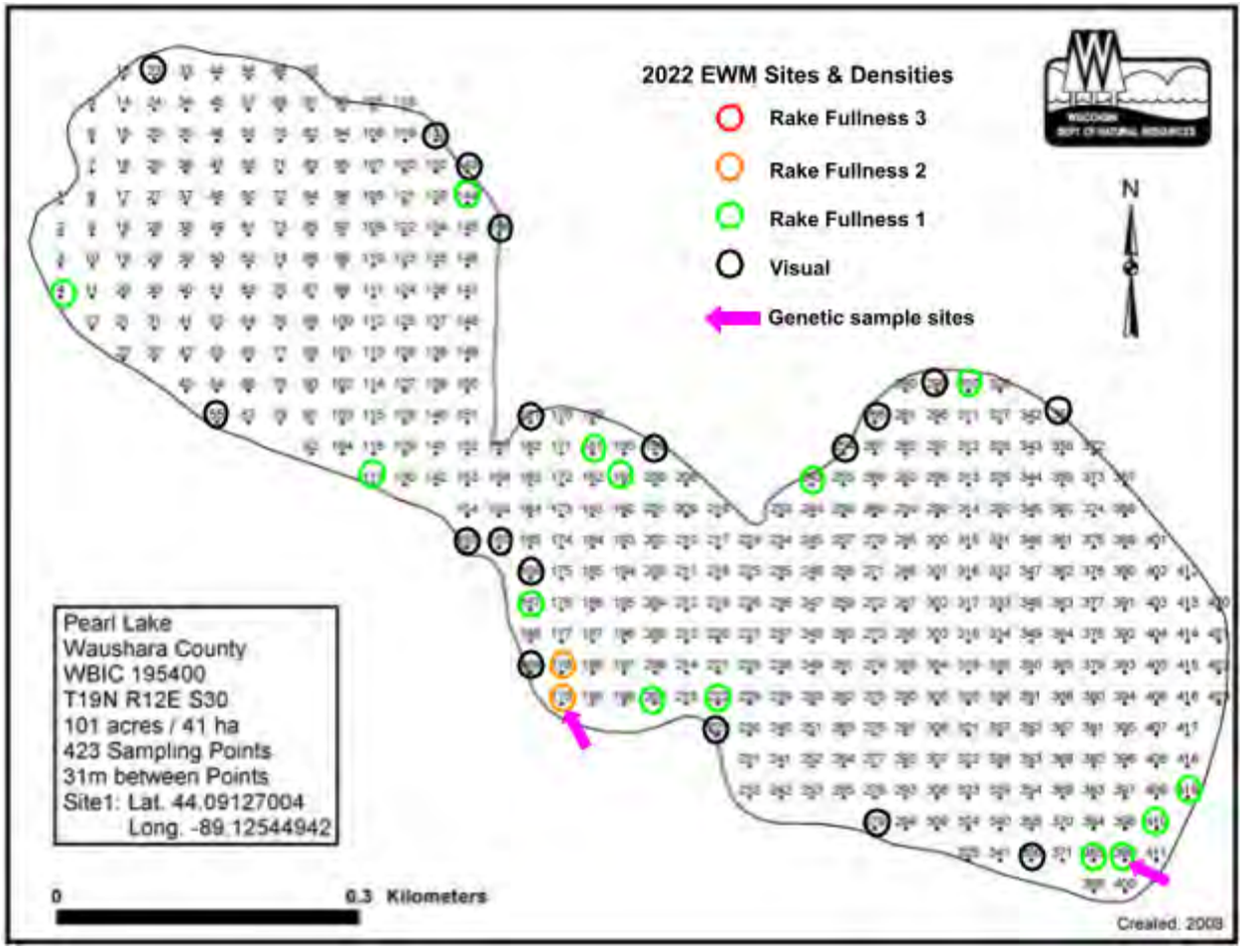
EWM densities and locations were mapped by boat using a meander survey. Visual observations, rake drops and a Garmin plotter graph were used to determine edges of EWM beds. GPS coordinates were recorded to create the polygons. Map 1 shows the locations and relative abundance of observed EWM locations in Pearl Lake. Two acreage values are shown. One covers only the dense and abundant locations, 9.3 acres. The other is the total of all observed EWM locations, 15.3 acres. Several notable beds of native, northern watermilfoil were also mapped. These were recorded for educational purposes, should lake residents want to see the difference between the milfoils. Map 2 is taken from the 2022 PI survey and shows the points on the map where EWM was collected on the rake. PI points on Pearl Lake are 31 meters or 101 feet apart. This map also indicates where the two genetic samples were collected. Comparing the two maps shows why visually mapping the EWM is critical to understanding the actual area the plant covers.

Map 1: EWM Survey Locations & Acreage.

