

Introduction

The first annual Snapshot Day 2001 was held on June 2nd, 2001 in the Lake Tahoe and Truckee River watersheds. More than 100 committed citizen-volunteers, working closely with many water quality management agencies, participated in gathering water quality information in the form of visual assessments, photos, and water quality data at 44 locations.

This collaborative effort was planned and coordinated by the Citizen Monitoring Working Group of the Lake Tahoe Environmental Education Coalition (LTEEC). The Citizen Monitoring Working Group includes independent citizens and representatives from non-profit organizations, agencies, and the academic community. Organizations involved in planning this event included the California State Water Resources Control Board, California Tahoe Conservancy, citizens at Fallen Leaf Lake, Incline Village General Improvement District, Lahontan Regional Water Quality Control Board, Lake Tahoe Community College, Lake Tahoe Marine Research and Education, League to Save Lake Tahoe, Sierra Club, Tahoe Regional Planning Agency, Tahoe Resource Conservation District, Truckee River Aquatic Monitors, U.S. Forest Service, UC Davis Tahoe Research Group, University of California Cooperative Extension, University of Nevada Cooperative Extension, and the University of Nevada Reno Electrical Engineering Department. The citizen-monitoring program of the California State and Regional Boards is the *Clean Water Team*, and the participating volunteers in the Lake Tahoe and Truckee River watersheds adopted that moniker as well.

What is Snapshot Day?

Snapshot Day is a one-day, volunteer-based event designed to collect watershed information during one moment in time. Volunteer leaders are trained, and these leaders accompany teams of volunteers to various pre-determined sites to collect information relative to the health of our watersheds. The purpose of this effort is two-fold: to promote environmental education and stewardship, and to collect valuable water quality information. While there is a great deal of high quality agency and research monitoring taking place in the region, there is still insufficient information to adequately assess the status of some of the aquatic resources in the Truckee River and Lake Tahoe Basin watersheds. With proper training and quality assurance, community volunteers can help fill this void by providing valuable information for watershed management and pollution prevention.

Citizen Monitoring: The Clean Water Team

The mission of the Clean Water Team citizen monitors is to produce environmental information that is needed to protect the Truckee River and Lake Tahoe Basin watersheds and aquatic resources. Citizen monitoring will inform and engage the community in effective watershed stewardship. *This team is one of the eight working groups of the Lake Tahoe Environmental Education Coalition whose goal is to support coordinated public outreach education efforts throughout the Tahoe Basin.*

The goals of the Citizen Monitoring Working Group are:

- Identifying valued resources and watershed characteristics for setting management goals,
- Identifying physical watershed characteristics influencing pollutant inputs, transport and fate,
- Identifying the status and trends of chemical characteristics and biological resources in and around an aquatic environment,
- Screening for water quality problems,
- Identifying pollution sources and illegal activities (spills, wetland fill, diversions, discharges),
- Establishing trends in water quality for waters that would otherwise be un-monitored,
- Evaluating the effectiveness of restoration or management practices,
- Evaluating the effect of a particular activity or structure,
- Evaluating the quality of water compared to specific water quality criteria, and
- Building awareness of water quality issues, aquatic resources and pollution prevention.

Citizen monitoring is designed to supplement existing agency monitoring efforts. The focus of the project is on habitat and chemical, physical and biological water quality measures that will identify the status of our aquatic resources. Citizen monitoring information is provided to the regulatory and resource management agencies, whose responsibility it is to protect water quality.



A Few Photos From Snapshot Day 2001

Methods

Citizen monitoring captains were provided training during the month prior to Snapshot Day. This training was provided by Dominic Gregorio of the California State Water Resources Control Board (SWRCB) Clean Water Team, and covered the visual observations, photo-documentation, water quality field measurements (dissolved oxygen, temperature, pH, conductivity), and water sampling (grab samples). There were three training sessions, one in Tahoe City and two in South Lake Tahoe. Each monitoring captain had to attend at least one session.

