Estero Americano Watershed Sediment Reduction Project, Phase II, Sonoma and Marin Counties, CA

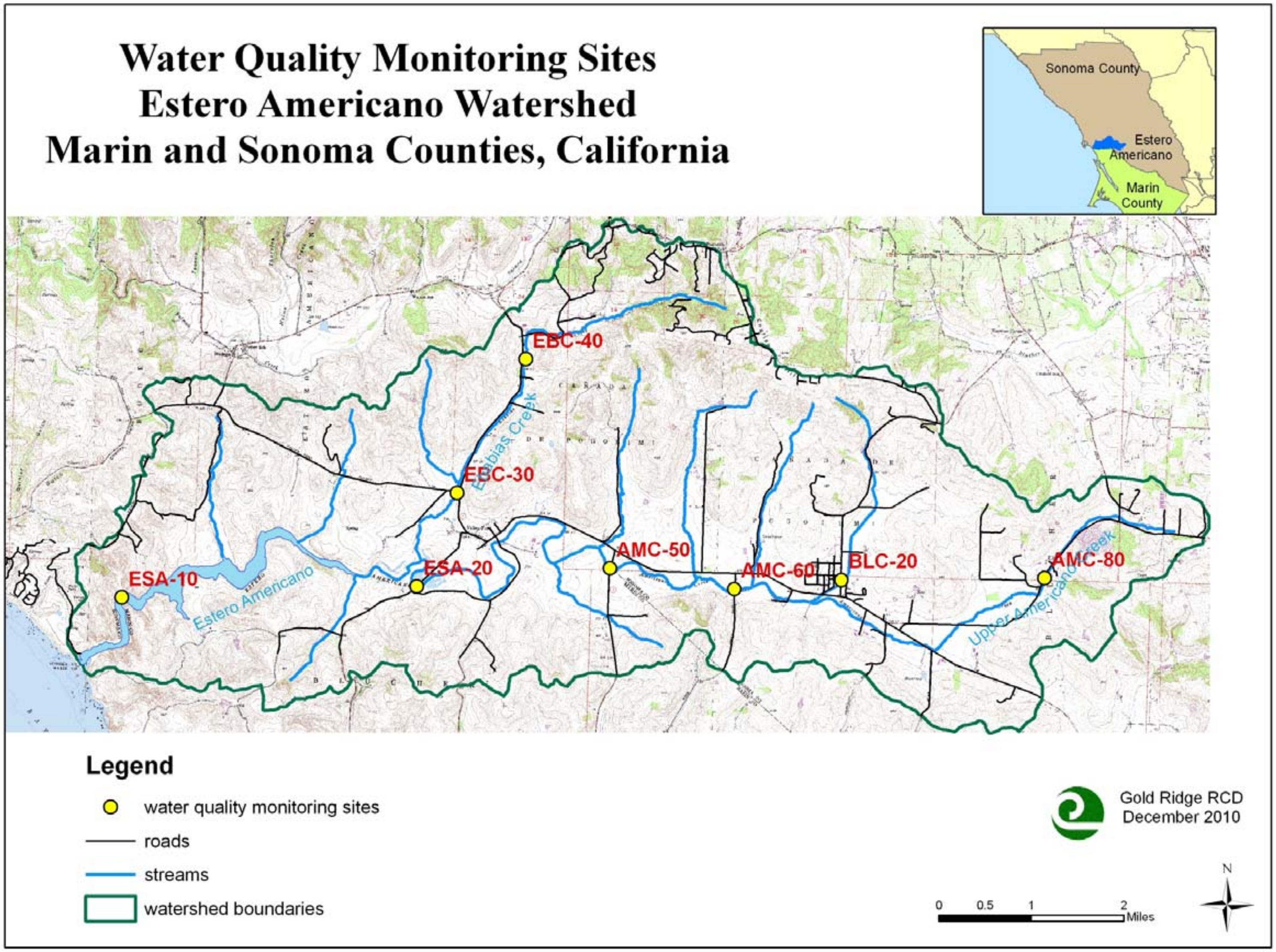
Draft Quarterly Monitoring Report
Item B.4.2

This quarterly report summarizes data collected from March through May 2013 under the SWRCB 319(h) funded Estero Americano Watershed Sediment Reduction Project, Phase II. The data period included a spring baseflow sampling event on March 29, 2013 and a storm sampling event on April 4, 2013. Due to equipment malfunction during the April baseflow sampling event, the pH probe on the sonde malfunctioned causing all other probes to be inaccurate, no additional sampling was conducted in April or May. Gold Ridge staff has since worked with NCRWQCB staff to borrow a meter for monthly sampling until a replacement can be purchased. Data depicted in this report covers December through April for comparative purposes.

