Angle Lake Water Quality

A Report on Water Quality Monitoring Results for Water Year 2010 at Angle Lake

Angle Lake

Prepared for the City of SeaTac
by the King County Water and Land Resources Freshwater Program

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King County

Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Angle Lake in 1994, although monitoring data collected by METRO goes back as far as the 1970s. There was a break in monitoring during 1996, but work resumed in 1997. In 2005, the City of SeaTac contracted with KCLSP to continue monitoring Angle Lake. During the 2010 water year, 4 citizens volunteered their time to continue monitoring on Angle Lake as in previous years. The water quality data indicate that currently the lake has low productivity categorized as oligotrophic, with very good water quality.

An algae bloom by a species of *Uroglena* early in 2010 was unusual for the lake and caused some concern among residents that conditions were deteriorating. When abundant, *Uroglena* can produce a very fishy odor that can persist for the duration of the bloom, and this occurred in the late winter through spring at Angle Lake. However, with the onset of warmer weather, the bloom dissipated and did not return again in 2010. Based on experience with other lakes in the region, *Uroglena* success is not predictable in any given year, but blooms are generally limited in duration and may not occur again in Angle Lake for some time.

Angle Lake has a popular public access boat ramp, and residents may want to monitor aquatic plants growing nearshore to catch early infestations of Eurasian milfoil, Brazilian elodea, or other noxious aquatic weeds.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae that could be produced in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict which groups of algae may become dominant in the lake during the sample period. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2010 water year. Specific data used to generate the charts in this report can be downloaded from the King County small lakes 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 Microsoft Excel files upon request.

Physical Parameters

Excellent records of precipitation and water level were kept over the 2010 water year (October 1, 2009–September 30, 2010; Figure 1). The lake level followed a pattern commonly found in the Puget lowlands of winter high to summer low stands, with some sensitivity shown to inputs from large rain events, particularly in winter. The lake ended the water year about 25cm higher than it had been the previous autumn, which could have been influenced by the wet September weather.

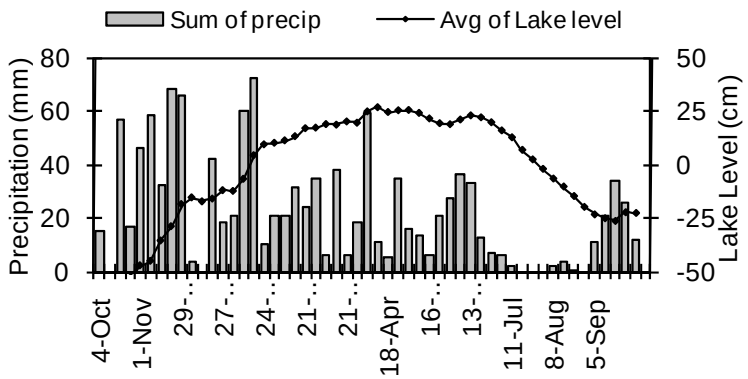

Figure 1. Angle Lake precipitation and lake level, WY2010

Lake levels appear to have fluctuated less over the last three years than in previously recorded years, but are still significantly lower than in the mid-1990s when measurements began on a regular basis (Figure 2).