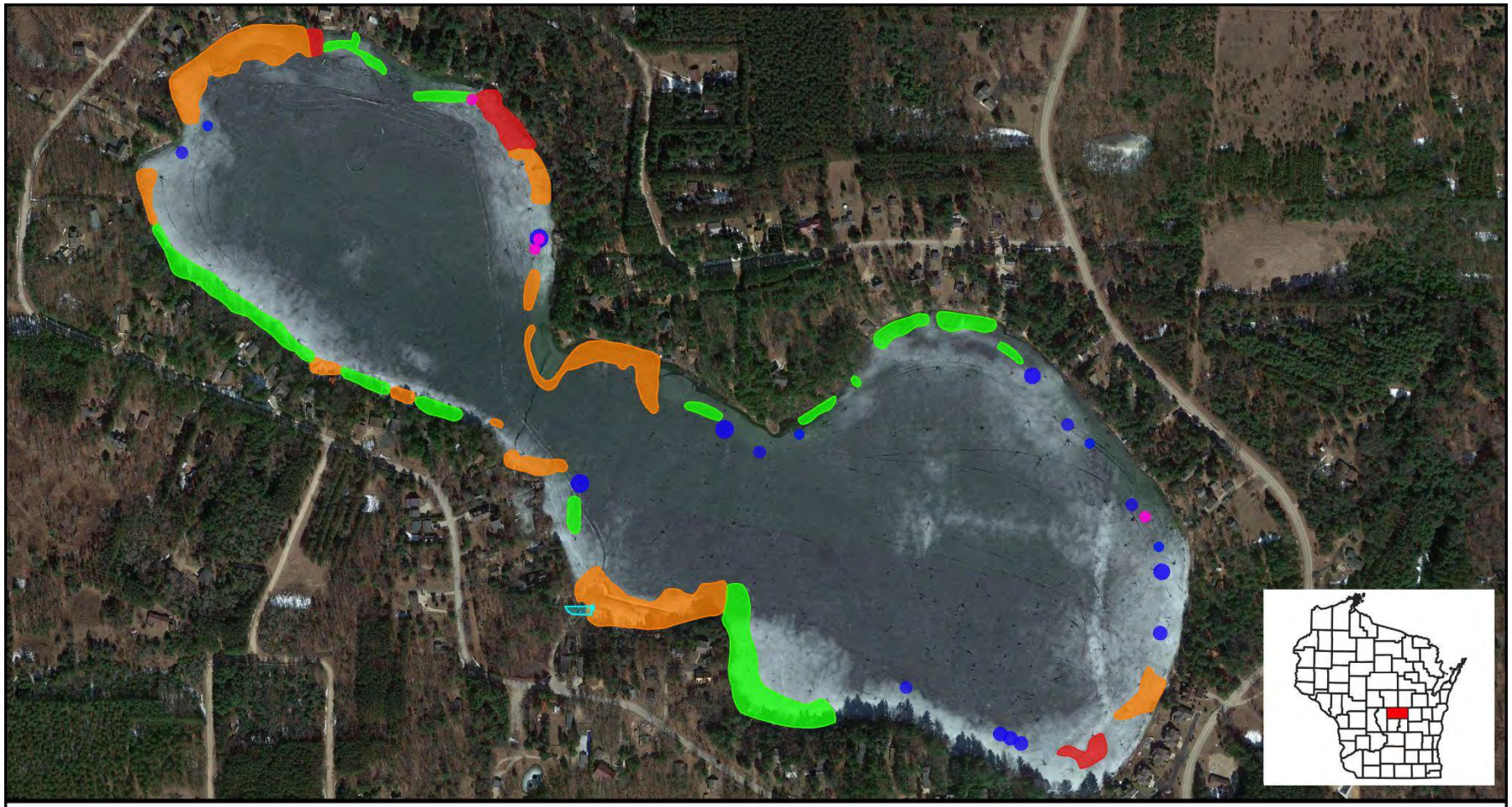


Map 2: 2022 PI Survey EWM Sites and Densities

* PI points on Pearl Lake are 31 meters or 101 feet apart. The collection rake may miss plants that are very close.



If there are any questions regarding the EWM survey or maps please contact Golden Sands RC&D, Chris Hamerla, chris.hamerla@goldensandsrcd.org (715) 343-6215



Pearl Lake Eurasian Watermilfoil (EWM) Survey
WBIC: 195400

Waushara County, Wisconsin

August 23rd, 2022

Legend

- Boat Landing
- Native watermilfoil
- EWM Patch
- Dense EWM
- Abundant EWM
- Scattered EWM

Dense and Abundant EWM: Approx. 9.3 Acres
Total EWM: Approx. 15.3 Acres

0 0.25 mi

N

Golden Sands Resource Conservation & Development Council, Inc.
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Pearl Lake, Waushara County WBIC #195400
Point Intercept Aquatic Plant Survey
July 26 & 27, 2022

Pearl Lake Protection & Rehabilitation District,

Golden Sands Resource Conservation & Development Council, Inc (RC&D) completed a Point Intercept Aquatic Plant Survey (PI Survey) on Pearl Lake on July 26 & 27, 2022. The survey was completed by Golden Sands RC&D staff Chris Hamerla and Kendra Kundinger to update the aquatic plant community data for lake management planning purposes.

Benefits of Aquatic Plants

Aquatic plants are an important part of the state's wet ecosystems. They produce oxygen and help protect water quality. They help clarify water in wetlands, lakes and rivers by using nutrients like phosphorus and nitrogen that might otherwise be used to produce algal blooms. Aquatic plants help reduce wave action and current flow which reduces shoreland erosion and helps stabilize sediments in the waterbody. Perhaps most apparent, plants provide food, shelter and habitat for fish, invertebrates and all sorts of wildlife. Finally, diverse, healthy plant communities can help prevent invasive species from establishing. Invasive species are more likely to become established in disturbed areas.

Aquatic Invasive Species

Aquatic invasive species (AIS) are plants or animals that are not native to a particular area and dominate an area where they are introduced. They can be very successful because they fill a niche that isn't occupied, are able to tolerate a wider range of living conditions, they don't have any natural predators or diseases or perhaps they begin growing earlier. EWM, curly leaf pondweed and purple loosestrife are common examples of AIS. AIS can threaten an area both ecologically and economically. They can disrupt food chains and degrade habitat which negatively impacts fish, invertebrates and wildlife. Nuisance levels of AIS can reduce or even prevent recreational opportunities like fishing, boating, wildlife watching, etc... These reduced recreational opportunities have negative impacts to the local and statewide economy. AIS such as zebra mussels can negatively impact water quality, food chains, aquatic habitat, recreation and industry. Unfortunately the effects of AIS are difficult to foresee since the degree of impact can vary greatly from one place to another. One system may be completely taken over by AIS while AIS in another nearby system may become a part of the community and have little to no negative effects.

No new AIS were observed during the 2022 survey. Curly leaf pondweed is known to be in Pearl Lake but was not observed. This is likely due to the plant's tendency to die back as the water warms. Surface water temperatures during the survey averaged 74 degrees fahrenheit.

Zebra mussels were not observed on collected plants or through casual observation.

Point Intercept Aquatic Plant Surveys

Point intercept (PI) surveys are completed by traveling to predetermined GPS points across the lake. Each PI lake map is based on the area and depth specific to that lake. The maps with GPS coordinates are obtained through the WDNR. Pearl Lake contains 423 sample points. Using a GPS, staff traveled by boat to each of the GPS points. At each point a two-sided rake was used to sample roughly a one foot area of the lake bottom. Sediment type (sand, rock or muck), water depth in half foot increments and the aquatic plant community was recorded. Once the rake is brought to the surface the amount of plant material on the rake is assessed and recorded. The overall fullness of plants on the rake is rated a one, two or three (see illustration to the left). Then the individual species are ranked using one, two or three. All data is recorded on the PI worksheet. Plants seen within six feet of the sample point are recorded as a "visual". Other plants seen on the lake are recorded as a "boat survey".(Figure 1 shows a map with the survey points and EWM locations. Figure 2 shows 2019 EWM locations) To learn more about PI sampling methods and how data is collected please visit:
https://dnr.wi.gov/lakes/plants/research/project.aspx?project=96832337

Frequency of occurrence is the percentage of time a species is found on the rake out of the total number of points sampled. Not all sample points are capable of supporting plant growth. *Littoral frequency of occurrence* is how often a species is found out of the total number of points that support plant growth. (Shown in Table 1) The deepest depth where plant growth is found is called *maximum depth of plant growth*. *Species richness* is the total number of different species found on the rake while sampling points. *Floristic Quality Index (FQI)* is the ranking of the plants in the lake that compares to an undisturbed lake. The higher the FQI the closer the plant community is to that of an undisturbed system. Approximately 250 lakes across Wisconsin are used to calculate the statewide and ecoregion averages for comparison. Only species which were found on the rake during the PI survey are used to calculate FQI and species richness. This helps to standardize surveyor efforts across the entire state and is why visual observations are not included. Table 2 summarizes the lake's littoral frequency of occurrence, maximum depth of plant growth, species richness and FQI. It should be noted that a lake falling below the statewide average for that ecoregion isn't necessarily "disturbed". Many influences play a role in determining the species and abundance of plants in a lake. Water chemistry, acidity, hardness, clarity and bottom sediment are examples of natural influences. Increased nutrient runoff, use of chemicals, development and water control structures are examples of human influences.

