Truckee River Watershed Council

Annual Monitoring Data Report

Submitted to Sierra Nevada Alliance

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1.0 INTRODUCTION

The Adopt a Stream Program of the Truckee River Watershed Council is a volunteer based water quality monitoring program. The program began in 1999 and has expanded through the present day. The purpose of this report is to report water quality data for the Truckee River watershed, outline the monitoring objectives for the monitoring program, and relate data back to those monitoring objectives.

The Truckee River Watershed

The watershed area covered under the Adopt a Stream program is the Middle Truckee River. This includes all drainages to the Truckee River, from below the dam at Lake Tahoe to the California/Nevada state line. The watershed includes 26 major sub-basins (or sub-watersheds) and covers an area of 435 square miles. A map of the watershed, including monitoring locations, is included as Figure 1.

The Truckee River watershed has a 170-year history of significant human disturbance. Timber harvests (including multiple clear cuts) began early to support silver mining and the transcontinental railroad; railroad construction and operation were (and still are) the source of many watershed problems; the native trout species (Lahontan cutthroat trout) was fished to extinction as a food source for California expansion by 1930; gravel mining to support large scale road construction including Interstate 80 have left behind degraded areas; and the largest subdivision in the United States – Tahoe Donner - was built in the 1960s and 1970s before stormwater and erosion regulation. A series of dams in the Truckee River system were established for water supply and flood control.

More recent impacts of concern in the Truckee River watershed include extensive construction particularly in the Town of Truckee and Martis Valley. Although construction has slowed in the past few years, development continues. Ski resorts are expanding to year-round resorts with an increase in golf course use and residential development. Additionally, the flow regime in the Truckee River may see significant changes as the Truckee River Operating Agreement is implemented.

The Truckee River and three tributaries (Bronco Creek, Gray Creek, and Squaw Creek) are listed as impaired for excessive sediment under the Clean Water Act. The primary pollutant of concern in the watershed is excessive sediment. Sediment sources include road and highway salting and sanding, construction, ski runs, and natural sediment sources including landslides and debris flows.

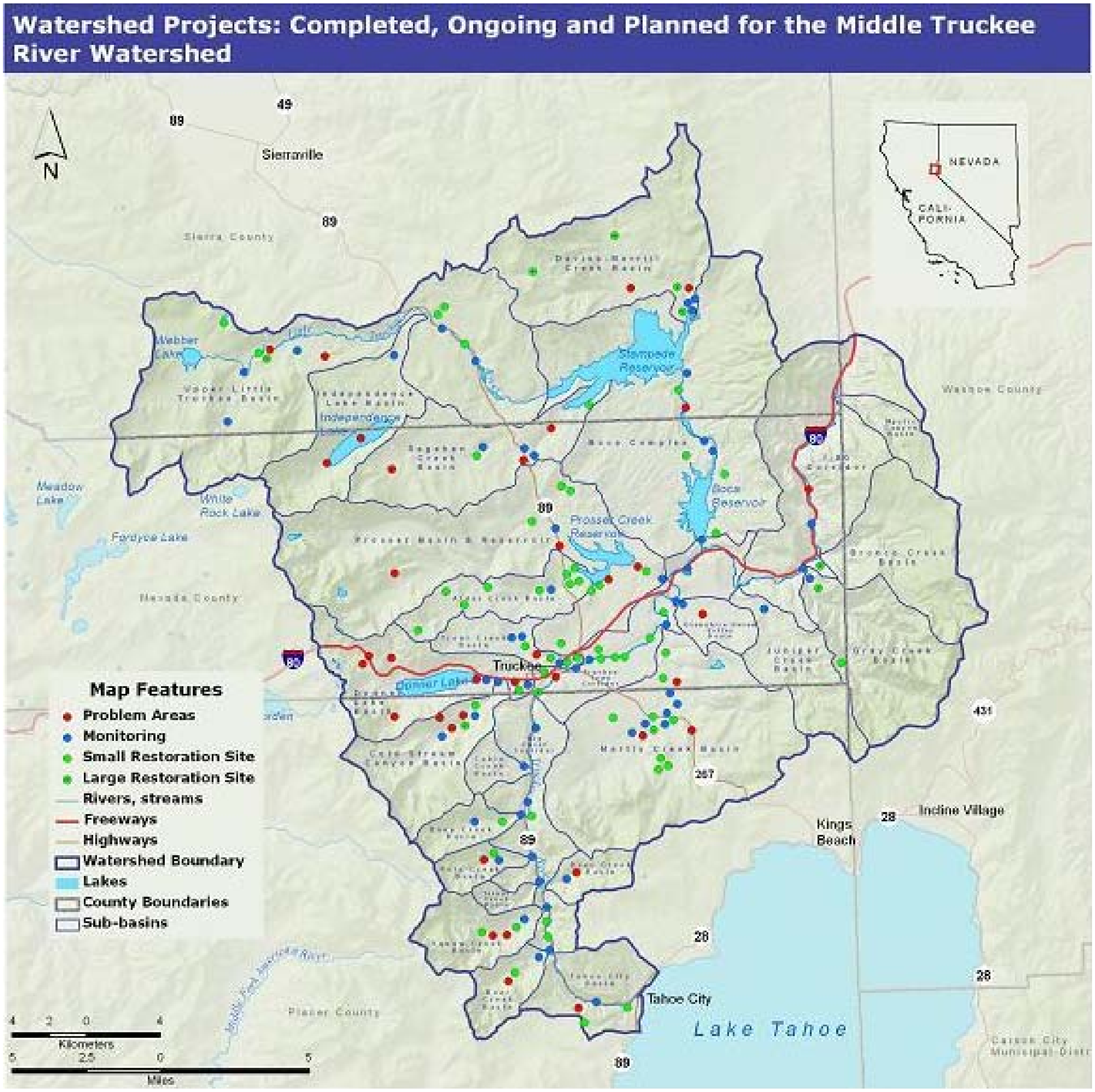

Figure 1. Middle Truckee River watershed with major stream sub-basins outlined. Monitoring locations are indicated by blue dots. Map created by Digital Mapping Solutions.

Monitoring goals and objectives

The primary goals of the Adopt a Stream program are:

- To assess the condition of the Truckee River ecosystem.
- To screen for water quality problems typically associated with common land use practices in the Truckee River watershed.

- To empower citizens to be responsible stewards and decision-makers.
- To support the Truckee River sediment TMDL monitoring program.
- To support the Biological Resources Monitoring Plan for the Truckee River Operating Agreement (TROA)

The Adopt a Stream (AS) program is designed to supplement existing agency monitoring efforts in the Truckee River watershed. The focus of AS is on measuring chemical, habitat and biological parameters in order to assess land use impacts on water quality and watershed health.

The primary objectives of AS are:

1. To better understand and document the relationship between water quality, hydrologic function, river system management, and land use.
2. To identify land use practices that negatively impact the Truckee River watershed, the extent of impact, and the geographic locations of concern.
3. To engage and educate residents about local watershed processes and strengthen their understanding of watershed stewardship.
4. To enhance the quality and quantity of data available for resource managers and decision makers in the Truckee River watershed.
5. To provide data that can be used to help monitor the implementation of the Truckee River sediment Total Maximum Daily Load (TMDL).
6. To collect data to help provide pre-Truckee River Operating Agreement (TROA) implementation data, and to establish a program that will help to track changes in the condition of biological resources in the Truckee River watershed once TROA is implemented.

Funding Sources

Funding for Adopt a Stream has come from a variety of sources including the Sierra Nevada Alliance, Department of Water Resources, Lahontan Regional Water Quality Control Board, and the Truckee Tahoe Trout Fund of the Tahoe Truckee Community Foundation.

Program Description

The Truckee River Watershed Council (TRWC) has conducted water quality monitoring since 1999. Parameters monitored, timing, and frequency have all changed over the years as the monitoring program has matured. All monitoring activities are contained under the umbrella of “Adopt a Stream”; however there are three primary components to the monitoring program:

1. Snapshot Day. This program has existed since 2001 and is a one-day watershed wide (Lake Tahoe and Truckee River) monitoring event. Basic physical and chemical parameters are measured. The focus

of Snapshot Day is to cover as much geographic area as possible in order to capture a “snapshot” in time of water quality for the entire Truckee River watershed. Several different groups are involved in Snapshot Day; TRWC manages the event for the Middle Truckee River watershed. Snapshot Day takes place in the spring of each year during snowmelt run-off (high flow).

2. Adopt a Stream – Stream Teams. Regular monitoring of basic physical and chemical parameters began in 2007. Volunteer teams have adopted 14 streams in the Truckee River watershed and monitor them four times per year (including Snapshot Day).

3. Truckee River Aquatic Monitors (TRAM). This group has collected bioassessment and basic habitat data since 1999. Approximately five streams are monitored each year, with a different selection of streams monitored each year. Streams are only monitored once in any given year.

This report will include data from all three components of Adopt a Stream.

2.0 FIELD AND LAB METHODS

Monitoring locations and parameters monitored can be found in Table 1 for physical and chemical monitoring and Table 2 for bioassessment sites.

Physical and chemical monitoring includes measurement of water temperature, dissolved oxygen, pH, electrical conductivity, and turbidity. On Snapshot Day, grab samples are also collected and sent to a laboratory for nutrient and coliform analysis. Bioassessment monitoring includes collection of benthic macroinvertebrates following the State Water Resources Control Board 2007 SWAMP protocol (Ode, 2007). Prior to 2007, the California State Bioassessment Protocol was followed (Harrington and Born, 1999).

Table 1. Sites monitored for basic physical and chemical parameters (temperature, electrical conductivity, dissolved oxygen, pH, and turbidity). Each year, some of these sites are tested for nutrients and/or coliform bacteria. All sites listed here are monitored on Snapshot Day (spring runoff); the Stream Team Sites are also monitored at other times of year.

Site ID	**Site Name**
Stream Team Sites - including Snapshot Day	
MTR-ALDR	Alder Creek
MTR-BEAR-00	Bear Creek
MTR-BOCA-01	Little Truckee at Boyington Mill
MTR-COLD-00	Cold Creek
MTR-DONN-01	Donner Creek at Hwy 89
MTR-EMAR	East Martis Creek at bridge
MTR-GLEN-00	Union Creek below Glenshire
MTR-JUNI	Juniper Creek at Iceland road
MTR-MART-00	Martis near mouth
MTR-PROS-01	Prosser Creek below dam
MTR-PROS-02	Prosser Creek
MTR-SAGE-00	Sagehen Creek at Highway 89
MTR-SQCR-00	Squaw Creek
MTR-TROU-00	Trout Creek near Mouth
Snapshot Day Only Sites	
MTR-BIGC	Truckee River in Big Chief Corridor
MTR-BOCA-00	Little Truckee Below Boca Dam
MTR-BOCA-02	Worn Mill Creek
MTR-CABN	Cabin Creek subbasin
MTR-DEEP	Deep Creek
MTR-DMCB	Davies Creek
MTR-DONN-03	Donner Creek 3
MTR-GRAY	Gray Creek
MTR-I80C	Truckee River in I-80 Corridor-Floriston
MTR-INDE	Independence Creek
MTR-MART-01	Martis at COE boundary
MTR-POLE-00	Pole Creek
MTR-SAGE-02	Sagehen Creek at Field Station
MTR-SILV	Silver Creek
MTR-TOWN	Truckee River in Town Corridor
MTR-TR01	Truckee River near Tahoe City
MTR-TROU-01	Trout Creek in Town
MTR-TROU-02	Trout Creek in Tahoe Donner
MTR-ULTB	Upper Little Truckee

Table 2. Bioassessment monitoring locations including years monitored.

Stream	Location	Years Monitored
Bear Creek	Near confluence with Truckee River	2002, 2003, 2004, 2006, 2009
Cold Creek - lower	Just above confluence with Donner Creek	2008, 2010, 2011
Cold Creek - upper	Near horseshoe bend in railroad	2000
Cold Stream	0.5 mile upstream of confluence with Little Truckee River	2002
Davies Creek	Just below confluence with Merrill Creek	2003, 2005, 2006, 2008, 2010, 2011
Deep Creek	1.75 miles from confluence with Truckee River	2005
Deer Creek	About 1 mile upstream of confluence with Truckee River	2004
Donner Creek	Immediately downstream of Highway 89	2005, 2008
East Martis Creek	At bridge on Waddle Ranch	2003, 2008
Gray Creek	Near mouth	2001, 2002, 2005, 2006
Independence Creek	Below road crossing, near campground	2007
Independence Creek - lower	On Ranz Property in Meadow	2009
Independence Creek tributary	About 2.5 miles downstream of lake, 1.3 miles upstream of confluence with Little Truckee (at road crossing)	1999, 2001
Juniper Creek	About 1.3 miles upstream of confluence with Truckee River	2004
Little Truckee River	Along highway 89, approximately 0.6 miles downstream of turnoff to Kyburz Flat	1999, 2011
Little Truckee River	Between Boca and Stampede – downstream of USGS gage	2006, 2007
Little Truckee River – Lower Perazzo	In Lower Perazzo Meadow, downstream most reach	2010, 2011
Little Truckee River – Perazzo Meadows	In Middle meadow restoration site near old road	2009
Lower Martis Creek	Near confluence with Truckee River	2006
Martis Creek - Main	In Wildlife Area (upstream of Hwy 267)	2001, 2002, 2003, 2004, 2005, 2007
Martis Creek – Main	Main branch, downstream of highway 267	2000
Martis Creek – West	Below golf course, on USACE land	2003
Upper Perazzo Creek	About 1.5 miles upstream of confluence with Little Truckee River	2003
Perazzo Creek	Near confluence with Little Truckee River	2005, 2008, 2009
Pole Creek	About 1.4 miles upstream of confluence with Truckee River	2004
Prosser Creek	Below the dam – just upstream of I-80	2003, 2007, 2008

Sagehen Creek	Downstream of highway 89	1999, 2000, 2010
Sagehen Creek	Just downstream of the field station	2004, 2006, 2007
Silver Creek	Approximately 0.1 miles upstream of Highway 89	2011
Squaw Creek	Lower end of Squaw Meadow	2002, 2003, 2007
Trout Creek	At Bennett Flat	2003
Trout Creek	At mouth	2000, 2003, 2007
Truckee River at Granite Flat	Granite Flat Campground	2001, 2004
Truckee River at Horseshoe Bend	Near Hirschdale	2001, 2004

Table 3. Field methods used for each parameter. Analysis location refers to whether the measurement is taken in the field ("Field") or collected and analyzed later ("grab sample").

Parameter	Method	Analysis location
Dissolved Oxygen	Winkler Titration method, Chemet, or YSI meter	Field
pH	Meter or pH strips	Field
Conductivity	Hand held conductivity meter	Field
Turbidity	Turbidity Meter – kept in office	Grab sample
Temperature	Thermometer (-5 to 50 °C)	Field
Nutrients	NH_3-N, NO_3 & NO_2-N, SRP, TP	Grab sample
Coliform	Colony forming units/100 mL	Grab sample
Benthic Macroinvertebrates	2007 SWAMP protocol	Grab sample

Nutrient samples are analyzed by High Sierra Water Lab, located in Truckee, and coliform samples are analyzed by the U.S. Geologic Survey in Carnelian Bay.

Benthic macroinvertebrate samples are collected by volunteers and are processed one of two ways. TRWC volunteers identify the samples from about 2 streams per year and the remainder is sent out for professional identification, typically to the California Department of Fish and Game Aquatic Bioassessment Laboratory. Samples identified by volunteers are only identified to family level, whereas the professionally processed samples are identified to SAFIT Level II (species or genus; Richards and Rogers 2011). This varying level of taxonomic resolution affects several metrics; therefore data from volunteer- and professionally-identified samples are presented separately where appropriate. Prior to the adoption of the 2007 SWAMP protocol, the number of organisms in a subsample from each stream varied as well. Volunteers counted out and identified 300 organisms from each stream and professional labs counted out and identified 900 organisms. The number of organisms present also skews some metrics.

In 2009 an Index of Biological Integrity (IBI) was published for the Eastern Sierra (Herbst and Silldorff, 2009). An IBI gives each stream a "score" based on the species diversity found in a sample. IBIs are derived from multiple taxonomic metrics. The IBI is designed to use 500 count data (the current 2007 SWAMP standard), and requires genus or species level identification. Therefore, IBI scores can be easily calculated for a subset of TRAM collected data from 2008 forward. Data analyzed by professional laboratories prior to 2008 used a 900 count standard. These data can be subsampled down to 500 count, however this time consuming analysis has not been completed for our data yet. Simply plugging the 900 count data into the IBI will skew richness metrics and yield a higher IBI score.

3.0 RESULTS AND ANALYSIS

The following parameters were monitored.

1.) Temperature: To identify areas of concern for thermal pollution.

2.) Dissolved Oxygen: To determine health of aquatic ecosystem. Dissolved oxygen availability affects photosynthesis, and the metabolic rates of organisms and their sensitivity to toxic wastes, parasites, and diseases in addition to their distribution. Also used to identify areas of concern for hypoxia/anoxia.

3.) Conductivity: To determine potential sources of dissolved solids or salts. High conductivity indicates impaired water quality. Common anthropogenic sources in the Truckee River watershed include road salt and sand.

4.) pH: To determine if a stream will support aquatic life. pH can be affected by many types of sources, both natural and anthropogenic and indicates whether water is acidic or basic.

5.) Turbidity: To identify areas of increased erosion. Turbidity is an indicator of the amount of suspended particles in the water.

6.) Nutrients: Nitrogen and phosphorus are used to identify sources of nutrient loading. Excess nutrients, particularly phosphorus, can lead to algal blooms and eventual anoxic conditions.

7.) Benthic Macroinvertebrates: To determine the ability of the water body to support aquatic communities. Different types of benthic macroinvertebrates respond differently to pollution in aquatic ecosystems. By sampling the stream community directly, it is possible to determine water quality.

The purpose of the Status and Trends section of this report is to present monitoring results for all sites to give an overview of the water quality in the Middle Truckee River watershed. Data are grouped by high flow and low flow results. Stream flow has a strong effect on several parameters, as discussed below. Many sites only are monitored during Snapshot Day in May, when flows are high (with some exceptions in dam controlled tributaries). Therefore, many sites only have data from high flow events and high flow and low flow data are presented separately.

The second part of the Results and Analysis section will focus on relating data back to the Monitoring Plan objectives.

Status and Trends

Box plots of ambient monitoring parameters can be found in Figures 2-6. These plots show the range of variability and central tendency for the standard parameters of water temperature, electrical conductivity, dissolved oxygen concentration, and pH. Average value is indicated by the “X” symbol. The graphed points correspond to (from highest to lowest) maximum observed value, 3rd quartile value, mean (X), median, 1st quartile value, and minimum observed value.

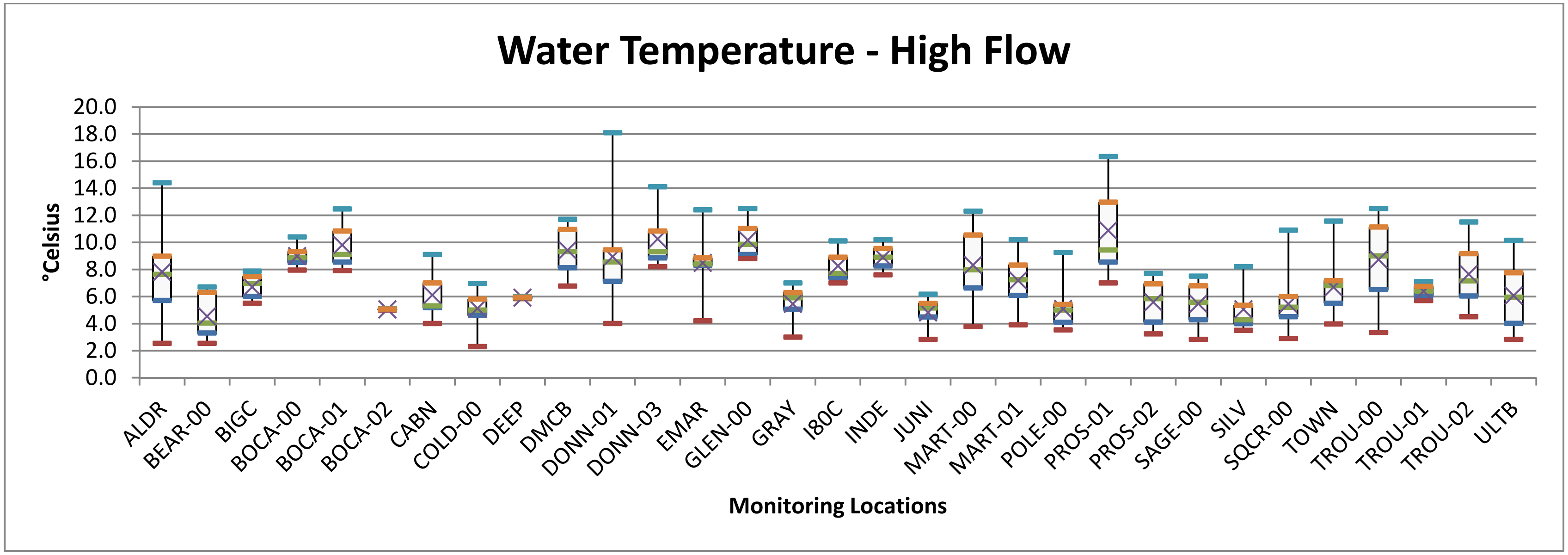

Figure 2a. Water Temperature measured during high flows for all locations.

