Morro Bay National Estuary Program's Implementation Effectiveness Program For the Morro Bay Watershed

Data Summary Report

2011

Ann Kitajima, Monitoring Program Manager
Annie Gillespie, Monitoring Projects Manager
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Morro Bay National Estuary Program
601 Embarcadero, Suite 11
Morro Bay, CA 93442

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CONTENTS

1.0 INTRODUCTION

The Morro Bay National Estuary Program's Implementation Effectiveness Program (IEP) and its Volunteer Monitoring Program (VMP) conducted environmental monitoring throughout the Morro Bay watershed to track both ambient water quality trends and the outcome of specific implementation projects.

The time period of data covered by this report is from approximately June 2002 through May 2011. Where this is not the case, the time period for the data is provided. Data was collected with funding from the following sources: CWA Section 319(h), Proposition 13 Coastal Nonpoint Source Pollution Control Program, Proposition 50 Coastal Nonpoint Source Pollution Control Program, ARRA funding through the Clean Water State Revolving Fund, and CWA Section 320.

DATA ANALYSIS: OVERVIEW

The Morro Bay National Estuary Program (MBNEP) monitoring program has conducted monitoring in the following areas: creek water quality, creek discharge volume, pathogen indicator bacteria, stream cross section profiling, riparian bioassessment and macroinvertebrate analysis, bay water quality, phytoplankton, urban stormwater, shorebird monitoring, Surface Elevation Tables, and algae documentation. The following table summarizes the parameters monitored through these efforts and the frequency of monitoring.

Component	Sub-component	Analytes	Frequency	Year Data Collection Initiated	Number of Sites
Water Quantity	Flow	instantaneous flow volume (depth and width of water, velocity)	monthly	1995	14 total
Bacteria	Bacteria	total coliform, *E. coli*, *Enterococcus spp*.	monthly	1997	8 bay and 16 creek sites
Water Quality - Chemistry & Nutrients	Freshwater Sampling	temperature, dissolved oxygen concentration (mg/L), dissolved oxygen percent saturation (%), turbidity, pH, conductivity, nitrate as N, orthophosphate as PO_4	monthly	2001	18 total
	Estuarine Sampling (Dawn Patrol)	dissolved oxygen, salinity, temperature	monthly	2002	7 total

Component	Sub-component	Analytes	Frequency	Year Data Collection Initiated	Number of Sites
Geomorphology	Cross-Sectional Profiles	cross-sectional area, bankfull width and depth, floodprone width, channel slope	variable, depending on rainfall	1993	22 (all Chorro Basin)
	Bay Sediment Monitoring (SETs)	change in surface elevation, mean sediment accretion	variable, depending on rainfall	2004	6 salt marsh, 4 mudflat
Biotic	Macro - Invertebrates	canopy cover, bank stability, substrate measurement, stream gradient, temperature, dissolved oxygen, conductivity, pH, alkalinity, SAFIT Level II taxonomic classification	annually	1995	12 water-shed sites (not all sites monitored each year)
	Algal Cover	point-intercept data (percent cover), canopy cover	annually	2011	10 creek sites
	Plankton Diversity	community density and diversity, % *Alexandrium spp*., % *Pseudonitzschia spp*.	monthly	1998	north T-Pier
	Shorebird Monitoring	species count, population count	annually	2003	15 sectors in bay, sand spit and strand
	Eelgrass Mapping	eelgrass acreage, other aquatic vegetation acreage	biennially	2002	baywide
	Eelgrass Monitoring	shoot density, above-ground biomass	biannually	2012	baywide

Urban runoff data related to stormwater and dry season runoff were collected at varying intervals between 2005 and 2010. For information on these monitoring efforts, refer to the annual stormwater monitoring reports generated by the MBNEP, which are available on the MBNEP website.

The data shown here was collected by the VMP between June 2002 and May 2011, unless otherwise stated. In each section, the number of samples and time period during which they were collected is summarized to provide context for the analysis.

Water quality data collected by the program is compared to various standards to understand its implications. The Central Coast Region Basin Plan contains standards established to protect the beneficial uses of water bodies within this immediate region. Another source of criteria for analyzing local data is the Central Coast Ambient Monitoring Program (CCAMP). Managed by the Central Coast Regional Water Quality Control Board (CCRWQCB), CCAMP provides additional informal attention levels for various chemical analytes. While these are not regulatory standards, they provide a regional context for the data.

NOTE ON REPORT STRUCTURE

The water quality, bacteria, macroinvertebrate and algae data are discussed in a single section called Creek Data Analysis. The discussions are focused around each waterbody, rather than each analytical constituent. Thus, the chapter for Dairy Creek will include discussion of all of these monitoring parameters for the sites on that waterbody. The Morro Bay watershed was divided into the following chapters based on subwatersheds: Dairy Creek, Pennington Creek, San Luisito Creek, San Bernardo Creek, Chorro Creek, and Los Osos and Warden Creeks.

A summary chapter titled Creek Water Quality Sites Overview contains some overview plots of the data by parameter, with sites for all waterbodies compared amongst each other.

The MBNEP's marine monitoring efforts are combined in a separate section, which includes shorebird surveys, bay bacteria, bay water quality, and phytoplankton enumeration.

The final section of the document includes a discussion of the Implementation Effectiveness Program (IEP) analysis, for which monitoring and analysis are conducted specifically to understand the effectiveness of various implementation efforts throughout the watershed.

Within this report each monitoring site is referenced with a three-letter code. During the last year, during efforts to coordinate the MBNEP data collection and maintain naming consistency with broader state-wide efforts, it was discovered that some MBNEP monitoring sites were described with different three-letter codes. Thus, some updates have been made to monitoring site codes. These changes are noted throughout the text.

Data from eelgrass and sediment monitoring efforts are not included in this report. Separate reports were developed for each of these topics and are available on the program's website, www.mbnep.org/understand.

Finally, no discussion was included of stream profiling because this monitoring was not conducted during the most recent year.

2.0 CREEK DATA ANALYSIS

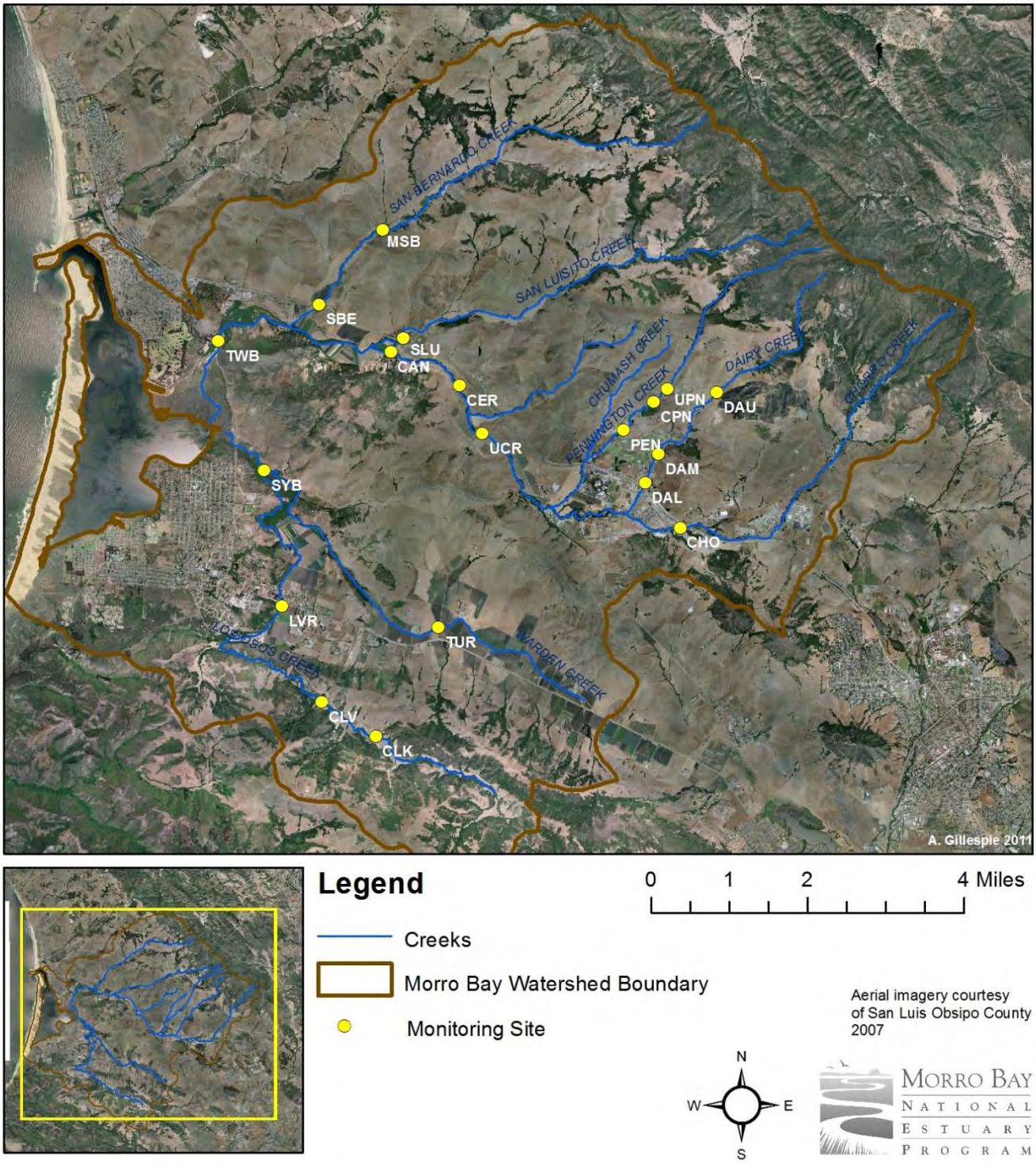
The following analysis includes data collected from the creeks throughout the Morro Bay watershed.

CREEK WATER QUALITY SITES OVERVIEW

Data presented in this section compares water quality data among 16 sites throughout the watershed. Sites with relatively shorter data records (italicized) are discussed in the creek specific sections later in the report. The table below details the full selection of sites that are discussed in this report. The length of the data record varies among each site.

Site Code	Waterbody	Description
CHO	Chorro Creek	Chorro Creek at Camp San Luis Obispo, near Hwy 1
UCR	Chorro Creek	Chorro Creek bridge crossing upstream of Gilardi Road at the Cal Poly bridge
CER	Chorro Creek	Chorro Creek crossing between Gilardi and Canet roads on the Chorro Creek Ecological Reserve
CAN	Chorro Creek	Chorro Creek at Canet Road bridge off Hwy 1
TWB	Chorro Creek	Chorro Creek at South Bay Blvd bridge, near State Park Rd.
DAU	Dairy Creek	Dairy Creek at El Chorro Regional Park and Camp SLO Boundary, at the creek crossing
DAM	Dairy Creek	Dairy Creek upstream of dog park, near locked gate across road
DAL	Dairy Creek	Dairy Creek upstream of culvert under park entrance road
CPN	Pennington Creek	At the Pennington Creek Rd bridge, on the border of Cal Poly property
PEN	Pennington Creek	Pennington Creek at El Chorro Outdoor School amphitheater
UPN	*Pennington Creek*	*Upper Pennington Creek, stream crossing near Cal Poly barn*
SLU	San Luisito Creek	San Luisito Creek at (public) Adobe Road bridge crossing
MSB	*San Bernardo Creek*	*San Bernardo creek, access through (private) pasture land*
SBE	San Bernardo Creek	San Bernardo Creek at (private) Adobe Road crossing
CLV	Los Osos Creek	Clark Valley branch at (private) road crossing
CLK	*Los Osos Creek*	*Clark Valley branch at upstream (private) road crossing*
LVR	*Los Osos Creek*	*Los Osos Creek crossing under Los Osos Valley Road*
TUR	Warden Creek	Warden Creek crossing under Turri Road near Los Osos Valley Rd
SYB	Los Osos Creek	Los Osos Creek off Turri Road near South Bay Blvd
COO	Coon Creek	Coon Creek trail at first bridge in Montana De Oro State Park

Note: Coon Creek, which is not in the Morro Bay watershed, is monitored as a control site for comparison to watershed sites. It is not included on the following map.



Legend

Creeks

Morro Bay Watershed Boundary

Monitoring Site

0 1 2 4 Miles

Aerial imagery courtesy of San Luis Obsipo County 2007

N W E S

MORRO BAY NATIONAL ESTUARY PROGRAM

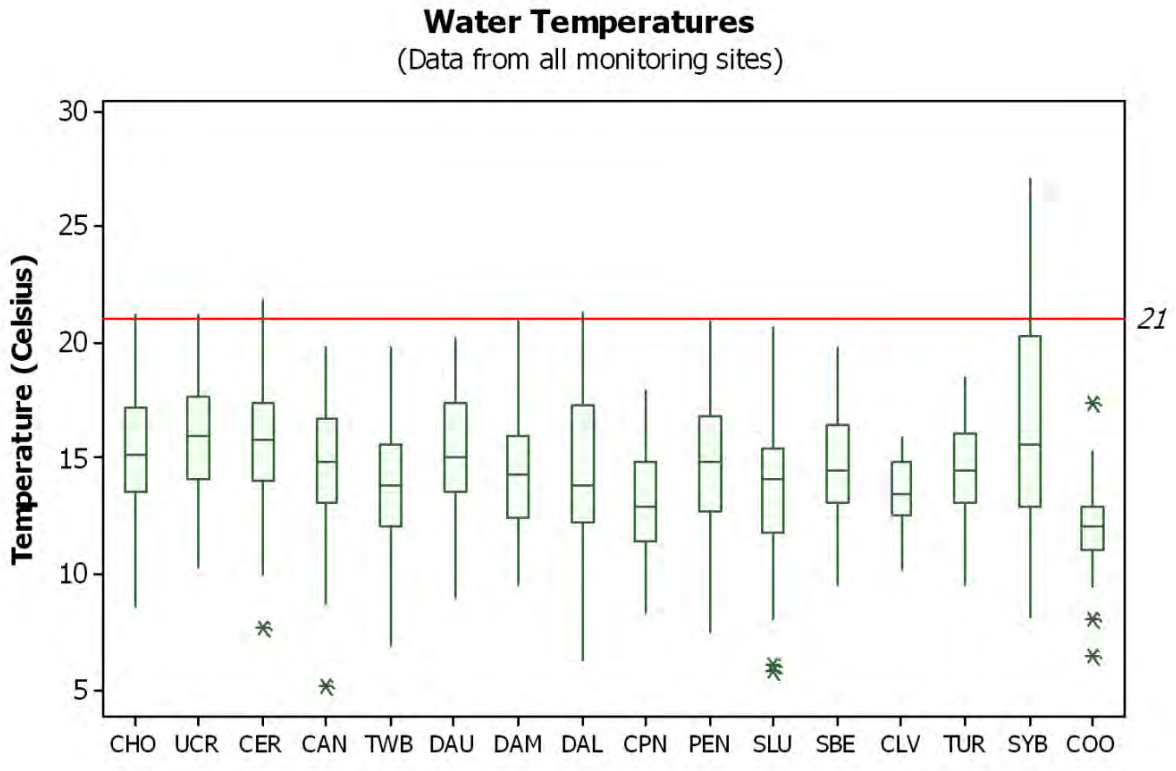
TEMPERATURE

Water temperature was measured as part of the water quality monitoring effort, which could take place at any time during daylight hours, not necessarily at a consistent time of day. Water quality was generally monitored at each site once or twice monthly, depending on volunteer availability and site hydrology.

Temperature data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to determine water temperature in degrees Celsius. The meter's range is -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with new Model 85 units.

The centerlines of the box plots indicate the median temperature for each site, and the interquartile range is shown in the box (Q1 to Q3). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from each site.

The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line. This standard is used throughout the report for comparison purposes.



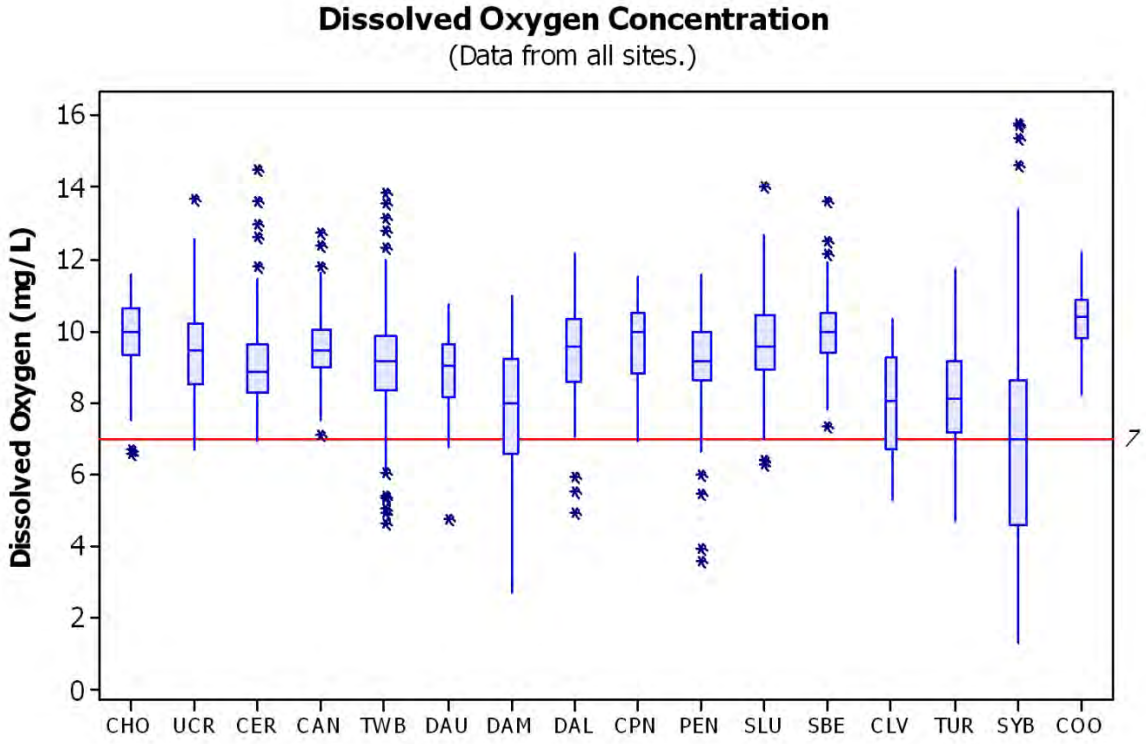
DISSOLVED OXYGEN

Dissolved oxygen was measured as part of the water quality monitoring effort, which could take place at any time during daylight hours, not necessarily at a consistent time of day. Dissolved oxygen was monitored at each site once or twice monthly, depending on volunteer availability and site hydrology.

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation with a resolution of 0.1%. For DO concentration, the meter's range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter.

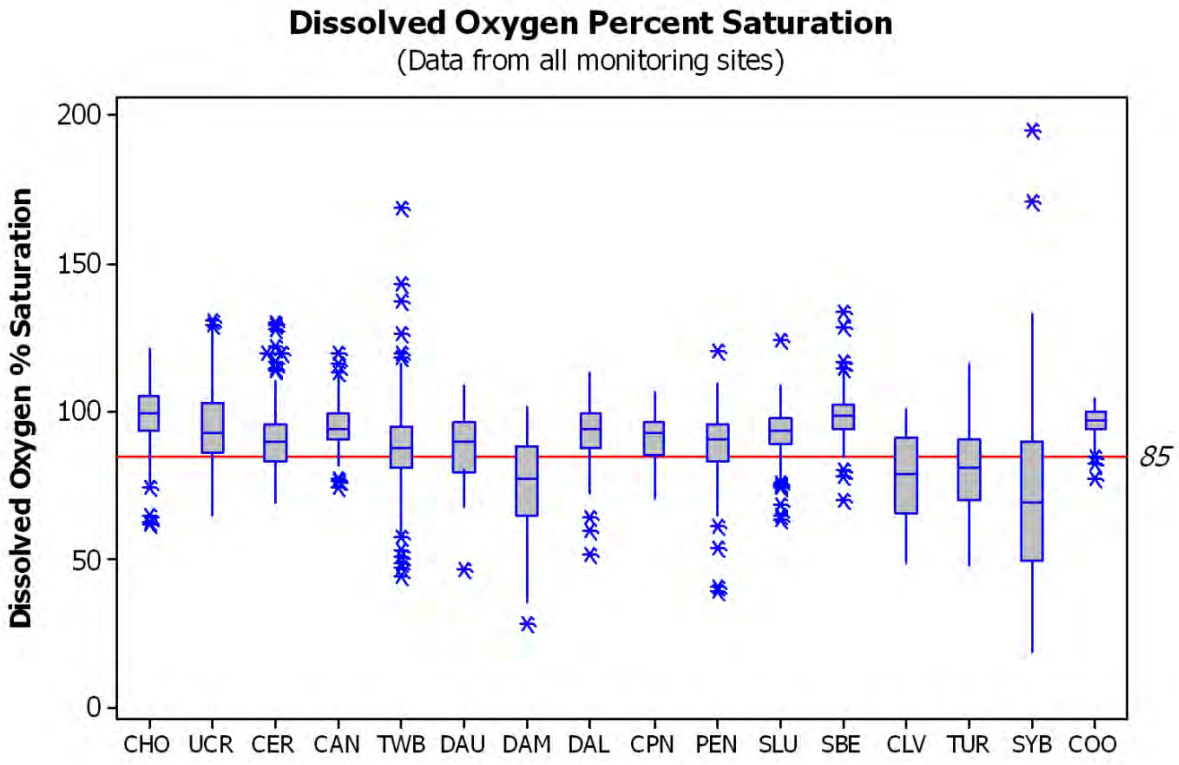
The centerlines of the box plots indicate the median dissolved oxygen percent saturation for each site, and the interquartile range is shown in the box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from each site.

The Central Coast Basin Plan regulatory standard states that at no time shall DO concentrations fall below 7.0 mg/L, which is represented by the red line on the following graph.



The following graph displays the DO measurements as a percent saturation. The centerlines of the box plots indicate the median dissolved oxygen concentration for each site, and the interquartile range is shown in the box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from each site.

The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.



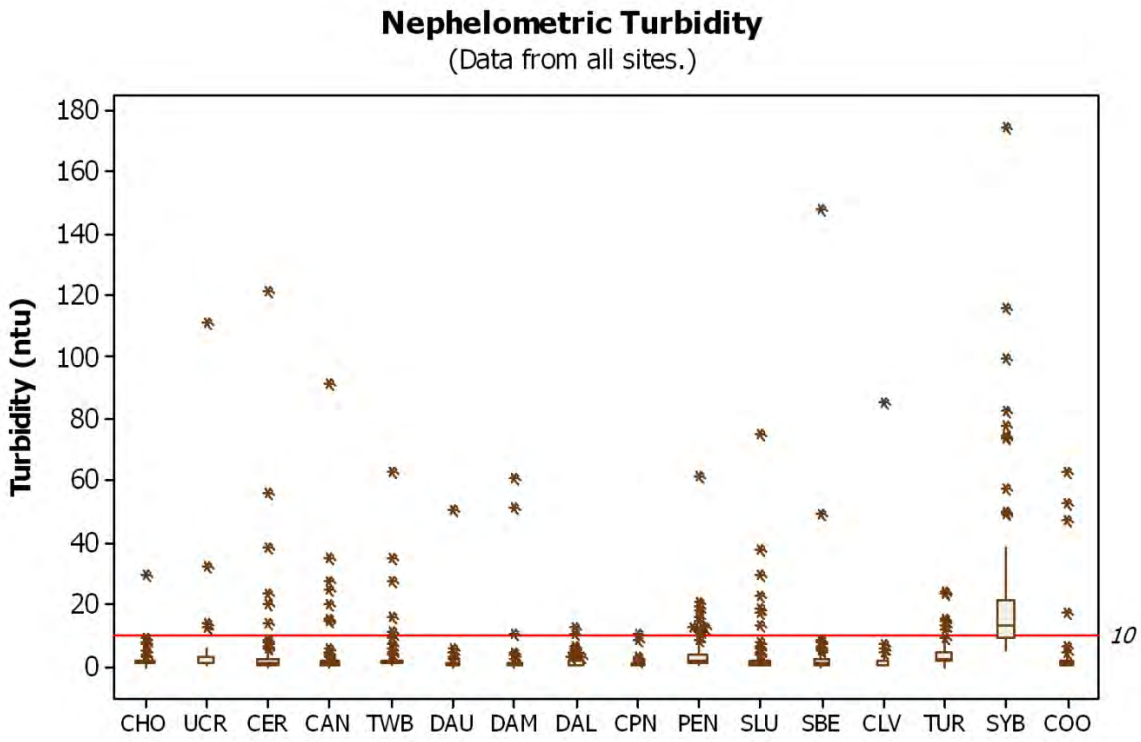
TURBIDITY

Turbidity was measured as part of the water quality monitoring effort, which could take place at any time during daylight hours, not necessarily at a consistent time of day. Water quality was usually monitored at each site once or twice monthly, depending on volunteer availability and site hydrology.

Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU.

The centerlines of the box plots indicate the median turbidity for each site, and the interquartile range is shown in the box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from each site. A few outlier readings were removed from analysis as they were collected during or immediately after storm events and were deemed not representative of ambient base flow conditions. Excluded data are noted in subwatershed specific sections later in the report.

Although the Basin Plan contains no water quality objectives for turbidity, CCAMP lists a level of concern of 10 NTU for protection of aquatic life, represented on the graph by a red line. In nearly all cases, the interquartile range of the data (50% of measurements) lies below the 10 NTU standard.



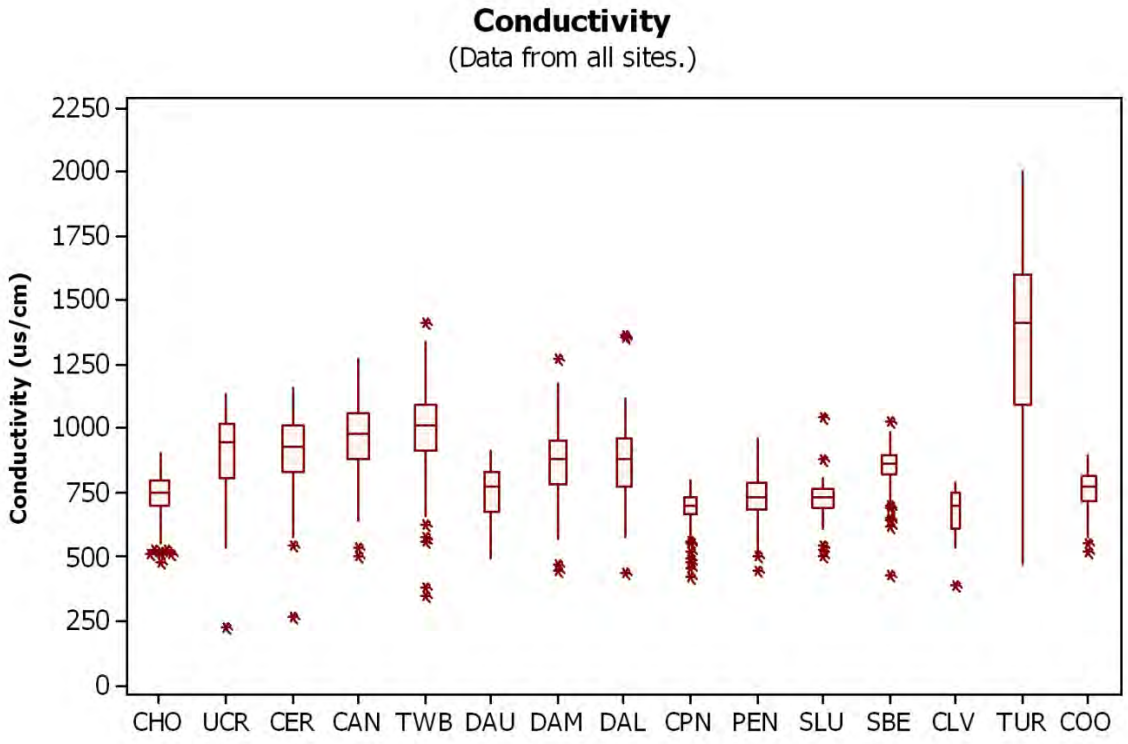
CONDUCTIVITY

Temperature-corrected conductivity data was collected using a YSI 85 meter with nickel electrodes. Conductivity was measured as part of the water quality monitoring effort, which could take place at any time during daylight hours, not necessarily at a consistent time of day. Water quality monitoring was conducted at each site once or twice monthly, depending on volunteer availability and site hydrology.

The meter has a range of 0 to 200,000 uS/cm with a resolution of 0.1 uS/cm. Prior to 2007, the data was collected with an Oakton ECTestr with a range of 0 to 1,990 uS/cm with a resolution of 10 uS/cm.

The centerlines of the box plots indicate the median conductivity for each site, and the interquartile range is shown in the box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from each site.

The CCRWQCB Basin Plan includes a conductivity objective of 3,000 uS/cm to protect the Agriculture beneficial use. Elevated conductivity levels, as a measure of dissolved solids, can be indicative of pollution such as agricultural or road drainage runoff.

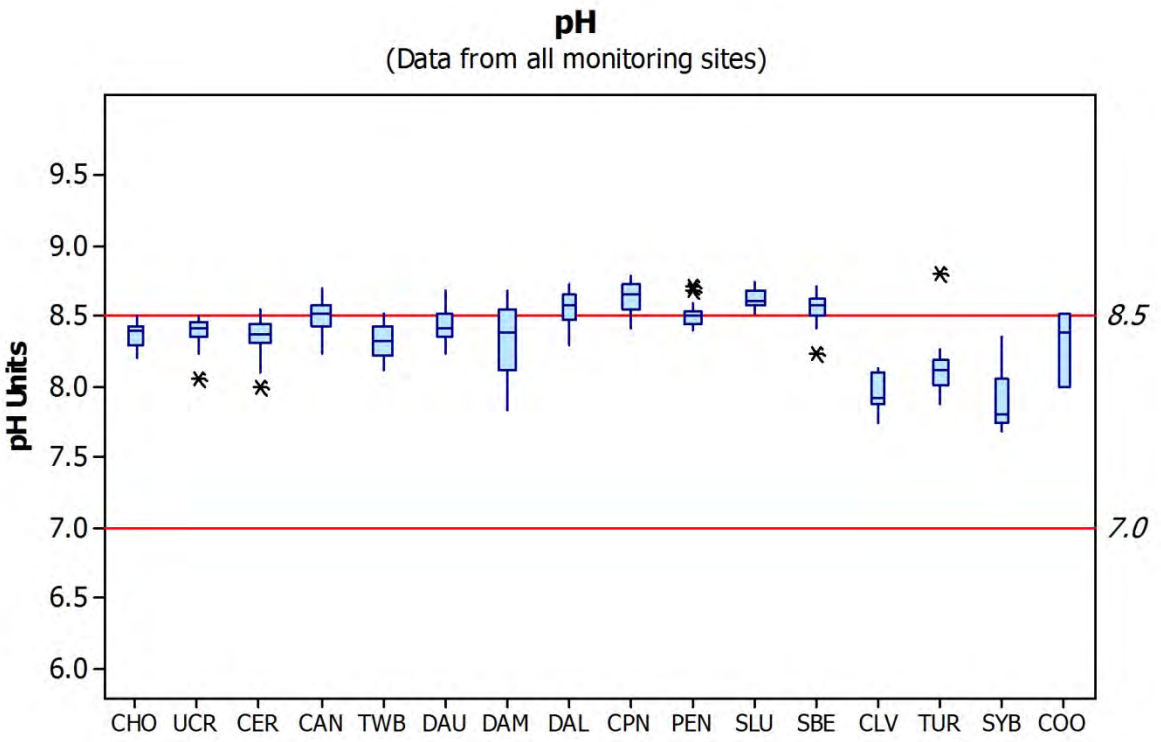


pH

Since July 2010, program volunteers measured pH during each water quality field visit using a pH probe. The meter has a range of -1.0 to 15.0 pH units, with a resolution of 0.1 pH units. Prior to July 2010, pH paper was used for the measurement. The paper has a range of 4.5 to 10.0 with a resolution of 0.5 pH units. pH paper measurements are currently collected along with the probe measurement in the hopes that a correlation could be determined between the two values. Following quality control comparisons of the probe and paper data with lab analysis, the pH probes appear to be very accurate, whereas the pH paper was consistently underestimating the pH.

The centerlines of the box plots indicate the median pH for each site, and the interquartile range is shown in the box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from the site.

Per the Central Coast Basin Plan, pH concentrations must remain between 6.5 and 8.3 to be protective of the recreational contact beneficial use (REC-1). For protection of aquatic life, the Basin Plan standard is between 7.0 and 8.5 (COLD, WARM).



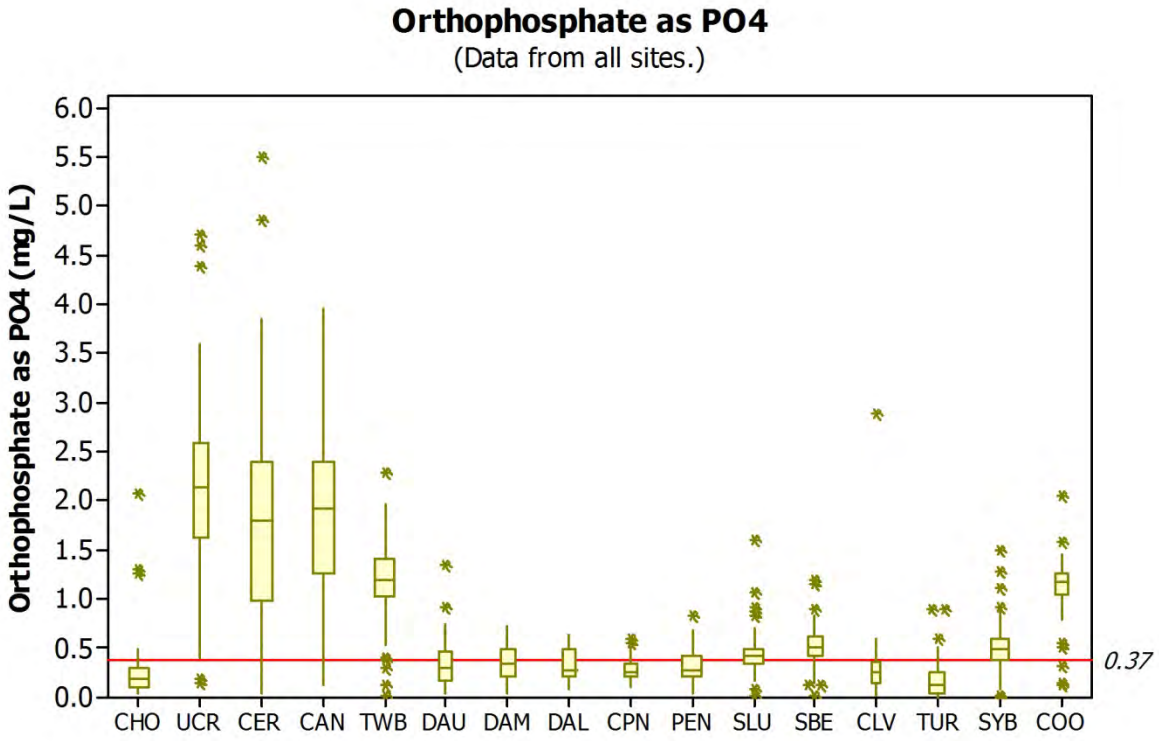
NUTRIENTS

Orthophosphates as PO_4^{3-} and nitrate as nitrogen were measured as part of the water quality monitoring effort. Monitoring could take place at any time during daylight hours, not necessarily at a consistent time of day. Samples were collected by trained volunteers, and analysis was conducted at the office using chemical test kits.

The methodology for orthophosphates as PO_4^{3-} analysis has changed over the years in an effort to improve the quality of the data. Volunteer-generated data prior to April 2004 was discarded due to the determined inaccuracy of the test kit. Any data included in the report prior to April 2004 was obtained from an analytical laboratory. From early 2004 through mid-2005, a Hanna meter and Hanna reagent was used. From mid-2006 through mid-2007, a YSI 9000 meter with YSI reagent was used. Starting in mid-2007 to the present, the analysis method uses a Hanna Low Range Phosphate colorimeter (HI 93713) with HACH PhosVer 3 Phosphate Reagent, which utilizes an ascorbic acid reaction. The meter has a range from 0.00 to 2.50 mg/L with a resolution of 0.01 mg/L. Out-of-range samples were analyzed by diluting the sample with deionized water and multiplying the result by the dilution factor. This is a simple colorimeter which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab-generated data.

The centerlines of the box plots indicate the median orthophosphates as PO_4^{3-} concentration for each site, and the interquartile range is shown in each box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from the site.

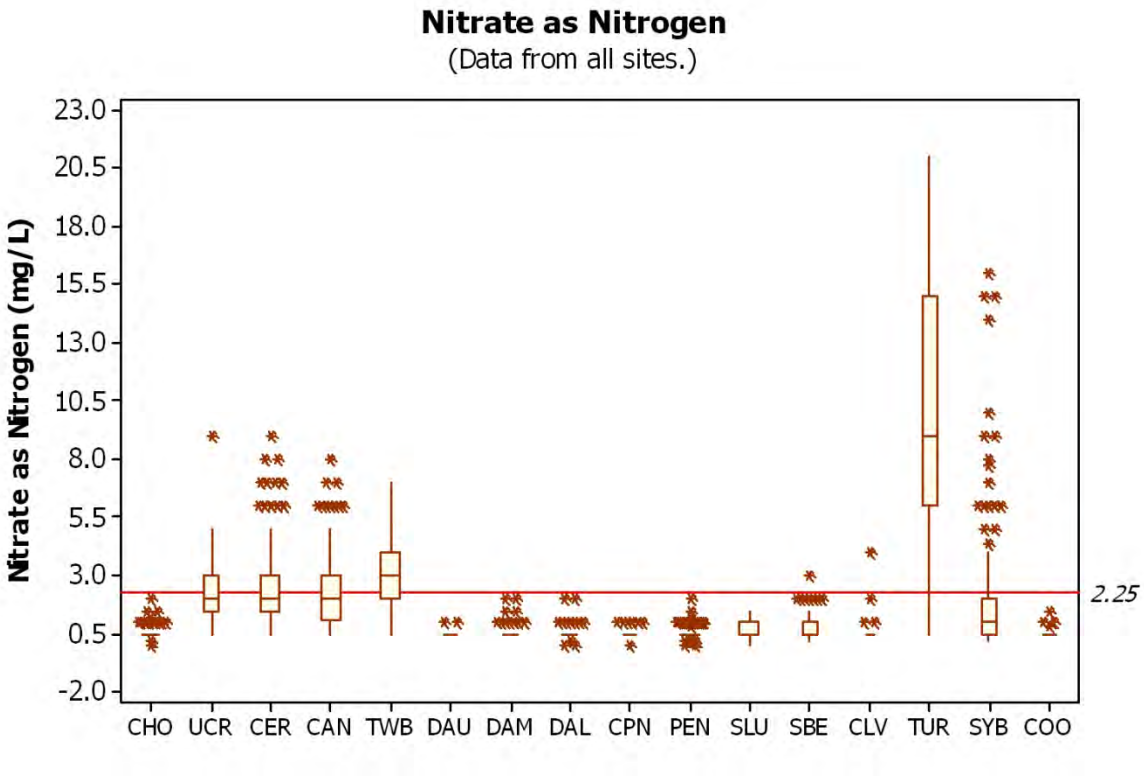
The CCAMP informal attention level is 0.37 mg/L as PO_4^{3-}, a value created specifically for the Pajaro River but adapted for the Morro Bay watershed.



Nitrates as nitrogen was monitored with a test kit that uses a zinc reduction reaction. The method utilizes a color change reaction and compares the reacted sample to a color chart with gradations at 0, 1, 2, 4, 6, 8, 10 and 15 mg/L. For this method, readings between 0 and 1 are considered to be non-detects and are reported as 0.5 mg/L for the purpose of analysis. This is a simple test kit which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab generated data.

The centerlines of the box plots indicate the median nitrate as nitrogen concentration for each site, and the interquartile range is shown in each box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from the site.

The CCAMP informal attention level for nitrates as nitrogen is 2.25 mg/L for the protection of aquatic life.



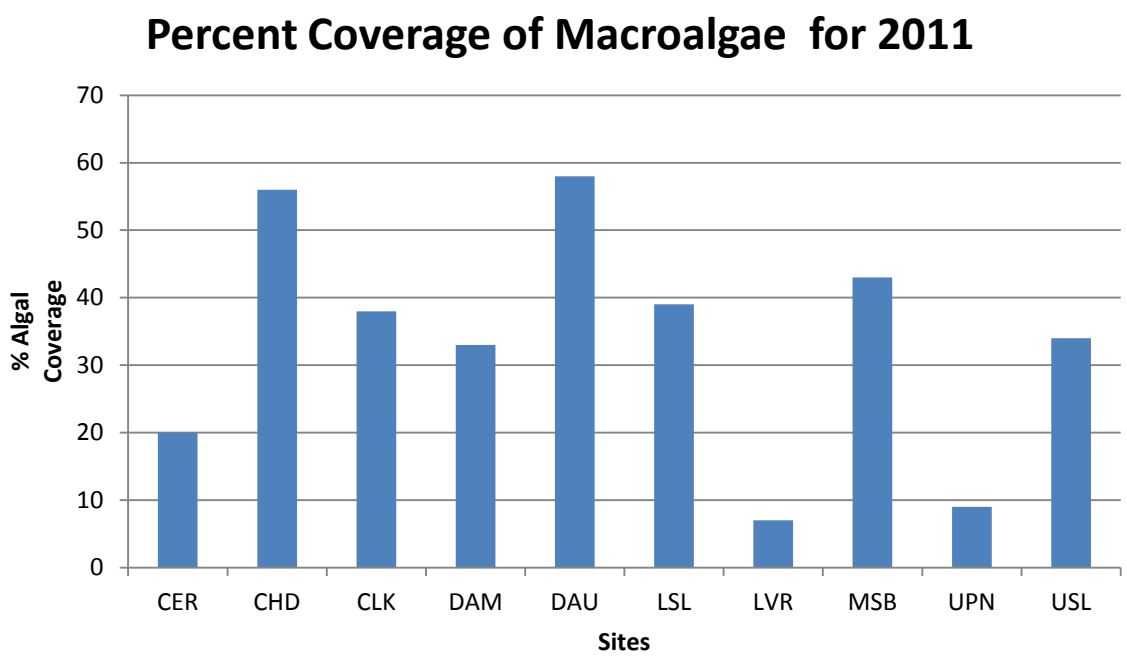
ALGAE DOCUMENTING

In previous years, volunteers collected monthly data at eight established algae documenting sites. Measurements and photos were taken at a sunny location and a shady location, and an algal percent coverage and observations of the types of algae were recorded. The canopy coverage was estimated using a densiometer. Beginning in 2011, algae data was collected using the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, 2010. The protocol involves noting the presence or absence of macroalgae and filamentous algae while collecting habitat assessment data throughout a 150 meter reach of the stream. The complete SWAMP algae monitoring protocol, including sample collection and analysis, was not conducted in 2011 due to limited financial and staff resources.

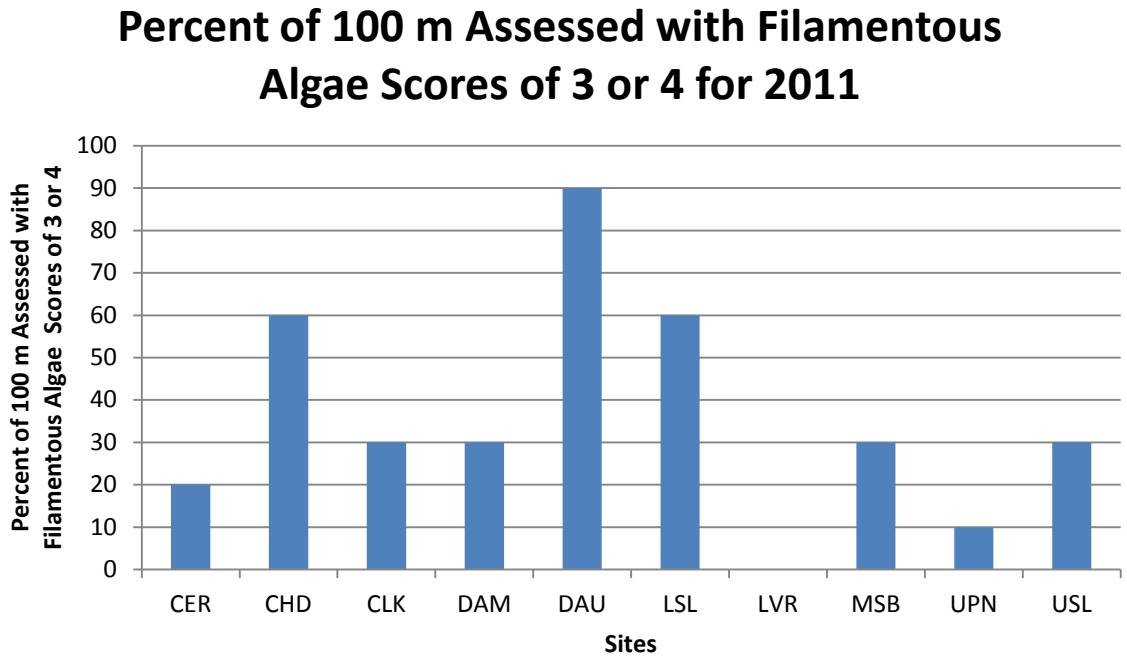
The CCRWQCB utilizes the data in assessing 303(d) listings and de-listings, as well as TMDL implementation effectiveness. Algal blooms can be considered supporting information when making a decision to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Betty Fetscher of the Southern California Coastal Water Research Project, one of the authors of the SWAMP algae monitoring protocol, recommended calculating the percent coverage of macroalgae and the percent of heavy filamentous algae coverage. The following graph displays the percent coverage of macroalgae present during the habitat assessment. This was calculated by tallying the number of assessed points at a site where water was present. The number of wet points in the creek with macroalgae present was tallied, and a percent algal coverage was calculated. Sites CHD, DAU and MSB

have algae percent coverage values greater than 40%.



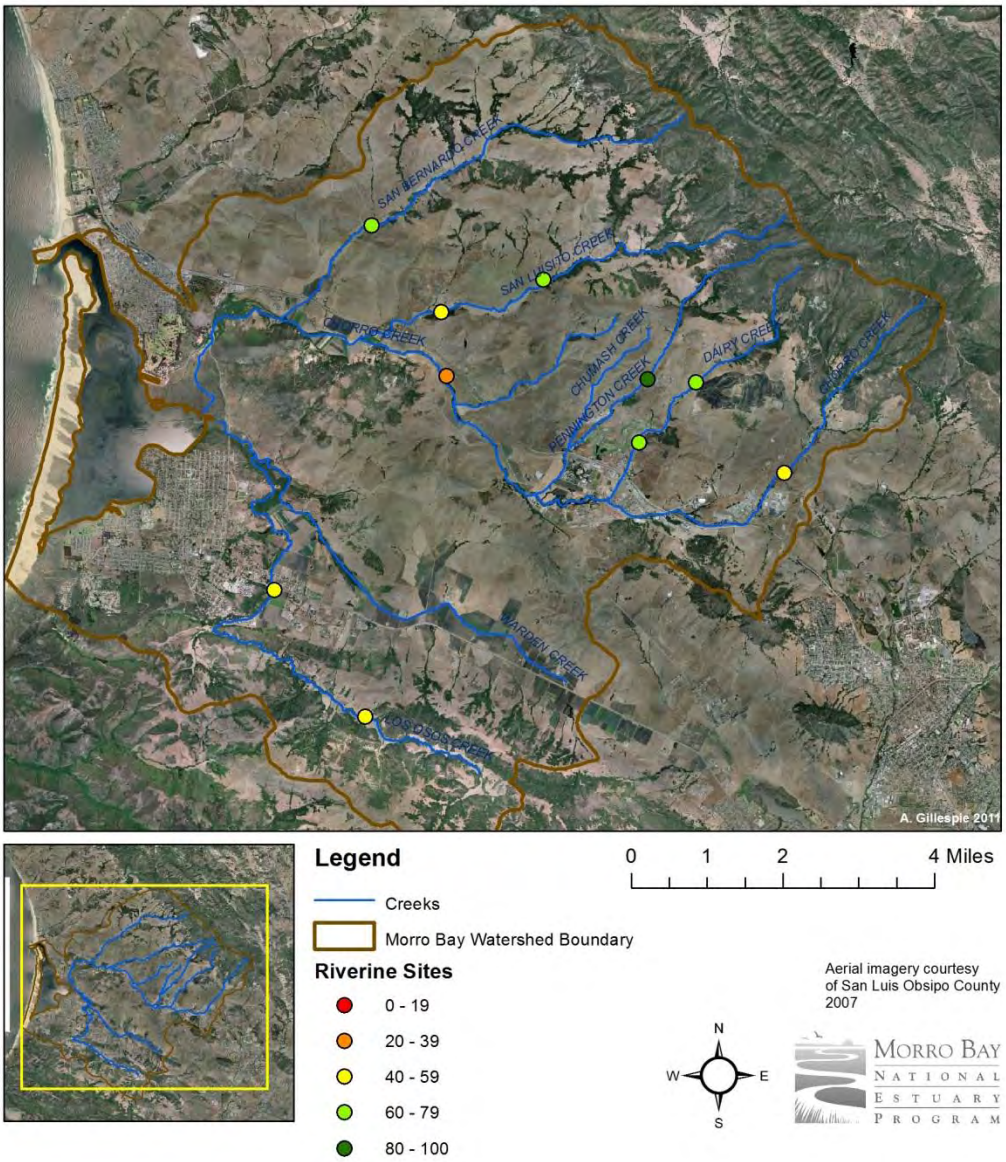
As part of the habitat assessment, the coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) was assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1 indicating < 10% coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. Ms. Fetscher recommended tallying the areas scored with a 3 or 4 out of the 100 m assessed at each site. The graph below shows the percent of area with filamentous algae scores of 3 or 4 out of the 100 m assessed at each site.



MACROINVERTEBRATES

Data collected between 2007 and 2011 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was approved in spring 2007. The VMP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, rotating between the margin and center of the creek. The samples were composited into a single sample, which was sent to a lab for sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as several calculated metrics.

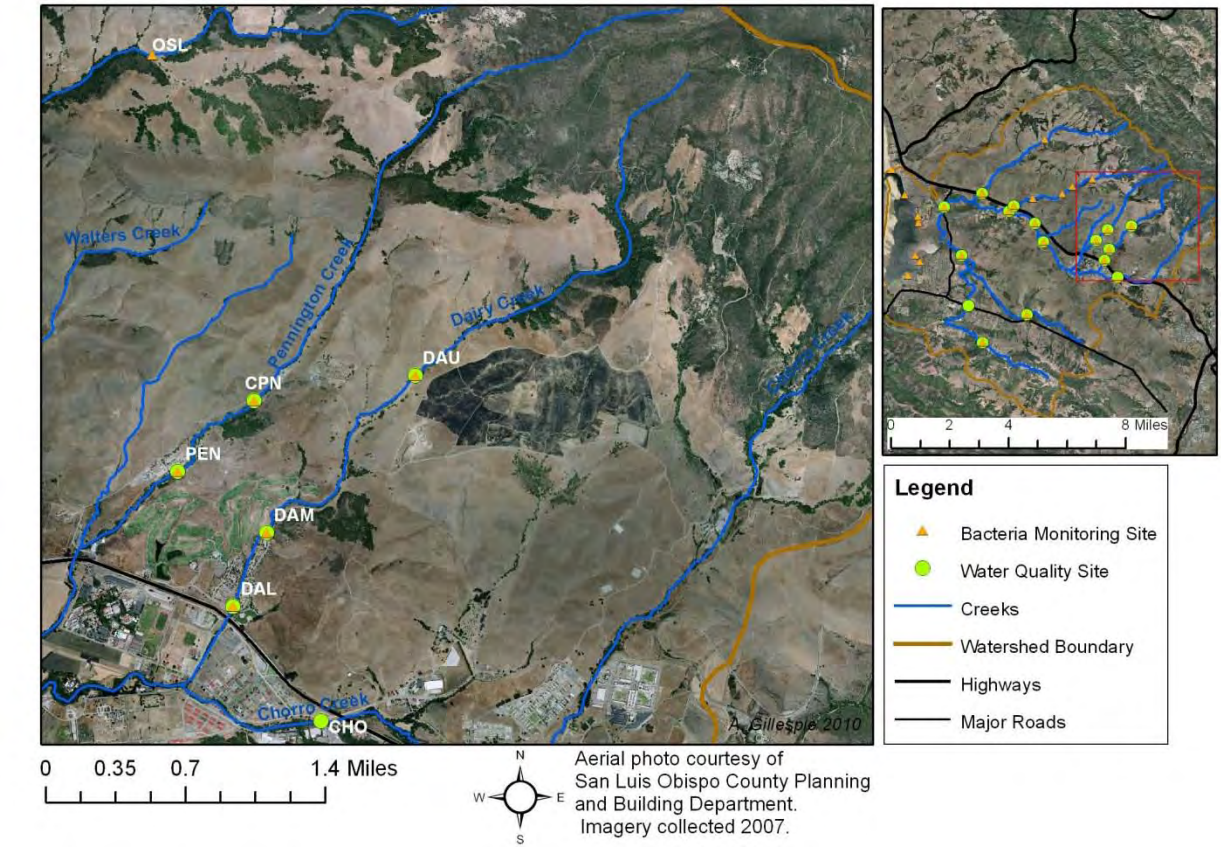
The metrics included in this report are taxa richness, EPT richness, EPT% and IBI score. These metrics are detailed in site specific chapters later in this report. The Index of Biotic Integrity (IBI) score used in this report is the Southern California Coastal IBI developed by the Aquatic Bioassessment Laboratory of the California Department of Fish & Game. IBI scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good. The figure below demonstrates the site locations and IBI scores for sites monitored in 2011. The following table displays the IBI score for each creek site monitored from 2008 through 2011.



	CHD	CER	TWB	DAU	DAM	DAL	UPN	WAL	USL	LSL	USB	MSB	CLK	LVR	COO
2008 IBI Score	44.3	30.0	55.8	80.1	50.1	50.1	78.7	38.6	*	67.2	*	75.8	58.6	*	81.5
2009 IBI Score	57.2	*	*	91.5	74.4	*	*	*	*	70.1	*	*	*	*	*
2010 IBI Score	*	*	*	71.5	52.9	60.1	*	28.6	91.5	75.8	77.2	67.2	65.8	41.5	*
2011 IBI Store	54.3	34.3	*	58.6	65.7	*	85.7	*	58.6	54.3	*	62.9	52.9	48.6	*
Avg IBI	50.8	32.2	55.8	75.4	60.8	55.1	79	33.6	75.1	66.8	77.2	68.6	59.1	45.1	81.5

DAIRY CREEK

SITE MAP AND DESCRIPTION



The Dairy Creek subwatershed encompasses an area of approximately 2.5 square miles. The watershed is predominately utilized as rangeland for beef cattle operations. Most of the watershed is publicly owned by the County of San Luis Obispo, the U.S. Forest Service, Cal Poly and Camp San Luis Obispo (California Army National Guard). The volunteer monitoring program monitors Dairy Creek at three sites in El Chorro Regional Park: Dairy Creek Upper (DAU), Dairy Creek Middle (DAM) and Dairy Creek Lower (DAL). These sites were established in the early 1990's as part of the National Monitoring Program (NMP), and data collection was continued by the VMP following the conclusion of the NMP in 2001.

WATER QUALITY N VALUE SUMMARY

A challenge with monitoring at Dairy Creek was the intermittent nature of the flow. DAL rarely flowed year-round. Flows appeared to go sub-surface above DAM and re-appear at the small impoundment waterfall where the monitoring site is located. Site DAU flowed for more of the year, although flows typically become quite low by the end of the dry season. In particularly dry years, such as 2009, minimal data could be collected. In 2009, DAU was likely flowing for more of the year, however monitoring was limited due to the condition of the road out to the site. The table below indicates the frequency of water quality monitoring at Dairy Creek sites throughout the monitoring period.

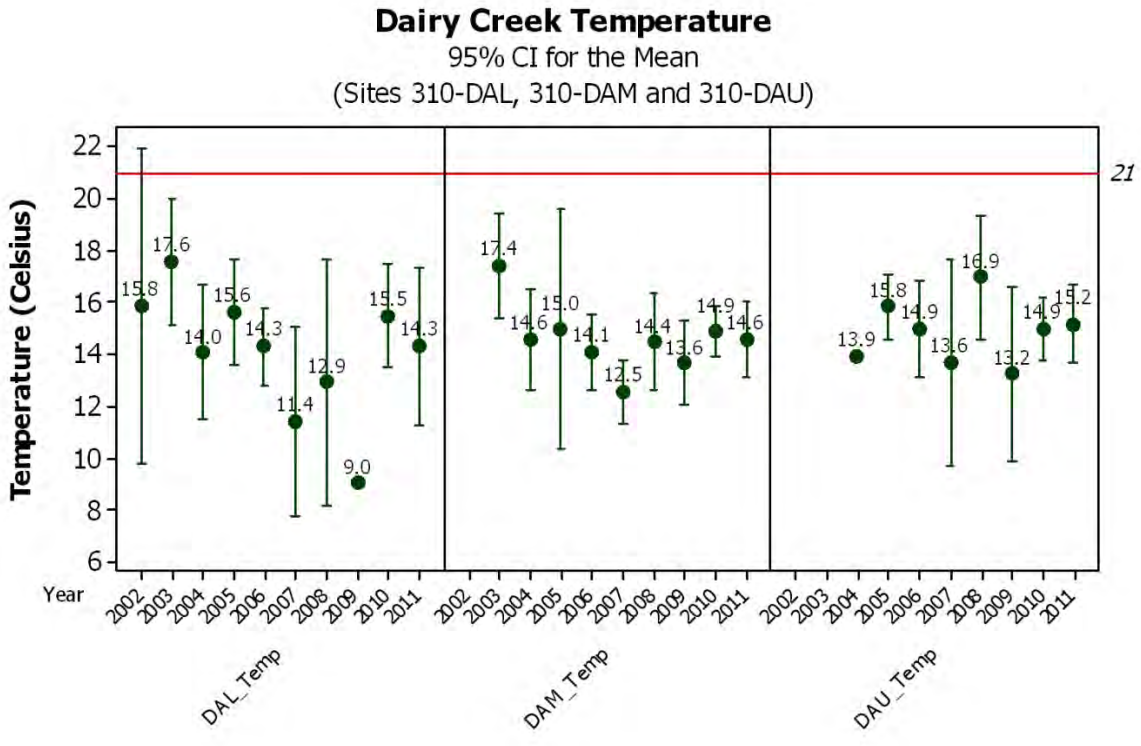
Site	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	Sum
DAL	4	7	6	13	20	7	5	1	13	6	**82**
DAM	0	8	8	4	12	12	10	9	18	10	**91**
DAU	0	0	1	16	11	5	8	4	18	4	**67**
Sum	**4**	**15**	**15**	**33**	**43**	**24**	**23**	**14**	**49**	**22**	

** 2011 values include January to May 2011.*

TEMPERATURE

Water temperature is measured as part of the water quality monitoring effort, which can take place at any time during daylight hours, and is not necessarily measured at a consistent time of day. Water quality monitoring may take place once or twice monthly, depending on volunteer availability and site hydrology. Data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to collect water temperature. The meter has a range of -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with Model 85 units.

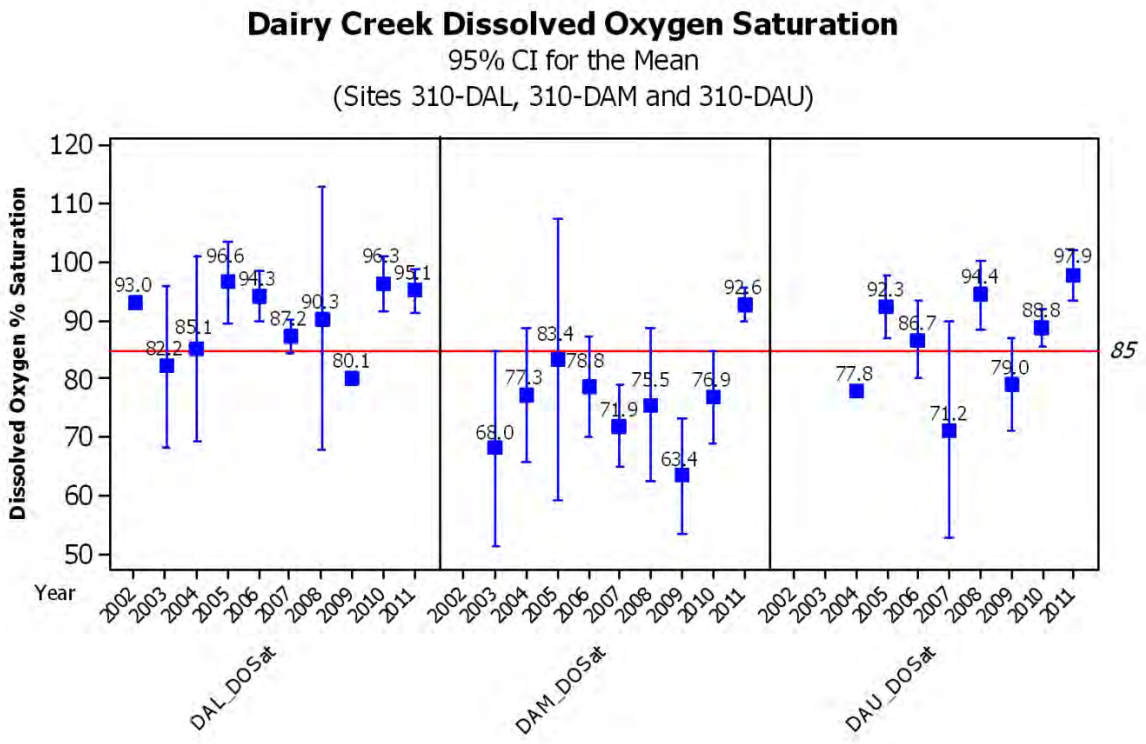
The following plot shows the mean temperature for each year, with the results grouped by site. The interval bars indicate the 95% confidence interval (CI) for the mean, which is the range within which 95% of the data can be expected to fall. The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line. This standard is used throughout the report for comparison purposes. A more detailed discussion of temperature trends at Dairy Creek is included in the IEP chapter of this report.



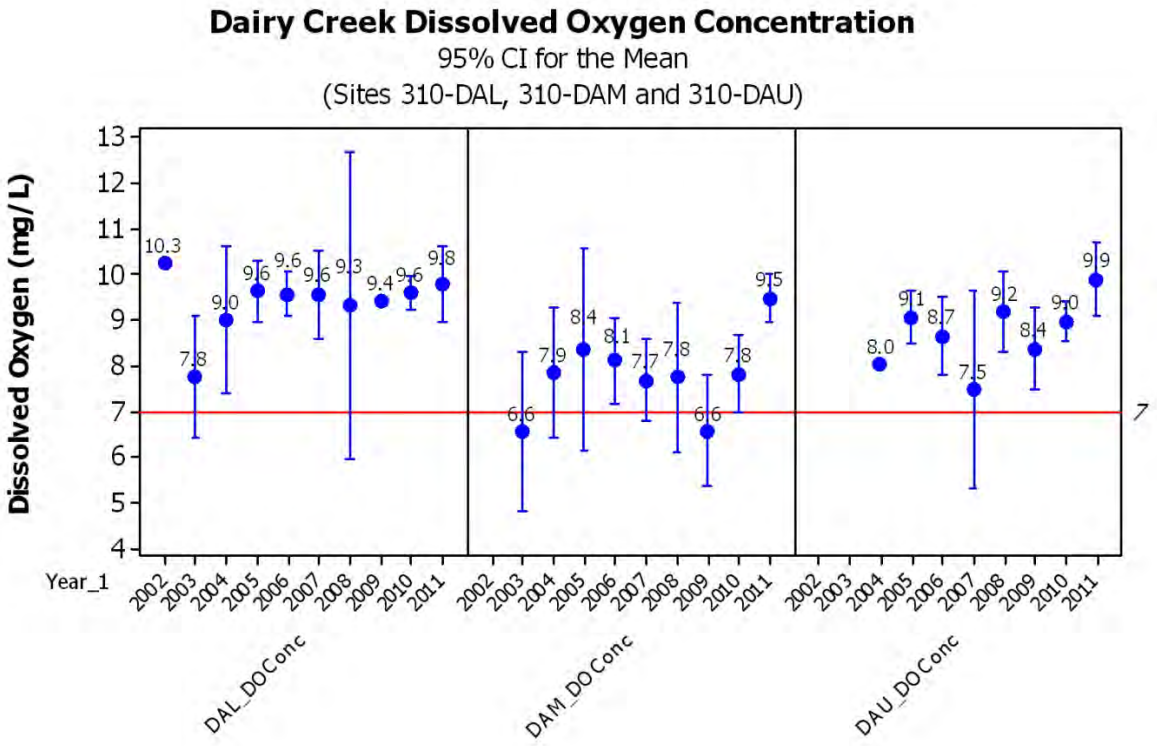
DISSOLVED OXYGEN

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation and a resolution of 0.1%. For DO

concentration, the meter range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter. Measurements were collected at various times during daylight hours and were not necessarily measured at a consistent time of day. The graph below displays the mean and 95% CI of dissolved oxygen percent saturation for the three monitoring sites located on Dairy Creek, grouped by year. The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.

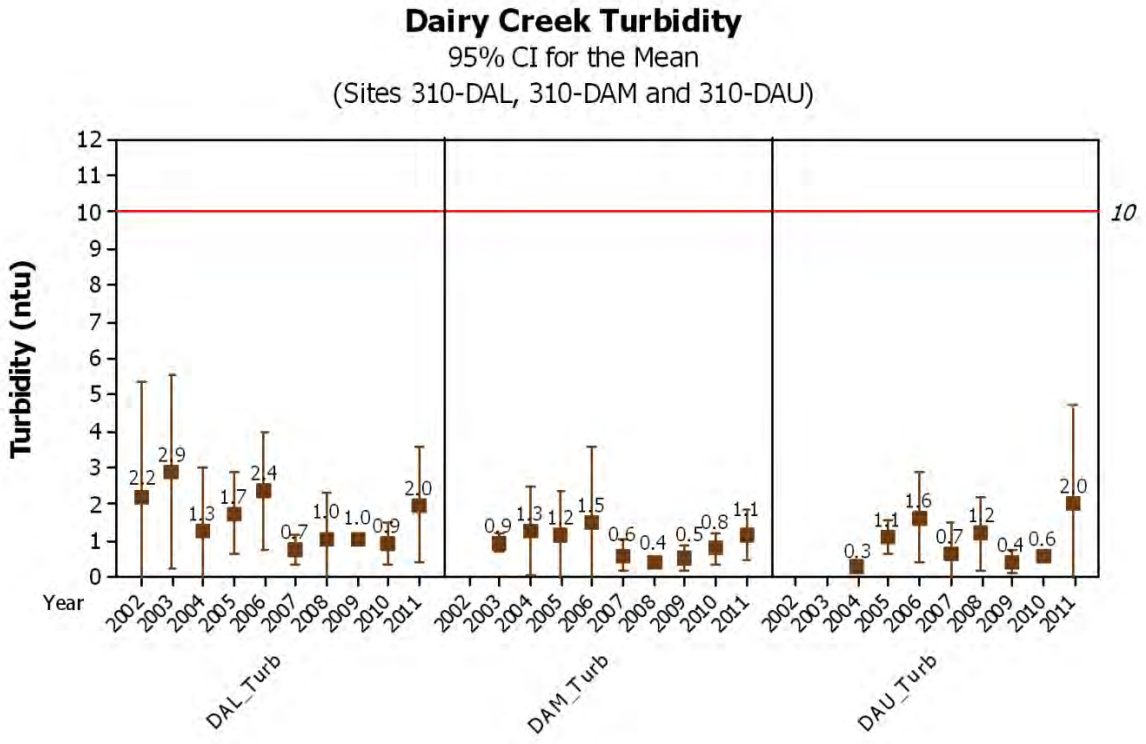


Measurements were also collected of DO concentration in mg/L. The following graph shows the mean and 95% CI for the dissolved oxygen concentration data. The Central Coast Basin Plan has a regulatory standard that states that at no time shall DO concentrations fall below 7.0 mg/L. A detailed discussion of dissolved oxygen data from Dairy Creek are provided in the IEP chapter.



TURBIDITY

Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU. Although the Basin Plan contains no water quality objectives for turbidity, CCAMP lists a level of concern at 10 NTU for protection of aquatic life. A few outlier readings were removed from analysis as they were collected during storm events and were deemed not representative of ambient conditions. The removed values are listed below the figure. The following graph shows the mean and 95% CI for the turbidity data.



