The Lakes of Maple Valley and Covington

A Report on Monitoring Results for the 2010 Water Year at Lake Lucerne, Pipe Lake, and Lake Wilderness

Lake Wilderness, July 2009 *Lake Stewardship Program*

Prepared for the Cities of Maple Valley and Covington
by the King County Lake Stewardship Program

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Overview

The King County Lake Stewardship Program and its predecessor programs have worked with volunteer monitors for more than 18 years on each of the three lakes that are currently completely or partially within the Cities of Maple Valley and Covington. Lakes Lucerne, Pipe, and Wilderness have been monitored since the 1980s. The water quality data indicate that the three lakes are low to moderate in primary productivity with good water quality.

This report refers to two common measures used to predict water quality in lakes: the Trophic State Index or TSI (Carlson 1977), and the nitrogen to phosphorus ratio (N:P). The TSI and N:P ratios were calculated from the data collected through the King County Lake Stewardship (KCLSP) volunteer monitoring program. TSI values are derived from a regression that relates values of a parameter such as total phosphorus, chlorophyll *a* or Secchi transparency to the predicted algal bio-volume, assigning a number on a scale of 0 to 100. This scale can be used to compare water quality over time and between lakes. The TSI values at each of the lakes in Maple Valley have been relatively stable for at least the last 13 years, with no verified trends of declining water quality evident for any of the lakes.

The discussion in this report focuses on the 2010 water year. Specific data used to generate most of the charts in this report can be downloaded from the King County Lake Stewardship data website at:

http://your.kingcounty.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx

Or it can be provided in the form of excel files upon request.

Lake Lucerne

Volunteer monitoring began at Lake Lucerne in the 1980s and continued through 2010, with a gap in the early 1990s. The data indicate that this 16-acre lake is relatively low in primary productivity (oligotrophic - mesotrophic) with good to excellent water quality.

Lake Lucerne has no public access boat launch, but does have a history of both milfoil and hydrilla infestations for which eradication efforts have been underway since 1995. Milfoil has been eradicated, and the last hydrilla plant was found six years ago. Lake Lucerne is no longer treated with herbicide and had no residual levels of fluridone (Sonar PR ™) when tested in spring 2010. The year 2010 was the first that adjoining Pipe Lake was no longer treated. King County and its contractor will monitor as aquatic plants begin to recover in the shallow water zones of the lake. Lake users and residents should keep a close eye on aquatic plants growing nearshore to catch new or expanding patches of noxious weeds.

Physical Parameters

No precipitation or lake level data were collected for Lake Lucerne in 2010.

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

Volunteers collected Secchi transparency and temperature data from early May through late October during the “Level 2” monitoring season when volunteers collect water samples for laboratory analysis. Secchi transparency ranged between 4.3 and 7.3 m from May through October (Figure 1), averaging 5.4 m, which was in the upper third of the small lakes monitored in 2010.

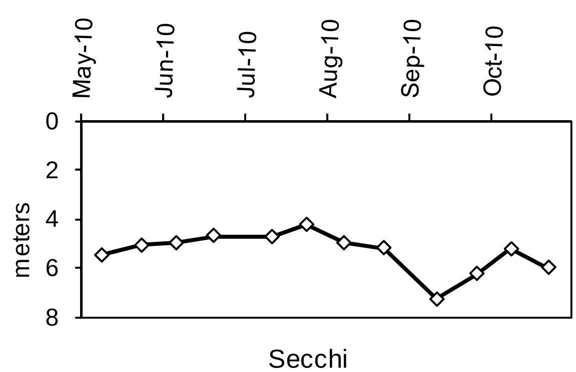

Figure 1. WY 2010 Lake Lucerne Secchi Depth

Surface water temperatures reached ranged from 14.0 to 23.5 degrees Celsius, with an average of 18.8 degrees Celsius, which was also in the upper third for monitored lakes, but which was cooler than in 2009 (Figure 2).

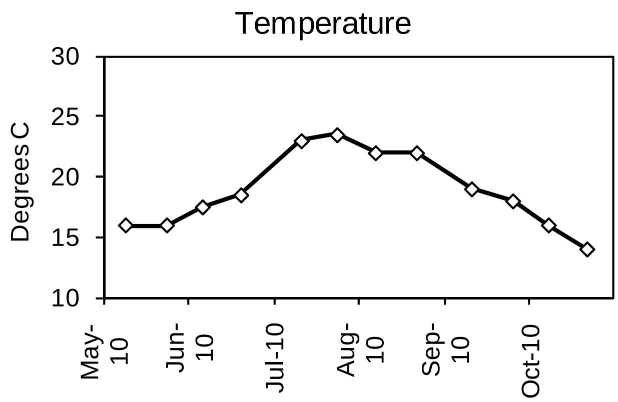

Figure 2. WY 2010 Lake Lucerne Temperature

Nutrient and Chlorophyll Analysis (Lake Lucerne)

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms – a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

Total phosphorus (TP) and total nitrogen (TN) varied slightly through the sampling period. TN concentrations began higher in spring and tapered off until fall with little variation between dates. Phosphorus was generally stable at low levels throughout the season (Figure 3).

