TAHOE: STATE OF THE LAKE REPORT 2012

UC DAVIS
TAHOE ENVIRONMENTAL RESEARCH CENTER

A PORTION OF THE FUNDING USED TO ASSEMBLE AND DISTRIBUTE
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CONTENTS, CONTINUED

INTRODUCTION

The University of California, Davis, has conducted continuous monitoring of Lake Tahoe since 1968, amassing a unique record of change for one of the world's most beautiful and vulnerable lakes.

In the UC Davis Tahoe: State of the Lake Report, we summarize how natural variability, long term change and human activity have affected the lake's clarity, physics, chemistry and biology over that period. We also present the data collected in 2011. The data shown reveal a unique record of trends and patterns – the result of natural forces and human actions that operate at time scales ranging from days to decades. These patterns tell us that Lake Tahoe is a complex ecosystem, behaving in ways we don't always expect. This was never truer than in this last year where despite a very wet winter, clarity improved markedly over the previous year. While Lake Tahoe is unique, the forces and processes that shape it are the same as those acting in all natural ecosystems. As such, Lake Tahoe is an analog for other systems both in the western U.S. and worldwide.

Our role is to explore this complexity and to use our advancing knowledge to suggest options for ecosystem restoration and management. Choosing among those options and implementing them is the role of those outside the scientific community and needs to take account of a host of other considerations. This annual report is intended to inform non-scientists about the most important variables that affect lake health. Until recently, only one indicator of Lake Tahoe's health status was widely used: the annual clarity (often called the Secchi depth, after the instrument used to collect the clarity data). In this report we publish many other environmental and water quality factors that all provide indicators of the lake's condition.

This report sets the context for understanding the changes that are seen from year to year and those that are observed over a time scale of decades: Was Lake Tahoe warmer or cooler than the historical record last year? Are the inputs of algal nutrients to the lake declining? How much are invasive species affecting Lake Tahoe? And, of course, how do all these changes affect the lake's famous clarity?

The data we present are the result of efforts by a great many scientists, students and technicians who have worked at Lake Tahoe throughout the decades since sampling commenced. I would, however, like to acknowledge (in alphabetical order) the contributions of Veronica Alumbaugh, Brant Allen, Nancy Alvarez, Patty Arneson, Sudeep Chandra, Bob Coats, Kristin Fauria, Bill Fleenor, Alex Forrest, Allison Gamble, Alfredo Gimenez, Charles Goldman, Scott Hackley, Tina Hammell, Alan Heyvaert, Simon Hook, Andrea Hoyer, Debbie Hunter, Peter Hunter, Emily Iskin, Camille Jensen, Anne Liston, George Malyj, Dan Nover, Kristin Reardon, John Reuter, Bob Richards, Dave Rizzo, Heather Segale, Steve Sesma, Nicole Shaw, Todd Steissberg, Collin Strasenburgh, Raph Townsend, Katie Webb and Monika Winder, to this year's report.

Funding for the actual data collection and analysis comes from many sources. While many additional water quality variables could be tracked, funding ultimately limits what we measure. Current funding for the long-term monitoring and analysis is provided by the Lahontan Regional Water Quality Control Board, the Tahoe Regional Planning Agency, the U.S. Forest Service, the U.S. Geological Survey and UC Davis. Our monitoring is frequently done in collaboration with other research institutions and agencies. We are grateful for the participation of our colleagues in the Tahoe Science Consortium. In particular we would like to acknowledge the U.S. Geological Survey (USGS), the Desert Research Institute (DRI), the University of Nevada, Reno (UNR), the National Aeronautics and Space Administration (NASA), and the U.S. Forest Service. Some data are also collected as part of research projects funded through a variety of sources. Without these data there are many questions that could not even be asked let alone answered.

This year we are presenting updates on some recent research, as well as providing updates on the lake monitoring efforts. These new research results highlight some of the most exciting findings of work that is still in progress, and will be reported on fully in the months and years to come.

Part of the cost for the production of Tahoe: State of the Lake Report this year was provided through funding by the California Tahoe Conservancy. We gratefully acknowledge that funding.

Sincerely,

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EXECUTIVE SUMMARY

The long-term data set collected on the Lake Tahoe ecosystem by the University of California, Davis, and its research collaborators is an invaluable tool for understanding ecosystem function and change. It has become essential for responsible management by elected officials and public agencies tasked with restoring and managing the Tahoe ecosystem, in part because it provides a basis for monitoring of progress toward reaching Tahoe's restoration goals and desired conditions.

This annual Tahoe: State of the Lake Report presents data from 2011 in the context of the long-term record. While the focus is on data collected as part of our ongoing, decades-long, measurement programs, this year we have also included summarizing current research on detailed sections summarizing current research on lake color, near-shore attached algae (periphyton), Angora Fire, gyres and currents in Lake Tahoe, boat traffic in Emerald Bay, forest health, and progress on the efforts to control Asian clams. This year's report also includes data about changes in the algae composition and abundance, lake clarity, and the current effects of climate change on precipitation, lake water temperature and density stratification.

The UC Davis Tahoe Environmental Research Center (TERC) has developed sophisticated computer models that help scientists predict and understand how Lake Tahoe's water moves and how the entire ecosystem behaves. Long-term data sets are essential to refine the accuracy of those models and to develop new models as knowledge increases and new challenges arise. In times of rapid change, reliable predictive models are indispensable tools for Lake Tahoe Basin resource managers. This report is available on the UC Davis Tahoe Environmental Research Center website (http://terc.ucdavis.edu).

In many respects 2011 was an unusual year for Lake Tahoe. From the point of view of weather, precipitation and air temperature were extreme—the winter of 2010-2011 was one of the wettest on record and the temperatures were some of the coldest on record. More of the precipitation occurred as snow than has been the trend lately, and the spring snowmelt timing was relatively late.

Lake level was a little more than a foot above the natural rim in early 2011, but during the massive snowmelt it rose by 3.9 feet. The annual average surface water temperatures increased by 0.6 deg. F this year, even though winter surface temperatures were some of the coldest on record and the July water temperatures were also cool. The stability (the energy needed for mixing) of the upper 330 feet of the lake was calculated for the first time this year, and it was found that this index had remained relatively constant over the last 43 years. What was noticeable, however, was that the length of time that the upper waters remain stratified has increased by almost 20 days in this same period, a likely outcome of climate change.

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[1] *"Previous year" for some parameters means data collated in terms of the water year, which runs from October 1 through September 30; for other parameters, it means data for the calendar year, January 1 through December 31. Therefore, for this 2011 report, water year data are from Oct. 1, 2010 through Sept. 30, 2011. Calendar year data are from Jan. 1, 2011 through Dec. 31, 2011.*

EXECUTIVE SUMMARY

(CONTINUED FROM PAGE 2.1)

A factor different to last year was the depth of mixing. This year the entire 1645-foot depth of the lake mixed.

Despite these extreme weather conditions, the annual average lake clarity showed a marked improvement over 2010, increasing by 4.5 ft. Such large year-to-year fluctuations are not unusual in the long term record, and are part of the reason we advocate focusing on the long term changes rather than annual or even shorter term changes when trying to evaluate effectiveness of management programs.

On careful examination it can be seen that there are actually two underlying trends in the annual Secchi data. First there is an actual improvement in winter clarity, something that has been occurring for a decade. In 2011 winter clarity improved 11.9 feet over 2010. At the same time there is the continued decline in summer time clarity. In 2011, summer clarity was the second worst value on record. The improvement in winter clarity may be due to recent efforts to reduce urban stormwater flows to the lake. However, an independent, comprehensive urban stormwater monitoring program is needed to establish reliable data to substantiate this hypothesis. The decline in summer clarity may be related to the impacts of climate change. In the last few years lake conditions are strongly favoring the growth of *Cyclotella*, a tiny (4-10 micron) diatom-algae cell. Numbers of Cyclotella have grown exponentially in the last five years, particularly in the surface layers where Secchi depth would be impacted. These small cells strongly scatter light, producing lower Secchi disk values. It is evident from the data that the times of maximum Cyclotella concentration coincide with the lowest summer Secchi depths. While some of the conclusions presented herein are still working hypotheses, they serve to remind us of the importance of controlling both inorganic particles and nutrients to Lake Tahoe. This is a focus of the recently enacted clarity TMDL for Lake Tahoe.

Asian clams, a non-native species that has flourished in Lake Tahoe in the last few years has been the subject of Agency control efforts, and research has played an important role in this work. Continued monitoring of a half acre treatment site in Nevada, has shown that 12 months after treatment was completed, Asian clams are only returning in very small numbers. On the opposite side of the lake in Emerald Bay, research has played an important role in testing and designing for the unique needs of an Asian clam control program at the sill separating the bay from the lake. Researchers identified sub-surface flows that transported oxygen to clams and are now working with agencies on implementing a new treatment strategy to take place this fall.

ABOUT LAKE TAHOE AND THE TAHOE BASIN

- Maximum depth: 1,645 feet (501 meters), making it the 11th deepest lake in the world and 2nd deepest lake in the United States
- Average depth: 1,000 feet (305 meters)
- Lake surface area: 191 square miles (495 square kilometers)
- Watershed area: 312 square miles (800 square kilometers)
- Length: 22 miles (35 kilometers)
- Width: 12 miles (19 kilometers)
- Length of shoreline: 72 miles (116 kilometers)
- Volume of water: 39 trillion gallons
- Number of inflowing streams: 63, the largest being the Upper Truckee River
- Number of outflowing streams: one, the Truckee River, which leaves the lake at Tahoe City, Calif., flows through Truckee and Reno, and terminates in Pyramid Lake, Nev.
- Average residence time of water in the lake: about 600 years
- Average elevation of lake surface: 6,225 feet (1,897 meters)
- Highest peak in basin: Freel Peak, 10,891 feet (3,320 meters)
- Latitude: 39 degrees North
- Longitude: 120 degrees West
- Age of the lake: about 2 million years
- Permanent population: 55,000 (2010 Census)
- Number of visitors: 3,000,000 annually

ABOUT THE UC DAVIS TAHOE ENVIRONMENTAL RESEARCH CENTER (TERC)

The UC Davis Tahoe Environmental Research Center (TERC) is a world leader in research, education and public outreach on lakes, their surrounding watersheds and airsheds, and the human systems that both depend on them and impact them. TERC provides critical scientific information to help understand, restore and sustain the Lake Tahoe Basin and other lake systems worldwide. We partner closely with other institutions, organizations and agencies to deliver solutions that help protect Lake Tahoe and other lakes around the world.

TERC's activities are based at permanent research facilities in the Tahoe Basin and at the University's main campus in Davis, California, about 90 miles west of the lake.

Our main laboratories and offices are in Incline Village, Nevada, on the third floor of the Tahoe Center for Environmental Sciences building. On the first floor, we operate the Thomas J. Long Foundation Education Center, a learning resource that is free and open to the public.

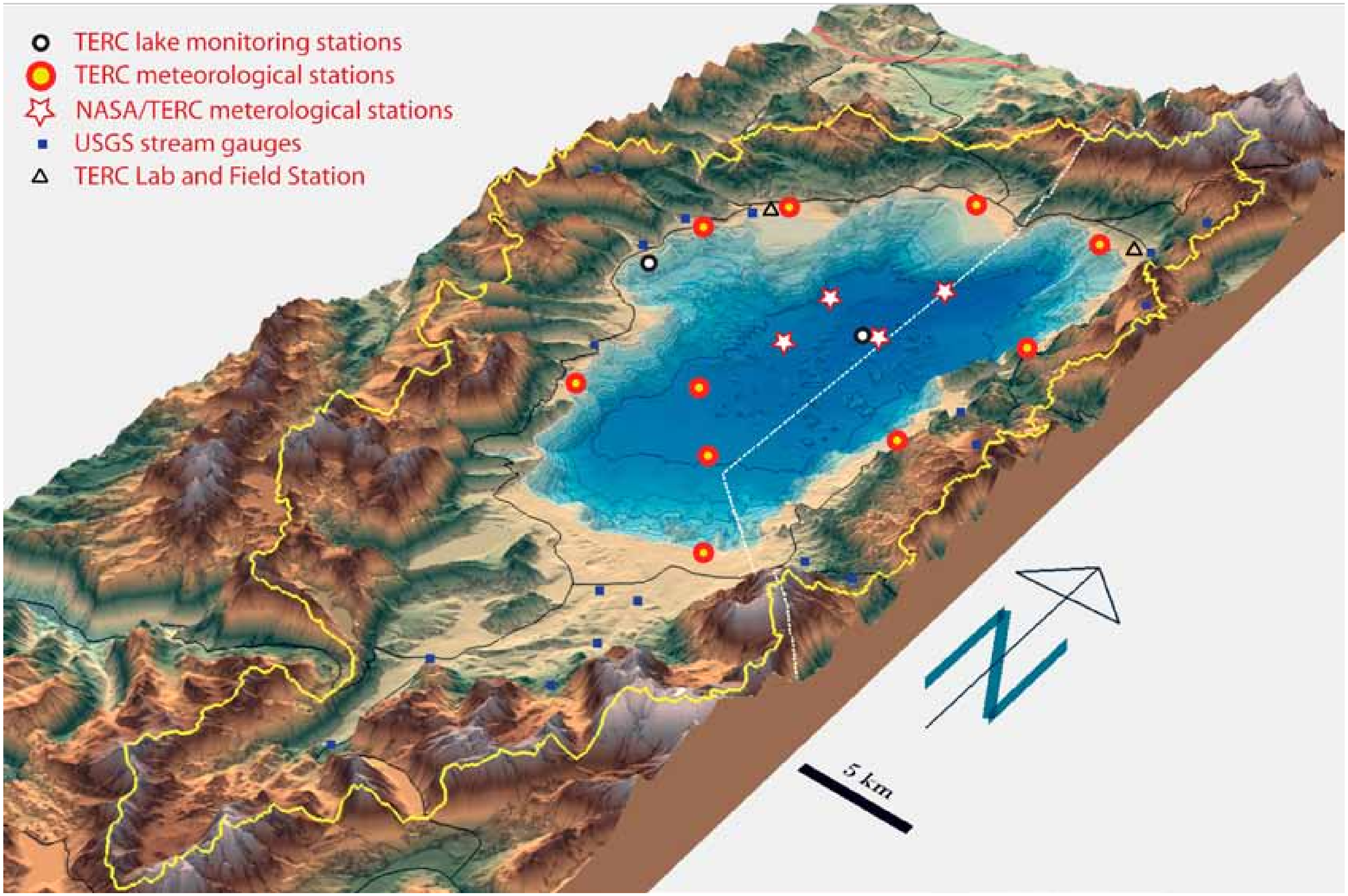
In Tahoe City, Calif., we operate a field station (housed in a fully renovated, former state fish hatchery) and the Eriksson Education Center (opened in July 2010). Tahoe City is also the mooring site for our three research vessels, the John LeConte, the Bob Richards and the Ted Frantz.

Our secondary laboratories and offices are located on the UC Davis campus at the Center for Watershed Sciences.

Our website (terc.ucdavis.edu) has more information about our programs, including:

- Information for potential students, staff, faculty, and research collaborators;
- Access to near-real-time meteorological data gathered by our network of sensors;
- A list of publications;
- Exhibits and events at the Education Centers; and
- Information about supporting our research and teaching programs.

MAP OF TAHOE BASIN DATA COLLECTION SITES



TAHOE: STATE OF THE LAKE REPORT 2012

RECENT RESEARCH UPDATES

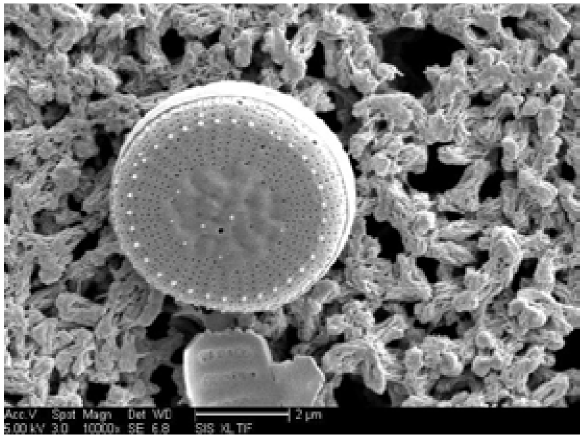
UC DAVIS
TAHOE ENVIRONMENTAL RESEARCH CENTER

Overview

Each year different research areas emerge as the most topical in the State of the Lake Report. In past years we have focused on topics such as the remote sensing, climate change, and the emergence of Asian clams as a major threat to Lake Tahoe's ecosystem. This year we are taking a broad look at a range of ongoing research. These include the issues associated with invasive species in Emerald Bay, the currents of the lake, the long-term water quality impacts of the Angora Fire and forest health.

Emerald Bay boat traffic across the sill was recorded in 2011 using a remotely operated camera.

This Aquadopp instrument measured current velocity at one-inch intervals through the water column in Emerald Bay. The instrument was on loan from the University of Iceland.



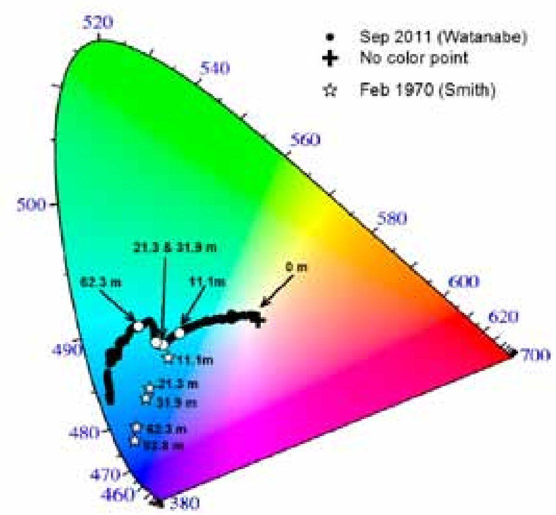
Cycoletella sp. diatoms are very small algae which are less than 4 microns in size. This size of particle scatters light causing a reduction in lake clarity.

RECENT RESEARCH UPDATES: LAKE PHYSICS

Lake Tahoe color

Lake Tahoe is renown for its dazzling blue color. In the early 1880s, it was said that the Lake water was “Marie-Louise blue”, the color of the French army uniforms. The intense blue results from light scattering in deep and very dilute waterbodies. Using state-of-the-art field and lab instruments, we measured individual wavelengths in the full spectral range and converted them to color. Values were less blue than reported in 1970 (the only other time similar measurements have been made). This is supported by visual observations by the two long-term TERC boat captains. Also, note how real water color changes with depth. Employing these sophisticated techniques, color change can serve as an indicator of lake optical properties, along with Secchi depth. Additional measurements are planned for February, 2013.

In the early 1880s, it was said that Lake Tahoe water color was “Marie-Louise blue”, the color of the French army uniforms

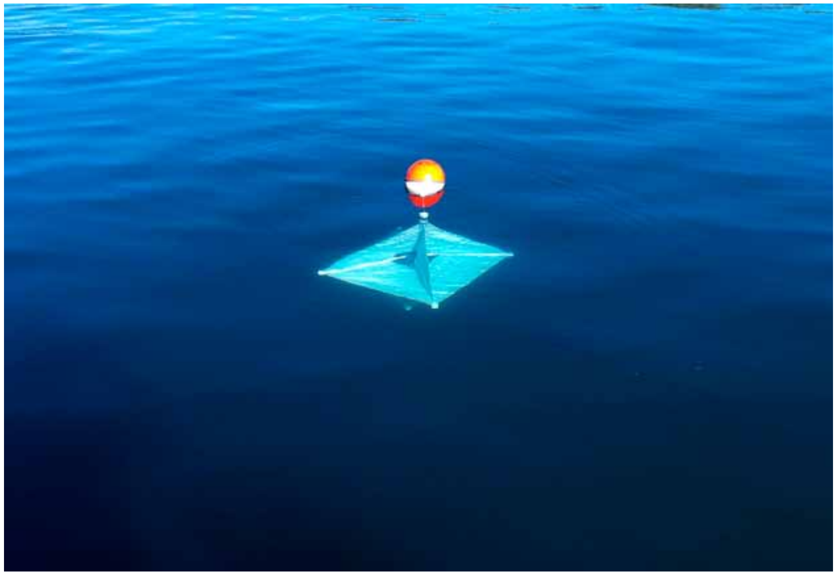


A plot of the true color of Lake Tahoe at different depths in 1970 and 2011

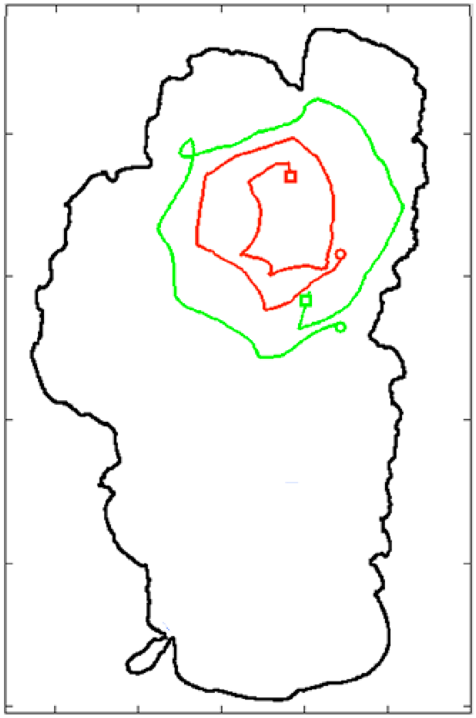
Research buoys on Lake Tahoe a collaborative project with UC Davis TERC and NASA/JPL

Gyres within Lake Tahoe

Gyres are the names given to large scale circular motions that are traced out by currents in large lakes and the ocean. In lakes such as Tahoe, they arise on account of both the wind patterns and the earth's rotation. One way of measuring gyres is to use drogues, that comprise of underwater sails connected to a surface buoy containing a GPS recorder and satellite transceiver (left panel). Two drogues were released in Lake Tahoe between August 18 and August 22, 2011. The map below shows the path of the drogues and the gyres they traced out. The squares represent where they were released and the circles where they were picked up. Both drogues traced out a counter-clockwise gyre, consistent with previous satellite observations.

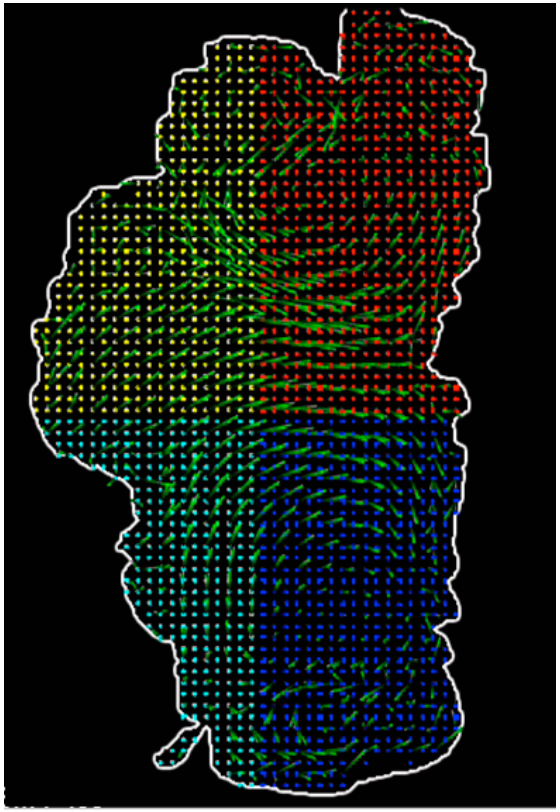


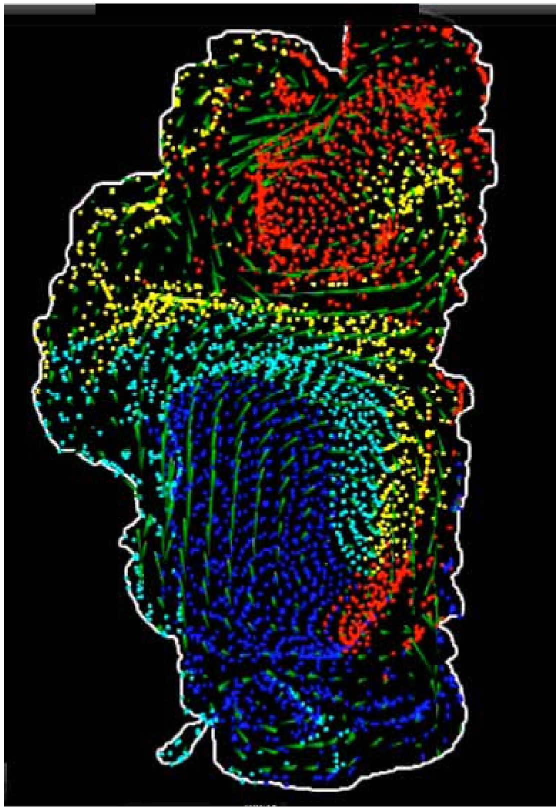
Drogue floating in Lake Tahoe used to measure surface currents



Gyres within Lake Tahoe, continued

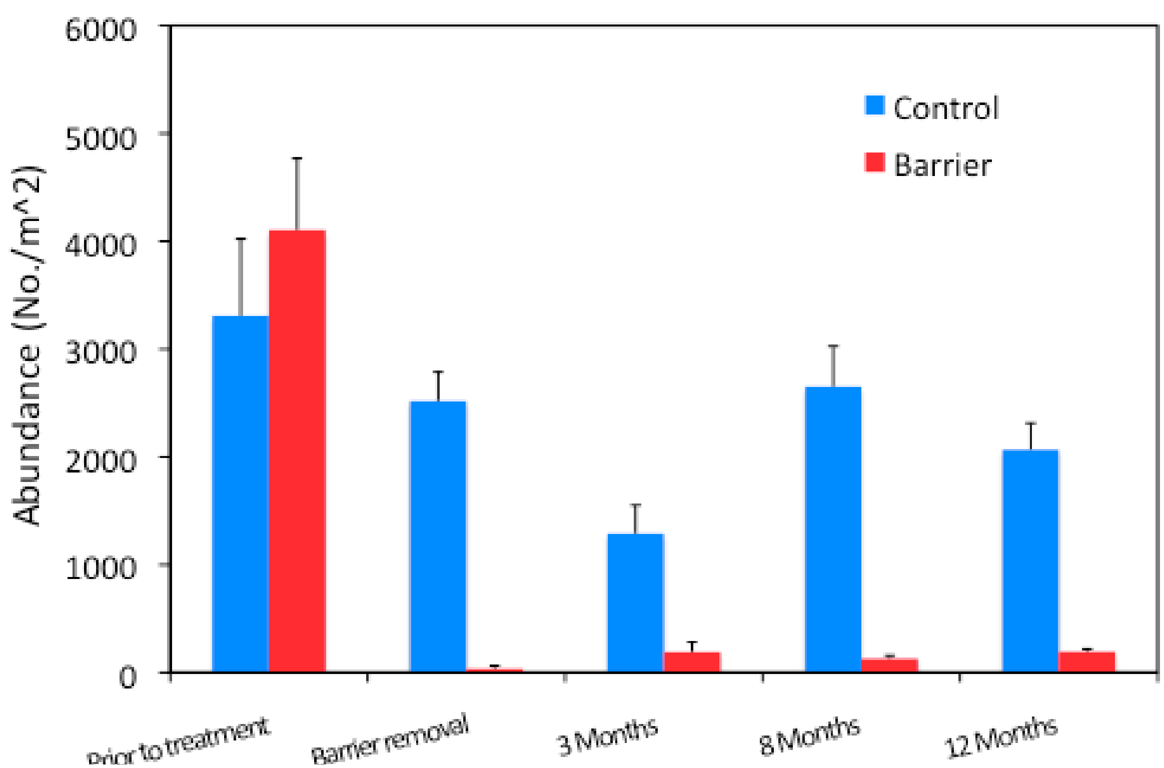
Computer models help us better understand the processes that occur within Lake Tahoe. The green pointers in the figure below show the surface currents in Lake Tahoe on one day in August. The red, yellow, cyan and blue dots represent "floating particles" that have been added to the surface. In the figure on the right we see how these particles have been moved by the gyres in just 18 hours. The counter-clockwise gyre in the north of the lake is evident, as is a clockwise gyre in the south of the lake. Smaller gyres are evident closer to the shoreline. What is most remarkable is the distance around and across the lake that particles (and pollutants) can get carried in a relatively short time.





