Angle Lake Water Quality

A Report on Water Quality Monitoring Results
for Water Year 2012 at Angle Lake

Angle Lake *photo by Lake Stewardship Program*

Prepared for the City of SeaTac
by the King County Lakes and Streams Monitoring Group
Science and Technical Support Section,
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King County Department of Natural Resources and Parks

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King County

Overview

The King County Lakes and Streams Monitoring (KCLSM) Group and its predecessor the Lake Stewardship Program have been working with volunteers on Angle Lake since 1994, although monitoring data collected by METRO goes back as far as the 1970s. In 2005, the City of SeaTac contracted with KCLSM to continue volunteer monitoring of Angle Lake. During the 2012 water year, four citizens volunteered their time to continue monitoring on Angle Lake. The water quality data indicate that currently the lake continues to have low productivity categorized as oligotrophic, with very good water quality.

Angle Lake is popular for fishing, boating and swimming. The lake has a well-used 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, which are often transported by boats and boat trailers.

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 2012 water year. Specific data used to generate the charts in this report can be downloaded from the King County Lake small lakes data website at:
http://your.kingcounty.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx

Data can also be provided in the form of excel files upon request.

Physical Parameters

Excellent records of precipitation and water level were kept over the 2012 water year (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 slightly higher than has been typical over recent years, but lower than the 2011 water year. This possibly can be attributed to the return to more normal weather patterns in the Pacific Northwest.

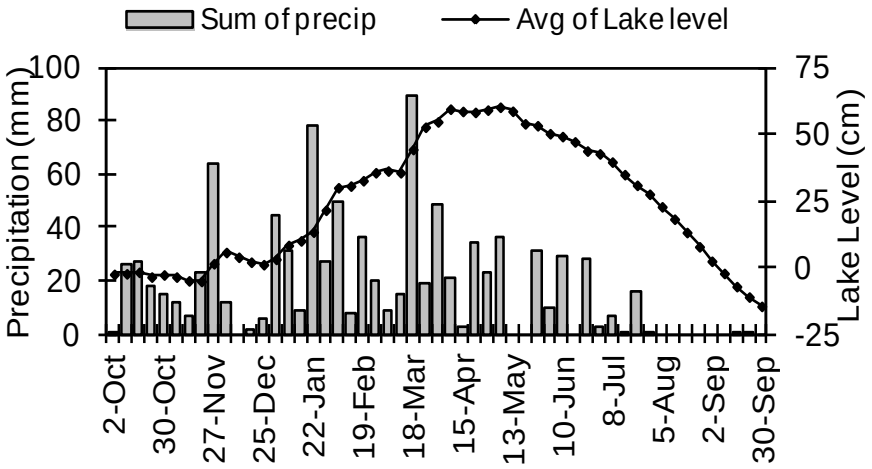

Figure 1. Angle Lake precipitation and lake level, WY2012

Water levels were still higher than what the monitoring records typically show.
Lake levels appear to be increasing overall since the average low recorded in 2005 Figure 2). This year was similar to lake levels seen in the late 1990s and 2000. However, water levels in future years should be documented in order to test the increasing trend for statistically significance.

