RUGGS LAKE

REPORT DESCRIPTION

This report is an update on the health of Ruggs Lake based on water quality data collected from 1996 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 Ruggs Lake, please visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Ruggs Lake is an 11-acre, private-access lake located just south and east of the Everett city limits. The lake is fed by the outlet stream from Silver Lake and drains into Thomas Lake and North Creek. The Ruggs Lake watershed, which is the land area that drains to the lake, is very large in relation to the size of the lake, which means there is a high potential to receive excess nutrients and sediment from the watershed. Most of the lake shore is developed with single family homes.

Ruggs Lake has a maximum depth of 4.6 meters (15 feet) and is also several feet shallower than it was in the early 1980s. Sedimentation is rapidly filling in the eastern portion of the lake. The majority of the fill appears to be coming from the decomposition of dense aquatic plants that grow in the rich sediments of the lake.

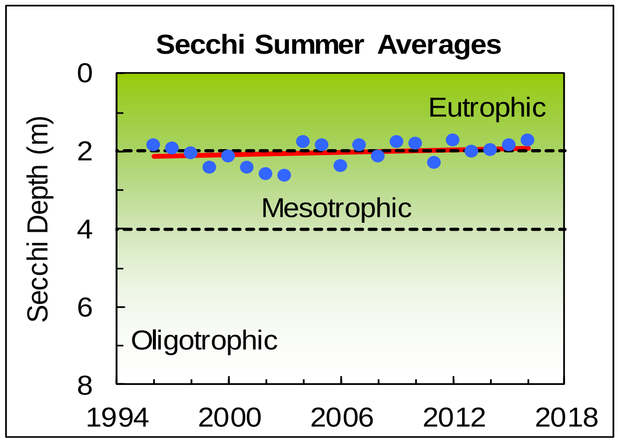
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (shown in red) for water clarity and total phosphorus for Ruggs 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 Ruggs Lake is relatively low, with a 1996 – 2016 long-term summer average of 2.0 meters (6.6 feet). From 1996 through 2003, it appeared that water clarity averages were improving, reaching a high of 2.6 meters in 2002 and 2003. However, water clarity dropped in 2004 and has gradually decreased since then. From 1996-2016 there has been a statistically significant trend towards decreasing water clarity (p=0.09). There are occasional algae blooms, as described below, which may reduce water clarity. The low water clarity is also partly the result of the naturally dark-colored water in the lake.



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 Ruggs Lake averaged 33 pcu (platinum-cobalt color units) in 2010 – 2011, which indicates a moderate amount of color in the water. As mentioned above, the color of the water is partly responsible for the low water clarity in the lake.

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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.

From April through October 2015, the most recent data available, temperature was measured at each meter throughout the Ruggs Lake water column (see graph). Temperature profiles for 2015 show that the lake was thermally stratified from June through August. This means that there was a substantial temperature difference between the warm upper waters and the cool bottom waters, and mixing between these layers was limited. In April, the upper waters measured about 61°F (16°C) in temperature. Through the summer, the upper waters continued to warm, and by August had reached their peak at 79°F (26°C). At the same time, bottom water temperatures changed only a little, warming up from about 52°F to about 58°F (11 to 14°C). The stratification at Ruggs Lake is not as strong as in some other local lakes because the lake is relatively shallow.

By September, the surface waters began to cool, and by October/November the temperatures are almost equal from top to bottom. As stratification weakened, the lake water began to turn over (or mix). The lake will stay mixed during the winter until springtime, when the upper waters began 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 Ruggs Lake water column from April through October 2015 (see graph). Oxygen levels were moderately high in the upper waters in April and June. During the same time, there was a slight increase in dissolved oxygen levels between about 4 and 10 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water.

In early summer, the water at the very bottom of the lake contained much less dissolved oxygen, and oxygen levels declined in the bottom waters throughout the summer. 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.

By July, even the upper waters declined in dissolved oxygen. This was partly because warmer water cannot hold as much oxygen as colder water, but also because of the large biological oxygen demand in the lake. During the summer period, there was virtually no dissolved oxygen in the lake below about 4 feet. 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. Low dissolved oxygen can result in phosphorus being released from the bottom sediments and contributing to future algae growth in the lake. 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.