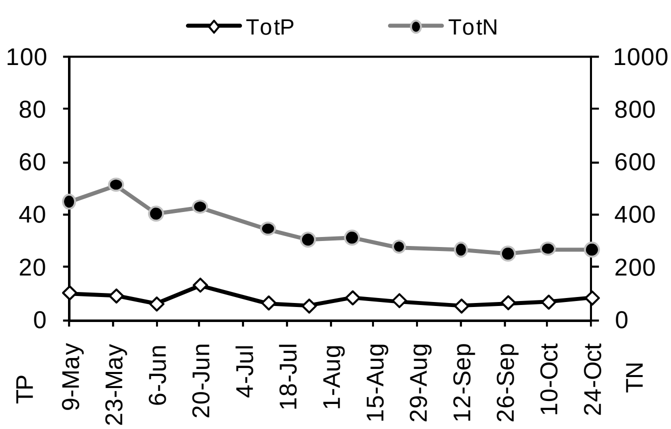

Figure 3. WY 2010 Lake Lucerne Total Phosphorus and Total Nitrogen Concentrations

The ratio of nitrogen (N) to phosphorus (P) can be used to determine if conditions are favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. When N:P ratios are near 20 or below, cyanobacteria often dominate the algal community due to their ability to take nitrogen from the air. Total phosphorus and total nitrogen remained in relatively constant proportion to each other through the sampling period, ranging from 32.7 to 69.8 with an average of 47.0, which suggests generally poor conditions for growing nuisance bluegreen algae at Lake Lucerne.

Chlorophyll *a* concentrations remained relatively stable throughout the season, except for a slight rise through the summer months. Pheophytin, which is degraded chlorophyll, was at levels near or below detection levels throughout the period (Figure 4).

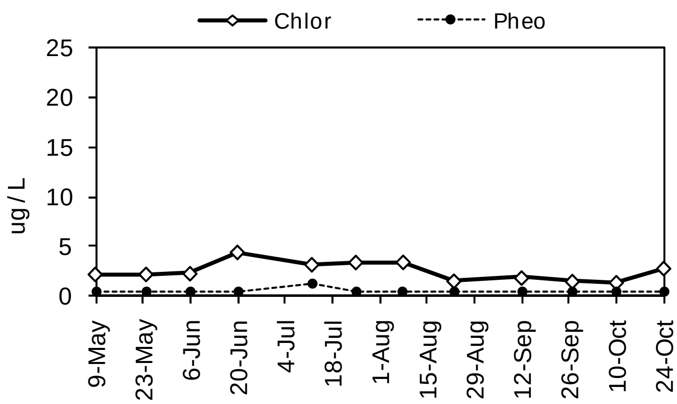

Figure 4. WY 2010 Lake Lucerne Chlorophyll *a* and Pheophytin concentrations

Temperature profile data indicate that thermal stratification was present by mid-May and persisted through the summer (Table 1).

Table 1. Lake Lucerne Profile Sample Analysis Results. Sample values below minimum detection level are marked <MDL.

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Lucerne	5/24/10	5.1	1	16.0	2.2	**0.5**	0.512	0.024	0.0089		0.066	32.9
			5	12.0	3.8	**0.5**	0.598		0.0174			
			9	8.0			0.414	0.016	0.0299	0.0036		
Lucerne	8/23/10	5.2	1	22.0	1.6	<MDL	0.277	<MDL	0.0071	0.0021	0.082	29.3
			5	19.0	3.0	1.3	0.303		0.0069			
			9	10.0			0.571	<MDL	0.0427	<MDL		

Concentrations of total phosphorus (Total P) in the deep water remained relatively low, though the deep water concentration did increase by the end of August. The amount of orthophosphate (OPO4) also was low on both dates, showing no sign of major release of phosphorus from the sediments. This suggests that internal loading of phosphorus to the lake was relatively minor.

Very little ammonia built up in the deep water over the period of stratification, which indicates that the deep water remained relatively well-oxygenated

Chlorophyll *a* data (Chlor) indicate that algae were more or less equally distributed through the upper depths of the water column at fairly low concentrations, with little degraded chlorophyll present (pheophytin).

Alkalinity, also known as acid neutralizing capacity or buffering capacity, was relatively low, while water color (UV254) was very low, indicating that dissolved organic carbon was not important in the lake.

