California Urban Streams Alliance –The Stream Team
Big Chico Creek Watershed
Citizen Monitoring Program
Data Report
2010

A program of:
California Urban Streams Alliance –The Stream Team

December 2010

Table of Contents

List of Tables

List of Figures

Appendix

A. EXECUTIVE SUMMARY

The purpose of this report is to summarize watershed data collected during 2010 by the Big Chico Creek Watershed Citizen Monitoring Program (The Stream Team), a program of the California Urban Streams Alliance –The Stream Team, as funded through the City of Chico. Historical data for 2005 through 2009 has also been provided for comparison.

The Stream Team began in 2004 to assess water quality and habitat conditions within the Big Chico Creek watershed. Efforts utilize a multi-pronged approach which engages community members in monitoring efforts, compiles and analyzes data collected, and provides education and outreach to promote understanding and action related to watershed health.

Physical, chemical, and biological data are collected within three general land-use zones (mountain, foothill, valley) within the Big Chico Creek watershed to track stream conditions from near the headwaters to the mouth. Land use in the upper mountain zone consists primarily of fire prevention and forest management practices. Land use in the foothill zone consists of rural residential, fire prevention, an ecological reserve, and recreational use. Land use in the valley zone consists primarily of urban residential, recreational uses, flood control, and a small portion near the mouth managed for agricultural purposes.

Ten monitoring stations have been established and are monitored monthly during May through October, and additionally during storm events, and bioassessment surveys. In addition, stream temperature is monitored continuously from May through October.

General stream chemistry and physical conditions were found to be comparable with other streams in the region, and a more complete summary will be provided in Section B of this document.

Program Mission

The Stream Team's mission is to gather technically robust environmental information needed to protect the ecological health of the Big Chico Creek watershed, while engaging the local community in effective watershed stewardship.

Monitoring Program Goals

- Implement a watershed scale, citizen-monitoring program, which documents long-term trends in watershed condition cumulatively resulting from restoration activities, land management changes, and natural processes.
- Involve student and community volunteers in monitoring efforts to encourage an understanding of watershed ecological functions and the intrinsic values of natural resource protection.

- When possible, build on prior monitoring efforts to facilitate data sharing and to improve data analysis.

Why Monitor Creeks?

Clean water is an important resource that most of the public has shown a great willingness to protect. Healthy creek systems like Big Chico Creek are integral to the overall function of the Sacramento River ecosystem and are important for providing safe drinking water, ground water recharge, flood control, critical habitat for listed and endangered fish and wildlife, and provide intrinsic scenic value to the Chico community.

Population growth in the Sacramento Valley is projected to double in the next 30 years, which implies associated sources of urban runoff pollutants from small tributaries such as Big Chico Creek, will become increasingly important to pinpoint and control. A variety of cumulative impacts can stress aquatic ecosystems and impair their beneficial functions. Non-point source pollutants can flow from the land into creeks including sediment, synthetic materials from our roads and automobiles, fertilizers, nutrients, sewage leaks, and animal wastes. Creek monitoring provides useful baseline information that can be used to track these potential impacts. Baseline information collected now will facilitate the ability to track changes over time and help prioritize efforts for identifying sources of pollutants, and appropriate land use changes needed to minimize impacts.

Why Rely On Citizen Volunteers?

Citizen monitors have specific knowledge and expertise about our local environment and can help attain access to areas within the watershed that would otherwise be inaccessible. Their involvement has an important impact in reducing urban pollution from entering our waterways through an improved understanding of the ecological function of creek systems in general and increased use of pollution prevention measures leading to improved participation in watershed stewardship and resource protection efforts. They are also very dedicated and have a proven capacity to accurately and precisely perform monitoring tasks and ensure data quality objectives are achieved. Through their passionate, informed dedication an amazing amount of information is collected that would not otherwise be possible.

Summary Of Volunteer Participation (2005-2010)

Interest and participation in The Stream Team has increased annually since the program began in 2004. Collaborative monitoring conducted by multiple individuals and organizations, with different interests, and forms of expertise provide an important opportunity for building a shared ecological understanding among diverse participants, and awareness of the interdependence of humans and natural resources. Through these efforts, internal trust among participants has been enhanced, leading to communications of monitoring findings to a broader community, increasing the likelihood that the monitoring data generated will be used to make informed decisions for protecting watershed health.

Table 1 shows a summary of participation. During 2005 through 2008, the average number of volunteers each year totaled 332, providing over 3,000 hours of community service annually. During 2009, the number of participants totaled 1,137, providing nearly 6,000 hours of community service, which is a significant increase compared with previous years. During 2010, over 4,000 hours of community service were provided, which is a slight decrease in average number of hours when compared with 2009, resulting from decreased funding and reduced hours for working with students from Chico Unified School System.

Table 1. Citizen Monitoring Program Participation Levels: 2005-2010

Number of Hours and Participants						
Citizen Monitor Category	2005-2008		2009		2010	
	Hours	Participants	Hours	Participants	Hours	Participants
Monitoring Program Member	4,192	168	1,498	197	2,620	524
CUSD Students and Teachers	7,423	893	3,306	776	953	335
CSU Chico Students/Interns	873	127	637	72	119	357
TAC	360	15	200	10	80	6
Others	532	128	327	82	115	115
Total	13,380	1,331	5,968	1,137	4,125	1,108

Table 2. Citizen Monitoring Program Events: 2005-2010

Total Number of Outreach / Training / Monitoring Events			
	2005-2008	2009	2010
Outreach	156	38	40
Training	120	36	34
Monitoring	100	30	53
Total Events	376	104	127

Citizen volunteers were recruited and coordinated to participate in monthly water quality monitoring events, storm event monitoring, restoration efforts, data management, urban storm water pollution prevention measures, school-based watershed and storm water education, and public presentations. Activities took place in varied habitats throughout the watershed to enhance public understanding of watershed function, and to provide increased perspective on the geographic relationship of the Big Chico Creek watershed with the Sacramento River watershed, an important source of clean water for the entire state of California.

Program Outreach

Citizen monitoring efforts rely heavily on providing public outreach and education to solicit stakeholder interest and participation in monitoring efforts. Outreach was conducted through attendance at public meetings, conferences, workshops, one-on-one visits to local schools, Chico State University, community organizations, distribution of flyers, and public announcements and presentations. An important aspect of the outreach activities is public education regarding water quality and sources of contaminants such as animal waste, improper pesticide use, dumping, and urban runoff.

Efforts to build collaborations with Butte Environmental Council, Kids and Creeks, Chico Creek Nature Center, Big Chico Creek Ecological Reserve, City of Chico Park Volunteer and Storm Water Programs, and Big Chico Creek Watershed Alliance (BCCWA) continue. The goal of this effort is to promote the development of collaborative outreach and education materials focused on providing consistent watershed and urban storm water pollution prevention information.

As a result of this effort, two collaborative pending grant proposals were prepared, one with the City of Chico to support youth involvement in improving park infrastructure (Stewardship Council), and the other with BCCWA (Department of Conservation) to support their respective watershed coordinators.

Although individual program leaders have shown a consistent willingness to work together, formal planning rarely occurs. The ultimate barrier seems to be linked to the limited available time program leaders have to devote to collaborative endeavors, and changing leadership and emerging goals of each individual program. The extra steps required for coordinating multi-agency efforts is time consuming, and requires consistent and timely planning, which is challenging for small entities struggling to keep their individual efforts moving forward. Sustainability issues, and perceived and real competition for funding and participants is also a barrier.

It is this practitioner belief that these issues could be somewhat remediated if individual program roles were more clearly defined, overlaps and gaps in services identified, and a community collaboration plan developed for Butte County. Such efforts would facilitate the ability of local groups to secure larger funding sources for collaborative efforts with clearly defined outreach and education goals to achieve larger community awareness of measures needed to protect watershed health.

The reality of long-term collaborations occurring, is also dependent on the monitoring program itself taking the initiative to better define education and outreach objectives more clearly, tied to monitoring program needs and resource management goals, in order to better evaluate program effectiveness, and necessary changes to enhance public awareness.

Training

Training is an essential element of citizen monitoring efforts and is provided annually each spring, and during each monthly monitoring event to ensure standard methods and sampling protocols are followed. This in turn ensures that data quality objectives are met and that data integrity is consistent with the previous years of data collected increasing the usefulness for other data users.

Technical Advisors

A Technical Advisory Committee (TAC) was established to provide on-going technical advice and oversight throughout the duration of this project.

Guy Chetelat, Associate Engineering Geologist, Regional Water Quality Control Board
Erick Burress, Citizen Monitoring Coordinator, State Water Resources Control Board
Randy Senock, Professor of Geological Sciences, CSU Chico
Paul Maslin, Professor of Biology, CSU Chico
Jennifer York, Aquatic Bioassessment Lab, Department of Fish and Game

Ruben Martinez, Director of Operations and Maintenance, City of Chico
Nani Teves, Watershed Coordinator, BCCWA
Timmarie Hamill, Watershed Coordinator, The Stream Team

Quality Assurance Project Plan and Monitoring Plan Update

The existing Quality Assurance Project Plan (QAPP) and Monitoring Plan were approved in spring 2005, and are updated each year to guide monitoring efforts.

Funding Support

Funding Agency	Year	Activities Supported
Sierra Nevada Alliance	2004	Initiated Citizen Monitoring @ 4 sites quarterly
CALFED Prop 13	2005	Established Citizen Monitoring Program w/expanded monitoring objectives for 10 sites, including equipment and lab costs, operating budget, and development of Monitoring Plan and QAPP
City of Chico	2005	Storm Drain Illicit Discharge Outlet Survey (40 priority outfalls)
SWRCB Prop 40	2006	Expanded existing citizen monitoring effort to provide pre post monitoring and education for 2 large restoration projects
Stewardship Council	2006	Formed Youth Stream Teams @ 6 schools providing 70 classroom and field trip events for 266 students
Sierra Nevada Alliance	2007	Continued Citizen Monitoring effort @ 10 sites including MP/QAPP update and funding to analyze bioasessment samples
City of Chico	2007	Storm Drain Marking (1200 inlets marked)/Outlet Surveys (210 outfalls)
Stewardship Council	2008	Formed Youth Stream Teams @ 4 schools providing 40 hours of classroom and field trip events for 243 students
City of Chico	2008	Storm Drain Inlet Marking (1295 inlets)
City of Chico	2009	Storm Drain Inlet Surveys (1100 inlets)/Outlet Surveys (550 outfalls)
City of Chico	2009	Continued Citizen Monitoring @ 10 sites including MP/QAPP update, bacteria monitoring, and storm water education and outreach
City of Chico	2010	Continued Citizen Monitoring @ 10 sites including MP/QAPP update, bacteria monitoring, and storm water education and outreach

Over the years funds received have provided the resources necessary (staff, equipment, laboratory fees, operating costs) to engage citizens in watershed monitoring, and beyond by building community capacity to answer questions and/or support resource management goals. The Big Chico Creek Watershed Alliance (BCCWA) provided the fiscal umbrella for the various grants received to support the citizen monitoring effort and related activities. This initial arrangement was a critical factor for achieving success and provided an avenue for linking monitoring efforts with large local restoration projects that would not have otherwise have been possible. Throughout the years the monitoring effort maintained a consistent approach, although changing leadership within the BCCWA sometimes made it difficult to strategically plan for sustaining the monitoring effort into the future, and existing funding was rarely leveraged to land companion grants or local funding support.

As a result, The Stream Team incorporated during 2010 as an independent non-profit entity in order to provide more focused administration and fiscal responsibility for The Stream Team, Youth Stream Team (K-12 storm water education), and storm drain inlet/outlet survey efforts. Although funding has not yet been secured to continue this effort during 2011, the founding board of directors is currently evaluating the merits of past efforts, and prioritizing organizational goals and objectives in order to develop a long-term strategic plan to evolve the monitoring effort forward. Local support is being sought to bridge the funding gap during this transition while additional sources of support are secured.

Monitoring Approach

Monitoring efforts focus on collecting information during the summer months (May-October), and during storm events, specifically in stream reaches where spring-run Chinook salmon have been historically present. Temperature and water quantity are primary factors influencing spring-run abundance in Big Chico Creek. Spring-run salmon enter Big Chico Creek during spring and depend on cool water pools for refuge from warmer water temperatures during the summer months while they wait to spawn later in the fall.

This approach provides opportunities for volunteers to participate during months when conditions are more conducive for wading, when stream flows are lower, and water temperatures are warmer, allowing basin plan water quality objectives to be tracked during months most critical for spring-run Chinook salmon survival.

Sampling Methods

Sampling is conducted according to the Quality Assurance Project Plan (QAPP) and Monitoring Plan (MP). The QAPP and MP were first approved by the State Water Resources Control Board in 2005 and was updated in 2007, 2009, and again in 2010. The QAPP describes field protocols, sample handling and analysis, and other activities designed to ensure data quality objectives are achieved and high quality data obtained during the investigation.

