2020 Silver Lake Management Plan

Columbia County, Wisconsin

2020

This lake management plan was developed to provide guidance to protect desirable conditions, address existing challenges, and prevent future problems in the Silver Lake ecosystem.

WBIC #107700

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COLUMBIA COUNTY

PORTAGE WISCONSIN

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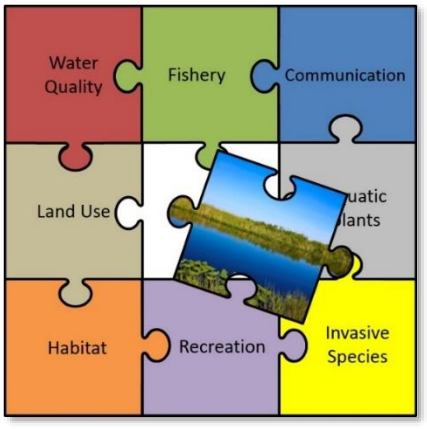
What is a lake management plan?

A lake management plan (LMP) is a living document that changes over time to meet the current needs, challenges and desires of the lake and its community. Although each lake is different, the WDNR requires that each comprehensive lake management plan address a specific list of topics affecting the character of the lake, whether each topic has been identified as a priority, or as simply something to consider.

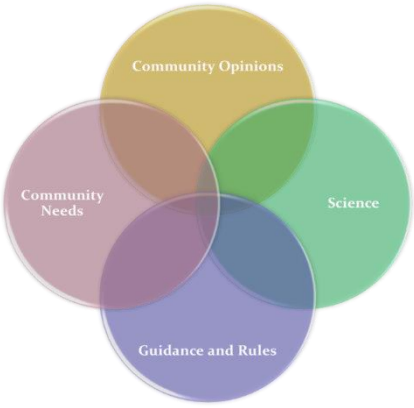
What is the purpose of this LMP?

This plan was created to ensure that Silver Lake is healthy now and for future generations. It was designed to learn about Silver Lake and identify features important to the Silver Lake community, in order to provide a framework for the protection and improvement of the lake.

Implementing the content of this LMP will enable citizens and others to work together to achieve the vision for Silver Lake now and in the years to come. It is a dynamic document that identifies goals and action items for the purpose of maintaining, protecting and/or creating desired conditions in the lake and identifies steps to correct past problems, improve on current conditions, and provide guidance for future boards, lake users, and technical experts.



Because many entities are involved in lake and land management, it can be challenging to navigate the roles, partnerships and resources that are available. The planning process and content of this plan have been designed to identify where some key assistance exists. The actions identified in this LMP can serve as a gateway for obtaining grant funding and other resources to help implement activities outlined in the plan.



Introduction

Silver Lake is a 70-acre groundwater drainage lake located within the City of Portage in Columbia County, Wisconsin. Because of its proximity to a city park and the city center, local residents and visitors enjoy it daily throughout the year. It is appreciated by those who use it for its natural beauty, peace and tranquility, wildlife viewing, and recreational opportunities including swimming, fishing, boating, and canoeing/kayaking.

> ***"The City of Portage will work to protect the natural resources including groundwater, surface water (lakes, wetlands and rivers), forests, agriculture, and important natural environments to maintain and protect the biological diversity and health that provides important services such as water infiltration and flow regulation, and contributes to human enjoyment and sense of place."***
> Goal A1, Chapter 5, City of Portage Comprehensive Plan 2008-2028

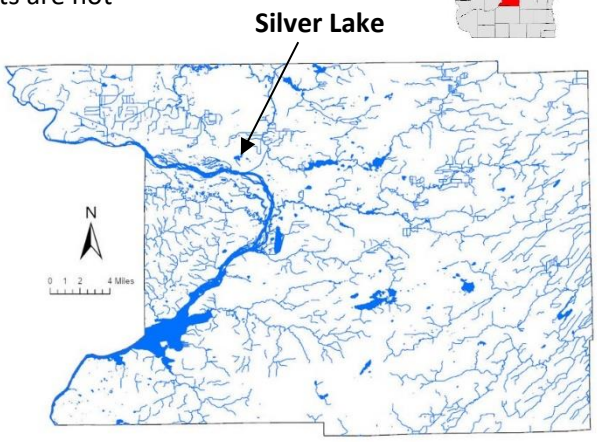
The comprehensive plan for the City of Portage, as recommended by the plan commission and adopted by the Common Council in August 2008 under Ordinance No. 08-015, specifically recommends the implementation of plans to protect and improve the water quality and health of Silver Lake under Objective A1.1. On February 27, 2020 the Common Council adopted an update to the 2008 Comprehensive Plan or the 2030 Comprehensive Plan which can be found here: https://www.portagewi.gov/business-development/2030_comprehensive_plan_final/ under which the updated Silver Lake Management plan is referenced on pages, 1-4; 2-9; 2-10

This plan was created by a committee of dedicated citizens and professionals from the City of Portage, Columbia County, UWSP Center for Watershed Science and Education (CWSE), and the Wisconsin Department of Natural Resources (DNR) while considering input from more than 50 citizens and lake users that attended public meetings or participated in an opinion survey (results of survey are included as Appendix A). A citizen survey was conducted to gather information on citizens' values, opinions, and perceived issues with Silver Lake prior to the planning process. A direct mailing was sent to all riparian landowners and an online version was advertised in various publications in the Portage and Madison areas and on the City's website and Facebook page, and was available at the County office. This lake management plan was constructed using water quality data collected as part of a lake study conducted by CWSE on Silver Lake in 2017-2019, citizen water quality monitoring data, Department of Natural Resources (DNR) fisheries survey data, and shoreland and aquatic vegetation surveys conducted by the CWSE in the summer of 2018. In addition to a series of public meetings held at the Portage City Hall on February 12, March 2 and June 23, 2020 (virtual), the Silver Lake Restoration Ad-Hoc Steering Committee met over two years to learn about the lake and discuss management strategies with professionals, create a vision for the lake, and identify the necessary actions needed to maintain good water quality and wildlife habitat that is in balance and harmony with human activity in Silver Lake.

Our vision for the management of Silver Lake is that the lake will have excellent water quality and wildlife habitat that is in balance and harmony with human activity on the lake.

Setting

A healthy lake ecosystem is comprised of many components that include in-lake habitat and vegetated shorelands that support aquatic plants, fish, wildlife, good water quality and quantity, absence of aquatic invasive species and more. These components are not only found in lake but also extend to where the water meets the land and beyond into the watershed. Silver Lake is a reflection of the health and activities that occur in the lake, near the shore, and in the watershed.

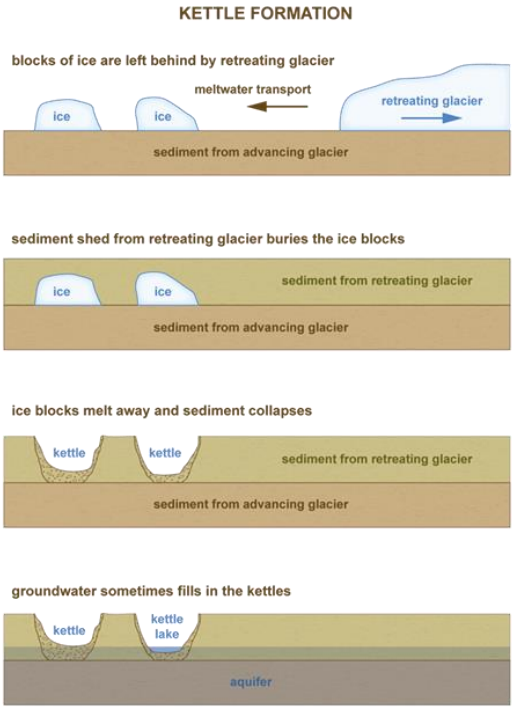


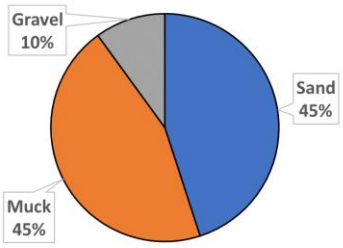
Silver Lake is surrounded by the City of Portage, which has a population of approximately 11,000 residents. Located near a groundwater divide, the Wisconsin River flows south in the Mississippi Watershed just ¾ of a mile south of the lake and the Fox River flows north toward the Great Lakes about 1.5 miles to the east. Roads surround the lake and residential development occurs along the majority of the land adjacent to the lake. Silver Lake Park, a city park, is located between the lake's two basins along Silver Lake Drive and provides public access to the lake, a boat landing, swimming beach, picnic area, fishing pier and washroom facilities.

Silver Lake is a groundwater drainage lake comprised of two connected basins residing in a kettle pothole, which is a bowl-like depression. Silver Lake covers approximately 70 acres, has a maximum depth of 42 feet, and an average depth of 16 feet. The deeper west basin's littoral zone (area where rooted aquatic plants grow) is small because of the steep lakebed that quickly descends to greater depths, whereas the east basin is shallow and completely littoral. Part of a larger wetland complex that extends east to the Fox River, Silver Lake is fed primarily by groundwater through springs.

History

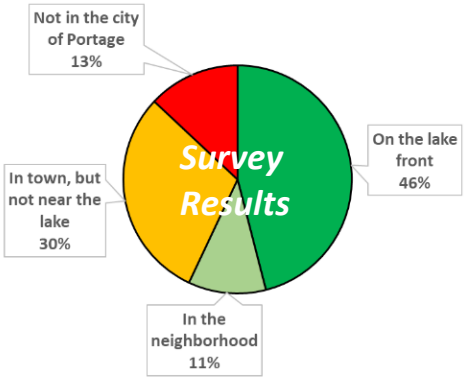
Silver Lake's basin was formed in the outwash plain of the receding Green Bay Lobe of the Cary ice sheet that developed in Pleistocene glaciations about 12-14,000 years ago. As this ice sheet melted or wasted back northward large blocks of ice separated from the main glacier and remained in the newly laid glacial sediment. Deposited ice melted within the sediment and formed glacial lakes, often called "kettle lakes" because of the lakes morphological resemblance. Around Silver Lake, glacial deposits and outwash sediment of fine to medium grained sand compose the top 50-100 ft of soil and overlay 50 ft of glacial till, which is a variable mixture of soil, pebbles, rocks, and boulders. Underneath lies the parent material composed of dolomite bedrock (Hooyer, Mode, Clayton and Attig, 2015).





The lake's bottom is composed of outwash that has been overlain with muck and marl sediment that have been formed and deposited by the lake itself.

