South Lake Tahoe Monitoring Project

Citizen Volunteer Water Quality Monitoring

2008 Annual Data Report

SIERRA NEVADA ALLIANCE

Keeping light in the range.

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This project is coordinated by the Sierra Nevada Alliance. Since 1993, the Sierra Nevada Alliance has been working to restore and protect Sierra Nevada land, water, wildlife, and communities. The Alliance is a network of over 100 conservation groups and leads region-wide campaigns on land-use, watersheds, and climate change.

I. Introduction

A. South Lake Tahoe Region of the Upper Truckee Watershed

The Truckee River Watershed covers approximately 2720 square miles and includes the Lake Tahoe Basin in the upper portion of the watershed. The output from Lake Tahoe forms the middle Truckee River which flows north and east a total of 116 miles through Reno, Nevada to its terminal at Pyramid Lake in western Nevada. The Lake Tahoe Basin consists of the Upper Truckee River and several smaller creeks flowing into Lake Tahoe. The lake is designated as an Outstanding National Resource Water (ONRW), which is a special designation under the Clean Water Act. Only two other waterbodies have this designation in the Western United States: Mono Lake in California and Crater Lake in Oregon. This monitoring project focuses solely on the South Lake Tahoe region of the Tahoe Basin, which has been substantially impacted by land use practices that have compromised water quality in the lake and the Truckee River. The purpose of the monitoring project is to measure chemical, physical and biological parameters in streams draining into the South Lake Tahoe Region in order to assess land use impacts on water quality and watershed health.

Human residents have long occupied the Lake Tahoe Basin and Truckee River Watershed. The indigenous people of Lake Tahoe are the Washoe and are known to have inhabited the basin for at least 3,000 years. However, the last 170 years of human residence have caused the greatest environmental impacts on the watershed. Major disturbances to the watershed have included degraded water quality from non-point source pollution, altered flow regimes, excessive erosion and sedimentation, habitat loss for native and endangered species including the yellow-legged mountain frog and lahontan cutthroat trout, and proliferation of invasive terrestrial and aquatic organisms. These disturbances are a result of human impacts including clear cut logging, forest fire suppression, channelization of streams and rivers, rapid urban upland development, and development on sensitive wetlands. The types of non-point source pollution that have degraded water quality include sediment and nutrients. Fine sediments become suspended and decrease lake clarity, while nutrients such as phosphorus and nitrogen promote excess algal growth in Lake Tahoe.

In the past 30 years, there have been many efforts to restore and protect Lake Tahoe and the Truckee River Watershed in the form of direct regulation from state and federal agencies, such as the US Forest Service, U.S. Environmental Protection Agency (US EPA), Lahontan Regional Water Quality Control Board (Lahontan), Nevada Division of Environmental Protection

(NDEP), Resource Conservation Districts, and the Tahoe Regional Planning Agency (TRPA). Advocacy groups working on water quality and clarity issues include the League to Save Lake Tahoe and the Sierra Club. Large land acquisitions for restoration and managed public access have been conducted by the California Tahoe Conservancy (CTC) and Nevada State Lands.

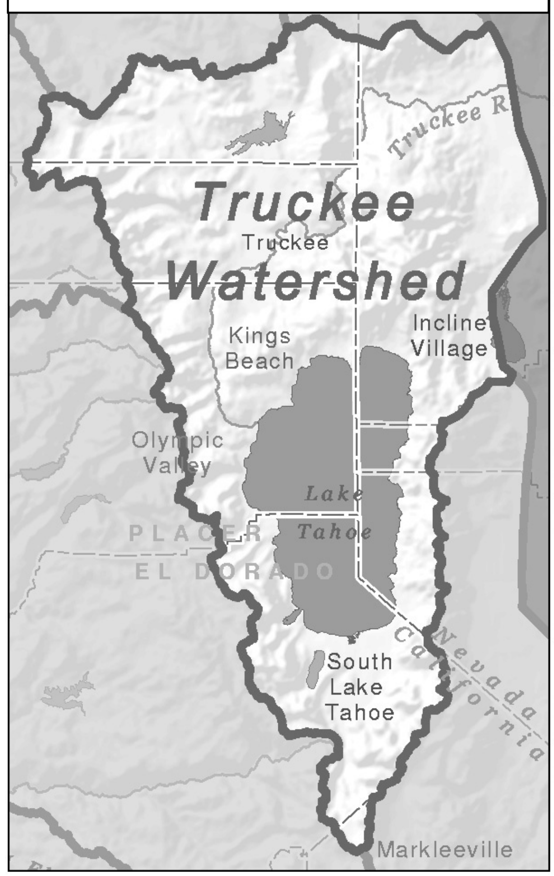
The South Lake Tahoe Monitoring Project was formed to assess the health of the local watershed in terms of water quality by examining legacy impacts of human disturbance, current watershed impacts, and efforts put forth to restore and protect the watershed. According to Rowe and others (2001) and Lake Tahoe Interagency Monitoring Program (LTIMP) results, the Upper Truckee River watershed has the highest nutrient and suspended sediment loads in the Truckee River watershed.[i] Therefore, there is a need for water quality monitoring in the South Lake Tahoe region of the Truckee River Watershed. The South Lake Tahoe Monitoring Project works collaboratively with other monitoring agencies to coordinate efforts and share information.

The project also functions as a local watershed stewardship and education group. With citizen monitoring, a bridge is formed between the gap of citizen involvement and scientific research. Monitoring gets citizens involved in the process and also educates them on what significant water quality parameters are and what influences them.

B. The South Lake Tahoe Monitoring Project

The South Lake Tahoe Monitoring Project (SLTMP) began in 2007 and is a volunteer water quality monitoring project coordinated by the Sierra Nevada Alliance for the purposes of data collection and watershed education. The project area is the Upper Truckee River Watershed. The watershed contains the largest tributary to Lake Tahoe, the Upper Truckee River, as well as other major tributaries, including Trout Creek, Taylor Creek, Angora Creek, and Cascade Creek. The Upper Truckee marsh, which is at the mouth of the Upper Truckee River, is one of the largest meadows in the Sierra Nevada and is habitat for many bird, mammal, and aquatic species.

The Truckee River Watershed



The monitoring project completed its first active monitoring year in 2008. Twenty-five volunteers monitored fifteen sites in the South Lake Tahoe region of the Upper Truckee River Watershed. Creeks were monitored in January, March, May, and July. The May monitoring day was coordinated with the 8th Annual Snapshot Day, a basin-wide volunteer water quality monitoring event. This report is a summary of the project design, 2008 activities, data, and next steps.

The focus of the project is on monitoring areas where past and current land use practices and issues are affecting water quality in the Upper Truckee River watershed. Monitoring is conducted by citizen volunteers at 15 stream sites in the region and includes water quality field readings, water quality sample collection for chemical parameters. Refer to section III.2 for a complete list of monitoring parameters. Ten of the fifteen sites monitored are included in this report since they were monitored more than once in 2008. Limited resources did not allow for repeat monitoring of all sites and therefore the five sites that were only visited once are not included in this report. The long-term scope of the project includes the following goals and objectives are for the long-term scope of the project.

C. Goals and Objectives

1. Goals

The primary goals of the South Lake Tahoe Monitoring Project:

- Implement a citizen monitoring project in the South Lake Tahoe region of the Lake Tahoe Basin within the Truckee River Watershed.
- Collect baseline water quality data for streams and rivers in the South Lake Tahoe region.
- Determine how common land use practices in the South Lake Tahoe region affect stream water quality and habitat function.
- Monitor water quality conditions for possible impacts typically associated with common land use practices in the South Lake Tahoe region.
- Assess the effectiveness of restoration projects aimed at reducing non-point source pollution in the Upper Truckee River Watershed in the South Lake Tahoe region.
- Empower citizens to be responsible stewards and decision-makers.
- Design and execute scientifically credible studies that assess ecosystem condition within the South Lake Tahoe region.

2. Objectives

The primary objectives of the South Lake Tahoe Monitoring Project:

- Better understand and document the relationship between stream water quality, hydrologic function, river system management, and land use.
- Identify land use practices that negatively impact the Lake Tahoe Basin in the Truckee River Watershed, the extent of impact, and the geographic locations of concern.
- Engage and educate residents about local watershed processes and strengthen their understanding of watershed stewardship.
- Enhance the quality and quantity of data available for resource managers and decision makers in the South Lake Tahoe region.
- Provide documentation linking water quality problems to land use practices in the Lake Tahoe Basin and the Truckee River Watershed.

II. Study Site Description

The project area is the Upper Truckee River Watershed, within the South Lake Tahoe region. The watershed contains the largest tributary to Lake Tahoe, the Upper Truckee River, as well as other major tributaries, including Trout Creek, Taylor Creek, Angora Creek, and Cascade Creek. Additional creeks included in the monitoring plan are Eagle Creek, Tallac Creek, and Cold Creek. With ONRW designation, these tributaries are not permitted any new or increased discharges which would result in reduced water quality of Lake Tahoe. The Upper Truckee Marsh located at the mouth of the Upper Truckee River at the southern margin of Lake Tahoe is one of the largest meadows in the Sierra Nevada and is habitat for many bird, mammal, and aquatic species.

Figure 3.1 – South Lake Tahoe Region of the Upper Truckee Watershed

This region of the Truckee River Watershed is located in an alpine environment and is exclusively above 6000 feet in elevation. Precipitation and temperature vary through the year. Table 1 indicates the climate patterns for the Lake Tahoe Basin. The data was collected in Tahoe City, CA between 1903 and 2007. The winter months are wet, cold periods, while the summer months are warm and dry. This typically results in high spring runoff from snowmelt. The South Lake Tahoe region is at the convergence of 2 plate tectonics, which form the Carson Range to the east and the Sierra Nevada to the west. The geology is composed largely of sandy granitic soils, igneous, and metamorphic rock. All of the streams monitored in this program are primary or secondary tributaries into Lake Tahoe.

Table 1 – Climate Summary of the Tahoe Basin (1903 – 2007)[ii]

	January	August	Annual Average
Maximum Temp.	38.4 °F	77.5 °F	57.6 °F
Minimum Temp.	18.4 °F	43.3 °F	26.9 °F
Average Precipitation as snow	46.5 in.	0 in.	194.4 in.
Average total Precipitation	5.88 in.	.30 in.	31.49 in.

