2009 STATE OF THE LAKES UPDATE

LAKE MARTHA (MARTHA N.)

REPORT DESCRIPTION

This report is an annual update to the 2003 State of the Lakes Report and includes water quality data collected from 2003 through 2009. For additional background on the information provided here or to find out more about Lake Martha, please visit www.lakes.surfacewater.info or call Snohomish County Surface Water Management (SWM) at 425-388-3464.

LAKE DESCRIPTION

Lake Martha is a 63-acre lake located in the Seven Lakes area north of the Tulalip Reservation. It is fed by runoff from Lake Howard and empties into an unnamed stream that discharges to Port Susan near Warm Beach. Lake Martha is one of the deeper lakes in the county, with a maximum depth of 21.3 meters and a mean depth of 10.1 meters.

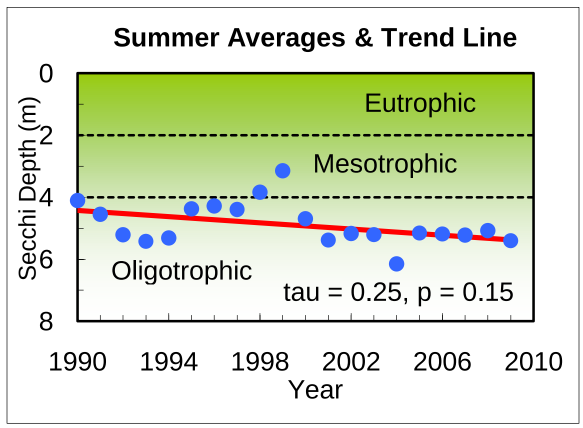
The total watershed, including the drainage area from Lake Howard, is large—about 17 times the size of the lake. There are over 70 homes clustered around the lake shore. Much of the overall watershed is still undeveloped, but more development is anticipated, including the possibility of a large planned development north and east of the lake. Future land use changes could have an impact on the water quality of the lake.

LAKE CONDITIONS

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

Water clarity in Lake Martha is high and variable, with a long-term 1990-2009 summer average of 4.9 meters. There was a decline in water clarity between 1994 and 1999, suggesting that the lake was receiving more nutrients from the watershed and producing more algae. However, the water clarity improved in 2000 and 2001 and has remained stable since then, averaging around 5.3 meters in recent years. Despite these past variations, there has been no statistically significant trend in water clarity between 1990 and 2009.



LAKE MARTHA (MARTHA N.)

Temperature

From May through October 2009, temperature data were collected at each meter throughout the Lake Martha water column. The temperature data showed that the lake was strongly thermally stratified during the entire May through October period (see graph on following page). This means that there was a strong temperature difference between the warm upper waters and the cool bottom waters, and mixing did not occur between these layers. By May the upper waters were already significantly warmer than the lower waters, with a 12°C (22°F) temperature difference. The upper waters reached a peak in temperature in late July of 24°C (75°F), and then cooled down until October. Over the same time period, bottom water temperatures changed only a little, remaining around 6°C (43°F). In November and December, the surface waters will continue to cool 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 began to warm again.