TSI Ratings (Lake Lucerne)

The 2010 TSI values for chlorophyll and Secchi were in the upper range of oligotrophy and TSI-TP was somewhat lower (Figure 5). The average of the three values was 37.1, putting Lake Lucerne in the upper range of oligotrophy, indicating it is fairly low in primary productivity. The relationships between the 3 different indicators have held steady for the past 4 years, with the phosphorus concentrations predicting the lowest algae populations.

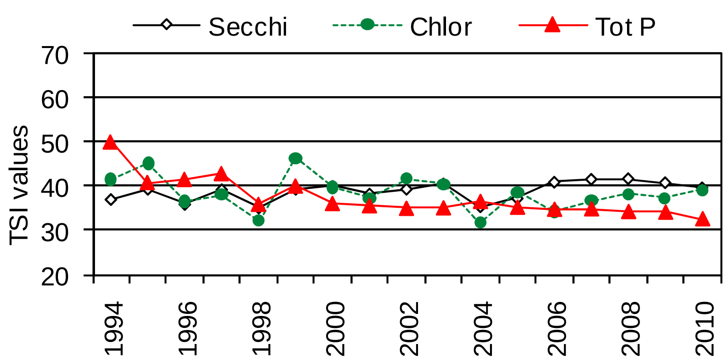

Figure 5. Lake Lucerne Trophic State Indicators

Side-by-side measurements

In 2003, a Hearing Examiner took testimony concerning a SEPA appeal on the permit for development of a piece of land within the City of Maple Valley known as the "Brown Plat." The appeal was based in part on the potential for adverse effects from the development on water quality in Lake Lucerne. The document entitled Findings, Conclusions and Decision on the Shoreline Substantial Development Permit (Case no. PP01-1482/CD0207-001) included instructions to the City of Maple Valley to fund professionally-collected water quality sampling of Lake Lucerne in tandem with the long-term volunteer-assisted lake monitoring by the King County Lake Stewardship Program.

In 2010, the second series of side-by-side measurements of lake water quality were made by both King County professional staff and the Lake Lucerne water quality monitor. These included water sample collection, Secchi transparency and temperature readings taken within a short time span. All water samples were delivered to the King County

Environmental Laboratory for analysis and were run in the same batch, thus limiting analytical error as an explanation for differences. Samples were collected at 1 m for comparison on four different dates: July 12, July 25, August 19, and August 23, 2010.

Compiling all the results from 2009 and 2010 suggest very good consistency between professionally collected and volunteer collected data for Lake Lucerne at this time (Table 2), support the reliability of volunteer collected data from the Lake Stewardship Program. All of these data were well within the bounds of sample variability, with an average difference of 10% or less, even for the Secchi transparency reading which depends on light levels, windiness, glare off the water surface, and the keenness of vision and experience of the field crew.

Table 2. Lake Lucerne Profile Sample Analysis Results July – August 2009-2010

Parameter	Volunteer	King County	%diff
Secchi transparency (m)	5.0	5.5	9%
Temperature (deg Celsius)	23.2	22.8	2%
Total Nitrogen (mg/L)	0.314	0.332	6%
Total Phosphorus (mg/L)	0.0077	0.0087	10%
N : P ratio	43.1	39.1	10%
Trophic State - TP	33.1	35.1	6%

Analytical tools, such as the N:P ratio and the trophic state indicators, also produced small differences within a tight range, indicating that the conclusions drawn from either set of data would have been the same.

Conclusions and Recommendations

Based on monitoring data, water quality in Lake Lucerne appears to have been stable over the period measured. High N:P ratios indicate conditions are not favorable for nuisance bluegreen algae blooms. Watershed development is occurring in the Lake Lucerne basin, and the lake should continue to be monitored to insure that conditions from increased development do not affect the water quality of the lake. With the sunset of herbicide treatments as part of the hydrilla eradication project in both Pipe and Lucerne Lakes, the city and the residents around the lake should be vigilant in looking for invasive aquatic plants colonizing the lake, such as Eurasian watermilfoil, in addition to the return of native aquatic plants.

The side-by-side measurements made over two summers between samples collected by King County staff and samples collected by volunteers shows that little or no difference in conclusion would be found between analysis of the data sets, and data from volunteer collected samples in this case may be treated as equally valid to data from professionally collected samples.

Pipe Lake

Volunteer monitoring began at Pipe Lake in the 1980s and has been continuous since 1993. The data indicate this 52-acre lake is fairly low in primary productivity (high oligotrophic) with very good water quality. Nearly 55% of the shoreline of Pipe Lake is in the City of Maple Valley. The remainder is in the City of Covington.

Pipe Lake has no public access boat launch, but there is a community boat launch at Cherokee Bay. The lake is connected to Lake Lucerne by a short channel and has a history of both milfoil and hydrilla infestations for which eradication efforts have been funded by government agencies since 1995. Eurasian watermilfoil has been eradicated, and the last plant of hydrilla was found in 2006. The 2010 season the first in seven years in which no herbicide was applied to the lake. Instead, diving and snorkeling surveys focused on finding remnants of hydrilla and documenting the return of native aquatic plants to the lake. Residents should watch aquatic plants growing nearshore to catch growing patches of milfoil, Hydrilla or other noxious weeds.

