SWAMP
Surface Water Ambient Monitoring Program

Data Report | 2015

Smith River Plain
2013 Surface Water and Sediment Interim Monitoring Report

North Coast Region

SWAMP-DR-RB1-2015-0001

November 2015

California Water Boards

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NORTH COAST REGIONAL WATER QUALITY CONTROL BOARD

Smith River Plain 2013 Surface Water and Sediment Interim Monitoring Report

November 30, 2015

Surface Water Ambient Monitoring Program (SWAMP)
North Coast Region

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Background

The North Coast Regional Water Quality Control Board (Regional Water Board) addresses water quality impacts associated with agriculture in the Agricultural Lands Discharge Program. Agricultural lands have the potential to contribute to water quality problems through the over-application of fertilizers and pesticides, human-caused erosion of sediment, pollutants in tailwater return flows, and the removal or suppression of riparian vegetation. There are approximately 350,000 acres of agricultural lands in the North Coast Region, which are primarily used for vineyards, orchards, dairies, and row crops including flowers, grain, alfalfa, and hay pasture.

On the Smith River Plain in Del Norte County, approximately 1,900 acres are used to grow Easter lily bulbs. The Regional Water Board is developing a permit for waste discharges from the cultivation of lily bulbs in order to address water quality issues and meet the requirements of the California Water Code and the Nonpoint Source Policy. In order to help inform permit conditions and to better understand water and sediment quality conditions, the Regional Water Board initiated a monitoring study in 2013. The surface water and sediment quality portions of the study are funded by the Water Board's Surface Water Ambient Monitoring Program (SWAMP) as a special study of the North Coast Region. The groundwater portion of the study is funded by the Regional Water Board discretionary laboratory funds.

This report provides an interim summary of the study design and the data and results from surface water and sediment samples collected in 2013. A final report will be available following completion of the study. A monitoring report for 2015 groundwater data is currently available.

Goals and Objectives

The goals of this study are to gather and assess data from which the Regional Water Board can evaluate current water and sediment quality conditions, develop appropriate permit requirements, and use the results as a point of reference when assessing future monitoring data to determine the effectiveness of the permit and agricultural management practices. Specifically, this study is designed to answer the following questions:

- Are contaminants detected in surface waters, shallow groundwaters, and depositional stream sediments in agriculturally-dominated areas of the Smith River Plain?
- Is sediment toxicity observed in depositional stream sediments located downstream of agricultural land use?
- Is water column toxicity observed in runoff downstream of agricultural land use?
- Is there a relationship between contaminant concentrations and the level of agricultural intensity?
- What is the direction and magnitude of change in contaminant concentrations and/or toxicity over multi-year time periods?

Monitoring Design

The Smith River Plain Water and Sediment Quality Study Monitoring Plan (Fadness 2013a) was finalized on April 15, 2013. Sample site selection incorporated the protocols established by SWAMP (DFG-MPSL 2007 and MPSL 2009). In addition, the data being collected is consistent with the Statewide SWAMP Stream Pollution Trends Monitoring (SPoT) Program (SWAMP 2008b) and the Regional Water Board's Status and Trends Monitoring Program (Fadness 2013b). The Regional Water Board incorporated the full analyte list and sampling protocols of both programs into the Smith River Plain Water and Sediment Quality Study and collected all samples in a manner consistent with the SWAMP SPoT Program Quality Assurance Project Plan (SWAMP 2010) and the SWAMP Quality Assurance Program Plan (SWAMP 2008a).

Site Selection

The Smith River Plain Water and Sediment Quality Study was designed to obtain information on the range of constituent concentrations found in waters potentially affected by agricultural discharges and does not provide an investigation of specific sites. Thus, surface water and stream sediment site selection utilized a targeted approach to identify locations at the downstream portion of tributaries draining areas of the Smith River Plain used to grow Easter lily bulbs, based on the following criteria:

- Locations accessible to staff;
- Locations at the base of a watershed;
- Locations with adequate stream flow;
- Locations with available fine-grained depositional sediment;
- Locations amenable to seeing changes in contaminant concentration and effects over time;
- Locations most likely to characterize the accumulation of contaminants draining from agricultural lands.

Three tributary sites meeting the above criteria were selected within the Smith River Plain: Tilas Slough, Lower Rowdy Creek, and Morrison Creek. Two additional sites were also incorporated into this study: Upper Rowdy Creek, which is located upstream of the lily bulb production area to serve as a control; and Delilah Creek, which is located where previous 2010 testing demonstrated reduced reproduction. Ideally, monitoring at these sites should characterize the cumulative contribution of contaminants from the target watersheds (See Figure 1).

