PANTHER LAKE

REPORT DESCRIPTION

This report is an update on the health of Panther Lake based on water quality data collected from 1990 through 2016 by local volunteers and Snohomish County Surface Water Management (SWM) staff. For additional background on the information provided here or to find out more about Panther Lake, visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Panther Lake is a 49-acre lake located four miles northeast of Snohomish. It is the third lake in a three-lake chain. Storm Lake flows into Flowing Lake, which drains through a small stream into Panther Lake. The lake outlet becomes Panther Creek, which flows into the Pilchuck River.

Panther Lake has a maximum depth of 11 meters (36 feet) and an average depth of 7 meters (23 feet). The Panther Lake watershed, which is the land area that drains to the lake, includes the drainage from Flowing Lake and Storm Lake. This total watershed area is over 30 times the size of the lake, and the portion of the watershed that drains directly to Panther Lake is 15 times the size of the lake. Having a large watershed means that there is more potential for the lake to receive pollution from surrounding lands. Housing density around the lake shore is moderate. The overall watershed is mainly rural, but residential development is slowly increasing.

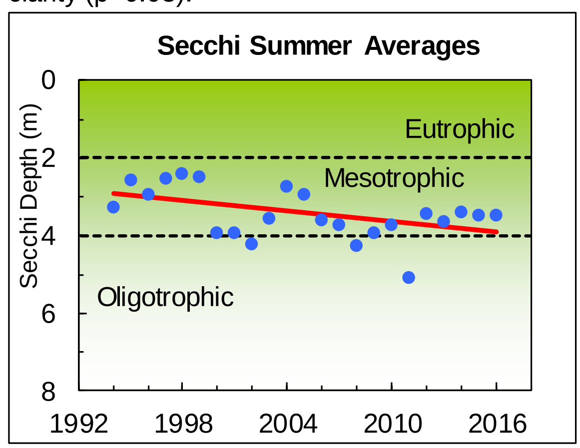
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (shown in red) for water clarity, total phosphorus, and chlorophyll *a* for Panther Lake. 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. 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 Panther Lake is moderate, with a long-term 1990 to 2016 summer average of 3.4 meters (11 feet). There has been considerable variation in annual averages, ranging from a low of 2.3 meters in 1990 to a high of 5.1 meters in 2011. The variable water clarity may be a result of higher levels of algae in some years or changes in the amount of natural water color in the lake. Overall, between 1990 and 2016, there has been a statistically significant trend toward increasing water clarity (p=0.03).



Water Color

The color of lake water affects water clarity and the depths at which algae and plants can grow. In many lakes, the water is naturally brown, orange, or yellow. This darker color comes from dissolved humic compounds from surrounding wetlands and does not harm water quality. Measurements of true water color provide clues to changes in water clarity. True water color is only the color from dissolved materials and not of the color of algae or sediment suspended in the water.

The water color of Panther Lake averaged 23 pcu (platinum-cobalt color units) in 2010 – 2011, which indicates a moderate amount of color in the lake water. This is lower than the 1994 – 1995 average of 28 pcu, meaning that the true water color of Panther Lake has decreased and become less dark. Reduced water color may be a factor in the improving water clarity conditions in the lake.

Temperature

The temperature of lake water changes with the seasons and varies with depth. During spring and summer, the sun 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, and these layers do not mix easily. This process is called stratification and occurs during the warm months. 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.

The most recent data collected was April through October 2014. Temperature data were collected at each meter throughout the Panther Lake water column (see graph). Temperature profiles show that the upper waters of the lake were beginning to warm up in April. Then, from May through September, 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 May and June, the upper waters measured about 65-66°F (18-19°C) in temperature. In July, the upper waters reached their peak temperature of 77°F (25°C). At the same time, bottom water temperatures changed only a little and remained around 45°F (7.2°C). Then, in September and October, the surface waters began to cool. The upper waters will continue to cool through the fall until the temperatures are almost equal from top to bottom. As stratification weakens, the lake water will turn over (or mix). 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 of the 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 the separation between water layers. Meanwhile, bacteria in the lake bottom are consuming 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.

Dissolved oxygen was also measured at every meter throughout the Panther Lake water column from April through October 2014 (see graph). Oxygen levels were relatively high in the upper waters every month, although the levels were slightly lower in the hottest months because warm water cannot hold as much dissolved oxygen as colder water. From May through July, there was a sharp increase in dissolved oxygen levels about 10-15 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water. Meanwhile, dissolved oxygen in the bottom waters declined each month. From July through October, there was little to no dissolved oxygen below about 20 feet deep.

