2023 STATE OF THE LAKES UPDATE

LAKE SERENE

REPORT DESCRIPTION

This report is an update on the health of Lake Serene based on water quality data collected from 1992 through 2021 by community volunteers and Snohomish County Surface Water Management (SWM) staff. For additional background on the information provided here or to find out more about Lake Serene, please visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Lake Serene is located just west of Highway 99, between Lynnwood and Mukilteo. The surface area of Lake Serene covers 45 acres. The lake is quite shallow, with a maximum depth of 6.7 meters (22 feet). The Lake Serene watershed, which is the land area that drains to the lake, is relatively small, only 5.3 times the size of the lake, but it is densely developed with residential uses. New developments in the watershed and on the shoreline have the potential to adversely affect water quality unless measures are implemented to control nutrient inputs.

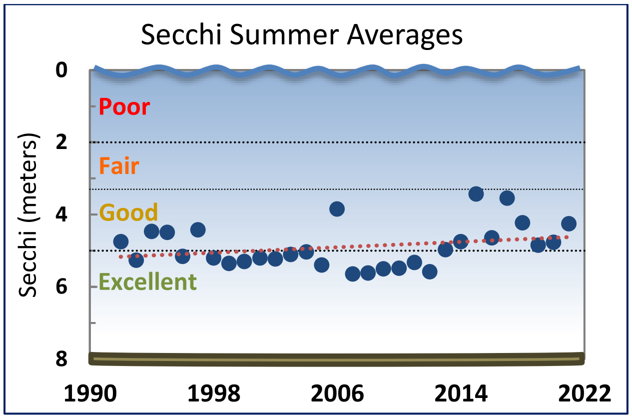
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (shown in red) for water clarity, total phosphorus, chlorophyll *a*, and total persulfate nitrogen for Lake Serene. Please refer to the table at the end of the report for long-term averages and for averages and ranges for individual years.

Water Clarity

The water clarity of a lake, measured with a Secchi disk, is a reading of how far one can see into the water. Water clarity is affected by the amount of algae and sediment in the lake, as well as by water color (see below). Lakes with high water clarity usually have low amounts of algae, while lakes with poor water clarity often have excessive amounts of algae.

Water clarity in Lake Serene is moderately high, with a 1992 - 2021 long-term summer average of 4.9 meters (16.1 feet). Water clarity has shown periods of slight improvement over time. The notable decreases in some years can be associated with slightly elevated levels of chlorophyll a, an indicator of algae. Overall, water clarity was at its best from 2007 - 2012, and between 1992 and 2014, there was a weak, but statistically significant trend towards improved water clarity. However, this improving trend disappeared in 2015. Water clarity improved slightly in 2016 (4.6 meters), and again from 2019 - 2020 (4.8 meters).



Water Color

The color of lake water affects the depths at which algae and plants can grow, and measurements of true water color provide clues to changes in water clarity. In many lakes, the water is naturally brown, orange, or yellow. This true color is a result of dissolved humic compounds entering the lake from surrounding wetlands, rather than algae or sediment suspended in the water, and does not harm water quality.

The water color of Lake Serene averaged 12 pcu (platinum-cobalt color units) in 2010 - 2011, which indicates a slight amount of color in the lake water. This is a small decrease from the 1994 - 1995 average of 15 pcu. This reduction in the color of the water in Lake Serene could be a factor in the trend of increasing water clarity over the same period.

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Water color data will be taken again in the summers of 2021 and 2022. After two years of data collection, the results can be compared to previous measurements and assessed for changes. As water color affects clarity, updated information will help explain potential causes of improving water clarity.

Temperature

The temperature of lake water changes with the seasons and varies with depth. During spring and summer, sunlight warms the upper waters. Because warmer water is less dense, it floats above the cooler, denser water below. The temperature and density differences create distinct layers of water in the lake during warmer months, and these layers do not mix easily. This process is called stratification. The warm, upper water layer is called the epilimnion. The colder, darker bottom zone is called the hypolimnion. These layers will stay separated until the fall when the upper waters cool, the temperature differences decrease, and the entire lake mixes, or turns over.

From May through September 2019 (excluding August), the most recent data available, temperature was measured at each meter throughout the Lake Serene water column (see graph). Temperature profiles show that throughout the sampling season, the lake was not thermally stratified. This means that the lake remained mixed and there was minimal difference in temperature between the upper waters and the bottom waters. Lake Serene tends to stay mixed throughout the year with only short periods of minimal stratification. In May, the lake waters measured about 64˚F (17.8°C) in temperature, and by July had reached their peak at 74°F (23.3°C).

By winter, the lake completely destratified. It will remain a uniform temperature until summer when temperatures in the upper waters increase slightly relative to temperatures in the hypolimnion.