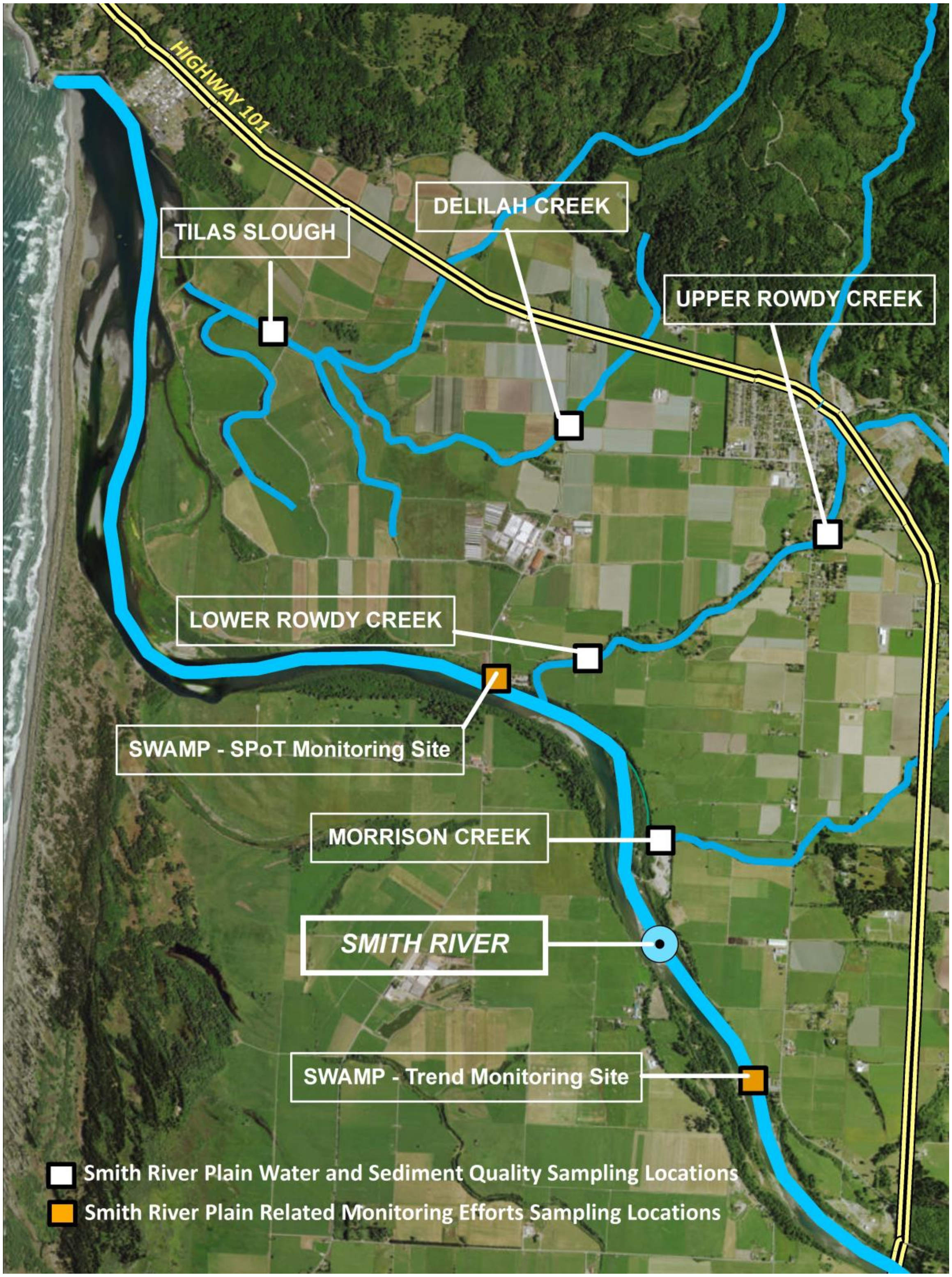


Figure 1. Sample Site Locations.

Analytes

During all site visits, Regional Water Board staff collected standard field parameters using a YSI Datasonde and collected surface water grab samples for the analysis of conventional water quality constituents, water column metals concentrations, pesticides and pesticide residues, and water and sediment toxicity. Water Board staff collected streambed sediment samples on one occasion at Morrison Creek and Lower Rowdy Creek during base flow or near-base flow conditions to be analyzed for metals concentrations, pesticides and pesticide residues, Polychlorinated Biphenyls (PCBs), Polynuclear Aromatic Hydrocarbons (PAHs), Polybrominated Diphenyl Ethers (PBDEs), and sediment toxicity. The individual constituents are listed in Tables 1 and 2.

Table 1. Smith River Plain Water and Sediment Quality Analytes per Sample Category.

Field Measurements	
Dissolved Oxygen	pH
Specific Conductivity	Temperature
Conventional Water Chemistry	
Silica	Chloride
Alkalinity as CaCO3	Chlorophyll-a
Hardness as CaCO3	Soluble Reactive Phosphorous
Ammonia as N	Phosphorous as P (total)
Nitrate as N	Suspended Sediment Concentration
Nitrite as N	Total Dissolved Solids
Nitrogen, Total	Dissolved Organic Carbon
Sulfate	Total Organic Carbon
Total Metals	
Zinc (total and dissolved)	Silver
Chromium	Cadmium
Manganese	Lead
Nickel	Arsenic
Copper (total and dissolved)	Mercury
Sediment and Water Toxicity	
Water Column Toxicity	Sediment Toxicity

The SWAMP program contracts all laboratory analyses to a number of public laboratories. Under these contracts, the Regional Water Board is limited to a specific set of pesticide analytes for which the laboratories are capable and accredited to process. Though the list of pesticides is extensive, over 200 water and sediment constituents combined, the list falls short of being able to detect all of the pesticides that are being utilized within the Smith River Plain. A few of the "missing" pesticides of importance are Metam Sodium, Methyl Isothiocyanate (MITC), and 1,3-Dicholoropropene (1,3-D).

Table 2. Pesticide Analytes

Aldicarb	Dieldrin	Oxamyl
Aldrin	Dimethoate	Oxychlordane
Ametryn	Dioxathion	Parathion, Ethyl
AMPA	Dipropetryn	Parathion, Methyl
Aspon	Disulfoton	PCB 005
Atraton	Diuron	PCB 008
Atrazine	Endosulfan I	PCB 015
Azinphos Ethyl	Endosulfan II	PCB 018
Azinphos Methyl	Endosulfan Sulfate	PCB 027
Bifenthrin	Endrin Aldehyde	PCB 028
Bolstar	Endrin Ketone	PCB 029
Captan	Endrin	PCB 031
Carbaryl	Esfenvalerate/Fenvalerate	PCB 033
Carbofuran	Ethion	PCB 044
Carbophenothion	Ethoprop	PCB 049
Chlordane, cis-	Famphur	PCB 052
Chlordane, trans-	Fenchlorphos	PCB 056
Chlordane	Fenitrothion	PCB 060
Chlordene, cis-	Fenpropathrin	PCB 066
Chlordene, trans-	Fensulfothion	PCB 070
Chlordene	Fenthion	PCB 074
Chlorfenvinphos	Fonofos	PCB 077
Chlorothalonil	Glyphosate	PCB 087
Chlorpyrifos Methyl	HCH, alpha-	PCB 095
Chlorpyrifos	HCH, beta-	PCB 097
Cinerin-1	HCH, delta-	PCB 099
Cinerin-2	HCH, gamma-	PCB 101
Ciodrin	Heptachlor Epoxide	PCB 105
Coumaphos	Heptachlor	PCB 110/151
Cyanazine	Hexachlorobenzene	PCB 110
Cyfluthrin, Total	Hydroxyatrazine, 2-	PCB 114
Cyhalothrin, Total lambda-	Jasmolin-1	PCB 118
Cypermethrin, Total	Jasmolin-2	PCB 126
Dacthal	Leptophos	PCB 128
DDD(o,p')	Linuron	PCB 137
DDD(p,p')	Malathion	PCB 138
DDE(o,p')	Merphos	PCB 141
DDE(p,p')	Methidathion	PCB 149
DDMU(p,p')	Methiocarb	PCB 151
DDT(o,p')	Methomyl	PCB 153
DDT(p,p')	Methoxychlor	PCB 156
Deltamethrin/Tralomethrin	Mevinphos	PCB 157
Demeton-s	Mirex	PCB 158
Desethyl-Atrazine	Molinate	PCB 170
Desisopropyl-Atrazine	Naled	PCB 174
Desmetryn	Nonachlor, cis-	PCB 177
Diazinon	Nonachlor, trans-	PCB 180
Dichlofenthion	Nonylphenol	PCB 183
Dichlorvos	Nonylphenolethoxylate	PCB 187
Dicrotophos	Oxadiazon	PCB 189

Table 2 (cont'd). Pesticide Analytes

PCB 194	Phosmet	Tedion
PCB 195	Phosphamidon	Terbufos
PCB 200	Prometon	Terbuthylazine
PCB 201	Prometryn	Terbutryn
PCB 203	Propazine	Tetrachlorvinphos
PCB 206	Pyrethrin-1	Thiobencarb
PCB 209	Pyrethrin-2	Thionazin
PCNB	Secbumeton	Tokuthion
Permethrin, cis-	Simazine	Toxaphene
Permethrin, trans-	Simetryn	Trichlorfon
Phorate	Sulfotep	Trichloronate

A separate contract was developed with a private laboratory in 2015 which allowed for the incorporation of Metam Sodium analysis into the March 2015 sampling and the incorporation of MITC and 1,3-D into the surface water and groundwater sampling in June 2015.