Visual observations and photo-documentation were performed according to the procedures provided by the SWRCB Clean Water Team. A standardized observation form, the California Stream and Shore Walk Visual Assessment Form, was employed. A minimum of three photos was taken at each sampling site (bed conditions, view across stream and view upstream from the starting point) and all stream-walks were initiated from a downstream position, traveling upstream.

There were a variety of instruments and kits used on Snapshot Day by the monitors. The majority of the monitoring teams were assigned Chemet dissolved oxygen kits (colorimetric, indigo carmine dye reaction, 1 mg/L resolution below 6 mg/L and 2 mg/L resolution above 6 mg/L), armored EnviroSAFE thermometers (alcohol filled, 0.5° C resolution) or hand-held digital thermometers (0.1° C resolution), non-bleeding Whatman pH indicator strips (0.5 pH unit resolution), and hand-held Oakton TDS Tester Conductivity meters (10 µS/cm resolution). Most of these instruments/kits were provided via funding from University of Nevada Reno (UNR) Electrical Engineering Department, with some other instruments/kits loaned from Lake Tahoe Community College (LTCC) and the California State Water Resources Control Board (SWRCB). Some of the monitoring teams were equipped with higher resolution instruments provided by UC Davis Tahoe Research Group, U.S. Geological Survey, Sierra Nevada College, Tahoe Regional Planning Agency (TRPA) and the SWRCB. Turbidity meters, to be used at two centralized drop off points, were supplied by the U.S. EPA and the US Forest Service. All of the instruments and kits were calibrated and tested/standardized at a quality control session held on the eve of Snapshot Day.

All observations, photos, field measurements and samples were taken between 9:00 am and 12:00 noon on June 2, 2001. All samples were kept chilled with ice or blue ice in coolers from the point of collection until analyzed. Coliform samples were collected in sterile Whirl-paks and nutrient and turbidity samples were collected in clean nalgene plastic bottles. Samples were brought to two centralized locations, Commons Beach and Lake Tahoe Community College. Coliform samples were then transported from these drop off points and delivered to the Lahontan Regional Water Quality Control Board laboratory within 4 hours of collection. The analysis procedure for fecal coliform was initiated within 6 hours of sample collection. Nutrient samples were kept refrigerated and then analyzed by Mark Palmer of High Sierra Lab within one week of sampling. Turbidity samples were run on the afternoon of Snapshot Day.

Site Locations

Volunteers gathered data at 44 locations in the Lake Tahoe and Truckee River watersheds (see maps in appendix), as follows:

North Shore Lake Tahoe:

- Blackwood Creek (West Shore)
- Burton Creek
- Dollar Hill Creek
- East Shore Lake Tahoe near Thunderbird Lodge
- General Creek (West Shore)
- Griff Creek (Kings Beach area, pond at old mill)
- Griff Creek (Kings Beach area, pedestrian bridge)
- Hatchery Creek at Star Harbor
- Incline Creek (Incline Village)
- Marlette Creek (East Shore)
- McKinney Creek (West Shore)
- Meeks Creek (Meeks Bay)
- North Shore Lake Tahoe Near Dollar Point Outfall #58
- North Shore Lake Tahoe Near Sunnyside
- North Shore Lake Tahoe Near Tahoe City Outfall #65
- North Shore Lake Tahoe Near Watson Creek
- Polaris Creek
- Rosewood Creek (Incline Village)
- Third Creek (Incline Village)
- Ward Creek (West Shore)

South Shore Lake Tahoe:

- Angora Creek
- Burke Creek
- Cold Creek at Pioneer Trail
- Edgewood Creek at Edgewood
- Fallen Leaf Lake
- Glen Alpine Creek (Fallen Leaf Lake)
- Heavenly Ski Area
- Shoreline South Shore Lake Tahoe (Ski Run Marina Harbor Entrance)
- Tahoe Keys
- Tahoe Keys Marina Cove East
- Taylor Creek
- Trout Creek
- Trout Creek (south of Pioneer Trail)
- Trout Creek Behind LTCC
- Upper Truckee River, Christmas Valley
- Upper Truckee River, Elks Club to Golf Course
- Upper Truckee River, Airport Reach
- Upper Truckee River, Mosher Reach