Silver Lake has a long cultural history dating back to pre-settlement when Native Americans used the area for encampment along the portage between the Wisconsin and Fox Rivers. In the mid-1800s, European settlers came to the region and began development beginning with Conrad Collipp who laid claim to 160 acres along the shore of Silver Lake by cutting his name on trees. In the 1850s he started a brickyard and built a brick Victorian 'mansion' for his family which still stands at 647 Silver Lake Drive. Collipp built a bridge that spanned the neck between the two basins in 1859. In 1875, the city built a causeway in its place and Collipp Avenue became Silver Lake Drive. Property along the south shore was sold to the city of Portage in 1968 and development of the park starting in 1975 with a federal Land and Water Conservation Fund grant (McCarthy, 2010).



With Silver Lake now lying within the City of Portage, its proximity makes it an important asset to the culture and lifestyle for city residents and visitors. Results from the survey confirmed that Silver Lake, along with the adjacent city park, provides a variety of recreational opportunities for citizens throughout the year including swimming, fishing, boating, picnicking, hiking, and enjoying nature. The lake is heavily used by local residents along with visitors from other areas.

Of all the surveys returned (48), 46% lived on Silver Lake, 11% lived in the Silver Lake neighborhood, 30% lived in the City of Portage, but not near the lake, and 13% did not live in the City of Portage. Sixty-three percent

of respondents have lived or recreated on the lake for more than 20 years, 15% 11-20 years, 15% 2-10 years, and 7% less than two years.

Water Quality and Land Management

Most people interpret the water quality in a lake by visuals such as how murky it is, how much algae or aquatic plants they see, or through sense of smell if odors are present. Managing water quality involves taking measurements in the lake and collecting samples for analysis. Interpreting the results involves looking at what is happening in a lake as well as what is happening on the landscape.

Silver Lake is receiving water from direct precipitation on the lakes, from surface runoff during rainstorms and snowmelt, and from groundwater inflow. It is also receiving water from a wetland channel draining from the south. The lake is losing water to groundwater and the channel draining to Mud Lake and on to the Fox River. Understanding how water gets to and from a lake is important because different sources of water impact the amount of time water stays in a lake, its water quality and chemistry and thus, the aquatic plants and biota in an aquatic system. During snowmelt or a precipitation event water moves across the surface of the landscape towards lower elevations such as wetlands, lakes and rivers, or internally drained areas (where water on the surface recharges groundwater). The capacity of this landscape to hold water and filter particulates ultimately determines the water quality, habitat, and in-stream erosion. Simply put, the more the landscape can hold water during a storm, the slower the water is delivered to the streams and the greater the ability to filter the runoff.

As water moves across the land surface, particles are picked up and travel with the flow. Surface water runoff is partially filtered when plants divert and slow water movement causing sediment and associated nutrients to be deposited or absorbed. The best plant filters (buffers) consist of a combination of trees, shrubs, and deeply rooted perennial vegetation. This vegetation also provides essential habitat for many animals that inhabit or use lake shorelines. Although some of the land around the lake contains this type of vegetation, one layer or another is missing from much of the landscape. Where native vegetation is absent, bluegrass (sp. *Poa*) predominates, and its short height, flexibility, and shallow rooting depth do not provide good sediment filtration (UW-Extension, 1999).

Surface Watershed

A surface watershed is the land area where runoff from precipitation drains to water bodies before it can infiltrate into the ground. Surface watersheds with large amounts of steeply sloped land, stream inflows to the lake, and a large percent of impervious surface (buildings, roads, compacted soil) deliver additional surface runoff by averting infiltration into the soil and by funneling water directly to the lake. The surface watershed for Silver Lake was determined using the high topographic points around the lake and evaluating maps showing the networks of natural and man-made inflows that feed or divert water to/from the lake. By the nature of Silver Lake's location within the city, its surface watershed includes a large amount of impervious surfaces. This results in increased runoff, reduced groundwater (that feeds the lakes during dry periods) and impacts the fishery. Although it would be impractical to remove most of these features, there are many practices that can be put in place to handle storm water that would reduce negative impacts to water quality.

Residential development covers approximately 49% of the watershed (Figure 1). The other dominant land uses include forest (22%), the lake itself (15%), barren land (10%), wetland (5%), and grassland (0.2%).

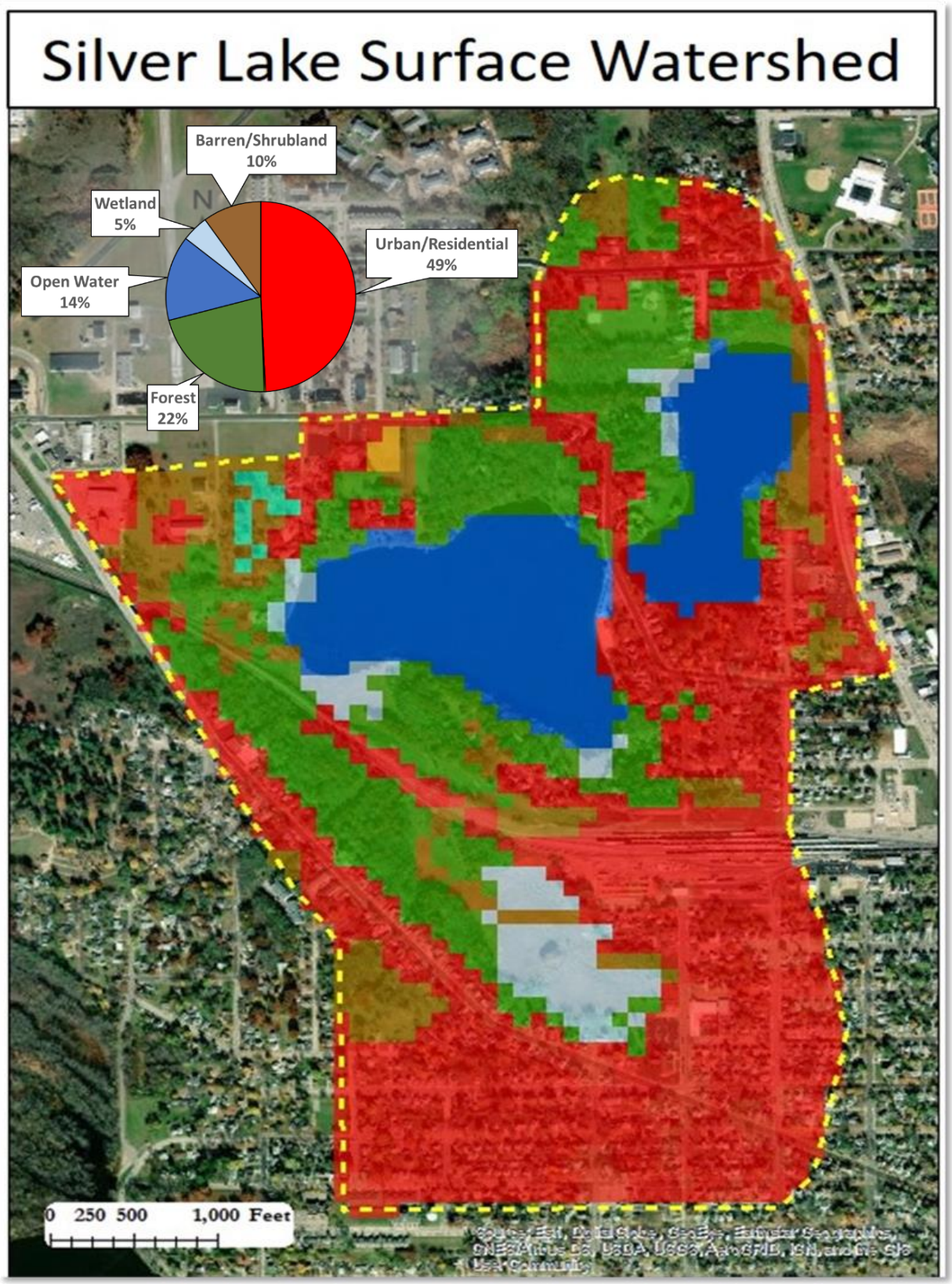


Figure 1. Land uses within the Silver Lake surface watershed.

In addition to surface water runoff, two channels (Figure 2 in blue arrows) deliver or remove surface water to/from Silver Lake. They include:

- The channel leading from the upstream wetland complex to the south into Silver Lake. The wetland primarily receives drainage from Portage residential areas and a railroad yard.
- The channel under New Pinery Road from Silver Lake to the downstream wetland complex incorporating Mud Lake to the east. This wetland extends to the Fox River.

Figure 2. Wetlands up and downstream of Silver Lake.

Groundwater Watershed

Groundwater is water that infiltrates through the soil and then moves into the local lake and streams. Because this water passes through soil and the groundwater aquifer, the more groundwater that enters a lake, the more influence the local geology has on the lake. Groundwater can spend years to decades in the ground from the time it enters to the time it discharges to the lake or stream. This length of time means that the groundwater temperature is near constant year-round; during the summer, groundwater entering Silver Lake is cooler than the water temperature. In the winter, groundwater entering the lake is warmer than the water and leads to areas of the lake that may freeze later or thaw earlier.

Groundwater flows below ground from areas of higher to lower water elevations and ultimately discharges to the wetlands and lake. The groundwater feeding the lakes in Columbia County originates nearby as this area is located along a groundwater (and surface water) divide between water heading toward the Wisconsin/Mississippi Rivers and the Gulf of Mexico and water heading toward the Fox River and Great Lakes.

