## Background

Data collected through the Siuslaw Volunteer Water Quality Monitoring Program (VWQMP) is entered into the SWC Water Quality database and sent to the Oregon DEQ Volunteer Monitoring Coordinator for storage in a statewide database. 2015 Monthly data is uploaded to the SWC Water Quality Geodatabase and posted to the SWC website as scatterplots, with previous data represented in line graphs. Field data sheets for each water quality monitoring site are archived at the SWC. Please refer to the attached historic grab sample line graphs and 2015 raw data (Appendix A & B, respectively) and 2015 continuous temperature line graphs (Appendix C).

**Table 1.** Site descriptions and latitude, longitude coordinates for the eighteen 2015 monitoring sites for the Siuslaw Watershed Volunteer Water Quality Monitoring Program (Please see attached map).

| Grab Sample Sites | | | | |
|---|---|---|---|---|
| **Site ID #** | **Tributary or Mainstem** | **Site Name/Location** | **Length of record (years)** | **Coordinates** |
| FB-2 | Mainstem Siuslaw/Tidal | Florence Boat Dock, Old Town Florence, RM 5 | 2002-2015 | -124.10128, 43.96752 |
| SS-3 | Tributary/Tidal | South Slough, below tide gate, RM 2 | 2002-2015 | -124.05996, 43.95122 |
| NF-M | Tributary | North Fork Siuslaw River, Minerva | 2011-2015 | -123.979993, 44.058332 |
| MD-6 | Mainstem Siuslaw/Tidal | Mapleton Public Dock, RM 20 | 2004-2015 | -123.85750, 44.03030 |
| KC-7 | Tributary/Tidal | Karnowsky Creek, County Bridge above confluence with Siuslaw River | 2003-2015 | -123.99589, 44.00339 |
| CH-11 | Tributary | Chickahominy at bridge, Walton, RM 4 | 2005-2015 | -123.57618, 44.04639 |
| TL-12 | Mainstem Lake Creek | Lake Creek above Triangle Lake, 4 RM above Triangle Lake | 2005-2015 | -123.54290, 44.19919 |
| DW-13 | Tributary | Deadwood Creek, Hwy 36 bridge above confluence with Lake Creek | 2007-2015 | -123.75918, 44.09504 |
| BT-14 | Mainstem Lake Creek | Below Triangle Lake on Lake Creek below confluence with Fish Creek, RM 17 | 2009-2015 | -123.58324, 43.14798 |
| MU-15 | Mainstem Siuslaw | Middle/Upper Siuslaw Mainstem above Whittaker | 2011-2015 | -123.65930, 43.98494 |
| LO-16 | Mainstem Siuslaw (New) | Above confluence of North & South Forks of Upper Siuslaw River, at Fire Road bridge near Lorane | 2015 | -123.26780, 43.82577 |
| **Continuous temperature sites** | | | | |
| LAL | Mainstem Lake Creek | Lake Creek below Hult Pond | 2007, 2014, 2015 | -123.49679, 44.23781 |
| LFT | Mainstem Lake Creek | Lake Creek above Fish Creek | 2007, 2014, 2015 | -123.58324, 44.14798 |
| SIT | Mainstem Lake Creek | Lake Creek above Indian Creek | 2007, 2014, 2015 | -123.78402, 44.08383 |
| SBT | Mainstem Siuslaw | Siuslaw River above Barber Creek | 2005, 2007, 2014, 2015 | -123.72179, 44.0539 |
| SAE | Mainstem Siuslaw | Siuslaw River above Esmond Creek | 2005 & 2015 | -123.6420, 43.9320 |
| SPT | Mainstem Siuslaw | Siuslaw River below Pheasant Creek | 2005 & 2015 | -123.443, 43.8960 |
| SDT | Mainstem Siuslaw | Siuslaw River above Doe Creek | 2005, 2014, 2015 | -123.38527, 43.84246 |

## Results and Analysis for Grab Sample Sites

Data are collected and processed under Oregon DEQ Volunteer Monitoring Quality Assurance Project Plan (QAPP) and the SWC's associated Sampling and Analysis Plan (SAP) to ensure data quality is evaluated and reported. Outliers have not been removed from these data. In addition to the monthly postings on the website, the VWQMP data is presented annually to the SWC Tech Team and the communities with sites exhibiting frequent exceedances or not meeting the standards. These 2015 data will be presented to the SWC Tech Team in early 2016. Further monitoring and restoration efforts have been implemented as a result of the long-term SWC VWQMP. Those include a DEQ 319 grant which funded multi-parameter continuous data loggers and riparian restoration work with landowners in Lorane, North Fork Siuslaw, and the Lower Siuslaw (including South Slough), the targeting of the ongoing Siuslaw Riparian Restoration Project towards areas with consistent WQ issues, the newly completed Hawley Creek Restoration project in Lorane, and presentations at outreach meetings in Lorane.