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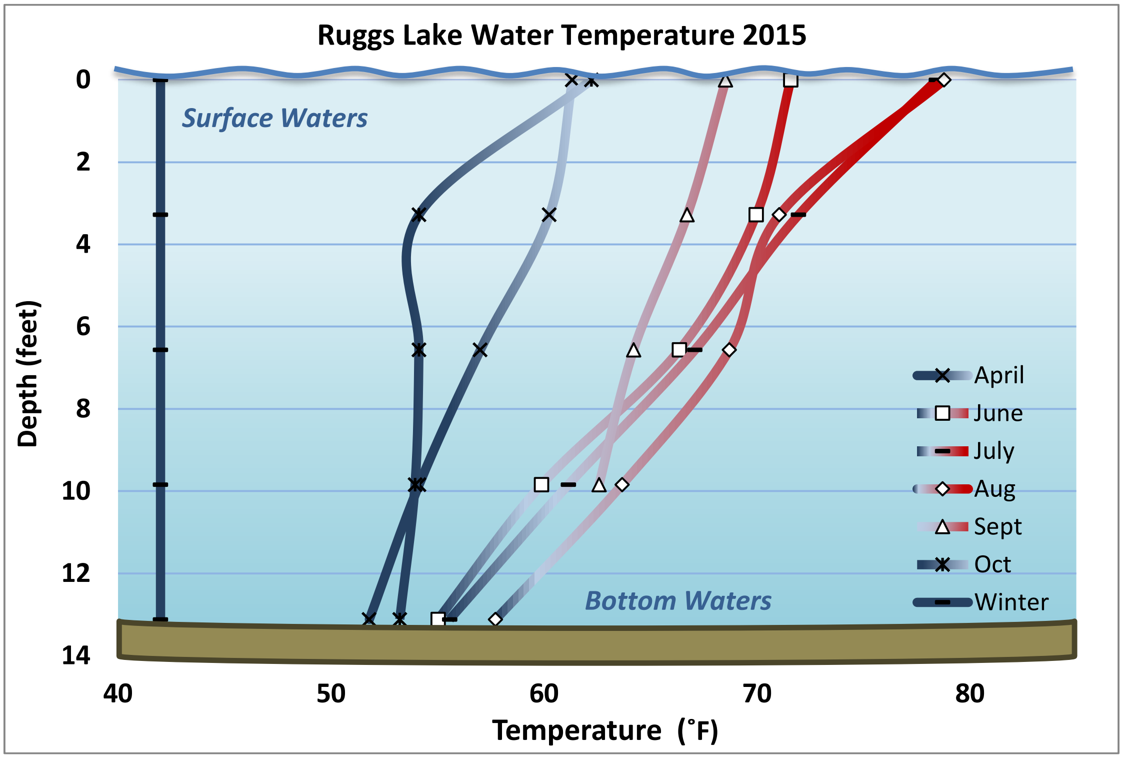
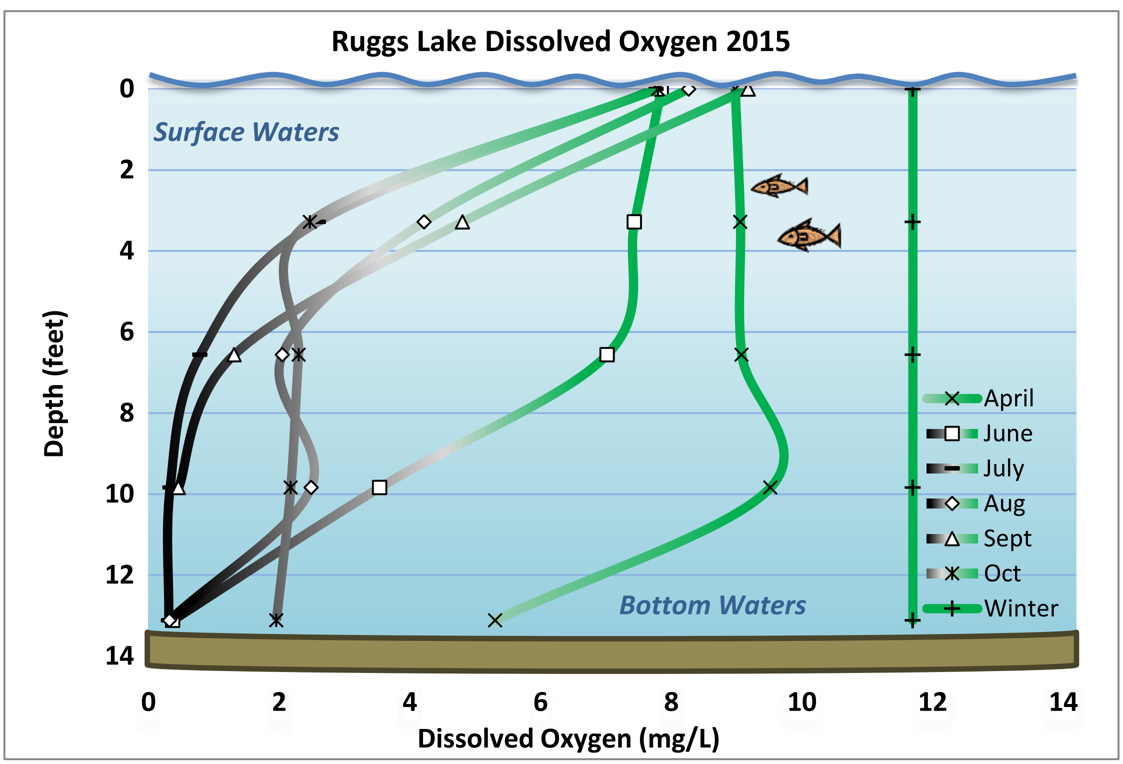