A. Monitoring Site Overview

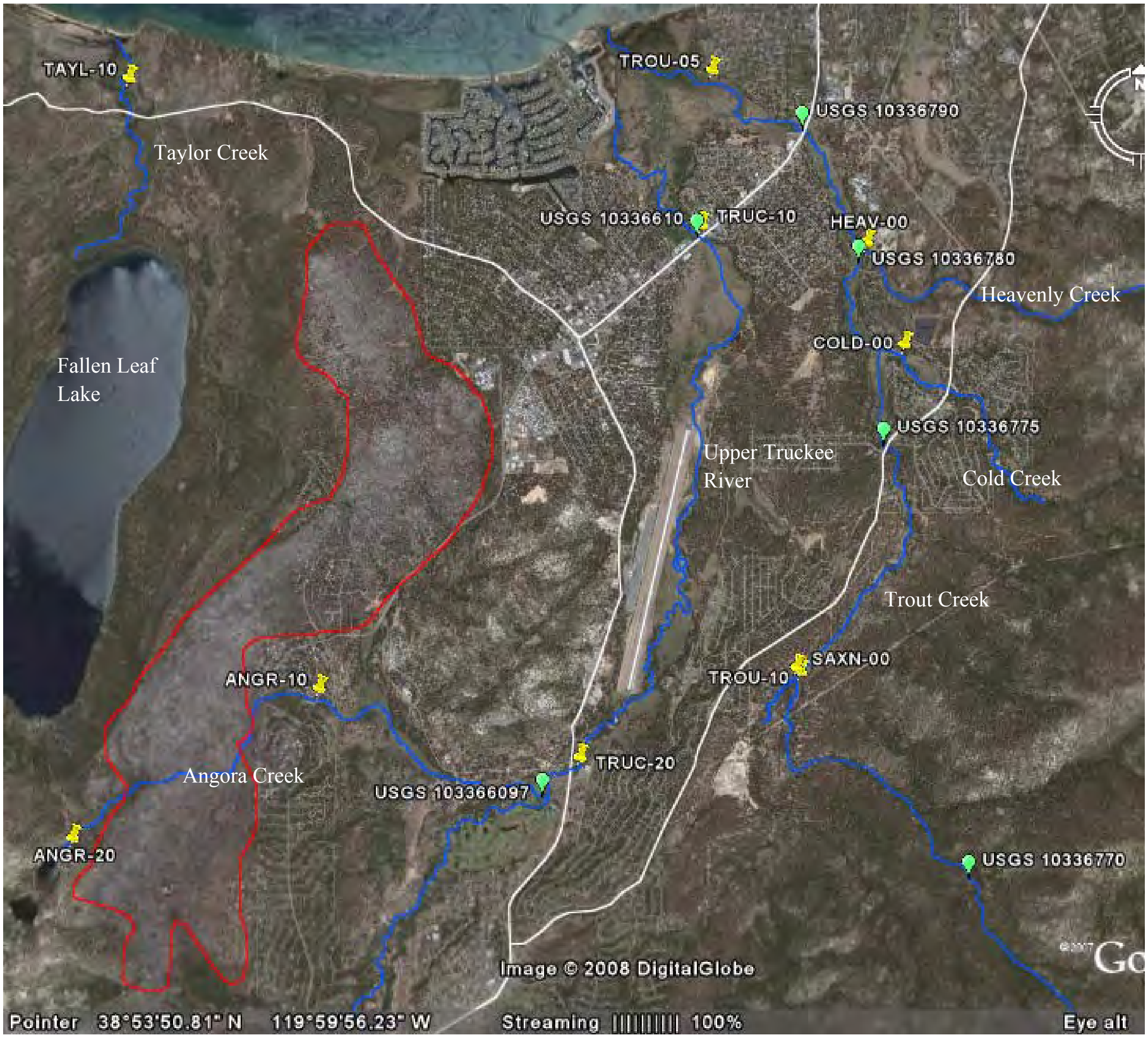


Figure 3.2 Monitoring Sites – East Map

Figure 3.3 – SLTMP Monitoring Sites – South Map

Figure 3.4 Monitoring Sites – West Map

Table 2. Sampling Sites and Sampling Days in the South Lake Tahoe Region of the Lake Tahoe Basin for South Lake Tahoe Monitoring Project for 2008

Watershed	Site ID	Map	Site Name	Site Description	Dates Monitored in 2008
Upper Truckee River	ANGR-20	East	Angora Creek below Angora Lakes	Angora Creek downstream of Angora Lakes	Mar 22
	ANGR-10	East	Angora Creek at View Circle	Angora Creek upstream of View Circle	Jan 27 Mar 16 May 10 Jul 19
	TRUC-20	East	Upper Truckee at Elks Club	Upper Truckee River just downstream of middle Hwy 50 bridge at Elks Club	Jan 26 Mar 16 May 10
	TRUC-10	East	Upper Truckee at Lake Tahoe Blvd.	Upper Truckee River just downstream from Lake Tahoe Blvd./ Hwy. 50 bridge in South Lake Tahoe	Jan 26 Mar 16 May 10 Jul 19
Trout Creek	SAXN-00	East	Saxon Creek at mouth	Saxon Creek just upstream from confluence with Trout Creek	May 10
	TROU-10	East	Trout Creek above Saxon Creek	Trout Creek just upstream of the confluence with Saxon Creek	Jan 27 Mar 15 May 10 Jul 19
	COLD-00	East	Cold Creek at Mouth	Cold Creek just upstream of the confluence with Trout Creek	Jan 26 Mar 15 May 10 Jul 19
	HEAV-00	East	Heavenly at Mouth	Heavenly Creek just upstream of the mouth	May 10
Other Lake Tahoe Creeks and Watersheds	EAGL-00	West	Eagle Creek at Mouth	Eagle Creek just upstream from the mouth	Jan 26 Mar 9 May 10 Jul 17
	TALC-20	West	Tallac Creek above Spring Creek Road	Tallac Creek just upstream from Spring Creek Road	Mar 15 May 10 Jul 19

	TALC-10	West	Tallac Creek at Hwy. 89 near mouth	Tallac Creek just upstream of HWY 89	Jan 26 Mar 15 May 10 Jul 19
	CASC-10	West	Cascade Creek Above Hwy. 89	Cascade Creek just upstream of HWY 89 crossing	Jan 27 Mar 16
	CASC-00	West	Cascade Creek near mouth	Cascade Creek just upstream of the mouth	May 10
	TAYL-10	East/West	Taylor Creek near mouth	Taylor Creek near the Rainbow trail at the USFS visitor Center	Jan 27 Mar 16 May 10 Jul 20

B. Narrative Description of Sites

All sites have water quality objectives, or standards, set by the Lahontan Regional Water Quality Control Board (Lahontan), but each site is being monitored for additional reasons. The following is a narrative description of each site.

1. Upper Truckee River Watershed

ANGR-20 - Angora Creek at Angora Lakes near South Lake Tahoe, CA (South/East Map): This Angora Creek site is located just below Angora Lakes near Angora Lakes Road. This site is upstream of the Angora Fire burn area and was not affected by the 2007 fire.

ANGR-10 - Angora Creek at View Circle near South Lake Tahoe, CA (East Map): This Angora Creek site is located just upstream of Angora Creek at View Circle. Originally, this site was chosen to monitor recent channel restoration efforts on Angora Creek. In light of the recent Angora Fire (2007), however, it may be difficult to recognize previous benefits from the channel reconfiguration restoration project. The site will now be used to look at the impacts of the Angora Fire and restoration projects in the burn area. UC Davis and the Desert Research Institute (DRI) sampled this site in 2008 for Angora Fire monitoring purposes. USGS also has a Lake Tahoe Interagency Monitoring Project (LTIMP) sampling site and streamflow gage at the mouth of Angora Creek- below this monitoring site.

TRUC-20 - Upper Truckee River at Hwy 50 at Elks Club near Meyers, CA (East Map): This Upper Truckee River site is located downstream from the middle Hwy 50 bridge near Meyers and is just upstream of the Elks Club property. This site will be used to assess water quality downstream of the Lake Tahoe Golf Course (Washoe Meadows State Park), where there is a proposed river restoration project. Angora Creek comes into the Upper Truckee

River upstream of this site. This site also has active beaver populations upstream, which may have affected water quality.

TRUC-10 - Upper Truckee River at Hwy 50/Lake Tahoe Blvd. at South Lake Tahoe, CA (East Map): This Upper Truckee River site is located on the Upper Truckee River, approximately 50 meters downstream of the Lake Tahoe Blvd. Hwy 50 bridge over the river at Carrow's Restaurant in South Lake Tahoe. This site will be used to evaluate the impacts of urban development and fine sediment on water quality. The site is also downstream of the Middle Reaches (2, 3, & 4) Restoration Project, a large river reconfiguration restoration project under construction during 2008 – 2010 at the Airport reach of the Upper Truckee River. The project is not monitoring at the Airport reach because the site is already being monitored for water quality parameters, including continuous turbidity, by the project's agency sponsors. This monitoring site is also a USGS LTIMP sampling site and gaging station (USGS station number 10336610).

2. Trout Creek Watershed

SAXN-00 - Saxon Creek above Trout Creek near Meyers, CA (East Map): This site is located on Saxon Creek just upstream of the confluence with Trout Creek. This area is popular for OHV recreation, mountain biking, and snowmobiling. No USGS water quality monitoring stations currently exist on this creek.

TROU-10 - Trout Creek above Saxon Creek near Meyers, CA (East Map): This Trout Creek site is located on Trout Creek just upstream of the confluence with Saxon Creek. The site is located downstream of an OHV bridge. This area is popular for OHV recreation, mountain biking, and snowmobiling.

COLD-00 - Cold Creek at Mouth near South Lake Tahoe, CA (East Map): This Cold Creek site is located on Cold Creek just above the confluence with Trout Creek and can provide a summary of water quality of the entire Cold Creek watershed. However, this site is occupied by an active beaver population which may influence water quality. This site is below TROU-10, but not located on Trout Creek as it is on Cold Creek upstream of the confluence with Trout Creek.

HEAV-00 - Heavenly Creek at Mouth near South Lake Tahoe, CA (East Map): This Heavenly Creek site is located just upstream of the confluence with Trout Creek. This site receives runoff from Heavenly ski resort and is located downstream of the South Tahoe Public Utility District (STPUD) wastewater treatment plant.

3. Other Creeks and Watersheds

EAGL-00 - Eagle Creek at mouth near South Lake Tahoe, CA (West Map): This Eagle Creek site is located on Eagle Creek approximately 150 meters above the mouth to Emerald Bay and Lake Tahoe and downstream of Eagle Lake, Eagle Falls, and Hwy. 89. This site experiences heavy recreational use and is below a steep mountain slope with a roadway cut, which makes the creek vulnerable to water quality problems.

TALC-20 - Tallac Creek above Spring Creek Rd. near South Lake Tahoe, CA (West Map): This Tallac Creek site is located just above Spring Creek Road, where there is a small community of seasonal cabins. The monitoring site is just upstream from the area where Spring Creek Road dead ends. This will be a non-impacted reference site to be compared with TALC-10.

TALC-10 - Tallac Creek above Hwy. 89 near mouth near South Lake Tahoe, CA (West Map): This Tallac Creek site is located just above the Hwy. 89 bridge. This site, along with TALC-20, will provide a summary of water quality in Tallac Creek, and will be used to determine if the water quality standards set by the Lahontan Regional Water Quality Control Board are being met.

CASC-10 - Cascade Creek above Hwy. 89 near South Lake Tahoe, CA (West Map): This site is located just above Highway 89 on Cascade Creek. This site will provide a summary of water quality in Cascade Creek, and will be used to determine if the water quality targets set by the Regional Water Board are being met.

TAYL-10 - Taylor Creek at USFS Visitor's Center near mouth (West Map): This Taylor Creek site is located off of the heavily visited recreational area, the Rainbow Trail at the USFS Visitor's Center. The site is downstream of Fallen Leaf Lake and the Hwy. 89 bridge. Since access to the mouth during spring runoff is difficult, the monitoring location was moved upstream. This site will provide a summary of water quality in Taylor Creek, and will be used to determine if the water quality standards set by the Regional Water Board are being met. The creek is dam controlled and is spawning grounds for non-native Kokanee salmon.