During the summer period, oxygen in the lower waters is consumed by the decomposition of organic material within the lake. When the lake is stratified, the oxygen is not replenished by the overlying oxygen-rich upper waters or the atmosphere. Very low dissolved oxygen levels in the bottom waters can lead to a release of phosphorus from the lake sediments that can result in increased algae growth in late summer and fall or the next spring. The bottom of the lake will remain devoid of oxygen until the lake mixes (typically in late October/early November). The lake then remains mixed through the winter until springtime when the upper waters begin to warm and dissolved oxygen begins to decline in the bottom.

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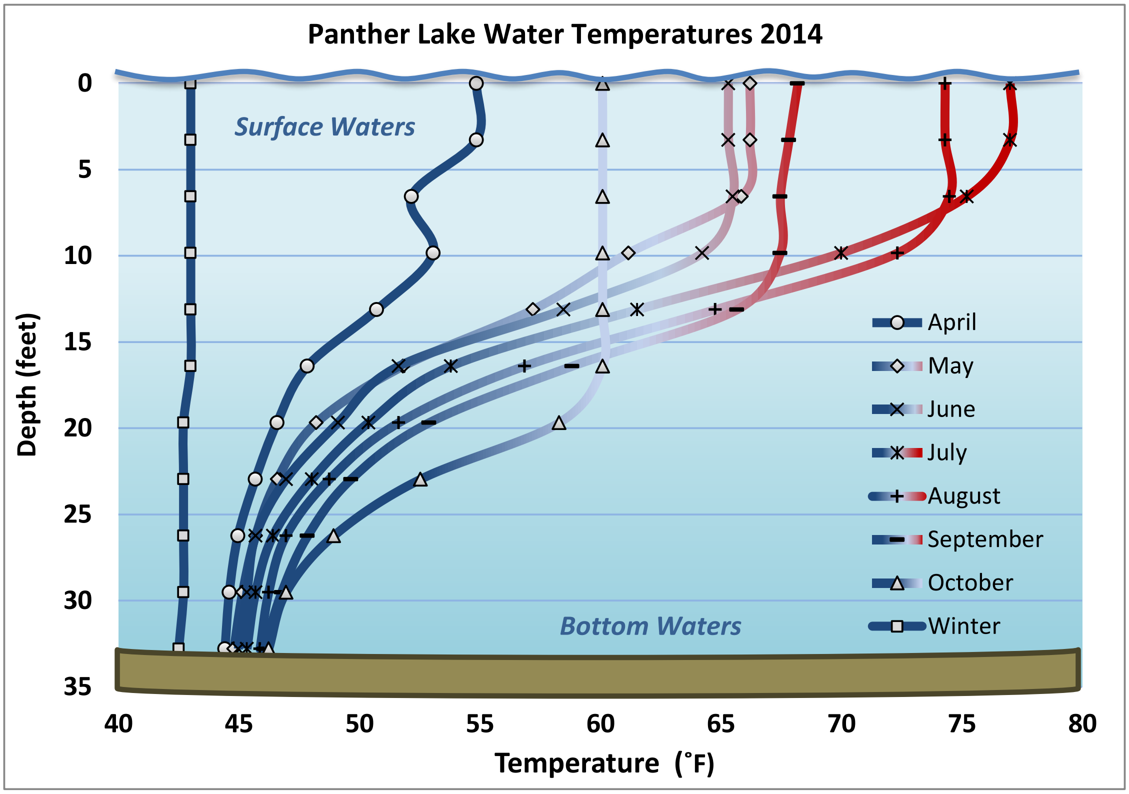
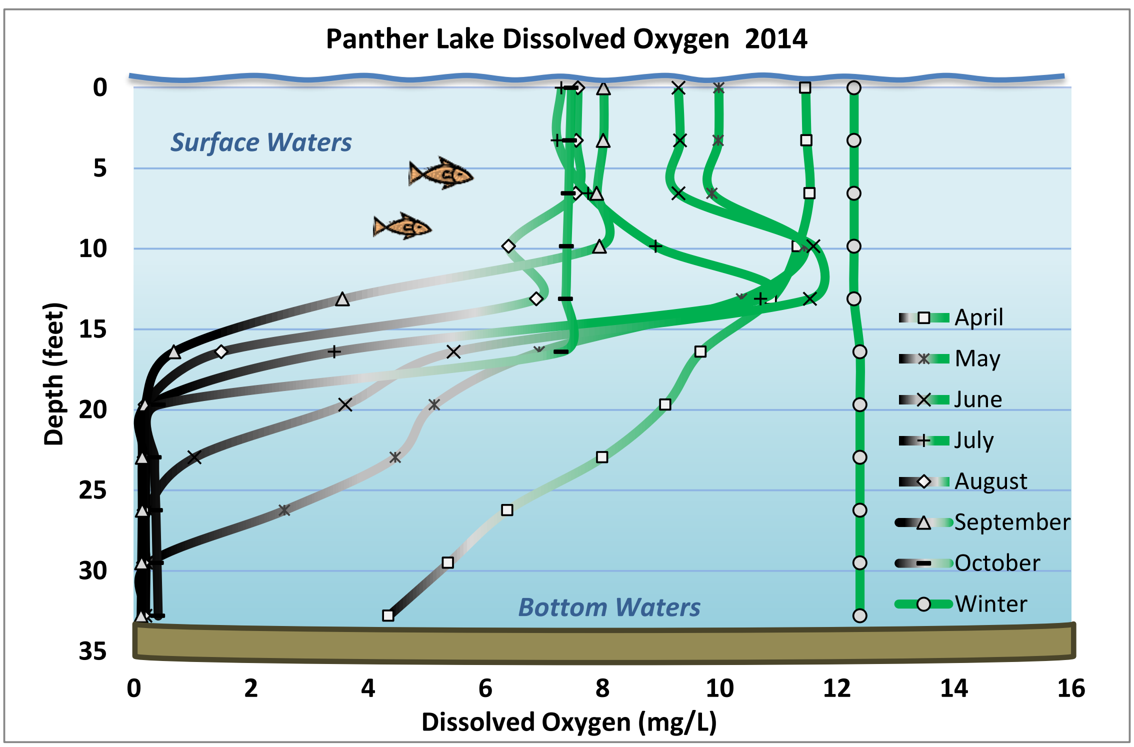


