2014 Summer Ozone Study

This summer, the Puget Sound Clean Air Agency conducted a small survey of ozone pollution in the areas to the south and south east of Seattle. Ozone is a pollutant that is sometimes called "smog," it forms on hot days in the summer months and is typically higher in rural areas downwind of urban centers (even though the source of the pollution comes from the urban center.) The summer survey was designed to serve as a quick look at the levels of ozone and an ozone precursor called NO_x in order to determine which areas in our jurisdiction are at the highest risk for ozone exposure. We focused on pollution levels in Tacoma and Seattle as well as areas outside the urban center toward the Cascade Foothills.

The study used low cost, passive samplers to collect measurements of ozone, nitrogen dioxide (NO_2), and nitrogen oxides (NO_x). The passive samplers collect data for two weeks and produce an average measurement that represents the two week period. It is important to note that this method does not allow us to properly compare sites, as one location may have had a constant measurement and another site may have had a wide range of values and both sites may report the same value because the measurement represents an average.

Sites were selected based on their location, and were placed at various distances from urban areas. Figure 1 shows a map of the sites and the colored dot at the site corresponds to the average ozone concentration during the two week period. Each site also has a pie chart showing the relative contributions from ozone, nitrogen dioxide, and nitrogen oxides at each location. All the data shown was collected from August 8 – 22, 2014.

Table 1 shows the overall results from the summer ozone survey. All concentrations represent an average over the two week period. The ozone to NOx ratios and the NO2/NOx ratios are included in the table to help us understand the ozone chemistry at each site. With only one data point available we cannot draw conclusions and the data should only be seen as a rough estimate to be used to guide future work.

Table 1: Average concentrations from the Ogawa Badges used in the summer survey Aug 8-22, 2014

Site	NO_2 (ppb)	NO_x (ppb)	O_3 (ppb)	Ratio O_3/NO_x	NOx – NO_2 (mostly NO)	Ratio NO/NO_2	Ratio NO_2/NO_x
Auburn	9.82	17.97	17.18	1.0	8.15	0.83	0.55
Graham	3.82	5.63	16.50	2.9	1.81	0.47	0.68
Kent	11.97	21.61	15.42	0.7	9.64	0.81	0.55
Maple Valley	4.11	7.39	16.27	2.2	3.28	0.80	0.56
Mud Mountain	1.49	4.32	21.24	4.9	2.83	1.90	0.34
Orting	2.70	3.39	12.87	3.8	0.69	0.26	0.80
Puyallup	8.55	16.54	16.63	1.0	7.99	0.93	0.52
South Tacoma	7.95	14.47	19.91	1.4	6.52	0.82	0.55
10th and Weller	27.01	83.18	15.97	0.2	56.17	2.08	0.32