Asian clams: Large-scale experiment

In June 2010 two half-acre synthetic rubber barriers were placed over the Asian clam infestations in the southeast portion of the lake to deprive the clams of oxygen. The barriers were removed after 120 days. Clams under the barrier were reduced by more than 98 % due to oxygen removal. Twelve months later, clam density was still reduced by more than 90%. The density of of clams in an untreated "control" plot remained high throughout. Non-targeted benthic organisms were also reduced, but they returned at greater rates than the Asian clams. The data shown is from Marla Bay. This work is a joint effort by UC Davis and University of Nevada, Reno.



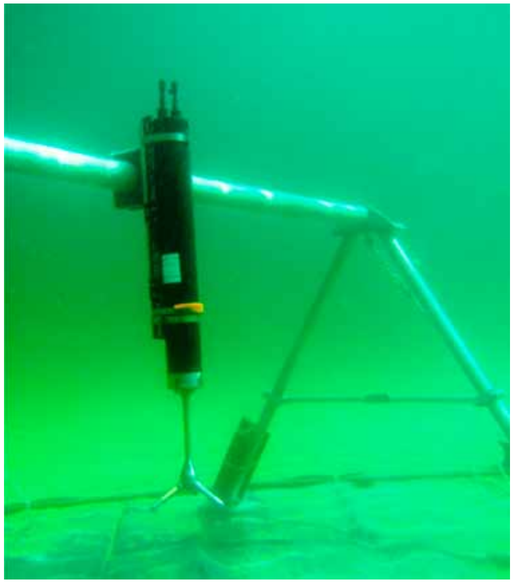
RECENT RESEARCH UPDATES: AQUATIC INVASIVE SPECIES

Asian clams in Emerald Bay

Asian clams on the sill between Emerald Bay from Lake Tahoe, necessitated experiments to confirm whether their spread can be controlled. Unlike prior Asian clam infestations, the Emerald Bay population was adjacent to heavy boat traffic and was on a permeable glacial moraine.

A test rubber barrier (100 ftx10 ft) was installed in the Emerald Bay boat channel (left panel – barrier at lower center) and acoustic instruments (right panel) were installed to measure water velocity over the barriers. Instruments for measuring water temperatures and dissolved oxygen were also installed. The results indicated that boat wakes did not disturb the rubber mats, however, despite this, the dissolved oxygen did not fall sufficiently under the barriers to kill the clams in the expected 30 days. This was due to water travelling through the permeable sill from Lake Tahoe to Emerald Bay, carrying highly oxygenated water.

Aerial photo of the rubber bottom barrier installed on the sill of Emerald Bay



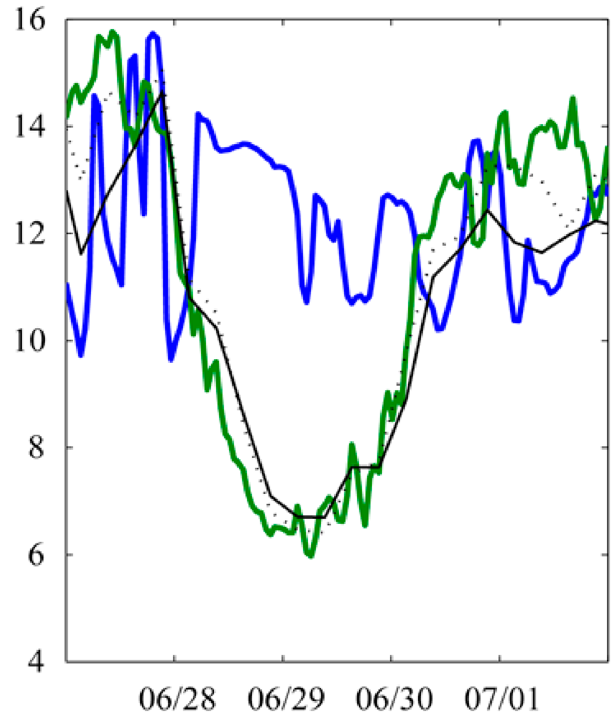
Acoustic instrument used to measure water velocity across the sill of Emerald Bay

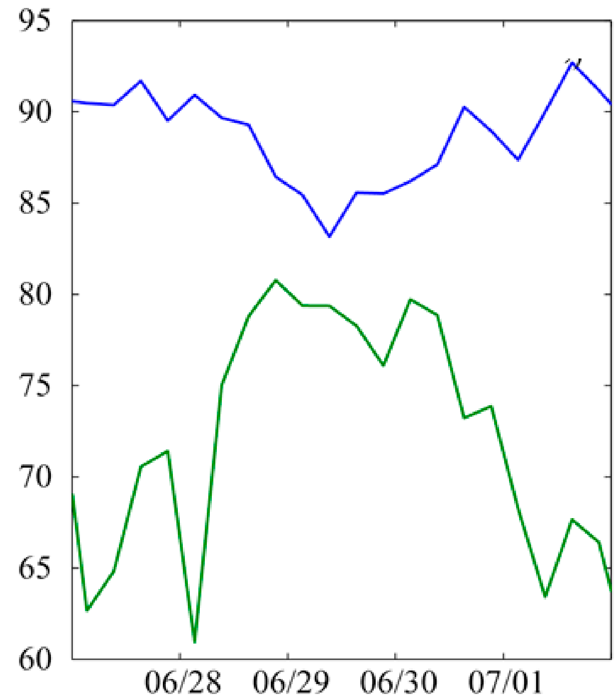
Asian clams in Emerald Bay, continued

The left panel shows water temperature (deg C) in Lake Tahoe (green line), in Emerald Bay (blue line), beneath the barrier (black line) and above the barrier (dotted line). When the lake temperature dips, the colder water is transmitted though the sill to the barrier in a few hours.

The right panel shows the oxygen below the mat (green line) at the same time in terms of percent oxygen saturation. The blue line is dissolved oxygen above the barrier. Such spikes in oxygen are sufficient to sustain the clams.

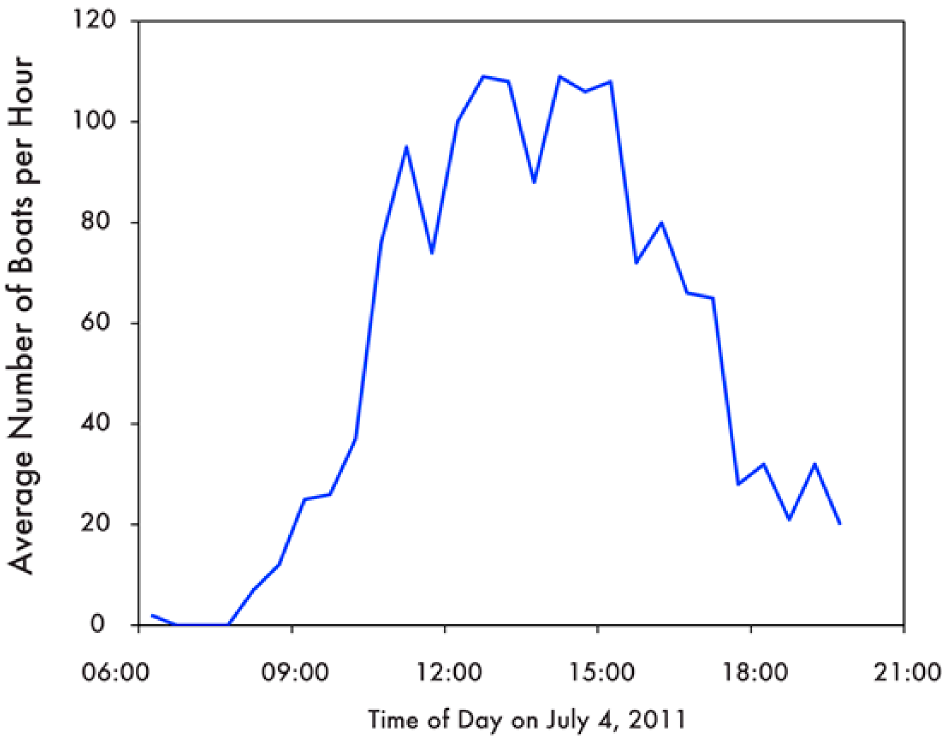
Experiments using organic material under the barriers have produced much lower oxygen under the barriers, sufficient to produce clam mortality under these conditions. This approach will be used in 2012-2013 in Emerald Bay.





Boats in Emerald Bay

Emerald Bay is the most frequented part of Lake Tahoe, but exactly how many boats pass through the channel each day has not been known. As part of an invasive species study at Emerald Bay, TERC researchers mounted a high resolution camera in a tree above Emerald Bay, and images were recorded every 10 seconds. The results indicated that July was the busiest boating month, with almost 1000 boats visiting the bay on a single day (July 3). The figure below indicates the number of boats per hour entering Emerald Bay on July 4, 2011. In the middle of the day this number exceeded 110 boats per hour.



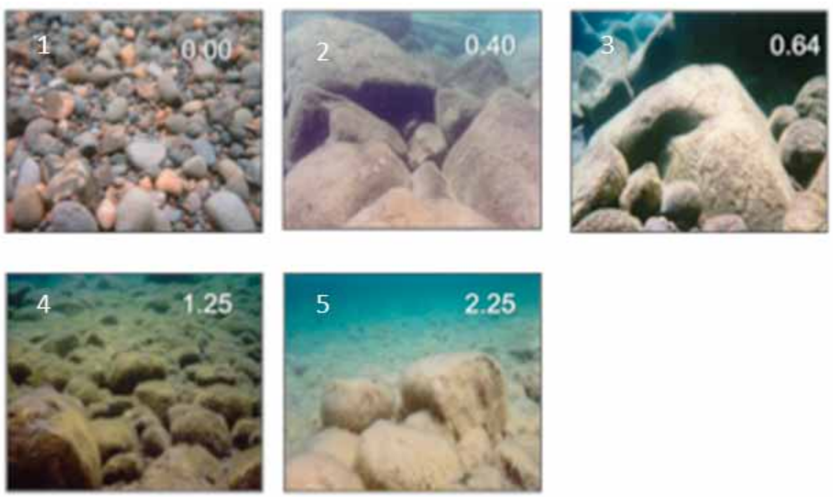
RECENT RESEARCH UPDATES: BIOLOGY

Desired conditions for shoreline algae

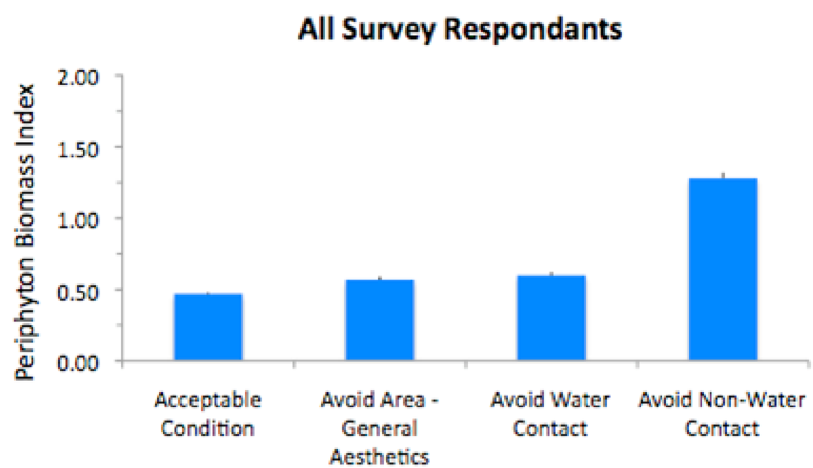
Water quality standards to protect Lake Tahoe from excessive shoreline algae are underway. One approach to setting these target values involves public perception.

Nearly 150 visitors to the UC Davis, Thomas J. Long Education Center were asked to rank five photos. Each condition received a PBI (periphyton biomass index) score, related to the area of bottom covered and length of the algae. The photographs covered a range of PBI values including, 0.00 (no visible biomass), 0.40 (limited biomass), 0.64 (moderate biomass), 1.25 (heavy biomass) and 2.25 (very heavy biomass).

A PBI of 0.50-0.60 was considered acceptable for aesthetics and non-water contact (between photos 2 and 3). A higher values of 1.25 (photo 4) was considered the upper limit for non-water contact activities.



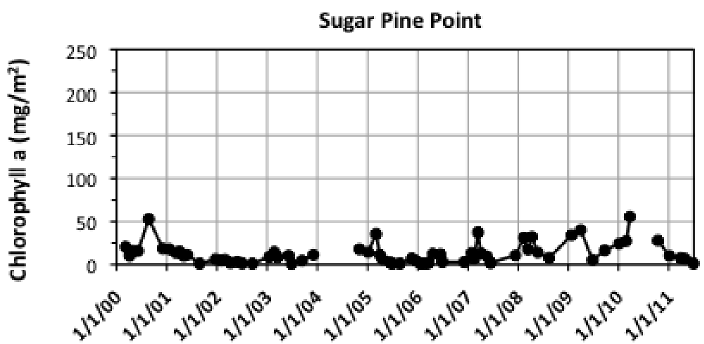
Periphyton Biomass Index (PBI) for different substrate conditions

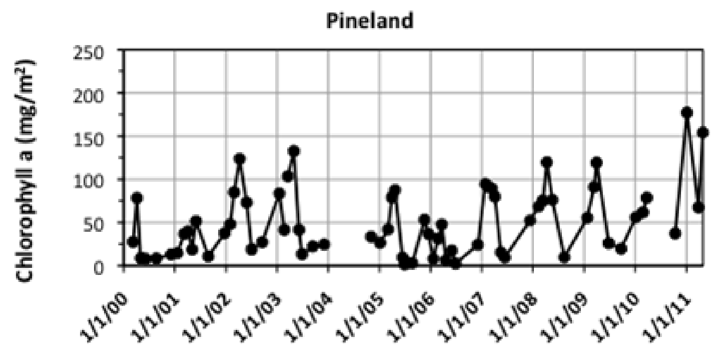


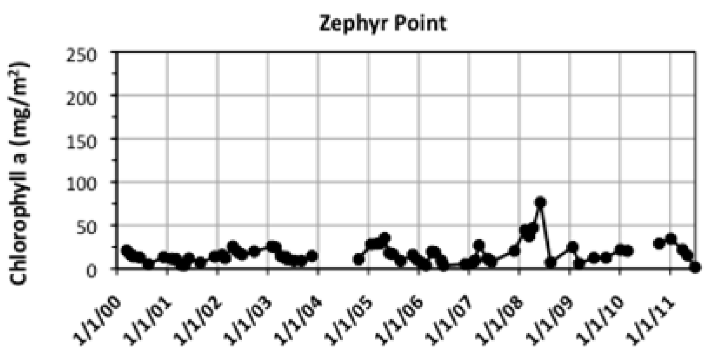
RECENT RESEARCH UPDATES: BIOLOGY

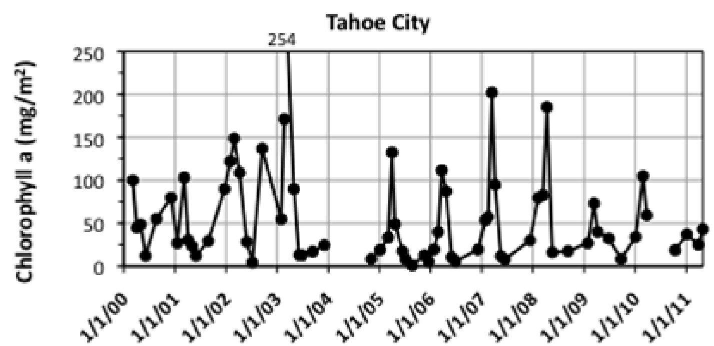
Time series for shoreline algae

Unsightly shoreline algae exhibit a distinct and regular seasonal pattern with a peak in the late-winter to early spring. These points of annual maximum are best seen in areas of high urban development and high algal growth (e.g. Pineland and Tahoe City). Algae declines rapidly following maximum growth and is often washed up on the shore or trapped in marinas and other enclosed areas. Minimum algae are seen in the summer and by December-January the buildup begins anew.









Angora Fire: Stream Water Quality

The 2007 Angora Fire burned 3,100 acres or 9 % of the Upper Truckee River drainage. A large portion of the burn area was on steep slopes. Angora Creek water quality data were collected within the burn area, upstream of the residential parcels, with wide agency support. DRI, USGS and TERC partnered in this study. The 'x' symbol in the Table represents the increase above the baseline level.

Data from a 1991-2000 El Dorado County study served as a baseline for water quality.

Nitrate spiked in 2008 but returned to baseline by 2010. Total N, Total P and sediment increased, although less dramatically and have remained elevated, but constant. In 2010 turbidity was still above baseline. Conductivity, a measure of ionic concentration, returned to baseline in 2010.

While concentrations in Angora Creek are still higher than historic conditions, no effects have been seen further downstream in the Upper Truckee River or in Lake Tahoe. A full report of the study was published in the journal Biogeochemistry in 2011.

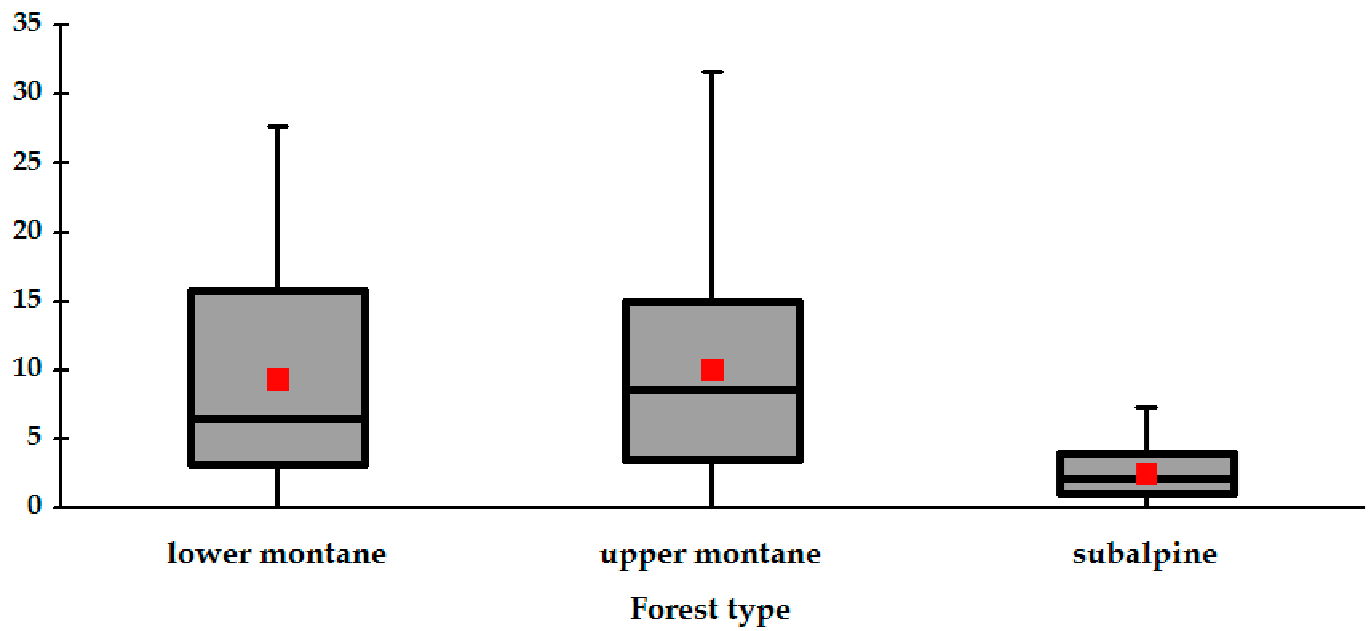
	Baseline Concentration 1991 - 2000	Post - Angora Fire 2008	2009	2010
Nitrate	6 µgN/L	12.2 x	8.2 x	1.3 x
Total nitrogen	154 µg/L	1.0 x	1.7 x	1.6 x
Soluble phosphorus	3 µg/L	2.0 x	1.7 x	1.7 x
Total phosphorus	15 µg/L	1.3 x	1.6 x	1.7 x
Suspended sediment	2.0 mg/L	1.9 x	2.3 x	1.8 x
Turbidity	0.55 NTU	2.9 x	4.5 x	3.8 x
Conductivity	23 µS/cm	1.7 x	1.8 x	1.2 x

Tree mortality

From 2007 to 2009 forest health assessments (observations of pathogens, insects, and mortality) were made across elevation zones in the Lake Tahoe Basin by researchers from the UC Davis and USDA Forest Service collaborators.

These are long-term monitoring plots to evaluate changes in forest health conditions in the Lake Tahoe Basin.

The highest levels of mortality were found in upper montane forests (dominated by red fir and western white pine), followed by lower montane mixed-conifer forests (white fir, Jeffrey pine, sugar pine and incense cedar), with the lowest levels of mortality in subalpine forests dominated by whitebark pine.

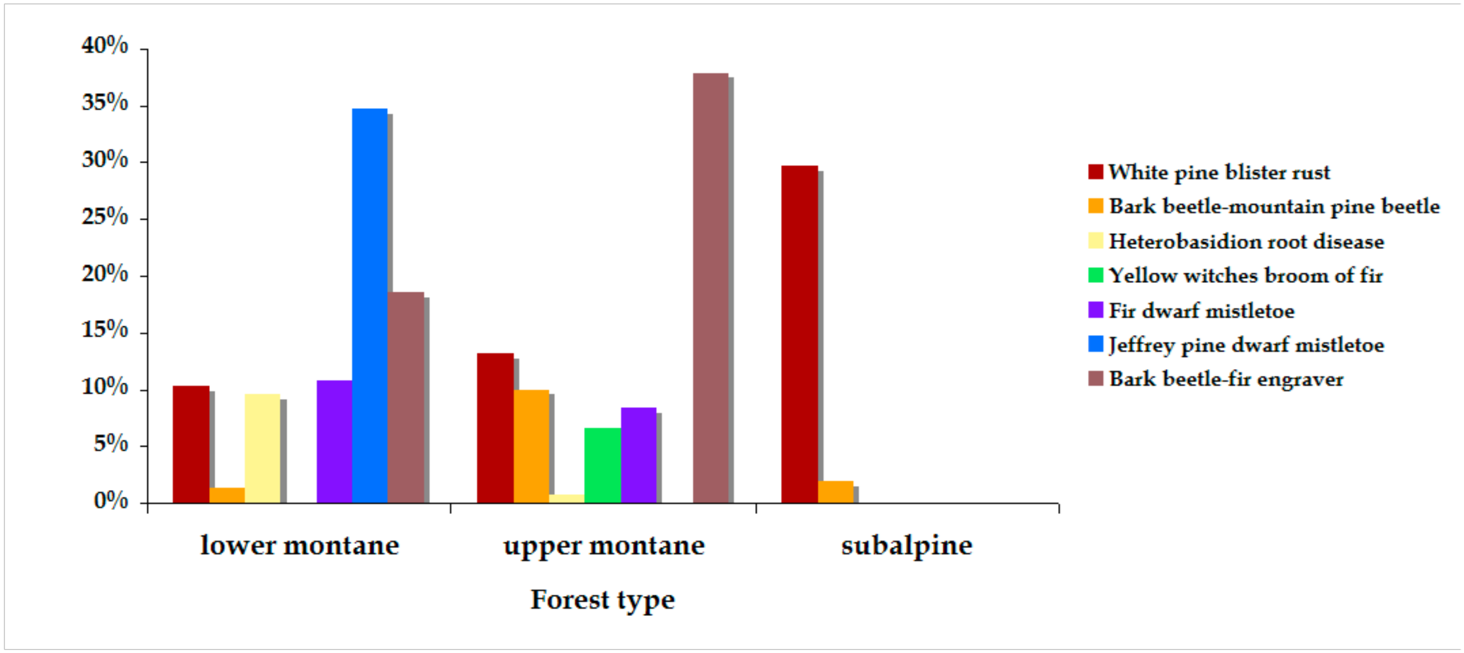


RECENT RESEARCH UPDATES: FOREST HEALTH

Tree mortality, continued

As shown, bark beetles and dwarf mistletoes are the most common forest pests found across forest types. Dwarf mistletoe, root diseases, and white pine blister rust, in combination with drought stress, can predispose trees to bark beetle attack and subsequent beetle-mediated mortality.

High disease pressure is found in the Lake Tahoe Basin by the invasive and exotic pathogen, Cronartium ribicola (cause of white pine blister rust), infecting sugar pine (lower montane), western white pine (upper montane), and whitebark pine (subalpine). Adverse effects of white pine blister rust are on cone production (i.e. reproductive output) and survival of small- and intermediate-sized trees.



TAHOE: STATE OF THE LAKE REPORT 2012

METEOROLOGY

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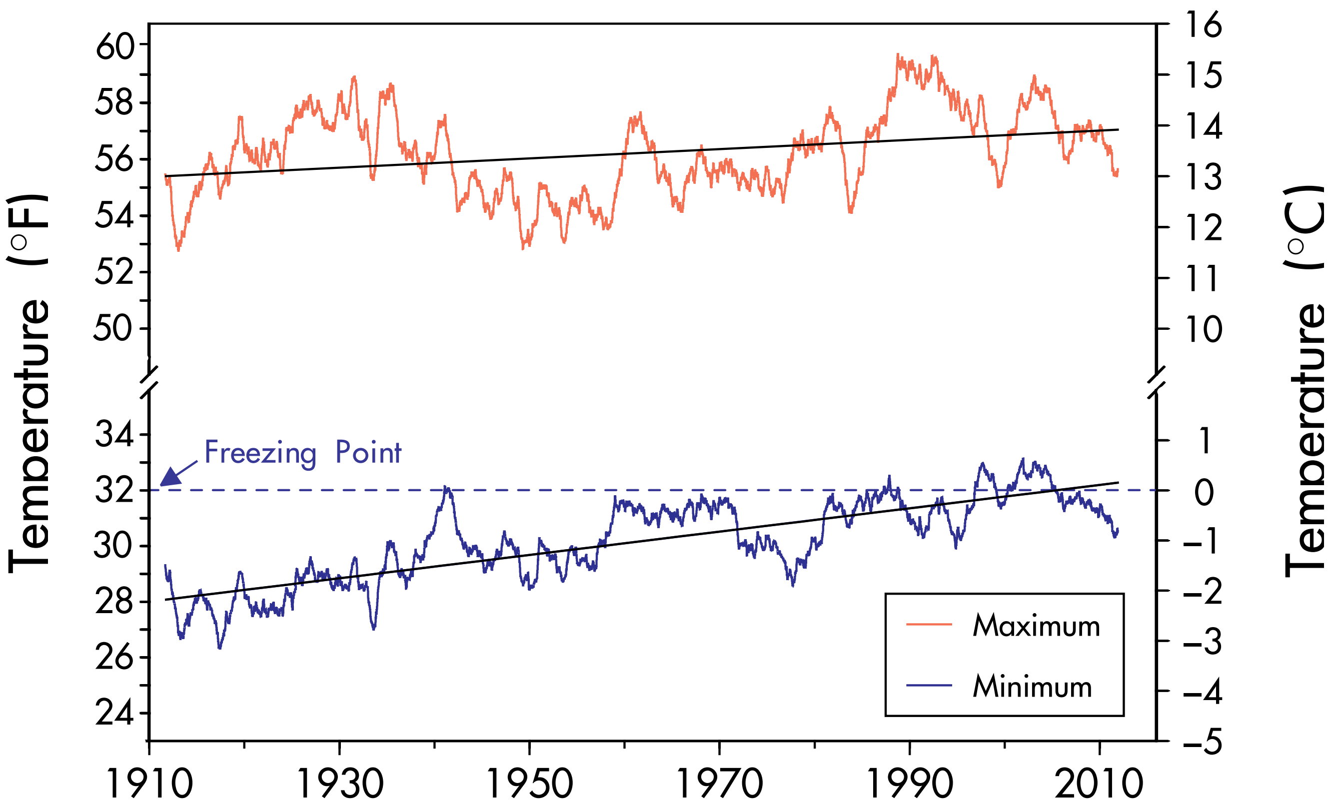
METEOROLOGY

Air temperature

Daily since 1911

Daily air temperatures have increased over the 100 years measured at Tahoe City. The trend in daily minimum temperature has increased by more than 4 degrees F (2.2 degrees C), and the trend in daily maximum temperature has risen by less than 2 degrees F (1.1 degrees C). The average minimum air temperature now exceeds the freezing temperature of water, which points to more rain and less snow, as well as earlier snowmelt. These data have been smoothed by using a two-year running average to remove daily and seasonal fluctuations. 2011 was a particularly cool year at Lake Tahoe.