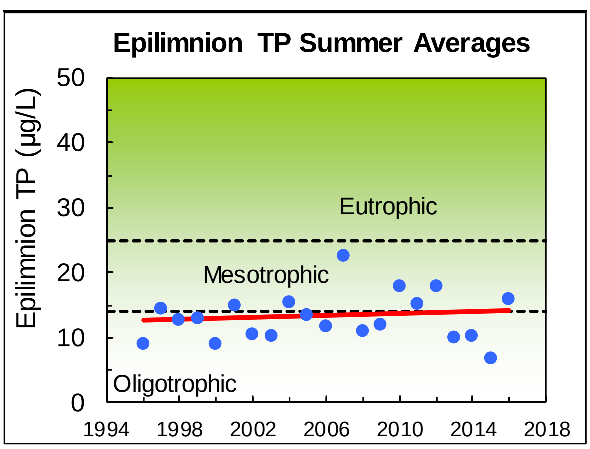


PANTHER LAKE

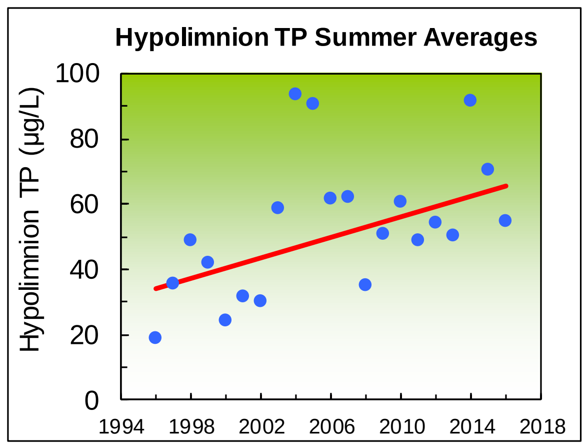
Phosphorus (key nutrient for algae)

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 of phosphorus levels over time helps to identify changes in nutrient pollution.

