2016 STATE OF THE LAKES UPDATE

NINA LAKE

REPORT DESCRIPTION

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

LAKE DESCRIPTION

Nina Lake is a private 14-acre, man-made lake located just west of I-5 and north of the Tulalip Reservation. The lake is fed primarily by groundwater and drains into the west fork of Quilceda Creek. The Nina Lake watershed, which is the land area that drains to the lake, is very small; it consists of only the homes and streets that immediately encircle the lake. The 2003 bathymetric map shows that the lake has a maximum depth of 12.5 meters (41 feet) in the west basin, and only 5.2 meters (17 feet) in the east basin. The two basins are distinctive, with few aquatic plants in the west basin and dense aquatic plants and more algae in the east basin.

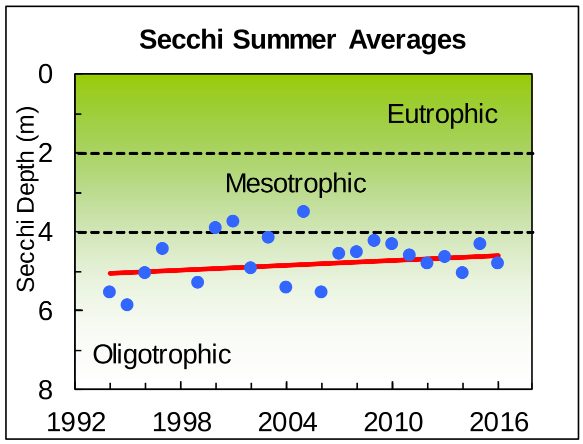
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (shown in red) for water clarity and total phosphorus for Nina 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 Nina Lake (measured in the west basin) is moderate to high. The 1993 – 2016 long-term summer average is 4.7 meters (15.4 feet). The water clarity is quite variable from year to year and even within a single summer. For example, water clarity measurements ranged from 1.5 to 7.0 meters in 2015. This variability is likely in response to the amount of algae in the lake. Also, it is possible that algae growing in the shallow east basin sometimes drifts into the west basin and affects the water clarity readings. Unfortunately, there are no chlorophyll *a* measurements to document the amount of algae growth. When water clarity does decline, it likely means that there is more algae growth occurring in the lake at that time. Overall, between 1993 and 2016, there has been no increasing or decreasing trend in water clarity in Nina 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 Nina Lake averaged 6 pcu (platinum-cobalt color units) in 2010 – 2011, which indicates a very slight amount of color in the lake water. This amount of color is not enough to have a significant effect on water clarity or algae growth.

NINA 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 was collected from April through October 2014 (except for August). Temperature data were collected at each meter throughout the Nina Lake 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 April the upper waters measured about 56°F (13°C) in temperature. In May and June the upper waters measured 66°F (19°C), and by July had reached their peak at 76°F (24°C). At the same time, bottom water temperatures changed only a little and remained at 43-46°F (6.1-7.8°C). Through September and October, the surface waters began to cool. This cooling will continue 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.