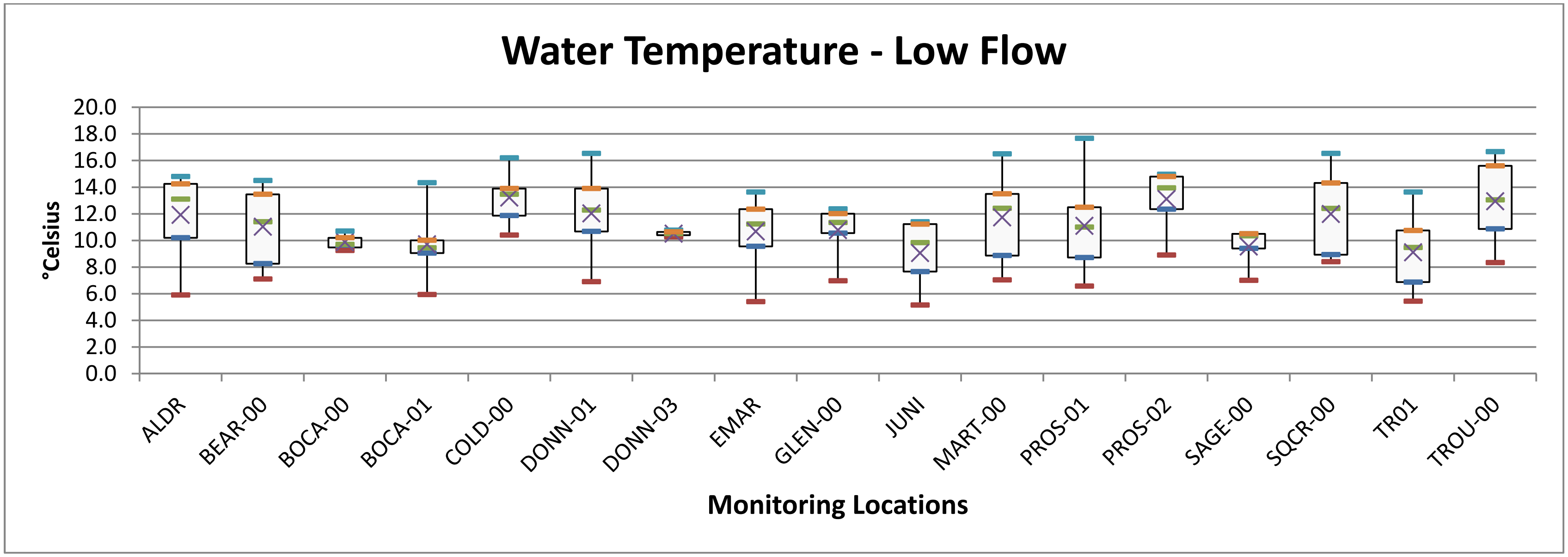

Figure 2b. Water temperature measured during low flows for sites measured quarterly and some dam-controlled sites.

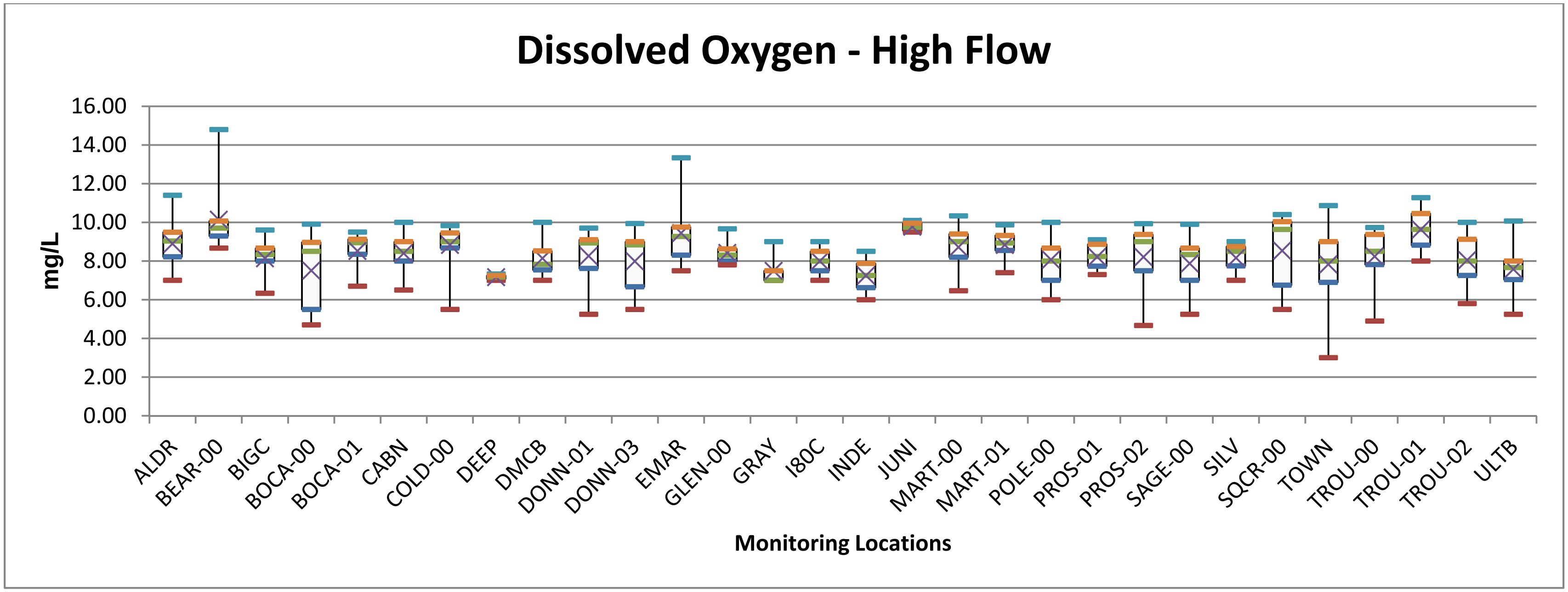

Figure 3a. Dissolved oxygen measured during high flows for all locations.

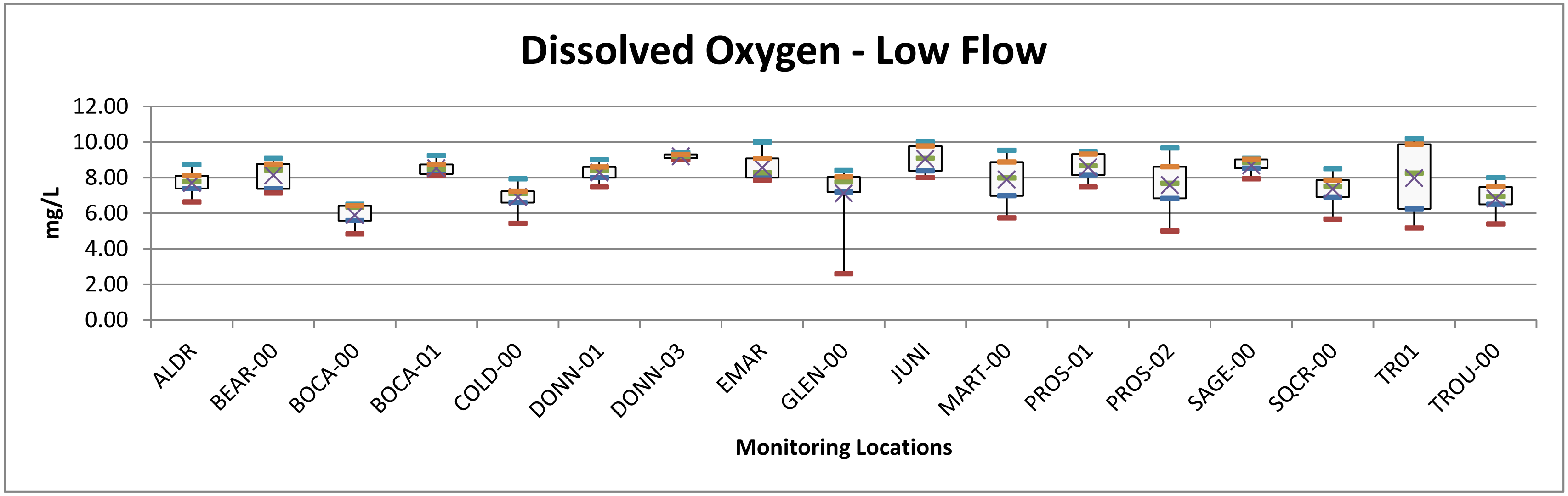

Figure 3b. Dissolved oxygen measured during low flows for sites measured quarterly and some dam-controlled sites

Water Temperature Results

Figures 2a and 2b show water temperature data, separated by flow levels. In unregulated tributaries, high flow corresponds to early season monitoring (May and June) and low flow corresponds to late season monitoring (July, August, and September). Dam regulated tributaries often follow the same pattern, but not always. In the case of dam-regulated tributaries, USGS-reported flow rates for the monitoring date are used to classify the data into high and low flow categories. In general, water temperature is higher during low flow and lower during high flows. There is less variation in the data for low flow events; this is partially due to the fact that the low flow data set is smaller than the high flow data set.

Generally speaking, water temperatures in the Middle Truckee River watershed are capable of supporting aquatic life (Figures 2a, 2b, Table 4).

Table 4. Temperature ranges required for rainbow trout *(Oncorhynchus mykiss)* survival and reproduction. These temperature ranges are representative of those required by most salmonids.

Species	**Growth**	**Maxima**	**Spawning***	**Embryo Survival****
Rainbow Trout	19°C (66 °F)	24°C (75 °F)	9°C (48 °F)	13°C (55 °F)

* The optimum or mean of the range of spawning temperatures reported for the species.

** The upper temperature for successful incubation and hatching reported for the species.
Adapted from EPA's Draft Volunteer Stream Monitoring: A Methods Manual.

Dissolved Oxygen Results

Figures 3a and 3b show dissolved oxygen concentration, separated by flow levels. Dissolved oxygen concentration is related to water temperature. Cold water holds more dissolved gasses; therefore dissolved oxygen is expected to be higher at lower water temperature. Comparing data site by site, dissolved oxygen concentration in the Middle Truckee River watershed is lower during the warmer times of year (low flow).

Cold, clean water usually has levels of dissolved oxygen averaging above 6.0 mg/L, and single-measurement levels below 5 mg/L are considered dangerous for cold water aquatic life. A few measurements below 5 mg/L have been recorded in the Middle Truckee River, but no site consistently reads low, except perhaps the Little Truckee River below Boca Dam (BOCA-00). Most of the low dissolved oxygen measurements have been taken with Chemet kits, which can be misinterpreted more easily than the Winkler titration. BOCA-00 has typically been monitored using a Chemet kit, but during low flow conditions there is typically little to no flow at this site – only a pool of standing water is present.

Dissolved oxygen levels just above 5.0 mg/L at Trout Creek have been recorded on a few occasions during low flow and with Winkler titration kits. In recent years, the beaver population upstream of the monitoring site has drastically increased. Because standing water is less oxygenated than flowing water, this may be affecting dissolved oxygen levels. Regular monitoring will continue at Trout Creek.

Electrical Conductivity Results

Figures 4a and 4b show electrical conductivity, separated by flow levels. Electrical conductivity is also sensitive to flows – at high flows, the charged particles that make up conductivity are diluted, and so measured conductivity should be lower. At low flows, the particles are more concentrated, and conductivity measurements will often be higher. Primary sources of charged particles in the Middle Truckee River watershed are road sands, road de-icers, and natural sources. Typically urban areas or sites adjacent to high traffic roads will show higher electrical conductivity readings (see Figures 20-21).

At high flow, electrical conductivity is primarily centered between 50-100 microsiemens/cm (µS/cm). During low flow, the distribution of measured values shifts to primarily above 100. This scale of variation is to be expected between flow levels because of concentration of ions in low flows. Trout Creek (TROU-00), East Martis Creek (EMAR), Gray Creek (GRAY), Squaw Creek (SQCR-00), and Union Valley Creek (GLEN-00) frequently have high conductivity measurements. Trout, Squaw, and Union Valley Creeks are all fairly urbanized watersheds. East Martis and Gray are undeveloped but both have a system of poorly developed historic logging roads and are in naturally erosive areas.

pH Results

pH is a ratio of ions and is therefore not strongly affected by flow. Therefore, all pH data were graphed together. Low pH indicates acidic water; high pH indicates basic water, with a measurement of 7 being neutral. In the Middle Truckee River watershed, pH is typically very consistent with measurements between 6 and 8 (Figure 5). Very low or very high pH measurements are dangerous for aquatic life. A pH value of 6-8 will support the widest range of biota. A few monitored streams have exhibited pH of 5 on at least one occasion, but the average pH measurements for most streams fall between 6 and 8.

Turbidity Results

Turbidity is highly related to flow. Turbidity is a measure of the amount of suspended particles in the water. Algae, suspended sediment, organic matter and some pollutants can all increase turbidity in water. Suspended particles diffuse sunlight and absorb heat, which can increase temperature and decrease light available for algal photosynthesis. Turbidity caused by suspended sediment can be an indicator of erosion. If sedimentation is extreme, fish and invertebrate populations can be affected. Because erosion is higher during high flows, spring runoff measurements will tend to be higher than during low flow.

In general, turbidity is fairly low in the Middle Truckee River watershed, with a few exceptions (Figures 6a, 6b, 6c). The most notable exception is Gray Creek (Fig. 6b). Gray Creek is a steep, volcanic watershed with naturally erosive soils (Northwest Hydraulic Consultants, 2006). The watershed was extensively burned in 2001 during the Martis Fire. Prior to that, the watershed had been logged, grazed, and a poorly developed road network was in place. Although Gray Creek has recovered to some extent from the Martis Fire, it is still a significant source of fine sediment.

Other tributaries that periodically demonstrate high turbidity levels are: Donner Creek at Highway 89 (DONN-01), Prosser Creek at Highway 89 (PROS-02), Squaw Creek (SQCR-00), Juniper Creek (JUNI), and Little Truckee River below Boca Dam (BOCA-00).

The monitoring location for Donner Creek at Highway 89 (DONN-01) is below the confluence with Cold Creek. Cold Creek is a known sediment producer, whereas Donner Creek drains Donner Lake, and would be expected to have low turbidity. However, our turbidity monitoring data do not show Cold Creek as being particularly high in turbidity. The reach of Donner Creek between the confluence of Cold Creek and Highway 89 has been highly manipulated and was channelized during the construction of Interstate 80. The creek through this reach is fairly erosive – so the elevated turbidity that we sometimes observe at this location may be coming from instream erosion from immediately upstream of the monitoring location.

The Prosser Creek watershed above the monitoring site is largely undeveloped, but is steep and has a substantial road network. In 2011, the Forest Service conducted an analysis of the dirt roads in Prosser Creek on their property, attempting to identify areas of potential erosion. Future work may help to reduce erosion from this watershed.

Squaw Creek is also 303(d) listed as impaired for excess sediment and has its own TMDL for sediment control. The watershed is naturally erosive and has been extensively disturbed through roads, development, and graded ski runs.

Juniper Creek also exhibits elevated turbidity relative to other area streams. Juniper Creek is adjacent to Gray Creek and was also partially affected by the Martis Fire. The underlying geology of Junioper Creek is similar to that of Gray Creek.

As mentioned above, the monitoring location for the Little Truckee River below Boca Dam (BOCA-00) can be extremely low flow. If no water is being released from the dam, the only water present is a stagnant pool. In measurements categorized as “low flow”, BOCA-00 has exhibited fairly high turbidity. The turbidity is likely due to algal growth in the still water. Trout Creek near the mouth (TROU-00) has also yielded high turbidity measurements during low flow conditions. Flow in Trout Creek at the monitoring location can be minimal during the summer months, so algae may contribute to the high turbidity measurements.

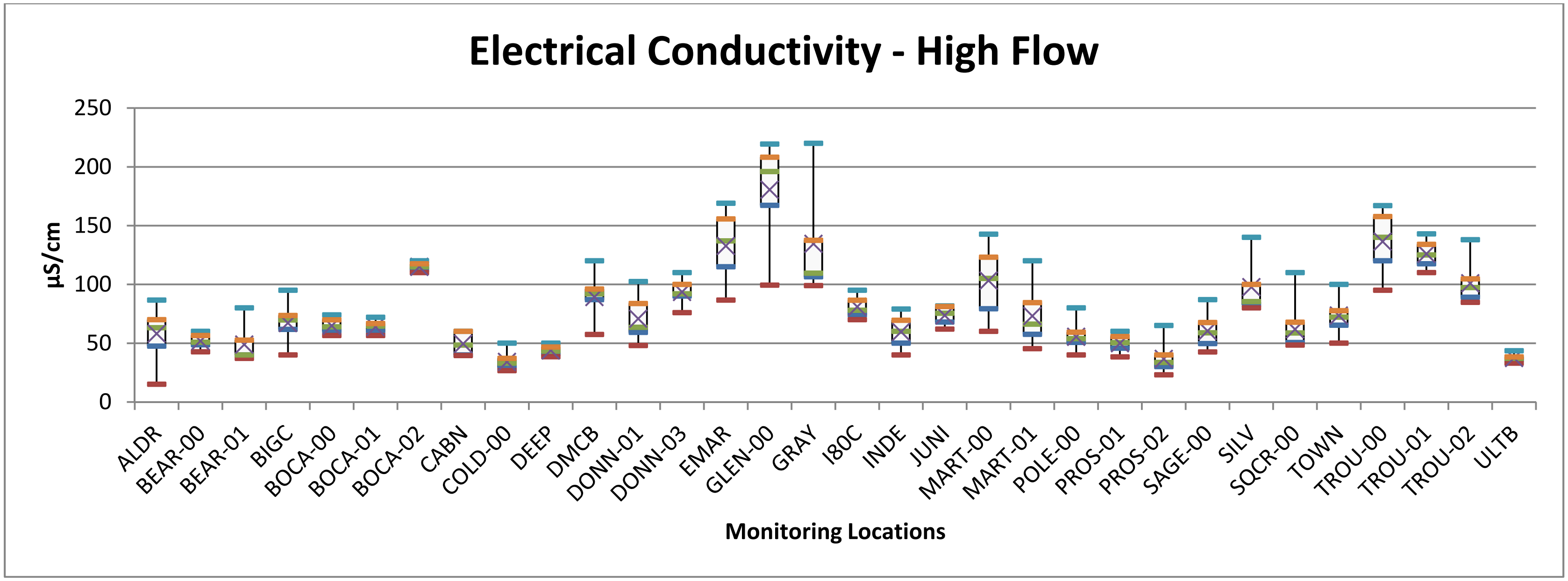

Figure 4a. Electrical conductivity measured during high flows.

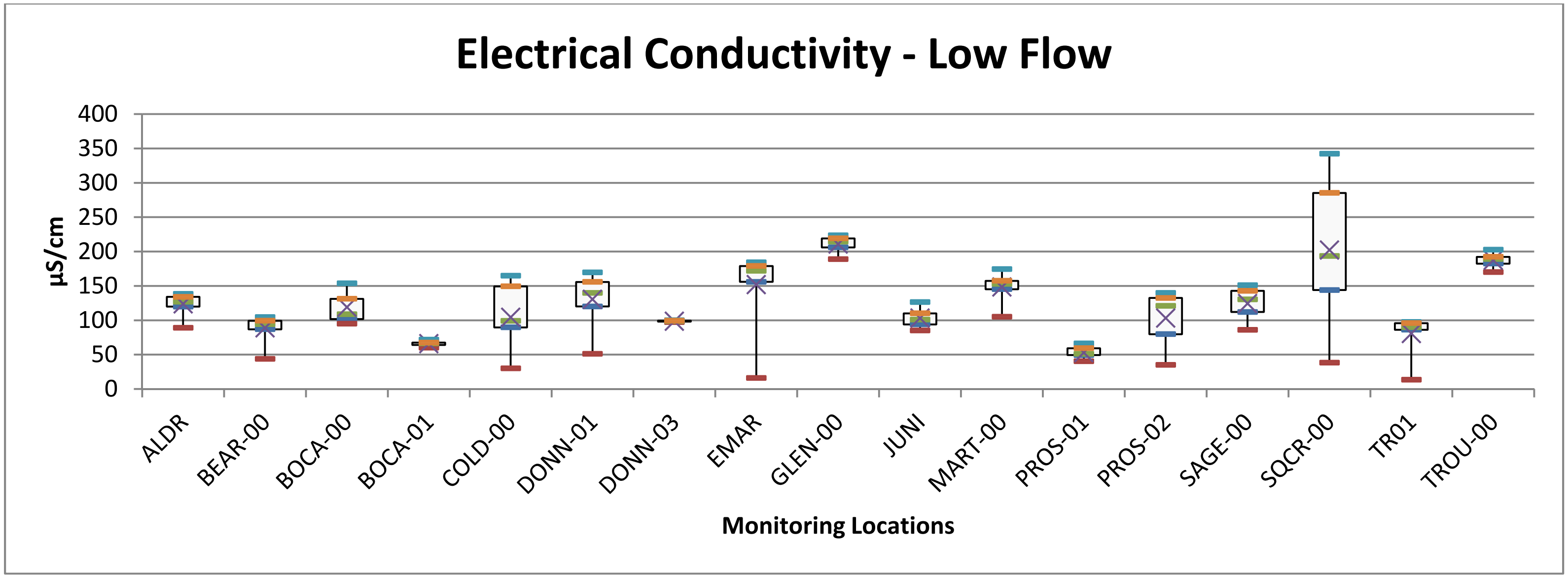

Figure 4b. Electrical conductivity measured during low flows.