Total phosphorus (TP) concentrations in the epilimnion (upper waters) are low to moderate. The long-term summer average phosphorus concentration from 1996 to 2016 is 13 µg/L (micrograms per liter, which is equivalent to parts per billion). In 2007, the summer average jumped to 23 µg/L, the highest on record. This was primarily due to the June measurement of 53 µg/L. Since 2013, the summer averages are much lower. With these variable summer averages, there has not been a statistically significant trend in phosphorus concentrations in the upper waters. Any increase in phosphorus levels can result in more algae growth in the lake.



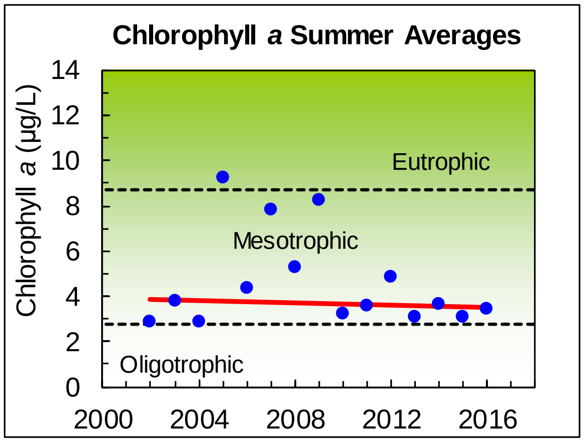
Summertime phosphorus levels in the hypolimnion (bottom waters) are moderate to high and quite variable. The long-term 1996-2016 summer average is 53 µg/L. Over this time period, there has been a statistically significant trend toward increasing phosphorus levels in the hypolimnion (p=0.02). Phosphorus concentrations reached a peak in 2004, 2005 and again in 2014. In addition, throughout each summer, phosphorus concentrations steadily increase in the bottom waters of the lake as the dissolved oxygen levels fall. This build-up is an indication of phosphorus being released from the bottom sediments and may be a sign of accelerated eutrophication.



Chlorophyll a (Algae)

Algae are tiny plant-like organisms that are essential for a healthy lake. Fish and other lake 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* measurements are one method for tracking the amount of algae in a lake.

Chlorophyll *a* values show moderate levels of algae, with a 2002 – 2016 long-term summer average of 4.6 µg/L. Chlorophyll *a* levels are quite variable from year to year, perhaps in response to fluctuating levels of phosphorus. Overall, no long-term trends are evident.



Algae blooms have been noted on occasion in Panther Lake, but have not created serious impacts for lake users until early 2015. From January through March 2015, there was a persistent bloom of blue-green algae with scum that covered large portions of the lake. The bloom may have been a result of the high phosphorus concentrations in the bottom waters during the previous summer that spread throughout the lake and were available for algae growth during the unusually warm winter.

Blue-green algae, also called cyanobacteria, are a group of algae capable of producing toxins during periods of high growth. The toxins can cause serious illness in people and pets that come into contact with affected water. Blooms often look like blue or green paint floating on the surface. Fortunately, the bloom in Panther Lake in early 2015 had only very minor amounts of the liver toxin, microcystin. Lake users should avoid contact with the water and keep pets away from the lake anytime it is experiencing a blue-green algal bloom. No algae blooms were reported in 2016.

Nitrogen (another essential nutrient for algae)

Nitrogen is another important nutrient for plant and algae growth. Similar to phosphorus, lakes with high levels of nitrogen typically have more aquatic plants and algae. From 2014 to 2016, Panther Lake had moderately low levels of total nitrogen (summer average of 300 µg/L). This is consistent with the low to moderate chlorophyll *a* concentrations measured in the lake.

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 the lake bottom sediments are contributing most of the nutrients to the lake.

In contrast, when lakes have higher N:P ratios (greater than 20), algae growth will be limited by the amount of phosphorus available, and blue-green algae are usually less of a problem. Panther Lake had a moderate average N:P ratio of 27. Blue-green algae blooms were not a problem in 2016.

PANTHER LAKE

SHORELINE CONDITION

The condition of the lake shoreline is important to understanding overall lake health. Frequently, lake shorelines are modified through removal of natural vegetation, the installation of bulkheads or other hardening structures, and/or removal of partially submerged logs and branches. These types of alteration can be harmful to the lake ecosystem because natural shorelines protect the lake from harmful pollution, prevent bank erosion, and provide important habitat for fish and wildlife.