Since there are no public streamflow gauges deployed in the Estero Americano Watershed, the Salmon Creek streamflow gauge is used as a proxy for evaluating streamflow response to rainfall. Unfortunately, this gauge has been offline from September 2012 to May 5, 2013 and no hydrograph data is available for the early 2012-13 water year storms.

All of the sampling sites had continuous surface flow during all sampling events during this data period, as would be expected of spring ambient streamflow conditions.

Figure 1: Map of sampling locations throughout the Estero Americano Watershed.



Water Quality Objectives/Targets

As with previous GRRCD evaluations of water quality in the Estero Americano 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 Estero Americano 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 North Coast Regional Water Quality Control Board (NCRWQCB, 1994) have been used as targets and are outlined in Table 2 below.

Table 1: 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 (for streams and flowing waters not discharging into lakes or reservoirs)	USEPA(2000)
Turbidity	1. Not to exceed 55 NTUs during low flow; 2. not to exceed 150 NTUs during storm events	GRRCD selected thresholds, 1. Supported by Sigler (1984); 2. supported by Newcombe (2003)

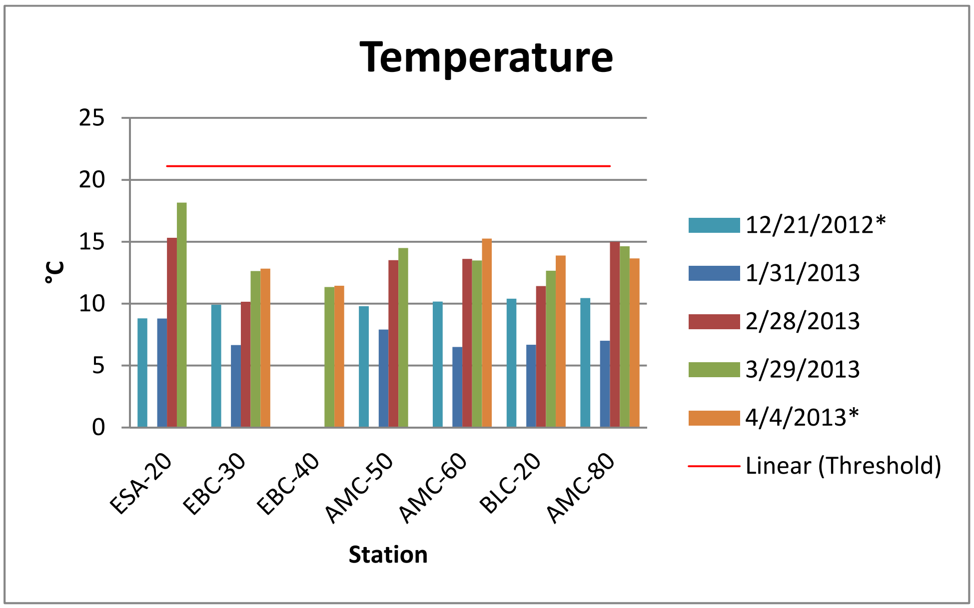
Results and Discussion

Temperature

Water temperature is important to fish and other aquatic species, as well as the function of the aquatic ecosystem. It influences the rate of metabolism for many organisms, including photosynthesis by algae and other aquatic plants, as well as the amount of dissolved oxygen that the water can hold.

Over the data period, temperature measurements were taken during each sampling event. Water temperature is not generally of concern during the spring months and all temperature from this data period met water quality objectives.

Figure 2: Temperature Measurements (* denotes storm sampling)

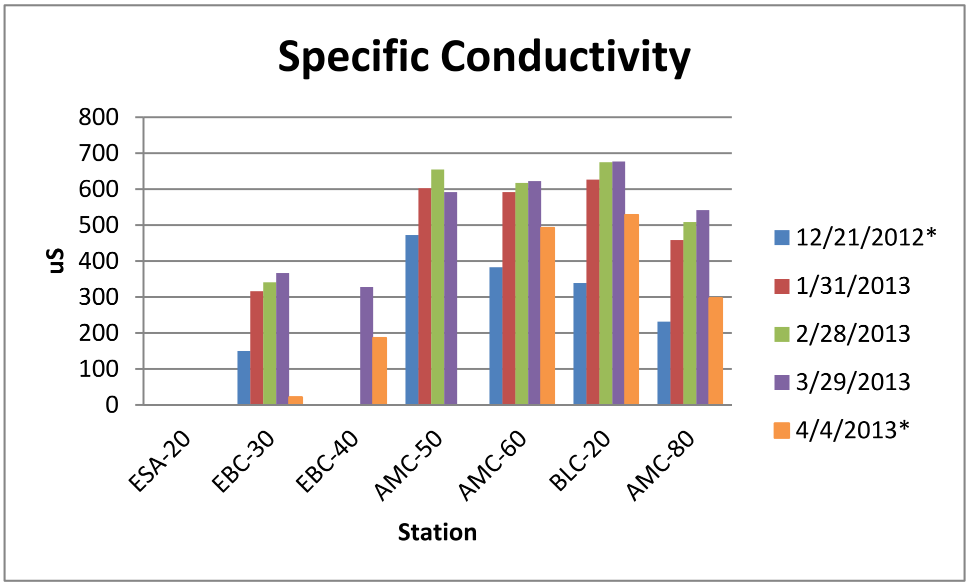


Conductivity

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 an indicator of pollutant levels.

