LAKE HOWARD

REPORT DESCRIPTION

This report is an update on the health of Lake Howard based on water quality data collected from 1993 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 Howard, visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Lake Howard is a 28 acre lake located in the Seven Lakes area north of the Tulalip Reservation. The lake is relatively deep, with a maximum depth of 15.2 meters (49.9 feet) and an average depth of 8.8 meters (28.9 feet). The lake is situated in a protected bowl surrounded by hills. Much of the watershed, which is the land area that drains to the lake, is undeveloped. However, there are numerous homes around much of the lake shore, and more growth is planned in the area which may impact the lake.

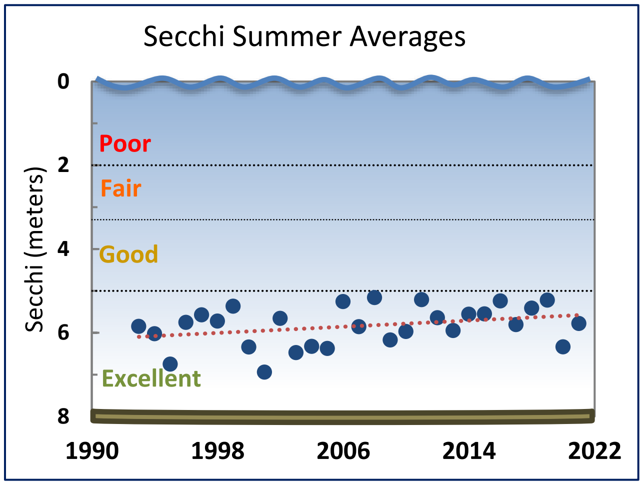
LAKE CONDITIONS

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 Howard. 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 is generally high at Lake Howard, with a 1993 - 2021 long-term summer average of 5.8 meters (19 feet). Water clarity averages vary considerably from year to year, from a high of 6.9 meters in 2001 to a low of 5.2 meters in 2008, 2011, 2016 and 2019. The water clarity may vary because higher nutrient levels in some years lead to more algae growth. Overall, between 1993 and 2021, there was a statistically significant trend in declining water clarity (p=0.06).



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 Howard averaged 13 pcu (platinum-cobalt color units) in 2010 - 2011, which indicates a slight amount of color in the lake water and is similar to the 1994 - 1995 average of 10 pcu. This slight amount of color in the lake water should not have much of an effect on water clarity or algae growth within the lake.

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.

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 June through September 2020, the most recent available data, temperature was measured at each meter throughout the Lake Howard water column. Temperature profiles for 2020 (see graph) show that throughout the summer season, the lake was strongly thermally stratified. This means that there was a large temperature difference between the warm upper waters and the cool bottom waters, and mixing did not occur between these layers. In June the upper waters measured about 66°F (18.9°C) in temperature, and by August had reached their peak at 75°F (23.8°C). At the same time, bottom water temperatures remained between 43-44°F (6.1-6.7 °C).

The upper waters cooled through the fall. As stratification weakened, the lake water turned over, or mixed. The lake will stay mixed during the winter until springtime, when the upper waters begin to warm again.

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 has also been measured some years at every meter throughout the Lake Howard water column, most recently in 2020 (see graph). Oxygen levels were relatively high in the upper waters from June through September. From May through August, there was an increase in dissolved oxygen levels between about 12 and 23 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water. Otherwise, between May and September, there was little or no oxygen in the water at 20 feet and below.

The bottom of the lake contained little to no oxygen until fall turn over. By winter, the lake was fully mixed, and oxygen from the atmosphere replenished the dissolved oxygen levels within the bottom waters.