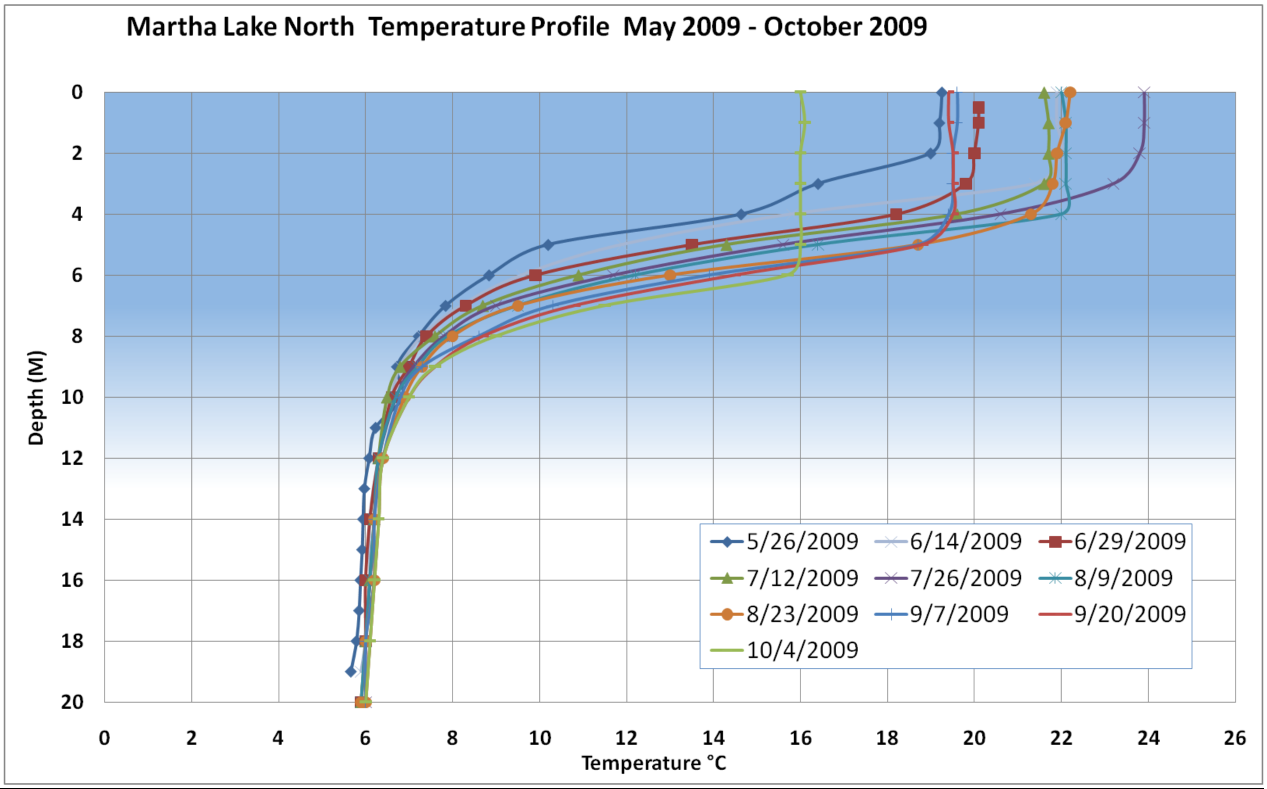
Dissolved Oxygen

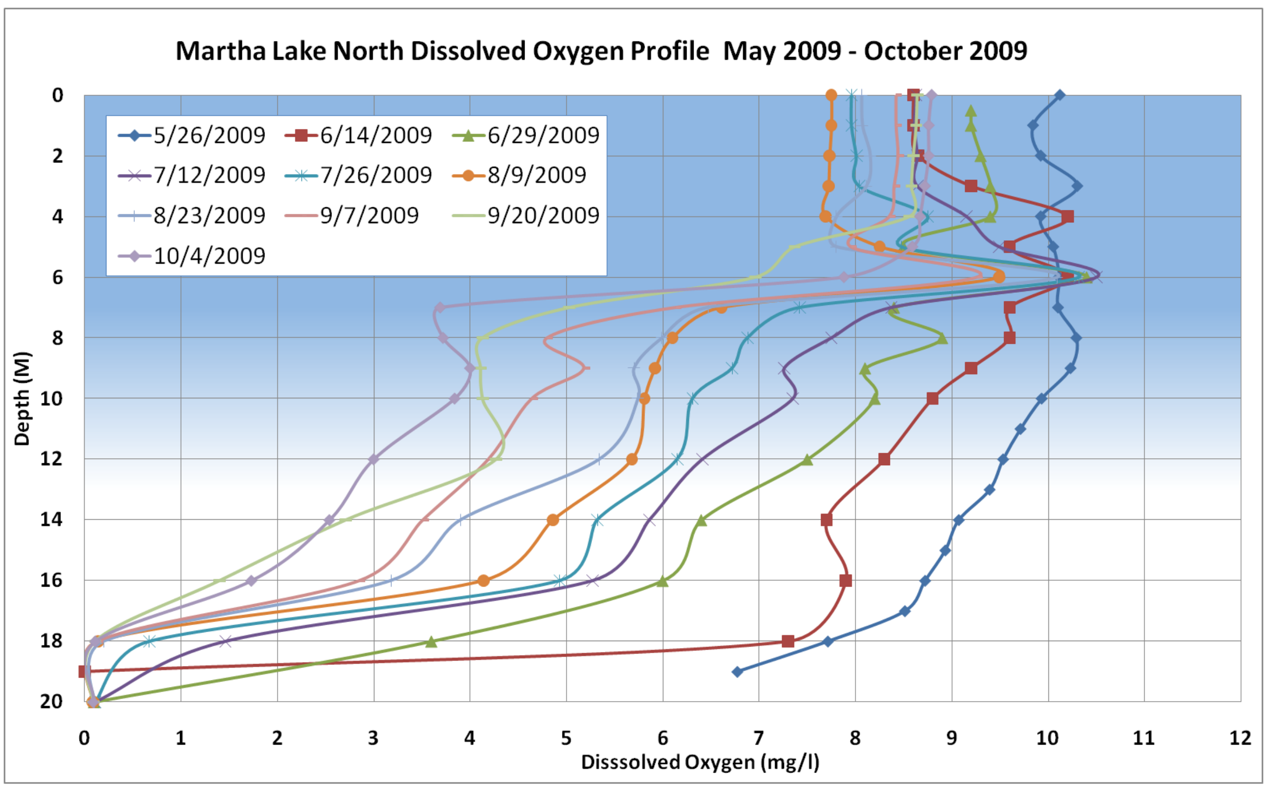
The depth profiles of dissolved oxygen measured in 2009 largely mirrored the temperature profiles seen during that time period (see next graph). Oxygen levels were high in May and declined in the bottom layers of the lake throughout the summer. By June there was little or no oxygen in the water at 18 meters and below. During the stratified summer period, oxygen in the lower waters is consumed by the decomposition of organic material within the lake. Since the lake is strongly stratified, the oxygen is not replenished by the overlying oxygen-rich upper waters or by the atmosphere. Even in October when the upper waters began to cool, the dissolved oxygen was still near zero below approximately 18 meters, meaning that the lake had not completely mixed. During the winter, the lake will mix, and dissolved oxygen will be replenished throughout the lake.

From late June through mid-September, measurements showed a spike in dissolved oxygen near 6 meters depth. This is likely due to vigorous algal growth at the interface between the upper and lower waters. Algae often thrive in this zone because there is available light in the upper waters and higher nutrients available in the lower waters. During this period the water clarity was also reduced, which indicates that algae were likely present and affecting the clarity of the water.

Another interesting observation about Lake Martha is that several times between June and October there was a decline in dissolved oxygen around 7 to 9 meters depth followed by a slight increase in dissolved oxygen immediately below that depth. The reasons for this phenomenon (which is seen every year) may be slow settling and decomposition of organic matter, an abundance of zooplankton (tiny animals) at this depth, and/or the shape of the lake which causes much of the lake bottom decomposition to occur at this depth. Sometimes there is also another smaller indication of this phenomenon at about 14 to 17 meters depth.

LAKE MARTHA (MARTHA N.)