Dissolved Oxygen

Oxygen dissolved in the water is essential for life in a lake. Most dissolved oxygen comes from the atmosphere. Like temperature, dissolved oxygen levels vary over time and with depth. During the warm months, the upper waters receive oxygen from the atmosphere, but the lower waters cannot be replenished with oxygen because of stratification. Meanwhile, bacteria in the lake bottom consume oxygen as they decompose organic matter. Eventually, oxygen is depleted in the bottom waters. Low dissolved oxygen in the bottom waters can lead to a release of nutrients from the lake sediments. The bottom of the lake remains devoid of oxygen until the lake mixes in late fall.

Dissolved oxygen was also measured at every meter throughout the Lake Serene water column from May to September (excluding August) in 2019 (see graph). Oxygen levels remained relatively high in the upper waters throughout the summer, although the levels were slightly lower in the hottest months because warm water cannot hold as much dissolved oxygen as colder water. Meanwhile, the bottom waters contained less dissolved oxygen. In June and July, there were increases in dissolved oxygen at 13 and 9 feet deep, respectively. This indicates algae growth at those depths which added oxygen to the water.

By September, the lake was mostly unstratified again, but dissolved oxygen levels throughout the water column were lower than in winter months. By winter, the lake was fully mixed, and oxygen from the atmosphere replenished the dissolved oxygen levels within the both the surface and the bottom waters.

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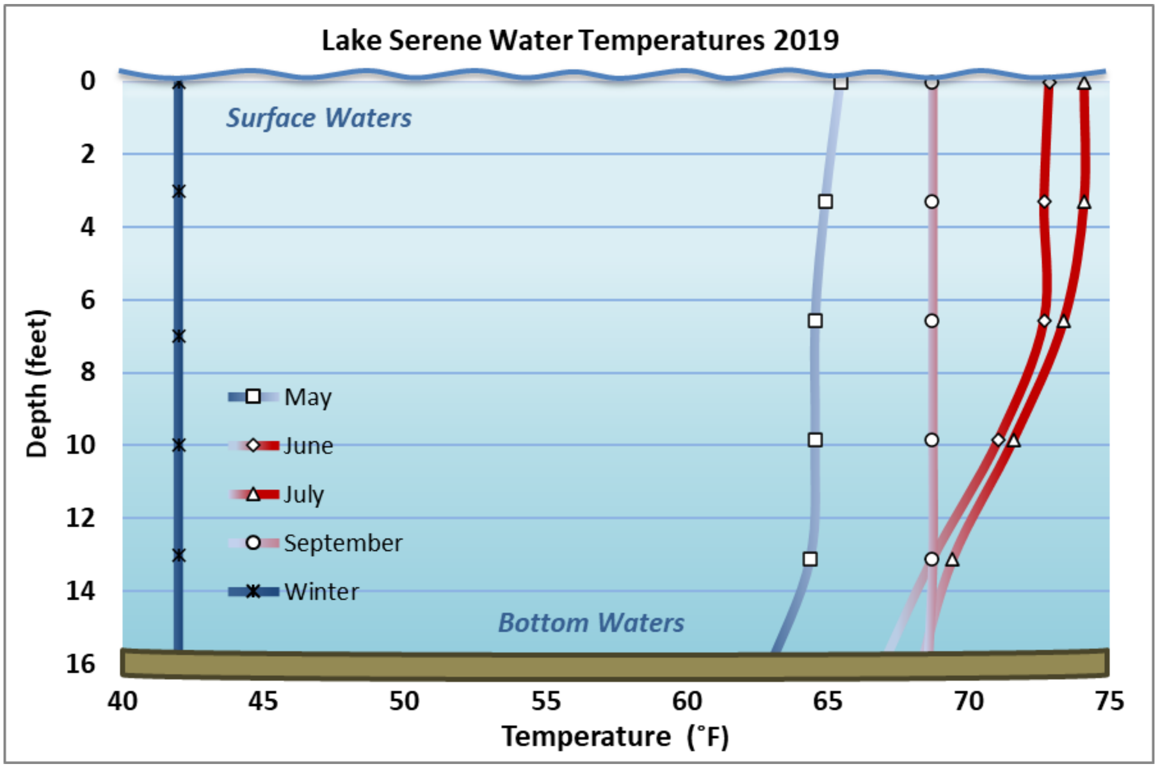
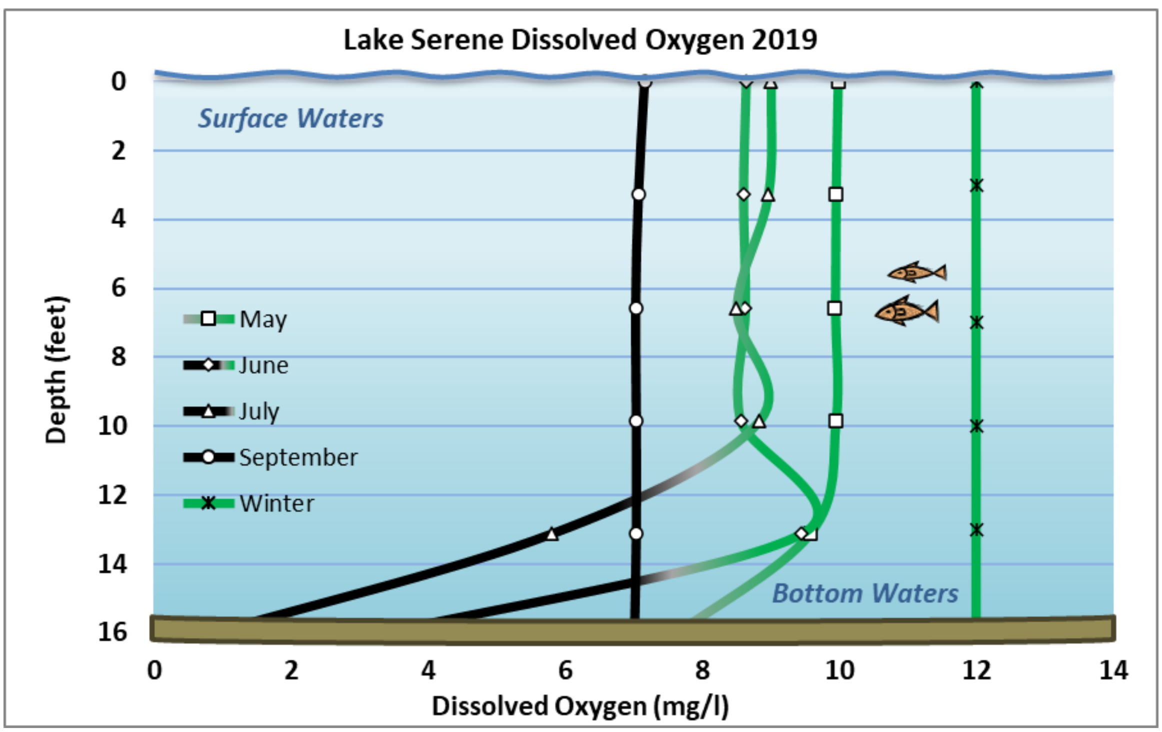