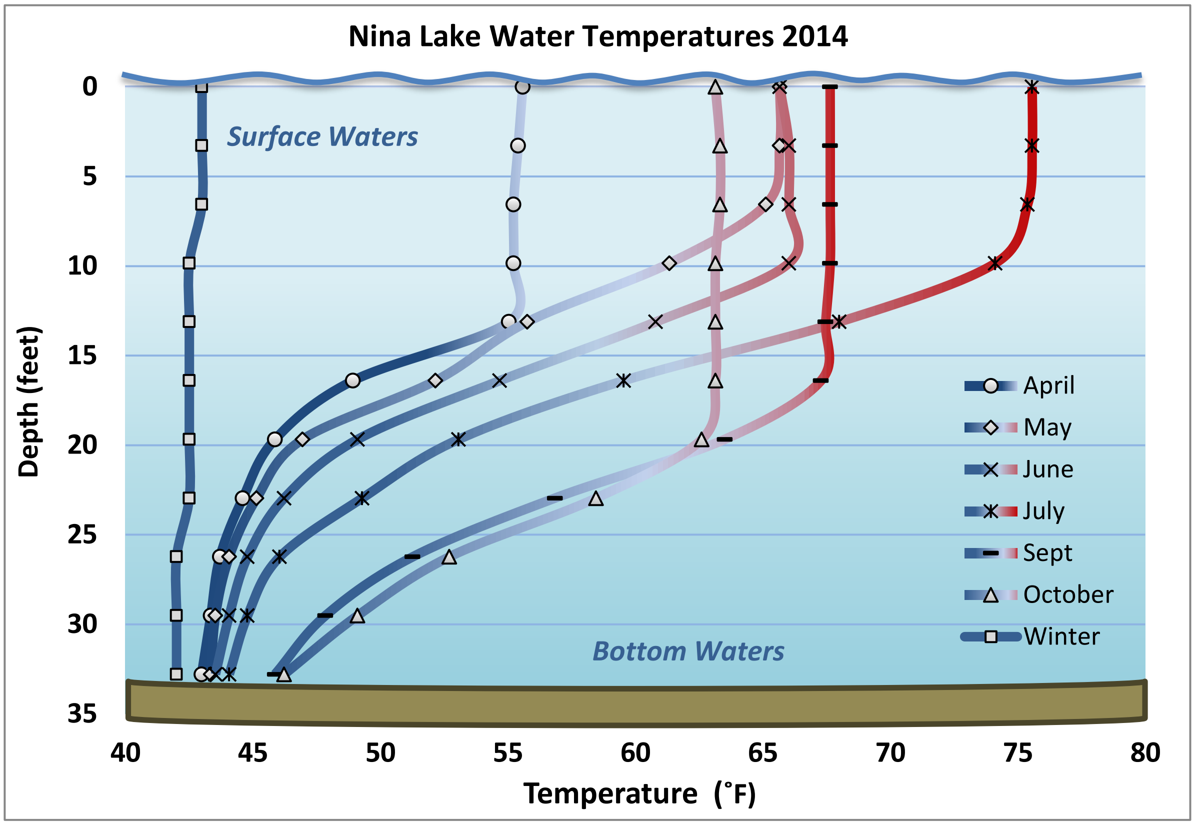
Dissolved Oxygen

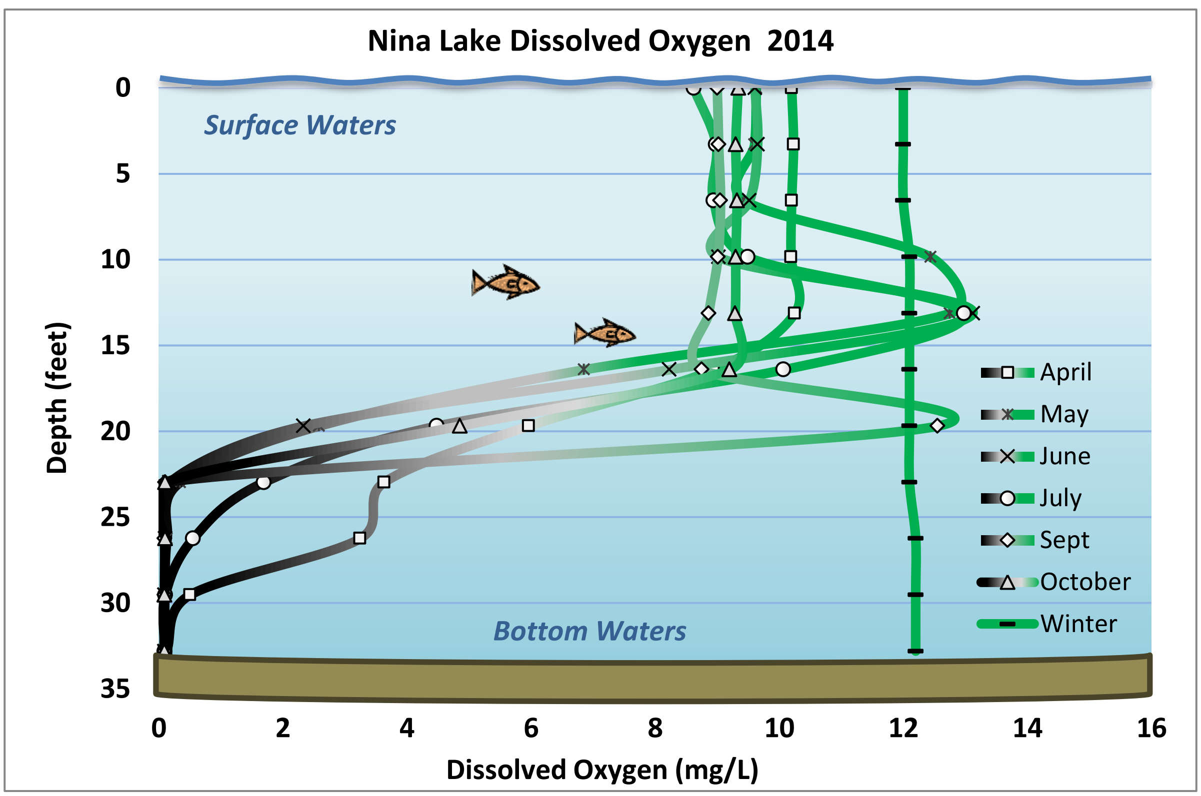
Oxygen dissolved in the water is essential for life in a lake. Most of the dissolved oxygen comes from the atmosphere. Like temperature, dissolved oxygen levels vary over time and with depth. During the warm months, the upper waters receive oxygen from the atmosphere, but the lower waters cannot be replenished 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 Nina Lake water column from April to October in 2014 (see graph). Oxygen levels were relatively high in the upper waters each month. Meanwhile, beginning in May, the bottom waters contained little to no dissolved oxygen below about 23 feet deep. However, from May through July, there was a sharp increase in dissolved oxygen levels about 10 to 15 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water. By September, this spike in dissolved oxygen migrated down to around 20 feet deep as the zone of warmer water expanded.

