



# 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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## *Lake Tahoe Climate Change Forecasts*

UC Davis scientists recently issued the most detailed forecast to date of likely climate-change effects at Lake Tahoe, complete with estimates of when those effects might be seen and how big they might be.

Their findings suggest that even under the most optimistic projections:

- The average snowpack in the Tahoe Basin will decline by 40 to 60 percent by the year 2100;
- Floods will increase in the middle of the century;
- Prolonged droughts will become more common at the end of the century; and
- A new threat to the lake's unique ecology, one that will come from the very bottom of the lake, will become important by the second half of the century.

In recent years, UC Davis researchers have drawn on 100 years of data to describe changes in temperature and precipitation that have already occurred in the Tahoe region.

The new report combines those findings with sophisticated computer models to produce detailed local projections out to the year 2100.

“While there is always some uncertainty when projecting this far into the future, the results appear reasonable,” said Dr. John

Reuter. “They provide environmental managers and scientists with our first detailed glimpse of the potential impact of climate change on precipitation, runoff, water quality, and plant and animal resources in Lake Tahoe.”

This glimpse gives scientists and resource managers a better chance of taking strategic steps to minimize coming impacts of climate change.

View the full report at [http://terc.ucdavis.edu/publications/Climate\\_Change\\_Report\\_2010.pdf](http://terc.ucdavis.edu/publications/Climate_Change_Report_2010.pdf).



Winter has arrived at the UC Davis Tahoe Environmental Research Center laboratory and education center in Incline Village

## LETTER FROM THE DIRECTOR

Another year is drawing to an end, and it has clearly been one in which TERC's scientists and staff can all take considerable pride.

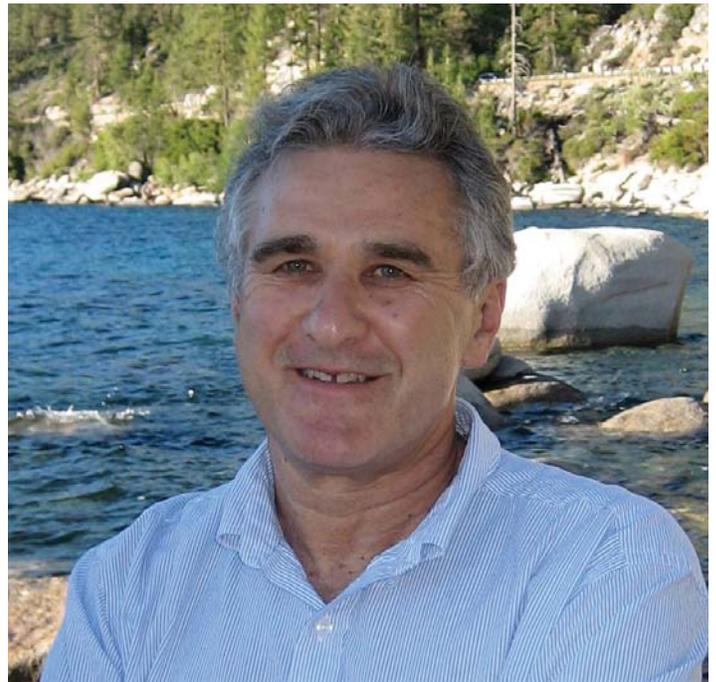
Three major themes have emerged in our work in recent years – invasive species, climate change and the restoration of lake clarity – and the year saw major advances in each area.

Just two weeks ago, TERC researchers lifted an acre of rubber barriers from the lake (held down by over a mile of rebar) to reveal millions of shells from clams that had been asphyxiated. This was the end of the first stage in a massive Asian clam control experiment that TERC has been leading in conjunction with researchers at the University of Nevada Reno and management agencies. The next 12 months will be used to monitor whether the clams return, and to measure the rate at which native species recolonize the area. The experiment received national news coverage, and project scientists were invited to Lake George, New York, to

advise on treating their recent discovery of Asian clams. Collaborations such as these are vital to the rapid progress of science, and will help us in our efforts at home.

Climate change has been recognized to be affecting Lake Tahoe since the beginning of our continuous data set over 40 years ago. This year, working with a team of leading scientists from around the country, TERC completed the most comprehensive modeling study of climate change impacts to the Tahoe region to date.