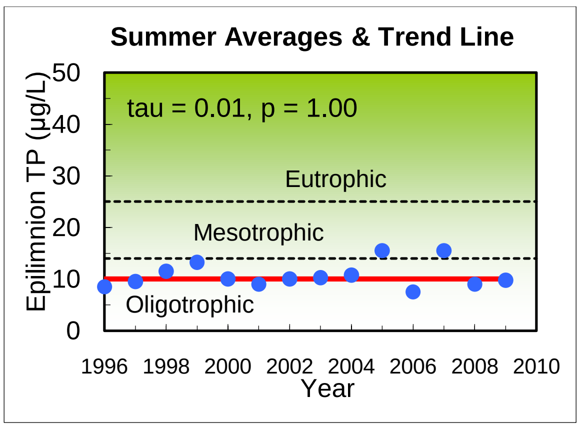




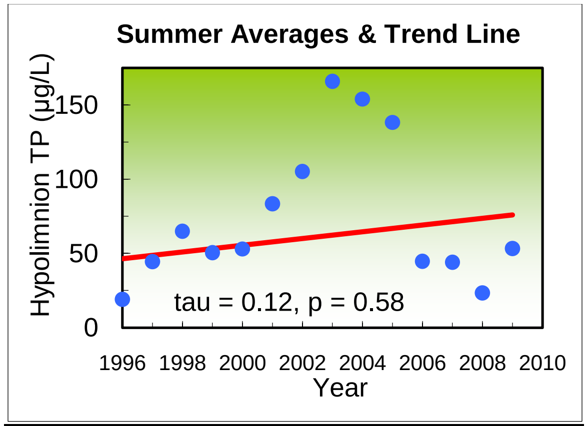
LAKE MARTHA (MARTHA N.)

Total Phosphorus (key nutrient for algae)

Total phosphorus concentrations in the epilimnion (upper waters) of Lake Martha are relatively low, with a long-term 1996 to 2009 average of 11 µg/l. The average phosphorus concentrations in 2005 and 2007 were the higher at 16 µg/l. However, the summer averages in 2006, 2008, and 2009 were lower, between 8 and 10 µg/l. There is no evidence of a trend toward higher phosphorus concentrations in the epilimnion.

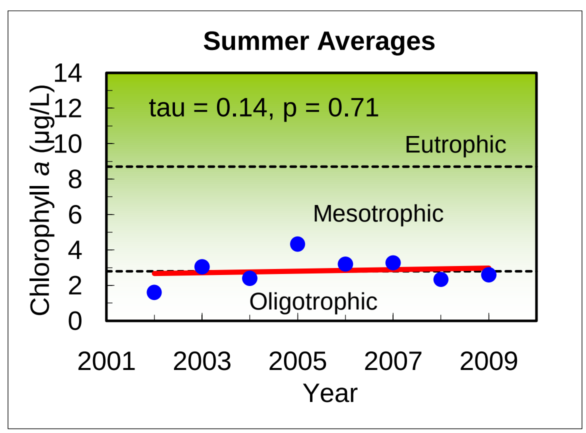


In contrast, summertime phosphorus levels in the hypolimnion (bottom waters) are high, with a long-term 1996-2009 summer average of 75 µg/l. Prior to 2007, there was a statistically significant trend toward increasing phosphorus in the bottom waters because of a large increase between 1996 and 2005. However, lower values in 2006 through 2009 have obscured evidence of any increasing trend. Higher phosphorus levels in the bottom waters can indicate a build-up of phosphorus being released from the bottom sediments during periods of low dissolved oxygen. If this occurs, it would point to accelerated eutrophication and could lead to future algae problems. The recent lower levels may be an indication of stabilizing lake conditions and reductions in nutrients from the watershed, but more years of data will be needed to confirm this as a long-term pattern.



Chlorophyll a (Algae)

Chlorophyll *a* values consistently showed low to moderate levels of algae in Lake Martha during the summers of 2002 through 2009, with a long-term average concentration of 2.9 µg/l. However, dense blue-green algal blooms are sometimes reported in the lake.



LAKE MARTHA (MARTHA N.)

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 algal blooms. 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. Lake users should avoid contact with the water and keep pets away from the lake when it is experiencing a blue-green algal bloom. If a bloom is identified as toxic, the lake will be posted with signs at the public access site.

Since 2005, volunteers and SWM staff have screened algae at Lake Martha for potentially toxic blooms. Beginning in 2009, routine toxin testing at Lake Martha also began as part of a larger project coordinated by the Washington State Department of Health. The project is funded by a grant from the U.S. Centers for Disease Control (CDC) and includes monitoring of thirty lakes in Snohomish, King, and Pierce Counties. The CDC project is being conducted to identify algal blooms that could pose a potential health threat and to alert the public about toxic algae. In 2009, water samples were tested for two types of toxins: microcystis (a liver toxin) and anatoxin-a (a neurotoxin). Tests for saxitoxin (a neurotoxin) and cylindrospermopsin (a liver toxin) will be added in 2010.