### Dissolved Oxygen (DO)

For salmonids and resident trout, 11mg/L is Oregon's minimum standard for healthy spawning season conditions in the Siuslaw sub-basin (October-June; green dashed line), 8mg/L is the minimum standard for any freshwater streams or rivers providing cold-water aquatic life (non-spawning; blue dashed line) habitat, and 6.5 mg/L for estuarine waters (red dashed line). Where conditions of barometric pressure, altitude, and temperature preclude attainment of the applicable numeric criterion, dissolved oxygen levels must not be less than a specified percent of saturation (95% or 90%) in the rules[1]. These standards will be used as the basis of this evaluation.

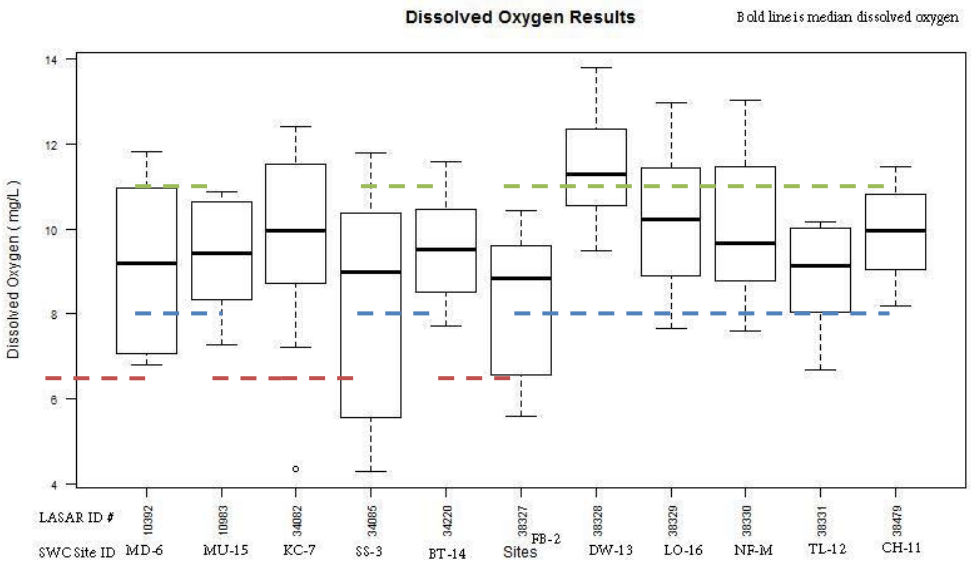


**Figure 1.** Box plot of 2015 Dissolved Oxygen Results by grab sample site.

[1] http://www.deq.state.or.us/regulations/rules.htm; see OAR 340-41, Table 21 DISSOLVED OXYGEN & INTERGRAVEL DISSOLVED OXYGEN CRITERIA (Applicable to All Basins)

Generally the 2015 DO data followed past years' data patterns, with various weather events providing a few exceptions on some sites (dry late spring/early summer, first flush). Tributary and upperwatershed sites generally had higher DO levels than lower in the system (see Figure 1).

Estuary Sites:
FB-2: DO levels fell below the cool-water habitat standard during July-September. Compared to past years, DO levels were the lowest since sampling began in 2002.

SS-3: Between July and October, DO levels fell below the 6.5 mg/L minimum requirement for cool-water habitat. DO results at SS-3 have been consistently low in this estuarine site on the lower Siuslaw River.

MD-6: This site was above the DEQ cool-water habitat minimum for all months; however, 2015 had the lowest DO levels during the summer since sampling began in 2002. There was a gap in sampling in May.

KC-7: This site was below the 6.5 mg/L cool- water habitat standard in August; however, there were gaps in sampling in June. DO at this site is consistently low during summer months over the past several years of sampling.

Generally, the 2015 data from the estuarine sites followed previous years' patterns. Further examination of the interaction of salinity, tides, temperature, and DO is needed in the estuarine sites. Up to fifteen river miles separates the estuarine sites as do their salinity levels. It is known that as the salinity of water increases, its ability to dissolve oxygen decreases. In 2015, the two lowest tidal sites at SS-3 and FB-2 had higher salinity levels than MD-6 and KC-7 and typically had lower DO levels and % DO saturation in summer.