It should also be noted that plant species may differ from year to year on the following Table 1. GPS coordinates are accurate only within twenty feet and plant communities can shift. Table 1 represents species which were detected on the rake with a numerical value. Species observed but not collected on the rake are listed as visuals. 2022 species are in the fourth column while 2019 species are in the final column.

Table 1: **Species Present**
% Littoral frequency of occurrence: This is calculated by taking the total number of times a species is recorded divided by the total number of points in the lake where plant growth is possible.

***** means a non-native species, potentially invasive.

Common Name	Scientific Name	Plant type: floating leaf, free floating, submergent, emergent	% Littoral Frequency Occurrence 2022	% Littoral Frequency Occurrence 2019
Nitella	*Nitella sp.*	submergent	18.97	50.00

Muskgrasses	*Chara sp.*	submergent	43.89	39.53
Slender naiad	*Najas flexilis*	submergent	7.91	23.84
Southern naiad	*Najas guadalupensis*	submergent	16.6	Not observed
Aquatic moss	----------	submergent	17.79	17.44
Common Name	**Scientific Name**	**Plant type: floating leaf, free floating, submergent, emergent**	**% Littoral Frequency Occurrence 2022**	**% Littoral Frequency Occurrence 2019**
Wild celery	*Vallisneria americana*	submergent	7.51	8.72
Filamentous algae	----------	free floating	.40	3.49
Sago pondweed	*Stuckenia pectinata*	submergent	.40	3.49
*Eurasian water-milfoil	*Myriophyllum spicatum*	submergent	6.32	2.91
Stiff pondweed	*Stuckenia strictifolius*	submergent	6.72	2.91
Common waterweed	*Elodea canadensis*	submergent	3.56	2.33
Flat-stem pondweed	*Potamogeton zosteriformis*	submergent	1.98	2.33
Small pondweed	*Potamogeton pusillus*	submergent	.40	2.33
Coontail	*Ceratophyllum demersum*	free floating	Not observed	1.16
Floating-leaf pondweed	*Potamogeton natans*	submergent	.79	1.16
Large leaf pondweed	*Potamogeton amplifolius*	submergent	2.77	Not observed
Leafy pondweed	*Potamogeton foliosus*	submergent	Not observed	1.16
Nothern water-milfoil	*Myriophyllum sibiricum*	submergent	3.56	0.58
Fries pondweed	*Potamogeton friesii*	submergent	.40	0.58
Water stargrass	*Heteranthera dubia*	submergent	.40	Not observed
Variable pondweed	*Potamogeton gramineus*	submergent	11.46	11.05
Three square rush	*Scirpus americana*	emergent	Visual	Not observed

Table 2: **Lake Survey Summary** (filamentous algae and visuals are not included in species richness)

	Lake	**Statewide Average**	**North Central Hardwoods Forests Ecoregion Average**
Littoral Frequency of Occurrence (%)	**71.94**	**74.3**	**76.0**
Maximum Depth of Plant Growth	**32**	**15.3**	**15.9**
Species Richness	**17**	**16.8**	**16.2**
Floristic Quality Index (FQI)	**25**	**24.1**	**23.3**

Figure 1: **2022 EWM Sites and Densities**
* PI points on Pearl Lake are 31 meters or 101 feet apart. More locations of EWM are likely present than the map shows. EWM surveying and mapping are needed to show a more accurate assessment of locations and total area.