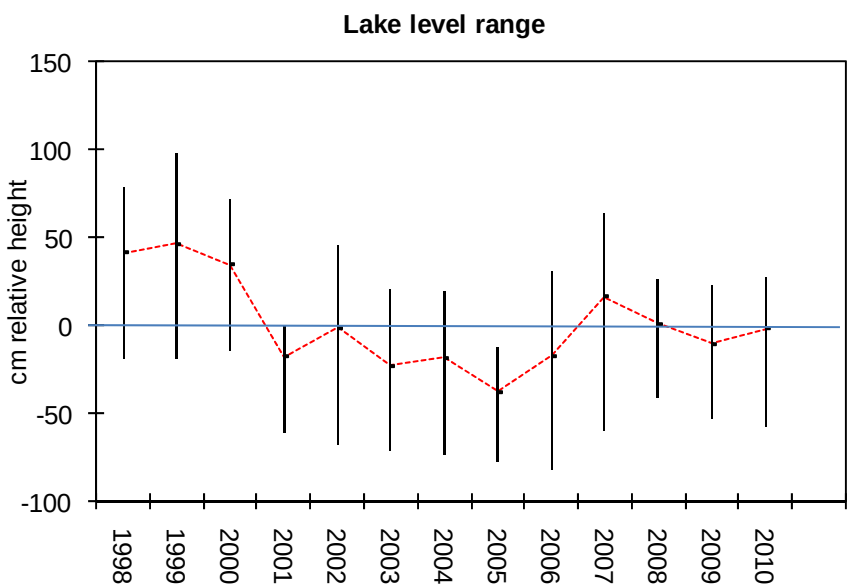

Figure 2. Each vertical line represents the range of lake levels recorded each water year relative to a zero datum set by a meter stick affixed to a static dock (not floating).

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

For Angle Lake, Secchi transparency values ranged from 0.5 m to 7.5 m, averaging 4.5 m over the entire year (Figure 3, symbols differentiate the two observers on the lake). The 0.5 m was during the height of the *Uroglena* bloom, and from late January through April 2010, Angle Lake had the lowest transparency values measured since the beginning of monitoring in 1997. However, after the bloom crashed, Angle Lake became very clear again, equivalent to previous years in transparency measurements.

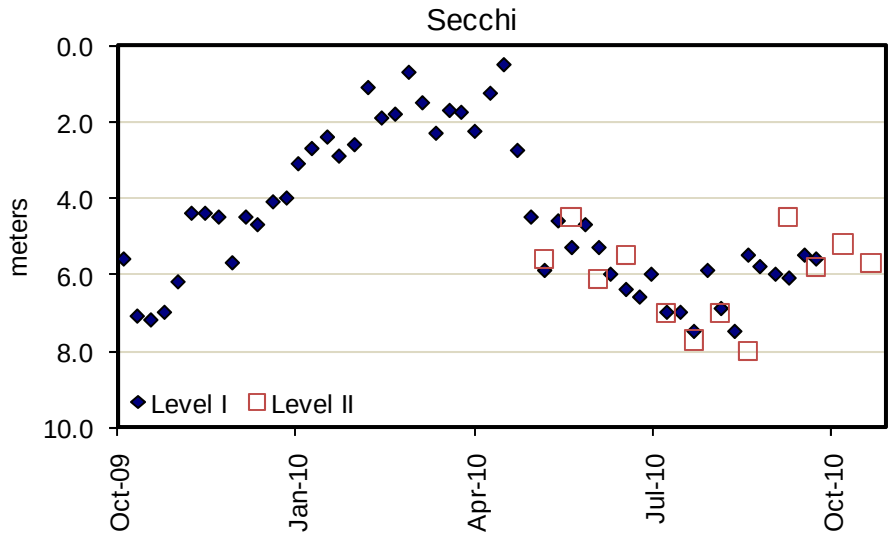

Figure 3. Angle Lake Secchi Transparency

The Secchi transparency values exhibited the normal and expected variability through the season when compared to data collected in previous years.

Water temperatures during the water year followed a pattern similar to other lakes in the region, with cool temperatures in the winter and spring, followed by summer maximum temperatures occurring between mid-July and mid-August, and temperatures cooling in the fall. Angle Lake temperatures ranged from 5.0 to 22.0 degrees Celsius with an average temperature of 13.2 degrees Celsius (Figure 4). Compared with other lakes monitored through in 2010, Angle Lake had the lowest summer temperature maximum.