There is still a need to understand the management of the tidegate at the SS-3 site as associated with DO and other parameters. Due to issues of private land and disputes around the management of the tidegate, it may be awhile before we are able to fully understand the management and impacts on WQ. The consistently low dissolved oxygen levels in the summer at the KC-7 site on Karnowsky Creek may continue to be affected by channel migration from the decade old restoration project and upstream beaver activity. Sites should be continued to be sampled for trending.

Freshwater Sites:
NF-M: At this site, DO did not meet applicable spawning habitat standards for October and April or for coldwater aquatic life in July and August. There was greater seasonal fluctuation compared to past years.

LO-16: This site did not meet the minimum 11mg/L spawning standard in October, November and March to May and fell below the 8 mg/L standard in July and August. In January 2015, LO-10 was discontinued and a SWC volunteer began sampling this new grab sample site downstream of the

confluence of the South Fork and North Fork Siuslaw where SWC deployed a temperature/conductivity logger in summer 2014 and 2015 (DEQ 319 funded).

CH-11: On Chickahominy Creek, DO levels were above DEQ minimum requirements for salmon spawning habitat in January, February, March and December; however, DO levels were below 11 mg/L in April, May and November. All summer months met the DEQ cold water minimum.

TL-12: From June to August, the site did not meet the DEQ cold water minimum. All months sampled were below the spawning requirement.

BT- 14: During spawning months, DO was below the DEQ minimum in November, March, April and May and did not meet the cold water standard in June.

DW-13: This site consistently exhibits relatively high levels of DO compared to other VWQMP sites in the basin. Standards were met for the cold water minimum and spawning habitat minimums were met for all months except April.

MU-15: DO was measured below the salmonid spawning standard for all months. The site was below coldwater habitat standard in July and August.

In the freshwater sites as well, the 2015 data followed the previous years' patterns. NF-M and MU-15 are newer sites that fell below the spawning and cold water standards. Additional years of data will be necessary to characterize these sites. CH-11 and DW-13 appear to continue to respond well to multiple restoration efforts upstream of the site. TL-12 & BT-14 continue to demonstrate low dissolved oxygen in the summer and winter months. In October 2015, SWC applied for funding in 2016-17 to deploy continuous DO loggers upstream of TL-12 at LAL and downstream of BT-14 at SIT near the mouth of Lake Creek to compare DO levels above and below Triangle Lake and determine the range of seasonal and diurnal fluctuations. Consistently high turbidity levels and temperature exceedances at the older LO-10 site prompted the use of this type of logger, since conductivity is a proxy for TDS (total dissolved solids) and is related to turbidity. Grab and continuous sampling efforts will complement each other and allow for both broad and fine scale comparisons throughout the year. This was the first year sampling LO-16 and more years of data will need to be collected to analyze for trends.

<u>Temperature (grab sample sites)</u>
Oregon's water temperature standards are based on a seven day average maximum (OAR 340-041-0028). Comparing grab sample data to seven day standards provides guidance as to where continuous monitoring is needed but is not conclusive about if significant thermal habitat degradation exists for coldwater species.