C. Upper Truckee Watershed Legacy Impacts

People of the Washoe Tribe are indigenous to the Lake Tahoe basin and occupied the area on a seasonal basis for thousands of years before the arrival of colonial settlers. The area was rich in natural resources for food and shelter. During this time, fire was not suppressed and low intensity forest fires occurred frequently. By examining tree rings, scientists estimate forest fires occurred every 5 to 20 years in the Tahoe Basin during this period.[iii] This cycle promoted forest regeneration, open pine stands, and greater ecological diversity in plant species. Natural filtration systems in the watershed, such as meadows and pervious soil, maintained good water quality.

In 1859, the biggest silver strike in Nevada history was discovered. The Comstock Lode, near Virginia City, Nevada, drew fortune seekers from California gold country, past Lake Tahoe, to the Great Basin. Shortly thereafter, the Tahoe Basin's timber was clear-cut to support the Nevada mining boom. Since this time, dense mono-culture forests have regenerated, coupled with forest suppression to create the potential for catastrophic wildfire throughout the basin. Wildfire threatens not only the human inhabitants but the ecosystem health and clarity of the lake.

Another major impact on the basin is a result of tourism and development. Tourists have been visiting the basin since the late 1800's. Tourism swelled with the Olympics at Squaw Valley in 1960. To accommodate visitors, South Lake Tahoe grew rapidly and the ecological impacts as a result of the development were not thoroughly considered. As a result, non-point source pollution increased dramatically and several sensitive meadows areas, which naturally filter runoff, have become impaired.

In 1969, the Tahoe Regional Planning Agency (TRPA) was created by a bi-state compact between Nevada and California to regulate impacts to environmental quality in the Lake Tahoe Basin. Although this helped to reduce problems associated with unregulated development, water quality in the Basin continues to be threatened by human land uses and impacts. These include 1) impacts from high recreation use – such as boating, snowmobiling, off high-way vehicles, camp grounds, and others; 2) impacts from urban upland development – including increased nutrients from lawn fertilizers and other sources, expansion of impervious surfaces and urban run-off, re-channelization of streams, removal of natural wetlands, and general land disturbance; and 3) introduction of non-native species and removal of native vegetation.

As a result of these impacts, Lake Tahoe is experiencing eutrophication, which is the buildup of phosphates, nitrates, and other nutrients, which promote algal blooms in aquatic bodies, which in turn affects water clarity and disrupts aquatic ecosystems. Historically, the Lake was nutrient deficient and did not support algal growth. The growth of algae in Lake Tahoe has increased about three-fold since measurements were first taken in the late 1950's.[iv] In addition to problems associated with increased nutrients, lake clarity is also being affected by increased ultrafine sediments being carried into the Lake. Ultrafine sediments become suspended in water, do not settle, and reduce Lake clarity.

When the visibility of Lake Tahoe's water was first measured by the Tahoe Research Group in the late 1960's, visibility was 100 feet. Lake Tahoe is losing its clarity at a rate just less than one foot per year due to increased fine sediments in the water and unnatural algae growth. In 2005, the average clarity level (annual average Secchi depth) was 72.4 feet.[v]

Lake Tahoe does not benefit, as a result of its size, depth and retention time, from the flushing action of runoff like other water bodies such as the nearby and smaller water body, Fallen Leaf Lake. Therefore correcting Lake Tahoe's imbalanced nutrient and sediment load is a difficult task. A drop of water resides in Fallen Leaf Lake approximately eight years, which is often described as "residence time." The entire volume of water in Fallen Leaf Lake exchanges, or is completely flushed, approximately every eight years. In contrast, Lake Tahoe has a remarkable residence time of 700 years, making Tahoe behave like a sink without a drain (although technically the lake does outsource into the Truckee River).[vi] Preventing additional sediment from flowing into Lake Tahoe is a complicated endeavor and controlling the sources of nutrients is paramount to reversing the loss of water clarity.

D. Recent and Current Watershed Disturbances and Restoration Efforts in SLTMP Study Area

There are several recent watershed events and restoration efforts in the project area that are either completed, in progress, or in the planning phase. These activities are important to note for framing monitoring results and discussing next steps for the project. These watershed activities include, but are not limited to, the following:

1. Detrimental Legacy Impacts

- 1997 Flood Event
  On January 1, 1997, a rain-on-snow event resulted in the highest recorded flows at several gages operated by the United States Geological Survey (USGS) in the Lake Tahoe Basin. A rain-on-snow event is when rain falls on existing snowpack causing high volume rapid runoff. The flooding caused significant erosion, sedimentation and other NPS pollutant deposition in rivers and Lake Tahoe. The Upper Truckee River and Trout Creek breached their banks and formed new channels, which disrupted annual flood plain cycles.[vii]

- 2007 Angora Fire
  The 3,100 acre Angora Fire of June 2007 was anticipated to have significant impacts on Lake Tahoe's water quality. However, the 2008 State of the Lake Report (UC Davis Tahoe Environmental Research Center) indicated that atmospheric deposition from the Angora Fire had a negligible impact on Lake clarity and algal biomass. Meteorological conditions preceding, during, and after the Angora Fire were marked by relatively low levels of precipitation, which resulted in no significantly polluted runoff into the Lake, according to studies by the USGS, UC Davis, and the Desert Research Institute (DRI).[viii]

- Urban Upland Development
  The city of South Lake Tahoe developed rapidly after the 1960 Winter Olympics at Squaw Valley, CA. This rapid, unregulated development gave South Lake Tahoe and Incline Village areas the unplanned, sprawling urban growth pattern that exists today.

2. Current Watershed Disturbances[ix]

- Road Sand Used in Winter Months
  Large particle sand is spread on the roads in the winter months for enhanced vehicle grip on ice. Over time, vehicles grind it into fine sediment, which is then washed into the lake degrading water quality and lake clarity.

- On-going Stormwater Runoff
  Stormwater runoff is difficult to control and can have significant water quality impacts if polluted. Best Management Practices (BMPs) are required on all properties in the Basin to reduce runoff. Runoff can contain non-point source (NPS) pollution as a result of nutrients from residential chemical fertilizers, sediment from erosion, and other sources such as development/construction sites. Agencies currently monitoring stormwater include the Surface Water Ambient Monitoring Program (SWAMP), which is a division of the State Water Board. The Nevada Tahoe Conservation District (NTCD) and TPRA are also investigating methods to treat, pump, and/or filter storm water before it reaches Lake Tahoe and the effectiveness of installing curb and gutter systems in areas that currently do not have them.

3. Restoration Projects

- Angora Creek at View Circle Restoration – Completed (2005-2006)
  Lead Agency: City of South Lake Tahoe (CSLT)
  The stream reach of Angora Creek above View Circle was reconfigured to restore channel sinuosity, restore the functioning flood plain, and reduce excess erosion within the channel. When the 2007Angora Fire occurred, the habitat and vegetation restoration efforts were damaged. The site has since been revegetated to enhance habitat conditions and stream bank stabilization. Upstream from this site, there are major erosion control measures in place to reduce stream environment zone (SEZ) impacts from the Angora Fire, which include sedimentation and eutrophication.

- Upper Truckee River, Sunset Reach – Proposed/Planning Phase - Construction Starting in 2009
  Lead Agency: California Tahoe Conservancy (CTC)
  This project will include habitat enhancement and 1 of 4 proposed channel realignments. This property formerly known as "Elks Club," was recently purchased by the CTC. The goals and purpose of this project include: restoring a naturally functioning river and floodplain, improving water quality by restoring geomorphic and ecological function in the area, and providing compatible public access opportunities. Four different alternatives are being considered for the implementation of this project.

- Upper Truckee River, Middle Reaches (2, 3 & 4) Restoration Project (Airport Reach) – In Progress (2008 – 2010)
  Lead Agency: CTC/CSLT
  The Upper Truckee River Restoration Project, Middle Reaches 2, 3 and 4 is addressing the degraded hydrologic function of the river bordering the South Lake Tahoe Airport. Project objectives include restoring hydrologic functions within the project area with respect to over bank flooding, flood water attenuation, ground water recharge, sediment and nutrient retention, and water quality. Subsequent project objectives include habitat restoration for in-stream, riparian, and upland wildlife and vegetation. By the end of 2008, dewatering infrastructure was in place and the new channel was excavated. In 2009, the site will be revegetated and flows will be directed into the new channel in 2010.

- Upper Truckee River and Marsh Restoration Project – Proposed/Planning Phase
  Lead Agency: CTC
  Four channel realignment alternatives in the marsh are being considered as well as options for directing and mitigating recreational use in the meadow. The purpose of this project is to restore natural geomorphic processes and ecological function to the Upper Truckee River and the surrounding marsh. Ultimately, the discharge of sediment and nutrients into Lake Tahoe will be reduced and ecological value of the area will increase. The project will likely reflect a combination of the four different alternatives. [x]

- Lake Tahoe Golf Course/Washoe Meadows State Park/Lake Valley State Recreation Area – Proposed/Planning Phase
  Lead Agency: California State Parks (CSP)
  The Lake Tahoe Golf Course is situated within the Washoe Meadows State Park and Lake Valley State Recreation Area. The Golf Course borders reaches of Angora Creek and the Upper Truckee River which are ecologically significant and sensitive stream environment zones (SEZs). California State Parks has worked with contractors and staff to develop a golf course reconfiguration plan that has five different alternatives for consideration. This project was still in the draft/public comment phase at the time of this report. The California Environmental Quality Act (CEQA) and Environmental Impact Statement (EIS) documents will be produced in the winter of '08/'09 and will be available for public comment at that time.

III. Methods

The design of the South Lake Tahoe Monitoring Project is based on the above goals and objectives. Project participants included 30 trained citizen monitors, a Technical Advisory Committee (TAC) consisting of local agency staff from the California Tahoe Conservancy (CTC), TRPA, California State Parks, United States Forest Service (USFS), League to Save Lake Tahoe, USGS, Lahontan Regional Water Quality Control Board (Lahontan), and University of California Cooperative Extensions. The TAC meets quarterly to provide project oversight to the Sierra Nevada Alliance (Alliance) staff and an AmeriCorps member who coordinate the project, maintain the database, and perform watershed education activities associated with the project.

A. Coordination, Training, and Collection Methods

The site selection, volunteer training, and monitoring schedules and protocols were arranged by the project coordinators and the TAC. Fifteen sites were monitored by 30 volunteers in the 2008 water year. The 2008 water year is defined as October 1, 2007 through September 31, 2008. The volunteers conducted monitoring over two days in January, March, May, and July. The volunteers were assembled in teams of 2-3 monitors prior to the monitoring day. Sites were matched with monitors, but it was not required that the same monitors return to the same sites each monitoring day. New monitors not trained at the November 2007 training session were permitted to "shadow" the group to learn the techniques until the next training day before the next monitoring season.

Each monitoring day was coordinated by the Sierra Nevada Alliance watershed program. The May monitoring day was part of the 8th Annual Snapshot Day, a Basin and watershed wide citizen volunteer water quality monitoring event.[xi] Snapshot Day is a collaborative effort among agencies and organizations in the Truckee River watershed. South Lake Tahoe Snapshot Day events and sites were coordinated with the South Lake Tahoe Monitoring Project.