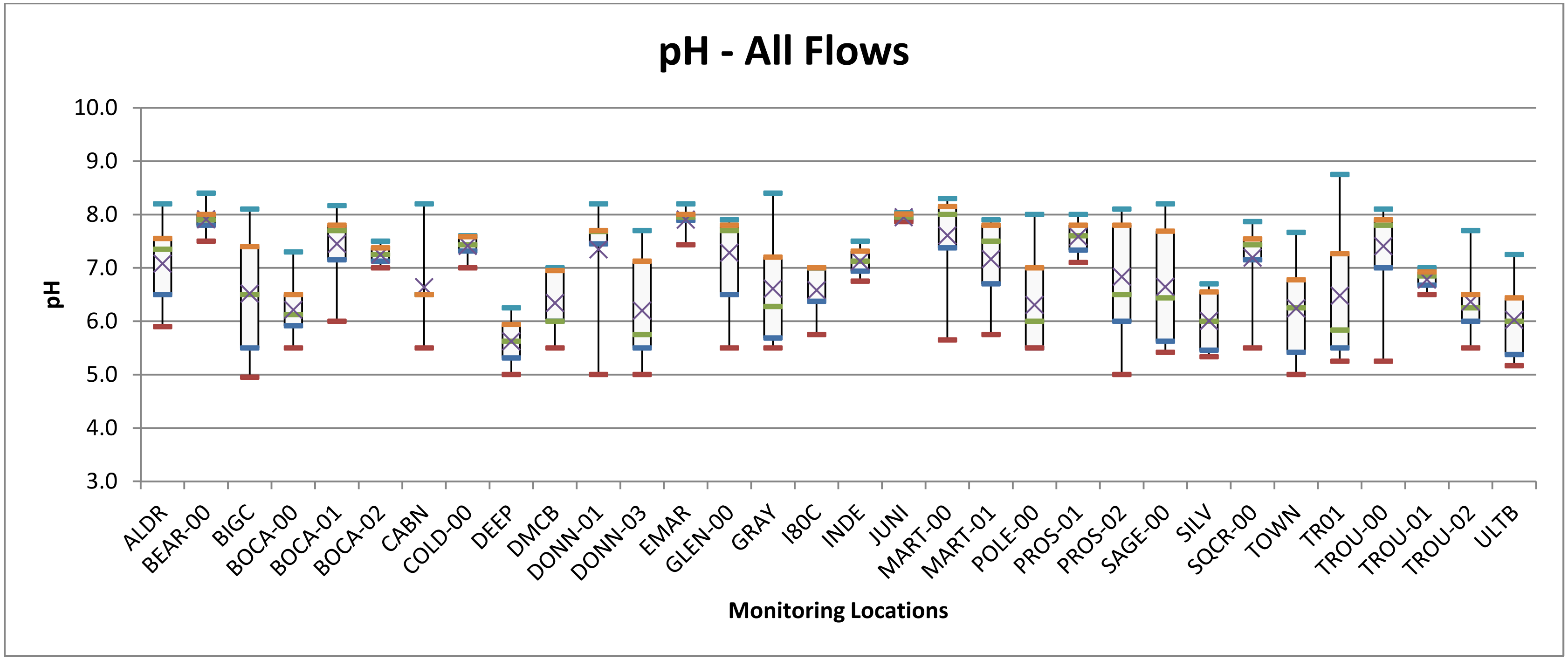

Figure 5. pH measurements. pH is not strongly affected by flows, therefore all data were graphed together.

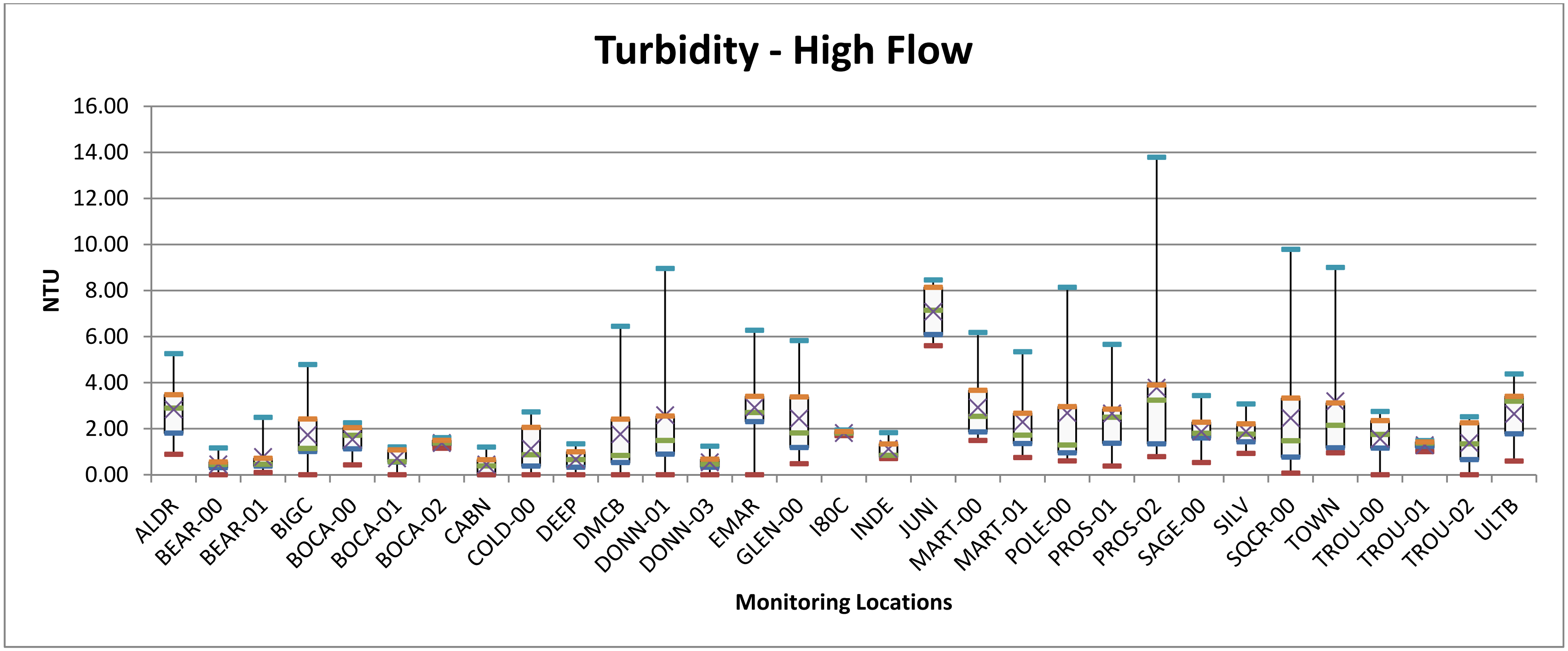

Figure 6a. Turbidity measured during high flow.

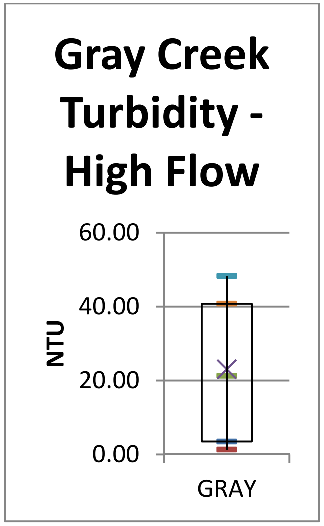

Figure 6b. Gray Creek turbidity. Note the scale, Gray Creek has much higher turbidity than other sites.

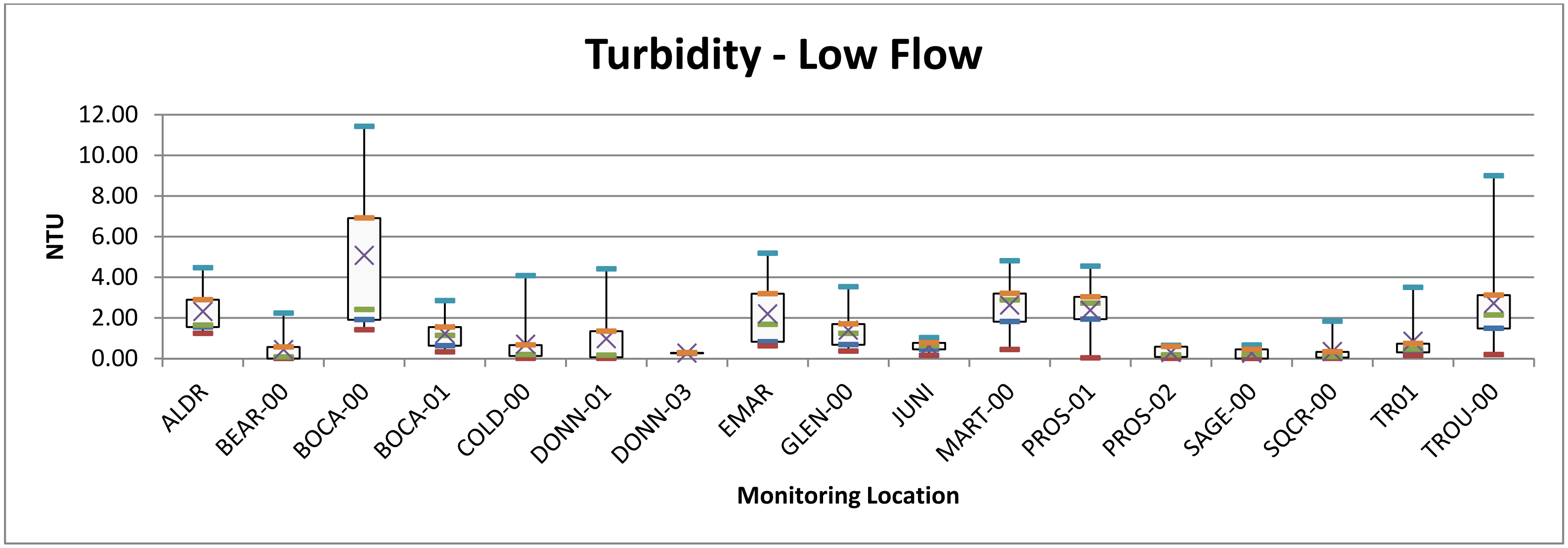

Figure 6c. Turbidity measured during low flow.

Nutrient Data

Each year, samples are taken from a subset of sites during spring run-off and analyzed for forms of nitrogen and phosphorus. Nitrogen and phosphorus are necessary to support aquatic life, however high concentrations of either of these nutrients lead to declines in water quality.

Nitrogen

Nitrogen occurs in several different forms: nitrate, nitrite, ammonia, and TKN or Total Kjeldahl Nitrogen. Until 2006, funding was not available to analyze samples for all forms of nitrogen; therefore we only have total nitrogen concentration data from 2006 forward.

Nitrate-Nitrite (NO3/NO2-N)

Nitrate stimulates algal growth, which in turn can lead to eutrophication in aquatic systems. The most common source of nitrate is runoff from fertilized areas such as lawns or other landscaped areas. Nitrate is also a byproduct of septic systems – it is a naturally occurring chemical left after the decomposition of human (and other animal) waste. In the Middle Truckee River watershed, Union Valley Creek (GLEN-00) stands out as having extremely high nitrate measurements (Figure 7b). Squaw Creek (SQCR-00) has also exhibited high nitrate levels, and to a lesser degree so have Alder Creek (ALDR), Bear Creek (BEAR), Martis Creek (upper site, MART-01), and the mainstem of the Truckee River in the Town of Truckee (TOWN) (Figure 7a).

Ammonia

Ammonia is a reduced, toxic form of nitrogen and is usually associated with the decomposition of organic matter and wastes. Total ammonia consists of the un-ionized (NH_3) plus the ionized (NH_4^+) forms. Ionized ammonia is relatively nontoxic while un-ionized ammonia is toxic to fishes and aquatic invertebrates, even in low concentrations. Generally ammonia is very low in the Truckee River watershed, as can be seen in Figure 8. As a point of comparison, the EPA Ammonia water quality criteria are expressed in mg/L or parts per million, our measurements are expressed in µg/L or parts per billion.

Total Nitrogen

Total nitrogen includes Nitrate-Nitrite, Ammonia, and Total Kjeldahl Nitrogen (TKN). TKN is the organic portion of nitrogen and is a more expensive analysis than nitrate or ammonia. However, many state standards are for total nitrogen, so since 2006, we have attempted to include analysis of TKN. Union Valley Creek (GLEN-00) has had very high total nitrogen during monitoring events. Other sites that have somewhat high total nitrogen levels include Alder Creek (ALDR), Little Truckee River below Boca Dam (BOCA-00), East Martis Creek (EMAR), Martis Creek (lower and upper, MART-00 and MART-01), Squaw Creek (SQCR-00), and Trout Creek (at mouth, TROU-00). Water quality standards are discussed later in this report.

Phosphorus

Phosphorus is also critical for stimulating algal growth in aquatic systems. Phosphorus is naturally present in the environment, in granitic and volcanic rocks. Anthropogenic sources include various soaps and detergents, fertilizers, and other household chemicals. Figure 10 shows results from 2001-2010, all measurements were taken during spring run-off. High phosphorus concentrations have been found at Union Valley Creek (GLEN-00), Martis Creek (MART-00 and MART-01) and sites along the mainstem Truckee River (BIGC, TOWN). See Figure 31 and associated text for discussion of phosphorus standards.

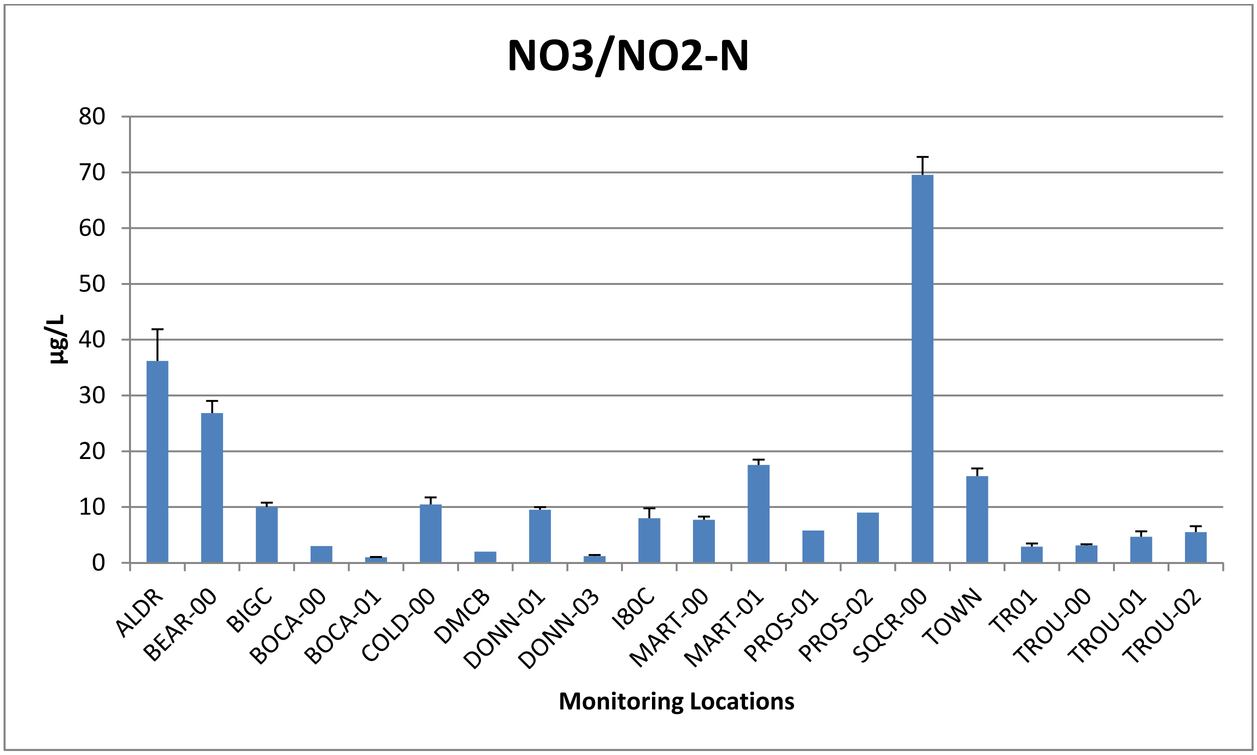

Figure 7a. Nitrate levels, data taken during May of each year. The bars represent the average value, the error bars show standard error.

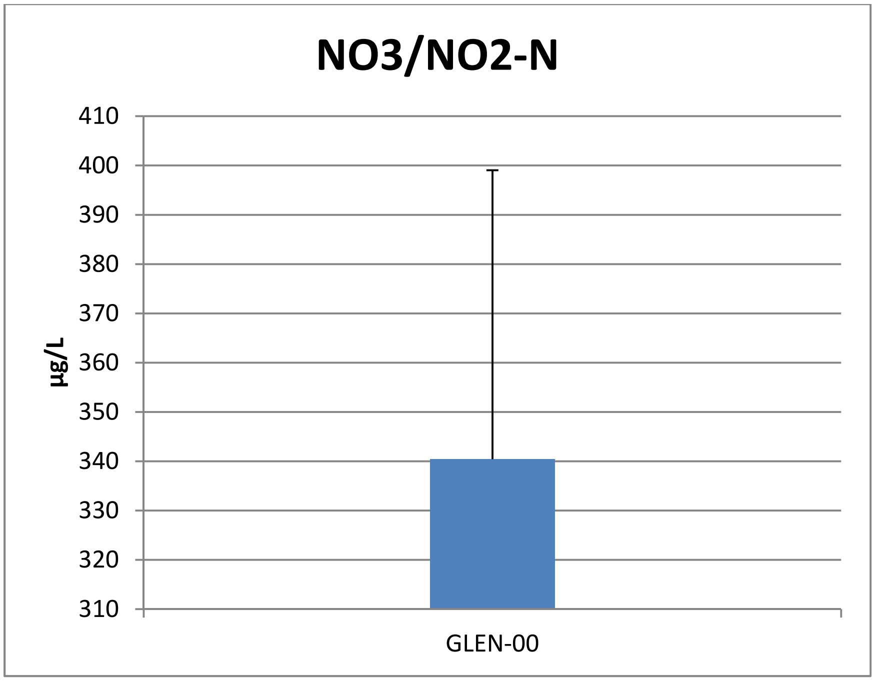

Figure 7b. Nitrate measurements for Union Valley Creek. The bar represents the average value, the error bar shows standard error.

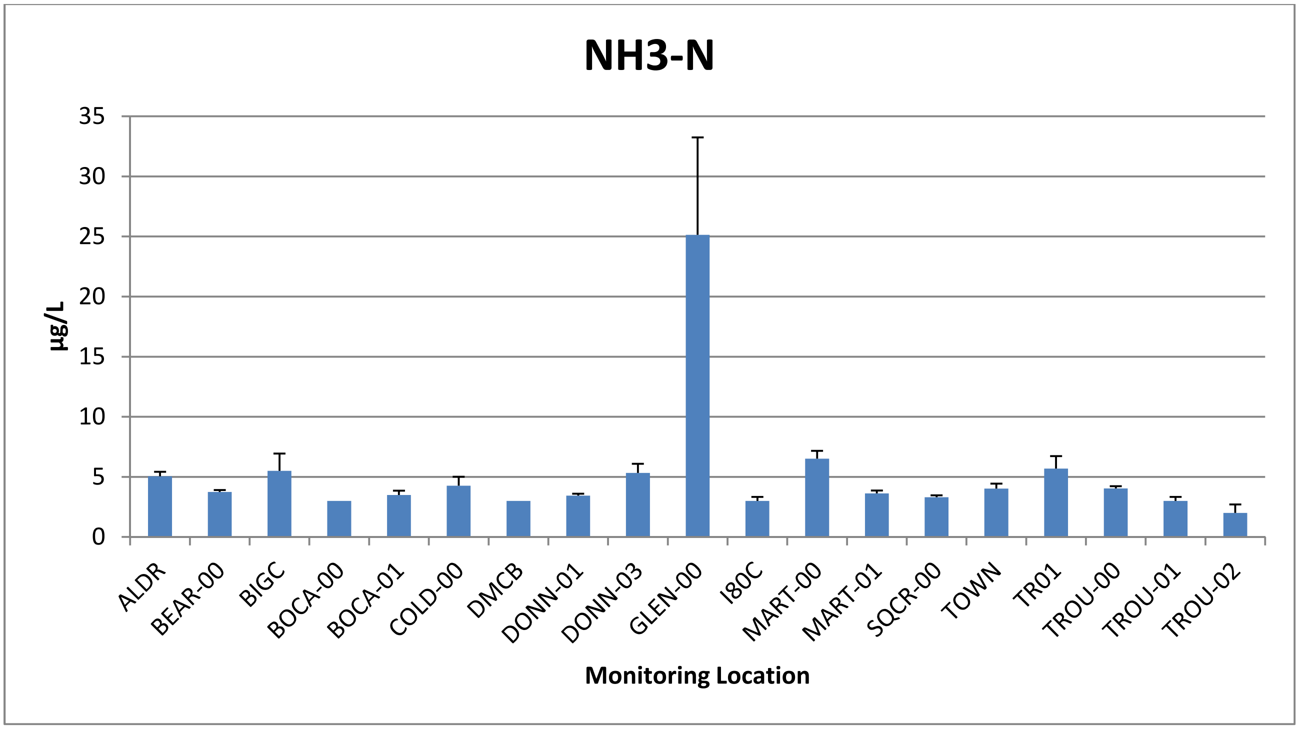

Figure 8. Ammonia measurements, data collected in May of each year. The bars represent the average value, the error bars show standard error.

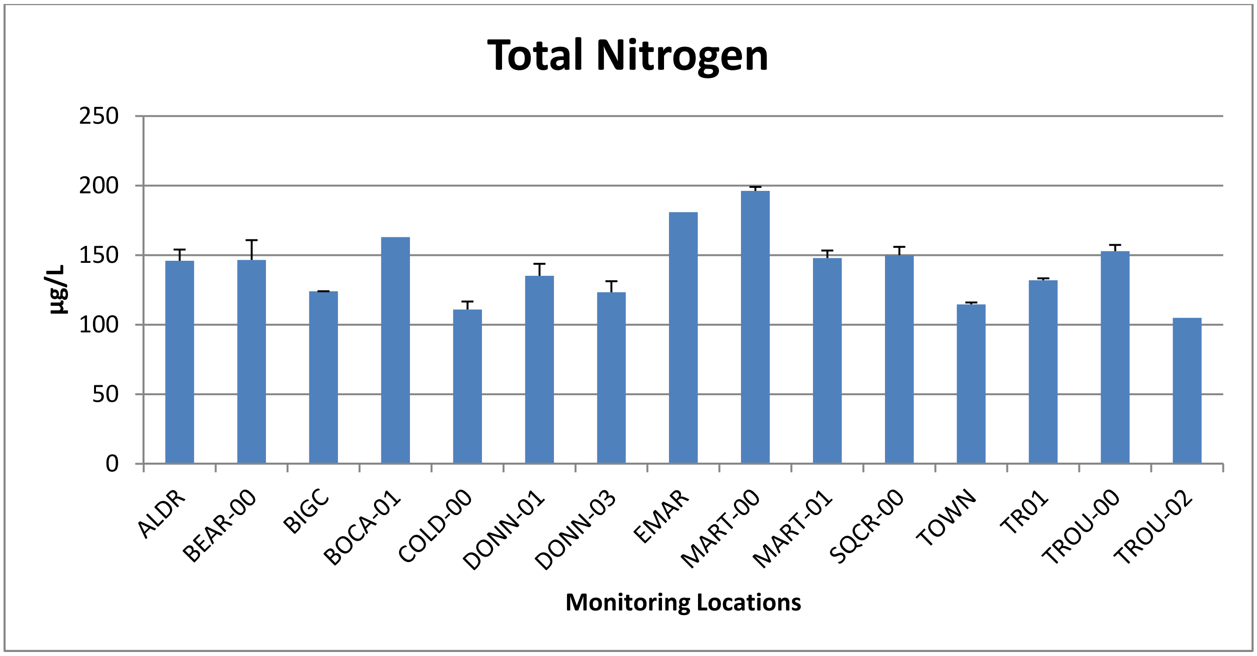

Figure 9a. Total Nitrogen, data collected during May of each year. Total Nitrogen data are only available from 2006, 2007, 2009, and 2010. The bars represent the average value, the error bars show standard error.