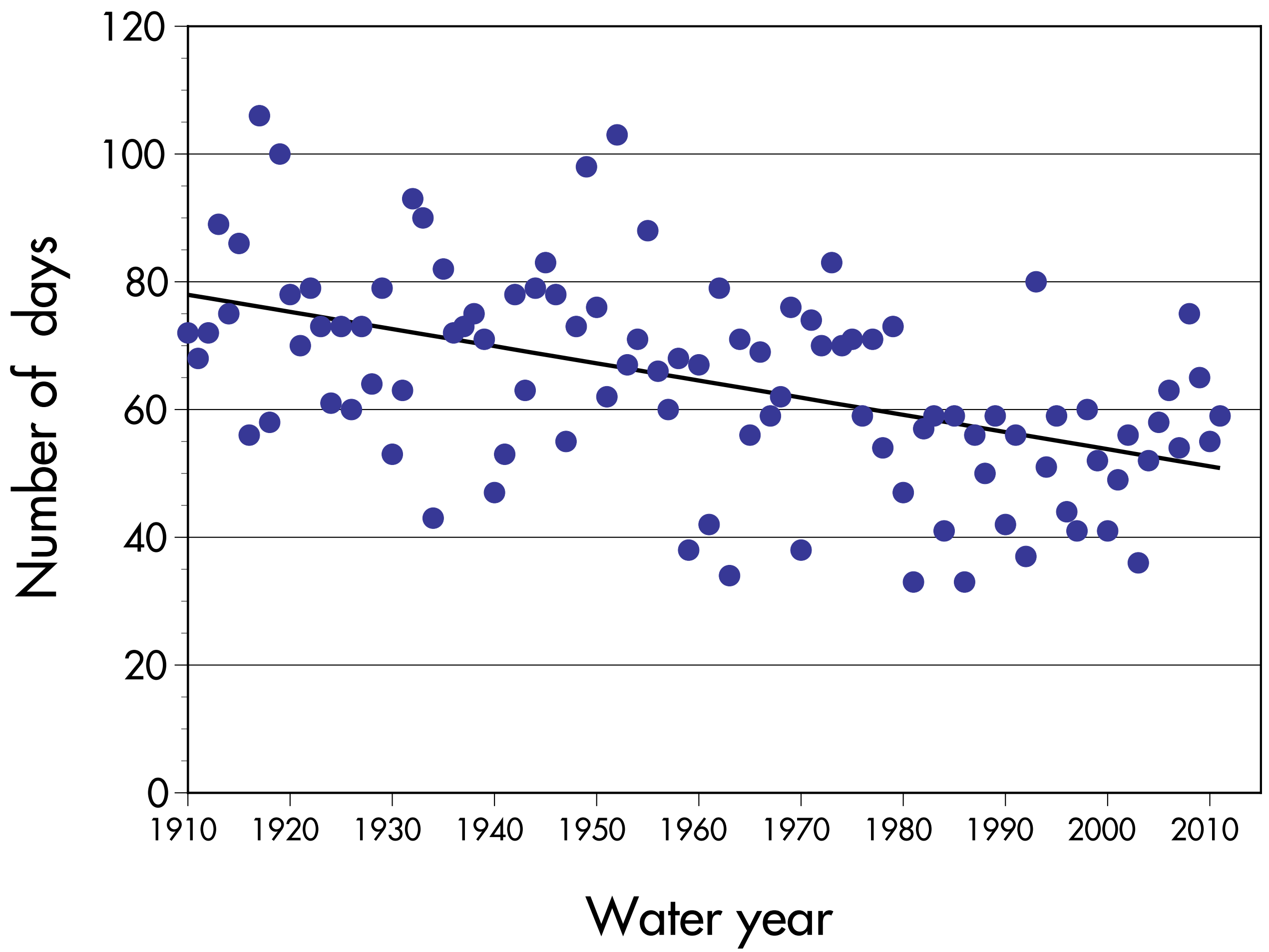


METEOROLOGY

Below-freezing air temperatures

Yearly since 1910

Although year-to-year variability is high, the number of days when air temperatures averaged below freezing (32 degrees F) has declined by about 25 days since 1911. In 2011, the number of freezing days was above the long-term trend for the seventh year in a row.

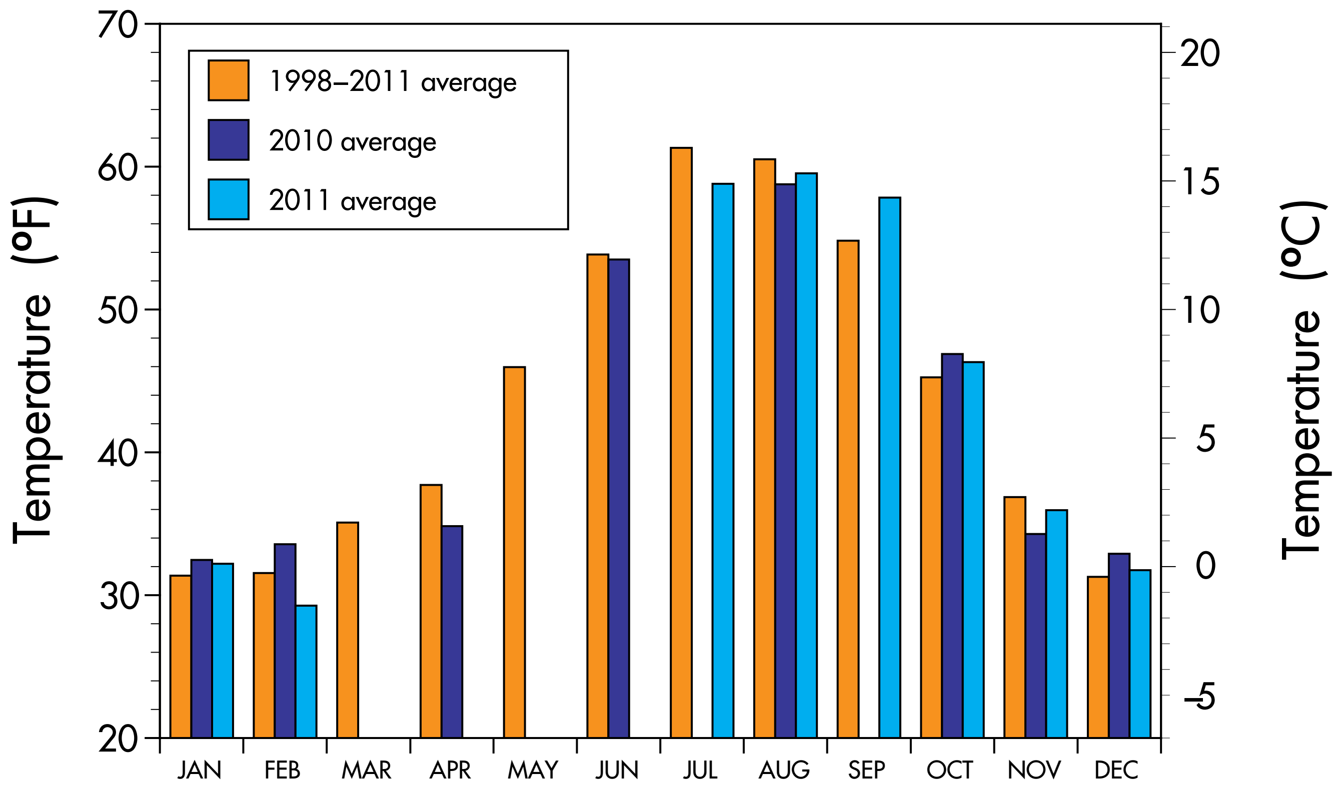


METEOROLOGY

Monthly air temperature

Since 1998

In 2011, months where there was sufficient data appeared to be similar or slightly cooler than the previous year or long term average. Any month with more than 25 percent of the daily data missing were not plotted.



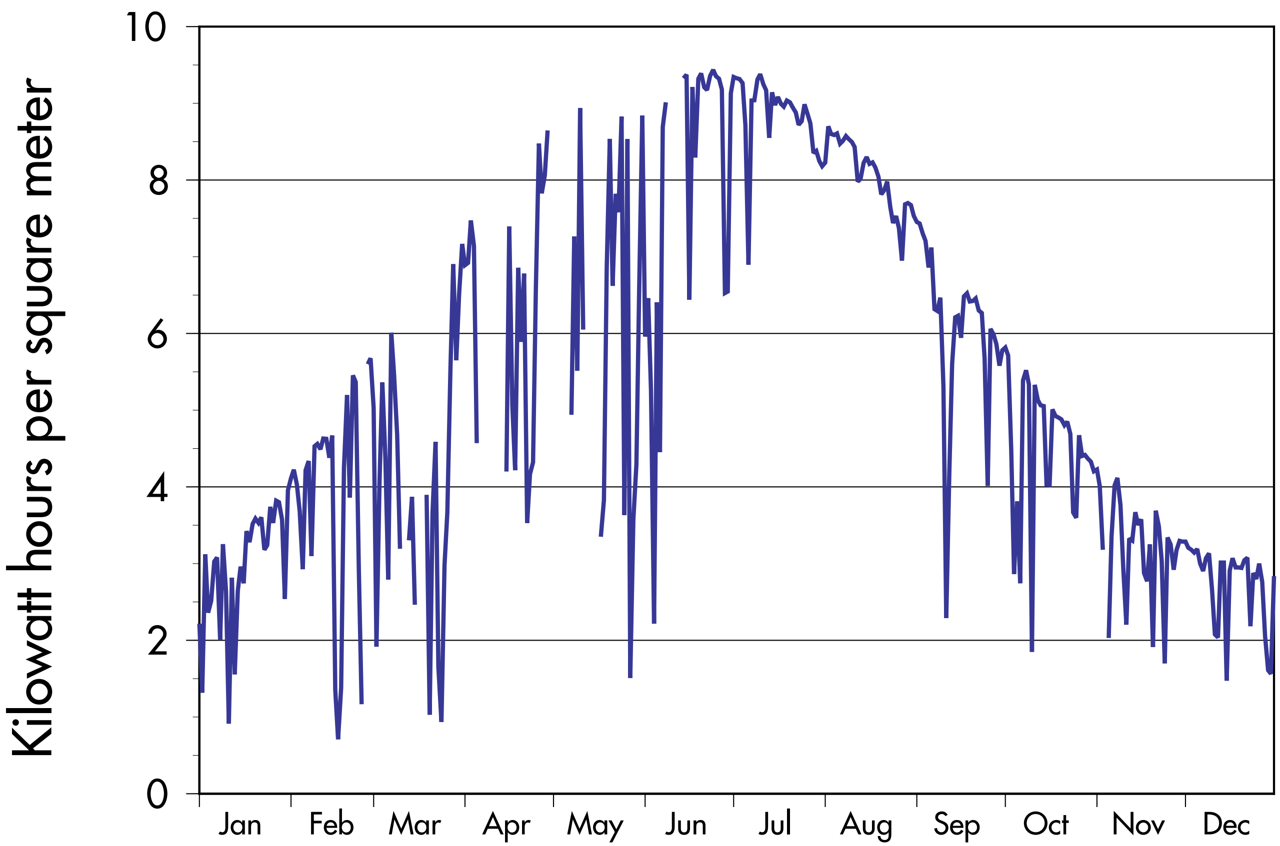
METEOROLOGY

Daily Solar Radiation

Daily in 2011

Solar radiation showed the typical annual pattern of increasing then decreasing, peaking at the summer solstice on June 21 or 22. Dips in daily solar radiation are due primarily to clouds. Smoke and other atmospheric constituents play a smaller role. It is noteworthy that solar radiation on a clear day in mid-winter can exceed that of a cloudy day in mid-summer.

The station where these data are collected is located on the U.S. Coast Guard dock at Tahoe City.

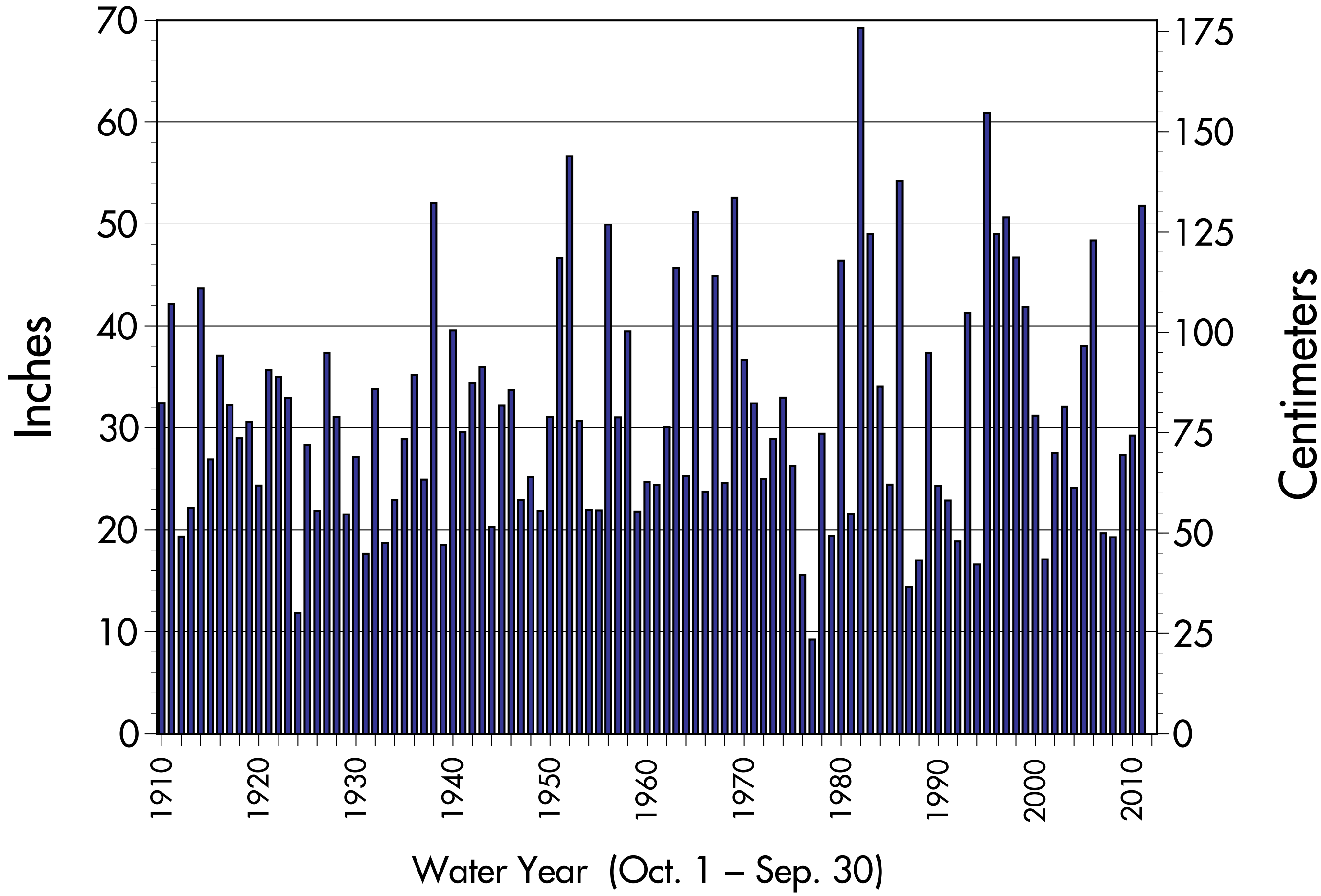


METEOROLOGY

Annual precipitation

Yearly since 1910

From 1910 to 2011, average annual precipitation (water equivalent of rain and snow) at Tahoe City was 31.68 inches. The maximum was 69.2 inches in 1982. The minimum was 9.2 inches in 1977. 2011 was well above average, with 51.78 inches of precipitation. Generally there is a gradient in precipitation from west to east across Lake Tahoe, with almost twice as much precipitation falling on the west side of the lake. (Precipitation is summed over the Water Year, which extends from October 1 through September 30.)

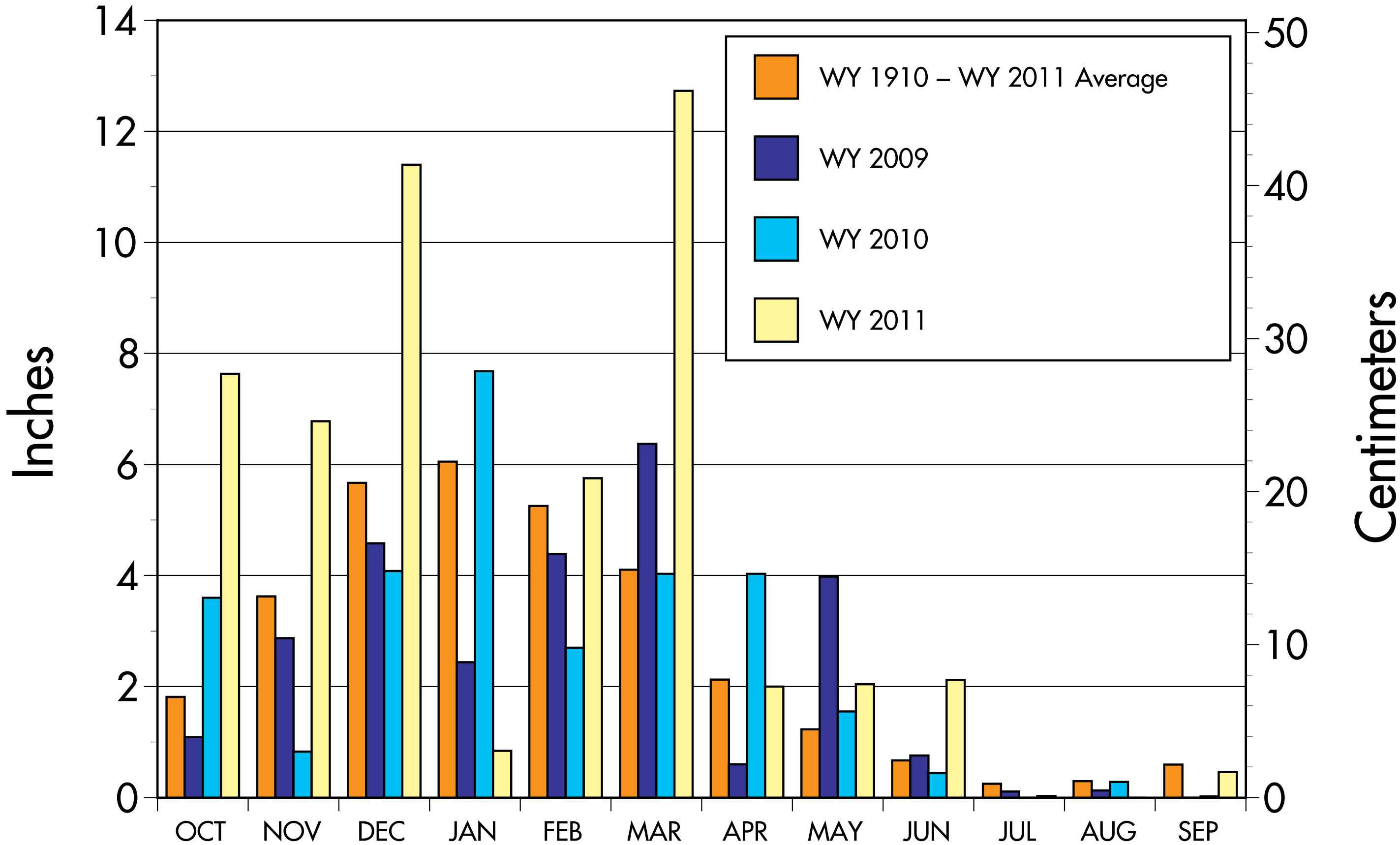


METEOROLOGY

Monthly precipitation

2009, 2010, 2011 and 1910 to 2011 Average

2011 was well above average in total precipitation. The first five months of the water year were particularly wet, with October and March having over three times the long term mean and December and June having twice the long term mean. The 2011 Water Year extended from October 1, 2010, through September 30, 2011.

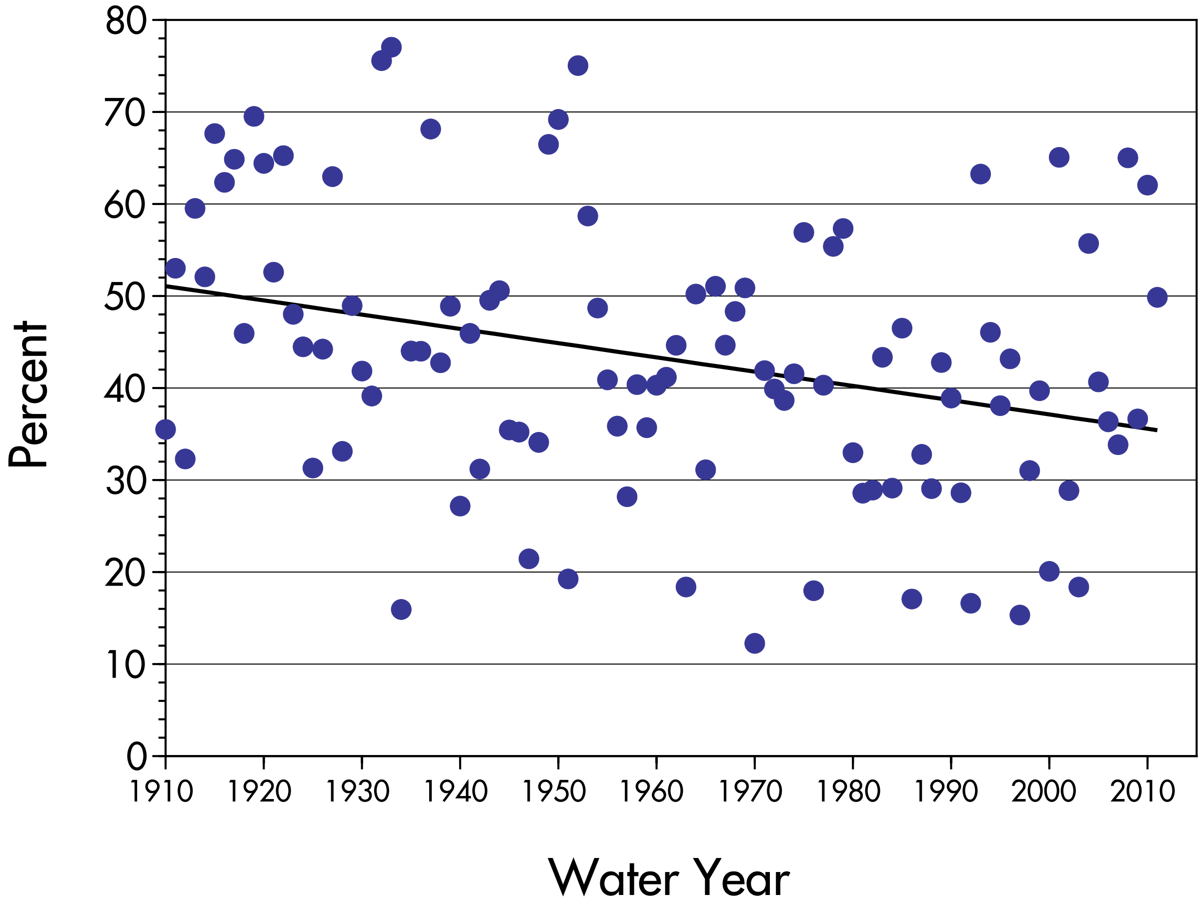


METEOROLOGY

Snow as a fraction of annual precipitation

Yearly since 1910

Snow has declined as a fraction of total precipitation, from an average of 52 percent in 1910 to 36 percent in present times. In Tahoe City, snow represented 50 percent of 2011 total precipitation, much higher than the long-term trend. These data assume precipitation falls as snow whenever the average daily air temperature is below freezing. (Precipitation is summed over the Water Year, which extends from October 1 through September 30.)

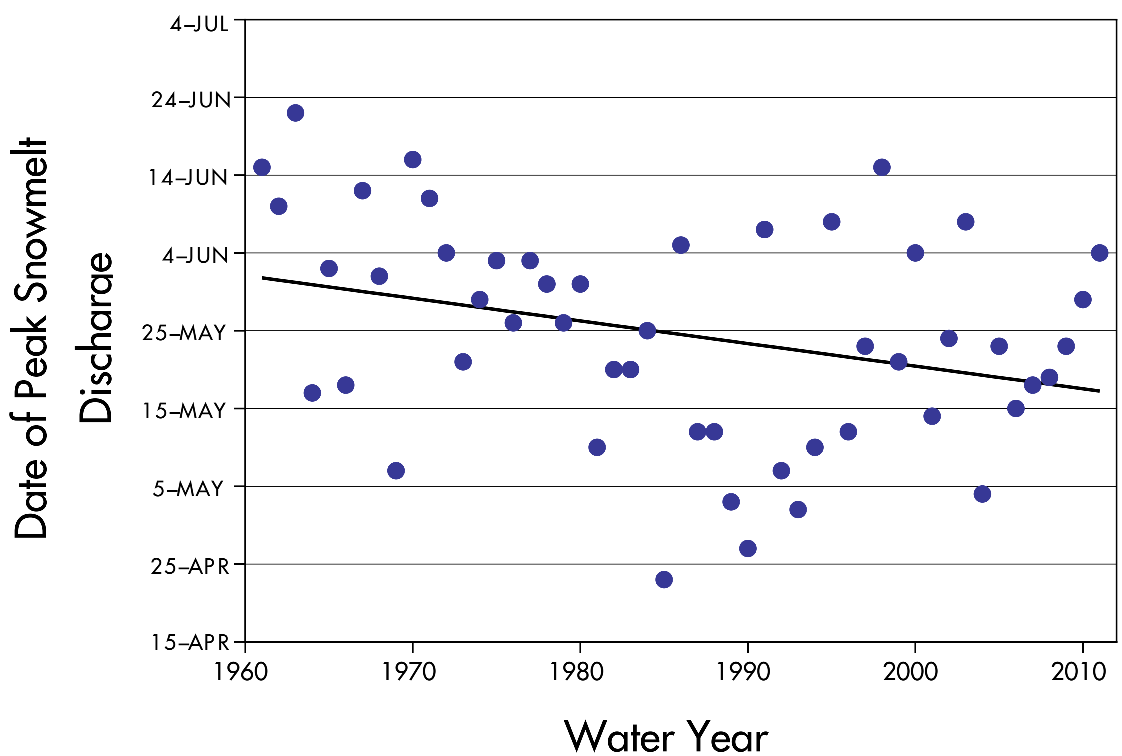


METEOROLOGY

Shift in snowmelt timing

Yearly since 1961

Although the date on which peak snowmelt occurs varies from year to year, since 1961 it has shifted earlier an average of 2 weeks (14.5 days). This shift is statistically significant and is one effect of climate change on Lake Tahoe. In 2011, peak discharge occurred later in early June and closer to historical timing. Peak snowmelt is defined as the date when daily river flows reach their yearly maximum. Daily river flows increase throughout spring as the snow melts because of rising air temperatures, increasing solar radiation and longer days. The data here are based on the average from the Upper Truckee River, Trout Creek, Blackwood Creek, Ward Creek, and Third Creek.



