2015 STATE OF THE LAKES UPDATE

LAKE COCHRAN

REPORT DESCRIPTION

This report is an update on the health of Lake Cochran based on water quality data collected from 1992 through 2015 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 Lake Cochran, visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Lake Cochran is a private 33-acre lake located approximately five miles northeast of Monroe. It is relatively deep for a lake of this size, with a maximum depth of 16.5 meters (54 feet) and a mean depth of 7.9 meters (26 feet). The watershed, which is the land area that drains to the lake, is largely undeveloped, but much of the lake shore is occupied by single family homes.

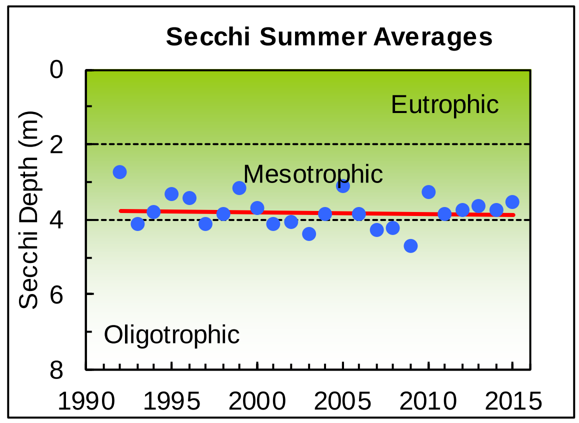
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (shown in red) for water clarity, total phosphorus, and chlorophyll *a* for Lake Cochran. 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.

The water clarity in Lake Cochran is moderate to good and somewhat variable, with a long-term summer average of 3.8 meters (12 feet). Between 1992 and 2009 there had been a trend towards improving water clarity. In 2009, the average clarity was 4.7 meters, which is the deepest Secchi depth average on record. However, in 2010 the water clarity average fell to only 3.3 meters. The summer averages from 2011 through 2015 were near the long-term average. Although there have been some years with better water clarity, overall there has been no trend toward improving water clarity. Instead, there seems to be an oscillating pattern where the water clarity improves for a few years and then gets worse for a few years. Such a pattern may be tied to weather cycles, with more nutrients or increased color in some years.



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 Lake Cochran averaged 26 pcu (platinum-cobalt color units) in 2010 – 2011, which is a moderate amount of color in the lake water. This was a slight increase in color from the 1994 – 1995 average of 22 pcu. Changes in water color do not appear to be related to changes in water clarity or algae growth.

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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 was collected from May through October 2014. Temperature data were collected at each meter throughout the Lake Cochran water column (see graph). Temperature profiles for 2014 show that throughout the sampling 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 May, the upper waters measured about 64°F (18°C) in temperature, and by July had reached their peak at 79°F (26°C). At the same time, bottom water temperatures changed only a little and remained around 41°F (5°C). By October the upper waters were beginning to cool. Through the fall, the cooling will continue 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.