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.

NINA LAKE


Nina Lake Water Temperatures 2014
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Temperature (˚F)
April
May
June
July
Sept
October
Winter

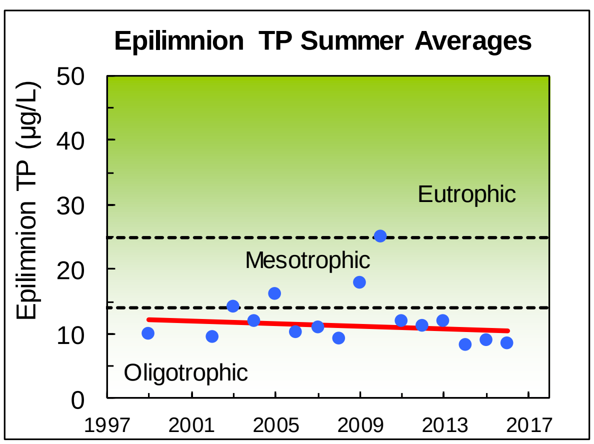

Nina Lake Dissolved Oxygen 2014
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
25
30
35
0
2
4
6
8
10
12
14
16
Dissolved Oxygen (mg/L)
April
May
June
July
Sept
October
Winter

NINA LAKE

Phosphorus (key nutrient for algae)

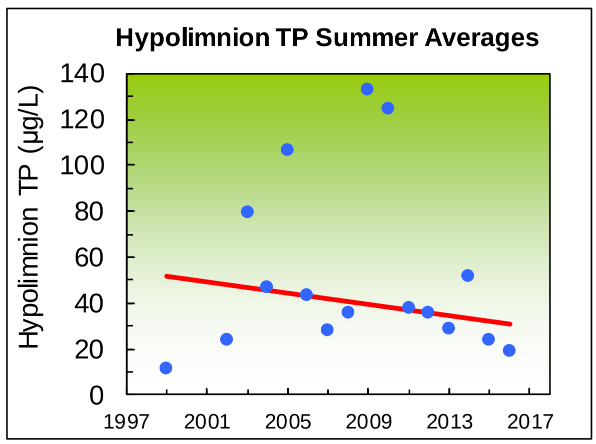
Nutrients are essential for the growth of algae, fish, and aquatic plants in a lake. However, too many nutrients, especially phosphorus, can pollute a lake and lead to unpleasant algae growth. Nutrients enter the lake through stormwater runoff or from streams flowing into the lake. Sources of nutrients 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 concentrations in the epilimnion (upper waters) of the west basin are low to moderate, with a 1999 to 2016 long-term summer average of 12 µg/L (micrograms per liter, which is equivalent to parts per billion). The summer averages were substantially higher in 2009 and 2010, but have been lower since 2011. Overall, there is no evidence of a trend toward increasing phosphorus levels in the upper waters. When more phosphorus is available, more algae growth occurs, leading to reduced water clarity in the lake.



Summertime phosphorus levels in the hypolimnion (bottom waters) are higher than in the upper waters, with a long-term summer average of 52 µg/L. The phosphorus levels are also much more variable than in the upper waters, ranging from a low of 13 µg/L in 1999 to a high of 133 µg/L in 2009. Since 2011 the summer averages dropped below 40 µg/L, with the exception of 2014 (summer average was 52 µg/L). The fluctuations seem to mirror the changes in total phosphorus in the upper waters and, to a lesser degree, the changes in water clarity.

