



UC DAVIS

TAHOE ENVIRONMENTAL RESEARCH CENTER

THE TAHOE ENVIRONMENTAL RESEARCH CENTER (TERC) IS DEDICATED TO RESEARCH, EDUCATION AND PUBLIC OUTREACH ON LAKES AND THEIR SURROUNDING WATERSHEDS AND AIRSHEDS. LAKE ECOSYSTEMS INCLUDE THE PHYSICAL, BIOGEOCHEMICAL AND HUMAN ENVIRONMENTS, AND THE INTERACTIONS AMONG THEM. THE CENTER IS COMMITTED TO PROVIDING OBJECTIVE SCIENTIFIC INFORMATION FOR RESTORATION AND SUSTAINABLE USE OF THE LAKE TAHOE BASIN.

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RESEARCH UPDATES

Beyond the Secchi Disk

The Secchi disk is one of the most common pieces of equipment used to measure water clarity. Since 1958, UC Davis scientists have been using the Secchi disk to collect clarity measurements in Lake Tahoe, and as early as 1874 University of California's first professor, John LeConte, used an almost identical instrument to measure lake clarity at 108 ft. The Secchi disk may not seem like a high-tech way to measure clarity, but it never fails, is easy to use, and never requires technical support. However, there are issues that arise when taking Secchi disk measurements. For example, readings depend on the eyesight of the person taking measurements as well as the weather. If it's windy, the surface of the water will be irregular and sunlight will be reflected off the surface, thus altering results. Multiple measurements are taken throughout the year to compensate for these discrepancies.



BRANT ALLEN

Researcher Dan Nover lowers the Laser In-Situ Scattering Transmissometer into Lake Tahoe from the Research Vessel John LeConte

Changes in water clarity are primarily caused by the concentrations of dissolved substances, phytoplankton, and suspended particles in the water. The Secchi disk measures overall clarity but does not indicate what is limiting light penetration in the lake on any given day. To understand this researchers also use new and innovative instruments. One such instrument is the Laser In-Situ Scattering Transmissometer (LISST) that continually measures the sizes of fine particles as it is lowered through the water column. The Fluoroprobe measures the concentrations of individual

phytoplankton species as it is lowered through the lake. Lastly, the Seabird CTD is a multi-faceted instrument that has specialized sensors to measure sunlight penetration through the water column and the transmission of blue light at all water depths. Used together with the Secchi disk, these instruments help determine the causes of Lake Tahoe's clarity change, and provide a reliable long term record. By better understanding the causes of clarity change, we have an opportunity to inform what is needed to reverse the loss of clarity at Lake Tahoe.

LETTER FROM THE DIRECTOR

If you have enjoyed being at Lake Tahoe this summer, then the drought parching many of the mid-western states, and the sweltering temperatures that have made life almost unbearable on the eastern seaboard seem like very distant events. But they are not. We in the west, and especially at Lake Tahoe, have never been immune to climate extremes. Twelve months ago, after one of the wettest winters on record, the lake was within 8 inches of its maximum legal depth. Eighteen months earlier the lake level had fallen below its natural rim and flow from the lake into the Truckee River at Fanny Bridge ceased. And next year will be...

That is the point. We don't know with much

assuredness what next year's weather for Lake Tahoe will be. What we do know is that it has been getting warmer since measurements began at the lake over 100 years ago, and this has contributed to many changes including earlier snow melt and more rain compared to snow. And we do know that these trends will continue for the foreseeable future. On top of these long term trends, extreme events, such as those the rest of the country are experiencing this summer, will become more frequent and increasingly extreme.

The potential impacts of climate change at Lake Tahoe have been studied in the last few years by researchers at TERC in collaboration with colleagues from across the



Geoffrey Schladow, Ph.D., Director Tahoe Environmental Research Center

country. A special edition of the scientific journal Climatic Change has just been released which details this work and what it might mean for Lake Tahoe. If anything, Lake Tahoe and the rest of the Sierra Nevada are likely to experience even greater climate change

impacts than most of the nation in the coming decades. These results provide a starting point for informing and guiding sustainable planning in the Tahoe basin.

A handwritten signature in black ink that reads "Geoff".



DALE HORCHNER

Visit the Tahoe City Field Station native plant demonstration garden for examples of the native plants that grow in the Lake Tahoe basin.