TAHOE: STATE OF THE LAKE REPORT 2012

PHYSICAL PROPERTIES

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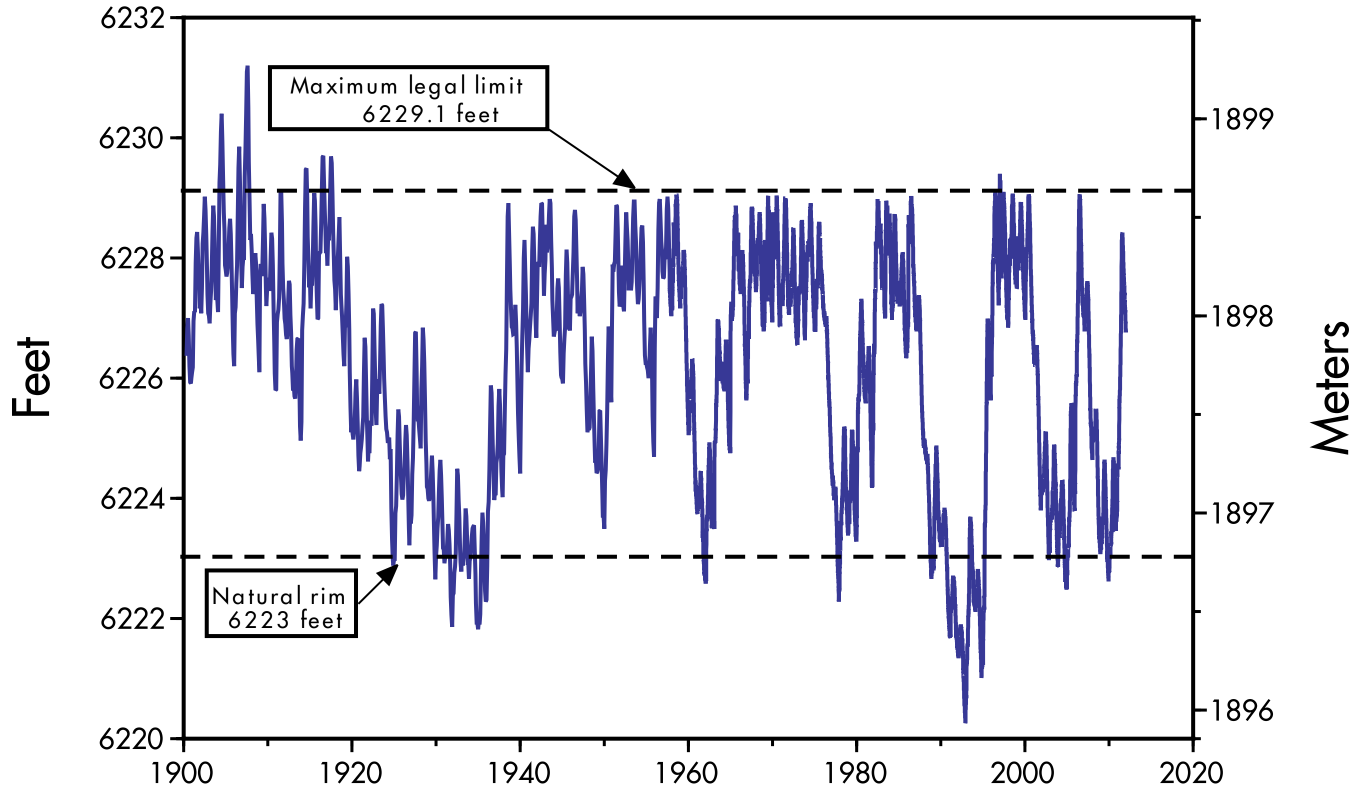
PHYSICAL PROPERTIES

Lake surface level

Daily since 1900

Lake surface level varies throughout the year. It rises due to high stream inflow, groundwater inflow and precipitation directly onto the lake surface. It falls due to evaporation, in-basin water withdrawals, groundwater outflows, and outflow via the Truckee River at Tahoe City. With the above-average precipitation, lake level rose rapidly in 2011. In 2011, the lake level rose by 3.9 feet during snowmelt. The highest lake level was 6228.42 feet on July 30, and the lowest was 6224.48 feet on February 15.

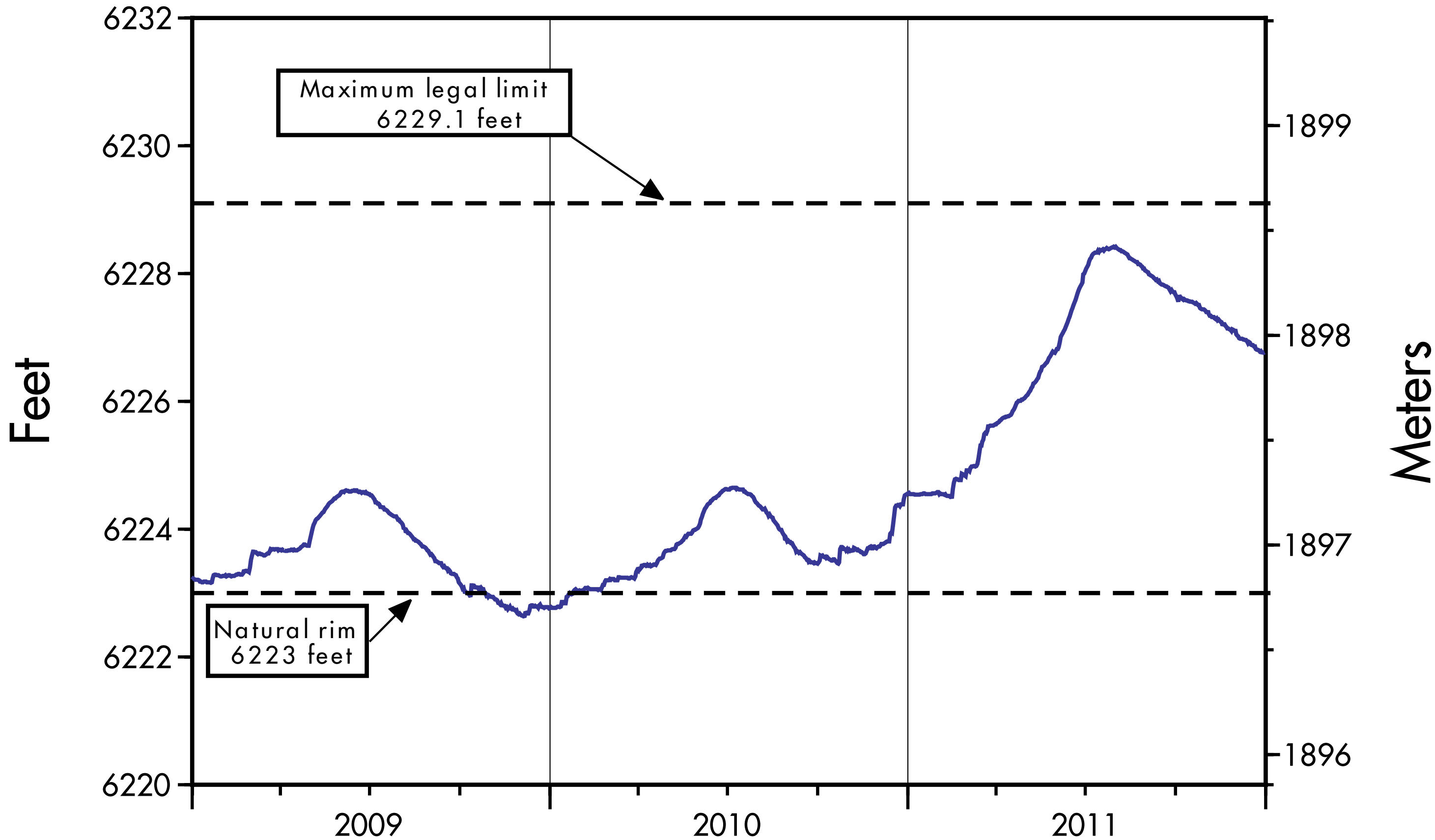


PHYSICAL PROPERTIES

Lake surface level

Daily since 2009

Identical data as used on page 8.1 except the period displayed is shortened to 2009-2011. This more time resolved presentation of recent lake level data allows us to see the seasonal patterns in higher definition. Data clearly show the lake level below the natural rim at the end of 2009 and early 2010 as well as the annual periods of highest lake level. That follows the annual spring snowmelt.

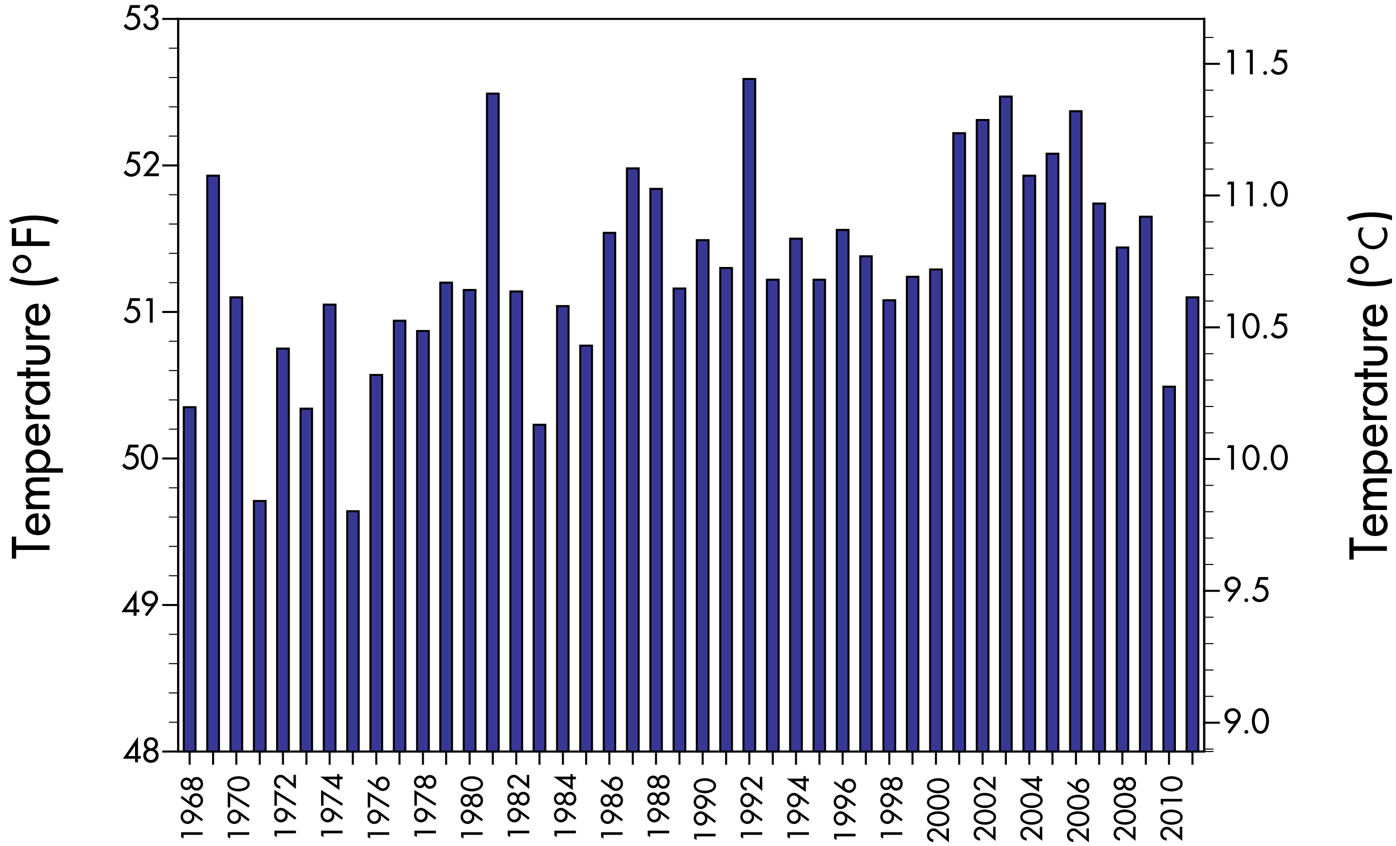


PHYSICAL PROPERTIES

Surface water temperature

Yearly since 1968

Surface water temperatures have been recorded at the mid-lake station since 1968. Despite year-to-year variability, water temperatures show an increasing trend. The average temperature in 1968 was 50.3 degrees F. For 2011, the average surface water temperature was 51.1 degrees F, an increase of 0.6 degrees F over 2010.

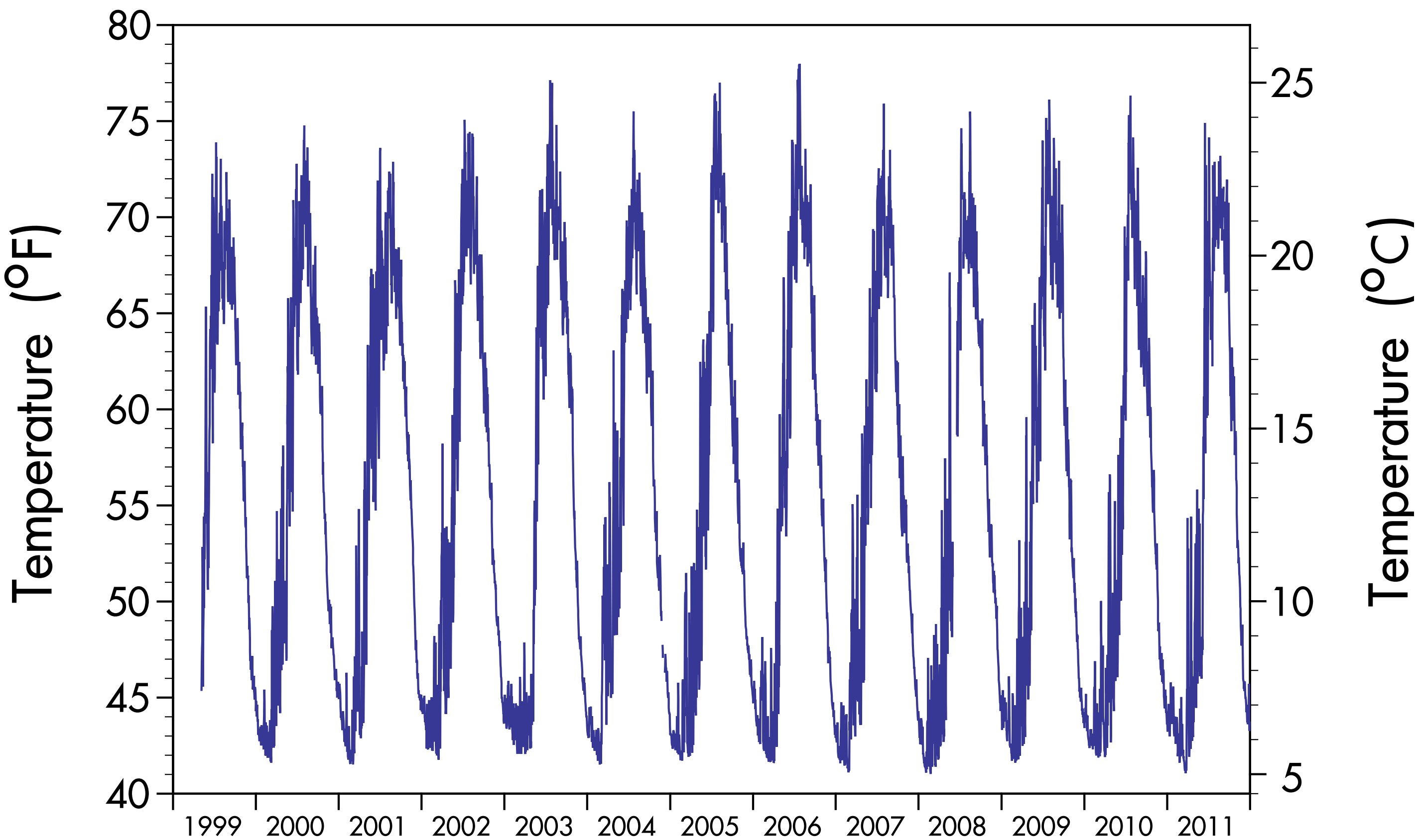


PHYSICAL PROPERTIES

Maximum daily surface water temperature

Every 15 minutes since 1999

Maximum daily surface water temperatures were generally cooler in 2011. The lowest maximum daily surface water temperature was 41.07 degrees F, which was recorded on March 24, 2011. This was the second lowest temperature recorded in this 13 year record. The lowest was 41.02 degrees F on February 24, 2008. These data are collected by NASA and UC Davis from a buoy located near the center of the lake.

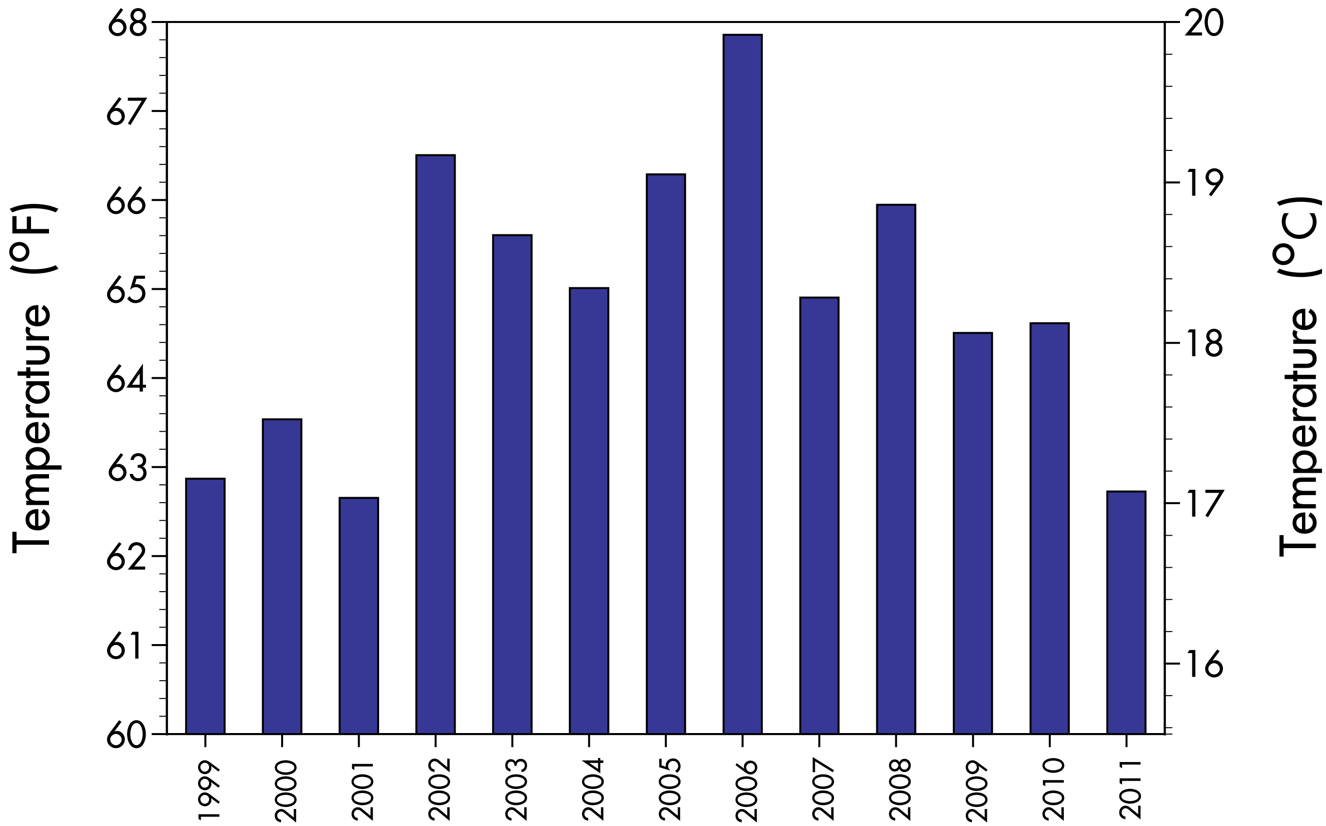


PHYSICAL PROPERTIES

July average surface water temperature

Since 1999

Since 1999, surface water temperature has been recorded every two minutes from four NASA/UC Davis buoys. Shown here are 13 years of average surface water temperatures in the month of July when water temperatures are typically warmest. In 2011, July surface water temperature averaged 62.7 degrees F, compared with 64.6 degrees F in 2010. This was the second coolest July for the 13 year record, surpassed slightly by 2001. Both of those years had deep lake mixing, an event that cools the surface layers of the lake.

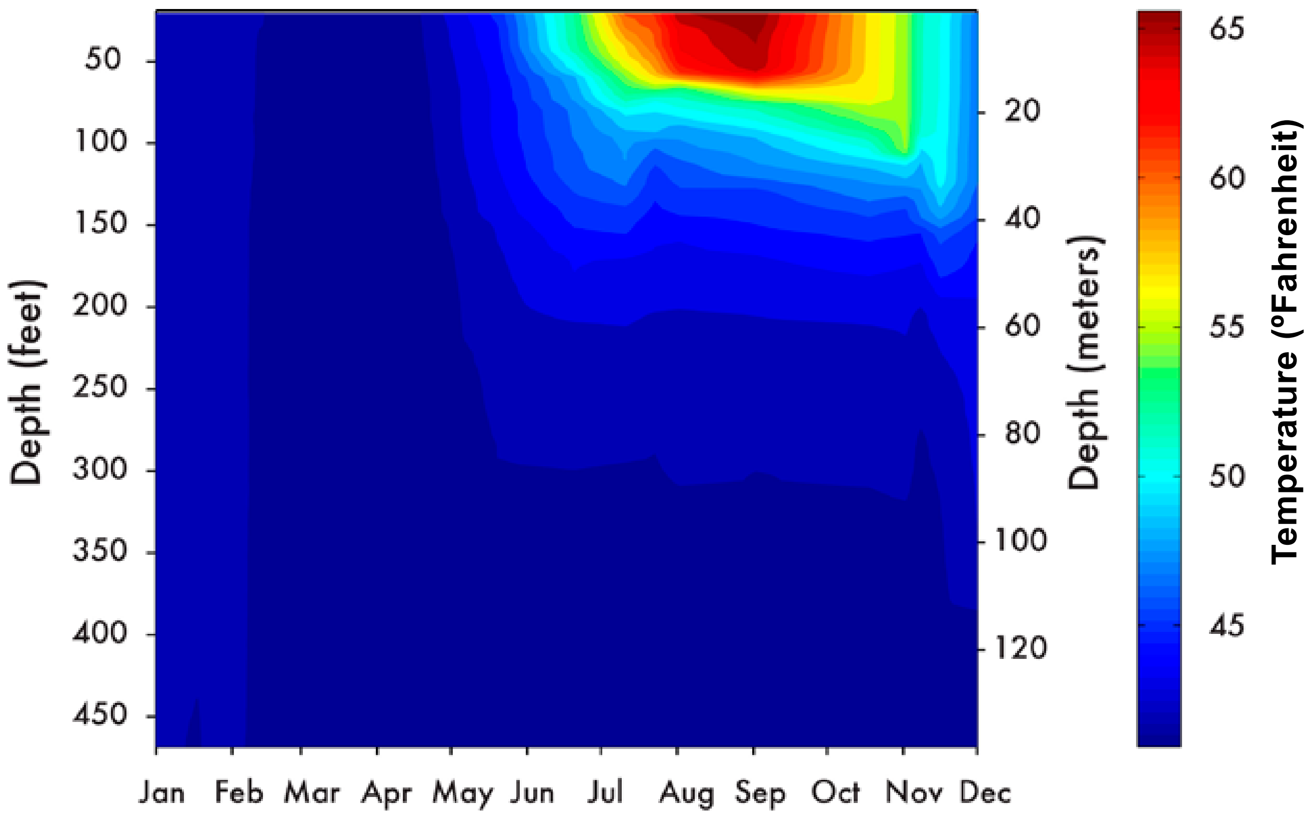


PHYSICAL PROPERTIES

Water temperature profile

In 2011

Water temperature profiles are measured in the lake at 10 day intervals using a Seabird CTD. The temperature is accurate to within 0.005 degrees F. Here the temperature in the upper 500 feet is displayed as a color contour plot. In 2011, the lake temperature followed a typical seasonal pattern. In late March, the lake surface was at its coldest and complete vertical mixing occurred. The beginning of the 2011-2012 winter mixing is evident at the end of the plot, with the surface layer both cooling and deepening. By the end of 2011, mixing had proceeded to 425 feet.

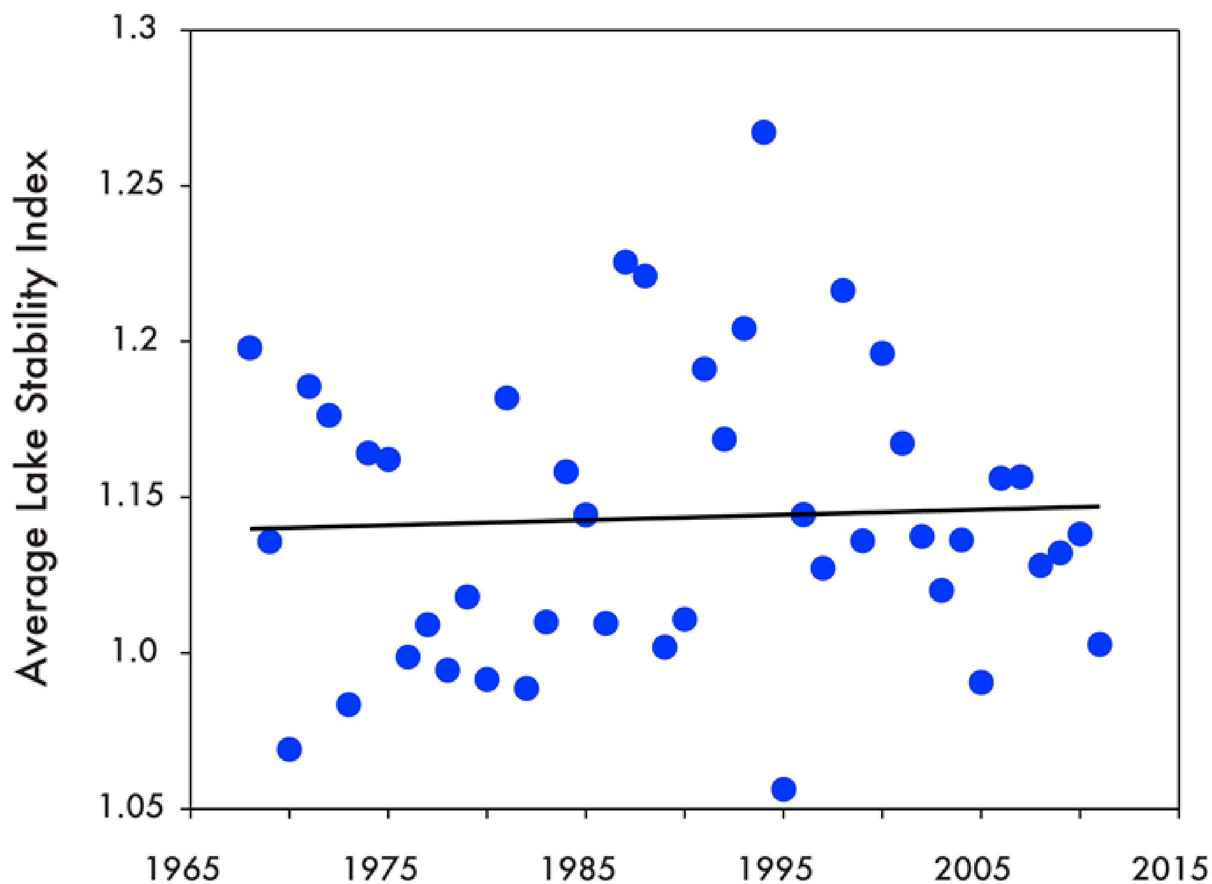


PHYSICAL PROPERTIES

Lake stability

Since 1968

Lake stability is a measure of the energy required to fully mix the lake when its density is stratified. Plotted here is the average annual stability for water in the upper 100 meters (330 feet) of Lake Tahoe. The values are derived from temperature profiles taken at the Index Station at approximately 10 day intervals. The flatness of the line indicates that the stability of the upper 100 meters has not increased very much since 1968.



