**Salmon Creek Watershed Sediment Reduction and Water Conservation Project**

**Quarterly Water Quality Monitoring Report, June to December, 2011**

Prepared by Gold Ridge Resource Conservation District

Jeremy Schroen, GRRCD employee, collecting data in Salmon Creek.


**Summary**

This quarterly report summarizes data collected by the Gold Ridge Resource Conservation District (GRRCD) from June 2011 to December 2011 under the North Coast Integrated Regional Watershed Management Program funded Salmon Creek Sediment Reduction and Water Conservation Project. The data period included five monthly sampling events (6/8, 8/31, 9/21, 10/25, 12/8). There were no storm events sampled during this period.


Gold Ridge RCD staff and SCWC volunteer monitors have been working together to coordinate monitoring efforts, standardize water quality data collection and increase the frequency of sampling for the Salmon Creek Watershed. This report also includes data collected by the

Salmon Creek Watershed Council citizen monitors for several stations during the data period (6/16, 7/14, 8/14, 10/5, 11/16 and 12/7). All reported data were collected in adherence with the quality control measures outlined in the "Quality Assurance Project Plan for Collection of Hydrologic Monitoring in the Salmon Creek Watershed" (Gold Ridge Resource Conservation District, Revised 2010).

**Weather Summary**

A late spring rainfall event occurred in the first week of June 2011 with 2.70 inches of rain recorded at the Occidental Arts and Ecology Center (OAEC) and the Bodega Marine Lab[1]. The remaining months of the 2011 water year[2] were seasonably dry and added just two-tenths of an inch of rain bringing the total rainfall to 49 inches in the Salmon Creek Watershed for the 2011 water year (Figure 1). From October 3rd to 6th between 3 and 4 inches of rain fell in the first storm of the 2012 water year (Figure 2). The next major rain event occurred during Thanksgiving weekend and brought from 2.5 to 5 inches of rainfall across the area (Figure 3). Drier conditions prevailed during the month of December when just a trace to 0.5 inches fell during that period bringing the total for this period to 10 inches recorded at Bodega Marine Lab and 11.6 inches at OAEC. Storm monitoring rainfall criteria requires forecasted storm that will deliver 0.5" rainfall in a 12 hour period and a cumulative 8-12 inches to "prime" the watershed for a potential runoff reponse. *There were no storm events that were monitoring during this period.*

**Figure 1: Hydrograph of Salmon Creek from June 1 to December 31, 2011.** This graph illustrates Salmon Creek streamflow throughout the reporting period. Note that despite the rain events in October and late November the fall was a relatively dry period with short lived responses in water depth and cold temperatures. An unusual rounded peak in stream depth occurred in the early part of August and was not due to rainfall but caused by the placement of a V-notch weir just above the stage gauge to measure the volume of water in the creek. These measurements were taken by scientists from Prunuske Chatham, Inc. who are monitoring water supply in Salmon Creek.

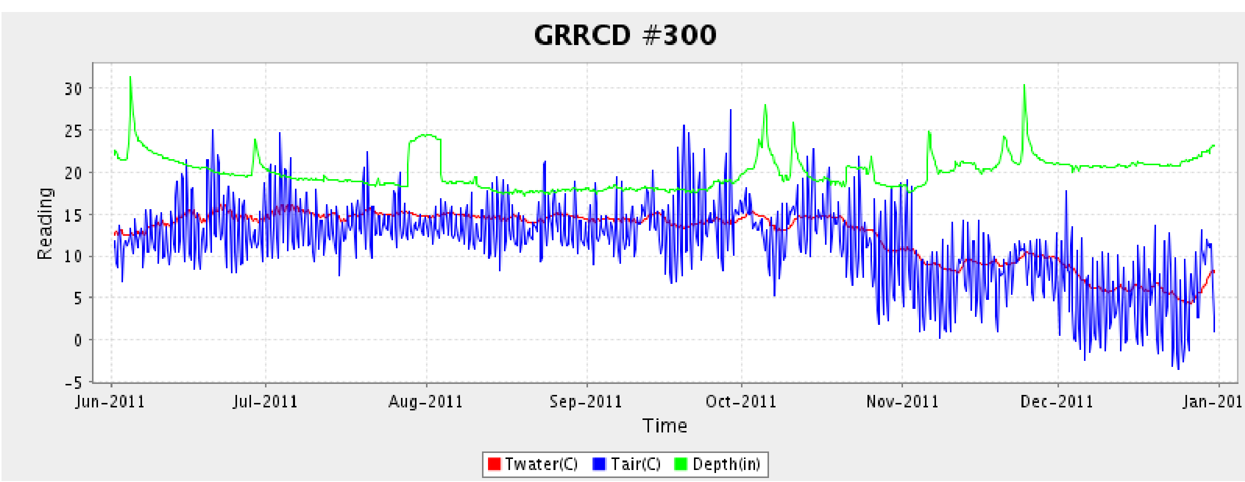


**Figure 2.** Hydrograph of Salmon Creek between October 4th to October 6th, 2011 depicting the first storm event of the 2012 water year (3 to 4 inches) and the short-lived response in the creek.