Over the next one hundred years, it is projected that snowpack will decrease by 40-60%, and extended periods of drought will see the lake level fall below the lake's rim. But change will not be steady, and the middle of the century is projected to be wetter. While the impacts on clarity are uncertain, the current efforts to decrease fine particles and nutrients are still considered the most important mitigation measures to ward off the most severe impacts of climate change on water



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

quality.

Finally, in November the Lahontan Regional Water Quality Control Board voted unanimously to modify the Basin Plan and adopt new goals for cutting contaminant loads to the lake ("the TMDL"). This represents a major step forward in improving clarity, and comes after much public consultation. TERC is proud to have played a major part in the technical studies that supported the TMDL. These technical studies have been a long-term effort, starting almost 10 years ago, but building on the entire data set that UC Davis has acquired over the decades. The efforts at understanding and now treating the root

causes of clarity decline exemplifies how science, management and the public can effectively work together.

Supporting science at Lake Tahoe is an important part of restoring and preserving our lake. What we are learning at Tahoe is also having an impact far afield, and Tahoe is both a bellwether of changed conditions in other lakes and an example of how to move forward. Thank you for your support of TERC in 2010. We wish you all the very best for 2011 and hope to see you on and around Lake Tahoe.

## RESEARCH UPDATE

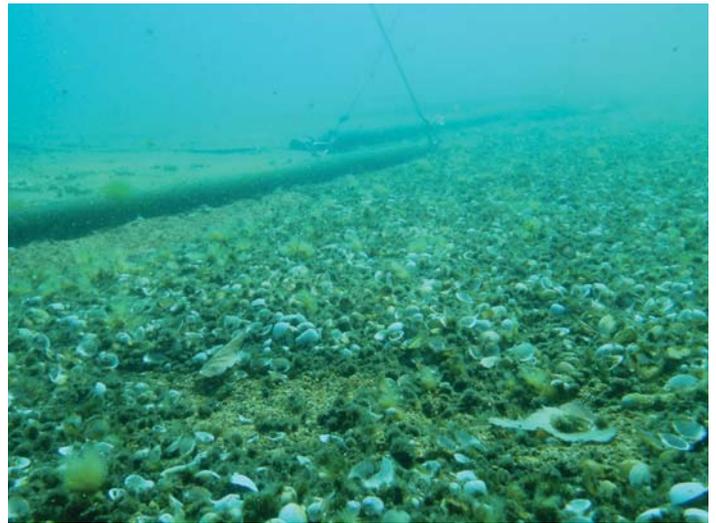
### Asian Clam Management

By now awareness of the Asian clam's (*Corbicula fluminea*) presence in southeastern Lake Tahoe and TERC's effort to control them is well known. TERC has partnered with the University of Nevada Reno and a number of Tahoe Basin management agencies, nonprofit organizations and groups from the private sector in a large-scale experiment to use gas impermeable bottom barriers to reduce Asian clam populations. In early July 2010, one acre of bottom barrier was installed in Lake Tahoe.

These barriers were removed in early November 2010 and field samples of the treatment plots

have been collected to assess what the impacts of the barriers have been over this four month period. Monitoring of these treatment plots will continue for an approximate 1 year period to quantify recolonization rates of both Asian clams and native invertebrate species that are impacted by this experimental method.

While TERC and UNR researchers are still processing their samples, visual inspection of the treatment plots shows that the barriers have had a desired impact on Asian clam populations in the treatment plots, yet further processing and analysis is needed to quantify the



Dead clams at the edge of the barriers; harnesses on floats make it easier for barge rollers to grapple and connect to barrier for removal

actual impact.

In addition, TERC and UNR researchers Marion Wittmann and Sudeep Chandra were invited to Lake George, New York to give advice to researchers there that have recently discovered Asian clam. Wittmann and Chandra urged the Lake George community to act quickly

in response to the recent discovery of Asian clam, while eradication is still a possibility. Chandra and Wittmann shared their research, spoke with students and other scientists, visited the Asian clam infestation sites in Lake George, and met with the Lake George Asian Clam Rapid Response Task Force.

### What is Happening at the "Hatchery"?

On July 10, 2010, UC Davis opened the doors to the new Eriksson Education Center at the UC Davis Tahoe City Field Station (Historic

Fish Hatchery). Visitors can once again enjoy this beautiful historic building and its surrounding land.

In the Eriksson Education Center visitors can view film footage of the hatchery operations to learn how fish were raised in the past. Other videos showcase research

currently underway, including the project to manage invasive Asian clams (see above). Interactive games teach youth and adults about the fish and other species in Lake Tahoe, while a timeline exhibit depicts the history of the building and ecological changes in the lake. A native and non-native fish aquarium is now available for visitors.