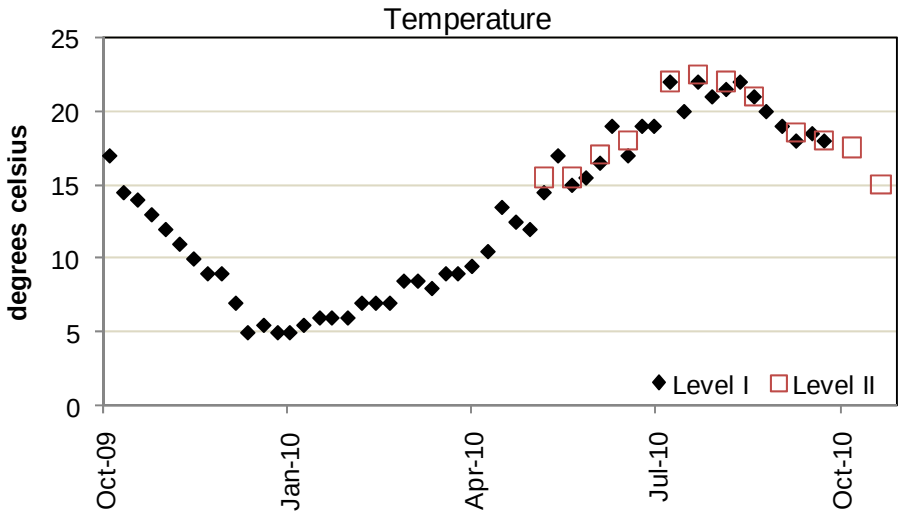

Figure 4. Angle Lake Water Temperatures

Nutrient and Chlorophyll Analysis

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential and commercial 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 in general limited by the amount of available phosphorus. Increases in phosphorus concentrations thus 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.

TP and TN varied little throughout the May–October sampling period (Figure 5) in 2010,with small peaks in May and July recorded.

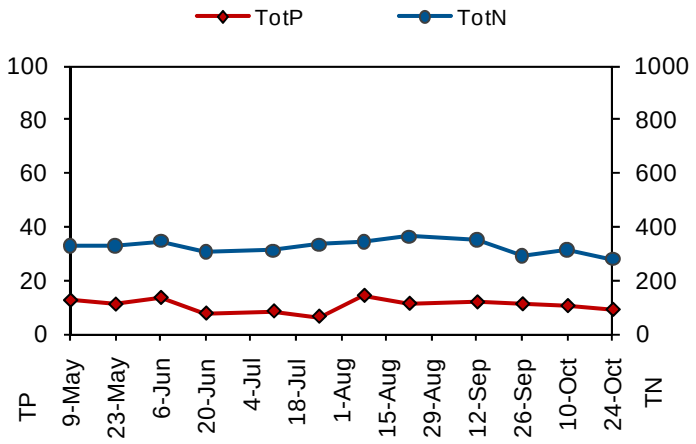

Figure 5. Angle Lake Nutrients

The ratio of nitrogen to phosphorus (N: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 below 20, cyanobacteria can dominate the algal community due to their ability to take nitrogen from the air. The N:P ratio in Angle Lake for this water year ranged from 24 to 53, with an average ratio of 32. This suggests that conditions in the lake were not favorable for bluegreen algae blooms in 2010.

Chlorophyll *a* values were low from late spring through early fall at Angle Lake (Figure 6). This indicates that phytoplankton populations remained relatively low throughout the sampling season. Pheophytin, which is a degradation product of chlorophyll, remained at or below detection limits throughout the majority of the season.