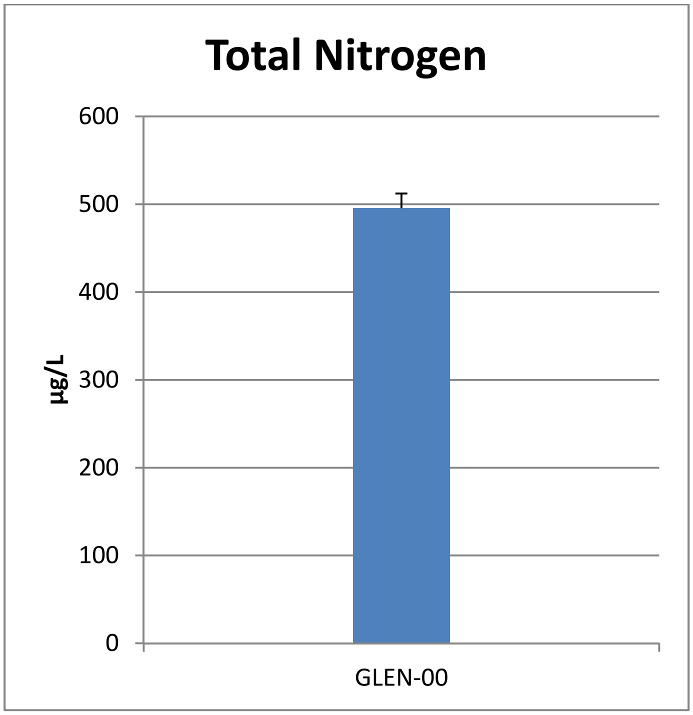

Figure 9b. Total Nitrogen for Union Valley Creek, data collected during May of each year. Total Nitrogen data are only available from 2006, 2007, 2009, and 2010. The bar represents the average value, the error bar shows standard error.

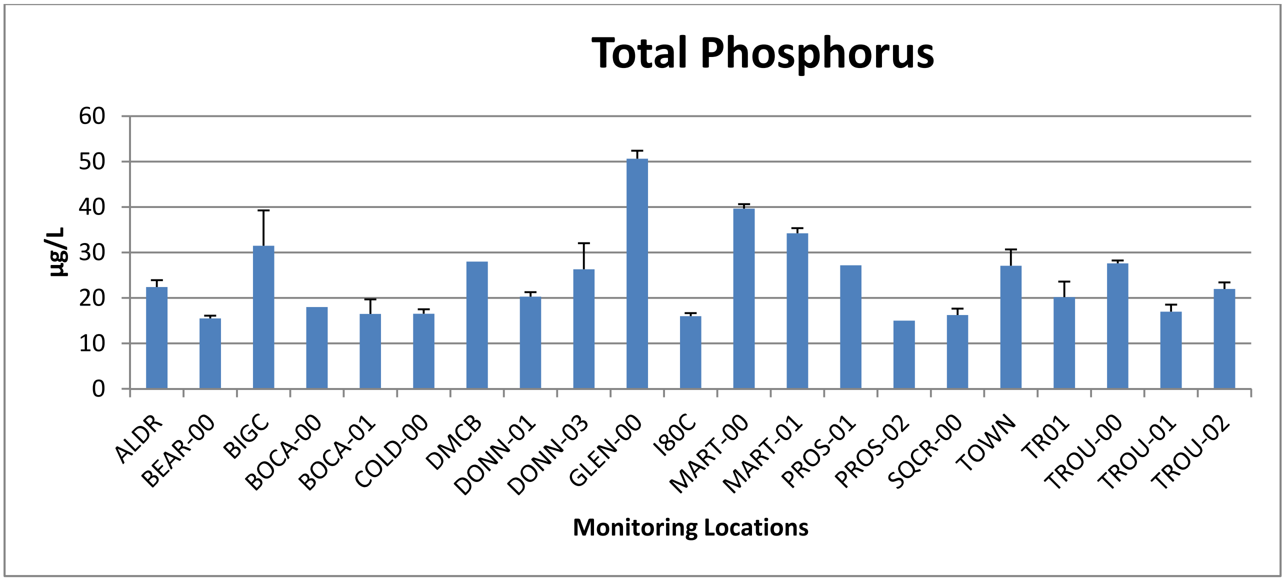

Figure 10. Total phosphorus, data collected in May of each year. The bars represent the average value, the error bars show standard error.

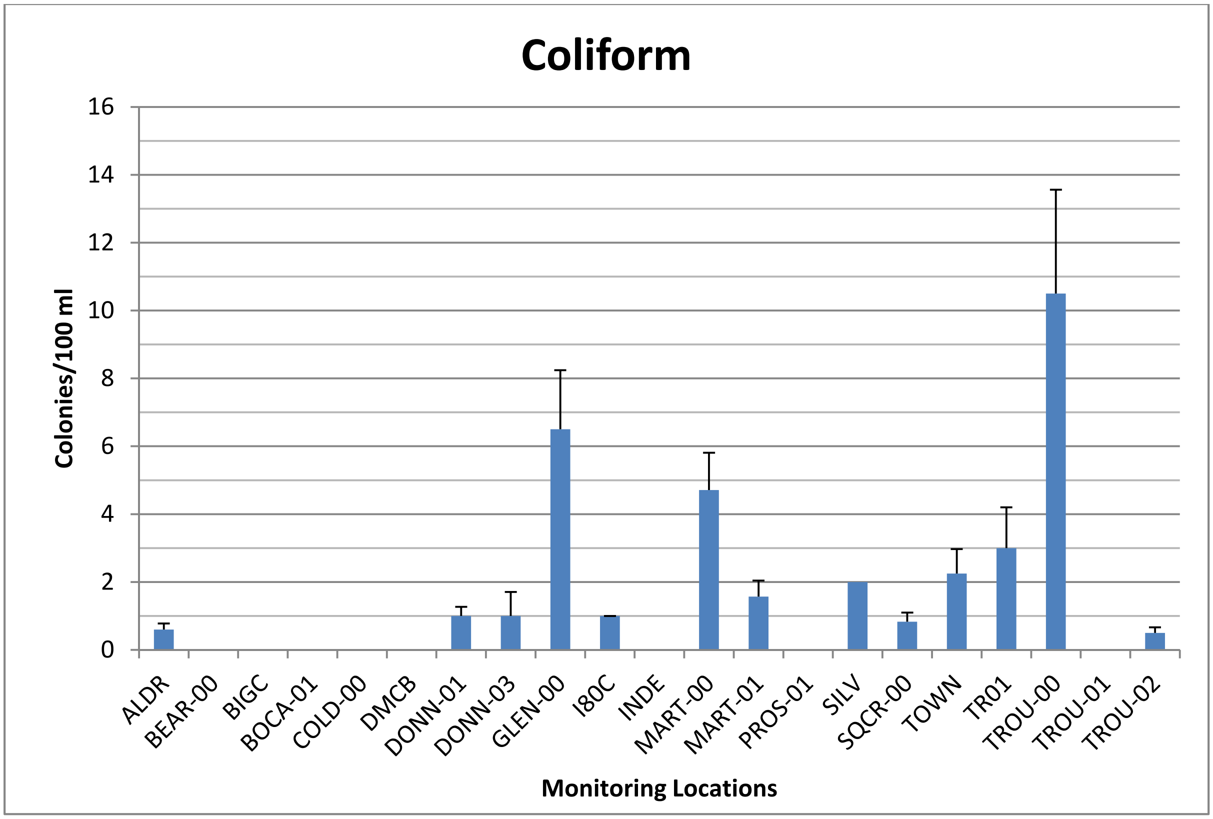

Figure 11. Coliform measurements. Only sites that have been tested for coliform at least once between 2001 and 2010 are listed. Sites with no bar tested “non-detect” for coliform.

Coliform

Coliform are a group of bacteria that are mostly found in the feces of warm-blooded animals, including humans, pets, livestock, beavers, and birds. Coliform is only monitored during spring runoff, and samples are taken from only a subset of sites. Figure 11 shows the results of coliform monitoring since 2001. Most coliform monitoring has yielded measurements of “non-detect”.

None of the samples have been dangerously high, although Union Valley Creek (GLEN-00) consistently has measurable numbers of colonies, as do Martis Creek (MART-00 and MART-01) and Trout Creek at the mouth (TROU-00). Union Valley Creek drains the Glenshire Pond, which has a sizeable waterfowl population. Additionally, it is a popular dog walking site. Lower Martis Creek (MART-00) is also an extremely popular dog walking site. Upper Martis (MART-01) drains a golf course, which probably attracts a large Canada Goose population. Upper Martis has only had high coliform in one year (2004), however. There is often evidence of homeless camps near the Trout Creek monitoring location which could be contributing to coliform measurements. Coliform monitoring will continue at all these sites during spring run-off.

Bioassessment Data

Figures 12-16 show some results from monitoring benthic macroinvertebrate (BMI) communities. Because taxonomic resolution affects most metrics, the data analyzed professionally and by volunteers are presented separately. See discussion in “Methods” section for explanation of differences in the analyses.

Tolerance Measures

Each taxon of aquatic invertebrate is assigned a tolerance value which is an indication of the amount of pollution that it can survive with. Taxa with high tolerance values are able to live in more degraded water (can tolerate more pollution) and taxa with a low tolerance values are less able to live in degraded streams (are intolerant of pollution). Tolerance values range from 0-10, with organisms like stoneflies on the low end and organisms like leeches on the high end. “Tolerant” taxa have tolerance values of 8-10 and “Intolerant” taxa have tolerance values of 0-2.

The Community Tolerance metric is a weighting of all the organisms in the sample by tolerance value. A high tolerance value means that in general, more tolerant taxa are found in that stream. The community tolerance metric includes all individuals in a sample, not just the highly tolerant or intolerant.

Figure 12 shows the tolerance metrics for streams that were professionally identified. In general, the biological condition of area streams is fairly high when looking at just these metrics. Percent Tolerant is generally low, and Percent Intolerant is generally high. A few streams stand out: West Martis, East Martis, and Davies Creek all have a relatively high percentage of tolerant organisms. The community tolerance for these streams is high, but not much higher than some of the other streams. Davies Creek is an ephemeral stream, so it probably should not be compared directly to the other streams, which are perennial.   On the other end, Independence Creek, Cold Creek, Trout Creek, Pole Creek, Little Truckee in Perazzo, and Perazzo Creek all have low community tolerance values and high percent Intolerant.

The data analyzed by volunteers are shown in Figure 13. Again, based on tolerance metrics, sampled streams are primarily in good condition. Most sampled creeks contain very few tolerant organisms (low % Tolerant). However, Squaw Creek, Davies Creek, Trout Creek (at Bennett Flat and at the mouth), Prosser Creek, and the Truckee River (at Granite Flat and Horseshoe Bend) have measureable % Tolerant values and most of those streams have high community tolerance values. Interestingly, Donner Creek in 2005 has a quite high community tolerance value, but 0% Tolerant individuals. Community Tolerance is calculated using all the organisms in the sample, whereas % Tolerant is simply the percentage of the sample composed of organisms with high tolerance values (8-10).

Deer Creek, Deep, Cold Creek, Cold Stream, Perazzo Creek, and the Upper Little Truckee River all show low % Tolerant, high % Intolerant, and low Community Tolerance values.

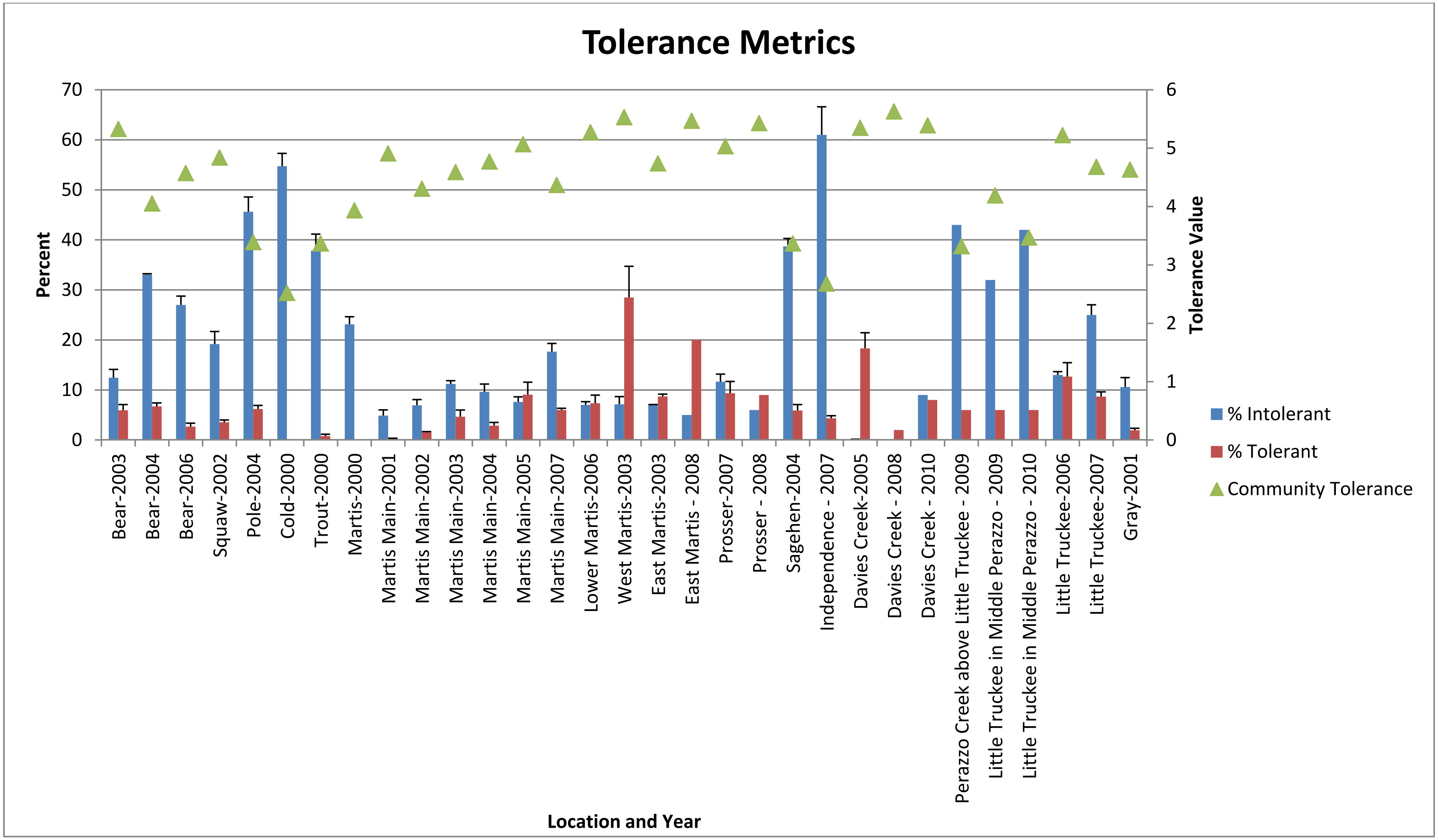

Figure 12. Tolerance metrics, data analyzed at professional labs. Data from 2000-2007 were analyzed using the CSBP method (900 individuals identified from each stream) and data from 2008 on were analyzed using the 2007 SWAMP protocol (500 individuals identified). All samples were analyzed to the same taxonomic resolution, corresponding to SAFIT level II.

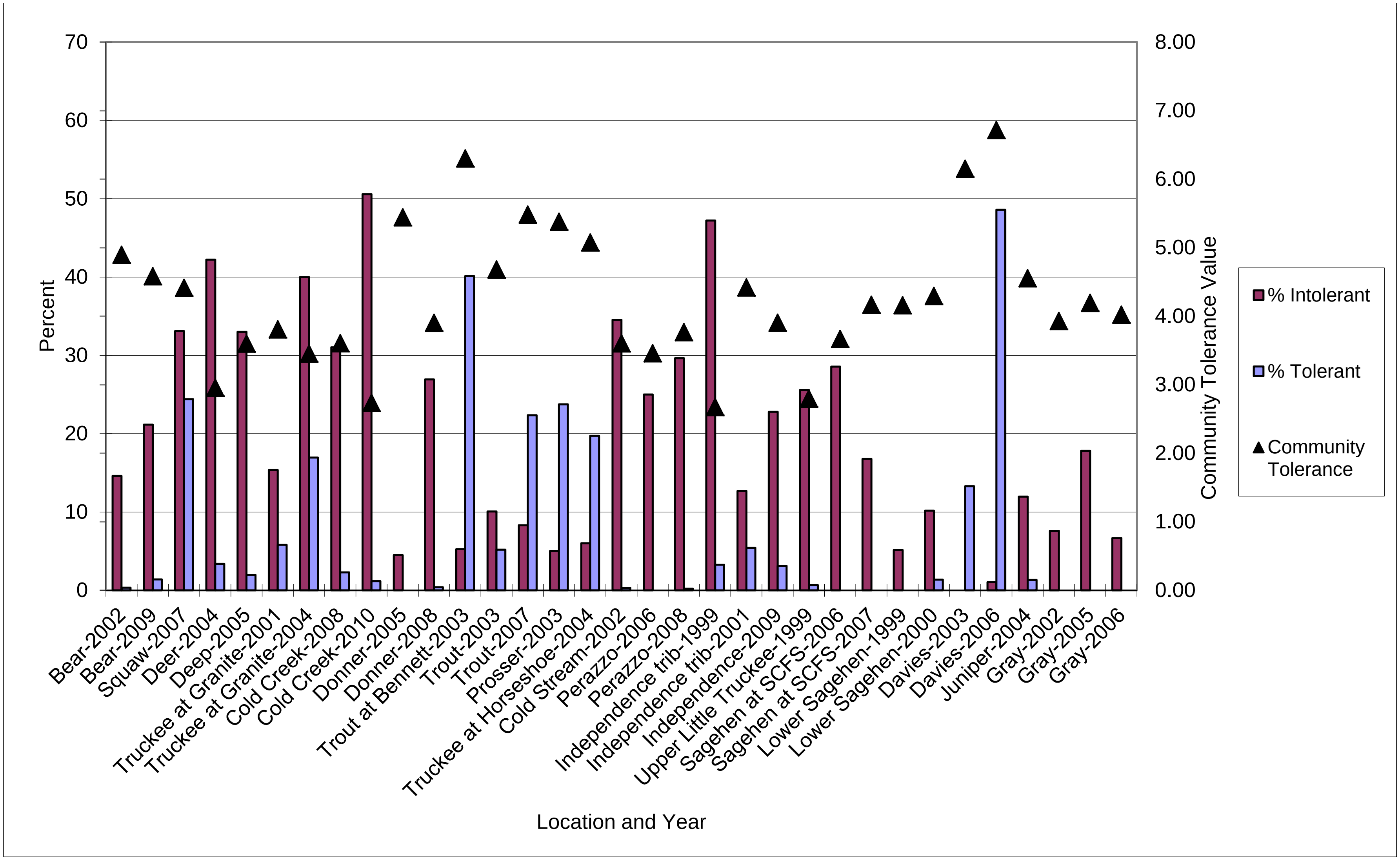

Figure 13. Tolerance metrics, data analyzed by volunteers. Data from 2000-2007 were analyzed using the CSBP method for volunteers (300 individuals identified from each stream) and data from 2008 on were analyzed using the 2007 SWAMP protocol (500 individuals identified). All samples were analyzed to the same taxonomic resolution: family for insects, order for other taxa.

Functional Feeding Groups

Available food sources in a stream vary depending upon the distance from the headwaters. The River Continuum Concept addresses how this different availability of food sources will affect the types of organisms found at different points along a stream. In headwater streams, the input of organic matter is primarily from terrestrial sources, these streams tend to be small and shaded, so very little sunlight can reach the stream to stimulate primary productivity (plant and algae growth). Leaves falling from streamside vegetation will provide the majority of the food base to these types of stream. Therefore, we predict to see many “shredders” and “coarse particulate organic matter collectors”, organisms that feed off of leaves or other types of terrestrial inputs. Some grazers will be present as well as some predators.

Further down the stream in “mid-reach” sections, the streams are larger and solar radiation can reach the water. The food base becomes a mix of terrestrial and in-stream primary productivity. Aquatic plants and algae form a significant part of the food web. The types of functional feeding groups that should be found in these types of streams are primarily grazers that feed on the algae and plants, and a wider range of collectors than are seen in the headwaters. More medium and fine particulate matter is present in the mid-reach streams. Shredders are found in much lower abundance, and a small number of predators will be present.

In very large river systems (like the lower Mississippi) the energy base for the food web is primarily leakage from upstream. In these systems, fine particulate organic matter collectors dominate the species assemblage, and a small number of predators will be present.

Locally, most of our streams would be considered headwater streams. The main stem of the Truckee River would even be considered a headwater stream according to how streams are classified, but has many of the characteristics of a mid-reach stream. In the tributary streams, we should see communities that have large percentages of both shredders and collectors, with small numbers of grazers and predators.