RESEARCH UPDATES, CONTINUED

Asian Clams in Emerald Bay

The discovery of Asian clams (*Corbicula fluminea*) at the mouth of Emerald Bay by TERC research divers two years ago was a very worrying turn of events. Asian clams filter large volumes of water and their waste products have been shown to produce elevated levels of nitrogen and phosphorus, which, in turn, stimulate growth of nuisance algal blooms. The Asian clam populations are in direct competition with native benthic organisms such as the Montane pea clam and the Ramshorn snail. Clam shells along the lakebed also have the potential to become a source of concentrated calcium carbonate, something required by Quagga and Zebra mussels. While these mussels are not present yet in Lake Tahoe, keeping them out is a high priority for management agencies and scientists alike. Scientists at the University of California, Davis and the University of Nevada, Reno have collaboratively found that using thin rubber mats over the Asian clam beds reduces dissolved oxygen concentrations to zero and asphyxiates the clams in a one to two month time period. This management strategy was effective at

Lakeside Marina, CA and Marla Bay, NV. However, this technique has not been as effective at Emerald Bay.

Emerald bay is separated from Lake Tahoe by a sill, which is in reality the terminal moraine left by the glacier that carved the bay 12,000 years ago. Test mats placed at the Emerald Bay sill, the site of the current Asian clam invasion, were equipped with underwater dissolved oxygen sensors. These showed that during summer there was a daily early afternoon increase in dissolved oxygen due to a combination of boat activity and wind. This increase in oxygen was the result of water passing through the sill, effectively negating the rubber mats. A further study, using an acoustic current meter on loan from Dr. Hrunn Andradottir of the University of Iceland, has helped better understand the complex flows through the sill and at the mouth of Emerald Bay. While the flow through the sill cannot be prevented, researchers have determined that there are times of year when such flows almost disappear, and these are the times when the clams are most prone to treatment. In addition, experiments showed that by placing organic matter under the rubber mats, it is possible to



TERC research diver installs acoustic current meter to measure complex flows across the sill at the mouth of Emerald Bay

decrease oxygen concentrations far more rapidly and to greatly extend the times when clams can be killed.

VISITING RESEARCHERS TO TERC

TERC has several visiting researchers from all around the world this summer. They are working with us to better understand changes in zooplankton, invasive species, water motions and clarity in Lake Tahoe, and the health of the smaller lakes of the region.



Marina Arbat-Bofill, Polytechnic University of Catalonia, Spain



Sewoong Chung, Chungbuk National University, Korea



Luciana de Souza Cardoso, Brazil Federal Univ. of Rio Grande do Sul



Sebnem Elci, Izmir Institute of Technology, Turkey



Adam Laister, Plymouth University, United Kingdom

EDUCATION AND OUTREACH

The UC Davis Tahoe Environmental Research Center (TERC) is comprised of researchers and educators who take an interdisciplinary approach to the study of lakes (limnology) and the watersheds that surround them. Researchers explore the interconnections between the physical, biogeochemical, and human environments that make up the ecosystem. TERC collects and analyzes scientific data for restoration efforts and sustainable use of the Lake Tahoe Basin. In addition to collecting information from research vessels out on the lake, scientific endeavors are conducted at the two main laboratory facilities operated by TERC.

UC Davis in Incline Village

The Tahoe Center for Environmental Sciences

(TCES), a Platinum LEED-certified building, houses TERC's public science education center, laboratories, and the main TERC administrative offices. Open year-round, the first floor of the building includes the Thomas J. Long Foundation Education Center, offering public drop-in and scheduled tours of a scaled model of the Research Vessel John LeConte and a simulated research laboratory. Visitors are invited to explore Lake Tahoe through the eyes of scientists in the 3-D Visualization Theater with the award-winning 3-D film *Lake Tahoe in Depth*. Green building tours highlight environmentally-friendly design and construction, emphasizing energy efficiency, water savings, recycled materials and indoor environmental air quality features.



Children's Environmental Science Day will be on Saturday, August 11, 2012

School field trips focused on watershed science, earth science, ecology, geology, resources and energy, and Lake Tahoe research are also available. Additionally, the TERC Education Team hosts several special events including monthly lectures and family science days.

UC Davis in Tahoe City

The UC Davis Tahoe City Field Station has evolved from its origins as a state fish hatchery opened in 1920 to its current function as a field station for UC Davis researchers. The Field Station houses the Eriksson Education Center, a living laboratory, native gardens, a small laboratory, and the equipment necessary for researchers to boat on, dive in, and scientifically examine Lake Tahoe.