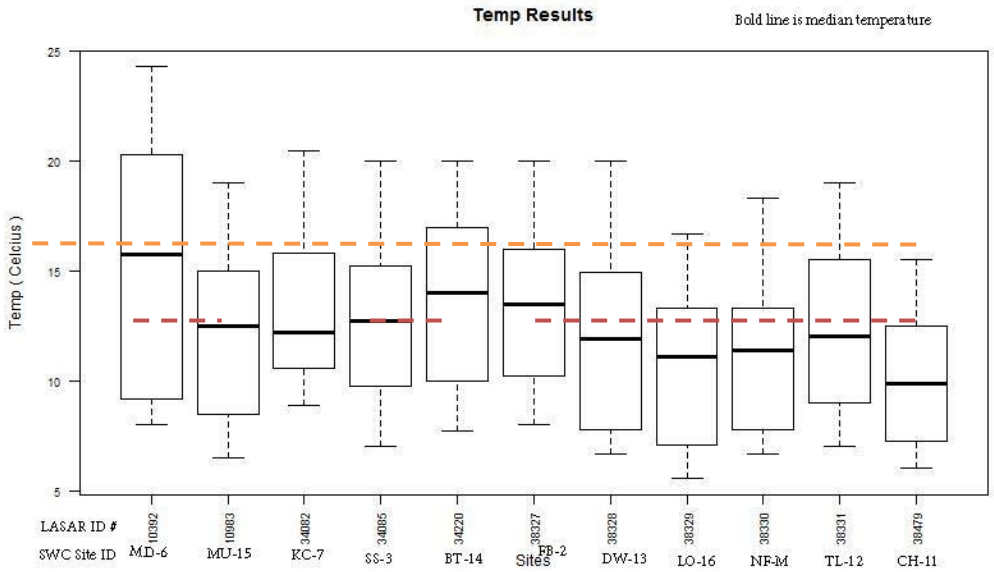


**Figure 2.** Box plot of 2015 Temperature results by grab sample site

Generally the temperatures followed previous years' patterns; although, the unseasonably dry and warm June combined with lower than normal flow levels likely influenced several sites in 2015. Sites BT-14, DW-13, KC-7, LO-16, MD-6, MU-15, NF-M, SS-3, FB-2, and TL-12 all had readings that exceeded the DEQ coldwater habitat maxima of 16 degrees Celsius (orange dashed line; see Figure 2). The only site not exceeding 16 degrees Celsius was CH-11 on Chickahominy Creek. All sites listed previously except CH-11 (and excluding non-spawning estuarine sites, KC-7, MD-6, SS-3 & FB-2) exceeded winter spawning maxima of 13 degrees Celsius (red dashed line) for one month or more from October 15$^{th}$ to May 15$^{th}$. This is a primarily a concern at sites higher in the watershed, specifically MU-15, LO-16, and BT-14. Continuous temperature data is needed to analyze the temporal extent of these exceedances and will be addressed in the paragraphs below.

<u>Temperature (continuous sites)</u>

During the summer from mid-May to early October, SWC staff deployed seven HOBO continuous temperature loggers at three locations along upper, middle and lower Lake Creek and four sites along the upper and lower reaches of the Siuslaw River. Of the seven logger sites, five were repeats from 2014 (LAL, LFT, SIT, SBT and SDT) and two were previous LASAR logger sites from SWC's 2005 and 2007 sampling efforts (SPT and SAE). All seven loggers were audited monthly and the logger temperatures were Grade A quality within 0.5 degrees Celsius of the NIST thermometer.

**Lake Creek Sites**

The uppermost site at Lake Creek (LAL) above Hult Pond/Triangle Lake recorded cooler 7-day average maximum temperatures (1.3 +/- 0.9 degrees Celsius) than the lowermost site above Indian Creek (SIT; sites were 23 river miles apart), although both sites recorded 138 days above the DEQ 7-day maximum

of 16 degrees Celsius and 120 and 123 days above the 18 degrees Celsius standard for rearing habitat, respectively (see Figure 3 and Table 2).