Lake Serene Water Temperatures 2019
Surface Waters
Bottom Waters
May
June
July
September
Winter
Depth (feet)
0
2
4
6
8
10
12
14
16
40
45
50
55
60
65
70
75
Temperature (˚F)


Lake Serene Dissolved Oxygen 2019
Surface Waters
Bottom Waters
May
June
July
September
Winter
Depth (feet)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/l)

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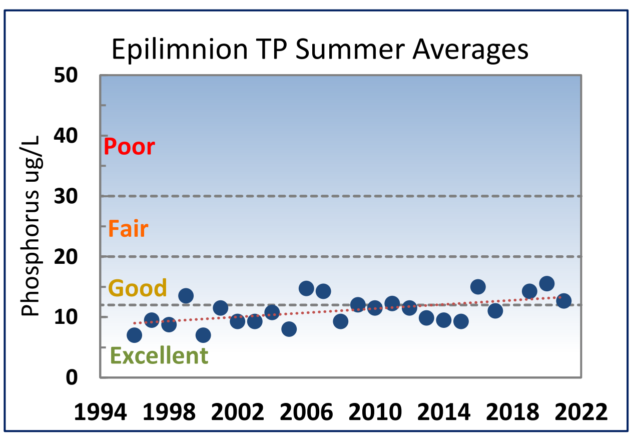
Phosphorus (key nutrient for algae)

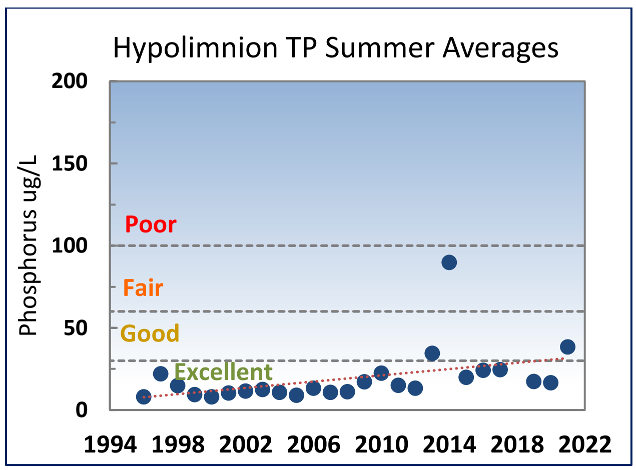
Nutrients are essential for the growth of algae, fish, and aquatic plants in a lake. However, too many nutrients, especially phosphorus, can pollute a lake and lead to unpleasant algae growth. Nutrients enter the lake through stormwater runoff or from streams flowing into the lake. Sources of nutrients include fertilizers, pet and animal wastes, poorly maintained septic systems, and erosion from land clearing and construction. Monitoring phosphorus levels over time helps to identify changes in nutrient pollution.