PHYSICAL PROPERTIES

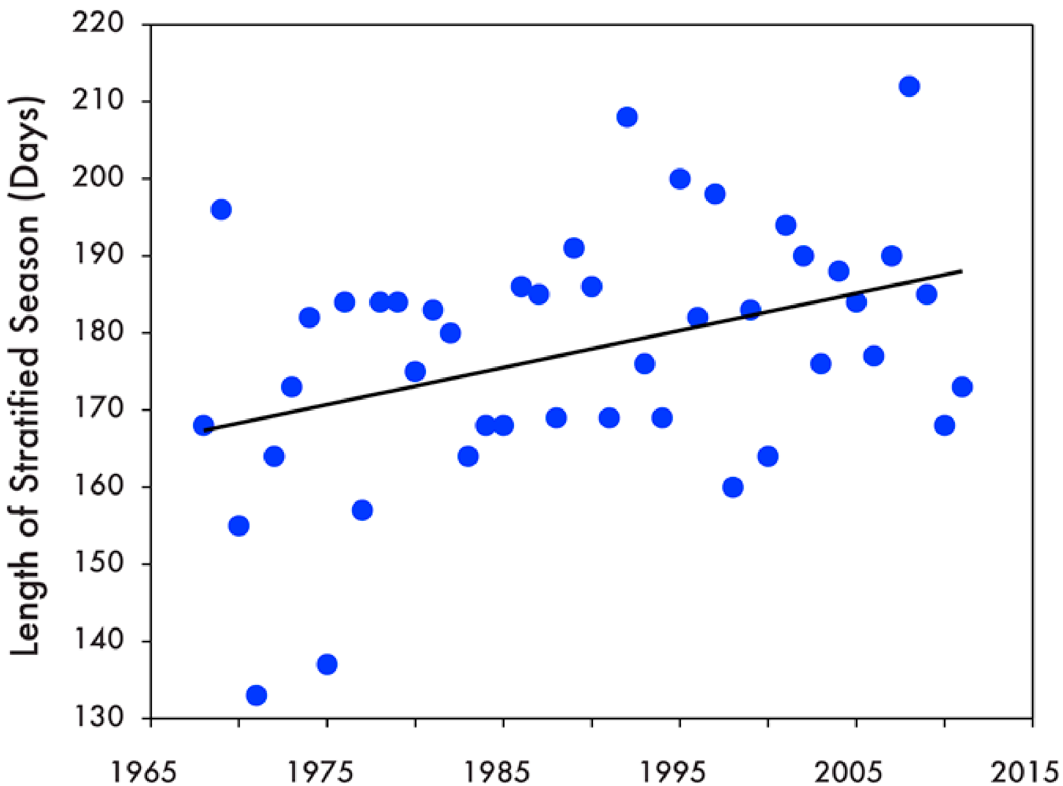
Stratified Season Length

Since 1968

During the year the lake's stability varies from low values in winter to high values in summer. Defining the stratified season as being when the Stability Index exceeds a critical value it is possible to calculate the length of the stratified season for each year.

Despite considerable interannual variability, it can be seen that this period has increased in length by almost 20 days since 1968.

The greater the length of the stratified season, the less time there is for mixing to occur. The long term increase in the length of the stratified season is believed to be due to climate change. Because 2011 was such a cold year, the length of the stratified season was considerably shorter than the long term trend.

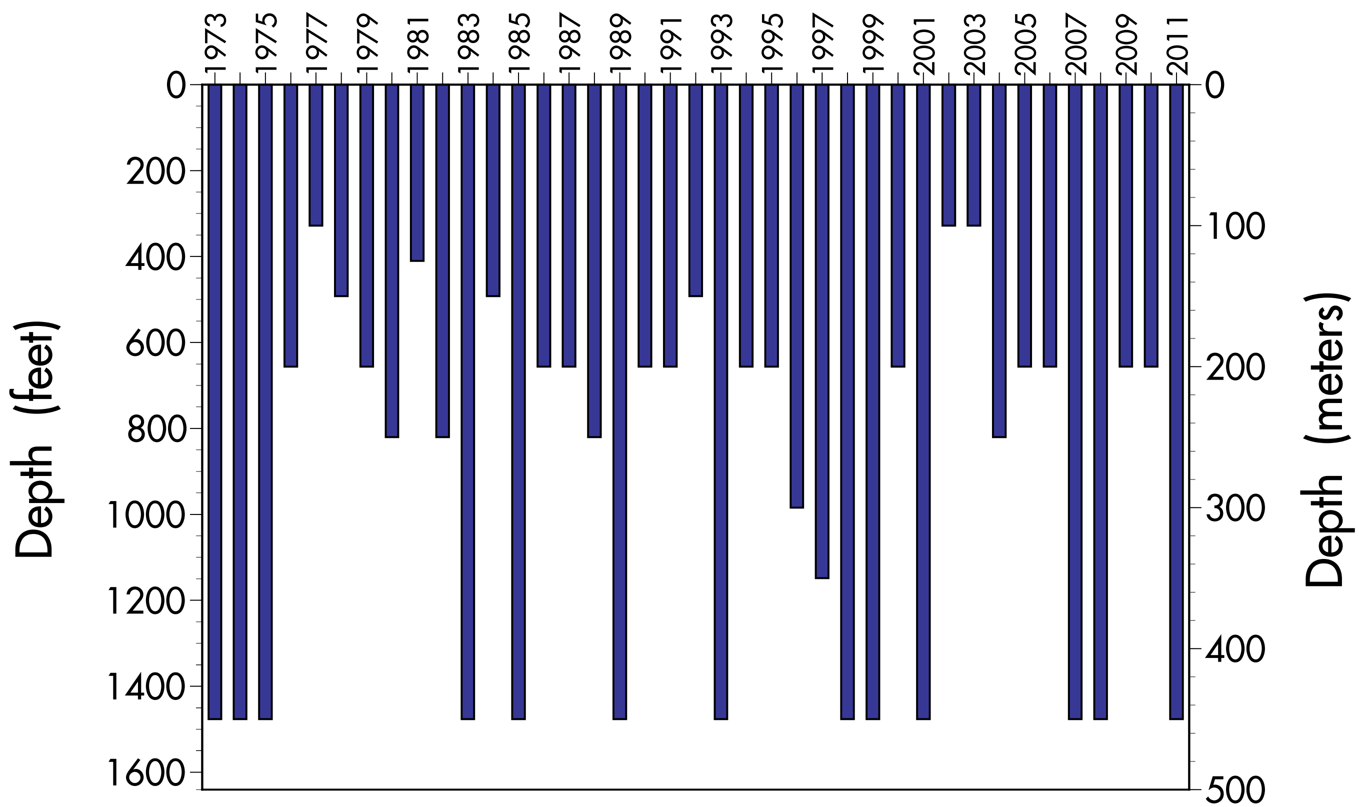


PHYSICAL PROPERTIES

Depth of mixing

Yearly since 1973

Lake Tahoe mixes each winter as surface waters cool and sink downward. In a lake as deep as Tahoe, the wind energy and intense cooling of winter storms helps to determine how deeply the lake mixes. Mixing depth has profound impacts on lake ecology and water quality. Deep mixing brings nutrients to the surface, where they promote algae growth. It also moves oxygen to deep waters, promoting aquatic life throughout the water column. The deepest mixing typically occurs in February to March. In 2011, Lake Tahoe mixed all the way to the bottom, owing to the very cold and long winter.

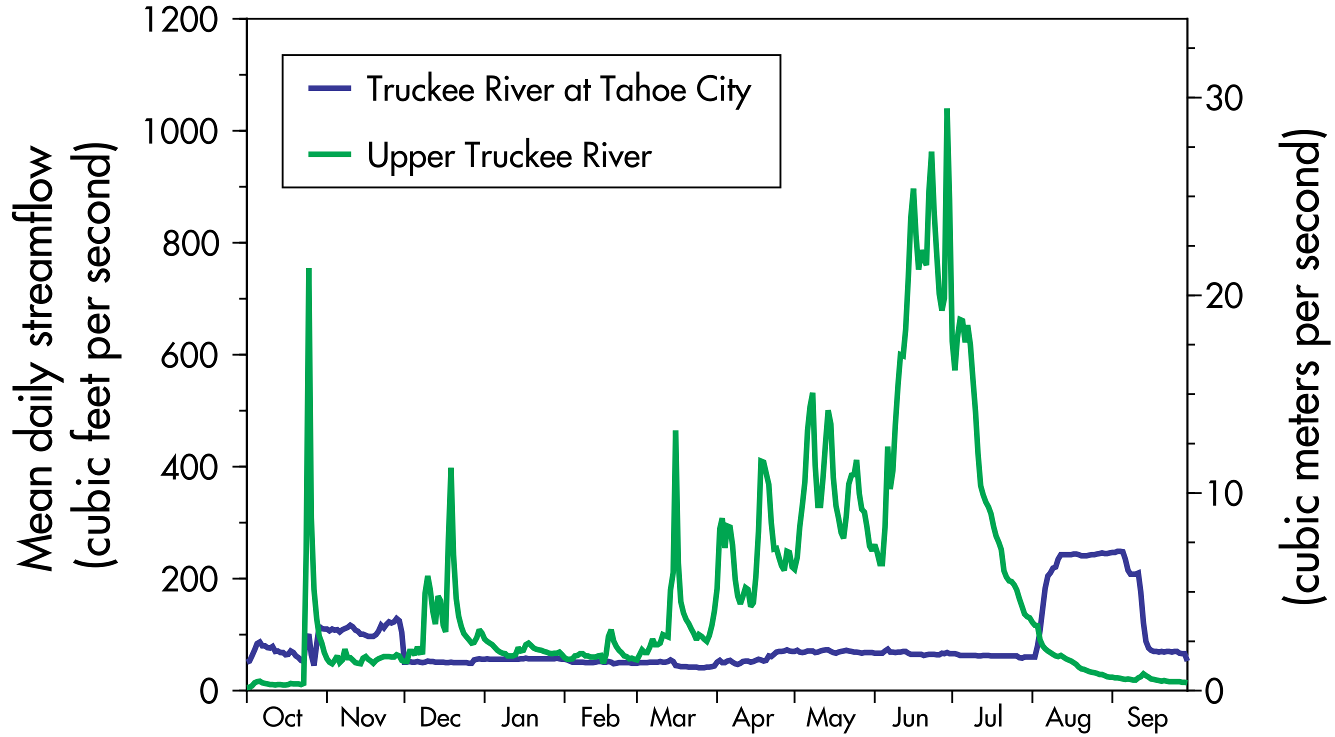


PHYSICAL PROPERTIES

Mean Daily Streamflow of Upper Truckee River vs. Truckee River

Water Year 2011

The Upper Truckee River, the largest stream to flow into Lake Tahoe, has a natural annual hydrograph for a snow-fed stream. The small peaks in the hydrograph represent rain events or short warm periods in winter or spring. The major peak in the hydrograph represents the maximum spring snowmelt. The peak in 2011 was 1040 cubic feet per second on June 29, well above the median peak of 250 cubic feet per second. The Truckee River is the only outflow from Lake Tahoe. The streamflow in the Truckee River is a regulated flow, with release quantity controlled by the Federal water master. The release rates are set according to downstream demands for water. The maximum discharge in 2011 was 249 cubic feet per second on September 3. Streamflow data are collected by the Lake Tahoe Interagency Monitoring Program (LTIMP).

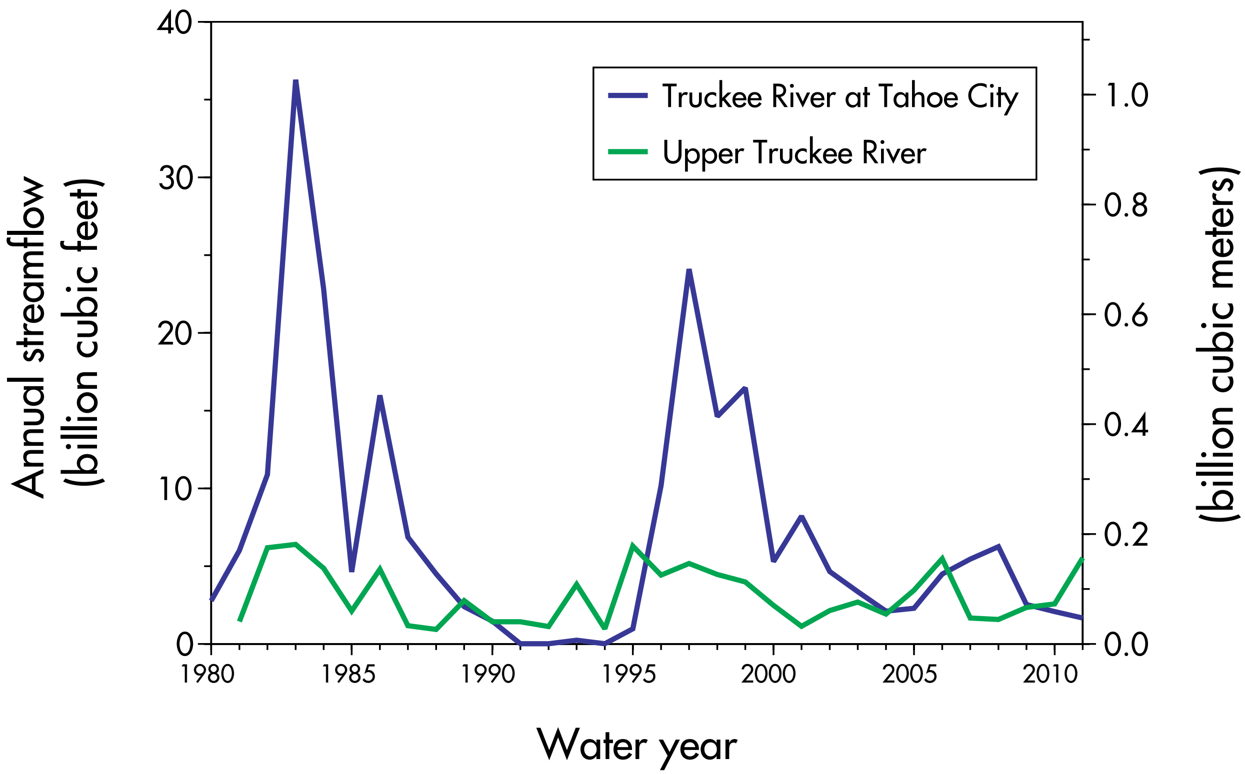


PHYSICAL PROPERTIES

Annual Discharge Volume for Upper Truckee River and Truckee River

Since 1980

Flow into Lake Tahoe (e.g. Upper Truckee River) and discharge out of Lake Tahoe (Truckee River at Tahoe City) have shown considerable variation since 1980. The large peaks in discharge from the lake correspond to years when precipitation (and therefore total inflow) was the greatest, e.g. 1982-1983, 1986, 1995-1999. Similarly, the drought-like conditions in the early 1990s and the low precipitation years in the beginning of the 2000s also stand out. Since many of the pollutants of concern for Lake Tahoe's clarity enter along with surface flow, year-to-year changes in clarity are influenced by precipitation and runoff.



TAHOE: STATE OF THE LAKE REPORT 2012

NUTRIENTS AND PARTICLES

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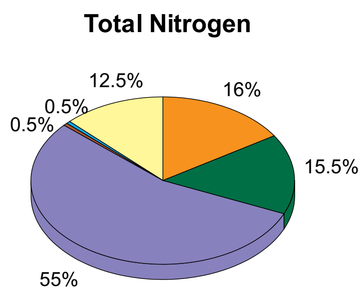
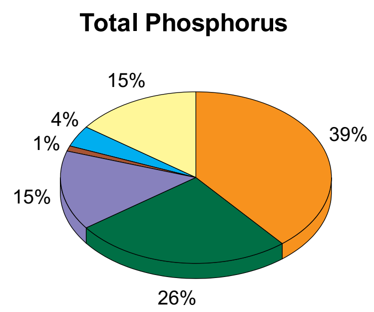
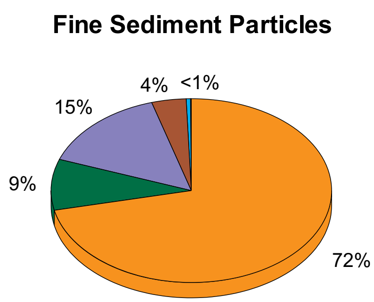
NUTRIENTS AND PARTICLES

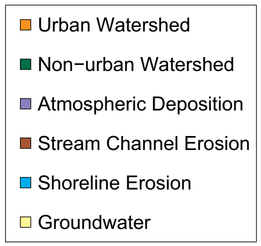
Sources of clarity-reducing pollutants

Previous research has quantified the primary sources of nutrients (nitrogen and phosphorus) and particulate material that are causing Lake Tahoe to lose clarity in its upper waters. Extremely fine particles, the major contributor to clarity decline, primarily originate from the urban watershed (70-75 percent), even though these areas cover only 10 percent of the land area. For nitrogen, atmospheric deposition is the major source (55 percent). Phosphorus is primarily introduced by the urban (39 percent) and non-urban (26 percent) watersheds. These categories of pollutant sources form the basis of a strategy to restore Lake Tahoe's open-water clarity by agencies including the Lahontan Regional Water Quality Control Board, the Nevada Division of Environmental Protection, and the Tahoe Regional Planning Agency. (Data were generated for the Lake Tahoe TMDL Program and this figure also appeared in previous year's State of the Lake Reports.)





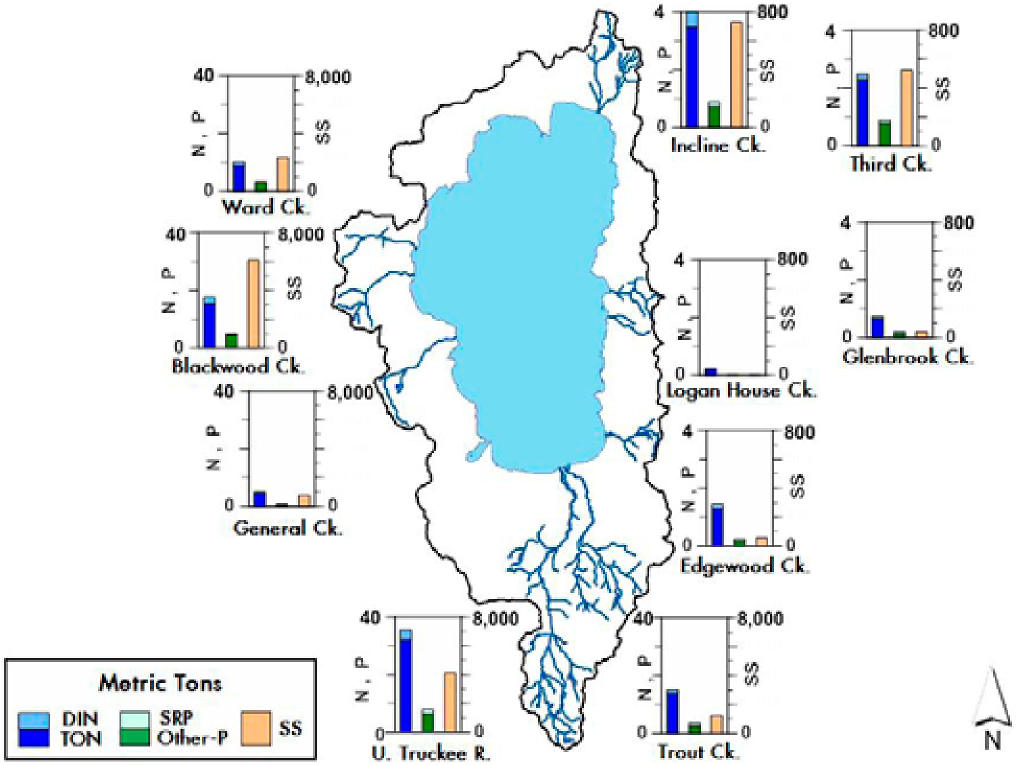




NUTRIENTS AND PARTICLES

Pollutant loads from 10 watersheds

The Lake Tahoe Interagency Monitoring Program (LTIMP) measures nutrient and sediment input from 10 of the 63 watershed streams – these account for approximately half of all stream flow into the lake. Most of the suspended sediment contained in the 10 LTIMP streams is from the Upper Truckee River, Blackwood Creek, Trout Creek and Ward Creek. Over 75 percent of the phosphorus and nitrogen comes from the Upper Truckee River, Trout Creek and Blackwood Creek. Pollutant loads from the west-side streams were again high in 2011. Blackwood Creek suspended sediment loads have exceeded those of the Upper Truckee River for the last four years. For most watersheds, the 2011 loads were 2 - 3 times greater than in 2010, largely on account of the wetter conditions. Notable exceptions were Incline Creek, where sediment input increased 9-fold over the previous year and Glenbrook Creek where the increase was 5-fold.



The LTIMP stream water quality program is managed by the U.S. Geological Survey in Carson City, Nevada, UC Davis TERC and the Tahoe Regional Planning Agency. Additional funding was provided by the USFS – Lake Tahoe Basin Management Unit.

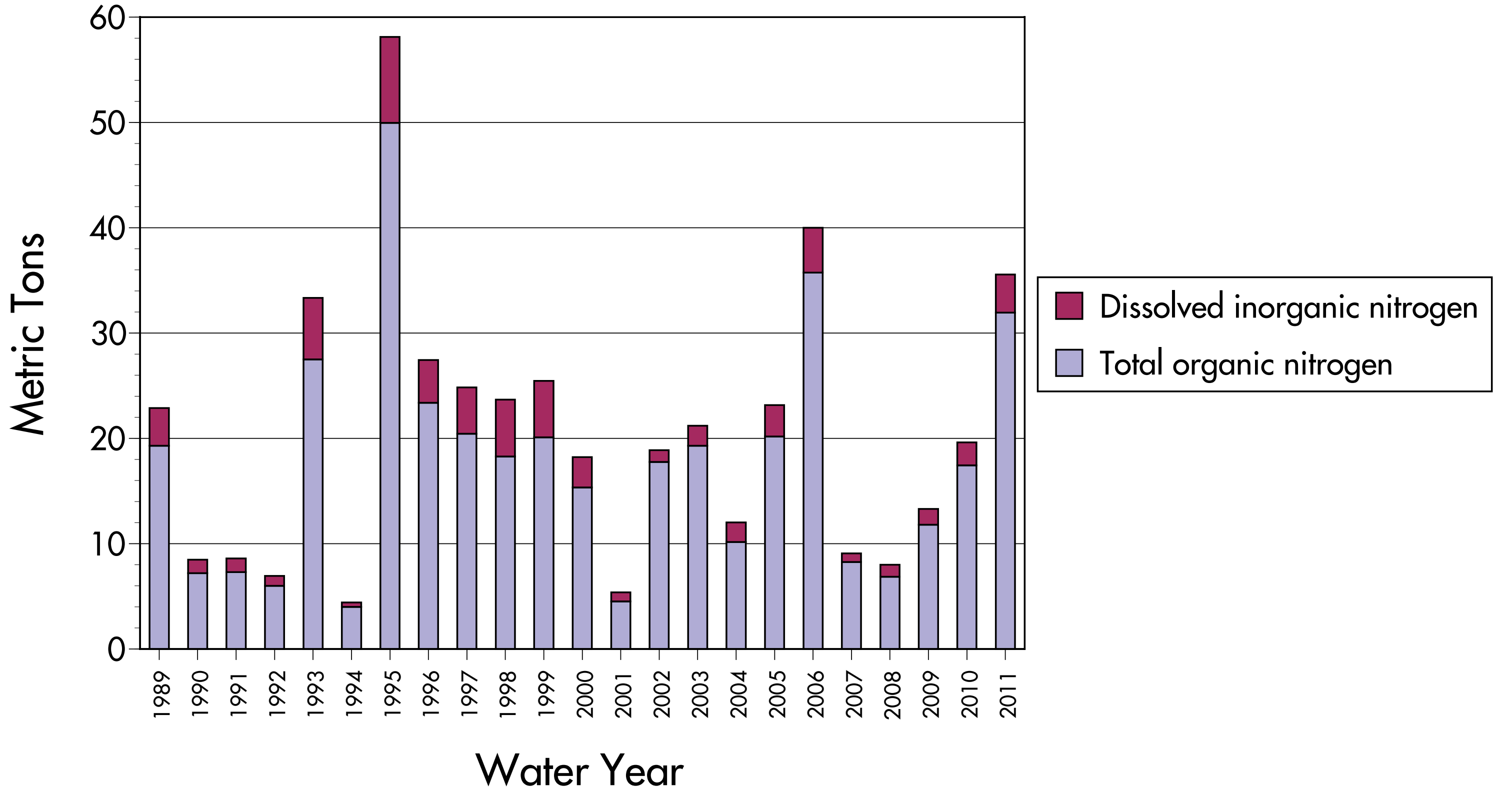
N = Nitrogen
P = Phosphorus
DIN = Dissolved Inorganic Nitrogen
SRP = Soluble Reactive Phosphorus
TON = Total Organic Nitrogen
SS = Suspended Sediment

NUTRIENTS AND PARTICLES

Nitrogen contribution by Upper Truckee River

Since 1989

Nitrogen (N) is important because it, along with phosphorus (P), stimulates algal growth (Fig. 9.1 shows the major sources of N and P to Lake Tahoe). The Upper Truckee River is the largest of the 63 streams that flow into Lake Tahoe, contributing about 25 percent of the inflowing water. The river's contribution of dissolved inorganic nitrogen (nitrate and ammonium) and total organic nitrogen loads are shown here. The year-to-year variations primarily reflect changes in precipitation. For example, 1994 had 16.6 inches of precipitation and a low nitrogen load, while 1995 had 60.8 inches of precipitation and a very high nitrogen load. Above-average precipitation in 2011 resulted in a nitrogen load that was almost double the previous year. (One metric ton = 2,205 pounds.)