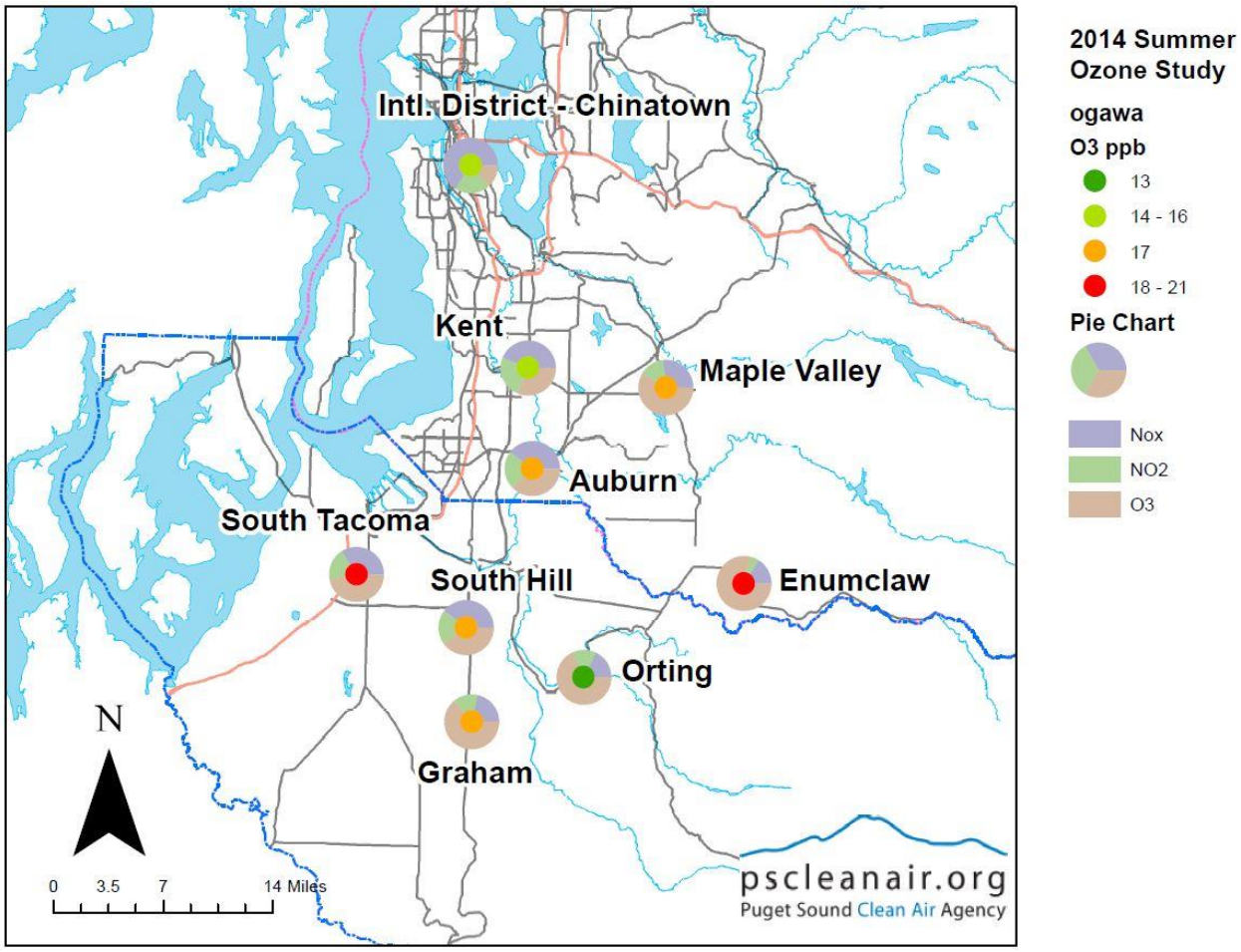

Figure 1: Average ozone concentrations in ppb at each site in the summer ozone survey

While the results of the study are inconclusive there are some interesting observations that may warrant further study. As we would expect, the Seattle monitoring site has the lowest O_3/NO_x ratio, with the highest NO_x concentrations and the lowest O_3 concentrations. This confirms our suspicion that Seattle ozone levels are VOC limited and are unlikely to increase without a significant decrease in NO_x concentrations. The highest O_3/NO_x ratio was observed at the Enumclaw/Mud Mountain site. The Mud Mountain site had the highest average ozone concentrations observed over the study period and we know from the hourly monitored data at the site that the average concentration is a result of both high and low ozone concentrations as opposed to a constant concentration over the study period. Based on what we know about ozone chemistry and the observed O_3/NO_x ratio, this site is very likely NO_x limited and should see lower ozone concentrations as NO_x levels decrease.

The Orting site has an O_3/NO_x ratio that suggests the ozone chemistry is NO_x limited at that site. Based on the distance from NO_x sources and the vegetation in the area I expected higher levels of ozone at the site. However, the Orting site shows a higher NO_2/NO_x ratio than the Enumclaw site which could mean that the Orting is more of a NO_x sink than an ozone production site. While there is far too little data to draw any real conclusions, it is possible we are losing NO_x in or before Orting to conversion to NO_2,

HNO_3 and ultimately deposition. This could be interesting as we consider areas that may be adversely impacted by ozone in the future. That said, it is important to keep in mind that the NO_2 measurement could be a bad data point and that the conversion of NO_2 to HNO_3 typically occurs at night. Not much can be drawn from one data point and it's always possible the high NO_2/NO_x ratio is a result of a bad sample or poor siting of the sensors.

The results of this analysis suggest that a future summer ozone study should include time resolved ozone and NO_x or NO_2 data at a few locations between the urban and rural areas of south King County and south or south eastern Pierce County. The study locations could be based on this summer's survey with priority for sites on the boundary of NO_x limited and VOC limited ozone chemistry. Figure 2, below, shows a map of the study sites and the colored dots correspond to the O_3/NO_x ratio. For best results we should include a VOC measurement in the analysis. Understanding the NOx and VOC chemistry is important for accurately evaluating ozone chemistry, but may be cost prohibitive.