Total phosphorus (TP) concentrations in Lake Serene are moderately low. The 1996 - 2021 long-term summer average for the epilimnion (upper waters) was only 11 µg/L (micrograms per liter, which is equivalent to parts per billion). The 2020 summer average in the epilimnion was the highest on record for the lake at 16 µg/L. Between 1996 and 2021, there was a statistically significant trend toward increasing phosphorus concentrations in the epilimnion (p=0.01). Increases in phosphorus can lead to more algae growing in the lake.



Phosphorus levels in the hypolimnion (bottom waters) are also relatively low. The 1996 - 2021 long-term summer phosphorus average in the bottom waters was 19 µg/L. However, there was a statistically significant trend toward increasing phosphorus levels in the hypolimnion between 1996 and 2021 (p=0.00). The 2014 and 2021 summer averages, 90 µg/L and 38 µg/L respectively, were the highest on record for the lake.

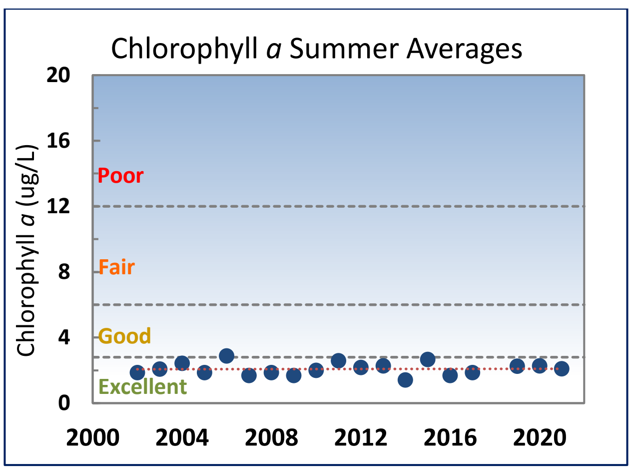
Increasing phosphorus levels in the hypolimnion can result from the release of nutrients from the lake sediments and can be a sign of accelerating eutrophication. However, Lake Serene has a small hypolimnion because the lake is shallow and stratifies into distinct layers only weakly. Also, wind action mixes the lake at times during the summer. Therefore, phosphorus concentrations in the hypolimnion are often similar to those in the epilimnion. For this reason, there is less opportunity for phosphorus that is released from the sediments during periods of low dissolved oxygen to build up in the hypolimnion compared to other lakes. The very high phosphorous averages in 2014 and 2021 may have resulted from prolonged periods without wind storms and lake mixing that otherwise would have spread the phosphorus throughout the entire lake.



Chlorophyll a (Algae)

Algae are tiny plant-like organisms that are essential for lake health. Fish and other aquatic life depend on algae as the basis for their food supply. However, excessive growths of algae, called algae blooms, can cloud the water, form unsightly scums, and sometimes release toxins. Excess nutrients, such as phosphorus and nitrogen, are the main cause of nuisance algae growth in a lake. Chlorophyll *a* (chl) measurements are one method for tracking the amount of algae in a lake.

Chlorophyll *a* values in Lake Serene have been relatively low and consistent from 2002 through 2021. The long-term summer average was 2.1 µg/L, indicating low levels of free-floating algae in the lake. No overall trend in changing chlorophyll *a* levels was evident. Algae levels are low partly because the lake supports dense aquatic plants that compete with algae for nutrients. Also, in some years, there have been widespread clumps or mats of filamentous algae which compete with free-floating algae for nutrients. However, there have been a few reports of occasional nuisance algae blooms during the winter and spring at the lake.

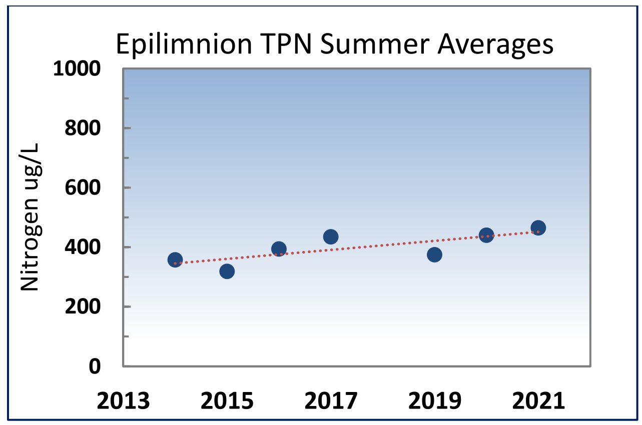


Nitrogen (another essential nutrient for algae)

Nitrogen is another important nutrient for plant and algae growth. Lakes with high levels of nitrogen typically have more aquatic plants and algae. The long-term 2012 - 2021 total persulfate nitrogen (TPN) epilimnion summer average for Lake Serene was 398 µg/L. There was a trend of increasing changing nitrogen concentrations overall ($p=0.02$).