Overall, in spite of some years with high averages, there has not been a statistically significant trend toward higher phosphorus averages in the bottom waters. Any increase of phosphorus in the bottom waters can be a sign that phosphorus is being released from the bottom sediments during periods of low dissolved oxygen in the summer. This would be an early sign of increasing eutrophication in the lake.



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.

No chlorophyll *a* data are available for Nina Lake from 1999-2015. The 2016 summer average of Chlorophyll *a* was 2.1 µg/L, with values ranging from 1.1 µg/L – 3.4 µg/L. This average is one of the lowest in the county, but should be treated with caution as no long term data are available. As mentioned above, the wide variations in water clarity from month to month are probably a result of fluctuating algae levels in the water. It is apparent that there are enough nutrients in the lake water to support nuisance algae growth in Nina Lake.

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, Nina Lake had relatively low levels of total nitrogen (summer average of 299 µg/L). This is consistent with the limited algae growth normally 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. Nina Lake had a relatively moverate average N:P ratio of 35, and algae blooms were not observed in 2016.

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 roots under the water 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 a lake ecosystem. Non-native aquatic plants choke out native plants and form dense stands that are a nuisance to humans and wildlife.

The east basin of Nina Lake supports dense growths of rooted aquatic plants because of the shallow water. There is a narrow band of aquatic plants around the west basin. Most of the plants are native, primarily elodea and thin-leaf pondweeds. However, since the late 1990s, residents have been trying to eliminate small patches of a non-native, invasive plant, parrotfeather milfoil (*Myriophyllum aquaticum*) in the east basin.

In 2010, a new infestation of Eurasian watermilfoil (*Myriophyllum spicatum*) was identified in numerous locations around Nina Lake. This invasive plant spreads by small fragments and is transported from lake to lake by boats and fishing gear. Property owners at Nina Lake contracted with aquatic plant specialists in 2011 to apply herbicides to control the milfoil in the lake. Results of the treatments have been promising, but control efforts must be on-going to eradicate the milfoil infestation. Otherwise, Eurasian watermilfoil has the potential to take over the entire shallow water portions of the lake and severely impact swimming, boating, and fishing.

NINA LAKE

SHORELINE CONDITION

The shoreline condition of a lake is important in overall lake health. At many lakes, bulkheads or other hardening structures are installed along the shoreline, and the zones of native vegetation by the water are removed. This type of developed shoreline does not protect a lake as well as more natural shorelines.

When Nina Lake was created, it had no natural shorelines around the lake. Fortunately, many land owners have allowed buffers of native vegetation to grow up along the shoreline. However, others cultivate lawns down to the water's edge. Efforts to create and maintain more natural shorelines with 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.

DRAINAGE INTO LAKE

As noted above, Nina Lake is fed mainly by groundwater, and the watershed that drains into the lake consists of only the properties right around the lake shore. However, during some periods of heavy rain, water from ditches along 140th Street N.E. overflows back into the lake. This occurs because the surrounding area is very flat, and water flows slowly out of roadside ditches and through the outlet stream of Nina Lake toward the West Fork of Quilceda Creek.

The water that overflows back into Nina Lake is often muddy and likely carries significant phosphorus and nitrogen into the lake. However, because the actual amount of water that flows into the lake is unknown, it is difficult to estimate the magnitude of the load of phosphorus that is reaching the lake from this source. In any case, this does add some additional pollution to the lake that may remain until the following summer. Unfortunately, because of the flat topography, there is little that can be done to prevent this occasional back flow of storm water.

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, the west basin of Nina Lake may be classified as oligo-mesotrophic, with moderate to high water clarity and low to moderate phosphorus concentrations. In contrast, the eastern basin of the lake supports dense aquatic plants and filamentous algae that create problems for lake users; so this portion of the lake may be classified as meso-eutrophic.

NINA LAKE

Condition and Trends

One of the water quality targets for Nina Lake is to maintain stable water clarity. Although there has been no statistically significant trend toward declining water clarity, the long-term average has declined from 4.9 meters in 2002 to 4.7 meters through 2016.

Another target for the lake is to maintain stable phosphorus levels. There has been no trend in long-term phosphorus averages, however phosphorus levels in both the upper and lower waters have been high in some years. Fortunately, the summer averages for both the epilimnion and hypolimnion have not been high since 2010. More phosphorus can lead to more algae in the lake and poorer water conditions.

Overall, Nina Lake is in good condition, but the lake appears to be at risk of future water quality declines if increases in phosphorus levels become trends. These changes may be signs of accelerating eutrophication. This is not unexpected in a man-made lake where nutrient levels and plant and algae growth can steadily increase.