Between Memorial Day and Labor Day, the Eriksson

Education Center offers visitors an opportunity to explore the facility at their own pace with self-guided tours. Volunteer docents are available on Saturdays from 10 a.m. – 2 p.m. for guided tours and hands-on science activities. The living laboratory and demonstration garden of native plants surround the Field Station, allowing visitors an opportunity to learn about truly “green” gardening and the restoration of the wetlands area. This summer, visitors will have the opportunity to conduct citizen science by participating in World Water Quality Monitoring, Bird Monitoring, and the USA National Phenology Network project. Visitors will conduct basic monitoring of the local water bodies, identify migrating bird species, and observe life stages of plants in an effort to monitor the influence of climate.



HEATHER SEGAL

Education Center guests examine the tiny zooplankton that live in the lake

FEATURED STAFF

Shohei Watanabe

Dr. Shohei Watanabe comes to Lake Tahoe from Kobe, Japan. Shohei is a recent graduate of Laval University in Canada with a Ph.D. in Biology after studying hydrologic optics in lakes ranging from thermokarst thaw ponds in sub-arctic permafrost areas to northern temperate lakes. In the fall of 2011, he worked at Lake Tahoe to understand spectral properties of underwater light and its controlling factors. He hopes to link his results to biological data and understand the relationship between underwater light climate and species composition of phototrophic organisms.

Dr. Watanabe is now a post-doctoral researcher with TERC and the UC Davis Center for Spatial Technologies and Remote Sensing (CSTARS). In his current research project he utilizes remote sensing technologies, working with high spatial multispectral satellite images (WorldView-2) and airborne hyperspectral images. With these images, he is conducting assessments of near-shore water quality and underwater lake substrate conditions. Remote sensing technology has become an important monitoring tool for water resources management. The goals of this research are to use remotely sensed data to retrieve fine sediment,



Shohei Watanabe downloads data from the spectral radiometer

chlorophyll, and organic matter concentrations in the near shore. Next, the information will be used to map the distribution of attached algae, submerged plants, and clam beds in the near shore of Lake Tahoe.

Dr. Watanabe is also collaborating with Dr. Simon Hook at NASA to establish a real-time underwater light

station at the center of Lake Tahoe. Attached to one of the NASA/UC Davis buoys on Lake Tahoe, this station is the first of its kind in the world, measuring the changing light field at three depths every 30 minutes. Such high resolution data are needed to better understand the drivers of changing lake clarity.

UPCOMING EVENTS

August 11, 2012:
13th Annual Children's Environmental Science Day in Incline Village for families with children ages 6 and up. Children's Environmental Science Day is a collaborative event with local non-profit, state, and federal agencies sharing hands-on environmental science activities with a special focus on Lake Tahoe.

August 14, 2012:
Green Thumb Gardening—Composting with or without

worms with Stephen Andrews, UC Berkeley, at the Tahoe City Field Station

August 16, 2012:
Fishing In and Around Lake Tahoe, with Victor Babbitt, Tahoe Fly Fishing Outfitters

August 18, 2012:
Fishing In and Around Lake Tahoe Part 2 (Fly casting instruction and tying demonstrations) at Tahoe City Field Station

August 22, 2012:
USGS Lecture with Gary

Scoppettone, USGS

September 11, 2012:
Seeing Sierra Nevada Uplift from Space, with Dr. Bill Hammond, UNR

October 3, 2012:
Lahontan Cutthroat Trout Recovery Project with Dr. Dave Beauchamp

November 1, 2012:
Meteorites with Dr. Yin, UC Davis Geology Dept.

Visit <http://terc.ucdavis.edu/calendar/> for more info.

STATE OF THE LAKE REPORT



The *Tahoe: State of the Lake Report 2012* summarizing recent research updates is now available online at <http://terc.ucdavis.edu/stateofthelake/>.

GIVING TO THE TAHOE ENVIRONMENTAL RESEARCH CENTER

Charitable gifts to the Tahoe Environmental Research Center provide crucial support for research, teaching and public outreach that helps promote understanding and conservation of the Lake Tahoe Basin and other lake

systems. Your gift helps ensure the Center's continued excellence in restoring Lake Tahoe and other lakes around the world - now and for generations to come. Thank you!

- YES, I wish to support the Tahoe Environmental Research Center with the gift amount shown below.
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