Physical Parameters

No precipitation or lake level data were collected for Pipe Lake in 2010.

Volunteers collected Secchi transparency and temperature data from early May through late October during the "Level 2" monitoring season when volunteers collect water samples for laboratory analysis. Secchi transparency from late May through October ranged from 4.0 to 7.0 m, averaging 5.7 m which placed it among the 3 clearest lakes during the 2010 monitoring (Figure 1).

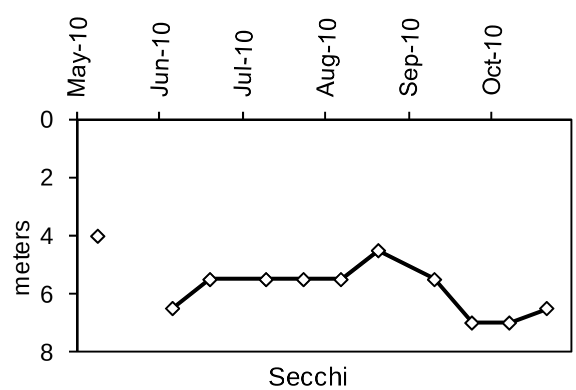

Figure 1. WY 2010 Pipe Lake Secchi Depth

Water temperatures for the same period ranged from 14.0 degrees Celsius to a peak of 25.5 degrees Celsius with an average of 19.3, which was the warmest of all monitored lakes in 2010, but which was cooler than the previous year (Figure 2).

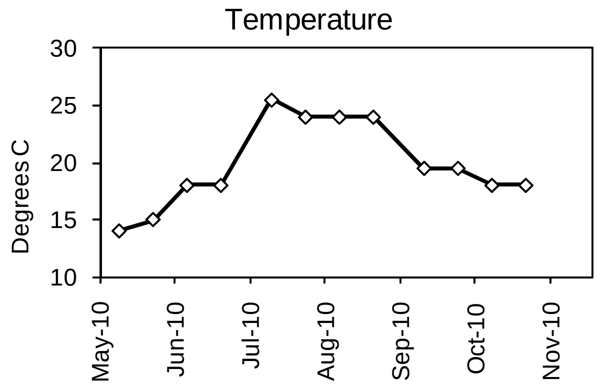

Figure 2. WY 2010 Pipe Lake Temperature at 1m

Nutrient and Chlorophyll Analysis (Pipe Lake)

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms – a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

Total phosphorus and total nitrogen had only slight variation through the sampling period. Nitrogen declined from early June through early August and then increased slowly through October (Figure 3). Phosphorus varied a little from date to date, but remained essentially the same throughout the period. The N:P ratio ranged from 32 to 74, averaging 48, which is very similar to previous years and indicated generally poor conditions for nuisance bluegreen growth.

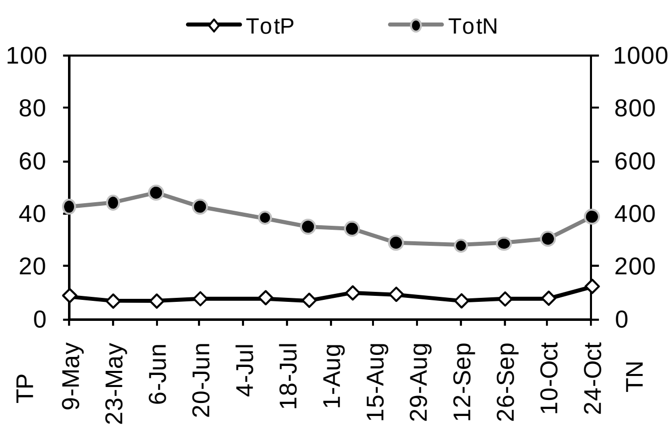

Figure 3. 2010 Pipe Lake Total Phosphorus and Total Nitrogen Concentrations

Chlorophyll was stable at low levels through the sampling season, with pheophytin levels at or below the minimum detection level. This indicates phytoplankton concentrations remained low in Pipe Lake throughout the summer.