The conductivity results from sampling station ESA-20 are not included in the graph below since high conductivity conditions are assumed to be a function of the tidal nature of this site, rather than an indicator of pollutant levels, and would have skewed the graph. As streamflow levels drop to baseflow conditions, specific conductivity results generally increase. There was very little rainfall in February and March. The highest conductivity result, 677 µS was observed at station BLC-20 during the March 29 sampling event. The lowest result of 22 µS was observed at EBC-30 during the 4/4/13 storm sampling event. Specific conductivity results dropped during the 12/21/12 and 4/4/13 storm events sampling due to the dilution effect of the inflow of rainwater.

Figure 3: Specific Conductivity Measurements (* denotes storm sampling)

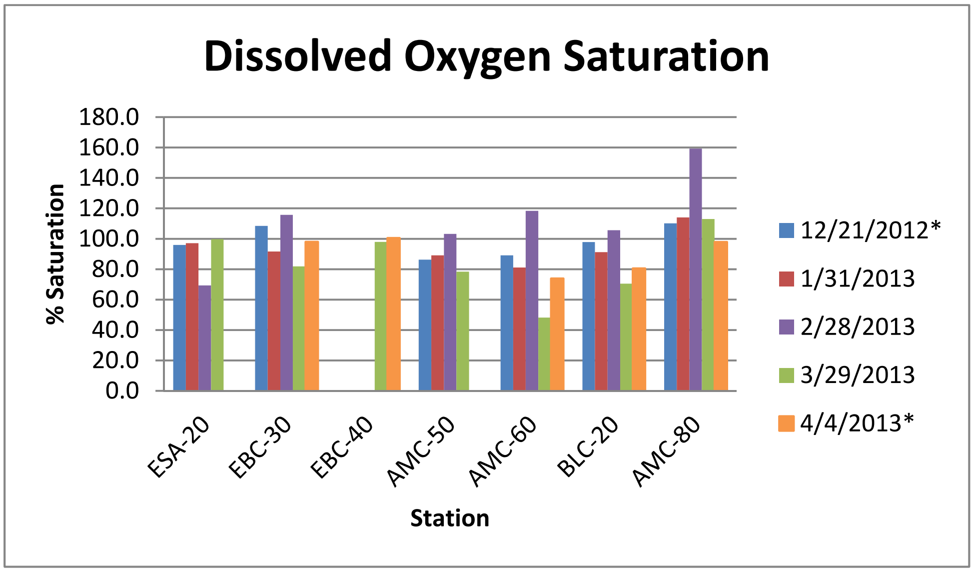


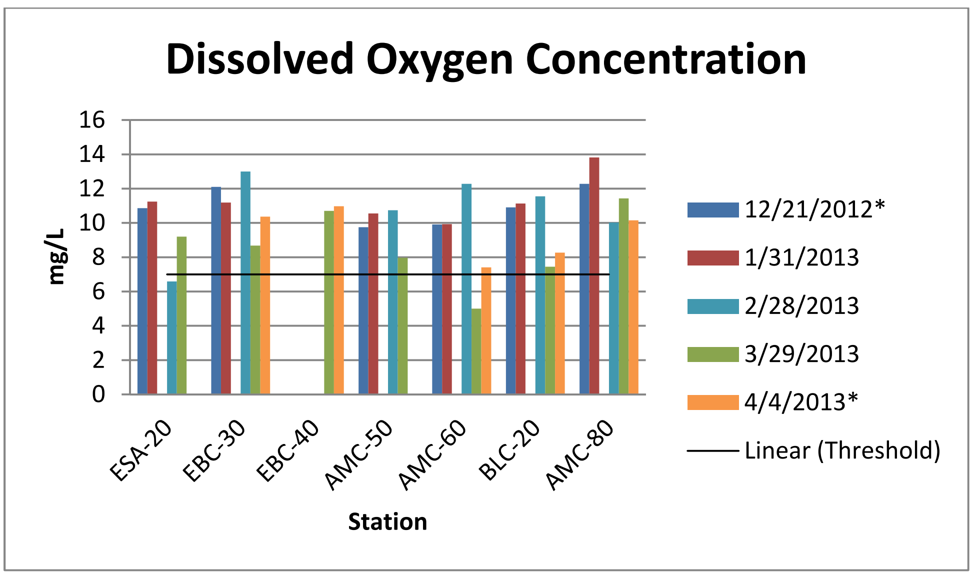
Dissolved oxygen

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.