Figure 14 shows the percentages of functional feeding groups seen in samples analyzed to a higher taxonomic level (by professional laboratories) and Figure 15 shows the same data for samples analyzed to family level (by volunteers). Generally speaking, most streams are dominated by collectors with low percentages of shredders. A lack of shredders often indicates that inputs of terrestrial vegetation as a food source are lacking. The percent of grazers should be low in our headwater streams, which is mostly the case. High levels of grazers typically indicate significant algal populations. In low water years, the grazer populations can increase.

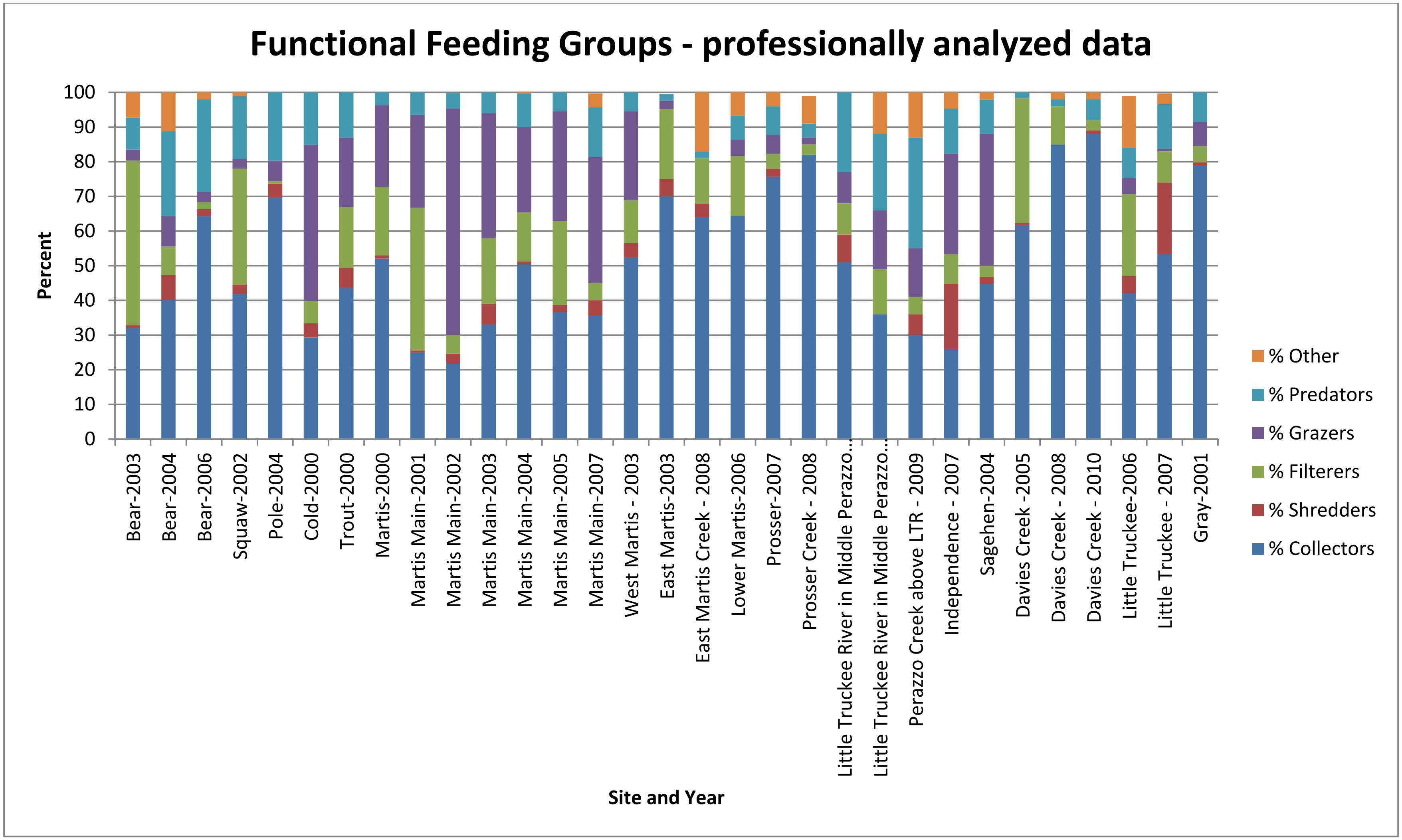

Figure 14. Functional feeding groups, data analyzed by professionals. Streams are organized from upstream to downstream by confluence with the Truckee River.

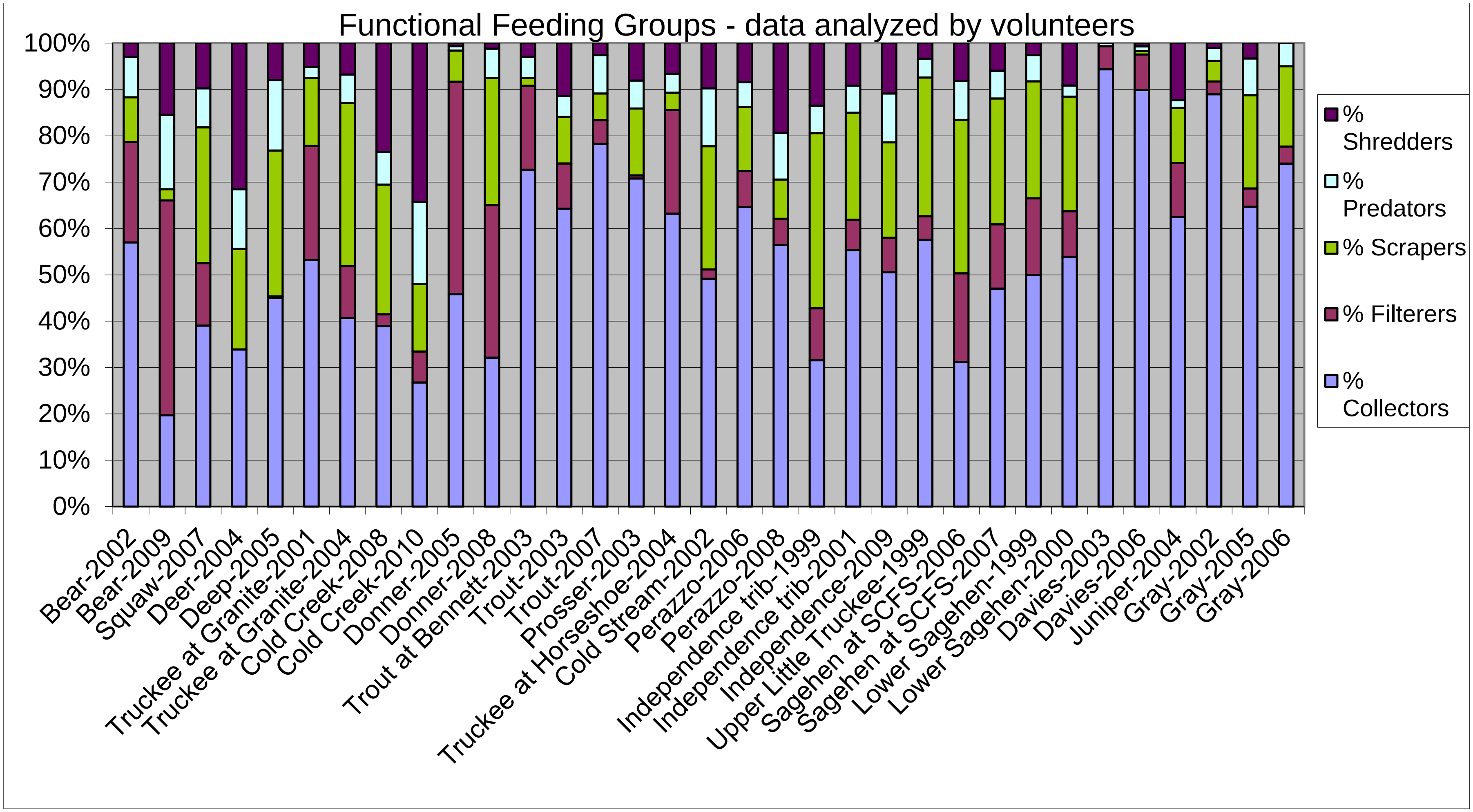

Figure 15. Functional feeding groups, data analyzed by volunteers. Streams are organized from upstream to downstream (point of entry to Truckee River).

Index of Biological integrity

In 2009 an Index of Biological integrity (IBI) for the Eastern Sierra was published (Herbst and Silldorff, 2009). An IBI allows for the comparison of the biological condition of streams based on a single score. An IBI is an index composed of multiple metrics that can be used to accurately and cost-effectively assess stream health.

IBIs are region- or even watershed-specific. To generate an IBI, data must be collected from many different streams of varying "known" condition. Streams are separated into reference and test streams with reference streams being relatively high quality, and test streams of varying quality. Many different metrics are typically considered for evaluation, and a subset are selected for inclusion in the IBI.

For the Eastern Sierra IBI, component metrics were selected for inclusion based on performance indicators such as sensitivity in response to disturbance stressors, high signal-to-noise ratio (strong response to stress with low variation), and little redundancy with other metrics. Thresholds for assessment of biological impairment were based on reference streams of the region, defined as those least influenced by land use disturbances. To identify reference streams, the developers of the IBI used criteria such as low levels of exposure both to the density of upstream road crossings in the watershed, and local reach-scale bank erosion. Streams not conforming to the reference site selection criteria were designated as test sites. The IBI scores of test sites were evaluated relative to the distribution of IBI scores for reference sites to determine whether biological integrity was impaired (according to 5 condition classes). A detailed description of the Eastern Sierra IBI development is included in Herbst and Silldorff, 2009.

The Eastern Sierra IBI was developed for 500-count data, with taxonomy done to genus/species level. Therefore, only our professionally identified data from 2008 forward can be easily inserted into the IBI. It is possible to subsample previously collected 900 count data; however we have not completed that analysis yet. Simply plugging the 900 count data into the IBI will give higher richness values and skew the IBI scores.

In 2010, Placer County implemented bioassessment monitoring as part of the Truckee River Water Quality Monitoring Plan (TRWQMP, 2ND Nature, 2008). We have included their IBI data for Squaw Creek and Martis Creek in our report. Prior to the development and implementation of the TRWQMP, TRAM had monitored both Martis and Squaw. To avoid excess impacts to the instream fauna of the streams and maximize limited monitoring resources, TRAM will not monitor Martis or Squaw while Placer County continues to implement the TRWQMP. The Placer County data are collected and analyzed using the same protocols as TRAM uses, therefore all the data are comparable.

Tables 5 and 6 include all the metrics used to calculate the IBI, and Figure 16 is a graphic representation of the IBI scores.

Table 5. IBI input data for streams monitoring by TRWC and Placer County. Please see http://www.placer.ca.gov/Departments/Works/StrmWtr/StmWtrMonitoring.aspx for the entire Placer County Truckee River monitoring report.

	Squaw Upper Meadow	Squaw Middle Meadow	Squaw Lower Meadow	Prosser Creek	Davies Creek	Davies Creek	Perazzo Creek at LTR	LTR in middle meadow	LTR in middle meadow
Sampling Date	7/30/2010	7/29/2010	7/27/2010	6/16/2008	6/1/2008	6/12/2010	7/18/2009	8/15/2009	8/7/2010
Sampled By	Placer Co.	Placer Co.	Placer Co.	TRWC	TRWC	TRWC	TRWC	TRWC	TRWC
Total Taxa Richness	46	30	39	40	18	23	43	42	43
Ephemeroptera richness	7	4	7	5	1	2	10	11	13
Plecoptera richness	6	4	6	2	0	0	6	7	4
Tricoptera richness	1	0	1	4	0	2	9	6	10
Acari richness	4	3	3	0	3	3	6	7	4
% Chironomidae richness	37	40	31	32.5	55.5	30	30.2	19	16
Tolerant taxa richness %	28	30	31	12.5	38.9	30	25.6	28.6	14
Shredder abundance %	4	1	2	0	0	1	8	6	0
% Dominant 3 Taxa	55	84	60	77.9	46.2	76.4	30.8	35.8	33.9
Biotic index	5.2	5.7	5.4	5.21	5.36	5.39	4.27	3.28	3.47
IBI Score	56	21	49	33	15	21	88	90	79

Table 6. IBI input data for various branches of Martis Creek. Note that most of the data were collected by Placer County in 2010. Please see http://www.placer.ca.gov/Departments/Works/StrmWtr/StmWtrMonitoring.aspx for the entire Placer County Truckee River monitoring report. TRWC volunteers collected the sample from 2008 in East Martis Creek.

	Martis Schaeffer Branch	Martis Middle Mainstem	Martis Upper West Branch	Martis Lower West Branch	Martis Lower Mainstem	Martis East Branch	Martis East Branch
Sampling Date	9/30/2010	9/7/2010	9/9/2010	9/29/2010	9/7/2010	6/10/2008	9/10/2010
Sampled By	Placer	Placer	Placer	Placer	Placer	TRWC	Placer
Total Taxa Richness	48	42	49	36	47	34	38
Ephemeroptera richness	11	9	10	5	7	4	5
Plecoptera richness	9	5	7	5	5	1	4
Tricoptera richness	7	4	4	6	3	2	1
Acari richness	5	2	6	4	0	2	1
% Chironomidae richness	6	21	18	8	36	32.3	32
Tolerant taxa richness %	15	21	20	22	19	26.5	34
Shredder abundance %	36	16	16	18	5	4	18
% Dominant 3 Taxa	46	47	32	56	45	64.6	49
Biotic index	2.6	4.4	3.5	4.1	4.7	5.42	5.1
IBI Score	94	73	92	69	64	30	41

Scores derived from the Eastern Sierra IBI can be ranked in tiers or classes based on statistical criteria described in detail in the IBI report (Herbst and Silldorff, 2009). Table 7 outlines the scoring tiers.

Table 7. Tiers of the Eastern Sierra IBI.

Tier	IBI Score	Designation
5/A	>89.7	Very Good – Supporting beneficial uses
4/B	80.4 - 89.7	Good – Supporting beneficial uses
3/C	63.2 -80.4	Fair – Supporting but uncertain
2/D	42.2 – 63.2	Poor – Partially supporting beneficial uses
1/F	<42.2	Very Poor – Not supporting beneficial uses

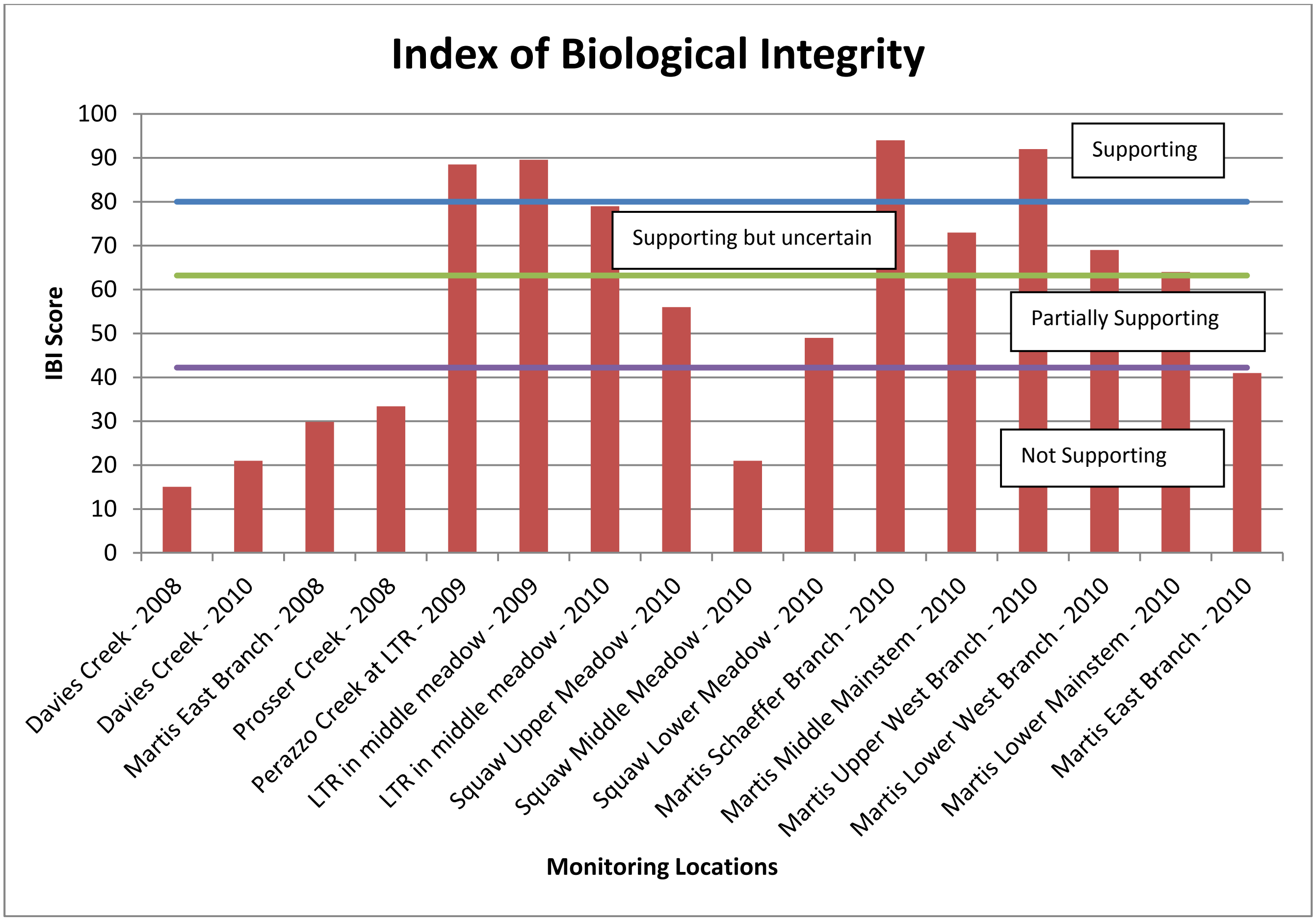

Figure 16. IBI scores for all streams with available data. All 2010 Martis and Squaw data were collected by Placer County; the remaining data were collected by TRWC volunteers and analyzed by California Department of Fish & Game. See Table 7 for further description of the tiers; note that no distinction is made between the top two tiers. Both tiers support beneficial uses, so only the break between fully supporting and below was made.

Monitoring Program Objectives

In developing the Adopt a Stream program, the Truckee River Watershed Council developed a series of monitoring objectives, which were refined with assistance from the Sierra Nevada Alliance. Much of our data collected relating to specific objectives is “baseline” or current condition data. Over time, as our focused data collection efforts increase, we will be better able to address our stated monitoring objectives.

In this report, we will address each of our monitoring objectives with data collected thus far.

As listed earlier in the report, the primary objectives of AS are:

1. To better understand and document the relationship between water quality, hydrologic function, river system management, and land use.

2. To identify land use practices that negatively impact the Truckee River watershed, the extent of impact, and the geographic locations of concern.
3. To engage and educate residents about local watershed processes and strengthen their understanding of watershed stewardship.
4. To enhance the quality and quantity of data available for resource managers and decision makers in the Truckee River watershed.
5. To provide data that can be used to help monitor the implementation of the Truckee River sediment Total Maximum Daily Load (TMDL).
6. To collect data to help provide pre-Truckee River Operating Agreement (TROA) implementation data, and to establish a program that will help to track changes in the condition of biological resources in the Truckee River watershed once TROA is implemented.

Objectives 1 and 2 are focused on trying to understand how different land uses may be affecting different water quality parameters. These objectives are broadly stated, so in this report we will examine specific ways in which we can use our data to attempt to understand these relationships.

One land use change that is occurring in the Truckee River watershed is increased urbanization. The urban areas are fairly concentrated in a handful of sub-basins: Bear Creek, Squaw Creek, Donner Creek, Trout Creek, and Union Valley Creek (Figure 17). Urbanization is predicted to affect some ambient parameters more than others. In particular we expect to see:

- Increased temperature in more urbanized areas because of lack of streamside vegetation
- Increased electrical conductivity in more urbanized area because of influences of roads and urban run-off
- Increased turbidity in more urbanized areas because of increased erosion

Temperature, turbidity, and conductivity are all fairly sensitive to flow, so the data have been broken out into high flow and low flow sampling events. Because of the history of our monitoring program, there are more high flow data available than low flow data and low flow data are only available for a subset of monitoring locations.