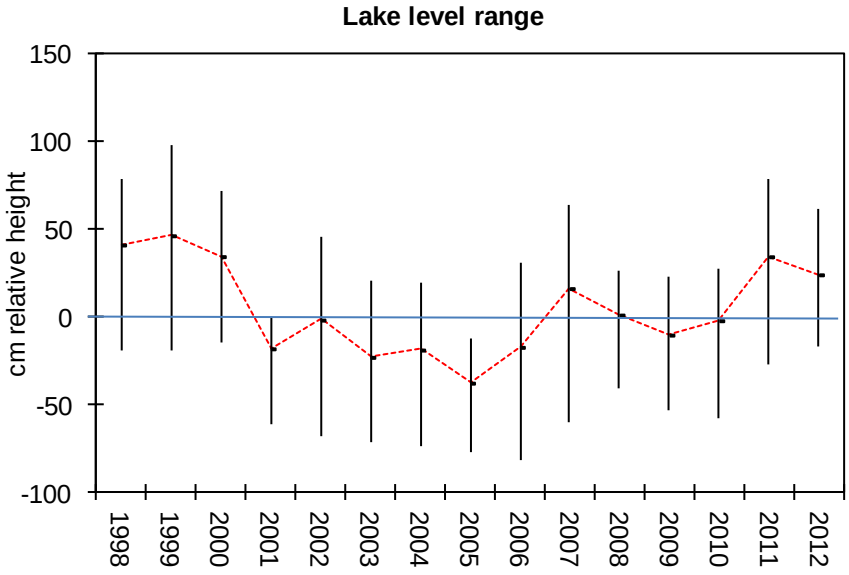

Figure 2. Each vertical line represents the range of lake levels recorded each water year relative to a zero datum set by a meter stick affixed to a static dock (not floating).

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.

Angle Lake level I volunteers collected weekly temperature and Secchi transparency data throughout the 2012 water year (Figure 3). A different level II volunteer collected water samples for laboratory analyses from early May through late October, and at the same time made temperature and Secchi measurements. Secchi transparency measured by the Level I volunteer ranged between 1.6 m and 8.0 m, with an annual average of 4.5m and a summer average of 6.4m. The data from the level II volunteer, measuring from May through October only, ranged from 4.5m to 7.3m, with a summer average of 6.1m. Secchi levels reported in 2012 are similar to transparency measurements from previous years.

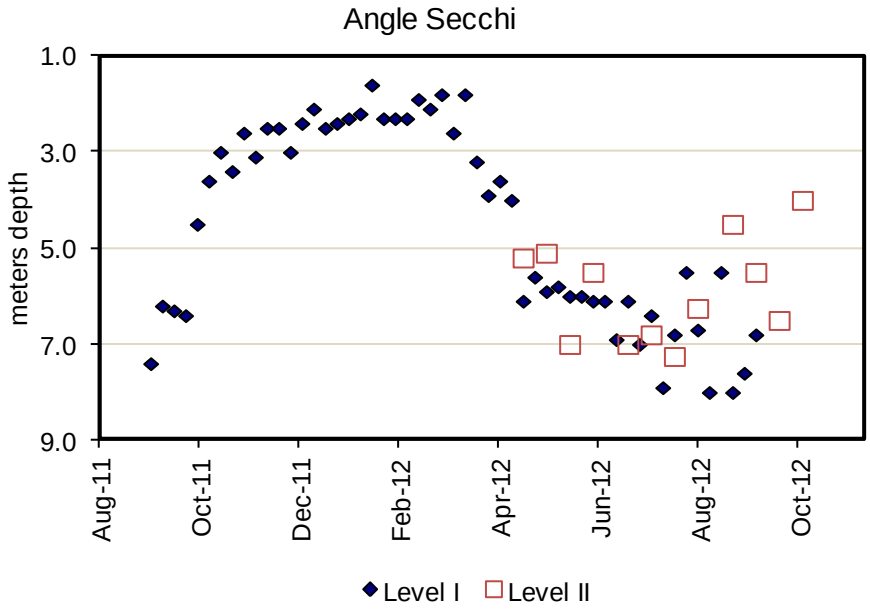

Figure 3. Angle Lake Secchi Transparency WY 2012

Observers can vary in how they read the endpoint of the Secchi test, depending on their ability to differentiate subtle changes and how their vision reacts to glare off the water surface, the type of boat they are using, and how close to the water surface they can safely view the disk. Therefore, it is not surprising that there are differences between the two observers, which also occur among professionally trained field crews. It is important to be consistent in examining one observer's measurements over time and, if at all possible, to calibrate differences by collecting concurrent measurements between observers for comparison.

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 in August and temperatures cooling by late September. Angle Lake temperatures ranged from 3.0 to 24.0 degrees Celsius over the year with an average temperature of 13.0 degrees Celsius and a summer average of 19.0 degrees Celsius (Figure 4).