This report focuses on quantitative chemical parameters of the monitoring project. Citizen volunteers were recruited and trained in November 2007 according to Surface Water Ambient Monitoring Program (SWAMP) standards set by the California State Water Board. The two-day training instructed volunteers on the protocol for monitoring chemical parameters, including pH, conductivity, air/water temperature, and dissolved oxygen (DO). Monitors were also trained on how to collect grab samples for turbidity, sediment concentration, nutrient, and bacteria analysis. Analysis for turbidity is conducted by the Alliance. When funding is available, nutrient, sediment, and bacteria samples are collected and sent to a laboratory for analysis.

Approximately 35 volunteers were trained at the November 2007 training. Most of the volunteers participated for the whole field season. However, there was some attrition as a result of the seasonal economy of South Lake Tahoe. Some volunteers moved out of town mid-project. Other volunteers, who were members of the California Conservation Corps (CCC), were called to duty to work on forest fires in other parts of the state and could not monitor during the July monitoring day.

The project will retain many of its current volunteers for 2009, but will recruit new volunteers and host another water quality monitor training. The training for the next monitoring season is tentatively scheduled for February 2009.

B. Field and Analytical Methods

The parameters monitored for the project in 2008 were focused mostly on chemical constituents of water quality. Field and lab measurements were collected in triplicate. An average was calculated from the three values and was used as the sample mean for that parameter on that day at that site. The parameters monitored in 2008 were:

Table 3 – Data Collection Methods at SLTMP Sites

Parameter	**Unit**	**Collection Method**	**Reporting Level**	**Basin Plan Threshold values**[xii]
Discharge	Cubic Feet per Second (CFS)	USGS Real-time Stream Gage	.01 CFS	N/A
Air Temp.	º C	Hand-held thermometer	.1º C	N/A
Water Temp.	º C	Hand-held electric pH meter	.1º C	N/A
pH	pH unit	Hand-held electric pH meter	.1 pH	6.5 – 8.5
Dissolved Oxygen	mg/L	Winkler Titration	.1 mg/L	7.0 mg/L or 80% saturation
Conductivity (TDS)	ppm	Hand-held electric meter	10 ppm	Varies by water body
Turbidity	NTU	Grab sample/lab analysis	.01 NTU	N/A
Bacteria	# of colonies/100 mL water	Grab sample/lab analysis	1/100 mL	20 colonies/100 mL water

- **Discharge**
  Real-time discharge data from USGS stream gages are acquired from the USGS Real-Time Water Data website and are useful for interpreting data collected by SLTMP. Some

parameters including conductivity, dissolved oxygen, and turbidity are correlated with discharge. In addition, the character of the stream flow data in terms of magnitude, timing, and rate of change identifies seasonal trends in the nature of the flow regime, which has implications on pollutant transport through the watershed and overall water quality conditions. For example, steady increases in flow in spring generally indicate spring runoff from snowmelt. A sharp increase in summer or fall could indicate a storm event, while a sharp increase in winter or spring could indicate a "rain-on-snow" event. These events are often associated with flooding, major erosion, and displacement of non-point source pollution.

- **Water Temperature**
  Water temperature is one of the most important water quality parameters because of its affect on water chemistry and the functions of aquatic organisms. In addition, temperature directly influences several other parameters including pH, conductivity, and dissolved oxygen. In particular, water temperature is used to calculate percent DO concentration.[xiii] Temperature is the measure of warmth or coldness of a substance with reference to a standard value and measures the average energy of water molecules. The unit of measure is degrees on a linear scale, either Celsius (C) or Fahrenheit (F). Some intolerant species such as stoneflies and native trout require specific temperature ranges for survival.

- **pH**
  The parameter pH is a measure of how acidic or basic (alkaline) the water is. The pH scale is logarithmic from 0-14 standard units with acids being from 0 - <7, 7 = neutral, and bases from > 7 – 14. Many chemical and biological processes in the water are affected by pH and different organisms flourish within specific ranges of pH. The largest variety of aquatic organisms prefers a range of 6.5-8.0. Values outside this range reduce the diversity in the stream by causing stress to the physiological systems of most organisms and potentially reducing reproduction.[xiv]

- **Dissolved Oxygen (DO)**
  Dissolved oxygen is the measure of molecular oxygen (oxygen gas) dissolved in water and units are milligrams per liter (mg/L). DO is affected by water temperature and elevation (barometric pressure). For example, as temperature increases, less oxygen can be dissolved in water. The stream system both produces and consumes oxygen. It gains oxygen from the atmosphere and from plants as a result of photosynthesis. Moving water dissolves more oxygen than still water, such as that of a reservoir behind a dam (beaver or man-made). Most aquatic organisms need oxygen to survive and grow. Some species, such as trout and stoneflies require high levels of DO. There are two ways to look at DO: concentration in mg/L and percent saturation. The Basin Plan has standards for both categories. The standard set by the Basin Plan is 7.0 mg/L DO concentration or 80% DO concentration, whichever is more restrictive.[xv] DO percent saturation was calculated with the following equation:

$$\frac{\text{DO sample mean (mg/L)}}{\text{DO saturation for water temp. (mg/L)}} \times 100 = \text{\% DO saturation}$$

DO saturation for mean sample water temperature in mg/L is determined using Table 4.

Table 4 - Dissolved Oxygen Saturation for Given Temperatures at 6,260' Elevation.[xvi]

Temp (ºC)	100% Dissolved Oxygen Saturation (mg/L)	Temp. (ºC)	100% Dissolved Oxygen Saturation (mg/L)
0	11.6	16	7.8
1	11.3	17	7.6
2	11.0	18	7.5
3	10.7	19	7.3
4	10.4	20	7.2
5	10.1	21	7.0
6	9.9	22	6.9
7	9.6	23	6.8
8	9.4	24	6.6
9	9.1	25	6.5
10	8.9	26	6.4
11	8.7	27	6.3
12	8.5	28	6.1
13	8.3	29	6.0
14	8.1	30	5.9
15	8.0	31	5.8

- **Specific Electrical Conductance**
  Specific Electrical Conductance (conductivity/salinity) is a measure of the electrical conductance of a substance normalized to unit length and unit cross section at a specific temperature. Conductivity refers to the concentration of dissolved minerals in water, including salinity. Most aquatic biota tolerate a wide range of conductivity. Conductivity will vary with water source influences such as geology, ground water, water drained from agricultural fields, municipal wastewater, and rainfall. Therefore standards for conductivity are set forth by the Basin Plan for individual streams.

- **Turbidity**
  Turbidity is an expression of the optical properties of a liquid that cause light rays to be scattered and absorbed rather than transmitted in straight lines through a sample. The main unit of measure is NTU (Nephelometric Turbidity Unit), which is a unit of light. Specifically, one NTU equals detection at 90 degrees in incident beam with a single illumination light source. Turbidity is often thought of as cloudiness or "murkiness" of water. Increased turbidity is typically increased cloudiness. Turbidity can be useful as an indicator of the effects of runoff from construction, agricultural practices, logging activity, roads, and other non-point sources of pollution. Turbidity often increases sharply during a storm event as a result of erosion and NPS displacement. In the South Lake Tahoe region, high turbidity is often caused by algae or sediment. The clarity of Lake Tahoe has been particularly affected by ultrafine particle sediment, which becomes permanently suspended in water. At the time of this report, there was no specific standard for turbidity set by the Lahontan Water Board.

- **Bacteria**
  Bacteria samples can be indicators of fecal contamination in water. Fecal coliform samples were collected and analyzed at 12 sites on May 10, 2008 during the 8th Annual Snapshot Day event. Six of the sampled sites were SLTMP sites. High levels of fecal coliform degrade water quality for human use and can cause increased water temperature and decreased dissolved oxygen.

IV. Results and Discussion

The data for the South Lake Tahoe Monitoring Project is stored at the Sierra Nevada Alliance. The database is maintained in Excel workbooks by the Watershed Program staff. At the time of this report, SLTMP was coordinating with the Tahoe Integrated Information Management System (TIIMS) to post the data online. Data analysis is a collaborative effort with the Alliance watershed staff and Technical Advisory Committee. Through this collaborative process, a method of analysis was developed to form sub-groups according to watersheds within the Upper Truckee River Watershed. By doing this, upstream and downstream samples can be accurately compared with reference to time and the other sites. Also, other monitoring data from other groups and agencies can be categorized appropriately.

The main method of data analysis was statistical analysis whereby the results from the monitoring at each site were entered into the database and sample means were calculated and used to determine annual statistics such as maximum, minimum, mean, median, and 1st and 3rd quartile values. This statistical method makes the results comparable and accessible for analysis according to water quality standards set by the Lahontan Regional Water Quality Control Board (Lahontan) in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan).

Another type of analysis included charting sample means vs. time. With this method of analysis, each parameter's relationship to time at each site could be examined. In the upper montane environment of the Lake Tahoe Basin, most precipitation falls and accumulates as snow, which directly influences stream flow. Therefore, there is often a close relationship between flow and time in the Basin. For this reason, the first section of results is stream flow data from USGS gaging stations in the study area.

A. USGS Gaging Station Data

USGS gaging stations collect a variety of water quality data including discharge, water temperature, specific conductance, nutrient, and sediment concentration. There are 4 active USGS stream gages in the Upper Truckee River watershed and 4 active gages in the Trout Creek watershed. Refer to figures 3.2 – 3.4 for the locations of these gages. Each gage has historically collected a wide range of parameters, but for the purpose of this report only those parameters collected in the 2008 water year are reported. At the time of this report, daily discharge and water temperature data were available, but USGS Water-Data reports for nutrient and sediment readings had not yet been published. The following are the 8 active USGS stream gages in the South Lake Tahoe region and the parameters each monitored in 2008. The order of the list descends from upstream to downstream. Refer to figures 3.1-3.3 for maps of the location of each gage.