The following monitoring elements are included:

- Temperature
- pH
- D.O.
- Conductivity
- Total Dissolved Solids
- Turbidity
- Fecal coli form
- Flow
- Photo Documentation
- Bioassessment

Data Management and Dissemination

The data collected by citizen monitors is housed in a database in the office of The Stream Team Citizen Monitoring Program Director, and is available upon request. In addition, reports will be posted on The Stream Team website and have been provided to the State Water Board for eventual inclusion in the Surface Water Ambient Monitoring Program (SWAMP) database.

Summary of Data Results

General stream chemistry and physical conditions were comparable with other streams in the region. Water temperature, EC, and TDS varied the greatest along the length of the study area with a general trend toward higher values downstream. The seasonal pattern in temperature, EC, and TDS was also influenced by elevation, flow and land use, and values were highest in the fall in the lower elevations.

Sampling results showed concentrations of E. coli bacteria were elevated in the lower watershed and exceeded basin plan water quality objectives for contact recreation 1-2 time each year at 3 sites during late summer and fall, and at 5 sites during storm events. Possible sources include: pet waste (dogs, livestock), septic systems, sewer leaks, and homeless encampments.

Sediment and turbidity levels were also low and closely linked to low summer stream flow conditions. Effects of erosion were not noted in the samples collected during summer months, but were higher during winter months. During storm events turbidity levels in the lower watershed increased directly below storm water discharge locations carrying urban runoff with significantly higher levels of sediment. Recent urban runoff investigations summarized by Robert Pitt (2002) have shown water column testing alone to be misleading, and suggest that aquatic life impacts are impacted less by transient water quality impacts from runoff, but instead from cumulative long-term problems caused by polluted sediments, and habitat and food web disruption.

Temperature recorders were installed in the upper reaches of the creek and indicate poor conditions for salmon during the months of July and August. Temperatures in the mountain zones indicate cool water conditions with an important influence on temperatures in the lower reaches. Data gaps exist between temperature monitoring stations in the upper reaches, and warrant further study to capture the influence of important tributary contributions from Web Hollow Creek and Campbell Creek.

Bioassessment is the science of using aquatic organisms as indicators of ecological health in streams and rivers. Many types of organisms can be used as indicators, for example fish or algae, but bioassessment is most frequently based on benthic macro invertebrates (BMIs), which are small bottom-dwelling aquatic insects. BMI data sets consist of diverse species (or taxa) found in a sample and their relative abundances, which can be further simplified into indices of biotic integrity (IBIs) that are designed to be sensitive to human-caused alterations to the landscape, physical stream conditions, and to water chemistry. IBIs function much like economic indicators: high IBI scores reflect good ecological conditions while low IBI scores reflect poor ecological conditions. Bioassessment results (IBI scores) were compared to the Southern California and Northern California IBI's, and indicate communities of "good to very good" stream conditions in the upper watershed, and "fair to poor" in the lower urban portions of the watershed. Physical/habitat conditions at each site were also assessed during macro invertebrate surveys and ranked in the optimal range for most of the survey sites.

Discharge measurements were taken during each sampling event and flows were highest in the spring, ranging from 100-200 cubic feet per second (CFS) and lowest in the fall, ranging from 4 to 11 CFS. Field measurements were correlated with the gauge located near the Bidwell Golf Course. An additional gauge is located downstream at Rose Avenue, but the data is not readily available. Some of the functions at these gauges need to be repaired and it is recommended that they be brought back up to optimal conditions with regular maintenance, in order to allow easy access to data for comparison.

Overall, general stream chemistry and physical conditions throughout the Big Chico Creek watershed were comparable with other foothill streams in the region, and seem to be in relatively good condition with seasonal patterns related to stream flow, elevation, and land use.

Impacts of land use are sometimes difficult to detect, so information will need to be collected over a long temporal scale to determine any variation due strictly to a particular land use. Citizen monitoring groups are ideal for collecting this information to determine long-term trends in stream habitat quality as a function of land use. In addition, to best identify and understand long-term impacts, it is necessary to include biological monitoring, and the addition of sediment quality analyses.

Land Uses And Other Impacts

The Big Chico Creek watershed includes urban, suburban, rural residential, orchard, rangeland, and timberland land uses and is a tributary to the Sacramento River. The underlying geology includes areas where the creek cuts through Tuscan layers important in the recharge of the Lower Tuscan aquifer, which is being explored for a regional conjunctive use project.

Boundaries to the land use zones described below are formed partly by physiological limitations of the biotic community but mostly by geological barriers. The physical barriers divide Big Chico Creek into a mountain zone from the headwaters to Higgin's Hole, a foothill zone between Higgin's Hole and Iron Canyon, and a valley zone between Iron Canyon and the river.

Land Use Zone	Land Use Practices	Potential Impacts
Mountain	Forest and fire management, rural residential	Erosion from clear cuts in the upper watershed (Web Hollow) and recent fire damage
Foothill	Rural residential, grazing, recreation	Erosion and urban run-off pollution as a result of increased population growth, recreational use, and new roads and trails.
Valley	Urban residential, light commercial, recreation, grazing, agricultural, roads, and flood control	Erosion and urban run-off pollution as a result of increased population growth, recreational use, and new housing tracks, roads and trails. There are also impacts to the morphology of the creeks as a result of flood controls and urban runoff causing channel incision and riparian habitat deletion.

Land Use Practices That Warrant Further Monitoring

Clear-cut logging operations have been conducted recently in the upper portion of the watershed (Web Hollow/ Campbell) and may lead to increased erosion and stream temperatures. Web Hollow and Campbell creeks are important tributaries of Big Chico Creek and contribute important cool water from headwater springs. It is unclear what effects current logging practices are having on temperature and erosion, and Southern Pacific Industries (SPI), which is conducting the logging, has shown little desire to collaborate or share information. There are other potential landowners in the upper watershed including the Bureau of Land Management (BLM) and several private landowners, who could be pursued to address this data gap. Continuous temperature monitoring efforts in the upper watershed should be expanded to better track cool water contributions from springs and tributaries including Web

Hollow and Campbell Creek, which have the greatest potential to impact water temperatures in the foothill reaches.

Several large restoration projects have been newly completed in the valley zone (Verbena Fields/Bidwell Avenue) to address flood management and improve riparian and upland habitats that should continue to be monitored to track pre and post construction conditions. In addition, the Iron Canyon Fish Ladder is moving closer to being repaired, and monitoring sites should be expanded to capture pre and post construction conditions.

Impacts associated with urban run-off pollution will continue to be important and monitoring objectives should be updated annually to address changes in land use practices. GIS layers for geology, soils, and land use should be correlated with data results to identify any data gaps and direct the location of additional monitoring stations. Correlating GIS layers with data results would also provide a useful tool for focusing monitoring objectives to answer specific questions regarding impacts of various land use practices and allow better translation of data results into public action.

Conclusions

Overall the program has been very successful in building participation levels in monitoring efforts within the Big Chico Creek watershed and has significantly increased the amount of assessment data available for making management decisions to protect watershed health. The most promising vehicle for enhancing sustainability of the Big Chico Creek Watershed Citizen Monitoring Program are efforts linking on-going environmental resource protection and monitoring efforts with the educational needs of local schools and the City of Chico's Storm Water Management Program requiring an urban pollution prevention education program.

The results of this program indicate that a carefully implemented citizen-monitoring program can provide valuable and reliable data which could provide State and local resource managers with the ability to track long-term changes in environmental condition.

Special Thanks

This program is possible thanks to the generous support and feedback provided by the Technical Advisory Committee, Big Chico Creek Watershed Alliance, participating professors and students from Chico State University, teachers and students from Chico Unified School District, City of Chico, Friends of Bidwell Park, Big Chico Creek Ecological Reserve, Stewardship Council, Sierra Nevada Alliance, and of course the extreme dedication by individual citizen monitors, and volunteers.

Special thanks to Randy Senock and Nancy Carter for providing technical assistance and data analysis and for facilitating participation by CSU Chico Geosciences students.

Special-special thanks for the incredible dedication of the over 4,000 citizen monitors who have joined in the efforts of the Stream Team Citizen Monitoring Program contributing over 25,000 hours of community service. Without citizen involvement, the monitoring program would have no merit, and cease to exist.

B. BACKGROUND

Approach

Monitoring efforts focused on collecting information during the summer months (May-October) and during storm events. Stream reaches where spring-run Chinook salmon have been historically present were specified as monitoring sites. In addition, sites were selected for easy access for schools and the general public, and for teasing out indicators of runoff pollution sources from various land use practices.

Temperature and water quantity are primary factors influencing spring-run abundance in Big Chico Creek. Spring-run salmon enter Big Chico Creek during spring and depend on cool water pools for refuge from warmer water temperatures during the summer months while they wait to spawn later in the fall (ECR, 1998).

Monitoring Station Locations

Table 3. Monthly Monitoring Stations

Station #	Site Name	Site Description	GPS
1	BCC @ Hwy 32	Hwy 32 Bridge Crossing	40°07’32.46” N 121°34’23.15”W
2	BCC @ Higgins	Ponderosa Way Bridge Crossing	39°53’17.53” N 121°41’48.57”W
3	BCC @ Reserve	Big Chico Creek Ecological Reserve @ Dance Floor Hole	39°52’10.61”N 121°42’24.62”W
4	BCC @ Above Browns Hole	End of Bidwell Park Road	39°48’22.22”N 121°43’39.23W
5	BCC @ Below Bear Hole	Below hazard marker on trail upstream of parking area	39°46’33.44”N 121°45’08.94”W
6	BCC @ Five- Mile	Five-Mile Picnic Area above footbridge	39°45’48.28”N 121°47’28.93”W
7	BCC @ One-Mile	Below restoration site	39°44’10.65”N 121°49’40.97”W
8	BCC @ Warner	Warner Street Bridge Crossing	39°43’39.32”N 121°50’55.81”W
9	BCC @ Rose	Rose Avenue Bridge Crossing	39°43’37.38”N 121°51’47.74”W
10	BCC @ Mouth	River Road Bridge Crossing	39°42’15.59”N 121°56’21.44”W

Table 4. Continuous Temperature Monitoring Stations

Station #	Site Name	Site Description	GPS
T-1	BCC @ Hwy 32	Hwy 32 Bridge Crossing	40°07'32.46" N 121°34'23.15"W
T-2	BCC @ Higgins	Higgins Hole	39°53'17.53" N 121°41'48.57"W
T-3	BCC @ Reserve	Big Chico Creek Ecological Reserve @ Dance Floor Hole	39°52'10.61"N 121°42'24.62"W
T-4	BCC @ Henning	Big Chico Creek Ecological Reserve @ Henning Hole	39°51'48.26"N 121°42'34.25"W
T-5	BCC @ Pool T	Big Chico Creek Ecological Reserve @ Pool T	39°50'37.15"N 121°42'55.59"W
T-6	BCC @ Salmon	Salmon Hole	39°50'37.15"N
T-7	BCC @ Rose	Rose Avenue Bridge Crossing	39°43'37.38"N 121°51'47.74"W

Table 5. Restoration Pre-Post Photo Monitoring Stations

Station #	Site Name	Site Description	GPS
R-1	Verbena	1st and Verbena	39°45'13.35"N 121°49'17.54"W

Table 6. Benthic Monitoring Stations

Station #	Site Name	Site Description	GPS
1	BCC @ Hwy 32	Hwy 32 Bridge Crossing	40°07'32.46" N 121°34'23.15"W
3	BCC @ Reserve	Big Chico Creek Ecological Reserve @ Dance Floor Hole	39°52'10.61"N 121°42'24.62"W
5	BCC @ Below Bear Hole	Below Bear Hole	N 39°46'33.44" W 121°45'08.94"
6	BCC @ Five- Mile	Five Mile Picnic Area Above Footbridge	39°45'48.28"N 121°47'28.93"W
7	BCC @ One-Mile	Above Sycamore Pool	N 39°44'10.65 W121°49'40.97
8	BCC @ Warner	Below Warner Street	N 39°43'39.32 W 121°50'55.81
9	BCC @ Rose	Rose Ave. Bridge	N 39°43'39.32 W 121°50'55.81
10	BCC @ Mouth	River Road Bridge Crossing	39°42'15.59"N 121°56'21.44"W
11	Rock Creek	Rock Creek below Richardson Springs	N/A

Narrative Description of Monitoring Stations

Monthly Monitoring Stations

Station #1- Hwy 32 Bridge, represents a reach of the creek in the upper mountain zone influenced by cool water springs. It is the uppermost station where monitoring is conducted.
Station #2- Higgin's Hole, represents a reach of the creek in the lower mountain zone and includes a large deep pool where spring-run salmon historically have been found holding over summer. Geological barriers prevent further upstream migration.
Station # 3 –Reserve, comprises a relatively pristine reach of the creek with good representation of stream conditions in the upper foothill zone. This site also represents an area above Bidwell Park with little recreational impacts, and active restoration activities.
Station #4 –Above Brown's Hole, represents the beginning of a steep gradient reach within the foothill zone (above iron canyon), located at the end of the road in upper Bidwell Park**.** This site will also provide a separation between the foothill and valley zones, and the Ecological Reserve.
Station #5 – Below Bear Hole, represents the uppermost reach of the low gradient valley zone in upper Bidwell Park, below the Lovejoy basalt formation, and above the golf course.
Station #6 – Five-Mile, represents a low gradient valley zone reach of creek with an urban influence below a golf course. This site is also below a USGS gauging station, and diversion weir, and is easily accessible, and is within walking distance of most schools within the Chico. This site is also the site where annual training is provided, and where citizen monitors meet to form teams and obtain equipment for monthly monitoring events.
Station #7 – One-Mile, represents a reach of creek in the valley zone in lower Bidwell Park with urban influence and includes a section of stream where the channel has been cemented to form a large public swimming pool. This site is also very accessible for public events, and within walking distance from most local schools.
Station #8 – Warner, represents another reach of the creek with urban influence, located on the CSU campus and includes a large pool where spring-run salmon have historically been found holding over summer.
Station #9 – Rose, represents the lower reach of the urban zone, where land-use begins to transition to an agricultural influence. It is also where a USGS gauging station is located, and where the creek water migrates underground during most summer months.
Station #10 – Mouth, represents a reach of the creek below the confluence of Lindo Channel, Mud and Rock Creek (Kusal Slough) just before it enters the Sacramento River.
Station #11 –Rock Creek site represents a site below Richardson Spring, important for understanding tributary contributions to Big Chico Creek, and provides an opportunity to link with students from CSU Chico Geosciences participating in environmental research.