Monitoring Activities

In 2013, sampling occurred during both the wet and dry seasons. Regional Water Board collected one dry season sample on August 7-8 and two separate wet season samples on October 1-2 and November 5-6. The August sampling event was collected during a dry period with the preceding precipitation event occurring on June 26 (42 days prior). Both wet weather sampling events were rain-triggered runoff events. The October sampling event followed a 5-inch rain event during the previous weekend (2 days prior). In November, the sample event followed a rain event on the previous weekend (2 days prior) of approximately 0.3-0.5 inches of rain.

Not all stations were sampled during all site visits. Upper Rowdy Creek and Morrison Creek were not sampled in August. A suitable sampling location on Morrison Creek had not been determined until the October sampling event. The site at Upper Rowdy Creek was added to the monitoring program as a control site following the documentation of reduced reproduction in the water column sample collected at the Lower Rowdy Creek sampling site in August. The Lower Rowdy Creek site was not sampled during the October runoff event as it was deemed unsafe to sample due to the depth and swiftness of the flow.

Related Monitoring Efforts

2010 Smith River Plain Copper and Toxicity Sampling

In response to questions and concerns expressed by members of the public, staff from the California Department of Fish and Wildlife and the Regional Water Board conducted a one-time sampling event to collect surface water and sediment samples from tributaries draining the Smith River Plain. Four samples were collected from four sampling locations; one sample at each site. The surface water samples were tested to measure copper concentrations only, while both the surface water and streambed sediment samples were tested for toxicity. The analysis did not include any additional constituents that could contribute to toxicity. These samples were collected on August 18, 2010, during the dry season in which the last rain event was June 10, 2010 (68 days prior).

The four sampling locations are:

Rowdy Creek Upstream of Smith River (used in the current study)
Rowdy Creek Upstream of Highway 101
Delilah Creek at Sarina Road (used in the current study)
Delilah Creek Upstream of Highway 101

2001-2012 SWAMP Status and Trends Monitoring Program

The goal for the Status and Trend Monitoring Program is to monitor and assess ambient surface water quality in the watersheds of the North Coast Region to determine if beneficial uses are being protected. This multi-parameter monitoring project is designed to answer the following questions:

- What is the spatial variability of ambient surface water quality in the North Coast Region?
- What is the seasonal variability of ambient surface water quality in the North Coast Region?
- What is the temporal variability or trends of ambient surface water quality in the North Coast Region?
- Is there evidence that beneficial uses are not being protected in the North Coast Region?

Sampling sites are located at the base of a watershed to capture water quality conditions influenced by the full watershed (these sites are known as integrator sites), at the discharge of a major tributary which drains the watershed, and at multiple locations along the main stem usually upstream or downstream of major tributary inputs.

Samples from the Smith River Watershed were collected at the following locations:

- Smith River Upstream of the South Fork Smith River (2001-2012)
  35 site visits with an average of 5 site visits per year
- South Fork Smith River upstream of the Smith River (2001-2012)
  35 site visits with an average of 5 site visits per year
- Smith River Downstream of the Dr. Fine Bridge (2001-2012)
  35 site visits with an average of 5 site visits per year
- Rowdy Creek Upstream of Smith River (2003)
  One sample
- Smith River at Sarina Road (2003)
  One sample

During all site visits, Regional Water Board staff collected standard field parameters using a Datasonde and collected grab samples for the analysis of conventional water quality constituents, water column metals concentrations, and pesticides and pesticide residues. Table 3 lists the individual constituents and total number (#) of pesticide analytes.

Table 3. Status and Trends Program Analytes per Sample Category.

Field Measurements	
Dissolved Oxygen	pH
Specific Conductivity	Temperature
Conventional Water Chemistry	
Boron	Chloride
Alkalinity as CaCO3	Chlorophyll-a
Hardness as CaCO3	Ortho-Phosphorous
Ammonia as N	Phosphorous as P (total)
Nitrate as N	Suspended Sediment Concentration
Nitrite as N	Total Dissolved Solids
Nitrogen, Total	Dissolved Organic Carbon
Sulfate	Total Organic Carbon
Total Metals	
Aluminum	Silver
Chromium	Cadmium
Manganese	Lead
Nickel	Arsenic
Copper	Selenium
Zinc	Mercury
Organic Chemistry	
Organophosphate Pesticides (19)	Triazine Herbicides (18)
Organochlorine Pesticides (32)	Pyrethroids/Pyrethrins (7)
Polychlorinated Biphenyls (50)	

SWAMP Stream Pollution Trends Monitoring Program

The Stream Pollution Trends (SPoT) program is a core component of SWAMP and monitors changes in water quality and land use in major California watersheds throughout the state by assessing stream sediment quality. Data are intended to be helpful in evaluating the effectiveness of regulatory programs and conservation efforts at a watershed scale.
To serve their purpose as integrator sites, SPoT sites are located at the base of large watersheds containing a variety of land uses. Because depositional sediment is needed for sample collection, sites are targeted in locations with slow water flow and appropriate micro-morphology, to allow deposition and accumulation. In the Smith River watershed, the SPoT program samples at one location in the mainstem:

- Smith River at Sarina Road (2008-2013)
  Sampled once per year

SPoT indicators were selected to measure contaminants previously demonstrated to be of concern in California streams. The following sediment indicators were selected: toxicity, organic contaminants (organophosphate, organochlorine, pyrethroid pesticides, and polychlorinated biphenyls (PCBs)), metal contaminants (Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Zn), total organic carbon (TOC), and sediment grain size.

Monitoring Timing

The Smith River Plain Water and Sediment Quality Study was originally scheduled to take place within the 2013 calendar year. The original schedule included sampling in the spring, summer and winter of 2013 to follow the seasonal timing of various pesticide applications and agricultural activities within the Smith River Plain.

Under this schedule data analysis was to occur in the summer/winter of 2014 and the delivery of a peer-reviewed final report by mid-2015. The following text is pulled directly from the Regional Water Board's original monitoring plan:

Schedule and Reporting

> *Monitoring for this project will begin in February 2013 and end in November 2013. Pending the availability of data, data analysis will be performed during September 2014 – December 2014. A technical report will be generated by NCRWQCB staff by May 31, 2015.*

Monitoring Activities

> *Sampling will occur in both wet and dry seasons. We anticipate conducting at least three separate sample events in the spring (wet season), one event in late spring/early summer (dry season), and at two additional sample events in the fall (wet season) during the course of this monitoring effort. All wet weather sampling will be rain-triggered. All of the sites will be sampled during stormwater runoff events. Runoff will be characterized by a single grab sample, if possible taken soon after 0.5 inches of rain in a given event has fallen.*

The start of the Smith River Plain Water and Sediment Quality Study was initially delayed from February to August 2013 as discussions continued with landowners regarding access to appropriate sample locations. The delay required the Regional Water Board to alter the timing of sample collection and as a consequence extended the completion of the study to beyond 2013. In early 2014 the SWAMP experienced governmental contracting delays and the drought conditions and lack of rainfall in the latter half of 2014 limited the Regional Water Board's ability to collect any samples in 2014.

In March and June of 2015, the Regional Water Board was able to collect the remaining wet weather and dry weather samples. Data results from the 2015 sample collections are not available for this interim report and will be presented in the final report.

Results

Water Quality Parameters

Water quality field parameters include the measurement of water column temperature, pH, specific conductance, and dissolved oxygen content. Water quality objectives for these parameters are listed in the *Water Quality Control Plan for the North Coast Region,* which is also known as the Basin Plan (NCRWQCB 2011).