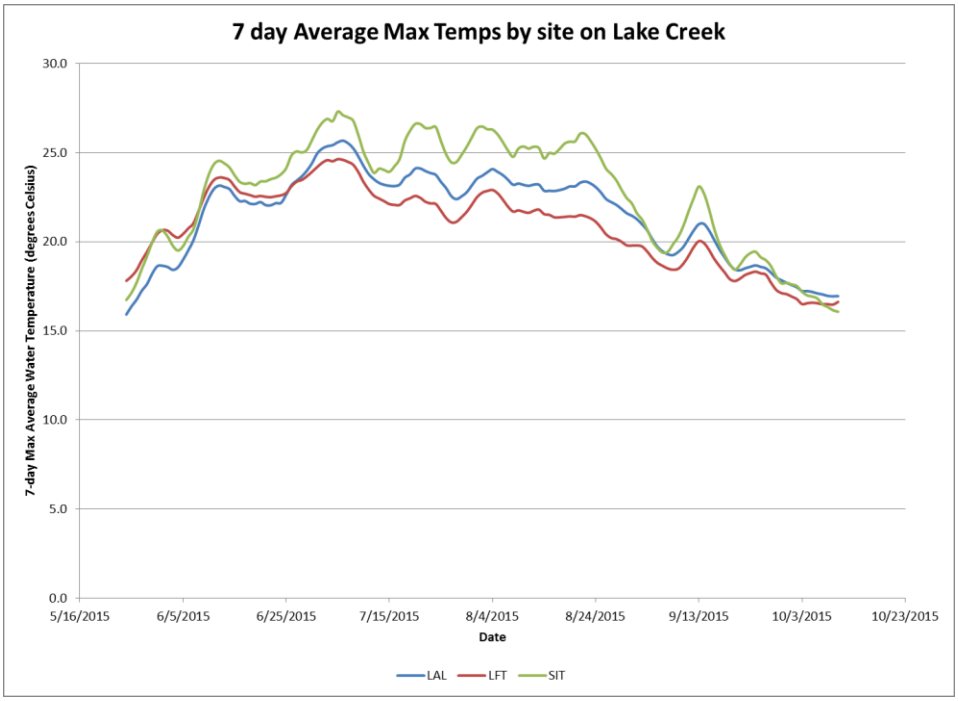


**Figure 3.** Line graph of 7 day Average Maximum Temperatures by site on Lake Creek

| Table 2: Summary Table of 2015 SWC Continuous Temperature Data | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site name | Site Abbreviation | Elevation (ft) | Distance between sites (miles) | # days logged | % of days > 18 C (7-day) | # days > 18 C (7-day) | # days > 16 C (7-day) | Average temp (degrees C) | Min | Max | Min/Max Difference |
| Siuslaw above Doe Creek | SDT | 687 | | 136 | 49.3% | 67 | 90 | 16.6 | 11.1 | 22 | 10.9 |
| Siuslaw below Pheasant | SBT | 500 | 8.35 | 136 | 64.7% | 88 | 109 | 18 | 11.7 | 23.4 | 11.7 |
| Siuslaw above Esmond | SAE | 355 | 13.7 | 136 | 78.7% | 107 | 120 | 19.2 | 11.6 | 27 | 15.4 |
| Siuslaw above Barber | SBT | 165 | 14.15 | 145 | 83.4% | 121 | 131 | 20.1 | 12.6 | 28.5 | 15.9 |
| Lake below Hult Pond | LAL | 820 | | 145 | 82.8% | 120 | 138 | 19.9 | 13.7 | 26.9 | 13.2 |
| Lake above Fish | LFT | 630 | 9.1 | 145 | 82.8% | 120 | 138 | 19.4 | 13.4 | 25.8 | 12.4 |
| Lake above Indian | SIT | 190 | 11.95 | 145 | 84.8% | 123 | 138 | 19.8 | 11.8 | 29.6 | 17.8 |

**Table 2.** Summary Table of 2015 SWC Continuous Temperature data

Temperatures were more variable at the SIT site with higher maximums and lower minimums (average 4.9 degree difference) compared to the LAL site (average 2.4 degree difference). The middle logger site upstream of Fish Creek (LFT; site is 10 river miles downstream of LAL and 13 river miles upstream of SIT) also had 138 days above the 16 and 120 days above the 18 degree standards. The 7-day average maximum temperatures at LFT from mid-May to early October were slightly cooler (20.9 degrees Celsius or 69.6 degrees Fahrenheit) than the SIT (22.7 degrees Celsius or 72.8 degrees Fahrenheit) and LAL (21.5 degrees Celsius or 70.7 degrees Fahrenheit) sites. This may be due to the fact that the LFT site is 2 miles downstream of Triangle Lake, which may provide cooler water due to increased stream shade between Triangle Lake and LFT, more consistent flows and/or localized hyporheic flows. It is likely that this temperature difference is because the LAL site is located downstream of the dam and fish ladder at Hult Pond, where water is stored and heated in the spillway, thereby raising the temperature, especially during lower flows. When the loggers were retrieved in

early October, the temperatures at all three sites were still 3.1 to 3.9 degrees Celsius above the 13 degree spawning maximum. Flow measurements were taken by the Oregon Water Resources Department near the mouth of Lake Creek (downstream of SIT) on 7/15 (54.4 cfs) and 7/29 (40.7 cfs). Unfortunately, there were no flows recorded near the headwaters of Lake Creek at the LAL site. However, water depths were noted during monthly audits at all three Lake Creek sites. Water levels dropped 3" at the LAL site from May to August (12.5" to 9.5") and raised 4.5" (9.5" to 14") from August to October. At the LFT site, water levels dropped 4" from May to August (11" to 7") and remained the same from August to October. From July to August, water levels dropped at the SIT site by 1" (14" to 13") and increased to 2" from August to October (13" to 15"). As the water levels declined, loggers had to be relocated in July at two of the three sites (LFT and SIT) before the sensors were exposed and probably did not impact the quality of the data loggers were only moved 15-20 feet to deeper, well-mixed sites. Rain events occurred on 8/29, 8/30, 9/16, 9/17 and 10/10 and contributed to the slight rise in water levels and decline in water temperatures during the late summer. The reduction in flows during July might explain the greater variability in temperature at the SIT site. Also, the wider active channel, limited riparian shade and heat conducting properties of the bedrock substrate likely played a factor as well. Since flows were not measured at deployment or retrieval, we cannot tell how discharge changed over the summer or how it correlated with changes in water temperature at each site.