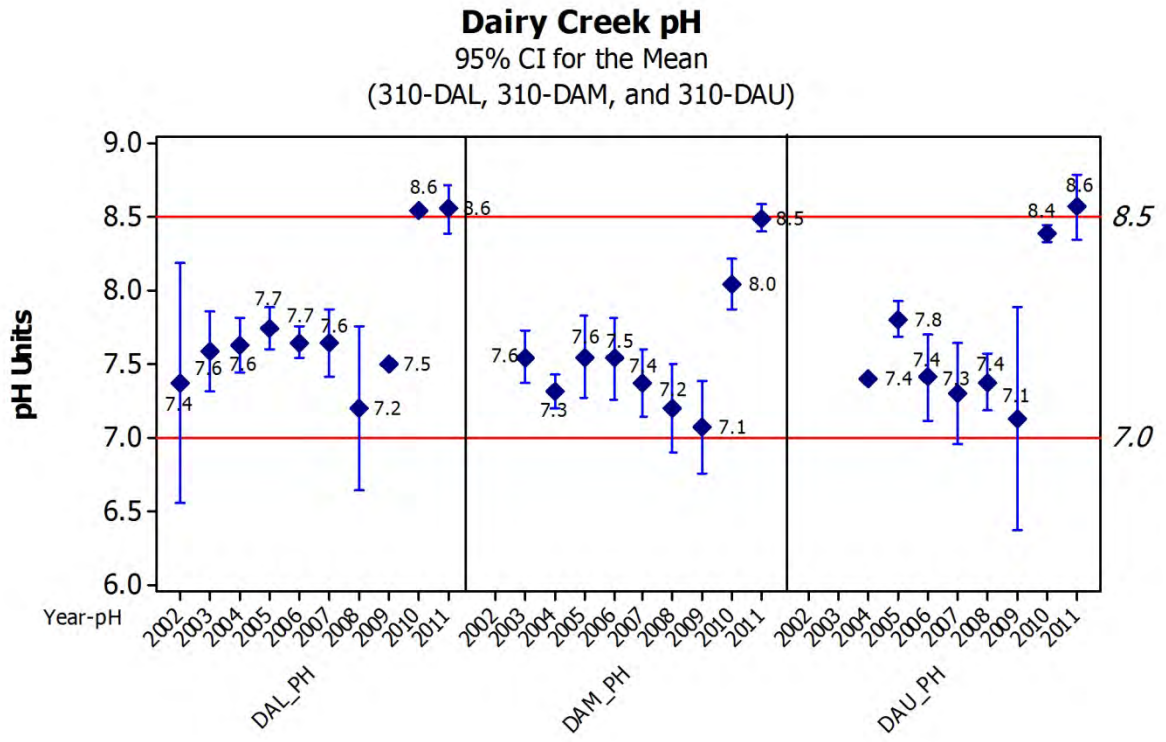
**Removed turbidity values collected at DAM on 3/29/2006 (51.5 NTU) and 2/23/08 (61 NTU).*
**Removed turbidity value collected at DAU on 2/17/2005 (50.5 NTU).*

pH

Since July 2010, pro6gram volunteers measured pH during each water quality field visit using a pH probe. The meter has a range of -1.0 to 15.0 pH units, with a resolution of 0.1 pH units. Prior to July 2010, pH paper was used for the measurement. The paper has a range of 4.5 to 10.0 with a resolution of 0.5 pH units. pH paper measurements are collected along with the probe measurement in the hopes that a correlation can be determined between the two values. Following quality control comparisons of the probe and paper data with lab analysis, the pH probes appear to be very accurate, whereas the pH paper was consistently underestimating the pH.

For this summary report, data generated with pH paper was reported from 2002 through 2009. For 2010, only data collected with a pH probe was included (July to December 2010). For 2011, only data collected with a pH probe was included. Thus, pH data from January to June 2010, which was collected with pH paper, have been excluded from this summary.

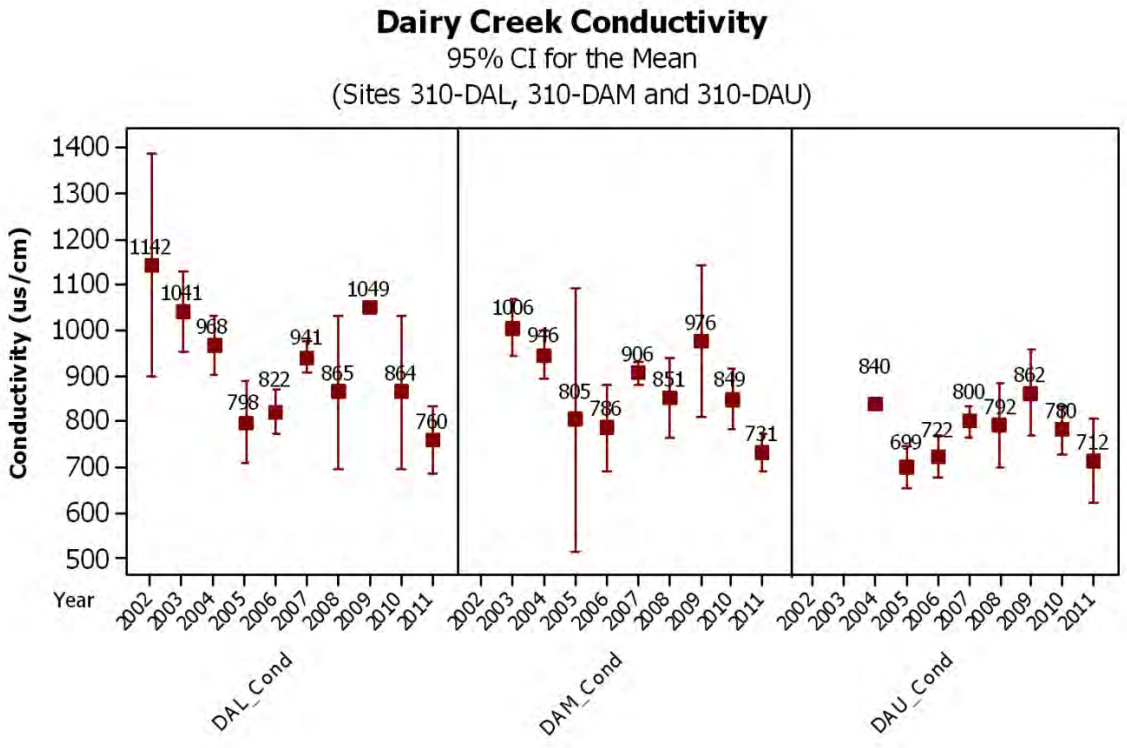
Per the Central Coast Basin Plan, pH concentrations must remain between 6.5 and 8.3 to be protective of the recreational contact beneficial use (REC-1). For protection of aquatic life, the Basin Plan standard is between 7.0 and 8.5 (COLD, WARM).



Note: For this summary report, data collected using pH paper was reported from 2002 through 2009. Data collected from July 2010 and after was with a pH probe. pH data collected from January to June 2010 with pH paper was not included in this analysis.

CONDUCTIVITY

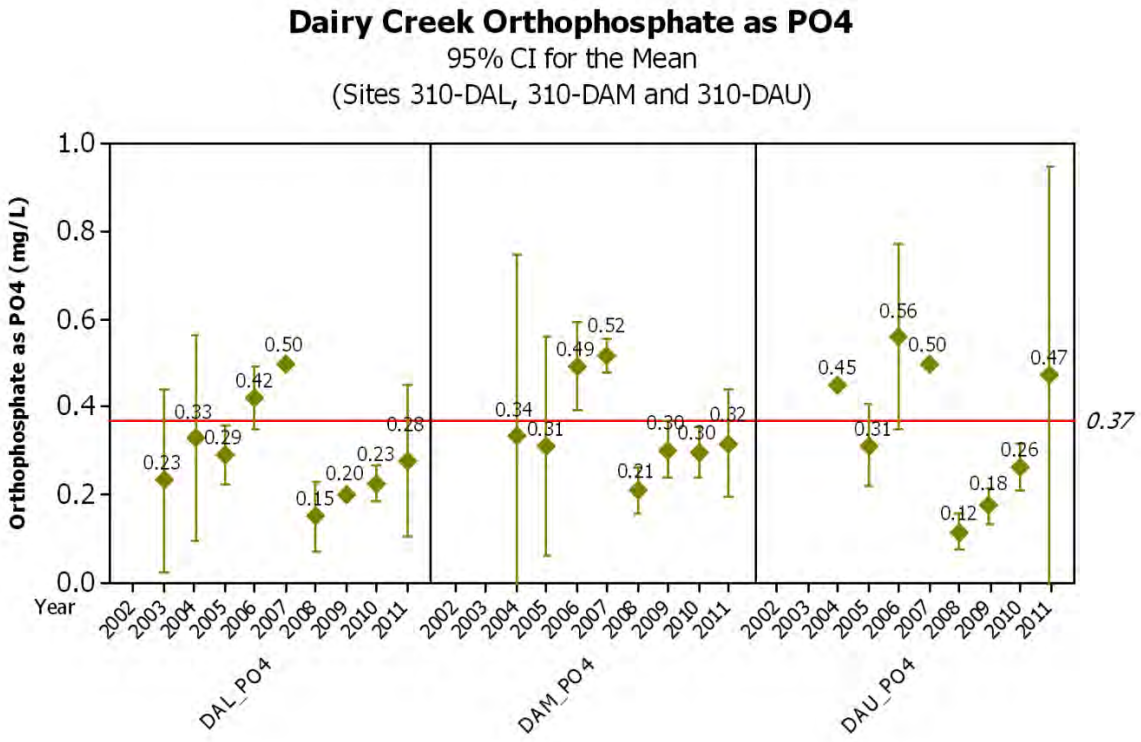
Program volunteers measured temperature-corrected conductivity during each water quality field visit using a YSI 85 meter with nickel electrodes. The meter has a range of 0 to 200,000 uS/cm with a resolution of 0.1 uS/cm. Prior to 2007, data was collected with an Oakton ECTestr which had a range of 0 to 1,990 uS/cm and a resolution of 10 uS/cm. The Central Coast Basin Plan includes a conductivity objective of 3,000 uS/cm to protect the Agriculture beneficial use. Elevated conductivity levels, as a measure of dissolved solids, can be indicative of pollution such as agricultural or road drainage runoff.



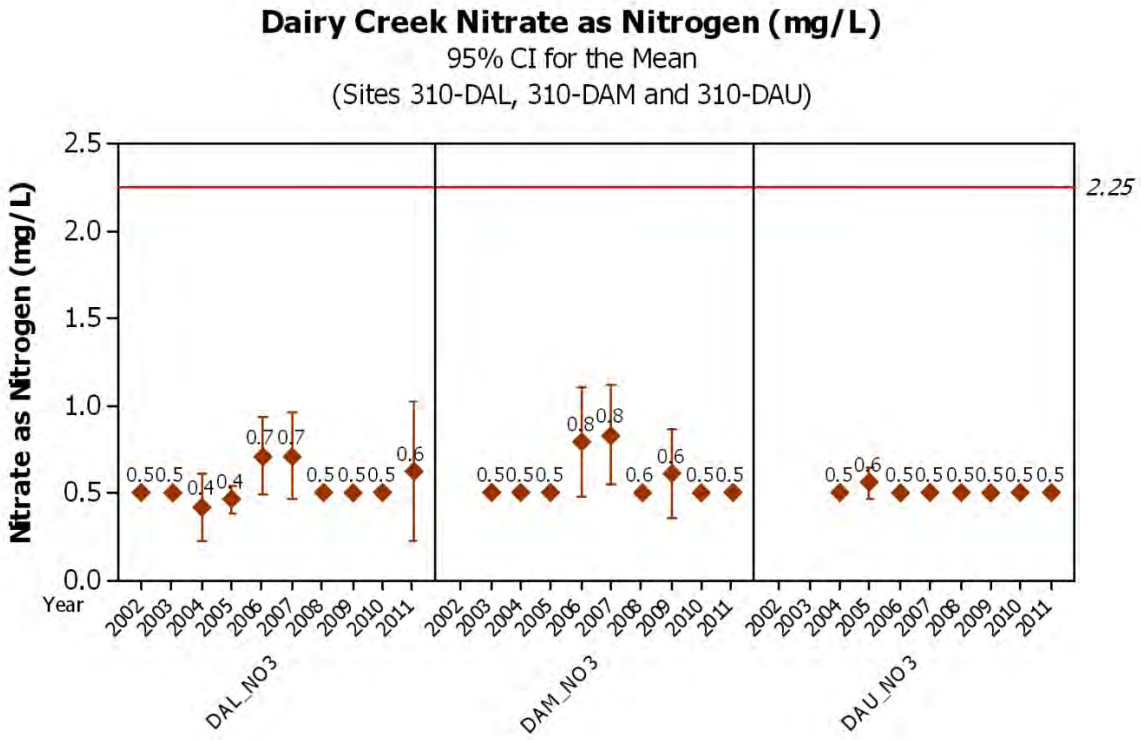
NUTRIENTS

Program volunteers measured orthophosphates as PO_4^{3-} and nitrates as nitrogen during each water quality field visit. Samples were collected by trained volunteers, and analysis was conducted at the MBNEP office using chemical test kits.

The methodology for orthophosphates as PO_4^{3-} analysis has changed over the years in an effort to improve the quality of the data. Volunteer-generated data prior to April 2004 was discarded due to the determined inaccuracy of the test kit. Any data included in the report prior to April 2004 was obtained from an analytical laboratory. From early 2004 through mid-2005, a Hanna meter and Hanna reagent was used. From mid-2006 through mid-2007, a YSI 9000 meter with YSI reagent was used. Starting in mid-2007 to the present, the analysis method uses a Hanna Low Range Phosphate colorimeter (HI 93713) with HACH PhosVer 3 Phosphate Reagent, which utilizes an ascorbic acid reaction. The meter has a range from 0.00 to 2.50 mg/L with a resolution of 0.01 mg/L. Out-of-range samples were analyzed by diluting the sample with deionized water and multiplying the result by the dilution factor. This is a simple colorimeter which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab-generated data. The CCAMP informal attention level is 0.37 mg/L as PO_4^{3-}, a value created specifically for the Pajaro River but adapted for the Morro Bay watershed.



Nitrates as nitrogen was monitored with a LaMotte test kit 3354 which uses a zinc reduction reaction. The method utilizes a color change reaction and compares the reacted sample to a color chart with gradations at 0, 1, 2, 4, 6, 8, 10 and 15 mg/L. For this method, readings between 0 and 1 are considered to be non-detects and are reported as 0.5 mg/L for the purpose of analysis. This is a simple test kit which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab generated data. The CCAMP informal attention level for nitrates as nitrogen is 2.25 mg/L to be protective of aquatic life.



ALGAE DOCUMENTING

Beginning in 2011, algae data was collected using the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, 2010. The protocol involves point intercept measurements that determine the presence or absence of macroalgae, as well as qualitative measurement of filamentous algae coverage throughout the reach. The complete SWAMP protocol for collecting stream algae samples, including sample collection and lab analysis, was not conducted in 2011 due to limited financial and staff resources.

The CCRWQCB utilizes algae abundance data in assessing 303(d) listings and de-listings, as well as tracking TMDL implementation. The presence and density of algal blooms can be considered supporting evidence when determining whether to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Algae data was analyzed through two data sets generated by 2011 assessments at each site. The percent coverage of macroalgae at the site was determined by calculating algae presence at wetted points located on the transects and inter-transects. This calculated value is used to represent percent algal coverage throughout the 150 m reach. The 2011 assessment indicated that DAU had 58% algae coverage, and DAM had 33% algae coverage Additionally, the observed spatial coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) was assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1 indicating < 10% coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. With this metric, DAU scored 90%, while DAM scored 30%.

BACTERIA

Program volunteers monitored total coliform and *E. coli* bacterial indicators. Monthly samples were collected and then analyzed by volunteers with the IDEXX method using Colilert-18 reagent. Analysis took place at the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory. Bacteria monitoring was not timed to coincide with monthly or bi-weekly water quality monitoring at these sites.

Based on typical sample dilutions, the range of detection for the test is from < 1 MPN/100 mL to 24,196 MPN/100 mL. The regulatory criteria for comparison are the recommended standards in EPA's 1986 guidance document *Ambient Water Quality Criteria for Bacteria*. For *E. coli* for a single grab sample, the water is considered to have an acceptable risk for swimming (REC-1 contact) if the concentration is below 235 MPN/100 mL. The analysis in this report is focused on *E. coli* rather than total coliform because the presence of *E. coli* is an indicator of the presence of fecal contamination from warm-blooded animals. Total coliform is a broader indicator of bacterial contamination and could be caused by plant matter, soil and other sources.

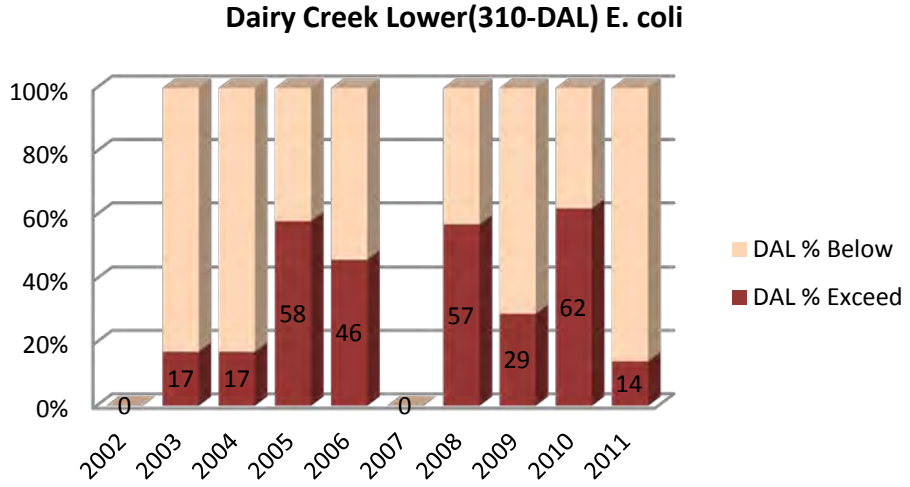
The following table contains the number of bacteria samples collected each year at the sites and the number of samples that exceeded the criteria.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011†
DAL n	5	6	6	12	13	1	7	7	13	7
DAL % Exceed	*	17	17	58	46	*	57	29	62	14
DAM n	0	6	9	11	11	2	10	9	17	7
DAM % Exceed	*	17	11	28	28	*	10	0	35	0
DAU n	0	0	0	5	11	1	12	7	19	5
DAU % Exceed	*	*	*	*	64	*	66	43	74	*

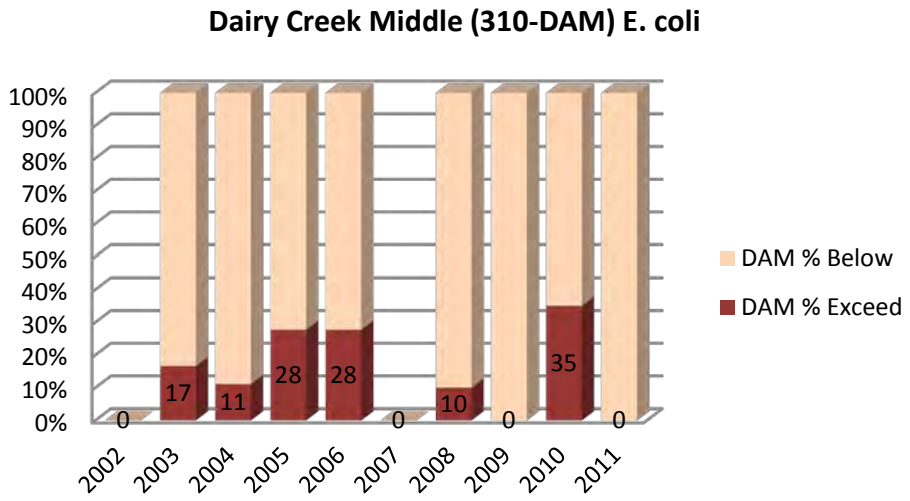
**The sample size n < 6 was deemed too small for inclusion in the analysis.*

† 2011 values include January to May 2011.

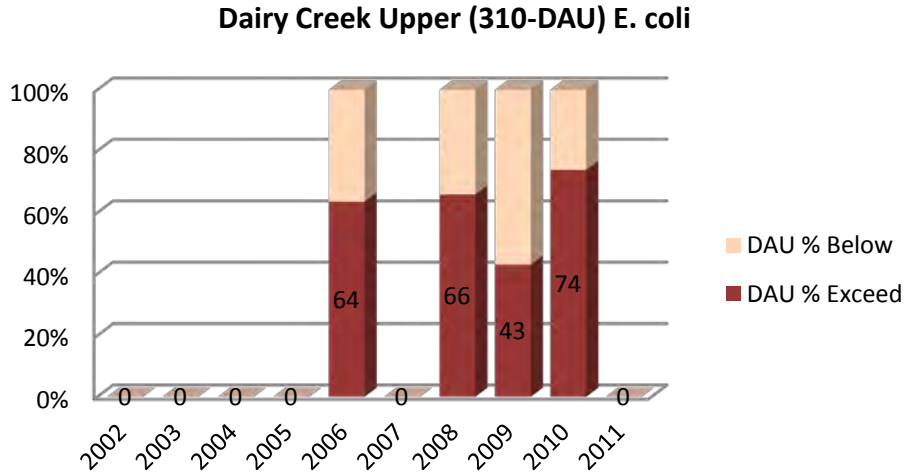
The following graphs depict the % of samples that exceeded the 235 MPN/100 mL recreational contact standard for *E. coli* each year. The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

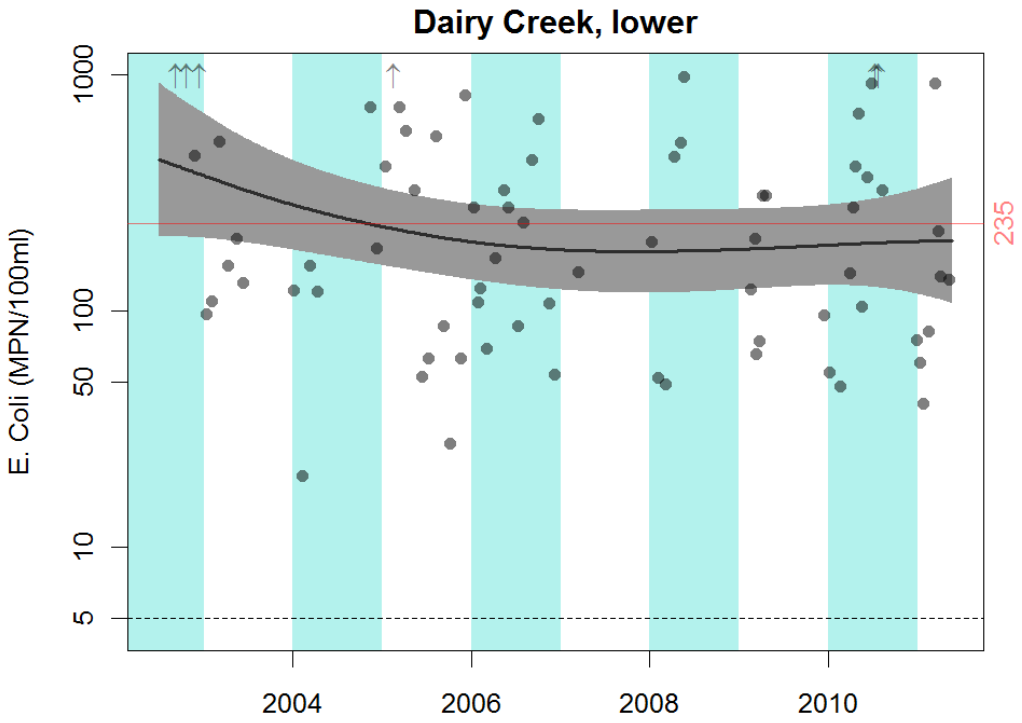


Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

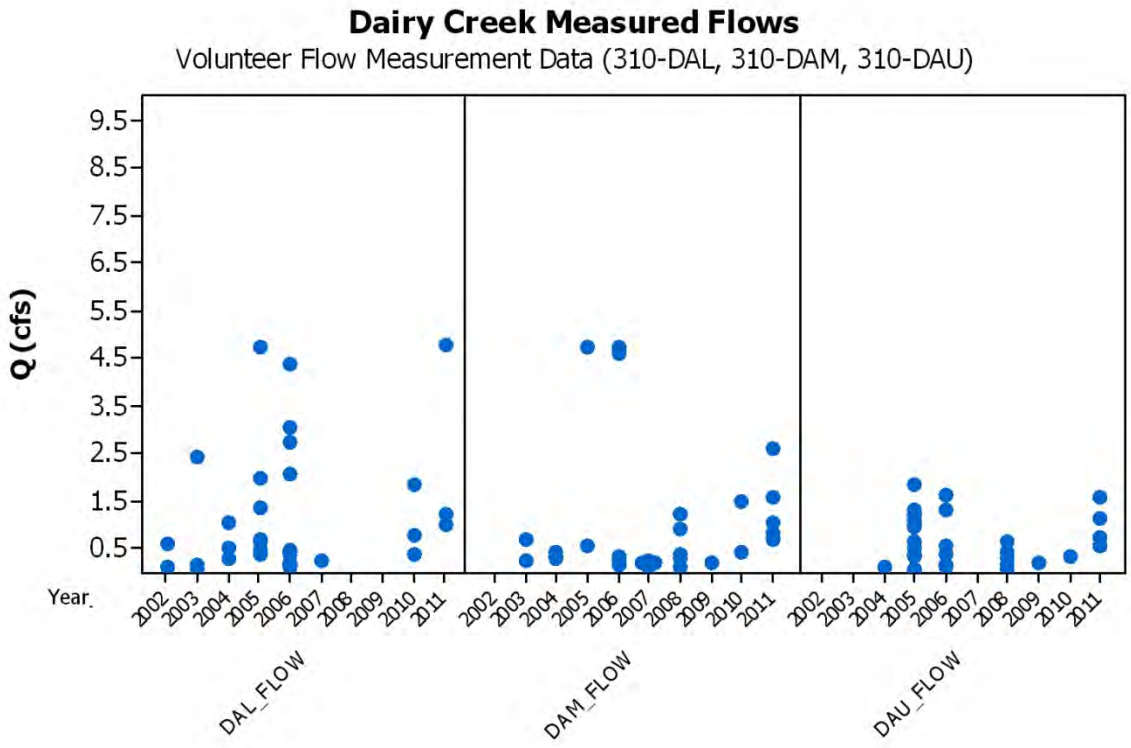
A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the small scale fluctuations. This analysis was conducted only for DAL since it had the longest running dataset of the three sites. Regardless of the sample size for a given year, all data was included in this analysis. The black line on the plot shows the geomean of the *E. coli* concentration over time using smoothing splines. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data, or less data available for analysis. In general, the data from DAL is substantially variable, resulting in a wide error band.



FLOW VOLUME

Instantaneous flow volumes were estimated using the velocity-area method. Depth and segment measurements were obtained using a top-setting rod and a measuring tape. Velocity measurements were obtained with a Marsh-McBirney Flo-Mate 2000 that reported 30-second fixed point average velocity measurements. Volunteers typically record six or more depth and velocity readings to generate volume estimates. The Flo-Mate 2000 meter has a range of measurement up to 20 feet per second.

The following graph shows flow measurements obtained from the creek at each site. The graph provides an overview of the range and frequency of flow measurements.



MACROINVERTEBRATES

Data collected between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was approved in spring 2007. The VMP monitored a 150 m reach at each site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

Data collected prior to 2007 was generated using prior approved methods. The data from previous surveys was standardized by a Monte Carlo analysis and is included for comparison.

The metrics included in this report are taxa richness, EPT richness, EPT% and IBI score. Taxa richness is a measure of the number of different species of organisms in the sample. EPT richness is a measure of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Taxa richness and EPT richness typically decrease with poor water quality. EPT% is the total number of EPT individuals divided by the total number of individuals in the sample. The Index of Biotic Integrity (IBI) score used in this report is the Southern California Coastal IBI developed by the Aquatic Bioassessment Laboratory of the California Department of Fish & Game. Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer + collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, coleoptera richness, predator richness, percent intolerant individuals and EPT richness. For the IBI

scores, scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good. The metrics are displayed below for each Dairy Creek site.

Dairy Creek, Lower (DAL)	*Taxa Richness*	*EPT Richness*	*EPT %*	*IBI Score*
2002	*	*	*	*
2003	43	10	23.0	-
2004	33	10	30.0	-
2005	20	9	45.0	-
2006	38	20	23.3	-
2007	*	*	*	*
2008	44	10	24.4	50.1
2009	*	*	*	*
2010	25	6	25.0	60.1
2011	*	*	*	*

** No data collected this year*

- Metric scores not currently available

Dairy Creek, Middle (DAM)	*Taxa Richness*	*EPT Richness*	*EPT %*	*IBI Score*
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	*	*	*	*
2006	*	*	*	*
2007	*	*	*	*
2008	56	7	9.2	50.1
2009	70	13	20.2	74.4
2010	30	5	6.4	52.9
2011	65	26	51.0	65.7

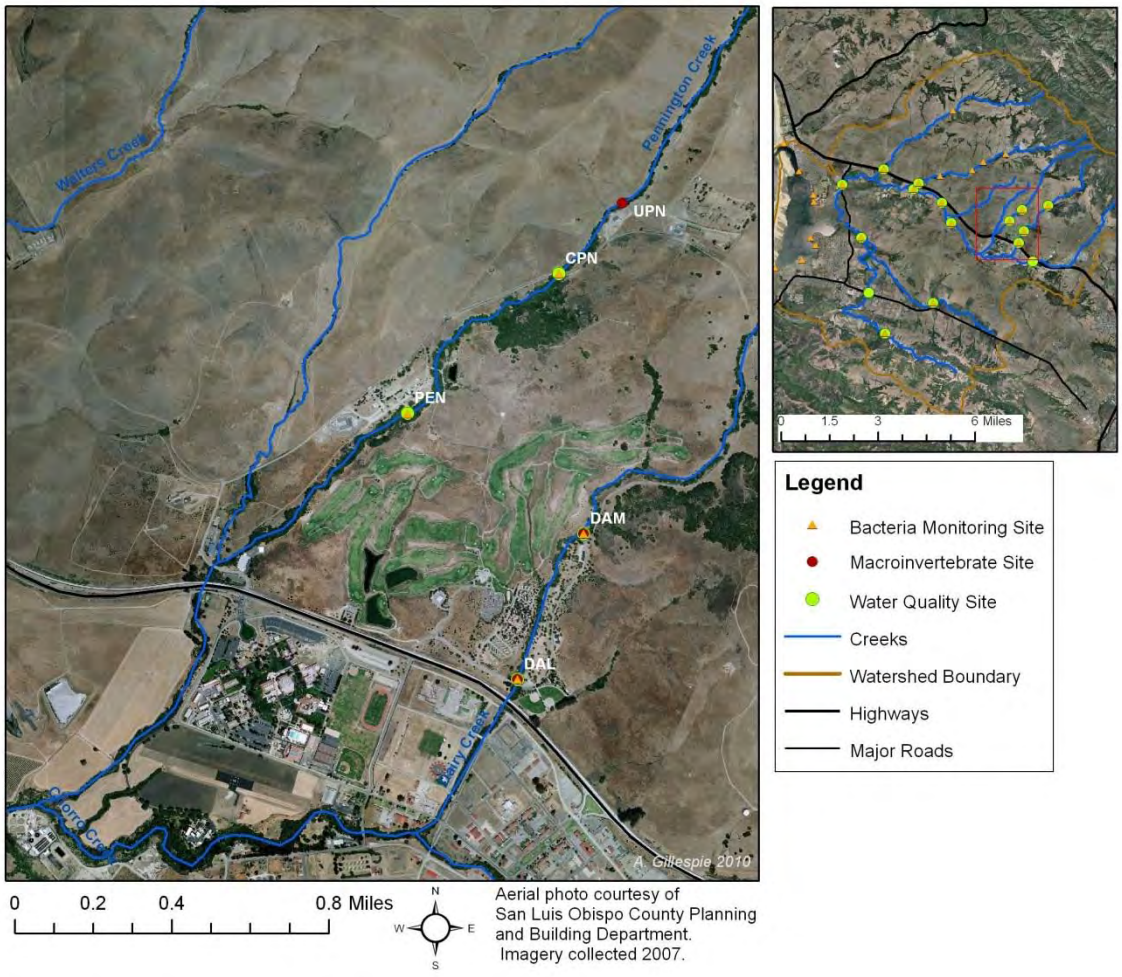
** No data collected this year*

Dairy Creek, Upper (DAU)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	*	*	*	*
2006	*	*	*	*
2007	*	*	*	*
2008	79	17	17.4	80.1
2009	64	16	31.8	91.5
2010	52	14	18.6	71.5
2011	45	13	53.5	58.6

** No data collected this year*

PENNINGTON CREEK

SITE MAP AND DESCRIPTION



The Pennington Creek subwatershed encompasses an area of approximately 3.09 square miles. The watershed is predominately utilized as parkland and beef cattle rangeland. Most of the acreage is publicly-owned by the County of San Luis Obispo, the U.S. Forest Service and Cal Poly State University.

The Rancho El Chorro Outdoor School and Cal Poly Escuela Ranch Cattle Enterprise operation dominate the acreage in the watershed.

The VMP has monitored Pennington Creek long term at two sites. The PEN site is located near the outdoor amphitheater and picnic area at the Ranch El Chorro Outdoor School. This site was established in the early 1990's as part of the National Monitoring Program (NMP), and data collection was continued by the VMP following the conclusion of the NMP in 2001. The CPN site is approximately 0.5 miles upstream from PEN at the bridge crossing on Pennington Creek Road. This site was established in 2007 with cooperation from Cal Poly State University.

In support of planned water conservation projects, two upstream sites were added to the monthly water quality monitoring regime in this watershed. Water quality monitoring, including flow monitoring, was begun in January 2011 on two sites (APN and UPN). The UPN site was established as a macroinvertebrate monitoring site in 2006, but was not included as part of regular ongoing water quality and bacteria monitoring efforts until 2010. The APN site is currently only monitored for water quality. Due to limited data currently available for these sites, they are not included in the analysis for Pennington Creek.

WATER QUALITY N VALUE SUMMARY

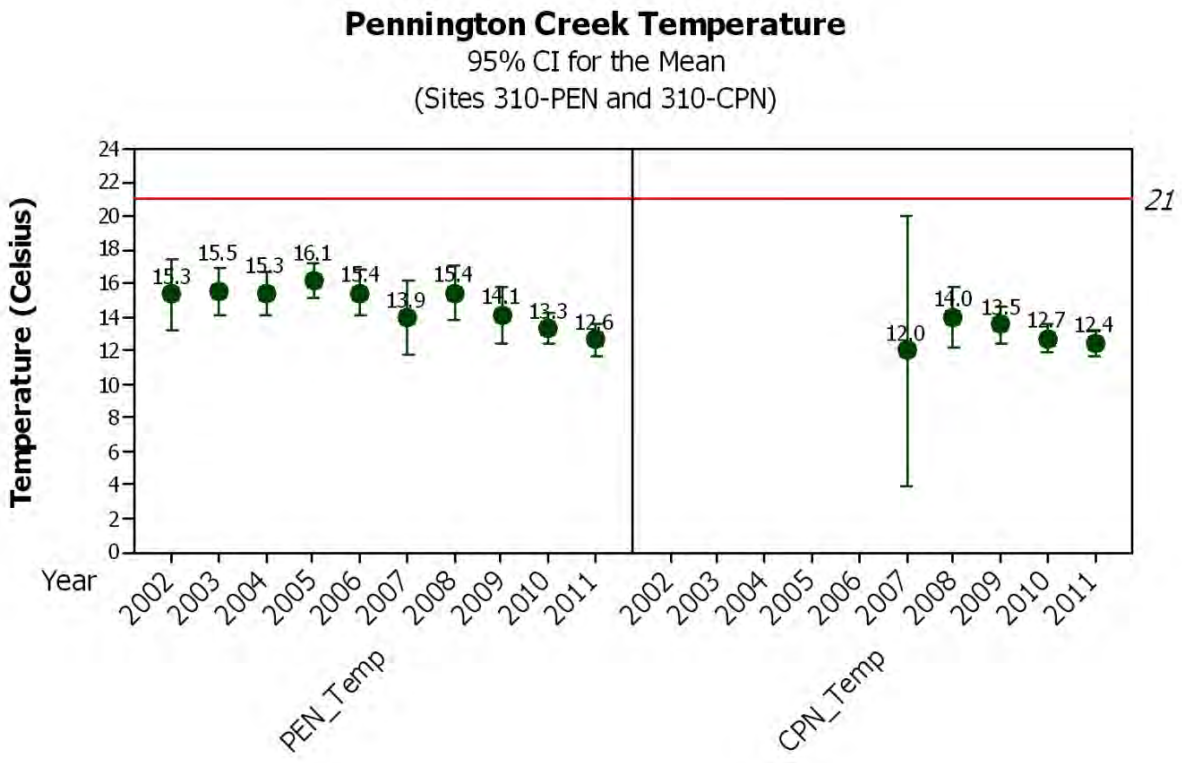
Although Pennington Creek is a perennial stream, summer flows can become too shallow to facilitate monitoring. Flow data for this creek is limited by velocity measurements due to the shallow depth of surface flows and large cobbles. The table below indicates the frequency of water quality monitoring at Pennington Creek sites throughout the monitoring period.

Site	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	Sum
PEN	8	11	14	18	21	16	11	12	24	9	**144**
CPN	0	0	0	0	0	3	12	19	23	10	**67**
Sum	**8**	**11**	**14**	**18**	**21**	**19**	**23**	**31**	**25**	**19**	

** 2011 values include January to May 2011.*

TEMPERATURE

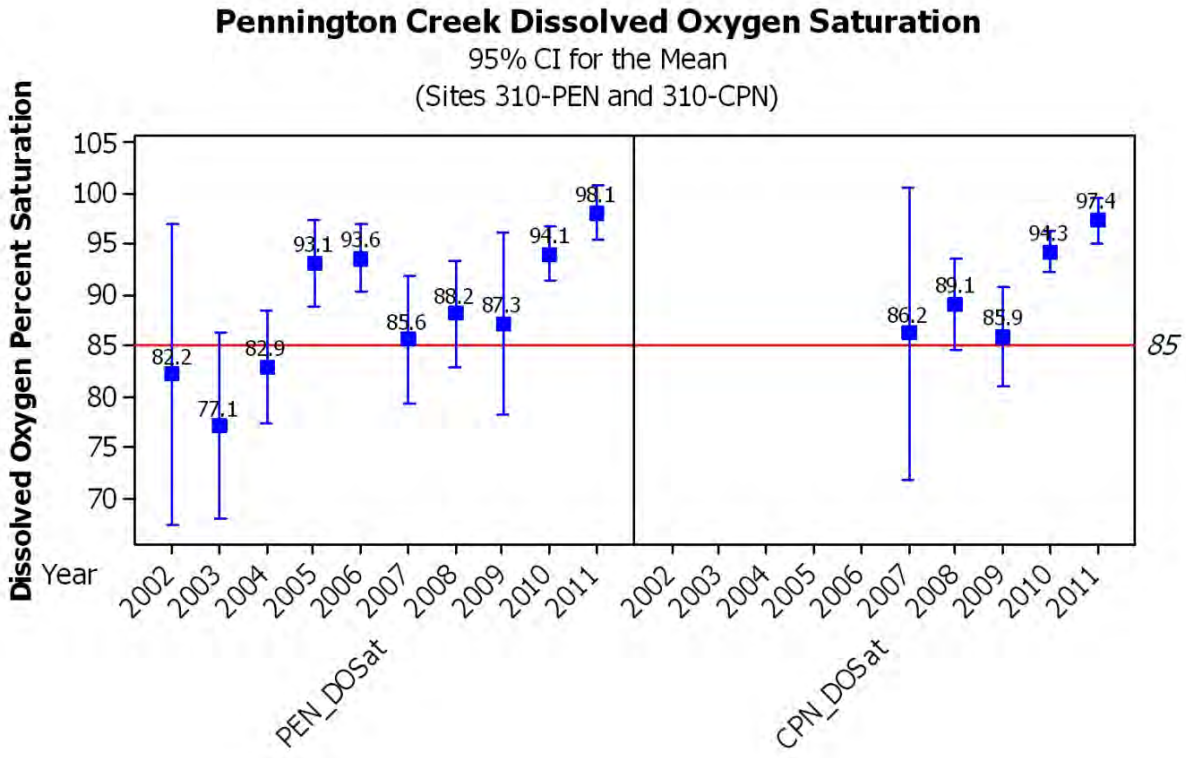
Water temperature was measured as part of the water quality monitoring effort, which can take place at any time during daylight hours and is not necessarily measured at a consistent time of day. Water quality monitoring may take place once or twice monthly, depending on volunteer availability and site hydrology. Data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to measure water temperature. The meter has a range of -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with Model 85 units. The plot shows the mean temperature for each year, with the results grouped by site and year. The interval bars indicate the 95% confidence interval (CI) for the mean, which is the range within which 95% of the data can be expected to fall. The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line.



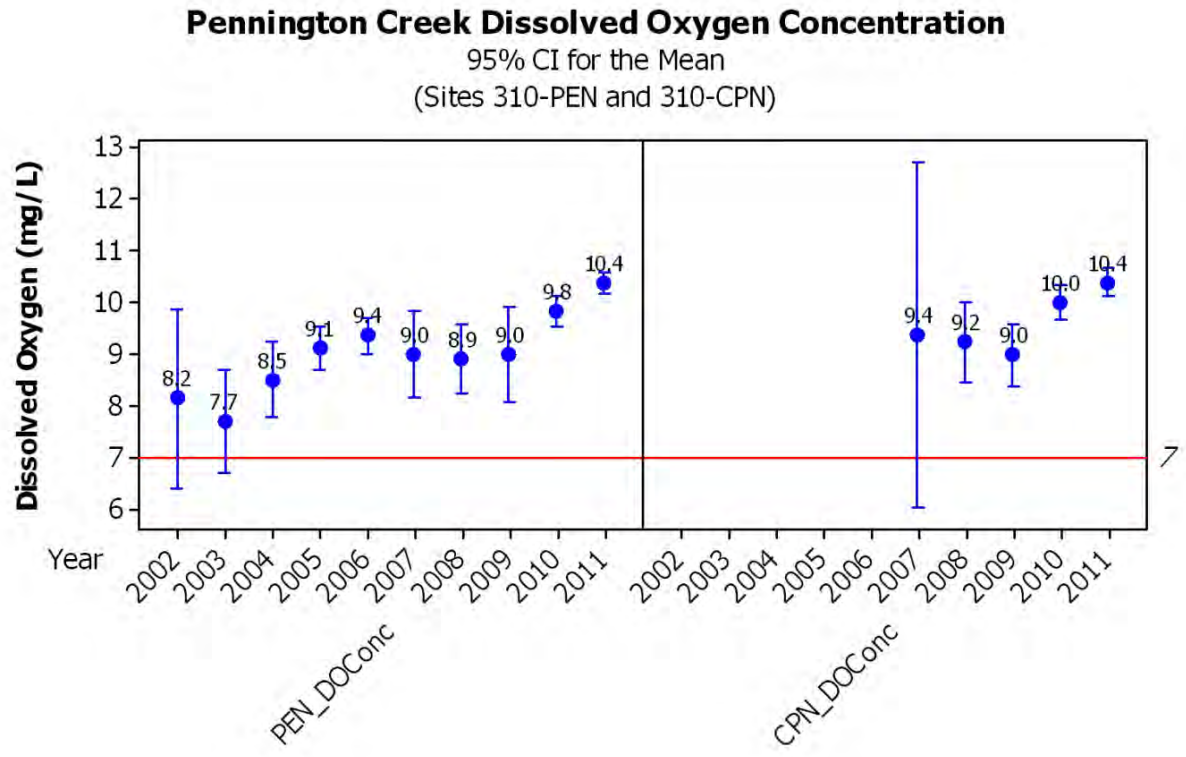
DISSOLVED OXYGEN

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation and a resolution of 0.1%. For concentration, the meter range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter. Measurements were collected at various times during daylight hours and were not necessarily measured at a consistent time of day.

The graph below displays the mean and 95% confidence interval of DO percent saturation for the two monitoring sites located on Pennington Creek, grouped by year. The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.

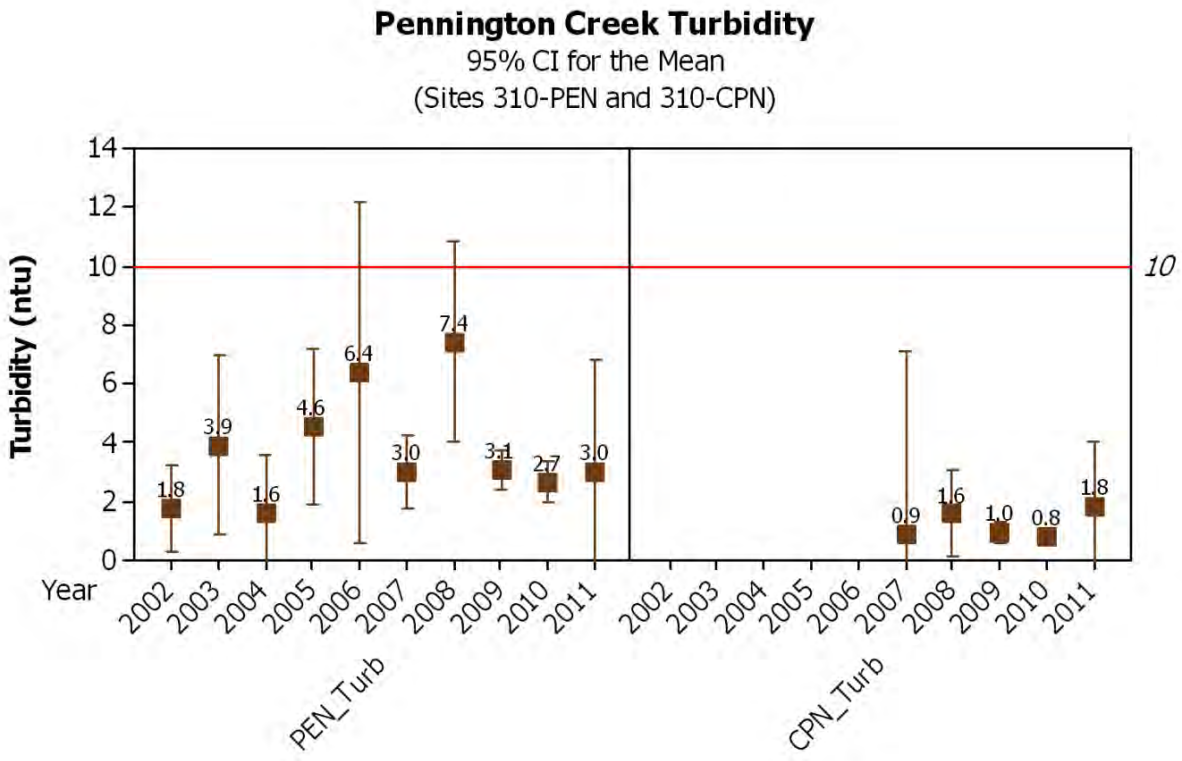


Dissolved oxygen measurements were also made as a concentration in mg/L. The following graph shows the mean and 95% CI for the DO concentration data. The Central Coast Basin Plan set a regulatory standard that states that at no time shall DO concentrations fall below 7.0 mg/L.



TURBIDITY

Program volunteers measured turbidity during each water quality field visit. Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU. Although the Basin Plan doesn't include water quality objectives for turbidity, CCAMP notes a level of concern at 10 NTU for protection of aquatic life. Measurements were collected at various times during daylight hours, and were not necessarily measured at a consistent time of day. A few outlier readings were removed from analysis as they were collected during storm events and were not representative of ambient conditions. The discarded values are listed below the figure.



**Removed turbidity outlier collected on 11/6/2008, 900 NTU due to unexplained event (possible construction or earth moving activity).*

pH

Since July 2010, program volunteers measured pH during each water quality field visit using a pH probe. The meter has a range of -1.0 to 15.0 pH units, with a resolution of 0.1 pH units. Prior to July 2010, pH paper was used for the measurement. The paper has a range of 4.5 to 10.0 with a resolution of 0.5 pH units. pH paper measurements are collected along with the probe measurement in the hopes that a correlation can be determined between the two values. Following quality control comparisons of the probe and paper data with lab analysis, the pH probes appear to be very accurate, whereas the pH paper was consistently underestimating the pH.

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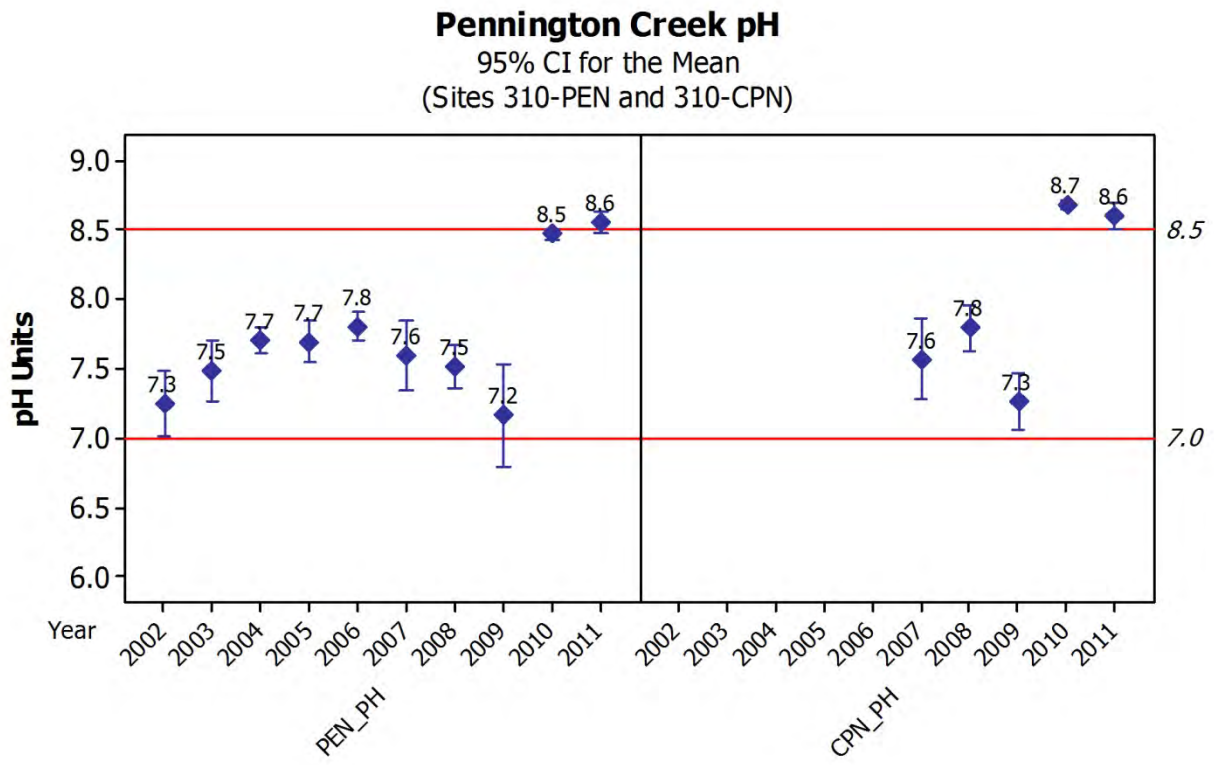

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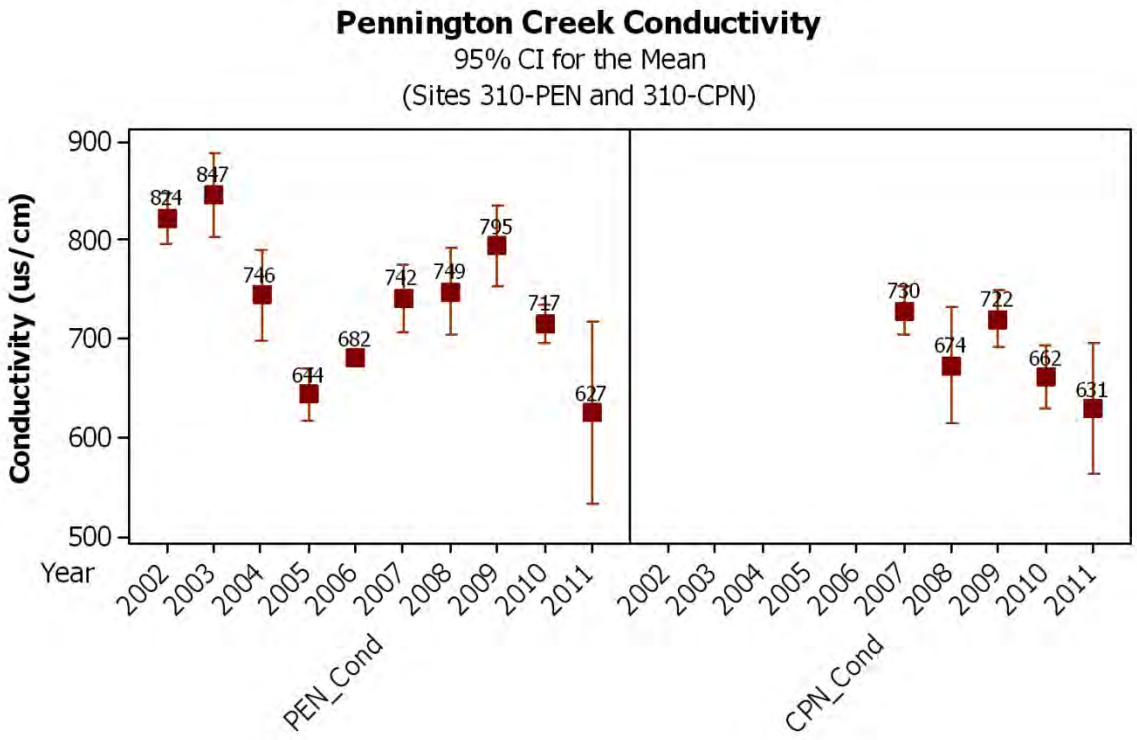

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Program volunteers measured orthophosphates as PO_4^{3-} and nitrates as nitrogen during each water quality field visit. Samples were collected by trained volunteers, and analysis was conducted at the MBNEP office using chemical test kits.

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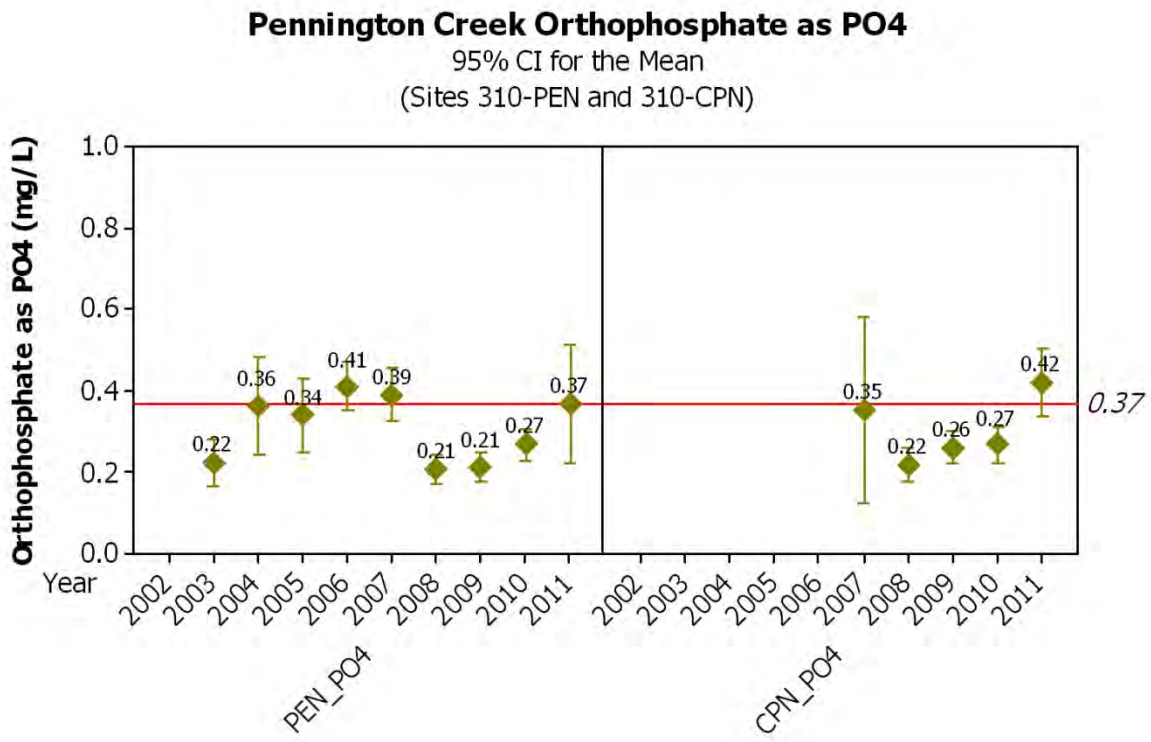

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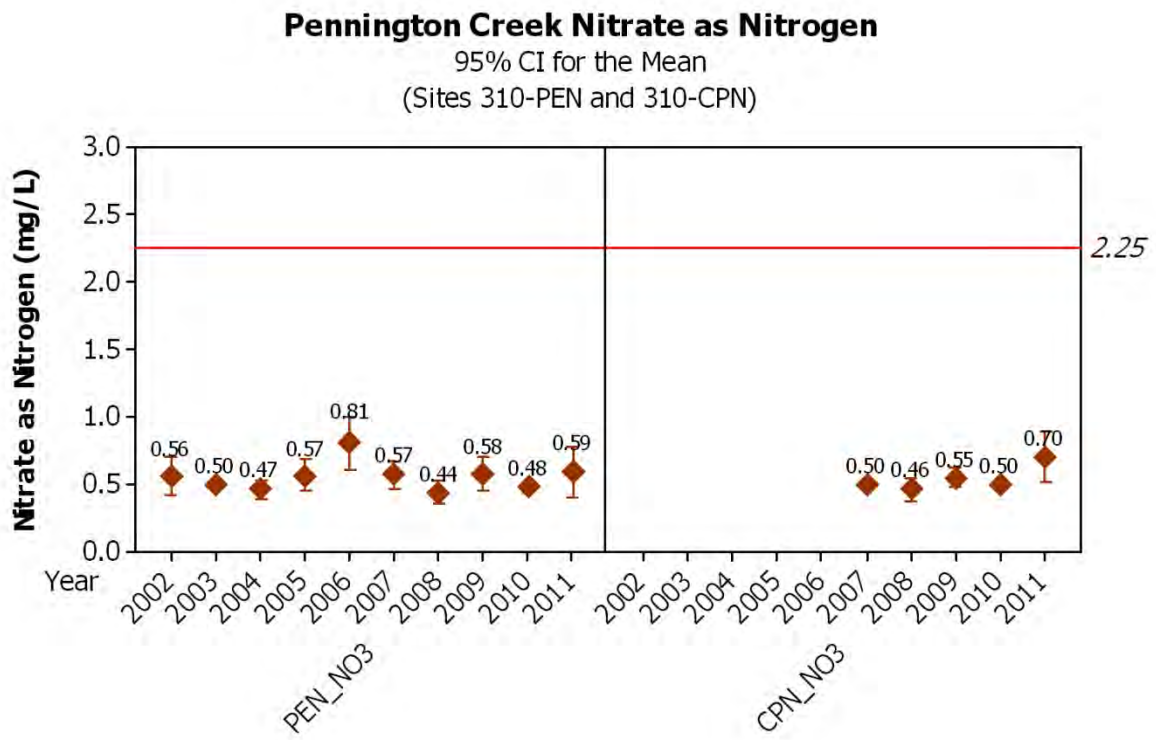

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The CCRWQCB utilizes algae abundance data in assessing 303(d) listings and de-listings, as well as tracking TMDL implementation. The presence and density of algal blooms can be considered supporting evidence when determining whether to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Algae data was analyzed through two data sets generated by 2011 assessments at each site. The percent coverage of macroalgae at the site was determined by calculating algae presence at wetted points located on the transects and inter-transects. This calculated value is used to represent percent algal coverage throughout the 150 m reach. UPN, the only site monitored on Pennington Creek, had a score of 9%, which is the second to lowest score of the ten sites assessed in 2011. Additionally, the qualitative spatial coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) was assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1 indicating < 10% coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. With this metric, UPN scored a 10%, the second to lowest score of the ten sites assessed in 2011.

BACTERIA

Program volunteers monitored total coliform and *E. coli* bacterial indicators. Monthly samples were collected and analyzed by volunteers with the IDEXX method using Colilert-18 reagent. Analysis took place at the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory. Bacteria monitoring was not timed to coincide with monthly or bi-weekly water quality monitoring at these sites.

Based on typical sample dilutions, the range of detection for the test is from < 1 MPN/100 mL to 24,196 MPN/100 mL. The regulatory criteria for comparison are the recommended standards in EPA's 1986 guidance document *Ambient Water Quality Criteria for Bacteria*. For *E. coli* for a single grab sample, the water is considered to have a tolerable risk for swimming (REC-1 contact) if the concentration is less than 235 MPN/100 mL. The analysis in this report is focused on *E. coli* rather than total coliform because *E. coli* is an indicator of the presence of fecal contamination from warm-blooded animals. Total coliform is a broader indicator of bacterial contamination and could be caused by plant matter, soil and other sources.

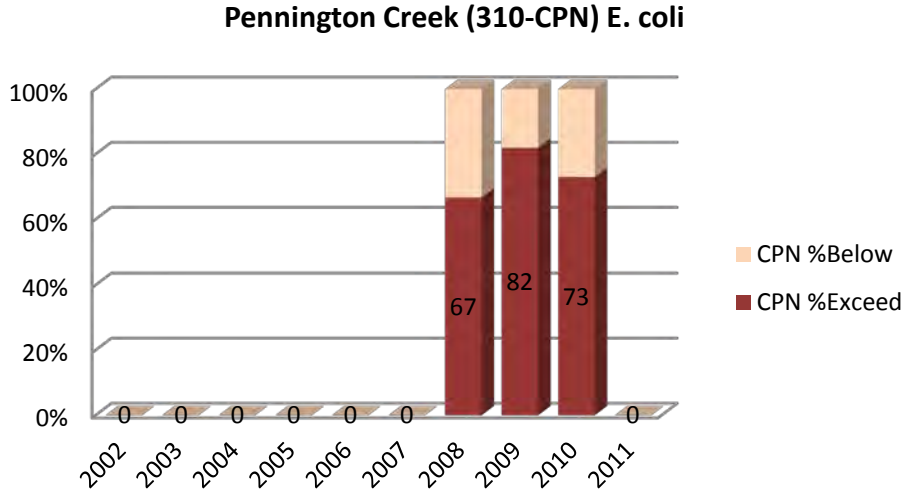
The following table contains the number of bacteria samples collected each year at the sites and the percentage of samples that exceeded the REC-1 contact standard.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011†
CPN n	0	0	0	0	0	0	12	11	11	5
CPN %Exceed	*	*	*	*	*	*	67	82	73	*

PEN n	5	13	12	12	12	14	13	10	12	5
PEN %Exceed	*	58	50	50	17	71	31	40	92	*

**The sample size n < 6 was deemed too small for inclusion in the analysis.*
† 2011 values include January to May 2011.

The following graphs depict the % of samples that exceeded the recreational contact standard for *E. coli* each year at the two monitoring sites. The blank columns with zeroes in the graphs depict that no data was collected or that a sample size that was too small (n < 6) for inclusion in the analysis, rather than a lack of exceedances of the standard.



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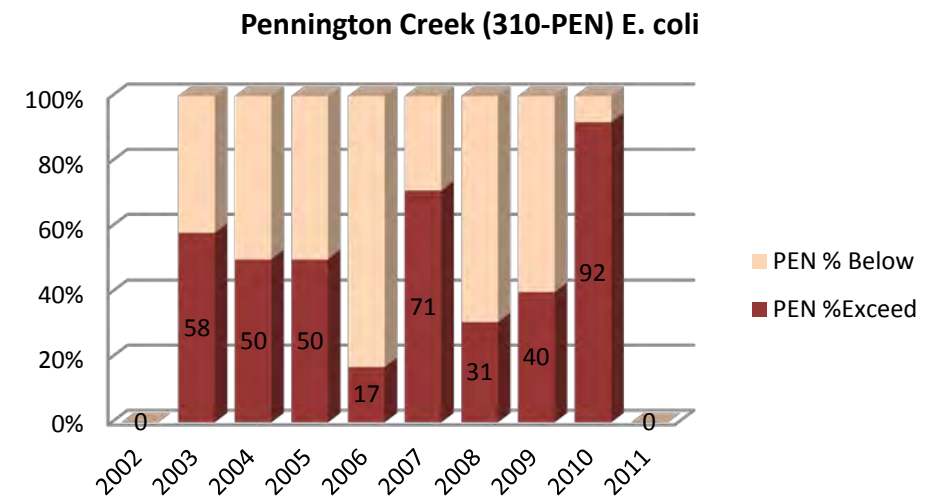
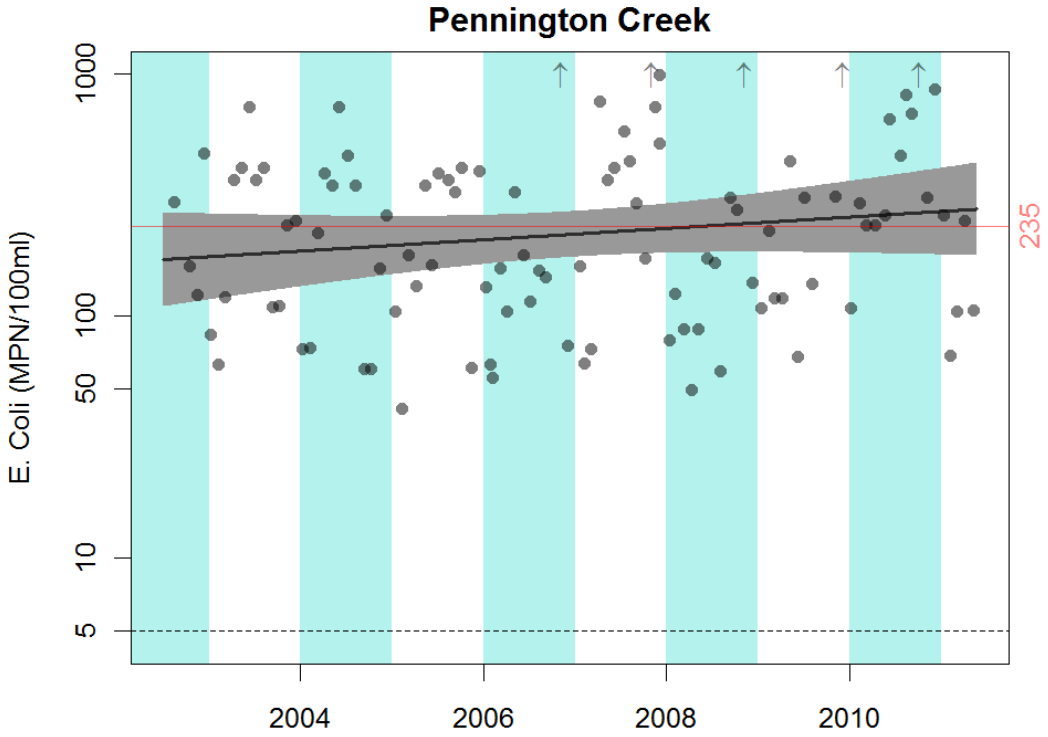


Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

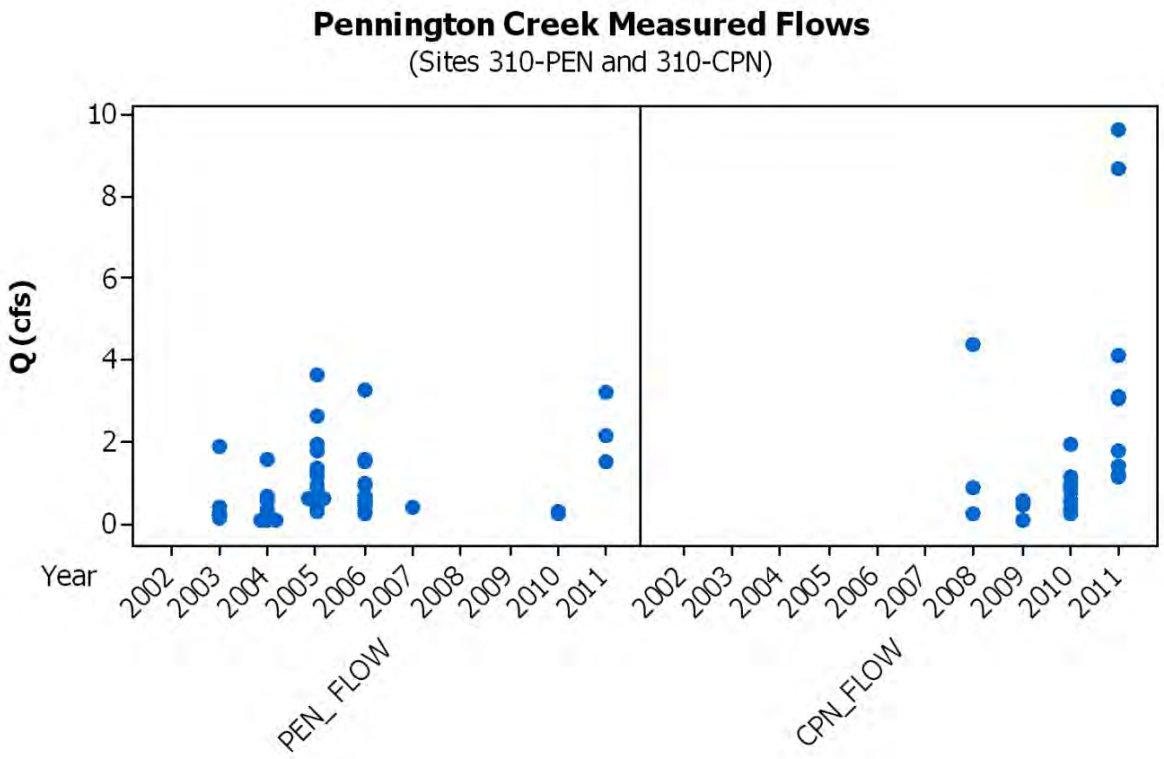
A statistical analysis was conducted to track the long-term trends of the bacteria data at PEN. The black line on the plot shows the geomean of the *E. coli* concentration over time using smoothing splines. Regardless of the sample size for a given year, all data was included in this analysis. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data, or less data available for analysis. The geomean of the data and the band have been consistently close to the 235 MPN/100 mL regulatory standard.