Continuous Temperature Monitoring Stations

Station #T-1 – Hwy 32, represents the upper mountain zone where the creek is influenced year-round by cold-water springs and deep, forested canyons.
Station #T-2 – Higgins, represents the upper most reach of the foothill zone where spring-run salmon can hold over summer, and consists of a very large deep pool. Geologic barriers prevent salmon from any further migration upstream.

Station #T-3 – Henning, represents a fairly large pool downstream from Higgins where spring-run salmon have been found holding over summer.
Station #T-4 – Pool-T, represents another pool in the foothill zone, downstream of Henning where spring-run have also been found to hold over summer.
Station #T-5 – Salmon Hole, represents a large pool in the lower foothill zone. In low-water years, this site represents the end of upstream migration for spring-run salmon, which are stranded by a deteriorated fish ladder preventing further upstream passage.
Station #T-6 – Rose, represents the lower reach of the urban zone, where it begins to transition to an agricultural influence.

Restoration Pre Post Photo Monitoring Stations

Station # R-1- Verbena, represents a site within a large flood plain restoration project.

Benthic Monitoring Stations

Station #1- Hwy 32 Bridge, represents a reach of the creek in the upper mountain zone influenced by cool water springs. It is the uppermost station where monitoring is conducted.
Station # 3 –Reserve, comprises a relatively pristine reach of the creek with good representation of stream conditions in the upper foothill zone. This site also represents an area above Bidwell Park with little recreational impacts, and active restoration activities.
Station #5 – Below Bear Hole, represents the uppermost reach of the low gradient valley zone in upper Bidwell Park, below the Lovejoy basalt formation, and above the golf course.
Station #6 – Five-Mile, represents a low gradient valley zone reach of creek with an urban influence below a golf course. This site is also below a USGS gauging station, and diversion weir, and is easily accessible, and is within walking distance of most schools within the Chico. This site is also the site where annual training is provided, and where citizen monitors meet to form teams and obtain equipment for monthly monitoring events.
Station #7 – One-Mile, represents a reach of creek in the valley zone in lower Bidwell Park with urban influence and includes a section of stream where the channel has been cemented to form a large public swimming pool. This site is also very accessible for public events, and within walking distance from most local schools.
Station #8 – Warner, represents another reach of the creek with urban influence, located on the CSU campus and includes a large pool where spring-run salmon have historically been found holding over summer.
Station #9 – Rose, represents the lower reach of the urban zone, where land-use begins to transition to an agricultural influence. It is also where a USGS gauging station is located, and where the creek water migrates underground during most summer months.
Station #11 –Rock Creek site represents a site below Richardson Spring, important for understanding tributary contributions to Big Chico Creek, and provides an opportunity to link with environmental research conducted by students from CSU Chico Geosciences Department.

Sampling Schedule

The sampling schedule varies by location and monitoring parameter, as summarized in Table 3.

During May 2005 through October 2009 monthly sampling was conducted regularly on the first or second Saturday of each month at all ten stations, and during storm events on an irregular schedule.

For coli form bacteria, and total solids, the sampling was during the months of September and October during 2005 through 2008, and during June through October in 2009 at seven stations and during storm events at four additional storm drain outlet sites during storm events.

Biological surveys (bioassessment) and physical habitat assessments were limited to four stations during fall 2005, expanded to seven stations in 2006 through 2008, and eight stations during 2009.

Continuous temperature monitoring in 2005-2010 was conducted at 5-8 sites during May through October.

Table 7. Sampling Schedule

Parameter	**Frequency of monitoring**
Temperature	Monthly (May- Oct.)
Dissolved Oxygen	Monthly (May- Oct.)
pH	Monthly (May- Oct.)
Conductivity	Monthly (May- Oct.)
Total Dissolved Solids	Monthly (May- Oct.)
Turbidity	Monthly (May- Oct.)
Total Solids	Storm Event
Coli form Bacteria	Monthly (May- Oct.), and Storm Event
Benthic Macro invertebrates	Fall
Photo Documentation	Monthly (May- Oct.)
Flow	Monthly (May- Oct.)

Figure 1. Monitoring Site Locations

Sampling Methods

Sampling was conducted as described in the Project's Quality Assurance Project Plan (QAPP). The QAPP describes field protocols, sample handling and analysis, and other activities designed to ensure data quality objectives were achieved and high quality data obtained during the investigation. The following monitoring elements were included in the Big Chico Creek Watershed Citizen Monitoring Program:

- Temperature
- pH
- D.O.
- Conductivity
- Turbidity
- Total Dissolved Solids
- Total Solids
- Fecal coli form
- Flow
- Photo Documentation
- Benthic Macro invertebrates

C. DATA RESULTS

Stream Temperature

Stream temperature affects water chemistry and the function of aquatic organisms. Factors that can elevate stream temperature include vegetation removal, soil erosion, storm water run-off, and alterations to stream flow. It is important to protect the upper watershed from impacts, where cool water springs influence the overall temperature regime within the Big Chico Creek watershed.

High stream temperatures during summer months have been identified as a contributing factor in the decline of spring-run Chinook salmon populations within the Big Chico Creek watershed. Temperatures of 13-18 ° C or greater are stressful to juvenile salmon, and temperatures of above 20° C can be lethal.

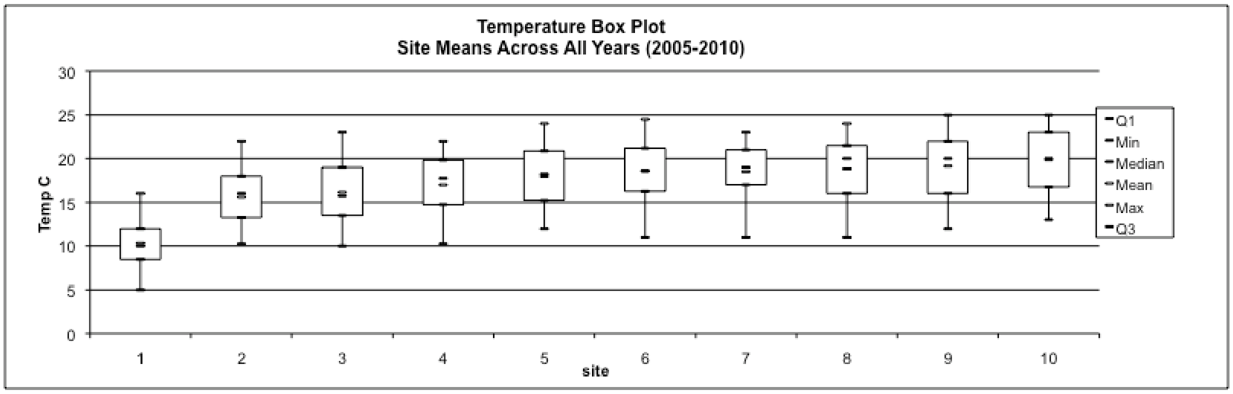
Many of the sites surveyed exceed 20° C during the summer months indicating poor conditions for spring-run salmon. Stream temperatures were lowest in the mountain zone where elevations range from 1600-5,400 ft. and cool water springs feed the system year round. Highest stream temperatures were found in the foothill and valley zones where elevations range from 120-1600 ft. and stream temperatures warm relative to air temperature and elevational lapse rates.

Monthly Stream Temperatures

Table 8. Temperature ranges during 2005-2009

Year	Upper Watershed (°C)	Lower Watershed (°C)
2005	7 to 20	10 to 23
2006	8 to 18	11 to 25
2007	5 to 21	10 to 25
2008	10 to 20	12 to 24
2009	5 to 20	13 to 22
2010	8 to 22	13 to 24

Figure 2. Mean Water Temperature During 2005-2010 (Dry Weather)



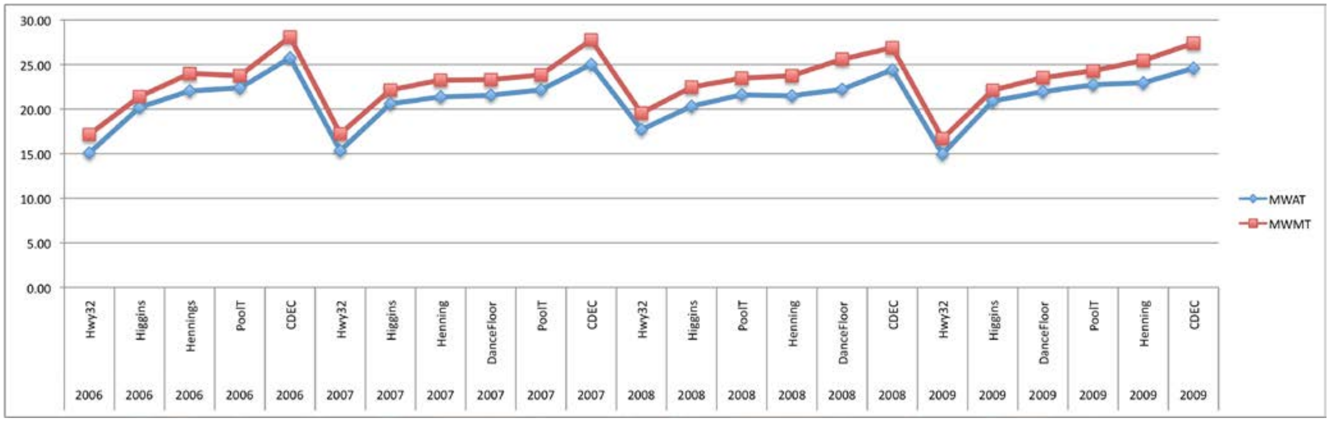
Continuous Stream Temperatures

Water and air temperatures were measured continuously on Big Chico Creek and several tributaries during 2005 -2009. Seven main stem monitoring sites are distributed from the Hwy 32 downstream to Rose Ave. The accuracy of the probes was ±0.2°C. Data loggers were deployed from May through November and provided a continuous record of water temperature at one-hour intervals. Temperature probes were positioned at mid- water depth in well-mixed water (runs) and not exposed to direct sunlight.

In-stream temperature monitoring provided daily and seasonal maxima and minima, diurnal ranges, Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWMT) at specific sites within the creek. The MWAT and MWMT are the highest seven-day moving average of the daily mean or maximum temperature, respectively. Stream temperature statistics for 2006-2009 are in Figure 7.

* 2010 data was not available in time for this report, but will be incorporated upon receipt (See Appendix 2 for preliminary water temperature data)

Figure 3. 2006 – 2009 Maximum Weekly Average Temperature ° C (MWAT) and Maximum Weekly Maximum Temperature ° C (MWMT)



	2006		2007		2008		2009	
SITE	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT
Hwy32	15.07	17.15	15.33	17.23	17.70	19.54	14.95	16.69
Higgins	20.18	21.39	20.60	22.14	20.31	22.46	20.88	22.11
Henning	22.04	23.98	21.37	23.25	21.49	23.75	22.94	25.45
PoolT	22.36	23.75	22.16	23.84	21.62	23.46	22.72	24.30
CDEC	25.73	28.08	25.01	27.75	24.40	26.88	24.57	27.39

Temperature Calculations/Definitions:

MWAT (maximum weekly average temperature) is the highest seven-day moving average of the daily mean temperatures. The date of the seven-day moving averages is attributed to the mid-point of the 7- day period (for example, for Week 1 (Day 1 - Day 7) the mid-point of the period is Day 4).

MWMT (maximum weekly maximum temperature) is the highest seven-day moving average of the daily maximum temperature. The date of the seven-day moving averages is attributed to the mid-point of the 7-day period (for example, for Week 1 (Day 1 - Day 7) the mid-point of the period is Day 4).