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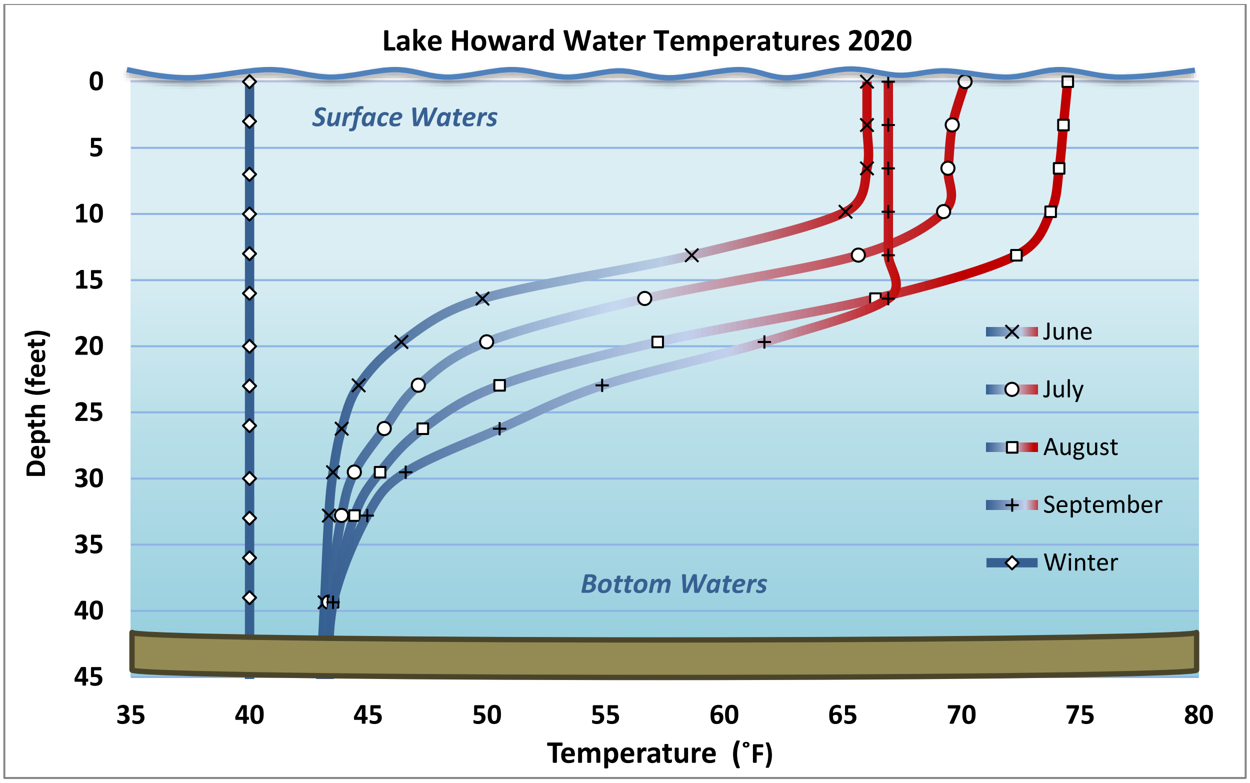
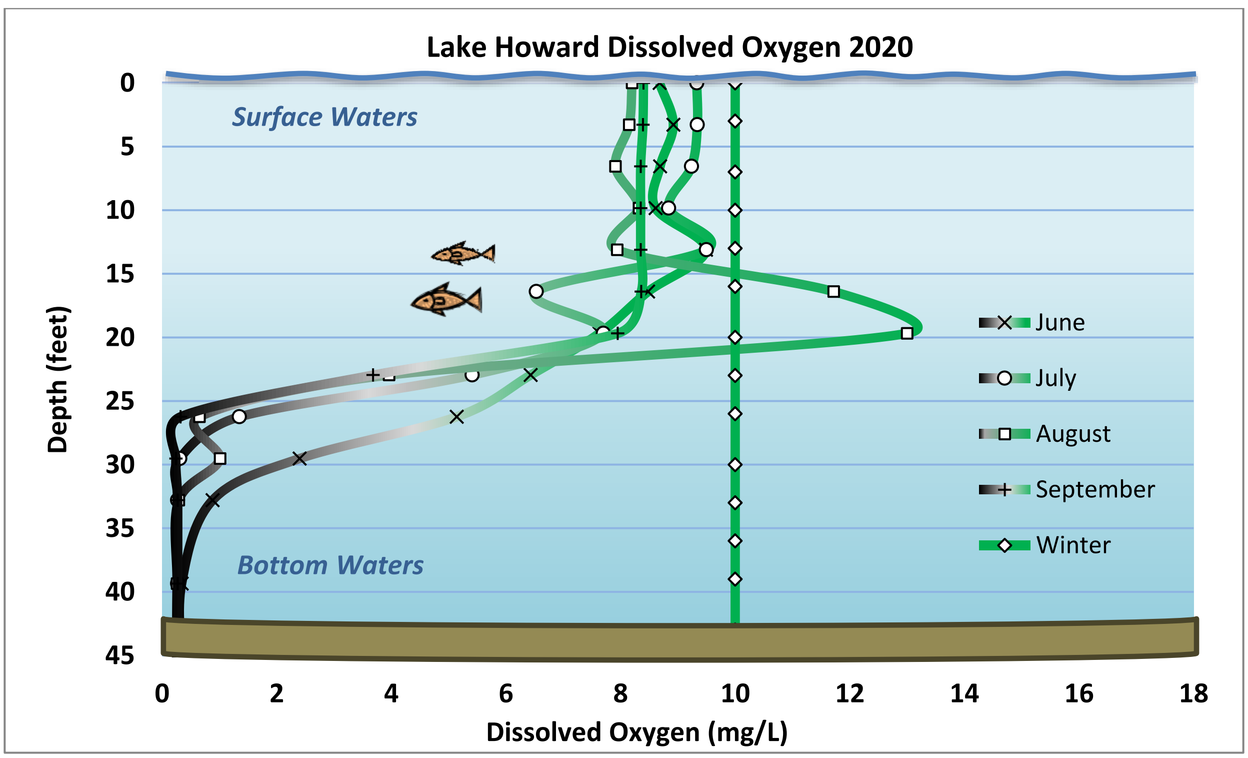