Outside, a path runs through upland and

wetland demonstration gardens. A half dozen interpretive signs tell about native plants and wetlands wildlife, development impacts, the restoration of Polaris Creek and the importance of wetlands, as well as the research that is under way in test plots.

Free tours of the historic fish hatchery are available by appointment or on summer Saturdays. Contact [tercinfo@ucdavis.edu](mailto:tercinfo@ucdavis.edu) to schedule a site visit.



More than 600 people gathered for the grand opening of the Eriksson Education Center

## EDUCATION AND OUTREACH

### 3-D Visualization Lab Improvements

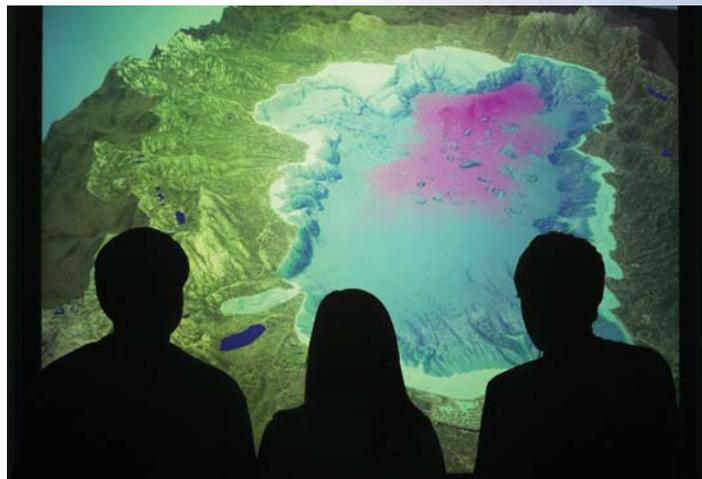
The 3-D Lake Tahoe Terrain Viewer, presented in the Otellini 3-D Visualization Lab, has been upgraded with a brighter, more colorful and visually accurate version.

Working off the older Tahoe Digital Elevation Model (DEM) software developed by the UC Davis W. M. Keck Center for Active Visualization in the Earth Sciences (KeckCAVES), the newer program has improved many of the criticisms of the older one.

This was a team effort, with Heather Segale as project manager, Braden Pellett supplying new program code, Steve McQuinn providing graphics skill and a technical vision of image quality improvements, and Oliver Kreylos converting

McQuinn's files to the format used by the Terrain Viewer. The cooperation of these people, as well as feedback from visitors made these improvements possible.

The original version of the program used computer graphic lighting to illuminate the landscape. The problem with the computer graphic lighting was that only the landscape directly in front of the viewer is illuminated with light, flattening the images and casting shadows that were too dark and actually hid detail. With the new code Braden created something akin to what is used in many computer graphic games, a process called emissive lighting. In other words, the landscape now emits its own light and does not need to have



Visitors to the Otellini 3-D Visualization Lab can “fly” through the Lake Tahoe watershed, both around the mountain basin and under the water

light cast upon it. But shadows were still needed to show detail so McQuinn created the shadows in the overlay itself, independent of the 3D model of the landscape. The shadows “painted” onto the overlay are balanced for revealing the shape of the landscape and bathymetry without being too dark. “Now the shadows are actually working for us, instead of against us,” McQuinn says.

McQuinn also created a new satellite overlay that is much brighter and more colorful than the overlay previously used, and applied a color gradient scheme to the bathymetry data so the landscape beneath the water could be better seen. Previously, that bathymetry data was draped with the dark image of the water surface.

Some other seemingly small but significant modifications were

made. A color profile was created between the 3-D Visualization Lab computer and projection setup to optimize the color and brightness quality for the projectors. What a difference in brightness and color!

Another important improvement is the removal of the objectionable digital artifacts that created sharp points, seams and deep depressions where the terrain should be flat. Specialty software and many hours of hard work were required to erase these.

Now a movie version of the current Tahoe fly-through is being produced. The movie version will provide a precisely timed and narrated alternative to the interactive fly-through. A new graphic recreation of the McKinney Bay Landslide and ensuing tsunami are now also available.



With the 3-D Earth Viewer, visitors can easily “see” the tectonic plate boundaries made visible by actual earthquake data points

## FEATURED STAFF

### *Forrest Returns from Antarctica*

UC Davis TERC researcher Alexander Forrest just returned from Antarctica after a successful three weeks on the ice. Forrest was part of an international collaboration between New Zealand, Canada, United States and France to deploy an underwater robot to study Antarctic sea ice, which is expected to decline more than 33 percent by 2100.