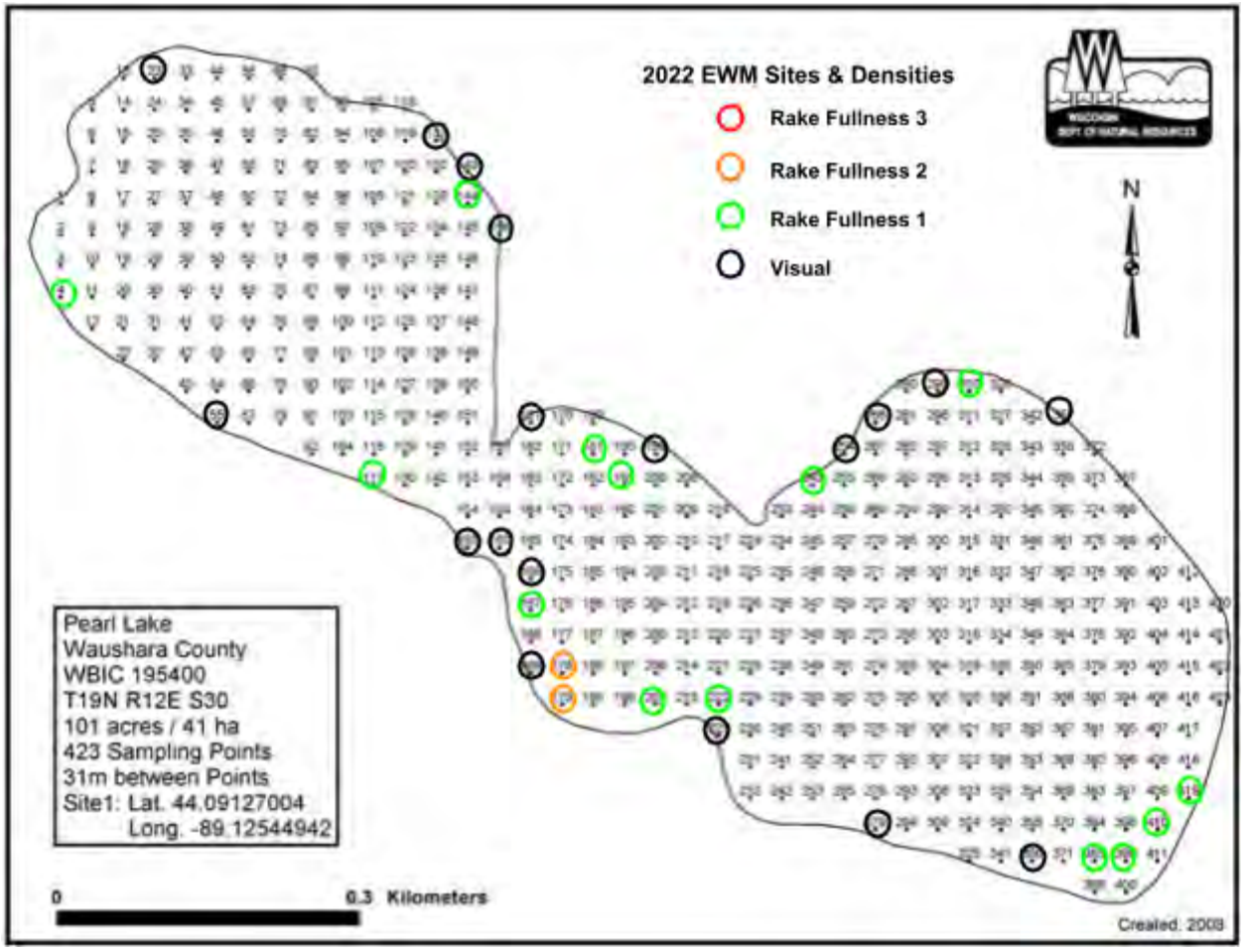
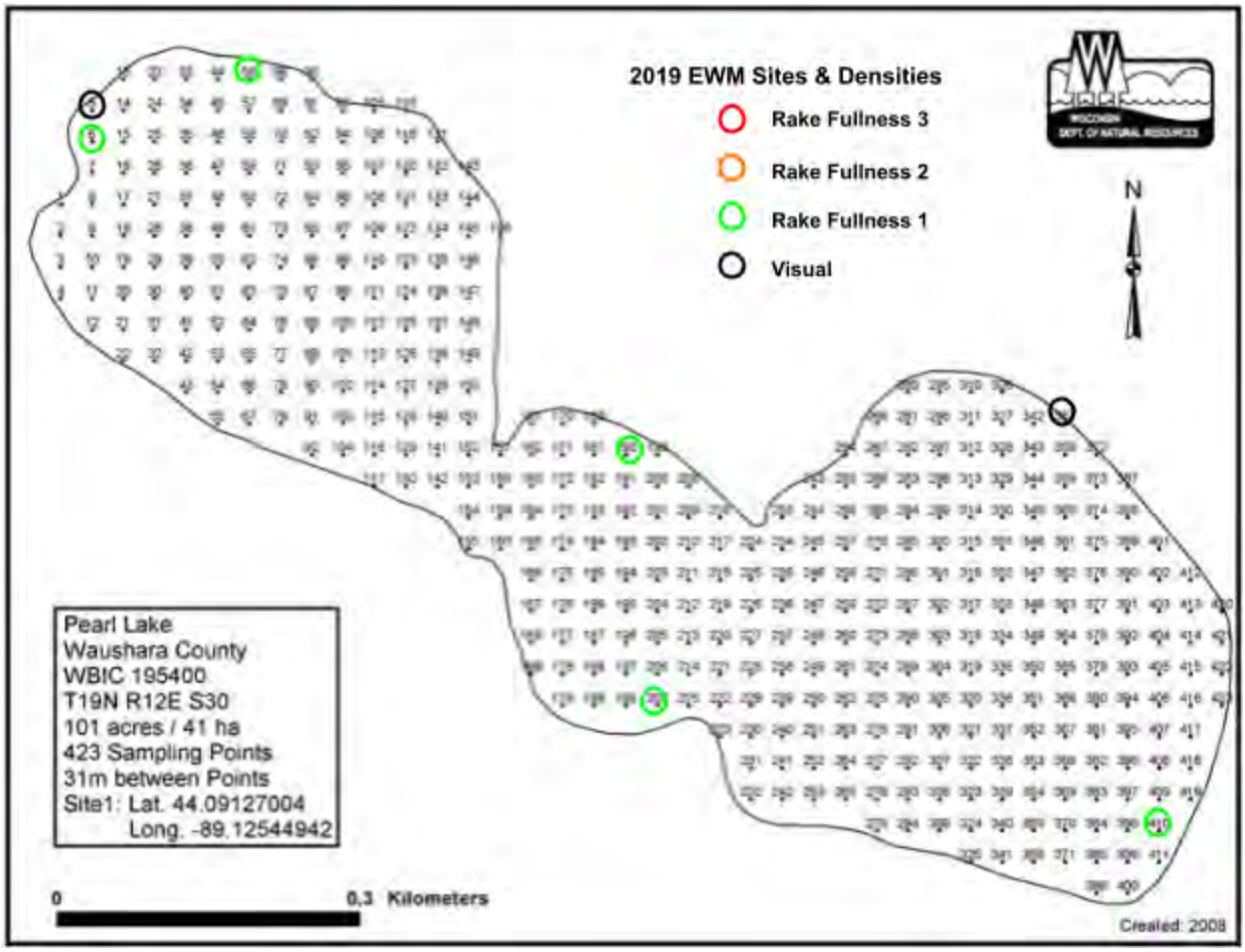


Figure 2: **2019 EWM Sites and Densities**



If there are any questions regarding the PI survey or results please contact Golden Sands RC&D, Chris Hamerla, chris.hamerla@goldensandsrcd.org (715) 343-6215

Appendix E 2022 AQUATIC PLANT MANAGEMENT PLAN (WLPR)

Pearl Lake
Aquatic Plant Management Plan
Addendum for AIS Management

October 13, 2022

Prepared for:
Pearl Lake Protection & Rehabilitation District

Prepared by:

James Scharl

Toll Free: 866-208-0724
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INTRODUCTION / SUMMARY

The Pearl Lake Protection & Rehabilitation District (PLPRD or the District) is a group responsible for the management of Pearl Lake and its aquatic invasive species (AIS), particularly Eurasian water-milfoil (*Myriophyllum spicatum* – EWM). It's likely that plant of EWM include hybrid strains between a cross of EWM and native, northern water-milfoil (*Myriophyllum sibiricum* – NWM). For purposes of this report, EWM will be used to indicate population of EWM and/or hybrid water-milfoils within Pearl Lake. Wisconsin Lake & Pond Resource, LLC (WLPR) was contracted by the District to provide an aquatic management planning report that summarizes past results and lays out options for future aquatic plant management within the Lake.

Aquatic Plant Management Background

Pearl Lake is a 101-acre natural seepage lake in east-central Waushara County. Two aquatic invasive plant specie (AIS) are confirmed to be present in the Lake: curly-leaf pondweed (*Potamogeton crispus* - CLP) and Eurasian water-milfoil (EWM). During recent surveys curly-leaf pondweed has not been found, requiring no management. Eurasian water-milfoil has historically grown to nuisance levels and required active management. Control of EWM has focused on the use of aquatic herbicides dosed primarily to small spot areas with the active ingredient 2,4-D. Recent plant has shifted to the use of mechanical removal with diver assisted suction harvesting (DASH). The following table outline historical EWM control efforts.

Table 1: EWM Control Efforts Within Pearl Lake, Waushara Co., WI.

Year	Acres mapped year-end	Acres Managed	Management Type
2009	---	3	Chemical - 2,4-D
2010	---	5	Chemical - 2,4-D
2011	---	3.5	Chemical - 2,4-D
2012	---	1.9	Chemical - 2,4-D
2013	---	5.5	Chemical - 2,4-D
2014	---	1	Chemical - 2,4-D
2015	---	1	Chemical - 2,4-D
2016	---	2	Chemical - 2,4-D
2017	---	3	Chemical - 2,4-D
2018	---	2.4	Chemical - 2,4-D
2019	---	0.2	Chemical - 2,4-D
2020	1.65	1.4	Chemical - endothall & diquat
		0.79	Mechanical - DASH*
2021	10.16	2.4	Mechanical - DASH*
2022	15.3	0	None