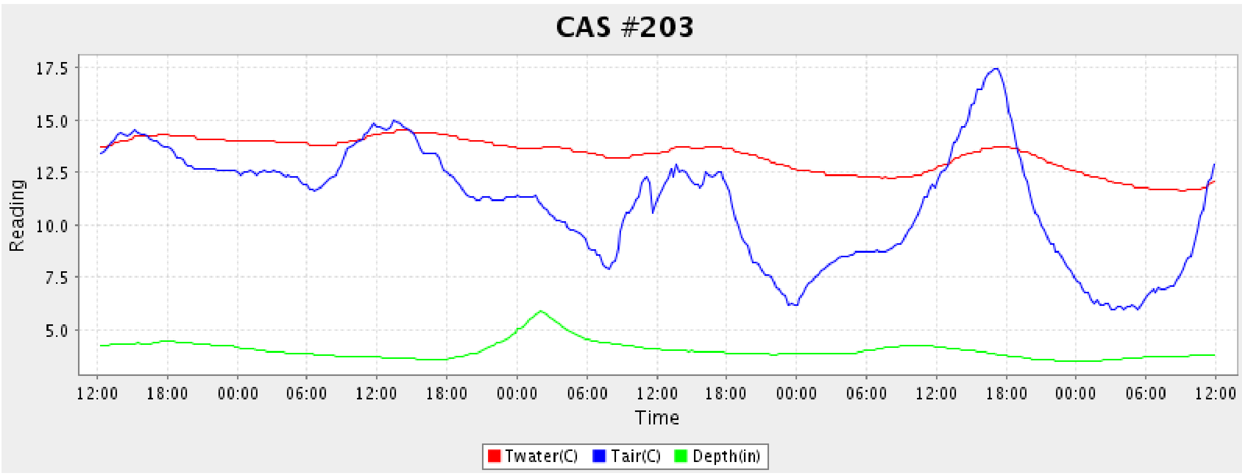
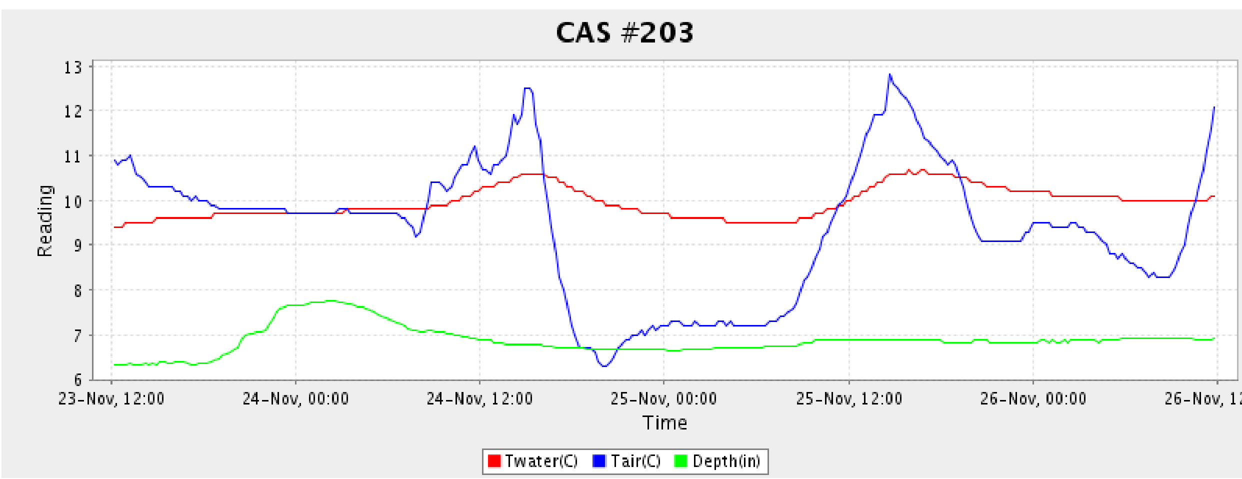



**Figure 3.** Hydrograph of Salmon Creek between November 23rd to November 26th, 2011 illustrating a rain event that brought from 2.5 to 4.75 inches of rain across the watershed. Note the slight elevation in water depth after this event and the continued low baseflow conditions.

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[1] Rainfall data for this report was taken from two sources. Located close to the headwaters of Salmon Creek is the Occidental Arts and Ecology Center where they maintain daily rainfall records going back 17 years. At the other end of the watershed near where Salmon Creek enters the Pacific Ocean is the Bodega Marine Lab's BOON weather station and they maintain rainfall data going back to the late 1960s.

[2] Water year 2011 extends from October 1, 2010 through September 30, 2011 and water year 2012 extends from October 2011 to September 30, 2012.