In order to protect the condition of the lake, measures to control nutrients around the shoreline should be taken. 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.

NINA LAKE

DATA SUMMARY FOR NINA 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	**1993**	4.0 - 6.0 (5.1) *n = 7*	-	-	-	-
Volunteer	**1994**	4.0 - 7.5 (5.5) *n = 9*	-	-	-	-
Volunteer	**1995**	4.1 - 7.7 (5.9) *n = 5*	15	33	305	-
Volunteer	**1996**	4.1 - 5.8 (5.0) *n = 5*	9	20	451	-
Volunteer	**1997**	2.3 - 5.6 (4.5) *n = 3*	-	-	-	-
SWM Staff or Volunteer	**1999**	5.3 (5.3) *n = 2*	8 - 12 (10) *n = 2*	11 - 14 (13) *n = 2*	-	-
Volunteer	**2000**	3.2 - 4.6 (3.9) *n = 2*	-	-	-	-
Volunteer	**2001**	3.5 - 4.0 (3.8) *n = 2*	-	-	-	-
Volunteer	**2002**	2.5 - 5.7 (4.9) *n = 8*	8 - 13 (10) *n = 4*	16 - 37 (24) *n = 4*	-	-
Volunteer	**2003**	2.5 - 6.0 (4.2) *n = 12*	9 - 18 (14) *n = 4*	38 - 152 (79) *n = 4*	-	-
Volunteer	**2004**	5.0 - 6.5 (5.4) *n = 8*	10 - 14 (12) *n = 4*	31 - 67 (47) *n = 4*	-	-
Volunteer	**2005**	2.0 - 4.8 (3.5) *n = 7*	12 - 19 (16) *n = 4*	49 - 159 (107) *n = 4*	-	-
Volunteer	**2006**	3.9 - 6.5 (5.6) *n = 8*	6 - 19 (10) *n = 4*	39 - 50 (43) *n = 4*	-	-
Volunteer	**2007**	3.9 - 5.1 (4.6) *n=6*	9 - 15 (11) *n=4*	20 - 34 (28) *n=4*	-	-
Volunteer	**2008**	4.1 - 4.9 (4.5) *n=6*	8 - 11 (9) *n=4*	21 - 61 (36) *n=4*	-	-
Volunteer	**2009**	1.4 - 5.8 (4.2) *n = 9*	12 - 30 (18) *n = 3*	66 - 179 (133) *n = 3*	-	-

NINA LAKE

DATA SUMMARY FOR NINA LAKE						
Source	**Date**	**Water Clarity (Secchi depth in meters)**	**Total Phosphorus (µg/L) Surface**	**Total Phosphorus (µg/L) Bottom**	**Total Nitrogen (µg/L) Surface**	**Chlorophyll *a* (µg/L) Surface**
Volunteer	**2010**	3.2 - 5.3 (4.3) *n = 6*	12 - 42 (25) *n = 4*	75 - 176 (125) *n = 4*	-	-
Volunteer	**2011**	2.9 - 6.7 (4.6) *n = 8*	10 - 13 (12) *n = 3*	31 - 43 (38) *n = 4*	-	-
Volunteer	**2012**	2.1 - 6.3 (4.8) *n = 4*	10 - 13 (11) *n = 4*	29 - 45 (36) *n = 4*	-	-
Volunteer	**2013**	2.9 - 6.6 (4.7) *n = 10*	11 - 13 (12) *n = 4*	24 - 35 (29) *n = 3*	-	-
Volunteer	**2014**	*3.0 - 6.5* *(5.1)* *n = 9*	*6 - 11* *(8)* *n = 4*	*20 - 77* *(52)* *n = 4*	303 - 378 (329) *n = 4*	-
Volunteer	**2015**	*1.5 - 7.0* *(4.3)* *n = 12*	*4 - 15* *(9)* *n = 4*	*5 - 46* *(24)* *n = 4*	*159 - 441* *(267)* *n = 4*	-
Volunteer	**2016**	4.2 - 6.5 (4.8) *n = 8*	5 - 12 (9) *n = 4*	13 - 24 (19) *n = 4*	213 - 381 (301) *n = 4*	1.1 - 3.4 (2.1) *n = 4*
Long Term Avg		**4.7** **(1993-2016)**	**12** **(1999-2016)**	**52** **(1999-2016)**	**299** **(2014-2016)**	**2.1** **2016**
TRENDS		**None**	**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 from 1995-1996 are from **composite samples** taken at varied depths.
- Total phosphorus data from 1999 and later 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.