The relative abundance of nitrogen and phosphorus can also be a useful indicator of lake conditions. This is referred to as the nitrogen to phosphorus ratio, or N:P ratio. When lakes have low N:P ratios (typically less than 20), algae growth is often high, and harmful blue-green algae blooms may be a problem. Low N:P ratios may also indicate that fertilizers, septic systems, polluted runoff from developed areas, and release of phosphorus from bottom sediments are contributing most of the nutrients to the lake.

In contrast, when lakes have higher N:P ratios (substantially greater than 20), algae growth will be limited by the amount of phosphorus available, and blue-green algae blooms are usually less of a problem. Lake Serene had an N:P ratio of 33.



Aquatic Plants

Aquatic plants are also important in a lake ecosystem. Plants provide food and shelter for fish and other aquatic animals, stabilize the shoreline and bottom sediments, and in some cases, increase water clarity by out-competing algae for nutrients. Some plants grow entirely submersed under the water (like elodea), some have leaves that float on the surface (like lilies), and others have subsurface roots with most of the plant standing above the water (like cattails).

Although aquatic plants are essential for lake health, excess growth of aquatic plants can interfere with swimming, boating, fishing, and wildlife habitat. In addition, invasion by non-native plant species can seriously damage lake ecosystems. Invasive species can choke out native plants and form dense stands that are a nuisance to humans and wildlife.

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An invasion of non-native Eurasian watermilfoil was discovered in Lake Serene in August 2004. Milfoil is a threat to the health and recreational use and enjoyment of the lake. With help from a grant from the Washington State Department of Ecology, SWM worked with local residents to control the milfoil. An herbicide treatment was performed in 2005, and divers removed scattered plants by hand-pulling. The initial results of these actions were promising. In 2006 and 2007, divers found no living Eurasian watermilfoil plants in the lake. However, in later years, several milfoil hot spots appeared and seemed to be spreading. In some cases, this may have been the result of community members trying to remove the plants by raking them out and unintentionally spreading the plant fragments. Divers were able to successfully hand-pull the remaining plants. Fortunately, no milfoil has been found in the lake since 2012.

Snohomish County has a State permit to allow the use of herbicides as another option for controlling milfoil. Herbicides will not be used in Lake Serene unless the milfoil returns and spreads into large patches. SWM will continue to conduct milfoil surveys in the future. SWM will also be working with the Lake Serene community to address funding for future work.

SHORELINE CONDITION

The condition of the lake shoreline is important for understanding overall lake health. Frequently, lake shorelines are modified through the removal of natural vegetation, installation of bulkheads or other hardening structures, and/or removal of partially submerged logs and branches. These alterations leave the lake ecosystem susceptible to pollution from the watershed, eliminate the buffer of native vegetation that can filter out excess nutrients, and limit the amount of habitat available for fish and wildlife. The loss of native vegetation along the lake shore could also lead to shoreline erosion.

Lake Serene has one of the most densely developed shorelines in Snohomish County. There were 94 lakefront homes in the mid-1990s, with a few more added in recent years. There are also 80 docks present on the lake, covering about a half of an acre. Development around the lake has resulted in significant shoreline modifications. 72% percent of the 1.4-mile shoreline has some form of shoreline armoring. The primary types of armoring are bulkheads (39%), wood revetments (27%) and fill (6%). The zone of vegetation immediately adjacent to the shoreline has also been greatly altered. Only 6% of the shoreline now supports intact native vegetation. Furthermore, the amount of large wood remaining in the lake is also low (about 9 pieces). These old logs and branches are valuable habitat for aquatic life.

Shoreline condition data will be taken in the summers of 2021 and 2022 and will be compared to previous survey data.

LAKE LEVELS AND FLOODING

Lake level data tracks the amount of water in the lake. Changes in lake level can affect boating, fishing, and other recreational activities.

Lake levels naturally fluctuate. In our region, they are highest in early spring and lowest in late summer and fall. Lake levels are influenced by water coming in from streams, precipitation, and groundwater and water leaving by evaporation or outflow. In addition, lake levels can be affected by sediment flowing into the lake, the surrounding topography, beaver activity, plugged outlets, and the ratio of developed to undeveloped land in the watershed. Paved or impervious surfaces will create faster runoff and quickly raise lake levels during large rain events, while forests, wetlands, and pastures will slow down runoff and limit large rises in lake level.

Lake Serene has a history of high water levels during periods of heavy, sustained rainfall. When water levels get very high, many yards and docks are affected, and several the lowest properties experience water in basements or crawl spaces.