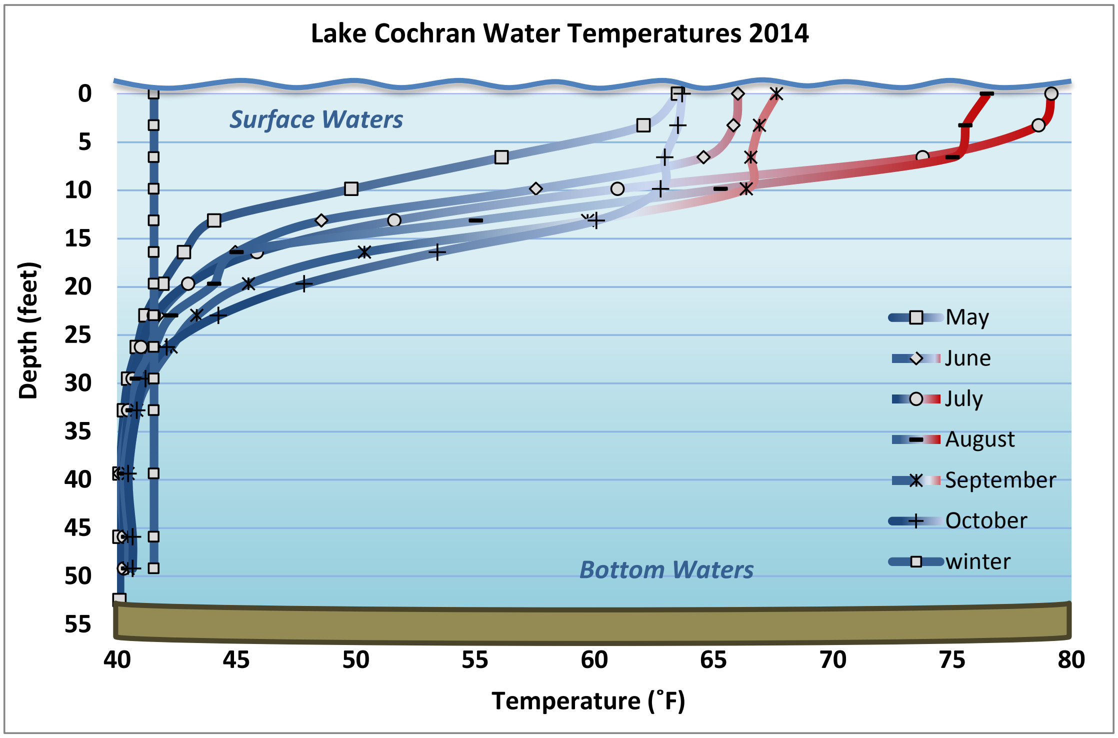
Dissolved Oxygen

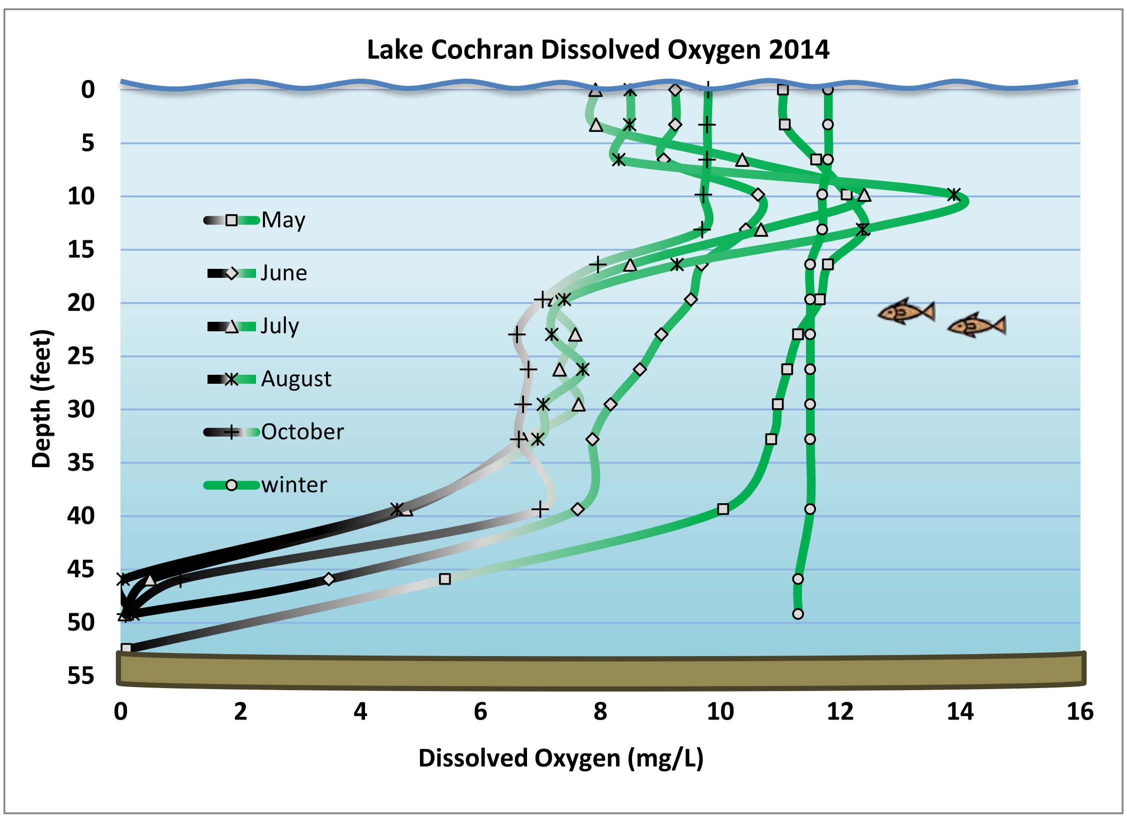
Oxygen dissolved in the water is essential for life in a lake. Most of the dissolved oxygen comes from the atmosphere. Like temperature, dissolved oxygen levels vary over time and with depth. During the warm months, the upper waters receive oxygen from the atmosphere, but the lower waters cannot be replenished 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 Lake Cochran water column from May through October (see graph; September data removed for readability). Oxygen levels were relatively high in the upper waters throughout the period. Meanwhile, between about 20 and 35 feet deep, the water contained less dissolved oxygen; and there was little to no dissolved oxygen below 40 feet. For several months, there was a sharp increase in dissolved oxygen levels about 10 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water.