In 2009, Martha Lake did have blooms of blue-green algae. However, only one sample, taken during a bloom, showed the presence of algal toxins (microcystin). The concentration was very low (0.053 ppb), which is below the recreational standard of 6 ppb set by the State Department of Health. Anatoxin-a was not detected in any of the samples collected. The project will continue in 2010 and 2011 and will help to determine if 2009 was a typical year for algal blooms and associated toxins.

SHORELINE CONDITION

The Lake Martha shoreline was surveyed in 2009 (see map on page 7). The condition of the lake shoreline is important to understanding overall lake health. As development on a lake increases, lake shorelines typically are modified through removal of natural vegetation, the installation of bulkheads or other hardening structures, and/or the removal of large logs and branches. This type 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.

The Lake Martha shoreline is moderate to highly developed. Surveys conducted in the mid-90s identified 74 homes bordering the lake, with an average of 7.5 homes per 1000 feet of shoreline. Although homes were not surveyed in 2009, 79 docks were counted. Approximately 38% of the 1.9 miles of shoreline has been modified with bulkheads, rock or log revetments, or fill. Much of the native vegetation immediately adjacent to the shoreline has also been significantly altered, with only 34% now being classified as intact. There is still a moderate amount (about 129 pieces) of large wood remaining in the lake. These old logs and branches are valuable for fish and wildlife habitat.

The overall amount of shoreline modification leaves the lake susceptible to pollution from the watershed, eliminates the buffer of native vegetation that can filter out pollution, and limits the amount of habitat available for fish and wildlife. The loss of native vegetation along the shoreline could also lead to shoreline erosion.

LAKE MARTHA (MARTHA N.)

SUMMARY

Trophic State

Based on high water clarity, low phosphorus levels in the epilimnion, high phosphorus in the hypolimnion, low to moderate algae concentrations, and moderate oxygen depletion, Lake Martha may be classified as mesotrophic.

Condition and Trends

Water clarity in Lake Martha has been good in recent years. Although there is no evidence of a statistical trend, the lake is exceeding the water clarity target of 4.6 meters set forth in the 2003 State of the Lakes Report.

The lake is also meeting the target of maintaining stable phosphorus levels in the upper waters. The phosphorus levels in the epilimnion have remained low with no evident trends.

The target of maintaining stable total phosphorus levels in the hypolimnion is not being fully met because phosphorus concentrations in the bottom waters have been quite variable. Also, the long-term average concentration of phosphorus between 1996 and 2009 is higher than the long-term average prior to the 2003 report. Although phosphorus levels in the hypolimnion have been lower since 2006 and there is no longer evidence of a statistical trend toward higher phosphorus in the hypolimnion, it is too early to know if lake conditions have improved over the long term. Higher hypolimnion phosphorus levels may be an indication of accelerating eutrophication, which could be an early warning sign of future increases in algal growth in the lake.

Lake Martha remains in satisfactory condition. However, the lake is at risk of future water quality declines as indicated by high phosphorus levels in the hypolimnion and severe, if occasional, blue-green algal blooms. Lake Martha is susceptible to an increase of nutrients in stormwater runoff from new development and from other human activities in the watershed. Sources of nutrients include fertilizers, pet wastes, runoff from roofs and driveways, and erosion from construction and land clearing. Nutrients may also directly enter the lake from poorly maintained septic systems. Measures to control nutrients in the watershed should be taken now and as new development occurs 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 www.lakes.surfacewater.info.