CDEC represents station data from the Golf Course Stream Gauge

Stream reaches within historical salmon bearing areas (Higgins, Henning, and Pool T) Maximum Weekly Average Temperatures (MWAT) ranged between 20 and 23°C, and Maximum Weekly Maximum Temperatures (MWMT) ranged between were 20 and 25°C during 2006 to 2009, which poses a stress for spring-run salmon during summer months.

Maximum Weekly Average Temperatures (MWAT) for stream reaches within the mountain zone (Hwy 32) ranged between 15 and 17°C, and Maximum Weekly Maximum Temperatures (MWMT) ranged between 17 and 19°C.

Maximum Weekly Average Temperatures (MWAT) for stream reaches within the valley zone (CDEC) ranged between 24 and 25°C, and Maximum Weekly Maximum Temperatures (MWMT) ranged between 26 and 28°C.

Table 9, shows temperature tolerance ranges for spring-run salmon summarized from various undocumented literature sources.

Table 9. Temperature Tolerances

	Life History Stage	**Primary Time Period**	**Optimal**	**Suboptimal**	**Chronic Acute Stress**
Spring-Run Salmon	Upstream Migration	Apr-Jun	13.3/56	13.3-18.3/56-65	>18.3/>65
	Adult Holding	mid Apr-late Sep	<16/<60.8	16-19/60.8-66.2	>19/>66.2
	Spawning	Sep-Oct	<13.3/<56	13.3-15.6/56-60	>15.6/>60
	Egg Incubation	late Sep-Jan	<12/<54	12-14.4/54-58	>14.4/>58
	Fry/Juvenile Rearing	mid Nov-Apr	<15.6/<60	15.6-18.3/60-65	>18.3/>65

Figure 4. 2005 7-Day Running Maximums

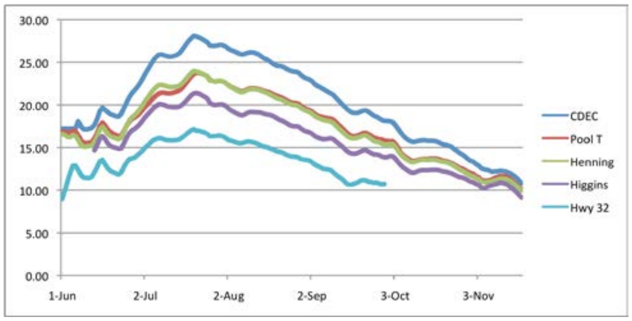


Figure 5. 2006 7-Day Running Maximums

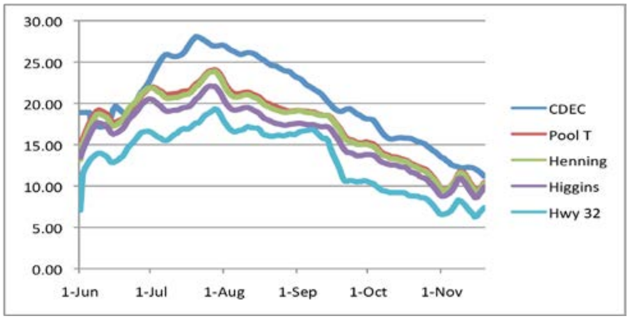


Figure 6. 2007 7-Day Running Maximums

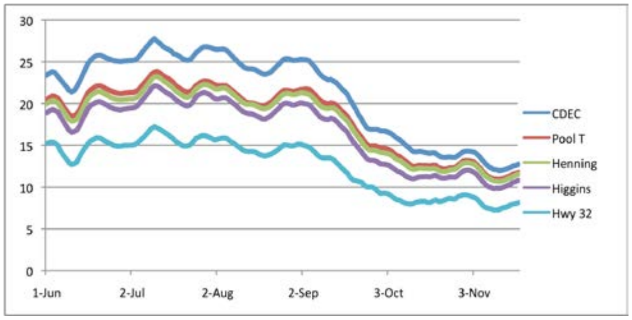
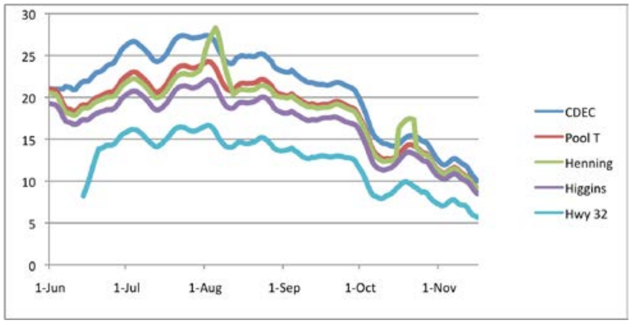


Figure 7. 2008 7-Day Running Maximums

Figure 8. 2009 7-Day Running Maximums



*2010 7-Day Running Averages were not available in time for this report**,** but will be incorporated upon receipt.

Water Chemistry

Dissolved Oxygen (DO)

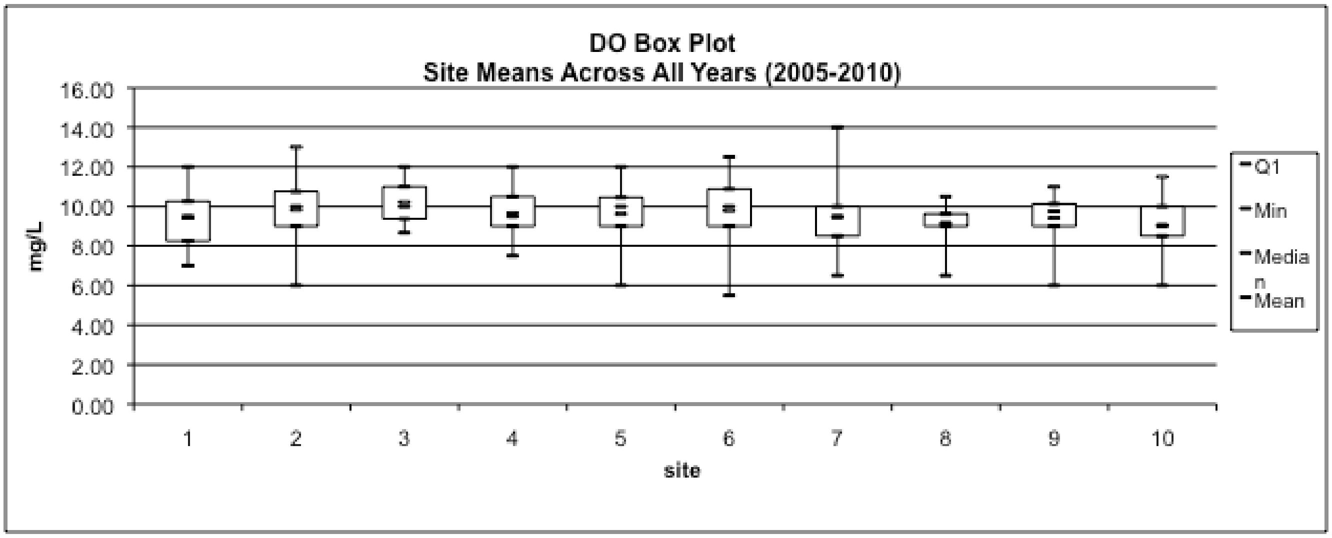
DO is the amount of oxygen dissolved in water. Aquatic organisms need oxygen to survive and grow. Oxygen from air is dissolved in water at its surface, mostly through turbulence. Plants also produce oxygen when they photosynthesize. As temperature, altitude, salinity, and mineral content increase, the DO levels decrease. Most aquatic organisms require ranges of DO between 5 and 8 mg/L to survive depending on the species.

Average DO levels in Big Chico Creek ranged between 6 and 12 mg/L in the upper watershed, and between 6 and 14 mg/L in the lower watershed.

Table 10. Dissolved Oxygen Ranges during 2005-2010

	Dry Weather	Dry Weather	Storm Event	Storm Event	Storm Event
Year	**Upper Watershed (mg/L)**	**Lower Watershed (mg/L)**	**Upper Watershed mg/l**	**Lower Watershed mg/l**	**Storm Drain Outfall mg/l**
2005	9 to 9.6	7 to 9.6	N/A	N/A	N/A
2006	8 to 11	6 to 9	N/A	N/A	N/A
2007	8.5 to 11	8.5 to 10.5	N/A	N/A	N/A
2008	9 to 12	8.5 to 11.5	N/A	N/A	N/A
2009	8 to 12	6 to 12.5	N/A	N/A	N/A
2010	6 to 13	5.5 to 14	N/A	N/A	N/A

Figure 9. Mean Dissolved Oxygen During 2005-2009 (Dry Weather)



pH

pH measurements were taken to assess how acidic or basic the water is within Big Chico Creek. Most organisms have evolved to survive within a narrow range of pH. Most fresh water aquatic organisms can survive in ranges between 6.5 and 8.5. pH levels decrease with higher water temperatures, and may also raise the toxicity of substances.

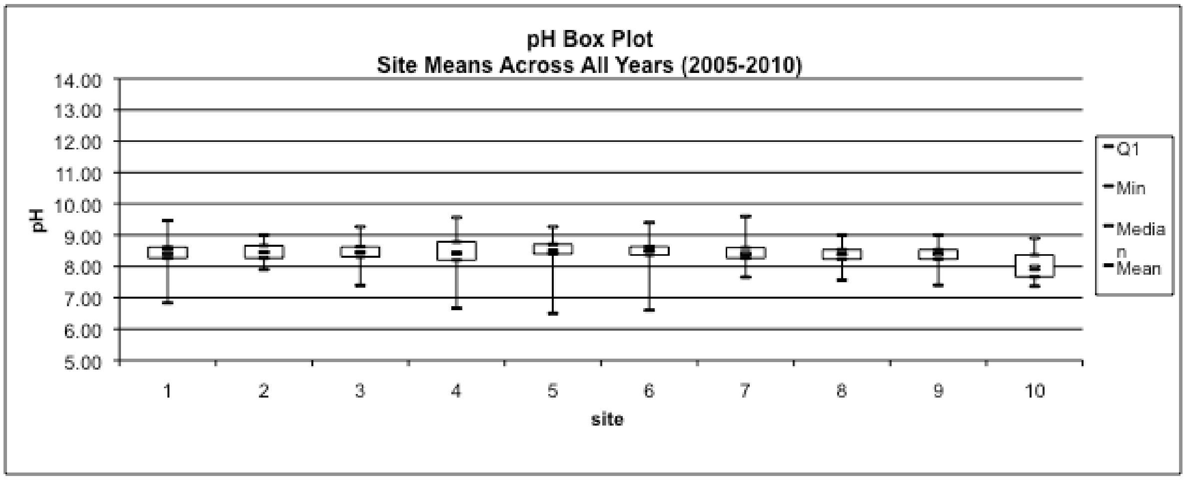
During dry weather monitoring pH levels slowly declined for all years with a drop in elevation and increase in urban land use. In the upper watershed ph ranged from 6.8 to 9.5, and in the lower watershed from 7.4 to 9.2 during 2005 through 2010.

During storm event monitoring, pH levels ranged from 7.0 to 8.4 in the upper watershed, 7.1 to 9.0 in the lower watershed, and 6.6 to 8.0 in storm drain outfalls. During storm events contributions from storm drains lowered pH directly below outfalls in the lower watershed.

Table 11. pH Ranges during 2005-2010

	Dry Weather	Dry Weather	Storm Event	Storm Event	Storm Event
Year	**Upper Watershed pH**	**Lower Watershed pH**	**Upper Watershed pH**	**Lower Watershed pH**	**Storm Drain Outfall pH**
2005	6.8 to 8.5	7.4 to 8.5	N/A	N/A	N/A
2006	8.0 to 8.7	7.4 to 8.0	N/A	7.8 to 8.5	N/A
2007	8.5 to 8.6	8.2 to 8.9	N/A	7.8 to 8.3	7.1 to 8.1
2008	8.0 to 8.9	7.4 to 9.0	8.1 to 8.2	7.7 to 9.0	N/A
2009	7.9 to 9.5	7.4 to 9.2	8.4	7.1 to 8.4	6.9 to 8.0
2010	6.8 to 9.0	6.5 to 9.6	7.0 to 8.3	7.5 to 8.1	6.6 to 7.6

Figure 10. Mean pH During 2005-20010 (Dry Weather)



Conductivity (EC)

EC measures the ability of water to conduct electrical current through the dissolved ions in the water. Natural factors associated with soil type and surrounding geology can affect conductivity levels. As temperature and nutrient content rises, EC levels increase. Human factors that can be correlated with an increase in EC include failed sewage systems and agricultural run-off. EC levels within the Big Chico Creek watershed increase with a decline in elevation and an increase in land use.