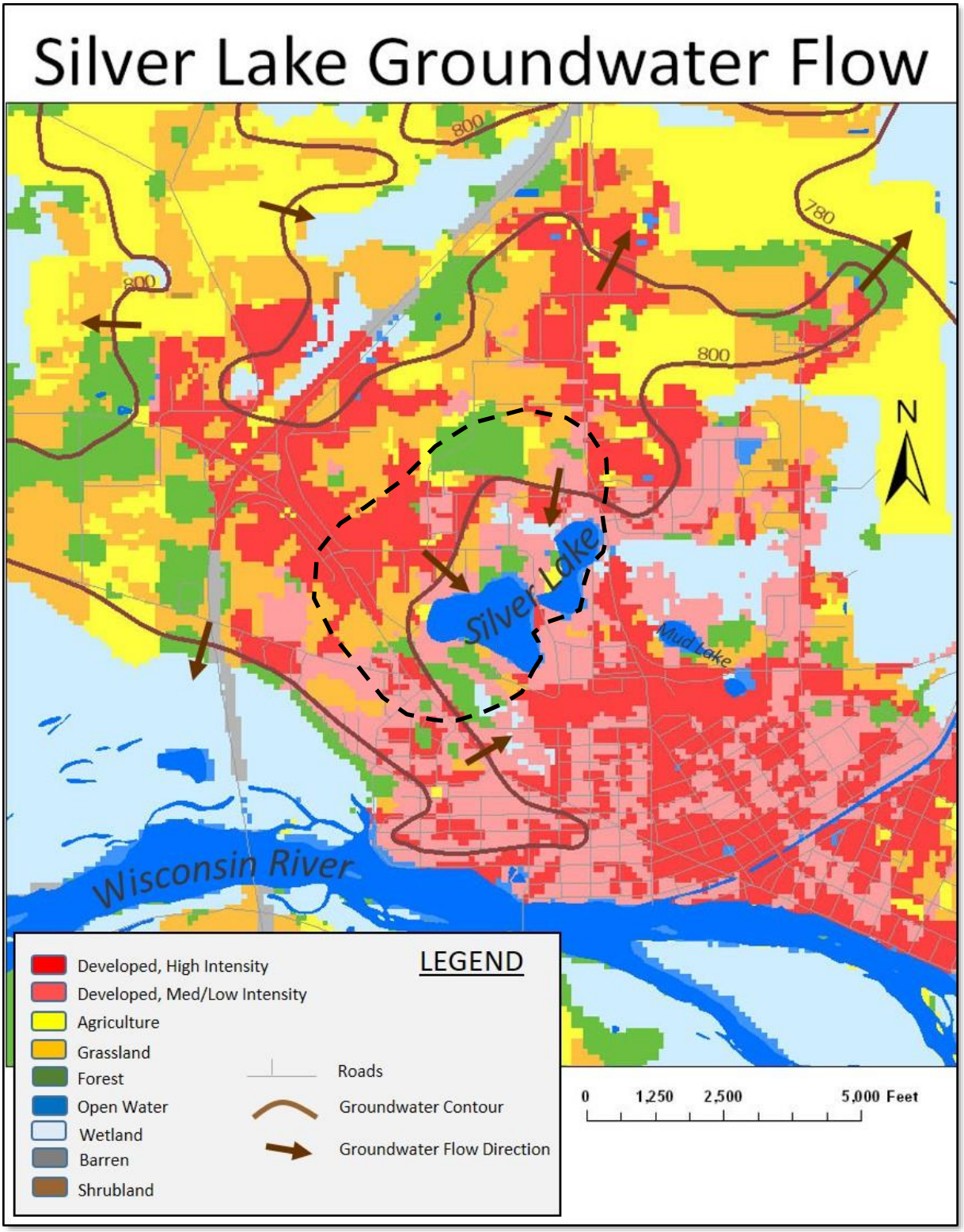
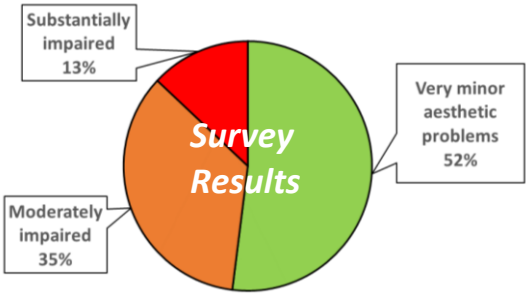


Figure 3. Land use within the groundwater contributing area of Silver Lake.

This results in a relatively small groundwater contributing area to the lake and a lake that is responsive to groundwater level fluctuations. As the water table moves up and down following years of higher or lower precipitation, respectively, the lake level will also be expected to vary in elevation. The approximate groundwater contributing area can be observed in Figure 3 within the black dashed line. The brown arrows indicate the general direction of groundwater flow (groundwater enters Silver Lake from the north and west).

Water Quality



When respondents were asked about the water quality in Silver Lake, most of the people felt the water quality had minor to moderate aesthetic problems due to algae or other water quality issues. Most felt that water quality had a major impact on both the economic and personal enjoyment of the lake and about half of the people surveyed felt that water quality has declined over the period that they were familiar with the lake. Respondents felt that the top causes for a decline in water quality were excess algae, excess aquatic plants, and invasive species. The perceived causes for a decline in water quality can be used to address if these are actual concerns in the watershed or not and may serve as a guide for educational outreach.

The assessment of water quality in a water body involves a number of measures including water clarity, temperature, dissolved oxygen, chemistry, and chlorophyll *a/* algae. Each of these measures play a part in Silver Lake's overall water quality. A water quality study was conducted in the lake by CWSE in 2017-2019. Though considered one lake, each basin (West and East) were characterized separately. The official monitoring station for the lake (No. 113079) is in the West Basin over the deep hole.

Water clarity is a measure of how deep light can penetrate the water and is assessed using a Secchi Disk. It is an aesthetic measure and is related to the depth that rooted aquatic plants can grow. Water clarity can be affected by sediment, algae, and color in water. These measurements are highly variable on a day to day basis but tracking over time can illustrate trends that correlate to other changes happening in the lake ecosystem. Clarity measurements in the West Basin ranged from 3.5 to 15 feet (Figure 4) and suggests a decreasing trend when compared to historical data going back to 1972. Clarity measurements in

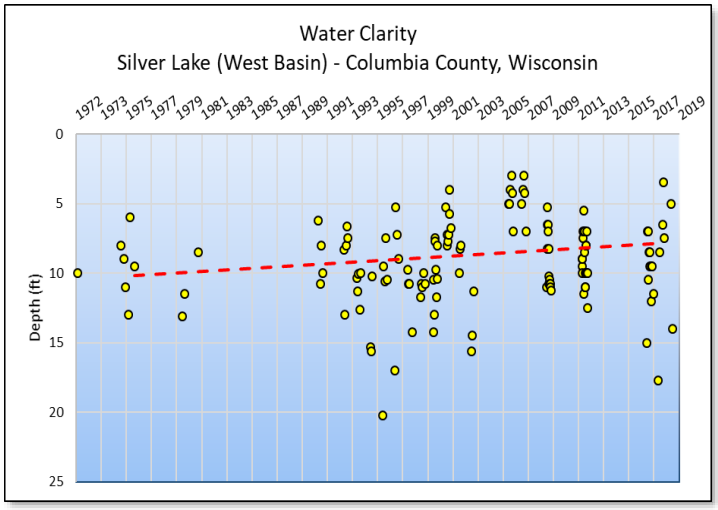
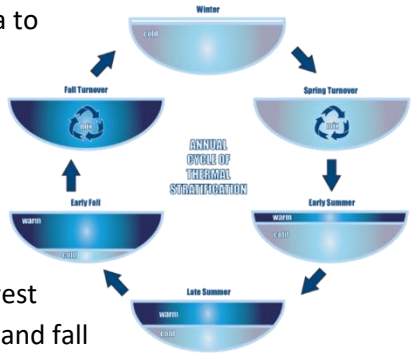


Figure 4. Water clarity in Silver Lake, 2017-2019.

the East Basin ranged from 5.5 to 13 feet (Figure 4) with little to no historical data to compare to. The spring and fall months had the best water clarity in both basins and the summer had the poorest.



Water temperature in the lake changes throughout the year and may vary with depth. Water temperature was measured in each basin of Silver Lake from the surface to the bottom at the time of sample collection (Figure 5). During the 2017-2019 study, temperature data illustrated a typical deep lake profile in the west basin with a well-developed thermocline by June between 15 and 25 feet. Spring and fall overturn profiles are apparent maintaining a similar temperature between 37 and 42 degrees with depth. The east basin, in contrast, illustrates typical profiles of a shallow, mixed lake that maintain a similar temperature from surface to bottom throughout the year. During the summer months, a period of slight stratification develops as surface temperatures warm.

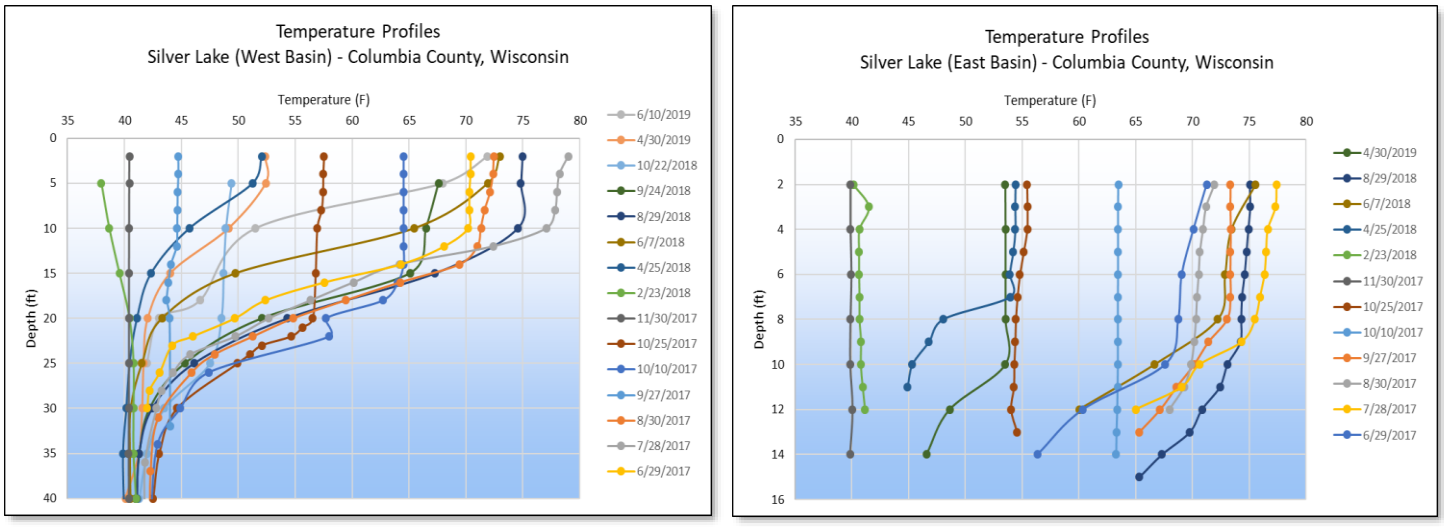
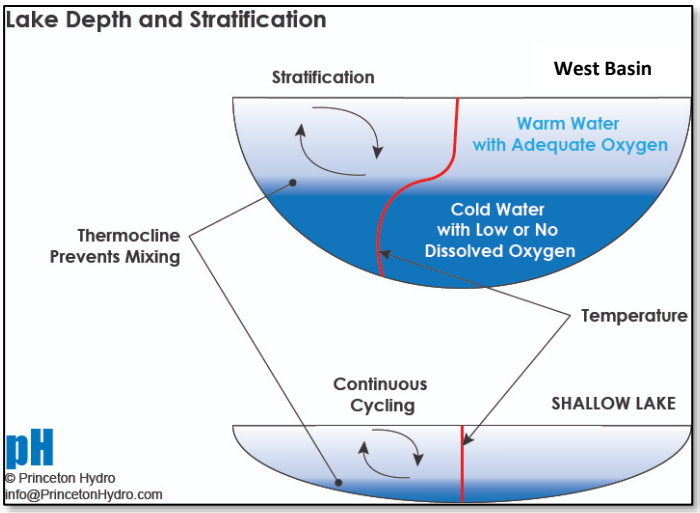


Figure 5. Temperature profiles in Silver Lake, 2017-2019.