Lake Howard Water Temperatures 2020
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
25
30
35
40
45
35
40
45
50
55
60
65
70
75
80
Temperature (˚F)
June
July
August
September
Winter


Lake Howard Dissolved Oxygen 2020
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
25
30
35
40
45
0
2
4
6
8
10
12
14
16
18
Dissolved Oxygen (mg/L)
June
July
August
September
Winter

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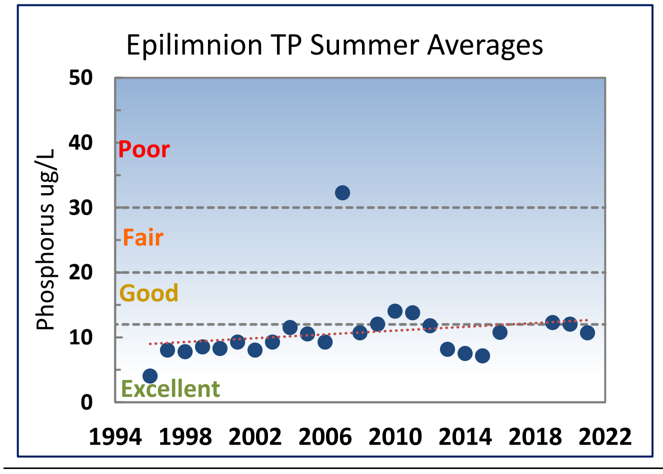
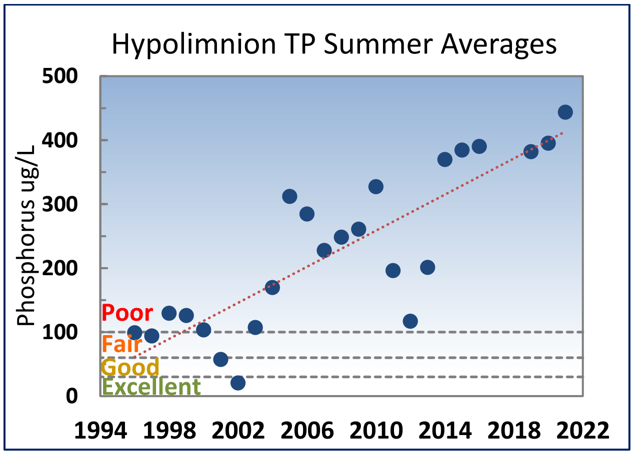
Phosphorus (key nutrient for algae)