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.

LAKE COCHRAN

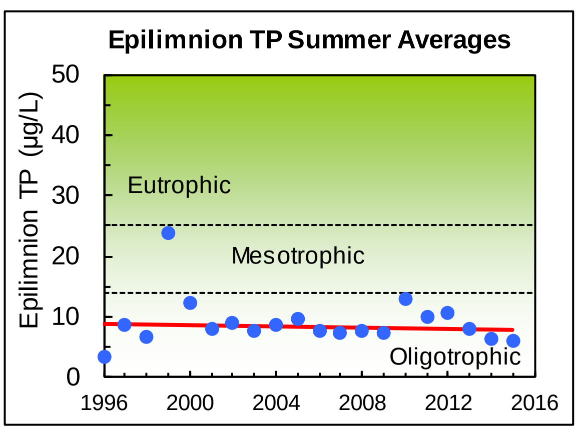




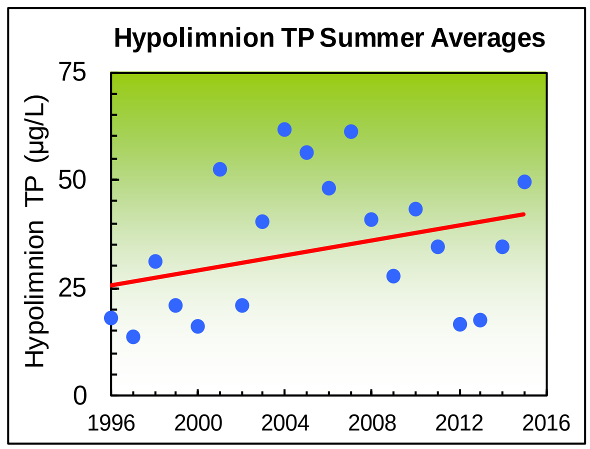
Phosphorus (key nutrient for algae)

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 concentrations in the epilimnion (upper waters) are low and stable, with a long-term 1996 – 2015 average of 9 µg/L (micrograms per liter, which is equivalent to parts per billion). In 1999, there were much higher levels of phosphorus, with a summer average of 24 µg/L. However, with the exception of 2010 when the average increased to 13 µg/L, from 2000 to 2015, phosphorus levels in the epilimnion have been stable and close to the long-term average. Overall, there has been no significant trend detected in phosphorus values in the upper waters.