--- - Data not provided

* - DASH - Diver Assisted Suction Harvesting

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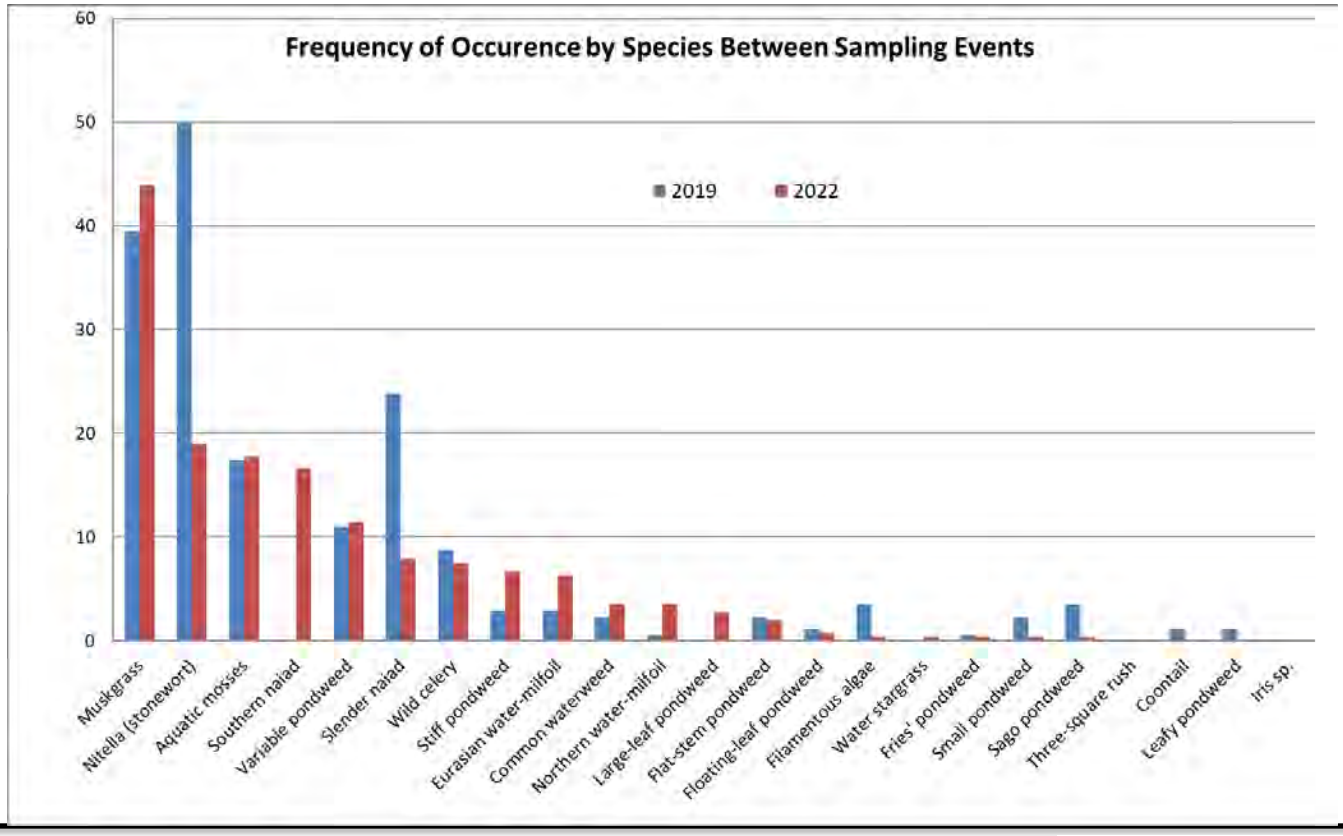
EWM growth was noted to be increasing and less responsive to typical management regimes, which prompted a management plan update. Part of the updated included a whole-lake point-intercept aquatic plant survey (PI survey). The PI survey was completed July 26-27, 2022 by Golden Sands RC&D. Additionally, Golden Sands RC&D as completed an EWM bed mapping survey on August 23, 2022 to more accurately map bed size and density of EWM populations. Bed mapping indicated 15.3 acres of EWM present, of which 9.3 acres were dense or abundant (Map 1, *Pearl Lake, Waushara County WBIC #195400 Eurasian Watermilfoil (EWM) Survey, August 23 2022* – Golden Sands RC&D).

AQUATIC PLANT SURVEYS

The entire aquatic plant community of the lake was last surveyed by a whole-lake point intercept survey in in 2019. Golden Sands RC&D conducted the 2022 survey using the point-intercept method with rake throws and visual observations to verify the presence of all aquatic plant species present. The survey was completed according to the point-intercept sampling method described by Madsen (1999) and as outlined in the WDNR draft guidance entitled "Aquatic Plant Management in Wisconsin" (WDNR, 2005). This survey repeated sampling identical to past whole-lake surveys and at established sample points. Further description of methods used and data calculated from these surveys can be found in the remainder of this management plan and *Pearl Lake, Waushara County WBIC #195400 Point Intercept Aquatic Plant Survey, July 26 & 27, 2022* – Golden Sands RC&D. For reference, the following graph displays the frequency of occurrence by species for the 2019 and 2022 surveys. Presence of EWM for the 2022 survey is displayed in Figure 1.1.



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Changes in the Aquatic Plant Community

An aquatic plant community is dynamic and will see changes in species from year to year under natural conditions. To assess changes between 2022 and the 2019 survey, statistical analysis was completed using a Chi-square test with a 5% Type-I error rate. This error rate is standard in ecological studies and equals that there is a 5% chance of claiming statistically significant change when no real change occurred. Only those species that display a p-value of 0.05 or lower changed significantly population-wise between years. To calculate these values the total number of sample locations each species was found at, including visuals, is compared between years. Table 2 displays statistical changes, if any, for each species sampled.

Table 2: Statistical Significance of Species Between Sampling Events, Pearl Lake, Waushara Co. WI.

Species	2019 v 2022		
	P-value	Significance	+ / -
Filamentous algae	0.069963824	n.s.	-
Coontail	0.170981976	n.s.	-
Muskgrass	9.20347E-06	***	+
Common waterweed	0.125867519	n.s.	+
Water stargrass	0.142523421	n.s.	+
Aquatic mosses	0.028249959	*	+
Northern water-milfoil	0.002540274	**	+
Eurasian water-milfoil	2.14019E-06	***	+
Slender naiad	0.002966961	**	-
Southern naiad	2.68217E-12	***	+
Nitella (stonewort)	0.000819451	***	-
Large-leaf pondweed	0.005838305	**	+
Leafy pondweed	0.170981976	n.s.	-
Fries' pondweed	0.961157122	n.s.	+
Variable pondweed	0.021062138	*	+
Floating-leaf pondweed	0.200680849	n.s.	-
Small pondweed	0.203494725	n.s.	-
Stiff pondweed	0.007330429	**	+
Flat-stem pondweed	0.674398106	n.s.	+
Three-square rush	0.300225036	n.s.	+
Sago pondweed	0.184175444	n.s.	-
Wild celery	0.218222492	n.s.	+
Iris sp.	0.333472862	n.s.	-
Naiad species combined	0.025483134	*	+
Muskgrass & Nitella	0.187208624	n.s.	+

* - somewhat significant change, ** - moderately significant change, *** - very significant change

n.s. - Change not significant

--- - Species was not sampled in both comparison years

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The 2022 survey was completed following past procedures to further assess the aquatic plant and assist planning for future management. Overall, the native aquatic plant community of Pearl Lake was largely still in good condition during the 2022 survey. In total, eight species saw a statistically significant increase while two decreased significantly. It should be noted that the two species that decreased, slender naiad and nitella, were likely mis-identified in past surveys. Both species are very similar in appearance to related species and commonly found throughout Wisconsin. Nitella can be easily confused with muskgrass, both of which are macroalgaes. Nitella and muskgrass typically occupy different depth niches within a lake, but often overlap ranges. Additionally, slender naiad is very similar in appearance to southern naiad, which was not identified in past surveys. It is highly likely southern naiad was present during all past surveys, but identified as slender naiad.