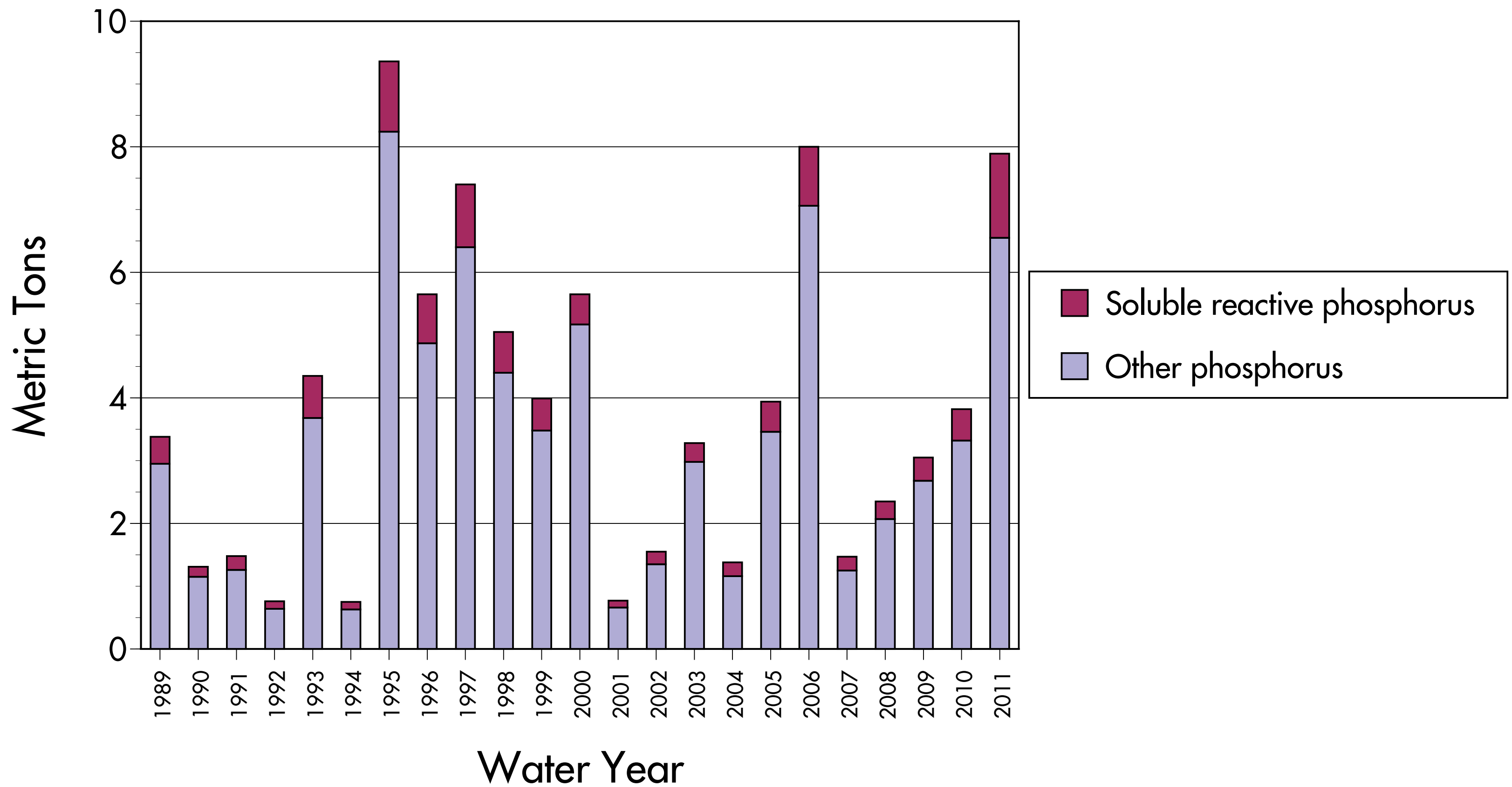


NUTRIENTS AND PARTICLES

Phosphorus contribution by Upper Truckee River

Yearly since 1989

Soluble reactive phosphorus (SRP) is that fraction of phosphorus immediately available for algal growth. As with nitrogen (Fig. 9.3), the year-to-year variation in load largely reflects the changes in precipitation. Above-average precipitation in 2011 resulted in a doubling of the phosphorus load over the previous year. Total phosphorus is the sum of SRP and other phosphorus, which includes organic phosphorus and phosphorus associated with particles. (One metric ton = 2,205 pounds.)

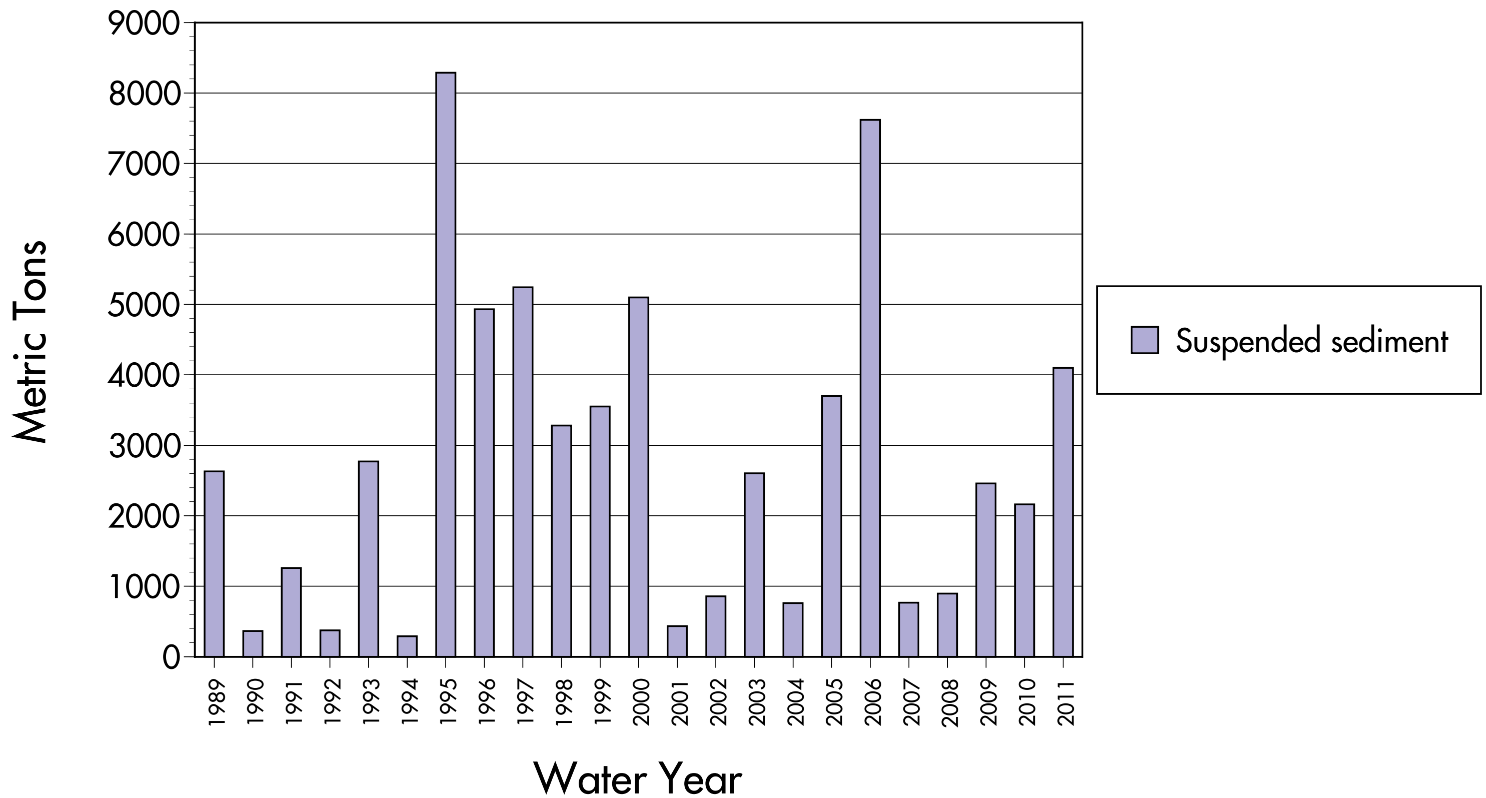


NUTRIENTS AND PARTICLES

Suspended sediment contribution by Upper Truckee River

Yearly since 1989

The load of suspended sediment delivered to the lake by the Upper Truckee is related to landscape condition and erosion as well as to precipitation and stream flow. Certainly, interannual variation in sediment load over shorter time scales is more related to the latter. Above-average precipitation in 2011 resulted in a doubling of the suspended sediment load compared with the two prior years. However, the value was still well below values from earlier years (e.g. 1995-1997). This and the previous two figures illustrate how greatly changes in hydrological conditions affect pollutant loads. Plans to restore lake clarity emphasize reducing loads of very fine suspended sediment (less than 20 microns in diameter). Efforts to restore natural stream function and watershed condition focus on reducing loads of total sediment regardless of size.

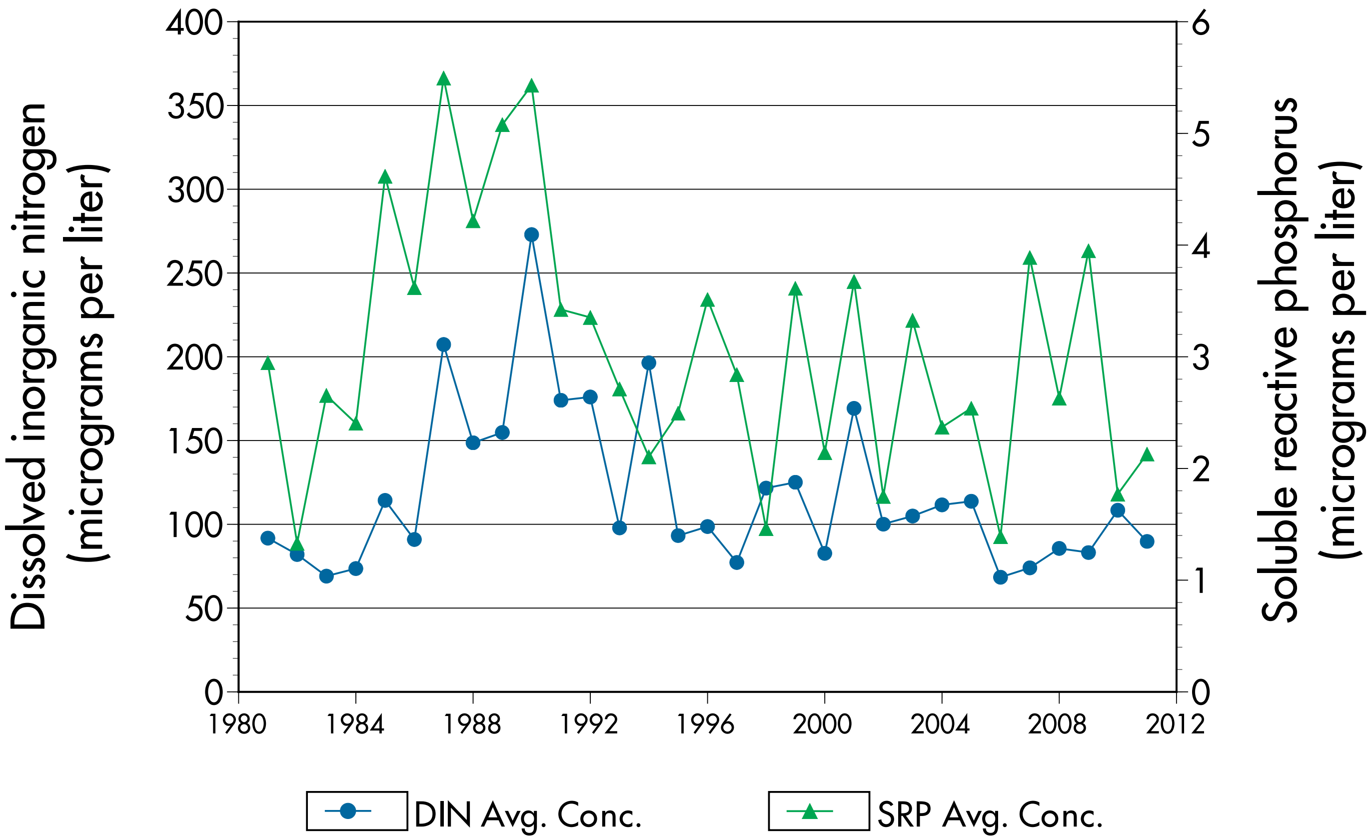


NUTRIENTS AND PARTICLES

Nutrient concentrations in rain and snow

Yearly since 1981

Nutrients in rainwater and snow (called wet deposition) contribute large amounts of nitrogen, but also significant phosphorus, to Lake Tahoe. Nutrients in precipitation have been measured near Ward Creek since 1981, and show no consistent upward or downward trend. Annual concentrations in precipitation of dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) vary from year to year. In 2011, concentrations of DIN and SRP were similar to the previous year.

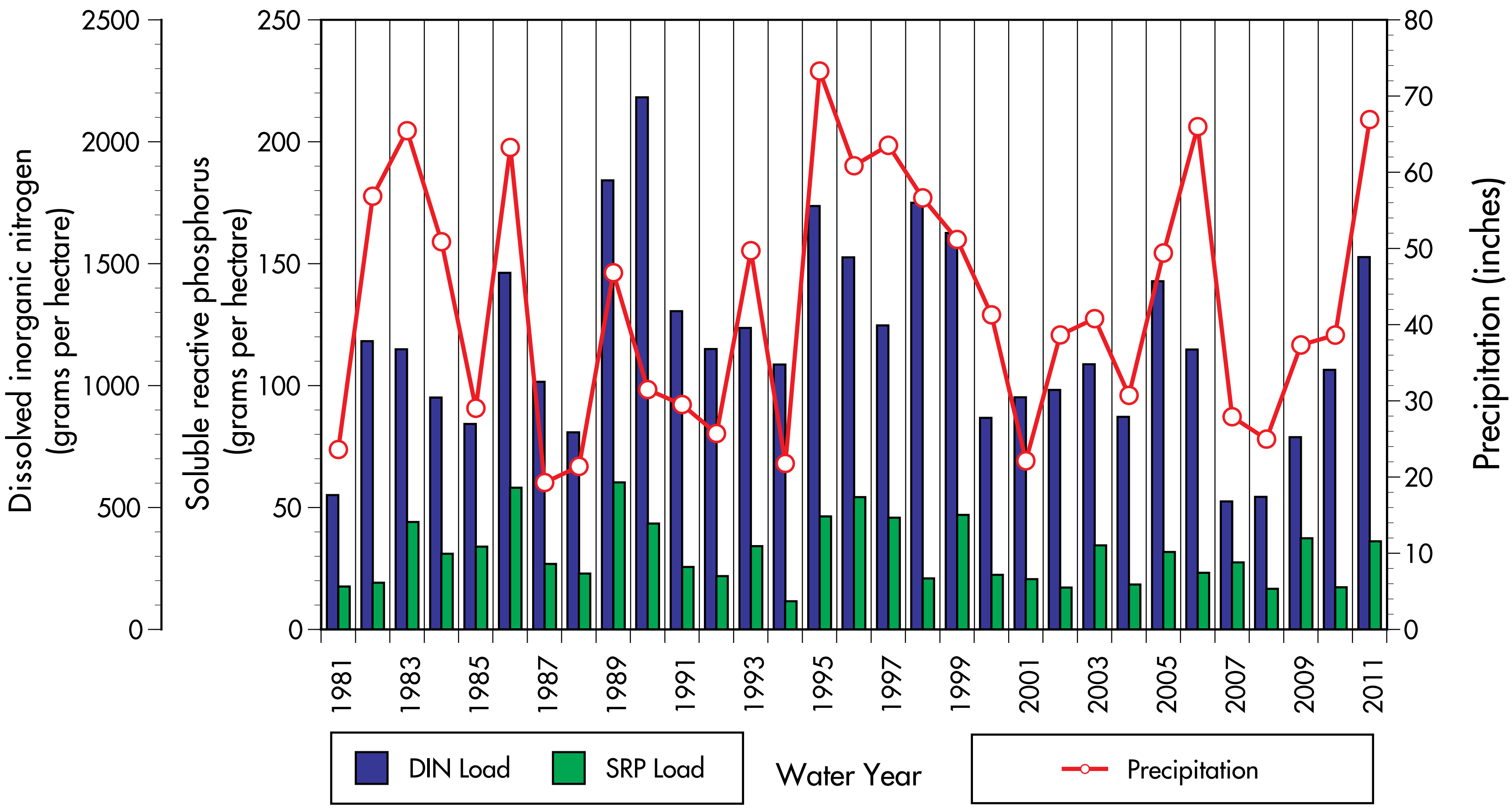


NUTRIENTS AND PARTICLES

Nutrient loads in rain and snow

Since 1981

The annual load for wet deposition is calculated by multiplying the concentration of dissolved inorganic nitrogen (nitrate and ammonium) and soluble reactive phosphorus (in the previous graph) by total annual precipitation. While nitrogen and phosphorus loads from precipitation have varied from year to year at the Ward Creek monitoring site, no obvious long-term trend has emerged. In 2011, the nitrogen and phosphorus loads were within the range seen in previous years..

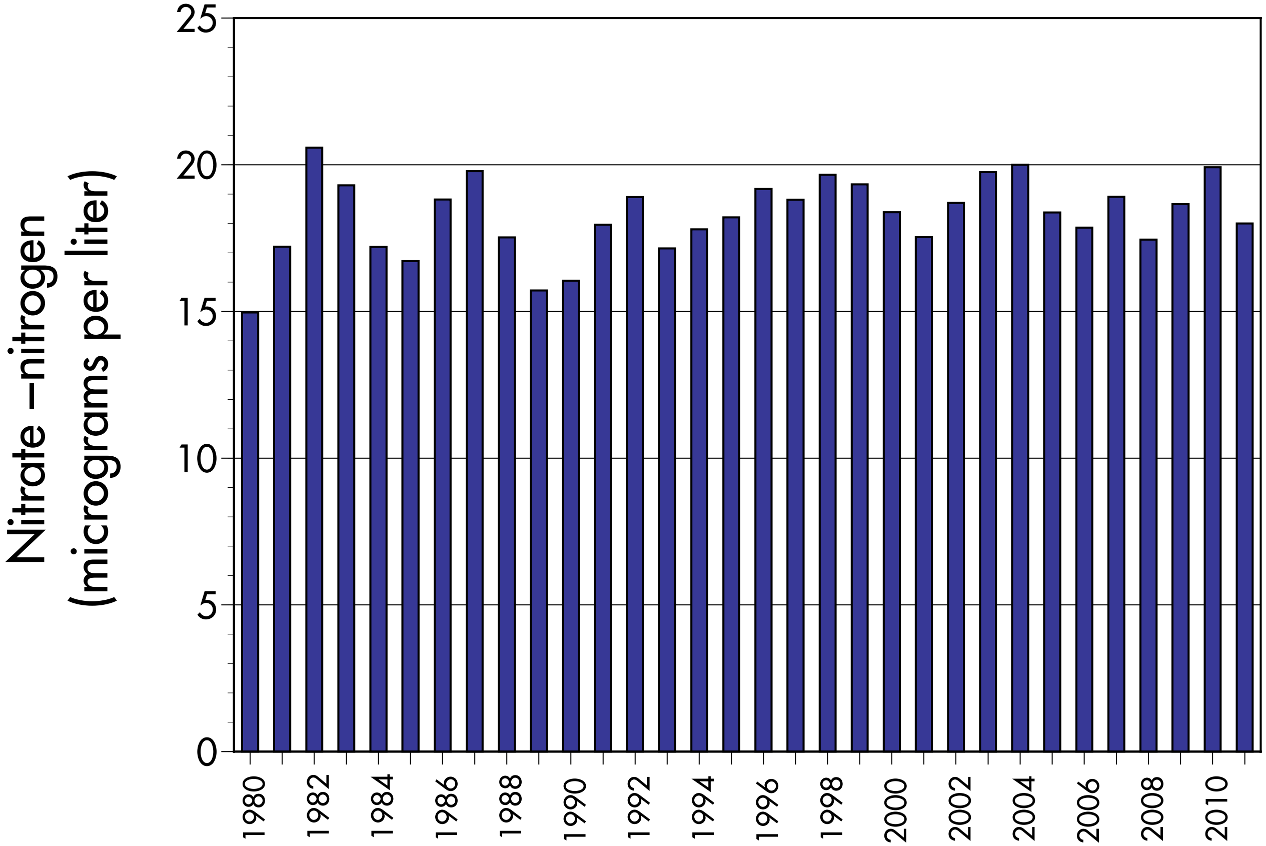


NUTRIENTS AND PARTICLES

Lake nitrate concentration

Yearly since 1980

Since 1980, the lake nitrate concentration has remained relatively constant, ranging between 15 and 21 micrograms per liter. In 2011, the water column annual average concentration of nitrate-nitrogen was 18 micrograms per liter which is at the middle of the range of the long-term record. These measurements are taken at the MLTP (mid-lake) station. Water samples could not be collected in February, August, October and December 2011.

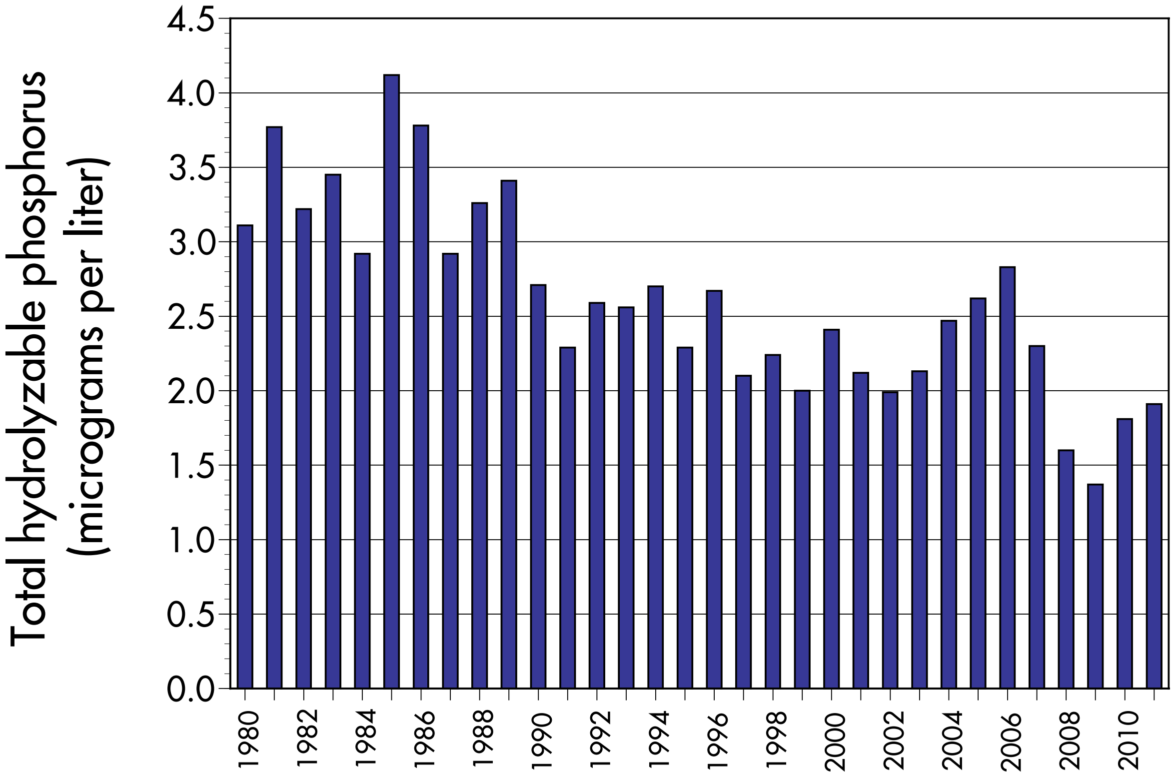


NUTRIENTS AND PARTICLES

Lake phosphorus concentration

Yearly since 1980

Phosphorus naturally occurs in Tahoe Basin soils and enters the lake from soil disturbance and erosion. Total hydrolyzable phosphorus, or THP, is a measure of the fraction of phosphorus algae can use to grow. It is similar to the SRP that is measured in the streams. Since 1980, THP has tended to decline. In 2011, the water column annual average concentration of THP was approximately 1.9 micrograms per liter, a slight increase over the previous year. Water samples could not be collected in February, August, October or December 2011.



TAHOE: STATE OF THE LAKE REPORT 2012

BIOLOGY

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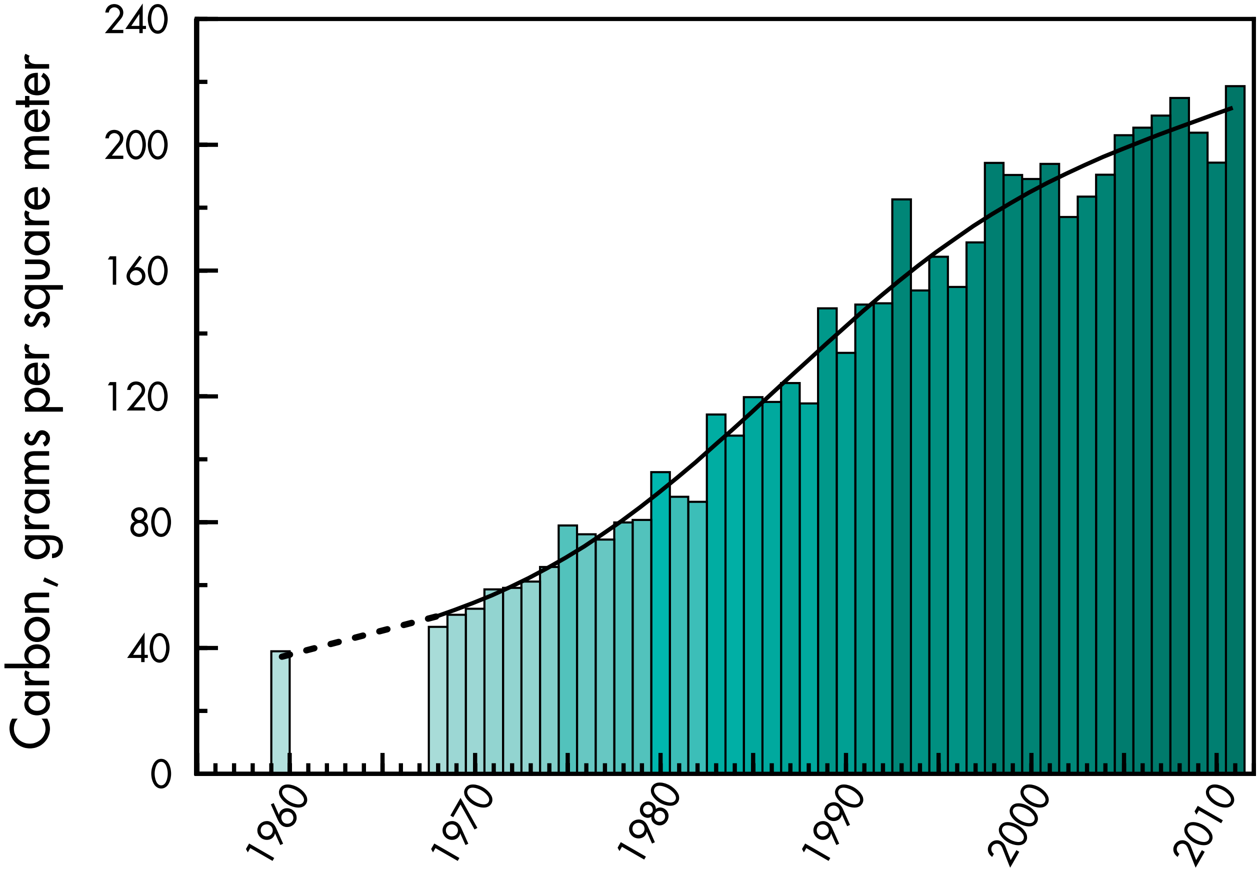
BIOLOGY

Algae growth (primary productivity)

Yearly since 1959

Primary productivity is a measure of the rate at which algae produce biomass through photosynthesis. It was first measured at Lake Tahoe in 1959 and has been continuously measured since 1968. Primary productivity has generally increased over that time, promoted by nutrient loading to the lake, changes in the underwater light environment and a succession of algae species. In 2011, primary productivity was 218.6 grams of carbon per square meter.