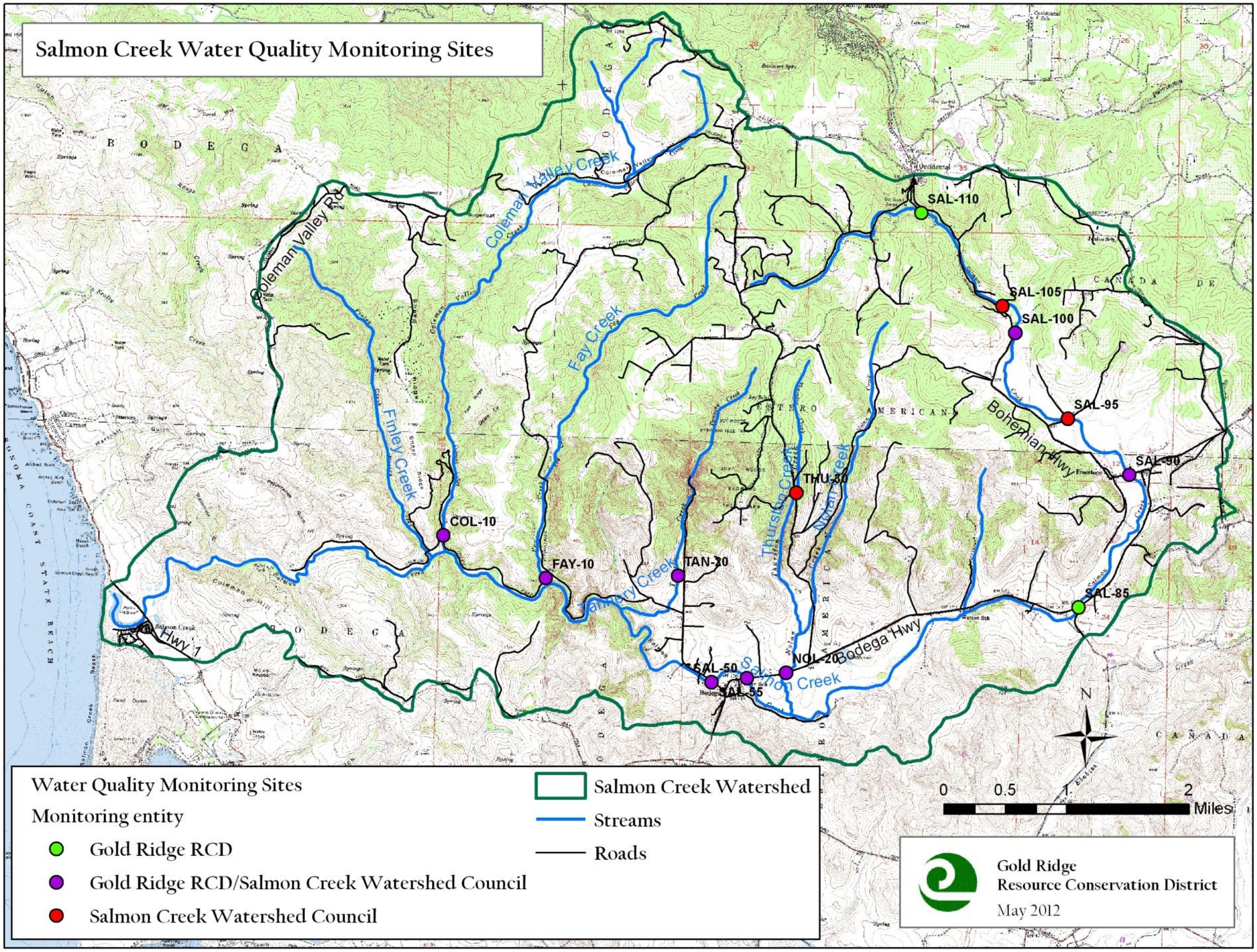
**Sampling Locations**

The sampling locations have been renamed to comply with SWRCB naming convention. See the table below and the associated map (Figure 4). An additional station, SAL-40, was added to the graphs below but is not part of the established sampling stations. The location was selected and certain measurements were taken for a special one-time sampling event to help us understand the cause of low visibility that was observed during coho snorkeling surveys.

**Table 1: Revised monitoring station IDs sampled by GRRCD staff**

| Station ID | Monitoring Entity | Description |
|---|---|---|
| SAL-110 | GRRCD | Salmon Creek off of Scouts Camp Road |
| SAL-105 | SCWC | Salmon Creek at Bohemian Lane |
| SAL-100 | GRRCD/SCWC | Salmon Creek from the Salmon Creek Elementary School entrance bridge |
| SAL-95 | SCWC | Salmon Creek at Freestone Flat Road bridge |
| SAL-90 | GRRCD/SCWC | Salmon Creek at the Bohemian Hwy bridge in Freestone |
| SAL-85 | GRRCD | Salmon Creek at Bodega Hwy bridge adjacent to Valley Ford-Freestone Road |
| NOL-20 | GRRCD/SCWC | Nolan Creek at Bodega Hwy bridge |
| THU-30 | SCWC | Thurston Creek at Joy Road bridge |
| SAL-55 | GRRCD/SCWC | Salmon Creek at Bodega Hwy bridge at the upstream end of the town of Bodega |
| SAL-50 | GRRCD/SCWC | Salmon Creek at the Salmon Creek Road bridge |
| TAN-20 | GRRCD/SCWC | Tannery Creek off of Tannery Creek Road on private property |
| FAY-10 | GRRCD/SCWC | Fay Creek at Salmon Creek Road bridge |
| COL-10 | GRRCD/SCWC | Coleman Creek at Salmon Creek Road bridge |

**Figure 4: Salmon Creek Watershed map with GRRCD and SCWC monitoring stations**



**Water Quality Objectives/Targets**

As with previous GRRCD evaluations of water quality in the Salmon Creek Watershed, the Water Quality Objectives or comparative thresholds are listed in the table below. The North Coast Regional Water Quality Control Board (NCRWQCB) has not set numeric standard water quality objectives for the Salmon Creek Watershed, which falls into the "Bodega Bay" water body description (NCRWQCB, 1994). Statewide criteria set by the US Environmental Protection Agency (EPA), Region 9(US Environmental Protection Agency, 2000) and/or the objectives for the nearby Russian River water body by the NCRWQCB (NCRWQCB, 1994) have been used as targets and are outlined in Table 2 below.

**Table 2. Water Quality Objectives.**

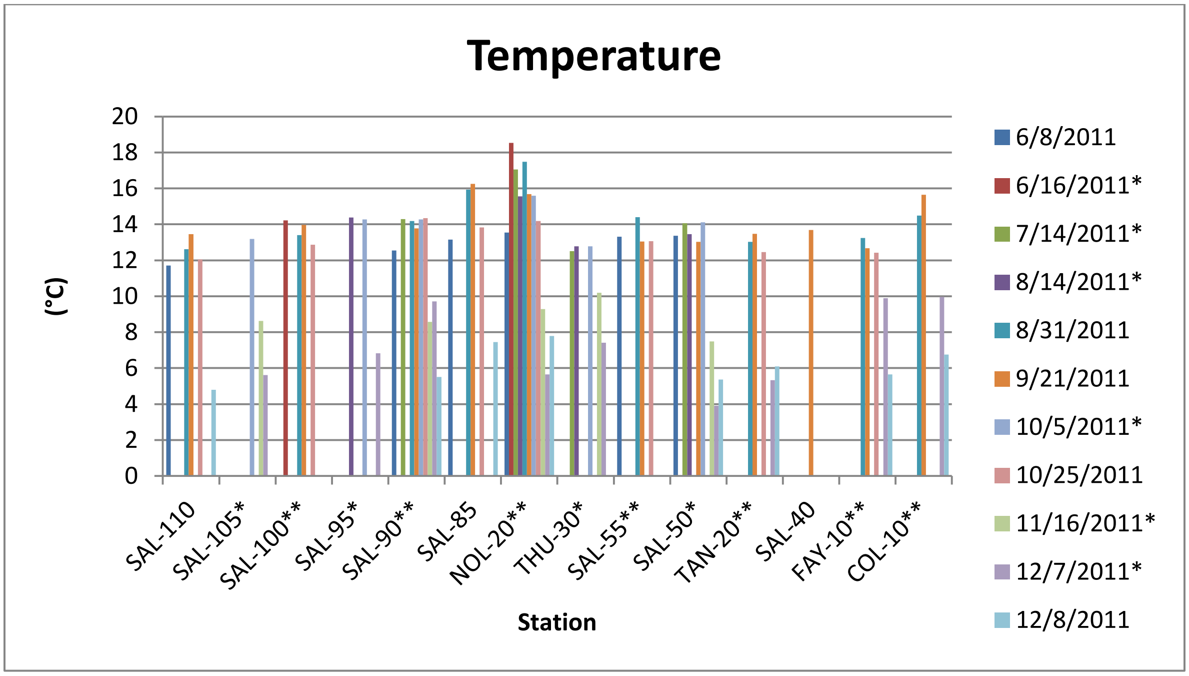
| **Parameter (reporting units)** | **Water Quality Objectives** | **Source of Objective** |
|---|---|---|
| Dissolved Oxygen (mg/L or ppm) | Not lower than 7 | North Coast Region Basin Plan Objective for Cold Water Fish |
| pH (pH units) | Not less than 6.5 or more than 8.5 | General Basin Plan objective |
| Water Temperature (°C) | Not to exceed 21.1 | USEPA (1999) 20-22 range, supported by Sullivan (2000) |
| Conductivity (uS) | None established | N/A |
| Nitrate as N (mg/L) | Not to exceed 1.0 | |
| Ammonia-Nitrogen (mg N/l) | Not to exceed 0.5 | USEPA (2009) |
| Orthophosphate (mg/L) | Not to exceed 0.10 | USEPA(2000) |
| Turbidity | 1.Not to exceed 25 NTUs during low flow; 2. Not to exceed 150 NTUs during storm events | GRRCD selected threshold, 1. Supported by Sigler (1984); 2. supported by Newcombe (2003) |