To account for possible mis-identification with these species the occurrences of nitella/muskgrass and southern/slender naiad were combined and also statistically compared between 2019 and 2022. Naiad species were still shown to increase significantly, but at much less of a level. The macroalgae species showed an increase, but one that was not statically significant.

Populations of EWM were noted to have the statistically largest increase between 2019 and 2022. EWM more than doubled, increasing from 2.91% frequency of occurrence to 6.32% in 2022. Coverage of EWM is currently mapped at 15.3 acres and increased in frequency and density throughout the lake. A historically diverse native plant community is vital for lake health if potential EWM control were to take place. If EWM were to be significantly reduced there are a wide array of species that provide better quality habitat to fill the voids. This is especially true for pondweed species, which are vital for the health of a lake and create excellent fisheries habitat.

Aquatic Invasive Species

EWM populations are significantly increased from 2019 whole-lake survey levels and 2021 bed mapping levels in both density and frequency. In 2021, 10.16 acres were mapped during a late summer meander survey. Current populations are now found in expanded locations from the 2021 survey and cover 15.3 acres. A majority of the expansion appears to be into deeper areas of the lake and multiple small beds filling in to create larger, more contiguous areas. Abundant and dense areas of EWM now cover approximately 9.3 acres. 2020 and 2021 control efforts included a mixed use of management efforts. Chemical and mechanical control was completed in 2020 while solely mechanical control in 2021. Even with active control, populations of EWM expanded each year. No active management was completed in 2022 to assess the condition of Pearl Lake and assist management planning.

Current spread of EWM in the lake has reached levels where active management is a viable option. Care must be taken in choosing a management approach that will be successful while also limiting non-target impacts. Tolerance of some EWM strains to 2,4-D is a known problem and likely created by repetitive management regimes of 2,4-D that merely injured a Lake's population of EWM by controlling the most susceptible plants and leaving behind more resistant strains. This same scenario appears to have occurred in Pearl Lake. Significant portions of past EWM management have solely used 2,4-D to spot-control areas at likely less than lethal rates. Decreased control timing from the 2017-2019 application bolsters the likelihood of 2,4-D tolerance.

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Curly-leaf pondweed, a second AIS present in Pearl Lake, was not noted during the 2022 survey. Curly-leaf pondweed begins growing under ice cover, has its highest density in late spring, then dies back naturally in early summer. Due to this, populations of CLP are often under-sampled during whole-lake surveys, which are timed to gather data on native species. Though no CLP was found, it may still be present in Pearl Lake. However, based on past experience and current data, CLP populations are not at levels to require active management and can often blend in with native plant communities.

MANAGEMENT RECOMMENDATIONS

Management of aquatic plants can take many facets, depending on each lake's unique condition and desire by the community. To be successful, a management option must be accepted by its users. Various management methods, including herbicide use, have been done in the past within Pearl Lake. Herbicides for aquatic plant management can have negative connotations and can be misunderstood by some users, making it potentially controversial. However, periodic treatments for AIS, even at up to whole-lake rates, have shown to reduce the need and frequency of management in following years.

It is important that appropriate management actions continue on a yearly basis to ensure that nuisance invasive aquatic plant growth does not reach unmanageable levels. Though EWM is moderately prevalent within Pearl Lake, the native plant community is in good condition with good diversity. Care must be taken in planning to maintain the native community for the health of the lake while controlling and reducing the spread of EWM.

Pearl Lake is a natural seepage lake with good water quality, a healthy native aquatic plant community, and can see periods of high-intensity recreational use. A growing concern is the significant increase of EWM within the lake and its impact to the health and use of Pearl Lake. Management actions recommended below are based on the findings of this plan and chosen to protect and enhance the conditions present:

- Largely, the aquatic plant community of Pearl Lake is of good quality and diversity, with 19 native species

- Though of high diversity, AIS such as EWM can and do grow to nuisance levels, requiring active management through various methods since 2001

- Aquatic invasive species are a constant threat to the quality of the lake and are presently expanding, specifically EWM. If control of EWM is sought, it should take on many facets. Additional information that is important to guide EWM control includes the following:

    - A hybrid between Eurasian and native, northern water-milfoil is highly likely in some plants within the lake
    - Past management with herbicides has almost exclusively used the active ingredient 2,4-D which may increase the resistance of remaining populations to its continued use
    - Targeted harvesting in 2019 and 2020 did little to slow the spread of EWM within the lake
    - EWM currently covers 15.3 acres or more and up to dominant, dense beds
    - Potential EWM control areas for future management include up to 8.75 acres (Figure 1.2)

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- A public user survey was conducted to gauge the perception of the lake and formulate aquatic plant management options that are not only viable for Pearl Lake, but also desired by its users and able to be successful
    - 76.4% of respondents expressed some level of concern about the plant and/or algae growth (Q17)
    - Plant and/or algae growth negatively impacted use of the lake to 51.2% of respondents throughout the year (Q18)
    - Potential management may take many forms, including the use of targeted chemical applications.
        - 68.65% agreed that chemical control is necessary to management AIS in Pearl Lake (Q23)
        - However, control must be completed in a form that protects the aquatic plant community while reducing targeted AIS. Respondents showed a clear agreement that aquatic plants play an important role in maintaining the health of Pearl Lake (Q19)
        - Respondents showed concern over potential non-target impacts of from chemical control for AIS (Q24). If selected, use of chemical control for AIS should have an informational component to keep lake residents and users involved and informed of management actions.

Expansion of EWM in Pearl Lake is creating a growing impact to the system and is currently at levels that may require targeted management. Dense aquatic invasive plant growth from EWM only worsens biological and navigational issues throughout the lake and negatively impacted users of the lake.

Only those options that will be supported by the District and lake users with high likelihood of approval from the WDNR will be selected to help accomplish management goals. However, not all desired management options are viable or feasible for each situation. The user survey showed a strong desire by the public and lake users to actively control populations of Eurasian water-milfoil within Pearl Lake.

A clear focus of the plan is to prevent the spread of AIS into or out of Pearl Lake while reducing the extent and density of AIS (EWM) already established. Management planning will follow Integrated Pest Management (IPM) with an approach that provides a variety of control actions, active ingredients, and monitoring to gauge results. Based on the above, the following recommended action plan includes a combination of management actions to achieve desired results.

The size of the infestation tends to dictate the type of the treatment. Small treatment areas or beds less than 2-5 acres are many times consider spot treatments and usually targeted with fast acting ingredients. When there are multiple "spot" treatment areas within a lake, it often makes more sense from economic and efficacy standpoints to target the "whole" lake for treatment.