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 the epilimnion (upper waters) are low, with a 1996 - 2021 long-term summer average of 11 µg/L (micrograms per liter which is equivalent to parts per billion). However, between 1996 and 2021, there was a gradual, and statistically significant, trend toward higher phosphorus concentrations in the upper waters of Lake Howard (p=0.02). Summer averages in 2010 and 2011 reached the mesotrophic range (the lower threshold value of mesotrophic is 14 µg/L). Fortunately, the summer averages declined in 2012 and have remained relatively low. The gradual increase in phosphorus levels over time, combined with the extremely high summer average in 2007 (32 µg/L), indicate that more phosphorus pollution is coming from the watershed and from the release of phosphorus from lake bottom sediments. Higher phosphorus levels will likely result in more nuisance algae in the lake.



The summertime phosphorus averages in the hypolimnion (bottom waters) are much higher than the upper waters and are quite variable. The long term summer average (1996 - 2021) was 227 µg/L. Although there were very low phosphorus values in 2001 and 2002, the averages steadily increased until 2010 and hit record highs in subsequent years. Overall, between 1996 and 2021, there was a strong statistically significant increasing trend in phosphorus concentrations in the bottom waters (p=0.00). This build-up of phosphorus in the bottom of the lake, coupled with the rising phosphorus levels in the upper waters, is a strong indicator of accelerating eutrophication and a warning for future water quality declines.



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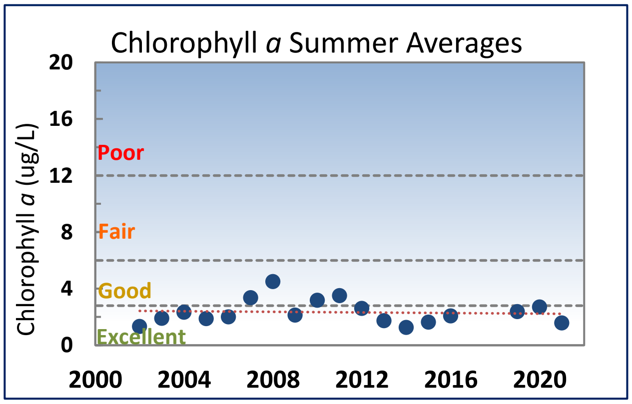
Chlorophyll a (Algae)

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* levels were low to moderate in the summers of 2002 - 2021, with a long-term average of 2.3 µg/L. From 2002 to 2016, there was a statistically significant increasing trend in chlorophyll *a* levels in Lake Howard ($p=0.07$); however, this trend has since disappeared. There are also often high dissolved oxygen and pH levels several meters below the surface of the lake, which indicate vigorous algae growth at that depth. The chlorophyll *a* samples, which are taken at 1 meter deep, may be missing this zone of algae growth, so in actuality, the algae levels may be even higher than shown by the chlorophyll *a* measurements. The lake does experience algae blooms from time to time, particularly in the spring and early summer.



Toxic Blue-Green Algae (Cyanobacteria)

Blue-green algae, also called cyanobacteria, are a group of algae capable of producing toxins during periods of high growth, known as blooms. The toxins can cause serious illness in people and pets that encounter affected water. Blooms often look like blue or green paint floating on the water's surface. Lake users should avoid contact with the water and keep pets away from the lake when it is experiencing a blue-green algae bloom. If a bloom has been identified as toxic, the lake will have postings at public access sites.