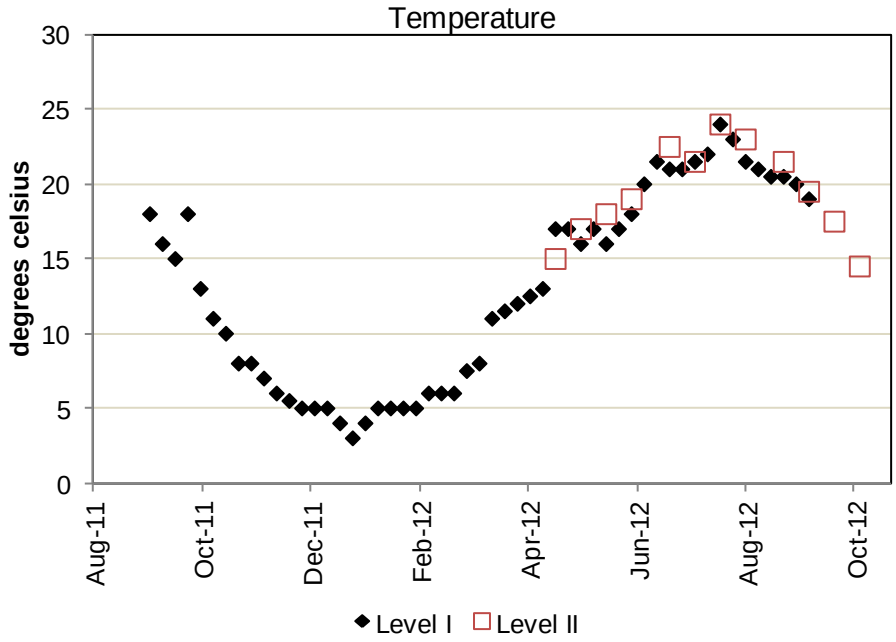

Figure 4. 2012 Angle Lake Water Temperatures

All monitored area lakes warmed up more quickly this year than 2011 because the weather pattern was more typical to the northwest and there was not the strong La Nina effect like there was in 2011. Figure 5 shows the average temperature of the lake from the Level II monitoring season, dating back to 2006. From 1996 to 2002 there appeared to be a cooling trend, which appears to be stable or slightly increasing since then. Further monitoring of temperature will help determine if water temperatures are indeed increasing or if there is a more cyclical pattern of warming and cooling in the lake.

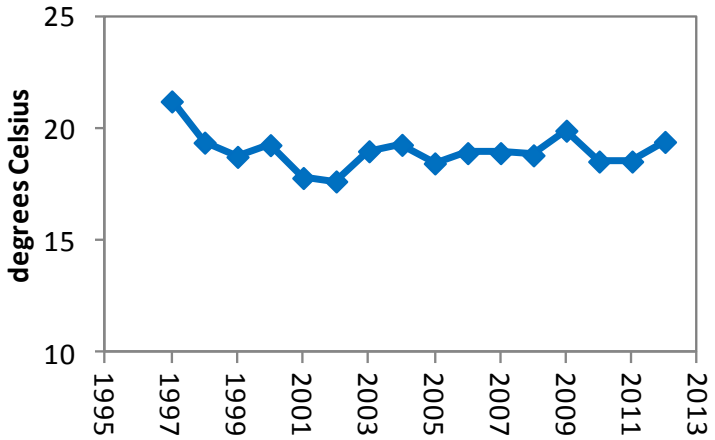

Figure 5: Angle Lake average water temperature for May-October since 1996

Nutrient and Chlorophyll Analysis

Phosphorus and **nitrogen** are naturally occurring elements that are necessary in small amounts for both plants and animals for healthy growth and reproduction. 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 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, between May and October, with deeper water analyzed twice through the season in May and August respectively.

TP and TN varied little throughout the May – October sampling period (Figure 6) in 2012. One small peak occurred in the TP and TN measurements during July. However, results during most of the sampling season were fairly static.