FLOW VOLUME

Instantaneous flow volumes were calculated using the velocity-area method. Depth and segment measurements were obtained using a top-setting rod and a measuring tape. Velocity measurements were obtained with a Marsh-McBirney Flo-Mate 2000 that reported 30-second fixed point average velocity in feet per second. Volunteers typically recorded six or more depth and velocity readings to generate volume estimates. The Flo-Mate 2000 meter has a range of measurement up to 20 feet per second.

The following graph shows flow measurements obtained from the creek at each site. The graph provides an overview of the range and frequency of flow measurements. Flow volume was infrequently measured at Pennington Creek due to the shallow depth of the water in fast moving habitats.



MACROINVERTEBRATES

Data collected annually between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was finalized in spring 2007. The VMP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Mcroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

Data collected prior to 2007 was generated using prior Fish and Game approved methods. The data from previous surveys was standardized by a Monte Carlo analysis and is included for comparison.

The metrics included in this report are taxa richness, EPT richness, EPT% and IBI score. Taxa richness is a measure of the number of different species of organisms in the sample. EPT richness is a measure of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Taxa richness and EPT richness typically decrease with poor water quality. EPT% is the total number of EPT individuals divided by the total number of individuals in the sample. The Index of Biotic Integrity (IBI) score used in this report is the southern California Coastal IBI developed by the Aquatic Bioassessment Laboratory of the California Department of Fish & Game. Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer + collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, coleoptera richness, predator richness, percent intolerant individuals and EPT richness. For the IBI scores, scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good. The metrics are displayed below for both Pennington Creek sites.

Upper Pennington Creek (UPN)	***Taxa Richness***	***EPT Richness***	***EPT %***	***IBI Score***
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	*	*	*	*
2006	49	16	44.0	-
2007	62	21	21.0	-
2008	47	17	18.4	79.0
2009	*	*	*	*
2010	*	*	*	*
2011	59	25	64.4	85.7

** No data collected this year*

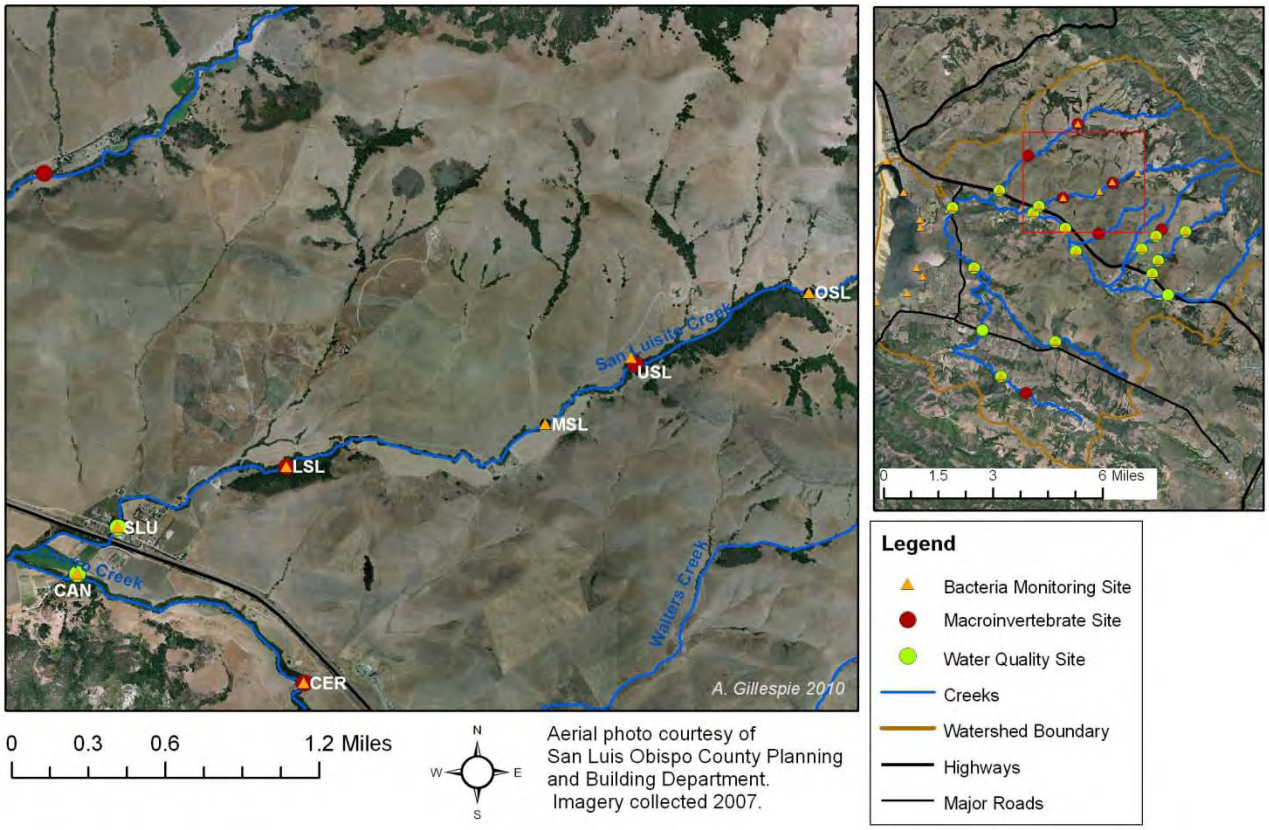
- Metric scores not currently available

Lower Pennington (PEN)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	*	*	*	*
2004	29	11	38.0	-
2005	*	*	*	*
2006	42	17	33.2	-
2007	*	*	*	*
2008	*	*	*	*
2009	*	*	*	*
2010	*	*	*	*
2011	*	*	*	*

** No data collected this year*
- Metric scores not currently available

SAN LUISITO CREEK

SITE MAP AND DESCRIPTION



The San Luisito Creek subwatershed encompasses an area of approximately 8.28 square miles. The watershed is predominately utilized as beef cattle rangeland with a small amount of acreage allocated to row crops and dry farming. There are a cluster of private residences near the Highway 1 crossing and a limited number of rural residences spread throughout the subwatershed. Most of the acreage is

privately owned, with a few holdings by the U.S. Forest Service and the California Department of Fish and Game.

The VMP has several monitoring sites on San Luisito Creek. The most downstream site, SLU, was established in the early 1990's as part of the National Monitoring Program (NMP), and data collection was continued by the VMP following the conclusion of the NMP in 2001. This site was monitored for water quality and bacteria either monthly or bi-weekly depending on volunteer availability.

Sites LSL, MSL and USL were established through cooperative agreement on private property in 2006. Site OSL was established through cooperative agreement on private property in 2009. These sites were monitored bi-weekly for bacteria only, and no water quality data was collected. A limited amount of macroinvertebrate data has been collected at sites LSL and USL since 2008. A detailed discussion of bacteria data on San Luisito Creek is provided in the IEP chapter of this report.

WATER QUALITY N VALUE SUMMARY

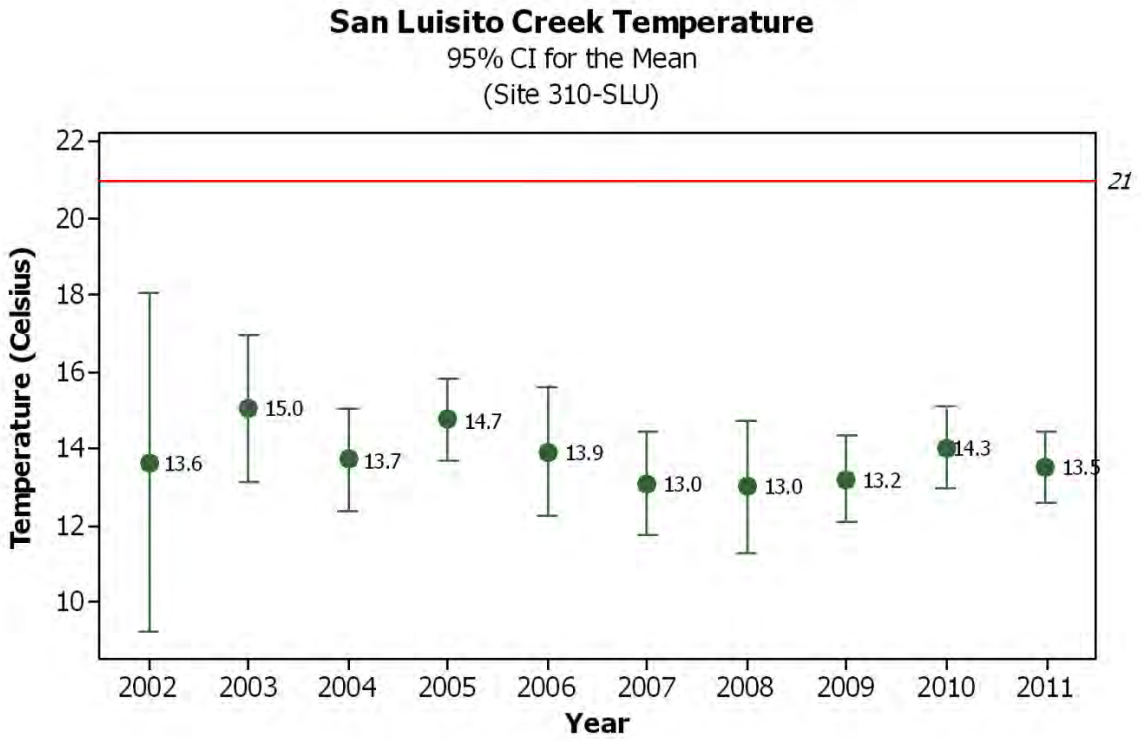
Water quality monitoring took place monthly or bi-weekly at SLU since 2002. San Luisito Creek is a perennial stream, and there are few gaps in the data during the study period. In a few instances, flow data collection was limited by shallow depths in fast water habitats. The table below indicates the frequency of water quality monitoring at the San Luisito Creek site (SLU) throughout the monitoring period.

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011***	**Sum**
SLU	6	9	12	20	18	23	12	22	23	10	**154**

** 2011 values include January to May 2011.*

TEMPERATURE

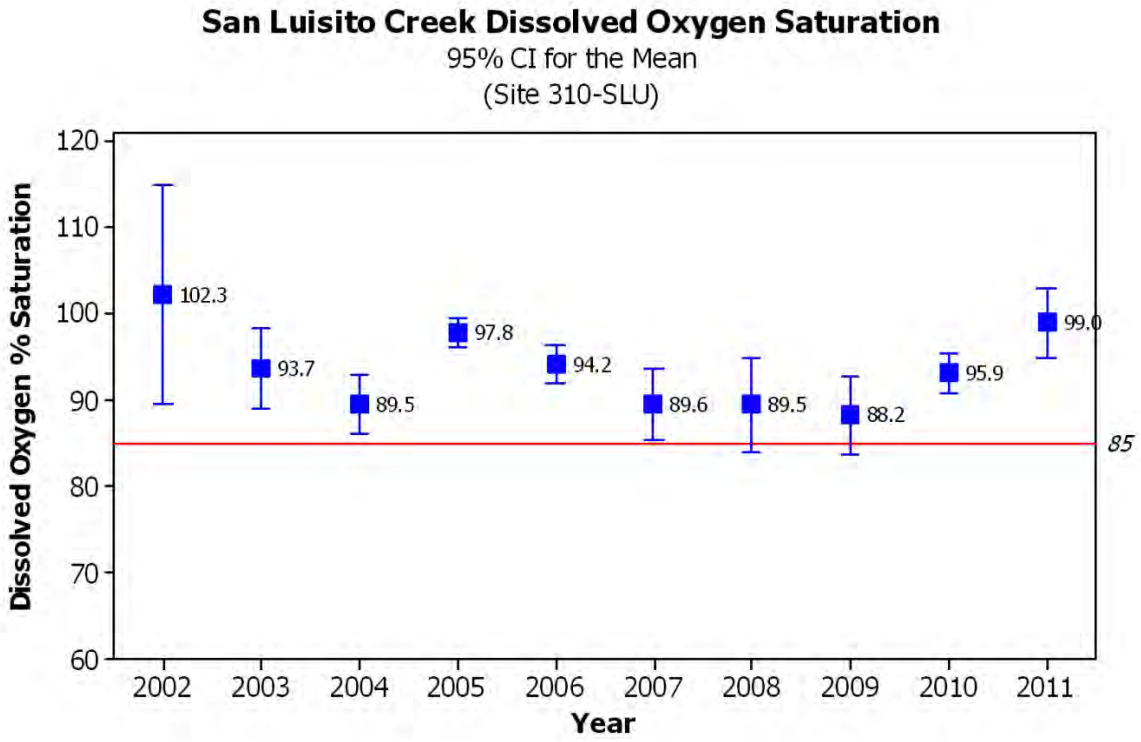
Water temperature is measured as part of the water quality monitoring effort, which can take place at any time during daylight hours, and was not necessarily measured at a consistent time of day. Water quality monitoring may take place once or twice monthly, depending on volunteer availability and site hydrology. Data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to measure water temperature. The meter has a range of -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with Model 85 units. The plot indicates the mean temperature for each year. The interval bars indicate the 95% confidence interval (CI) for the mean, which is the range within which 95% of the data is expected to fall. The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line.



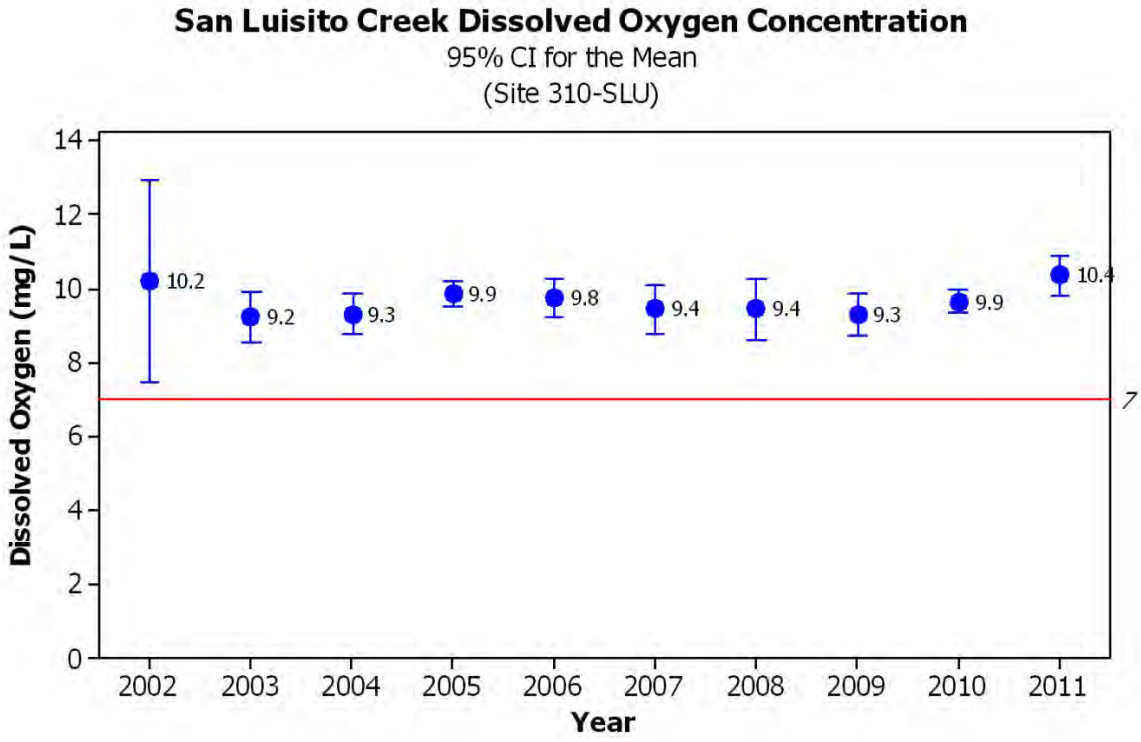
DISSOLVED OXYGEN

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation and a resolution of 0.1%. For concentration, the meter range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter. Measurements were collected at various times during daylight hours and were not necessarily measured at a consistent time of day.

The graph below displays the mean and 95% confidence interval of dissolved oxygen percent saturation for the site on San Luisito Creek, grouped by year. The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.

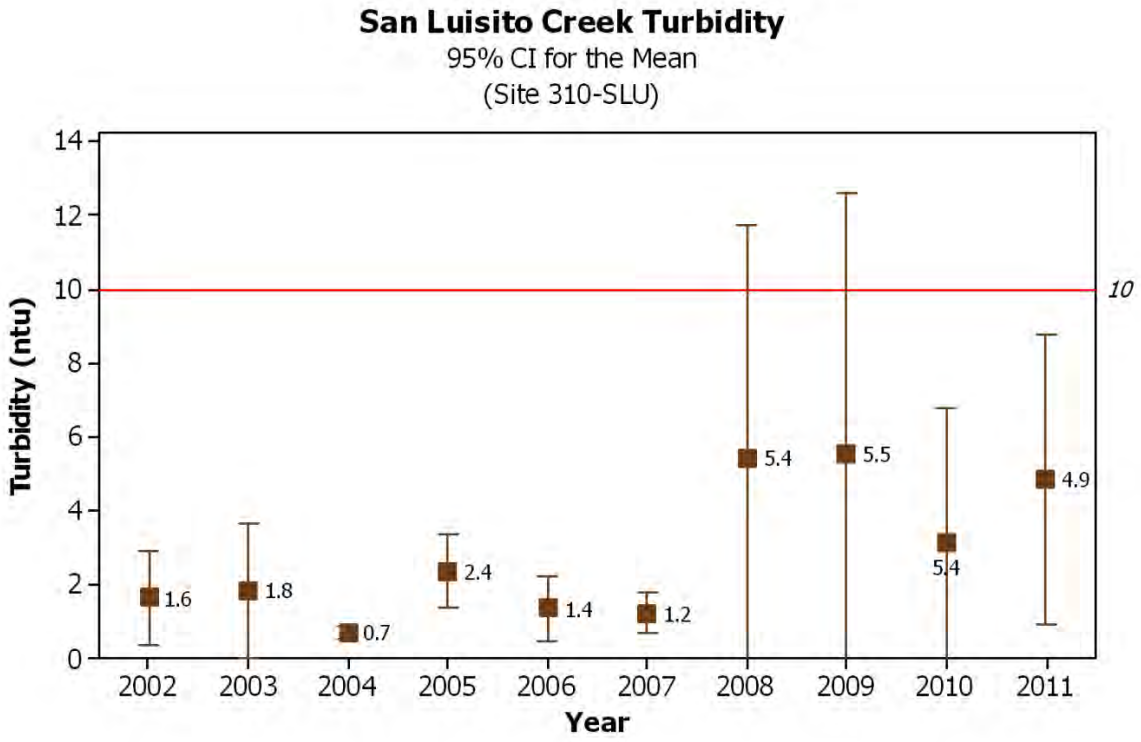


Dissolved oxygen measurements were also made as a concentration in mg/L. The following graph shows the mean and 95% CI for the dissolved oxygen concentration data. The Central Coast Basin Plan set a regulatory standard that states that at no time shall DO concentrations fall below 7.0 mg/L.



TURBIDITY AND SUSPENDED SEDIMENT

Program volunteers measured turbidity during each water quality field visit. Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU. Although the Basin Plan contains no water quality objectives for turbidity, CCAMP notes a level of concern at 10 NTU for protection of aquatic life. Measurements were collected at various times during daylight hours, and were not necessarily measured at a consistent time of day.



Beginning in 2007, program staff began data collection on suspended sediment concentration (SSC) and turbidity at SLU during the winter months. Samples were collected at 30 or 60-minute intervals during winter storm events via ISCO 6712 automated samplers. Samples were then analyzed at the VMP's lab facility at Cuesta College for nephelometric turbidity and SSC. This effort was part of a larger effort to track winter sediment loads in the Chorro watershed.

PH

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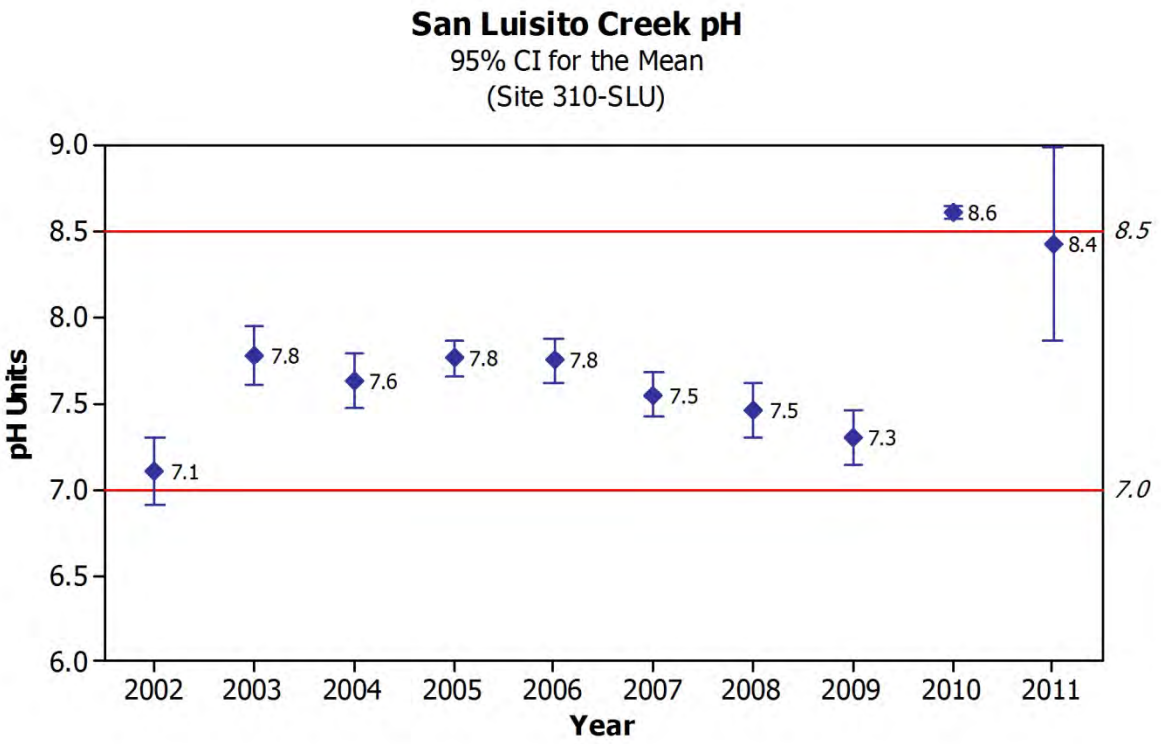

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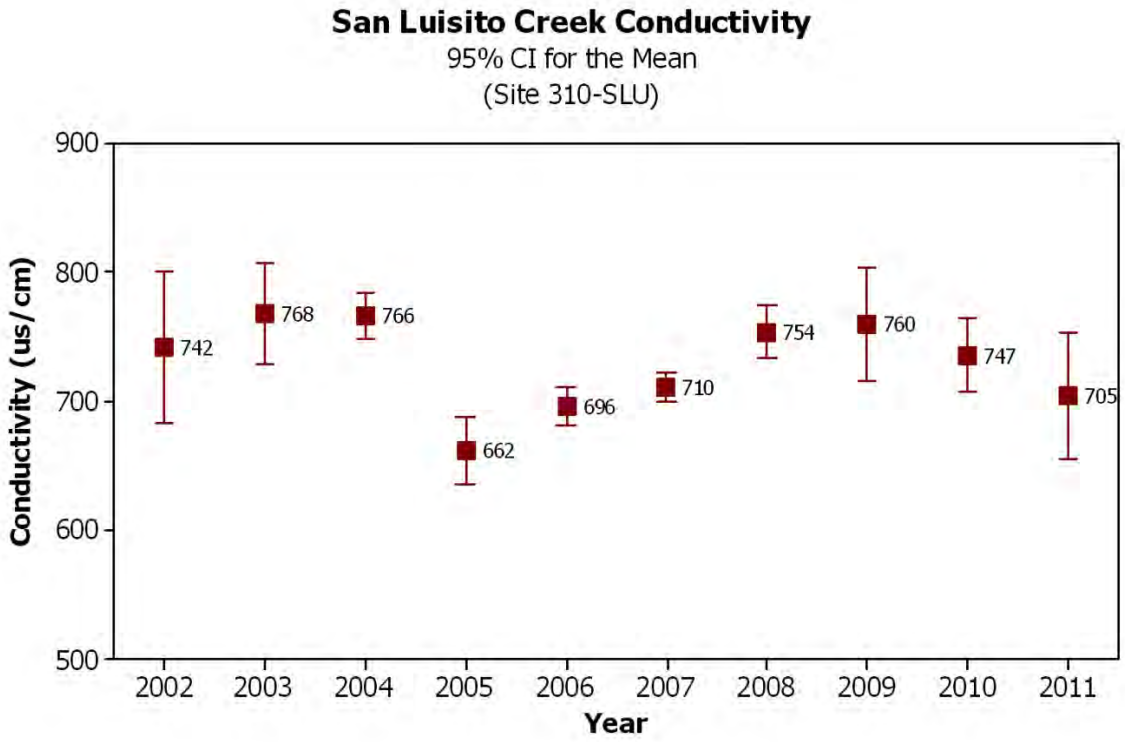

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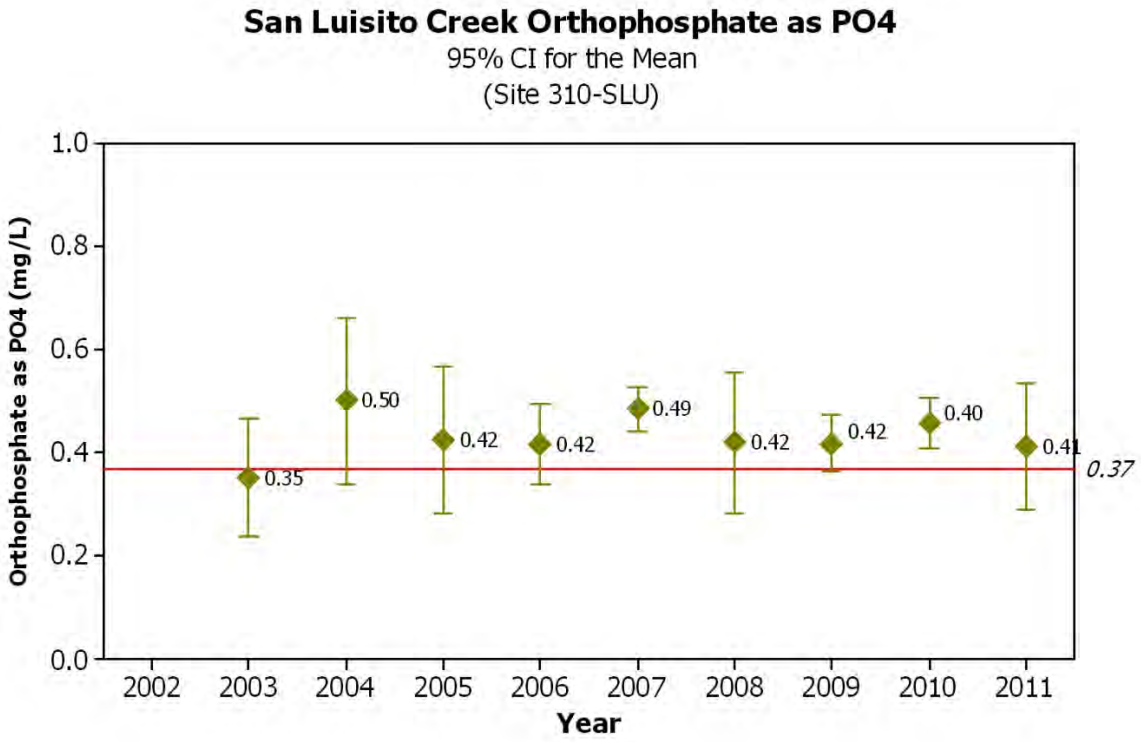

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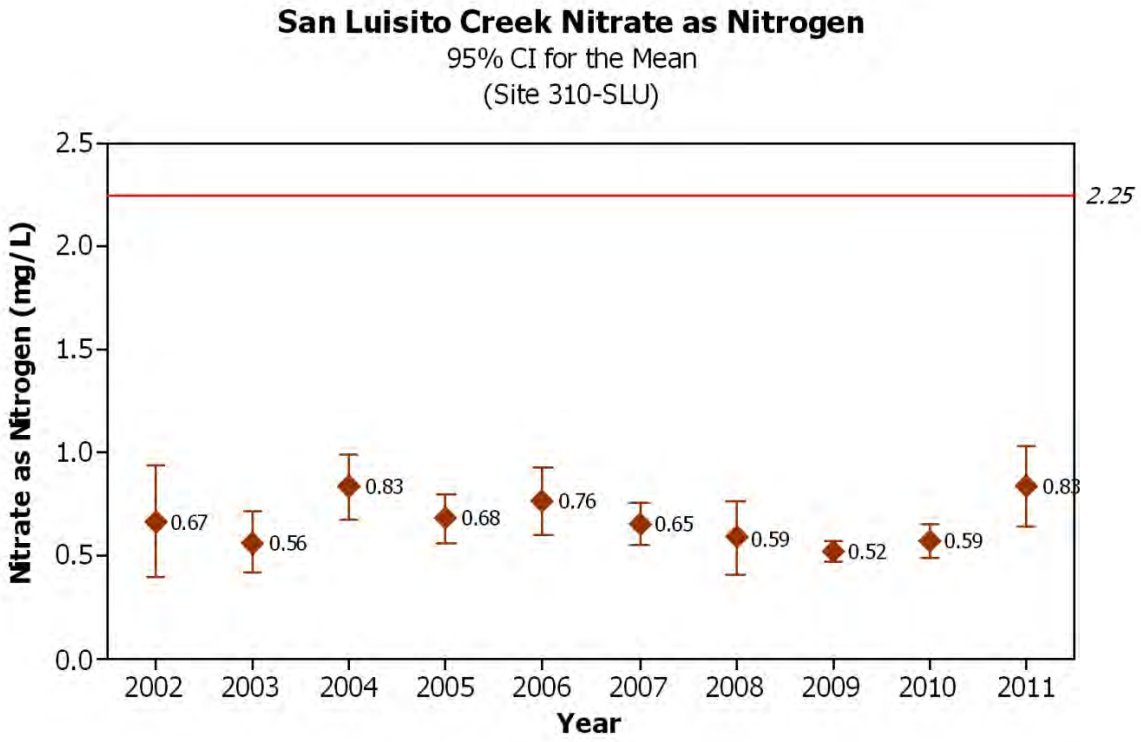

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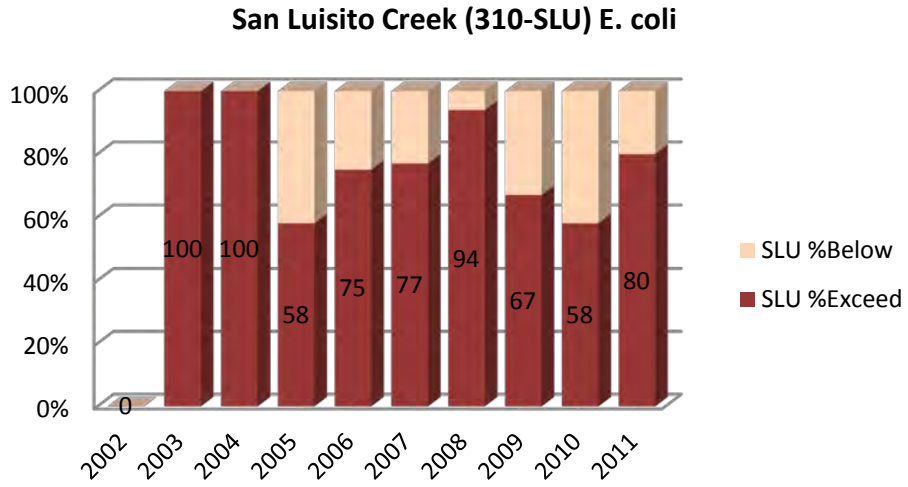
The following table contains the number of bacteria samples collected each year at site SLU and the percentage of samples that exceeded the regulatory standard. A detailed discussion of bacteria at San Luisito Creek sites is provided in the IEP chapter.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011†
SLU n	0	11	12	12	12	13	17	24	24	10
SLU %Exceed	*	100	100	58	75	77	94	67	58	80

**The sample size n < 6 was deemed too small for inclusion in the analysis.*
† 2011 values include January to May 2011.

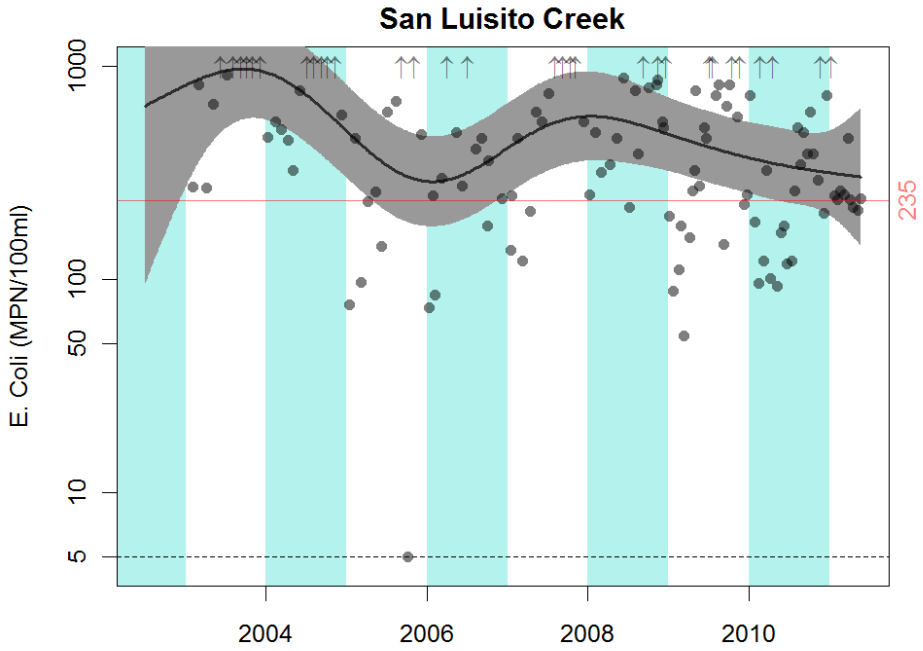
The following graph depicts the percent of samples that exceeded the recreational contact standard for *E. coli* each year.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the small scale fluctuations. The black line on the plot shows the geomean of the *E. coli* concentration at the SLU site over time using smoothing splines. The gray band indicates the error band for the

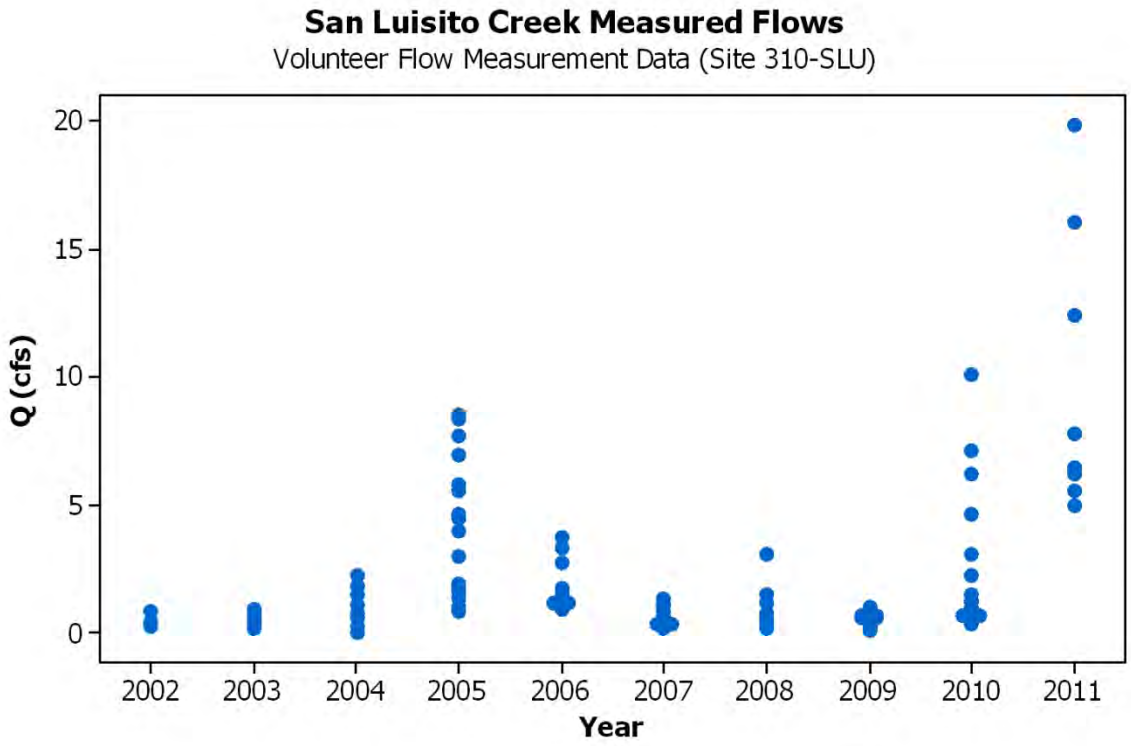
geomean, meaning the "true" geomean could be anywhere within the band. Wide error bands indicate more variability in the data, or less data available for analysis. The up arrows represent data with *E. coli* concentrations greater than 1,000 MPN/100 mL. The geomean of the *E. coli* concentration and the error band were consistently above the 235 MPN/100 mL regulatory standard for safe swimming up until 2005.The recent potential downward trend may be due to the installation of riparian fencing in early 2009. The trends in bacteria data in relation to the riparian fencing project are examined in more detail in the IEP chapter of the report.



Flow Volume and Rating Curve

Volunteers measured instantaneous flow volumes using the velocity-area method. Depth and segment measurements were obtained using a top-setting rod and a measuring tape. Velocity measurements were obtained with a Marsh-McBirney Flo-Mate 2000 that reported 30-second fixed point average velocity in feet per second. Volunteers typically record six or more depth and velocity readings to generate volume estimates. The Flo-Mate 2000 meter has a range of up to 20 feet per second.

The following graph shows flow measurements obtained from the creek during low or base flow conditions. The graph provides an overview of the range and frequency of flow measurements.



MACROINVERTEBRATES

Data collected annually between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was finalized in spring 2007. The VMP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

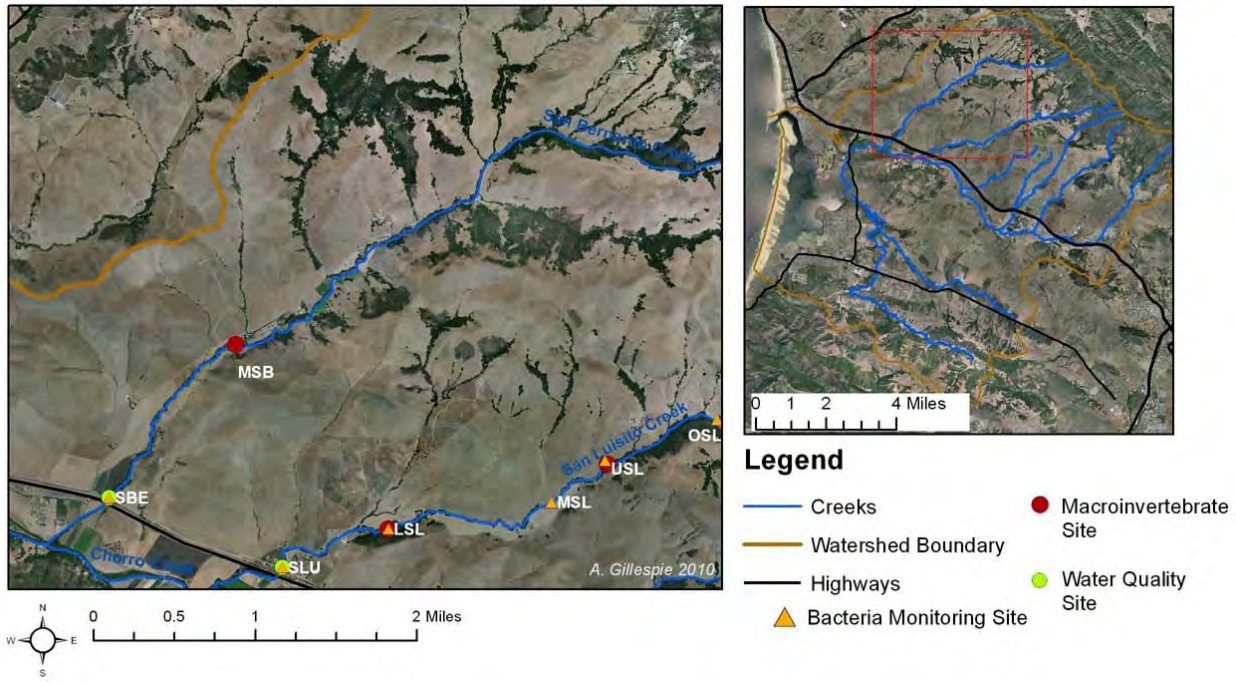
The metrics included in this report are taxa richness, EPT richness, EPT% and IBI score. Taxa richness is a measure of the number of different species of organisms in the sample. EPT richness is a measure of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Taxa richness and EPT richness typically decrease with poor water quality. EPT% is the total number of EPT individuals divided by the total number of individuals in the sample. The Index of Biotic Integrity (IBI) score used in this report is the Southern California Coastal IBI developed by the Aquatic Bioassessment Laboratory of the California Department of Fish & Game. Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer + collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, coleoptera richness, predator richness, percent intolerant individuals and EPT richness. For the IBI scores, scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good. The metrics are displayed below.

San Luisito Creek, Lower (LSL)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	*	*	*	*
2006	*	*	*	*
2007	*	*	*	*
2008	55	14	25.2	67
2009	49	15	12.4	70.1
2010	48	18	50.6	75.8
2011	45	17	44.5	54.3

San Luisito Creek, Upper (USL)	Taxa Richness	EPT Richness	EPT %	IBI Score
2010	60	24	35.2	91.5
2011	38	18	76.7	58.6

SAN BERNARDO CREEK

SITE MAP AND DESCRIPTION



The San Bernardo Creek subwatershed encompasses an area of approximately 8.49 square miles. The watershed is predominately utilized as beef cattle rangeland with a small amount of acreage allocated to row crops, small livestock operations, and dry farming. There are a limited number of rural

residences spread throughout the subwatershed. Most of the acreage is privately-owned, with a few holdings by the U.S. Forest Service in the upper watershed.

The VMP has three monitoring sites on San Bernardo Creek. The most downstream site, SBE, was established in the early 1990's as part of the National Monitoring Program (NMP), and data collection was continued by the VMP following the conclusion of the NMP in 2001. Hydrologic conditions at this site have limited the amount of data collection. During many months of the year, the creek goes underground at the lower reach. The limitations of the SBE site prompted staff to seek another upstream site for annual macroinvertebrate monitoring. Site MSB was established with agreement from private landowners on both sides of the creek. Due to difficult terrain and limited access, this site was not included as part of ongoing water quality or bacteria monitoring efforts.

Site USB was established through cooperative agreement on private property in 2009. This site was monitored monthly for bacteria and water quality. Data collection at this site was suspended in June 2010 at the landowner's request. USB has been removed from this report due to the lack of additional data.

A detailed discussion of bacteria and macroinvertebrate data on San Bernardo Creek are provided in the IEP chapter. The table below indicates the frequency of water quality monitoring at San Bernardo Creek sites throughout the monitoring period.

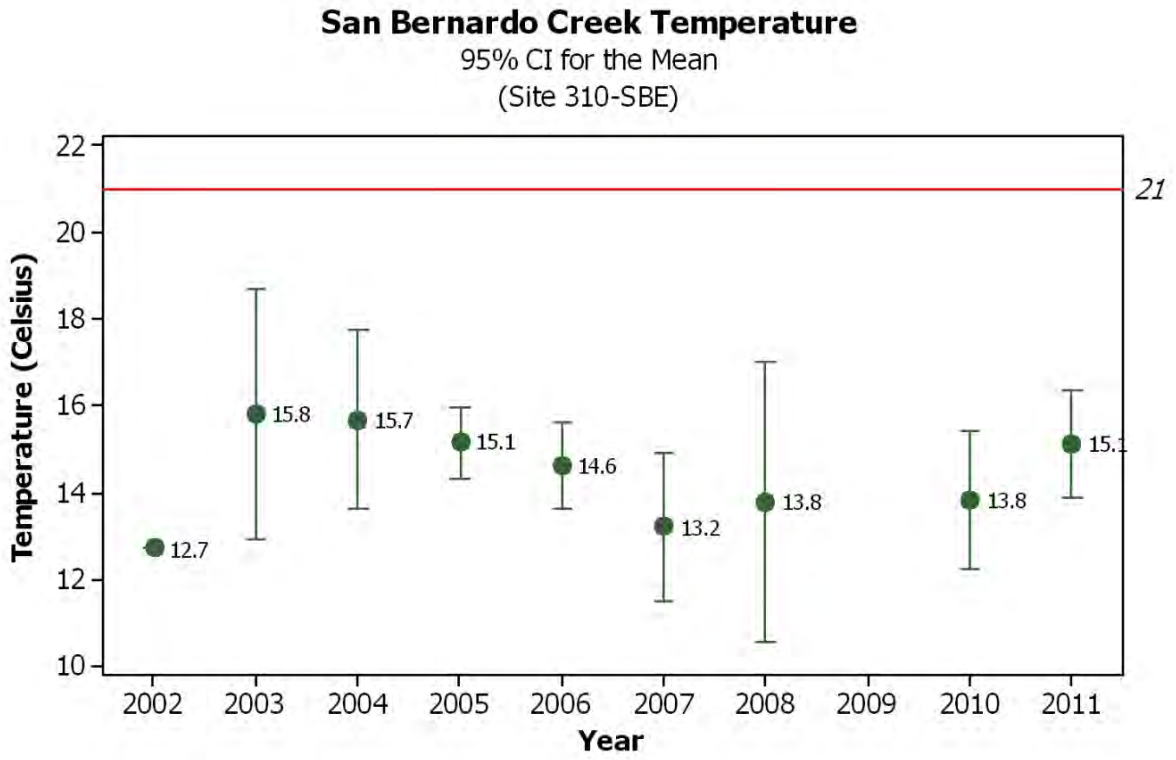
WATER QUALITY N VALUE SUMMARY

Sites	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	Sum
SBE	2	5	8	18	23	7	5	0	8	11	**86**

** 2011 values include January to May 2011.*

TEMPERATURE

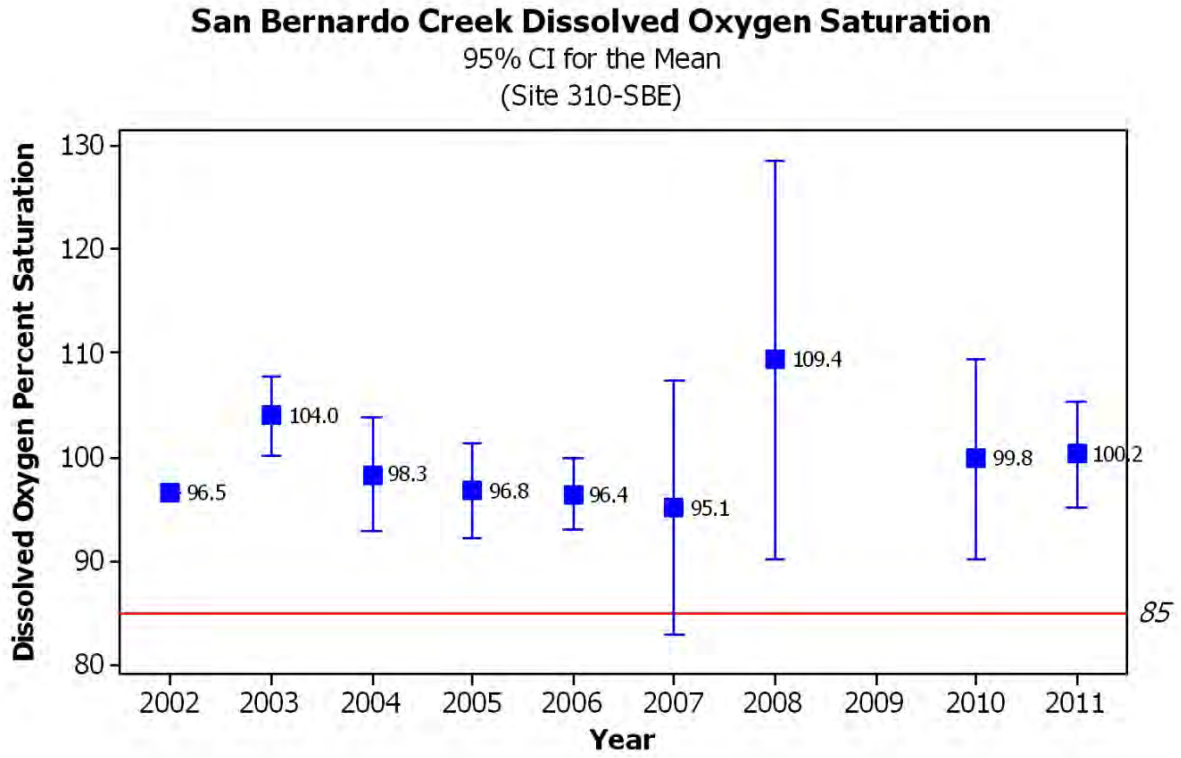
Water temperature is measured as part of the water quality monitoring effort, which can take place at any time during daylight hours, and is not necessarily measured at a consistent time of day. Water quality monitoring may take place once or twice monthly, depending on volunteer availability and site hydrology. Data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to collect water temperature. The meter has a range of -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with Model 85 units. The plot shows the mean temperature for each year, with the results grouped by site. The interval bars indicate the 95% confidence interval (CI) for the mean, which is the range within which 95% of the data can be expected to fall. The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line.



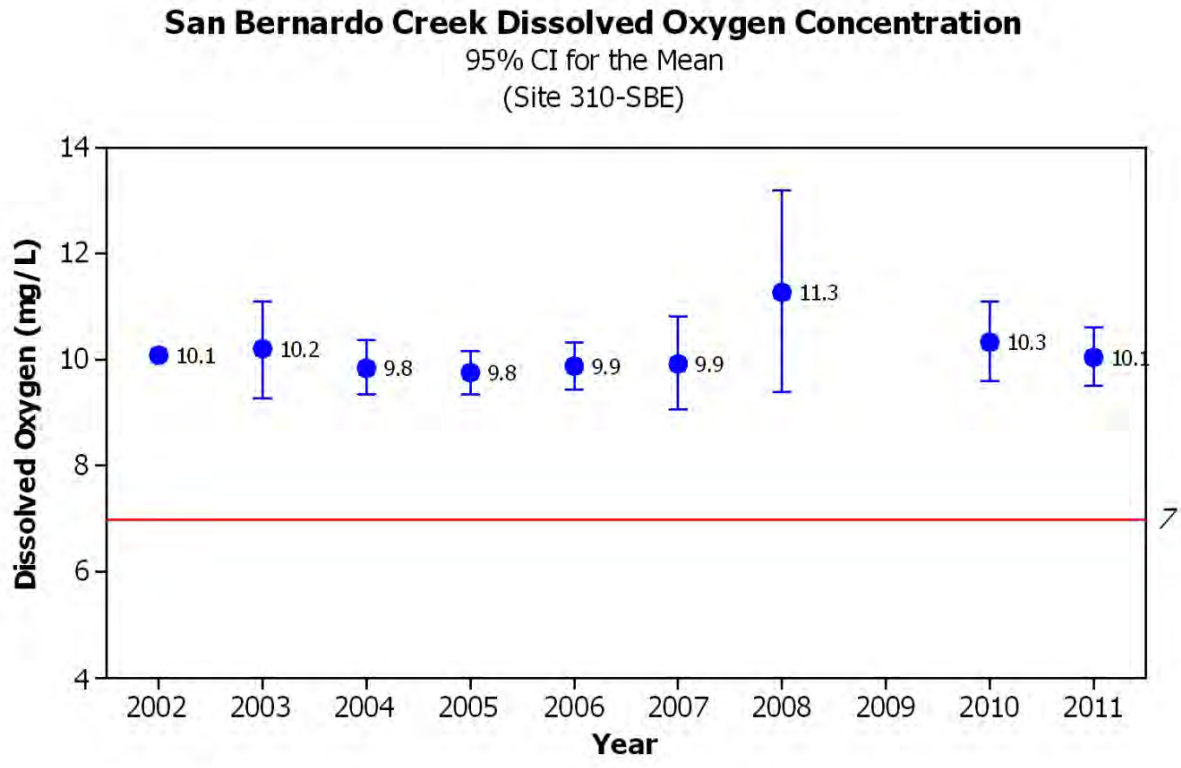
DISSOLVED OXYGEN

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation and a resolution of 0.1%. For DO concentration, the meter range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter. Measurements were collected at various times during daylight hours, and were not necessarily measured at a consistent time of day.

The graph below displays the mean and 95% confidence interval of DO percent saturation, grouped by year. The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.

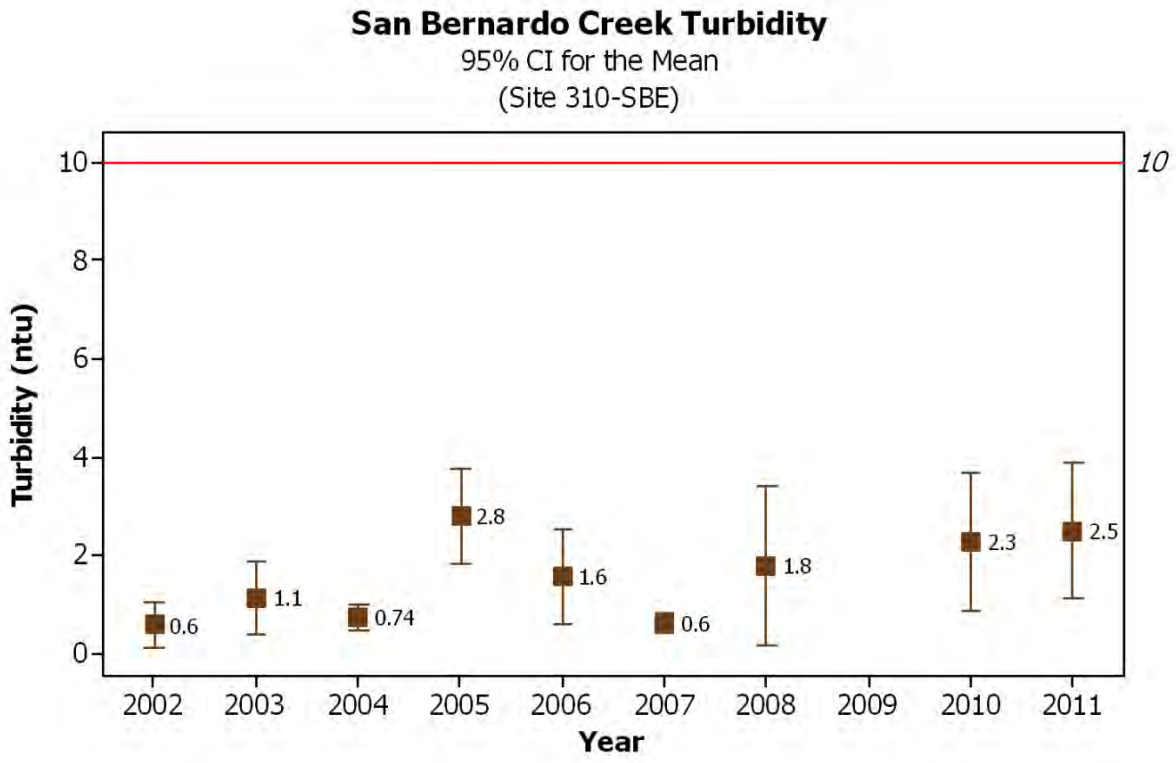


Dissolved oxygen measurements were also made as a concentration in mg/L. The following graph shows the mean and 95% CI for the dissolved oxygen concentration data. The Central Coast Basin Plan set a regulatory standard that states that at no time shall DO concentrations fall below 7.0 mg/L.



TURBIDITY

Program volunteers measured turbidity during each water quality field visit. Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU. Although the Basin Plan contains no water quality objectives for turbidity, CCAMP lists a level of concern at 10 NTU for protection of aquatic life. Measurements were collected at various times during daylight hours, and were not necessarily measured at a consistent time of day. A few outlier readings were removed from analysis as they were collected during storm events and were deemed not representative of ambient conditions. The removed values are listed below the figure.



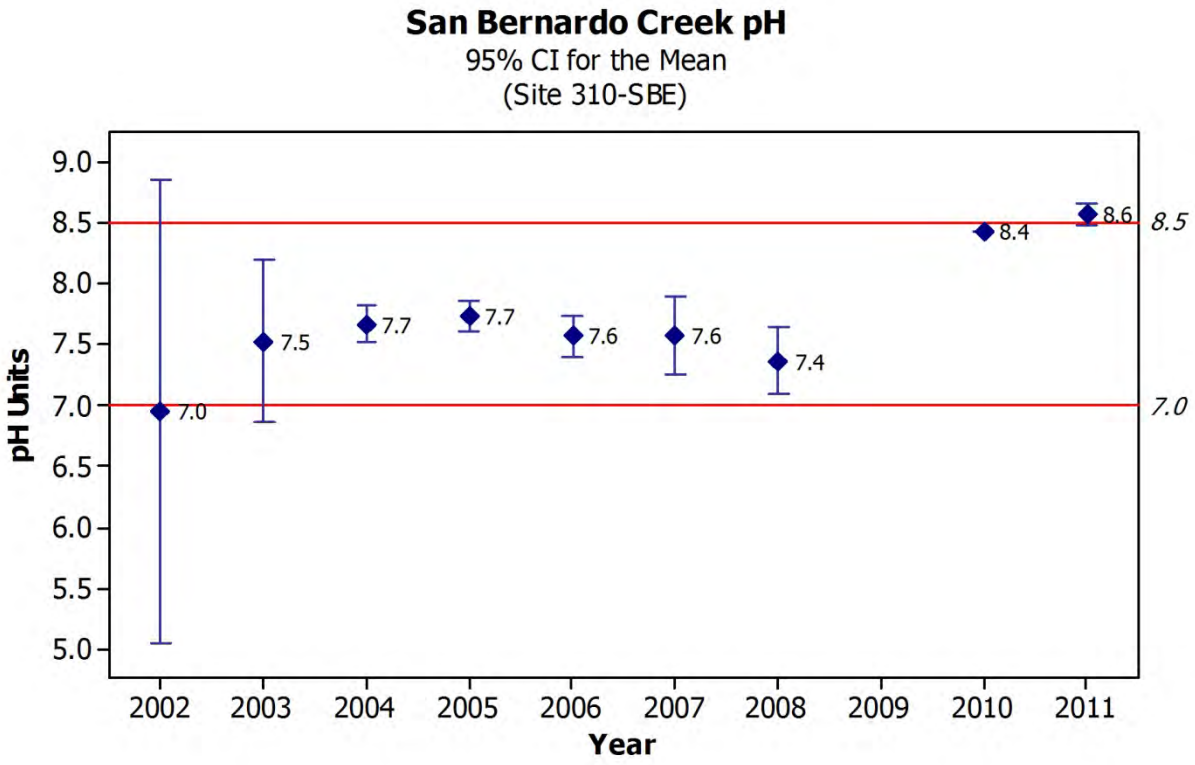
**Removed turbidity values collected on 3/17/2006 (148 NTU) and 3/3/2010 (49.50 NTU).*
Removed turbidity value collected on 12/29/2010 (504 NTU). Elevated turbidity values are likely due to a storm event.

pH

Since July 2010, program volunteers measured pH during each water quality field visit using a pH probe. The meter has a range of -1.0 to 15.0 pH units, with a resolution of 0.1 pH units. Prior to July 2010, pH paper was used for the measurement. The paper has a range of 4.5 to 10.0 with a resolution of 0.5 pH units. pH paper measurements are collected along with the probe measurement in the hopes that a correlation can be determined between the two values. Following quality control comparisons of the probe and paper data with lab analysis, the pH probes appear to be very accurate, whereas the pH paper was consistently underestimating the pH.

For this summary report, data generated with pH paper was reported from 2002 through 2009. For 2010, only data collected with a pH probe was included (July to December 2010). For 2011, only data collected with a pH probe was included. Thus, pH data from January to June 2010, which was collected with pH paper, have been excluded from this summary.

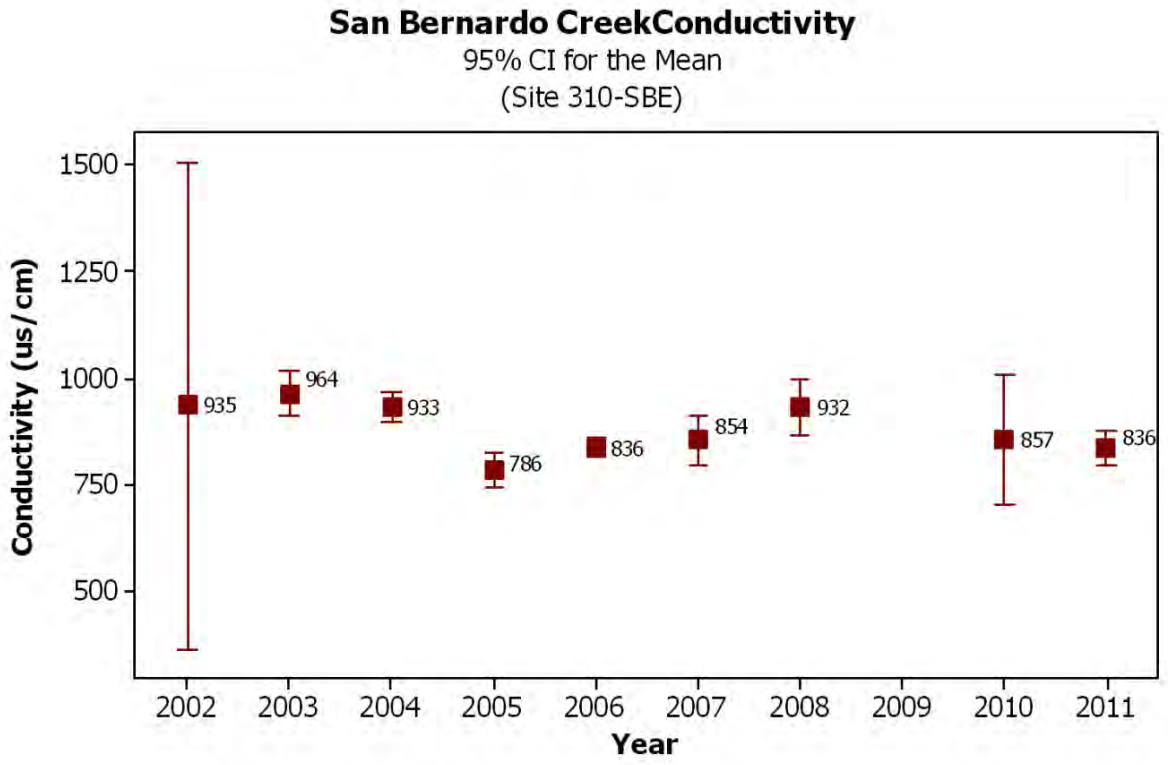
Per the Central Coast Basin Plan, pH concentrations must remain between 6.5 and 8.3 to be protective of the recreational contact beneficial use (REC-1). For protection of aquatic life, the Basin Plan standard is between 7.0 and 8.5 (COLD, WARM).



Note: For this summary report, data collected using pH paper was reported from 2002 through 2009. Data collected from July 2010 and after was with a pH probe. pH data collected from January to June 2010 with pH paper was not included in this analysis.

CONDUCTIVITY

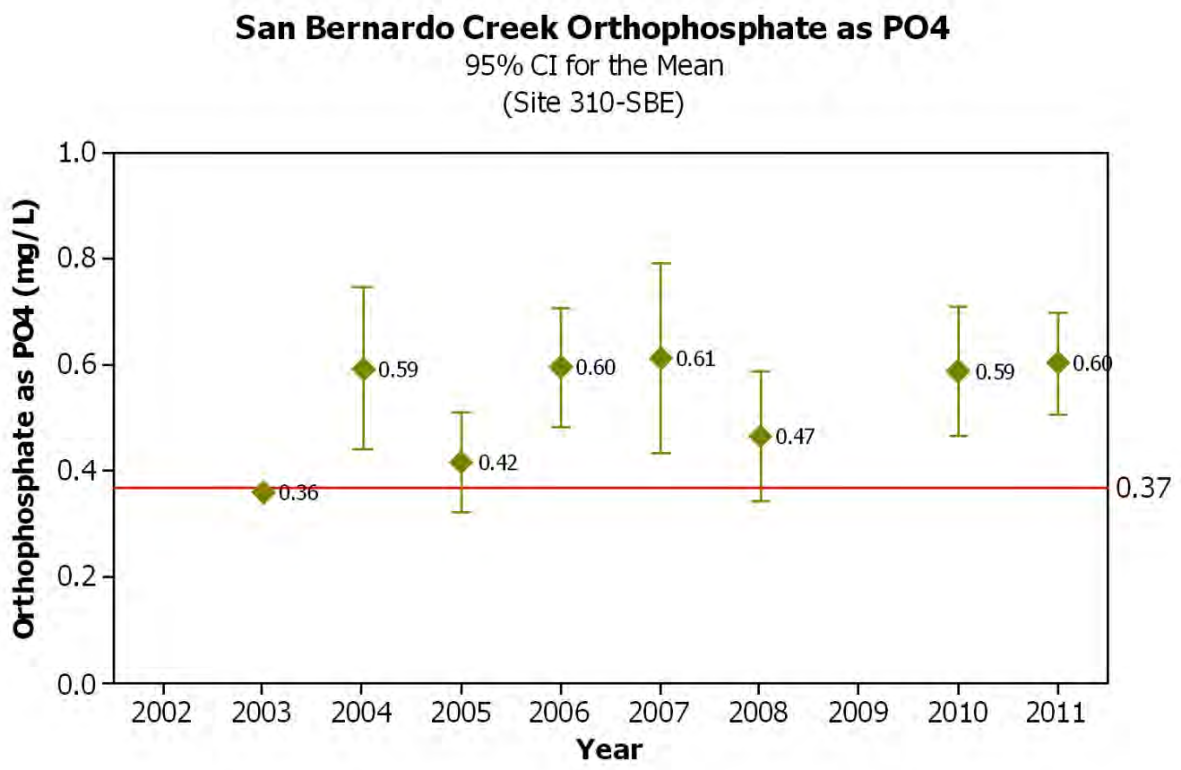
Program volunteers measured temperature-corrected conductivity during each water quality field visit using a YSI 85 meter with nickel electrodes. The meter has a range of 0 to 200,000 uS/cm with a resolution of 0.1 uS/cm. Prior to 2007, data was collected with an Oakton ECTestr which had a range of 0 to 1,990 uS/cm and a resolution of 10 uS/cm. The Central Coast Basin Plan includes a conductivity objective of 3,000 uS/cm to protect the Agriculture beneficial use. Elevated conductivity levels, as a measure of dissolved solids, can be indicative of pollution such as agricultural or road drainage runoff.



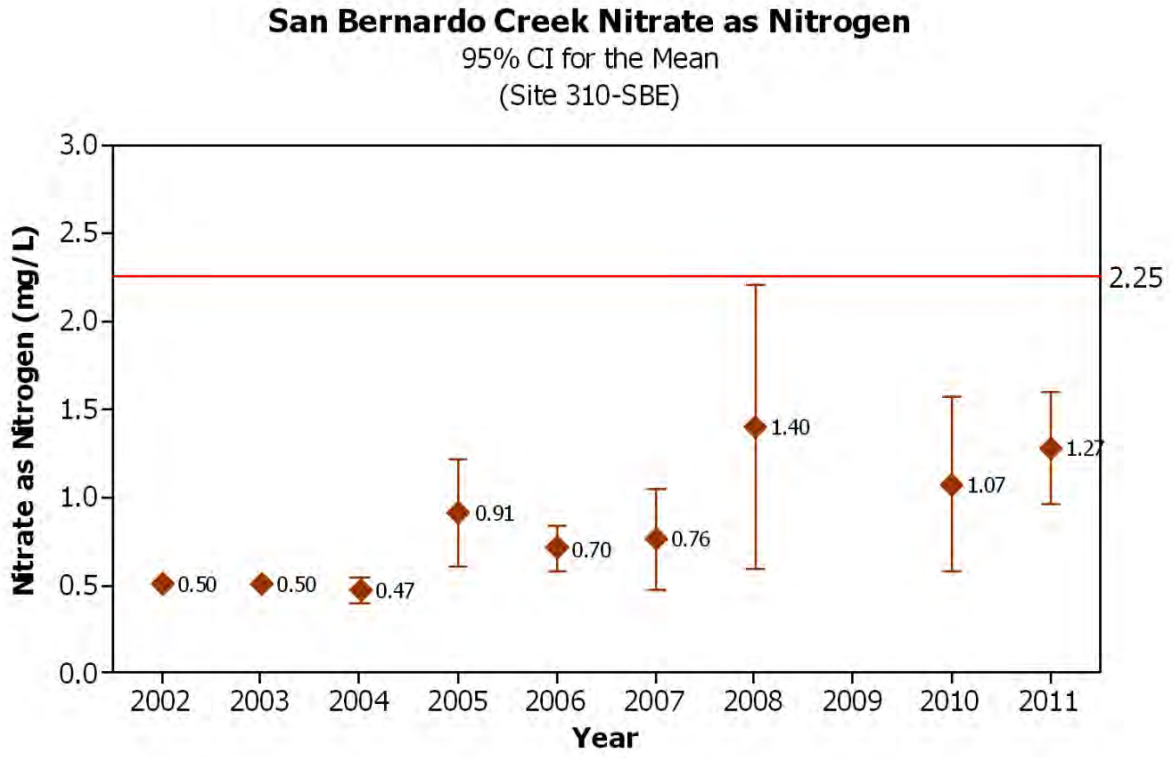
NUTRIENTS

Program volunteers measured orthophosphates as PO_4^{3-} and nitrates as nitrogen during each water quality field visit. Samples were collected by trained volunteers, and analysis was conducted at the MBNEP office using chemical test kits.