In 2010, Lake Howard experienced periods of intense blue-green algae growth known as blooms. In response, water samples were taken regularly to test for two types of algae toxins: microcystin (a liver toxin) and anatoxin-*a* (a neurotoxin) from 2011 through 2013. Most samples showed low levels of microcystin. However, samples taken in the late summer to early fall of 2011 through 2013 had higher levels, well above the Washington State Department of Health's recreational guideline of 8 µg/L for microcystin (see table below). There were no reported algae blooms in 2014, and in 2015 and 2016, microcystin and anatoxin-*a* were detected at concentrations below the State recreational standard. Blooms reported in 2017 had microcystin levels ranging from 0.9 to over 56 µg/L, as well as minor levels of anatoxin-*a*. Blooms were reported again in 2020 and 2021, but concentrations of both toxins were found to be below the recreational guideline. Surface Water Management has also tested blooms in Lake Howard for clindospermopsin and saxitoxin some years but has never detected concentrations of these toxins above State standards.

Surface Water Management will continue to respond to toxic algae reports at Lake Howard and warn community members when a bloom occurs by posting signs at public access sites.

More information about toxic algae can be found at https://snohomishcountywa.gov/1959/Toxic-Algae. You can also see current advisories and sign up for toxic algae alerts at https://snohomishcountywa.gov/5372/Howard.

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Lake Howard Toxic Algae Testing Results

Year	Weeks Posted	Microcystin Range (µg/L)	Anatoxin Range (µg/L)	Cylindrospermopsin Range (µg/L)	Saxitoxin Range (µg/L)
2011	13	0.56-56.3	<MDL	-	-
2012	10	0.26-2700	0.02	-	-
2013	-	1.88-20.6	<MDL	-	-
2014	-	-	-	-	-
2015	8	0.2-0.31	0.02-0.02	<MDL	0.03
2016	50	0.9-1.58	0.112-0.922	-	<MDL
2017	15	0.23-56.1	0.015-0.027	-	-
2018	14	-	-	-	-
2019	3	-	-	-	-
2020	31	0.21	0.145	<MDL	<MDL
2021	17	0.031	0.22		

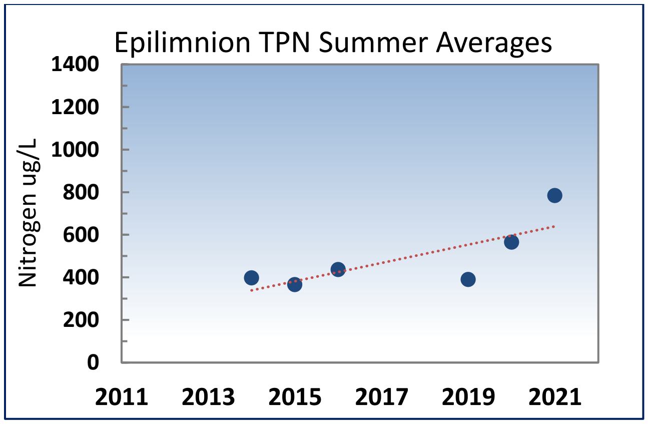
Washington State Department of Health recreational guidelines are 8 µg/L for Microcystin, 1 µg/L for Anatoxin, 15 µg/L for Cylindrospermopsin, 75 µg/L for Saxitoxin. Blooms are not sampled for toxins in the winter months.

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 Howard was 490 µg/L. There was a slight increasing trend in nitrogen concentrations overall ($p=0.09$).

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 Howard had a high N:P ratio of 49.



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 Howard has a moderately developed shoreline. Surveys conducted in the mid-90s showed 32 homes bordering the lake. There are also 35 docks present on the lake covering a quarter of an acre of the lake's surface. Armoring of the shoreline was found along 28% of the 0.9 mile lakefront. Most of the armoring takes the form of rock or log revetments (20% of the shoreline) in addition to a small number of bulkheads. The natural vegetation immediately adjacent to the shoreline has been significantly altered, with only 41% of the shoreline still supporting native grasses, shrubs, or trees. There is still a moderate amount of large wood (about 51 pieces) remaining in the lake. These old logs and branches are valuable habitat for aquatic life.

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

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 Howard is still in good condition but appears to be at risk for future water quality declines. With a long-term water clarity average of 5.8 meters, Lake Howard is very close to meeting the water clarity target of maintaining stable water clarity of 6.0 meters. However, there is a statistically significant trend of declining water quality from 1993 - 2021.