Truckee River Watershed:

- Bear Creek (Alpine Meadows)
- Shirley Creek (Squaw Valley)
- Squaw Creek (Squaw Valley)
- Steamboat Creek (Reno)
- Trout Creek - Railroad Tracks near Truckee River (Truckee)

- Truckee River 1/2 mile below Rampart Bridge
- Truckee River 200 m below first bridge below Squaw Creek
- Truckee River Dam Outlet (Tahoe City)

Results

Water temperature ranged from 7.0 to 22.6 ° C. The highest measured temperatures were at Steamboat Creek (17.3 ° C), Tahoe Keys Marina (18.5 ° C), and Taylor Creek on reach #2 (22.6 ° C). Generally, cooler water temperatures are considered better habitat for aquatic life in mountain streams and lakes. Cold water holds more oxygen, an essential ingredient for fish and invertebrates. Higher temperatures can occur as a result of low flow (shallow) conditions and/or a lack of canopy (tree) cover along stream banks. It should be mentioned that Steamboat Creek is outside the Tahoe Basin in Reno, Nevada and is at a much lower elevation than most of the other sites and in a high desert environment, where one would expect slightly higher temperatures.

The pH values for all measured sites fell within the range of 6.5-8.5, which is not atypical of fresh water streams or lakes in the Sierras. Conductivity measurements ranged from 4-170 $\mu\text{S}/\text{cm}$ (micro Siemens per centimeter, the units used for conductivity measurements in fresh water). Conductivity is used as an indicator of dissolved solids (e.g., minerals or salts), with higher levels associated with degraded water quality. The numeric value of total dissolved solids (TDS) is roughly 65% of the numeric value of conductivity measurements. TDS are measured in milligrams per liter (mg/L) which are equivalent to parts per million (ppm). Six sites had measurements $\geq$ (equal to or greater than) 100 $\mu\text{S}/\text{cm}$. The sites with elevated conductivity measurements, with their estimated corresponding TDS concentrations, are Hatchery Creek at Star Harbor (170 $\mu\text{S}/\text{cm}$, 111 mg/L), Burke Creek (137 $\mu\text{S}/\text{cm}$, 89 mg/L), Trout Creek in Truckee (130 $\mu\text{S}/\text{cm}$, 85 mg/L), Ski Run Marina (129.8 $\mu\text{S}/\text{cm}$, 84 mg/L), Griff Creek Reach 2 (120 $\mu\text{S}/\text{cm}$, 78 mg/L), and Edgewood Creek (120 $\mu\text{S}/\text{cm}$, 78 mg/L).

Dissolved oxygen measurements ranged between 4 and 10 mg/L. Cold, clean water usually has levels of dissolved oxygen averaging above 6.5 mg/L, and single-measurement levels below 5 mg/L are considered dangerous for (cold water) aquatic life. Six sites had oxygen levels below 6.5 mg/L. These were at Upper Truckee River at Mosher Ranch, near Highway 50 in South Lake Tahoe (4 mg/L), Squaw Creek (5 mg/L), Angora Creek (5 mg/L), Meeks Creek (above dam, 5.5 mg/L), Shirley Creek (6 mg/L), and Marlette Creek (6 mg/L).

Turbidity is a measure of the cloudiness of a water sample resulting mostly from suspended sediment, organic debris, or plankton in that sample. The U.S. Environmental Protection Agency's recommended criteria for turbidity in streams in Eco-Region II (forested mountains in the western U.S.), is 1.3 NTU (Nephelometric Turbidity Units). Higher NTU levels indicate poorer water clarity. Valid turbidity data was determined for nineteen sites, twelve of which had levels $\geq$ 1.3 NTU. The three most turbid sites were Taylor Creek (3.2 NTU), Tahoe Keys Marina (4.1 NTU) and Burke Creek (4.5 NTU).