**Results and Discussion**

**Temperature**

Over the data period, temperature measurements varied from 4.79 in December to 17.48 °C at Nolan Creek in August, none of which exceeded the threshold of 21 °C (Figure 5). Since the collected measurements were grab samples, this information is not conclusive that the stream conditions never exceeded the water temperature objective, though considering the spring ambient air conditions it isn't likely.

**Figure 5: Temperature Measurements**




***denotes dates and stations that were sampled by volunteers**

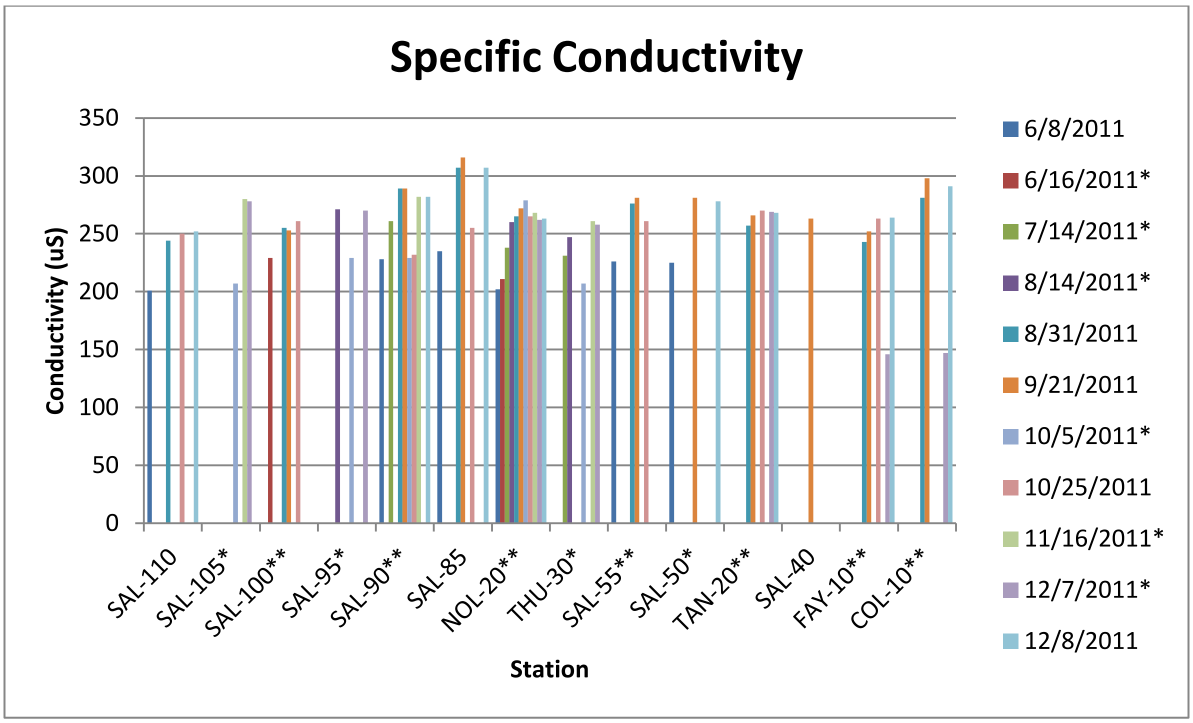
****denotes stations that were sampled by both GRRCD staff and volunteers**

**Conductivity**

Conductivity is a measure of water's capacity for conducting electricity and is a measure of the ionic (dissolved) constituents present in the sample. While there is no specific water quality objective for conductivity, conductivity can be used as a potential indicator of pollutant levels.

Over the data period, conductivity ranged from 146 to 316 uS (Figure 6) within the expected range with no indication of excessive pollutants during this sampling period.

**Figure 6: Specific Conductivity Measurements**

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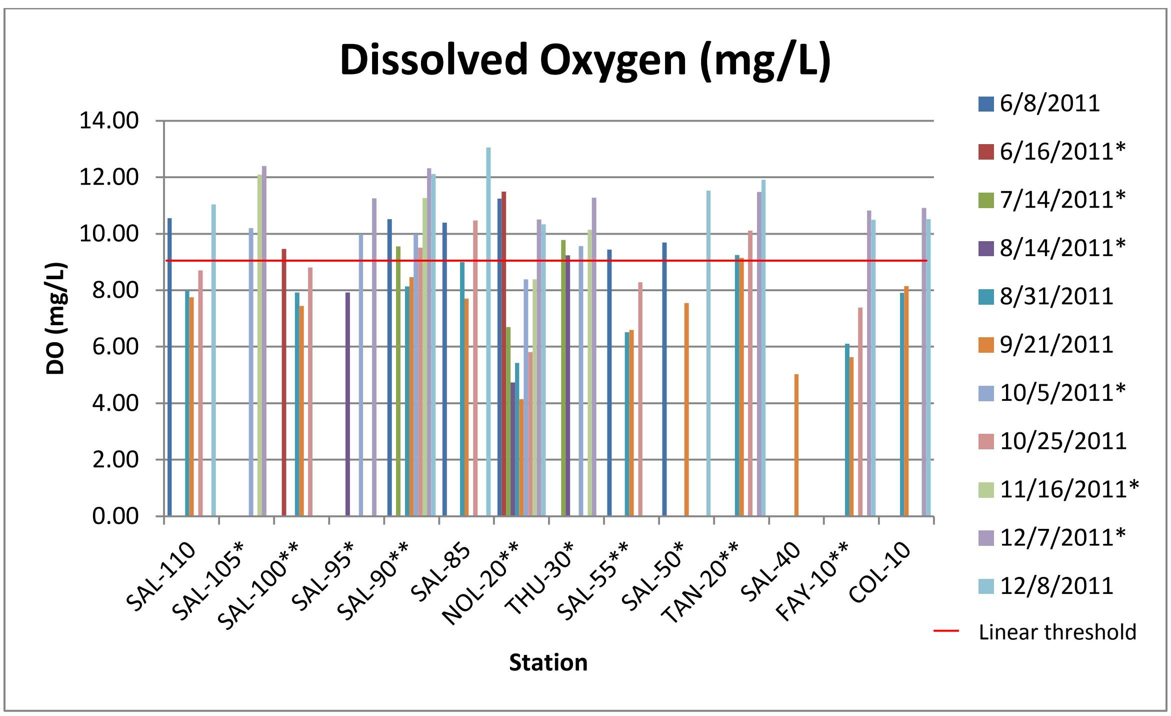
**Dissolved oxygen**

Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water and available to aquatic organisms. Dissolved oxygen is added to water through diffusion from air, turbulence, and photosynthesis of aquatic plants, and removed through respiration of aquatic organisms, decomposition of organic material, and other chemical reactions that use oxygen.

During the drier summer and fall months, creek levels are low and stream flow can become disconnected which creates natural conditions in which dissolved oxygen levels would be expected to be low. This was true during this time period in which there were higher dissolved oxygen levels in June from the wet winter and spring of 2011 with a decline across all sites until October and November storms brought more rain and increases in the level of dissolved oxygen (Figures 7a b and c). Three sampling stations and SAL-40 had levels below the recommended thresholds for freshwater fish during the late summer and fall months but levels returned to acceptable limits after the rain events in November and December.

Again, these are grab samples and only represent the conditions at the time of sampling. It is recommended that continuous dissolved oxygen sensors be deployed in some of the locations where DO levels have fallen below water quality objectives. A monitoring report entitled "Ecological and Roofwater Harvesting Effectiveness Monitoring Report: Save Our Salmon Program – Phase I", PCI, 2012" captures continuous water quality data collected just upstream of station SAL-55 and shows some of the diurnal and seasonal dissolved oxygen fluctuations that occurred in the stream.

**Figure 7a and b: Dissolved Oxygen Measurements**



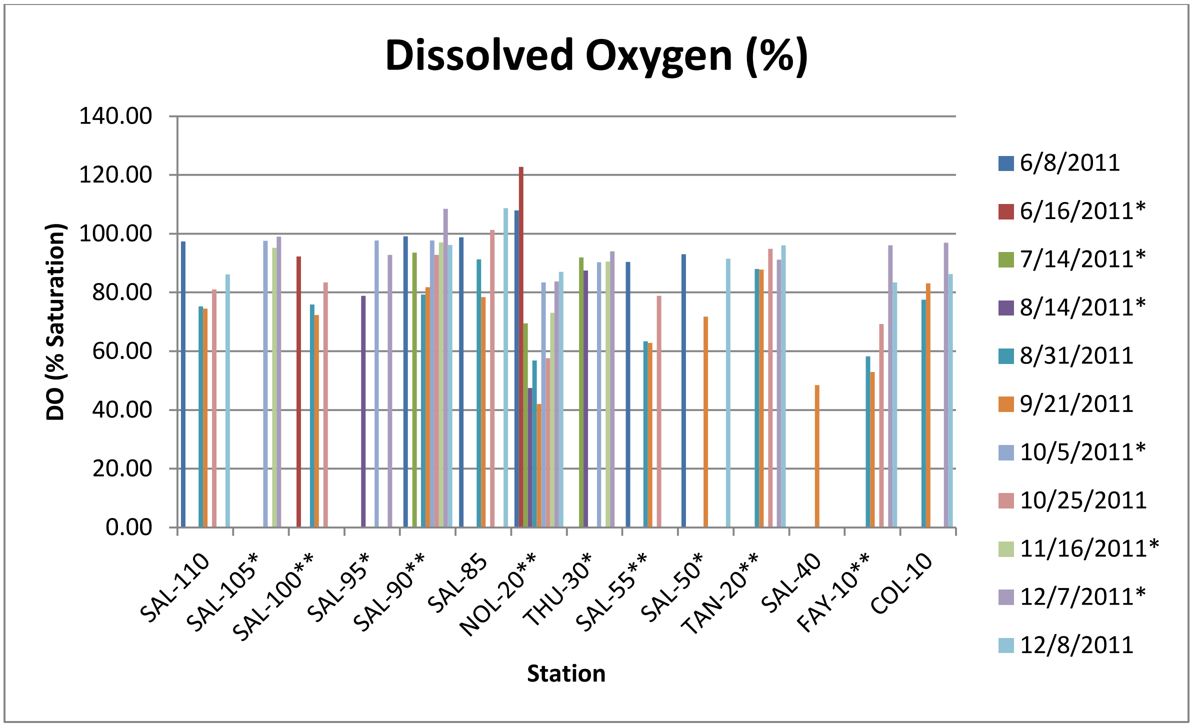
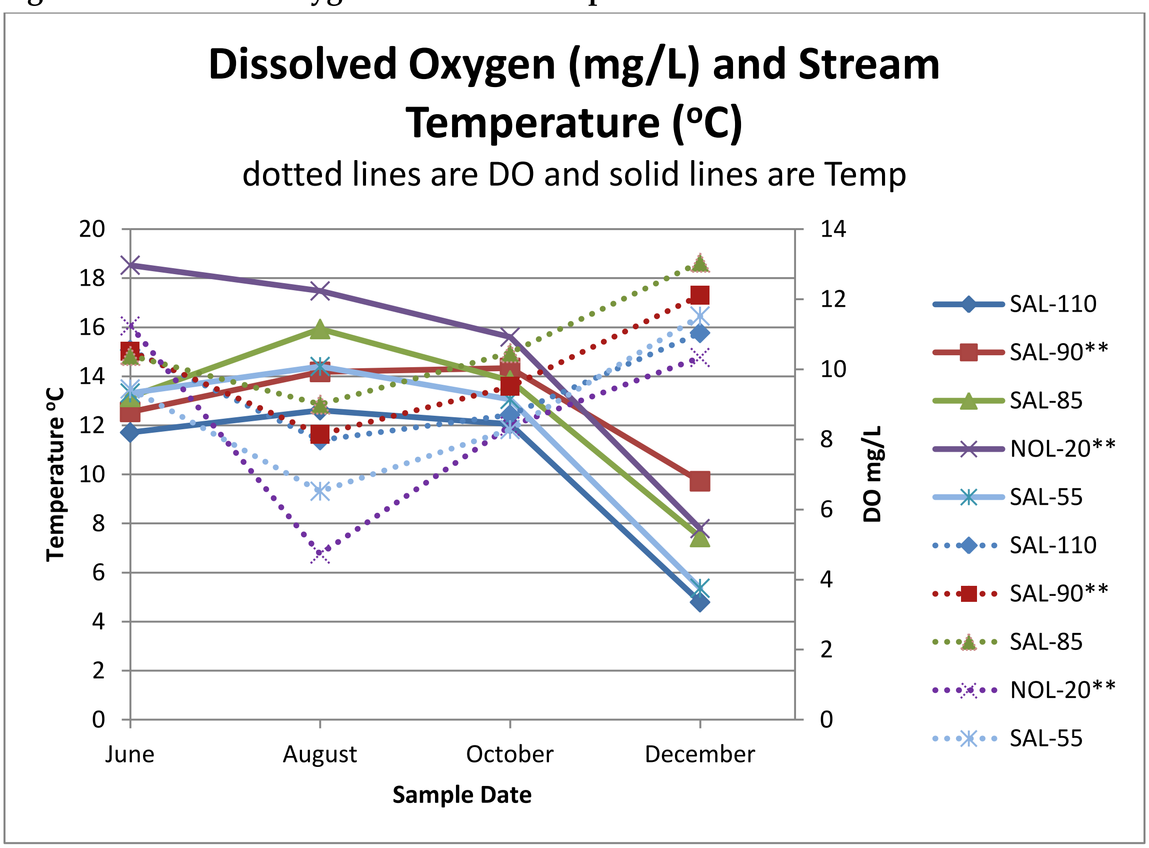