Dissolved oxygen (DO) is an important measure in aquatic ecosystems because a majority of organisms in the water depend on oxygen to survive. Oxygen is dissolved into the water from contact with the air, which is increased by wind and wave action. Algae and aquatic plants also produce oxygen when sunlight enters the water, but the decomposition of dead plants and algae reduces oxygen in the lake. Some forms of iron and other metals carried by groundwater can also consume oxygen when the groundwater discharges to the lake. During winter and summer when lakes stratify (layer), the amount of dissolved oxygen is often lower towards the bottom of the lake. DO concentrations below 5 mg/L stress some species of cold-water fish and over time can reduce the amount of available habitat for sensitive cold-water species of fish and other aquatic organisms.



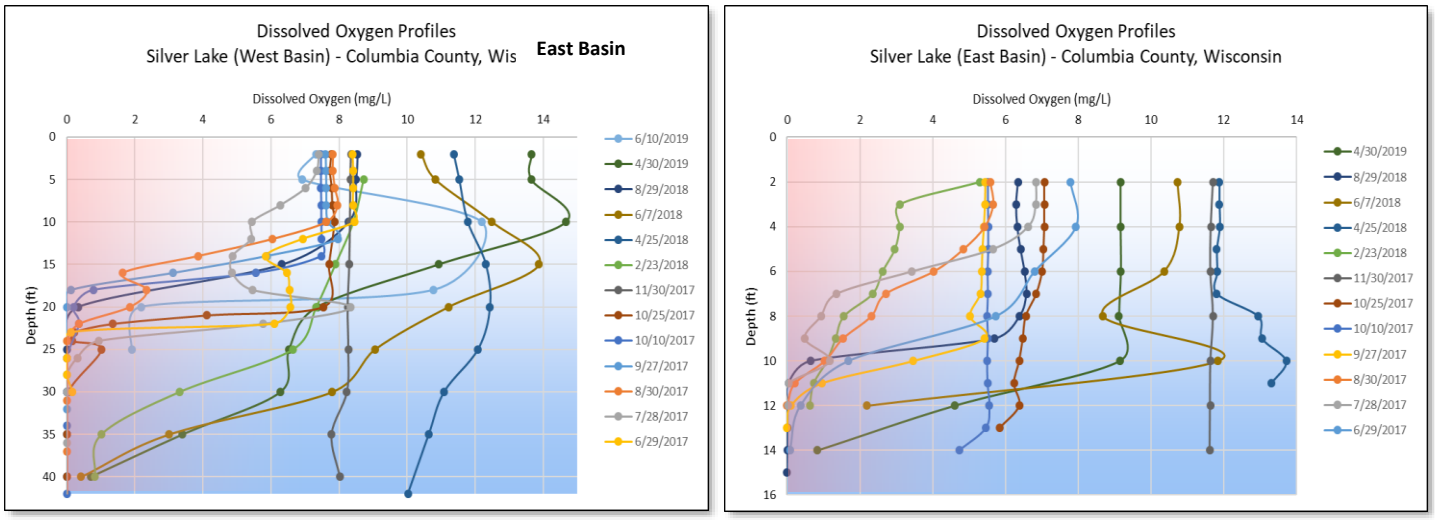


Figure 6. Dissolved oxygen profiles in Silver Lake, 2017-2019.

DO was measured in each basin of Silver Lake from the surface to the bottom at the time of each sample collection. During the study, DO data in the west basin illustrated a typical profile for a deep, stratified lake with moderate levels of nutrients (Figure 6). Most of the year, these concentrations start near saturation at the surface and drop off significantly as depths reach the thermocline between 10 and 25 feet. During the summer, there are low oxygen concentrations below the thermocline. During spring and fall overturn, mixing of the lake leads to oxygen concentrations that are relatively uniform from surface to bottom. The bumps in concentration during the June, July and August 2017 profiles (west basin) at 20 feet are indicative of algae blooms at depth. This is largely absent in the shallow, unstratified east basin where more plants are available to outcompete algae for nutrients.

Nutrients (nitrogen and phosphorus) are important measures of water quality in lakes and rivers because they are used for growth by algae and aquatic plants. In Silver Lake, the phosphorus concentrations periodically

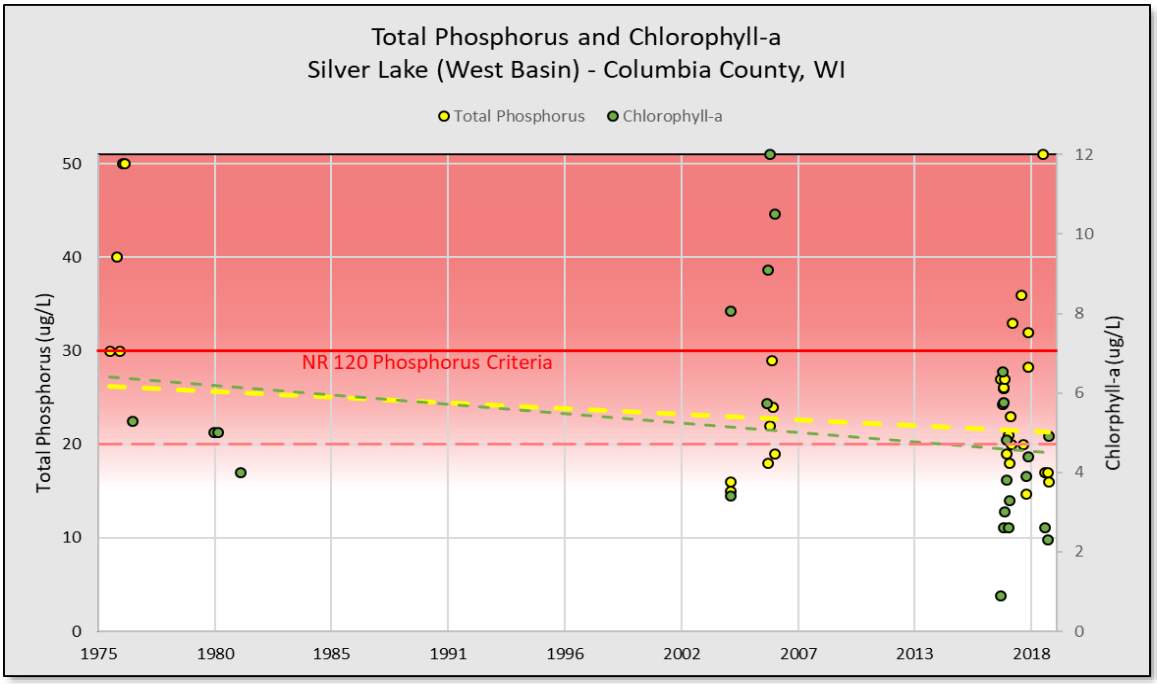
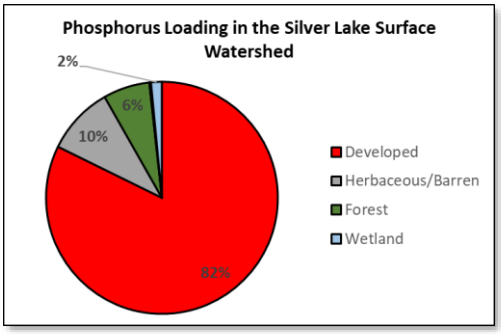


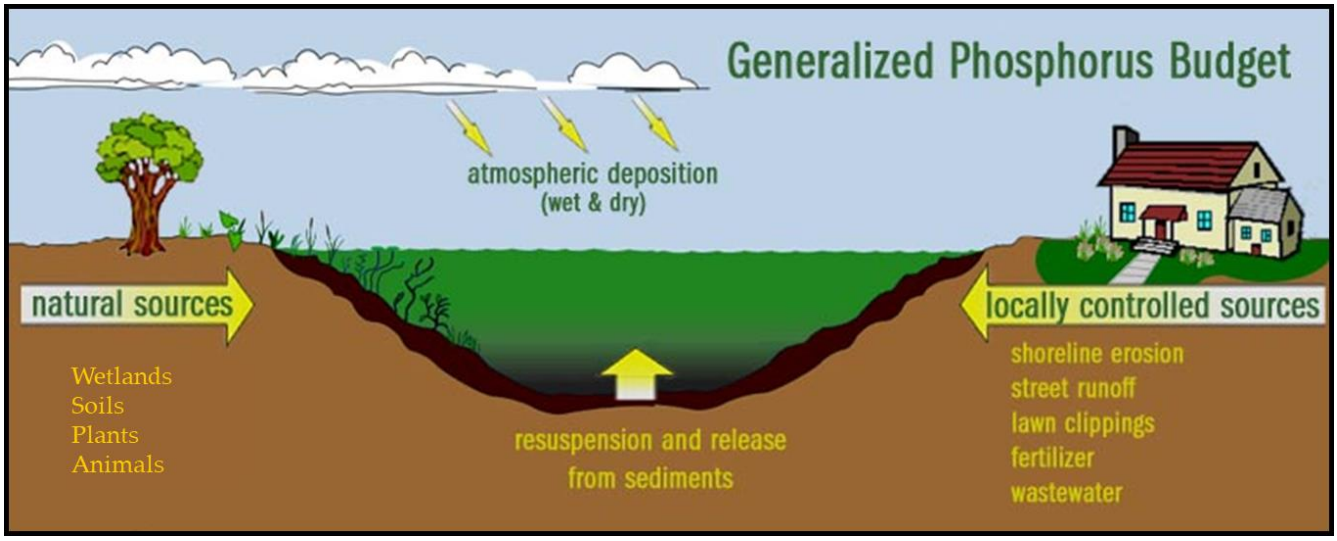
Figure 7. Nutrient concentrations in Silver Lake-West Basin (Deep hole).

exceeded the phosphorus criteria set by the Wisconsin DNR (Figure 7); concentrations were similar in either basin. Nitrogen concentrations in both basins were low.



Phosphorus is an element that is essential to most living organisms including plants. Sources of phosphorus can include naturally occurring phosphorus in soils, wetlands, and small amounts in groundwater. Sources from human influence include soil erosion, agricultural and residential runoff, septic systems, and animal waste.

Total phosphorus (TP) concentrations for the deep hole (West Basin) have ranged from historically high levels of 50 ug/L in April 1976 to as low as 16 ug/L in August 2019. The summer median TP concentrations were 24.5 ug/L, 23.8 ug/L and 16.7 ug/L in 2017, 2018 and 2019, respectively. This is just above Wisconsin's phosphorus standard of 20 ug/L for deep seepage lakes and just below 30 ug/L for drainage lakes. Concentrations in the East Basin had a similar range from 55 ug/L in May 2017 to 11 ug/L in August 2019 with summer median averages of 29.1 ug/L (2017), 40.8 ug/L (2018), and 22 ug/L (2019). Silver Lake is a headwater drainage lake that has a large seepage component to its behavior. So, though the 3-year growing season average is technically below standard, it is at levels that are approaching threshold levels. Inorganic nitrogen concentrations in Silver Lake were within the natural background range for lakes in Columbia County.