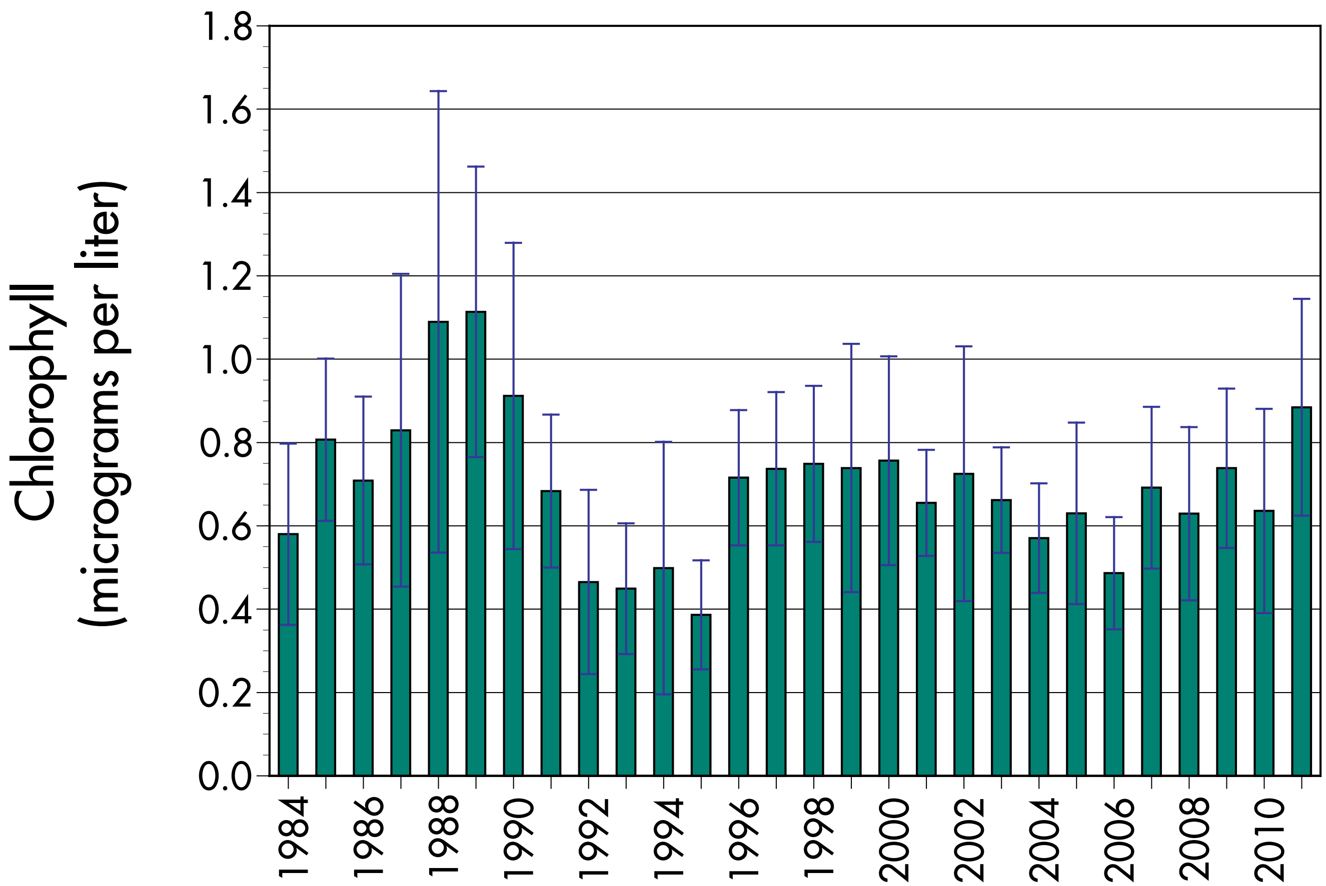
BIOLOGY

Algae abundance

Yearly since 1984

The amount of free-floating algae (phytoplankton) in the water is determined by measuring the concentration of chlorophyll *a*. Chlorophyll *a* is a common measure of phytoplankton biomass. Though algae abundance varies annually, it has not shown a long-term increase since measurements began in 1984.

The annual average value for 2011 was 0.88 micrograms per liter. The average annual chlorophyll *a* level in Lake Tahoe has remained relatively uniform since 1996.

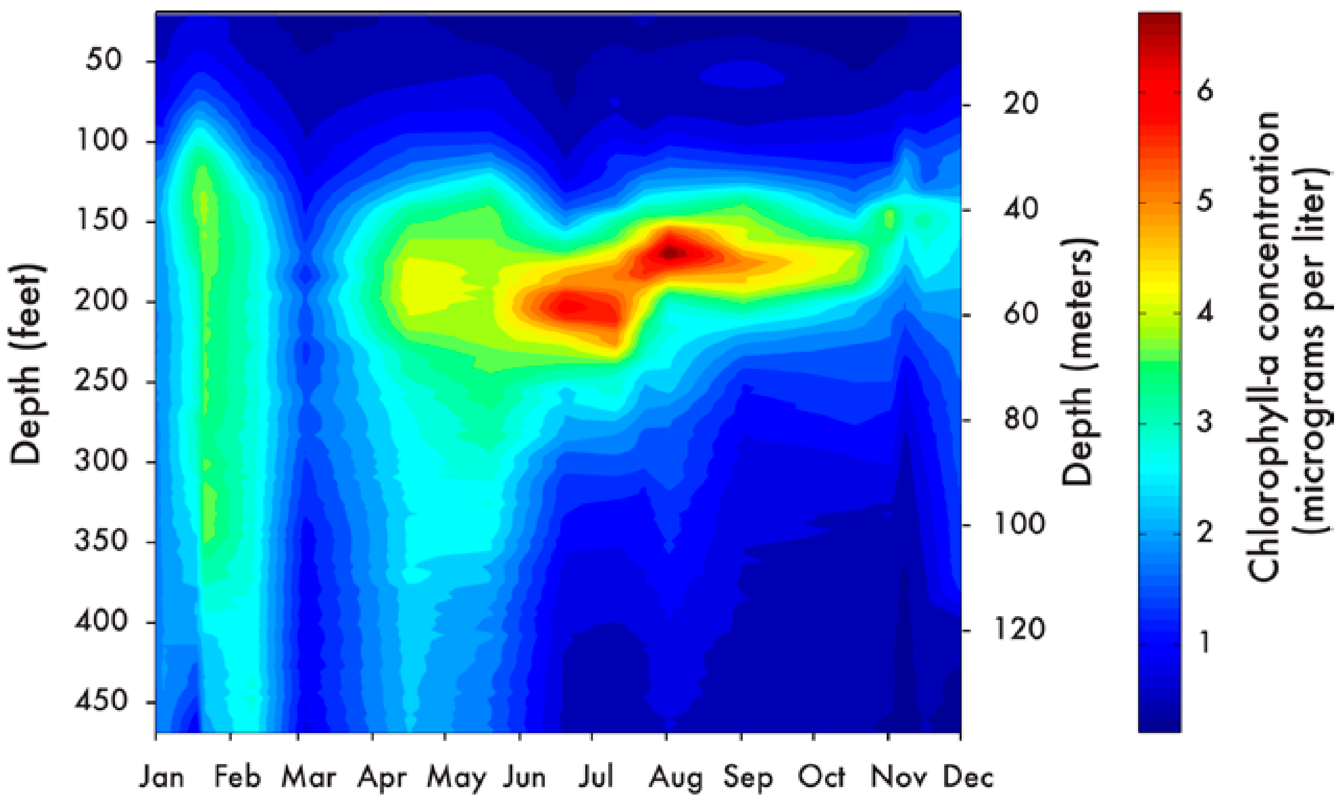


BIOLOGY

Algae concentration by depth

In 2011

Chlorophyll concentration can be measured in situ and is used for a surrogate for the concentration of algae. In summer in Lake Tahoe much of the algae is located within a deep chlorophyll layer, between 150 - 250 feet below the surface. In fall, when the lake commences to mix, the chlorophyll gets spread over a much broader depth range.

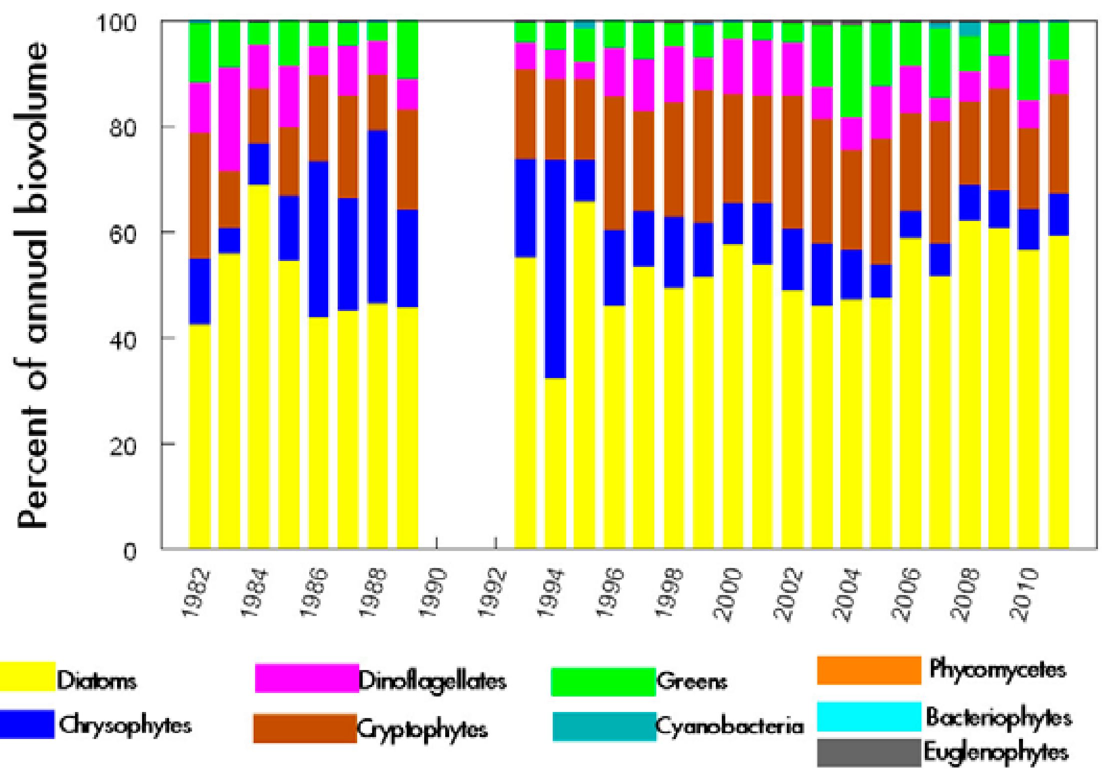


BIOLOGY

Annual distribution of algal groups

Yearly since 1982

The population, or biovolume, of algal cells from different groups varies from year to year. Diatoms are the most common type of alga, comprising 40 to 60 percent of the total biovolume each year. Chrysophytes and cryptophytes are next, comprising 10 to 30 percent of the total. While the major algal groups show a degree of consistency from year-to-year, TERC research has shown that the composition of individual species within the major groups is changing in response to lake condition.

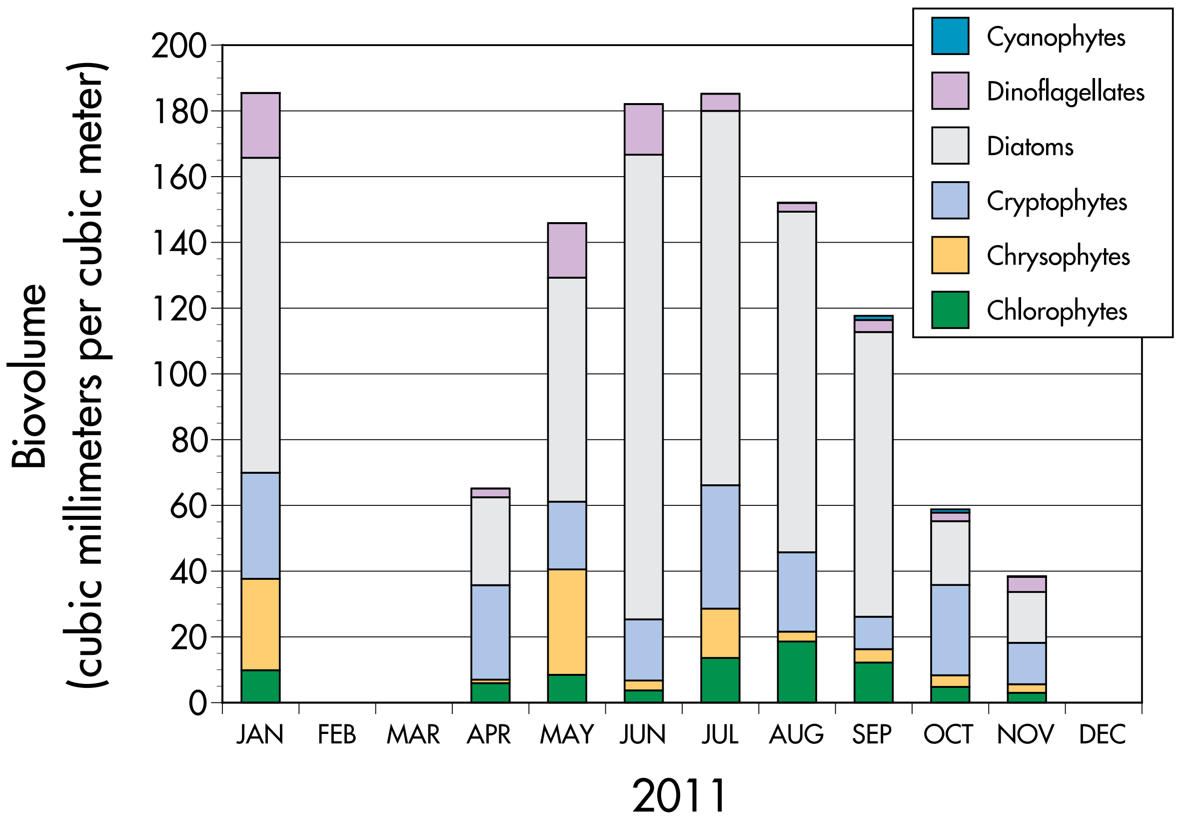


BIOLOGY

Algal groups as a fraction of total population

Monthly in 2011

Algae populations vary month to month, as well as year to year. In 2011, diatoms again dominated the phytoplankton community, especially in May-September when their biovolume was particularly high. In 2011, January had an unusually high biovolume compared to previous years.

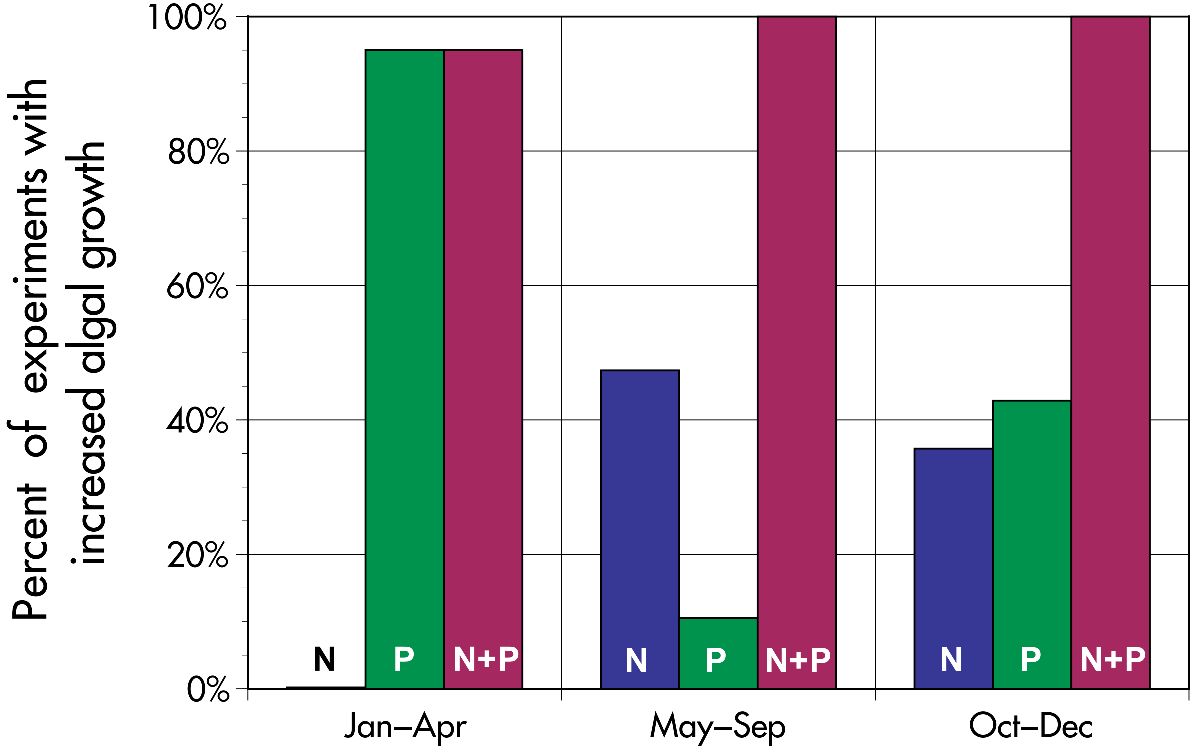


BIOLOGY

Nutrient limitation of algal growth

For 2002 - 2011

Bioassays determine the nutrient requirements of phytoplankton. In these experiments, nutrients are added to lake water samples and algal biomass is measured. These tests document both seasonal and long-term changes in nutrient limitation. Phytoplankton response to nutrient addition for the period 2002-2011 is summarized in the panels below. Between January and April, algal growth was limited purely by phosphorus (P). From May to September, Nitrogen (N) added by itself was more stimulatory, but the lake was co-limited, as shown by the greater response to adding both nutrients. Phosphorus was more stimulatory from October to December, but co-limitation was again the dominant condition. These results highlight the role of nutrients in controlling algal growth. They also underscore the synergistic effect when both are available.

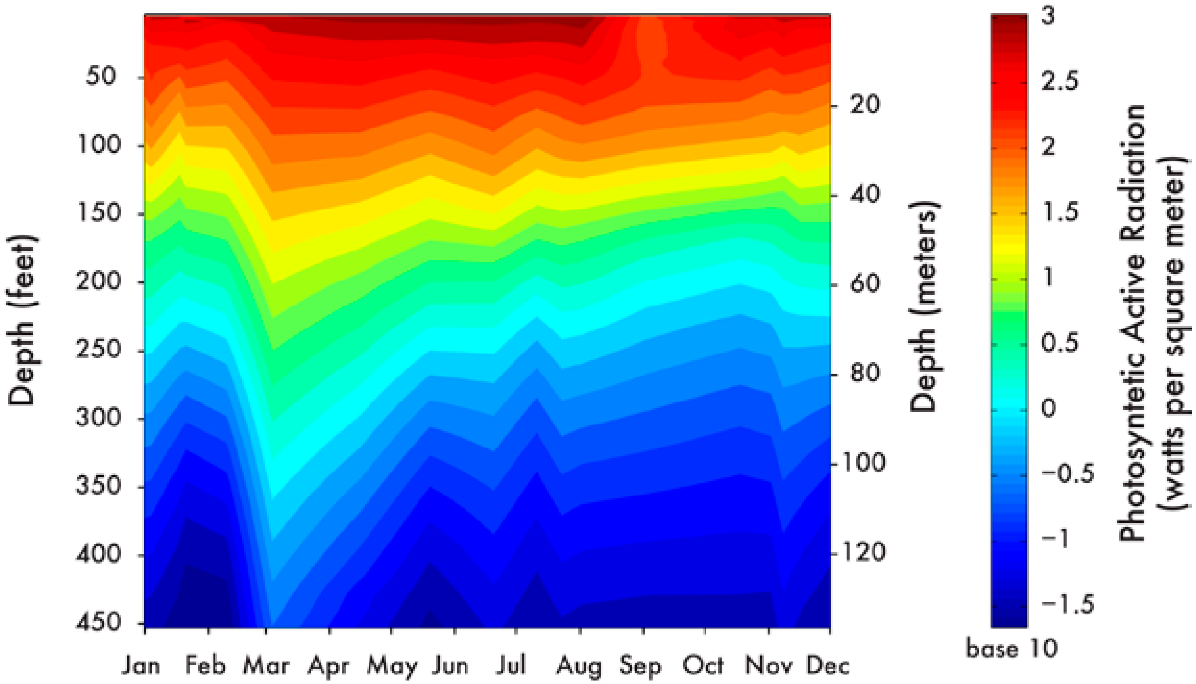


BIOLOGY

Photosynthetically active radiation

In 2011

Photosynthetically active radiation, often abbreviated PAR, designates the spectral range (waveband) of solar radiation from 400 to 700 nanometers that algae are able to use in the process of photosynthesis. Beyond a depth of about 300 feet there is insufficient light to promote photosynthesis. Higher intensity sunlight in summer produces an increase in the depth to which photosynthesis can occur.

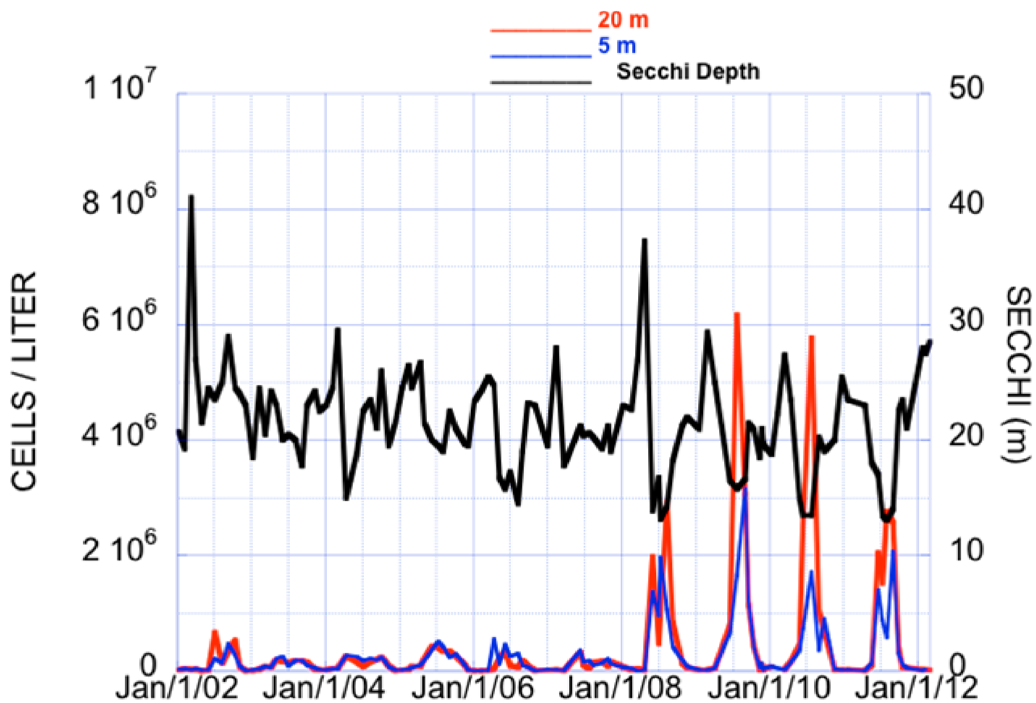


BIOLOGY

Predominance of Cyclotella sp.

From 2002 through 2011

In the last four years, one species of algae, *Cyclotella*, has started to dominate the make up of algae at Lake Tahoe. The individual cells are in the size range of 2 – 4 microns, the ideal size for light scattering. It is believed that the growing numbers of *Cyclotella* are in large part responsible for the decline in summer clarity. The red and blue lines below indicate the concentrations of *Cyclotella* at depths of 20 m (66 ft) and 5 m (16.5 ft) respectively. The black lines indicates the individual Secchi depths taken since 2002. The summer decline in Secchi depth coincides perfectly with the increase in *Cyclotella* concentration.

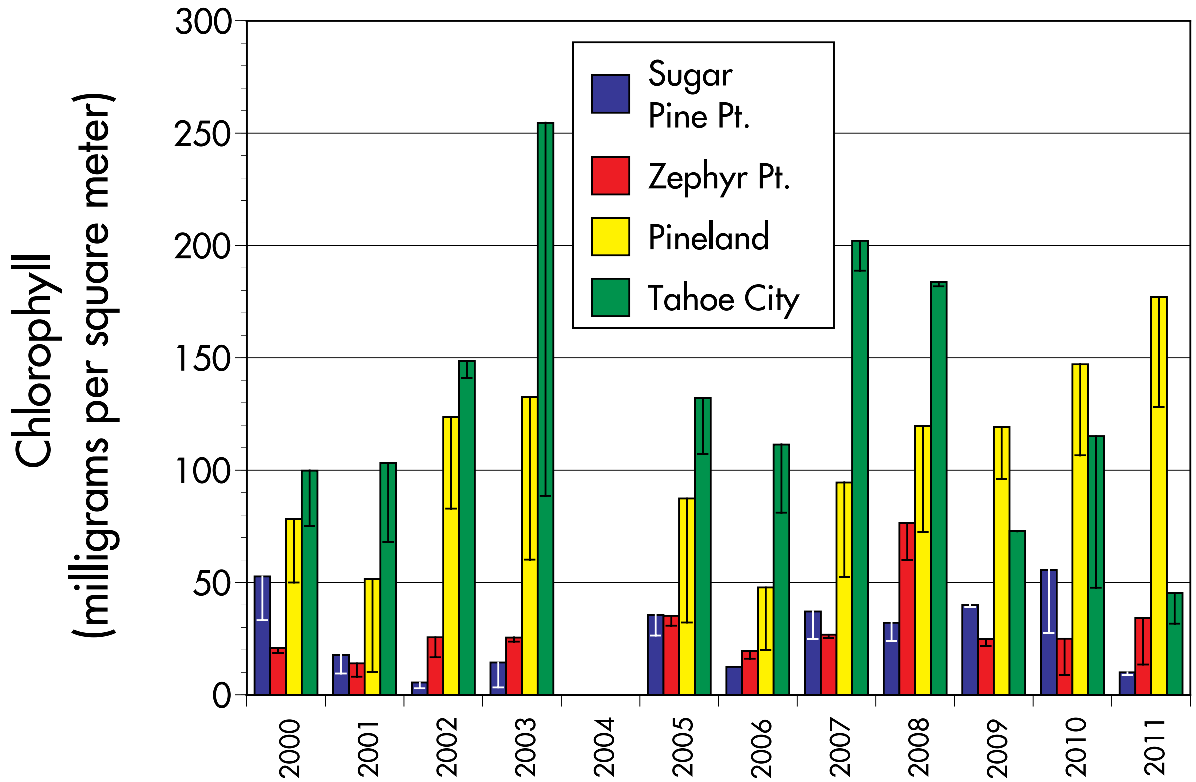


BIOLOGY

Shoreline algae populations

Yearly since 2000

Periphyton, or attached algae, makes rocks around the shoreline of Lake Tahoe green and slimy, or sometimes like a very plush white carpet. Periphyton is measured eight times each year, and this graph shows the maximum biomass measured at four sites. In 2011, concentrations were near or above average. The site with the most periphyton (Pineland) is close to urban areas. Tahoe City recorded the lowest values for that site since monitoring began in 2000. Peak annual biomass at the less urbanized Zephyr Point site remained down at the usual level, from the high value experienced in 2008. To date, no statistically significant long-term trend in maximum periphyton biomass has been detected at any of these individual locations. Monitoring periphyton is an important indicator of near-shore health.