**Figure 7c. Dissolved oxygen and stream temperature in Salmon Creek.**

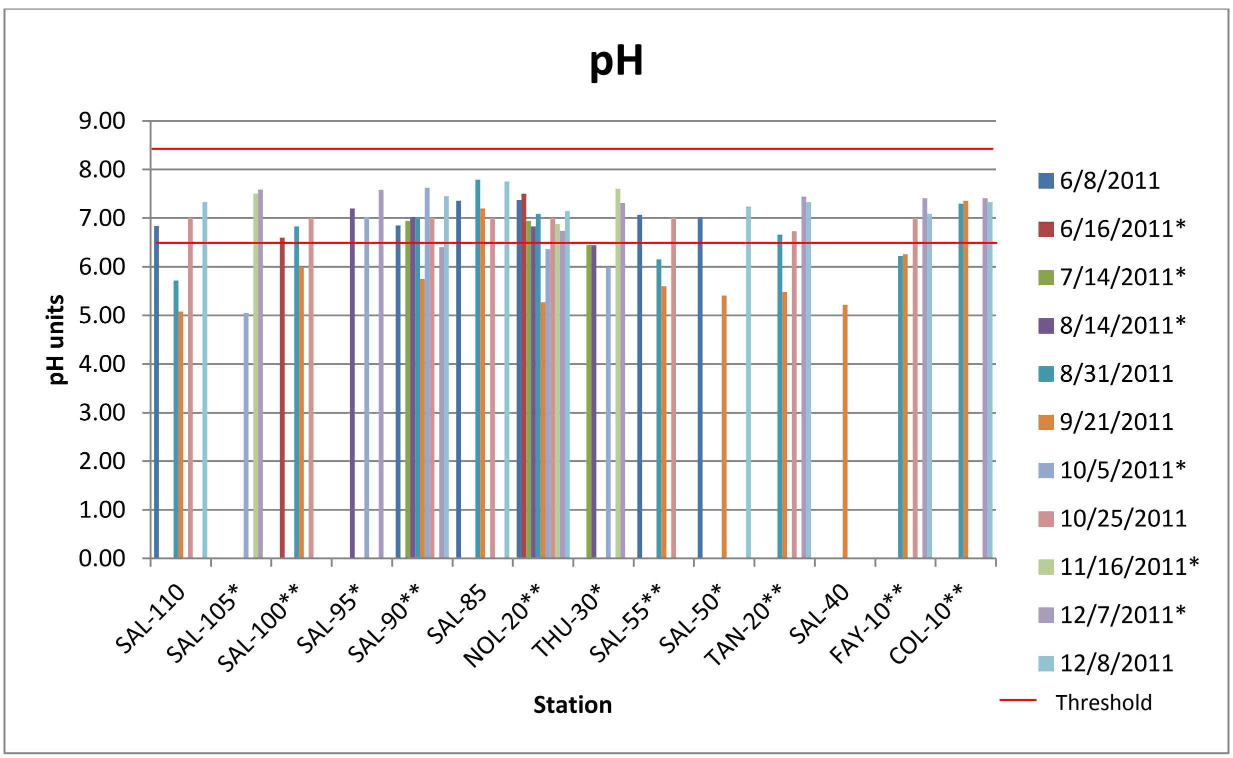


**pH**

pH refers to the concentration of hydrogen ions in water and determines the acidity or alkalinity of water. Natural pH levels are affected by geology, vegetation, and soil types in the streambed and surrounding the stream, and the availability of carbon dioxide. Changes in pH can have critical effects on water chemistry and the biological systems dependent on the aquatic environment. For example, the solubility and toxicity of metal compounds and nutrients changes greatly with pH.

Several stations had pH measurements below the Water Quality Objectives during the dry months of late summer and early fall with the lowest level (5.05) recorded at station SAL-105 in the town of Bodega by the volunteers with the Salmon Creek Watershed Council (Figure 8). The acidic conditions improved after the first significant rainfall in early October. It is also important to note that during this time we were experiencing difficulties with the pH probe and when samples were checked with pH strips, they were closer to 7, so it is probable that the low levels of pH can be attributed to the probe rather than creek conditions. The pH probe was sent back to the manufacturer and replaced with a new one.