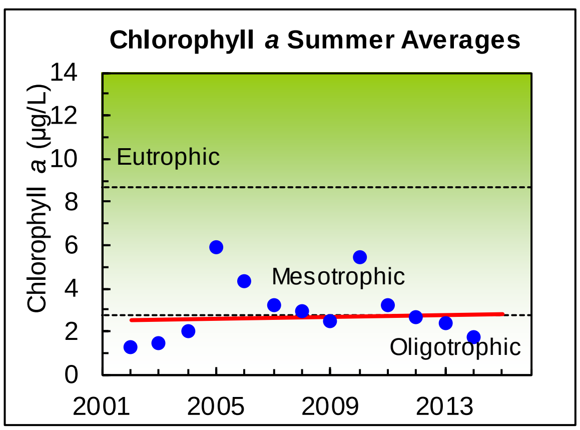
Summertime phosphorus averages in the hypolimnion (bottom waters) are moderate. The 1996 to 2015 long-term average is 35 µg/L. From 1996 through 2011, there had been a statistically significant trend toward increasing phosphorus concentrations in the hypolimnion. However, the 2012 and 2013 summer averages were much lower than the long-term trend. As a result, the data no longer show an increasing trend. Any increase of phosphorus in the bottom waters may be a warning sign of accelerated eutrophication that could lead to more frequent and severe algae blooms.



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 have been low to moderate and variable during the 2002 to 2014 sampling period. The long-term average summer concentration is 3.0 µg/L. The general pattern from 2005 through 2013 was for higher chlorophyll *a* values than in the early 2000s, reflecting more algae growth. The higher values might be a response to the available phosphorus in the bottom waters. However, between 2002 and 2014, there has not been a statistically significant increase in algae levels, and the chlorophyll *a* average in 2014 was only 1.7 µg/L. Chlorophyll *a* data was not collected in 2015.



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. The 2014 – 2015 summer average of total nitrogen for Lake Cochran is 288 µg/L. This relatively low summer average 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. Lake Cochran had a relatively high average N:P ratio of 51, and blue green algae blooms were not observed in 2015.

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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, Lake Cochran may be classified as oligo-mesotrophic, with moderate to good water clarity, low to moderate phosphorus levels, and low to moderate productivity of plants and algae.

Condition and Trends

The water quality targets for Lake Cochran are to maintain stable long-term water clarity and phosphorus levels. The lake appears to be meeting these targets because water clarity shows no trend, and phosphorus levels in the upper and bottom waters are stable, though quite variable. Any increased phosphorus in the lake raises concerns about accelerated eutrophication that may lead to more algae growth and reduced water clarity in the future.

Overall, Lake Cochran is in good condition. However, the lake may be at risk of future water quality declines. The primary threat to lake water quality is an increase of nutrients entering the lake through new development and 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, please visit SWM's website at www.lakes.surfacewater.info.