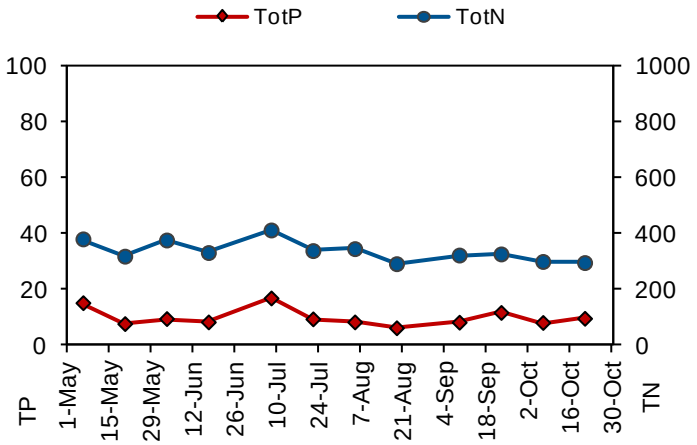

Figure 6. Angle Lake Total Phosphorus and Total Nitrogen in ug/L.

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 below about 25, 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 24.5 to 47.7 with an average ratio of 35.3 (Figure 7). The minimum ratio value was in early July, which coincides with the peak of the nutrients. This is the lowest N:P ratio over the course of the summer months, but was of short duration. However, in the past Angle Lake has seen N:P ratios that were low enough to favor bluegreen algae, most recently in 2011. However, during most of the summer, conditions are not favorable for bluegreen algae blooms.

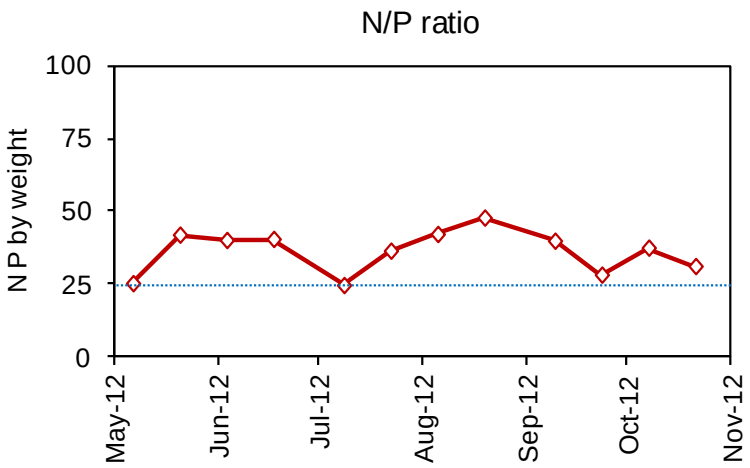

Figure 7: Angle Lake N:P ratio. Values below the blue line indicate a potential nutrient advantage for cyanobacteria.

Chlorophyll *a* values were low from late spring through early fall at Angle Lake (Figure 8), although values began to climb slightly at the end of October. Pheophytin, which is a degradation product of chlorophyll, remained at or below detection limits throughout the season.

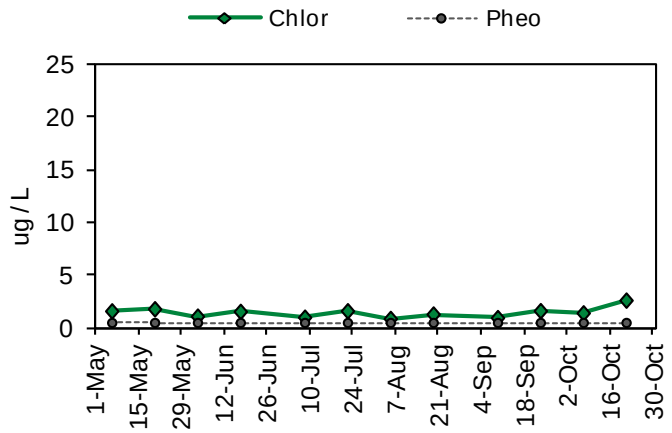

Figure 8. Angle Lake Chlorophyll *a* and Pheophytin Concentrations

Water column profiles

Profile temperature data indicate that thermal stratification was present early in the season and persisted through the summer (Table 1). In May, the deep water samples had significantly lower temperatures, as well as elevated levels of nutrients and detectable ammonia, all of that suggest that the hypolimnion (bottom water) of Angle Lake becomes anoxic during summer, facilitating internal phosphorus release from the sediments. This is confirmed by the NH3 (ammonia) concentrations and OPO4 (dissolved phosphorus) present in the deeper water. The increase in chlorophyll between 1 m and 8 m suggests that there may be more algae present at intermediate water levels than at the surface.