Throughout the data period dissolved oxygen levels ranged from 48.2 to 159.3% saturation and 5.0 to 13.82 mg/l in Americano Creek and its freshwater tributaries. Several super-saturated DO conditions were observed during this sampling period, but since the presence of algae and aquatic plants isn't generally a concern during winter months, this may be attributed to winter flows. Since the collected measurements were grab samples, this information is not conclusive of the minimum dissolved oxygen conditions, a future monitoring recommendation would be to install continuous DO loggers to capture diurnal and seasonal variations.

Figures 4, 5: Dissolved Oxygen Measurements (* denotes storm sampling)



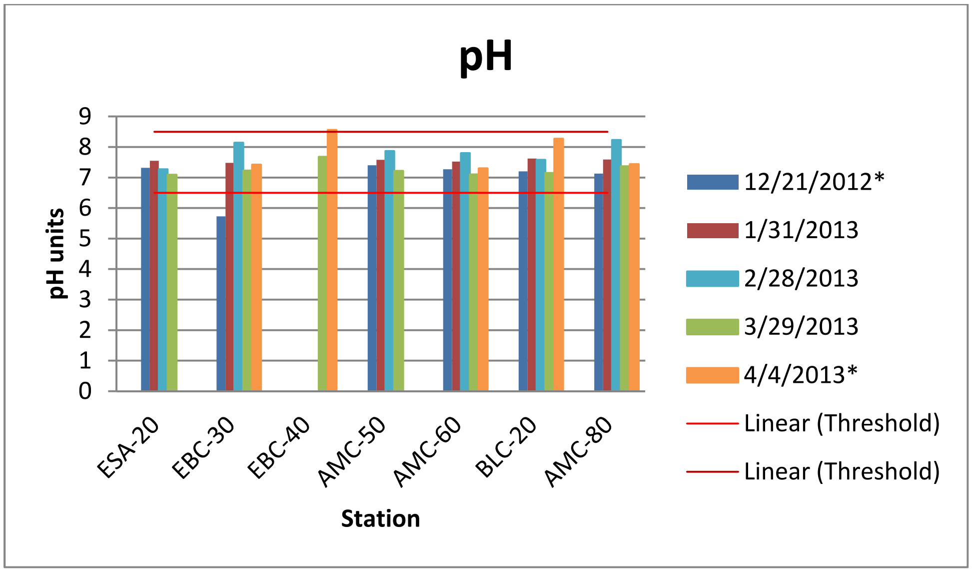


pH

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 in relation with pH.

pH measurements ranged from 5.73 (at EBC-30) to 8.56 pH units (at AMC-80) for freshwater stations, with EBC-40 station slightly exceeding the 8.5 pH unit objective, and 7.83 to 8.16 at the Estero station.

Figure 6: pH Measurements (* denotes storm sampling)



Nutrients

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 (i.e. plant and algae growth). 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. This effect is particularly of concern during summer and fall low flow conditions.

As per the Monitoring Plan for this project, nutrients are to be measured several times a year to characterize seasonal conditions when they may have water quality impacts. The next nutrient sampling event, to capture late summer nutrient levels during low flow conditions, was scheduled to occur during the August 2012 sampling event. Unfortunately, all but two stations were dry on 8/29/12 when sampling was scheduled.

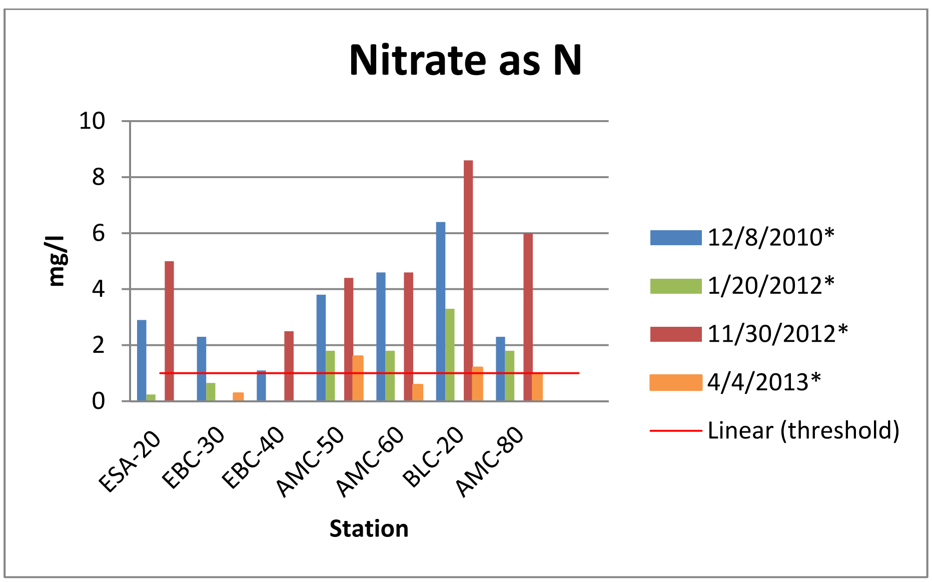
While nutrient levels generally have the greatest impact to water quality both directly (through toxicity) and indirectly (through decreased dissolved oxygen levels due to the biological oxygen demand of decaying plants and algae) during the low flow summer months, the highest concentrations are observed during storm runoff. Since this was a relatively dry winter/spring and baseflow conditions have been low, high concentration nutrient runoff can have a significant water quality impact.