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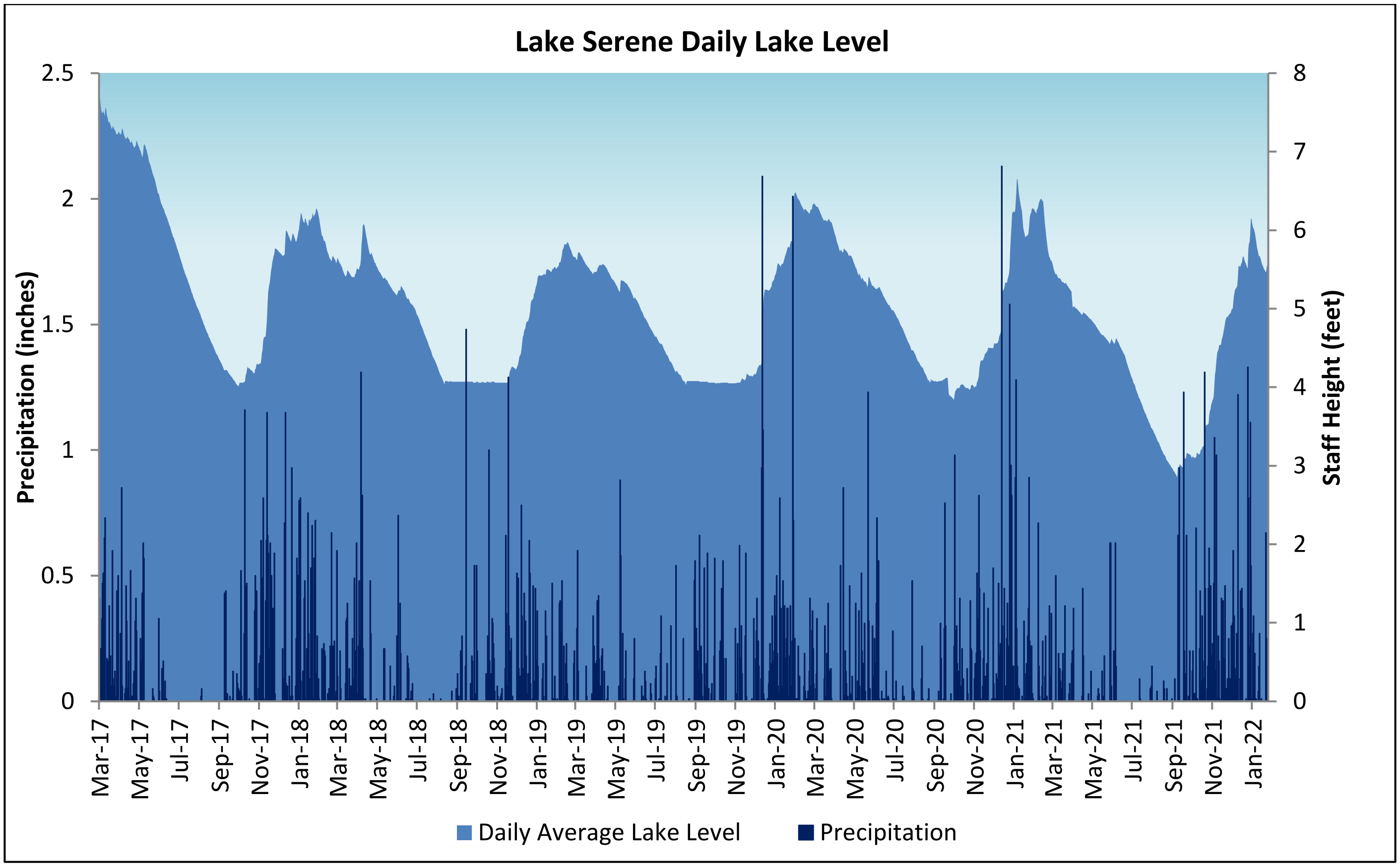
Drainage investigations found the current private outlet system in a state of disrepair. In February 2017, Snohomish County Executive Dave Somers authorized an emergency action to begin building a temporary drain at Lake Serene. The temporary drain was completed on March 14, 2017 and was designed to prevent water from rising to a level that would flood County roads. The County and residents worked together to find a long-term solution. With a cost share program, the County will construct and maintain an outfall system in the public right of way and improve portions of the downstream drainage system along Beverly Park Road.

SWM installed a continuous gage at Lake Serene in early 2013 to monitor lake levels year-round. Lake data is recorded hourly as elevation in feet. The graph below shows the daily average lake level and daily total rainfall for Lake Serene from March 2017 through early 2022. The precipitation data used for the graph was recorded at the Fire Station west of the lake. Lake levels fluctuate 1 - 6 feet in the winter months. Heavy rains in the fall and winter resulted in a rise of nearly 7 feet in lake level in early 2020 and 2021.

Learn more about lake level monitoring here: https://snohomishcountywa.gov/5821/Lake-Levels.



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SUMMARY

Lake Health Classifications

Snohomish County lakes vary greatly in their natural condition. The size and depth of a lake are major factors in determining the lake's characteristics. Lakes also vary based on their state of eutrophication. Eutrophication is a process of lake enrichment in which, over time, nutrient inputs cause an ever-increasing growth of algae and aquatic plants. As plants decay, organic matter, or sediment, builds up on the lake bottom. In some cases, lakes gradually fill up and become wetlands. Eutrophication is a slow, natural process that takes hundreds of years, but it can be accelerated by human activities that add nutrients to the system.