Panther Lake has moderate levels of shoreline development. Surveys conducted in 1973 identified 25 homes bordering the lake. The number of homes increased to 28 by the mid-90s. There are also 32 docks present on the lake. The Panther Lake shoreline is still relatively intact compared to many lakes. Only 13% of the shoreline has been armored with bulkheads or wood revetments. However, the zone of native vegetation immediately adjacent to the shoreline has been significantly altered, with only 52% still classified as intact. There is still a substantial amount (about 111 pieces) of large wood remaining in the lake. These old logs and branches are valuable for fish and wildlife habitat.

Shoreline modifications leave the lake susceptible to pollution from the watershed, eliminate the buffer of native vegetation that can filter out pollution, 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.

SUMMARY

Trophic State

All lakes go through a process of enrichment by nutrients and sediment. In this process, known as eutrophication, nutrients and sediment contribute to the ever-increasing growth of algae and aquatic plants. Over thousands of years, lakes will gradually fill up with organic matter and sediments.

Lakes can be classified by their degree of eutrophication, also known as their trophic state. There are three primary trophic states for lakes—oligotrophic, mesotrophic, and eutrophic—as well as intermediate states. Oligotrophic lakes are usually deep, with clear water, low nutrient concentrations, and few aquatic plants and algae. Mesotrophic lakes are richer in nutrients and produce more algae and aquatic plants. Eutrophic lakes are often shallow and characterized by abundant algae and plants, high nutrient concentrations, limited water clarity, and low dissolved oxygen in the bottom waters.

The trophic state classification of a lake does not necessarily indicate good or bad water quality because eutrophication is a natural process. However, human activities that contribute sediment and excess nutrients to a lake can dramatically accelerate the eutrophication process and result in declining water quality.

Based on the long-term monitoring data, Panther Lake may be classified as mesotrophic, with moderate water clarity and moderate phosphorus and chlorophyll *a* concentrations. The lake is moderately productive of aquatic plants and algae.

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Condition and Trends

Panther Lake is exceeding its water quality target of maintaining stable water clarity. In fact, there has been a statistically significant trend towards increasing water clarity since 1990.

However, the lake is not meeting the target for maintaining stable phosphorus concentrations in the epilimnion (upper waters) and hypolimnion (bottom waters). Between 1996 and 2016 there has been statistically significant trend toward higher phosphorus levels in the lower waters, and, in some years, phosphorus concentrations have been higher in the upper waters as well. Also, higher chlorophyll *a* values in some years indicate that more nutrients are available for algae growth. Increased phosphorus and more algae are likely signs of accelerating eutrophication in the lake.

Overall, Panther Lake is in good condition. However, the lake is at risk of future water quality declines as indicated by the increasing phosphorus levels and the recent blue-green algae blooms. If these changes continue and more algae growth occurs, it is possible that summertime use of the lake will be affected.

The primary threat to lake water quality is an increase of nutrients entering the lake through new development and other human activities in the watershed. Measures to control nutrients in the watershed should be taken now to prevent any future negative impacts to the lake. To find out more about ways to protect lake water quality and information on the causes and problems of elevated lake nutrient levels visit www.lakes.surfacewater.info.

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DATA SUMMARY FOR PANTHER LAKE						
		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	**8/3/73**	2.1	13	51	-	-
DOE	**1990**	1.8 - 2.7 (2.3) *n = 9*	-	-	-	-
Volunteer	**1992**	2.5 - 3.6 (3.1) *n = 4*	-	-	-	-
DOE	**1993**	-	-	-	-	*1.5 - 4.7* *(3.1)* *n = 2*
SWM Staff	**1994**	3.1 - 3.5 (3.3) *n = 2*	-	-	-	3.5 - 5.3 (4.4) *n = 2*
SWM Staff or Volunteer	**1995**	2.3 - 3.1 (2.6) *n = 13*	-	-	-	7.1
SWM Staff, Volunteer or DOE	**1996**	2.1 - 4.0 (3.0) *n = 10*	8 - 10 (9) *n = 2*	15 - 23 (19) *n = 2*	-	3.7 - 13 (8.5) *n = 2*
SWM Staff or Volunteer	**1997**	2.3 - 3.2 (2.5) *n = 6*	14 - 15 (15) *n = 2*	22 - 49 (36) *n = 2*	-	-
Volunteer	**1998**	2.1 - 2.8 (2.4) *n = 4*	6 - 18 (13) *n = 4*	30 - 75 (49) *n = 4*	-	-
SWM Staff or Volunteer	**1999**	2.3 - 3.0 (2.5) *n = 4*	11 - 17 (13) *n = 4*	26 - 77 (42) *n = 4*	-	-
SWM Staff	**2000**	3.3 - 4.6 (3.9) *n = 4*	4 - 14 (9) *n = 4*	8 - 46 (24) *n = 4*	-	-
SWM Staff	**2001**	3.4 - 4.8 (3.9) *n = 4*	6 - 29 (15) *n = 4*	18 - 44 (32) *n = 4*	-	-
Volunteer	**2002**	3.1 - 5.2 (4.2) *n = 21*	9 - 14 (11) *n = 4*	14 - 49 (30) *n = 4*	-	0.5 - 3.7 (2.9) *n = 4*
Volunteer	**2003**	3.0 - 5.0 (3.6) *n = 12*	8 - 12 (10) *n = 4*	23 - 87 (59) *n = 4*	-	1.9 - 6.4 (3.8) *n = 4*
Volunteer	**2004**	2.1 - 3.5 (2.8) *n = 19*	10 - 24 (16) *n = 4*	26 - 183 (94) *n = 4*	-	2.7 - 3.2 (2.9) *n = 4*
Volunteer	**2005**	2.0 - 3.9 (3.0) *n = 18*	10 - 19 (14) *n = 4*	28 - 184 (91) *n = 4*	-	1.1 - 23 (9.2) *n = 4*