The lake is not meeting the target of reducing phosphorus levels. In fact, there is a statistically significant increasing trend in phosphorous concentrations in both the upper and bottom waters. In addition, there is a slight increasing trend in nitrogen concentrations, and chlorophyll *a* levels appeared to be rising significantly until recently.

Increasing phosphorus in the upper and lower waters, combined with periodic algae blooms that are sometimes toxic, are warning signs that accelerated eutrophication is occurring in the lake. Shoreline modification is a probable factor in declining water quality, as the primary threat to Lake Howard is the inflow of nutrients into the lake from human activities and new development in the watershed.

In addition, it is very likely that the release of phosphorus from the lake bottom sediments during the period of low dissolved oxygen in the late summer is contributing more and more phosphorus to the lake. This internal phosphorus release can only be addressed with a chemical treatment of the sediments or other restoration alternatives. Measures to control nutrients in the watershed should be taken now to prevent future negative impacts to the lake.

Residents around the lake can help Lake Howard. 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 HOWARD						
		Water Clarity (Secchi depth	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
McConnell, et al, 1976	Summer **1973**	2.3 - 2.7 (2.5) *n = 3*	14 - 60 (32) *n = 3*	110 - 190 (150) *n = 3*	-	1.8 - 2.0 (1.9) *n = 3*
Sumioka and Dion, 1985	**6/30/1981**	6.4	20	310	-	2.3
Entranco, 1986	**1983**	3.8 - 5.0 (4.5) *n = 5*	<5 - 17 (10) *n = 5*	70 - 359 (157) *n = 5*	-	1.0 - 9.9 (3.9) *n = 5*
DOE	**1993**	5.0 - 7.3 (5.8) *n = 12*	-	-	-	-
SWM Staff or DOE	**1994**	5.3 - 6.9 (6.0) *n = 7*	-	-	-	0.1 - 3.2 (1.7) *n = 4*
SWM Staff	**1995**	6.8	-	-	-	2.4
SWM Staff or Volunteer	**1996**	4.6 - 6.8 (5.8) *n = 6*	3 - 5 (4) *n = 2*	76 - 122 (99) *n = 2*	-	-
SWM Staff or Volunteer	**1997**	5.1 - 6.1 (5.6) *n = 2*	5 - 11 (8) *n = 2*	82 - 106 (94) *n = 2*	-	-
SWM Staff or Volunteer	**1998**	4.0 - 6.9 (5.7) *n = 10*	6 - 10 (8) *n = 4*	89 - 150 (129) *n = 4*	-	-
SWM Staff or Volunteer	**1999**	3.7 - 7.4 (5.4) *n = 12*	7 - 10 (9) *n = 4*	74 - 150 (126) *n = 4*	-	-
SWM Staff or Volunteer	**2000**	5.1 - 7.3 (6.3) *n = 7*	3 - 11 (8) *n = 4*	58 - 175 (104) *n = 4*	-	-
Volunteer	**2001**	6.0 - 7.9 (6.9) *n = 5*	7 - 13 (9) *n = 4*	27 - 88 (57) *n = 4*	-	-
Volunteer	**2002**	3.7 - 7.3 (5.7) *n = 8*	7 - 9 (8) *n = 4*	9 - 30 (21) *n = 4*	-	0.8 - 2.1 (1.3) *n = 4*
SWM Staff	**2003**	5.7 - 7.1 (6.5) *n = 4*	8 - 11 (9) *n = 4*	46 - 188 (107) *n = 4*	-	0.8 - 2.7 (1.9) *n = 4*
SWM Staff	**2004**	5.4 - 7.5 (6.3) *n = 4*	9 - 15 (12) *n = 4*	61 - 270 (170) *n = 4*	-	1.1 - 3.7 (2.3) *n = 4*