Chlorophyll *a* is a measure of algae in the lake and often correlates with TP. In 2017-2019 chlorophyll *a* concentrations in the West Basin ranged from 0.9 to 6.54 mg/L. The highest readings were in June and August. In 2017-2019 chlorophyll *a* concentrations in the East Basin ranged from 0.9 to 12.4 mg/L. The highest levels in the East Basin were in July and August. Levels over 5 mg/L are considered to be elevated.

In Silver Lake, the aquatic plant and algal growth is most responsive to phosphorus due to its relative limited supply with respect to other nutrients necessary for growth. Increases of small amounts of phosphorus can result in increased abundance of aquatic plants and algae. Managing phosphorus in the Silver Lake watershed is the key to protecting the lake. Positive land management practices and land uses can result in good water quality in the lake. Phosphorus inputs to the lake can be controlled through the use of many different best

management practices (BMP's) that minimize the movement of runoff, nutrients, and contaminants (Table 1) to the lake. These concepts can be applied to the residential and urban areas within the watershed such as applying fertilizer only if soil tests indicate it is necessary, controlling sediment movement when soils are exposed, reducing runoff from impervious areas by installing rain barrels, rain gardens, maximizing native vegetation and minimizing the amount of turf in the landscape, etc. Some of the near shore land management practices that can help to reduce the inputs of phosphorus to Silver Lake are discussed in the next section.

Silver Lake-West	Average Value			Reference Value		
	Low	Medium	High	Low	Medium	High
Potassium (mg/L)			1.8	<.75	0.75-1.5	>1.5
Chloride (mg/L)			50.3	<3	3.0-10.0	>10
Sodium (mg/L)			33.2	<2	2.0-4.0	>4
Silver Lake-East	**Average Value**			**Reference Value**		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
Potassium (mg/L)			1.52	<.75	0.75-1.5	>1.5
Chloride (mg/L)			53.5	<3	3.0-10.0	>10
Sodium (mg/L)			34.9	<2	2.0-4.0	>4

Table 1. Average contaminant concentrations in Silver Lake, 2017-2019.

Goal 1: The water quality in Silver Lake will remain below the state phosphorus criteria for drainage lakes (30 ug/L) and there will be sufficient dissolved oxygen (DO) to support the fisheries.

Objective 1.1: Ensure that water quality goals are achieved and detect any degrading water quality though routine monitoring.

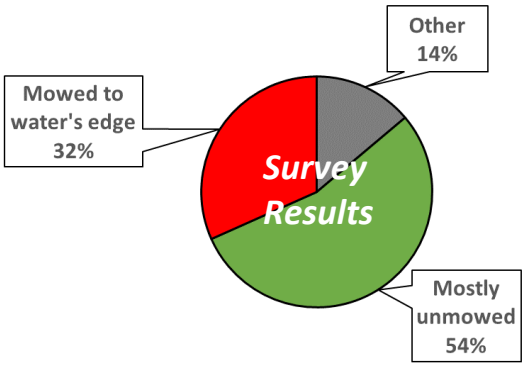
Action	Lead person/group	Start/end dates	Resources	Progress
The Portage Parks & Recreation Department will continue to monitor the lake at least once a month (temperature, dissolved oxygen and water clarity) June-September and submit data to WDNR SWIMS. Water clarity will be monitored more often as feasible.	Portage Parks & Rec	Ongoing	WDNR CLMN UWSP CWSE	
If D.O. levels are below 5 mg/L in the upper 10 ft of Silver Lake contact WDNR immediately.	Portage Parks & Rec	As needed	WDNR	

Objective 1.2: Educate property owners within the Silver Lake watershed about their connection to the lake and how to utilize resources for healthy land management practices.

Action	Lead person/group	Start/end dates	Resources	Progress
Work with the city to review the shoreland zoning ordinance to protect	City of Portage		UWSP-Ctr for Land Use Ed Columbia LWCD	

in-tact shorelands and reduce shoreland runoff.				
Work with the city to review stormwater flow and road design to identify ways to divert runoff to lake into infiltration areas such as wetlands.	City of Portage		Columbia LWCD	
Minimize erosion around the lake.	City of Portage		Columbia LWCD	
Work with landowners to minimize impacts from steep slopes.	City of Portage		Columbia LWCD	
Control runoff by encouraging the use of rain barrels, rain gardens, etc.	City of Portage		Columbia LWCD	
Provide information about the current building setbacks.	City of Portage		City of Portage	

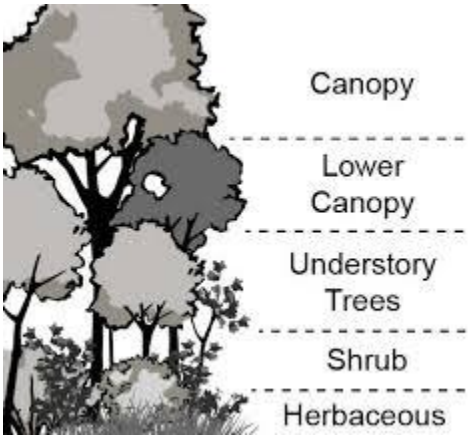
Shorelands



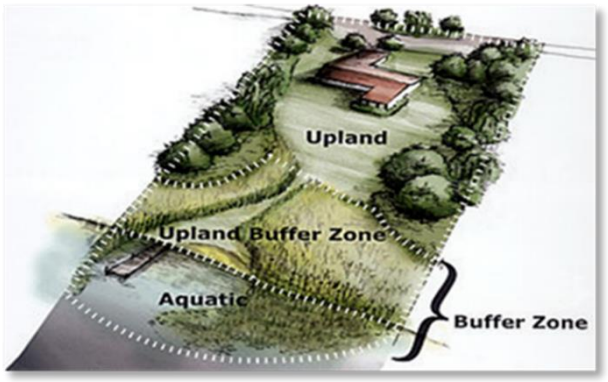
Shorelands play an important role in a lake's ecosystem. Many creatures rely on shorelands for all or part of their life cycles as a source of food, a place to sleep or hide from predators, and to raise their young. Shoreland vegetation helps prevent shoreline erosion by buffering lake waves and slowing down runoff washing towards the lake from the land. Native flowers and grasses help by filtering pollutants flowing towards the lake and by using nutrients that might otherwise be consumed by algae and aquatic plants. Near shore aquatic plants use nutrients that might otherwise grow algae and the plants help to break up waves which in-turn reduces shoreline erosion. In addition, natural shorelines can also make it harder for aquatic invasive species to establish themselves in a lake, muffle noise from watercraft, and preserve privacy and natural scenic beauty.

Vegetated shorelines are comprised of three different categories of vegetation; trees, shrubs, and tall native forbs/grasses. Ideally, all three types of vegetation should be present within the shoreline buffer in order to be healthy and provide for better water quality and habitat.

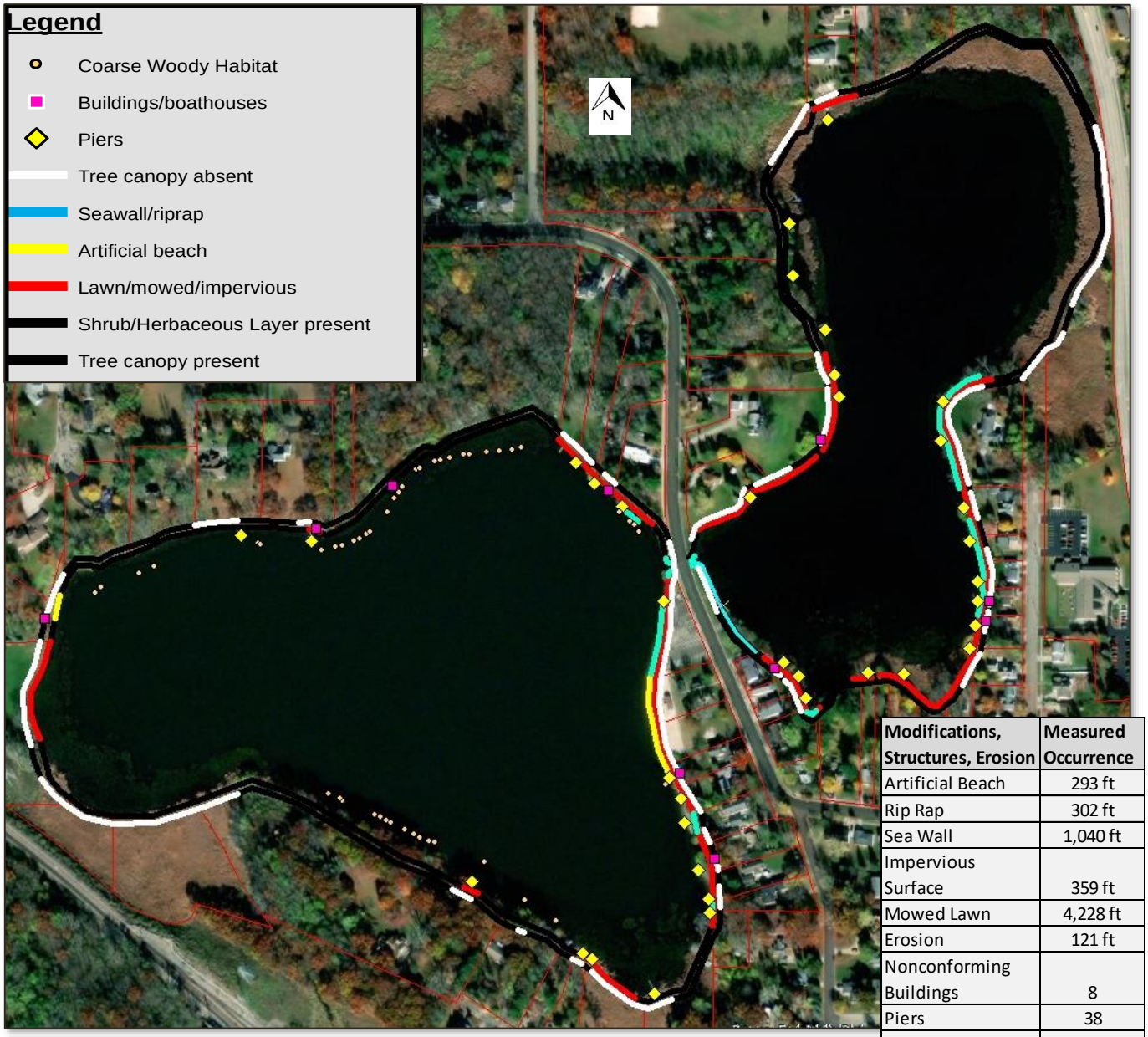
Trees provide a canopy over the shoreland. This canopy slows precipitation as it falls to the ground, reducing its chance of causing runoff and erosion. Roots hold soil and help stabilize slopes by trapping and using precipitation that would otherwise run off. Around Silver Lake, approximately 50% of the shore lacks trees (Figure 8). Shrubs provide some of the same benefits as trees to shorelands. Shrubs also offer habitat for wildlife and privacy for humans. Native grasses and forbs (flowers and herbs) are perhaps the most important layer of vegetation on the shoreline. They help to slow runoff, filter sediments, and utilize excess nutrients that could otherwise cause water quality problems. Forbs, along with trees and shrubs, also help prevent shores from erosion and provide important habitat for many creatures including frogs and turtles. This layer also



reduces shoreland access to geese. During the survey, this layer was identified as vegetation ranging in height from 0.5-3 feet. Around Silver Lake, 37% percent of the shore lacks shrubs and/or grasses/forbs.