Snohomish County used the natural variation in lake characteristics to develop four lake health classifications as follows:

- **Excellent** – often deep, with clear water, low nutrient concentrations, few aquatic plants, and low levels of algae.
- **Good** – can be deep or shallow with moderate levels of nutrients, algae, and aquatic plants.
- **Fair** – often shallow with high nutrient concentrations, abundant plants, high levels of algae, occasional toxic blooms, and limited water clarity.
- **Poor** – very high nutrient concentrations, abundant plant growth, very high levels of algae (often with toxic blooms), very limited water clarity, and very low dissolved oxygen in the bottom waters.

Lakes classified as "excellent", "good" and "fair" are all potentially natural states of area lakes. However, lakes should remain in the same category over decades. A shift in a lake health rating is a sign of deteriorating water quality or shoreline conditions that require action. Similarly, lakes classified as "poor" have had excessive nutrient pollution or severe shoreline degradation, leading to unhealthy conditions. These lakes will likely require restoration.

Health Summary

Overall, Lake Serene is in excellent condition, especially given the high level of development in the watershed and around the lake shoreline. The lake has moderate to high water clarity, low to moderate phosphorous levels in both the upper and bottom waters, moderate nitrogen concentrations, and low levels of chlorophyll *a*. However, phosphorus concentrations in the lake should be watched closely for continued surges, as a statistically significant increasing trend has been observed in both the epilimnion and hypolimnion between 1996 and 2021, which could lead to future algae problems. Any increases in phosphorus are a concern and may be a sign of nutrient enrichment in the lake. Further, nitrogen concentrations also appear to be increasing in the lake overall. More nitrogen relative to phosphorous could indicate and exacerbate water quality declines.

Residents around the lake can help Lake Serene. Some of the most important actions to reduce harmful phosphorus pollution include picking up pet waste, practicing natural lawn care, preventing soil erosion, infiltrating roof and driveway runoff, and maintaining a leak-free septic system. Shoreline landowners can also create a Healthy Shoreline by replacing some shoreline lawns with trees and shrubs. Snohomish County's LakeWise program is here to help by providing free educational site visits and resources to help you complete these actions. Visit www.lakewise.org to learn more.

To find out more about ways to protect lake water quality and obtain information on the causes and problems of elevated lake nutrient levels, visit www.lakes.surfacewater.info.

DATA SUMMARY FOR LAKE SERENE						
		Water Clarity (Secchi depth	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
Bortleson, et al, 1976	**7/25/73**	2.1	20	35	-	-
Sumioka and Dion, 1985	**7/1/81**	4.6	10	10	-	0.9
Volunteer	**1992**	3.8 - 5.7 (4.7) *n = 7*	-	-	-	-
Cooke, 1994 or Volunteer	**1993**	4.9 - 5.5 (5.3) *n = 10*	-	-	-	-
SWM Staff or Volunteer	**1994**	3.5 - 5.2 (4.5) *n = 6*	-	-	-	1.2 - 3.0 (2.1) *n = 2*
SWM Staff or Volunteer	**1995**	3.7 - 5.3 (4.5) *n = 6*	-	-	-	5.6
SWM Staff or Volunteer	**1996**	4.4 - 5.8 (5.2) *n = 5*	6 - 8 (7) *n = 2*	6 - 10 (8) *n = 2*	-	-
SWM Staff or Volunteer	**1997**	3.6 - 5.2 (4.4) *n = 8*	9 - 10 (10) *n = 2*	22	-	-
Volunteer	**1998**	4.6 - 5.6 (5.2) *n = 4*	6 - 10 (9) *n = 4*	9 - 23 (15) *n = 4*	-	-
SWM Staff or Volunteer	**1999**	4.9 - 6.3 (5.4) *n = 7*	6 - 28 (14) *n = 4*	6 - 11 (9) *n = 3*	-	-
SWM Staff or Volunteer	**2000**	4.7 - 6.0 (5.3) *n = 7*	4 - 9 (7) *n = 4*	4 - 11 (8) *n = 4*	-	-
SWM Staff or Volunteer	**2001**	3.5 - 5.8 (5.2) *n = 7*	8 - 16 (12) *n = 4*	9 - 13 (10) *n = 4*	-	-
Volunteer	**2002**	3.6 - 6.2 (5.2) *n = 8*	7 - 11 (9) *n = 4*	8 - 14 (12) *n = 4*	-	0.5 - 2.9 (1.9) *n = 4*
Volunteer	**2003**	4.4 - 5.8 (5.1) *n = 6*	8 - 10 (9) *n = 4*	8 - 22 (13) *n = 4*	-	1.1 - 3.2 (2.1) *n = 4*
Volunteer	**2004**	4.5 - 5.3 (5.0) *n = 6*	8 - 12 (11) *n = 4*	8 - 14 (11) *n = 4*	-	1.1 - 3.5 (2.4) *n = 4*
Volunteer	**2005**	84.7 - 5.9 (5.4) *n = 9*	6 - 10 (8) *n = 4*	8 - 11 (9) *n = 3*	-	1.3 - 2.4 (1.9) *n = 3*