Field measurements obtained from the Delilah Creek site on October 1 failed to meet pH objectives. In addition, field measurements collected from the Tilas Slough site documented conditions that did not meet the water quality objectives for dissolved oxygen during all three site visits. Tilas Slough is an estuarine waterbody located in the lowest part of the Smith River Plain and subject to saltwater inundation during high tides. The dissolved oxygen conditions documented in this portion of the watershed may be indicative of tidal cycling and most likely not directly related to overall water quality conditions. The scope of this effort does not include the investigation of the dissolved oxygen conditions observed in Tilas Slough. All other measurements attained objectives (see Tables 4 and 5).

Table 4. Standard Water Quality Results

Sample site	Date	Standard Water Quality Parameters			
		Dissolved Oxygen mg/L	pH	Specific Conductivity	Temperature
Delilah Creek	8/7/2013	9.8	7.27	123	14.25
	10/1/2013	9.03	6.23	290	14.21
	11/5/2013	10.71	7.84	90	10.83
Morrison Creek	8/7/2013	No Sample Collected			
	10/1/2013	9.96	7.23	181	14.28
	11/6/2013	8.08	7.14	93	9.35
Lower Rowdy Creek	8/7/2013	10.74	7.41	91	13.95
	10/1/2013	No Sample Collected			
	11/5/2013	10.65	7.15	83	10.99
Upper Rowdy Creek	8/7/2013	No Sample Collected			
	10/1/2013	11.78	7.54	180	13.02
	11/5/2013	11.16	7.45	77	11.21
Tilas Slough	8/8/2013	0.65	6.67	205	17.39
	10/2/2013	2.93	6.56	301	10.13
	11/5/2013	4.85	6.55	349	12.51

Red text indicates field parameters that do not meet Regional Water Board Basin Plan Objectives

Table 5. Regional Water Board Basin Plan Objectives for Standard Water Quality Parameters

Parameter	Value	Threshold	
DO (mg/L)	10.00	50% lower limit	50% or more of the monthly means must be greater than or equal to 10.00
	7.00	minimum	
Specific Conductivity (uS/cm)[1]	150	90% upper limit	90% or more of the monthly means must be less than or equal to 150
	125	50% upper limit	50% or more of the monthly means must be less than or equal to 125
pH	8.5	maximum	
	6.5	minimum	
Hardness (mg/L)[1]	60	50% upper limit	50% or more of the monthly means must be less than or equal to 60
Temperature		Varies	

1) Threshold does apply to estuarine waterbodies

Nutrients

Nutrient analytes includes nitrogen and phosphorus components as well as suspended sediment, and dissolved solids. In almost every sample event, the concentrations of each analyte were higher in Delilah Creek, Morrison Creek and Tilas Slough, while both Upper and Lower Rowdy Creek sampling sites had the lowest concentrations (see Table 6).

Table 6. Minimum and Maximum Nutrient Concentrations in mg/L

Sample Site	Total Nitrogen		Total Phosphorus		Suspended Sediment Concentration		Total Dissolved Solids	
	Min	Max	Min	Max	Min	Max	Min	Max
Upper Rowdy Creek	0.155	0.448	0.010	0.024	*ND*	6.4	48	49
Lower Rowdy Creek	0.200	0.321	0.006	0.009	*ND*	*ND*	47	55
Morrison Creek	1.270	1.990	0.034	0.035	2.0	5.3	52	56
Delilah Creek	1.910	10.500	0.054	0.120	5.0	43.2	60	119
Tilas Slough	0.639	4.520	0.284	0.464	*ND*	6.0	109	170
EPA Ecoregion II Sub-Ecoregion 1 Refrence Nutrient Criteria Total Phosphorus: 0.0 - 0.325 mg/L								
EPA Ecoregion II Sub-Ecoregion 1 Refrence Nutrient Criteria Total Nitrogen: 0.0 - 0.53 mg/L								

Red text indicates nutrient concentrations that do no meet thresholds
ND = Non-Detect

The Regional Water Board Basin Plan does not include numeric objectives for total dissolved solids, suspended sediment concentrations, total nitrogen, or total phosphorus. Total nitrogen and total phosphorus results are compared to USEPA's recommended nutrient criteria for rivers and streams in Western Forested Mountains portion of the US, also known as Ecoregion II Sub-Ecoregion I (USEPA 2000). Total nitrogen concentrations exceeded US EPA reference condition thresholds at Delilah Creek, Morrison Creek and Tilas Slough on every sample event, while total phosphorus concentrations at Tilas Slough also exceeded US EPA reference condition thresholds on August 8, 2013 (0.284 mg/L) and on October 2, 2013 (0.464 mg/L).

Pesticides

The analytes sampled included various pesticides and pesticide residues. These included organochlorine pesticides, organophosphorus pesticides, pyrethroid and pyrethrin pesticides, triazine pesticides, carbamate pesticides, glyphosate, and PCBs. Of these 111 pesticide and pesticide residues analyzed on 12 site visits (1,332 separate data results) and 53 PCB congeners analyzed on 9 site visits (277 separate data results), there were 28 quantifiable concentrations of 11 different detected pesticides. These pesticides included pesticides that were registered with the California Department of Pesticide Regulation (DPR) for use in Del Norte County in the last several years as well as pesticides that are no longer registered for use.

Table 7 documents the maximum concentrations of detected pesticides and the associated water quality criteria threshold for each site sampled as part of the Smith River Plain Water and Sediment Quality Study. Table 8 documents the maximum concentrations of detected pesticides for each sampling site as sampled by the SWAMP Status and Trends Program. All other pesticides samples were not detected. Pesticide results obtained from 2013 surface water samples from this study and the SWAMP Status and Trends Program all meet water quality thresholds at all locations.

Table 7. Maximum Concentrations of Detected Pesticides and Associated Thresholds

Analyte (ug/L)		Last Use per CaDPR	Delilah Creek	Morrison Creek	Lower Rowdy Creek	Upper Rowdy Creek	Tilas Slough	Threshold (ug/L)	Reference
Aldicarb		**	*ND*	0.01	*ND*	*ND*	*ND*	*3.0*	1
Captan		2012	1.601	*ND*	0.277	*ND*	*ND*	*15.0*	2
Carbaryl		2013	0.087	*ND*	*ND*	*ND*		*2.1*	3
Carbofuran		2008	0.008	*ND*	*ND*	0.021	0.007	*18.0*	4
Diuron		2013	0.56	0.029	0.02	*ND*	0.139	*2*	5
Ethoprop		2013	0.183	*ND*	*ND*	*ND*	0.158	*No Thresholds*	
Fenpropathrin		**	*ND*	*ND*	*ND*	*ND*	0.0003	*180*	6
HCH, beta-	(Lindane)	1998	0.005	*ND*	*ND*	*ND*	0.005	*0.95*	7
HCH, gamma-			0.003	*ND*	*ND*	*ND*	0.002		
Hexachlorobenzene		**	*ND*	*ND*	*ND*	*ND*	0.001	*1.0*	1
Simazine		1999	*ND*	*ND*	*ND*	*ND*	0.002	*4.0*	1

1: USEPA Drinking Water Standards Maximum Contaminant Levels (MCLs)
2: California Department of Public Health Notification and Response Levels
3: USEPA National Recommended Water Quality Criteria - Freshwater Aquatic Life Protection
4: Regional Water Board Basin Plan
5: USEPA Health Advisory
6: USEPA IRIS Reference Dose (Drinking Water)
7: California Toxics Rule (CTR)
** No Reported Use 1990 - 2013
ND = Non-Detect

Table 8. Maximum Concentrations of Detected Pesticides from SWAMP Status and Trends Monitoring Program.