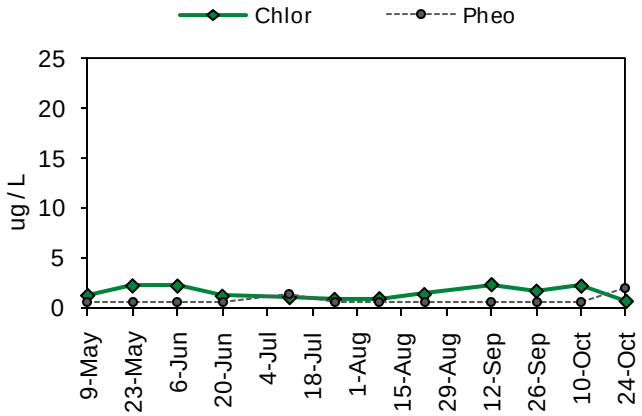

Figure 6. Angle Lake Chlorophyll *a* and Pheophytin Concentrations

Profile data indicate that thermal stratification was present early in the season and persisted through the summer (Table 1). The deepwater samples had significantly lower temperatures, as well as elevated levels of nutrients and detectable ammonia, all of which suggest that the hypolimnion (bottom water) of Angle Lake becomes anoxic during summer, facilitating internal phosphorus release from the sediments. The slight increase in chlorophyll between 1 m and 8 m suggests that there may be more algae at deeper levels of water than at the surface; the difference is possibly not significant.

The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances, while the total alkalinity values show that the water in the lake is soft and only very lightly buffered from pH change. NOTE: In Table 1, <MDL stands for "below minimum detection level" of the analytical method.

Table 1: Angle Lake Profile Sample Analysis Results

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Angle	5/23/10	4.5	1	15.5	2.3	<MDL	0.328	<MDL	0.0109	<MDL	0.031	13.9
			8	13.0	4.3	<MDL	0.384		0.0156			
			15	9.0			0.679	0.325	0.0798	0.0222		
Angle	8/22/10	8.0	1	21.0	1.4	<MDL	0.363	<MDL	0.0112	<MDL	0.043	13.6
			8	20.0	4.5	1.1	0.194		0.0086			
			15	9.0			1.070	0.573	0.1580	0.0063		

The Trophic State Index

A common method of tracking water quality trends in lakes is through calculation of the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI values predict the biological productivity of the lake based on water clarity (Secchi) and concentrations of TP and chlorophyll *a*. The 2010 indicators for TP and chlorophyll *a* were close to each other in the midrange of oligotrophy, while the Secchi indicator is slightly higher in the upper range of oligotrophy (Figure 7). For Angle Lake, the average of the three TSI values is solidly in the oligotrophic range. An upward trend in values seen between the years 1997 through 2007 was reversed in 2008, but in 2009 and 2010, values were increasing again. This may be year-to-year variation without direction, evidence of a cyclical pattern, or a true upward trend with some unusual years superimposed on it, and time will be necessary to sort it out.

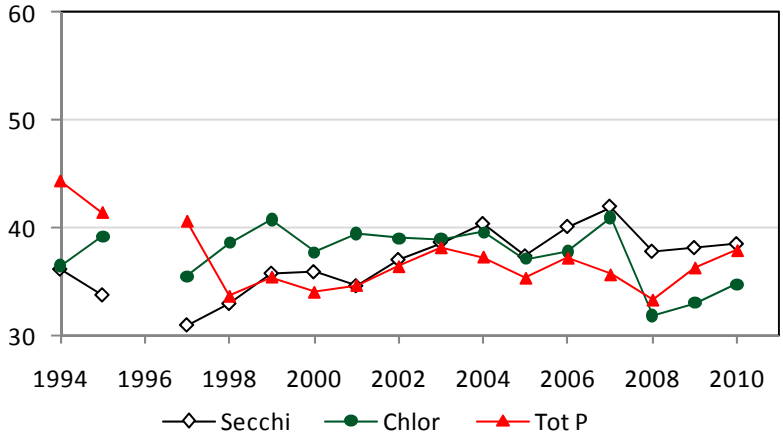

Figure 7. TSI Values at Angle Lake

Conclusions and Recommendations

Based on monitoring data, water quality in Angle Lake appears likely to be varying around a relatively stable level over the last decade, but a slow, long-term increase in algae productivity cannot be ruled out. Nutrients in the lake remain in low concentrations through the season, and the majority of the N:P ratios are high, which makes the conditions in the lake generally unfavorable for bluegreen cyanobacterial blooms. Continued monitoring of nutrient and chlorophyll concentrations will track conditions to ensure that water quality remains consistent in Angle Lake over time.