Ruggs Lake Water Temperature 2015
Surface Waters
Bottom Waters
Depth (feet)
0
2
4
6
8
10
12
14
40
50
60
70
80
Temperature (˚F)
April
June
July
Aug
Sept
Oct
Winter



Ruggs Lake Dissolved Oxygen 2015
Surface Waters
Bottom Waters
Depth (feet)
0
2
4
6
8
10
12
14
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/L)
April
June
July
Aug
Sept
Oct
Winter

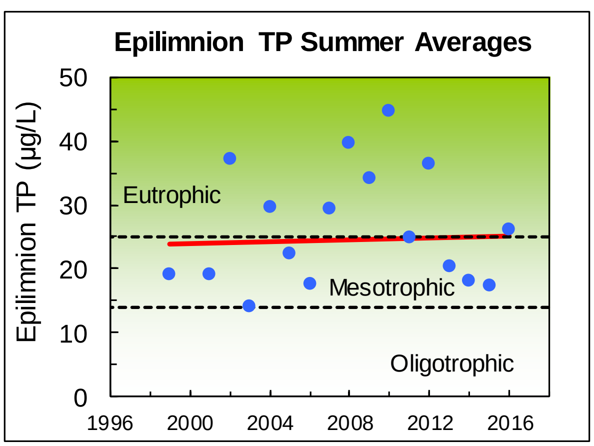
RUGGS LAKE

Phosphorus (key nutrient for algae)

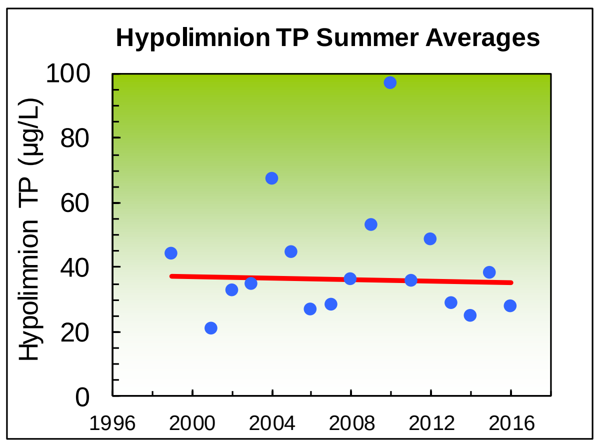
Nutrients are essential for the growth of algae, fish, and aquatic plants in a lake. However, too many nutrients, especially phosphorus, can pollute a lake and lead to unpleasant algae growth. Nutrients enter the lake through stormwater runoff or from streams flowing into the lake. Sources of nutrients 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 moderate to high and extremely variable. The 1999 - 2016 long-term summer average is 27 µg/L (micrograms per liter, which is equivalent to parts per billion). The summer average for 2010 was 45 µg/L, the highest on record, and several other recent years have seen high phosphorus levels. The summer averages in 2013 to 2015 were much lower, although the average increased again in 2016. Because of the variability in phosphorus averages, there has not been a statistically significant trend toward increasing phosphorus levels between 1999 and 2016.