Analyte (ug/L)	Last Use per CaDPR	South Fork Smith River	Lower Smith River	Upper Smith River	Threshold (ug/L)	Reference
February 2002 Sampling Event						
Endosulfan Sulfate	2001	0.0010	0.0010	0.0010	*0.056*	1
Chlordane	Legacy or - No Reported Use 1990-2008	*ND*	0.0010	*ND*	*0.0043*	1
Dioxathion		*ND*	0.0300	*ND*	*No Thresholds*	
Fonofos		0.0300	*ND*	*ND*	*10.0*	2
Heptachlor Epoxide		*ND*	*ND*	0.0010	*0.0038*	1
Hexachlorobenzene		0.0007	0.0007	0.0007	*1.0*	*3*
Methoxychlor		*ND*	*ND*	0.0010	*0.03*	1
April 2006 Sampling Event						
Dimethoate	2005	0.0400	*ND*	*ND*	*1.4*	4
Sampling Events From February 2002- November 2006						
Diazinon	2008	0.0220	0.0210	0.0290	*0.05*	1

1: USEPA National Recommended Water Quality Criteria - Freshwater Aquatic Life Protection
2: USEPA Health Advsiory
3: USEPA Drinking Water Standards Maximum Contaminant Levels (MCLs)
4: USEPA IRIS Reference Dose (Drinking Water)
ND = Non-Detect

Metals in Sediment

In 2013, the Regional Water Board collected two of three streambed sediment samples measuring the concentrations of various metals. The two sites were Morrison Creek and Lower Rowdy Creek. In addition, the SWAMP SPoT program collected one sediment sample in the Smith River at Sarina Road each year between 2008-2013 (see Table 9).

In every sample collected in the Smith River at Sarina Road and in Morrison Creek, the concentrations of Chromium and Nickel were above the USEPA Probable Effects Concentration. Probable Effect Concentration (PEC) is the concentration level of an analyte that is likely to cause a biologically adverse effect if exceeded. Though the concentrations exceeded the USEPA PEC values, toxicity testing did not demonstrate reduced survival in the sediments from Morrison Creek. However, samples collected as part of the SPoT program did document reduced survival in the mainstem Smith River at Sarina Road in 2010. The SPoT program did not identify the cause of the reduced survival.

Chromium and Nickel are not utilized in the production of Lily Bulbs or the raising of cattle. The presence of these metals may be a consequence of the underlying geology of the Smith River watershed.

Table 9. Metal Concentrations in Streambed Sediments

ANALYTE (Total; mg/Kg dw)	Morrison Creek	Lower Rowdy Creek	Smith River at Sarina Road							US EPA Criteria
			2008	2009	2010	2011	2012	2013	AVG	
Arsenic	7.46	ND	4.79	6.74	4.71	5.00	4.53	6.00	5.30	33
Chromium	115	ND	288	394	277	342	277	346	321	111
Copper	38.9	ND	38.4	34.2	32.8	39.2	35.9	40.6	36.9	149
Lead	9.62	ND	5.98	5.79	6.26	9.28	5.07	6.29	6.45	128
Nickel	77.3	ND	339	336	283	299	260	340	310	48.6
Zinc	91.1	ND	67.9	69.9	67.2	88.9	76.1	90.9	76.8	459

Smith River at Sarina Road: SWAMP SPoT Program Samplign Location

Red text indicates exceedances of US EPA Criteria: Probable Effects Concentration

Metals in Surface Water

Pesticide compounds that include copper and zinc are applied to the agricultural fields of the Smith River Plain at various times throughout the year. The toxicity of copper and zinc in surface water is dependent upon the concentration of each metal and the hardness of the surface water.

Zinc was not detected in any samples but low levels of dissolved copper were detected in every surface water sample collected as part of the Smith River Plain Water and Sediment Quality Study (see Table 10). Delilah Creek had two dissolved copper concentration/hardness pairs that were equivalent to or exceeded the EPA criteria for reproductive toxicity on August 7 and October 1, 2013. Tilas Slough had one dissolved copper concentration/hardness pair that was equivalent to or exceeded the EPA criteria for reproductive toxicity on October 1, 2013 (See Figure 2). These low level exceedances alone are not indicative of an environment that may lead to reduced reproduction or survival, but rather can assist in understanding the conditions should reproduction or survival reductions be documented. These three samples did not demonstrate a reduction in survival or reproduction rates as determined by the toxicity tests. See below for additional discussion on toxicity results.

Table 10. Dissolved Copper and Hardness Results

Sample Site	Dissolved Copper; ug/L			Hardness; mg/L		
	8/7/2013	10/1/2013	11/5/2013	8/7/2013	10/1/2013	11/5/2013
Delilah Creek	3.96	3.03	3.2	38.1	66.6	24.6
Morrison Creek	Not Sampled	0.99	0.94	Not Sampled	25.6	32.6
Lower Rowdy Creek	0.39	Not Sampled	0.16	35	Not Sampled	34.3
Upper Rowdy Creek	Not Sampled	0.28	0.17	Not Sampled	37.2	34
Tilas Slough	1.36	6.5	2.06	76.4	65	73.6

The copper concentration results from the sampling effort on August 18, 2010 are listed in Table 11. The copper concentration/hardness pair at Lower Delilah Creek exceeded the EPA criteria for reproductive toxicity and the sample demonstrated a reduced reproduction rate when compared to the Laboratory Control (See Figure 3).