1. **Upper Truckee River Watershed**[xvii]

- USGS 103336580 - Upper Truckee River at South Upper Truckee Road near Meyers, CA
  - Daily discharge; 1990 – current
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; 1990-current
- USGS 103366092 – Upper Truckee River at Hwy. 50 above Meyers, CA
  - Daily discharge; 1990 – current
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; 1990-current
- USGS 103366097 – Angora Creek near Mouth at Lake Tahoe Golf Course
  - Daily discharge; February 2008 – current
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; June 2007-current
- USGS 10336610 – Upper Truckee River at Hwy. 50 in South Lake Tahoe, CA
  - Daily discharge; 1971-74, 76-77, 77-78, 80– current
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; 1972-74, 78, 1980-current

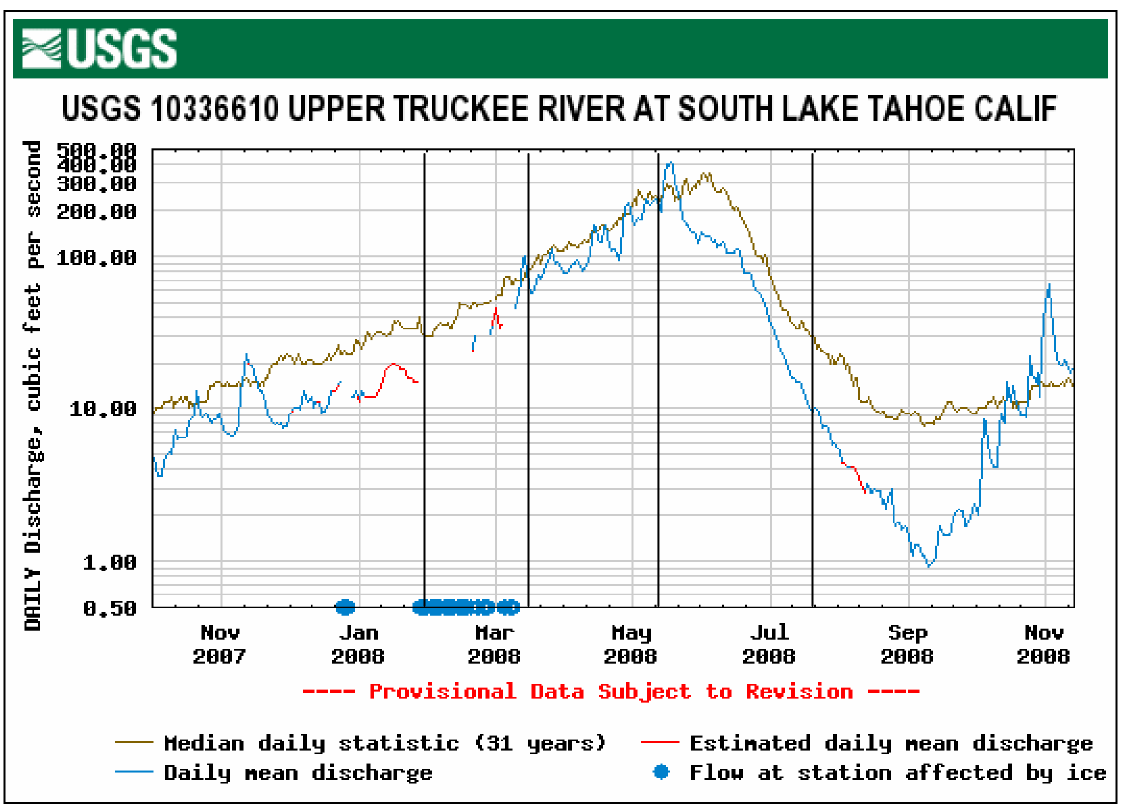


Figure 5.1 – Hydrograph for USGS Stream Gage 10336610 at SLTMP TRUC-10 Site

USGS stream gage 10336610 on the Upper Truckee River is located at the SLTMP site TRUC-10 near Hwy. 50/Lake Tahoe Blvd (figure 3.1 – East Map). Discharge at this site and its relationship to time from October 1, 2007 through November 13, 2008 is shown in figure 5.1. The blue line is mean daily discharge in cubic feet per second. The breaks in the blue line are points where flow measurements were disrupted by ice at the station. The red lines are periods where the mean daily discharge was estimated by USGS staff. The brown line represents the 31 year daily mean at this site. The vertical black lines indicate SLTMP sampling dates.

The 2008 water year had an earlier and drier spring runoff compared to the 31 year daily mean due to a dry, warm winter and the unusual almost total lack of precipitation in March and April. Flows were also well below average in and around September 2008 before spiking in October due to rain storm events. Peak flows from spring runoff were within days of the May monitoring day, which was also the 8th Annual Snapshot Day.

2. Trout Creek Watershed[xviii]

- USGS 10336770- Trout Creek at U.S. Forest Service Road 12N01 near Meyers, CA
  - Daily Discharge; 1990 – current
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; 1990-current

- USGS 10336775 Trout Creek at Pioneer Trail near South Lake Tahoe, CA
  - Daily Discharge; 1990 – current
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; 1990-current

- USGS 10336780 Trout Creek (at Martin Ave) near Tahoe Valley, CA
  - Daily Discharge; 1960 – current

- USGS 10336790 Trout Creek (at Hwy 50) at South Lake Tahoe, CA
  - Instantaneous sampling of nitrates, phosphorus, iron, and suspended sediment concentration; 1972-74, 1990-current

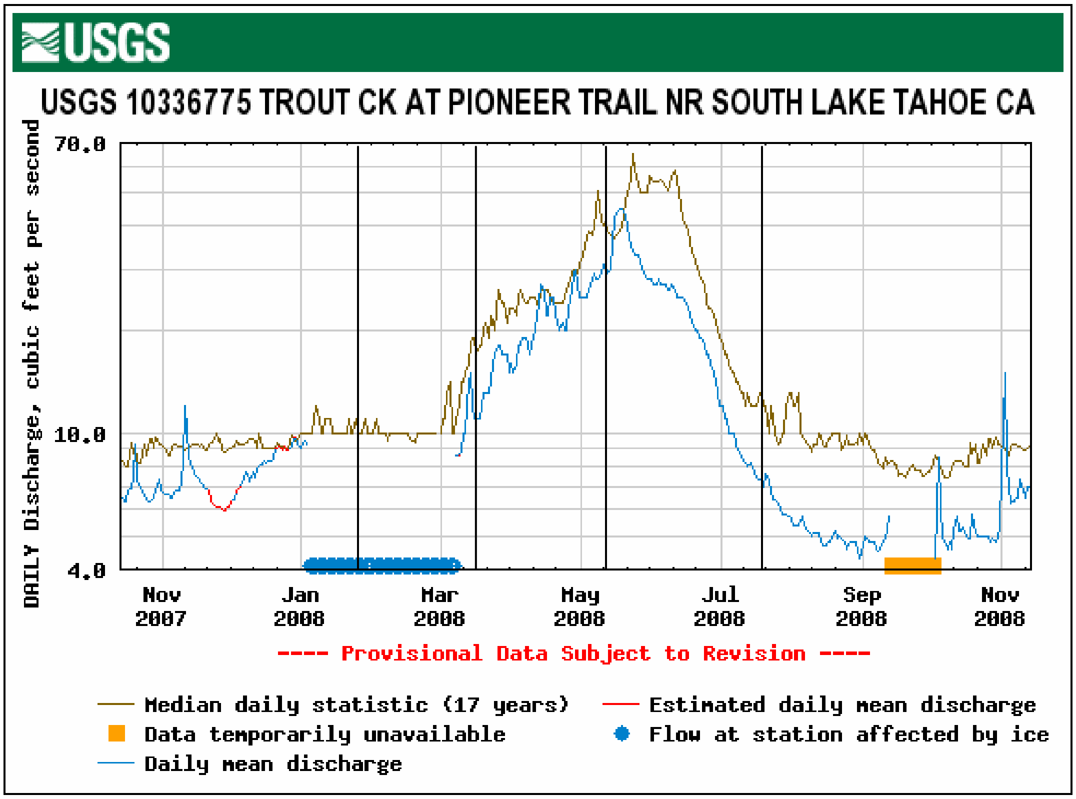


Figure 5.2 – Hydrograph for USGS Stream Gage 10336775 Upstream of Trout Creek Sites

Mean daily discharge for the 2008 water year and the 17 year daily mean discharge in CFS are shown in figure 5.2. This hydrograph shows a similar pattern to the Upper Truckee River 10336610 gage with respect to earlier and lower than average spring runoff and lower than average fall flows followed by rain storm events. Peak runoff occurred within the same one week period as the USGS 10336610.

B. SLTMP Data for 10 Monitoring Sites in 2008

SLTMP sites with more than one data point have been included in this report. The following is the data and analysis for each parameter monitored at these 10 sites in 2008. The values are displayed in a box plot format, which shows the minimum, maximum, mean, median, and 25th (Q1) and 75th (Q3) percentile values. The range between Q1 and Q3 values are represented by the white boxes. The sites are presented along the x-axis sequentially west to east by watershed and upstream to downstream when applicable. In parentheses next to the site ID is the number of samples collected for each box plot figure.

1. Water Temperature

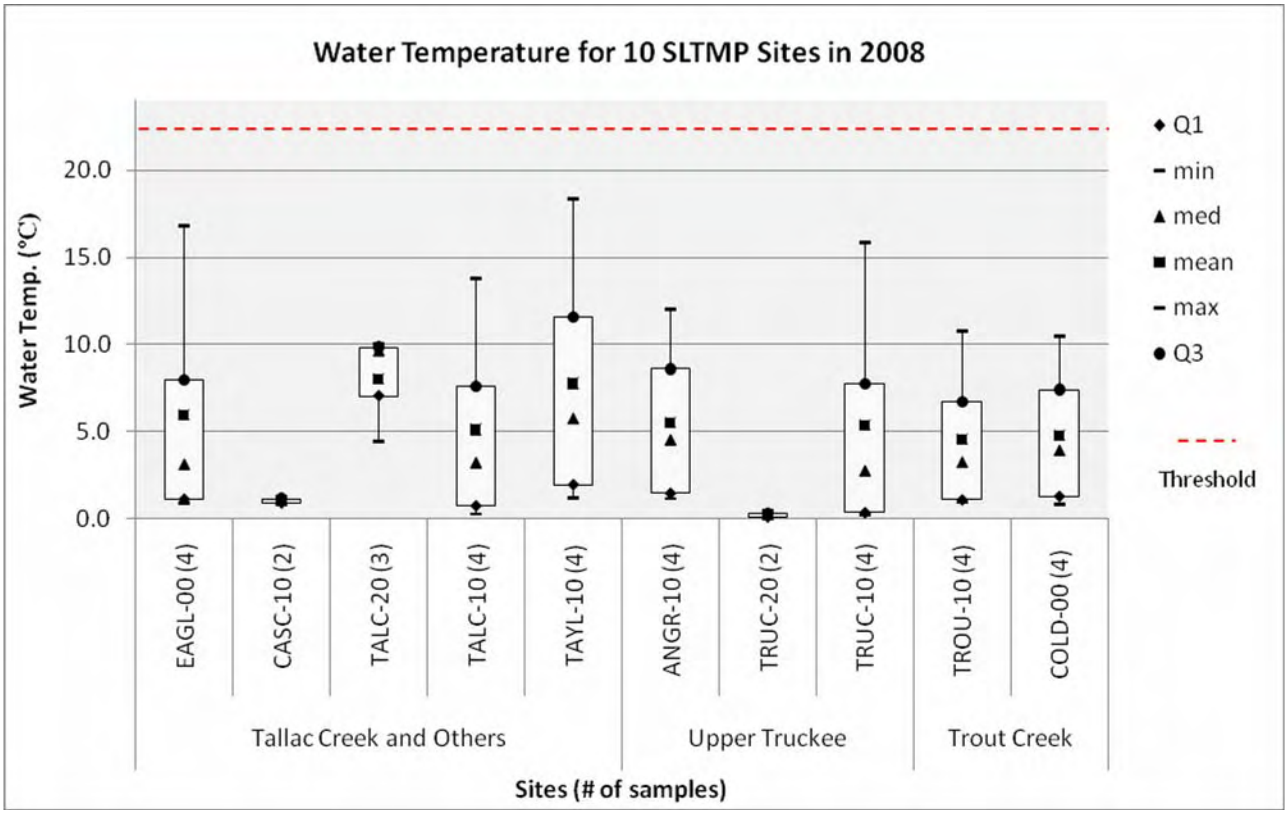


Figure 5.3 – Mean Summary Statistics: Field Water Temperature Readings for 10 SLTMP site for 2008

The distribution of sample mean water temperature readings taken at 10 of the SLTMP water quality monitoring sites is show in Figure 5.3. Box plot format is useful for arranging data to characterize the spread of data at point locations. Line graphs are useful for arranging continuous data.