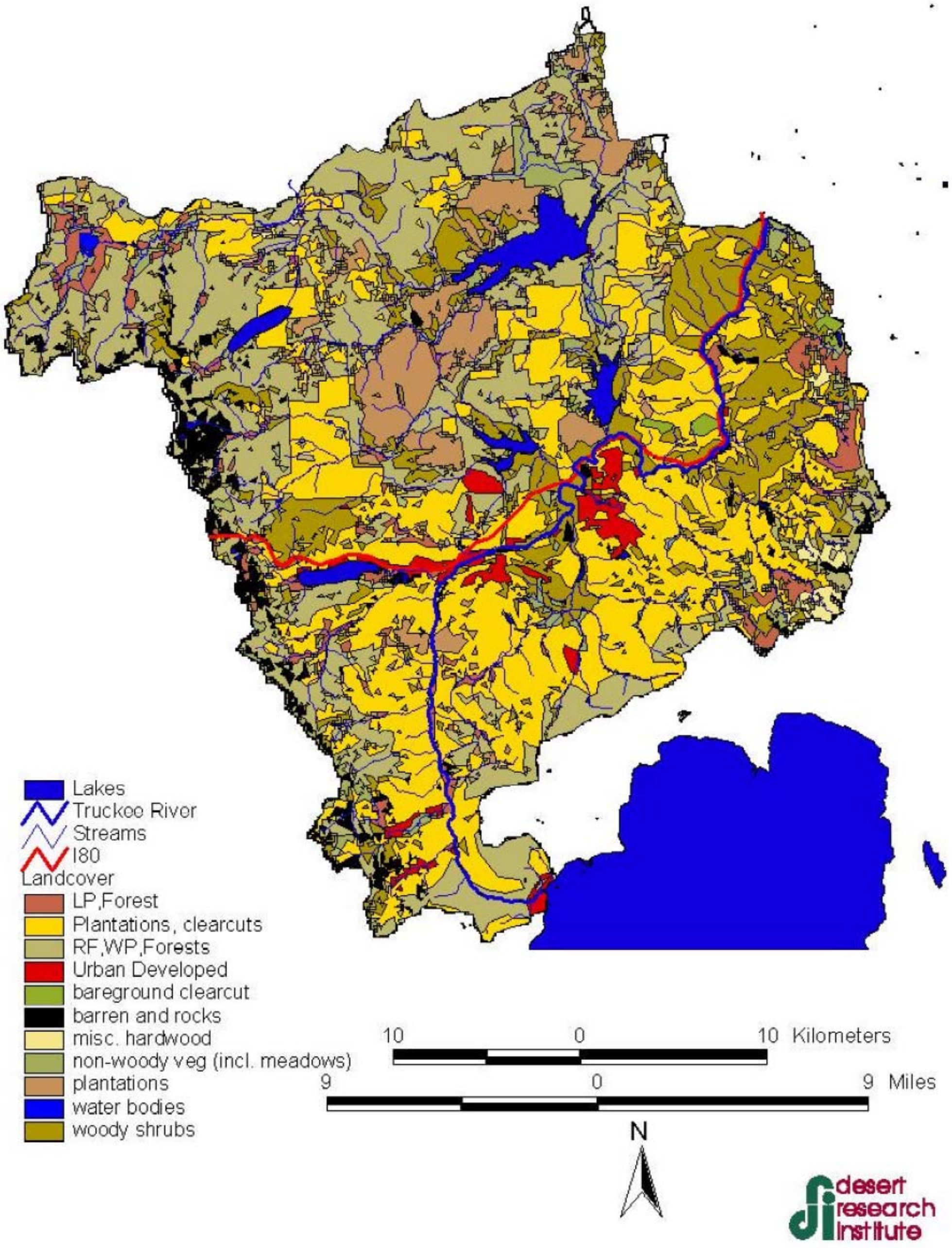

Figure 5. Land cover data layer.

Figure 17. Land cover in the Middle Truckee River watershed. Figure generated by Desert Research Institute, taken from McGraw, et al., 2001.

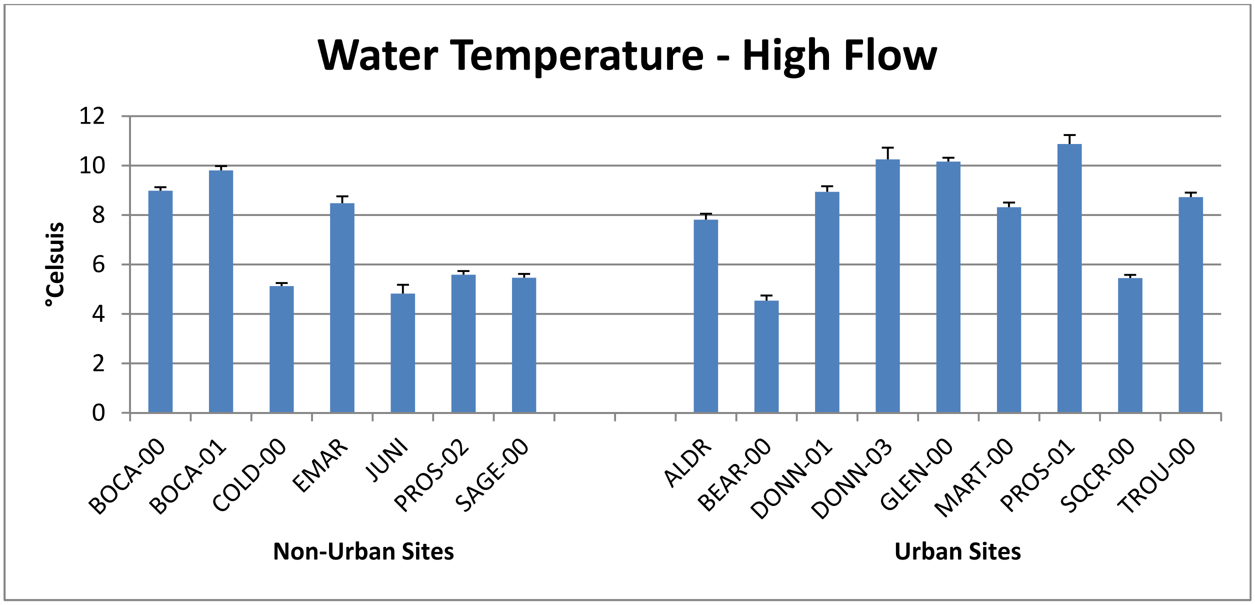

Figure 18. Average water temperature at urban and non-urban sites, measured during high flow. Error bars show standard error. Data are only shown from sites that have been monitored during both high and low flow conditions.

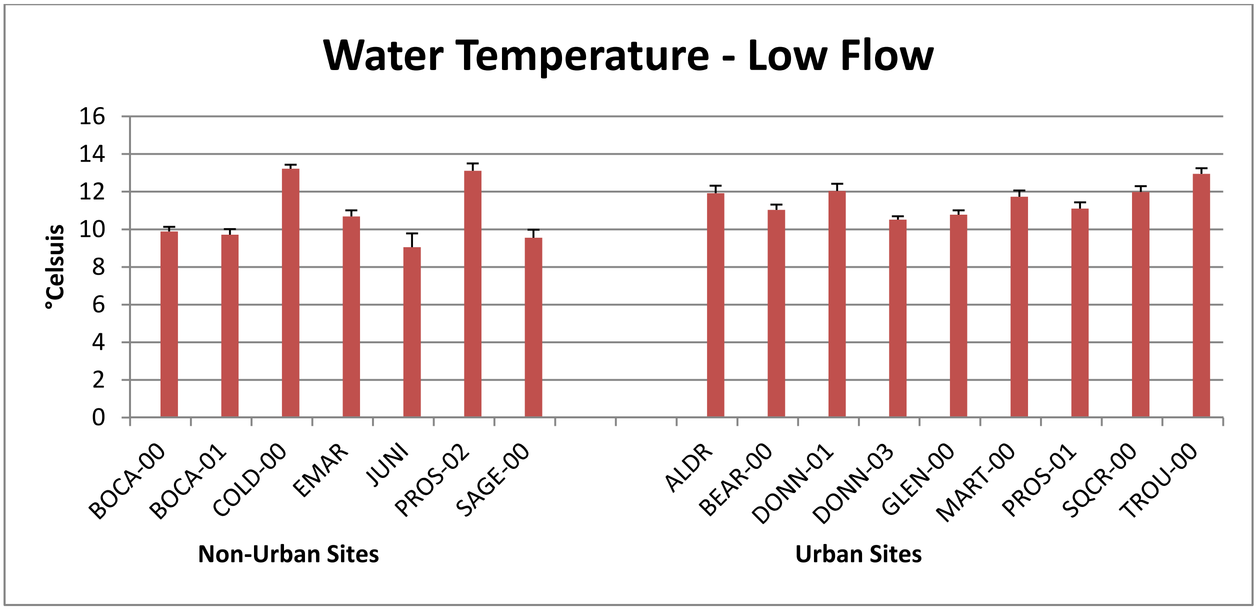

Figure 19. Average water temperature, at urban and non-urban sites, measured during low flow. Error bars show standard error. Data are only shown from sites that have been monitored during both high and low flow conditions.

Table 8. Average water temperature by site type (non-urban and urban) and flow regime (high or low). We predicted that water temperature should be higher in urban areas than non-urban.

	Average Water Temperature	
Site Type	High Flow	Low Flow
Non-Urban	6.9	10.7
Urban	8.3	11.6

When we performed this analysis last year, water temperature did not show a clear pattern between urban and non-urban sites. When data from 2011 are included, the trend is in the predicted direction with urban sites exhibiting warmer water temperature than non-urban sites.

Conductivity Data

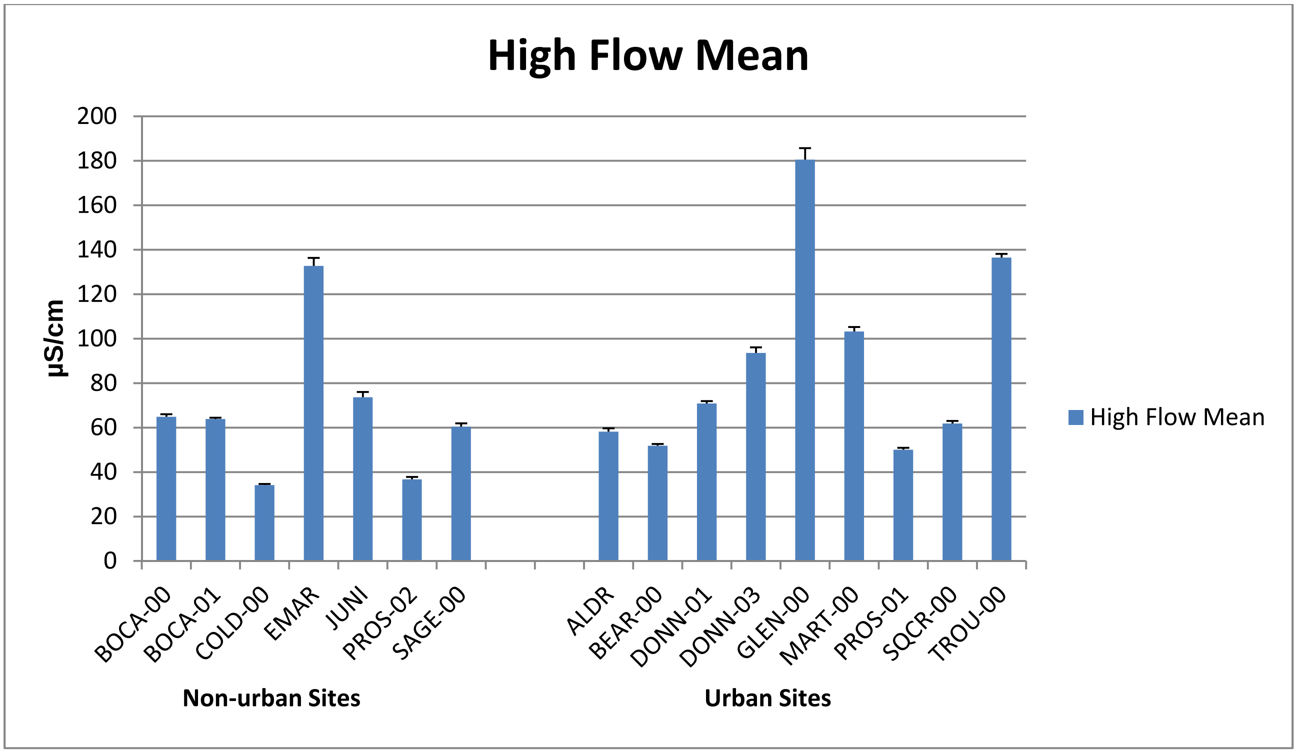

Figure 20. Average electrical conductivity measured during high flow for non-urban and urban sites. Error bars show standard error. Data are only shown from sites that have been monitored during both high and low flow conditions.

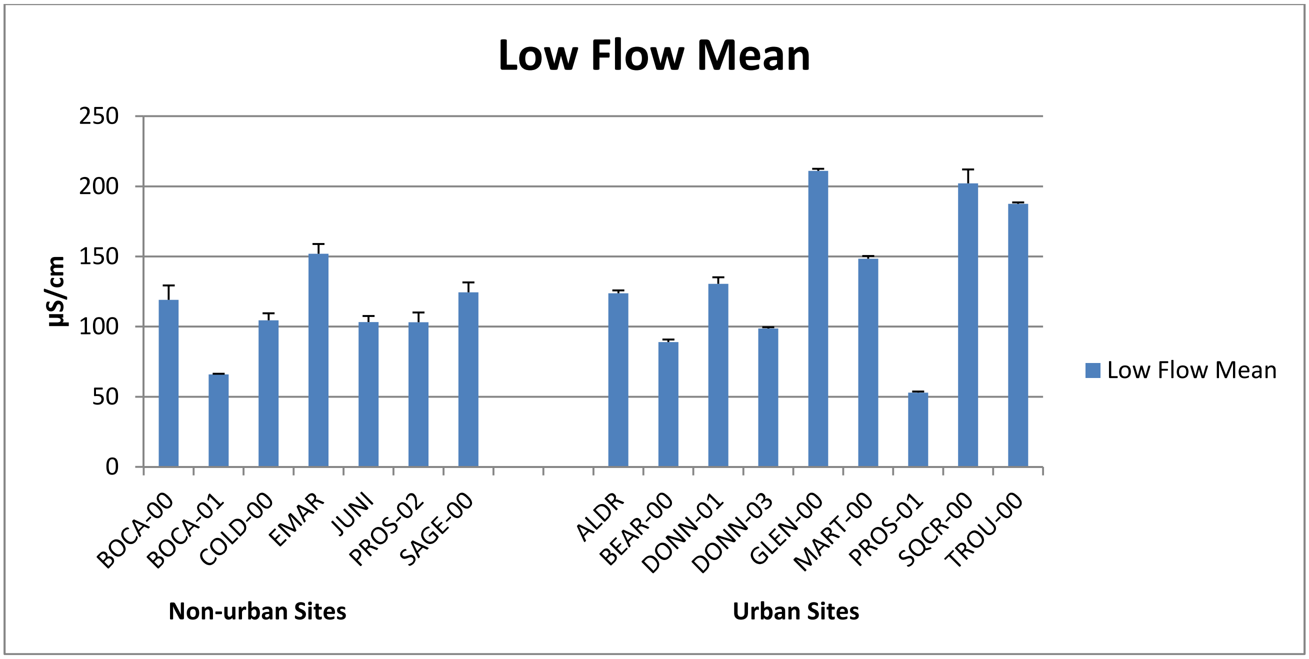

Figure 21. Average electrical conductivity measured during high flow for non-urban and urban sites. Error bars show standard error. Data are only shown from sites that have been monitored during both high and low flow conditions.

Table 9. Average electrical conductivity by site type (non-urban or urban) and flow regime (high flow, low flow). Conductivity is higher, on average, at urban sites at both high and low flows.

	Average Conductivity	
Site Type	High Flow	Low Flow
Non-Urban	66.6 µS/cm	110.3 µS/cm
Urban	89.6 µS/cm	138.2 µS/cm

In a previous analysis of data through 2008, there was not a clear difference between urban and non-urban sites. Additional data, especially from low flow events, has helped to demonstrate that there does appear to be a difference between the two types of sites – the trend was apparent after 2010, and has strengthened with inclusion of data from 2011. As is apparent from the graphs, there is a lot of overlap and variation between individual sites. Many other factors are likely to be influencing conductivity readings besides relative urbanization in the watershed (for example, proximity of the sampling location to a road that is regularly sanded could have a much greater influence).

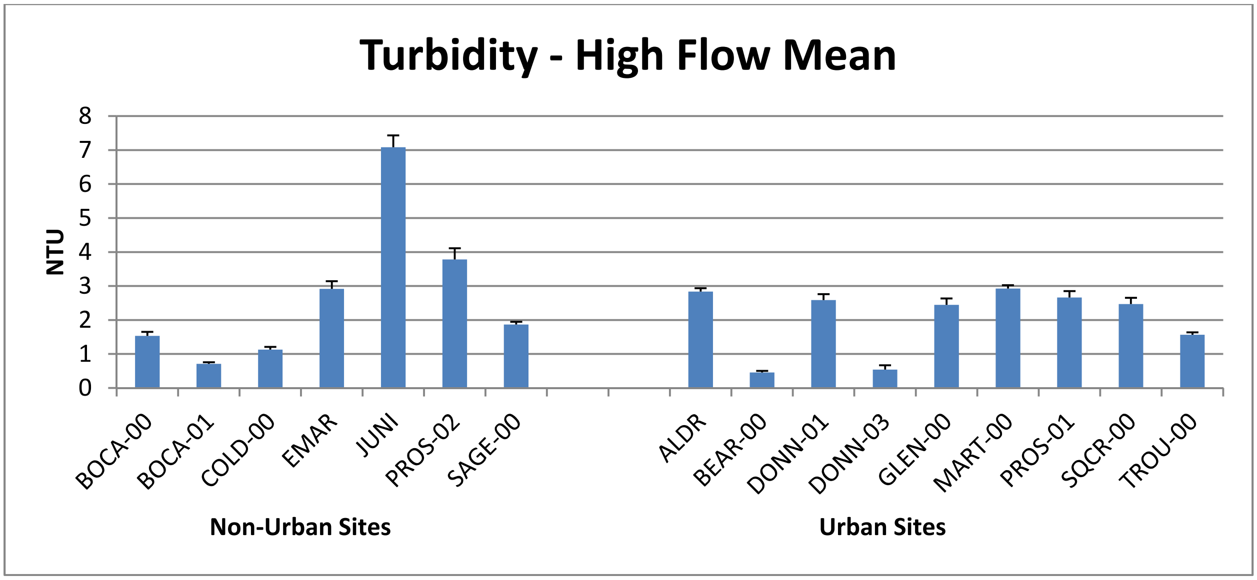

Figure 22. Average turbidity measured during high flow for non-urban and urban sites. Error bars show standard error. Data are only shown from sites that have been monitored during both high and low flow conditions.

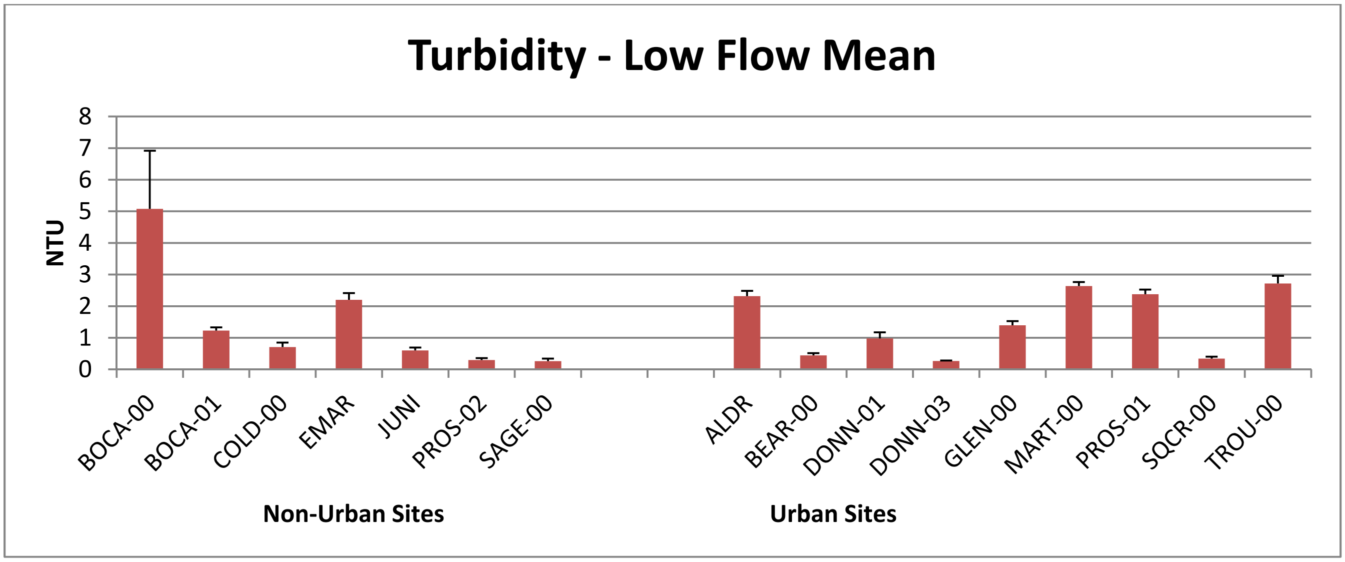

Figure 23. Average turbidity measured during low flow for non-urban and urban sites. Error bars show standard error. Data are only shown from sites that have been monitored during both high and low flow conditions.

Turbidity is highly variable among our sites. The highest measurements come from non-urban sites – Little Truckee River below Boca Dam (BOCA-00), East Martis Creek (EMAR), Juniper Creek (JUNI), and Prosser Creek at Highway 89 (PROS-02). Gray Creek (only measured during high flow; Figure 6b) has the highest turbidity readings in our watershed and is non-urban. The East Martis Creek, Juniper Creek, and

Prosser Creek watersheds all have networks of poorly developed dirt roads, which may contribute significant amounts of fine sediment to the stream. The Juniper Creek watershed was also burned during the 2001 Martis Fire, and some effects from that incident are still apparent. Little Truckee below Boca Dam shows high turbidity during low flow, which is probably due to algal growth. Low flow at this monitoring location typically corresponds with no water being released from the dam, so only stagnant pools of water are present at those times. Under these conditions very high turbidity is to be expected.

Restoration Sites

Relating back to Objective 1, another land use we are tracking is the change in watershed condition achieved through restoration projects. Many of the restoration projects planned for the Truckee River watershed (either by TRWC or partners) are either in the planning phase or in very early implementation. Therefore, data collected thus far are essentially baseline or pre-project data. The majority of restoration projects are aimed at reducing fine sediment. Because we are interested in improving aquatic habitat through restoration, bioassessment data will be a good indicator of whether or not our restoration goals are being achieved.

Table 10. Sub-basins targeted for restoration, restoration goals, and metrics expected to improve after restoration.