Another way of measuring water clarity, primarily in lakes, bays and harbors, is by determining the transparency of the water using a Secchi disk. Some Secchi disk measurements were made on Snapshot Day. Additional Secchi disc measurements were made as part of the North American Secchi Dip-In, during July of 2001. In some cases, in shallow water, the Secchi disc could be seen all the way bottom, and those results are not

presented here. In other cases, where there was deep water or turbid conditions, the Secchi disk results are given below:

Date	Location	Secchi depth in meters
June 3	Tahoe Keys Marina	3.5
June 3	North Lake Tahoe	20.0
July 2	North Lake Tahoe	25.0
July 7	North Lake Tahoe	27.0
July 9	South Lake Tahoe (1 mile from Tahoe Keys)	17.0
July 9	Tahoe Keys Marina	3.0
July 19	Fallen Leaf Lake	21.9

Of the above results, the worst readings were from Tahoe Keys Marina, where the Secchi depth measurements (the point at which the disk was no longer visible) were only 3.0 and 3.5 meters below the surface. These measurements do not meet the EPA's recommended minimum criteria for Secchi depths in lakes in Eco-Region II, which is 4.5 meters.

Stream flow data was obtained from USGS gauging stations, which corresponded to many of the Snapshot Day monitoring sites. In general, flows were relatively low this year due to lower precipitation (snow pack) conditions. Low flow conditions can have an impact on several water quality parameters such as dissolved oxygen, conductivity, temperature, and algae growth.

Visual observations at most of the study locations were indicative of generally good water quality conditions. For example floating oil or highly turbid conditions were not observed anywhere. There were, however, a few locations that did exhibit indications of some water quality degradation. Five locations (starting and/or ending points) had algae covering over 25% of the streambeds or shores. These locations were at Tahoe Keys Marina, Hatchery Creek at Star Harbor, Angora Creek, Ward Creek and Polaris Creek (Polaris Creek was nearly dry during the Snapshot and was not representative of flowing conditions). The worst locations were Tahoe Keys Marina and Angora Creek, with algae observations exceeding 50% coverage at either the starting or ending points of the surveyed reach or shore. However, it should be noted that Angora Creek displayed considerable variability with regard to algal coverage, since the starting point on that reach had no observable algae.

Thirty-seven samples were analyzed for nutrient concentrations. One of those nutrients was ammonia. Ammonia is a reduced, toxic form of nitrogen and is usually associated with the decomposition of organic matter and wastes. Only four samples had ammonia nitrogen concentrations >10 µg/L (micrograms per liter, equivalent to parts per billion). These samples were from Truckee River below the dam at Lake Tahoe (21 µg/L), Hatchery Creek at Star Harbor (13 µg/L), Edgewood (52 µg/L), and Taylor Creek (11 µg/L).

In terms of total nitrogen, the EPA's recommended criterion for streams in Eco-Region II is 100 µg/L. None of the samples tested exceeded that level for total inorganic nitrogen (ammonia + nitrite + nitrate nitrogen). Only five sites were >25 µg/L total inorganic nitrogen. These sites were Edgewood Creek (88 µg/L), Taylor Creek (45 µg/L), McKinney Creek (40 µg/L), Dollar Hill Creek (33 µg/L), and Incline Creek (32 µg/L).

Nitrogen in the form of ammonia, nitrite or nitrate is a nutrient that stimulates the growth of algae in streams and lakes. Algae include benthic forms, attached to the rocks and sediment of the streambeds (as observed by the monitors), as well as phytoplankton. Phytoplankton are microscopic single cell algae that drift in the water and cause the water to have a green color. Benthic algae and phytoplankton are essential components to the ecosystem, in relatively large concentrations these organisms are known to reduce water clarity, or reduce oxygen levels during the evening. One cause for decreasing clarity in Lake Tahoe is an increase in phytoplankton populations as a result of increasing nutrient concentrations.