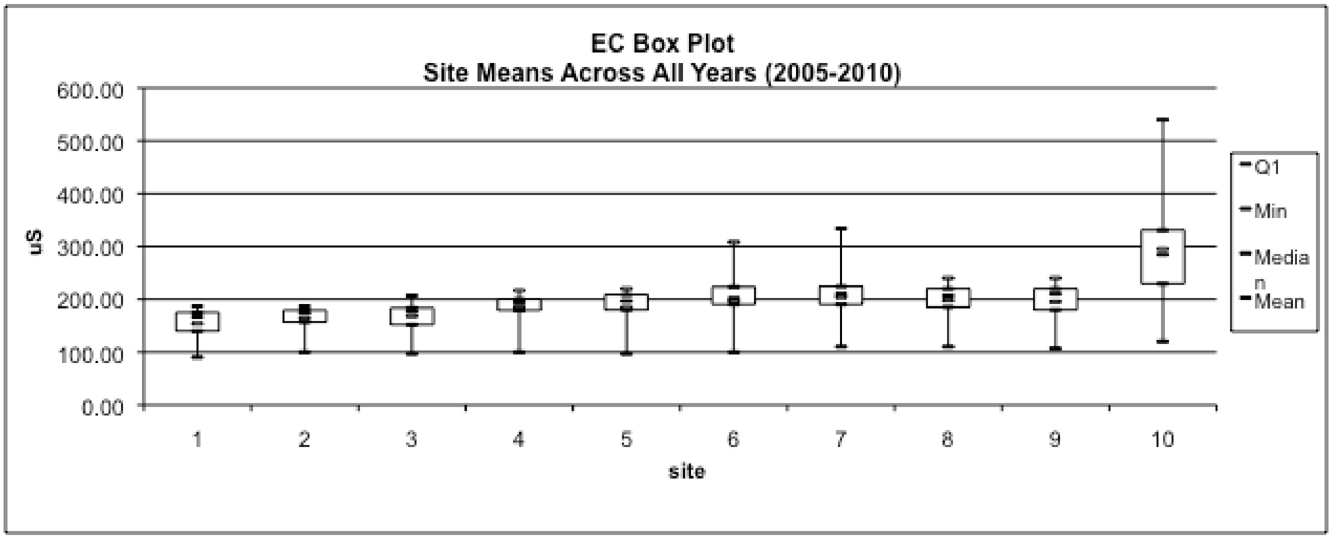
During dry weather EC ranged from 90 to 190 µS/cm in the upper watershed, and 96 to 540 µS/cm in the lower watershed during 2005-2010.

During storm events EC ranged from 80 to 190 µS/cm in the upper watershed, and 50 to 230 µS/cm in the lower watershed, and 20 to 70 µS/cm in storm drain outlets during 2005-2010.

Table 12. Conductivity Ranges during 2005-2010

	Dry Weather	Dry Weather	Storm Event	Storm Event	Storm Event
Year	**Upper Watershed EC (µS/cm)**	**Lower Watershed EC (µS/cm)**	**Upper Watershed EC (µS/cm)**	**Lower Watershed EC (µS/cm)**	**Storm Drain Outfall EC (µS/cm)**
2005	107 to 180	130 to 250	N/A	N/A	N/A
2006	160 to 180	180 to 240	N/A	100 to 130	20
2007	150 to 190	150 to 240	100 to 110	140 to 220	50 to 70
2008	140 to 190	180 to 240	110 to 120	110 to 120	N/A
2009	90 to 190	100 to 240	140 to 190	160 to 230	30 to 70
2010	90 to 186	96 to 540	80 to 110	50 to 180	30 to 40

Figure 11. Mean Conductivity During 2005-2010 (Dry Weather)



Total Dissolved Solids

Total Dissolved Solids (TDS) measures the combined content of dissolved ions in the water. Human factors that can be correlated with an increase in TDS include residential and agricultural run-off. TDS levels within the Big Chico Creek watershed increase with a decline in elevation and an increase in land use.

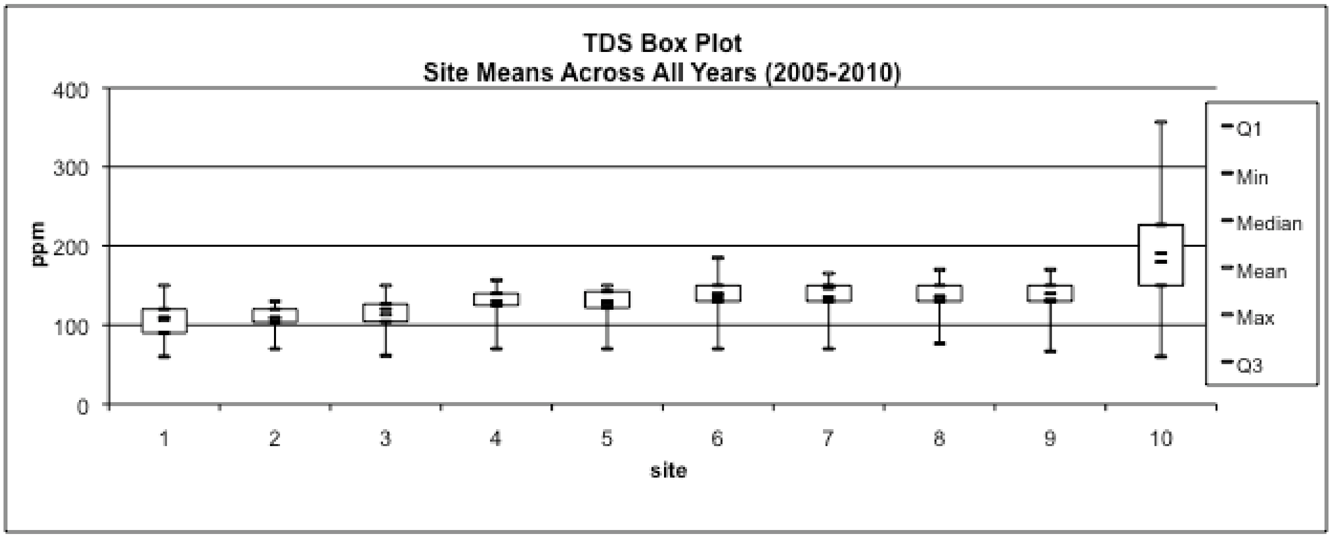
During dry weather TDS ranged from 60 to 150 ppm in the upper watershed, and 75 to 310 ppm in the lower watershed during 2005-2010.

During storm events TDS ranged from 70 to 110 ppm in the upper watershed, and 20 to 40 ppm in the lower watershed, and 20 to 30 ppm in storm drain outlets during 2005-2010.

Table 13. Total Dissolved Solids Ranges during 2005-2010

	Dry Weather	Dry Weather	Storm Event	Storm Event	Storm Event
Year	**Upper Watershed TDS (ppm)**	**Lower Watershed TDS (ppm)**	**Upper Watershed TDS (ppm)**	**Lower Watershed TDS (ppm)**	**Storm Drain Outfall TDS (ppm)**
2005	60 to 150	75 to 310	N/A	N/A	N/A
2006	60 to 120	70 to 170	N/A	N/A	N/A
2007	90 to 130	110 to 360	N/A	N/A	N/A
2008	90 to 130	120 to 360	N/A	N/A	N/A
2009	70 to 120	70 to 190	70 to 110	80 to 90	20 to 40
2010	70 to 130	80 to 300	80 to 110	50 to 90	20 to 30

Figure 12. Mean Total Dissolved Solids During 2005-2010 (Dry Weather)



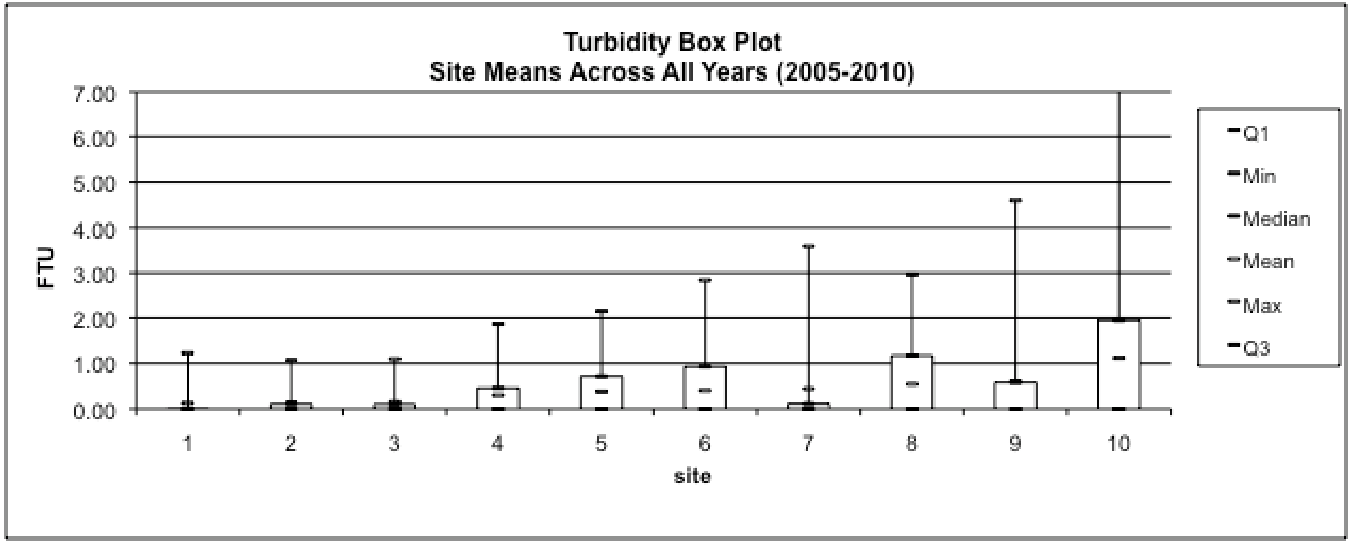
Turbidity

Sediment values were generally low and ranged from non-detectible to under 3.5 NTU at all sites during 2005 through 2010 during dry weather in the upper and lower watershed. During storm events turbidity ranged from 0.11 to14.41 NTU in the upper watershed, 0 to 77 in the lower watershed, and 1.33 to 78 in storm drain discharges in the lower watershed.

Table 14. Turbidity Ranges during 2005-2010

	Dry Weather	Dry Weather	Storm Event	Storm Event	Storm Event
Year	**Upper Watershed Turbidity (NTU)**	**Lower Watershed Turbidity (NTU)**	**Upper Watershed Turbidity (NTU)**	**Lower Watershed Turbidity (NTU)**	**Storm Drain Outfall Turbidity (NTU)**
2005	0	0.27 to 2.10	N/A	N/A	N/A
2006	0 to 0.12	0.27 to 3.46	N/A	0.17 to 2.42	2.74
2007	0 to 0.36	0 to 2.65	0.11 to 0.14	0 to 12.87	12.87 to 30.62
2008	N/A	N/A	0.27 to 0.57	1.07 to 47	N/A
2009	0 to 0.78	0 to 1.86	5.25 to 14.41	0.36 to 10.44	10.1 to 22.69
2010	0 to 1.09	0 to 2.83	0.11 to 6.11	0.29 to 71	1.33 to 78

Figure 13. Turbidity Ranges during 2005-2010 (Dry Weather)



Bacteria

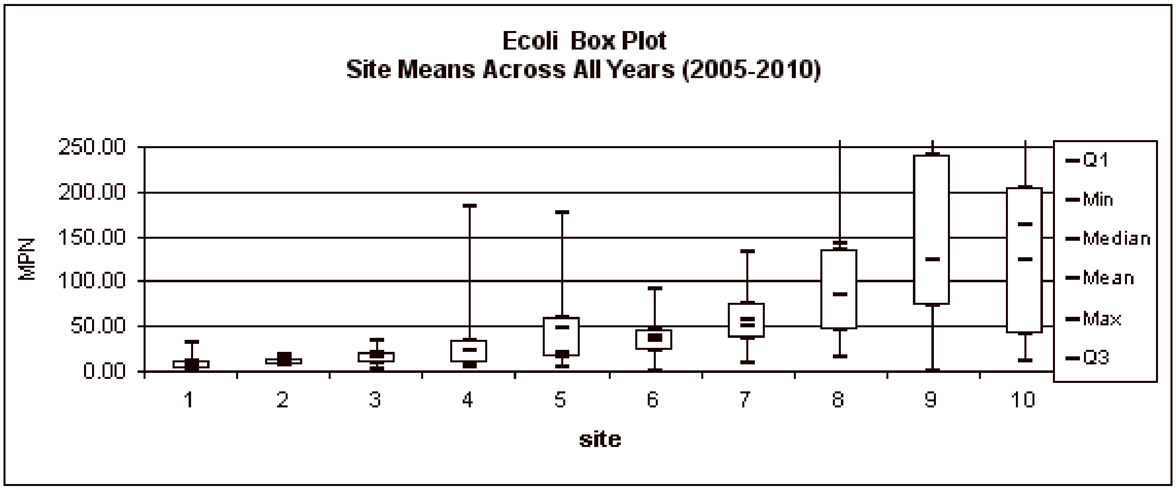
Fecal bacteria are single-celled microorganisms commonly used to indicate microbiological contaminants in drinking water, and are virtually always associated with fecal contamination of water, but not always harmful.

Sampling results show concentrations of E. coli bacteria were elevated for the lower watershed, and exceed basin plan water quality objectives for contact recreation, and warrant further investigation. Possible sources include: pet waste (dogs, livestock), septic systems, sewer leaks, and homeless encampments. Highest levels of E.coli were found during storm event monitoring and in storm drain outfalls.