Again, as mentioned in previous reports, based on the large amount of algae and aquatic macrophytes observed throughout the Americano Creek system, particularly during the summer and fall months, it would be a good future monitoring priority to collect continuous dissolved oxygen data to see if the aquatic vegetation is causing the assumed diurnal and seasonal dissolved oxygen concentration fluctuations and associated impacts. Access to deploy a multi-parameter probe in summer 2012 was thwarted by the mainstem Americano Creek sites drying up by early July. Access will be requested earlier next year.

Nitrate

Nitrate (NO_3) is an inorganic form of nitrogen that is soluble and therefore subject to leaching and biological uptake. For the 11/30/12 storm sampling event, Nitrate results at freshwater stations ranged from 2.5 to 8.6 mg/l for freshwater stations, with all stations exceeding the 1.0 mg/l Water Quality Objective. As with most years, the first significant storm tends to show the highest nutrient concentrations, with resulting storms showing a decrease in nutrient concentrations over time.

Figure 7: Nitrate Measurements (* denotes storm sampling)



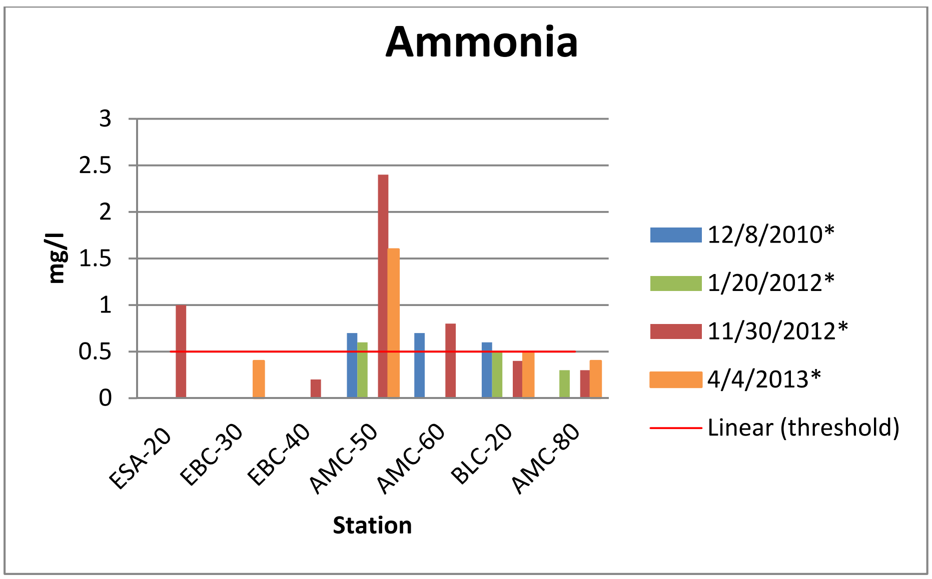
Ammonia

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.

Ammonia concentrations ranged from <0.1. to 2.4 mg/L during the 4/4/13 sampling event. Ammonia concentrations exceeded the water quality objective at only one station, AMC-50. As with most years, the first significant storm tends to show the highest nutrient concentrations, with resulting storms showing a decrease in nutrient concentrations.

Due to the low water temperatures and generally neutral pH values during the sampling period, toxicity due to unionized ammonia concentration is not likely a threat to aquatic organisms. Ammonia concentration becomes more potentially toxic as water volumes decrease and water temperatures increase under summer conditions. BMPs that target reducing nutrient sources for surface runoff should continue to be employed throughout the watershed.

Figure 8: Ammonia Measurements (* denotes storm sampling)



Orthophosphate

Phosphorus is a natural element found in rocks, soils and organic material and is a nutrient required by all organisms for basic biological function. Phosphorus clings to soil particles and is readily used by plants, so in natural conditions, phosphate concentrations are very low. Phosphorus is considered the growth-limiting nutrient in freshwater systems, meaning that when it is present and available in freshwater systems, it is readily absorbed and utilized by algae and aquatic plants for their growth. Orthophosphate is a dissolved and readily bioavailable form of Phosphorus. When Orthophosphate is present in measurable concentrations under conditions that allow algal and aquatic plant growth, it is considered excessive since it can result in algal blooms and eutrophication.