Phosphorous is another nutrient that stimulates algal growth. Most of the samples (32 out of 37) were above the EPA's recommended criteria for streams in Eco-Region II, which is 8.75 µg/L total phosphorous. Over half of the samples (21) were at least twice as high (17.5 µg/L total P) as that EPA criterion. Phosphorus pollution has been identified as a serious problem contributing to the degradation of water quality in Lake Tahoe. Sediment entering streams from the erosion of rocks, soil, and roads is a common source of phosphorous. When phosphorous is in the form of orthophosphate molecules it is considered "soluble reactive phosphorous," the form of phosphorous that stimulates algae to grow. Eight sites had levels > 8.75 µg/L for soluble reactive phosphorous. These sites were Trout Creek in Truckee (13 µg/L), Dollar Hill Creek (16 µg/L), Hatchery Creek at Star Harbor (9 µg/L), Incline Creek (9 µg/L), Marlette Creek (13 µg/L), Upper Truckee River at Christmas Valley (9 µg/L), Edgewood (19 µg/L) and Angora Creek (10 µg/L).

Valid coliform bacteria data was developed for eighteen sites. Fecal coliform bacteria are a group of bacteria that are mostly found in the feces of warm-blooded animals, including humans, livestock, beaver, and birds. *E. Coli* is a common type of fecal coliform bacteria. Of these eighteen sites, four sites had fecal coliform levels in excess of 40 CFU/100 ml (CFU/100 ml are colony forming units, roughly equivalent to the number of bacteria cells, in 100 ml of sample water). These sites were Hatchery Creek at Star Harbor (706 CFU/100 ml), Edgewood Creek (474 CFU/100 ml), Ski Run Marina (134 CFU/100 ml), and Trout Creek in Truckee (46 CFU/100 ml).

One disturbing result involved trash. Over half of the reaches studied (24 out of 44) had some form of trash present at their starting and/or ending points. The worst points observed, with over 5 pieces of trash visible from the observation point, were on General Creek, Incline Creek, Polaris Creek, Hatchery Creek at Star Harbor, and Trout Creek behind Lake Tahoe Community College.

The UNR Electrical Engineering Department is storing all of the data and photos electronically. Visual assessment data, water quality data, and site photographs will be made available for viewing on <http://paradise.ee.unr.edu>.

Discussion

It is important to remember that the measurements made on Snapshot Day were designed to represent a single point in time and do not necessarily represent average conditions. Still, it is interesting to compare the results with some applicable standards. As mentioned in the results, the U.S. EPA has recommended criteria for nutrients, Secchi depth, and turbidity. These and other EPA recommended water quality criteria are considered by the states when developing their own water quality standards.

In California, the Lahontan RWQCB water quality standards are composed of the beneficial uses and objectives described in the Basin Plan. The Lahontan Basin Plan is approved by the U.S. EPA, and includes many watershed specific standards. The Basin Plan takes into account the natural background levels of certain constituents. For example, concentrations of dissolved solids and nutrients are relative to natural geologic conditions; in other words, some water bodies have naturally higher levels of these substances. Likewise, the State of Nevada's Division of Environmental Protection also has water quality standards that are specific to certain watersheds and their beneficial use. Some of Lake Tahoe's Nevada tributaries also have standards to maintain higher quality waters.

Some of the standards are somewhat complex, in some cases requiring complex calculations. For example, one must consider the temperature and pH of a water sample when determining the allowable concentrations of ammonia. While a full discussion of all of the standards is not within the scope of this report, the following table provides some relatively simple examples, mostly paraphrased, of a few of the standards.