Table 15. E.coli Bacteria Concentrations Exceeding Threshold Limits During 2005-2010

Lower Watershed Sites Exceeding E. coli standard (Max 235 mpn and Mean 126 mpn)		
Dry Weather Events		
Date	Site	E. coli (#/100ml)
9-9-05	10	488.4
9-28-06	9	275.5
5-4-07	9	235.9
2008	No sites exceeded standard	
8-14-09	8,9,10	1011, 549, >2419
9-11-10 10-9-10	9,10 9,10	240, 390 245, 345
Storm Events		
2005	N/A	
2-27-06	6, 7, 8, 9, 10	248, 727, 542, 686, 1986
2-9-07 9-23-07	6,7,9,10 6,7,8,9,10	249, 1120, 727,1732 >2419, 2419, 2419, 2419
2-22-08	9,10	275,1413
11-19-09 12-12-09	8 8,9,10	533 304, 534, >2419
11-7-10 12-6-10	6,7,8,9,10 6,7,9,10	238, 328, >2419, 2419, 2419 360, 574, 549, >2419

Figure 14. E.coli Bacteria Concentrations During 2005-2010 (Dry Weather)



Discharge (Flow)

Discharge measurements were taken during each sampling event and flows were highest in the spring and lowest in the fall. Field measurements were correlated with the USGS gauge located near the Bidwell Golf Course.

Table 16. Discharge Ranges during 2005-2010

Year	Upper Watershed Flow (CFS)	Lower Watershed (CFS)
2005	16 to 55	4 to 199
2006	16 to 89	4 to 198
2007	13 to 69	4 to 88
2008	16 to 43	4 to 101
2009	11 to 111	8 to 210
2010	12 to 53	7 to 156

Figure 15. Discharge Ranges during 2005-2010 (Dry Weather)

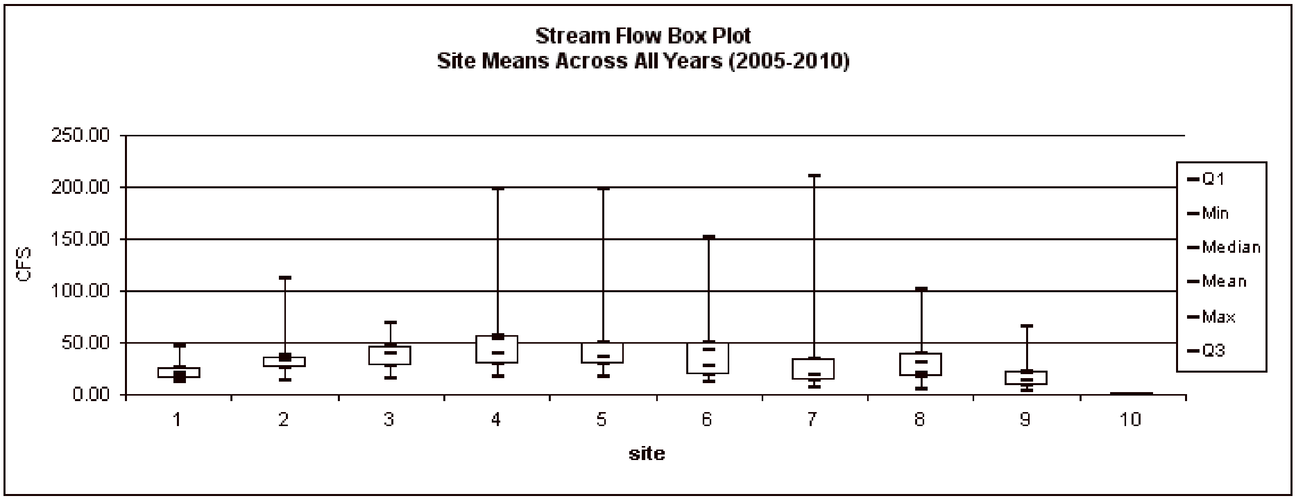


Photo Documentation

Photos were taken during each monthly monitoring event and during bioassessment surveys. Photos were taken to document upstream, downstream, and substrate condition at established sites.

Bioassessment

State and federal agencies have developed protocols for measuring the integrity of stream biological communities. This approach is called bioassessment, and is an effective way to integrate effects of pollutants, and habitat alterations that may impact a stream system. Prominent stream-bottom insect larvae are collected and used as indicators to characterize water quality conditions. Insect larvae live in the stream for up to two years before metamorphosing into adults with wings and provide an excellent way to integrate effects of water quality conditions over a long period of time.

A certified laboratory analyzed the macro invertebrate samples, and various metrics were calculated for each site. Selected metrics were then ranked, scored, and compared with the Southern California and Northern California Index of Biological Integrity (IBI).

Results show the communities of aquatic macro invertebrates rank between 46 and 71 in the upper reaches of the Big Chico Creek watershed indicating "good to fair" stream conditions when compared with both the Southern California and Northern California IBI. Physical habitat conditions were also ranked and the upper reaches show conditions are in the optimal range. Sites within the lower watershed ranked between 9 and 66 indicating "very poor to good" conditions, with physical habitat conditions in the poor to suboptimal range.

Table 17. Index of Biological Integrity (IBI)

Index of Biological Integrity (IBI)						
Date	Site	Nor Cal IBI Score	Quality Rating	So Cal IBI Score	Quality Rating	Physical Habitat Quality Rating
Fall 2005	Hwy 32	62	Good	62	Good	Optimal
Fall 2006	Hwy 32	71	Good	67	Good	Optimal
Fall 2006	Hwy 32	71	Good	68	Good	Optimal
Fall 2007	Hwy 32	59	Fair	60	Good	Optimal
Fall 2005	Reserve	46	Fair	51	Fair	Suboptimal
Fall 2006	Reserve	48	Fair	54	Fair	Suboptimal
Fall 2007	Reserve	55	Fair	53	Fair	Suboptimal
Fall 2005	Bear	35	Poor	33	Poor	Suboptimal
Fall 2006	Bear	33	Poor	34	Poor	Suboptimal
Fall 2007	Bear	24	Poor	27	Poor	Suboptimal
Fall 2005	Five-Mile	25	Poor	33	Poor	Suboptimal
Fall 2006	Five-Mile	19	Very Poor	23	Poor	Suboptimal
Fall 2007	Five-Mile	31	Poor	36	Poor	Suboptimal
Fall 2007	Five-Mile	46	Fair	51	Fair	Suboptimal
Fall 2005	One-Mile	24	Poor	66	Good	Suboptimal
Fall 2005	Warner	43	Fair	41	Fair	Suboptimal
Fall 2007	Warner	22	Poor	18	Very Poor	Marginal
Fall 2007	Warner	23	Poor	15	Very Poor	Marginal
Fall 2007	Warner	20	Poor	17	Very Poor	Marginal
Fall 2005	Rose	35	Poor	32	Poor	Marginal
Fall 2006	Rose	37	Poor	40	Fair	Suboptimal
Fall 2007	Rose	30	Poor	31	Poor	Marginal
Fall 2007	Rose	12	Very Poor	16	Very Poor	Marginal
Spring2008	Verbena	23	Poor	30	Poor	Marginal
Fall 2009	Hwy 32	69	Good	51	Fair	Optimal
Fall 2009	Reserve	N/A	N/A	N/A	N/A	Suboptimal
Fall 2009	Bear	51	Fair	36	Poor	Suboptimal
Fall 2009	Five-Mile	21	Poor	22	Poor	Marginal
Fall 2009	One-Mile	20	Poor	16	Very Poor	Marginal
Fall 2009	Warner	9	Very Poor	16	Very Poor	Marginal
Fall 2009	Rose	14	Very Poor	14	Very Poor	Marginal
Fall 2009	Mud	59	Good	39	Poor	Marginal
Quality Ranking	Very Poor	Poor	Fair	Good	Very Good	Very Good
	0-20	20-40	40-60	60-80	80-100	80-100

*2010 lab analysis was not available in time for this report, but will be incorporated once received

Quality Assurance Project Plan (QAPP) Compliance

All samples were collected as described in the Big Chico Creek Watershed Volunteer Monitoring Program QAPP. Volunteers were provided with training in the proper use of monitoring equipment and protocols each spring and re-fresher training was provided at each monitoring event. Volunteers also participated in quality control sessions throughout the year and validated their understanding of testing procedures by running test on standards with know concentrations. Monitoring equipment was calibrated each monitoring day and equipment was checked to be sure it was in good repair. Reagents, and chemicals were replaced and expiration dates checked regularly. Triplicate samples were collected and tested for each parameter to ensure an acceptable level of precision and accuracy was met, and planned sampling events were achieved with a 90% completion rate.

References:

1. Big Chico Creek Existing Conditions Report, 1998.

2. Robert Pitt, 2002. "Receiving Water Impacts Associated with Urban Runoff", *Handbook of Ecotoxicology, 2nd Edition*. CRC-Lewis. Boca Raton, FL, 2002.

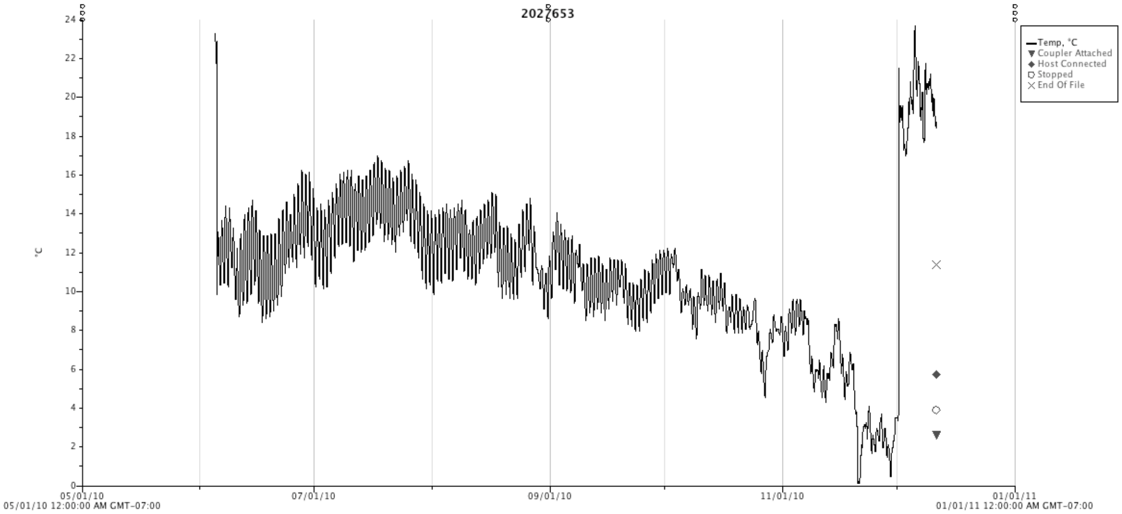
3. Andrew C. Rehn[1], Jason T. May and Peter R. Ode, 2008. "An Index of Biotic Integrity (IBI) for Perennial Streams in California's Central Valley", draft document, 2008.

4. Vicki Ozaki and David G. Anderson, 2005. "Evaluation of Stream Temperature Regimes for Juvenile Coho Salmon in Redwood Creek Using Thermal Infrared". Redwood National and State Parks, California Crescent City, CA 95531. Technical Report/NPS/NRWRD/NRTR-2005/331