The red-dashed line represents the average temperature standard of native Lahontan cutthroat trout. Temperatures at all monitoring sites are below the threshold temperature 23 ºC, which is the upper limit at which trout become sensitive and demonstrate signs of stress.[xix]

2. pH Levels

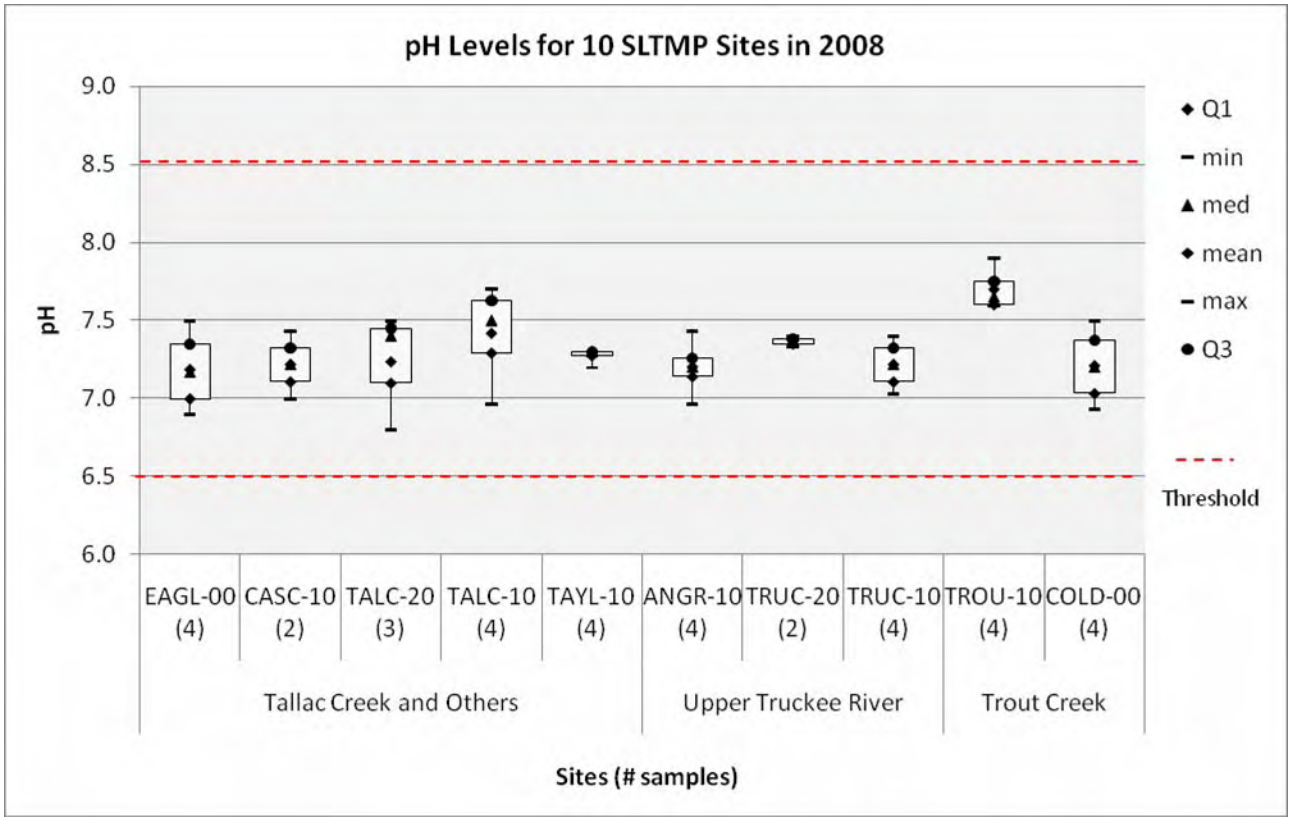


Figure 5.4 – Mean Summary Statistics: Field pH Readings for 10 SLTMP Sites in 2008

Figure 5.4 shows the distribution of sample means of pH field readings for 10 SLTMP sites in 2008. The box plot is arranged in the same format as Figure 5.3. The red dashed line indicates the acceptable range of pH values as part of the water quality standards set by the Basin Plan. The water quality standard or "threshold" states that surface waters in the watershed may not exceed 8.5 or go below 6.5 pH units.[xx] The pH levels at the 10 sites were well within range of the standards. The sample means ranged between 6.8 and 7.9. The highest mean pH found was at Trout Creek (TROU-10) above the Saxon Creek site (SAXN-00). The lowest mean pH was found at the Cascade Creek (CASC-10) site.

3. Dissolved Oxygen

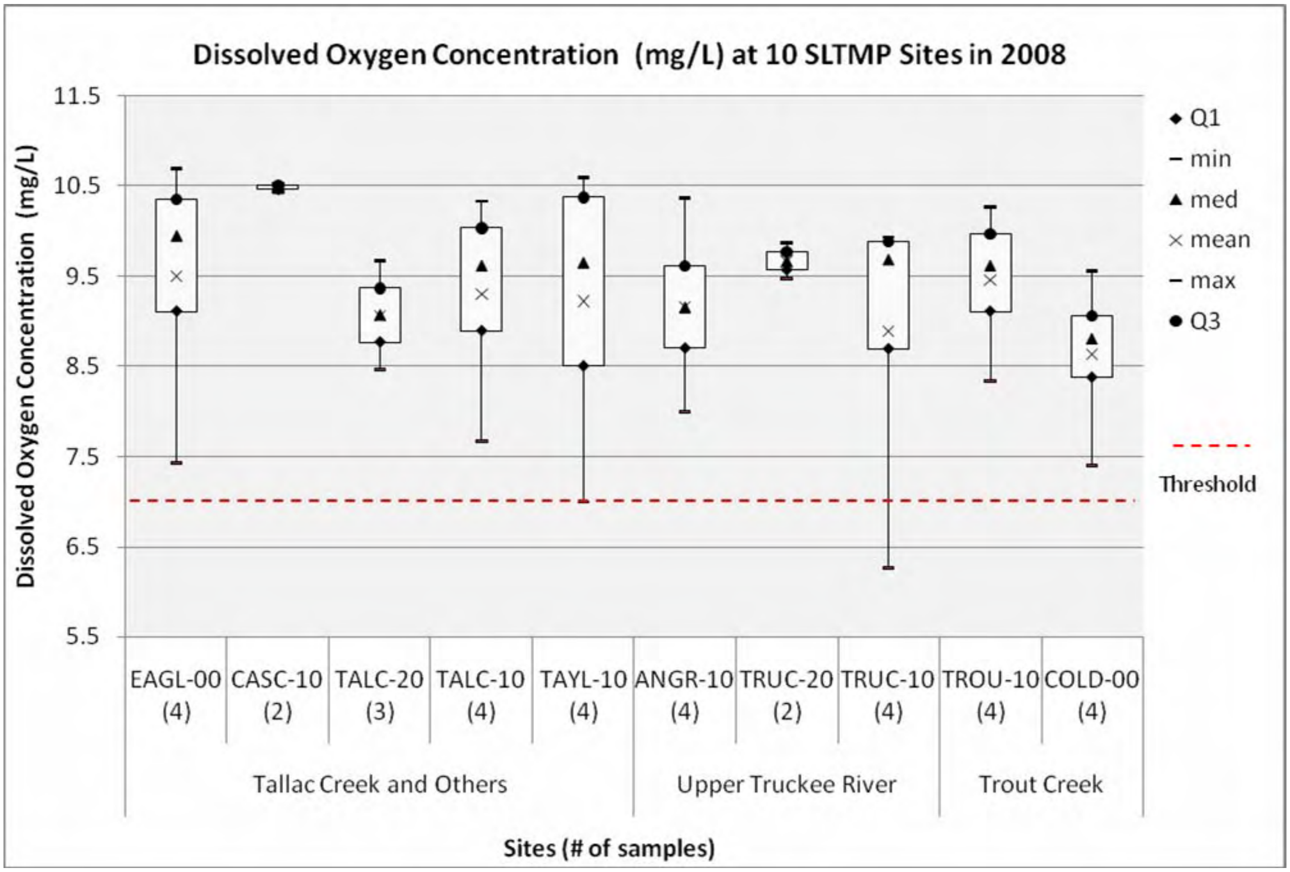


Figure 5.5 – Mean Summary Statistics: Field Dissolved Oxygen (DO) Concentration Readings for 10 SLTMP Sites in 2008

The distribution of dissolved oxygen concentration (DO) in mg/L at 10 sites through the monitoring season in 2008 is shown in figure 5.5. This box plot shows DO concentration in mg/L. The standard of 7.0 mg/L is indicated on the box plot by the red-dashed line. The range of sample mean DO concentrations was a low of 6.3 mg/L at TRUC-10 in July and a high of 10.7 mg/L at ANGR-00 in May. The range of annual mean DO concentrations was a low mean of 8.9 mg/L at TRUC-10 and a high mean of 9.5 mg/L at EAGL-00.

DO concentration spans a wide range as a result of variability in water temperature and topography. For example, cold water can absorb more oxygen resulting in higher DO values. Also, creeks with waterfalls or other sources of highly aerated water such as EAGL-00 will absorb more oxygen thus elevating DO values.