The methodology for orthophosphates as PO_4^{3-} analysis has changed over the years in an effort to improve the quality of the data. Volunteer-generated data prior to April 2004 was discarded due to the determined inaccuracy of the test kit. Any data included in the report prior to April 2004 was obtained from an analytical laboratory. From early 2004 through mid-2005, a Hanna meter and Hanna reagent was used. From mid-2006 through mid-2007, a YSI 9000 meter with YSI reagent was used. Starting in mid-2007 to the present, the analysis method uses a Hanna Low Range Phosphate colorimeter (HI 93713) with HACH PhosVer 3 Phosphate Reagent, which utilizes an ascorbic acid reaction. The meter has a range from 0.00 to 2.50 mg/L with a resolution of 0.01 mg/L. Out-of-range samples were analyzed by diluting the sample with deionized water and multiplying the result by the dilution factor. This is a simple colorimeter which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab-generated data. The CCAMP informal attention level is 0.37 mg/L as PO_4^{3-}, a value created specifically for the Pajaro River but adapted for the Morro Bay watershed.



Nitrates as nitrogen was monitored with a LaMotte test kit 3354 which uses a zinc reduction reaction. The method utilizes a color change reaction and compares the reacted sample to a color chart with gradations at 0, 1, 2, 4, 6, 8, 10 and 15 mg/L. For this method, readings between 0 and 1 are considered to be non-detects and are reported as 0.5 mg/L for the purpose of analysis. This is a simple test kit which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab generated data. The CCAMP informal attention level for nitrates as nitrogen is 2.25 mg/L to be protective of aquatic life.



ALGAE DOCUMENTING

Beginning in 2011, algae data was collected using the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, 2010. The protocol involves point intercept measurements that determine the presence or absence of macroalgae, as well as qualitative measurement of filamentous algae coverage throughout the reach. The complete SWAMP for collecting stream algae samples, including sample collection and lab analysis, was not conducted in 2011 due to limited financial and staff resources.

The CCRWQCB utilizes algae abundance data in assessing 303(d) listings and de-listings, as well as tracking TMDL implementation. The presence and density of algal blooms can be considered supporting evidence when determining whether to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Algae data was analyzed through two data sets generated by 2011 assessments at each site. The percent coverage of macroalgae at the site was determined by calculating algae presence at wetted points located on the transects and inter-transects. This calculated value is used to represent percent algal coverage throughout the 150 m reach. MSB scored 43% algal coverage, the third highest score of the ten sites monitored in 2011.

Additionally, the qualitative spatial coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) and assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1 indicating < 10% coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. With this metric, MSB scored 30%.

BACTERIA

Program volunteers monitored total coliform and *E. coli* bacterial indicators. Monthly samples were collected by volunteers in the field and then analyzed with the IDEXX method using Colilert-18 reagent. Analysis took place at the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory. Bacteria monitoring was not timed to coincide with monthly or bi-weekly water quality monitoring at these sites.

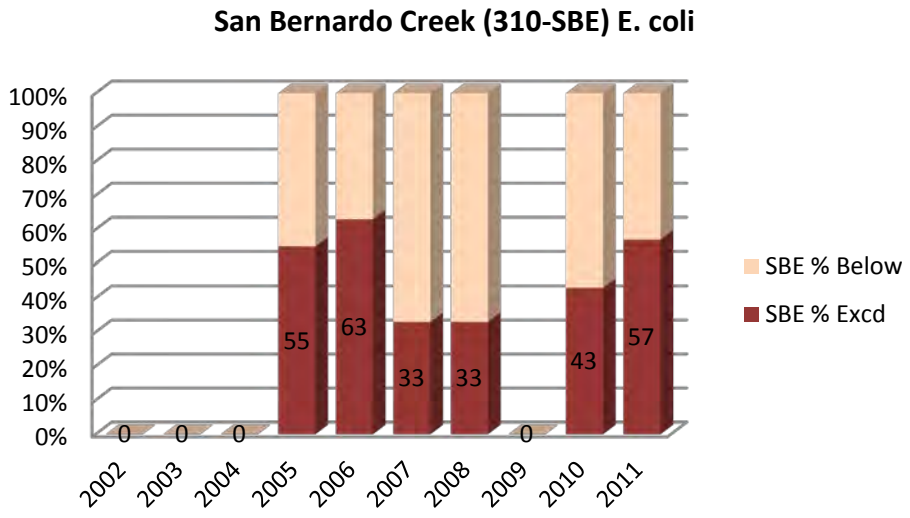
Based on typical sample dilutions, the range of detection for the test is from < 1 MPN/100 mL to 24,196 MPN/100 mL. The regulatory criteria for comparison are the recommended standards in EPA's 1986 guidance document *Ambient Water Quality Criteria for Bacteria*. For *E. coli* for a single grab sample, the water is considered to have an acceptable risk for swimming (REC-1 contact) if the concentration is below 235 MPN/100 mL. The analysis in this report is focused on *E. coli* rather than total coliform because *E. coli* is an indicator of the presence of fecal contamination from warm-blooded animals. Total coliform is a broader indicator of bacterial contamination and could be caused by plant matter, soil and other sources.

The following table contains the number of bacteria samples collected each year and the number of samples that exceeded the criteria.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011†
SBE n	0	5	5	11	11	6	6	2	7	7
SBE % Excd	*	*	*	55	63	33	33	*	43	57

**The sample size n < 6 was deemed too small for inclusion in the analysis.*
†2011 values include January to May 2011.

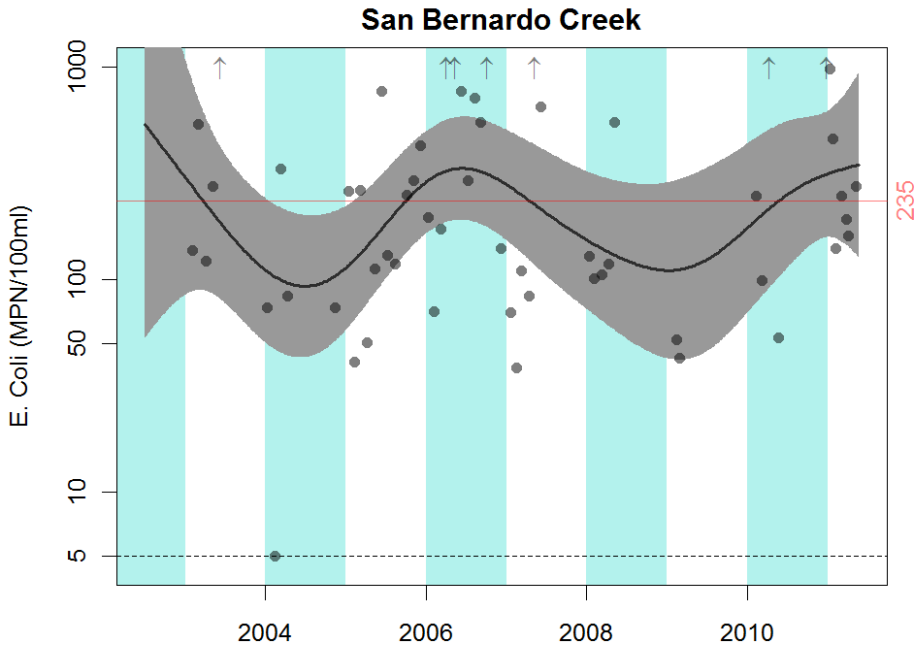
The following graphs depict the % of samples that exceeded the 235 MPN/100 mL recreational contact standard for *E. coli* each year. The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the small scale fluctuations. The black line on the plot shows the geomean of the *E. coli* concentration over

time using smoothing splines. Regardless of the sample size for a given year, all data was included in this analysis. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data, or less data available for analysis. The higher the variability in the data, the wider the error band. Where more data was available for analysis, the error band is narrower. Minimal data was available in 2008 and 2009 due to lower than normal rainfalls, resulting in a wider error band.



FLOW VOLUME

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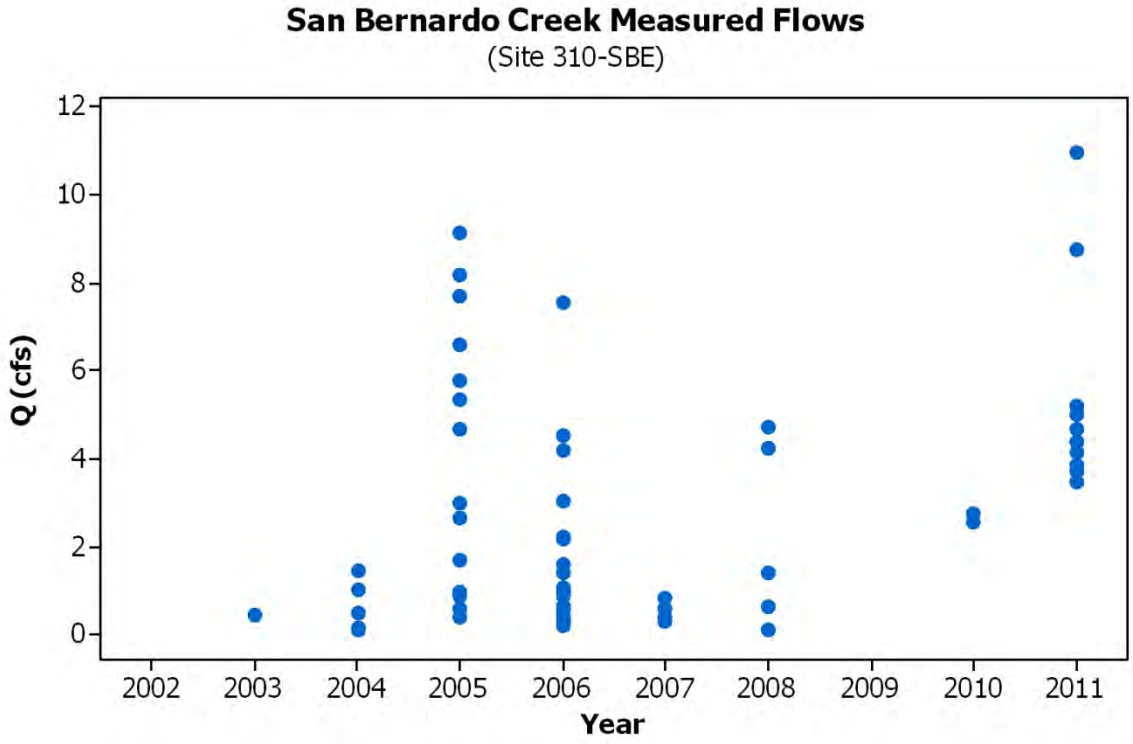
The following graph shows flow measurements obtained from the creek during low or base flow conditions. The graph provides an overview of the range and frequency of flow measurements.



MACROINVERTEBRATES

The highly variable hydrology of San Bernardo Creek proved challenging for macroinvertebrate monitoring. The downstream site (SBE) has limited above ground flows, and often did not run above ground at all during light winters. Prior to 2008, the monitoring program did not have any additional access to the creek. In 2008, landowners on both sides of the creek allowed macroinvertebrate monitoring to take place at site MSB, a location upstream of SBE. Although the reach near MSB is also intermittent, the longer hydroperiod allowed sufficient time to conduct bioassessment monitoring.

The data collected utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was finalized in spring 2007. The VMP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as calculated metrics.

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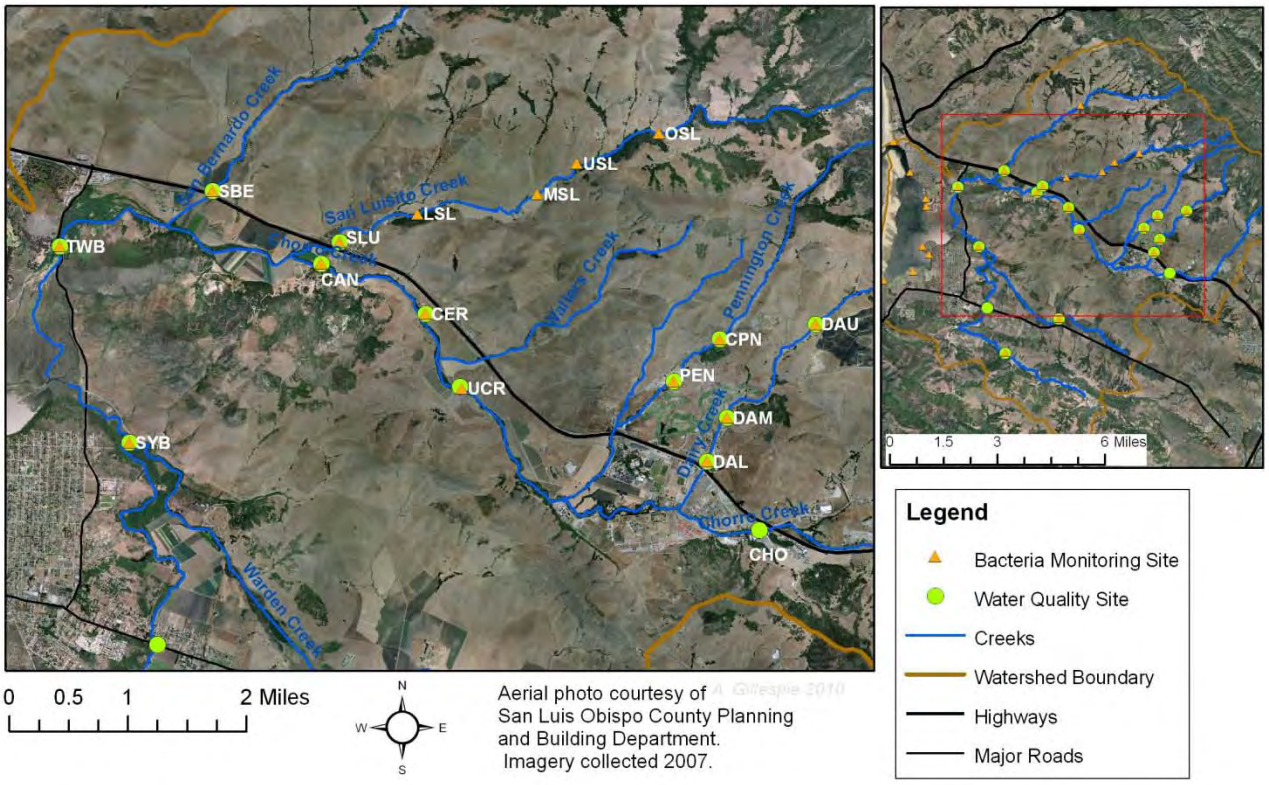
Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer + collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, coleoptera richness, predator richness, percent intolerant individuals and EPT richness. For the IBI scores, scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good. The metrics are displayed below.

Middle San Bernardo Creek (MSB)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	*	*	*	*
2006	*	*	*	*
2007	*	*	*	*
2008	64	20	50.4	75.8
2009	*	*	*	*
2010	42	14	61.8	67.2
2011	52	17	37.6	62.9

CHORRO CREEK

SITE MAP AND DESCRIPTIONS



The Chorro Creek watershed encompasses an area of approximately 43 square miles and includes the tributaries Dairy Creek, Pennington Creek, Walters Creek, San Luisito Creek and San Bernardo Creek.

The watershed is predominately utilized as beef cattle rangeland with a small amount of acreage allocated to row crops and rural residences. The San Luis Obispo County Operations Center, California Men's Colony and Cuesta College are all located within close proximity to Chorro Creek. Publicly-owned property includes the California Army National Guard Camp San Luis Obispo, the Chorro Creek Ecological Reserve, and rangeland owned by Cal Poly.

The VMP has five regular monitoring sites on the mainstem of Chorro Creek. The most upstream site (CHO) is located on Camp San Luis Obispo property near the Highway 1 overpass. The California Department of Corrections Wastewater treatment plant discharges tertiary treated effluent to Chorro Creek downstream of the CHO monitoring site. The UCR site was established in 2007 with cooperation from Cal Poly. This site is located downstream of the wastewater plant and the confluences of Dairy and Pennington Creeks. Site CER was established in 2003 at the main creek crossing on the Chorro Creek Ecological Reserve. This site differs hydologically from UCR in that it includes the confluence of Walters Creek. Site CAN was established in the early 1990's as part of the National Monitoring Program (NMP), and data collection has been continued by the VMP following the conclusion of the NMP in 2001. This site has also been the focus of suspended sediment monitoring efforts and is an instrumented gauging station. The most downstream site, TWB was also established in the early 1990's as part of the NMP and is a CCAMP Coastal Confluences site. This site has been monitored consistently either monthly or twice monthly since 2002.

A detailed discussion of bacteria, nutrient and macroinvertebrate data on Chorro Creek are provided in the IEP chapter. The table below indicates the frequency of water quality monitoring at Chorro Creek sites throughout the monitoring period.

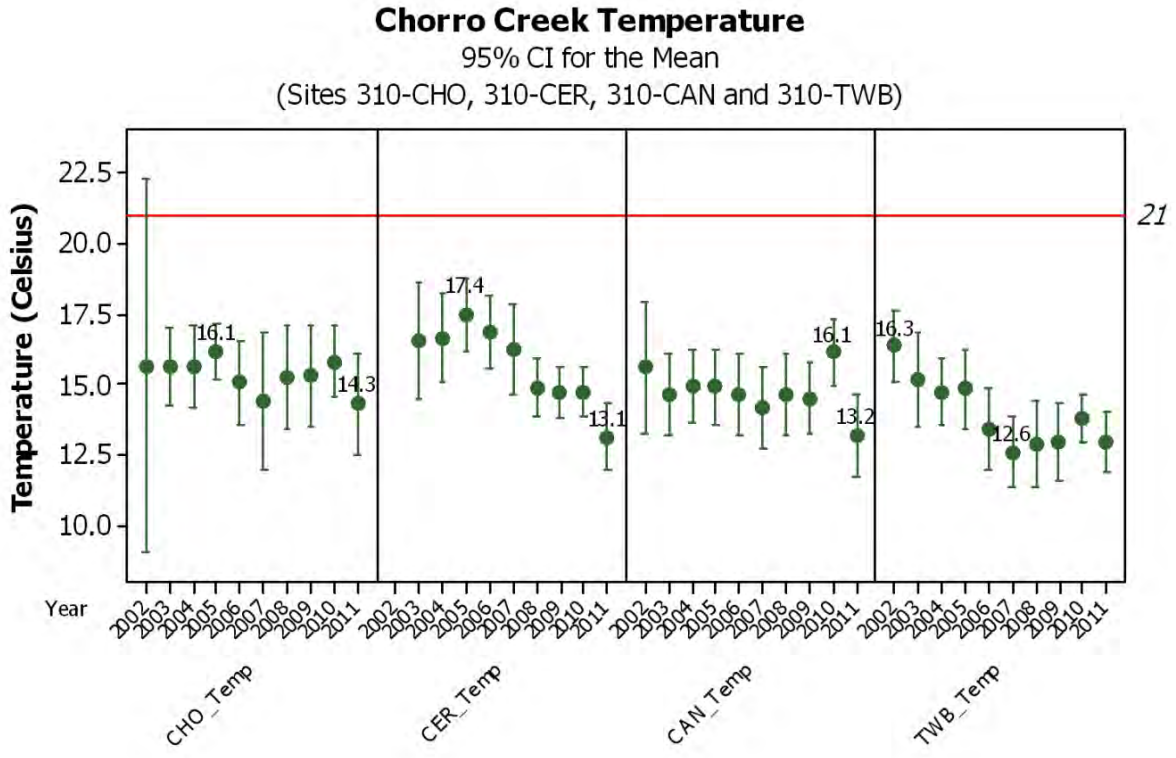
WATER QUALITY N VALUE SUMMARY

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011†	Sum
CHO	3	12	13	18	16	12	11	11	15	6	**117**
UCR	*	*	*	*	*	9	17	20	17	8	**71**
CER	0	7	14	17	20	17	17	28	26	10	**156**
CAN	8	12	12	16	18	20	13	18	21	9	**147**
TWB	7	12	16	16	17	15	13	18	24	10	**148**
Sum	**18**	**43**	**55**	**67**	**71**	**73**	**71**	**95**	**103**	**43**	

†2011 values include January to May 2011.
** No data available*

TEMPERATURE

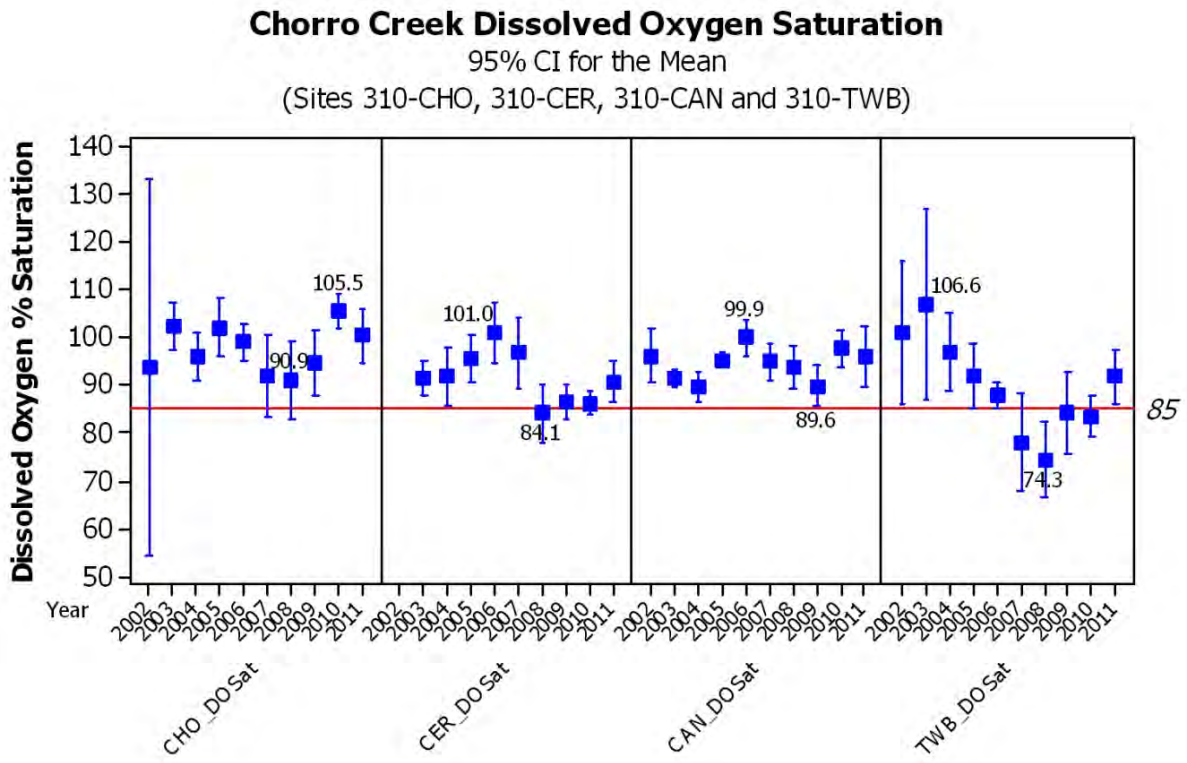
Water temperature is measured as part of the water quality monitoring effort, which can take place at any time during daylight hours, and is not necessarily measured at a consistent time of day. Water quality monitoring may take place once or twice monthly, depending on volunteer availability and site hydrology. Data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to collect water temperature. The meter has a range of -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with Model 85 units. The plot shows the mean temperature for each year, with the results grouped by site. The interval bars indicate the 95% confidence interval (CI) for the mean, which is the range within which 95% of the data can be expected to fall. The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line.



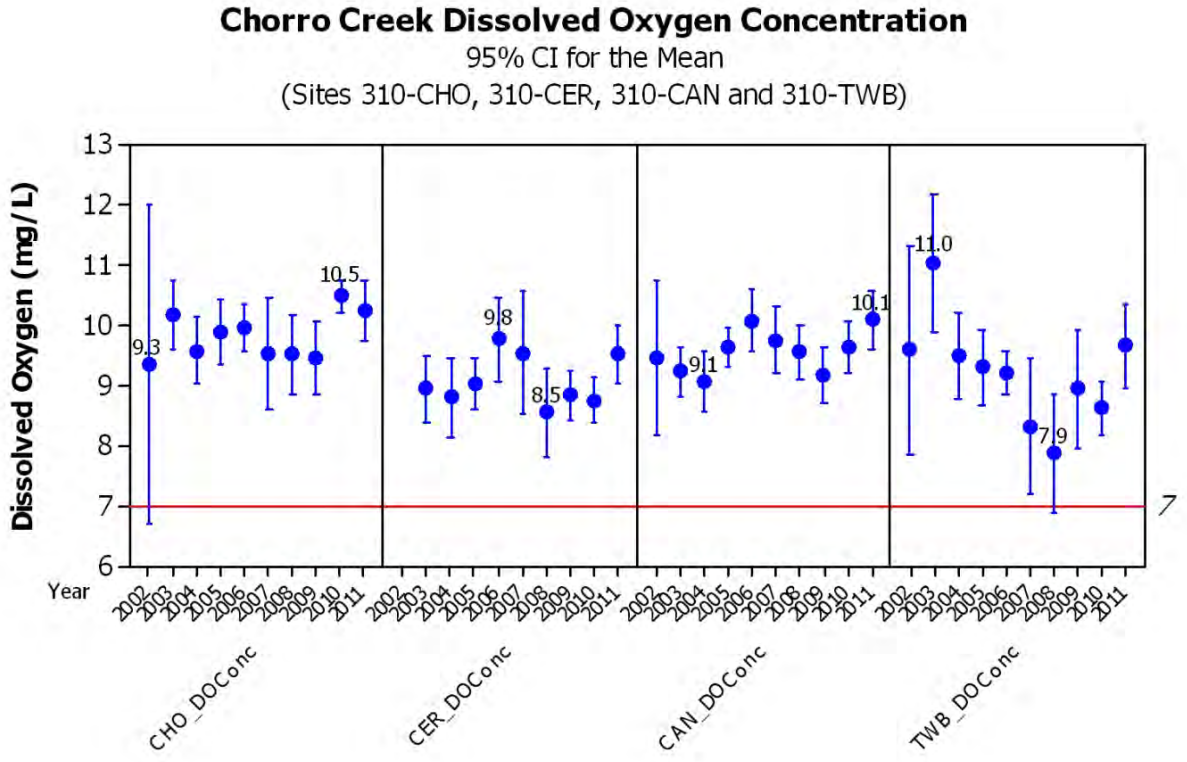
DISSOLVED OXYGEN

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation and a resolution of 0.1%. For DO concentration, the meter range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter. Measurements were collected at various times during daylight hours, and were not necessarily measured at a consistent time of day.

The graph below displays the mean and 95% confidence interval of DO percent saturation for the sites on Chorro Creek, grouped by year. The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.

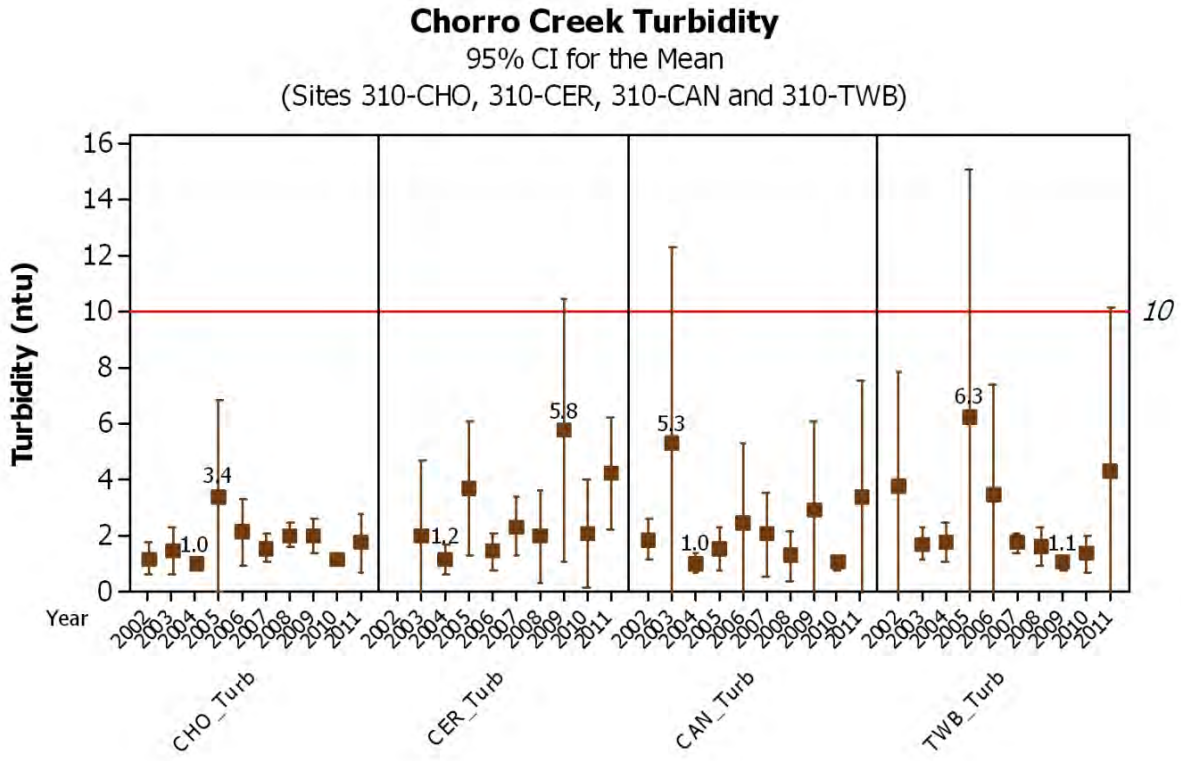


Dissolved oxygen measurements were also made as a concentration in mg/L. The following graph shows the mean and 95% CI for the dissolved oxygen concentration data. The Central Coast Basin Plan set a regulatory standard that states that at no time shall DO concentrations fall below 7.0 mg/L.



TURBIDITY AND SUSPENDED SEDIMENT

Program volunteers measured turbidity during each water quality field visit. Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU. Although the Basin Plan contains no water quality objectives for turbidity, CCAMP lists a level of concern at 10 NTU for protection of aquatic life. Measurements were collected at various times during daylight hours and were not necessarily measured at a consistent time of day. A few outlier readings were removed from analysis as they were collected during storm events and were deemed not representative of ambient conditions. The removed values are listed below the figure.



**Removed TWB turbidity value collected on 2/18/2005, 320 NTU. 1.87" of rainfall in week prior.*
**Removed CER turbidity value collected on 12/2/2005, 121 NTU. 0.5" of rainfall in preceding 24 hours.*
**Removed CAN turbidity value collected on 3/21/11, 91.5 NTU. 5.2" of rainfall in week prior.*

Beginning in 2007, program staff began data collection on SSC and turbidity at CAN during the winter months. Samples were collected at 30 or 60-minute intervals during winter storm events via ISCO 6712 automated samplers. Samples were then analyzed at the VMP's lab facility at Cuesta College for nephelometric turbidity and SSC. This effort was part of a larger effort to track sediment loads in the Chorro watershed. Further details on the suspended sediment monitoring effort are available in a separate report.

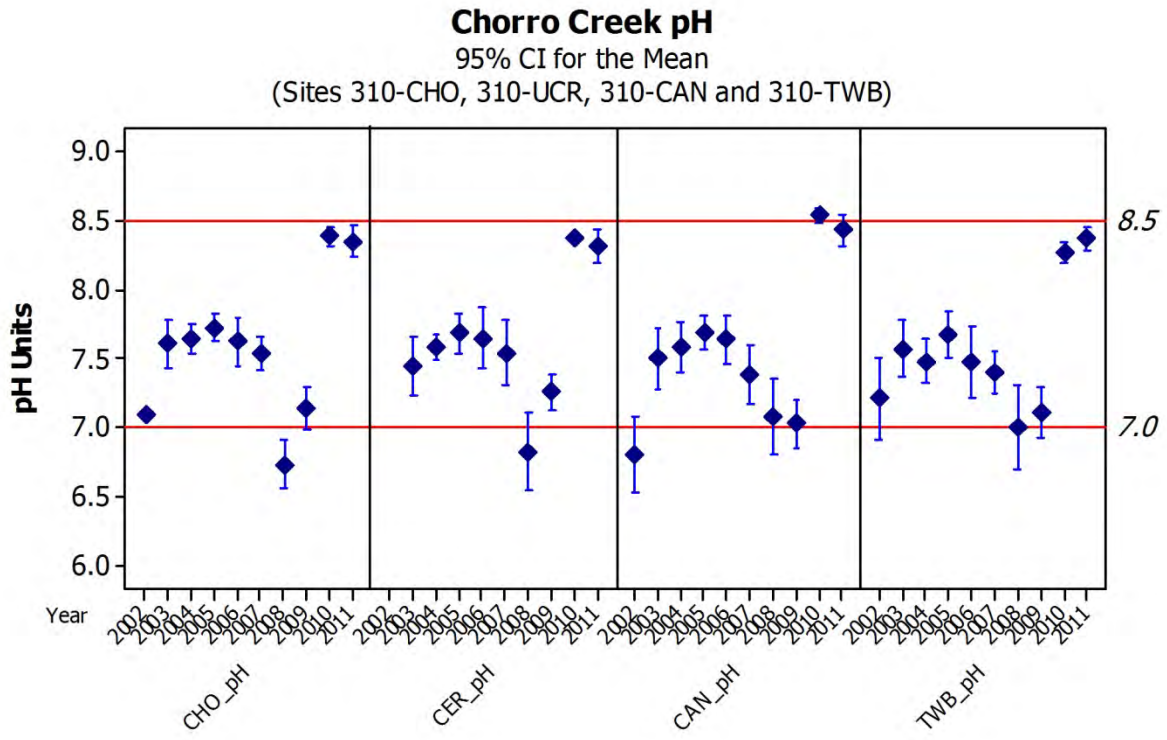
PH

Since July 2010, program volunteers measured pH during each water quality field visit using a pH probe. The meter has a range of -1.0 to 15.0 pH units, with a resolution of 0.1 pH units. Prior to July 2010, pH paper was used for the measurement. The paper has a range of 4.5 to 10.0 with a resolution of 0.5 pH units. pH paper measurements are collected along with the probe measurement in the hopes

that a correlation can be determined between the two values. Following quality control comparisons of the probe and paper data with lab analysis, the pH probes appear to be very accurate, whereas the pH paper was consistently underestimating the pH.

For this summary report, data generated with pH paper was reported from 2002 through 2009. For 2010, only data collected with a pH probe was included (July to December 2010). For 2011, only data collected with a pH probe was included. Thus, pH data from January to June 2010, which was collected with pH paper, have been excluded from this summary.

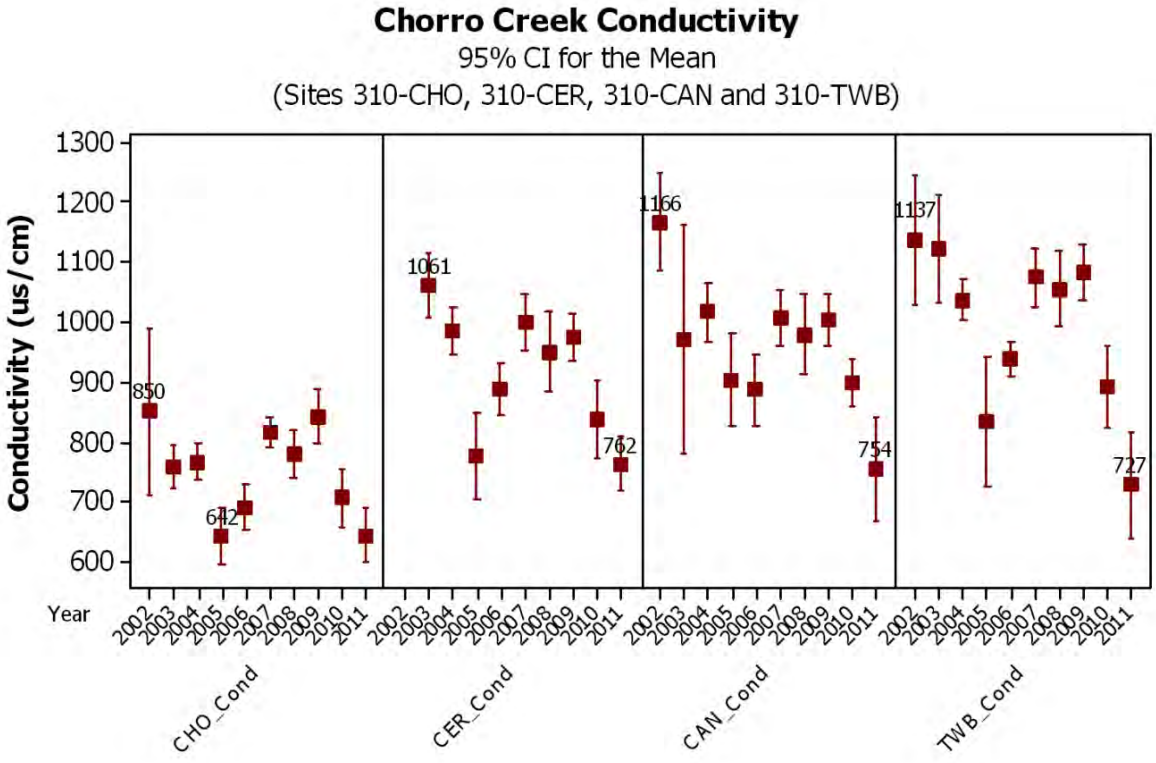
Per the Central Coast Basin Plan, pH concentrations must remain between 6.5 and 8.3 to be protective of the recreational contact beneficial use (REC-1). For protection of aquatic life, the Basin Plan standard is between 7.0 and 8.5 (COLD, WARM).



Note: For this summary report, data collected using pH paper was reported from 2002 through 2009. Data collected from July 2010 and after was with a pH probe. pH data collected from January to June 2010 with pH paper was not included in this analysis.

CONDUCTIVITY

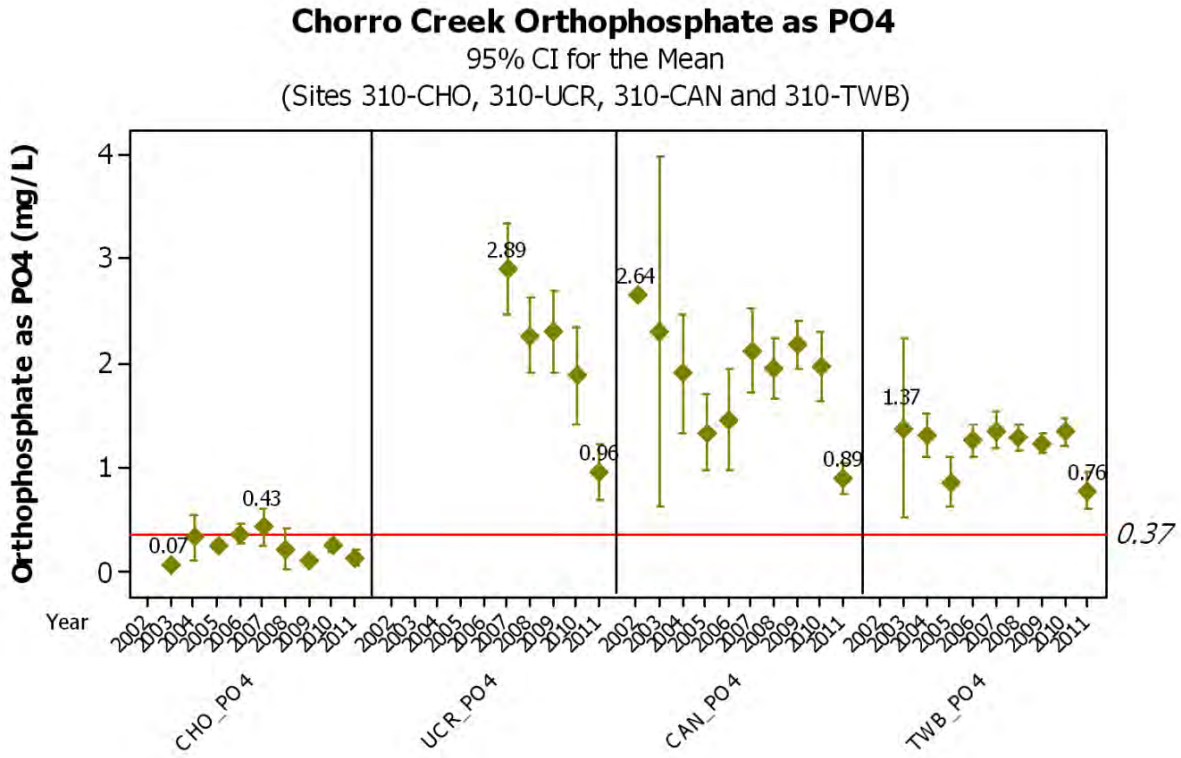
Program volunteers measured temperature-corrected conductivity during each water quality field visit using a YSI 85 meter with nickel electrodes. The meter has a range of 0 to 200,000 uS/cm with a resolution of 0.1 uS/cm. Prior to 2007, data was collected with an Oakton ECTestr which had a range of 0 to 1,990 uS/cm and a resolution of 10 uS/cm. The Central Coast Basin Plan includes a conductivity objective of 3,000 uS/cm to protect the Agriculture beneficial use. Elevated conductivity levels, as a measure of dissolved solids, can be indicative of pollution such as agricultural or road drainage runoff.



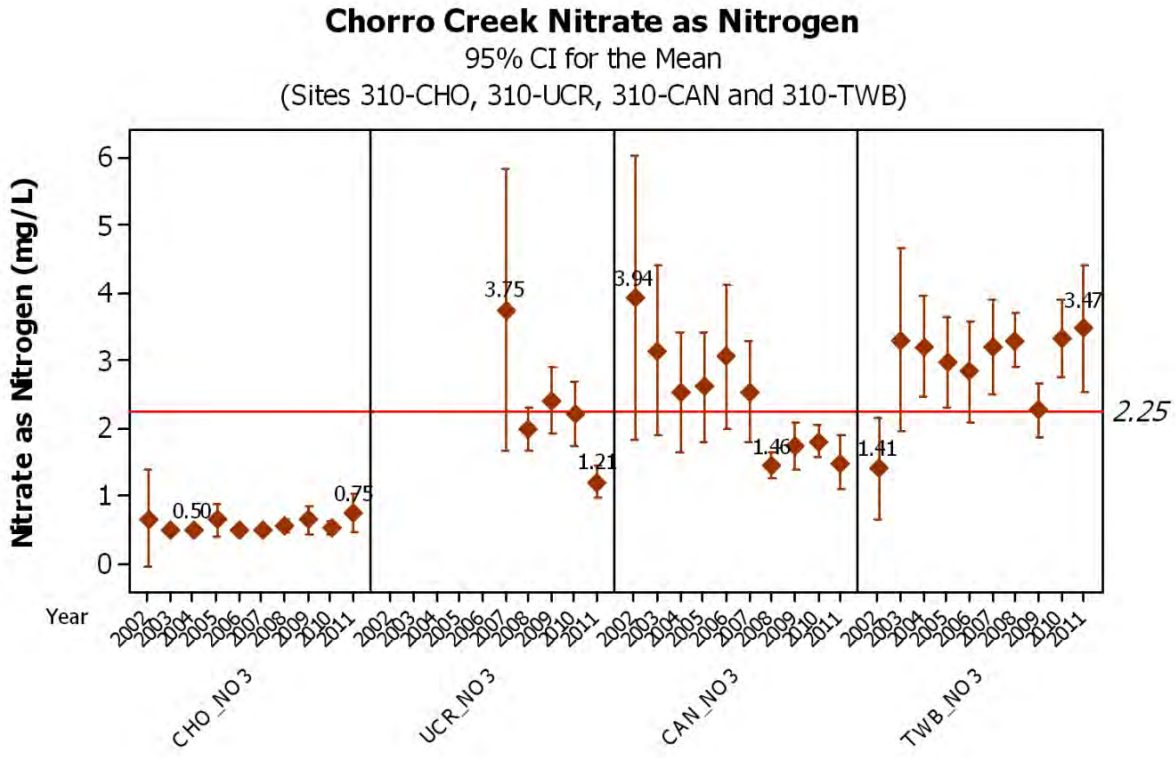
NUTRIENTS

Program volunteers measured orthophosphates as PO_4^{3-} and nitrates as nitrogen during each water quality field visit. Samples were collected by trained volunteers, and analysis was conducted at the MBNEP office using chemical test kits.

The methodology for orthophosphates as PO_4^{3-} analysis has changed over the years in an effort to improve the quality of the data. Volunteer-generated data prior to April 2004 was discarded due to the determined inaccuracy of the test kit. Any data included in the report prior to April 2004 was obtained from an analytical laboratory. From early 2004 through mid-2005, a Hanna meter and Hanna reagent was used. From mid-2006 through mid-2007, a YSI 9000 meter with YSI reagent was used. Starting in mid-2007 to the present, the analysis method uses a Hanna Low Range Phosphate colorimeter (HI 93713) with HACH PhosVer 3 Phosphate Reagent, which utilizes an ascorbic acid reaction. The meter has a range from 0.00 to 2.50 mg/L with a resolution of 0.01 mg/L. Out-of-range samples were analyzed by diluting the sample with deionized water and multiplying the result by the dilution factor. This is a simple colorimeter which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab-generated data. The CCAMP informal attention level is 0.37 mg/L as PO_4^{3-}, a value created specifically for the Pajaro River but adapted for the Morro Bay watershed.



Nitrates as nitrogen was monitored with a LaMotte test kit 3354 which uses a zinc reduction reaction. The method utilizes a color change reaction and compares the reacted sample to a color chart with gradations at 0, 1, 2, 4, 6, 8, 10 and 15 mg/L. For this method, readings between 0 and 1 are considered to be non-detects and are reported as 0.50 mg/L for the purpose of analysis. This is a simple test kit which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab generated data. The CCAMP informal attention level for nitrates as nitrogen is 2.25 mg/L to be protective of aquatic life.



ALGAE DOCUMENTING

Beginning in 2011, algae data was collected using the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, 2010. The protocol involves point intercept measurements that determine the presence or absence of macroalgae, as well as qualitative measurement of filamentous algae coverage throughout the reach. The complete SWAMP protocol for collecting stream algae samples, including sample collection and lab analysis, was not conducted in 2011 due to limited financial and staff resources.

The CCRWQCB utilizes algae abundance data in assessing 303(d) listings and de-listings, as well as tracking TMDL implementation. The presence and density of algal blooms can be considered supporting evidence when determining whether to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Algae data was analyzed through two data sets generated by 2011 assessments at each site. The percent coverage of macroalgae at the site was determined by calculating algae presence at wetted points located on the transects and inter-transects. This calculated value is used to represent percent algal coverage throughout the 150 m reach. The monitoring sites on Chorro Creek were located at CHD, which is below Chorro Dam on Camp San Luis Obispo property behind the California Men's Colony, and CER which is located on the Chorro Creek Ecological Reserve. CHD had a percent algal coverage of 56%, the second highest score of the ten sites monitored in 2011, and CER had a percent coverage of 20%.

Additionally, the qualitative spatial coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) was assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1

indicating < 10% coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. With this metric, CHD scored 60% and CER scored 20%.

BACTERIA

Program volunteers monitored total coliform and *E. coli* bacterial indicators. Monthly samples were collected by volunteers in the field and then analyzed with the IDEXX method using Colilert-18 reagent. Analysis took place at the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory. Bacteria monitoring was not timed to coincide with monthly or bi-weekly water quality monitoring at these sites.

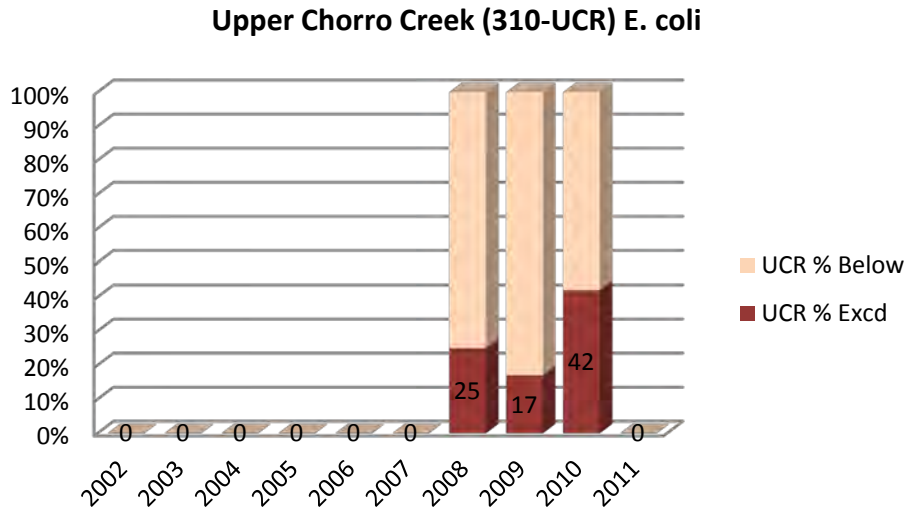
Based on typical sample dilutions, the range of detection for the test is from < 1 MPN/100 mL to 24,196 MPN/100 mL. The regulatory criteria for comparison are the recommended standards in EPA's 1986 guidance document *Ambient Water Quality Criteria for Bacteria*. For *E. coli* for a single grab sample, the water is considered to have an acceptable risk for swimming (REC-1 contact) if the concentration is below 235 MPN/100 mL. The analysis in this report is focused on *E. coli* rather than total coliform because *E. coli* is an indicator of the presence of fecal contamination from warm-blooded animals. Total coliform is a broader indicator of bacterial contamination and could be caused by plant matter, soil and other sources.

The following table contains the number of bacteria samples collected each year at Chorro Creek sites and the percent of those samples that exceeded the regulatory standard protective of recreational contact (*E. coli* concentration of 235 MPN/100 mL). A detailed discussion of bacteria data from Chorro Creek sites is provided in the IEP chapter.

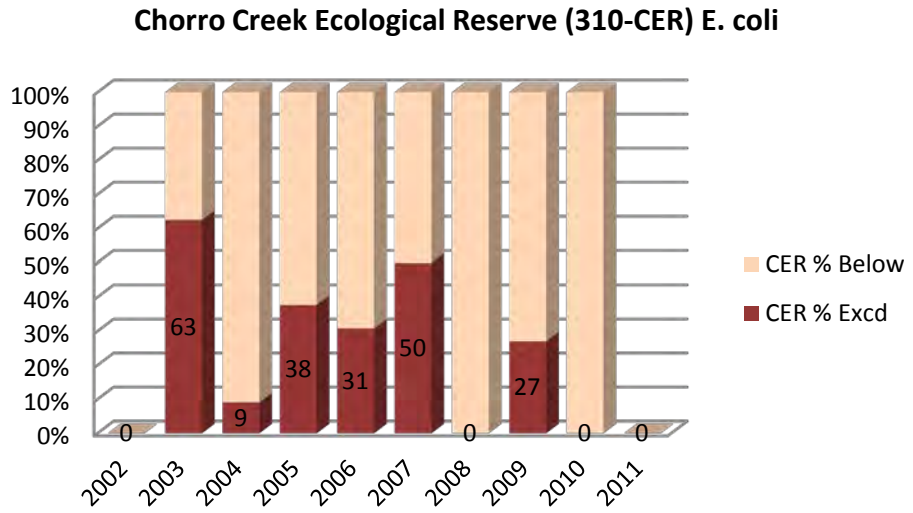
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011†
UCR	*	*	*	*	*	4	12	12	12	5
UCR % Excd	*	*	*	*	*	*	25	17	42	*
CER n	0	8	11	11	13	14	13	11	12	4
CER % Excd	*	63	9	38	31	50	0	27	0	*
CAN n	5	12	12	13	12	17	12	23	22	8
CAN % Excd	*	8	42	31	25	6	17	22	23	0
TWB n	0	0	0	6	11	13	12	19	22	8
TWB % Excd	*	*	*	0	18	15	8	5	23	13

**The sample size n < 6 was deemed too small for inclusion in the analysis.*
†2011 values include January to May 2011.

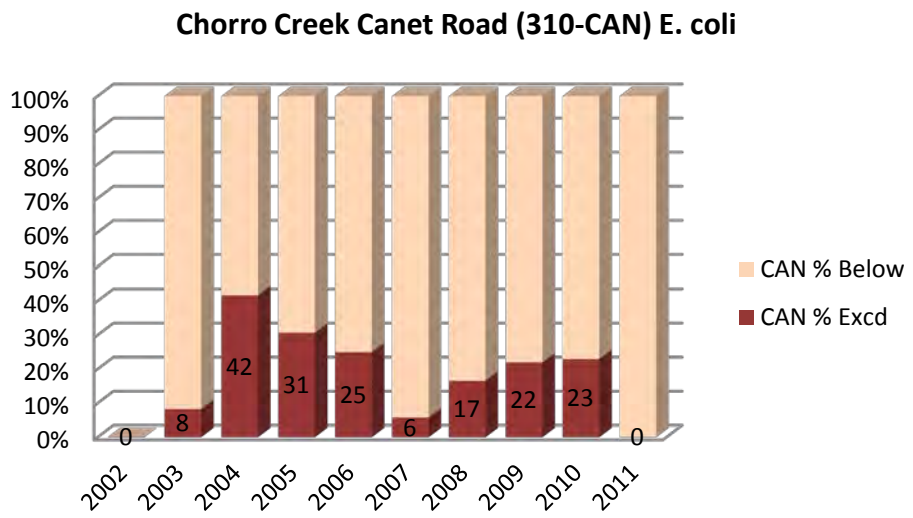
The following graphs depict the % of samples that exceeded the 235 MPN/100 mL recreational contact standard for *E. coli* each year. The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



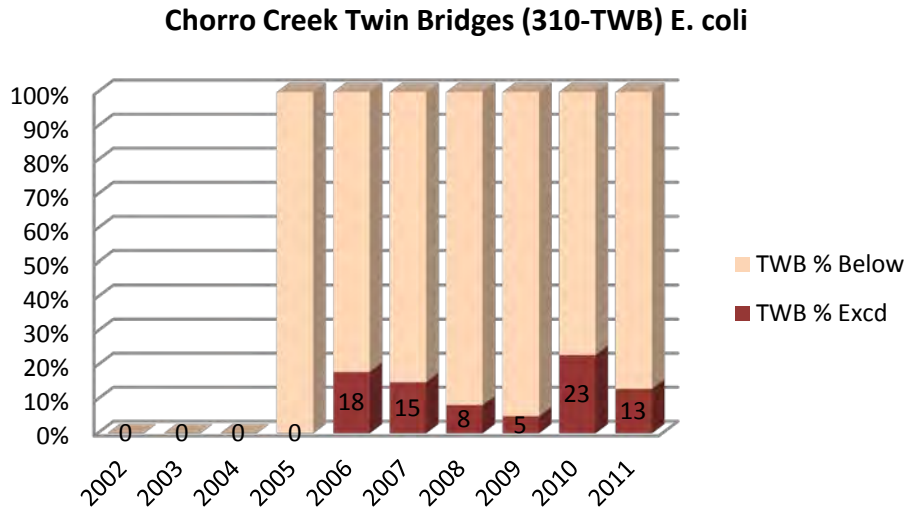
Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

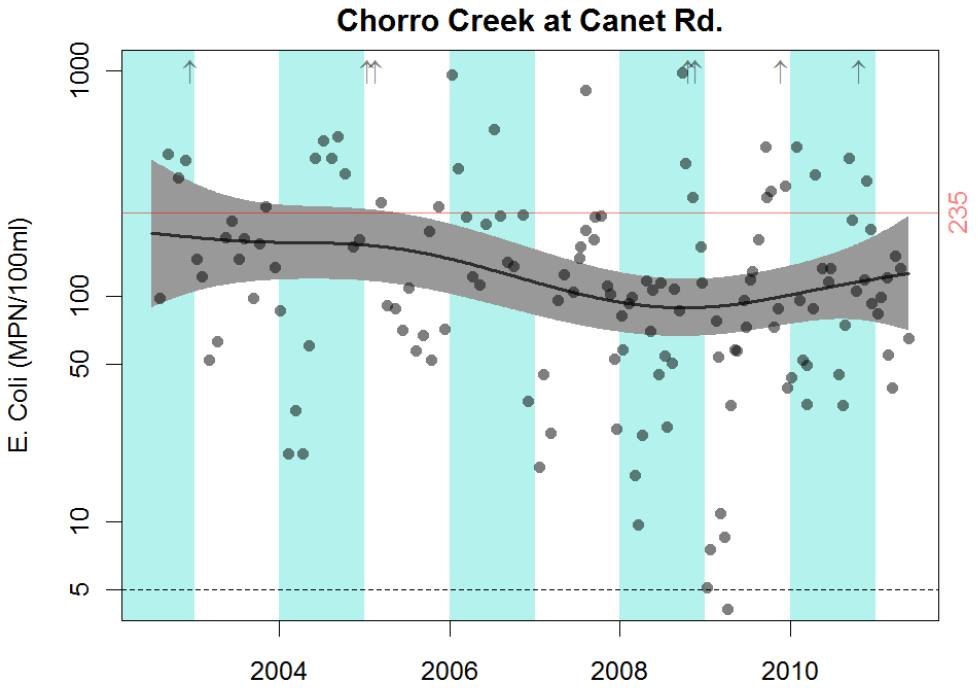


Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

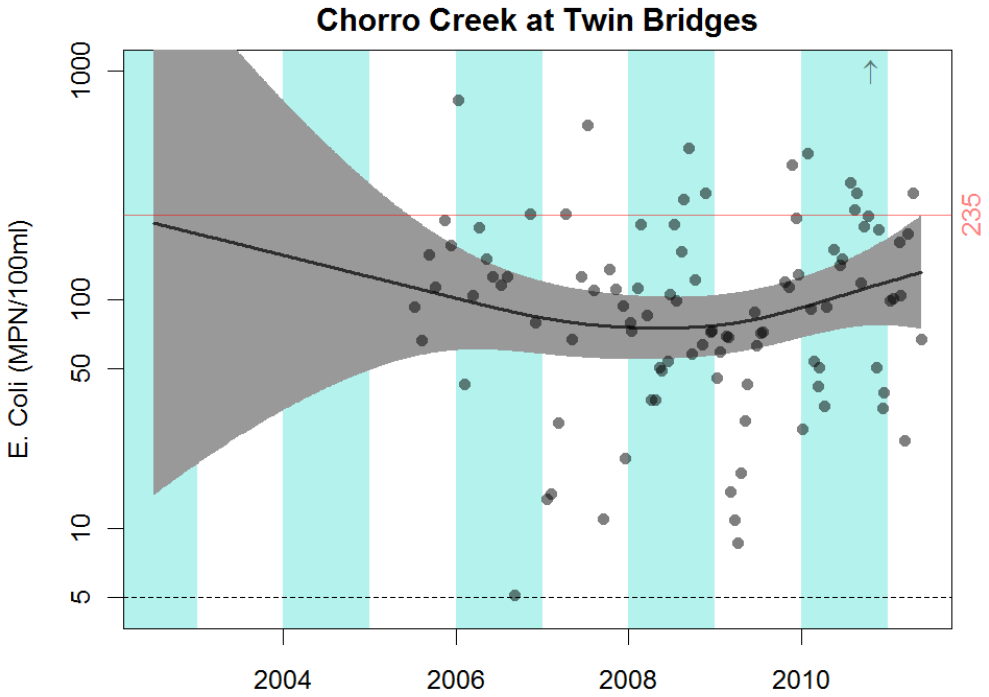


Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the small scale fluctuations. The black line on the plot shows the geomean of the *E. coli* concentration over time using smoothing splines. Regardless of the sample size for a given year, all data was included in this analysis. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data or less data available for analysis. The higher the variability in the data, the wider the error band. Where more data was available for analysis, the error band is narrower. Both the trend line and the error band have remained below 235 MPN/100 mL over time at the site at Canet Road.



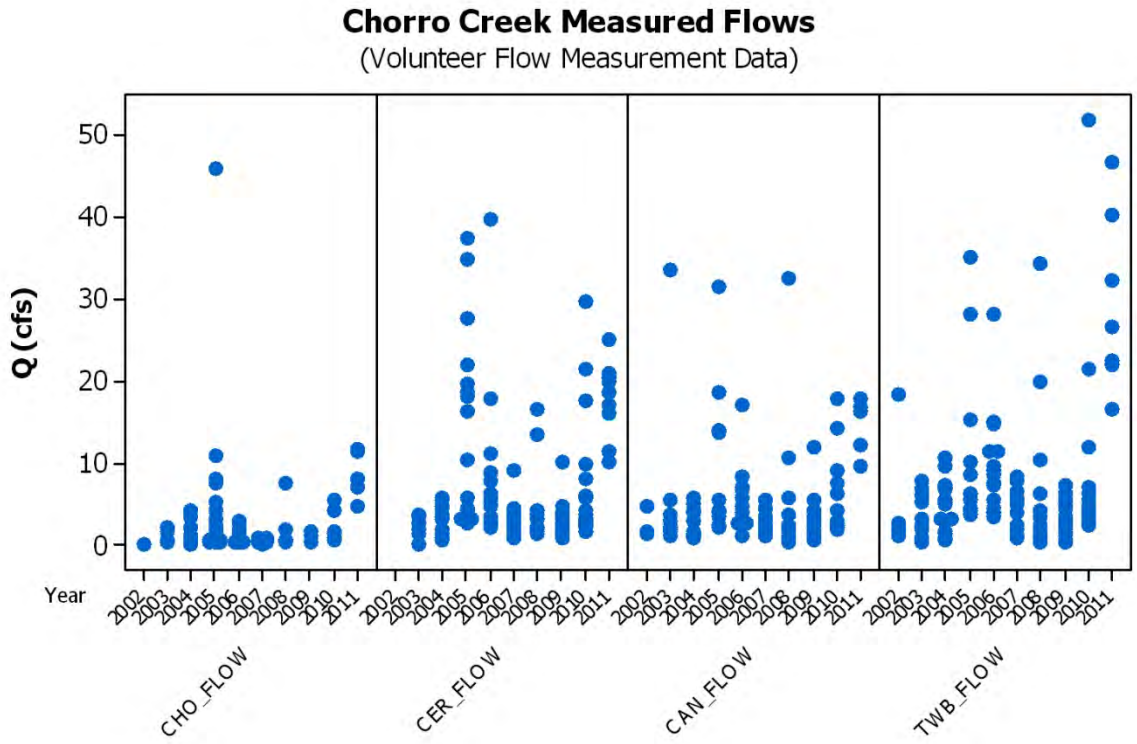
The trend line and error band both remain below 235 MPN/100 mL consistently over time at the Twin Bridges site. The large amount of uncertainty in the data (represented by the wide error band) prior to 2005 was due to a lack of monitoring data.



FLOW VOLUME

Volunteers measured instantaneous flow volumes using the velocity-area method. Depth and segment measurements were obtained using a top-setting rod and a measuring tape. Velocity measurements were obtained with a Marsh-McBirney Flo-Mate 2000 that reported 30-second fixed point average velocity in feet per second. Volunteers typically record six or more depth and velocity readings to generate volume estimates. The Flo-Mate 2000 meter has a range of up to 20 feet per second.

The following graph shows flow measurements obtained from the creek during low or base flow conditions. The graph provides an overview of the range and frequency of flow measurements.



MACROINVERTEBRATES

Data collected annually between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was updated in spring 2007. The VMP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

Data collected prior to 2007 was generated using prior Fish and Game approved methods. The data from previous surveys was standardized by a Monte Carlo analysis and is included for comparison.

The metrics included in this report are taxa richness, EPT richness, EPT% and IBI score. Taxa richness is a measure of the number of different species of organisms in the sample. EPT richness is a measure of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Taxa richness and EPT richness typically decrease with poor water quality. EPT% is the total number of EPT individuals divided by the total number of individuals in the sample. The Index of Biotic Integrity (IBI) score used in this report is the Southern California Coastal IBI developed by the Aquatic Bioassessment Laboratory of the California Department of Fish & Game. Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer + collector-filterer individuals, percent non-insect taxa, percent tolerant taxa,

coleoptera richness, predator richness, percent intolerant individuals and EPT richness. For the IBI scores, scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good. The metrics are displayed below for the three Chorro Creek sites, which are located just below Chorro Dam (CHD), on the Chorro Creek Ecological Reserve (CER) and just below the bridge on South Bay Boulevard and State Park Road (TWB).

In recent years, CER and TWB were monitored by the CCRWQCB. The data are not yet available from the CCRWQCB.

Chorro Creek, Chorro Dam (CHD)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	31	11	35.0	-
2004	42	15	36.0	-
2005	*	*	*	*
2006	36	16	19.3	-
2007	59	12	16.4	-
2008	54	13	33.4	44.3
2009	40	10	11.9	57.2
2010	*	*	*	*
2011	47	11	52.9	54.3

** No data collected this year*

- Metric scores not currently available

Chorro Creek, Ecological Reserve (CER)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	*	*	*	*
2004	27	6	22.0	-
2005	18	4	22.0	-
2006	*	*	*	*
2007	31	4	8.3	-
2008	48	6	14.6	30.0
2009	-	-	-	-
2010	-	-	-	-
2011	50	14	48.1	34.3

** No data collected this year*

- Metric scores not currently available

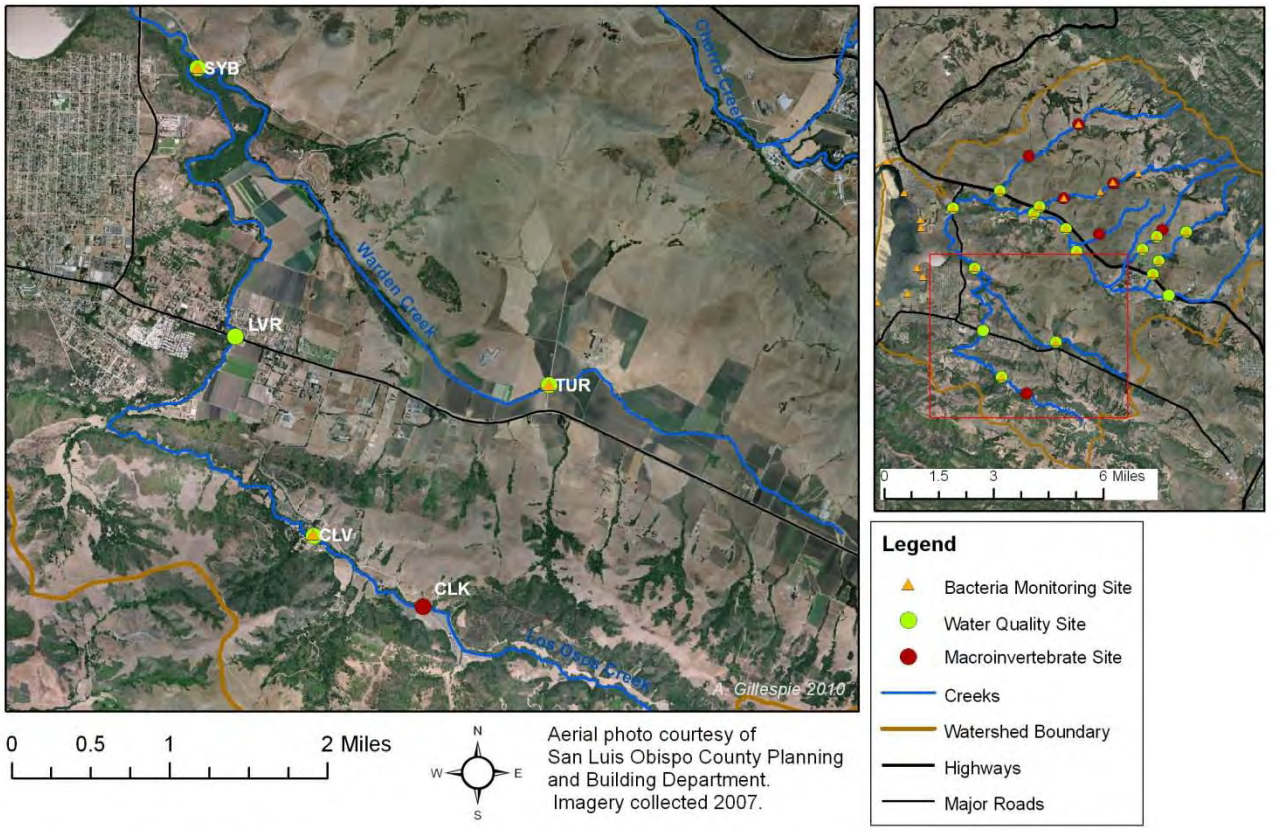
Chorro Creek, South Bay Blvd. (TWB)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	25	6	24.0	-
2003	23	6	26.0	-
2004	*	*	*	*
2005	*	*	*	*
2006	36	12	20.3	-
2007	37	7	2.9	-
2008	55	14	27.3	55.8
2009	-	-	-	-
2010	-	-	-	-
2011	-	-	-	-

** No data collected this year*

- Metric scores not currently available

LOS OSOS AND WARDEN CREEK

SITE MAP



The Los Osos Creek and Warden Creek watershed encompass an area of approximately 23 square miles. The monitoring program monitored four water quality sites and two bioassessment sites in the Los Osos watershed. Site SYB is the most downstream site and is located downstream of the Warden Creek and Los Osos Creek confluence. Because the site is tidally-influenced by Morro Bay, it was not included in the analysis of conductivity data later in this section. Site TUR is located at the bridge

crossing over Warden Creek on Turri Road. The bridge was rebuilt in 2009, and limited site access prevented data collection for several months. Although there is typically water present at the TUR site year-round, extremely low flow volumes and velocities often prevent monitoring during the dry season.