Mowed lawn within the buffer zone often acts just as bare ground would. Lawn grass has shallow roots that don't help water to easily soak into the ground and during heavy precipitation events the grass blades can fold over flat and allow runoff to enter the lake with little filtration of sediment and other pollutants. Mowed lawn doesn't provide habitat for many creatures that are typically associated with lakes such as frogs and turtles. It encourages geese by providing food and its open scape is an



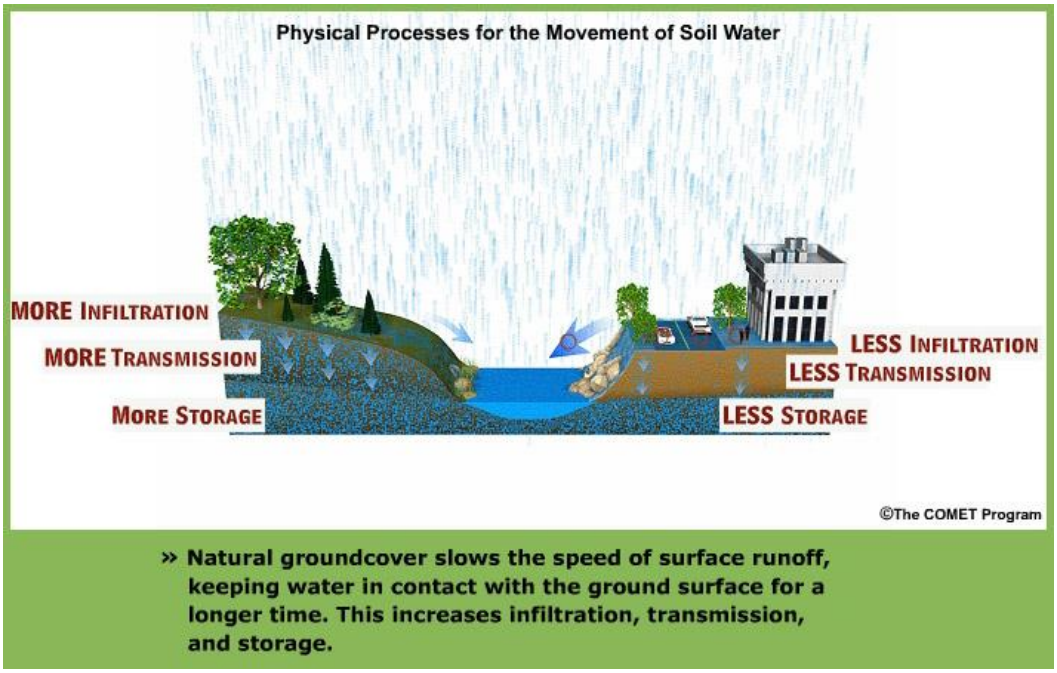
Modifications, Structures, Erosion	Measured Occurrence
Artificial Beach	293 ft
Rip Rap	302 ft
Sea Wall	1,040 ft
Impervious Surface	359 ft
Mowed Lawn	4,228 ft
Erosion	121 ft
Nonconforming Buildings	8
Piers	38
Coarse Woody Habitat	22 logs/mile

Figure 8. Overall shoreland health around Silver Lake, 2017.

invitation to geese as they are weary of going on shore where tall vegetation prevents them from seeing potential predators. Around Silver Lake, 34% of the shore within the shoreland buffer is mowed.

There have been concerns voiced about the large numbers of Canada Geese present on Silver Lake. Geese find ideal habitat on the manicured lawns and parks around the lakes. These mowed areas provide excellent spring, summer, and fall forage for geese, as well as safe sites for geese because there are few predators present and those that are can be seen easily. The key to controlling the damage is to make the problem site less attractive to geese. One of the easiest and most effective methods to do this is through landscape modification. Landscape modification deters geese by restricting the ability of geese to move between water and the lawn without flying, by making the site appear to be potentially unsafe for geese, and by reducing the nutritional value provided by a lawn. This can be accomplished by planting shrubs, hedges, and/or tall native vegetation along the shoreline. Ways to reduce the nutritional value of a lawn include mowing and fertilizing the lawn as infrequently as possible or by planting a less palatable grass species. These landscape modifications can also have positive impacts on water quality and shorelines around the lake.

Surfaces such as roofs, driveways, roads, patios, and compacted soil increase the amount of runoff moving across the landscape towards Silver Lake. Runoff that enters the lake can carry a variety of pollutants into the water. Some of the negative impacts in the lakes due to additional runoff may include increased nutrients (such as phosphorus), which can cause algae blooms and excessive plant growth, and increased amounts or changes in the type of sediment. This in turn can lead to cloudy or turbid water, sediment burying fish spawning areas and other critical habitat, and sediment transporting additional contaminants such as bacteria, debris, metals, and pesticides.



Goal 2: Silver Lake will have healthy shorelands that protect water quality and provide essential habitat. Approximately 1,000 feet of shoreline will be restored over the next 5 years.

Objective 2.1: Shoreland property owners will understand why the shorelands are important to the lake's ecosystem and their roles in protecting these areas. They will make informed land management decisions that minimize their impacts to water quality and habitat.

Actions	Lead person/group	Start/end dates	Resources	Progress
Provide information to landowners on how to prevent soil erosion on steep shorelines around the lake.		Ongoing	UWEX Lakes WDNR	
Provide information about ways to protect and restore shoreland vegetation and why it is important.	City of Portage	Ongoing	Columbia LWCD UWEX Lakes	

Provide information on how to control stormwater on your own property.	City of Portage	Ongoing	Columbia LWCD UWEX Lakes	
Identify willing properties and install fish sticks to improve fish habitat.			WDNR	
Consider restoring and showcasing a "demonstration site" with a sign at the water's edge about shoreland restoration (perhaps at the boat launch or on one of the commercial properties).				
Re-assess shoreline vegetation survey at least every ten years.		2030	WDNR Consultant	

Objective 2.2: To the greatest extent possible, reduce the amount of storm water draining to Silver Lake.

Actions	Lead person/group	Start/end dates	Resources	Progress
Support the use of bioretention ponds and swales to infiltrate water stormwater instead of it running off.	City of Portage		Columbia LWCD UWEX Lakes	
Work with the city to reduce erosion and runoff at the beach and in the city parks.	City of Portage		Columbia LWCD UWEX Lakes	
Work with city to design and install a water diversion structure at the boat ramp to keep runoff from flowing directly into lake.	City of Portage		Columbia LWCD	
Work with the city to review stormwater flow and road design to identify ways to divert runoff to lake into infiltration areas such as wetlands.	City of Portage		Columbia LWCD	

Objective 2.3: Protect undeveloped and vegetated areas around Silver Lake.

Actions	Lead person/group	Start/end dates	Resources	Progress
Provide information to landowners and park managers about keeping vegetated buffers intact.	City of Portage		Columbia LWCD UWEX Lakes	
Encourage the city to keep the existing buffers and increase them where feasible.	City of Portage			
Encourage the city to enhance the shoreland zoning ordinance for Silver Lake so that it addresses vegetative shoreland buffers			City of Portage Columbia LWCD UWEX Lakes	
Control Japanese knotweed along the shorelines of Silver lake and adjacent areas		Ongoing	WDNR Local youth groups	

Goal 3: All shorelands (adjacent to the lake) around Silver Lake will be conducive to limit geese populations on the lake.

Objective 3.1: Reduce and control the resident goose population

Actions	Lead person/group	Start/end dates	Resources	Progress
Provide information to shoreland owners about the direct relationship between mowed lawns and increased goose populations.		Ongoing	UWEX Lakes	
Encourage vegetative buffers to keep geese out of yards. Track the progress in implementation.		Ongoing	WDNR	
Post signage prohibiting feeding wildlife in the parks.	City of Portage			
Use harassment methods to make the geese wary.				
Decrease nesting success of geese.			WDNR	

Aquatic Plants and Invasive Species

A healthy aquatic plant community is comprised of a healthy diversity of native plant species. Aquatic plants such as lily pads play many important roles in aquatic ecosystems including providing habitat for aquatic and semi-aquatic organisms, food for fish, waterfowl, and other animals, use of nutrients that would otherwise be used by algae, and modifying/cooling water temperatures on hot days. While it is important to maintain recreational opportunities on the lake, it is also important to maintain intact aquatic plant communities.


Lily pads on Silver Lake, July 2017.

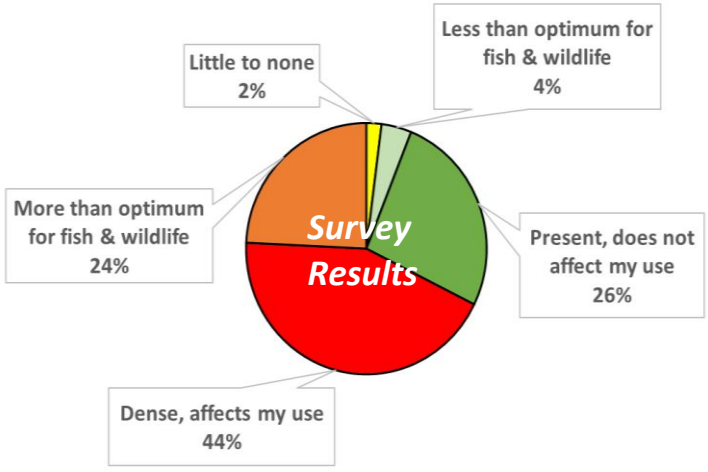
Aquatic Plant Community

According to the aquatic plant survey conducted in Silver Lake in the summer of 2017, 23 species of aquatic plants were observed (Table 3) with the maximum depth of growth at 16 feet. Botanists and plant ecologists use a quantitative measure called the *Floristic Quality Index* (FQI) to express the "quality" of an aquatic plant community. This standardized tool replaces subjective assessments to provide a useful number for comparing various plant communities. FQI is not a stand-alone value but is used together with other assessments to evaluate the quality of a lake community. The basis of the FQI calculation is the coefficient of conservatism (C), a value given to each species. Each native species has been assigned a value from 0 to 10, which represents the likelihood that this species will occur in relatively unaltered environments. Aquatic plant species with high C-values are relatively specialized in their requirements, and thus are found in more limited habitats. The FQI for Silver Lake is 21.6, with the mean C-value for plants species of 5.8. Invasive species Eurasian watermilfoil (EWM) and Curly-leaf pondweed (CLP) had the lowest C-values of 0 and southern naiad (*Najas guadalupensis*) had the highest C-value of 8. Statewide the average FQI value is 22.2 and the average C-value is 6.0.