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DATA SUMMARY FOR LAKE HOWARD						
		Water Clarity (Secchi depth	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
SWM Staff	**2005**	5.5 - 7.6 (6.4) *n = 4*	8 - 13 (11) *n = 4*	256 - 350 (312) *n = 4*	-	1.6 - 2.0 (1.9) *n = 4*
Volunteer	**2006**	4.3 - 6.9 (5.3) *n = 7*	6 - 13 (9) *n = 4*	222 - 360 (285) *n = 4*	-	1.6 - 2.9 (2.0) *n = 4*
Volunteer	**2007**	5.1 - 6.7 (5.9) *n = 6*	11 - 55 (32) *n = 4*	160 - 314 (228) *n = 4*	-	2.1 - 5.3 (3.4) *n = 4*
Volunteer	**2008**	3.9 - 6.1 (5.2) *n = 10*	9 - 12 (11) *n = 3*	174 - 372 (248) *n = 3*	-	1.6 - 10 (4.5) *n = 3*
Volunteer	**2009**	4.5 - 7.3 (6.2) *n = 11*	11 - 14 (12) *n = 4*	146 - 462 (261) *n = 4*	-	1.9 - 2.4 (2.1) *n = 4*
Volunteer	**2010**	4.0 - 7.2 (6.0) *n = 11*	10 - 19 (14) *n = 4*	188 - 524 (327) *n = 4*	-	1.6 - 6.9 (3.2) *n = 4*
Volunteer	**2011**	4.0 - 6.3 (5.2) *n = 12*	11 - 15 (14) *n = 4*	93 - 358 (196) *n = 4*	-	2.7 - 4.1 (3.5) *n = 4*
Volunteer	**2012**	4.8 - 6.9 (5.6) *n = 11*	9 - 13 (12) *n = 4*	46 - 154 (117) *n = 4*	-	1.8 - 4.3 (2.6) *n = 4*
Volunteer	**2013**	4.4 - 7.2 (6.0) *n = 11*	6 - 11 (8) *n = 4*	61 - 289 (201) *n = 4*	-	0.5 - 3.0 (1.7) *n = 4*
Volunteer	**2014**	3.8 - 7.2 (5.6) *n = 12*	6 - 10 (8) *n = 4*	246 - 492 (370) *n = 4*	317 - 486 (397) *n = 4*	0.5 - 2.7 (1.3) *n = 4*
Volunteer	**2015**	4.0 - 7.1 (5.2) *n = 10*	6 - 9 (7) *n = 4*	183 - 489 (385) *n = 4*	310 - 436 (366) *n = 4*	1.5 - 1.8 (1.6) *n = 4*
Volunteer	**2016**	3.2 - 7.1 (5.2) *n = 10*	9 - 13 (11) *n = 4*	355 - 428 (390) *n = 4*	294 - 589 (436) *n = 4*	0.95 - 3.5 (2.1) *n = 4*
Volunteer	**2017**	4.3 - 6.9 (6) *n = 10*	-	-	-	-
Volunteer	**2018**	4.1 - 6.8 (5.4) *n = 8*	-	-	-	-
Volunteer	**2019**	4.7 - 5.8 (5.2) *n = 9*	9 - 14 (12) *n = 4*	249 - 494 (382) *n = 4*	272 - 464 (390) *n = 4*	1.1 - 3.7 (2.4) *n = 4*

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DATA SUMMARY FOR LAKE HOWARD						
		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	**2020**	5.7 - 7.6 (6.3) *n = 4*	10 - 14 (12) *n = 4*	226 - 594 (395) *n = 4*	364 - 735 (565) *n = 4*	1.8 - 3.7 (2.7) *n = 4*
Volunteer	**2021**	4.8 - 6.4 (5.8) *n = 10*	7 - 16 (11) *n = 3*	319 - 526 (444) *n = 4*	345 - 1,750 (783) *n = 4*	1.1 - 2.1 (1.6) *n = 4*
Long Term Avg		**5.8** **(1993-2021)**	**11** **(1996-2021)**	**227** **(1996-2021)**	**490** **(2014-2021)**	**2.3** **(2002-2021)**
TRENDS		**Decreasing**	**Increasing**	**Increasing**	**Increasing**	**None**

NOTES

- DOE = Washington Department of Ecology.
- 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.
- No water sampling in 2017.
- TP, TPN, chl data rejected in 2018.