DATA SUMMARY FOR LAKE COCHRAN						
		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	**7/23/73**	3.0	7	13		-
Volunteer	**1992**	2.8	-	-		-
Volunteer	**1993**	2.8 - 5.6 (4.1) *n = 10*	-	-		-
Volunteer	**1994**	3.1 - 4.9 (3.8) *n = 9*				2.0 - 8.3 (5.2) *n = 2*
Volunteer	**1995**	2.7 - 4.0 (3.3) *n = 5*				3.2
Volunteer	**1996**	3.0 - 4.0 (3.4) *n = 6*	3 - 4 (4) *n = 2*	17 - 19 (18) *n = 2*		-
Volunteer	**1997**	3.8 - 4.5 (4.1) *n = 3*	8 - 9 (9) *n = 2*	10 - 17 (14) *n = 2*		-
Volunteer	**1998**	3.3 - 4.5 (3.9) *n = 7*	5 - 8 (7) *n = 4*	13 - 65 (31) *n = 4*		-
Volunteer	**1999**	2.9 - 3.9 (3.2) *n = 6*	9 - 52 (24)[a] *n = 4*	13 - 31 (21) *n = 4*		-
Volunteer	**2000**	3.1 - 4.2 (3.7) *n = 5*	9 - 20 (12) *n = 4*	5 - 25 (16) *n = 4*		-
Volunteer	**2001**	4.0 - 4.4 (4.1) *n = 5*	4 - 13 (8) *n = 4*	48 - 57 (53) *n = 4*		
Volunteer	**2002**	3.7 - 4.4 (4.0) *n = 4*	6 - 12 (9) *n = 4*	11 - 29 (21) *n = 4*		0.3 - 2.1 (1.3) *n = 4*
Volunteer	**2003**	4.0 - 5.3 (4.4) *n = 9*	5 - 9 (8) *n = 4*	22 - 57 (40) *n = 4*		0.8 - 2.1 (1.5) *n = 4*
Volunteer	**2004**	3.2 - 4.5 (3.9) *n = 8*	5 - 11 (9) *n = 4*	40 - 79 (62) *n = 4*		1.6 - 2.4 (2.0) *n = 4*
Volunteer	**2005**	1.8 - 4.2 (3.1) *n = 9*	6 - 16 (10) *n = 4*	31 - 99 (57) *n = 4*		1.1 - 19 (5.9) *n = 4*
Volunteer	**2006**	3.1 - 4.4 (3.8) *n = 10*	6 - 9 (8) *n = 4*	30 - 64 (48) *n = 4*		1.1 - 11 (4.4) *n = 4*

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DATA SUMMARY FOR LAKE COCHRAN						
		Water Clarity (Secchi depth in meters)	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**		**Surface**	**Bottom**	**Surface**	**Surface**
Volunteer	**2007**	2.2 - 5.1 (4.3) *n = 10*	4 - 10 (7) *n = 4*	40 - 80 (61) *n = 4*		1.1 - 6.9 (3.2) *n = 4*
Volunteer	**2008**	3.5 - 5.1 (4.2) *n = 10*	6 - 10 (8) *n = 4*	24 - 71 (41) *n = 4*		1.8 - 4.3 (3.0) *n = 4*
Volunteer	**2009**	3.5 - 5.9 (4.7) *n = 13*	7 - 8 (7) *n = 4*	16 - 37 (28) *n = 4*		1.8 - 3.7 (2.4) *n = 4*
Volunteer	**2010**	2.4 - 4.0 (3.3) *n = 6*	7 - 20 (13) *n = 4*	32 - 55 (43) *n = 4*		2.1 - 9.3 (5.4) *n = 4*
Volunteer	**2011**	3.0 - 4.8 (3.9) *n = 10*	8 - 12 (10) *n = 4*	16 - 52 (35) *n = 4*		1.9 - 5.3 (3.3) *n = 4*
Volunteer	**2012**	3.0 - 4.8 (3.8) *n = 8*	5 - 16 (11) *n = 4*	13 - 19 (17) *n = 4*		1.5 - 4.3 (2.7) *n = 4*
Volunteer	**2013**	2.9 - 4.7 (3.6) *n = 11*	6 - 9 (8) *n = 4*	13 - 24 (18) *n = 4*		1.1 - 3.2 (2.4) *n = 4*
Volunteer	**2014**	*2.8 - 5.4* *(3.7)* *n = 12*	*6 - 7* *(6)* *n = 4*	*27 - 47* *(34)* *n = 3*	*228 - 416* *(330)* *n = 4*	*1.6 - 2.1* *(1.7)* *n = 4*
Volunteer	**2015**	3.2 - 4.1 (3.5) *n = 5*	5 - 7 (6) *n = 4*	6 - 90 (50) *n = 4*	251 - 336 (288) *n = 4*	
Long Term Avg		**3.8** **(1992-2015)**	**9** **(1996-2015)**	**35** **(1996-2015)**	**288** **(2014-2015)**	**3.0** **(2002-2014)**
TRENDS		**None**	**None**	**None**	**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.
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.

[a] Average is influenced by one high TP value.