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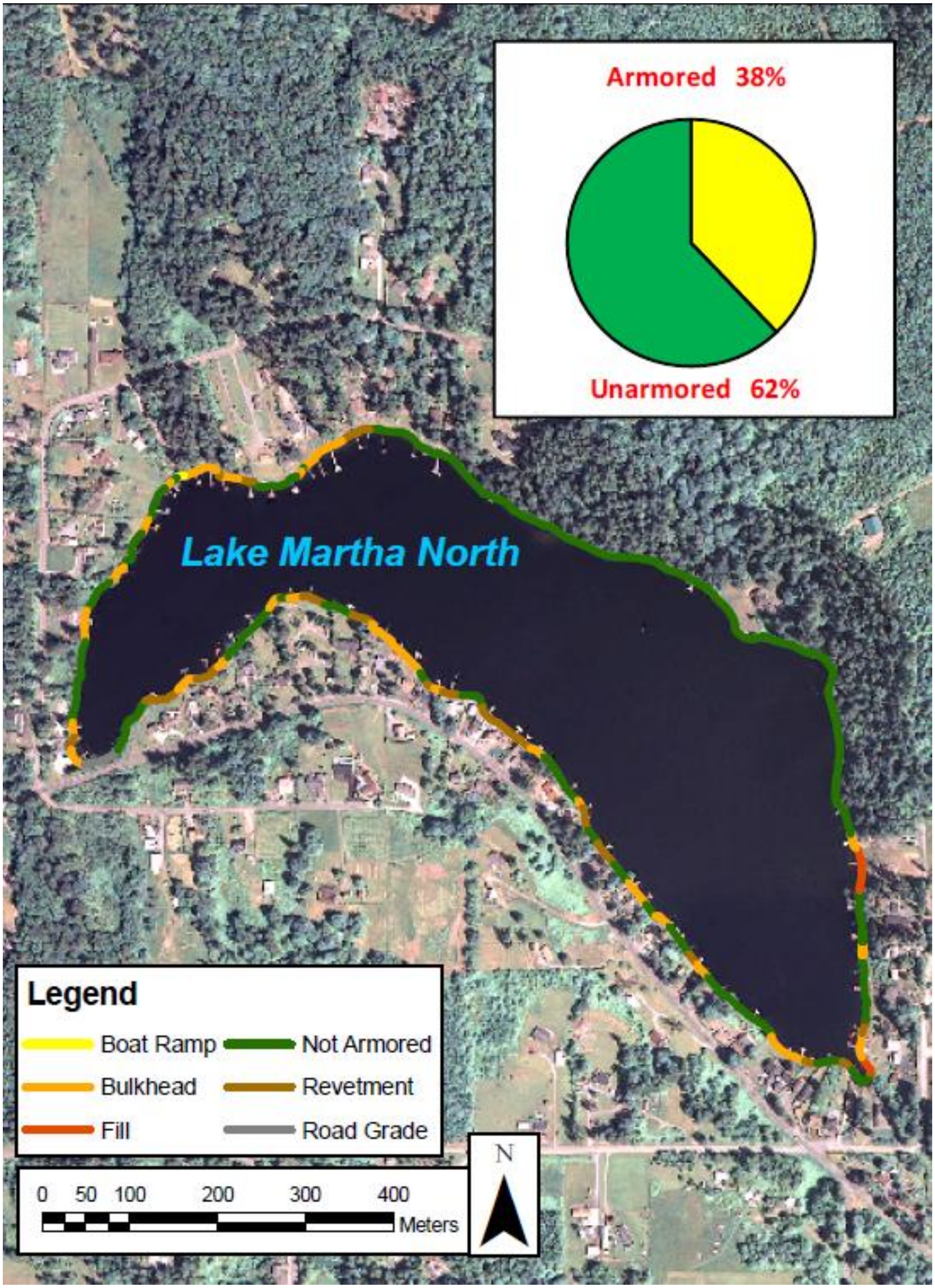

LAKE MARTHA (MARTHA N.)