The program monitored two sites in Clark Valley on Los Osos Creek. Site CLK is monitored annually for macroinvertebrates. Monthly water quality and bacteria data are not collected at this site. Site CLV was established in 2008 at a private road crossing over the creek and is monitored monthly for water quality and bacteria. Site LVR is located at the Los Osos Valley Road bridge over Los Osos Creek. This site is monitored very infrequently and only contains surface flows during brief periods of very wet years. When flowing, the site is monitored for water quality. On limited occasions, site LVR is monitored for macroinvertebrates.

The Coastal San Luis Resource Conservation District was recently awarded a grant for a project to implement agricultural water quality enhancement projects. These will include on-farm audits of irrigation and fertilizer use to reduce the impacts of run-off. Riparian fencing will be installed to help ranches minimize the impacts of cattle on fragile streambanks and to improve water quality. As a partner in this project, the MBNEP is responsible for ambient monitoring of nutrients in the Los Osos Creek subwatershed, as well as bacteria monitoring wherever individual fencing projects are implemented. This monitoring was begun in December 2010, and data will be submitted quarterly to the CCRWQCB. At the end of the three year project, the data will undergo statistical analysis and a monitoring report will be compiled and submitted to the CCRWQCB. Data collected for this agricultural water quality project was not included in this data summary report.

WATER QUALITY N VALUE SUMMARY

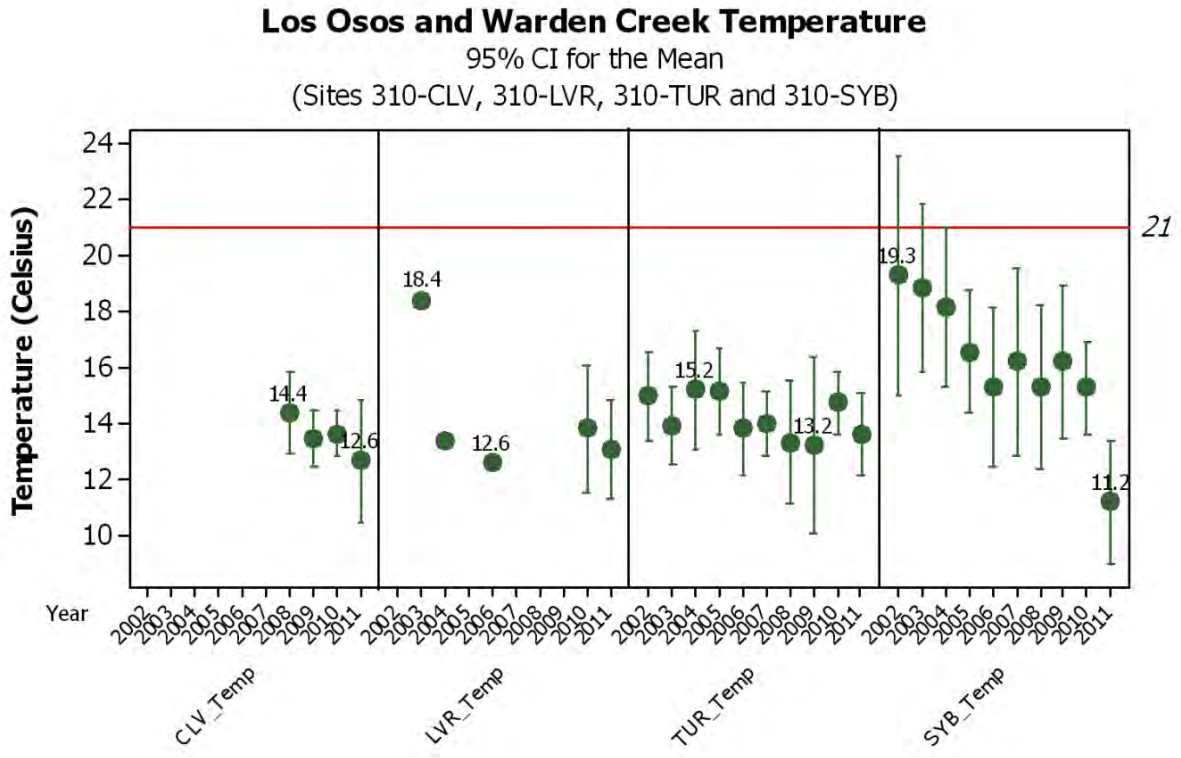
The table below indicates the frequency of water quality monitoring at Los Osos and Warden Creeks throughout the monitoring period.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum
CLV	0	0	0	0	0	0	7	8	12	5	**32**
LVR	0	1	0	0	1	0	0	0	7	8	**17**
TUR	8	12	9	11	5	6	8	4	13	8	**84**
SYB	5	12	12	16	11	7	12	13	13	5	**106**
Sum	**13**	**25**	**21**	**27**	**17**	**13**	**27**	**25**	**45**	**26**	

TEMPERATURE

Water temperature is measured as part of the water quality monitoring effort, which can take place at any time during daylight hours, and is not necessarily measured at a consistent time of day. Water quality monitoring may take place once or twice monthly, depending on volunteer availability and site hydrology.

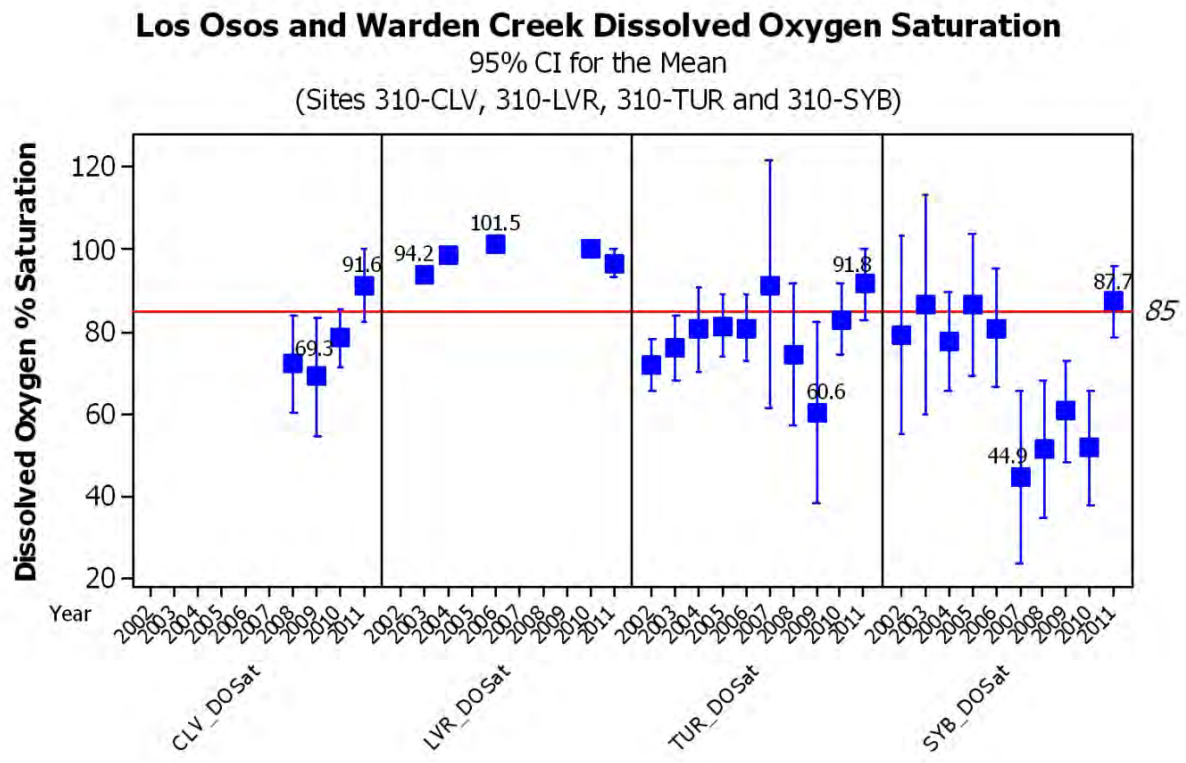
Data was collected with a YSI Model 55 or 85 multi-parameter meter, which uses a thermistor to measure water temperature. The meter has a range of -5 to +65°C with a resolution of 0.1°C. Starting in 2007, the YSI Model 55 was replaced with Model 85 units. The plot shows the mean temperature for each year, with the results grouped by site. The interval bars indicate the 95% confidence interval (CI) for the mean, which is the range within which 95% of the data can be expected to fall. The 21°C level of concern for protection of steelhead habitat is a CCRWQCB 303(d) Listing Guidance Value, which is indicated on the graph by a red line.



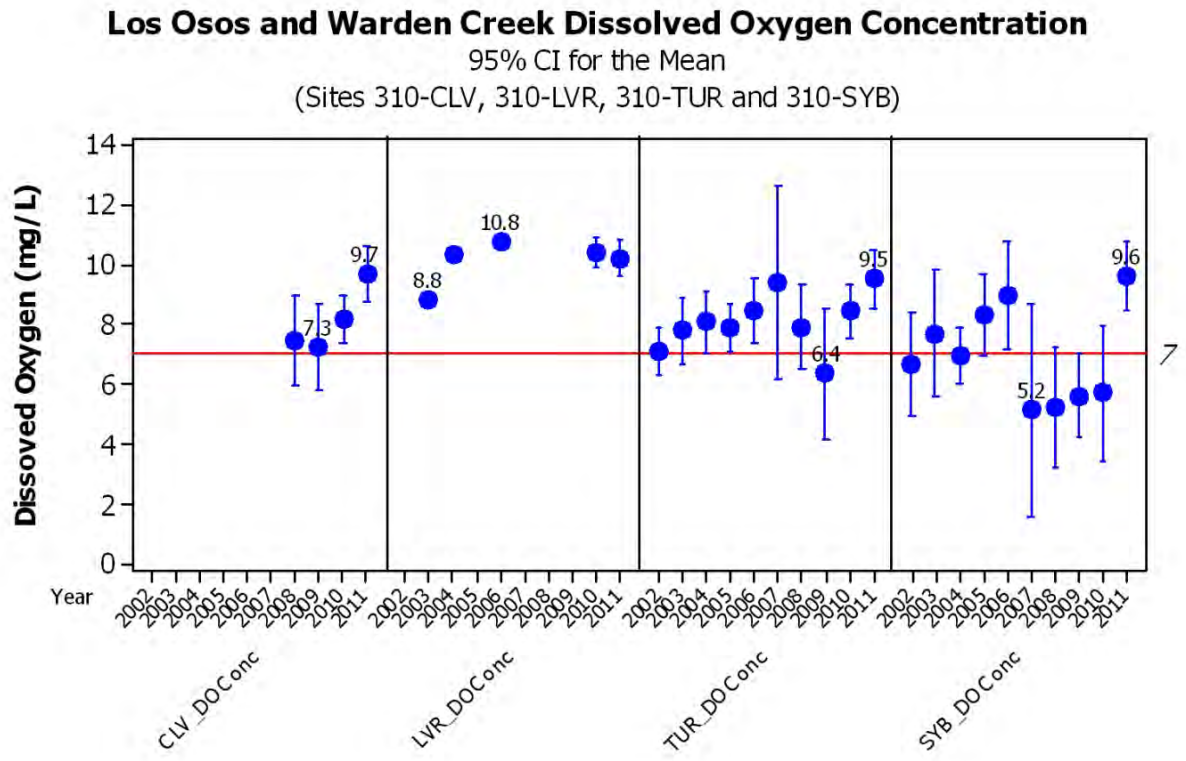
DISSOLVED OXYGEN

Program volunteers measured dissolved oxygen (DO) concentration and percent saturation during each water quality field visit. Data was collected with a YSI 85 meter utilizing Clark Cell technology. The YSI 85 meter measures a range of 0 to 200% for saturation and a resolution of 0.1%. For DO concentration, the meter range is 0 to 20 mg/L with a resolution of 0.01 mg/L. Prior to 2007, measurements were taken with a YSI model 55 meter. Measurements were collected at various times during daylight hours and were not necessarily measured at a consistent time of day.

The graph below displays the mean and 95% confidence interval of DO percent saturation for the sites on Los Osos and Warden Creeks, grouped by year. The Central Coast Region Basin Plan states that the median DO saturation value must not fall below 85.0%, which is represented by the red line on the graph.

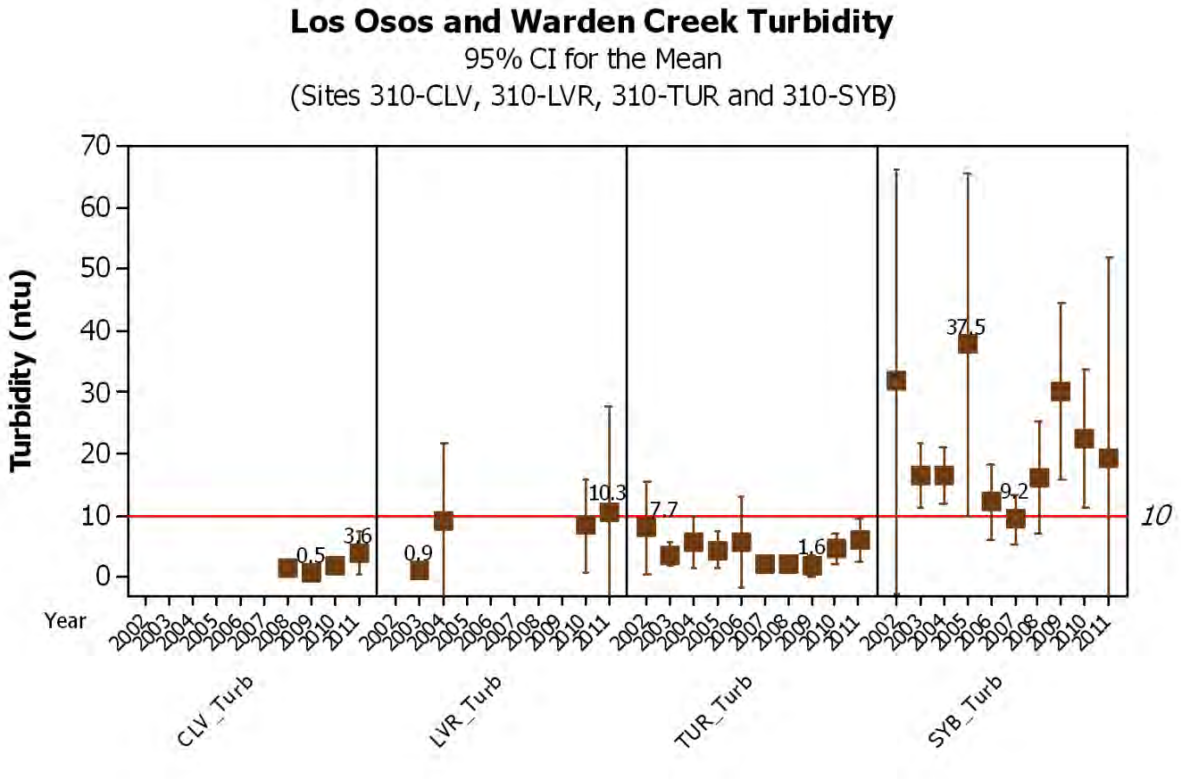


DO measurements were also made as a concentration in mg/L. The following graph shows the mean and 95% CI for the DO concentration data. The Central Coast Basin Plan set a regulatory standard that states that at no time shall DO concentrations fall below 7.0 mg/L.



TURBIDITY

Program volunteers measured turbidity during each water quality field visit. Turbidity data was collected using a HACH 2100P field meter, which makes use of the nephelometric method of measurement. The meter has a range of 0 to 1,000 NTU and a resolution of 0.01 NTU. Although the Basin Plan contains no water quality objectives for turbidity, CCAMP lists a level of concern at 10 NTU for protection of aquatic life. Measurements were collected at various times during daylight hours, and were not necessarily measured at a consistent time of day. A few outlier readings were removed from analysis as they were collected during storm events and were deemed not representative of ambient conditions. The removed values are listed below the figure.

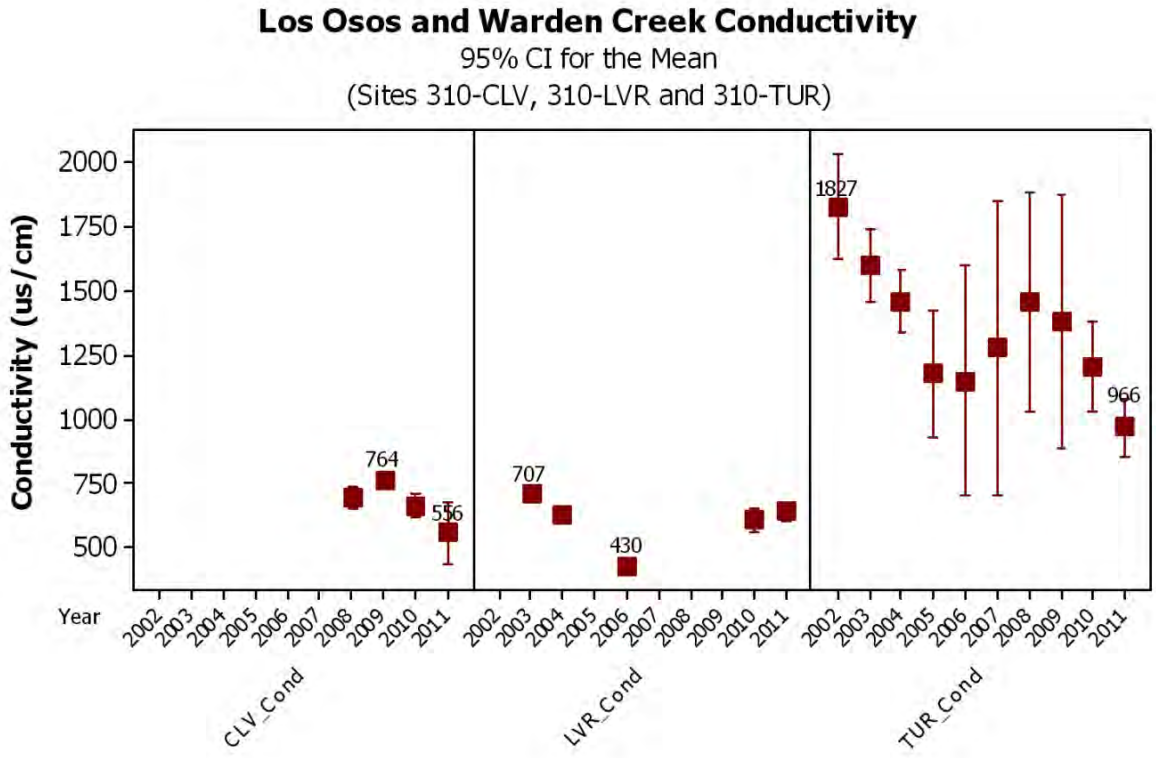


**Removed LVR turbidity value collected on3/29/2006, 115 NTU. 1.77" of rainfall in week prior.*

CONDUCTIVITY

Program volunteers measured temperature-corrected conductivity during each water quality field visit using a YSI 85 meter with nickel electrodes. The meter has a range of 0 to 200,000 uS/cm with a resolution of 0.1 uS/cm. Prior to 2007, data was collected with an Oakton ECTestr which had a range of 0 to 1,990 uS/cm and a resolution of 10 uS/cm. The Central Coast Basin Plan includes a conductivity objective of 3,000 uS/cm to protect the Agriculture beneficial use. Elevated conductivity levels, as a measure of dissolved solids, can be indicative of pollution such as agricultural or road drainage runoff.

Data from site SYB is not shown on the graphic. The site is tidally influenced and thus has substantially higher salinity than other monitoring sites on Los Osos and Warden Creeks.

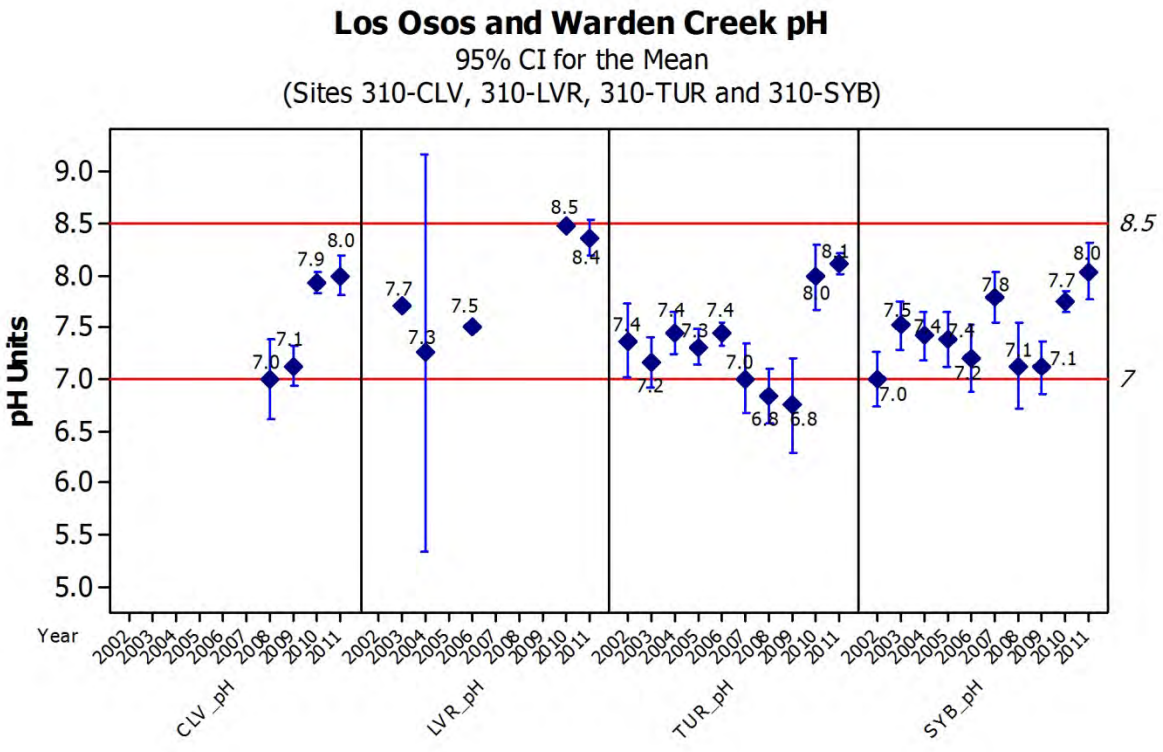


pH

Since July 2010, program volunteers measured pH during each water quality field visit using a pH probe. The meter has a range of -1.0 to 15.0 pH units, with a resolution of 0.1 pH units. Prior to July 2010, pH paper was used for the measurement. The paper has a range of 4.5 to 10.0 with a resolution of 0.5 pH units. pH paper measurements are collected along with the probe measurement in the hopes that a correlation can be determined between the two values. Following quality control comparisons of the probe and paper data with lab analysis, the pH probes appear to be very accurate, whereas the pH paper was consistently underestimating the pH.

For this summary report, data generated with pH paper was reported from 2002 through 2009. For 2010, only data collected with a pH probe was included (July to December 2010). For 2011, only data collected with a pH probe was included. Thus, pH data from January to June 2010, which was collected with pH paper, have been excluded from this summary.

Per the Central Coast Basin Plan, pH concentrations must remain between 6.5 and 8.3 to be protective of the recreational contact beneficial use (REC-1). For protection of aquatic life, the Basin Plan standard is between 7.0 and 8.5 (COLD, WARM).

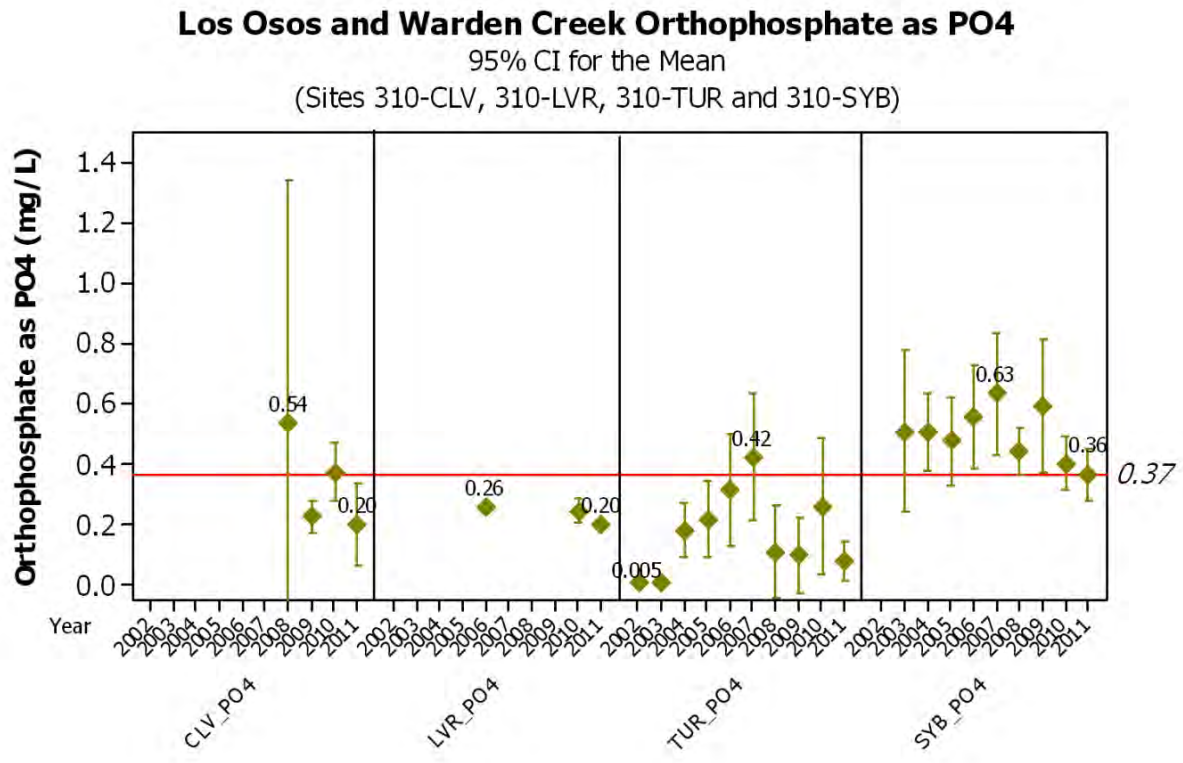


Note: For this summary report, data collected using pH paper was reported from 2002 through 2009. Data collected from July 2010 and after was with a pH probe. pH data collected from January to June 2010 with pH paper was not included in this analysis.

NUTRIENTS

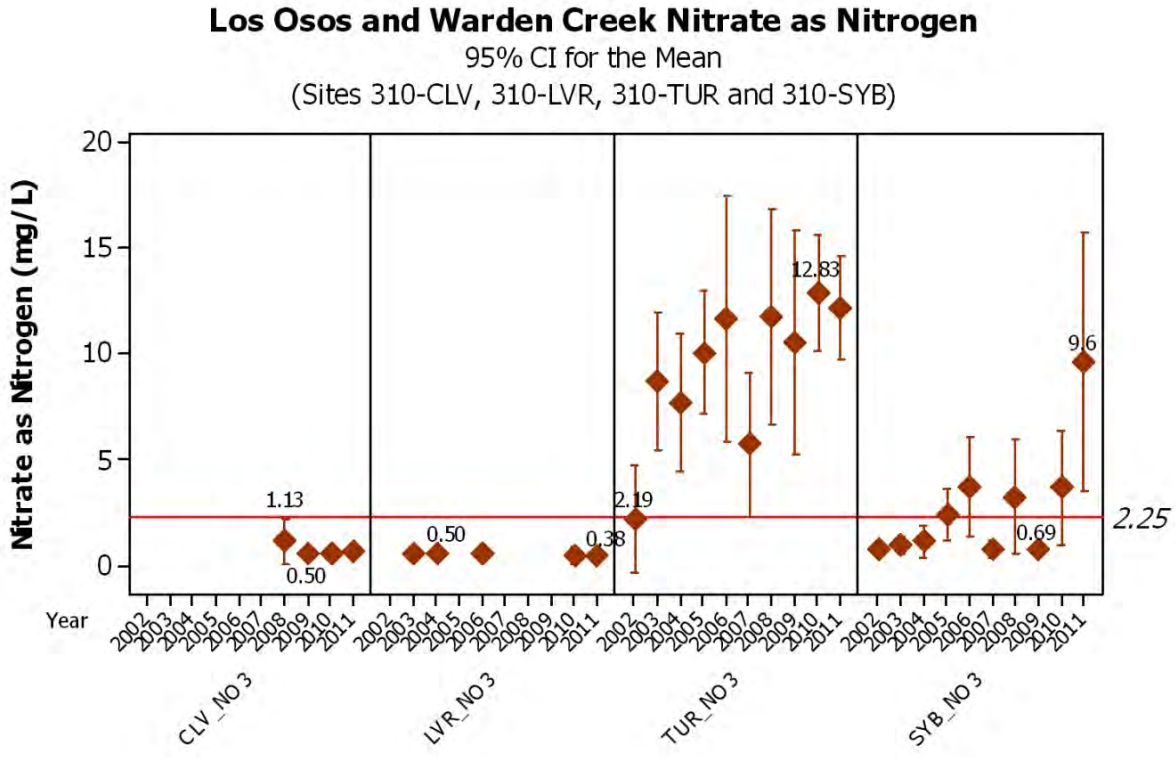
Program volunteers measured orthophosphates as PO_4^{3-} and nitrates as nitrogen during each water quality field visit. Samples were collected by trained volunteers, and analysis was conducted at the MBNEP office using chemical test kits.

The methodology for orthophosphates as PO_4^{3-} analysis has changed over the years in an effort to improve the quality of the data. Volunteer-generated data prior to April 2004 was discarded due to the determined inaccuracy of the test kit. Any data included in the report prior to April 2004 was obtained from an analytical laboratory. From early 2004 through mid-2005, a Hanna meter and Hanna reagent was used. From mid-2006 through mid-2007, a YSI 9000 meter with YSI reagent was used. Starting in mid-2007 to the present, the analysis method uses a Hanna Low Range Phosphate colorimeter (HI 93713) with HACH PhosVer 3 Phosphate Reagent, which utilizes an ascorbic acid reaction. The meter has a range from 0.00 to 2.50 mg/L with a resolution of 0.01 mg/L. Out-of-range samples were analyzed by diluting the sample with deionized water and multiplying the result by the dilution factor. This is a simple colorimeter which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab-generated data. The CCAMP informal attention level is 0.37 mg/L as PO_4^{3-}, a value created specifically for the Pajaro River but adapted for the Morro Bay watershed.



Nitrates as nitrogen was monitored with a LaMotte test kit 3354 which uses a zinc reduction reaction. The method utilizes a color change reaction and compares the reacted sample to a color chart with gradations at 0, 1, 2, 4, 6, 8, 10 and 15 mg/L. For this method, readings between 0 and 1 are considered to be non-detects and are reported as 0.50 mg/L for the purpose of analysis. This is a simple test kit which was selected because it is safe and easy to use, but it does not yield data with the same precision and accuracy as lab generated data. The CCAMP informal attention level for nitrates as nitrogen is 2.25 mg/L to be protective of aquatic life.

The nitrate concentrations at site TUR are substantially higher than all of the other monitoring sites in the Morro Bay watershed. The mean nitrate concentration at SYB increased in 2011, with readings in the range of 6 to 15 mg/L. In highly saline waters, the salts interfere with the zinc reaction and can affect the results of the analysis. However, the exact salinity concentration at which interference occurs is not known for this analytical method.



ALGAE DOCUMENTING

Beginning in 2011, algae data was collected using the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, 2010. The protocol involves point intercept measurements that determine the presence or absence of macroalgae, as well as qualitative measurement of filamentous algae coverage throughout the reach. The complete SWAMP protocol for collecting stream algae samples, including sample collection and lab analysis, was not conducted in 2011 due to limited financial and staff resources.

The CCRWQCB utilizes algae abundance data in assessing 303(d) listings and de-listings, as well as tracking TMDL implementation. The presence and density of algal blooms can be considered supporting evidence when determining whether to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Algae data was analyzed through two data sets generated by 2011 assessments at each site. The percent coverage of macroalgae at the site was determined by calculating algae presence at wetted points located on the transects and inter-transects. This calculated value is used to represent percent algal coverage throughout the 150 m reach. The monitoring sites on Los Osos Creek were located at CLK, which is on private property in Clark Valley, and LVR which is located at the Los Osos Valley Road bridge. CLK had a percent algal coverage of 38% in 2011, and LVR had a percent coverage of 7%.

Additionally, the qualitative spatial coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) was assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1 indicating < 10% coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. With this metric, CLK scored 30% and LVR scored 0%.

BACTERIA

Program volunteers monitored total coliform and *E. coli* bacterial indicators. Monthly samples were collected by volunteers in the field and then analyzed with the IDEXX method using Colilert-18 reagent. Analysis took place at the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory. Bacteria monitoring was not timed to coincide with monthly or bi-weekly water quality monitoring at these sites.

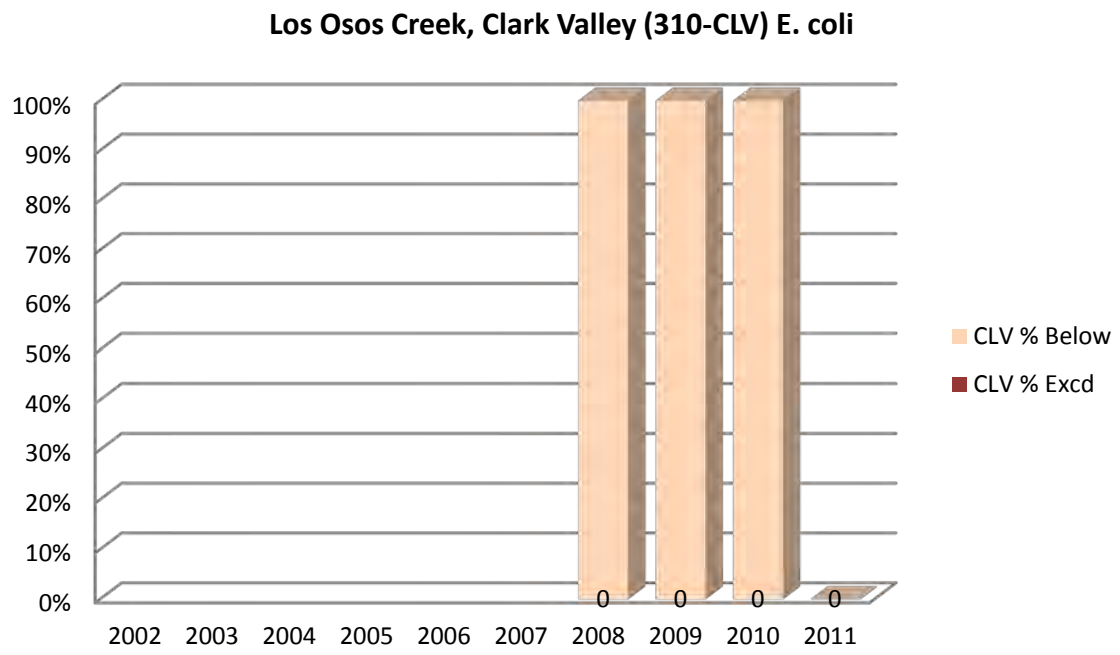
Based on typical sample dilutions, the range of detection for the test is from < 1 MPN/100 mL to 24,196 MPN/100 mL. The regulatory criteria for comparison are the recommended standards in EPA's 1986 guidance document *Ambient Water Quality Criteria for Bacteria*. For *E. coli* for a single grab sample, the water is considered to have an acceptable risk for swimming (REC-1 contact) if the concentration is below 235 MPN/100 mL. The analysis in this report is focused on *E. coli* rather than total coliform because *E. coli* is an indicator of the presence of fecal contamination from warm-blooded animals. Total coliform is a broader indicator of bacterial contamination and could be caused by plant matter, soil and other sources.

The following table contains the number of bacteria samples collected each year at the sites and the number of samples that exceeded the criteria.

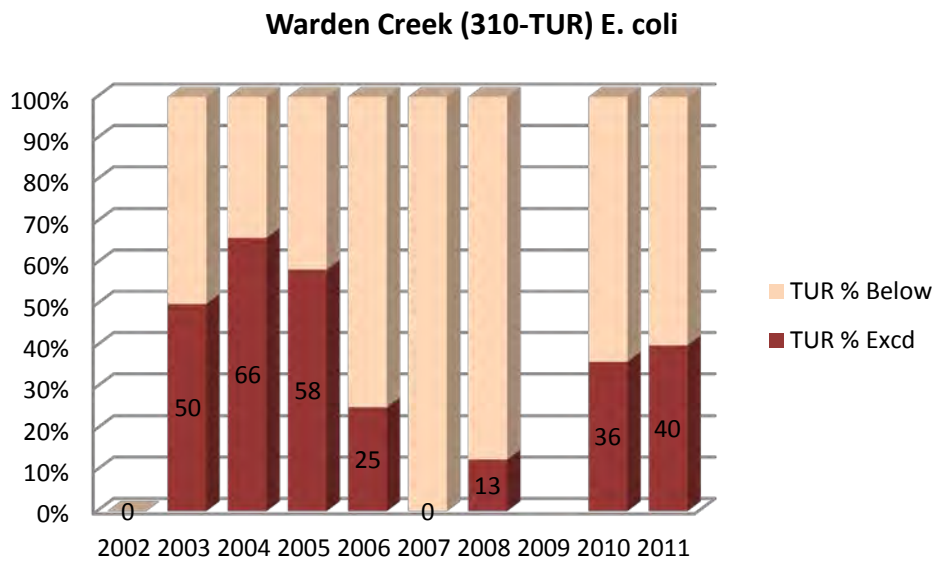
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011†**
CLV n	*	*	*	*	*	*	8	9	12	5
CLV % Excd	*	*	*	*	*	*	0	0	0	*
TUR n	6	12	12	12	8	6	8	5	11	10
TUR % Excd	*	50	66	58	25	*	13	*	36	40
SYB n	5	12	12	11	11	13	13	12	12	5
SYB % Excd	*	25	42	9	27	8	15	8	25	*

**The sample size n < 6 was deemed too small for inclusion in the analysis.*
†2011 values include January to May 2011.

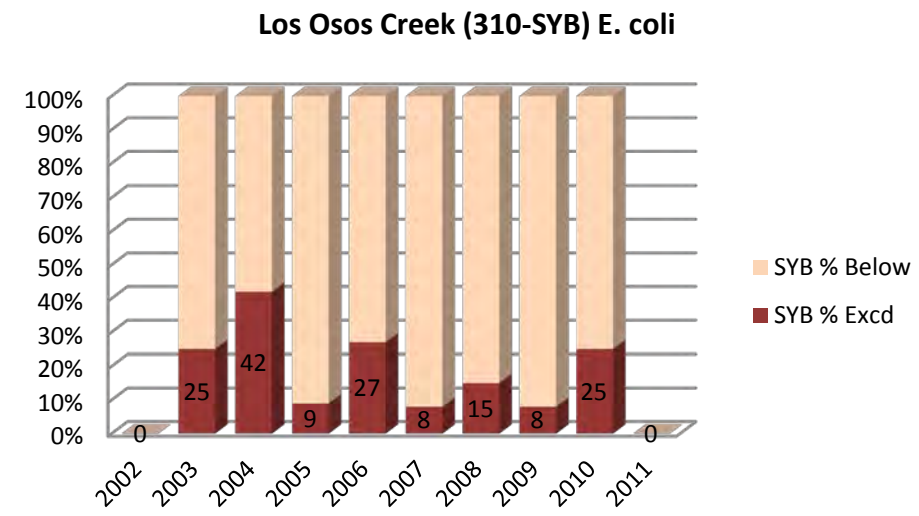
The following graphs depict the % of samples that exceeded the 235 MPN/100 mL recreational contact standard for *E. coli* each year. The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

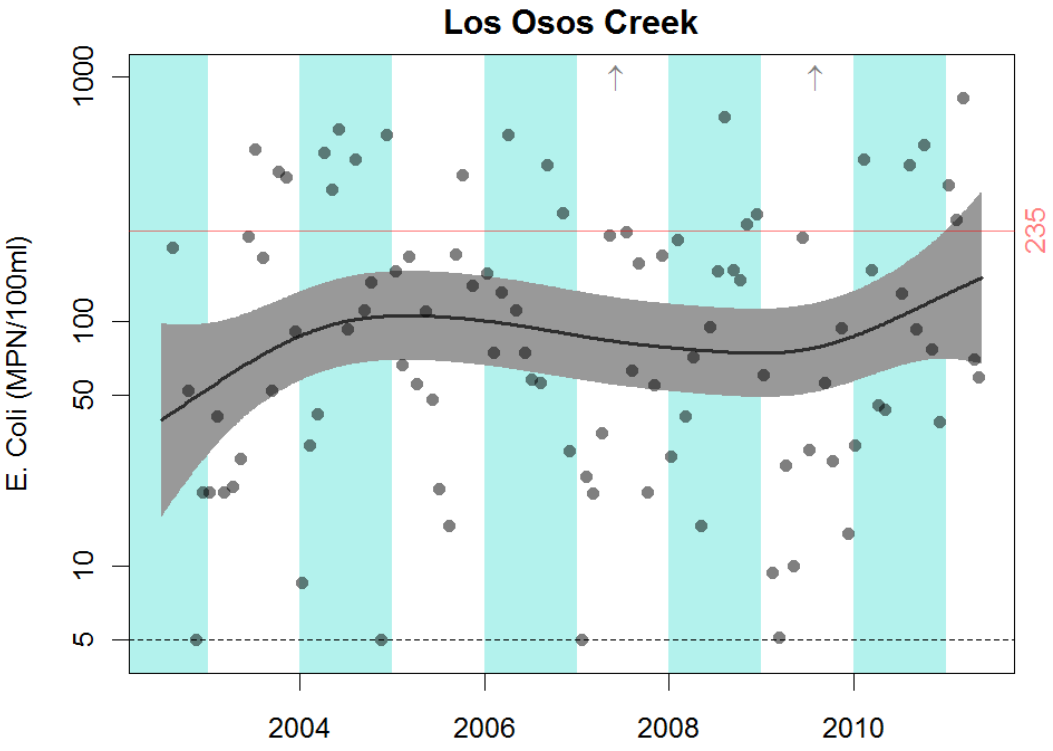


Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.



Note: The blank columns with zeroes in the graphs depict a sample size that was too small for inclusion in the analysis (n < 6), rather than a lack of exceedances of the standard.

A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the small scale fluctuations. The analysis was conducted for SYB only since it had the longest running dataset of the sites in the subwatershed. The black line on the plot shows the geomean of the *E. coli* concentration over time using smoothing splines. Regardless of the sample size for a given year, all data was included in this analysis. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data, or less data available for analysis. Both the trend line and the error band have remained below 235 MPN/100 mL over time at the site on Los Osos Creek near South Bay Boulevard (site code SYB).

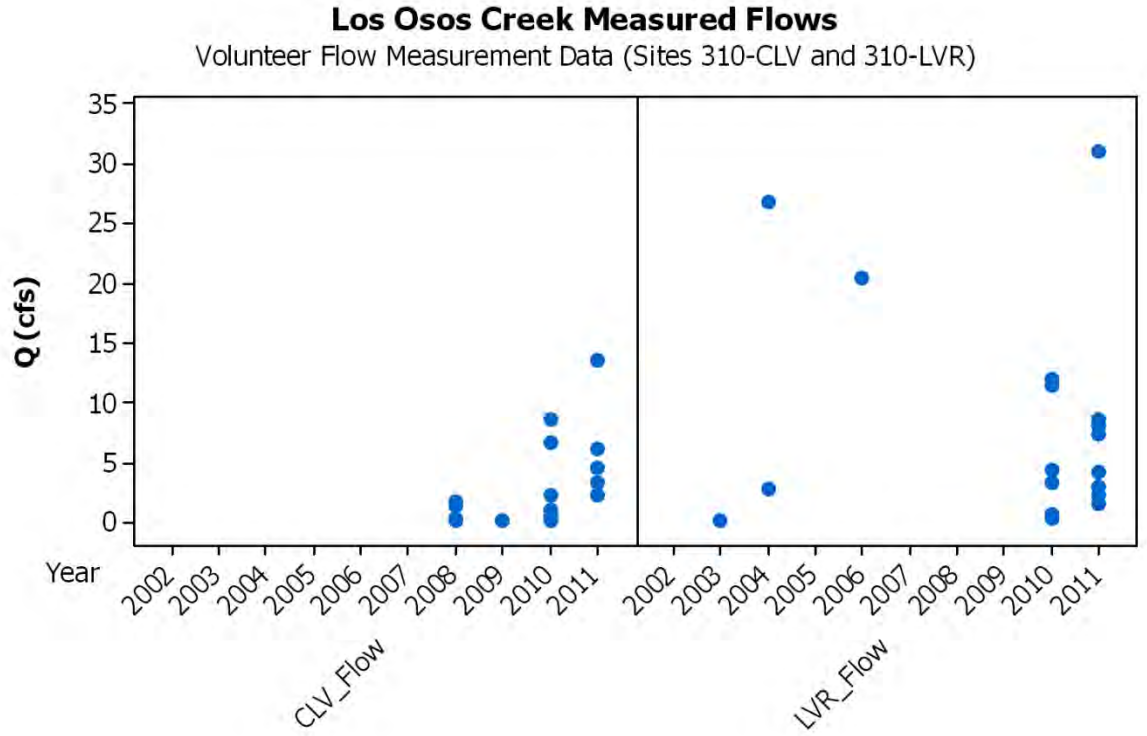


Flow Volume

Volunteers measured instantaneous flow volumes using the velocity-area method. Depth and segment measurements were obtained using a top-setting rod and a measuring tape. Velocity measurements were obtained with a Marsh-McBirney Flo-Mate 2000 that reported 30-second fixed point average velocity in feet per second. Volunteers typically record six or more depth and velocity readings to generate volume estimates. The Flo-Mate 2000 meter has a range of up to 20 feet per second.

Flow volume measurements were not conducted at SYB due to tidal influence and bi-directional flow. The substrate in the channel and water depth are not suitable for wading measurements. Extremely shallow depths and overgrown vegetation at site TUR have prevented consistent flow measurement at that site.

The following graph shows flow measurements obtained from Los Osos Creek at sites CLV and LVR. Data from site LVR is not representative of base flow conditions, as the site is usually dry eight to ten months per year. The graph provides an overview of the range and frequency of flow measurements.



Macroinvertebrates

Data collected annually between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was updated in spring 2007. The VMP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for

sorting and counting until 500 organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

Data collected prior to 2007 was generated using prior Fish and Game approved methods. The data from previous surveys was standardized by a Monte Carlo analysis and is included for comparison.

The metrics included in this report are taxa richness, EPT richness, EPT% and IBI score. Taxa richness is a measure of the number of different species of organisms in the sample. EPT richness is a measure of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Taxa richness and EPT richness typically decrease with poor water quality. EPT% is the total number of EPT individuals divided by the total number of individuals in the sample. The Index of Biotic Integrity (IBI) score used in this report is the Southern California Coastal IBI developed by the Aquatic Bioassessment Laboratory of the California Department of Fish & Game. Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer + collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, coleoptera richness, predator richness, percent intolerant individuals and EPT richness. For the IBI scores, scores of 0 to 19 are considered to be very poor, 20 to 39 are poor, 40 to 59 are fair, 60 to 79 are good, and 80 to 100 are very good.

Los Osos Creek, Clark Valley (CLK)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	30	9	30	-
2003	35	14	40	-
2004	35	17	49	-
2005	25	12	48.0	-
2006	33	13	51.0	-
2007	*	*	*	*
2008	29	13	17.9	58.6
2009	*	*	*	*
2010	39	13	31.7	65.8
2011	41	15	58.7	52.9

** No data collected this year*

- Metric scores not currently available

Los Osos Creek, Los Osos Valley Road (LVR)	Taxa Richness	EPT Richness	EPT %	IBI Score
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	15	6	40.0	-
2006	*	*	*	*
2007	*	*	*	*
2008	*	*	*	*
2009	*	*	*	*
2010	18	3	25.1	41.5
2011	46	13	53.0	48.6

** No data collected this year*

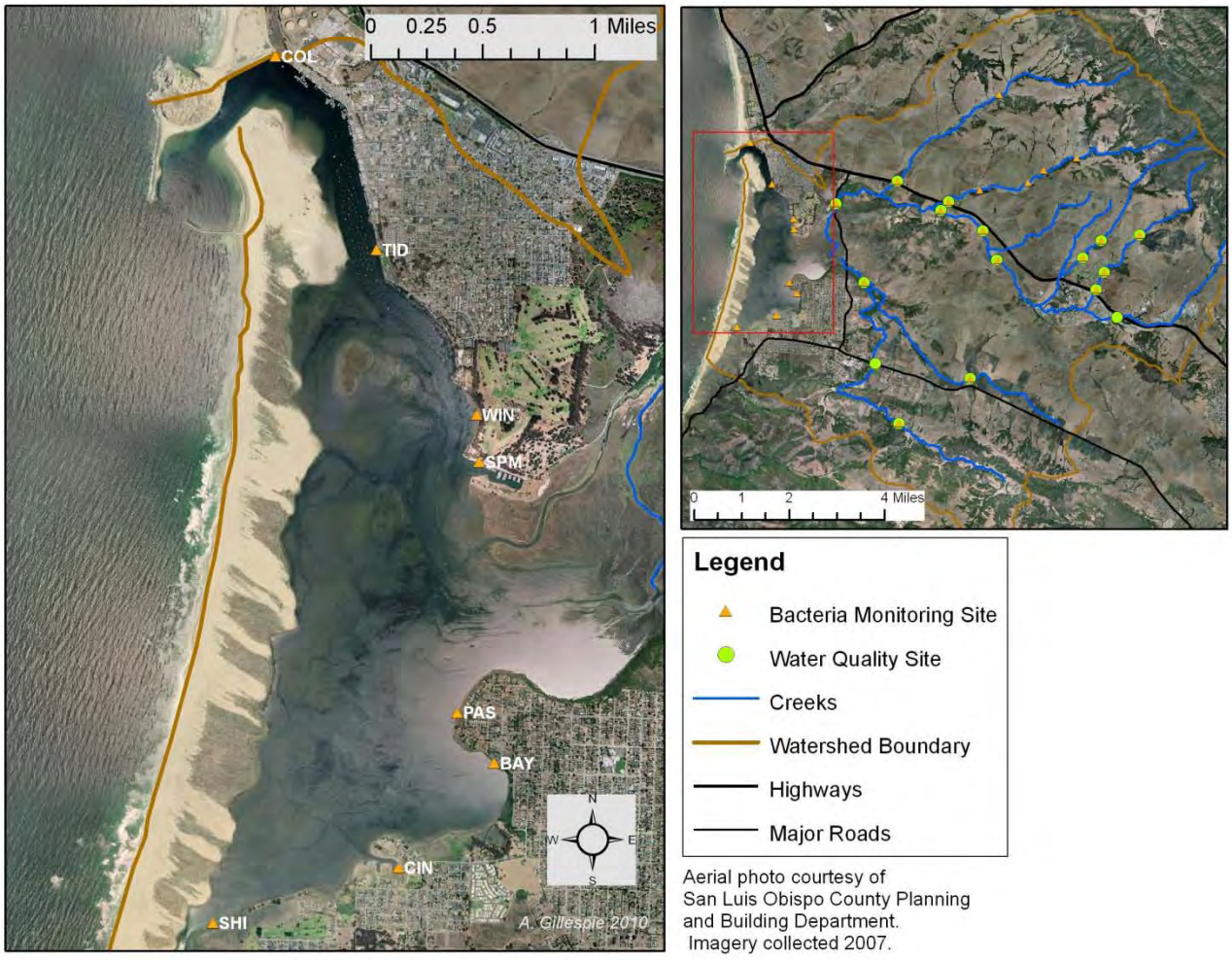
- Metric scores not currently available

3.0 BAY DATA ANALYSIS

The following analysis includes data collected from the bay, including bacteria, dissolved oxygen, shorebirds, phytoplankton and bay sediment monitoring.

MORRO BAY BACTERIA

SITE MAP AND DESCRIPTION



The Morro Bay estuary is a 2,300-acre semi-enclosed body of water which supports recreational activities for residents and visitors alike. Kayaking, windsurfing, swimming and wading are common activities in the bay. Recreational use is particularly heavy at various designated access points around the bay. The VMP monitors eight commonly used bay access point on a monthly basis for *E. coli* and *Enterococcus spp*. concentrations. These sites were established between 2002 and 2004, as shown in the following table.

Monthly samples were collected by volunteers in the field and then analyzed with the IDEXX method using Colilert-18 reagent to obtain *E. coli* results and Enterolert reagent to obtain *Enteroccocus spp.* results. Samples were analyzed by volunteers using lab space in the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory.

Although *Enterococcus spp*. is the preferred indicator for monitoring recreational contact safety in marine waters, the state of California continues to enforce regulations in shellfish growing waters using the fecal coliform indicator. In order to generate data comparable to the regulatory standards for fecal coliform, we continue to test for *E. coli* as well as *Enterococcus spp.* in the bay. The regulatory criteria for comparison are the recommended standards in EPA's 1986 guidance document *Ambient Water Quality Criteria for Bacteria*. For *E. coli* for a single grab sample, the water is considered to have an acceptable risk for swimming (REC-1 contact) if the concentration is below 235 MPN/100 mL in freshwater. Because no criteria exist for *E. coli* in marine waters, we've adapted the freshwater criteria for comparison. For *Enterococcus spp.*, the EPA guidance cites 104 MPN/100 mL from a single grab sample in marine waters as safe for recreational contact (REC-1).

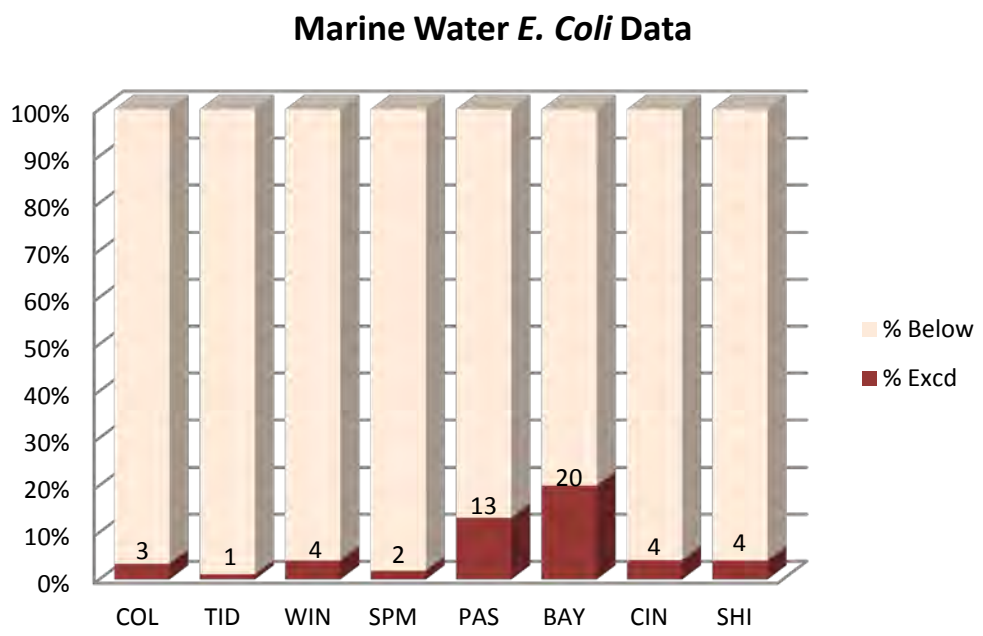
Based on typical sample dilutions, the range of detection for the *E. coli* and *Enterococcus spp*. testing is from < 10 MPN/100 mL to 24,196 MPN/100 mL.

E. COLI DATA

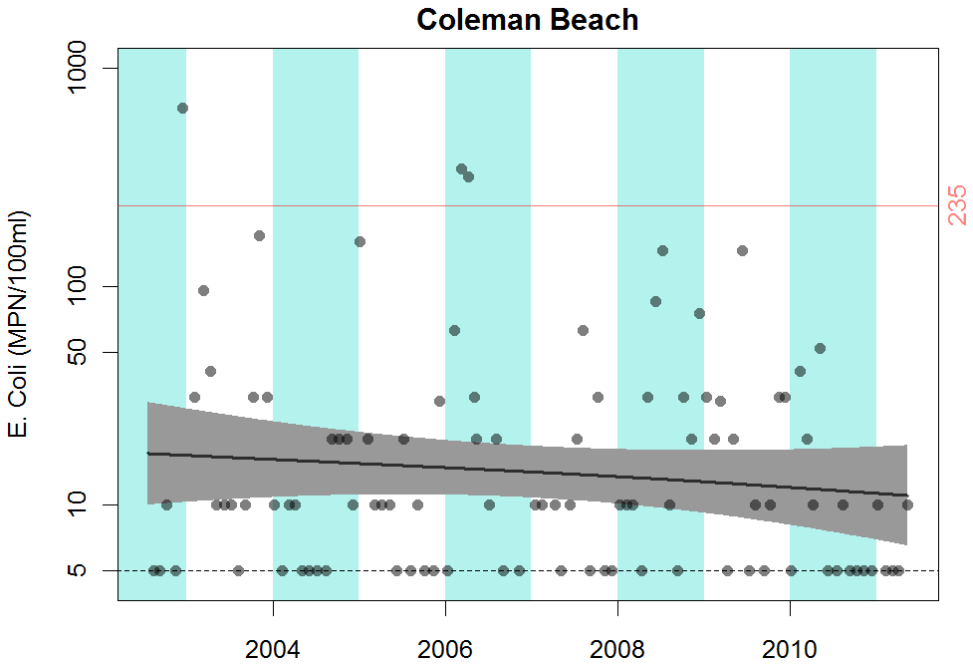
The following table contains the number of *E. coli* samples collected each year at the sites.

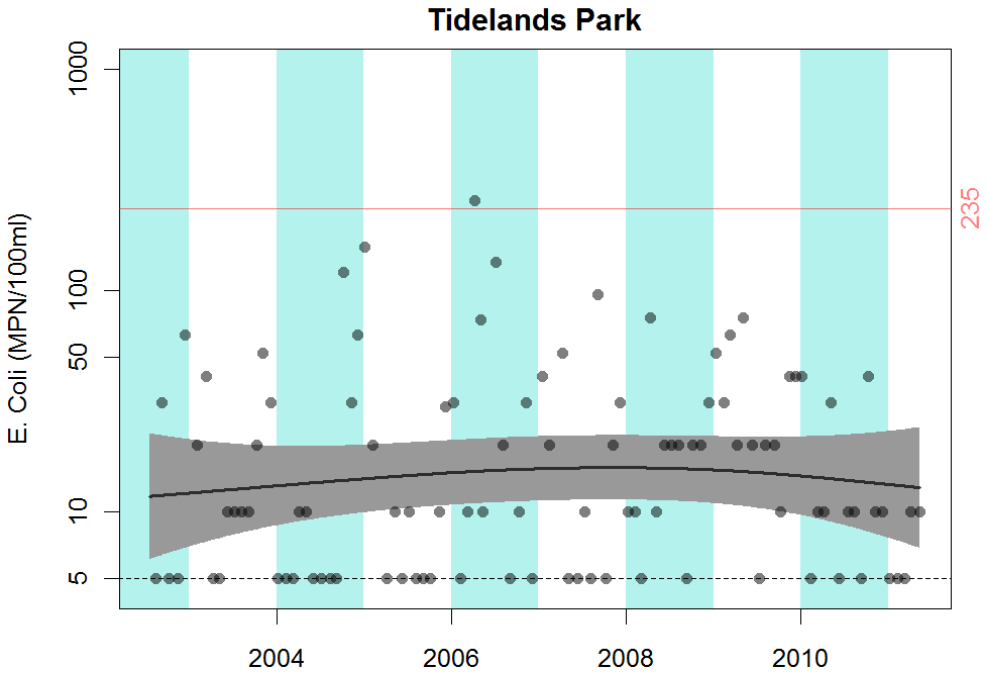
Site Code	Monitoring Start Date	Latest Monitoring Date	Number of Samples (n)	Number of Exceedances	Percent of Samples Exceeding
COL	July 2002	May 2011	102	3	3%
TID	July 2002	May 2011	103	1	1%
WIN	January 2004	May 2011	104	4	4%
SPM	July 2002	May 2011	120	2	2%
PAS	July 2002	May 2011	109	14	13%
BAY	July 2002	May 2011	103	21	20%
CIN	July 2002	May 2011	108	4	4%
SHI	December 2004	May 2011	48	2	4%

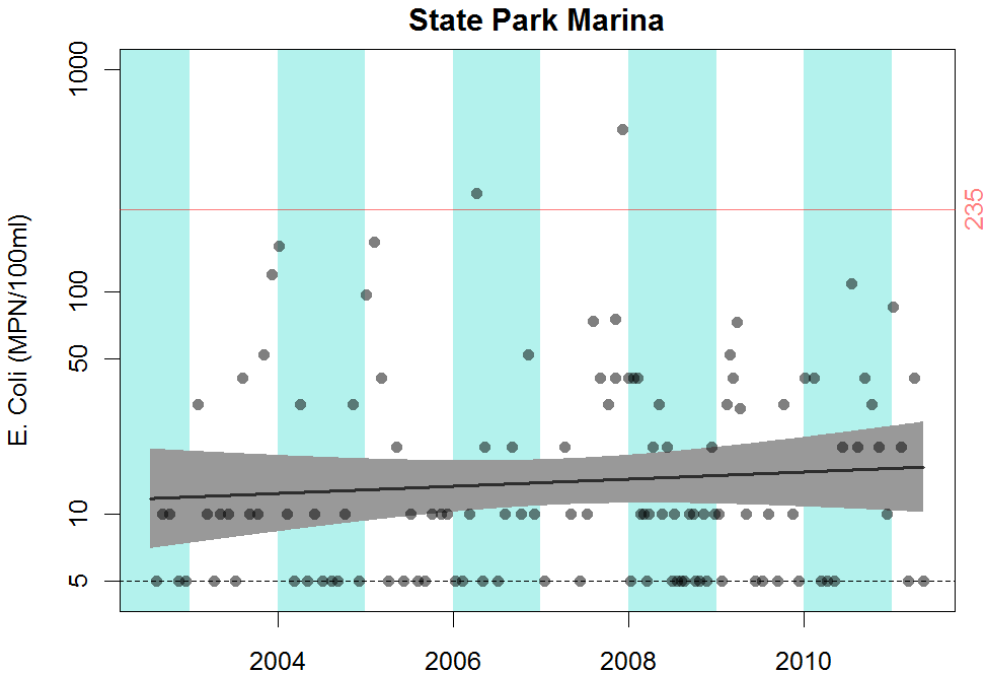
The following graph shows the % of samples that exceeded the *E. coli* regulatory standard of 235 MPN/100 mL for safe recreational contact that was adapted from EPA's criteria in freshwater.



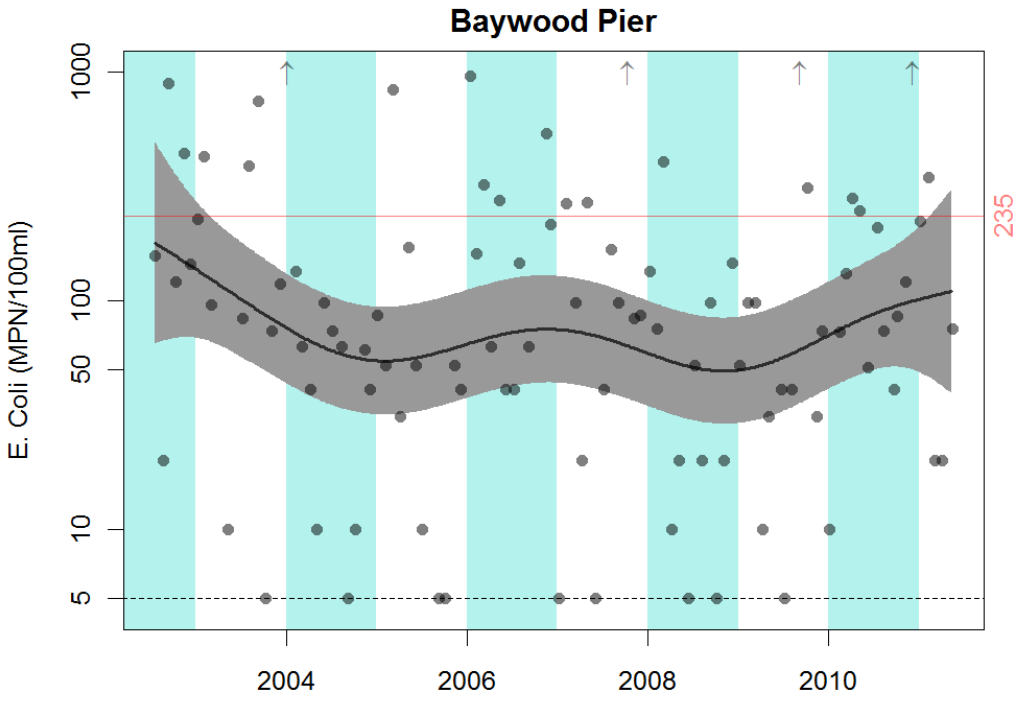
A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the year-to-year fluctuations. The black line on the plot shows the geomean of the *E. coli* concentration over time using smoothing splines. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data or less data available for analysis. The first three plots are for the sites located toward the north end of the bay: Coleman Beach, Tidelands Park and State Park Marina. For all three sites, the long-term trend and the error band are well below 235 MPN/100 mL.

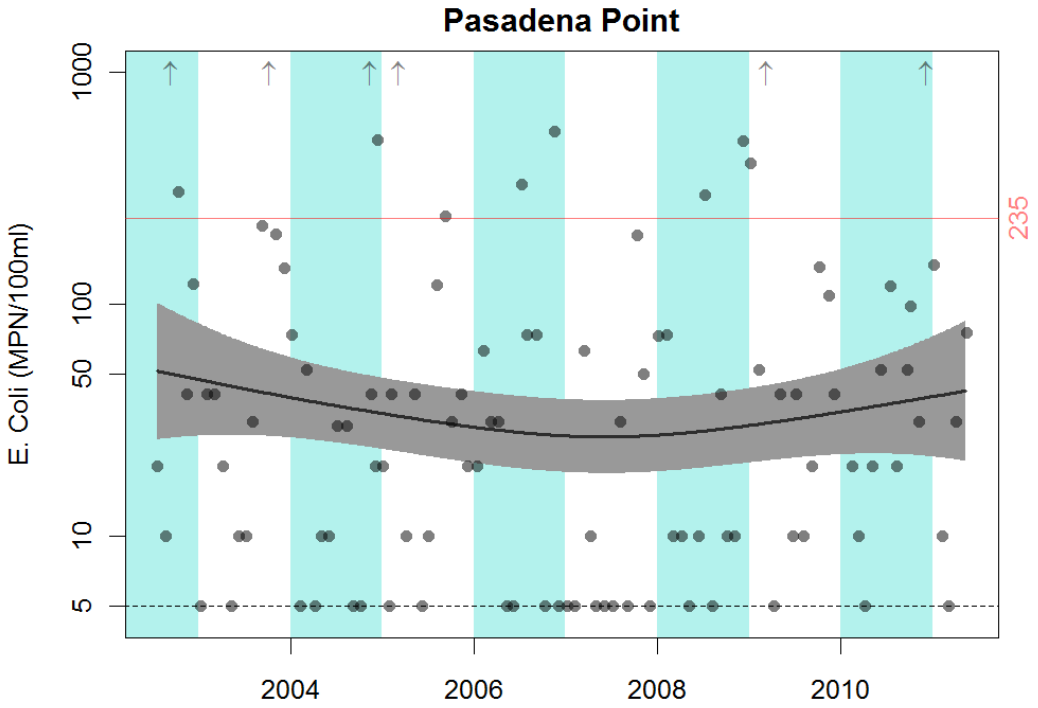


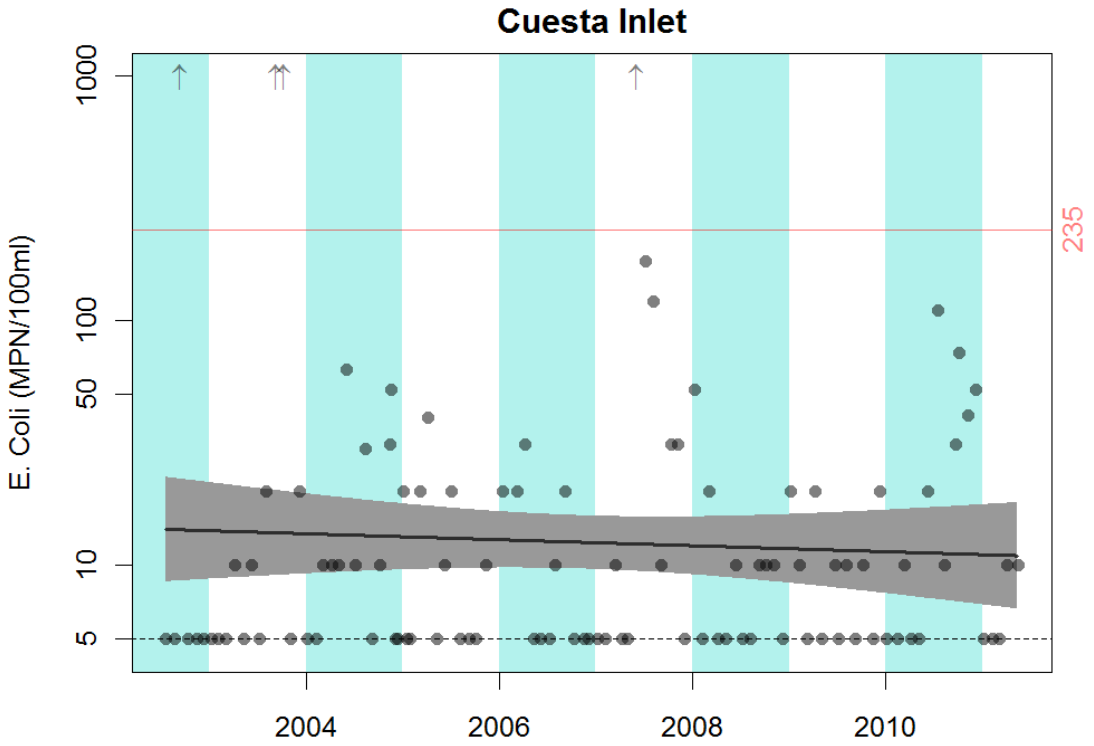




The following three plots are for monitoring sites toward the south of the bay, commonly referred to as the back bay: Baywood Pier, Pasadena Point and Cuesta Inlet. Baywood Pier and Pasadena Point have *E. coli* trend lines that are elevated as compared to the sites in the front bay and to Cuesta Inlet in the back bay. Due to limited data, Sharks Inlet was not included in these analyses. The up arrows indicate individual data records that exceeded 1,000 MPN/100 mL.