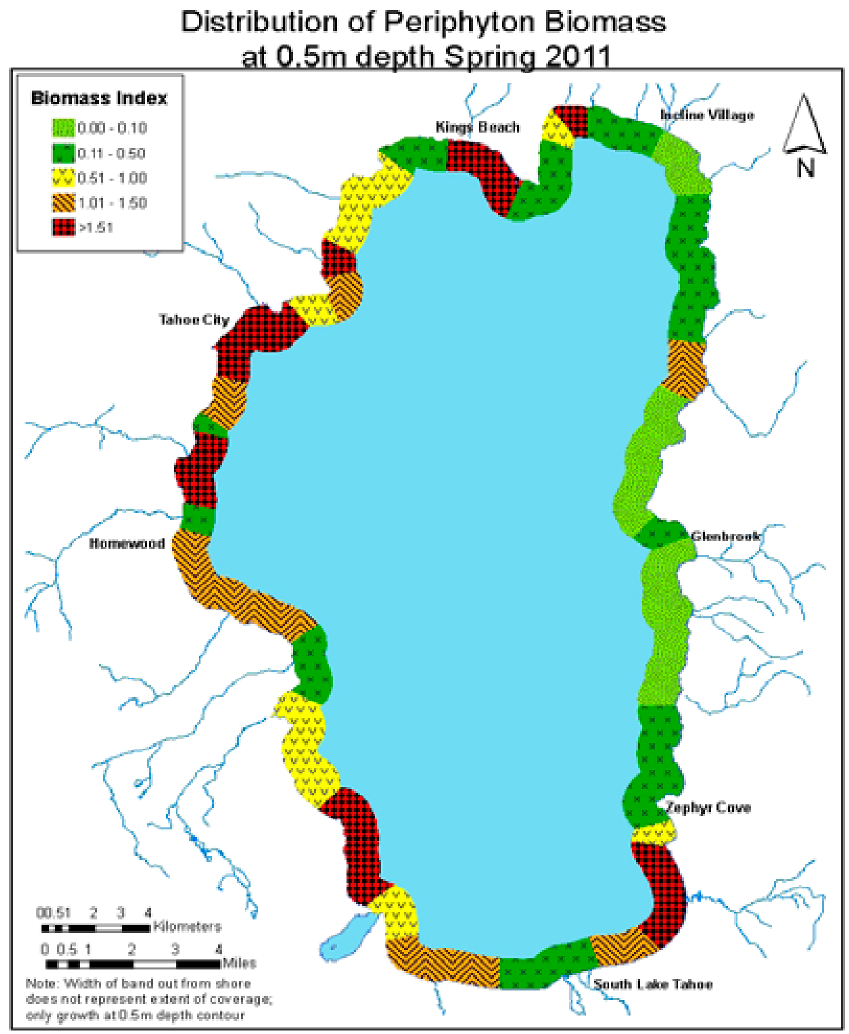


BIOLOGY

Shoreline algae distribution

In 2011

Periphyton biomass was surveyed around the lake during the spring of 2011, when it was at its annual maximum. Nearly 45 locations were surveyed by snorkel in 1.5 feet of water. A Periphyton Biomass Index (PBI) was developed as an indicator to reflect what the casual observer would visually detect looking into the lake from the shoreline. The PBI is defined as the percent of the local bottom area covered by periphyton multiplied by the average length of the algal filaments (cm). Zones of elevated PBI are clearly seen. (The width of the colored band does not represent the actual dimension of the onshore-offshore distribution.) Compared with 2008, there were higher concentrations of periphyton particularly in the north-west.



TAHOE: STATE OF THE LAKE REPORT 2012

CLARITY

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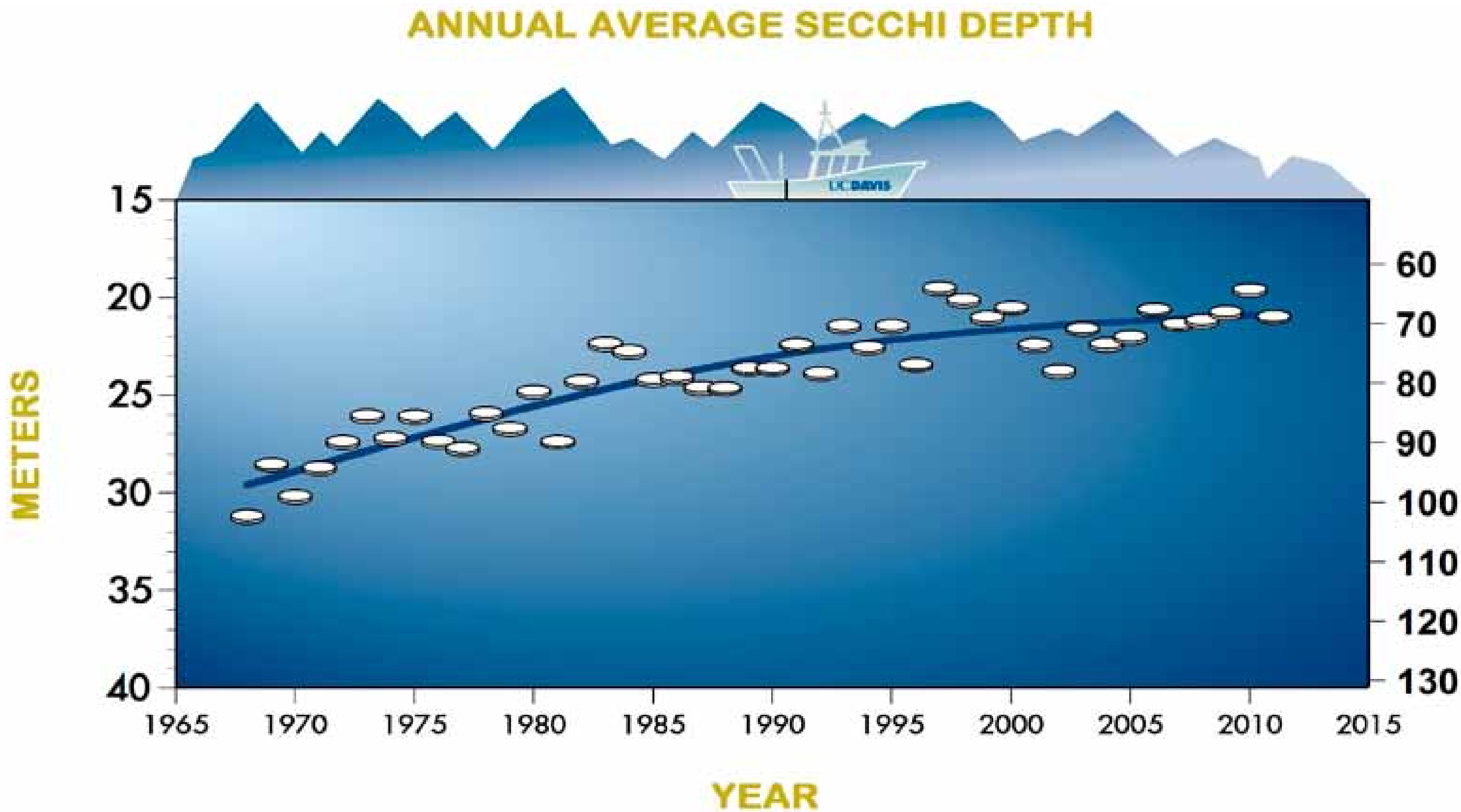
CLARITY

Annual average Secchi depth

Yearly since 1968

In 2011 the annual average Secchi depth was 68.9 feet, an improvement of 4.5 feet over the previous year. This improvement came despite an extremely wet year. The annual average clarity in the past decade has been better than in recent decades. In 1997-1998, annual clarity reached an all-time average low of 65.1 feet. From 2001-2011 the average clarity was 70.6 feet. It is important to understand the possible causes and to see what they tell us about past actions and future investments. Some of the critical knowledge gaps are in the monitoring of urban stormwater flows, where an independent and comprehensive monitoring program needs to be established to evaluate the status and trends of this important source of fine sediment and nutrients.

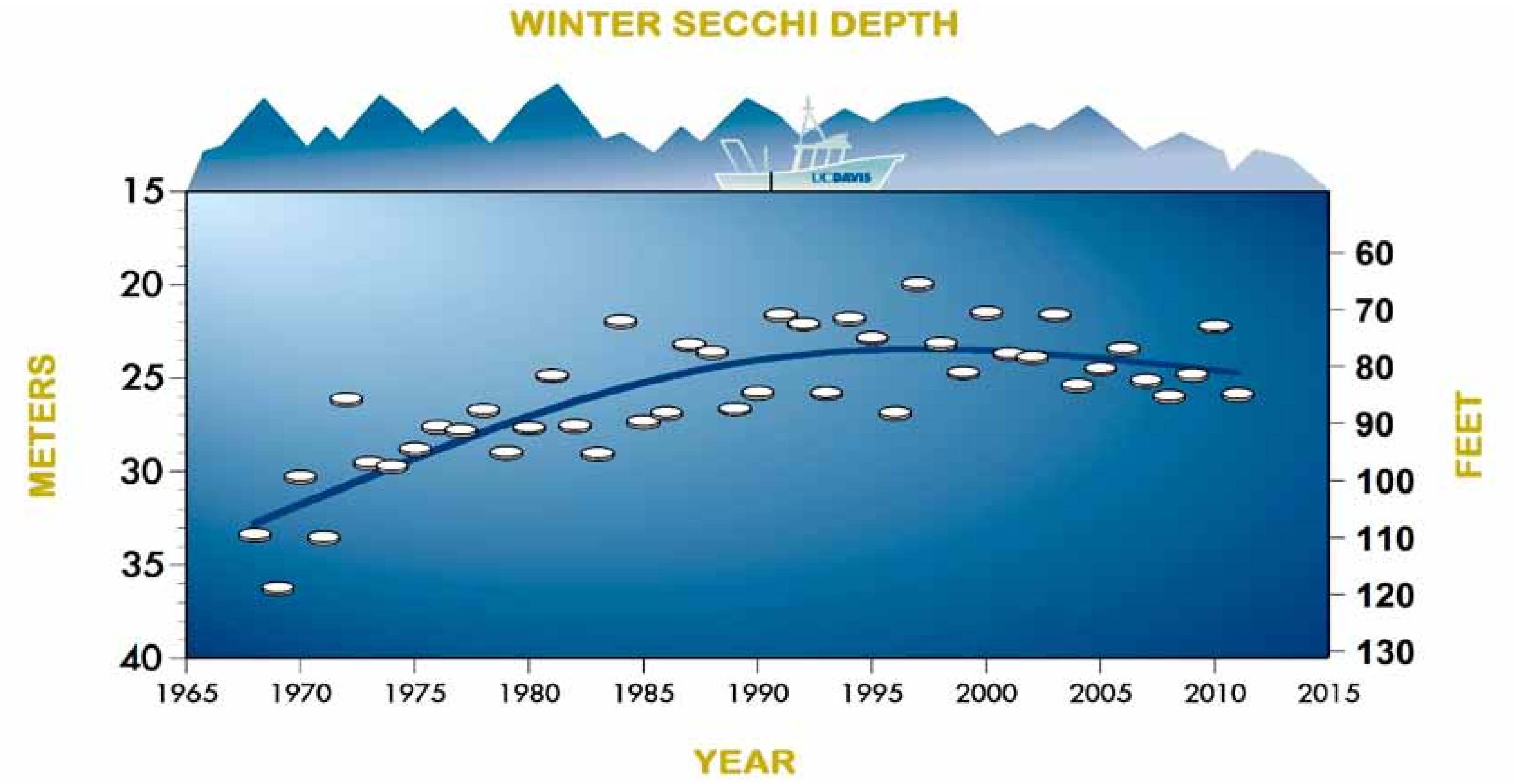


CLARITY

Winter Secchi depth

Yearly since 1968

Annual winter (December-March) Secchi depth measurements from 1968 to the present indicate that the long-term decline in winter clarity at Lake Tahoe is showing definite improvement. In 2011, the winter clarity increased to 84.9 feet, an improvement of 12.0 feet over the previous year. The reasons behind the continued improvement in winter clarity are not fully understood. One hypothesis is that there has been a reduction in the load of fine particles from urban stormwater. Urban stormwater is the largest source of fine particles to Lake Tahoe, and generally enters the lake in winter. A comprehensive, regional urban stormwater monitoring plan is needed to determine if recent capital investments in stormwater projects have indeed reduced these loads.



CLARITY

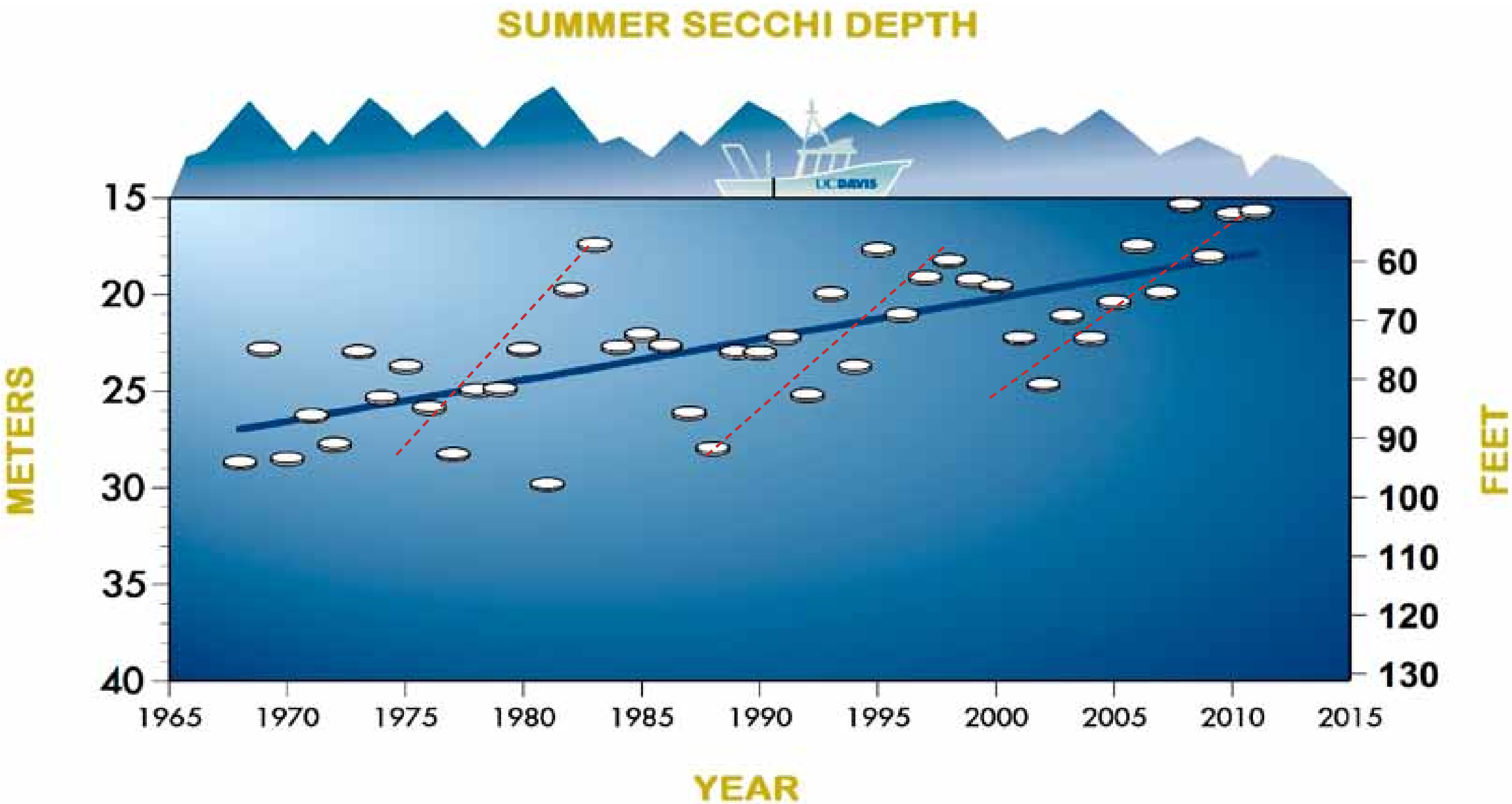
Summer Secchi depth

Yearly since 1968

Summer clarity in Lake Tahoe in 2008 and 2011 were the lowest values ever recorded (50.4 feet and 51.4 feet respectively). Unlike the winter clarity pattern, where there is a long-term trend of declining and then improving clarity, the summer trend is dominated by a consistent long-term decline but with a noticeable 10-15 year cyclic pattern.

This is clearly visible in 1968-1983, 1984-1997 and 2000-2011 (see red dashed lines on graph). For about the last decade there has been a near-continuous decline in summer clarity.

The reasons behind this periodicity are being investigated, however, there is evidence pointing towards increasing numbers of very small diatoms (2 – 4 microns diameter) scattering light in the same way that fine stormwater particles do.

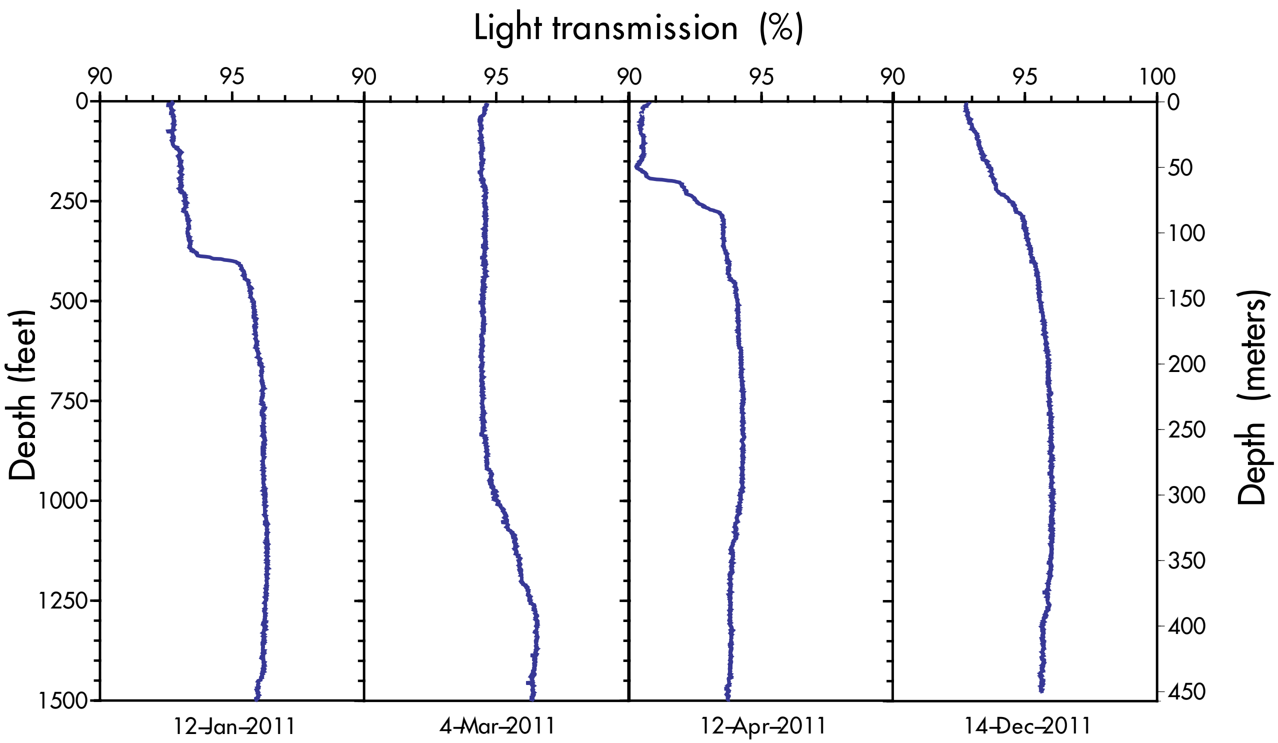


CLARITY

Light Transmission

In 2011

A light transmissometer measures what percentage of a given wavelength of light is received over a 10 inch pathlength. Here, the light transmission at all depths is shown for all four seasons. It is evident that the lowest light transmission is in the surface layers where 90 to 95 percent of light is transmitted. The highest light transmission is in the very deepest parts of the lake where over 95 percent of the light can be transmitted. The reason is that there are fewer fine particles in the deep lake water.



TAHOE: STATE OF THE LAKE REPORT 2012

EDUCATION AND OUTREACH

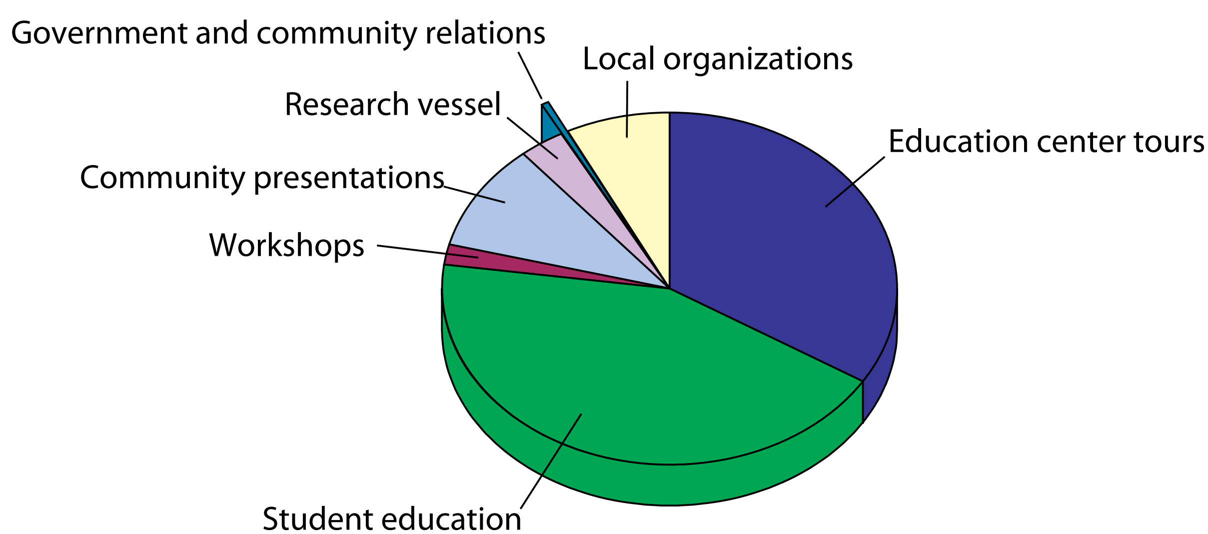
UC DAVIS TAHOE ENVIRONMENTAL RESEARCH CENTER

EDUCATION AND OUTREACH

TERC education and outreach

In 2011

Part of TERC's mission is education and outreach. During 2011, TERC recorded 12,283 individual visitor contacts. The majority represented student field trips and visitors to the Thomas J. Long Foundation Education Center at Incline Village. In addition, TERC hosts monthly public lectures and workshops, makes presentations to local organizations and takes a limited number of visitors out on our research vessels. TERC organizes and hosts annual events and programs including Children's Environmental Science Day, Science Expo, Youth Science Institute, Trout in the Classroom program, Project WET workshops, Summer Tahoe Teacher Institute and a volunteer docent training program. TERC also partners with numerous groups to deliver education in the Tahoe basin. In 2011, these included AmeriCorps, COSMOS, Sierra Watershed Education Partnerships (SWEP), Space Science for Schools, Young Scholars and many others.



TOTAL NUMBER OF CONTACTS: 12,283

EDUCATION AND OUTREACH

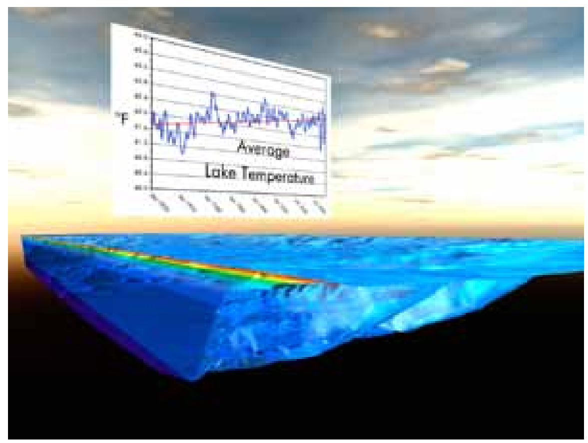
TERC educational exhibits

In 2011

A new 3D movie was developed for viewing in the 3D Theater at the Thomas J. Long Foundation Education Center in Incline Village, Nev. "Mapping Change In Sierra Nevada Forests" is a 10 minute short film about vegetation mapping surveys conducted across generations for understanding how Sierra Nevada forests are responding to climate change. Steven McQuinn, 3D Viz, created, directed and narrated the 3D visualization production which was funded by NSF through a grant with Dr. Jim Thorne, UC Davis.

"Lake Tahoe in Depth" 3D short film (16 minutes) continues to be a huge success in the 3D Theater as well.

Historic vegetation transect maps conducted in the 1930s are compared with modern remotely sensed maps to find changes in vegetation types in the Sierra.



Evidence for climate change is found in lake temperatures, air temperatures and changes found in the forest. See "Mapping Change" 3D to learn more.

The award-winning 3D movie "Lake Tahoe in Depth" (16 minutes) continues to show at the 3D Theater in Incline Village.

EDUCATION AND OUTREACH

TERC educational programs

In 2011

In addition to providing education center tours for the general public, the TERC Education Team also provides high quality informal science education to more than 5,000 fifth- and sixth-grade students by hosting 60 - 70 field trips each year.

A small group of select high school students participate in the afterschool Youth Science Institute from January through May. Participants work with scientists, conduct science experiments and share science activities with other students.

For the past several years, TERC has hosted a summer Tahoe Teacher Institute for educators from both California and Nevada.

School groups visit for informal science education programs on water, geology and biology

Youth Science Institute participants conduct science activities to improve their confidence in various scientific fields

Teachers come to Lake Tahoe for the Tahoe Summer Institute to improve their proficiency in environmental science topics and learn new science activities

EDUCATION AND OUTREACH

TERC special events

In 2011

TERC hosts monthly lectures throughout the year on various environmental issues, new scientific research and related regional topics of interest.

Special events hosted annually include Project WET training workshops (February), Science Expo (March), Green Thumb Tuesdays (July - August), Children's Environmental Science Day (August), Earth Science Day (October), and Family Science Day (December)

The annual Science Expo held each March brings in more than 600 third-, fourth- and fifth-grade students for hands-on science activities

Monthly lectures are held at both the Incline Village and Tahoe City locations

Children's Environmental Science Day is held annually each August with hands-on science activities designed for kids ages six and up

The UC Davis Tahoe Environmental Research Center (TERC) is a world leader in research, education and public outreach on lakes, their surrounding watersheds and airsheds, and the human systems that both depend on them and impact them. TERC provides critical scientific information to help understand, restore and sustain the Lake Tahoe Basin and other lake systems worldwide. We partner closely with other institutions, organizations and agencies to deliver solutions that help protect Lake Tahoe and other lakes around the world.

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http://terc.ucdavis.edu

FULL REPORT AVAILABLE AT

HTTP://TERC.UCDAVIS.EDU/STATEOFTHELAKE/

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