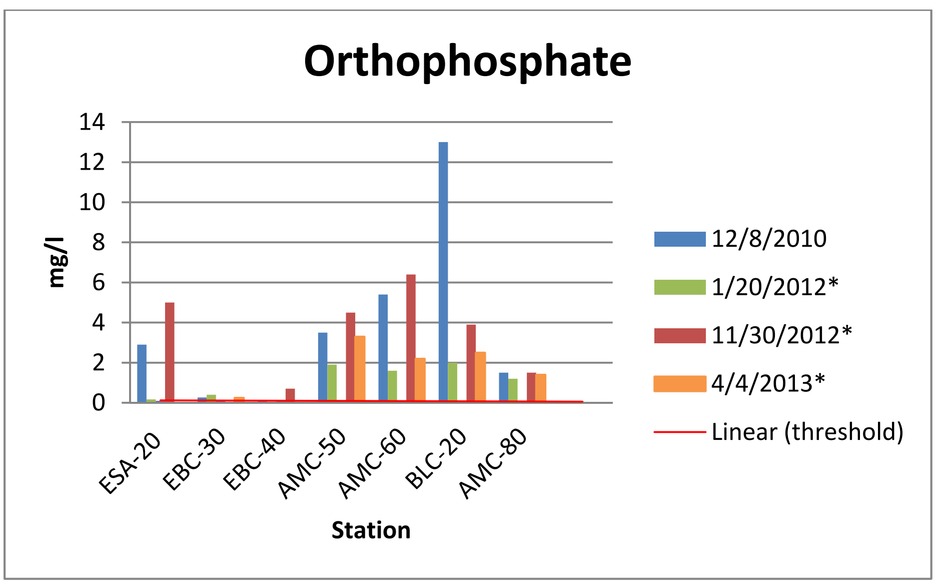
For the 4/4/13 storm sampling event, Orthophophate results ranged from 0.25 to 3.3 mg/l for freshwater stations, with all stations exceeding the 0.1 mg/l Water Quality Objective. As with previously sampled years, the first significant storm tends to show the highest nutrient concentrations, with resulting storms showing a decrease in nutrient concentrations.

It is likely that there may be several pathways of Phosphate entering Americano Creek and its tributaries, but based on past soil sampling conducted at selected locations in the Estero Americano watershed (see Table below), the Phosphorus concentrations stored in the soil are rated "VH" which stands for "very high". Since Phosphorus readily binds to soil particles that settle out in the stream channel, BMPs that target reducing nutrient sources and soil erosion for surface runoff should continue to be employed throughout the watershed.

Table 2. Soil Analysis Report taken from agricultural lands in Estero Americano Watershed

Sample ID	Organic Matter		Phosphorus	Potassium	Magnesium	Calcium	Sulfur
	% Rating	*ENR (lbs/A)	P ppm	K ppm	Mg ppm	Ca ppm	SO_4-S ppm
Field A	5.5VH	140	48VH	156M	359M	1746M	11M
Field B	4.4H	118	95VH	250M	441VH	1341L	8L
* Estimated Nitrogen Release (ENR) in lbs per acre is derived from % organic matter and represents the "potential" amount of organic nitrogen that will be mineralized by soil microbes during the growing season.							

Figure 9: Orthophosphate Measurements (* denotes storm sampling)



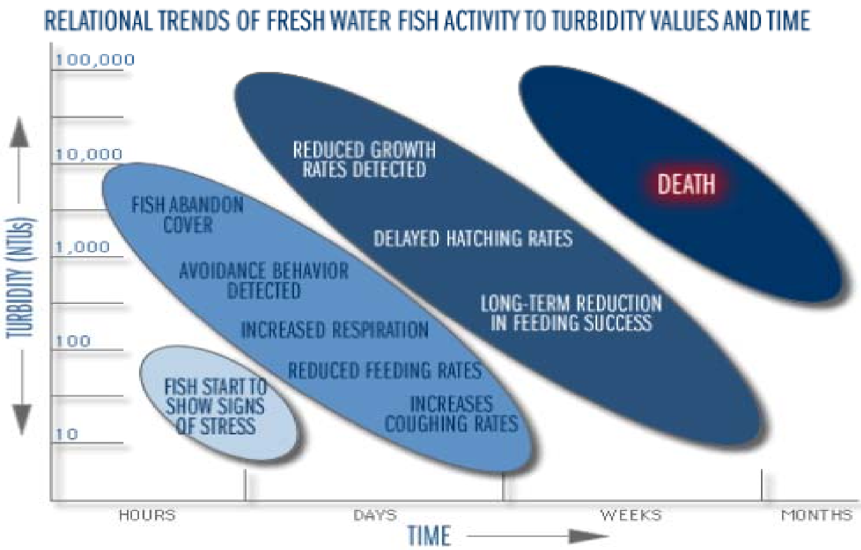
Turbidity

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.