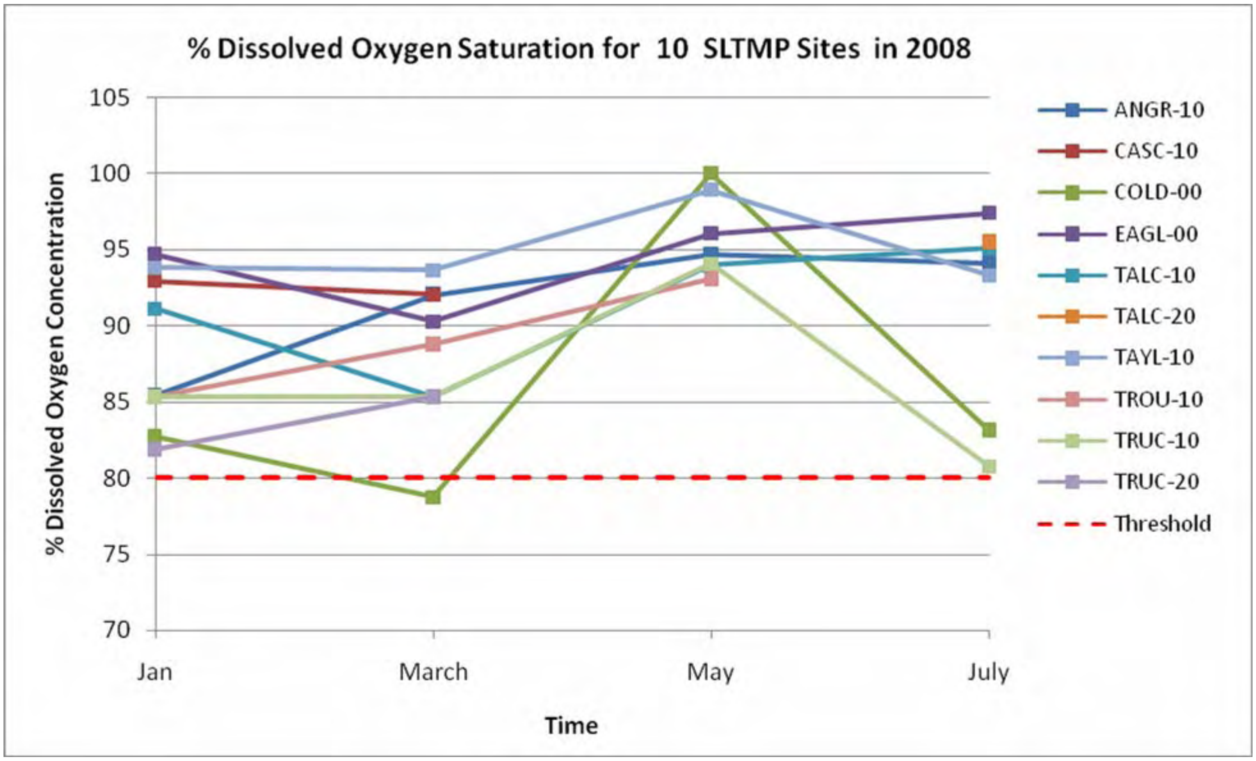


Figure 5.6 – Percent DO Saturation vs. Time for 10 SLTMP Sites in 2008

Percent DO saturation was calculated using the formula described in Section III.2. The calculation negates the temperature factor for DO concentration and provides an accurate observation of DO saturation over time in a project area where water temperature is highly variable. The red-dashed line indicates the 80% minimum standard set by the Basin Plan. The data collected ranges were from a low of 79% DO saturation at COLD-00 in March to a high of 100% at COLD-00 in May. Most DO concentrations collected by the SLTMP in 2008 reached a peak in May, which coincides with peak stream discharges associated with spring time runoff. This correlation between discharge and DO concentration was expected and deviations from this relationship could indicate changes in water quality conditions within an individual stream system. During the July monitoring day, only TRUC-10 and COLD-00 decreased dramatically in percent DO concentration from the May monitoring day. The low values at COLD-00 in March and July were likely a result of a maintained beaver dam downstream from the monitoring site, which blocked flow, causing water to become warmer and more stagnant.

4. Conductivity

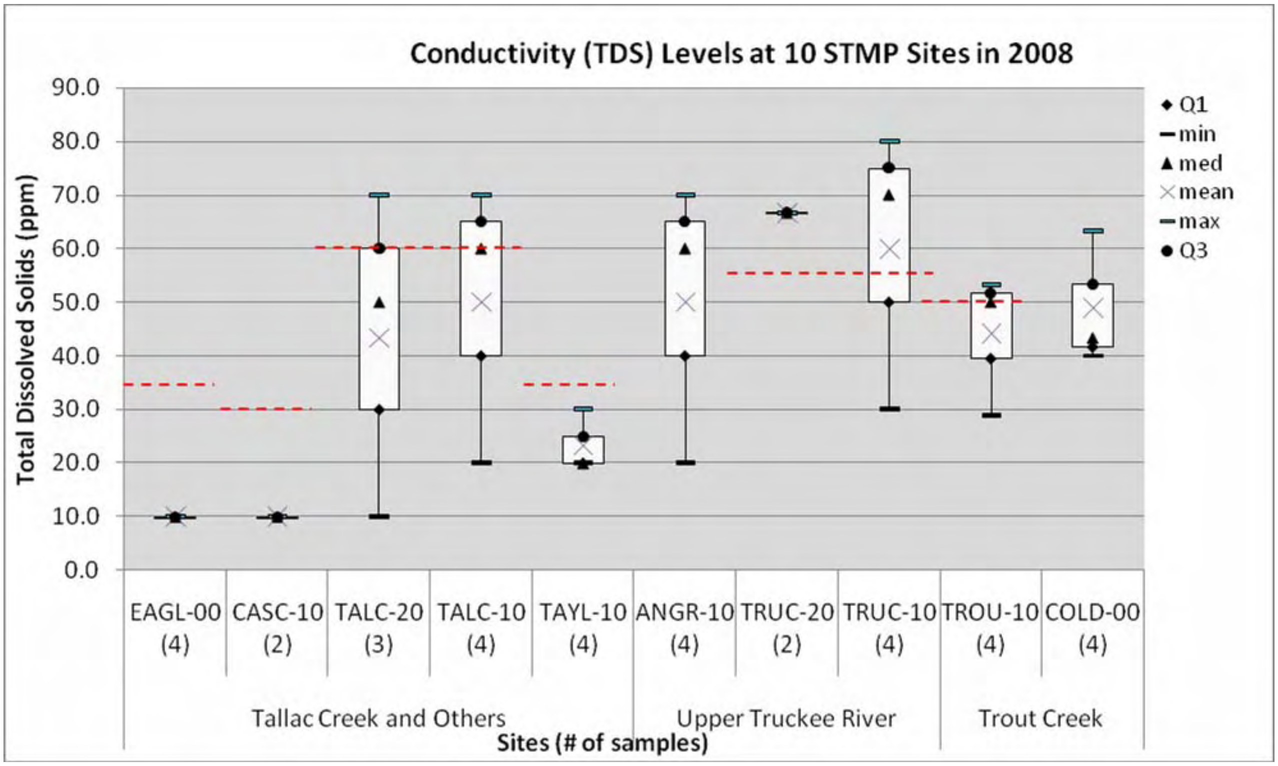


Figure 5.7 – Mean Summary Statistics: Field Conductivity Readings at 10 SLTMP Sites in 2008

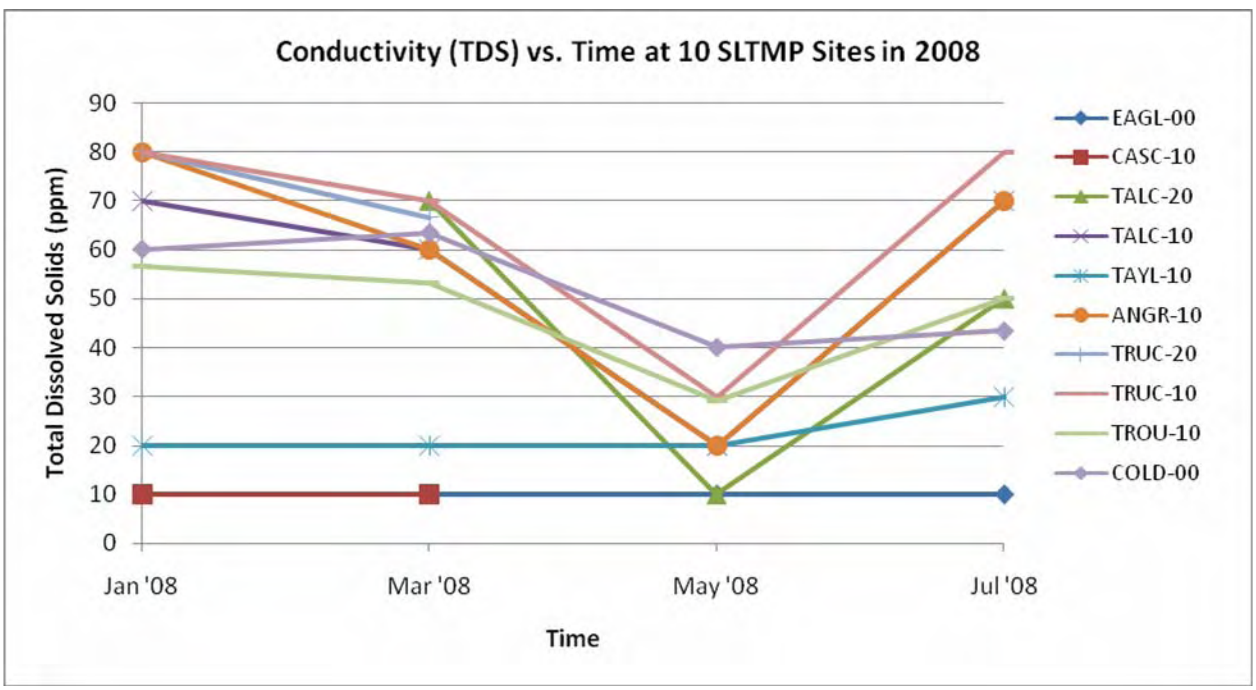


Figure 5.8 – Variation in Conductivity over Time at 10 SLTMP Sites in 2008

The range of conductivity levels at 10 sites as measured in parts per million (ppm) of total dissolved solids (TDS) is shown in figure 5.7. The standards set by the Basin Plan are expressed as an annual mean of total dissolved solids.[xxi] Due to varying geologic conditions in the watershed of each creek, there are different standards for different water bodies as indicated by the red-dashed lines in the box plot. The "X" represents the annual mean of the conductivity data that the SLTMP collected at each site. These values were compared to the standard values which are also expressed as an annual mean. According to figure 5.7, both Upper Truckee River sites (TRUC-20 and TRUC-10) exceed the standard.

It should be noted that the low number of samples, as indicated in parentheses on the x-axis, limits the reliability of the SLTMP annual means. Furthermore, some sites, such as CASC-10 and TRUC-20, were monitored as few as two times for conductivity. Regardless, the 4 monitoring months chosen for the project creates a reasonably representative cross-section of stream conditions for a typical water year in South Lake Tahoe with respect to water temperature, flow, and other seasonally variable conditions.

The relationship between time and conductivity can be observed in figure 5.8. The majority of sites followed a pattern of steady decrease from January through May monitoring days with steady increase between the May and July monitoring days. When compared to the USGS hydrographs in section IV.1, there appears to be an inverse correlation between conductivity and discharge. Specifically, conductivity decreases as discharge increases and vice versa. This correlation was expected and is likely the result of dilution from increased flow from spring snowmelt. However, some sites remained at a consistent TDS level throughout the monitoring season, including CASC-10, EAGL-00, and TAYL-10.