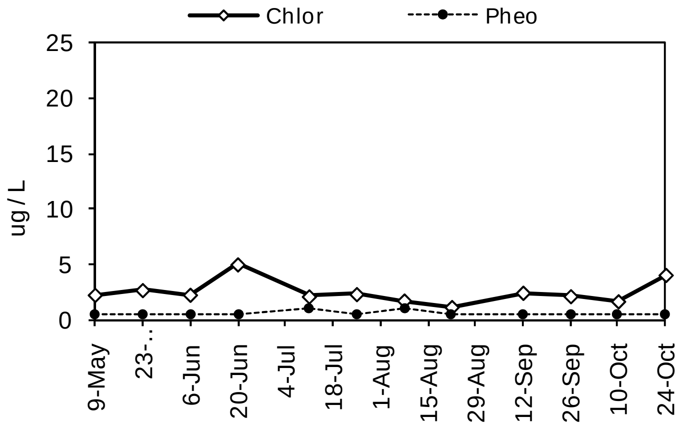

Figure 4. WY 2009 Pipe Lake Chlorophyll *a* and Pheophytin concentrations

Profile data were not collected during the first sampling date, but the August profile indicated thermal stratification was present and the cool temperature of the deep water supported the notion that it had been present for quite awhile. There was a significant build up of total and soluble reactive phosphorus (Total P and OPO4), as well as ammonia (NH3), in the deep water in the August profile, indicating that low oxygen conditions resulted in a phosphorus release from the sediments. Chlorophyll *a* data indicated that algae were approximately equivalent in August between the surface and mid depths.

Table 1. Pipe Lake Profile Sample Analysis Results. Sample values below minimum detection level are marked <MDL.

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Pipe	5/23/10		1	15.0	2.7	<MDL	0.443	0.017	0.0065	<MDL	0.070	31.9
Pipe	8/22/10	4.5	1	24.0	1.2	<MDL	0.288	<MDL	0.0091	<MDL	0.081	28.1
			10	9.0	1.0	<MDL	0.574		0.0093			
			19	6.5			1.180	0.905	0.2120	0.0085		

Alkalinity, also known as acid neutralizing capacity or buffering capacity, was relatively low and essentially equivalent to adjoining Lake Lucerne, while water color (UV254) also was very low, contributing to water clarity and indicating that dissolved organic carbon was not important in the lake.

TSI Ratings (Pipe Lake)

A common method of tracking water quality trends in lakes is by calculating the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of the lake based on water clarity (Secchi) and concentrations of TP and chlorophyll *a* (see discussion under Lake Lucerne). The 2010 TSI indicators for chlorophyll *a* and Secchi were close to each other in the upper range of oligotrophy. The TSI –TP indicator was in the oligotrophic mid range (Figure 5). Pipe Lake is solidly in the range for oligotrophy and it appears to have been essentially stable since 2003. Looking at the average of all 3 indicators over the entire range of monitoring, there appears to be a decreasing trend over time. However, the statistical basis for this is not strong, with the correlation coefficient of linear regression being quite low.

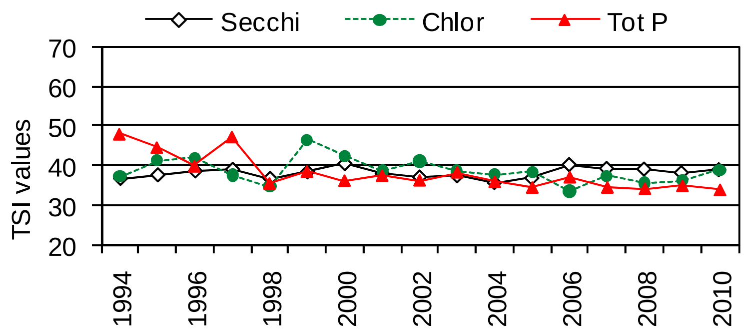

Figure 5. Pipe Lake Trophic State Indicators

Conclusions and Recommendations

Based on monitoring data, water quality in Pipe Lake appears to have been stable over at least the last 8 years and perhaps longer, although the values were more variable in the earlier years of the monitoring. High N:P ratios indicate conditions in the lake are not favorable for nuisance bluegreen algae blooms. With the sunset of the hydrilla eradication project, the city and the residents around the lake should be vigilant in looking for invasive aquatic plants, such as Eurasian watermilfoil and Hydrilla, as the aquatic vegetation returns to the lake.

Lake Wilderness

Volunteer monitoring began at Lake Wilderness in the early 1980s and has continued through 2010. The data indicate this 67-acre lake is moderate in primary productivity (mesotrophic) with generally good water quality.

Lake Wilderness has a public access boat launch. There is a history of Eurasian watermilfoil infestation, with control activities funded and monitored by the community and the city of Maple Valley. Residents have been active stewards of the lake through the years and should continue to watch for new patches of Eurasian milfoil, as well as other noxious weeds that might invade the lake, such as Brazilian elodea.

Physical Parameters

Excellent records of precipitation and water level were kept over the year (Figure 1). The lake level, which generally follows the regional pattern of winter high - summer low stands, increased in the winter and then remained high through June in response to the unusually wet period, only dropping through July and August, when the significant rains in September brought it back up again. There was a difference of 61 cm between the highest and lowest stands during the year, which is distinctly less than the difference recorded for many previous years.