Sub-basin	**Restoration Goals**	**Project Status**	**Metrics to monitor**
Upper Little Truckee River (Perazzo Meadows)	Reduce erosion, improve meadow and riparian habitat	Restoration began in 2009, project partially complete	% Chironomidae, % Baetidae, Community Tolerance, IBI Score
Trout Creek	Improve riparian habitat, reduce flood risk	Restoration began late in 2011	% Chironomidae, % Baetidae, Community Tolerance, water temperature
Davies Creek	Reduce erosion, improve meadow and riparian habitat	Restoration completed in 2010, phase 2 work in planning phase	% Chironomidae, % Baetidae, Community Tolerance, water temperature, turbidity
Cold Creek	Reduce erosion	Planning phase	% Chironomidae, % Baetidae, Community Tolerance, water temperature, turbidity
Squaw Creek	Reduce erosion, improve meadow, aquatic, and riparian habitat	Planning phase	% Chironomidae, % Baetidae, Community Tolerance, IBI score, water temperature, turbidity
Martis Creek	Reduce erosion, improve meadow, aquatic, and riparian habitat	Assessment phase	% Chironomidae, % Baetidae, Community Tolerance, IBI score, water temperature, turbidity

Restoration Sites – Bioassessment Data

Mayflies in the family Baetidae and true flies in the family Chironomidae can persist in streams that have an abundance of fine sediment. In the Truckee River watershed it has been found that abundance of these insect families decreases as the level of fine sediment in a stream decreases. Therefore, these are important metrics to track to determine if a biologically significant decrease in fine sediment is being achieved by restoration actions.

Community tolerance is a good overall metric that collapses data about how “tolerant” the overall condition of the biological community. We would expect that community tolerance would decrease as stream condition improves with restoration activities. Figure 24 is a graph of these sediment related bioassessment metrics for streams targeted for restoration.

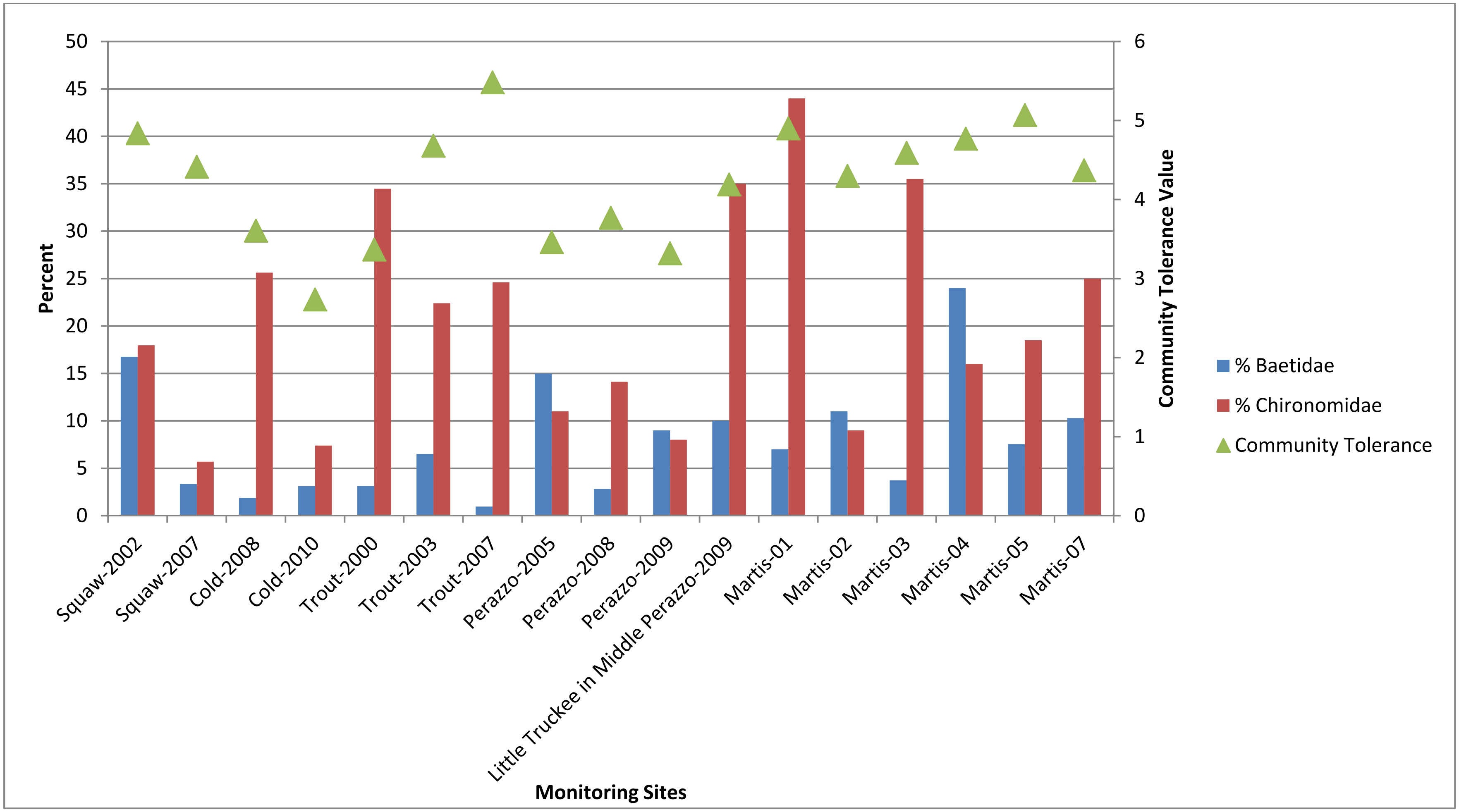

Figure 24. Bioassessment data from streams targeted for restoration, sediment related metrics.

We will continue to collect these data as restoration work is implemented at these sites. Most streams show elevated percentages of Baetid mayflies or Chironomid true flies. Community tolerance varies between about 3.5 to 6. Tolerance values of 3.5 are actually fairly good, compared to most streams in the watershed (Figures 12, 13).

The Davies Merrill stream and meadow restoration project began in 2005 and phase 1 was completed in 2010. By 2008, the majority of the restoration work had been completed. We can therefore begin to look at pre- and post-project data at this site. Figure 25 shows pre- and post-project bioassessment data for Davies Creek. The collection site is immediately below the confluence of Davies Creek and Merrill Creek, at the lowest point in the watershed.

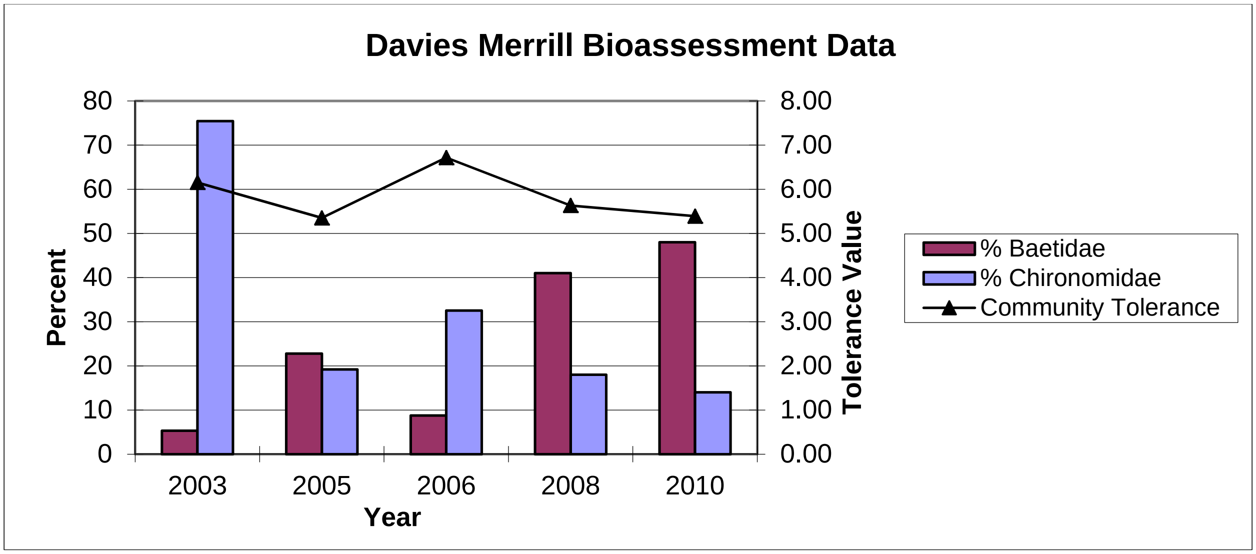

Figure 25. Bioassessment data for the Davies-Merrill Restoration Project, sediment related metrics. Restoration began in 2005 and was completed in 2010. Data collected in 2008 and later will be considered post-restoration.

Pre- and post-project data collected from Davies Creek are not much different. However, we expect that a response may not be observed until several years after restoration. Streams in the watershed are still adapting to their new courses, and vegetation has yet to fully mature. We also may not see a very strong response in bioassessment metrics from this site. Many of the stream segments in the project area are ephemeral, which tends to skew most bioassessment data. We will continue to monitor Davies creek every 2-3 years.

IBI Scores

IBI scores are only available for a handful of streams in the Truckee River watershed as of yet. The Eastern Sierra IBI focuses on several sediment related metrics, as that is a pollutant of concern throughout the region. IBI scores will be a good way to track improvements in watershed condition over time. Both Martis Creek and Squaw Creek are targeted for restoration work, Table 6 and Figure 16 show

IBI data from these watersheds. We will also be able use IBI data to track restoration progress in Davies Creek, Perazzo Creek, and the Little Truckee River through Perazzo Meadows in upcoming years.

Restoration Sites - Water temperature and turbidity

One reason for increased water temperature is reduced streamside vegetation. Many of our restoration projects target improving riparian vegetation, which will increase shading and decrease water temperatures. Water temperature is also related to fine sediment – dark particles absorb more heat and therefore can increase water temperatures. In other restoration areas, stream channels have become wider and shallower; this also results in increased water temperature. Restoring streams to more appropriately sized channels will also decrease water temperature. Therefore, temperature is an important and easy to measure indicator of restoration success.

Turbidity is also a good indicator of restoration success at many of our sites. Turbidity is a measurement of fine sediment and other particles in water. Restoration aimed at reducing erosion should also result in lower turbidity measurements.

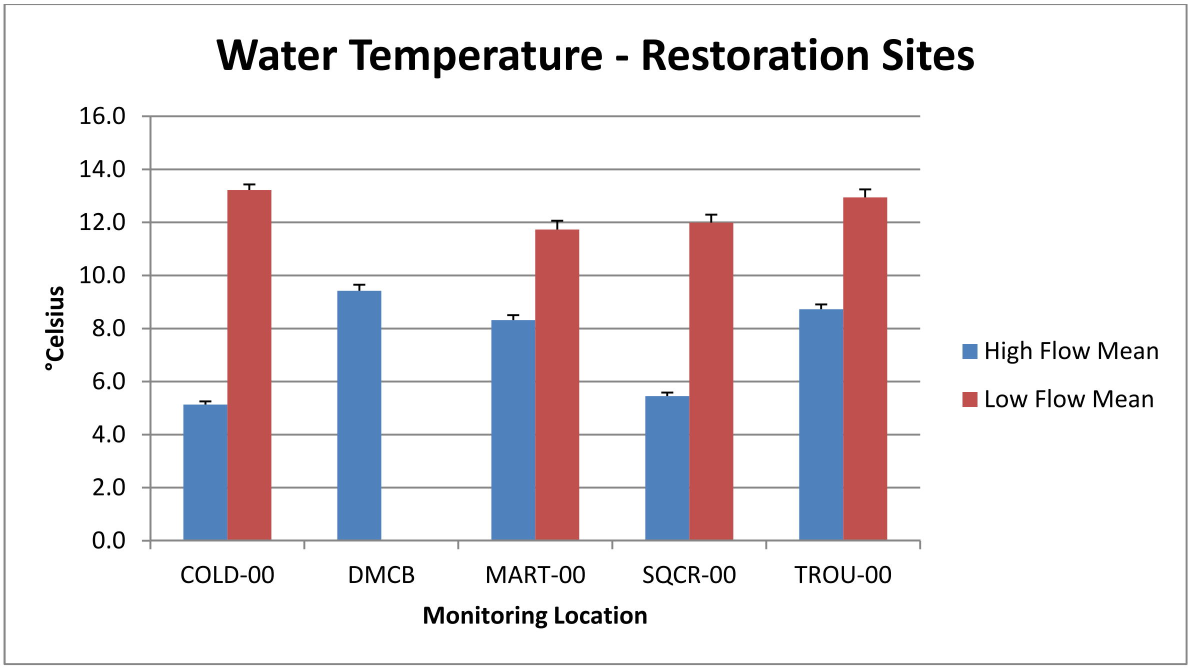

Figure 26. Water temperature from restoration sites, pre-project data.

Figure 26 shows pre-project temperature data, separated by high and low flow for restoration sites. With the exception of Davies Creek (DMCB), these are pre-project data. Some post-project data have been collected for Davies Creek; however we do not expect to see a change for several years, because vegetation is still maturing. In general, temperatures during the warmer times of year (low flow) should show the most change between pre-restoration and post-restoration measurements. During high flow, snow melt is a major component of stream flow, leading to relatively cold temperatures across all monitoring locations. During base flow, influences such as stream side shading and width to depth ratio of the stream will have a much greater impact on water temperature.

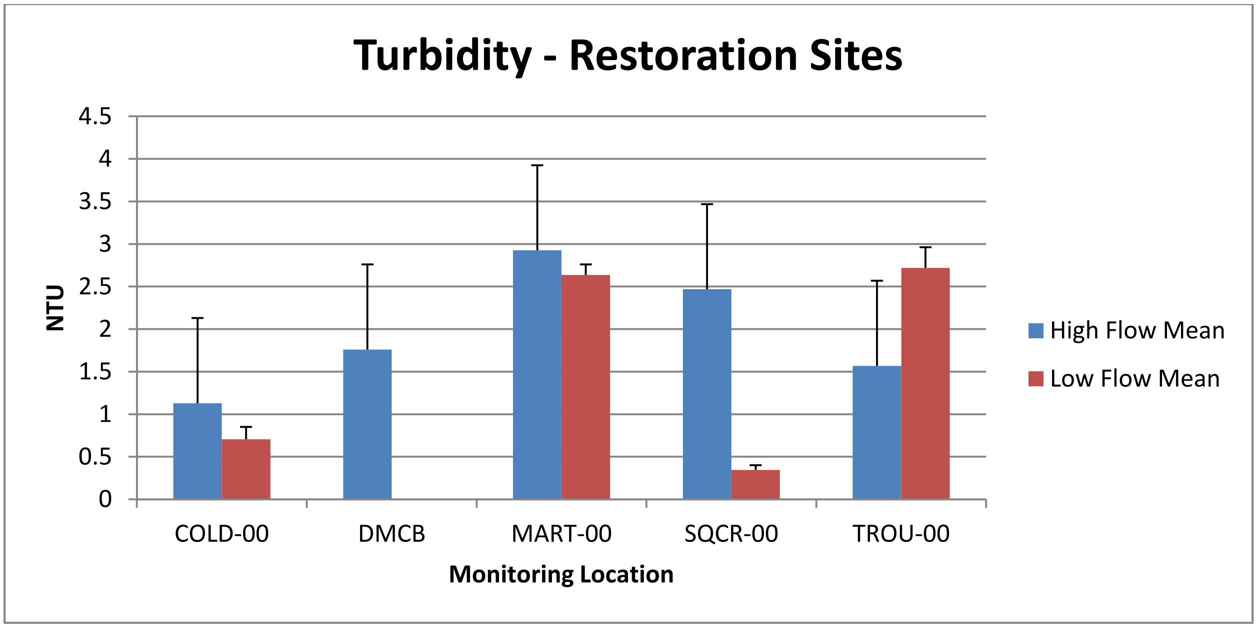

Figure 27. Turbidity measured at restoration sites, pre-project data.

Figure 27 shows turbidity data collected from sites targeted for restoration. As mentioned above, restoration has recently been completed at the Davies Merrill Site. Trout Creek exhibits an interesting pattern of having higher turbidity during low flow events. Water at the sampling location can become somewhat stagnant during low flow, due to many beaver dams upstream. The higher turbidity may be due to algal growth during these conditions.

Objective:

2. To identify land use practices that negatively impact the Truckee River watershed, the extent of impact, and the geographic locations of concern.

To address Objective 2, we can look for "hot spots" or areas that exhibit poor water quality in more than one aspect and we can also compare our data against state established water quality standards. These analyses will help us to pin-point locations of concern, and we may be able to then identify the causes of poor water quality.

"Hot Spots"

Union Valley Creek (GLEN-00) consistently shows elevated nutrients – nitrate, soluble reactive phosphorus, and total phosphorus. It has also had positive results for coliform bacteria. This stream drains the Glenshire Pond which is a shallow eutrophic body of water in the subdivision of Glenshire. This stream was added to our quarterly monitoring program in 2008 in order to better track water quality.

Squaw Creek has had consistently high electrical conductivity, turbidity, nitrate levels, and has had a high phosphorus reading. A sediment TMDL has been developed for this stream, but continued monitoring of other constituents such as nitrogen concentration should continue. The stream runs through a ski area, parking lot, and golf course. A restoration plan for the creek is in development, which should improve water quality once implemented.

Martis Creek has shown slightly elevated soluble reactive phosphorus at both monitoring stations. Additionally, total phosphorus at the lower station has consistently been high. This sampling site is just above where Martis Creek enters Martis Lake. There have been concerns over nutrient levels in the lake, particularly phosphorus. A preliminary study of phosphorus in the Martis watershed was undertaken by the Truckee Tahoe Sanitation Agency in 2004, however it was determined that further study was necessary. Martis Valley is a major focus area for Placer County, and several monitoring stations have been established in the Martis watershed (2nd Nature, 2008).

State Water Quality Standards.

The easiest standards against which to compare our data are those for nutrients. Table 11 contains standards for the Truckee River. Standards have only been established for a subset of our monitoring locations.

Table 11. California State Water Quality Objectives for the Truckee River Hydrologic Unit

Surface Water	Site ID	Total P (µg/L)	NO3-N (µg/L)	Total N (µg/L)	TKN (µg/L)
Trout Creek at Mouth	MTR-TROU-00	40	50	150	100
Squaw Creek at Mouth	MTR-SQCR-00	20	50	180	130
Bear Creek at Mouth	MTR-BEAR	20	50	150	100
Truckee River at Lake Tahoe outlet	MTR-TR01	10	20	120	100

Figures 28-30 show nitrogen data with standards indicated. Figure 31 shows total phosphorus data.

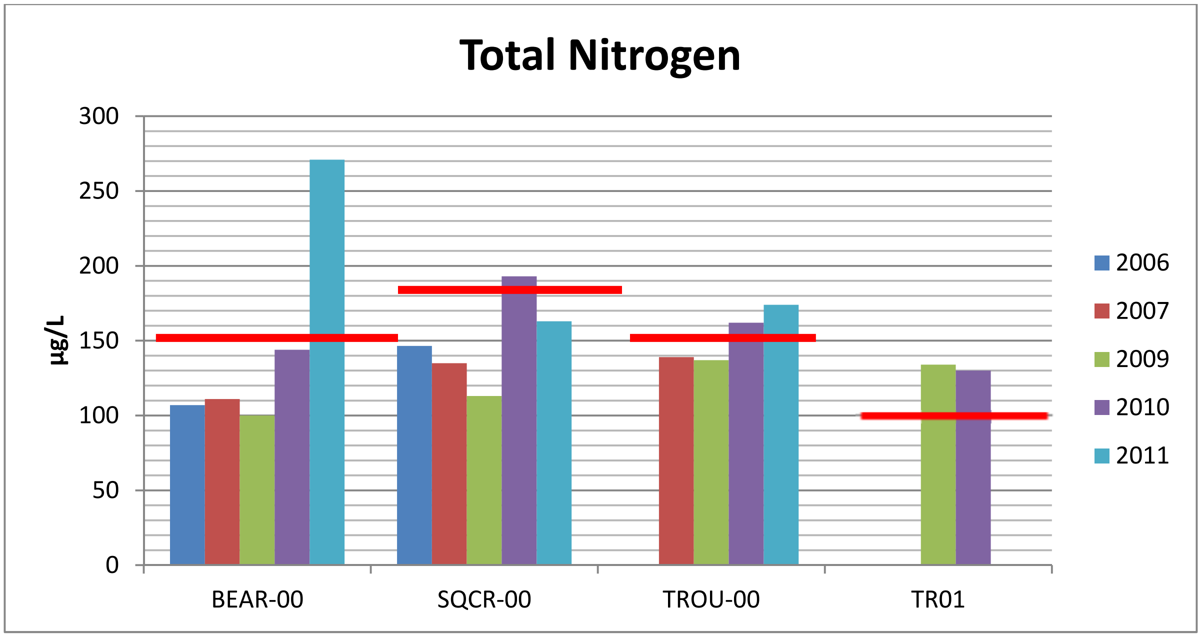

Figure 28. Total Nitrogen data for streams with California state standards. The red lines indicate the standard for each stream. Total nitrogen was only measured in 2006, 2007, 2009, 2010, and 2011.

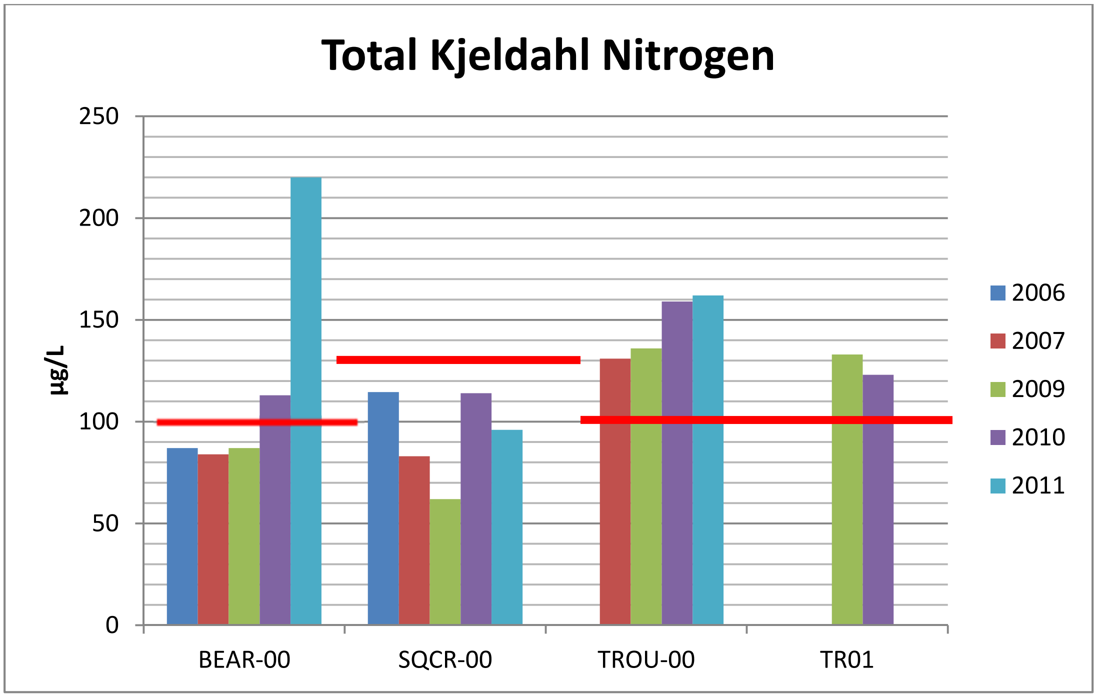

Figure 29. Total Kjeldahl nitrogen (TKN) for streams with California state standards. The red lines indicate the standard for each stream. TKN was only measured in 2006, 2007, 2009, 2010, and 2011.