**Siuslaw River sites**

As expected, the 7-day average maximum temperatures at the uppermost site on the Siuslaw River (SDT) above Doe Creek were 4.8 +/- 0.8 degrees Celsius cooler than the lowest site on the Siuslaw River above Barber Creek (SBT; sites were 43 river miles apart). The logger at the SDT site was deployed later in May and had 9 fewer days of data recorded. At the SBT site, the logger recorded 131 days above the DEQ 7-day average maximum temperature of 16 degrees Celsius and 121 days above the DEQ maximum rearing temperature of 18 degrees Celsius. By comparison, the SDT logger recorded 90 days above DEQ 7-day average maximum and 67 days above the DEQ maximum rearing temperature (please see Figure 4 and Table 1). In addition, two loggers were deployed below Pheasant Creek (SPT) and above Esmond Creek (SAE) between SDT and SBT at past LASAR sites to assess the change in temperature from the headwaters to the lower Siuslaw River. The 7-day average maximum temperature at SDT were 1.4 +/- 0.3 degrees Celsius cooler than SPT (8.35 river miles downstream of SDT), while SPT was 2.3 +/- 0.7 degrees Celsius cooler than SAE (13.7 river miles downstream of SPT) and SAE 1.0 +/- 0.6 degrees Celsius cooler than SBT (14.15 river miles downstream of SAE). At the SAE site, the logger recorded 120 days above the DEQ 7-day average maximum temperature of 16 degrees Celsius and 107 days above the DEQ maximum rearing temperature of 18 degrees Celsius. By comparison, the SPT logger recorded 109 days above DEQ 7-day average maximum and 88 days above the DEQ maximum rearing temperature.