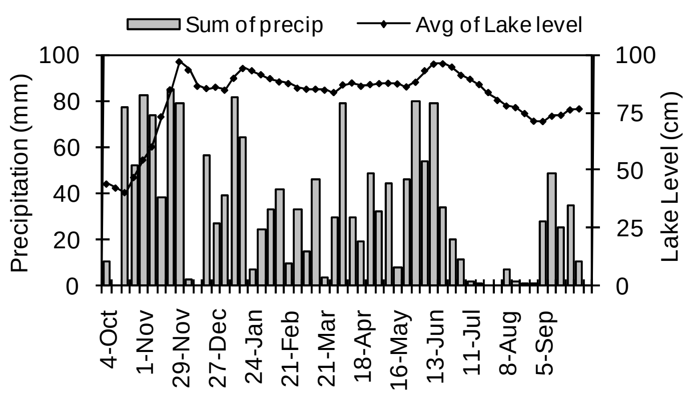

Figure 1. WY 2010 Lake Wilderness Level and Precipitation

Secchi transparency ranged from 2.7 to 8.1 m through the year (Figure 2). The summer average of 6.0 m placed it among the clearest of the small lakes monitored in 2010.

However, water clarity dropped in October, concurrent with the onset of a toxic bluegreen bloom, similar to 2009 though less abundant, which accumulated along downwind shorelines. While most of the lake water was clear, the algae scum moved around the lake rapidly with the wind direction, making it impossible to predict where it would accumulate on any particular day.

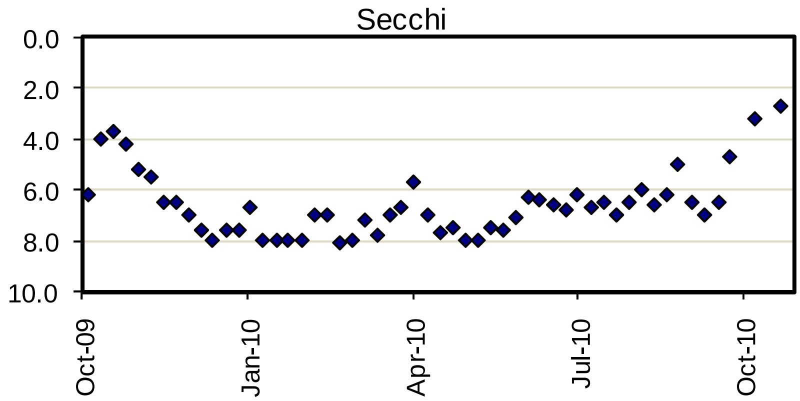

Figure 2. WY 2010 Lake Wilderness Secchi

Annual water temperatures ranged from 3.5 to 23.5 degrees Celsius (Figure 3), with a summer average of 18.4 degrees Celsius, placing Lake Wilderness in the middle group of the 12 lakes monitored in 2010.

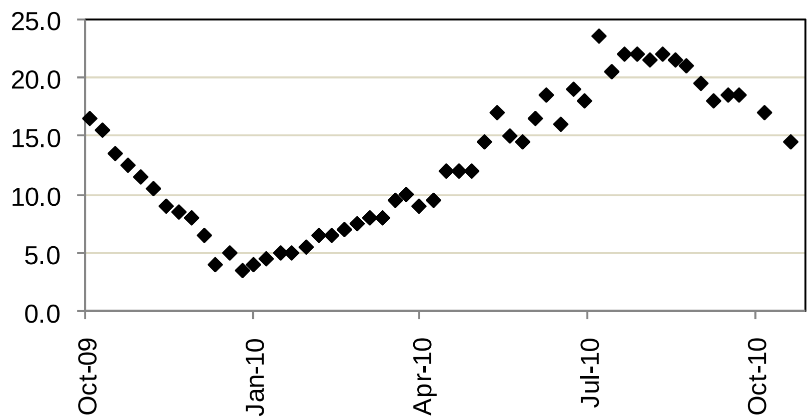

Figure 3. WY 2010 Lake Wilderness Temperature

Nutrients and Chlorophyll (Lake Wilderness)

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms – a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

Total nitrogen decreased from May through August, after which it began a moderate increase through the end of the sampling period. Total phosphorus remained steady through July and then increased slowly until October when it jumped up at the end of the sample period (Figure 4). The N:P ratio ranged from 12 to 67, averaging 37 over the whole season, which suggested that during some of the time conditions were poor for nuisance bluegreen growth. However, after August the N:P values were constantly at or below 20, indicating that favorable conditions existed for bluegreen algae growth, consistent with the development of a bluegreen bloom that persisted through fall. Cyanobacteria (bluegreen algae) in the lake will be discussed in a later section.