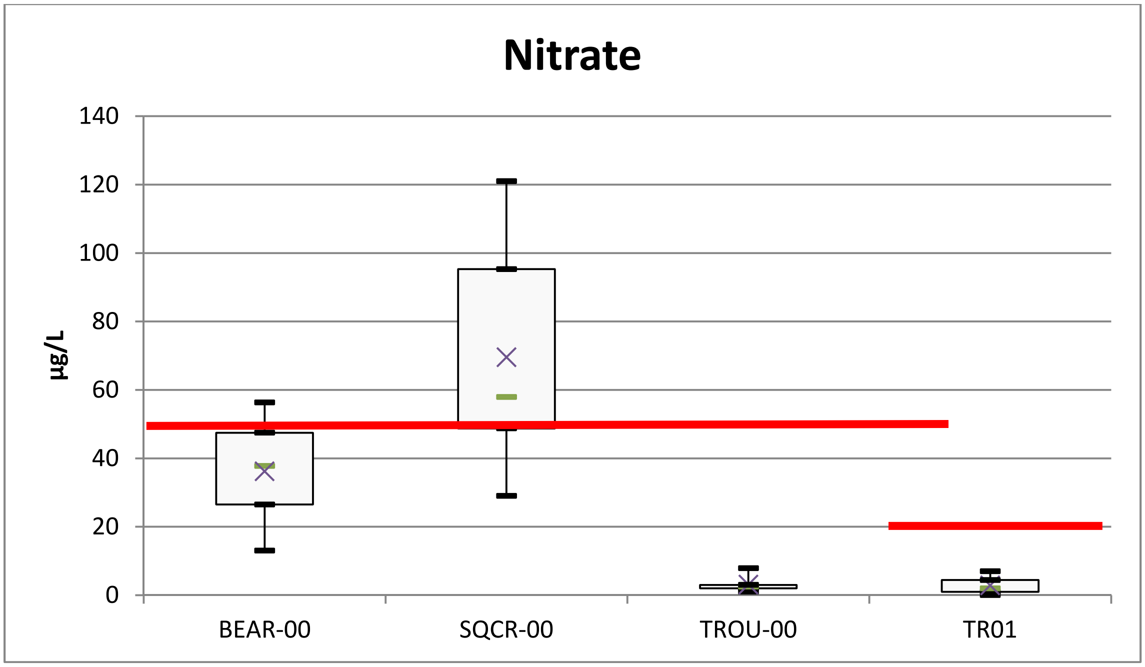

Figure 30. Nitrate for streams with California state standards. Nitrate has been measured since 2001; the box plots show the mean (X), median, maximum, minimum, 3rd quartile, and 1st quartile.

All of the streams monitored have exhibited at least one exceedance for one or more forms of nitrogen. TKN is an expensive analysis; therefore it has not always been possible to complete that analysis every year. However, these graphs point to the importance of analyzing all forms of nitrogen. If only nitrate is examined, then Trout Creek appears to be in good condition. However, once TKN is measured and total nitrogen can be calculated, a different picture emerges. Trout Creek has consistently exceeded the standard for TKN and has exceeded the standard for total nitrogen on one occasion. A similar picture emerges for the Truckee River at Lake Tahoe outlet (TR01).

Bear Creek has exceeded the nitrate standard on 3 occasions and Squaw Creek has exceeded the nitrate standard several times. However, both of these streams typically meet standards for both TKN and total nitrogen, with a couple exceptions.

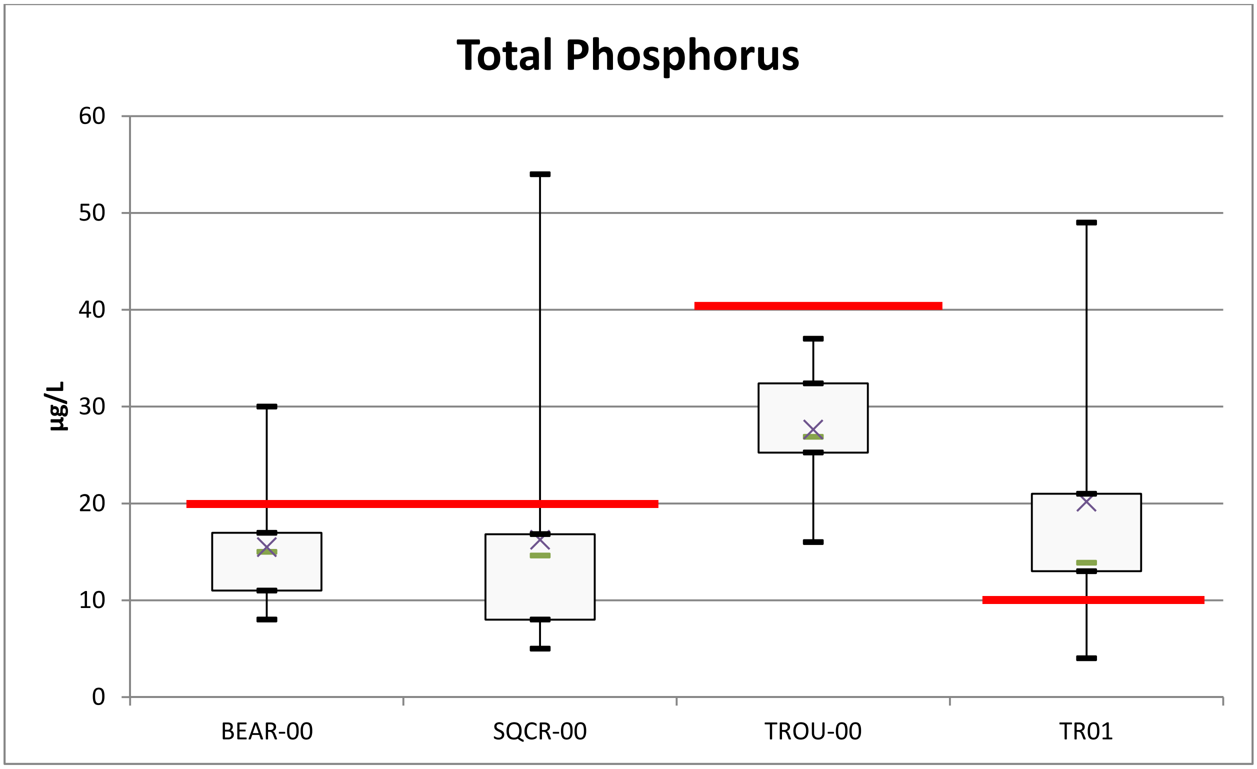

Figure 31. Total phosphorus for streams with California state standards. Total phosphorus has been measured since 2001; the box plots show the mean (X), median, maximum, minimum, 3rd quartile, and 1st quartile.

Phosphorus levels recorded from Trout Creek have always been below the state standard, whereas the other streams have exhibited exceedances on some occasions.

Comparisons with state standards show that most of the time, streams are meeting nutrient standards. However, all streams have exceeded at least one nutrient standard on at least one occasion. We will continue to monitor nutrients in these streams as funding allows.

Objective:

3. To engage and educate residents about local watershed processes and strengthen their understanding of watershed stewardship.

Over 83 volunteers participated in the monitoring program in 2011. Twenty-eight volunteers have committed to regular monitoring of 14 streams and 10 volunteers have committed to regular participation in the bioassessment team. Education is stressed at monitoring trainings and events and the level of awareness among participants has increased.

Objective:

4. To enhance the quality and quantity of data available for resource managers and decision makers in the Truckee River watershed.

The Town of Truckee and Placer County developed a water quality monitoring plan for a portion of the Truckee River watershed (2nd Nature, 2008), and are in the first phase of implementation. The Truckee River Watershed Council participated in plan development and we are participating in the citizen's advisory committee for implementation. Volunteer collected data were used to help shape the plan.

TRWC has begun an additional monitoring program in support of the Truckee River sediment TMDL, described below. We have formed an advisory committee for the project, with members from the Town of Truckee, Placer County, Lahontan Regional Water Quality Control Board, and U.S. Geologic Survey. The advisory committee will ensure coordination and data sharing among various monitoring efforts.

Objective:

5. To provide data that can be used to help monitor the implementation of the Truckee River sediment Total Maximum Daily Load (TMDL).

Most of these data should be considered baseline in terms of tracking implementation of the TMDL. The TMDL was adopted in 2008. TRWC has begun additional monitoring to support tracking of the TMDL, including establishment of continuous turbidity monitoring stations on two key tributaries (Cold Creek and Trout Creek) and further bioassessment studies, completed by contractors.   Volunteer collected data will help to track implementation of the TMDL as well. Turbidity values and sediment related bioassessment metrics will be analyzed over time. IBI scores will also help to assess impacts to aquatic communities from sediment.

Objective:

7. To collect data to help provide pre-TROA implementation data, and to establish a program that will help to track changes in the condition of biological resources in the Truckee River watershed once TROA is implemented.

The Truckee River Operating Agreement (TROA) is a plan for river management, currently under environmental review. TROA will affect dam operations in the Middle Truckee River watershed and one of the goals of TROA is to improve aquatic habitat in the river. A Biological Resources Monitoring Plan (BRMP) was developed with several stakeholders to monitor the impacts of TROA on biological communities in the river. However, the BRMP to date primarily consists of collecting turbidity data. To help fill some gaps, TRWC has collected benthic macroinvertebrate data from sites below dams that will be affected by TROA. The dams included in TROA are: Lake Tahoe, Donner Lake, Prosser, Boca, and Stampede. Martis dam is not included in TROA.

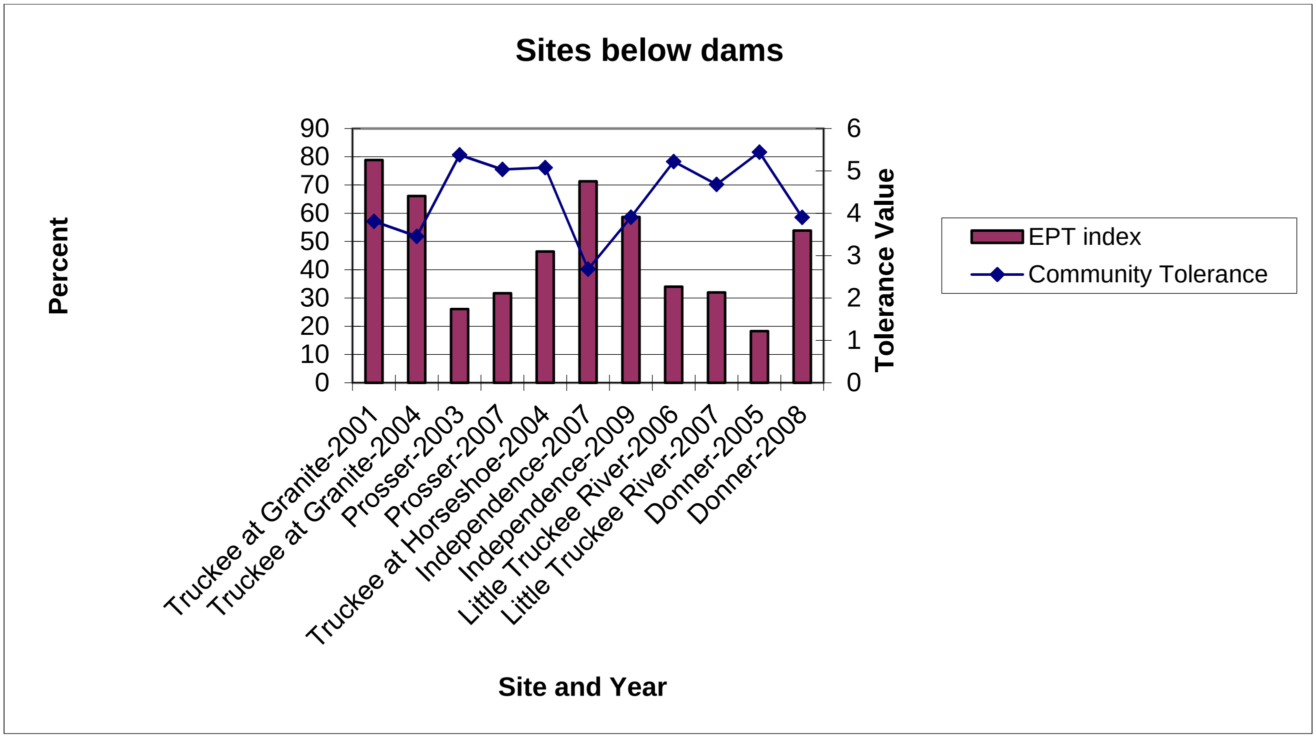

Figure 32. Community composition and tolerance data for sites below dams.

One commonly used metric of community composition is the “EPT Index”. This metric is simply the percent of the sample composed of insects in the order Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). Organisms in these orders tend to be less tolerant of poor water quality than other taxa. Additionally, this metric can be compared using both professionally and volunteer identified data. Community tolerance is also a good metric for looking at the overall biotic condition of the stream. Some of these below-dam sites are in fairly good condition based on these metrics (Figure 32), with the exception of Prosser Creek and the Little Truckee River.

Community composition metrics

Community richness is another metric that is a good indicator of ecosystem function. A more diverse community is typically more robust. One of the goals of the Truckee River Operating Agreement (TROA) is to ensure that dam operations have a minimal effect on biological resources in the Truckee River. Therefore, we would expect that family richness in streams or river segments directly affected by dams would remain similar after TROA is implemented. Because of the differences in taxonomic resolution and number of organisms counted, volunteer and professionally identified samples are not easily compared.

Another metric that is very indicative of the biological condition of the stream is % dominant taxon. This metric simply measures the percent of the sample that is made up of individuals in the most abundant species (or family in the case of volunteer identified samples). If a sample has a high % dominant metric, then there is likely to be some imbalance in the stream community. For example, Donner Creek has a very high % dominant (Figure 33). In this case, the most abundant type of insect is flies in the family Simuliidae (black flies). These are commonly found in streams where nutrients are high – they attach to rocks on the stream bottom and filter out organic materials from the water column.

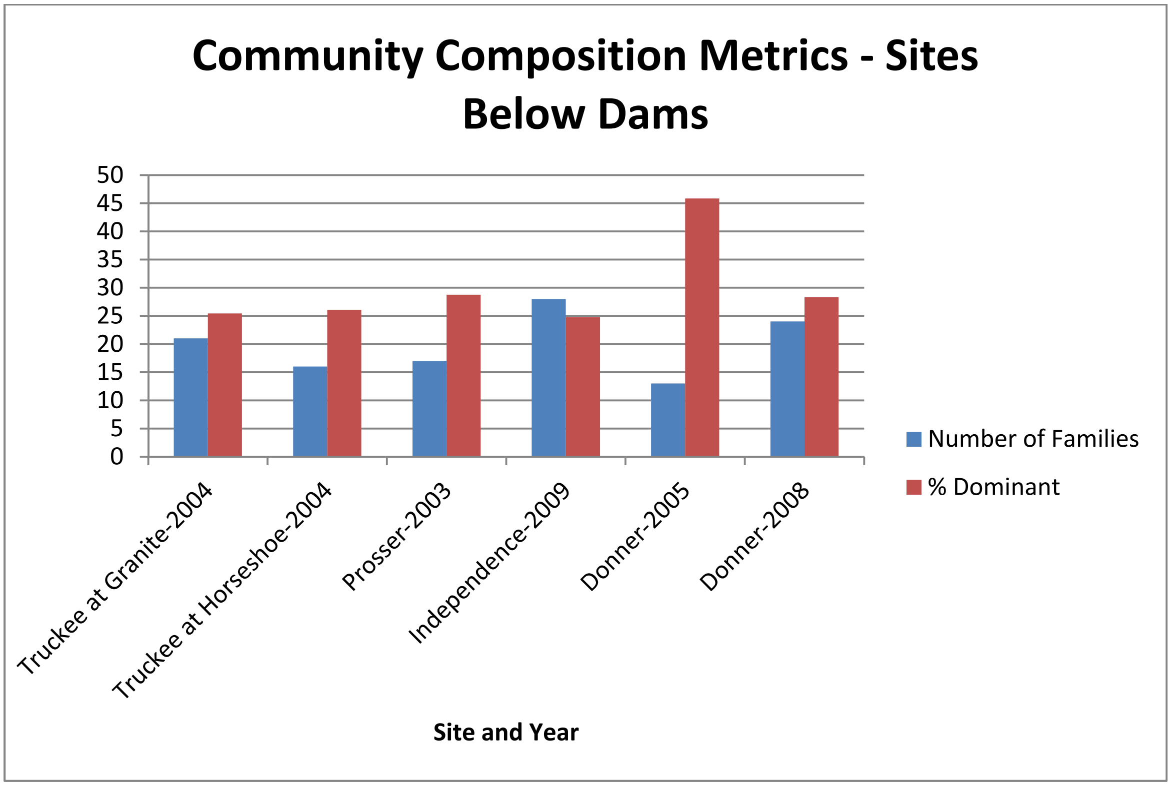

Figure 33. Community composition metrics for sites below dams, volunteer analyzed data. All data are from 300 count samples except Donner 2008 and Independence 2009 which are 500 count samples. % Dominant is not be affected by the difference, however family richness is likely to be – it should be higher in the larger sample.

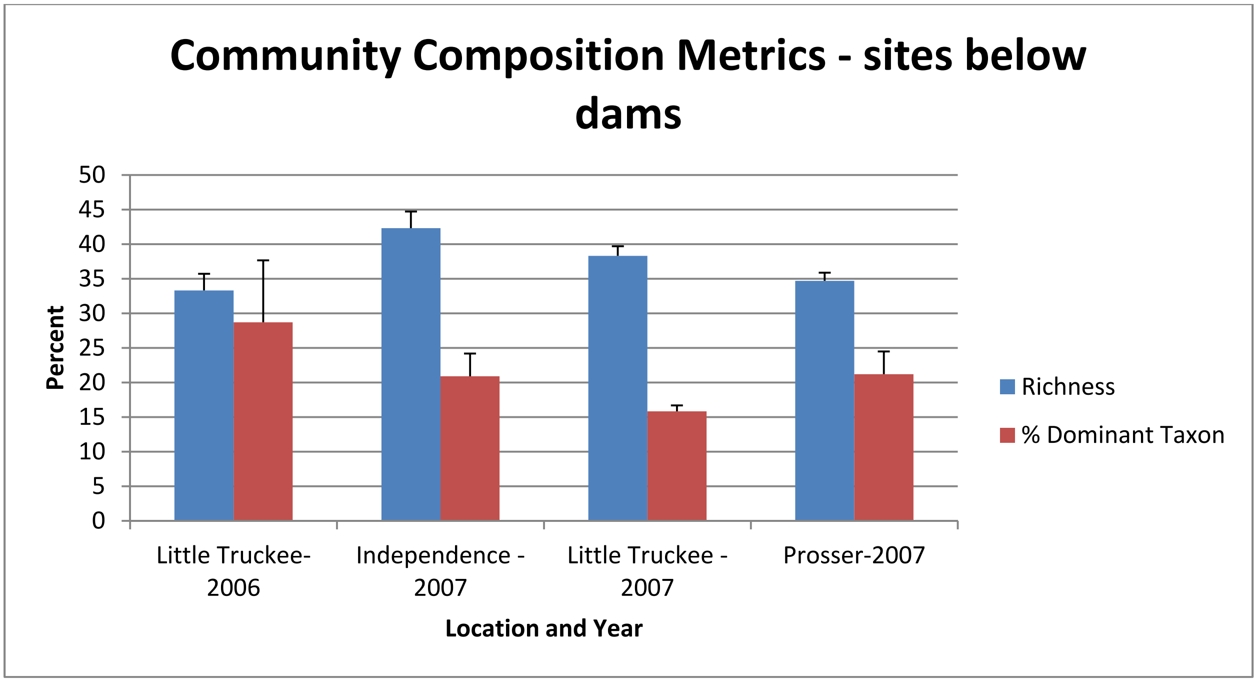

Figure 34. Community composition metrics for sites below dams, professionally analyzed data. Compared to the data in Figure 32, richness will be higher and % Dominant will be lower because of the greater taxonomic resolution.

Figures 33 and 34 show taxonomic richness and community composition metrics for TROA-affected streams. In general, the metrics indicate a fairly well balanced stream community at each of the sites. We will continue to track the biological condition of these sites through the process of TROA implementation.

4.0 CONCLUSIONS

The majority of water quality data indicate that the Middle Truckee river watershed is in fairly good condition. There are streams that have exhibited evidence of impairment, and we will continue to monitor these sites. Some of these sites such as Squaw, Martis, and Trout have been targeted for restoration work, so we expect to see improvement over time.

Collecting additional nutrient and coliform measurements during low flow times of year should be considered. At present, TRWC has only been able to perform these analyses in conjunction with Snapshot Day, when stream flow is at its peak. Both nutrients and coliform will concentrate with decreased flow, and we may find some impairment.

There continues to be strong volunteer involvement in our monitoring program. We anticipate being able to sustain and grow our existing programs to include more monitoring locations and volunteers while maintaining data quality. As we continue to monitor against our objectives, we will gain a greater understanding of our watershed.

5.0 REFERENCES

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