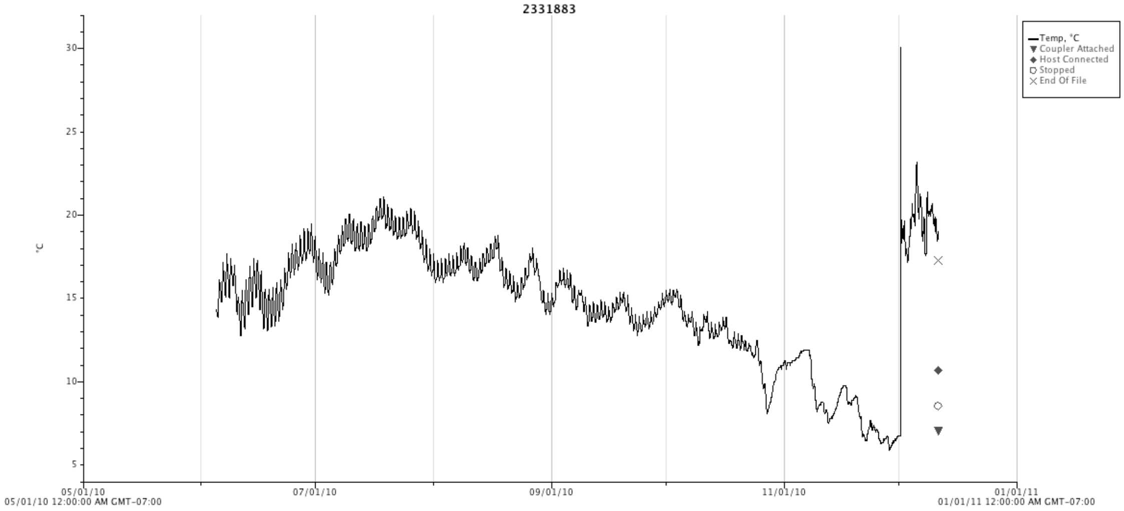
Partial List of Participants

Reporter
Brent
Conner
Craig
Dee Richmon
Dee Richmon
Eve Klescewski
Jenny
Larry
Michael York
Michael York
Rose Skytte
Taylor
Tyler
Adam Knapp
Akihiro
Rolandeli
Amy
Ann Schwab
Anna Alvarez
Autumn
Balam
Ben White
Benn Davenport
Blake Irwin
Bon White
Lourenzo
Breanna Huber
Brian Hanson
Brianna Huber
C. Daddy
Camille
Carly Freeman
Cathe Fish
Chelsie M
Cheyanna Hurley
Chris Bollinger
Cindy Ona
Dakota
Danny Burns
Danny Stevens
Dave Nopel
David
Dennis
Dick Gowins
Dusty
Emmett
Eric Grant
EricK D.
Grady Davis
Grant
Hanna Seidler
Hannah Atkinson
Huto Lyor
Ian Langford
Jack Wallace
Jake Morley
James Johnstone
James K
Jamie Claflin
Jamie K
Janene Ayer
Janet
Janet B.
Jeff Trobbe
Richardson
Jessica Lane
Jessican Nelson
John
Johnathan Green
Jon Ahlie
Jonathan Green
Jorden
Josh Cber
Josh Likeness
Josue Dole
Kaela
Kailyn Basker
Kellie Wilson
Kevin Serrao
Kurtis Spying
Kyle Siler
Lauren Fee
Levi
Louise Basker
Maiko
Martha Nuckolls
Martin Kilgoriff
Mason
Megan Garrity
Michael Harrell
Mike Burke
Mike MacLarsen
Alsadda
Nancy
Nick Merolla
Nicole King
Patrice Pagano
Patrick Ewing
Peter
Phoebe
Photographer
Prabjodh Sandhu
Rebeka Kinder
Reed Severson
Richard Puley
Riley
Rob Rhodes
Roben Verdugo
Rozane Coyell
Ryoko
Sadie
Samuel Tickenoff
Sarah
Sarah Carpenter
Sean
Sean Bradly
Shris Melyski
Spencer
Sterling
Tanya
Thomas
Tyler Palo
Willere
Yamme Lor
Zachary
Alicia Whittlesey
Amy Hornick
Amy Vigallon
Anderson
Brady Jewett
Brian Wobicle
Carey Kimbal
Celine OÕMalley
Charles Adams
Christine Crispin
Dan Cook
Danielle Baker
Dave Daly
David T
Gabriel Sampson
Gavin McCreary
Furunchi
Jack Klein
Janna Lathrop
Jason Aull
Jerry Grant
Jessica Gibbs
Jessie Brown
John Shooner
Kali Martin
Kate Taft
Kristin Gohan
Linda Dickson
Lori Cayo
Mark Aull
Michael DeSuet
Mike Willer
Owen Bettis
Cousineau
Rebeka Kimerer
Robert Flyn
Ryan Haugh
Saac Ingram
Salim Sidani
Sharon Fritsch
Steve Laurie
Teri Woods
Tiffany Maldrum
Tirotaka Sato
Tom Ward
Abel Expinosa
Bayon
Brad Powell
Brit. Gregory
Britt Lobdell
Brittany Ortiz
Dustin Benkle
Eldon Lucas
Glen Burns
Hildebrand
Justin Keeling
Justin Roberts
Kristin Carter
Ryan Hamelberg
Ryne McLaughlin
Teara Conner
Tyrel Arnett
Vang Lor
Vincent Ruffino
Jesse Brown
Joan Crawford
Macy Clowary
Mike A.
Alicai Gonzalez
Ameilia Z
Andrea Petersen
Barbara Henigan
Bob Henigan
Bob McNairn
Candi
Daniell Kaelia
Emily Fraser
Eric C.
Houston
Jackson M
Jon Murgia
Kim Donovan
Kristen Dufour
Kyle Afton
Matt McGowen
Mia Martha
Molly Benjamin
Naoyo Koga
Rachel
Rayan Hefzi
Robin M
Ryan Donner
Matsumoto
Andy B.
Brett
Brittany Bledsoe
CAVE Students
Chris Bower
Crystal Martinez
Daphane Peters
Jale Few
Jean Klein
Kenny Morey
Lee Altier
Nani Cristan
Nina Pillary
Nou
Sam McConnel
Stephan
Telisa Johnsen
Anthony J
CP Hewitt
Richardson
Mike Hornick
Heather Koeth
Jennifer Arbuckle
Megan Medley
Brad Gripenstraw
CC Teacher
Christina Donez
Cody
Danielle Carillo
Padgette
Marcus R
Margie McNairn
Mary Sisler
Megan Beck
Robert Garcia
Sam Bickle
Shandin Rudesill
Teacher
Tia Austin
Tyana Maddock
Victor Rangel
Jacob Troesler
Lee C.
Anthoney Beller
Carol Perkins
Eri Nimoto
Eve Delacare
Funsi Eum
GayAnne Silmau
Kevin Cleland
Mike Ashcroft
Ming Huen Han
Huneycutt
Robert Pedrosa
Teacher
Tricia Parker
Gabe Garbarino
Jeff Sanchez
Bree Stowie
Danial Lund
Fred Thomas
Henry
Mollison
Tiffani Kurtz
Cindy Horney
Marissa FierroÊÊ
Mary ThompsonÊ
Mike BennettÊÊÊ
Morgan Spont
Paul Heirling
Peter
Susan St. Germai
Teacher
Tristan BanwellÊ
Valdovinos
William JohnsonÊ
Yamme Lor
Adam Phillips
Airrean O'Reiley
Allicia Rominger
Amanda Oreodor
Andrew Arrieta
Andrew Megrath
Anthony Reyez
Bill Young
Billy Laplopt
Britny Whitw
Chris Kelso
Christie Thao
Courtney Scott
David Hottinger
David Xidea
Derek Flores
Dezi Davis
Doris Erkinny
Eva Thao
Harley Newtan
Jaime Campos
Jeff Rudd
Cumberland
Jer Xiong
Jesus Snadoval
Jim Vang
John Domue
Josh Ciulla
Joshua Perene
Juson Puce
Justin Cook
Justin Jousoner
Karissa Damon
Kellie Davis
Kevin Thao
Kimberly Taylor
Lisa Ubert
Michael Cords
Hershberger
Miranda Gun
Nick Cramer
Patnell Wendal
Pearl T
Phong Lor
Ping Vung
Stevenson
Ruth Balangead
Ryan Vang
Sandyl Pace
Shane Johnston
Sheng Vue
Shu Yang
Stephanie Rule
Sue
Tyler Meier
Vicent Audelett
Xia Thao
Yang Lee
Yesenia Ramos
Youa Thao
Jeff Mott
Jon Aull
Mark Haynes
Lindsay
Mechoopda
Nhu Huynn
ÊChris Raglin
Addie Hobbs
Ambyrr Murray
Arron Butos
Auron Bates
Barbara Pease
Becca Macke
Becky Jenkins
Brandon Gold
Brandon Wyonan
Brian Hicks
Darte Bwoole
David Valdez
Dulcie McEnespy
Dylan Gonzalez
Eric Willard
James Simenc
Jesseca D
Garduque
Jesus Aricya
Joshua Collins
Julia Burnett
Login Keyder
Lorena Tatoow
Lori Dieter
Marcus Gurr
Kamiyanagi
Matt Griffth
Matt Simenc
Nestina Rodden
Nicole Stern
Omar Barron
Parent
Paul Mulleman
Seng Thao
Sister Mendez
Gonzalez
Steve Manifor

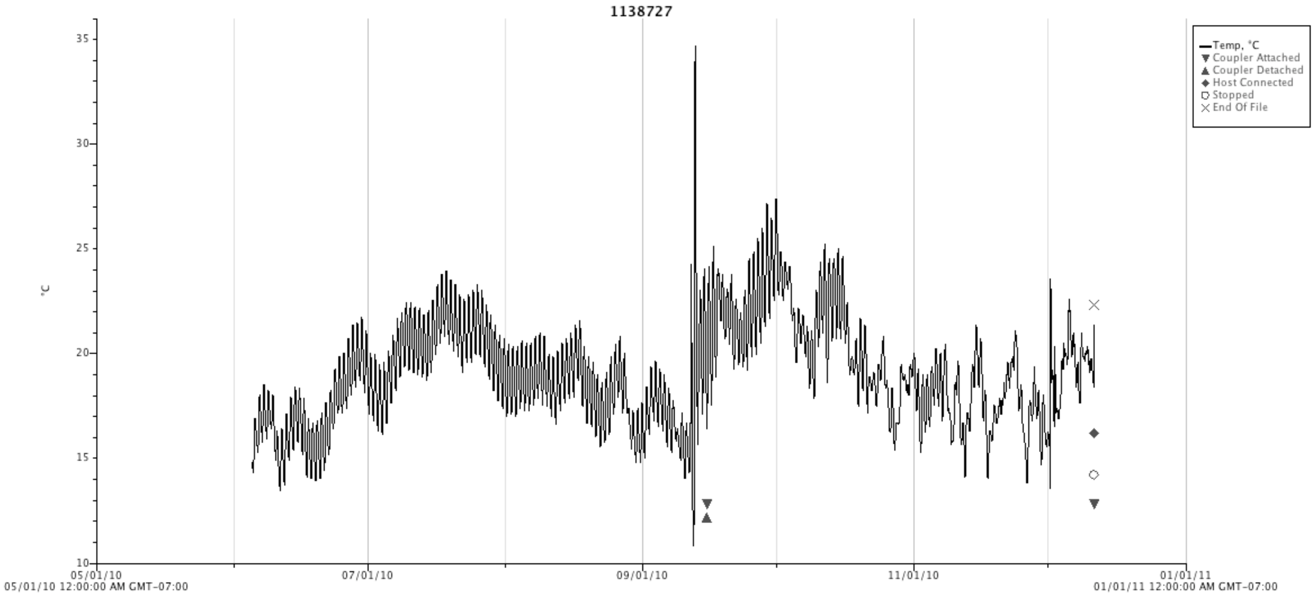
Appendix 1. Continuous Temperature Data



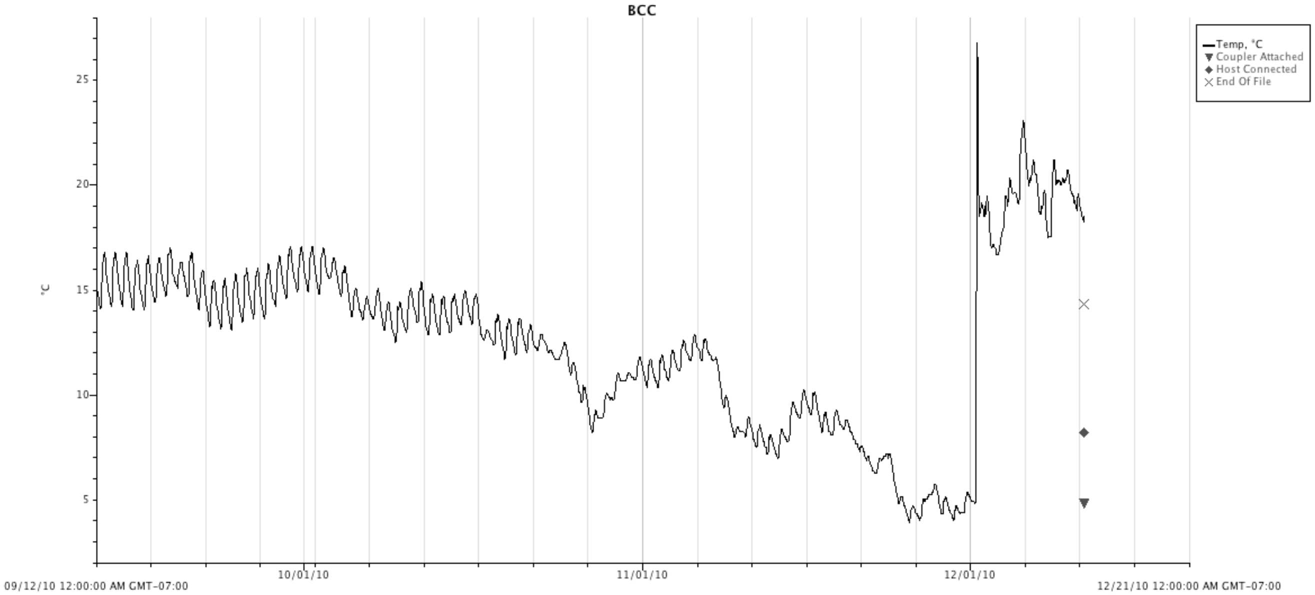
Station T-1 (5-1-10 to 12-1-10)