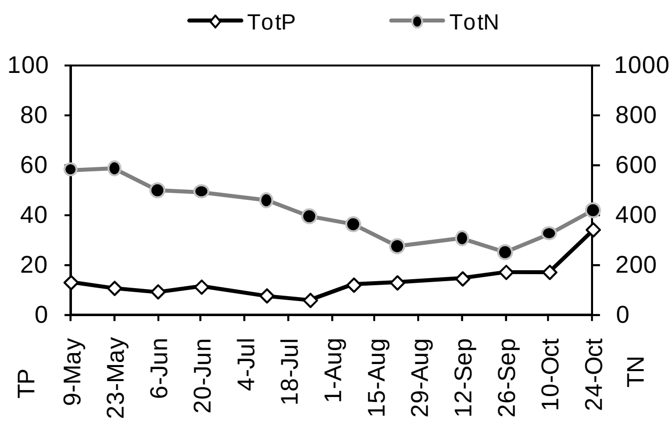

Figure 4. 2010 Lake Wilderness Total Phosphorus and Total Nitrogen Concentrations

Chlorophyll *a* remained low through mid-July, after which it began climbing steadily from early August through the end of the sampling period in October.

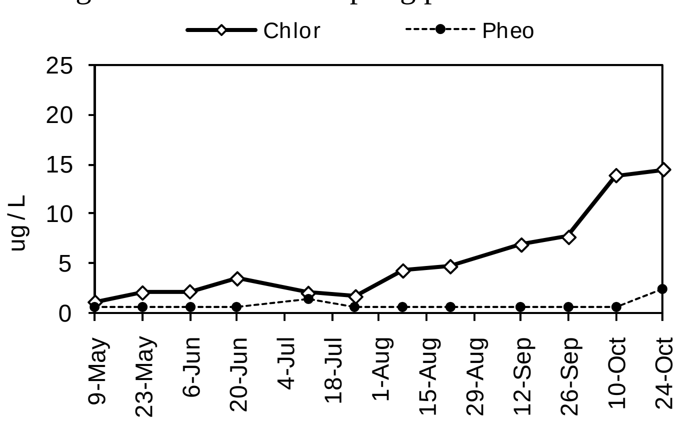

Figure 5. WY 2009 Lake Wilderness Chlorophyll *a* and Pheophytin concentrations

Profile data indicate that thermal stratification was present early in the season and persisted through the summer, though the deep water showed a significant temperature increase by the end of August. In the May profile event, phosphorus and ammonia were building in the deep water sample, consistent with low oxygen and nutrient recycling from the sediment. The lower values in the deep water in August, coupled with the warmer temperature, suggest that some water exchange had already occurred, thus making deep water nutrients available to the phytoplankton in late summer. While chlorophyll was evenly distributed through the water column in May, it was highly concentrated in the deeper water in August, and this may be related to the mixing of the water column as well.

Table 1. Lake Wilderness Profile Sample Analysis Results. Sample values below minimum detection level are marked <MDL.

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Wilderness	5/23/10	7.6	1	15.0	2.1	<MDL	0.584	0.021	0.0106	<MDL	0.019	46.5
			4	15.0	2.6	<MDL	0.552		0.0106			
			8.5	11.0	1.7	<MDL	0.385	0.092	0.0243	0.0080		
Wilderness	8/22/10	6.2	1	21.5	4.7	<MDL	0.274	0.008	0.0128	<MDL	0.041	44.4
			4	22.0	3.0	<MDL	0.269		0.0119			
			8.5	14.0	65.9	19.5	0.483	<MDL	0.1060	0.0043		

Alkalinity, also known as acid neutralizing capacity, was higher than in Pipe and Lucerne Lakes, suggesting that soils and source rocks in the watershed contain more dissolved salts that contribute to buffering capacity. Water color (UV254) was lower than Pipe and Lucerne, contributing to the exceptional water clarity and indicating that dissolved organic carbon from the surrounding watershed was not abundant in the lake.

TSI Ratings (Lake Wilderness)

In 2010, the average TSI-Secchi was in the lower range of mesotrophy, although both the TSI for phosphorus and for Secchi were on the threshold (Figure 6). This disparity among TSI values has been persistent over the years of monitoring, with water clarity being a predictor of lower algal biovolumes than what is predicted from the chlorophyll and phosphorus indicators. However, in the last few years, clarity has decreased slightly and the three indicators are very close together in their predictions.