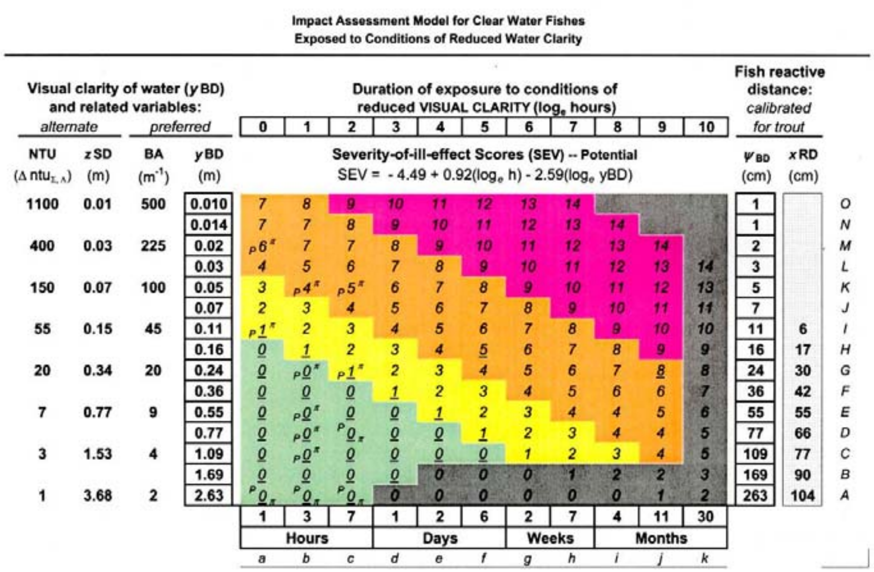
Excess turbidity reduces light, thereby reducing benthic organisms and ultimately fish populations. High turbidity level can increase water temperatures due to suspended particles absorbing heat. High turbidity levels also affect aquatic organisms by causing reduced feeding rates, reduced growth rates,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

Water quality objectives for turbidity and Total Suspended Solids (TSS) are not definitively established for the Estero Americano 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 the Estero), this objective is difficult to use. Since at least part of the watershed sustains anadromous fish, clear water fishery objectives have been employed as water quality targets. 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. For summer baseflow conditions, when turbidity is generally expected to be low, a threshold of 25 NTUs has been used.

Figures 10, 11: Representations of impairment relationships between turbidity and fresh water fish



"Figure 10: Idealized model of fish response to increased suspended sediments. Schematic source of above figure is unknown; it is a generic, un-calibrated impact assessment model based on Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693-727. Reprinted, with permission, from: http://wow.nrri.umn.edu/wow/under/parameters/turbidity.html" (Berry, 2003).



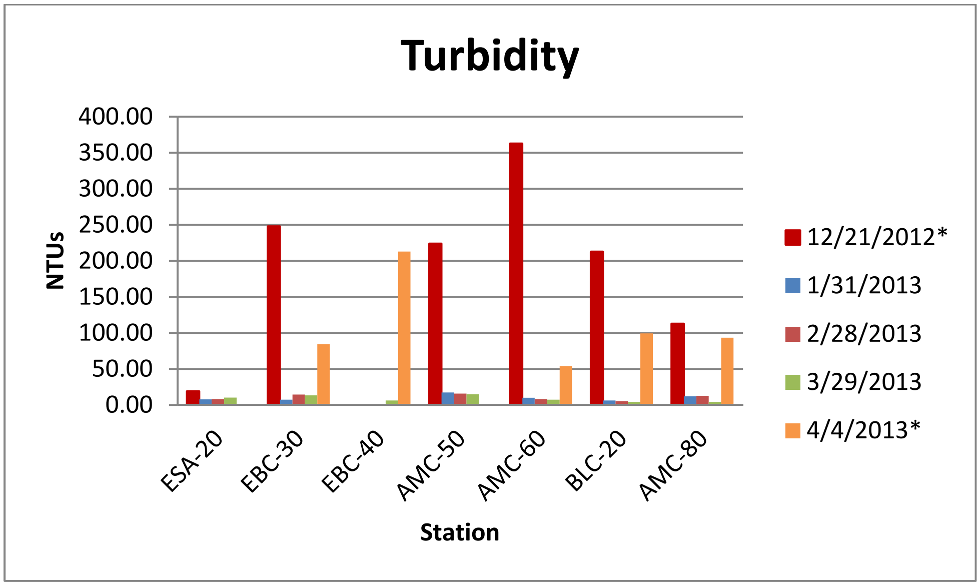
Impact Assessment Model for Clear Water Fishes Exposed to Conditions of Reduced Water Clarity