Figure 2. Dissolved Copper Concentrations and EPA Hardness for 2013 Samples

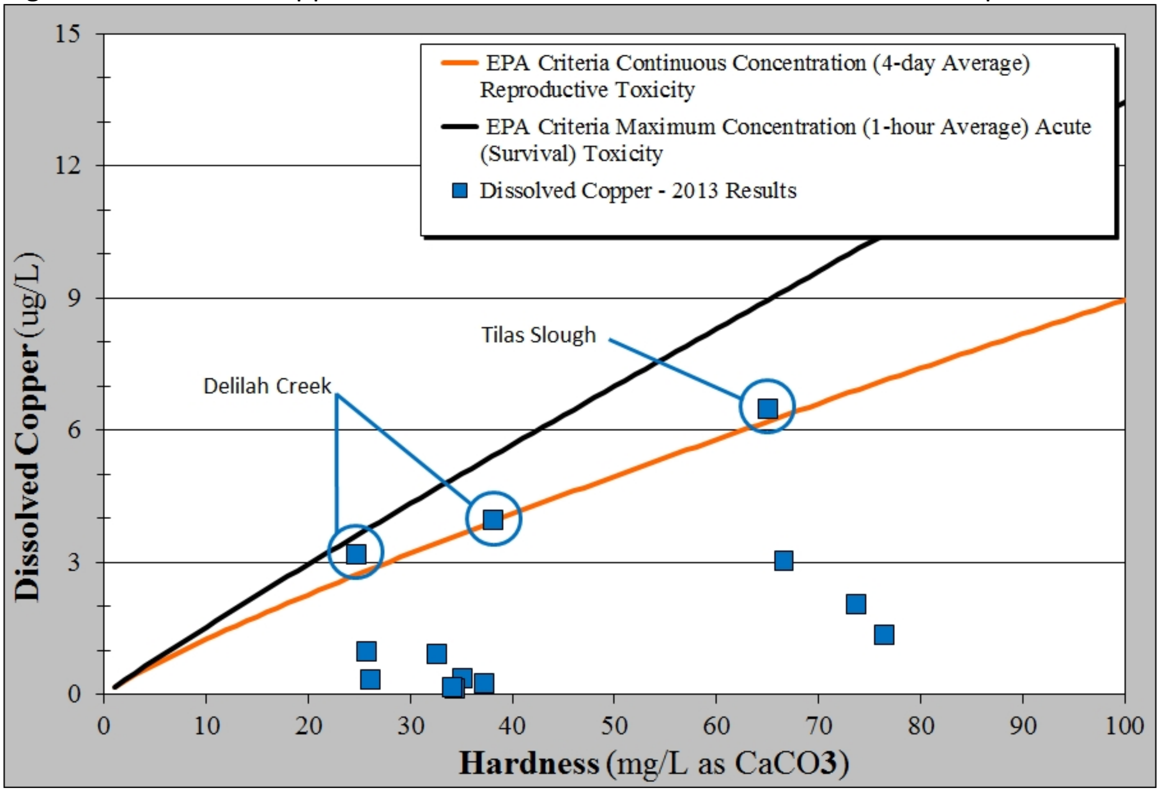


Figure 3. Total Copper Concentrations and EPA Hardness for 2010 Samples

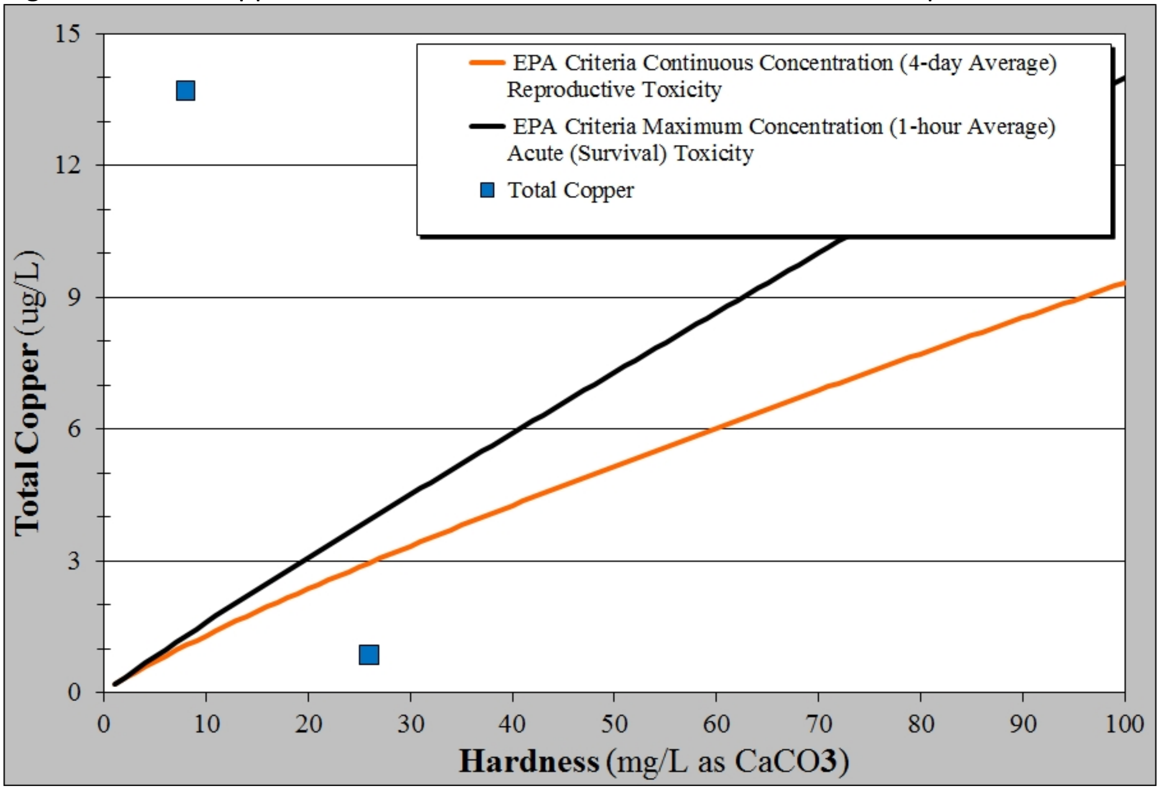


Table 11. Copper Concentrations from 2010 Special Study

Sampling Site	Total Copper (ug/L)	Dissolved Copper (ug/L)	Water Column Toxicity	Sediment Toxicity
Upper Rowdy Creek	0.6	0.53	NO	NO
Lower Rowdy Creek	0.94	0.58	NO	NO
Upper Delilah Creek	0.85	0.36	NO	NO
Delilah Creek	13.7	3.99	Reproductive	NO

Toxicity

To determine toxicity, freshwater zooplankton (*Ceriodaphnia dubia*) are grown in the laboratory using collected water samples (sample group) and laboratory prepared water (control group). The populations of the sample group must differ from that of the control group in a statistically significant manner. Statistical analysis is utilized to determine if the *C. dubia* demonstrate reduced reproduction rates or reduced survival rates in the sample water.

C. dubia are an abundant freshwater zooplankton found in lakes, ponds, streams, and rivers. The selection of *C. dubia* for toxicity testing is appropriate for a number of reasons including:

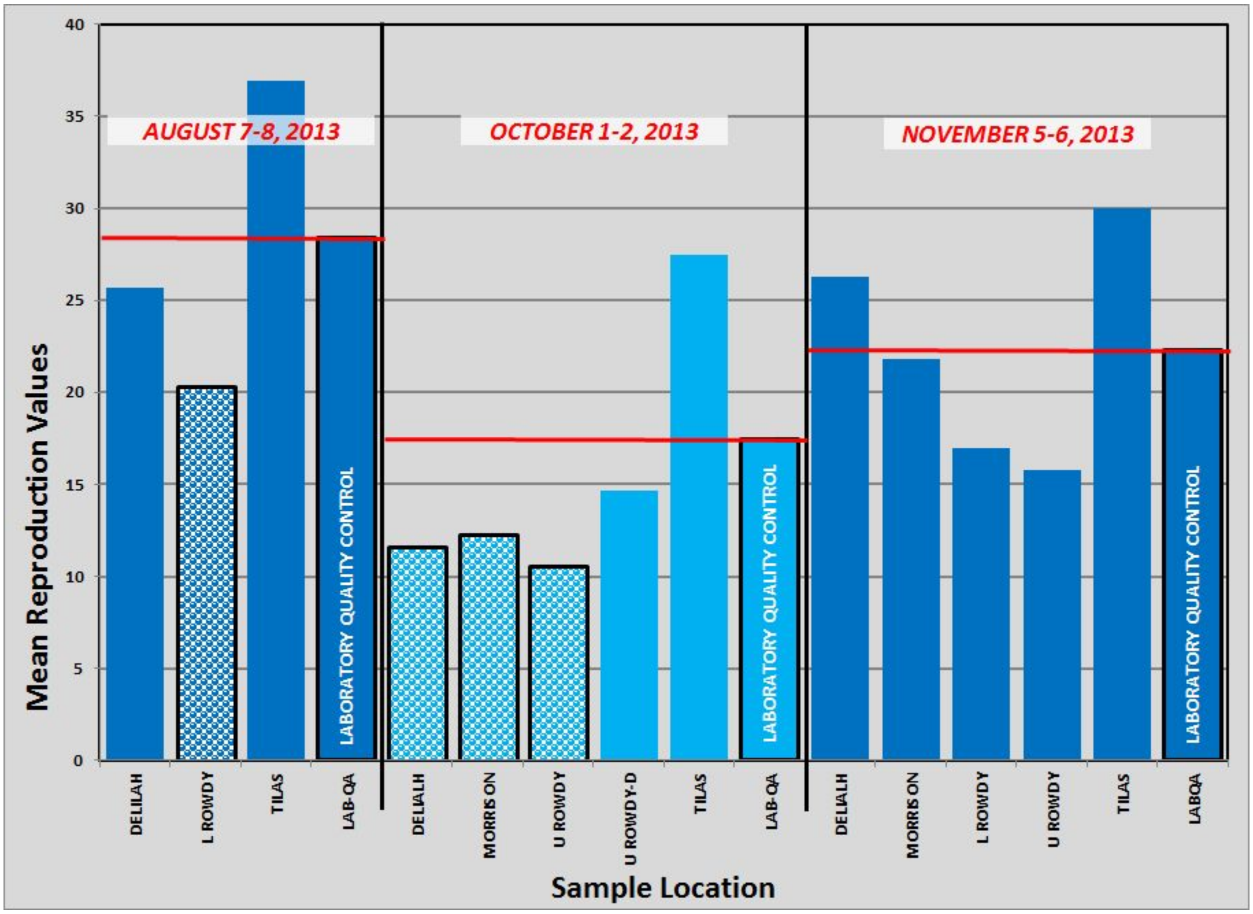
- They are present throughout a wide range of freshwater habitats.
- They are an important link in aquatic food chains and are a significant source of food for small fish.
- They have a short life cycle and can be cultured in the laboratory.
- They are sensitive to a broad range of aquatic contaminants and are widely used as test organisms for evaluating the acute or chronic toxicity of chemicals or effluents.
- Their small size requires only small volumes of test water leading to ease of sampling.

2013 Surface Water Results

In 2013 the Regional Water Board collected twelve surface water samples and one duplicate sample and tested each for water column toxicity. Of these twelve samples, three of the water samples demonstrated “chronic” or reduced reproduction while one water sample demonstrated “acute” or reduced survival (see Figure 4 and 5).

Lower Rowdy Creek tested positive for reduced survival during the dry season sampling event on August 7, 2013. The three positive tests which showed reduced reproduction all occurred during the runoff sampling event on October 1, 2013. Two of these sites, Delilah and Morrison Creeks, are located below the lily bulb farming area while the remaining site, Upper Rowdy Creek, is located upstream of the lily bulb farms. A duplicate sample was collected at Upper Rowdy Creek on October 21, 2013 and is labeled “U ROWDY-D” in Figure 4. As indicated in Figure 4, the duplicate sample did not demonstrate any reduced reproduction when compared statistically to the Laboratory Control.

Figure 4. Reproduction Values for Water Column Toxicity Tests and Lab Control



Checkered bars are samples demonstrating statistically-significant reduction in reproduction rates.

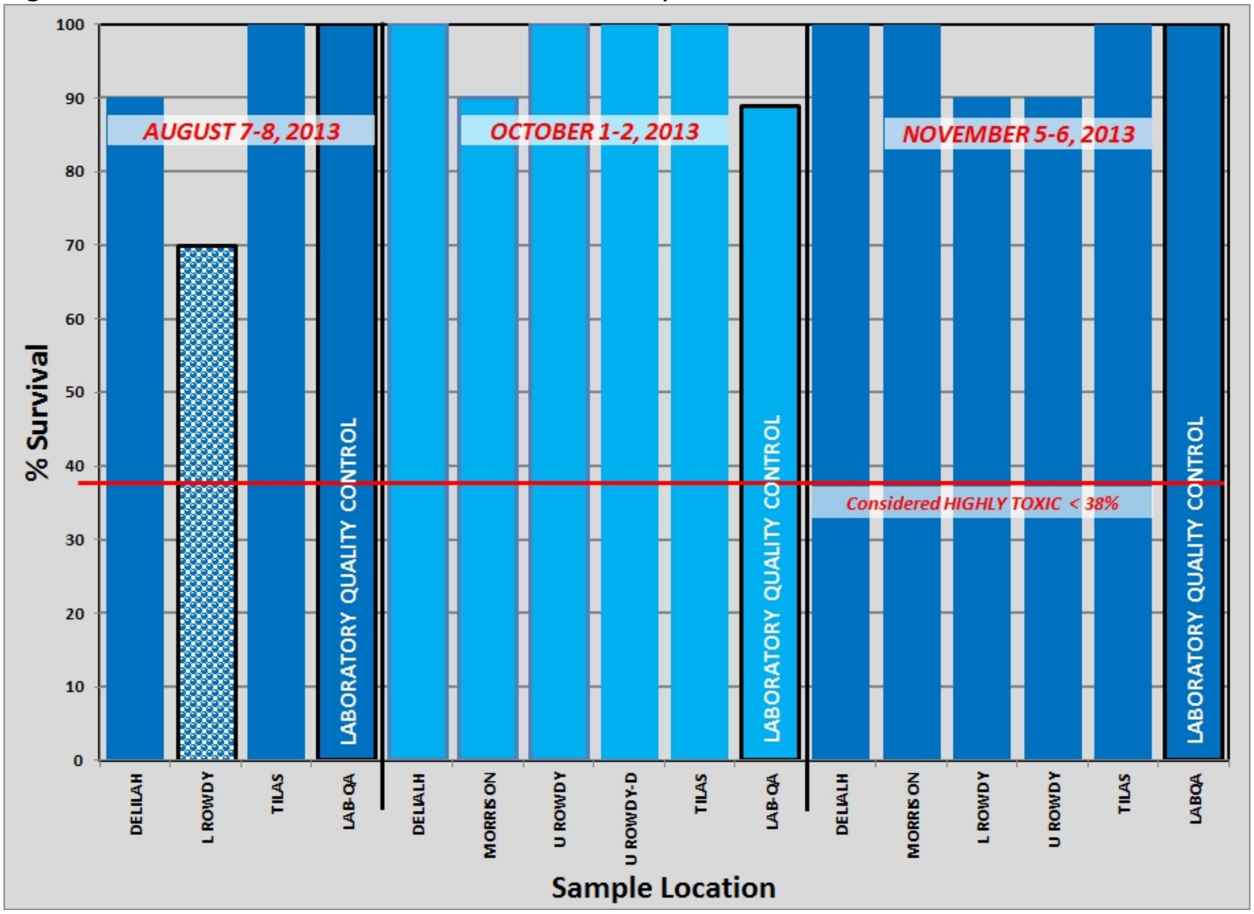
2010 Surface Water Results

On August 18, 2010, the water column sample collected at Delilah Creek showed reduced reproduction, but did not demonstrate any streambed sediment toxicity. The other three sampling sites tested as part of that same sampling event did not demonstrate any water column or streambed sediment toxicity.