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DATA SUMMARY FOR LAKE SERENE						
		Water Clarity (Secchi depth	Total Phosphorus (µg/L)		Total Nitrogen (µg/L)	Chlorophyll *a* (µg/L)
Source	Date	in meters)	Surface	Bottom	Surface	Surface
Volunteer	**2006**	3.5 - 4.6 (3.9) *n = 5*	10 - 21 (15) *n = 4*	12 - 16 (13) *n = 4*	-	1.6 - 4.3 (2.9) *n = 4*
Volunteer	**2007**	5.3 - 6.0 (5.7) *n = 5*	8 - 28 (14) *n = 4*	9 - 13 (11) *n = 4*	-	1.1 - 2.7 (1.7) *n = 4*
Volunteer	**2008**	5.2 - 6.3 (5.6) *n = 5*	6 - 13 (9) *n = 4*	7 - 16 (11) *n = 4*	-	1.6 - 2.1 (1.9) *n = 4*
Volunteer	**2009**	5.1 - 6.2 (5.5) *n = 6*	8 - 16 (12) *n = 3*	10 - 21 (17) *n = 4*	-	1.3 - 2.1 (1.7) *n = 4*
Volunteer	**2010**	5.2 - 6.2 (5.5) *n = 5*	10 - 13 (12) *n = 4*	12 - 46 (22) *n = 4*	-	1.6 - 2.7 (2.0) *n = 4*
Volunteer	**2011**	4.6 - 5.8 (5.3) *n = 4*	8 - 17 (12) *n = 4*	8 - 26 (15) *n = 3*	-	1.3 - 4.0 (2.6) *n = 4*
Volunteer	**2012**	5.3 - 5.8 (5.6) *n = 4*	8 - 14 (12) *n = 4*	12 - 17 (13) *n = 4*	-	1.1 - 4.3 (2.2) *n = 4*
Volunteer	**2013**	4.8 - 5.3 (5.0) *n = 6*	9 - 12 (10) *n = 4*	12 - 64 (34) *n = 4*	-	0.5 - 3.2 (2.3) *n = 4*
Volunteer	**2014**	4.4 - 5.1 (4.7) *n = 5*	7 - 12 (10) *n = 4*	18 - 179 (90) *n = 3*	335 - 375 (357) *n = 4*	0.50 - 2.7 (1.4) *n = 4*
Volunteer	**2015**	2.5 - 4.8 (3.4) *n = 6*	6 - 12 (9) *n = 4*	14 - 29 (20) *n = 4*	277 - 395 (319) *n = 4*	1.5 - 4.3 (2.7) *n = 4*
Volunteer	**2016**	3.9 - 5.1 (4.6) *n = 5*	9 - 19 (15) *n = 4*	8 - 53 (24) *n = 4*	319 - 436 (393) *n = 4*	1.1 - 2.4 (1.7) *n = 4*
Volunteer	**2017**	3.1 - 4.0 (3.6) *n = 4*	11 - 17 (11) *n = 2*	22 - 27 (25) *n = 2*	408 - 462 (435) *n = 2*	1.3 - 2.4 (1.9) *n = 2*
Volunteer	**2018**	2.6 - 5.0 (4.2) *n = 5*	-	-	-	-
Volunteer	**2019**	4.1 - 5.4 (4.8) *n = 5*	6 - 22 (14) *n = 4*	12 - 24 (17) *n = 4*	270 - 428 (375) *n = 4*	1.3 - 3.7 (2.3) *n = 4*
Volunteer	**2020**	3.1 - 5.9 (4.8) *n = 7*	9 - 22 (16) *n = 4*	15 - 18 (17) *n = 2*	236 - 682 (440) *n = 4*	1.3 - 3.5 (2.3) *n = 4*

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DATA SUMMARY FOR LAKE SERENE						
		Water Clarity (Secchi depth	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
Volunteer	**2021**	3.2 - 5.4 (4.3) *n = 6*	10 - 15 (13) *n = 3*	9 - 102 (38) *n = 4*	374 - 645 (465) *n = 3*	1.4 - 3.0 (2.1) *n = 4*
Long Term Avg		**4.9** **(1992-2021)**	**11** **(1996-2021)**	**19** **(1996-2021)**	**398** **(2014-2021)**	**2.1** **(2002-2021)**
TRENDS		**None**	**Increasing**	**Increasing**	**Increasing**	**None**

NOTES

- Table includes summer data only, Secchi (May-Oct) and TP, TPN and chl (Jun-Sep).
- Each box shows the range on top, followed by summer average in ( ) and number of samples (n).
- Total phosphorus data are from samples taken at discrete depths only.
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.
- TP, TPN, chl data rejected in 2018.