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DATA SUMMARY FOR PANTHER LAKE						
		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**	3.1 - 3.9 (3.6) *n = 8*	7 - 23 (12) *n = 4*	33 - 115 (62) *n = 4*	-	2.1 - 9.9 (4.3) *n = 4*
Volunteer	**2007**	3.2 - 4.3 (3.7) *n = 5*	11 - 53 (23) *n = 4*	31 - 127 (62) *n = 4*	-	5.9 - 10 (7.9) *n = 4*
Volunteer	**2008**	3.4 - 5.0 (4.3) *n = 4*	11 - 11 (11) *n = 2*	27 - 45 (35) *n = 3*	-	1.9 - 11 (5.3) *n = 3*
Volunteer	**2009**	2.8 - 4.8 (3.9) *n = 9*	10 - 14 (12) *n = 4*	23 - 102 (51) *n = 4*	-	3.7 - 14 (8.3) *n = 4*
Volunteer	**2010**	3.0 - 4.6 (3.7) *n = 12*	12 - 28 (18) *n = 4*	41 - 103 (61) *n = 4*	-	2.1 - 4.8 (3.2) *n = 4*
Volunteer	**2011**	2.8 - 20 (5.1) *n = 11*	10 - 22 (15) *n = 4*	24 - 82 (49) *n = 4*	-	2.8 - 4.5 (3.6) *n = 4*
Volunteer	**2012**	3.3 - 3.7 (3.5) *n = 7*	12 - 26 (18) *n = 4*	22 - 87 (54) *n = 4*	-	2.6 - 10 (4.9) *n = 4*
Volunteer	**2013**	3.3 - 4.2 (3.7) *n = 11*	9 - 11 (10) *n = 4*	17 - 90 (51) *n = 4*	-	2.1 - 4.8 (3.1) *n = 4*
Volunteer	**2014**	2.8 - 4.1 (3.4) *n = 12*	7 - 15 (10) *n = 5*	46 - 134 (92) *n = 5*	312 - 369 (338) *n = 4*	1.1 - 5.3 (3.6) *n = 5*
Volunteer	**2015**	*3.0 - 4.2* *(3.5)* *n = 13*	*5 - 8* *(7)* *n = 4*	*33 - 95* *(71)* *n = 4*	*235 - 278* *(262)* *n = 4*	*1.5 - 5.3* *(3.1)* *n = 4*
Volunteer	**2016**	2.6 - 4.4 (3.5) *n = 12*	6 - 40 (16) *n = 4*	28 - 87 (55) *n = 4*	248 - 385 (301) *n = 4*	1.9 - 4.8 (3.5) *n = 4*
Long Term Avg		**3.4** **(1990-2016)**	**13** **(1996-2016)**	**53** **(1996-2016)**	**300** **(2014-2016)**	**4.6** **(2002-2016)**
TRENDS		**Increasing**	**None**	**Increasing**	**NA**	**None**

NOTES

- Table includes summer (May-Oct) data only.
- 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.
- DOE = Washington Department of Ecology
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.