This typically entails calculating the entire volume of water within the lake, in acre/feet, and applying a liquid herbicide, such as 2,4-D, at a low dose, lake-wide rate. Current WDNR and Army Corps of Engineer research has shown that herbicide applied to water diffuses off-site due to a variety of environmental and physical conditions including wind, waves, water depth, and treatment area relative to lake volume. Due to these actions, as treatment areas decrease, herbicide retention time needed for impact is lessened due to diffusion off-site because of the small amount of area treated and herbicide applied relative to the surrounding water volume. To combat this, it is recommended to apply at higher rates when compared to a whole-lake rate or with a combination of active ingredients in hopes to extend contact time.

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Goal: Manage AIS to improve recreation, increase use opportunities, and maintain native plants by reducing AIS abundance and frequency within the littoral zone. For Pearl Lake, the littoral zone extends to an approximate depth of 32-ft and covers 64 acres. EWM currently occupies 24% of the littoral zone Only the deep, central basin of the lake is outside the littoral zone. If active AIS management is pursued, the goal should be to maintain the presence of the target species over a 3–5-year period at the following levels:

- 1 year after control: Less than 3% of the littoral zone (1.9 acres)
- 2-3 years after control: Less than 5% of the littoral zone (3.2 acres)
- 4-5 years after control: Less than 10% of the littoral zone (6.4 acres)

The following levels of AIS should be used to trigger active management of the target species, primarily EWM:

- >3% coverage of the littoral zone of EWM for small scale, spot treatment or control

Or

- Greater than 20% coverage of the littoral zone for large-scale control at up to whole-lake approaches

Primary Action: Continue monitoring for and mapping of AIS.

Primary Action: If populations of AIS exceed the above listed triggers pursue active management.

***Small-Scale control Action*:** Small-scale EWM control to follow-up whole-lake efforts and maintain low populations of EWM may be a necessary step to ensure the health of the lake. This may include a variety approaches and control methods based on the dominance and size of small-scale EWM control areas.

- EWM areas less than 0.25 acres of any density/dominance
  - Monitoring only through annual surveys
  - Hand pulling by shoreline residents
  - Diver Assisted Suction Harvesting (DASH) for small, dominant stands

- EWM areas 0.25 – 0.50 acres
  - Monitoring only through annual surveys
  - Hand pulling by shoreline residents
  - DASH for stands up to moderate dominance
  - Fast-acting, selective chemical control for stands of moderate dominance or more.
    - The active ingredients florpyrauxifen-benzyl, diquat, endothall, and/or flumioxazin may be used at appropriate label rates

- EWM areas greater than 0.5 acres
  - Fast-acting, selective chemical control for abundant stands of moderate or more density
    - The active ingredients florpyrauxifen-benzyl, diquat, endothall, and/or flumioxazin may be used at appropriate label rates

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***Large Scale Control Action*:** Targeted, whole-lake based control efforts. This may include a variety of active ingredients and be dosed at up to whole-lake volume rates.

- If possible, control should be completed to time application to early/mid spring when plants are young
- Application may be completed using a variety of active ingredients and rates. Some recommended active ingredients and application rates are as follows:
  - Active ingredient 2,4-D at 0.25-0.40 PPM and active ingredient endothall at 0.6-0.80 PPM at whole-lake volume rates. Due to past used of 2,4-D within Pearl Lake, the EWM present is likely tolerant to 2,4-D. Use of this method is likely to see shorter-lasting results than options below.
  - Active ingredient fluridone at 4-16 PPB whole-lake volume rates with follow-up "bump" applications to maintain 6 PPB in water for 120+ days. Target rates may be reduced by product uptake, loss through water flow out of the lake, and loss through natural degradation. Residual sampling of in-water concentrations should be completed approximately every 21 days after the initial application to properly dose and time "bump" applications.
  - Active ingredient florpyrauxifen-benzyl dosed at 5 - 11 PPB within areas of direct application only. Due to the fast-acting nature of florpyrauxifen-benzyl, applications do not need to take into account the entire lake's volume for dosing.
- An aquatic invasive species assessment survey should be completed 1-year prior to assess conditions and verify they exceed management triggers above. In addition, the survey should be repeated 1-year post control activities to gauge results. The assessment survey may be completed as a whole-lake point intercept survey or targeted AIS meander survey. Bed locations and dominance should be mapped to accurately assess conditions.

Goal: Obtain financial assistance for AIS management activities.

Primary Action: Apply for an AIS Established Population Control Grant through the WDNR's Surface Water Grant program for large-scale AIS control projects. The deadline for application is February 1 and can fund up to 75% of eligible project costs.

Goal: Enhance monitoring within Pearl Lake through the WDNR Citizen Lake Monitoring Network and support CB/CW efforts.

Primary Action: Continue monitoring for water quality through secchi readings, chlorophyll-a, and total phosphorus. Current monitoring is important to catch potential changes in water quality.

Primary Action: Continue participation in the Clean Boats / Clean waters program through Golden Sands RC&D and commit to a minimum of 100 hours of monitoring per year

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The Pearl Lake Protection & Rehabilitation District should continue to be involved in some type of aquatic plant management program to help monitor and manage nuisance aquatic plant growth of AIS, if present. AIS are extremely opportunistic plants and can grow to nuisance levels in a very short period of time. Continued monitoring and possible management actions must occur to ensure that the health, aesthetic and recreational value of the lake is not degraded.