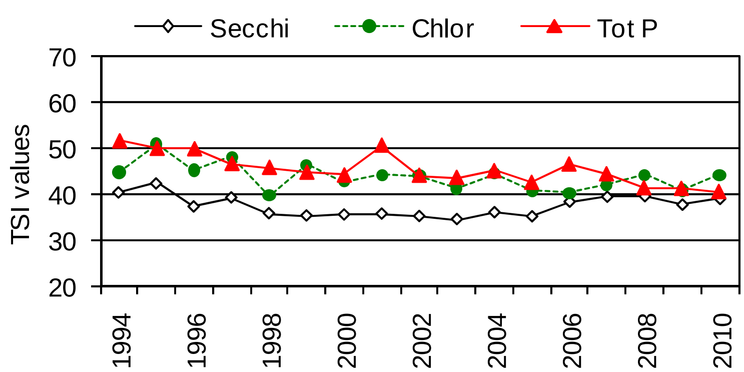

Figure 6. Lake Wilderness Trophic State Indicators

Lake Wilderness is exceptionally clear, and it may be that the type of algae that can do well in the lake are those that produce colonies that make particles in the water rather than single celled algae that produce cloudiness when abundant. This could make the lake more susceptible to scum formations on the downwind shorelines than a lake which produced algae that cloud the water, but are not easily moved en mass by wind and waves.

The average of the TSI values put Lake Wilderness in the lower end of mesotrophy, likely even a little lower in algal production than in previous years. However, because this is only the second year that bluegreen toxicity has been measured routinely, the general rate at which algae in the lake become toxic is not sufficiently known, which is a different question than how abundant the algae are.

Cyanobacteria toxins

Because of its history of occasionally producing bluegreen (cyanobacteria) blooms, Lake Wilderness was chosen as one of 30 Puget lowland lakes to be studied as part of work funded by a grant from the Center for Disease Control (CDC) to the Washington Department of Health, working with the collaboration of King, Snohomish, and Pierce Counties. The study involves regular biweekly sampling at a selected site for bluegreen species abundance and toxicity between June and October for three consecutive years. Blooms will be sampled as well when identified elsewhere in the lake other than the routine sample site. Four algal toxins are to be measured: microcystin, anatoxin, saxitoxin and cylindrospermopsin.

The second year of toxicity testing began in late March in response to a concern by the city for the safety of lake users during the opening of fishing season in April. Samples were submitted to the Washington Department of Ecology Algae Program for analysis. Although some microcystin was present (Figure 7), it was well below the draft threshold guideline of 6 ug/L recommended by the Washington Department of Health, and as a result no Opening Day activities were cancelled or revised.

Routine monitoring as part of the grant-funded Regional Examination of Harmful Blooms project began in June and continued on a biweekly basis through October (Figure 7). Half of these samples were below the detection limit for microcystin, while four out of the other five had negligible amounts. Only one routine sample had a significant amount of the toxin, but as this sample was taken after Labor Day and the high concentration was not sustained over time, there was not a need to close the lake or curtail recreational activities. Three other toxins that might have been present were not detected in any of the 2010 samples.

Lake Wilderness	2010 Date	Microcystin	Anatoxin-a	Saxitoxin	Cylindro-spermopsin
WDOE sample	23-Mar	0.449	<MDL		
WDOE sample	11-Apr	**0.117**	<MDL		
WDOE sample	18-Apr	**0.152**	<MDL		
Routine beach	7-Jun	<MDL	<MDL	< MDL	<MDL
Routine beach	21-Jun	<MDL	<MDL	< MDL	<MDL
Routine beach	12-Jul	<MDL	<MDL	< MDL	<MDL
Routine beach	26-Jul	<MDL	<MDL	< MDL	<MDL
Routine beach	9-Aug	**0.071**	<MDL	< MDL	<MDL
Routine beach	23-Aug	**0.201**	<MDL	< MDL	<MDL
Routine beach	13-Sep	**201**	<MDL	< MDL	<MDL
WDOE sample	20-Sep	**0.190**	<MDL	<MDL	
Routine beach	27-Sep	**0.164**	<MDL	< MDL	<MDL
Routine beach	11-Oct	**0.158**	<MDL	< MDL	<MDL
WDOE sample	11-Oct	**0.692**	<MDL	<MDL	<MDL
Routine beach	25-Oct	<MDL	<MDL	< MDL	<MDL
WDOE sample	27-Oct	**1.07**			

Figure 7. Cyanobacteria toxicity test results. All values in µg/L. <MDL means below minimum detection level. Green background indicates value is above the WDOH draft guideline for recreational safety.

Conclusions and Recommendations

Based on monitoring data, water quality in Lake Wilderness appears to be stable over the period measured. Low N:P ratios in the fall indicate conditions are probably favorable for nuisance bluegreen algae blooms, and the lake water clarity suggests that those blooms are taking the form of large colonies that make particles in the water, thus favoring scum accumulations along downwind shorelines.

Close monitoring of algae blooms at the lake, particularly in the fall should continue, including participation in the CDC grant project and the Washington State Department of Ecology's Toxic Algae Monitoring program to determine how frequently blooms at the lake produce toxins and often the concentrations are above the draft state guidelines for recreational activities.

There is a statistically weak trend suggesting total phosphorus is decreasing, and concentrations should continue to be monitored to determine if this is a strong long-term trend. Over time, it may contribute to an increase in the N:P ratio, which could make the lake less hospitable to bluegreen blooms.