**Figure 8: pH Measurements**

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**Nutrients**

As per the Monitoring Plan for this project, nutrients are measured several times a year to characterize seasonal conditions when they may have water quality impacts. During this period there were two dates when samples were measured for nutrients (6/8 and 9/21).

Total ammonia is composed of two forms; ionized ammonia ($NH_4^+$), and un-ionized ammonia ($NH_3$).Un-ionized ammonia, which primarily results from decomposition of manure and other organic debris by microbes, can be toxic to aquatic organisms in small concentrations. The percent of total ammonia in the harmful un-ionized form increase with higher temperatures and pH values.

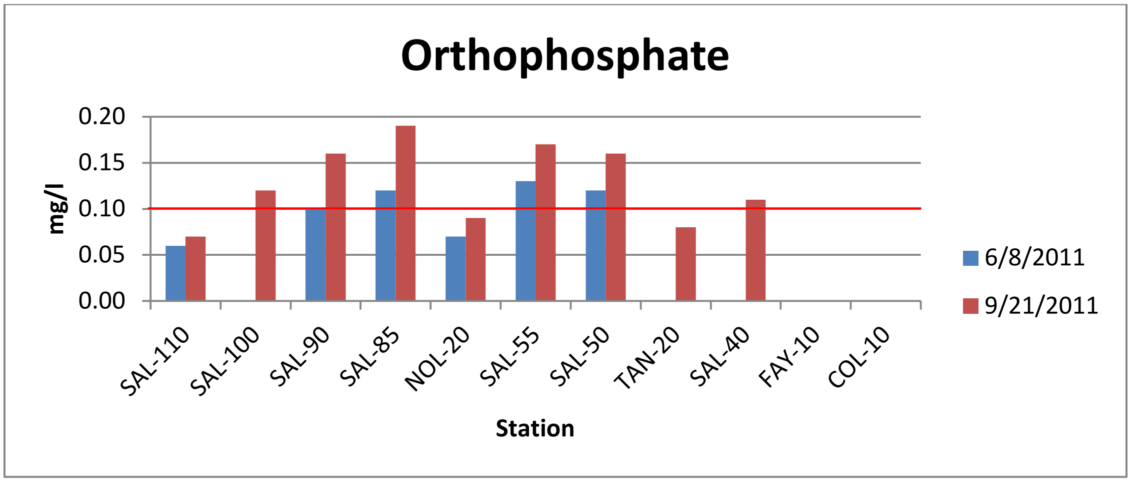
During this sampling period ammonia was not detected (<0.20 mg/L) at any of the sampling locations. This was also true during last year's sampling event on September 15th, 2010 (see Water Quality Summary Report 12/2010).

**Nitrate Measurements**

Nitrate-nitrogen, phosphate and phosphorous are not directly toxic to aquatic organisms but, where sunlight is available, these chemical nutrients act as biostimulatory substances that stimulate primary production. Excessive inputs of these nutrients, known as eutrophication, can result in abundant plant growth and resulting decay which depletes dissolved oxygen and can degrade habitat quality. Nitrate concentrations were undetectable at all stations but one, SAL-100 located the upper watershed had 0.46 mg/L reading on September 21, 2012.

Orthophosphate results ranged from <0.06 (not detected) to 0.19 mg/L (Figure 9). Detectable concentrations were measured at all of the sites except one at Fay Creek. In June 2011, three sampling stations had levels that exceeded the 0.10 mg/L Water Quality Objective established by the EPA. Elevated levels were also detected during the September 21, 2011 sampling event where six out of ten stations exceeded the recommended levels. The high levels of orthophosphate correspond with the lower levels of DO during this sampling period when algal growth is higher due to low flow conditions and higher stream temperatures. While water quality exceedences did occur, the concentrations were still very low and many stations had little or no observed algal growth.

**Figure 9: Orthophosphate Measurements**




This photo taken in Dec. 2011 of the lower section of Salmon Creek illustrates the presence of foam possibly from detergent or other phosphates in the water.

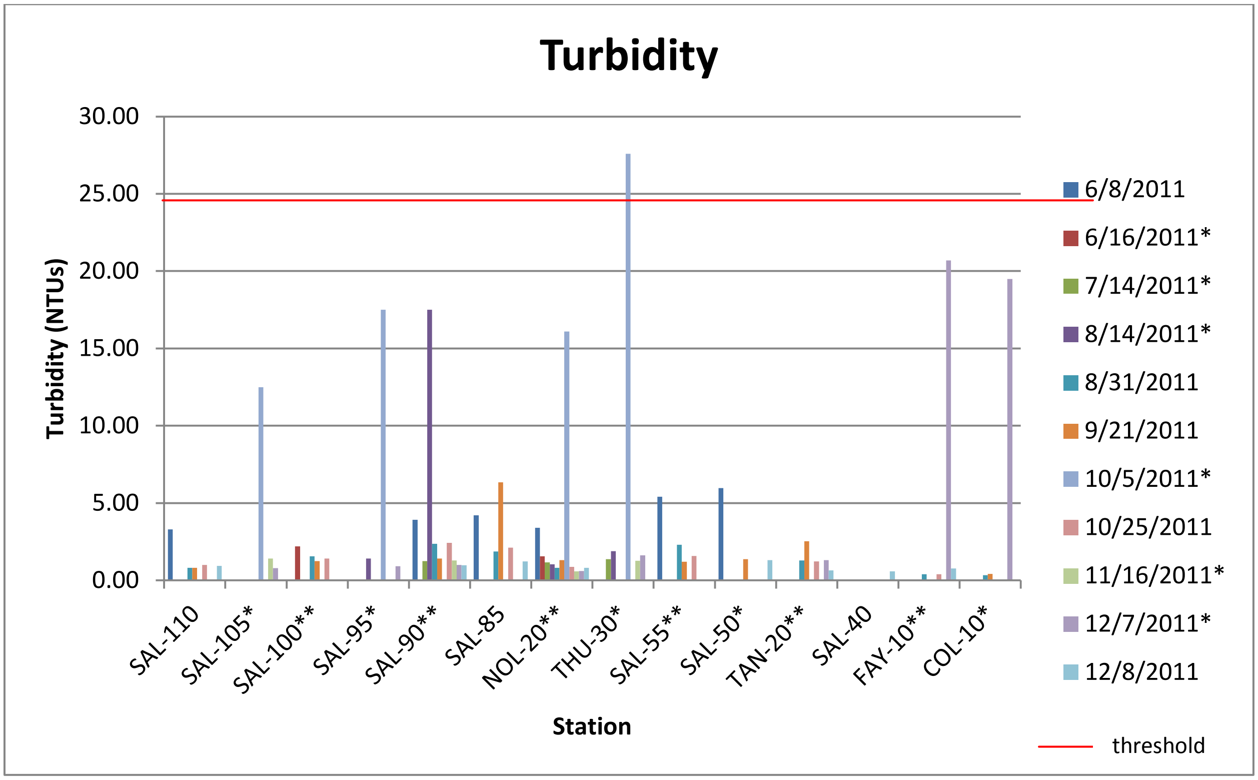
**Turbidity and Total Suspended Solids**