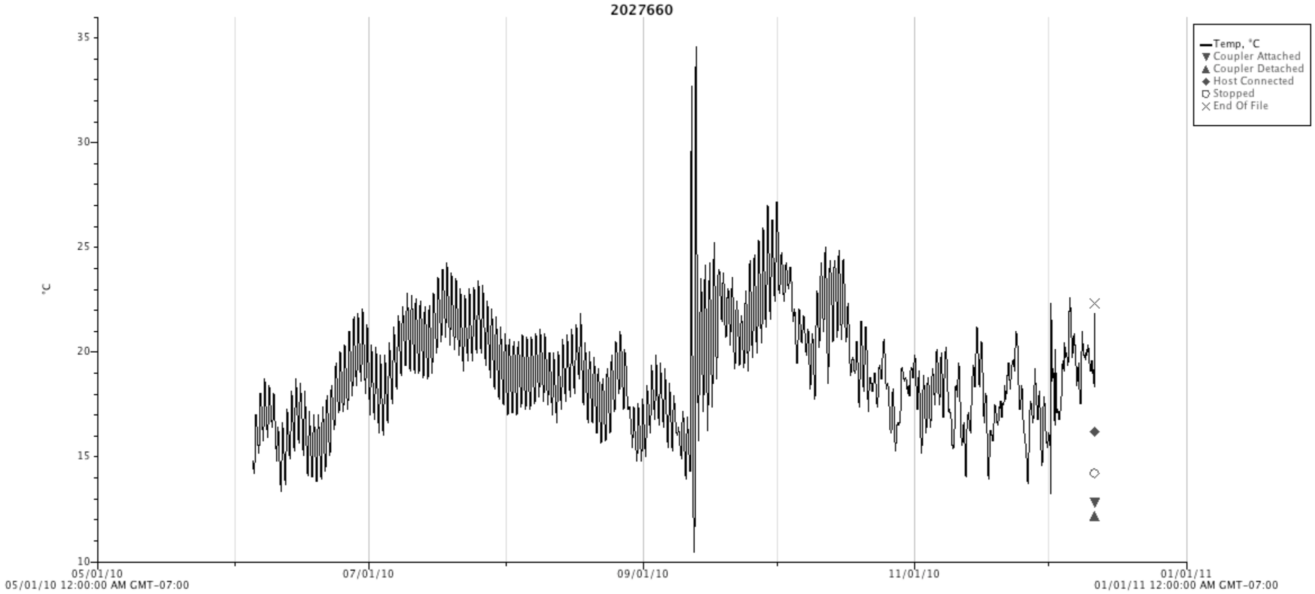
Station T-2 (5-1-10 to 12-1-10)



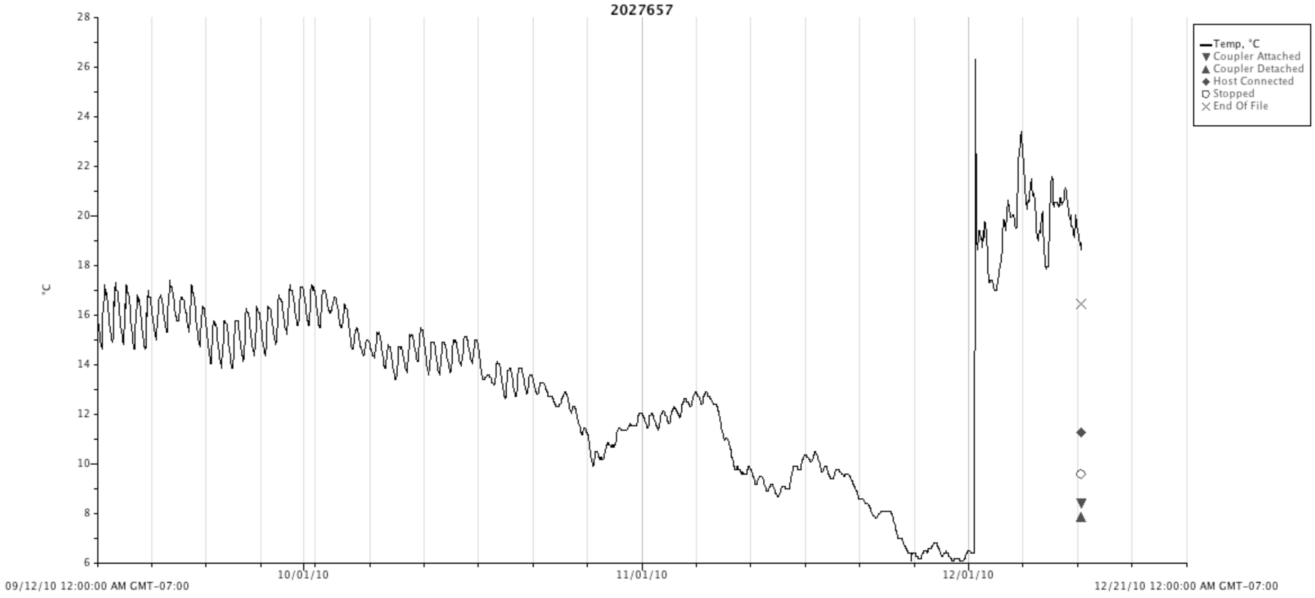
Station T-3 (5-1-10 to 9-12-10)



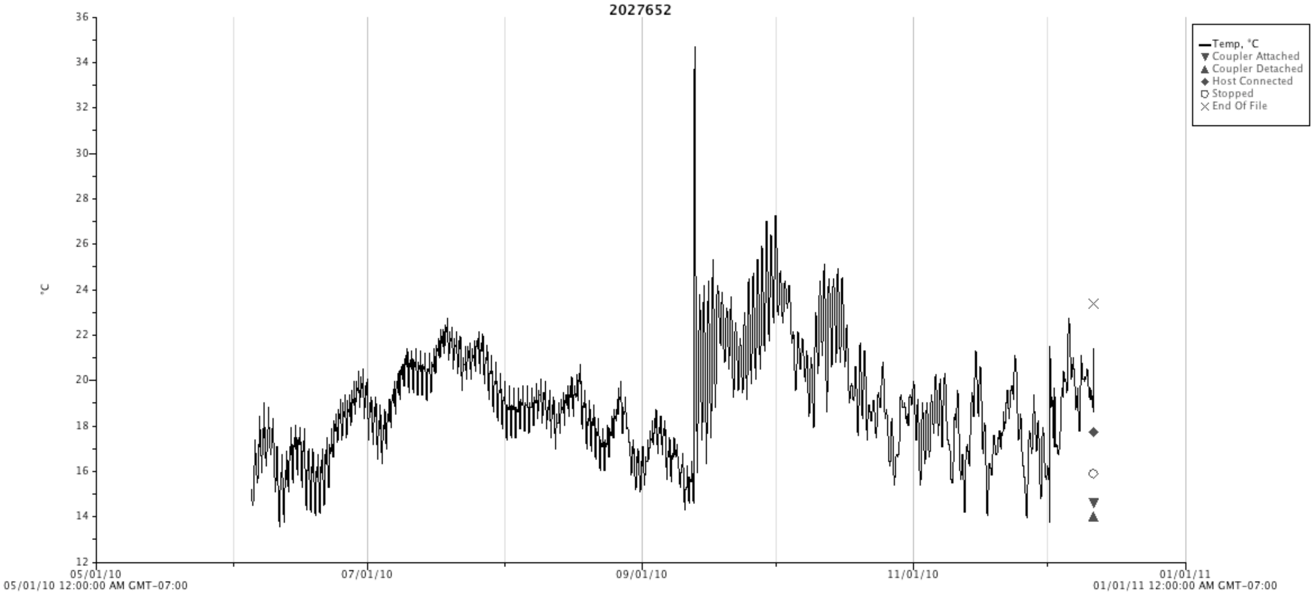
Station T-3 (9-12-10 to 12-1-10)



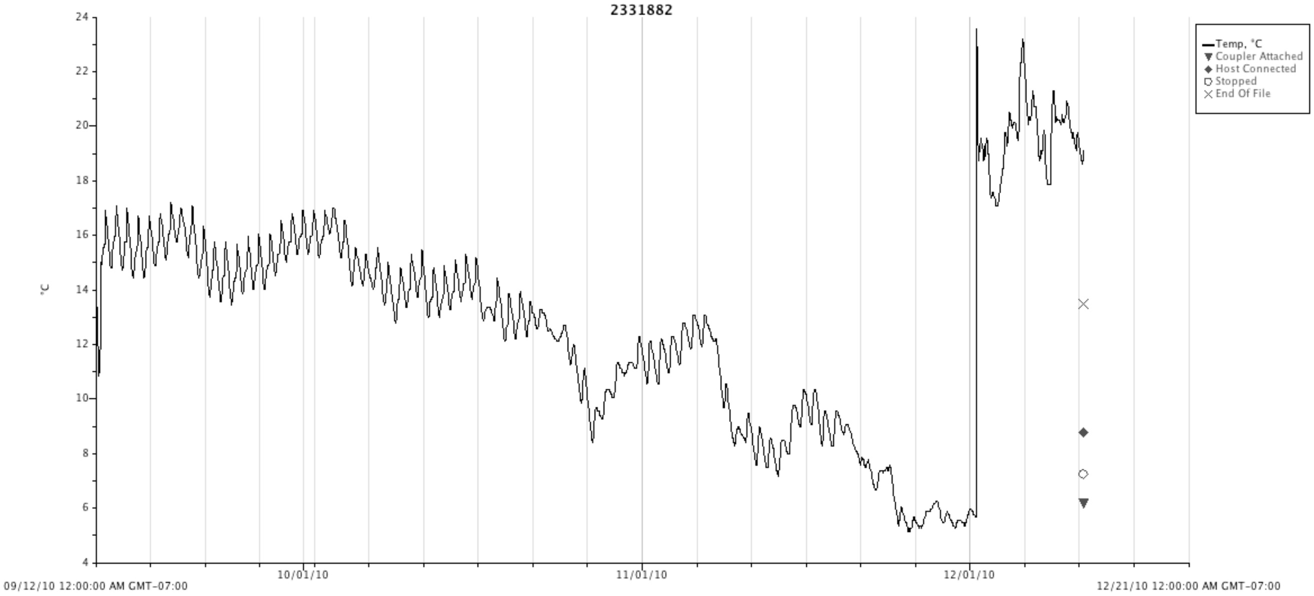
Station T-4 (5-1-10 to 9-12-10)



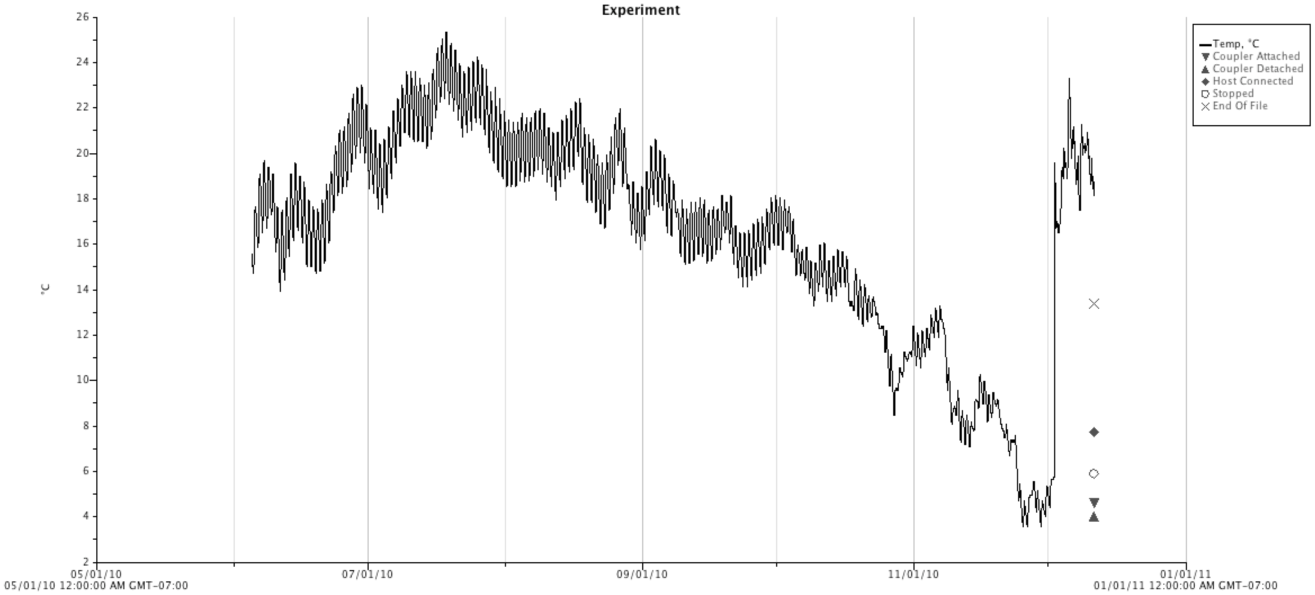
Station T-4 (9-12-10 to 12-1-10)



Station T-5 (5-1-10 to 9-12-10)



Station T-5 (9-12-10 to 12-1-10)



Station T-6 (5-1-20 to 12-1-10)

Station T-7 (No data: logger missing)