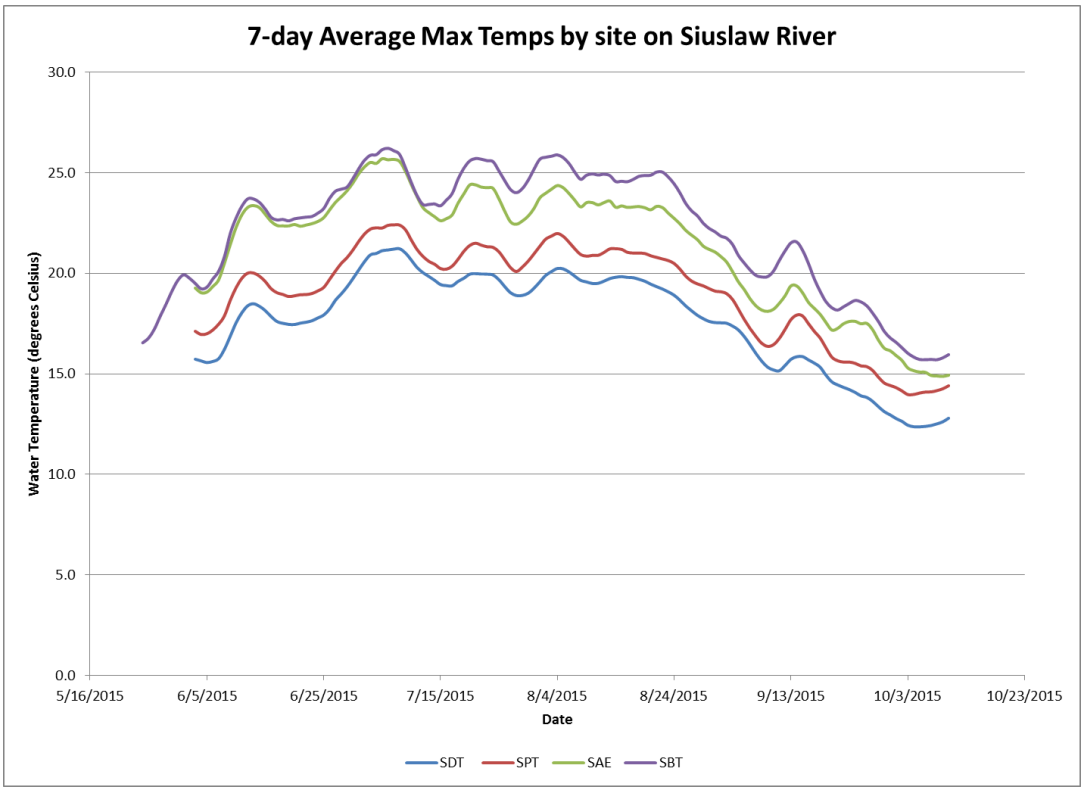


**Figure 4.** Line graph of 7-day Average Maximum Temperatures by site on the Siuslaw River

| Table 2: Summary Table of 2015 SWC Continuous Temperature Data | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
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| Lake above Indian | SIT | 190 | 11.95 | 145 | 84.8% | 123 | 138 | 19.8 | 11.8 | 29.6 | 17.8 |

**Table 2.** Summary Table of 2015 SWC Continuous Temperature data

Maximum and minimum temperatures at the SAE site showed wider variability (average 3.6 degree difference) compared to the SDT and SPT sites (average 1.7 degree difference) and SBT site (average 3.2 degree Celsius difference). When the loggers were retrieved in early October, the SDT site was 0.2 degrees Celsius below the DEQ spawning temperature of 13 degrees Celsius, while the downstream SPT, SAE and SBT sites were 1.6, 2.1 and 3.2 degrees Celsius above, respectively. The only flow measurements recorded by DEQ were from their LASAR site above Fire Road on the Upper Siuslaw (4.34 cfs on 7/22; 6.5 miles upstream of SDT). However, water levels were noted at monthly audits. Water levels on the Upper Siuslaw River dropped 4.5" at the SDT site from May to October (8.5" to 4"). At the SPT site, water levels dropped 6.5" from June to October (19" to 12.5") and the upstream tributary, Pheasant Creek, dried up in late August. From May to October, water levels declined at the SAE site (13.7 river miles downstream of SPT) by 6" from 30" to 24," and due to the lower flows and high temperatures, algae blooms occurred in June and July. At the SBT site, water levels dropped 1" from May to October (12" to 11"). As the water levels declined, loggers had to be relocated in July at

two of the four sites (SPT and SBT) before the sensors were exposed. This did not impact the quality of the data and loggers were only moved 4-6 feet to deeper, well-mixed sites. Water temperatures peaked in late June/early July and declined in late August to early September and late September to early October. Shorter days, cooler nights and rain events on 8/29, 8/30, 9/16, 9/17 and 10/10 contributed to this cooling even with lower flows.

**Comparison with 2014 continuous temperature data**

The limited rainfall in the late spring and early summer, coupled with the record high June temperatures, caused 7-day average maximum stream temperatures to peak in late June and early July. However, loggers were deployed later in June and July in 2014, so comparisons could only be made between years starting late June/July and not mid-May. In general, the number of days exceeding 18 degrees Celsius was similar between years during the same time period. The daily change in temperature was more variable in 2015, as minimum temperatures were cooler and maximum temperatures warmer by 1-3 degrees Celsius at SDT, SBT, LAL, LFT and SIT sites. This increased variability was likely a combined result of higher ambient air temperatures and lower flows and water volumes throughout the summer. Overall, the summers of 2014 and 2015 were two of the warmest summers on record, so this data provides a good representation of current conditions; however, temperature loggers must be deployed at least another 2 to 3 years to determine if there is in fact a trend.