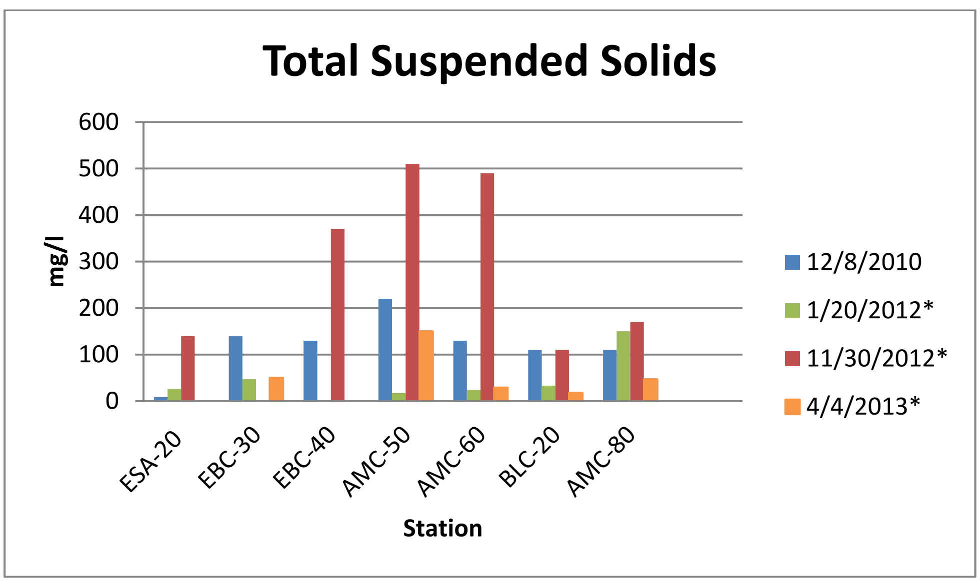
Visual clarity of water (yBD) and related variables: alternate		preferred		Duration of exposure to conditions of reduced VISUAL CLARITY ($\log_e$ hours)											Fish reactive distance: calibrated for trout		
				0	1	2	3	4	5	6	7	8	9	10			
NTU ($\Delta ntu_{\Sigma,\Lambda}$)	zSD (m)	BA (m^{-1})	yBD (m)	Severity-of-ill-effect Scores (SEV) -- Potential; SEV = - 4.49 + 0.92($\log_e$ h) - 2.59($\log_e$ yBD)											ψBD (cm)	xRD (cm)	
1100	0.01	500	0.010	7	8	9	10	11	12	13	14				1		O
			0.014	7	7	8	9	10	11	12	13	14			1		N
400	0.03	225	0.02	p6*	7	7	8	9	10	11	12	13	14		2		M
			0.03	4	5	6	7	8	9	10	11	12	13	14	3		L
150	0.07	100	0.05	3	p4*	p5*	6	7	8	9	10	11	12	13	5		K
			0.07	2	3	4	5	6	7	8	9	10	11	11	7		J
55	0.15	45	0.11	p1*	2	3	4	5	6	7	8	9	10	10	11	6	I
			0.16	0	1	2	3	4	5	6	7	8	9	9	16	17	H
20	0.34	20	0.24	0	p0*	p1*	2	3	4	5	6	7	8	8	24	30	G
			0.36	0	0	0	1	2	3	4	5	6	6	7	36	42	F
7	0.77	9	0.55	0	p0*	0	0	1	2	3	4	4	5	6	55	55	E
			0.77	0	p0*	p0*	0	0	1	2	3	4	4	5	77	66	D
3	1.53	4	1.09	0	p0*	0	0	0	0	1	2	3	4	5	109	77	C
			1.69	0	0	0	0	0	0	0	1	2	2	3	169	90	B
1	3.68	2	2.63	p0*	p0*	p0*	0	0	0	0	0	0	1	2	263	104	A
				1	3	7	1	2	6	2	7	4	11	30			
				Hours			Days			Weeks		Months					
				a	b	c	d	e	f	g	h	i	j	k			

"Figure 11: Matrix of impairment levels by turbidity level and duration. Yellow indicates slight impairment with changes in feeding and other behaviors, orange indicates significant impairment with altered fish growth and habitat quality, and red indicates severe impairment with physiological condition changes and habitat alienation (Newcombe 2001, 2003)" (Gold Ridge RCD, 2010).

The turbidity levels during the 12/21/12 storm sampling event were significantly higher during the early winter storm event (12/21/12) than the later spring storm sampling event (4/4/13). This was likely in part due the magnitude of rainfall events, the December storm generated far more runoff, but also continues the trend of higher turbidity and TSS levels in earlier season storms.

Figures 12, 13: Turbidity and TSS Measurements (* denotes storm sampling)





List of Works Cited

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Gold Ridge RCD. (2010). *Salmon Creek Integrated Coastal Watershed Management Plan.* Occidental, California: Gold Ridge Resource Conservation District.

Newcombe, C. (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.