Scientific Name	Common Name	1996 Survey	2002 Survey	2006 Survey	2017 Survey
Brasenia schreberi	Watershield	x	x	x	
Ceratophyllum demersum	Coontail	x	x	x	x
Chara spp.	Muskgrasses	x		x	x
Elodea canadensis	Common waterweed	x	x	x	x
Elodea nuttallii	Slender waterweed				x
Heteranthera dubia	Water star-grass			x	x
Lemna minor	Small duckweed	x	x	x	
Lemna trisulca	Star duckweed			x	
Myriophyllum sibiricum	Northern watermilfoil				x
Myriophyllum spicatum	Eurasian watermilfoil	x	x	x	x
Najas flexilis	Slender naiad	x			x
Najas guadalupensis	Southern naiad		x		x
Nitella spp.	Stoneworts				x
Nuphar lutea	Yellow pond lily	x	x	x	
Nymphaea odorata	White water lily	x	x	x	x
Potamogeton amplifolius	Large-leaf pondweed		x	x	x
Potamogeton crispus	Curly-leaf pondweed	x	x	x	x
Potamogeton foliosus	Leafy pondweed	x			x
Potamogeton friesii	Fries' pondweed				x
Potamogeton gramineus	Variable pondweed				x
Potamogeton illinoensis	Illinois pondweed		x		x
Potamogeton natans	Floating-leaf pondweed				x
Potamogeton perfoliatus	Clasping-leaf pondweed		x		
Potamogeton praelongus	White-stem pondweed	x			x
Potamogeton pusillus	Small pondweed				x
Potamogeton strictifolius	Stiff pondweed				x
Potamogeton zosteriformis	Flat-stem pondweed				x
Schoenoplectus acutus	Hard-stem bulrush		x	x	
Stuckenia pectinata	Sago pondweed		x	x	x
Vallisneria americana	Water celery				x

Table 3. Comparison of aquatic plant species found in Silver Lake – 1996, 2002, 2006, 2017.

During the citizen survey, when asked about the abundance of aquatic plants in Silver Lake, almost 70% of respondents said it was either dense, affecting their use of the lake, or more than optimum for fish and wildlife while ~30% did not seem to think there was an overabundance. This likely depends on which part of the lake they use as plants are not as abundant adjacent to the public beach or in deeper areas of the west basin (Figure 9). July and August



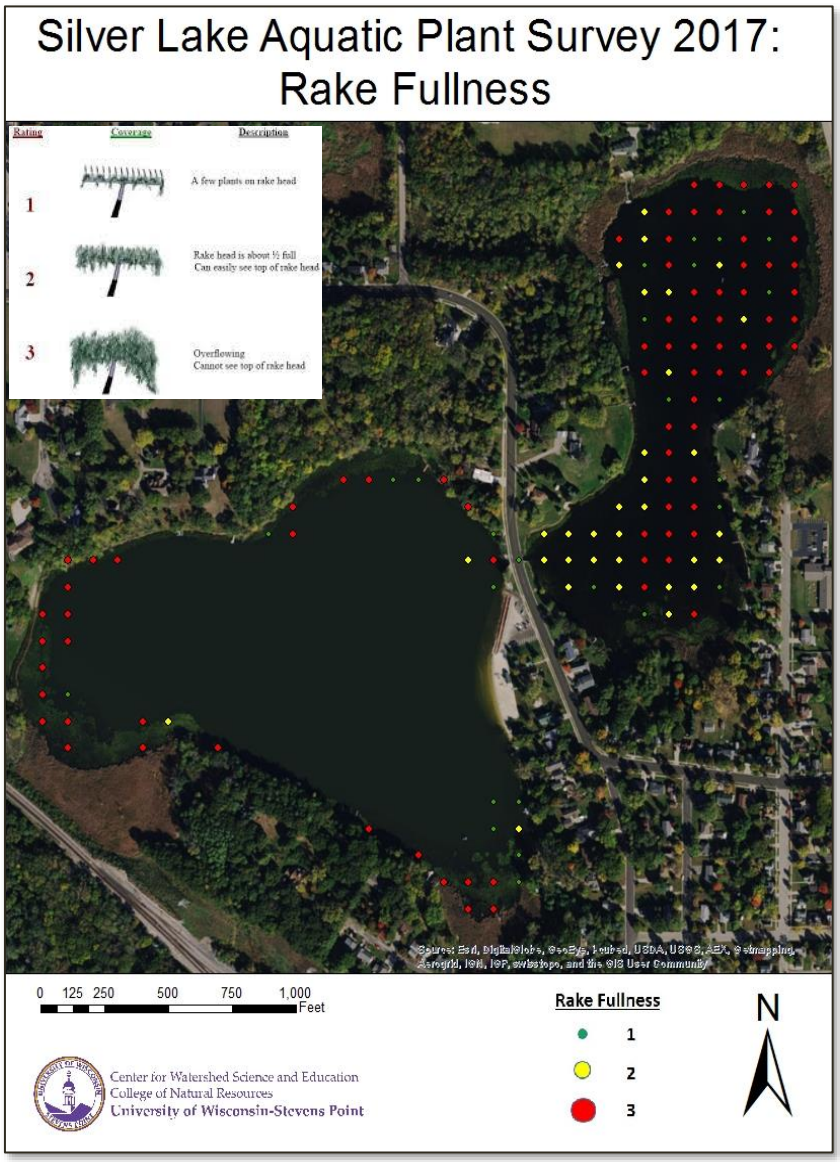


Figure 9. Rake fullness in Silver Lake, July 2017.

were identified as the months with dense and choked plant growth, typical for Wisconsin lakes.

Anecdotally, it has been reported that overall plant abundance in Silver Lake has increased over time. Nuisance levels of plant growth, particularly in the lake's littoral east basin, has been aggressively managed for decades beginning in the early 1990s with chemical applications in the near shore areas. Though likely effective at the time, the collateral damage of this approach only enriched nutrient levels in the substrate and is likely what opened the door for invasive species like EWM and CLP which were first documented in 1994.

Harvesting operations were first contracted in 1994 and a few years later, the City purchased its own harvester, which continues today. In 2018, more than 600,000 pounds of plant material (an estimated 114 lbs of phosphorus) was removed from the lake and composted by the City's Parks Department. Almost 90% of survey respondents felt that aquatic plant control was needed in Silver Lake with a majority of support for non-chemical, mechanical and manual removal methods. Harvesting has also been recommended to help balance predator-prey relationships in the fishery. An aquatic plant management plan (APM) is included in Appendix B.

Invasive Species

EWM and CLP were first documented in Silver Lake in 1994. EWM can hybridize with the native northern milfoil, and this hybrid (HWM) was confirmed in Silver Lake by professionals from the Wisconsin Department of Natural Resources in 2012. During the 2017 survey, EWM/HWM was found in 73% of vegetated areas and accounted for a large portion of the plant biomass in the lake. It is not likely that these two invasives will ever be eradicated from Silver Lake and as such, have become part of the aquatic plant community. No other invasive species have been observed.


EWM observed in Silver Lake.

Goal 4: Local citizens and lake users will be knowledgeable about the aquatic plant community in Silver lake and take appropriate actions.

Objective 4.1: Actively manage excessive aquatic plants in Silver Lake to improve recreational opportunities, facilitate predator/prey relationships in the fishery, and to remove nutrients from the system.

Action	Lead person/group	Start/end dates	Resources	Progress
Maintain an up-to-date aquatic plant management plan. Renew every 5 years as appropriate.	City of Portage		WDNR	
Conduct regular aquatic plant surveys (every 5 years) to monitor the plant community and track changes over time	City of Portage		WDNR	
Continue harvesting operations during the growing season in accordance with a DNR-approved APM (Appendix B).	City of Portage		WDNR	
Conduct early season harvesting after ice is out to cut and remove CLP turions (Appendix B).	City of Portage		WDNR	
Educate lakefront property owners about their options for maintaining access to open water from their pier. Harvesters cannot operate in <3 feet of water.	City of Portage		WDNR UWEX Lakes	
Explore options for cattail removal in near shore areas of the lake. This may include contracted services using special equipment or herbicides. A permit will be required. Lakefront property owners can clear up to a 30' wide swath from their property to open water to maintain access without a permit.	City of Portage		WDNR Columbia Co LCD	


Cattails at Silver Lake outlet, 2019.


Cattails in south bay of west basin, 2019.

Objective 4.2: Local citizens and lake users will be aware of the current aquatic plant management approach in Silver Lake, understand the limitations and have realistic expectations.

Actions	Lead person/group	Start/end dates	Resources	Progress
Describe the current aquatic plant management approach on the park's section of the city website	City of Portage	WDNR		

Fisheries

Healthy lake ecosystems are valuable natural resources for all. A sustainable fishery is a sign of the health of the lake's ecosystem. This means the needs of the fish are met with little or no additional inputs or efforts. This balance can be achieved by ensuring there is sufficient near-shore woody habitat for fish and their food, aquatic plants for food, cover, and oxygen; and fishing rules designed to keep populations in balance.

Species	Year
Brown trout	1972
Rainbow trout	1972-1974
Yellow perch	1974
Largemouth bass	1972-1974
Northern pike	1974
Walleye	15 yrs between 1974-2000
Tiger musky	7 yrs between 1987-2003
True musky	15 yrs between 1987-2009

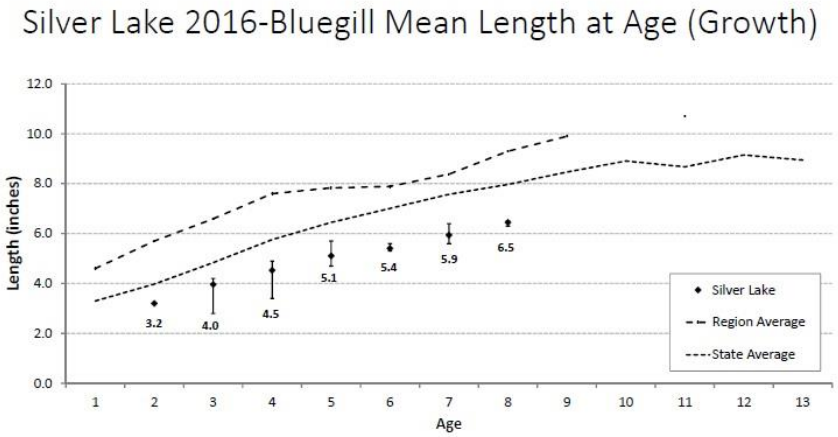
Table 4. Silver Lake stocking history.