*E.coli*

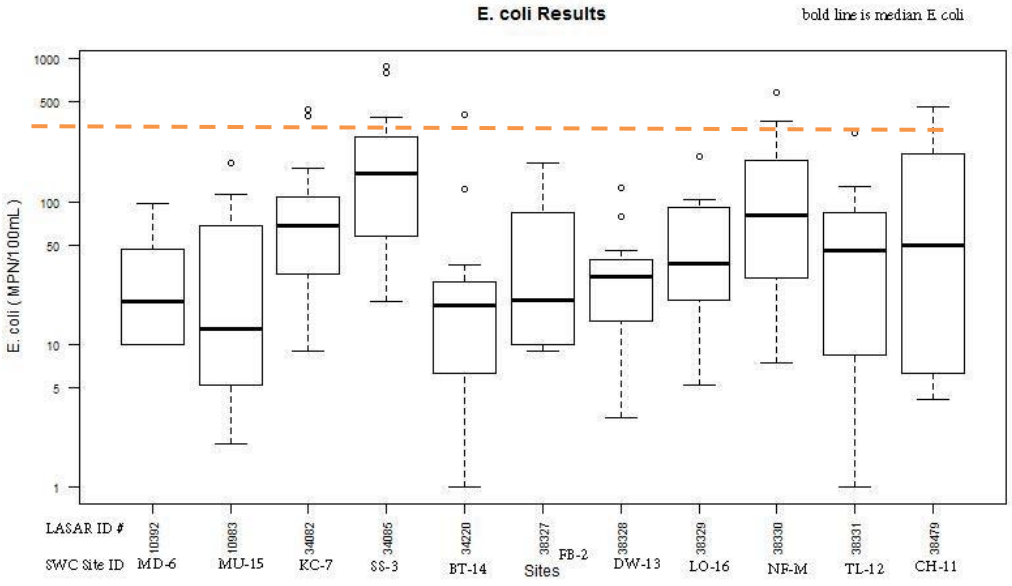


**Figure 5.** Box plot of 2015 *E. coli* results by grab sample site

Sites KC-7, SS-3, CH-11, NF-M and BT-14 had infrequent exceedances of Oregon's single sample maximum standard of 406 MPN/100ml (orange dashed line; see Figure 5) that were correlated with recent rain events or nearby beaver activity. MU-15 and LO-16 did not display any exceedances in our

data, but since they are newer sites, further sampling is necessary to characterize them and examine trends. For the remaining sites, further sampling will enable trending. Additionally, further sampling and analysis considering precipitation, flow, and salinity (in estuarine sites) may provide a more complete understanding of bacteria levels and patterns in the Siuslaw.

Turbidity

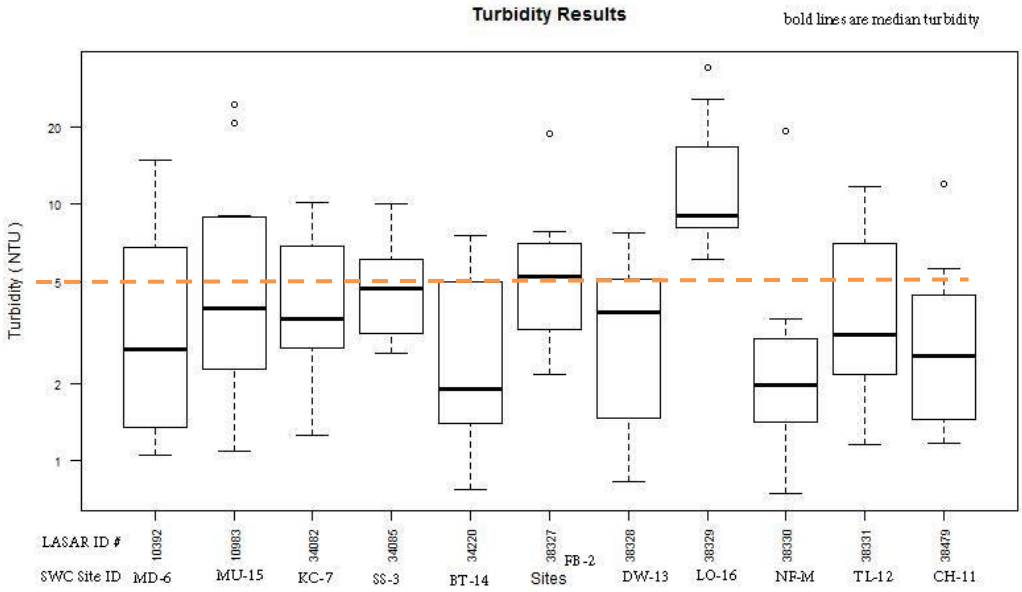


**Figure 6.** Box plot of 2015 turbidity results by grab sample site

Oregon's current turbidity standard is narrative and based on a comparison to upstream levels (10% change). More specific numeric criteria have been under evaluation by DEQ with a workgroup. So, for the sake of this analysis results will be compared to a level of 5 NTUs (orange dashed line; see Figure 6). This is the level at which most municipalities generally stop withdrawing surface water to protect drinking water treatment plants. The upper Siuslaw site in Lorane (LO-16) consistently has higher turbidity levels (6-34 NTU) throughout the year, just as the recently discontinued upstream site at LO-10 displayed from 2005 to 2014. The other sites generally display relatively low turbidity readings except when spikes occur after first flush or major rain/flow events.