Baywood Pier
E. Coli (MPN/100ml)
1000
100
50
10
5
235
2004
2006
2008
2010


Pasadena Point
E. Coli (MPN/100ml)
1000
100
50
10
5
235
2004
2006
2008
2010

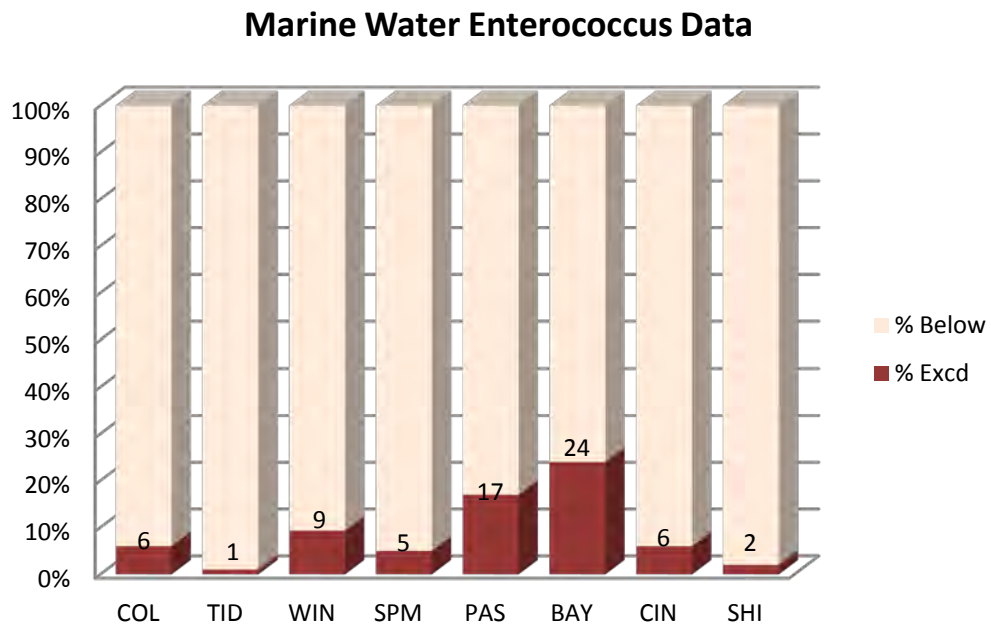


ENTEROCOCCUS SPP. DATA

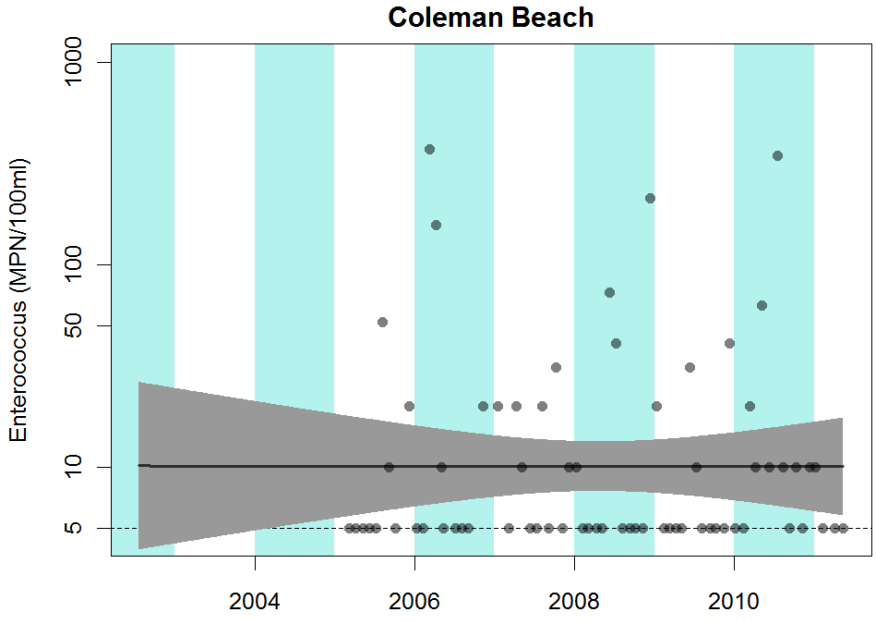
The following table contains the number of *Enterococcus spp*. samples collected at the sites.

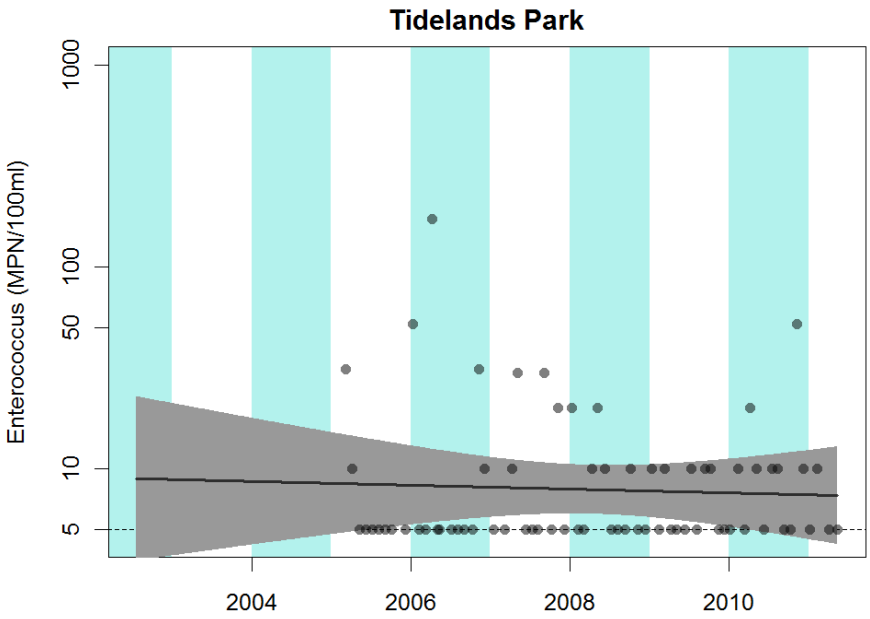
Site Code	Monitoring Start Date	Latest Monitoring Date	Number of Samples (n)	Number of Exceedances	Percent of Samples Exceeding
COL	March 2005	May 2011	70	4	6%
TID	March 2005	May 2011	72	1	1%
WIN	March 2005	May 2011	85	8	9%
SPM	March 2005	May 2011	87	4	5%
PAS	March 2005	May 2011	71	12	17%
BAY	March 2005	May 2011	71	17	24%
CIN	March 2005	May 2011	71	4	6%
SHI	July 2005	May 2011	47	1	2%

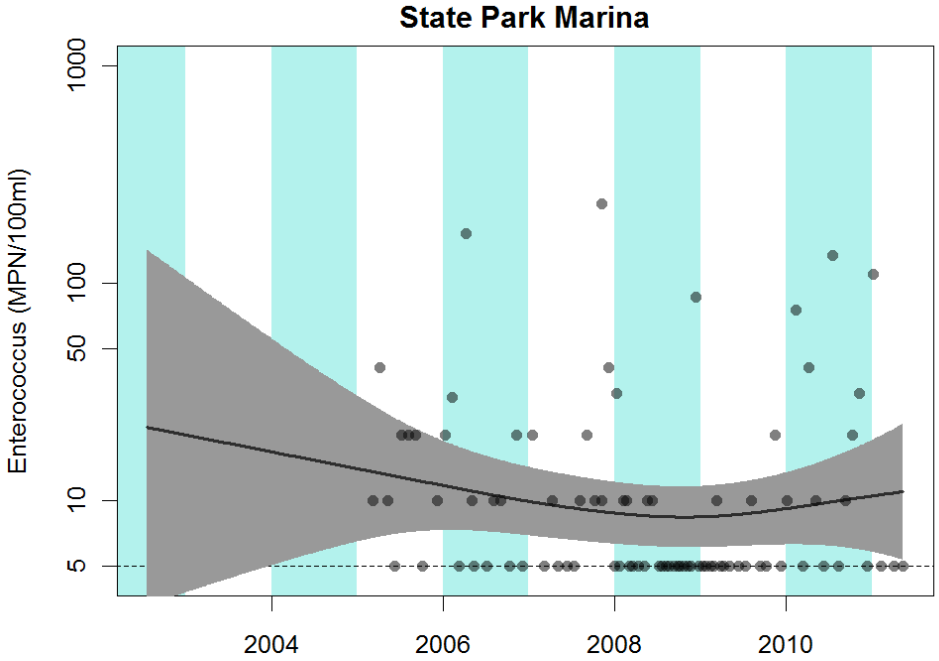
The following graph shows the % of samples that exceeded the 104 MPN/100 mL regulatory standard for safe recreational contact for *Enterococcus spp*.



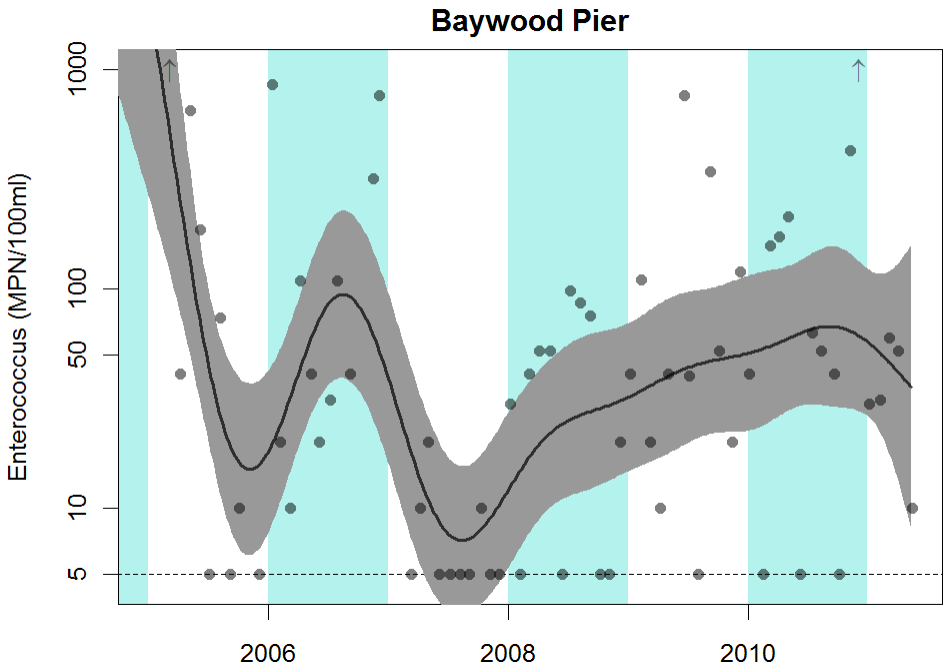
A statistical analysis was conducted to track the long-term trends of the bacteria data, rather than the year-to-year fluctuations. The black line on the plot shows the geomean of the *Enterococcus spp*. concentration over time using smoothing splines. The gray band indicates the error band for the geomean, meaning the "true" geomean could be anywhere within the band. Wider error bands indicate more variability in the data or less data available for analysis. The wide error bands prior to 2005 are due to a lack of data. The first three plots are for the sites located toward the north end of the bay: Coleman Beach, Tidelands Park and State Park Marina. For all three sites, the long-term trend and the error band are well below 104 MPN/100 mL.

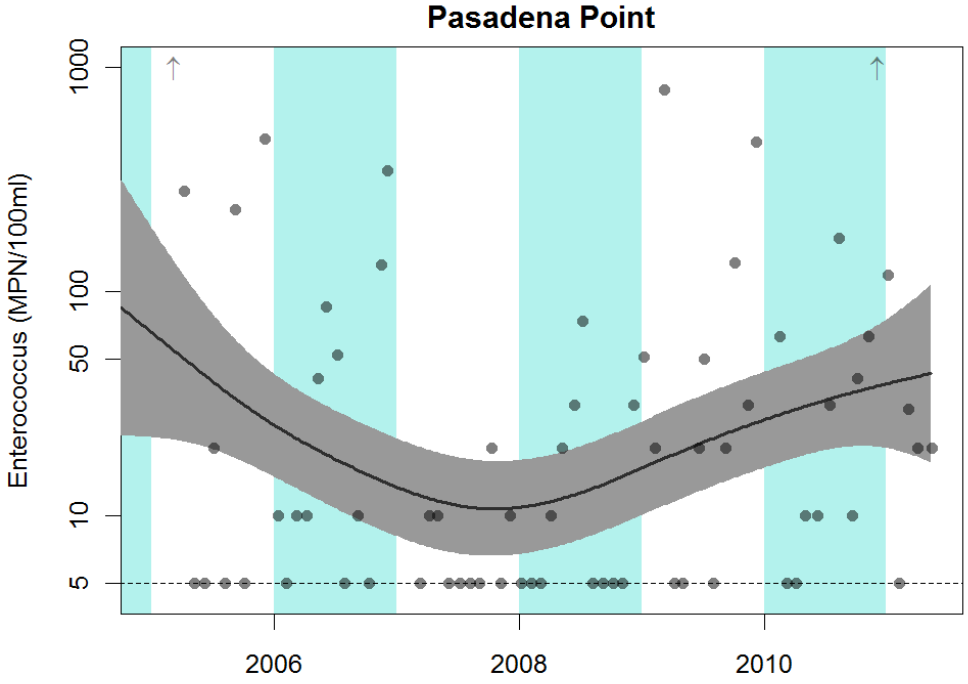


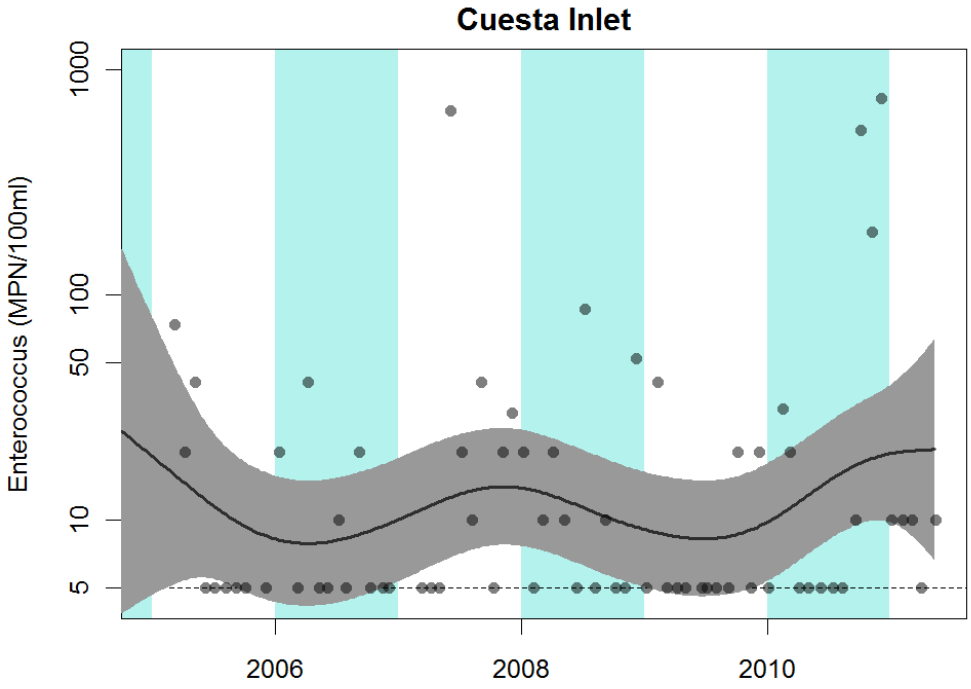




The following three plots are for monitoring sites in the back bay: Baywood Pier, Pasadena Point and Cuesta Inlet. Baywood Pier and Pasadena Point have *Enterococcus spp*. trend lines that are elevated as compared to the sites in the front bay and to Cuesta Inlet in the back bay. The up arrows represent individual data records that exceeded 1,000 MPN/100 mL.


Baywood Pier
Enterococcus (MPN/100ml)
1000
100
50
10
5
2006
2008
2010


Pasadena Point
Enterococcus (MPN/100ml)
1000
100
50
10
5
2006
2008
2010



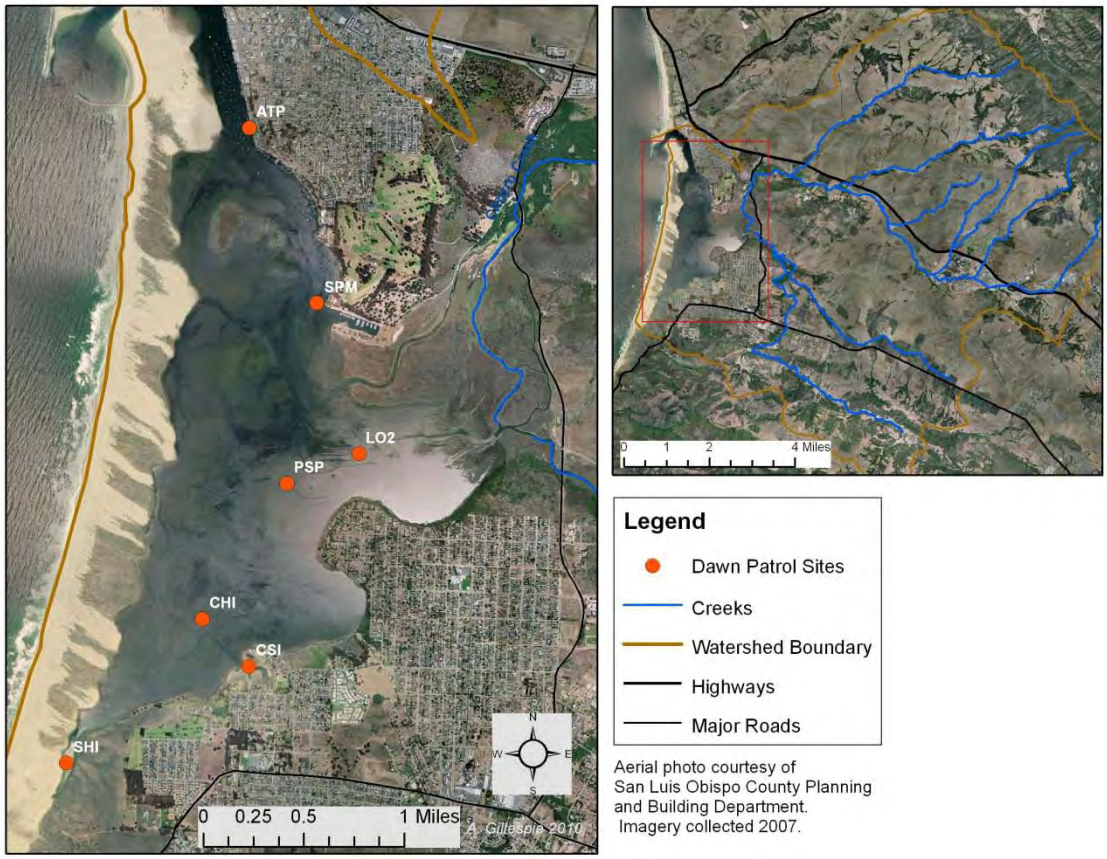
DAWN PATROL

SITE MAP AND DESCRIPTION

Early morning dissolved oxygen (DO) readings in the bay were monitored from 2002 to the present. Seven sites are monitored on a monthly basis in the pre-dawn or early morning hours. Volunteers kayak to the sites and take surface measurements of temperature, salinity, and DO percent saturation and concentration. Measurements collected with continuous monitoring equipment demonstrated that depressed DO levels continued until approximately two hours after sunrise. Thus, rather than sending volunteers out in the pre-dawn hours, the monitoring schedule was revised for within two hours of sunrise, which still allowed volunteers to capture the desired data.

The Central Coast Region Basin Plan states that bay DO concentrations must remain above 5.0 mg/L to be protective of marine aquatic life.

The monitoring sites were selected to provide a wide spatial distribution throughout the bay. The sites are divided into two regions which are covered by two separate monitoring teams each month. The front bay sites include Tidelands Park (ATP), State Park Marina (SPM), near the Los Osos Creek tributary in the mudflat area (LO2), and Pasadena Point (PSP) in the channel. The back bay sites include the main channel off of Cuesta Inlet (CHI), Cuesta Inlet (CSI), and Sharks Inlet (SHI). The two sets of sites were not necessarily monitored on the same day.



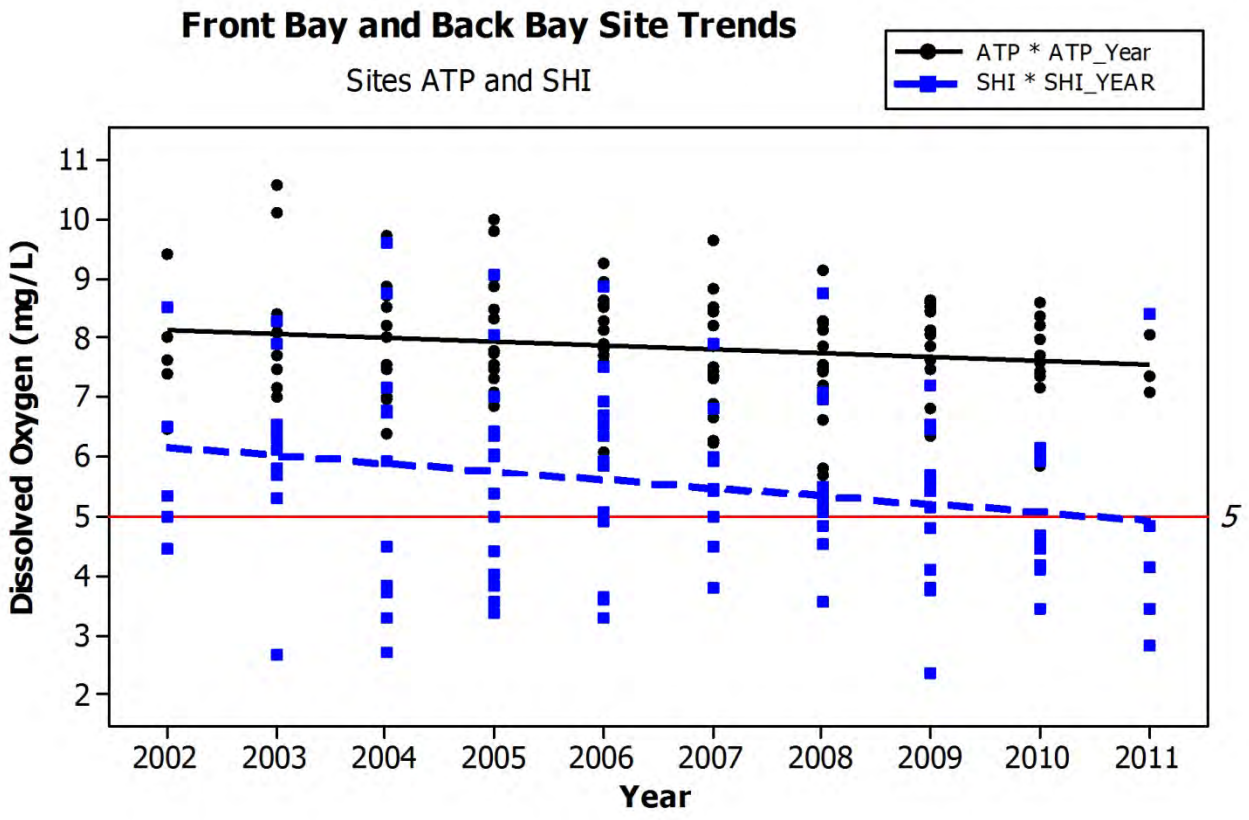
DAWN PATROL DO N VALUE SUMMARY

The following table shows the number of readings taken at each site by year. The table also shows the number and percent of samples that exceeded the 5.0 mg/L regulatory standard that is protective of marine habitat.

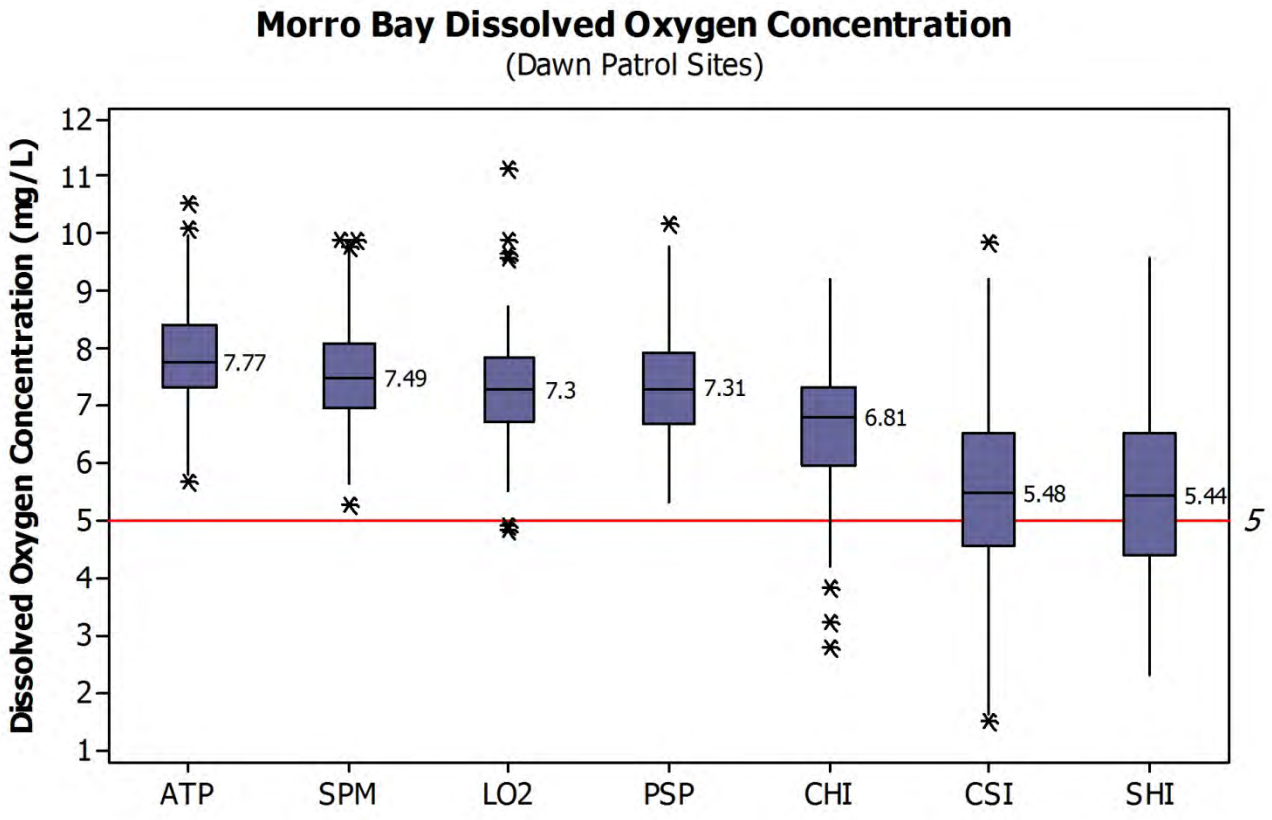
Sites	2002*	2003	2004	2005	2006	2007	2008	2009	2010	2011*	Sample Size	# of Exceed-ances	% of Exceed-ances
ATP	6	10	11	14	13	15	13	12	12	5	111	0	0
SPM	6	10	11	9	7	12	13	12	12	5	98	0	0
LO2	6	11	10	8	8	12	13	12	12	5	95	2	2
PSP	6	11	10	9	8	12	13	12	12	5	99	0	0
CHI	4	11	11	14	12	12	11	12	10	5	105	10	10
CSI	4	11	13	15	13	12	11	12	10	5	108	31	31
SHI	5	11	10	14	13	9	11	12	10	5	102	36	36

**2002 data includes June-December 2002. 2011 data includes January-May 2011.*

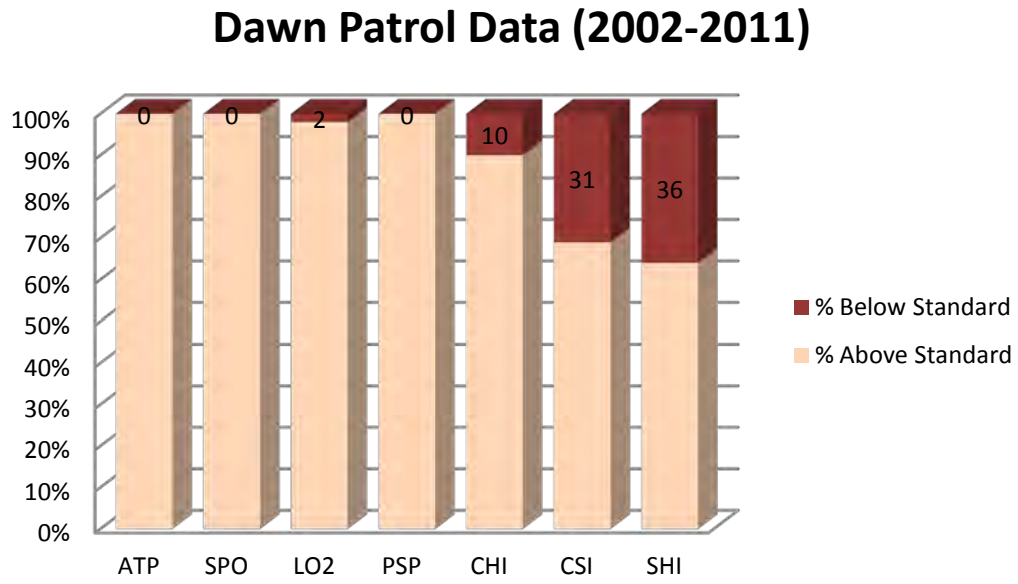
The following figure is a scatter plot of surface level DO levels at two sites, Tidelands Park (ATP) and Sharks Inlet (SHI). The southernmost site of Sharks Inlet (in blue) exhibits DO levels that tended to remain in the 5 to 6 mg/L range. The dashed blue line represents the trend line for the data, indicating a slight downward trend in DO levels between 2002 and 2011. In comparison, the front bay site at Tidelands Park (shown in black) consistently had levels at or above 7.0 mg/L. The trend line is represented by the solid black line, which is exhibiting decreased DO over time.



The next figure indicates the median DO levels at each of the sites. The centerline of the box plots indicates the median DO concentration for each site, and the interquartile range is shown in the box (Q1 to Q3, the middle 50% of the data). The upper whisker extends to the highest data value within the upper limit. The upper limit = Q3 + 1.5 (Q3 – Q1). The lower whisker extends to the lowest value within the lower limit. The lower limit = Q1 – 1.5 (Q3-Q1). Outliers are indicated by * marks. The width of each box is proportional to the amount of data available from each site. The red line indicates the Basin Plan DO standard of 5.0 mg/L that is protective of marine life. The data show the expected trend of higher DO levels along the main channel with more tidal flushing (ATP, SPM, LO2 and PSP) and lower DO levels in the back bay areas (CHI, CSI, SHI). Concentrations below 5.0 mg/L were regularly observed in the summer time. The low DO levels in the back bay could be a naturally-occurring phenomenon due to a lack of tidal flushing.



The following bar graph shows the percent of monitoring events where the DO concentration was below 5.0 mg/L for each site.



SHOREBIRD MONITORING

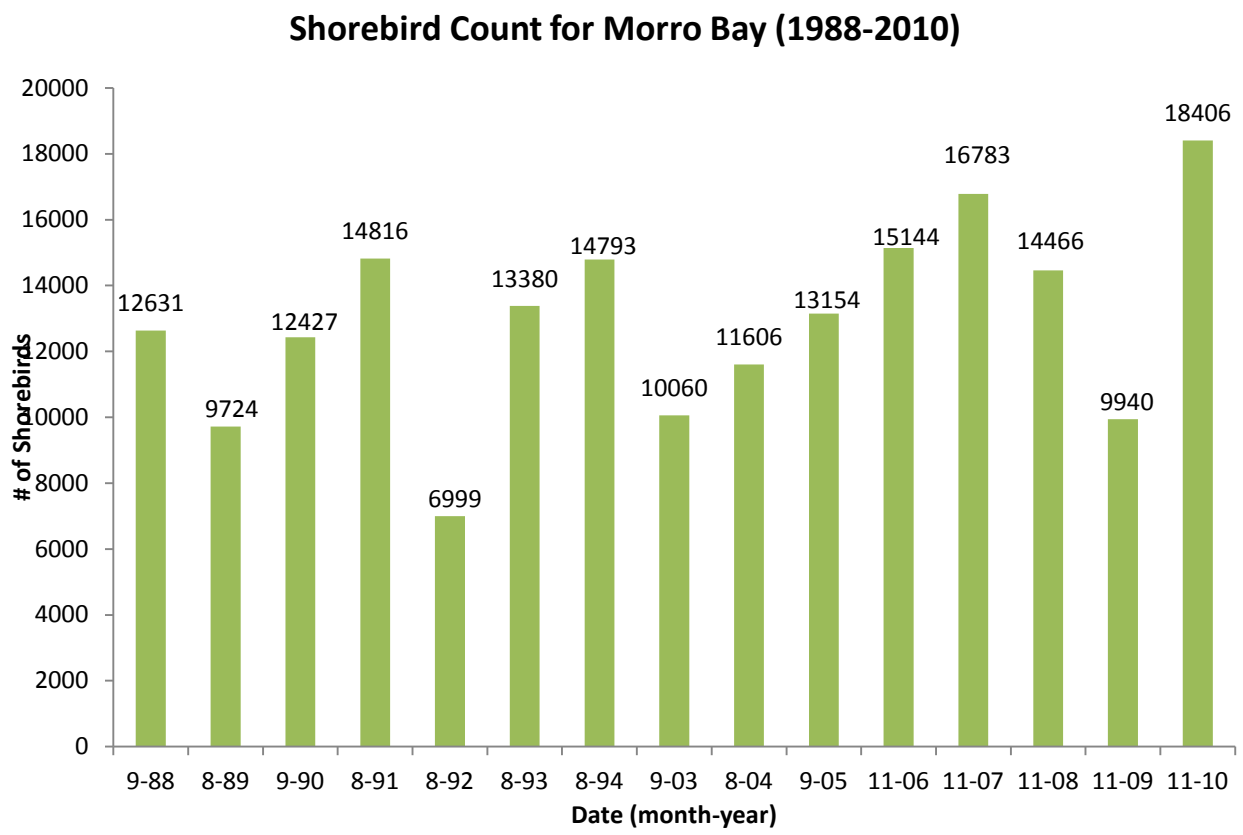
A shorebird survey has been conducted each fall, starting in 2003. The bay, sand spit and Morro strand beach are divided into 15 distinct regions. One to two birders occupy each region and conduct a count during a two-hour period. Depending on the conditions of the region, birders conduct counts from boats or at specified lookouts on land. They conduct species counts of shorebirds in their region while trying not to double count birds leaving one region and traveling to another. The protocol was developed by the Pt. Reyes Bird Observatory (PRBO) to monitor activity along the Pacific Flyway, and surveys were coordinated for Morro Bay by local birder Marlin Harms from the mid-1980s through the mid-1990s. When the MBNEP restarted this monitoring effort in 2003, the PRBO methodologies were adopted so that the recent trends could be compared with the historical data.

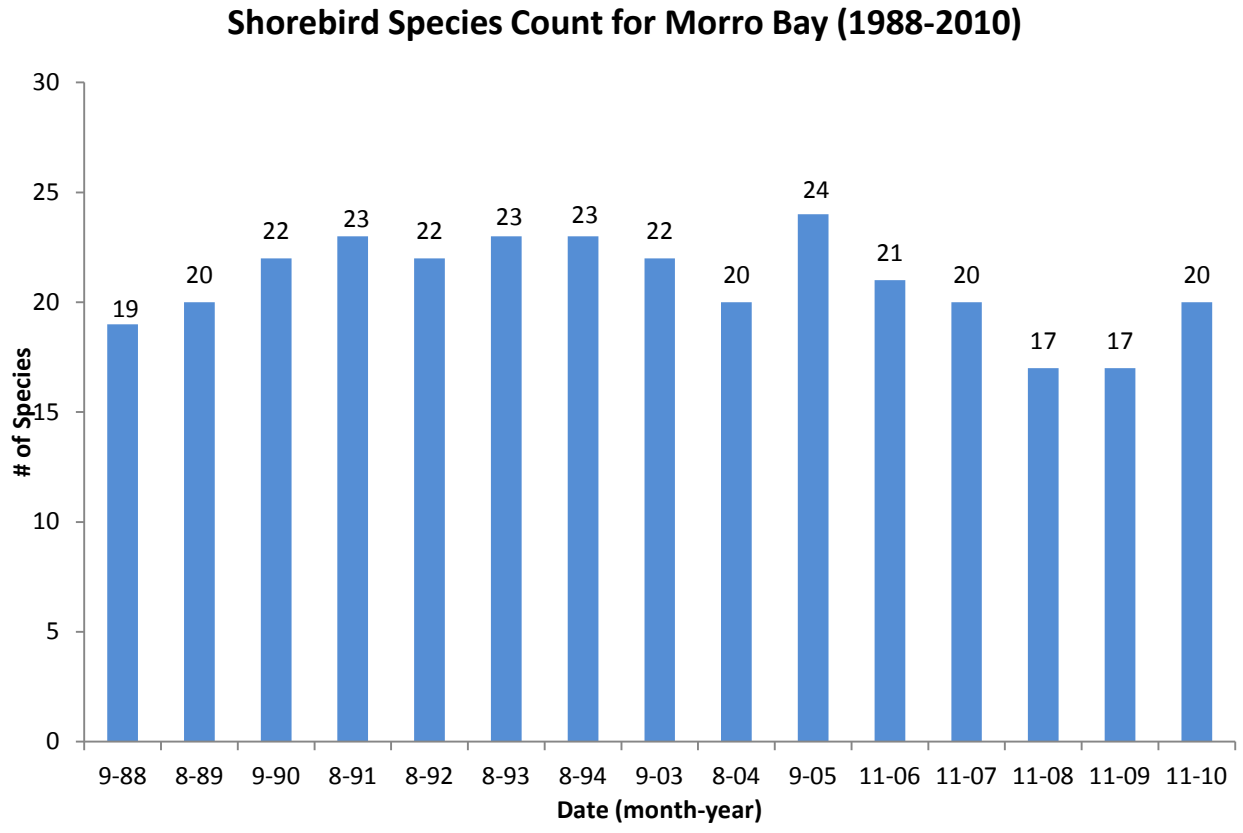
The following maps show the areas covered by the survey and the 15 regions.


15
14
13
12
2
3
4

In the fall of 2006, PRBO restarted its flyway monitoring effort. Volunteers in San Francisco, Humboldt, San Diego, Bolsa Chica, Newport Beach, Elkhorn Slough and a few other pockets in the Santa Barbara and San Diego areas conducted their counts during a one-week period. A longer survey period was allowed due to the varying tidal conditions required by each individual area.

The following figure shows the shorebird count totals.


Shorebird Count for Morro Bay (1988-2010)
# of Shorebirds
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
12631
9724
12427
14816
6999
13380
14793
10060
11606
13154
15144
16783
14466
9940
18406
9-88
8-89
9-90
8-91
8-92
8-93
8-94
9-03
8-04
9-05
11-06
11-07
11-08
11-09
11-10
Date (month-year)


Shorebird Species Count for Morro Bay (1988-2010)
# of Species
30
25
20
15
10
5
0
19
20
22
23
22
23
23
22
20
24
21
20
17
17
20
9-88
8-89
9-90
8-91
8-92
8-93
8-94
9-03
8-04
9-05
11-06
11-07
11-08
11-09
11-10
Date (month-year)

The average number of shorebirds for fall surveys was 12,955 birds and the average species counted was 21.

The reason for the elevated fall counts in 2006 and 2007 was likely a shifting of the survey date. While fall surveys had historically been conducted in August or September, the survey date was shifted back to November when coordination began with PRBO.

The survey in fall of 2009 had lower counts than all but two previous surveys. While the tide was high (5.1' at 11:45 a.m.), it was not as extreme as the tide for the previous year's survey (7' at 10:30 a.m. going down to -1.2' at 6 p.m.). The team monitoring the sand spit conducted their counts from 8:15 to 10:45 a.m. while the remaining sectors were counted from 10 a.m. to noon. If the birds were moving a great deal, these varying survey times made the data less accurate.

The survey in fall of 2010 had the highest count since 2003, although the timing of the survey was not consistent over that timeframe. The most abundant shorebird was the Least Sandpiper and the least abundant was the Long-billed Dowitcher. A total of 63 white pelicans were spotted, and a black skimmer was spotted toward the mouth of the bay.

PHYTOPLANKTON

Volunteers collect samples once a month throughout the year. Samples are collected by lowering a 20 um net into the water at the north T-Pier near the Coast Guard/Harbor Patrol station in Morro Bay. Volunteers then conduct taxa counts under the microscope and identify plankton down to the genus level. The datasheet and a preserved sample are sent to the California Department of Public Health (CDPH) to assist them with biotoxin monitoring to ensure the safety of farmed and sport harvested shellfish for human consumption. This effort was started in conjunction with CDPH in May of 2002.

Since the data is not used as a bioindicator for the watershed, it will not be summarized in this report. As far as toxic organisms present, monitoring since May 2002 have yielded 131 pulls containing species known to produce domoic acid and 23 pulls with species potentially containing paralytic shellfish poison toxins, out of a total of 209 pulls.

4.0 IMPLEMENTATION EFFECTIVENESS ANALYSIS

The MBNEP is focused on conducting implementation effectiveness monitoring, in addition to continuing the ambient monitoring efforts that have been underway in the Morro Bay watershed for many years. This effort is referred to as implementation effectiveness monitoring (IEP) and consists of targeted monitoring and analysis designed to evaluate water quality and habitat benefits resulting from specific restoration actions and projects.

To better determine the significance of these projects, the program consulted with Dr. Andrew Schaffner, a professor in the Department of Statistics at Cal Poly.

The following table contains an overview of the projects analyzed for effectiveness.

Project Status	Status of IEP Analysis	Comments
California Men's Colony Wastewater Treatment Plant Upgrade	Completed	See the following discussion for further details.
San Bernardo Creek Riparian Fencing Project	Ongoing	See the following discussion for further details.
Walters Creek Restoration, Phase II	Ongoing	See the following discussion for further details.
Dairy Creek Best Management Practices Implementation	Ongoing	See the following discussion for further details.
San Luisito Creek Riparian Fencing Project	Ongoing	See the following discussion for further details.
Walters Creek Riparian Fencing	Ongoing	See the following discussion for further details.

In some cases, pre-project data was collected by an agency other than the MBNEP and its Volunteer Monitoring Program (VMP).

CALIFORNIA MEN'S COLONY WWTP UPGRADE

Project background: Wastewater from the California Men's Colony (CMC), a state correctional facility, Cuesta College and the Camp San Luis Obispo California National Guard base, is collected and treated at the CMC Wastewater Treatment Plant (WWTP) located near Cuesta College. The effluent is discharged directly to Chorro Creek, the largest tributary to Morro Bay. The facility was aging and undersized, and rather than upgrade the system, a new facility was constructed. The new treatment plant went on-line in 2007 and includes an oxidation ditch and more advanced treatment infrastructure. The new facility was not required to meet its mandated discharge requirements during an interim period from May 31, 2007 through September 30, 2007 while the microbial population was building up in the oxidation ditch. Chorro Creek had historically contained elevated nitrate and orthophosphate concentrations downstream from the treatment plant outfall.

Expected project benefits: The new facility was constructed with technology to reduce the concentration of nitrogen in the plant effluent and reduce the frequency and volume of sewage spills. Anticipated secondary benefits resulting from reduced nitrogen inputs included reduced nuisance algal buildup and reduced orthophosphate levels in Chorro Creek. With the plant upgrade completed, our effectiveness monitoring tracked changes in nitrate and orthophosphate levels downstream of the plant.

Existing data: Concentrations of Nitrates as N and orthophosphates as PO_4 were monitored by the VMP at one site on Chorro Creek upstream and at four sites downstream of the plant outfall. Data was collected at each site at least on a monthly basis. Some of the sites were sampled more frequently than monthly, depending on volunteer availability. In January 2008, a targeted nutrient monitoring effort was begun along Chorro Creek. Rather than collecting data from the multiple Chorro sites on different days as had been done in the past, monitoring took place at the one upstream site and three of the downstream sites during a single outing. All samples were collected within a 45-minute time period, starting with the most upstream site. This targeted monitoring was conducted on a monthly basis.

In addition to the VMP monitoring, data on the concentrations of nutrients and other parameters is generated by the CMC from five points in Chorro Creek: immediately below Chorro Dam, one hundred feet upstream of the outfall, one hundred feet downstream of the outfall, at the Cal Poly vineyard property (which is also an MBNEP monitoring site with code UCR), and at Twin Bridges (an MBNEP monitoring site with code TWB). Intermittent data was obtained from the Central Coast Regional Water Quality Control Board (CCRWQCB) records for monitoring between January 2000 and project completion in September 2007. All available CMC data was obtained between October 2007 and April 2011. MBNEP-generated data through May 2011 was included in the analysis.

IEP activities: Comprehensive monthly water quality monitoring was conducted at all five sites, four of which were downstream of the project. Dissolved oxygen, temperature, pH, turbidity, conductivity, flow, nitrates as N and orthophosphates as PO_4 were monitored monthly to provide post-project data. Targeted nutrient monitoring on Chorro Creek sites was conducted where multiple sites were monitored in a single run to improve the power of the statistical analysis.

Annual macroinvertebrate monitoring and physical habitat assessment (including substrate diversity, in-stream habitat, canopy cover, and erosion) were conducted throughout the project assessment period. Pre- and post-project monitoring was conducted at a historical site located downstream of the plant on the Ecological Reserve (CER), at a site further downstream below Twin Bridges (TWB), and at an upstream site at Chorro Dam (CHD). Following project completion, improvements in freshwater invertebrate diversity were anticipated at the CER site.

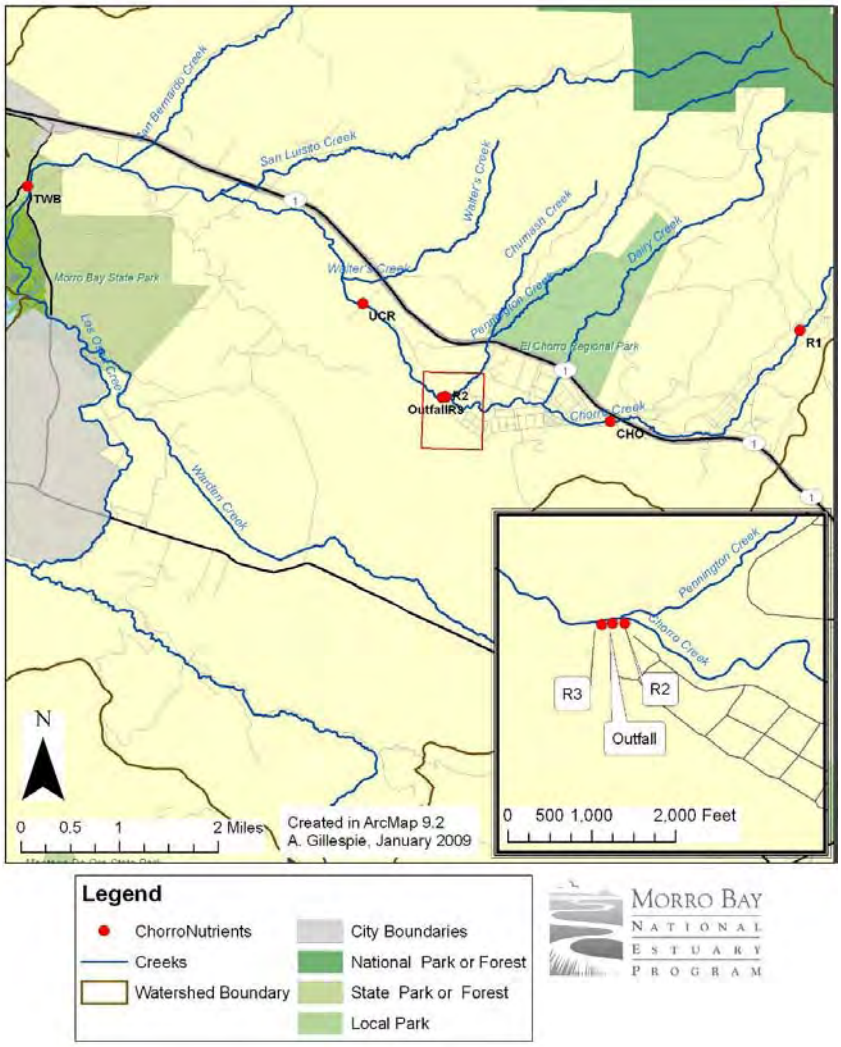
Data on algae was also collected during the bioassessment monitoring effort. Percent coverage of algae and the percent of the assessed area at a site with a high score for coverage of filamentous algae were determined. Monitoring took place at CHD (upstream of the plant outfall) and at CER (downstream of the outfall).

IEP data analysis: The nutrient concentration data underwent statistical analysis, including temporal sorting, to determine how best to combine historic and current sources of data. The sites monitored for nutrients are described in the following table.

Site Code	Site Description	Location With Respect to CMC WWTP	Party Responsible for Monitoring
R1	Directly below Chorro Dam	Upstream	CMC
CHO	On Camp SLO property, where Highway 1 crosses Chorro Creek	Upstream	MBNEP
R2	100' upstream from the CMC WWTP outfall	Upstream	CMC
R3	100' downstream from the CMC WWTP outfall	Downstream	CMC
UCR*	At the Cal Poly vineyard property, at the top of the Chorro Creek Ecological Reserve (CCER)	Downstream	CMC, MBNEP
CER	In the middle of CCER	Downstream	MBNEP
CAN	At Canet Road, at the bottom of CCER	Downstream	MBNEP
TWB**	At the bridge on S. Bay Blvd. near State Park Rd.	Downstream	CMC, MBNEP

**CMC refers to this site as R4.*
***CMC refers to this site as R5.*

In the following analysis, sites referred to as 'upstream' are ones located upstream of the CMC WWTP outfall (R1, CHO, R2), and sites referred to as 'downstream' are ones located downstream from the outfall (R3, UCR, CER, CAN, TWB). The figure shows the locations of the monitoring sites. Note that the locations of R1 and R2 are approximate as exact site coordinates were not available.



Nitrates

The plant upgrade was specifically intended to address elevated levels of nitrogen in effluent discharged to Chorro Creek. Analysis was conducted for nitrates as nitrogen in mg/L. All analysis was conducted by a certified laboratory using EPA Method 300.0. The lab conducting the analysis for the MBNEP was able to achieve a detection limit of reporting (DLR) of 0.10 mg/L. The CMC switched labs frequently, and each lab had a different DLR. The DLRs for the nitrate as nitrogen data were as follows:

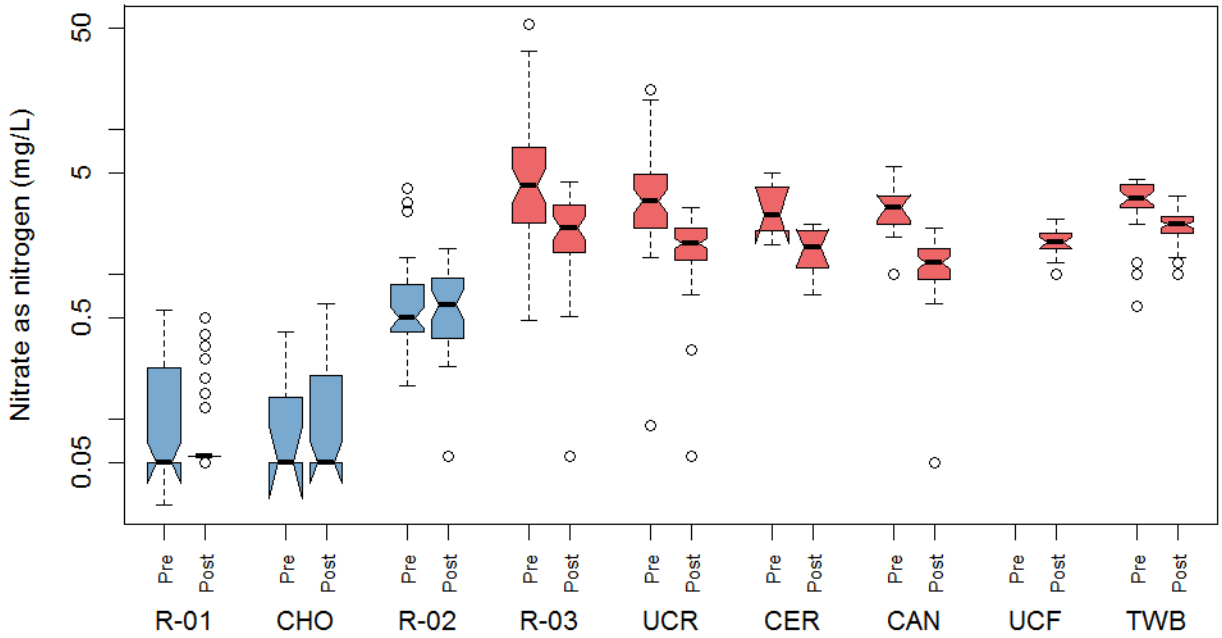
- From January 2000 to June 2001, the DLR was 0.10 mg/L.
- From July 2001 to June 2003, the DLR was 0.05 mg/L.
- From July 2003 to June 2005, the DLR was 0.45 mg/L.
- From July 2005 to July 2008, the DLR was 0.10 mg/L.
- From Aug 2008 to July 2011, the DLR was 0.11 mg/L.

For results reported by the lab as non-detect, half of the DLR value was used for analysis.

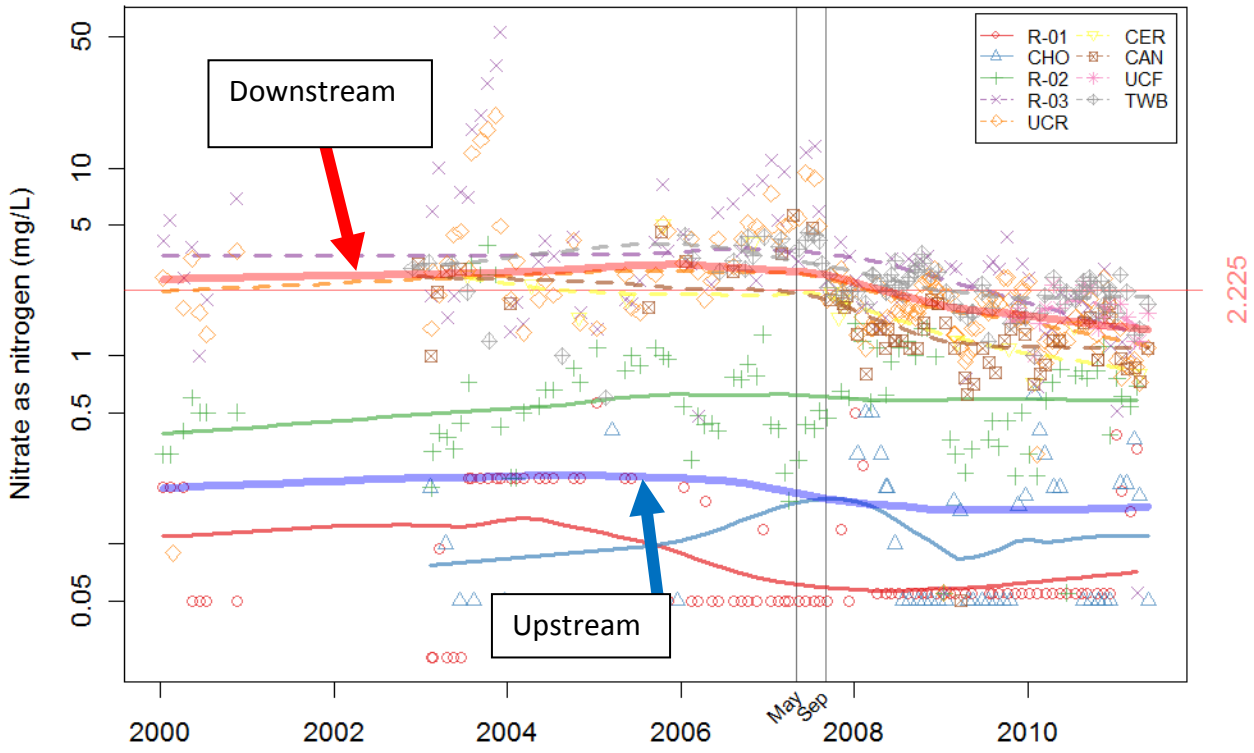
The box plot below shows the nitrogen data in mg/L before the plant upgrade (labeled ‘pre’) and after the plant upgrade (labeled ‘post’). The relative width of the boxes represents the amount of data included in the analysis. Thus, the wider boxes represent sites with more data available for analysis.

The bottom and top of the box represented 25th and 75th percentiles (the lower and upper quartiles). The dark horizontal line in each box showed the median value of the data set. The circles indicated potential outlier values. The boxes in blue were from sites upstream of the CMC WWTP, and the boxes in red are from sites downstream of the plant.

For the downstream sites, the post-project data had median values that were lower than the pre-project median values at all sites. Of interest, the upstream nitrate levels remained stable or increased post-project. As the project intended, the downstream post-project median nitrate concentrations were lower than the pre-project concentrations.



The figure below is a plot of the nitrogen values over time for each of the sites. It is simplest when analyzing this graph to observe the thick blue line which represents the averaged values for all sites upstream of the WWTP outfall and the thick red line which represents averaged values for all sites downstream of the WWTP outfall. The vertical lines through May and September of 2007 represent the time period when the plant was coming online and was not required to meet the limits listed in its permit. Pre-project data included all data prior to June 2007 and post-project data began after September 2007. Post-project, the thick red line (downstream sites) shows a slightly more downward trend than the thick blue line (upstream sites), indicating a slight change in nitrate levels after WWTP upgrade.



The following table shows the median nitrate concentrations at each monitoring site on the raw scale, both before and after the upgrade. R-01, CHO and R-02 are located upstream of the WWTP outfall, and the remaining sites are located below the outfall.

Site	Pre-upgrade Concentrations Nitrate as N (mg/L)	Post-upgrade Concentrations Nitrate as N (mg/L)	Location With Respect to CMC WWTP Outfall
R-01	0.05	0.055	Upstream
CHO	0.05	0.097	Upstream
R-02	0.50	0.615	Upstream
R-03	4.05	2.100	Downstream
UCR	3.20	1.630	Downstream
CER	2.55	1.520	Downstream
CAN	2.90	1.200	Downstream
UCF	-	1.650	Downstream
TWB	3.35	2.200	Downstream

The analysis demonstrated that after project installation, nitrate concentrations downstream of the project dropped by 51% ($p < 0.0005$) compared to upstream concentrations. In comparison, the change in nitrates upstream of the outfall following the project was only a 6% decrease ($p = 0.649$). These results were obtained with a model that accounted for a possible linear trend over time, removed seasonal variation, and took into account site specific differences (i.e., downstream sites generally had higher nitrates than upstream sites both before and after the upgrade project).

The data indicates that the plant upgrade did improve nitrate removal, with statistical modeling showing a decrease downstream of the plant relative to the upstream concentrations since the project was completed.

Orthophosphates

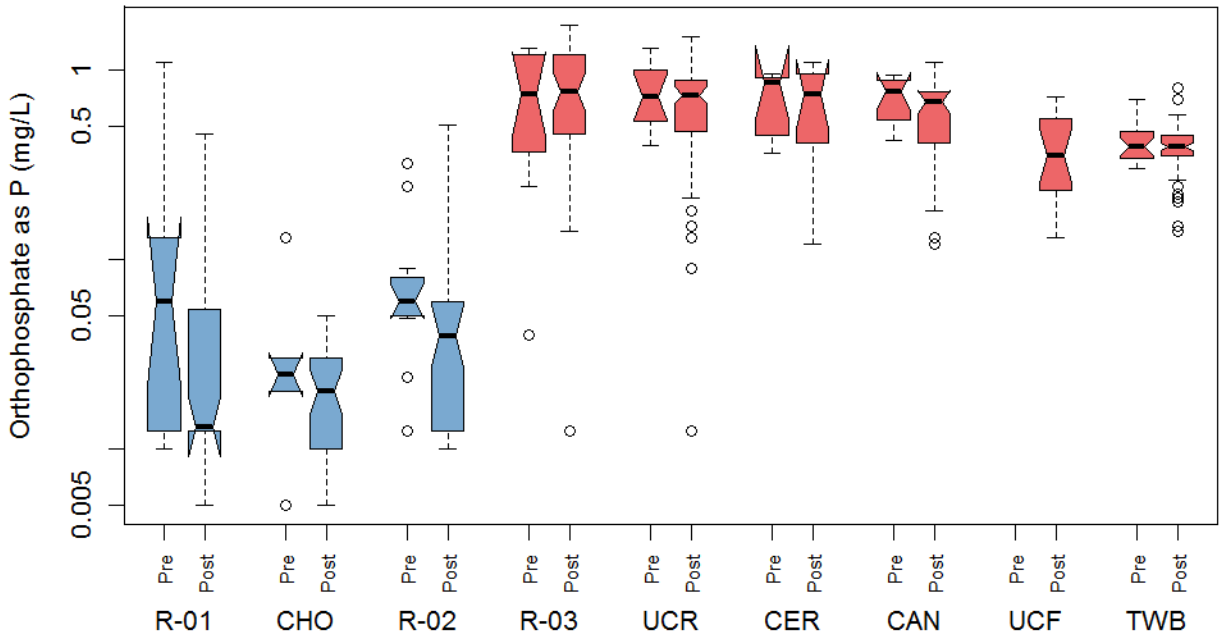
While the plant upgrade was not specifically intended to address orthophosphate levels, monitoring and analysis were conducted to determine whether there was reduction in these concentrations following the upgrade. All values were reported as orthophosphate as P in mg/L, and analysis was conducted by a certified lab. The CMC data was analyzed by EPA Method 365.3 with a DLR of 0.025 mg/L. The MBNEP data was analyzed by SM 4500-P E, which was formerly EPA Method 300.2. The DLR was 0.01 mg/L. According to the lab director at the lab formerly used by the MBNEP, Creek Environmental Laboratories, EPA Method 365.3 and SM 4500-P E provide results which are directly comparable.

For results reported by the lab as non-detect, half of the DLR value was used for calculations and analysis.

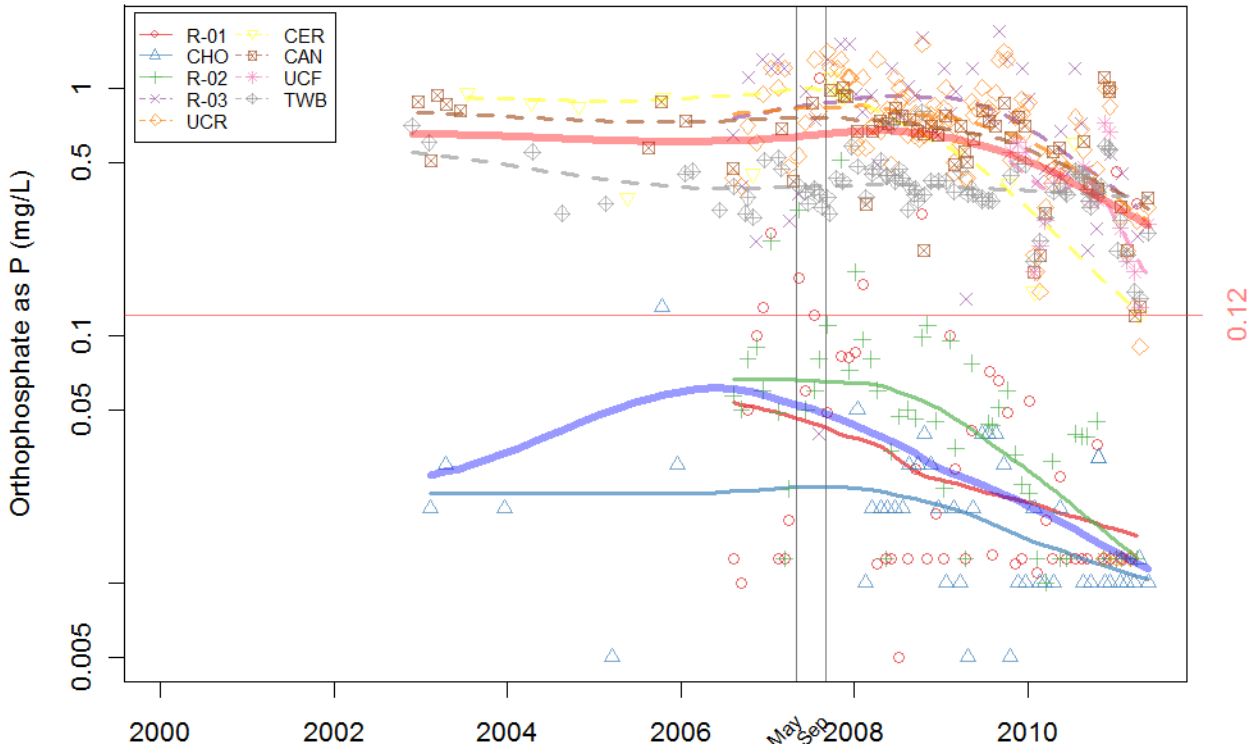
Less data was available for analysis from the CMC for orthophosphate than for nitrates. Prior to August 2006, CMC conducted analysis for organic phosphate as P, which cannot be converted to orthophosphate for a direct comparison of these two analytes.

The following figure shows the box plots of the data for the sites upstream (in blue) and downstream (in red) of the CMC WWTP. The width of the boxes represents the amount of data included in the analysis. Thus, the wider boxes represent sites with more data available for analysis. The bottom and top of the box represents 25^{th} and 75^{th} percentiles (the lower and upper quartiles). The dark horizontal line in each box shows the median value of the data set. The circles indicate potential outlier values. The boxes in blue are from sites upstream of the CMC WWTP, and the boxes in red are from sites downstream of the plant.

The data showed that at sites upstream of the WWTP, median orthophosphate concentrations decreased after the project was completed. However, downstream of the WWTP, the change post-project was mixed, with orthophosphate values remaining stable, dropping or increasing at various sites following project completion.



The following figure shows a plot of orthophosphate concentration (in mg/L) over time, with the thick blue line representing the average value for the upstream sites and the thick red line for the downstream sites. This analysis shows a slight decline in the orthophosphate levels below the treatment plant following the plant upgrade, but a steeper decline in orthophosphate levels upstream of the plant.



The following table provides the median orthophosphate as P concentrations on the raw scale. The upstream sites (R-01, CHO and R-02) all showed a decrease in median concentrations from pre-project to post-project. The downstream sites (R-03, UCR, CER, CAN and TWB) showed mixed results.