5. Turbidity

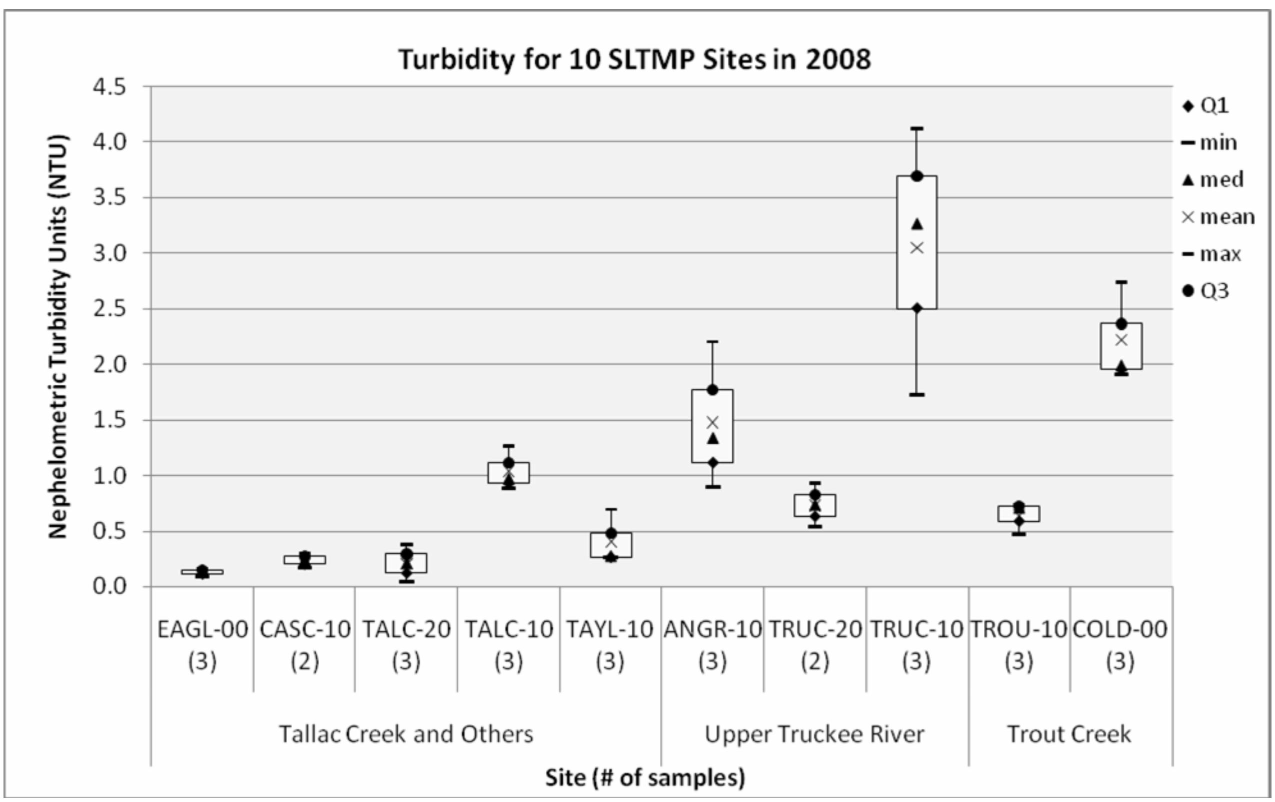


Figure 5.9 – Mean Turbidity Sample Results at 10 SLTMP Sites Monitored in 2008

The summary of statistics for turbidity values collected at 10 sites for 2008 is shown in figure 5.9. The unit of measurement, NTU, is a unit of light. The analysis involves injecting light through a standard sample size using a turbidity meter. Therefore, anything in a sample that absorbs or refracts light will cause turbidity readings to increase. In the South Lake Tahoe region, the typical sources of turbidity include suspended sediment and algae.

The lower Upper Truckee River site (TRUC-10) consistently had higher levels of turbidity compared to the other 9 sites. This could be a result of the site's location downstream from Hwy. 50. Continued monitoring may help determine the potential influence of the highway on this stream site. Another site, COLD-00, showed unexpectedly high turbidity measurements, which is possibly due to a maintained beaver dam downstream from the monitoring site. The lowest readings occurred at the upper Tallac Creek site (TALC-20), Cascade Creek (CASC-10), and Eagle Creek (EAGL-00).

6. Bacteria

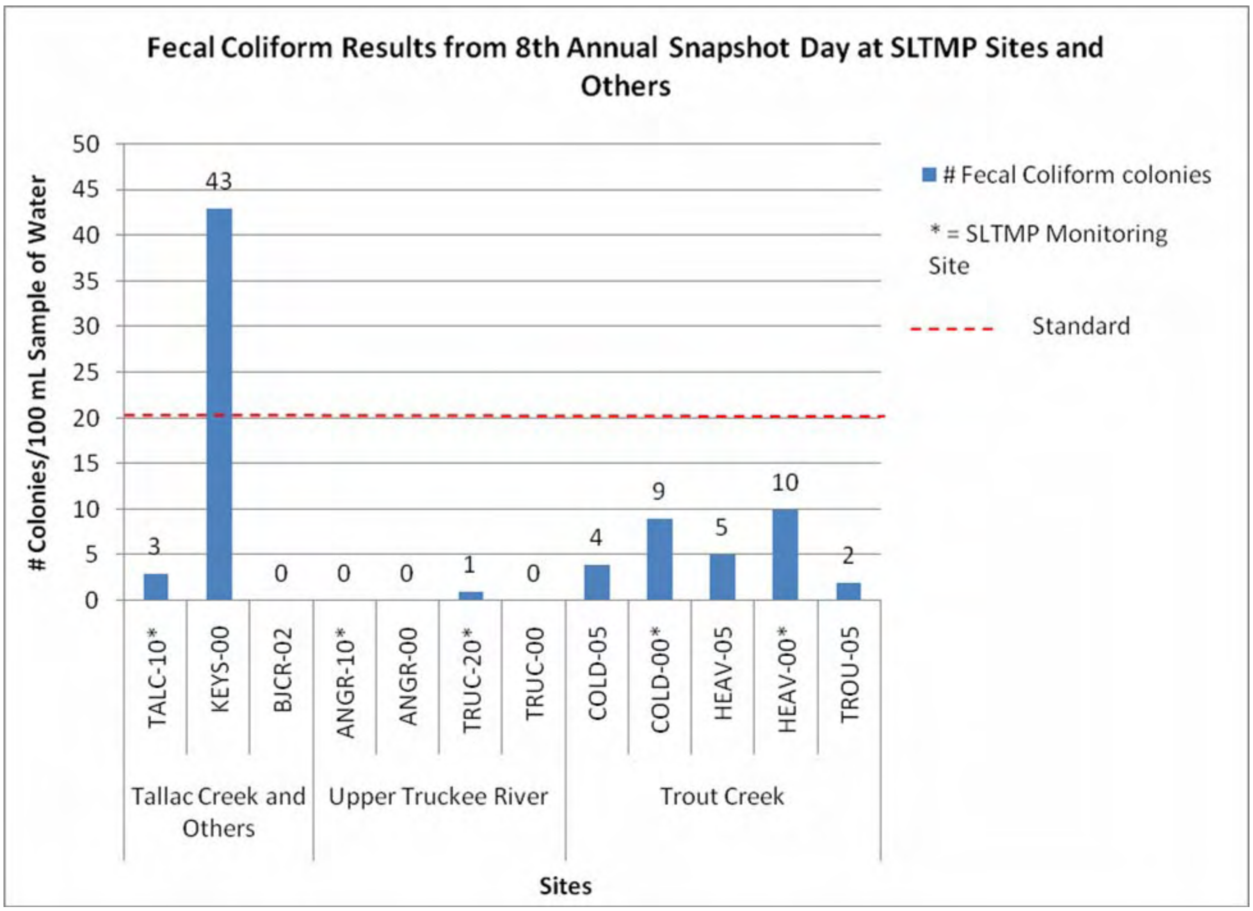


Figure 5.10 – Fecal Coliform Results for 5 SLTMP sites and 7 Additional Snapshot Day Sites from Samples Collected During the 8th Annual Snapshot Day on Saturday May 10, 2008

Table 5 – 8th Annual Snapshot Day Sites Monitored for Fecal Coliform

Site	Description

KEYS-00	This Lake Tahoe site is located in the Tahoe Keys lagoon area on the homeowners' side.
BJCR-02	This Bijou Creek site is downstream of the municipal golf course near Glenwood Way
ANGR-00	This Angora Creek site is just upstream of the confluence with the Upper Truckee River at Lake Tahoe Golf Course in Meyers, CA.
TRUC-00	This Upper Truckee River site is just upstream of the mouth in the Upper Truckee Marsh
COLD-05	This Cold Creek site is located upstream from SLTMP COLD-00 site near Pioneer Trail.
HEAV-05	This Heavenly Creek site is located where Pioneer Trail crosses Heavenly Creek upstream of the confluence with Trout Creek
TROU-05	This Trout Creek Site is located in the Upper Truckee Marsh near the dead end of Bellevue Ave.

The fecal coliform results from samples taken during Snapshot Day on May 10, 2008 are shown in figure 5.10. The sites in the figure with an asterisk are SLTMP sites. Sites without an asterisk are additional 8th Annual Snapshot Day specific sites and are described in table 5. The red-dashed line indicates the standard of 20 fecal coliform colony counts/100 mL of water as set by the Basin Plan.[xxii] All sites were below the standard for fecal coliform with the exception of KEYS-00. This Lake Tahoe site, located in the Tahoe Keys lagoon area, had excessively high fecal coliform counts. This is possibly a result of standing water in the lagoon, dog waste, and the large number of geese in the area, which reside in the Tahoe Keys neighborhood during the summer months and graze on grass lawns and Eurasian milfoil, an aquatic invasive plant thriving in the Keys lagoon. The average adult Canada Goose produces approximately 1½ lbs. of droppings a day and is a documented influence on water quality.[xxiii]

V. Conclusions and Next Steps

The South Tahoe Monitoring Project conducted its first field season in 2008. The data collected in this first year is baseline data, which will be used for comparison in future years of the project. The project plans to continue monitoring the same chemical and physical parameters in 2009. Some relationships observed in 2008 will be watched in 2009.

A. Data Conclusions

- <u>Stream discharge</u>
  The 2008 water year demonstrated abnormal flow patterns as a result of abnormal precipitation patterns, specifically a dry winter. Dissolved oxygen saturation and turbidity demonstrated a direct correlation with discharge, while conductivity demonstrated and inverse correlation with discharge. These relationships will continue to be observed in 2009.

- <u>Water Temperature</u>
  Water temperatures fluctuated greatly during the monitoring field season. Temperatures stayed within the range for the native Lahontan cutthroat trout. However, water temperatures

could have continued to increase after the July monitoring day. The 2009 field season will include monitoring in September, which will help assess low flow stream characteristics.

- pH
  pH levels remained within the standard range set by the Basin Plan at all SLTMP sites.

- Dissolved Oxygen
  Dissolved oxygen field measurements varied widely through the monitoring season as a result of variation in water temperature, topography, and discharge. TRUC-10 at Hwy. 50 and COLD-00 at the mouth of the Upper Truckee River demonstrated lower mean DO concentrations. COLD-00 and TRUC-10 also showed sharp decreases in DO saturation on the July monitoring day from the May monitoring day. Since this is only baseline data, no conclusions can be made, but these relationships will be observed in future years of the project.

- Conductivity
  Although most creeks remained within their prescribed standards, both Upper Truckee River sites exceeded the standard set by the Basin Plan. However, these data are limited in their reliability since an annual mean cannot be accurately constructed from so few data points. Additional data from future years of the project will produce a more robust mean estimate. Conductivity also appeared to show an inverse correlation with discharge.
- Turbidity
  TRUC-10, ANGR-10, and COLD-00 demonstrated the highest sample means of the 10 sites included in this report. TRUC-10 levels were well above all other sites. No conclusions can be drawn from this preliminary data, but these relationships will be monitored in future years of the project.

- Bacteria
  Fecal coliform samples collected on May 10, 2008 at SLTMP sites were within the standard set by the Basin Plan. KEYS-00, on the homeowners' side of the Tahoe Keys lagoon area, was substantially high.

B. Next steps for SLTMP include;

- Recruitment and training of more volunteers for field season 2009
- Posting data on the Tahoe Integrated Information Management System (www.tiims.org) website
- Observing trends in water quality data established in 2008 and tracking land use and watershed events that may impact water quality
- Expansion of bacteria, nutrient, and sediment analysis depending on the need and available funding
- Continued inter-agency collaboration and coordination with the 9th Annual Snapshot Day.

Acknowledgements: Thank you to SLTMP Technical Advisory Committee members, Tim Rowe, Carrie Monohan, Dan Sussman, and Sierra Nevada Alliance staff who helped prepare and review this report.

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