49" Musky caught on Silver Lake 2/1/20.

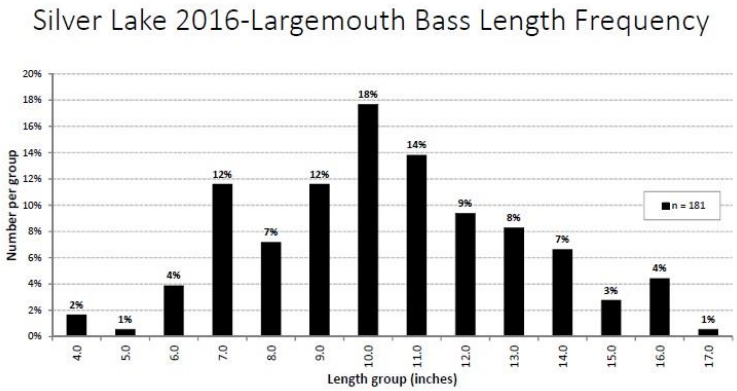
Silver Lake is dominated by bluegill and largemouth bass, common in headwater drainage lakes. Stocking efforts, including northern pike and walleye, have been largely unsuccessful in altering the poor size structure and overabundance of bluegill. Attempts to brood musky have also failed as the recent survey shows no indication of natural reproduction.

No good comprehensive survey data has been collected for Silver Lake since before 1990 as most sampling in recent decades has been done only to evaluate musky stocking. Due to budget constraints and other priorities, the most recent fish survey conducted in Silver Lake in 2016 was electrofishing only which favors species such as bass and bluegill but tends to underrepresent game and panfish species.

Nine species of fish were observed including bluegill (345/mile), largemouth bass (72.4/mile), grass pickerel (8/mile), pumpkinseed (5/mile), black crappie (4/mile), walleye (1.6/mile), warmouth (3/mile), yellow bullhead (1/mile) and yellow perch (1/mile). The next comprehensive fish survey is scheduled for 2026.

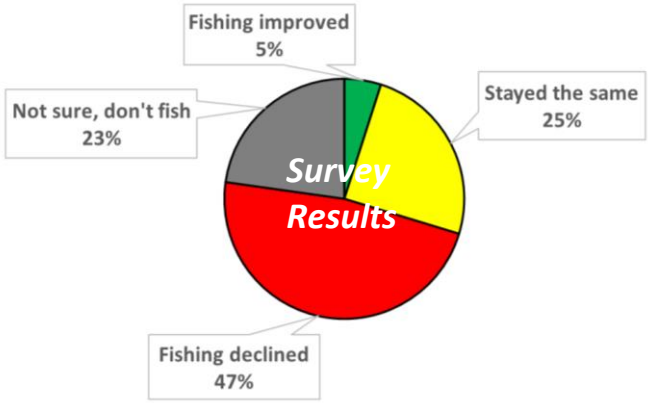


Bluegill abundance in 2016 was in the 96th percentile statewide but had very poor size structure with very few fish reaching 6 inches. This has been a consistent problem in Silver Lake as these growth rates have not changed in more than 30 years despite numerous attempts to correct it including a chemical treatment in 1974 that showed brief improvement, extra protection for bass (14" MLL) in 1982, a spawning disruption in 1992, removal of more than 65,000 fish combined with predator stocking in 1994, and most recently, the creation of predator lanes through thick vegetation by aquatic plant harvesting.



Largemouth bass showed moderate abundance and good size structure, much improved since the 1970s. Age structures were not collected, however, so growth rates are unknown.

Suggested management actions include maintaining largemouth bass and northern pike populations, decreasing bluegill abundance to improve size structure, maintain predator lanes through thick vegetation, and enhance shallow woody habitat necessary for a healthy fishery.



Almost half of survey respondents indicated that the felt the fishing had decline over time with causes primarily attributed to fishing pressure and the overabundance of aquatic plants.

Goal 5: Strategies will be implemented to support a healthy fishery in Silver Lake. We will know that we have achieved this goal when we have a balanced fish community.

Objective 5.1: Improve the fisheries habitat in Silver Lake to achieve better reproduction.

Actions	Lead person/group	Start/end dates	Resources	Progress
Disseminate information about the importance of woody habitat in the lake for fisheries and about leaving a tree in the lake when it drops (through door to door handouts).			WDNR WI Extension Lakes	
Continue harvesting operations that create predator lanes through thick vegetation.			WDNR	
Install woody habitat demonstration projects in familiar public and private areas where people can view them.			WDNR fishery biologist	

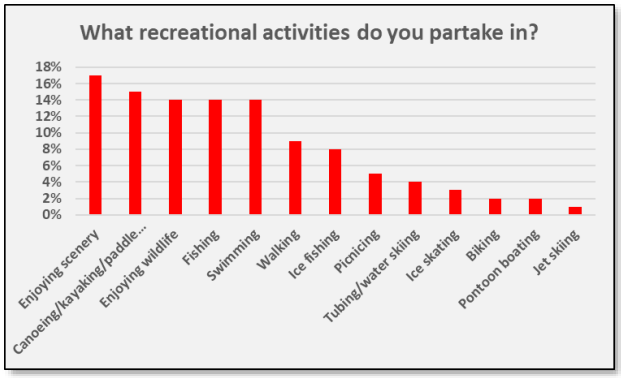
Identify willing landowners to install fish stick habitat structures in near shore areas. Also identify landowners (same or different from above) willing to source trees for fish sticks >35 feet from shore.				

Objective 5.2: Work with the WDNR to develop a sustainable fisheries management strategy for Silver Lake.

Actions	Lead person/group	Start/end dates	Resources	Progress
Continue to work with the WDNR fisheries biologist on developing actions/regulations to improve bluegill size structure/abundance issues. Consider change in minimum size and bag limit for largemouth bass depending on results of 2026 fish survey.	City of Portage		WDNR fishery biologist	
Post the fish survey report from WDNR on the park's section of the City website.	City of Portage		City of Portage	

Recreation

Silver Lake residents and users enjoy many recreational opportunities in, on, and near the lake. Based on survey results, the most popular recreational activities included swimming/snorkeling, enjoying scenery, walking, fishing, and picnicking.



These are relatively quiet activities, so conflicts are not likely to be significant; however, the large number of people using the lake may result in conflicts and recreational needs and uses of the lake will likely continue to increase as populations and development in the area grows. Survey results indicated that usage of the lake was primarily May through August, although data showed that the lake is used year-round and during all days of the week. The presence of Silver Lake Park enhanced the enjoyment of the lake for the majority of respondents.

No Wake is allowed on Silver Lake between 6pm and 9am. Two-thirds of survey respondents indicated that they like these rules as they are at least most of the time. Almost 25% would like to see these hours changed with some wanting more wake time, especially on weekends, and others wanting no wake time at all to be allowed. Almost everyone enjoys the presence and access that the Silver Lake Park provides, and it is identified as a key resource in city and county plans.

Goal 7: Recreational opportunities in, on, and near Silver Lake will protect the healthy ecosystem and safety of lake users.

Objective 7.1: Ensure recreational opportunities exist on Silver Lake for residents and lake users.

Actions	Lead person/group	Start/end dates	Resources	Progress
Maintain public access for swimming and boating on Silver Lake.	City of Portage			
Consider purchase of lakefront property as available to expand park setting and protect shorelands.	City of Portage			

Objective 7.2: Lake users will be informed of pertinent rules that are in place to protect the users and lake ecosystem.

Actions	Lead person/group	Start/end dates	Resources	Progress
Maintain signage at the boat landing regarding lake user expectations and rules, wake hours, etc.	City of Portage			

Objective 7.3: Maintain communication with Parks Department regarding plans for design changes in the park

Actions	Lead person/group	Start/end dates	Resources	Progress
Have a representative attend planning meetings.	City of Portage			

Communication/Organization

Many of the goals outlined in this plan are focused on disseminating information to lake and watershed residents and lake users, ultimately to help them make informed decisions that will result in a healthy ecosystem in Silver Lake that is enjoyed by many people. There is no single best way to distribute information to those that enjoy and/or affect the lake, so the planning committee has identified a variety of options to communicate with one another and in the community. Working together on common values will help to achieve the goals that have been outlined in this plan.

Goal 8: The City of Portage will use all available media to inform, educate, and advocate for Silver Lake.

Objective 8.1: Provide educational opportunities for the public using a variety of communication methods

Action	Lead person/group	Start/end dates	Resources	Progress
Schedule at least one lake event per year (fisheree, swim race, etc.).			UW-Extension Lakes	
Utilize monthly city water billing, the city website and Facebook to disseminate information.			City of Portage	
Publish and distribute topical information.				
Host a section specific to Silver Lake (activities, events, current management protocols, etc.) on the city of Portage's website.			City of Portage	
Explore new methods of communication including Facebook, electronic newsletter, etc.				
Explore using contact lists that are constructed to receive specific information.				

Objective 8.2: Maintain an active Silver Lake restoration and management committee

Action	Lead person/group	Start/end dates	Resources	Progress
Recruit any interested individuals to participate.				
Keep the committee e-mail list current with interested persons about the lake.				
Encourage members to attend the Wisconsin Lakes convention.			UW-Extension Lakes	
Meet at least twice a year.				
Work with other lakes and river citizen organizations that have similar goals.			UW-Extension Lakes	

Work with elected city officials and staff.			City of Portage	
Distribute information through newspaper, radio, cable access, website and social media.				

Goal 9: Keep the Silver Lake management plan updated with current information

Objective 9.1: Update the lake management plan annually

Action	Lead person/group	Start/end dates	Resources	Progress
Ensure that the lake management plan meshes with other local management plans including the City of Portage Comprehensive Plan and the Columbia County Land and Water Resource Management Plan.			City of Portage	
Review the lake management plan annually in the winter months to make any necessary changes, updates.			City of Portage Management committee	

The author would like to acknowledge the commitment and enthusiasm of the Silver Lake Restoration Ad-Hoc Steering Committee, City of Portage, Columbia County Land and Water Conservation Department, Wisconsin Department of Natural Resources, UW-Stevens Point Water and Environmental Analysis Laboratory, landowners in the Silver Lake watershed, and participants in the Silver Lake planning project.

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Appendices

Appendix A Lake User Survey Results

Appendix B 2020 Aquatic Plant Management Plan