Table 1. 2012 Angle Lake profile sample results. Secchi and Depth in meters. Temperature in degrees Celsius. Chlorophyll and Pheophytin in ug/L. Nitrogen, phosphorus, and alkalinity in mg /L. UV254 in absorption units. Sample values below minimum detection level (MDL) are marked in bold, red with the MDL value.

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Angle	5/20/12	5.1	1	17.0	1.80	**0.5**	0.318	**0.005**	0.0076	**0.002**	0.0466	14.2
Angle			8	11.0	5.65	**0.5**	0.326		0.0138			
Angle			15	8.0			0.471	0.113	0.0466	0.0188		
Angle	8/19/12	6.3	1	23.0	1.3	**0.5**	0.291	**0.005**	0.0061	**0.002**	0.041	14.6
Angle			8	13.0	2.26	**0.5**	0.298		0.0066			
Angle			15	9.0			2.010	0.365	0.4090	0.0355		

The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances. The total alkalinity values show that the water in the lake is soft and only very lightly buffered from pH change, thus sensitive to acidification.

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*. A value of 50 or higher indicates eutrophy, or a highly productive lake in terms of algae, while values below 40 indicate oligotrophy, or low rates of productivity. Values between 40 and 50 are considered moderate or mesotrophic.

The 2012 TSI indicator values were spread through the range of oligotrophy (low productivity). TP and Secchi were in the mid to upper range of oligotrophy and the chlorophyll-a indicator was lower (Figure 9). For Angle Lake the average of the three TSI values is solidly in the oligotrophic range. While TP and Secchi TSI remained steady compared to previous years, chlorophyll *a* decreased to 2009 levels, one of the lowest chlorophyll TSI values found in Angle Lake. This is interesting after seeing four years of steady increase in chlorophyll-a.

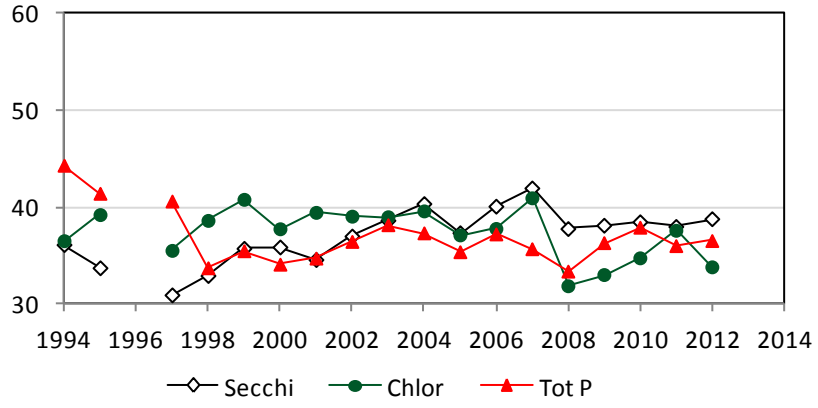

Figure 9. TSI Values at Angle Lake in TSI units.

No trend can be statistically validated for the individual TSI values or for the average of all 3 indicators. The ups and downs represent year-to-year variation without direction at this point, and only time will determine if there is a significant trend or pattern. Angle Lake remains an oligotrophic lake with excellent water quality.

Conclusions and Recommendations

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

The water level measurements in Angle Lake suggest that water levels have been increasing over the past several years from a low in the 2005 water year. Years 2010 and 2011 could be attributed to back-to-back la Nina weather patterns in the Pacific Northwest, but levels in 2012 remained nearly as high without La Nina Further monitoring will help determine if the water levels reflecting the hydrologic budget of Angle Lake is changing.

The long term monitoring that the volunteers at Angle Lake have performed over the fifteen years has created an impressive dataset that tells the story of water quality and quantity for Angle Lake. Continued monitoring will help build on this dataset, increasing our understanding of how the lake responds to weather events and changes in the watershed.