If higher phosphorus levels continue to occur, more algae growth can be expected in the lake, which would be a sign of accelerating eutrophication. High phosphorus levels are the reason that Ruggs Lake is listed as “impaired” in Washington State’s official 2012 water quality assessment.



Summertime phosphorus levels in the hypolimnion (bottom waters) are moderately high and also quite variable, with a long-term 1999 – 2016 average of 41 µg/L. Again, the 2010 summer average was the highest on record (97 µg/l). However, the averages from 2013 to 2016 have been much lower. Although there is no evidence of a statistically significant trend toward higher phosphorus levels in the hypolimnion, years with higher levels indicate a build-up of nutrients being released from the bottom sediments. Phosphorus release from the sediments occurs during periods of low dissolved oxygen in the summer and may be another sign of accelerating 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.

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Chlorophyll a values collected in 2015 showed moderate levels of algae, with a summer average of 5.1 µg/L (micrograms per liter, which is equivalent to parts per billion). No other chlorophyll *a* data are available for Ruggs Lake, so the long term levels of algae are unknown. Water clarity measurements reflect the amount of algae in the water. Low water clarity, even with naturally dark water color, indicate moderate levels of algae in Ruggs Lake. Also, the lake is rich in nutrients that support algae growth, and dense algae blooms have been observed in the lake from time to time.

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, Ruggs Lake had moderate levels of total nitrogen (summer average of 430 µg/L). This is consistent with the moderate levels of algae growth observed 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. Ruggs Lake had a low average N:P ratio of 21. However, blue green algae blooms were not a significant problem in 2015.

AQUATIC PLANTS AND SEDIMENTATION

Ruggs Lake supports dense growths of aquatic plants, especially in the shallow eastern end of the lake. The common aquatic plants are yellow water-lily, fragrant water-lily (a non-native), coontail, elodea, bladderwort, large-leaf pondweed, and naiad. The plants are so thick in places that they interfere with use of the lake.

Ruggs Lake is slowly filling with sediment and organic matter from dead plants and algae. The lake is becoming more and more shallow each year, particularly in the eastern end. Depending on conditions at the lake outlet stream and any beaver activity, some of the eastern portion of the lake has exposed mud flats during summer low water. The large watershed draining into Ruggs Lake also brings sediment that originates from land clearing and grading in areas of development. There are no feasible remedies for the increasing sedimentation in the lake and the dense plants that grow in the shallow areas. Dredging is the only way to removed excess sediment, but it would be very expensive and have other potential environmental impacts.

SHORELINE CONDITION

The shoreline condition of a lake is important in overall lake health. Frequently, lake shorelines are modified either through removal of natural vegetation and/or the installation of bulkheads or other hardening structures. These types of alterations do not protect a lake as well as more natural shorelines.

The shoreline of Ruggs Lake is mostly developed with residential uses. Fortunately, some land owners have protected or created buffers of native vegetation along the shoreline. However, others cultivate lawns down to the water's edge. Efforts to create and maintain more natural shorelines with buffers of native vegetation can reduce the sources of nutrients (such as fertilizers), can help filter out pollution before it reaches the lake, and can provide valuable habitat for fish and wildlife.

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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 long-term monitoring data, Ruggs Lake may be classified as eutrophic, with low water clarity, moderate to high phosphorus concentrations, periodic algae blooms, and dense aquatic plant growth. This means the lake is very productive of algae and plants.

Condition and Trends

The water quality targets for Ruggs Lake are to improve water clarity and reduce phosphorus levels. For a few years, it appeared that water clarity was improving, but recent measurements reveal little change in water clarity over the long run. There have been high phosphorus concentrations in both the upper and lower waters in some years, especially in 2010. Therefore, the target of reducing phosphorus levels is not being met. Any further increases in phosphorus may lead to nuisance algae growth that affects use of the lake.

Overall, Ruggs Lake is in fair condition, but it needs restoration to prevent gradual loss of lake uses. The sedimentation that is filling in the eastern portion of the lake is a major problem for lake residents. However, the costs to restore the lake through dredging are too high for local residents to undertake.