Site	Pre-upgrade Concentrations Orthophosphate as P (mg/L)	Post-upgrade Concentrations Orthophosphate as P (mg/L)	Location With Respect to CMC WWTP Outfall
R-01	0.060	0.018	Upstream
CHO	0.025	0.020	Upstream
R-02	0.060	0.0395	Upstream
R-03	0.740	0.760	Downstream
UCR	0.720	0.730	Downstream
CER	0.855	0.755	Downstream
CAN	0.770	0.670	Downstream
UCF	-	0.350	Downstream
TWB	0.390	0.390	Downstream

Using the same model that was applied to the nitrate data, further analysis was conducted. Orthophosphates were 0.295 higher on the log scale downstream of the plant post-upgrade ($p = 0.001$) compared to upstream. This difference is statistically significant ($p = 0.009$).

There is evidence that while orthophosphate concentrations are generally lower downstream of the plant post-project, these decreases are not attributable to the treatment facility but rather due to lower levels coming into the system upstream.

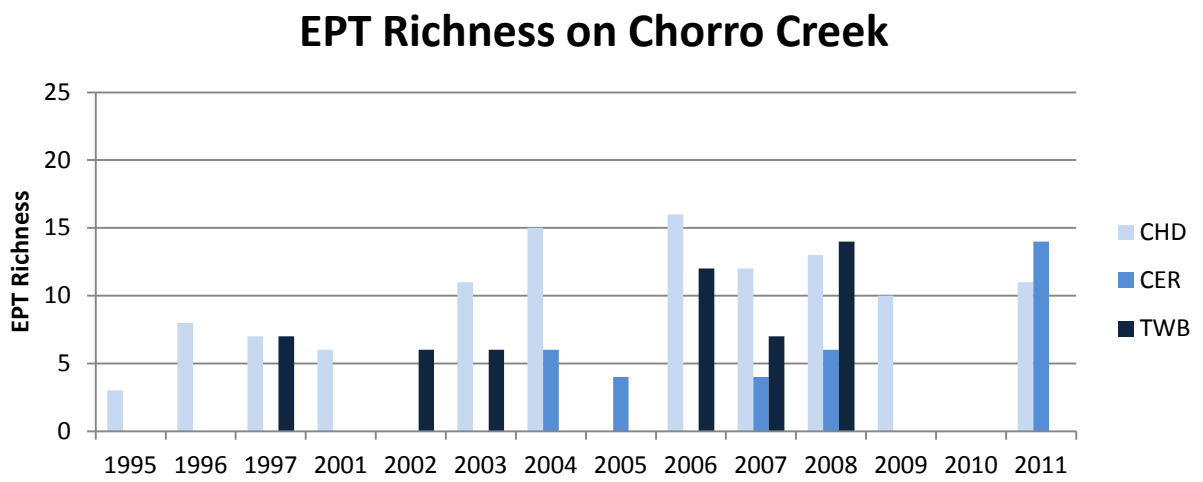
The conclusion with the data collected to date was that there was no evidence that the orthophosphate levels were affected by the plant upgrade. The project was not designed to control orthophosphates, so this result was not entirely surprising.

Macroinvertebrates

Data collected between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was finalized in spring 2007. The MBNEP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 randomly selected organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

Data collected prior to 2007 was generated using prior approved methods. The data from previous surveys was standardized by a Monte Carlo analysis and was included for comparison.

The following graph charts the changes in EPT richness over time at each Chorro Creek site. EPT richness is a count of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). CHD appeared to have seen increases in EPT richness over time. CER typically had lower scores than both the upstream and downstream sites. Following project completion, the hope is that continued monitoring will detect changes at CER. Samples from that site and downstream at TWB were collected in conjunction with the CCRWQCB. Unfortunately, that data was not yet available and could not be included in this analysis.



Algae Documenting

Beginning in 2011, algae data was collected using the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, 2010. The protocol involves point intercept measurements that determine the presence or absence of macroalgae, as well as qualitative measurement of filamentous algae coverage throughout the reach. The complete SWAMP protocol for collecting stream algae samples, including sample collection and lab analysis, was not conducted in 2011 due to limited financial and staff resources.

The CCRWQCB utilizes algae abundance data in assessing 303(d) listings and de-listings, as well as tracking TMDL implementation. The presence and density of algal blooms can be considered supporting evidence when determining whether to list a waterbody as impaired, in particular when nutrient concentrations are elevated and dissolved oxygen concentrations are erratic.

Algae data was analyzed through two data sets generated by 2011 assessments at each site. The percent coverage of macroalgae at the site was determined by calculating algae presence at wetted points located on the transects and inter-transects. This calculated value is used to represent percent algal coverage throughout the 150 m reach. The monitoring sites on Chorro Creek were located at CHD, which is below Chorro Dam on Camp San Luis Obispo property behind CMC, and CER which is located on the Chorro Creek Ecological Reserve. CHD had a percent algal coverage of 56%, the second highest score of the ten sites monitored in 2011, and CER had a percent coverage of 20%. Additionally, the qualitative spatial coverage of filamentous algae was scored for defined areas 5 m above and 5 m below each of ten transects assessed within each site. Each assessment area (10 m of wetted reach) was assigned a score between 0 to 4, with 0 indicating less than 5% algae coverage, 1 indicating < 10%

coverage, 2 indicating 10 to 40% coverage, 3 indicating 40 to 75% coverage, and 4 indicating > 75% coverage. With this metric, CHD scored 60% and CER scored 20%.

While nuisance algal blooms were more of an issue at the site upstream of the WWTP as compared to the site downstream of the plant, a possible explanation for this is differences in canopy coverage, rather than differences in nutrient loading.

Conclusions: With the data collected to date, there is evidence that the plant upgrade at the CMC WWTP resulted in a significant improvement in the removal of nitrates as nitrogen. There was no measurable impact from the project on orthophosphate as P removal. Unfortunately, three years of post-project macroinvertebrate data were not yet available. Due to a change in algae monitoring protocol, comparative analysis of data before and after project implementation was not possible. Upstream/downstream algae comparisons are difficult due to the differences in the physical habitat at the two monitoring sites. Statistical analysis demonstrated that adequate data has been collected to assess the effectiveness of CMC WWTP nutrient removal. Targeted monitoring on Chorro Creek, where all five sites were monitored in the same time period, was halted in the fall of 2011. Monthly monitoring of water quality parameters and screening-level nutrient analysis will continue into the future at five sites along the creek. Unless the CMC facility undergoes additional upgrades or changes, analysis of this project is considered to be complete.

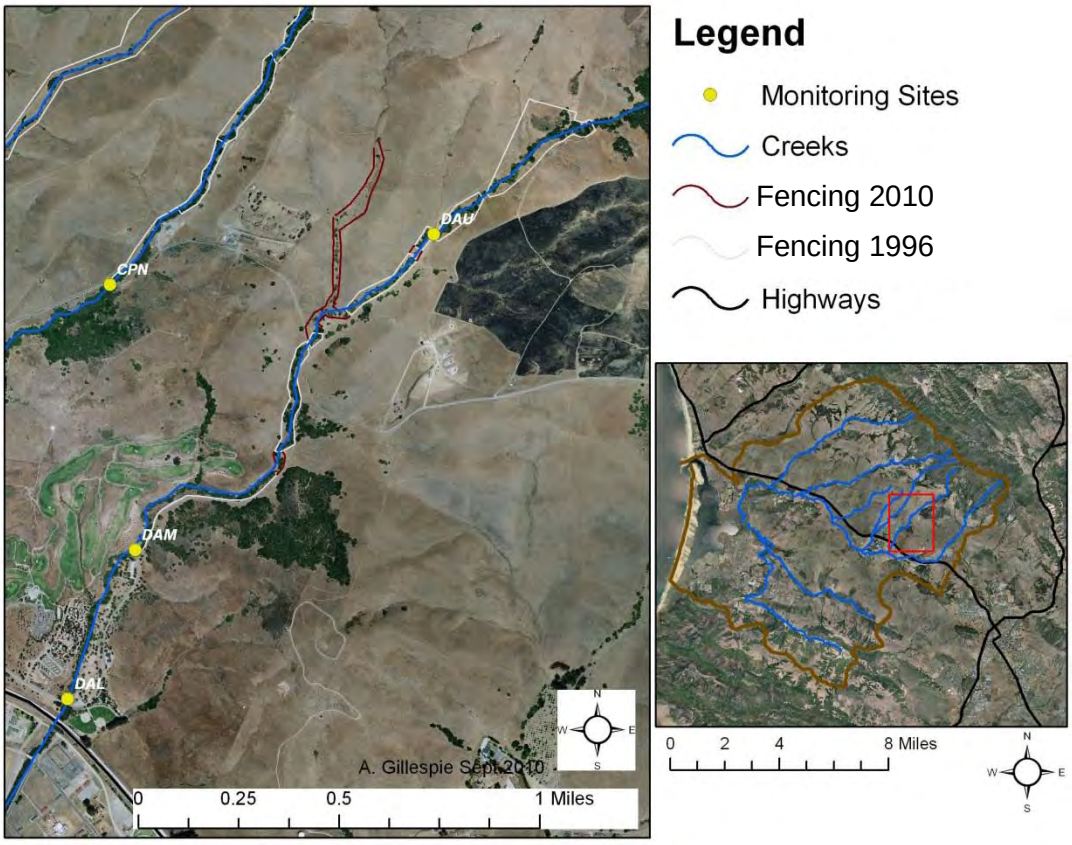
DAIRY CREEK BEST MANAGEMENT PRACTICES IMPLEMENTATION

Project background: As part of the National Monitoring Program (NMP), barbed wire fencing was installed on both banks of Dairy Creek to control cattle access to the creek. Unfenced gaps were incorporated to provide cattle limited access to a water source. The riparian corridor was re-vegetated in fenced areas. Work was completed on the lower mile of the creek in the summer of 1994 and on the upper half mile of creek fenced during the summer of 1995. In August 2010, an additional 2,028 feet of fencing were installed to close gaps in the riparian fencing, and an off-creek water system was installed. Another 5,097 feet of fencing were installed on a seasonal tributary in the upper portion of the project area. Cattle are now completely excluded from the creek throughout the entire project area with the exception of limited access for weed abatement.

Expected project benefits: The primary goal of the project was to reduce pathogenic bacteria concentrations through exclusion of cattle from the creek. The secondary goals were increased riparian vegetation, improved bank stability and improved in-stream habitat value resulting from increased dissolved oxygen levels and decreased water temperatures.

Existing data: Pre-project NMP data spanned from June 1993 to June 1996. Post-project NMP monitoring took place between July 1996 and June 2001. Three sites were monitored weekly in the wet season and twice monthly during the dry season from December 1993 until fall 2000 at Dairy lower, and until spring 2001 for the middle and upper sites. Sites were analyzed for total and fecal coliform. Sites were also monitored for water quality parameters including dissolved oxygen, temperature, pH, turbidity, conductivity, flow, nitrates as N and orthophosphates as P during the same time period. The upper Dairy Creek site (DAU) was directly upstream of the BMP implementation area and the middle site (DAM) was directly below the implementation area. The lower Dairy Creek site (DAL) was the most downstream monitoring site and was below both the project area and the El Chorro Regional Park open space.

Starting in 2002, DAL was monitored by the VMP on a monthly basis for total coliform and *E. coli*. Monitoring began at DAM in 2003 and at DAU in 2005. Beginning during the same timeframe, similar water quality constituents were analyzed on a monthly basis. However, different instruments or methodologies were used for the two data collection efforts. The following map shows the monitoring sites, as well as the locations of the fencing installed in the mid-1990s and in 2010.



Bioassessment was conducted prior to installation of BMPs prior to fencing installation in the mid-1990s at DAU, DAM and DAL. Following implementation, bioassessment was conducted by the NMP at all three sites. Historically, the MBNEP bioassessment monitoring was conducted only at DAL. Beginning in 2008, the program also began monitoring at DAM and DAU for comparison with NMP data.

IEP activities: Bacteria monitoring was continued for total coliform and *E. coli* at the three sites on a monthly basis. Because all NMP data was analyzed for fecal coliform using the multiple tube fermentation method, a study was conducted in 2008 to determine whether a useful predictive relationship existed between *E. coli* and fecal coliform data.

Samples were split, with a portion analyzed for *E.coli* using the IDEXX method and a portion analyzed for fecal coliform using the multiple tube fermentation method. These sets of values were compared to determine if a predictive relationship could be determined. The conclusion was that a useful predictive relationship did not exist between these two data sets. Thus, NMP fecal coliform data and VMP *E. coli* data could not be combined into a single data set for analysis. Instead, the project statistician

conducted an analysis using temporal sorting, which analyzed data from sites upstream and downstream of the project that were collected during the same time period to help understand the effectiveness of the project.

Bioassessment was conducted annually, which includes assessment of substrate diversity, in-stream habitat, canopy cover, and erosion. In 2011, an algae assessment protocol was added to the habitat assessment to track algal coverage.

Monthly water quality monitoring was conducted at three sites for dissolved oxygen, temperature, pH, turbidity, conductivity, flow, nitrates as N and orthophosphates as PO_4.

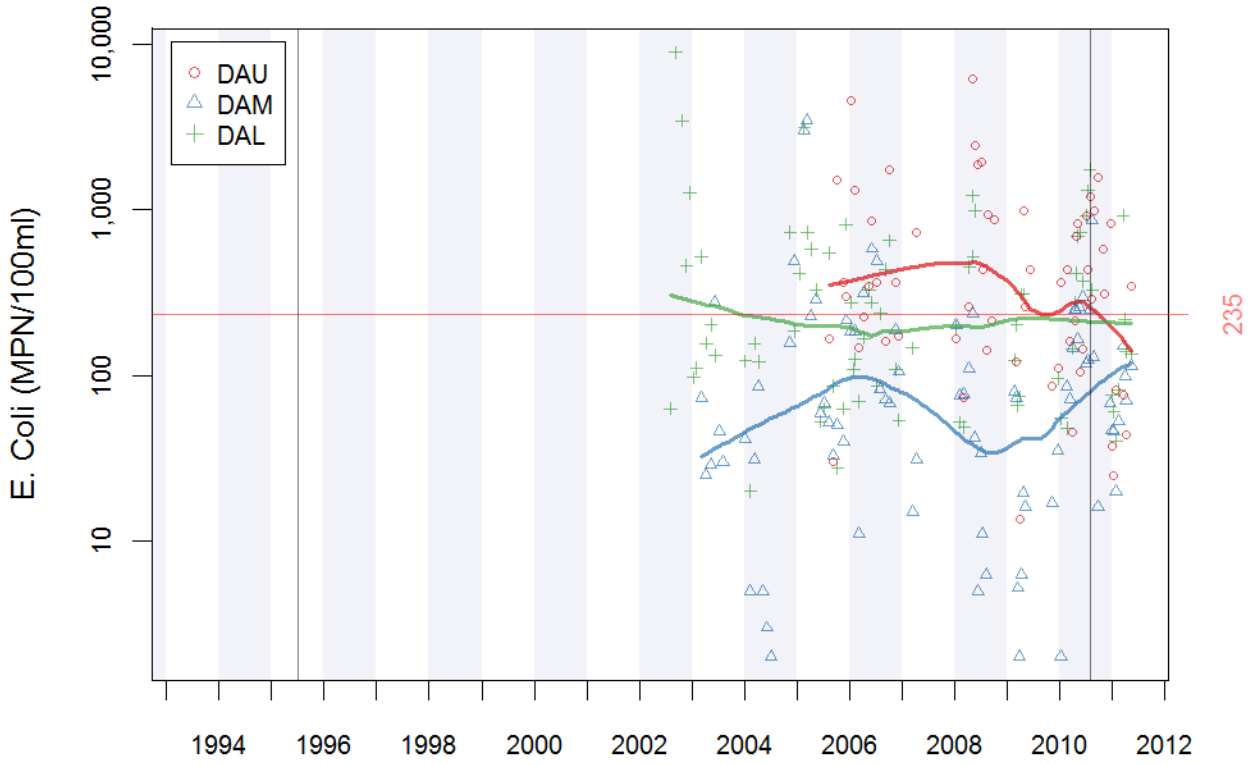
IEP data analysis: Historical data underwent a statistical analysis using temporal grouping. This means that even if pre and post-project data were not available for a particular analyte or site, that the effectiveness of the project could still be assessed because the upstream and downstream data were collected in the same time period.

Throughout the analysis, the 'pre-project' period refers to the time before any fencing was installed on the creek (1995 and earlier). 'Phase I' refers to the time period between mid-1996 (when the initial fencing was installed in the mid-1990s as part of the NMP) through July 2010. 'Phase II' refers to August 2010 later, after the remaining gaps in the fence were closed, a seasonal tributary was fenced, and an off-creek water system was installed.

Bacteria

The NMP data analyzed fecal coliform concentration, while the VMP analyzed *E. coli* concentration. A study was conducted which determined that there was no clear predictive model for converting this data from one analyte to the other, therefore a direct comparison could not be made between these two analytes. Thus, two individual statistical assessments were conducted for the two indicator species.

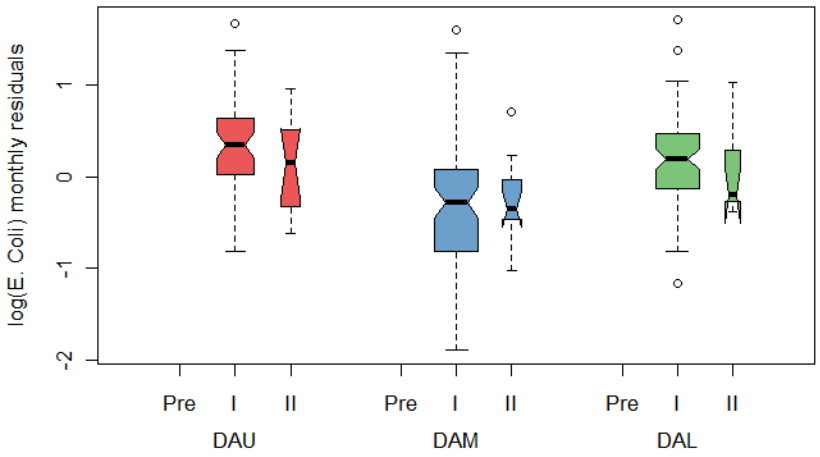
The following figure shows the *E. coli* concentrations over time. All data was collected by the MBNEP from 2002 to 2011 (following Phase I project installation). The results showed that the DAM site, immediately below the project area, had the lowest *E. coli* levels of the three sites, while DAU had the highest *E. coli* levels. The red line representing 235 MPN/100 mL indicates the EPA's recommended standard for safe recreational contact, meaning the water should be safe for swimming if the *E. coli* concentrations remain below this standard. The vertical line on the graph in the mid-1990s represents the time of Phase I fencing implemented during the NMP. The vertical line in 2010 represents Phase II fencing project.



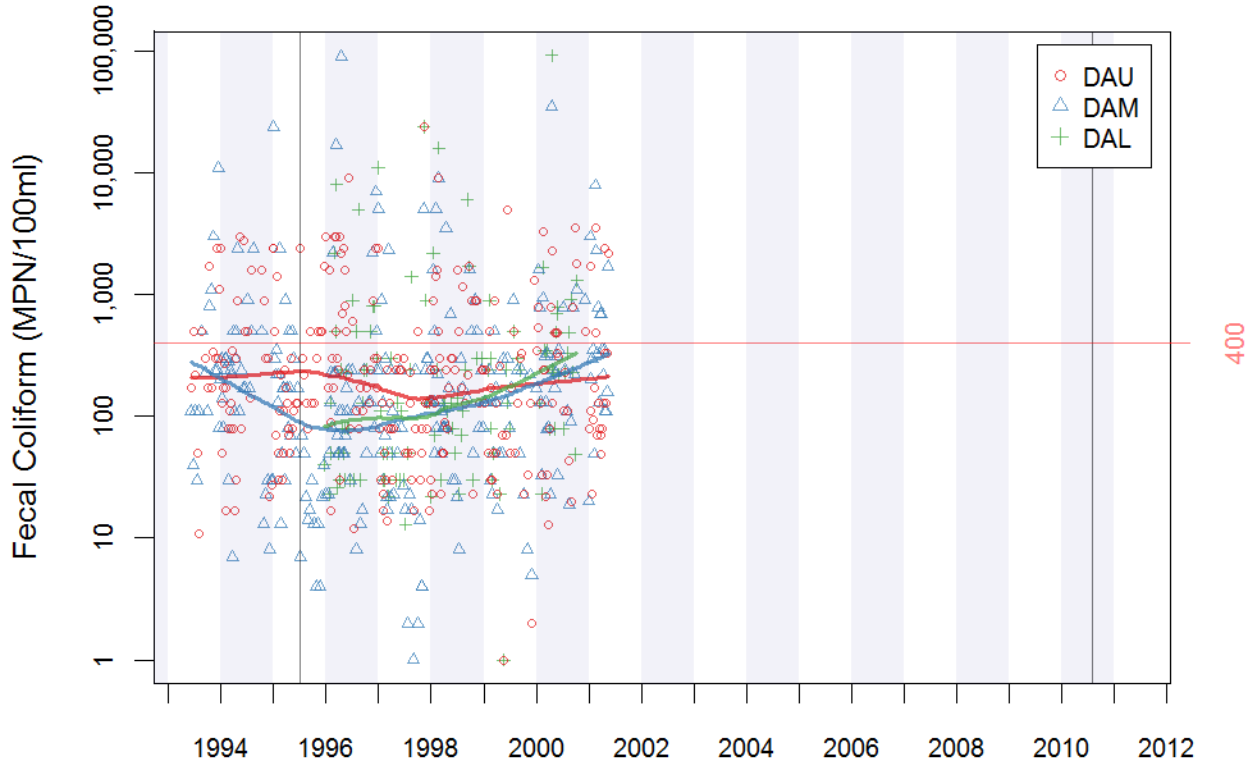
The following figure shows the *E. coli* concentrations on a log scale as notched box plots. All data shown was collected post-project, since a different bacterial indicator was used for the pre-project data collection. The boxes labeled 'I' represent data from Phase I, following the first phase of fencing installation in the mid-1990s. The boxes labeled 'II' represent data from Phase II, following the fencing installation in 2010. The width of the boxes indicates the amount of data included in the analysis. Thus, the wider boxes represent sites with more data available for analysis. The bottom and top of the box represents 25th and 75th percentiles (the lower and upper quartiles). The dark horizontal line in each box shows the median value of the data set. The circles indicate potential outlier values.

The highest median *E. coli* values in both Phase I and II were at DAU, which is the site above the project, while the lowest values were at DAM, which is the site immediately below the project. The model used for the analysis took into effect seasonal trends and removed their effect in order to focus on the effect of the project. Currently there is no significant evidence that the mean log counts differ between Phase I and Phase II, although preliminary results indicate a decrease in *E. coli* concentrations following project installation.

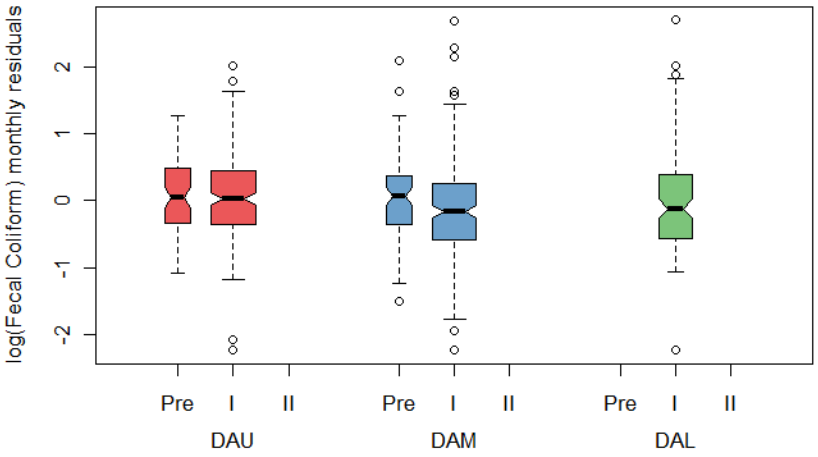
The figure shows that the mean *E. coli* count at DAL was between 116% and 448% higher than the mean count at DAM. The results were 95% confident that the mean *E. coli* counts at DAU were between 208% to 801% higher than counts at DAM, on average (with 95% confidence). Thus, bacteria concentrations decreased as water moved through the project area (between DAU and DAM). Below the project area (between DAM and DAL), the bacteria concentration increased, although not to levels as high as the concentrations at DAU.



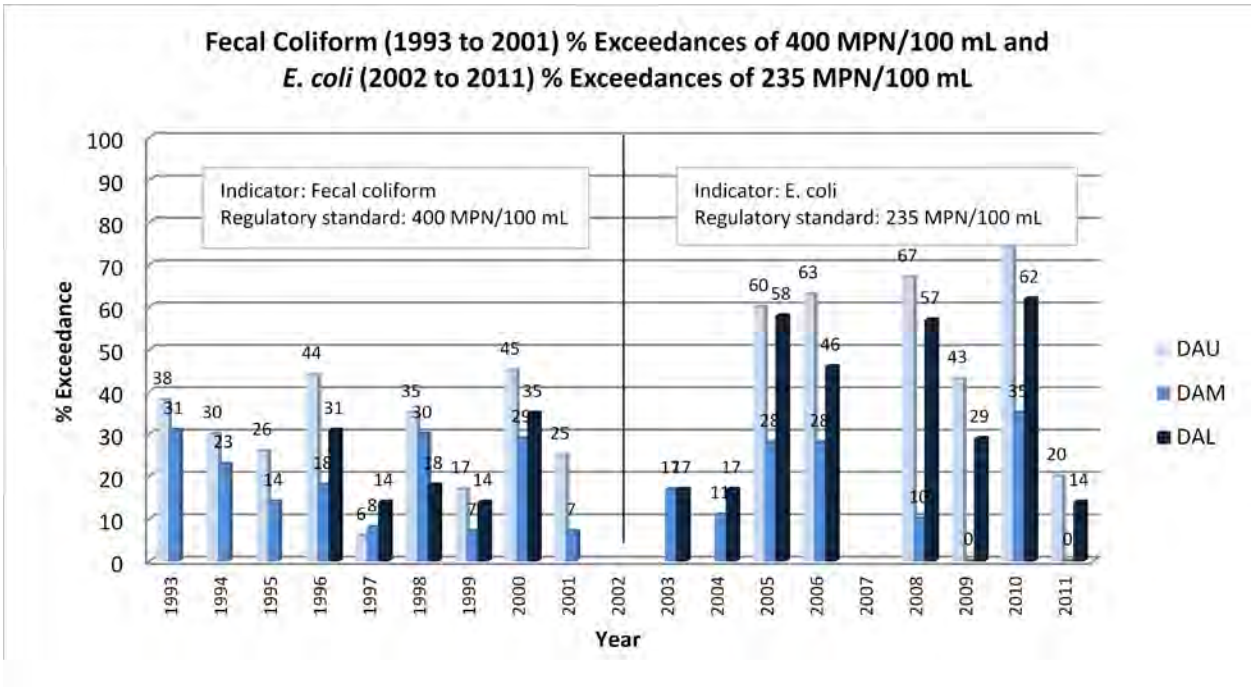
Analysis was also conducted for the fecal coliform data, which was collected by the NMP both before and immediately following Phase I implementation. The following figure provides a visualization of the range of data and of the general trends on a log scale. There was weak evidence for a difference in mean counts between DAM and DAU (with DAM means between 47.9% lower to 0.6% higher than the mean count at DAU). The red line at 400 MPN/100 mL indicates the Basin Plan standard for safe recreational contact when fecal coliform is the indicator species.



The next figure shows the notched box plots for the fecal coliform data. The graph depicts the slight decrease in fecal coliform concentrations from DAU to DAM, following Phase I project implementation. As with the analysis for *E. coli*, the model removed the effect of seasonal trends.



The following graph is a simple analysis of the bacteria data. For the NMP-collected fecal coliform data, the data were compared to the 400 MPN/100 mL regulatory limit for safe recreational contact. The percent exceedance of this standard by year for each site was plotted. For the MBNEP-collected *E. coli* data, the data were compared to the 235 MPN/100 mL regulatory limit for safe recreational contact. A cursory review of this analysis indicates that the exceedances were worse following implementation. This could be an artifact of the indicator species, rather than a real measure of change following implementation.



Note: Inadequate data was available in 2007 for inclusion in this analysis.

From pre-project to Phase I, the conclusion of the IEP analysis was that there was weak evidence for a difference between pre and post-project results at the site above and the site below the BMP implementation when fecal coliform was the indicator. In the analysis for the NMP conducted by Cal Poly and the CCRWQCB, the final report concluded that the statistical analysis showed fecal coliform levels at DAM remained the same before and after BMP implementation while fecal coliform levels at DAU improved.

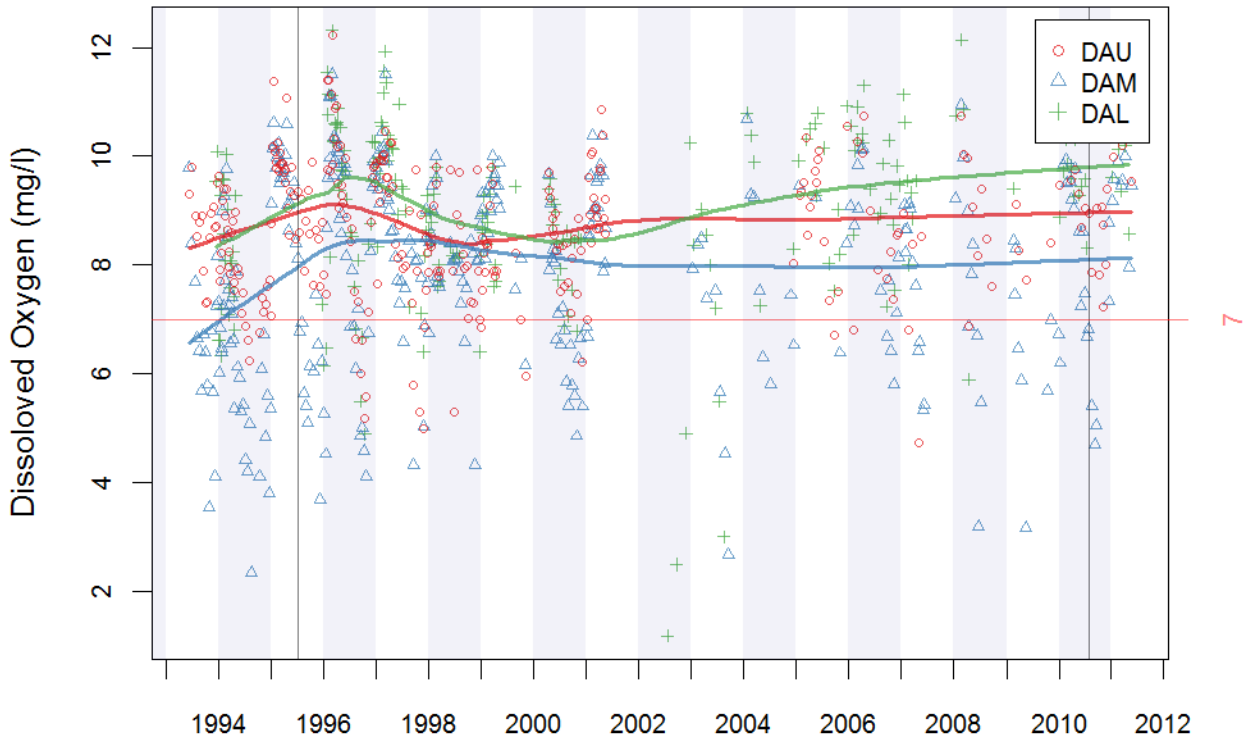
However, when *E. coli* was the indicator species during a later time period, the analysis detected a significant decrease in bacteria concentrations between DAU and DAM when comparing pre-project and Phase I data. However from DAM to DAL, an increase in *E. coli* was detected for data collected during the same time period. The time period for the *E. coli* data was completely different than the time period for fecal coliform analysis, and the effects of varying water years, cattle activity and other factors were not included in this analysis.

In comparing *E. coli* concentrations between Phase I to Phase II, currently there is no significant evidence for a project effect. However, initial data is trending in the direction of a decrease in *E. coli* concentrations following implementation of Phase II of the fencing. Additional data and analysis are needed to assess Phase II effectiveness. Project monitoring of *E. coli* concentrations at the three Dairy Creek sites will continue to allow additional analysis in the future.

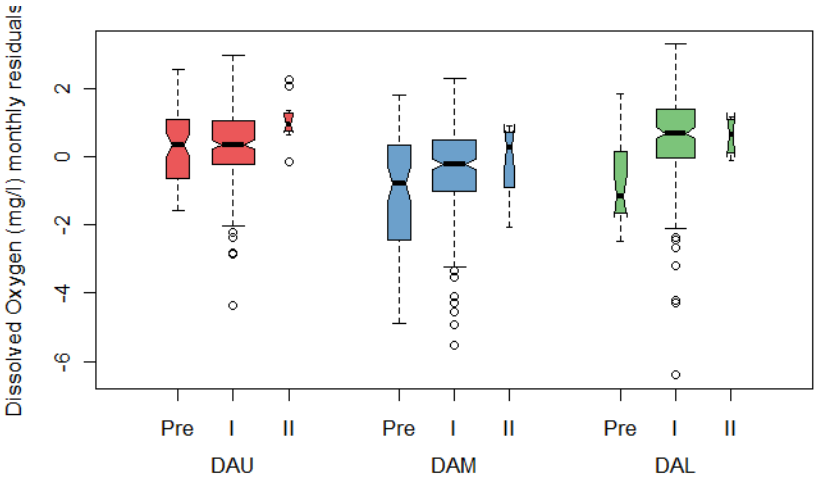
Dissolved Oxygen

Dissolved oxygen (DO) monitoring was challenging at Dairy Creek due to the intermittent nature of the creek. Most years, the creek was completely dry by late summer and did not flow again until well into winter. A temporal analysis was conducted where data collected during the same monitoring event were grouped for analysis. The NMP and the VMP data sets were combined, despite the difference in equipment used to collect the data. The NMP staff used a Hydrolab, and the VMP used either a Model 55 or Model 85 YSI unit.

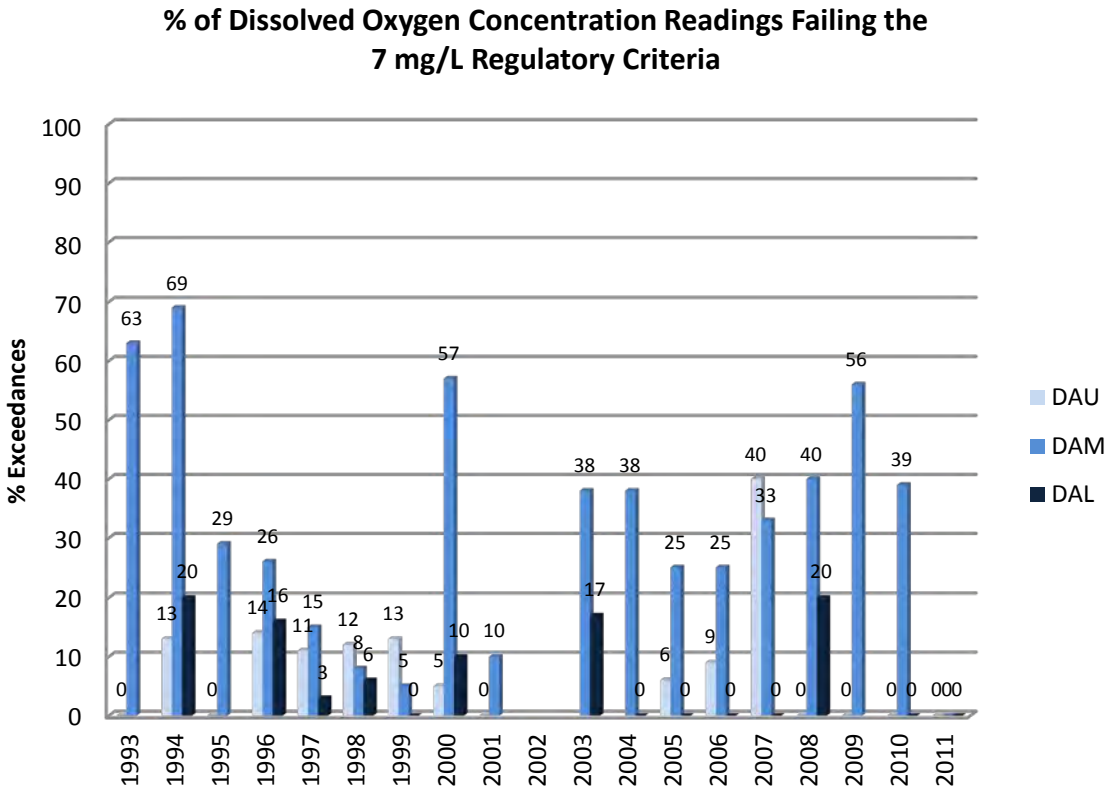
The following figure shows the range and general trend in the DO data collected over time. The plot shows the data in mg/L. The red line at 7.0 mg/L indicates the Basin Plan standard protective of aquatic life. To avoid impairment of the water body, DO levels must remain above 7.0 mg/L.



The next figure shows the notched box plots for the data at each site before implementation and after Phase I and Phase II of fencing installation. The width of the boxplot is indicative of the amount of data available for analysis. The DO concentrations increased by 1.2 mg/L at DAL (p = 0.0012) in Phase I compared to pre-project. To date, no statistically significant differences were apparent in the limited amount of data collected following Phase II implementation. The DO concentration of the water at DAU and DAM stayed the same before and after implementation of all of the projects (the median value for the pre-project, Phase I and Phase II DO levels were the same). The analysis did show evidence of improvement of DO concentrations at DAL following Phase I project implementation.



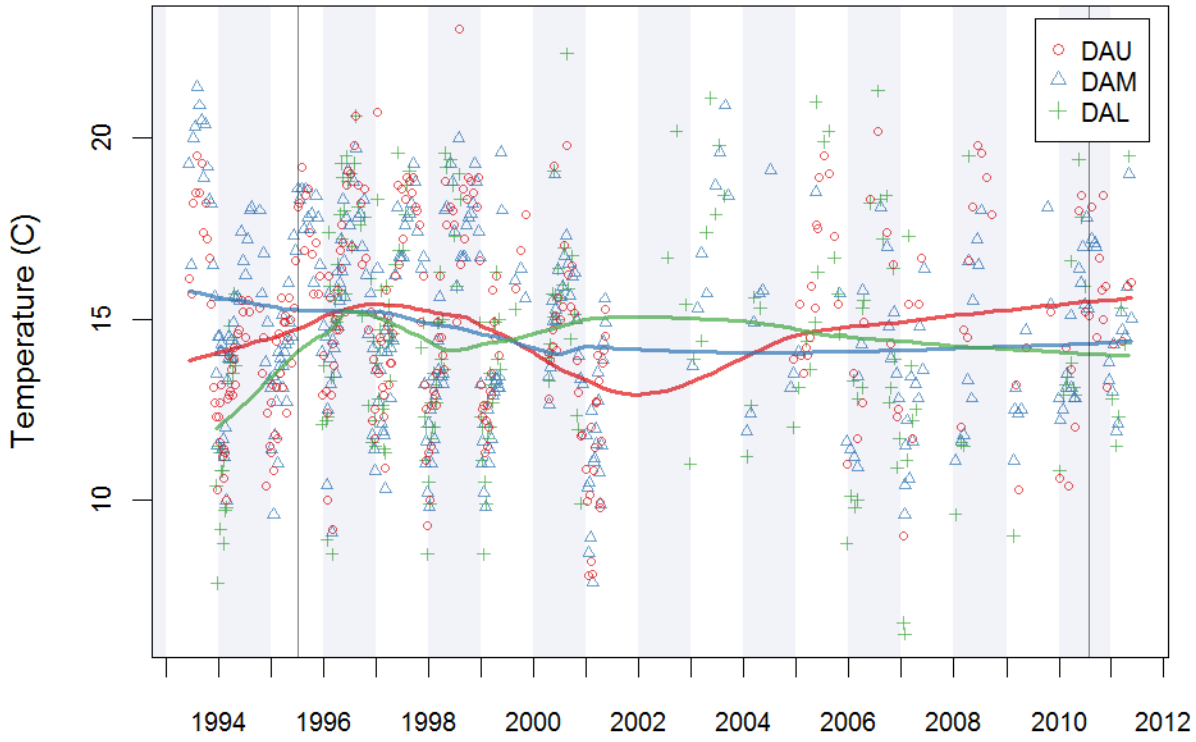
The following graph is a simple plot which illustrates the percent of measurements recorded each year that were below 7.0 mg/L, which is the Central Coast Region Basin Plan water quality objective protective of cold water habitat. Although an increase in DO concentrations at DAM before versus after project implementation was apparent in previous analyses, the following graph shows DAM as the site with the most frequent violations of the water quality objective.



Temperature

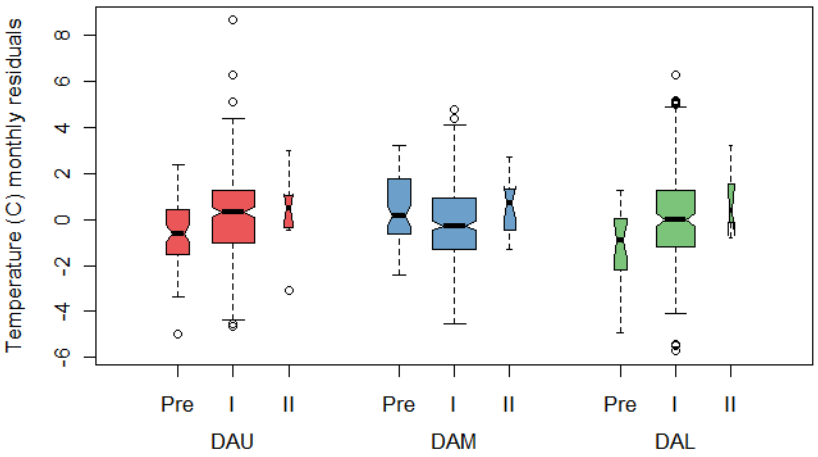
Following BMP implementation, the expected result was a decrease in water temperatures through the project area since riparian fencing should lead to increased density of canopy cover and improved shading of the creek. All data was reported in degrees Celsius. NMP data was collected with a Hydrolab, and MBNEP data was collected with a YSI Model 55 or Model 85.

The figure shows the range and general trend in the temperature data from the three monitoring sites.



The following figure shows the notched box plots for the data before and after the two phases of fencing at each of the sites. The red boxes show that there has been an increase in the water temperature from before BMP implementation to after Phase I of 1.11°C (p = 0.0002) at DAU and of 1.59°C (p = 0.0038) at DAL. The analysis showed significant evidence that temperature increased between 0.352 to 1.877°C at DAU following Phase I implementation. However, at DAM, shown in the blue, the temperature remained fairly stable with a slight reduction, although not a significant one (p = 0.99), following implementation of Phase I. Thus, even though the water entering the project site has gotten warmer since Phase I was implemented, the temperature below the project site has remained stable.

Prior to Phase I implementation, DAM had the highest temperatures of the three sites. Following implementation, it had the lowest temperatures. Analysis has not shown any evidence of project effect following implementation of Phase II, although only preliminary data are available.



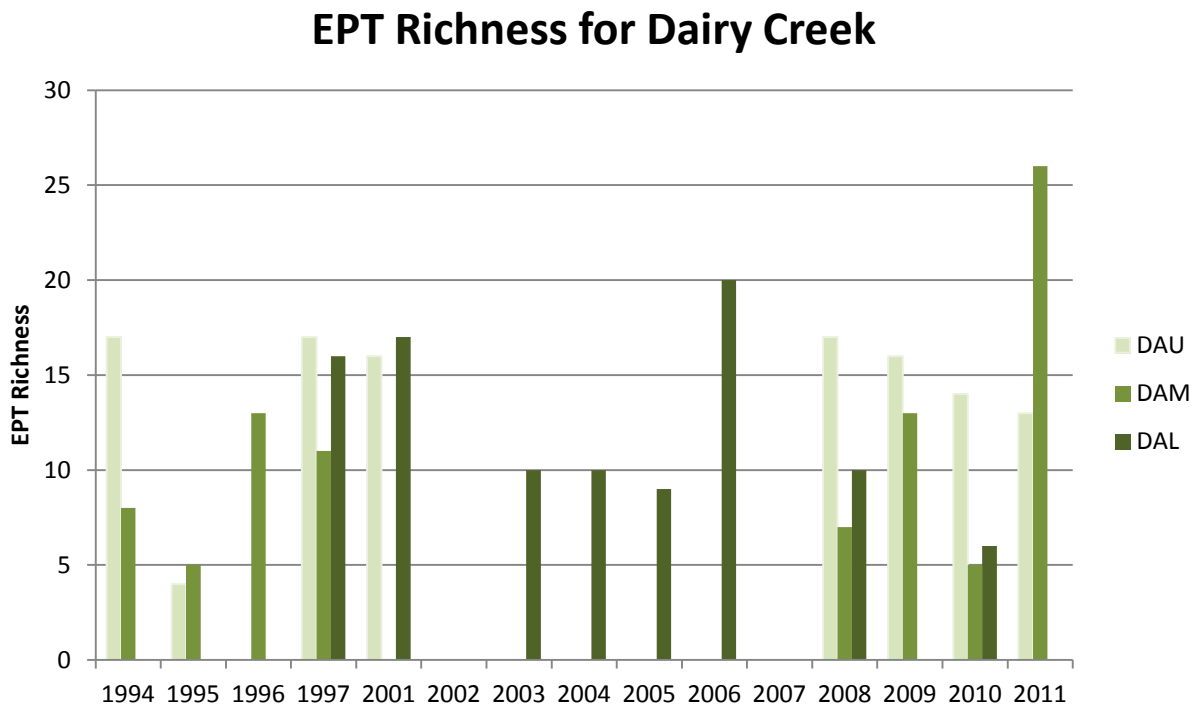
The conclusion of this analysis was that the implementation of Phase I was effective at lowering water temperatures. Prior to implementation, the temperature increased as water moved downstream from the upper to the middle site. Following implementation, the water temperature remained stable between a site at the top of the project area (DAU) and a site immediately below the project area (DAM). Insufficient data is available to assess the effectiveness of Phase II of the project due to the relatively short post-project timeframe.

Macroinvertebrates

Data collected between 2007 and 2010 utilized the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was updated in spring 2007. The MBNEP monitored a 150 m reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, following the reach-wide benthos protocol option. Macroinvertebrates were composited into a single sample, which was sent to a lab for sorting and counting until 500 randomly selected organisms were identified. The lab provided a count of the individual taxa as well as some calculated metrics.

Data collected prior to 2007 was generated using prior approved methods. The data from previous surveys was standardized by a Monte Carlo analysis and was included for comparison.

The following graph displays the changes in EPT richness over time at each Dairy Creek site. EPT richness is a count of the total number of taxa within the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Taxa richness typically decreases with poor water quality. As a comparison, Coon Creek, our control site, averaged an EPT richness of 20 species over six years of monitoring.



Conclusions: The analysis demonstrated a decrease in *E. coli* concentrations following Phase I implementation when comparing water quality upstream of the project area with water quality downstream of the project area. The *E. coli* concentration decreased from DAU to DAM then increased as the water moved from DAM to DAL, although the DAL concentrations were still lower than the DAU concentrations.

For dissolved oxygen following Phase I implementation, concentrations increased from DAM to DAL, while they remained stable at DAU and DAM. For water temperature, despite increases at DAU following Phase I implementation, temperatures at DAM and DAL remained fairly stable.

Due to the intermittent nature of Dairy Creek, bioassessment data was not collected consistently enough for statistical analysis.

Insufficient data was available at the time of analysis to assess the effect of Phase II of the project. Monitoring of these projects will continue in order to enable the detection of changes in DO, temperature and bacteria concentrations.

SAN BERNARDO RIPARIAN FENCING

Project background: The MBNEP has worked with landowners throughout the Morro Bay Watershed to install riparian fencing that limits direct cattle access to creeks. Approximately 5,000 feet of fencing was installed on both sides of San Bernardo Creek. Fencing installation was completed for the landowner on the eastern bank of the creek in late summer of 2006. Fencing installation for the landowner on the western bank of the creek was completed in early 2007. Cattle were fenced out from areas where they previously had free access to the creek.

Expected project benefits: The primary goal of the project was to reduce bacteria levels through exclusion of cattle from the creek. Secondary goals were increased riparian vegetation and shading of the creek, improved bank stability, reduced erosion, and improved habitat value for fish and wildlife.

Existing data: A site downstream of the fenced area was monitored monthly by the MBNEP beginning in May 2002 for total coliform and *E. coli.* Monthly analysis was also conducted for basic water quality parameters including dissolved oxygen, temperature, pH, turbidity, conductivity, flow, nitrates as N and orthophosphates as PO_4. Even-interval data was also collected at the same downstream site during the NMP study. Between June 1993 and May 2001, approximately 150 samples were collected for fecal and total coliform on a weekly basis during the wet season and twice monthly during the dry season.

IEP activities: Annual bioassessment monitoring (including substrate diversity, in-stream habitat, canopy cover, and erosion) were conducted starting in spring 2008 at a site within the fenced project area and one site upstream of the project area.

Monthly water quality monitoring was conducted at the historical site (SBE), which is downstream of the project location. Dissolved oxygen, temperature, pH, turbidity, conductivity, flow, nitrates as N and orthophosphates as PO_4 were monitored monthly for comparison to pre-project data.

IEP data analysis: To date, extensive post-project data could not be collected due to the highly intermittent nature of the creek. The site typically flowed only during the wet season (approximately six months of the year from January through June) and was dry for the remainder of the year.

Bacteria

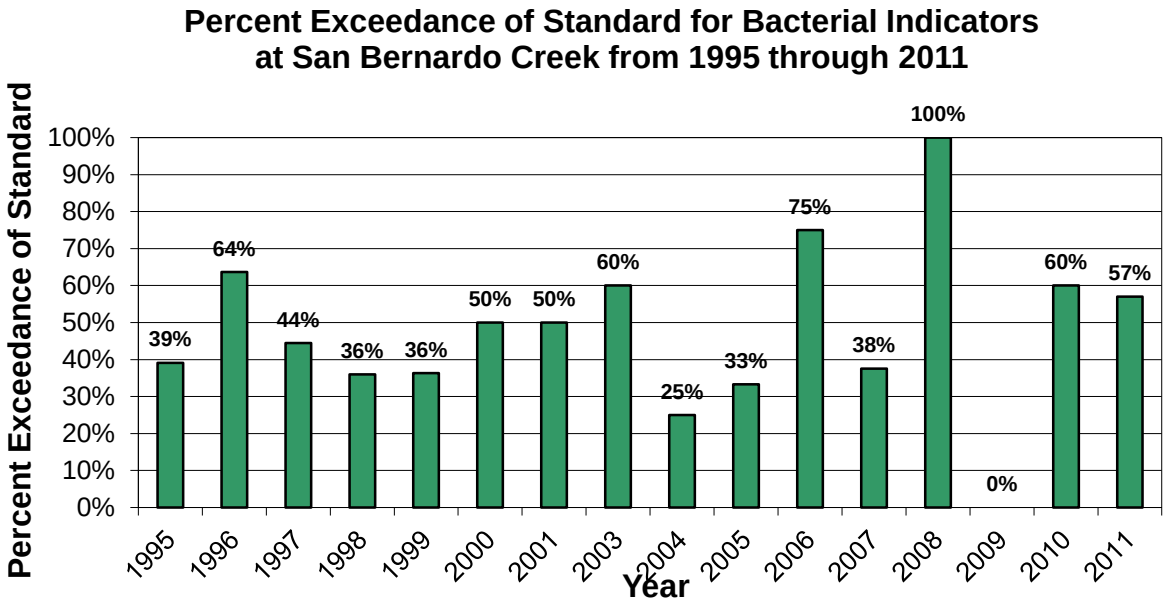
The following table summarizes the bacteria indicator measured, the number of samples collected during the water year, the number of samples that exceeded the appropriate regulatory criteria, and the entity that conducted the monitoring.

Water Year	Indicator	Standard for Single Sample (MPN/100 mL)	# Samples Exceeding Criteria for Single Sample	Total # of Samples	% Samples Exceeding Single Sample Standard	Geomean (MPN/100 mL)	Data Source
1995	Fecal coliform	400	9	23	39%	409.0	NMP
1996	Fecal coliform	400	21	33	63%	528.5	NMP
1997	Fecal coliform	400	12	27	44%	359.7	NMP
1998	Fecal coliform	400	9	25	36%	371.4	NMP
1999	Fecal coliform	400	8	22	36%	199.6	NMP

Water Year	Indicator	Standard for Single Sample (MPN/100 mL)	# Samples Exceeding Criteria for Single Sample	Total # of Samples	% Samples Exceeding Single Sample Standard	Geomean (MPN/100 mL)	Data Source
2000	Fecal coliform	400	12	24	50%	512.6	NMP
2001	Fecal coliform	400	1	2	50%	294.8	NMP
2003	*E. coli*	235	3	5	60%	325.2	MBNEP
2004	*E. coli*	235	1	4	25%	56.6	MBNEP
2005	*E. coli*	235	3	9	33%	133.8	MBNEP
2006	*E. coli*	235	9	12	75%	399.6	MBNEP
2007	*E. coli*	235	3	8	37.5%	208.1	MBNEP
2008	*E. coli*	235	6	6	100%	1581.0	MBNEP
2009	*E. coli*	235	0	2	0%	47.1	MBNEP
2010	*E. coli*	235	3	5	60%	339.3	MBNEP
2011*	*E. coli*	235	4	7	57%	279.4	MBNEP

**Includes data from January to May 2011.*

The following figure summarizes the pre and post-project data from the monitoring site downstream from the project, by water year.



Note: In 2009, only two samples were collected due to lack of flow. Data for 2011 includes January through May.

Ideally, fecal coliform and *E. coli* data could be directly compared. A study to determine a predictive relationship between the two parameters was not successful. Thus, a more sophisticated analysis was not possible for the bacteria data because data for the two different indicator species cannot be combined.

Macroinvertebrates

Prior to 2008, the MBNEP had access only to the downstream site (SBE) which has limited above ground flows, thus precluding macroinvertebrate monitoring on that creek. In 2008, landowners on both sides of the creek allowed macroinvertebrate monitoring to take place at a location upstream of SBE. Although this reach (site MSB) also experiences intermittent surface flows, the longer hydroperiod allowed sufficient time to conduct bioassessment monitoring. Monitoring was conducted at MSB In the spring of 2008, 2009, 2010 and 2011. The samples were collected according to the most recent SWAMP protocol over a 150 m reach with a composite sample collected from ten transects. A habitat assessment was also conducted.

In 2010, the monitoring program was allowed one-time access to conduct bioassessment at an upstream site (USB). Extremely difficult terrain limited the length of the surveyed reach to 110 meters rather than the full 150 meters.

While limited macroinvertebrate and habitat assessment data were available, the results were of interest in the context of other sites in the watershed. The EPT richness metric indicates the number of different species identified in the sample, and a higher score indicates that the habitat is healthy enough to support a wide range of macroinvertebrates. During most years, San Bernardo Creek had some of the highest EPT richness scores of all of the sites. Scores for 2011 were lower than in past years, which was the case at nearly all of the sites throughout the watershed. This is thought to be due to higher than normal rainfalls, which may have impacted the macroinvertebrates.

Conclusions: The hydrologic conditions at the lower monitoring site limited the data that could be collected each year. Due to the intermittent nature of the flow and the limited years since the project was installed, adequate bacteria data could not be collected to conduct an analysis of project effectiveness. The macroinvertebrate data has shown promise, with some of the higher metric scores measured among all sites in the watershed.

WALTERS CREEK RESTORATION, PHASE II

Project background: The Phase II of the Walters Creek Restoration Project was implemented along a 2,000 foot long reach that is surrounded by grassland pastures and an active private gun range. Formerly a military firing range, the property still operates as a shooting range, owned by the Department of Fish and Game, and operated by a private entity. The creek channel was altered by the military during WWII. The channel was straightened and earthen berms with undersized culverts were constructed. By the early 2000's, the channel morphology consisted of an incised, u-shaped channel that was dominated by non-native vegetation. The Phase II restoration project removed all berms, re-established a creek meander, and connected the channel to its floodplain. Construction was completed in April 2008, and included substantial planting of native riparian vegetation.

Expected project benefits: Upon completion of the project, we expected to see an improvement in vegetation, riparian habitat, and topography based on the habitat assessment component of the California Department of Fish and Game Bioassessment protocol.

Existing data: A bioassessment habitat assessment was conducted in 2007 prior to construction. Macroinvertebrates could not be sampled at that time, due to lack of flow.

IEP activities: In 2008 and 2010, a bioassessment habitat assessment (including substrate diversity, in-stream habitat, canopy cover, and erosion) was conducted, and macroinvertebrate samples were collected and analyzed. During the spring of 2008, post-project cross-sectional profiles were conducted for comparison with pre-project profiles. Riparian point count bird surveys were begun in June of 2008 and were conducted on a monthly basis. Vegetation within the replanted project area has been monitored annually.

IEP data analysis: The relatively recent completion date of the project limited the amount of post-project data that could be collected. At this point, preliminary data does not allow for an in-depth analysis of project benefits. Monitoring will continue at this site over the long term to track project benefits. However, with the data collected to date, some observations can be made.

Bird Surveys

Avian point count monitoring was selected as one approach to evaluate biological response. Birds are widely accepted as strong indicators of environmental condition because they occupy a diverse range of ecosystem niches and a relatively high position in the food chain. The MBNEP conducted surveys to identify Riparian Habitat Joint Venture (RHJV) and California Partners in Flight (CalPIF) focal species, California endemics, California special status species, breeding birds, winter residents, neo tropical migrants, and riparian associate and riparian obligate species presence. The surveys established baseline data of bird species diversity, breeding species composition, and seasonal presence.

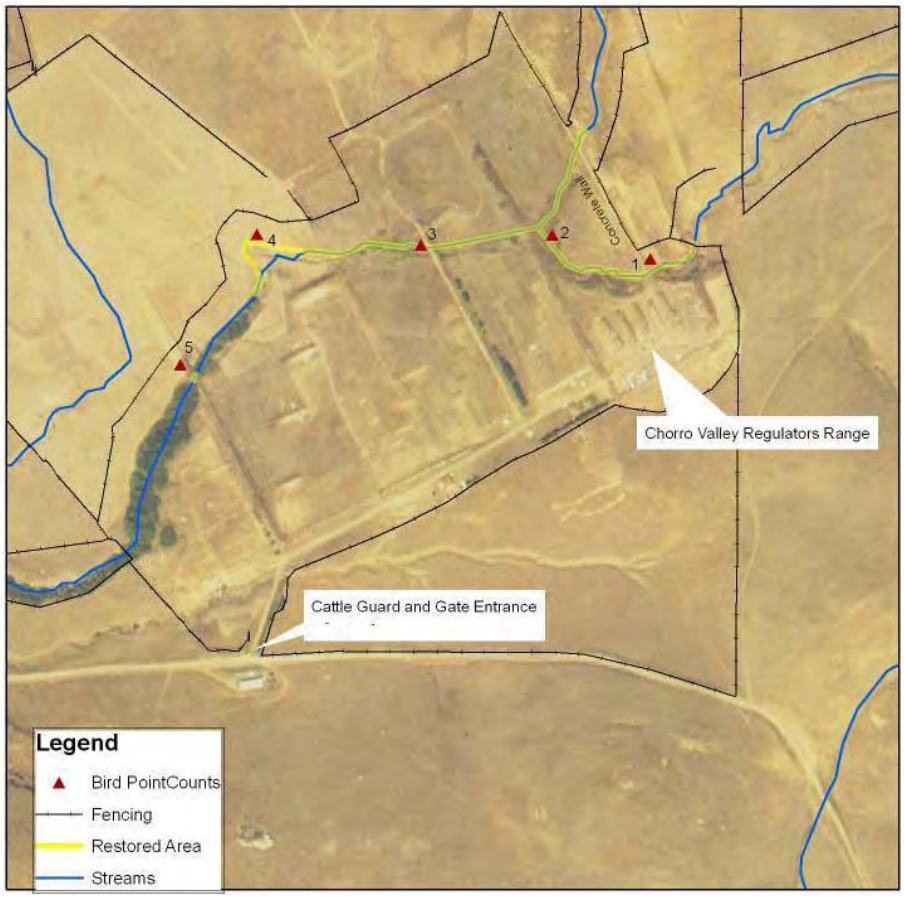
The data presented here represents approximately three years of data and should be viewed as preliminary. It can take up to ten years to establish a statistically viable data set that can describe bird

population trends over time.

The MBNEP Avian Point Count Protocol was developed with the guidance of the Morro Coast Audubon Society and closely mirrored the Point Reyes Bird Observatory (PRBO) Point Count methodology. Due to the relatively small survey area, Variable Circular Plots (VCP) were used where the distance to each detection was recorded to the nearest 10 m. Five monitoring points were established within the project area and spaced on average 100 m apart.

Surveys occurred monthly, usually mid month, and always on Tuesdays which were non-active days at the range. The firing range was active the other six days of the week. Additional site visits during the nesting season occurred when possible (e.g., twice in April and May). Counts took place within a half hour of sunrise. Each point was monitored for five-minute durations. Every species detected at a point was recorded, regardless of how far it was from the observer.

The following map shows the VCP point count stations.



At the Walters Creek restoration site, 81 species were observed from June 2008 through October 2011 during 37 surveys, as illustrated in the following table. This species count represents 18% of all the species detected in San Luis Obispo County as of November 2010.

Species Observed		Focal Species	Breed-ing	CA Endemic	Winter Resi-dents	Neo Tropical Migrants	CA Species of Special Concern	Riparian Obli-gate	Riparian Depend-ant
Anatidae									
MALL	Mallard		P						
CITE	Cinnamon Teal		P			X			
HOME	Hooded Merganser				X				
AMWI	American Wigeon				X	X			
BUFF	Bufflehead				X				
Phalacrocoracii dae									
DCCO	Double-crested Cormorant								
Ardeidae									
GBHE	Great Blue Heron								
GREG	Great Egret				X	X			
BCNH	Black-crowned Night Heron								
Cathartidae									
TUVU	Turkey Vulture								
Accipitridae									
COHA	Cooper's Hawk								X
NOHA	Northern Harrier					X			
SSHA	Sharped-shinned Hawk								
WTKI	White-tailed Kite					X			
RTHA	Red-tailed Hawk		C						
Falconidae									
AM KE	American Kestrel		C			X			
MERL	Merlin				X	X			
Odontophorid ae									
CAQU	California Quail								
Phasianidae									
RNPH	Ring-necked Pheasant								
Charadriidae									

Species Observed		Focal Species	Breed-ing	CA Endemic	Winter Resi-dents	Neo Tropical Migrants	CA Species of Special Concern	Riparian Obli-gate	Riparian Depend-ant
KILL	Killdeer					X			
Scolopacidae									
GRYL	Greater Yellowlegs					X			
LBCU	Long-billed Curlew				X	X			
COSN	Wilson's Snipe					X			
Columbidae									
BTPI	Band-tailed Pigeon								
MODO	Mourning Dove								
RODO	Rock Dove								
Strigidae									
GHOW	Great-horned Owl								
Apodidae									
VASW	Vaux's Swift					X	X		
Trochilidae									
ANHU	Anna's Hummingbird			X					
Alcedinidae									
BEKI	Belted Kingfisher					X		X	
Picidae									
NOFL	Northern Flicker				X				
NUWO	Nutttalls Woodpecker			X					
DOWO	Downy Woodpecker								
Tyrannidae									
PSFL	Pacific Slope Flycatcher					X			
SAPH	Says Phoebe				X	X			
ATFL	Ash-throated Flycatcher					X			
WEKI	Western Kingbird					X			
BLPH	Black Phoebe		PO						
Laniidae									
LOSH	Loggerhead Shrike						X		
Vireonidae									

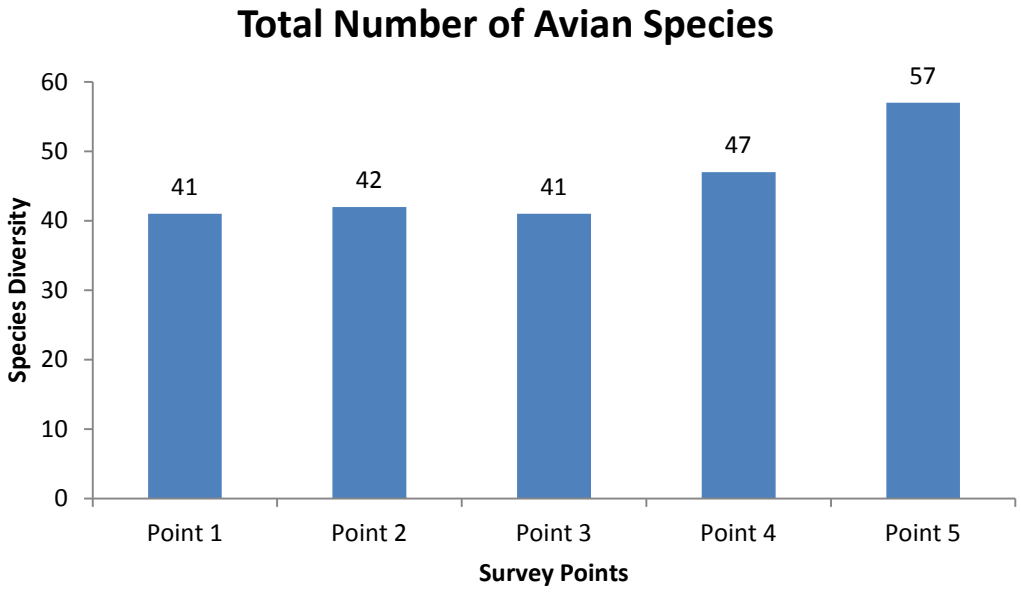
Species Observed		Focal Species	Breed-ing	CA Endemic	Winter Resi-dents	Neo Tropical Migrants	CA Species of Special Concern	Riparian Obli-gate	Riparian Depend-ant
HUVI	Huttons Vireo								
Corvidae									
WSJA	Western Scrub Jay								
AMCR	American Crow								
Alaudidae									
HOLA	Horned Lark								
Hirundindae									
CLSW	Cliff Swallow					X			
BASW	Barn Swallow					X			
TRSW	Tree Swallow	X				X			X
Paridae									
CBCH	Chestnut-backed Chickadee								
Aegithalidae									
BUSH	Bushtit								
Troglodytidae									
BEWR	Bewick's Wren								X
HOWR	House Wren								X
Timaliidae									
WREN	Wrentit			X					
Regulidae									
RCKI	Ruby-crowned Kinglet				X				
Sylviidae									
BGGN	Blue-Gray Gnatcatcher								
Turdidae									
WEBL	Western Bluebird		C						
HETH	Hermit Thrush				X	X			
Sturnidae									
EUST	European Starling								
Parulidae									
OCWA	Orange crowned warbler					X		X	
YRWA	Yellow-rumped Warbler					X			

Species Observed		Focal Species	Breed-ing	CA Endemic	Winter Resi-dents	Neo Tropical Migrants	CA Species of Special Concern	Riparian Obli-gate	Riparian Depend-ant
WIWA	Wilsons Warbler	X				X		X	
COYE	Common Yellowthroat	X	PO			X		X	
Emberizidae									
SPTO	Spotted Towhee								
CATO	California Towhee			X					
LASP	Lark Sparrow								
SAVS	Savannah Sparrow				X	X			
GRSP	Grassshopper Sparrow		C			X	X		
SOSP	Song Sparrow	X	C					X	
LISP	Lincoln's Sparrow				X			X	
YRWA	Yellow-rumped Warbler				X				
WCSP	White-crowned Sparrow				X				
Cardinalidae									
BLGR	Blue Grosbeak	X	C			X			X
LAZB	Lazuli Bunting					X			X
Icteridae									
RWBL	Redwing Blackbird		C						
TRBL	Tri-colored Blackbird	X		X	X				
WEME	Western Meadowlark		P						
BRBL	Brewers Blackbird		C						
BHCO	Brown-Headed Cowbird								
BUOR	Bullocks Oriole		P			X			X
BRSP	Brewer's Sparrow					R			

Species Observed		Focal Species	Breed-ing	CA Endemic	Winter Resi-dents	Neo Tropical Migrants	CA Species of Special Concern	Riparian Obli-gate	Riparian Depend-ant
Fringillidae									
AMGO	American Goldfinch		P		X				X
LEGO	Lesser Goldfinch								X
HOFI	House Finch		C						

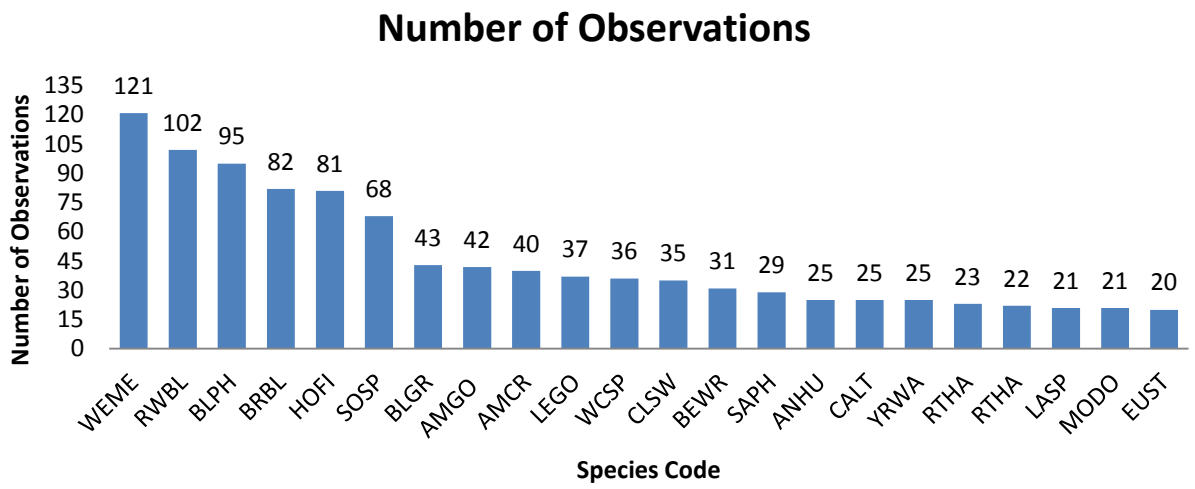
X= presence= Confirme P= Probable O=Possible R=Rare

The following graph illustrates the total number of species, by monitoring point.