DATA SUMMARY FOR LAKE MARTHA (N.)					
		Water Clarity (Secchi depth	**Total Phosphorus (*ug/l*)**		**Chlorophyll *a* (*ug/l*)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Epilimnion**
Bortleson, et al, 1976	**6/20/74**	2.7	17	29	-
Sumioka and Dion, 1985	**6/30/81**	3.0	10	80	6
Entranco, 1986	**1983**	3.8 - 5.0 (4.4) *n = 5*	<5 - 7 (5.4) *n = 5*	<5 - 39 (18) *n = 5*	1.8 - 6.2 (3.1) *n = 5*
DOE	**1990**	3.1 - 5.2 (4.1) *n = 11*	-	-	-
DOE	**1991**	3.6 - 5.5 (4.5) *n = 9*	-	-	-
DOE	**1992**	3.6 - 6.1 (5.2) *n = 9*	-	-	0.6 - 1.9 (1.3) *n = 2*
DOE	**1993**	3.8 - 6.3 (5.4) *n = 11*	-	-	3.1 - 5.0 (4.1) *n = 2*
SWM Staff or DOE	**1994**	3.7 - 6.6 (5.3) *n = 12*	-	-	0.1 - 4.0 (2.3) *n = 4*
SWM Staff or DOE	**1995**	3.7 - 5.5 (4.4) *n = 12*	-	-	3.6 - 9.9 (6.6) *n = 3*
SWM Staff or DOE	**1996**	3.0 - 5.6 (4.3) *n = 12*	4 - 13 (9) *n = 2*	18 - 20 (19) *n = 2*	2.6 - 3.0 (2.8) *n = 2*
SWM Staff or DOE	**1997**	3.2 - 5.0 (4.4) *n = 13*	8 - 11 (10) *n = 2*	28 - 61 (45) *n = 2*	3.0
SWM Staff or DOE	**1998**	3.2 - 4.7 (3.8) *n = 12*	9 - 15 (12) *n = 4*	29 - 104 (65) *n = 4*	-
SWM Staff or DOE	**1999**	1.9 - 5.0 (3.1) *n = 18*	10 - 18 (13) *n = 4*	37 - 65 (51) *n =4*	3.2 - 11 (8.3) *n = 4*
SWM Staff or DOE	**2000**	4.0 - 5.3 (4.7) *n = 14*	8 - 14 (10) *n = 4*	28 - 75 (53) *n = 4*	-
SWM Staff or Volunteer	**2001**	4.9 - 5.9 (5.4) *n = 10*	7 - 11 (9) *n = 4*	32 - 148 (84) *n = 4*	-
SWM Staff or Volunteer	**2002**	4.3 - 6.2 (5.2) *n = 9*	8 - 12 (10) *n = 4*	24 - 204 (105) *n = 4*	0.5 - 3.5 (1.6) *n = 4*
SWM Staff or Volunteer	**2003**	4.2 - 6.3 (5.2) *n = 10*	10 - 11 (10) *n = 4*	38 - 389 (166) *n = 4*	2.1 - 5.3 (3.1) *n = 4*

LAKE MARTHA (MARTHA N.)

DATA SUMMARY FOR LAKE MARTHA (N.)					
		Water Clarity (Secchi depth	**Total Phosphorus (*ug*/l)**		**Chlorophyll *a* (*ug*/l)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Epilimnion**
SWM Staff or Volunteer	**2004**	5.2 - 7.2 (6.2) *n = 9*	6 - 13 (11) *n = 4*	40 - 334 (154) *n = 3*	1.1 - 4.8 (2.4) *n = 4*
SWM Staff or Volunteer	**2005**	3.9 - 6.1 (5.2) *n = 13*	8 - 30 (16) *n = 4*	51 - 254 (138) *n = 4*	1.6 - 12 (4.3) *n = 4*
SWM Staff or Volunteer	**2006**	4.6 - 6.5 (5.2) *n = 12*	2 - 11 (8) *n = 4*	37 - 57 (45) *n = 3*	2.4 - 3.7 (3.2) *n = 4*
SWM Staff or Volunteer	**2007**	3.2 - 6.4 (5.2) *n = 12*	12 - 23 (16) *n = 4*	26 - 62 (44) *n = 4*	1.6 - 5.3 (3.3) *n = 4*
SWM Staff or Volunteer	**2008**	4.5 - 5.9 (5.1) *n = 11*	7 - 11 (9) *n = 3*	19 - 31 (23) *n = 3*	1.6 - 2.7 (2.3) *n = 3*
SWM Staff or Volunteer	**2009**	4.0 - 6.3 (5.4) *n = 11*	7 - 15 (10) *n = 4*	37 - 66 (53) *n = 3*	1.9 - 4.0 (2.6) *n = 4*
Long Term Avg		**4.9** **(1990-2009)**	**11** **(1996-2009)**	**75** **(1996-2009)**	**2.9** **(2002-2009)**
TRENDS		**None**	**None**	**None**	**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.