Turbidity, which can make water appear cloudy or muddy, is caused by the presence of suspended and dissolved matter, such as clay, silt, finely divided organic matter, plankton and other microscopic organisms. Sources of turbidity include soil erosion, streambank erosion, animal waste, road and urban runoff, and excessive algal growth.

Excess turbidity reduces light, which decreases aquatic plant life, reducing benthic organisms and ultimately fish populations. High turbidity levels increase water temperatures due to suspended particles absorbing heat. High turbidity levels also affect aquatic organisms by causing reduced feeding rates, reduced growth rates, damage to gills, and fatality.

Water quality objectives for turbidity and Total Suspended Solids (TSS) are not definitively established for the Salmon Creek Watershed. While the North Coast Regional Water Quality Control Board mandates that turbidity levels not be increased more than 20% above naturally occurring background levels (NCRWQCB, 2007), when a background level has not been established (as is the case with Salmon Creek), this objective is difficult to use. Since the recovery of coho salmon is a primary goal for the watershed, clear water fishery objectives have been employed. Newcombe (Newcombe, 2003) described the detrimental impacts to clear water fishes at several turbidity levels. Newcombe states that turbidity levels of 55 NTUs caused significant impairment to fish after one day and severe impairment after four months, while turbidity levels of 150 NTUs caused significant impairment after three hours and severe impairment after two weeks.

**Figure 10: Turbidity.** Turbidity levels were well below the acceptable threshold for this time of year except for a one station at Thurston Creek and Joy Road.

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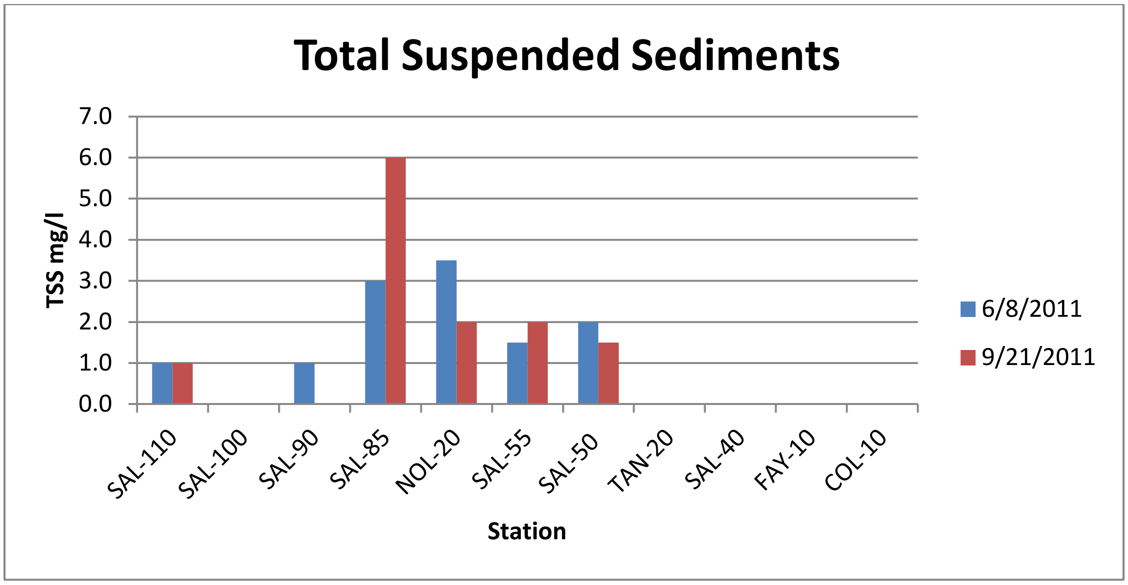
Total suspended sediment concentrations are of concern both due to their direct detrimental effects to fish as well as the impacts these sediments have on salmonid eggs when they settle out of the water column into the substrate gravels.

During this sampling period, TSS was measured on June 8th and September 21, 2011 and as expected turbidity levels were low with several stations reporting undetectable (<1.0 mg/L) levels (Figure 11).

**Figure 11: Total Suspended Sediments Measurements**




**List of Works Cited**

Berry, Walter, et al. 2003. *The Biological Effects of Suspended and Bedded Sediment (SABS) in Aquatic Systems: A Review.* Narraganset, RI. US Environmental Projection Agency.

Gold Ridge RCD. 2010. *Salmon Creek Integrated Coastal Watershed Management Plan.* Occidential, California. Gold Ridge Resource Conservation District.

Hammack and Green, personal communication, 10/5/10.

Newcombe, C.P. 2003. *Impact assessment model for clear water fishes exposed to excessively cloudy water*. Journal of the American Water Resources Association (JAWRA) 39(3):529-544.

North Coast Regional Water Quality Control Board. (1994). *Water Quality Control Plan North Coast Region 1.* Santa Rosa, California: North Coast Regional Water Quality Control Board.

US Environmental Protection Agency. (2000). *Ambient Water Quality Criteria Recommendations.* Washington, DC: USEPA Office of Water.

US Environmental Protection Agency. (2009). *Draft 2009 Update of Aquatic Life Ambient Water Quality for Ammonia - Freshwater.* Washington, DC: USEPA.