2013 Streambed Sediment Results

In addition to the water column toxicity samples, Regional Water Board staff collected two streambed sediment samples in 2013 from Morrison Creek and Lower Rowdy Creek. Neither sample demonstrated any reductions in survival or reproductive rates.

Figure 5. Survival Values for Water Column Toxicity Tests and Lab Control



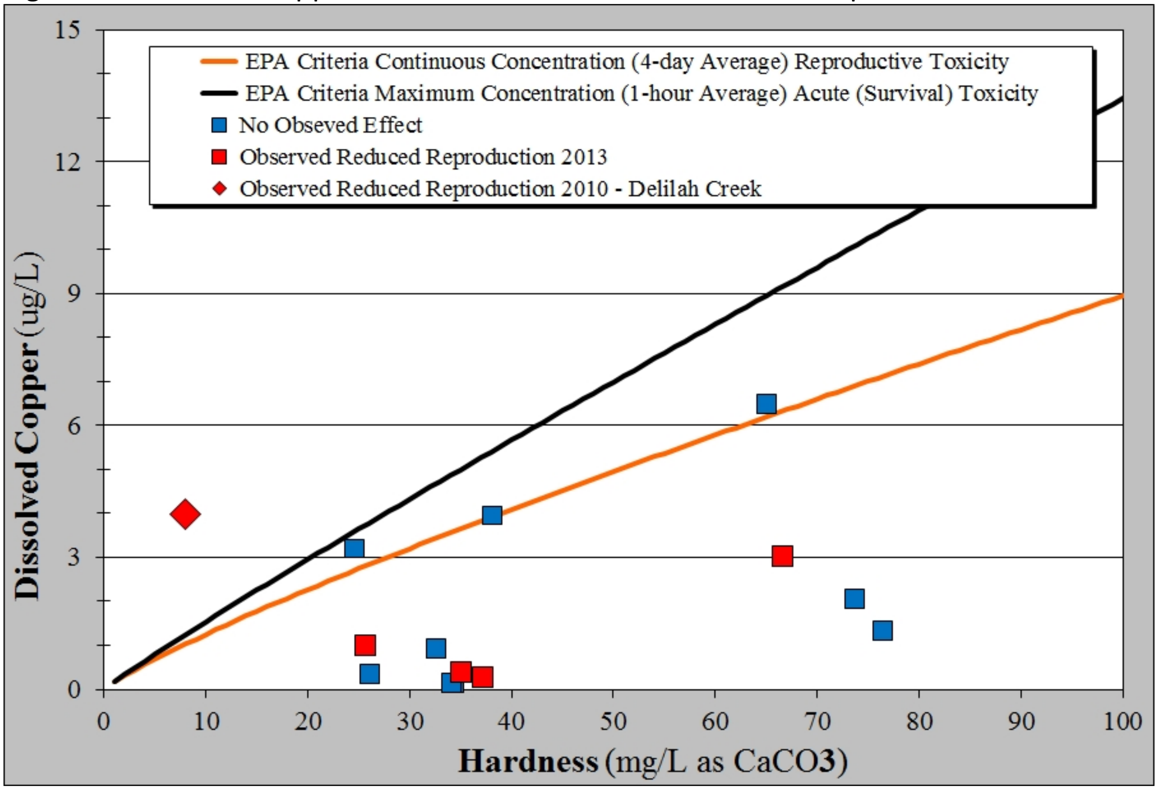
Checkered bars are samples demonstrating statistically-significant reduction in survival rates.

Discussion

The reductions in survival and reproduction rates are not likely caused by pH, dissolved oxygen, nutrients, or pesticides. Before toxicity tests are conducted, the samples are pH-adjusted if the pH values are outside of the physiological ranges of the testing organism necessary and sufficient dissolved oxygen is maintained to foster survival and reproductivity. Therefore it is unlikely that the low pH and dissolved oxygen levels in Delilah Creek in October 2013 are the cause of the reduced reproduction rates in that same sample. High levels of nutrients can be detrimental to aquatic life by increasing aquatic vegetation and algae. Increases in vegetation and algae have the ability to alter pH conditions and both increase and decrease dissolved oxygen to levels that can be harmful to aquatic life. In addition, elevated levels of ammonia can become toxic. The possibility of ammonia toxicity increases as pH increases and water temperature decreases. At the time of the 2013 sample collection, ammonia concentrations were very low and not considered toxic in-situ, as determined by the US EPA's 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater.

As discussed above, the pesticides sampled at the various sampling sites were all detected in concentrations below water quality thresholds and considered too low to be a direct factor in the toxicity results.

Figure 6. Dissolved Copper Concentrations and EPA Hardness-Dependent Criteria



Hardness values are low throughout the Smith River watershed including the tributaries that drain the Smith River Plain. For that reason, aquatic toxicity associated with metals may occur even when the concentrations of some metals are extremely low. In Figure 6, the detected concentrations of dissolved copper are plotted with the associated hardness for each sample and compared against the EPA criteria for survival and reproductive toxicity. In three of the samples, the dissolved copper concentration/hardness pairs are at or exceeding the EPA criteria for reproductive toxicity. However, the three 2013 samples at or exceeding the reproductive toxicity criteria did not demonstrate a reduction in survival or reproduction rates as determined by the toxicity tests. The four 2013 samples which did demonstrate reduced survival and reproduction rates have dissolved copper concentration/hardness pairs that are below EPA criteria for both survival and reproductive toxicity. Figure 6 also includes the copper concentration/hardness pair from the one time sampling event on Delilah Creek on August 18, 2010, in which reduced reproduction was documented.

To date, sampling has documented reduced reproduction in water column samples collected downstream, within, and upstream of the lily bulb agricultural areas. The analysis of pH, nutrients, pesticides, and metals does not provide a clear conclusion as to the source or sources of the reduced reproduction rates. The low level concentrations of each of the measured constituents do not appear to be directly responsible for the lowered reproduction rates. The additional monitoring in March and June of 2015 may provide the additional information necessary from which informed conclusions can be drawn.

Final Monitoring Schedule and Reporting

Two additional wet-weather runoff sampling events were conducted on March 13 and March 23, 2015. One additional dry-weather event was completed on June 23, 2015, in which Regional Water Board staff collected surface water, sediment, and groundwater samples. These samples are being analyzed for the pesticides metam sodium, MITC, and 1,3-D.

We have completed all of our sampling for this study. We anticipate that all of our contract laboratories and quality assurance personnel will complete their final reviews of the data by January 2016. We will conduct our analysis and draft a full report in the spring of 2016 and deliver a peer-reviewed report in mid-2016.

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