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Appendix A

Figures

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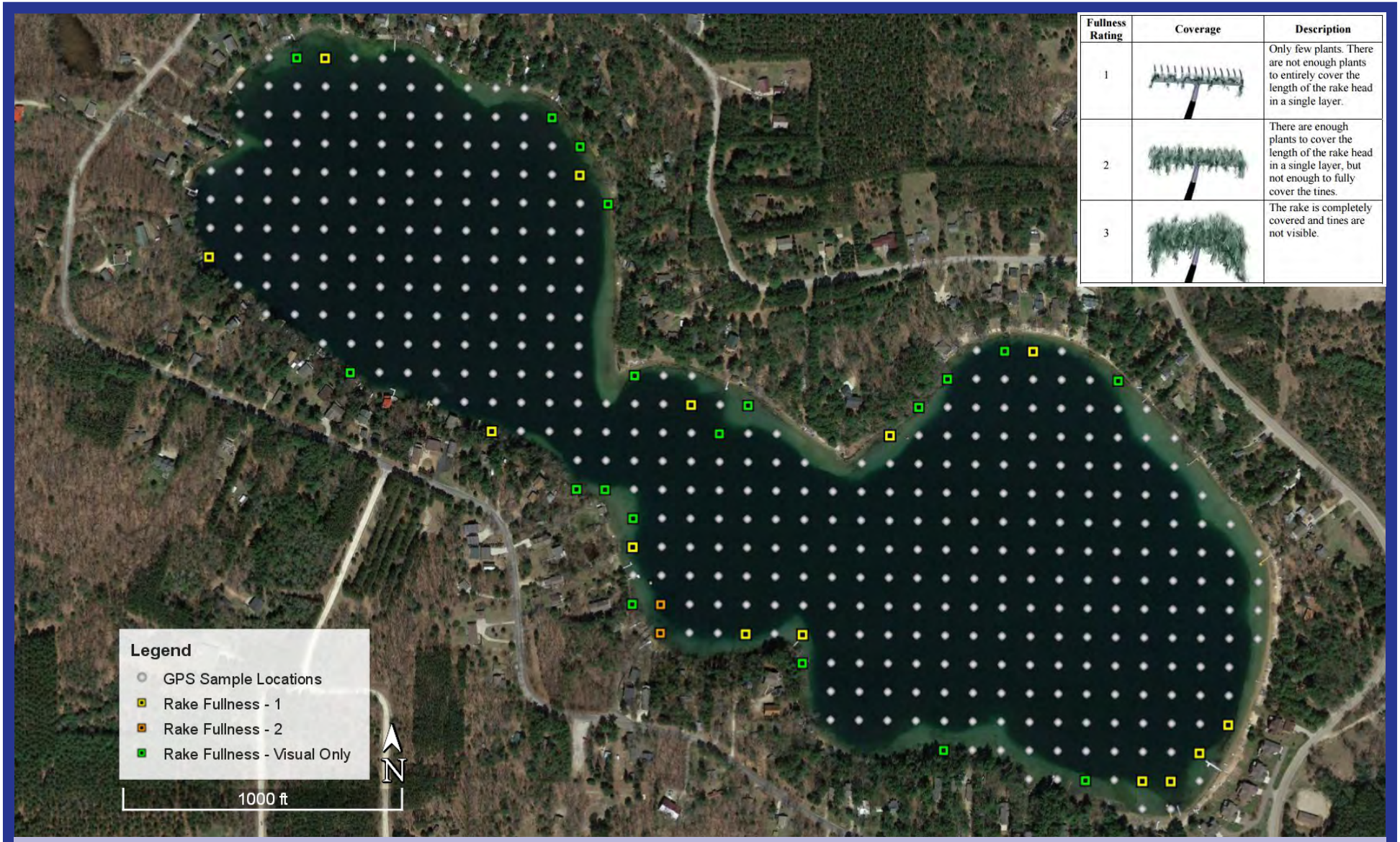

2022 Whole-Lake Survey EWM Locations

Pearl Lake, Waushara County

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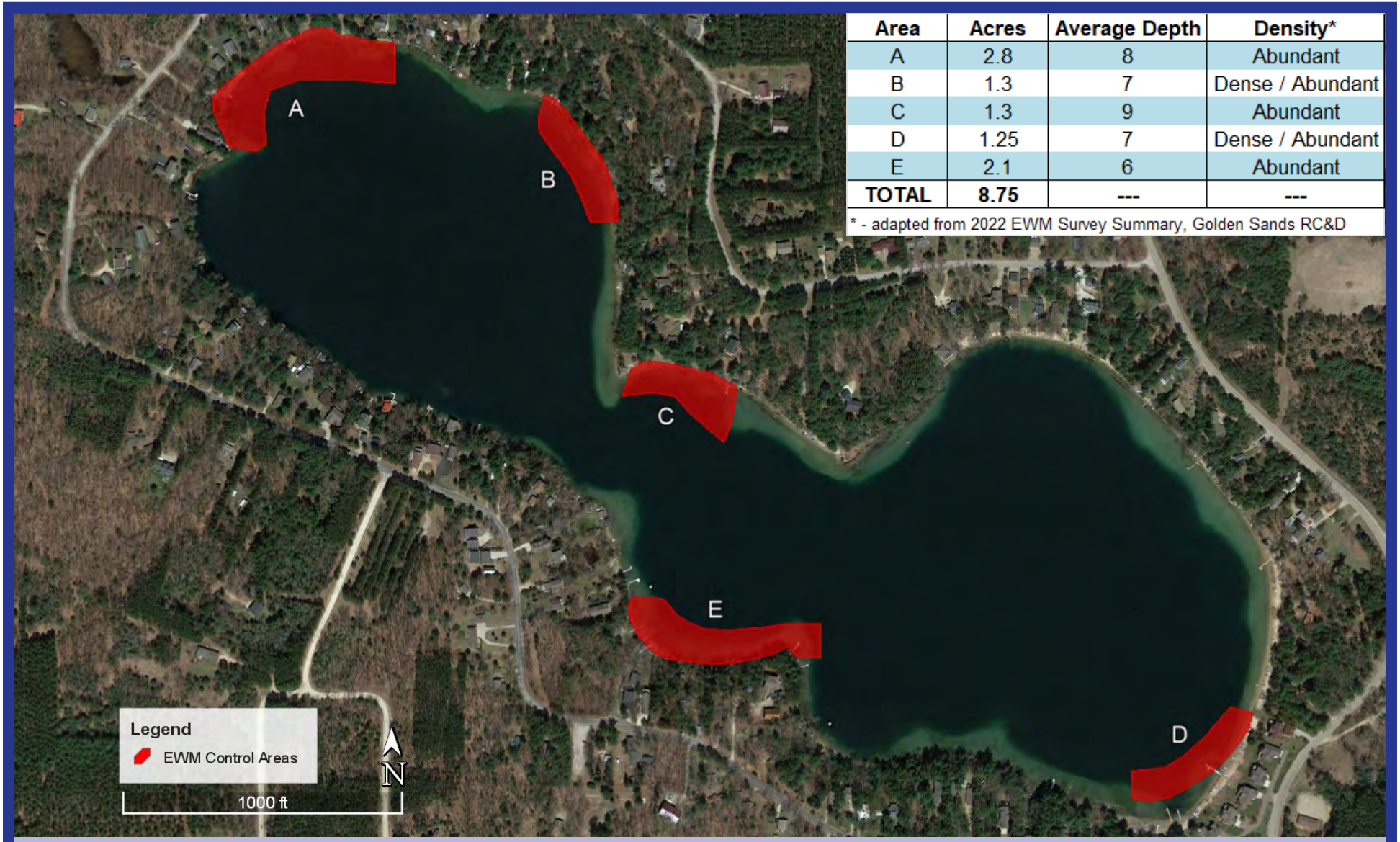
Adapted From:
Pearl Lake, Waushara County WBIC#195400 Point Intercept Aquatic Plant Survey, July 26 & 27, 2022
By: Golden Sands RC&D

Figure 1.1
July 26-27, 2022
Surveyed by Golden Sands RC&D



Area	Acres	Average Depth	Density*
A	2.8	8	Abundant
B	1.3	7	Dense / Abundant
C	1.3	9	Abundant
D	1.25	7	Dense / Abundant
E	2.1	6	Abundant
TOTAL	**8.75**	---	---

* - adapted from 2022 EWM Survey Summary, Golden Sands RC&D

Potential 2023 EWM Control Locations

Pearl Lake, Waushara County

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Adapted From:
Pearl Lake, Waushara County WBIC#195400
Eurasian Watermilfoil (EWM) Survey, August 23 2022
By: Golden Sands RC&D

Figure 1.2
August 23, 2022