Water quality could also be improved by reducing the inflow of nutrients to the lake from new development and from human activities in the watershed. Since runoff may also carry sediment, actions to reduce or slow runoff may also help to slow the sedimentation. Please visit www.lakes.surfacewater.info to find out how to protect lake water quality and to find more information on the impacts of elevated lake nutrient levels.

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DATA SUMMARY FOR RUGGS 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**
Sumioka and Dion, 1985	**7/1/81**	2.4	10	30	-	-
Volunteer	**1996**	1.4 - 2.3 (1.8) *n = 9*	-	-	-	-
Volunteer	**1997**	1.0 - 3.0 (1.9) *n = 10*	-	-	-	-
Volunteer	**1998**	1.2 - 3.3 (2.1) *n = 8*	-	-	-	-
SWM Staff or Volunteer	**1999**	1.1 - 4.0 (2.4) *n = 9*	19	44	-	-
Volunteer	**2000**	1.4 - 3.5 (2.1) *n = 8*	-	-	-	-
SWM Staff or Volunteer	**2001**	1.3 - 4.1 (2.4) *n = 7*	19	21	-	-
Volunteer	**2002**	1.7 - 4.1 (2.6) *n = 7*	14 - 58 (37) *n = 4*	20 - 63 (33) *n = 4*	-	-
Volunteer	**2003**	1.9 - 3.2 (2.6) *n = 3*	14	35	-	-
Volunteer	**2004**	1.0 - 3.0 (1.8) *n = 9*	11 - 52 (30) *n = 4*	49 - 97 (67) *n = 4*	-	-
Volunteer	**2005**	1.0 - 2.8 (1.8) *n = 8*	13 - 44 (22) *n = 4*	30 - 62 (45) *n = 4*	-	-
Volunteer	**2006**	1.2 - 4.4 (2.4) *n = 6*	13 - 22 (18) *n = 3*	15 - 39 (27) *n = 3*	-	-
Volunteer	**2007**	1.0 - 3.2 (1.8) *n = 6*	13 - 53 (30) *n = 4*	23 - 40 (29) *n = 4*	-	-
Volunteer	**2008**	1.0 - 4.1 (2.1) *n = 9*	11 - 99 (40) *n = 4*	21 - 54 (37) *n = 4*	-	-
Volunteer	**2009**	1.2 - 2.8 (1.7) *n = 7*	13 - 52 (34) *n = 4*	37 - 90 (53) *n = 4*	-	-
Volunteer	**2010**	0.9 - 2.7 (1.8) *n = 9*	14 - 92 (45) *n = 4*	54 - 169 (97) *n = 4*	-	-

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DATA SUMMARY FOR RUGGS LAKE						
		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	**2011**	1.2 - 3.8 (2.2) *n = 12*	14 - 53 (25) *n = 4*	15 - 54 (36) *n = 4*	-	-
Volunteer	**2012**	1.0 - 2.9 (1.7) *n = 11*	14 - 66 (37) *n = 4*	21 - 73 (49) *n = 4*	-	-
Volunteer	**2013**	1.3 - 3.1 (2.0) *n = 12*	10 - 33 (20) *n = 4*	10 - 39 (29) *n = 4*	-	-
Volunteer	**2014**	1.8 - 2.7 (2.0) *n = 11*	11 - 35 (18) *n = 4*	11 - 44 (25) *n = 3*	372 - 446 (404) *n = 4*	-
Volunteer	**2015**	*1.3 - 3.5* *(1.8)* *n = 11*	*13 - 22* *(17)* *n = 4*	*14 - 73* *(38)* *n = 4*	*373 - 397* *(384)* *n = 4*	*3.2 - 6.9* (5.1) *n = 4*
Volunteer	**2016**	0.7 - 3.7 (1.7) *n = 11*	8 - 54 (26) *n = 4*	12 - 52 (28) *n = 4*	243 - 786 (502) *n = 4*	-
Long Term Avg		**2.0** **(1996-2016)**	**27** **(1999-2016)**	**41** **(1999-2016)**	**430** **(2014-2016)**	**5.1** **2015**
TRENDS		**Decreasing**	**None**	**None**	**NA**	**NA**

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.