It would be difficult to discern whether the difference between species numbers per site was significant due to the close proximity of the survey points. However, Point 5 was the only point with a closed canopy over the creek and multiple vegetation levels including mature riparian vegetation. Concerted efforts were made to avoid double counting individuals at each point.

The species composition was composed of both grassland and riparian avian species. However, the most often recorded species were (in order) Western Meadowlark, Red-winged Blackbird, Black Phoebe, House Finch, and Brewer's Blackbird. These species are typically associated with open grasslands, agricultural areas, suburbs, forest edges and, in the case of Red-winged Blackbirds, wet brushy marshy areas. Black Phoebes tend to be found in open areas, typically near water. Many of the species specifically associated with riparian areas were not recorded frequently, with the exception of Blue Grosbeak and Song Sparrow. A total of 41 species, including the Tri-colored Blackbird, Tree Swallow and Orange-crowned warbler, were only viewed once. During the survey period, 57 species had less than 20 incidences where they were observed.



California Partners in Flight (CalPIF) and the Riparian Habitat Joint Venture (RHJV) developed a Riparian Bird Conservation Plan to assess landbird populations. This document identified 17 focal species of conservation interest that are representative of California riparian habitats. Six of these focal species were known to occur at the Phase II restoration site: Blue Grosbeak, Tri-colored Blackbird, Common Yellowthroat, Song Sparrow, Tree Swallow, and Wilsons Warbler. Of these six, the Blue Grosbeak and the Song Sparrow were recorded with breeding activity. The Common Yellowthroat had possible records of breeding activity, where an individual (male or female) was seen in suitable nesting habitat during breeding season.

Thirteen native bird species have ranges that fall entirely within the California Floristic Province. The limited range of these endemic species increases their vulnerability to both intrinsic (i.e., small population size, genetic bottlenecks, predation, disease) and extrinsic (i.e., habitat loss, invasive species, climatic changes) disturbance factors. Of these 13 native species, five were viewed during the point count surveys. These species were Anna's Hummingbird, Tri-colored Blackbird, Nuttall's Woodpecker, Wrentit, and California Towhee.

Five species observed are listed by the California Department of Fish and Game as California Bird Species of Special Concern. This list is a ranked assessment of species, sub-species, and distinct populations of birds of immediate conservation concern in California. Listed as a first priority species of concern, our surveys reported Tri-colored Blackbird presence. Under the secondary priority list, the Grasshopper Sparrow was recorded. Also, the Northern Harrier was observed, which is listed as a third priority species of concern. The breeding season was identified for each of these species as the season of conservation concern. Of these three species, the Grasshopper Sparrow was confirmed breeding within the restoration site, and breeding songs were heard upstream of the project area as well.

Sixteen species were recorded as winter residents on the site. Four of these species, the Long-billed Curlew, the Bufflehead, the American Wigeon, and the Hooded Merganser, are known to winter in the Morro Bay area but were only present during wetland inundation at the site. Duck species like the Mallard and Cinnamon Teal tended to be present only during wetland inundation, but they are typically classified as year-round species for this area. The Ruby-crowned Kinglet has only been recorded on site during the winter season but is not classified as a winter resident for the area.

Twelve species were classified as neo-tropical migrants, all or part of whose populations breed north of

the Tropic of Cancer and winter south of that line. Neo-tropical migrants are important to distinguish because of their significant need of healthy migratory habitat during a critical lifecycle stage. Some individuals listed as migrants may actually reside in the area year-round, but for the purposes of this analysis, all species were recorded as migrants. Though this species is not a neo-tropical migrant, there is record of the migrant Brewer's Sparrow at the site, which is a rare occurrence for this geographic area.

Fifteen species were listed by USGS as riparian obligate or riparian dependant species, representing 30% of all the riparian obligate, dependant species known to occur in San Luis Obispo County. Nine species were recorded and classified as being riparian dependent species. These are species that place 60% to 90% of their nests in riparian vegetation or where 60% to 90% of their abundance occurs in riparian vegetation during the breeding season. Of these species, four displayed probable or confirmed breeding activity.

Six species were recorded as riparian obligate species. These are species that place greater than 90% of their nests in riparian vegetation, or species with greater than 90% of their abundance occurring in riparian vegetation during the breeding season (but they may still forage outside of riparian vegetation). One riparian dependant species, the Song Sparrow, had confirmed breeding activity, and the Common Yellowthroat was recorded as possibly breeding within the site.

Avian inventory efforts at Walters Creek have been conducted to provide valuable data to land managers and restoration practitioners. Information from these surveys could, eventually, track population trends, assess species diversity and richness, and possibly describe restoration effectiveness.

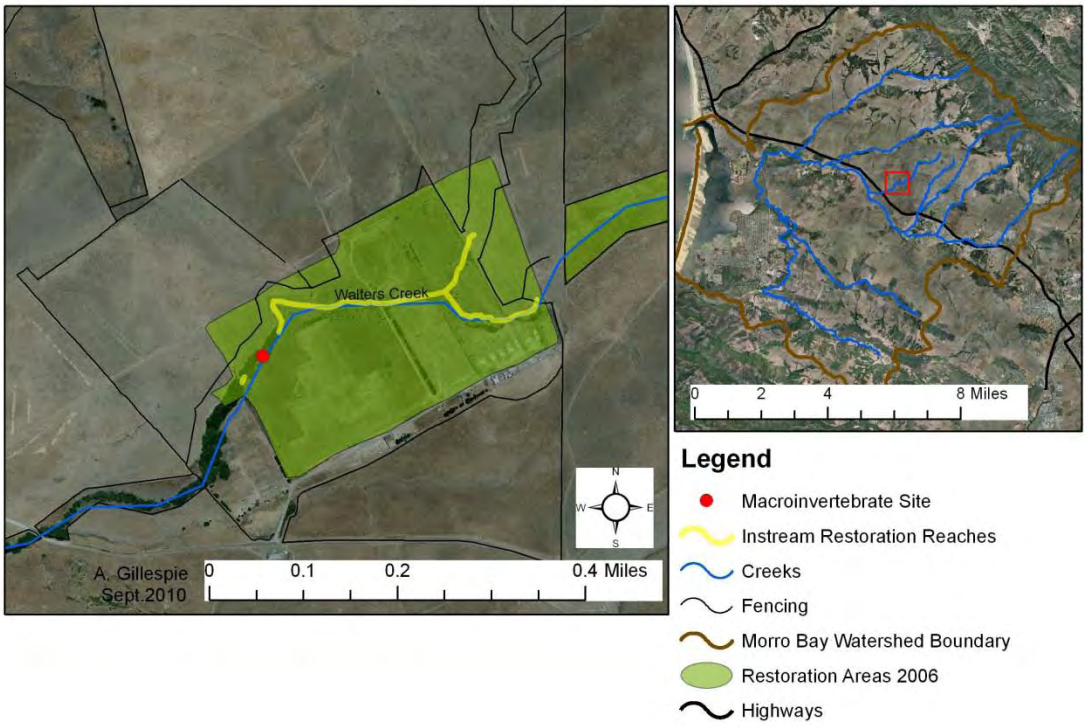
Information from these surveys will chart changes and effectiveness of the restoration project. However, without pre-project data for this site, it will be difficult to draw a comparison of species diversity or composition before and after restoration activities occurred. In future analyses, comparisons may be made between Walters Creek data and other restoration sites within local watersheds during the monitoring period. It could take up to ten years to establish a statistically-viable population trend.

Vegetation Monitoring

Three seasons of vegetation monitoring have occurred to date and were focused on the replanted areas of the project. Data collected included species code, growth height, vigor, herbivory evidence, vegetative competition, non-native species cover, canopy cover and, if dead, the probable source of mortality. Many of the species planted were wetland grasses and sedges, coastal shrub species and riparian trees. The planted vegetation arrived in one or five gallon containers, one quart containers, as seed, or in two inch flats. In 2008, the average plant height for the entire site was 1.3 feet. By 2009, the vegetation had grown 0.62 inches to an average height of 1.92 feet. In the 2010 survey, average plant height was 2.26 feet. Monitoring continued through the 2011 season, and this data will be incorporated into a final vegetation report. The final report will address plant survivability rates, average growth rates, structure overlap and variability, and recommendations for future management.

Macroinvertebrates

In 2007, a habitat assessment was conducted prior to construction. Due to lack of water, benthic macroinvertebrate samples could not be collected. In 2008 and 2010, adequate water was present for sample collection. In 2011, the site was not monitored due to lack of staff resources. The monitoring site is located immediately downstream of the Phase II restoration project. Historically, macroinvertebrate sampling took place near the flume site, which is higher up in the watershed. The monitoring sites are illustrated on the following map.



The metric scores are presented in the following table.

Walters Creek (WAL)	*Taxa Richness*	*EPT Richness*	*EPT %*	*IBI Score*
2002	*	*	*	*
2003	*	*	*	*
2004	*	*	*	*
2005	*	*	*	*
2006	*	*	*	*
2007	*	*	*	*
2008	39	2	1.0	38.6
2009	*	*	*	*
2010	44	4	1.8	28.6

** No data collected this year*

To provide context for this data, Walters Creek had EPT richness scores on the order of those from Los Osos Creek (LVR site) with a score of 3 and at Dairy Creek (6 at DAL and 5 at DAM) in 2010. For comparison, the upper San Luisito Creek had the highest score of all of the sites in 2010 of 24. Walters

Creek had the lowest EPT % scores of all of the Morro Bay sites in 2010 with a value of 1.76%. (For comparison, upper San Luisito Creek, which is considered to be relatively unimpaired, had a EPT % score of 35.17% in 2010.)

Conclusions: Given the limited amount of time since project construction was completed, the preliminary results from macroinvertebrate and bird surveys were not surprising. As the project becomes established and the site matures, habitat diversity is expected to continue to improve, leading to a more robust riparian ecosystem which will be reflected in the macroinvertebrate and bird survey data.

SAN LUISITO CREEK RIPARIAN FENCING

Project background: Of the sites monitored for bacteria in the Morro Bay watershed, the site on San Luisito Creek was notable for its year-round elevated bacteria concentrations. Of the samples collected from 2003 through 2008, 62 of 74 samples (84%) had *E. coli* levels above EPA's recommended criteria for safe recreational contact of 235 MPN/100 mL.

Based on this data, the MBNEP teamed with the Coastal San Luis Resource Conservation District (CSLRCD) to work with a private landowner to install approximately 9,000 feet of fencing on each side of San Luisito Creek as well as an off-creek watering system. Construction was completed at the end of January 2009. Other than a few times a year when cattle were allowed into the riparian area for weed-control, cattle have been excluded from the riparian area since project completion. The initial fencing project on the downstream property is referred to as Phase I.

When the fencing project was underway, the owner of the parcel upstream of the project became interested in improving riparian fencing on their property. Completed in May 2009, approximately 4,265 feet of fencing were installed to fill gaps in existing fencing. A few times a year, cattle are allowed into the riparian pasture, which serves as a staging area to prepare for transport off site. This phase of the fencing work is referred to as Phase II.

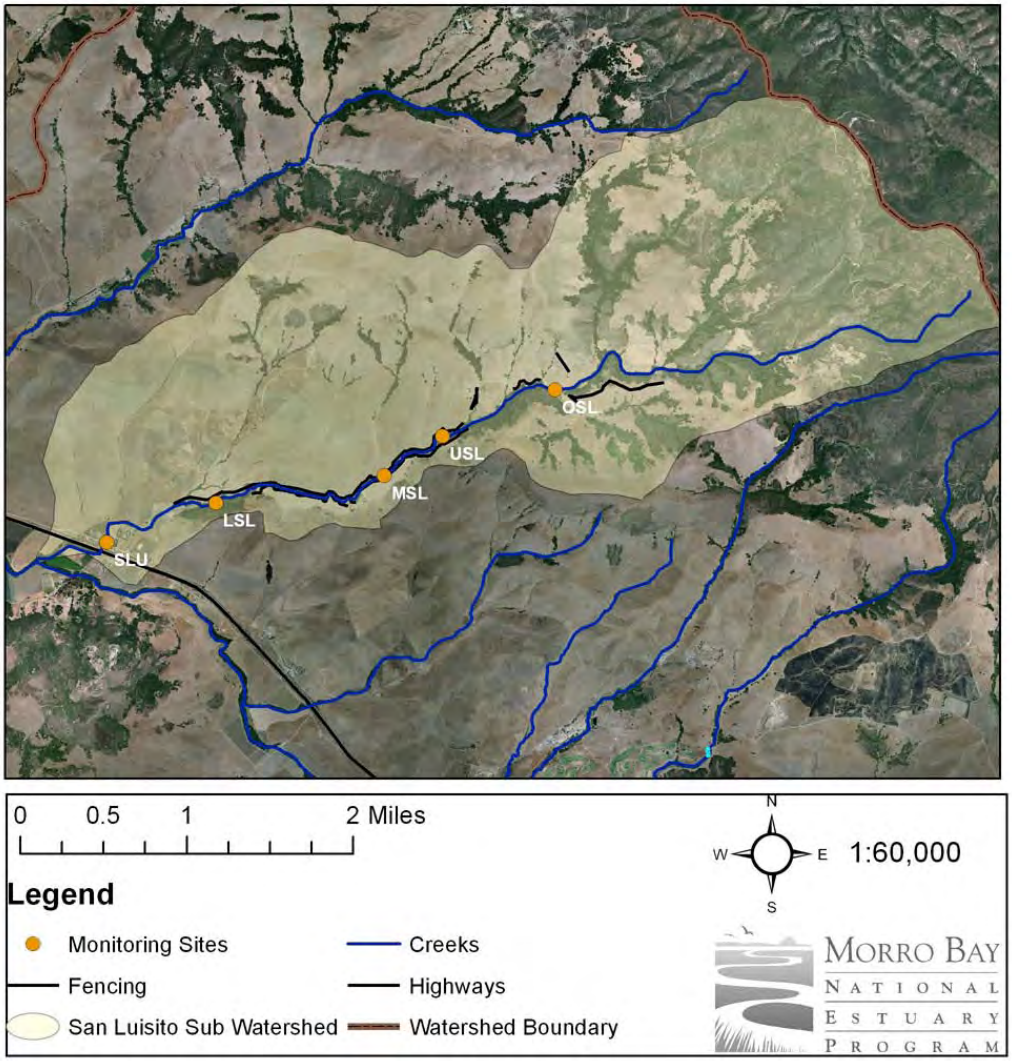
Expected project benefits: The primary goal of the project was to reduce creek bacteria concentrations through exclusion of cattle. Secondary benefits include increased riparian vegetation and shading of the creek, improved bank stability, reduced erosion, and improved habitat value for fish and wildlife.

Existing data: A site downstream of the fenced area was monitored monthly since February 2003 for total coliform and *E. coli* (site code SLU). Water quality monitoring also took place beginning in 2002 at the historical site downstream from the project. Water quality monitoring included analysis of dissolved oxygen, temperature, pH, turbidity, conductivity, flow, nitrates as N and orthophosphates as PO_4.

Beginning in September 2007, more extensive bacteria monitoring was begun at three new sites within the Phase I project area (site codes USL, MSL and LSL). In December 2008, this monitoring was increased to a frequency of twice monthly within the project area as well as at the historical downstream site. Beginning in June 2009, a monitoring site was established within the fencing in the Phase II project area (site code OSL).

The following map shows the location of the three bacteria monitoring sites within the Phase I project area (USL at the top of the project, MSL at the middle, and LSL at the bottom) and the one monitoring site within the Phase II project area (OSL). The map also shows the site downstream of the project

(SLU) where monitoring takes place for bacteria and water quality parameters. It also illustrates where fencing was installed. The fencing appears to be unconnected because it was installed in conjunction with existing fencing, which is not shown on the map.



IEP activities: Annual bioassessment monitoring (including substrate diversity, in-stream habitat, canopy cover and erosion) were conducted starting in spring 2008 at a site within the downstream reach of the project area (LSL). This monitoring was continued in 2009, 2010 and 2011. An upstream site at USL was monitored in 2010 and 2011.

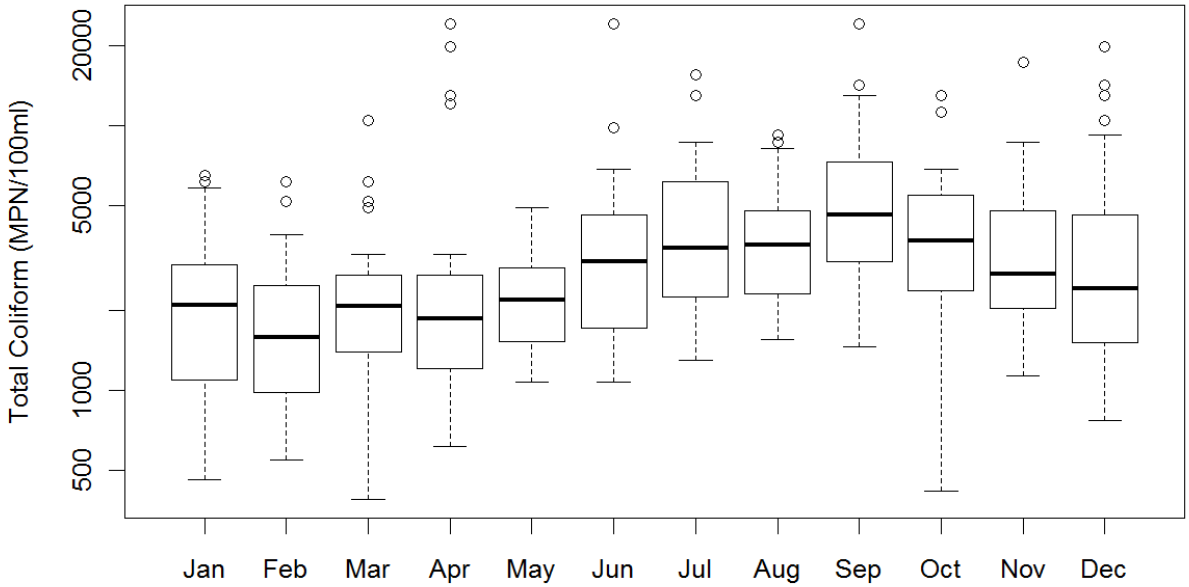
Bacteria monitoring was conducted pre and post-project at three sites within the Phase I project area and at the historical site downstream of the project area that has been monitored since 2003. Bacteria monitoring was only conducted post-project at the Phase II project area, due to the brief timeframe of project installation. These five sites were monitored within a brief time period (typically two hours), twice a month.

IEP data analysis: A pre and post-project comparison of bacterial levels was conducted, including the percent of samples exceeding recreational contact standards. Statistical models were developed that took into account the seasonal trends that existed at the monitoring sites.

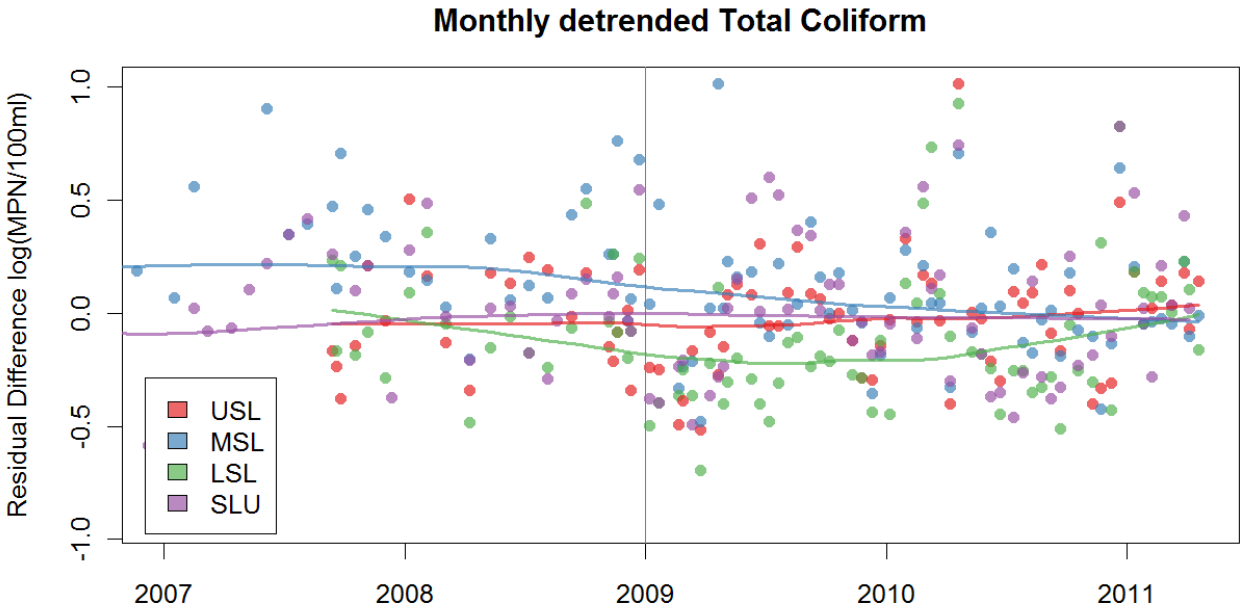
Bacteria at Phase I

The following graph shows an overview of the total coliform data over time at the four monitoring sites. Three of the sites were within the Phase I project area (USL, MSL, LSL), and one historical site was located downstream of the project (SLU).

The data exhibited a strong seasonal trend. The following plot shows log transformed total coliform concentration data. This plot includes data from SLU beginning in 2004 and all data from the three monitoring sites within the project area. For this plot, all January data from all sites was combined, all February data from all sites was combined, etc.



The next plot shows the detrended total coliform data after removing seasonal effects. The lines indicate loess smoothing results for each site.

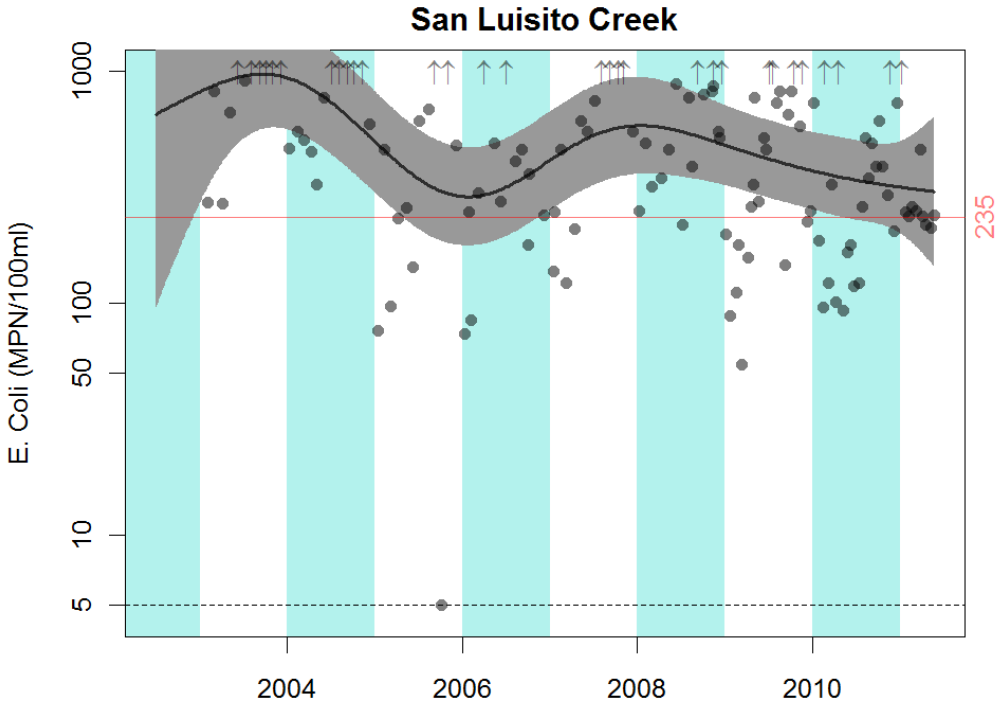


Based on this initial analysis, a model was developed to examine the effect of the project. Partial F-tests indicated that there was significant evidence of a project effect ($p < 0.0005$). When compared with previous analyses, the data from 2010 to 2011 provided stronger evidence that MSL reductions were driving this overall project effect ($p = 0.009$ compared to $p = 0.043$ last year), and that there was little effect driven by results from USL or LSL. This is illustrated by the following graph with the rather large drop in concentrations at MSL compared with more modest drops at the other sites.

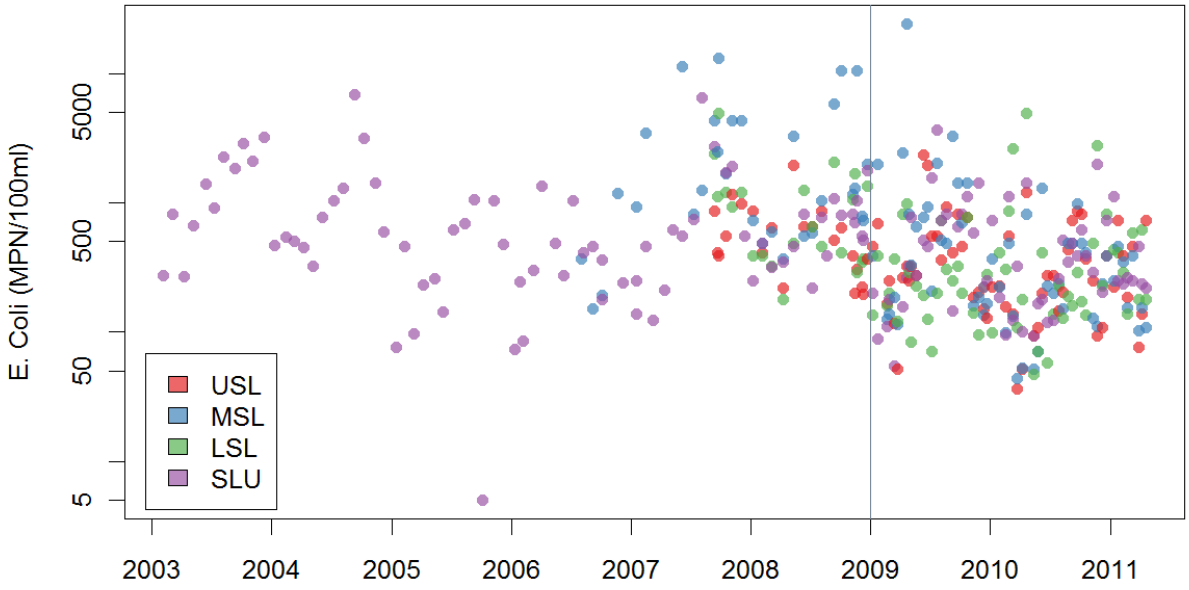
The model identified a different slope across all sites (indicating the trend) before and after Phase I project implementation. In last year's analysis, the trend illustrated that the initial reductions from the project were diminishing and, if the trend continued, indicated a potential emerging problem with total coliform at all sites except MSL. With the most recent year's data added to the analysis, this change in trend is not evident ($p = 0.526$). While the graph appears to have a steeper trend post-project, the difference in trend is not statistically significant.

The following plot shows the trend (slope) of total coliform concentrations at each site, both before and after Phase I project implementation (depicted by the vertical black line). The dotted lines for each site after 2009 show the predicted total coliform levels if the project had not been implemented. One positive indication was that the actual total coliform concentrations at MSL were below the predicted concentrations if no project had been implemented. The plots illustrate the justification for the project in that MSL had the highest total coliform concentrations of all of the sites before Phase I of the project, and the project had the greatest effect at this site.

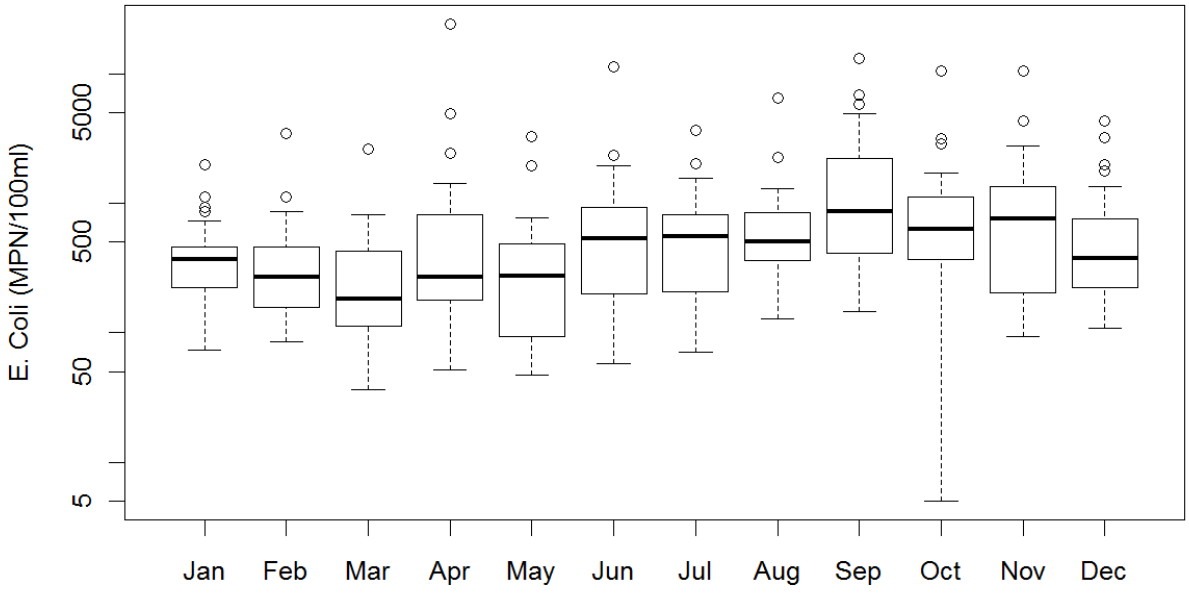
Water samples were also analyzed for *E. coli* concentrations throughout the project. The following plot shows the long-term trend at the SLU site, which was monitored beginning in 2003. The smooth curve is a spline smooth with degrees of freedom (df ≈ 6.3) chosen by cross-validation. The grayed area is the error band for the data. The up arrows represent values that were greater than 1,000 MPN/100 mL. Following Phase I project installation in early 2009, the trend line began showing a downward trend. The current data appears to have leveled out with a mean count stable above 235 MPN/100 mL.



The following graph displays all *E. coli* data across all monitoring sites, with the thin vertical line indicating the installation of the project.

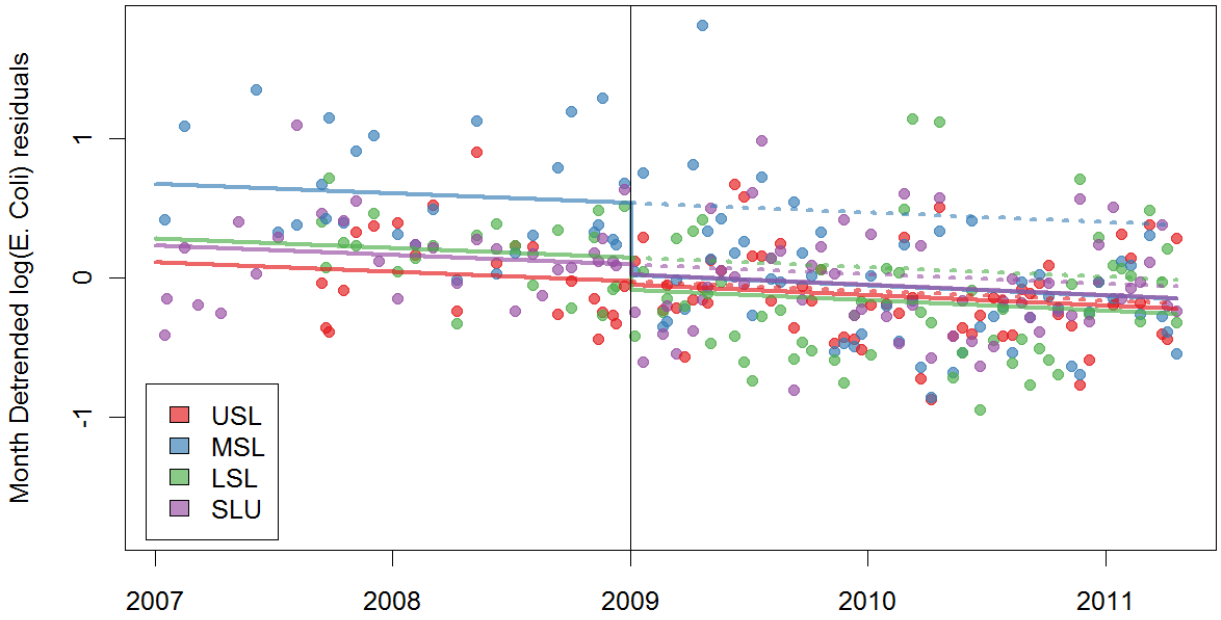


Next, as with the total coliform data, the seasonal effect was determined so that it could be removed to reveal only the project effect. The following plot shows a log plot of the *E. coli* data, grouped by month.

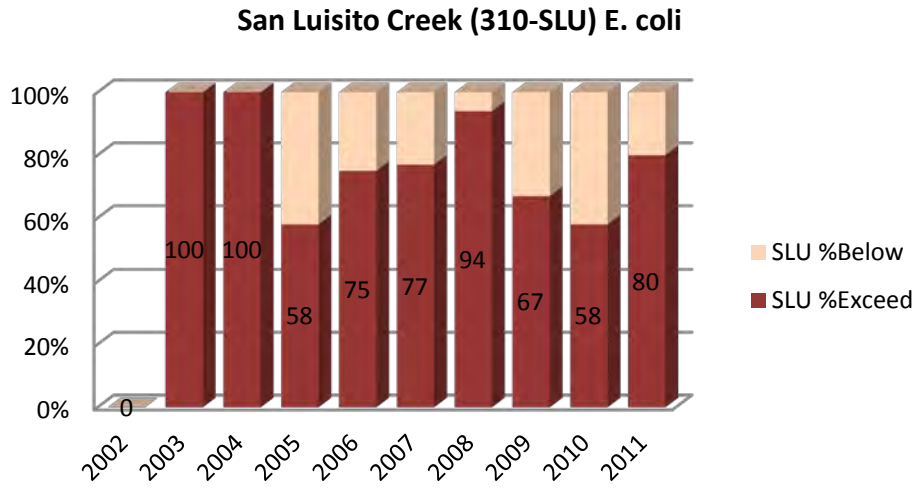


Partial F-tests indicated evidence of a project effect (p = 0.000) and some evidence that the relationship between *E. coli* concentrations and time was not fundamentally different across the sites (p = 0.040). There was strong evidence that the effect of the project was different at MSL (relative to USL) with respect to *E. coli*. On average over all four sites, there was no evidence that *E. coli* was lower post-project (p = 0.797), nor was there evidence that the apparent trend was more negative post-project (p = 0.782).

However, at MSL, the site with the highest *E. coli* concentrations before the project, the bacteria concentrations have shown significant improvement (p = 0.000) relative to USL. The following plot shows the trend lines for the *E. coli* concentrations at each site, pre and post-project. The dotted line shows the predicted *E. coli* concentrations if the project had not been installed.



A simplified analysis of data was conducted to compare the *E. coli* concentrations to the EPA's recommended standard for safe recreational contact (REC-1) of 235 MPN/100 mL. The following figure shows the percent of *E. coli* samples from the downstream SLU site that exceeded 235 MPN/100 mL, by year. The project was installed in January 2009. Following project installation, annual percent exceedances had been dropping, although there appears to be an increase in exceedances from the first half of 2011. This was an unusually wet year, and some of those exceedances may be attributable to storm events.

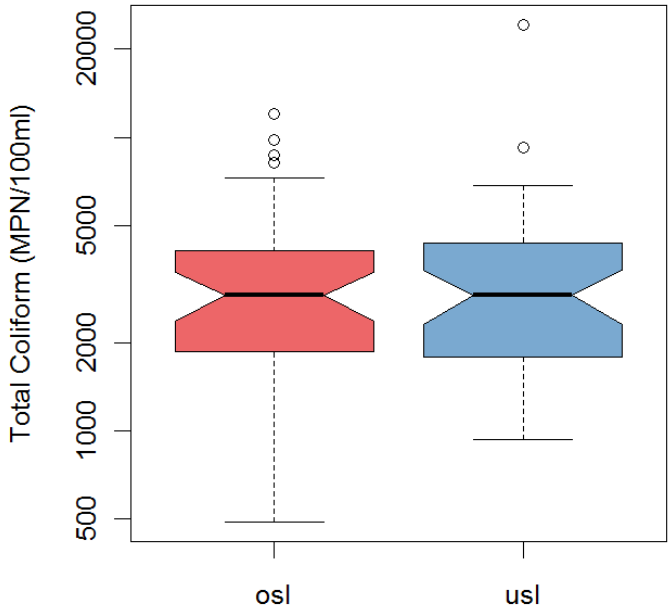


***Note**: The 2011 data includes January to May.*

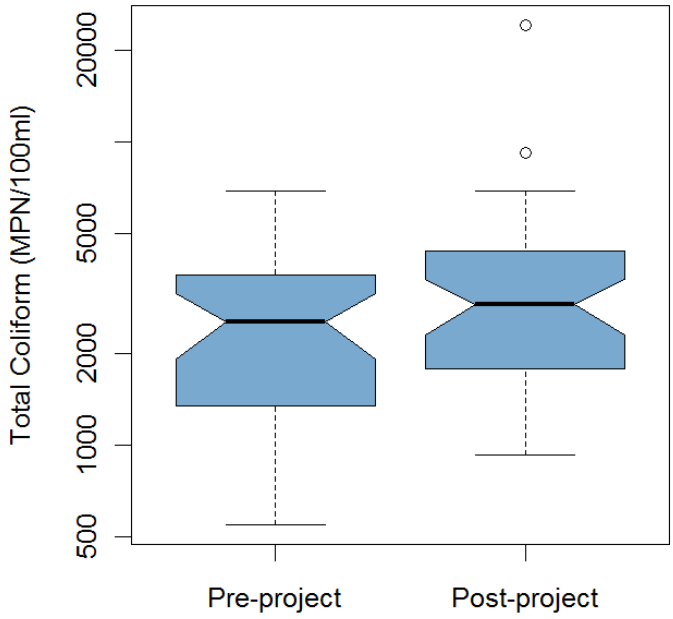
Bacteria at Phase II

USL was monitored pre-project as part of the monitoring for the Phase I project, and this data was incorporated into the analysis of the Phase II project. The paired data from OSL (within the Phase II project area) and from USL (located below the Phase II project area at the top of the Phase I project area) was analyzed to determine project effectiveness. The following graph shows an overview of the total coliform data for OSL and USL sites. The vertical line marks the fencing completion date of June 6, 2009.

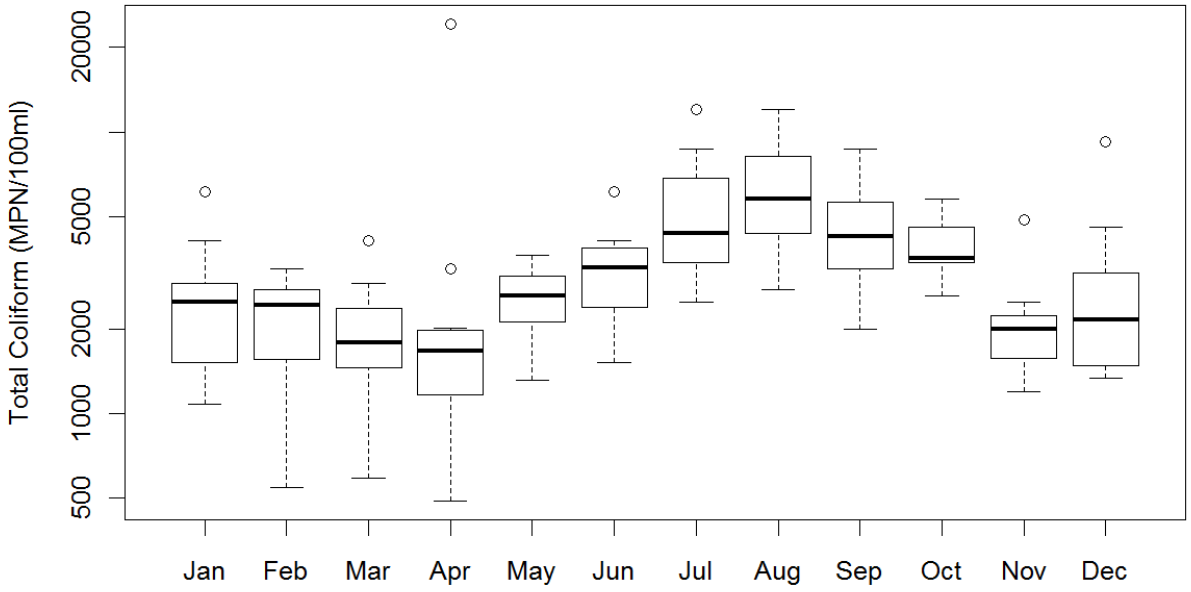
The following notches in the boxplots represent the 95% confidence intervals for the medians of the total coliform concentrations for samples collected following Phase II project installation. Overlap in the notches between the two box plots indicates a lack of evidence for any differences between the samples collected at OSL and at USL.



The following plot looks at total coliform data from the USL site only, before and after project installation. Again, the overlap in the notches between the two box plots shows a lack of evidence for any differences in total coliform concentrations before and after Phase II project installation.

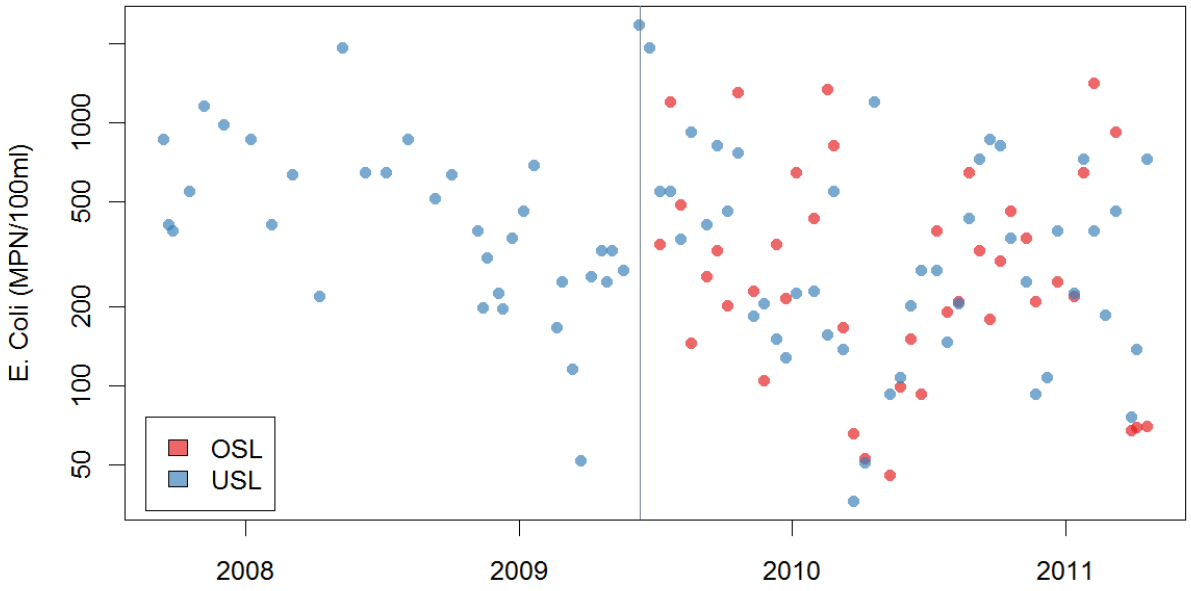


Next, the seasonal trend of the total coliform data was assessed. Removal of the seasonal trend can improve the statistical power. All data from OSL and USL were combined and grouped by month.

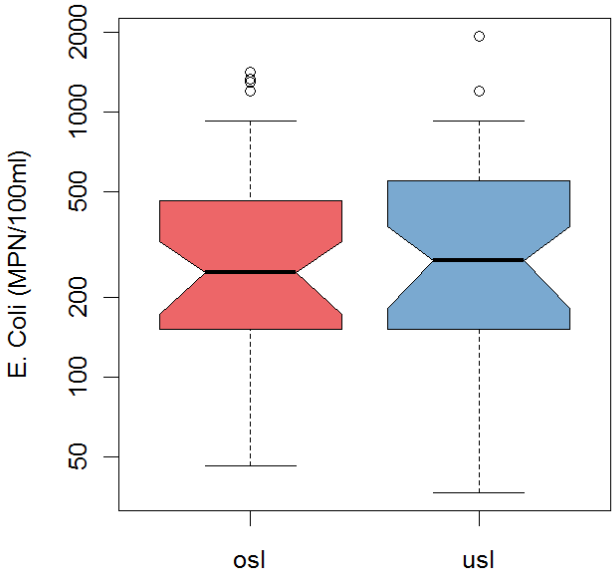


Models run to assess total coliform at USL versus OSL showed no evidence of project effect (p = 0.253). Models run to compare the data collected at USL showed no evidence of a difference in log-mean total coliform count before and after Phase II installation (p = 0.211).

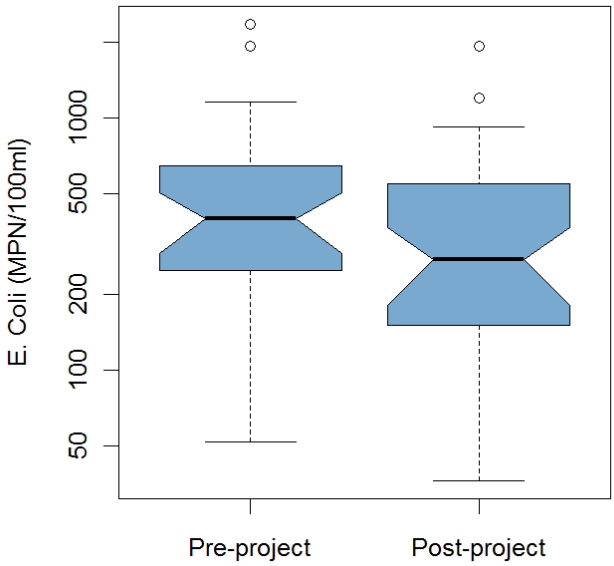
The following graph shows a summary of the *E. coli* data at the USL and OSL sites. As with total coliform, data was not collected at OSL prior to Phase II implementation.



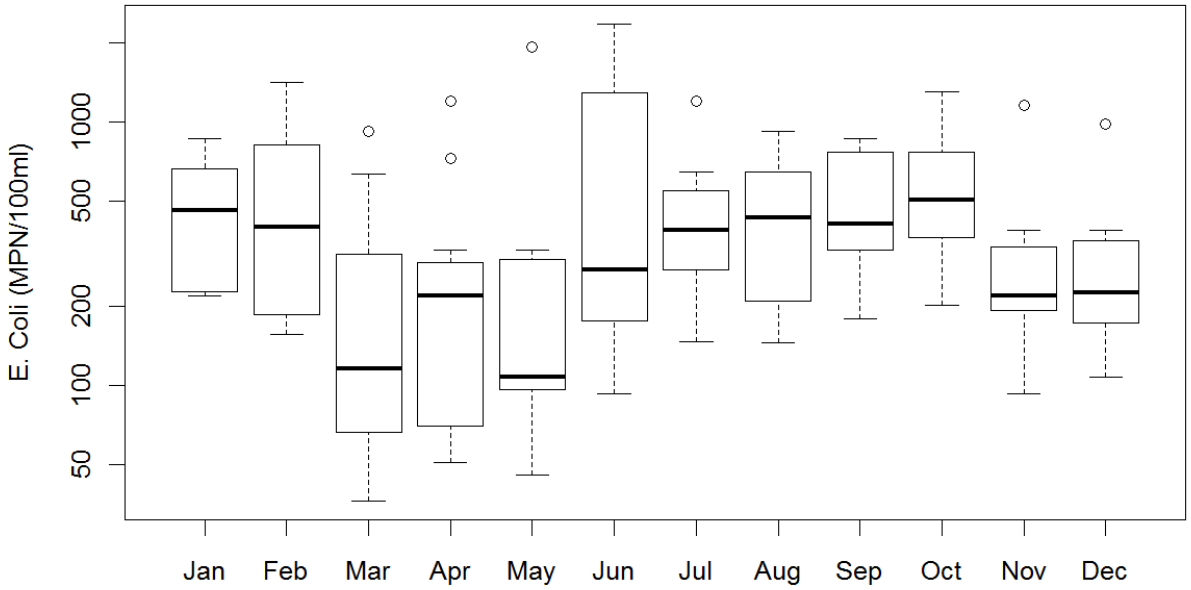
The following notches in the boxplots represent the 95% confidence intervals for the medians of the *E. coli* concentrations for samples collected following Phase II project installation. Overlap in the notches between the two box plots indicates a lack of evidence for differences between the samples collected at OSL and at USL.



The following plot looks at *E. coli* data from the USL site only, before and after project installation. While the notches overlap, subsequent models that remove seasonal trends showed evidence of lower *E. coli* levels following project installation.



Next, the seasonal trend of the *E. coli* data was assessed. Removal of the seasonal trend can improve the statistical power. All data from OSL and USL were combined and grouped by month.



Models were run to assess *E. coli* at USL versus OSL. This comparison is considered to be biased due to the lack of OSL pre-project data. There is evidence of a project effect on *E. coli* (p = 0.008) with significantly lower counts post project (38% lower). There is no evidence for a difference between OSL and USL log-mean *E. coli* levels (p =0.557). The next model was an unbiased comparison of USL to OSL *E. coli* counts following Phase II project installation. While this does not directly assess the impact of fencing, it is a method to compare sites to one another. The analysis showed no evidence of a different in logmean *E. coli* counts across the sites (p = 0.566). The last model run compared *E. coli* counts at USL before and after project implementation. The model shows significant evidence of a difference in log-mean *E. coli* counts (37% reduction) before and after Phase II fencing installation (p = 0.009).

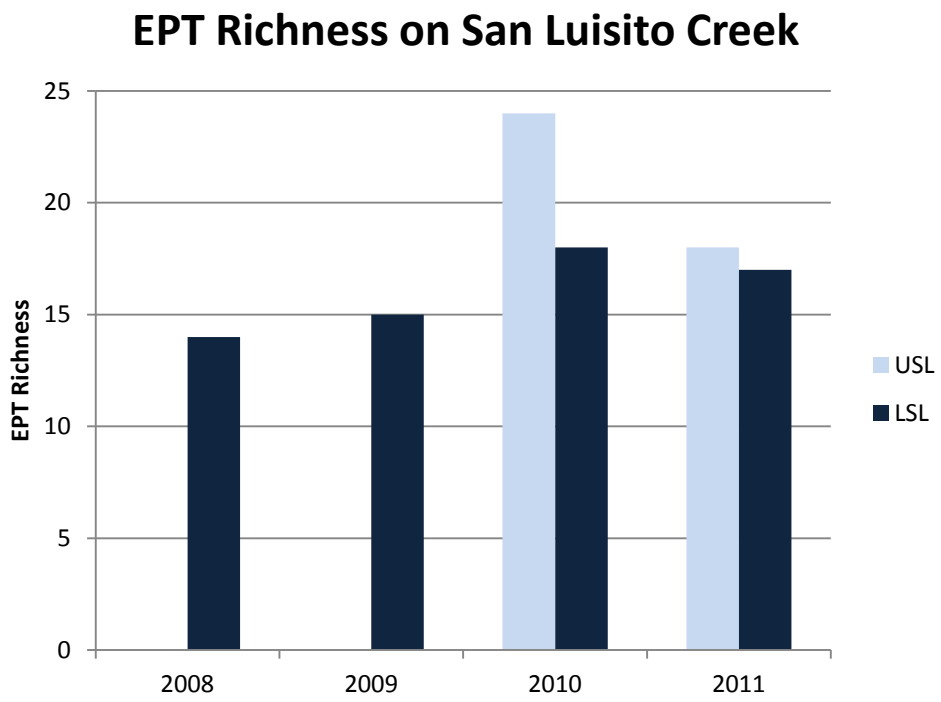
Macroinvertebrates

The LSL macroinvertebrate site, located at the bottom of the Phase I project area, was monitored from 2008 to 2011. The 2008 sampling occurred prior to project installation, and the three later samplings took place following installation. The USL site, at the top of the Phase I project area, was monitored in 2010 and 2011.

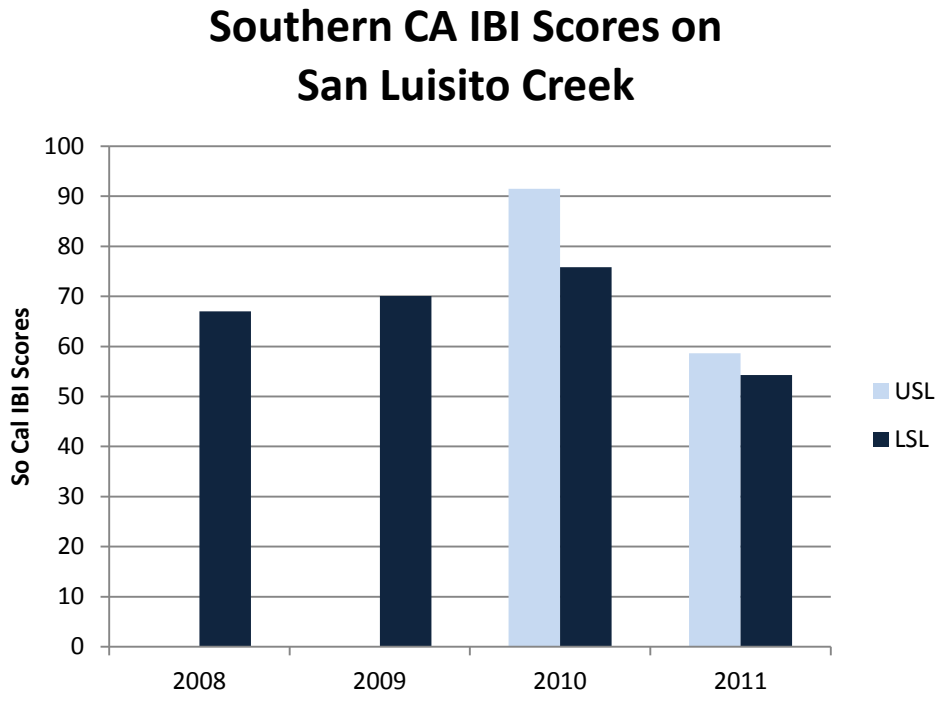
Data at the San Luisito Creek sites were collected utilizing the SWAMP bioassessment procedures titled *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, which was updated approved in 2007.

The USL site's EPT richness score of 18 was one of the highest of the ten sites monitored throughout the watershed in 2011. Scores at other monitoring sites varied from 11 to 26. USL had a Southern California Index of Biotic Integrity (IBI) score of 58.6. In 2010, the site had an IBI score of 91.5, the highest score of the sites monitored that year. Scores decreased at all sites in 2011, possibly due to higher intensity storms than what typically occurs in the area, which may have swept away the macroinvertebrate community. LSL had an IBI score of 54.3 in 2011, compared to 75.8 in 2010. The sites had % dominant taxon scores of 47% in 2011 (13.6% in 2010) at USL and 30.5% in 2011 (23% in 2010) at LSL. While these scores generally indicate impairment (moderate concentrations of 20 to 30%

or less are typically desirable), these values are not typical of these sites and may be due to the unusual winter weather.



The following plot is a comparison of Southern California IBI scores for the two sites.



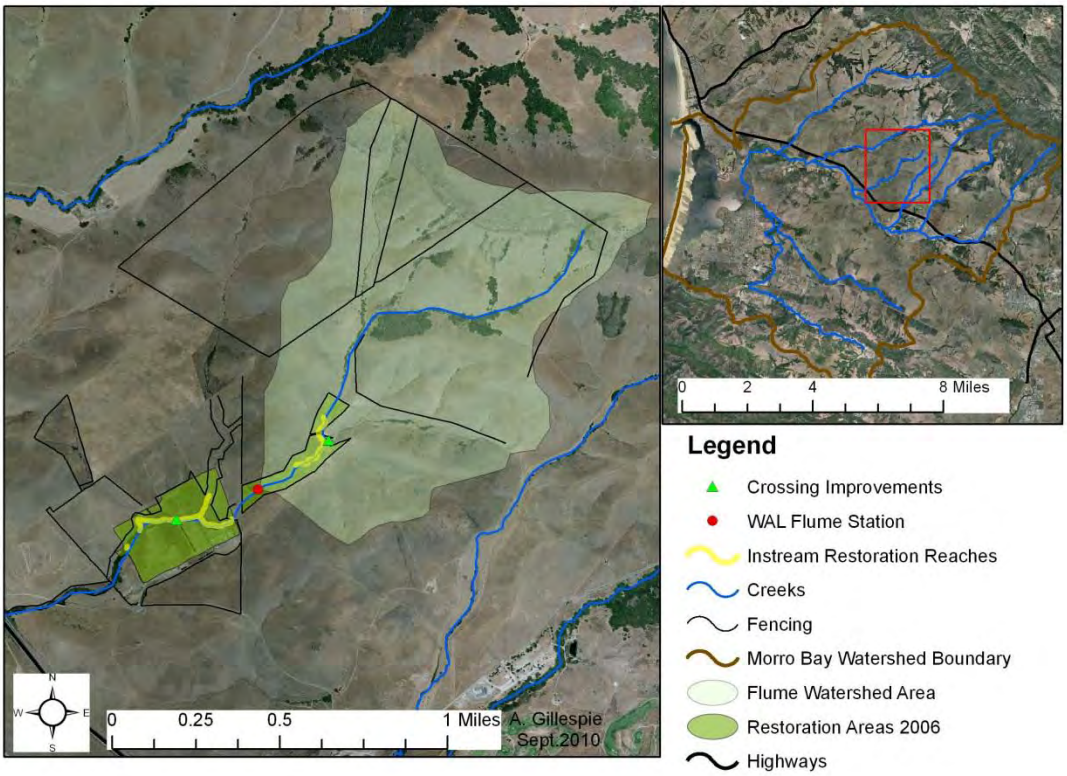
Conclusions: In the analysis conducted for the Phase I project, it was determined that the MSL site was the most heavily impacted by cattle access prior to project implementation. The project showed a

substantial post-project decrease in total coliform concentrations at the MSL site, with a more modest decrease at the other sites. The MSL site also showed significant reduction in *E. coli* concentrations following project implementation. For both indicator species, the concentrations at MSL were below the predicted concentrations had the project not been implemented. The lack of measurable improvement in bacteria concentrations at LSL and SLU has been disappointing and may indicate the presence of other bacteria sources. In the analysis conducted for the Phase II project, there was no evidence for a project effect on total coliform. When comparing *E. coli* data at the USL site before and after Phase II implementation, evidence was detected of a project effect with significantly lower *E. coli* counts post-project. The data at SLU for the percent of samples that exceeded the safe recreational contact standard for swimming is not exhibiting a clear trend, possibly due to the variability in rain years. Macroinvertebrate scores indicated high quality habitat conditions prior to the project and continue to reflect that following project implementation.

WALTERS CREEK RIPARIAN FENCING

Project background: Walters Creek was part of the NMP paired watershed study conducted in the 1990s and 2000s. Walters was treated as the control site in the study, while BMP implementation was completed at nearby Chumash Creek for comparison. During the study, instrumentation collected total suspended solids (TSS) samples and a flume was constructed to measure flows so that storm event sediment loading could be estimated. Following the completion of the NMP, work was conducted to bring the same types of improvements to Walters Creek. Extensive riparian fencing was installed in the Walters Creek subwatershed from 2003 to 2007. In-stream habitat restoration was conducted in two phases. Phase I, upstream of the flume site, began in 2004 and included installation of fencing, construction of in-stream habitat features, stabilization of banks, and implementation of rotational cattle grazing practices. Phase II, conducted downstream of the flume site, was analyzed as a separate component of this IEP analysis.

The following map illustrates the fencing installed at Walters Creek since the conclusion of the NMP study.



Expected project benefits: The expectation was to see a reduction in peak storm event suspended sediment load at the flume monitoring station.

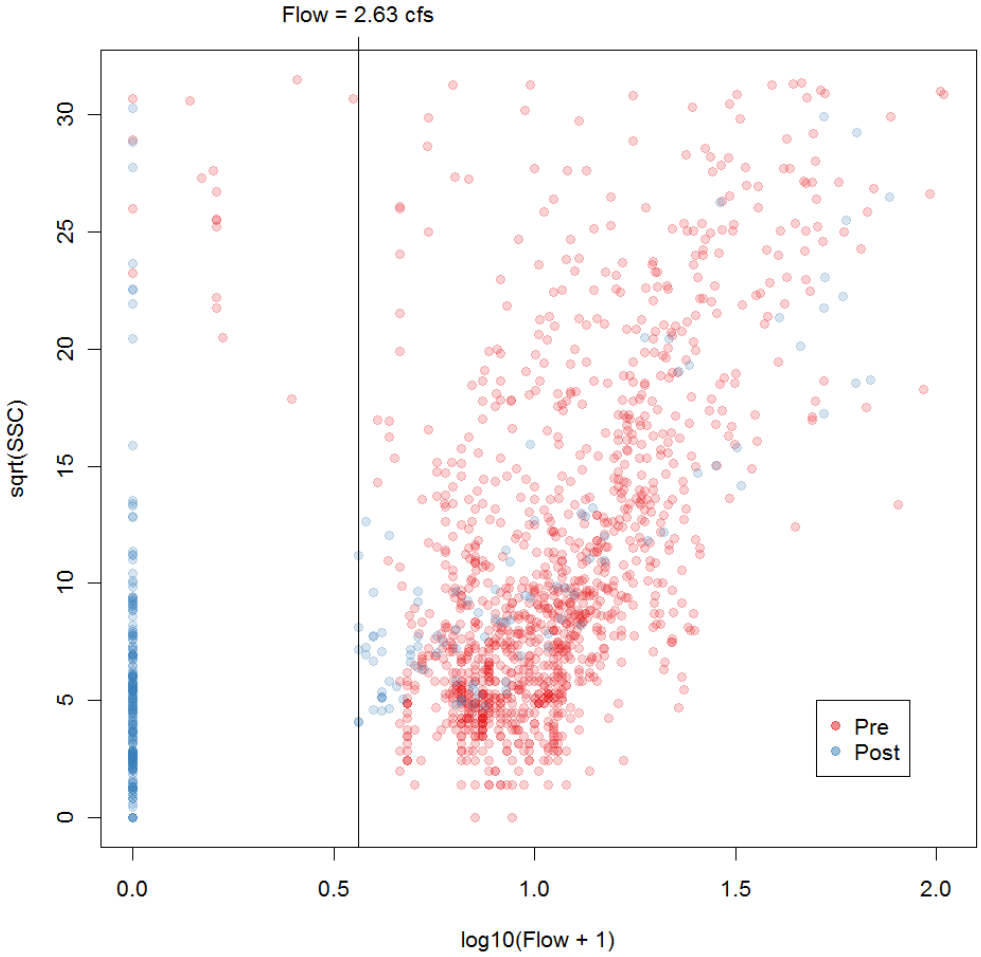
Existing data: During the NMP, an automated sampler collected samples that were analyzed for TSS and turbidity. Flow measurements were taken at the flume. Wet season samples were collected from 1995 through the 2000 to 2001 wet seasons.

IEP activities: Resurrection of the flume site for the IEP was logistically challenging due to the condition of infrastructure at the site. Instrumentation was installed in time for monitoring during the 2009 water year. However, due to lack of rainfall, no data could be collected during the 2009 water year. Data was collected in the 2010 and 2011 water years. Samples were processed for suspended sediment concentration (SSC) by MBNEP staff and interns at a water lab established at Cuesta College in 2007. In addition to SSC measurements, turbidity readings were taken of the samples in the lab.

IEP data analysis: The Walters Creek post-BMP suspended sediment dataset has been limited by the amount of flow occurring within the range measurable in the flume. Water depths in the flume below 0.25 feet and greater than 3.50 feet cannot be accurately measured in the flume. Discharge data from the pre-BMP dataset illustrates that Walters Creek sustained measurable surface flows for substantial periods following storm events throughout the NMP study period. Although measurable surface flows were sampled during the 2009-2010 water year, the falling limb of most storm events rapidly dropped below measurable flow volumes.

The following graphic displays the pre-project TSS and post-project SSC data on the same plot. Due to the different time periods of pre and post-project analysis, there is a greater number of pre-project (red) data points and also greater variability among the pre-project data. Data shown to the left of the

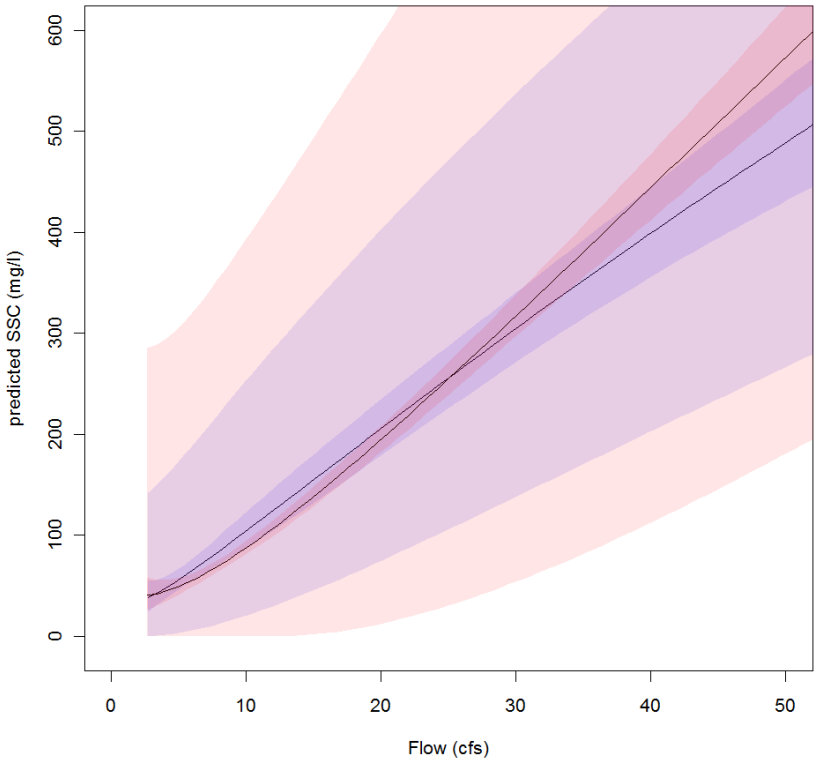
reference line at 2.63 cfs was not included in model analysis as it did not meet the minimum flow criteria.



The pre-project data was incorporated into the final model that was used for determining the relationship for the post-project data, assuming that the functional relationship between the two parameters would remain the same. However, the parameters in the pre-project period were allowed to differ from the post-project period. The residual behavior of the pre-project data was checked using the functional form of the post-project data and did not indicate a need for higher order terms in the model.

There was substantially more variability in the pre-project TSS data as noted by the residual standard error (pre-project data = 5.33 mg/l, post-project data = 2.836 mg/l), and thus a lower adjusted R-sq = 41% for pre-project data versus 79% with the post-project data.

The figure below displays the pre- and post-project model results. 95% confidence intervals are indicated by darker bands of red and blue, with lighter shades indicate corresponding prediction intervals for both conditions. The pre-project data (red) has a very narrow confidence band due to the large sample size but a wide prediction band due to highly variable predicted SSC values. The post-project data (blue) has a wider confidence band due to smaller sample size and narrower prediction band due to less variability within the post-project dataset.



The 95% confidence interval bands essentially overlap for the pre- and post-project datasets. A formal test to compare the model results (considering data for which flow is greater than 2.63 cfs) indicates there is only weak evidence for a difference between pre- and post-project conditions ($F(3,1288) = 2.2912$, $p = 0.077$).

While there is not a significant difference between the pre- and post-project conditions, there is some indication of a change in condition at different ranges of flow. At flows between approximately 5 to 25 cfs, the models indicate that SSC concentrations were higher in post-project conditions. While this may indicate a change of conditions in the watershed, changes in lab methodology (greater recovery of suspended particles) may also be influencing this apparent trend. The appearance of reduced SSC in the post-project condition at higher flows (greater than 30 cfs) may become significant by narrowing of the 95% confidence interval through the addition of more data. These empirical differences aren't statistically significant but indicate that further data collection may improve the ability to detect a difference between pre- and post-project conditions.

Further detail on the analysis and assumptions for creation of these plots are contained in our sediment monitoring report, *Morro Bay National Estuary Program's Implementation Effectiveness Program Suspended Sediment Monitoring Report 2011.*

Conclusions:

Post-project data collection at Walters Creek will be continued through water year 2011-2012. Infrastructure improvements at the flume station to expand data collection capabilities should result in a higher percentage of useable data during measureable flow conditions. Additional data collection and analysis will improve the ability to detect differences between the pre- and post-project condition at the site.