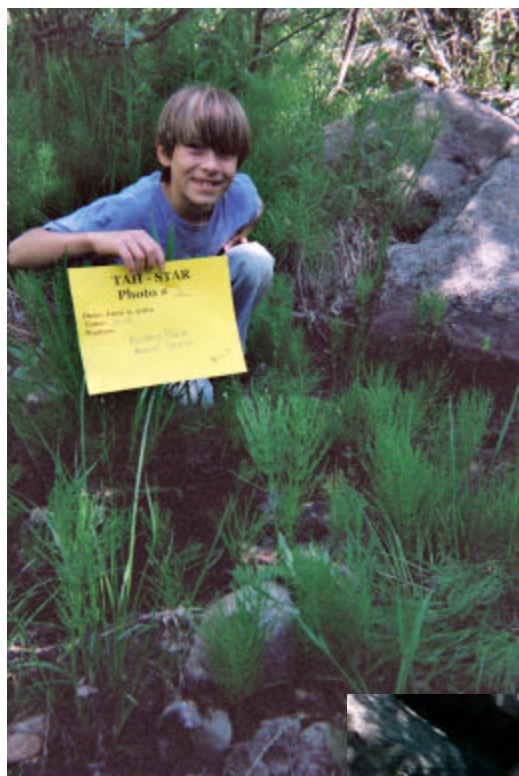
Parameter	Standard
Temperature	Shall not exceed 15 C, surface waters of Fallen Leaf Lake
pH	7.0-8.4 in Lake Tahoe (CA and NV)
TDS	Shall not exceed 60 mg/L average in Lake Tahoe (CA and NV)
Dissolved Oxygen	Mean no less than 6.5 and minimum of 4.0 mg/L, Lahontan waters designated as "cold freshwater habitat"
Turbidity	Shallow water shall not exceed 3 NTU near tributaries and 1 NTU not directly influenced by streams (TRPA)
Secchi Depth	December-March average of not less than 33.4 meters for Lake Tahoe (TRPA), and a mean of 18.5 meters for Fallen Leaf Lake (Lahontan)
Algae	Lahontan waters shall not contain biostimulatory substances (nutrients) that cause algae to become a nuisance or to affect the water's beneficial uses.
Total Nitrogen	Mean of no more than 190 µg/L for most tributaries (CA)
Inorganic Nitrogen	Mean of no more than 25 µg/L, Nevada side of Lake Tahoe (TRPA)
Soluble Phosphorous	Mean of no more than 7 µg/L, Nevada side of Lake Tahoe (TRPA)
Fecal Coliform	Log mean of 20 CFU (30 day period) and maximum of 40 CFU, Lahontan Region

For full and more detailed information on water quality objectives in California refer to the Lahontan Regional Water Quality Control Board Basin Plan at the following website: <http://www.swrcb.ca.gov/rwqcb6/> and select "Downloads." For water quality standards in Nevada see the following website: <http://ndep.state.nv.us/bwqp/standard.htm>. For the Tahoe Regional Planning Agency (TRPA) water quality standards, see the following website: <http://www.trpa.org/Documents.htm> and select "Environmental Threshold Carrying Capacities."

Snapshot Day was not only successful in engaging the public in active watershed stewardship, but it also provided much valuable data to the responsible agencies. Just one example is the collection of eighteen coliform samples over a wide area all on the same day.

This is the first time that such a sampling effort was undertaken. The Lahontan RWQCB used the data from this effort to focus on “hotspots” for fecal coliform. Based on the Snapshot results additional samples were collected and analyzed, and appropriate regulatory action was taken. In one case, new control measures implemented by an operator resulted in improved water quality.

A great deal was learned during this first snapshot day, both by the volunteers and by the organizers. A corps of citizen monitors has now been trained and field-tested to assist the agencies in continuing water quality monitoring. We all plan to build on this initial effort to encourage continuing monitoring throughout the year, during runoff events, and on Snapshot Day 2002!



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Appendices

Lake Tahoe Watershed Map
Truckee River Watershed Map
Field and Lab Data (6-2-01)