The team was studying the ocean mixing dynamics and how these are influenced by the Erebus Glacier Tongue as it extends into McMurdo Sound. Using the “UBC-Gavia” Autonomous Underwater Vehicle, or AUV, the research team was able to measure temperature and salinity differences that are difficult to obtain in the ocean located under the frozen ice. Better understanding of the processes at the ice/ocean interface will hopefully

provide clues to collapse of sea ice shelves, which cover almost 50 percent of Antarctica’s coastline.

The AUV has sensors to test salinity, water quality and measure currents. It is also equipped with sonar and a digital camera to image the underside of the ice.

The emerging story is a complex one of how the local ice conditions are modifying the dominant currents in the area.

Acoustic Doppler Current Profilers (ADCP) returned pictures of the complex water flows circulating around the ice tongue along with some large vertical flows which are likely strong influences on local mixing and ice growth. Collected imagery also provided further clues into the nature of floating ice tongues.

“Under-ice data will allow us to better understand ice-ocean interactions

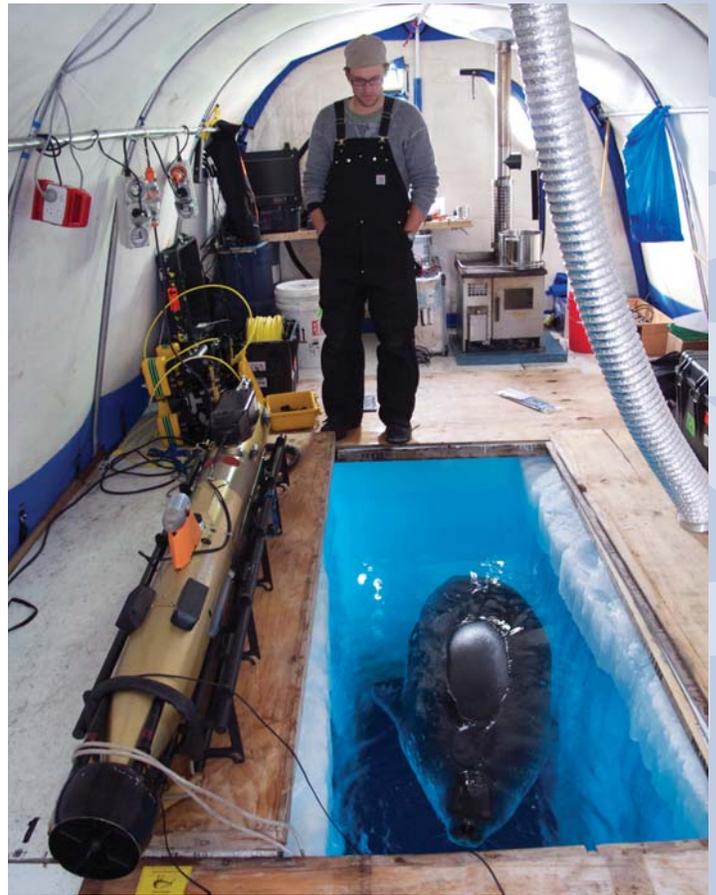
## UPCOMING EVENTS

**December 8, 2010:**  
Flying Under the Big Ice: Robotic Submarines Under Antarctic Ice, with Alexander Forrest

**December 29, 2010:**  
Family Science Day

**March 30, 2011:** Biophotonics Science and Technology Advances in Medicine and the Life Sciences, with Marco Molinaro

**March 16 – 18, 2011:**  
Science Expo



Researcher Alexander Forrest watches as another affectionate Weddell seal visits the ice hole; AUV “UBC-Gavia” shown left

and provide valuable information for climate modelers,” says Forrest.

Join Forrest for a presentation on the research

project, *Flying Under the Big Ice: Robotic Submarines Under Antarctic Ice* on December 8 at 6 p.m. at the Tahoe Center for Environmental Sciences.



Autonomous Underwater Vehicle “UBC-Gavia” and a Weddell seal share the open water

## SUPPORT THE TAHOE ENVIRONMENTAL RESEARCH CENTER

Help us preserve the beauty of Lake Tahoe for future generations. Gifts to the Tahoe Environmental Research Center help fund innovative research studies to combat threats to the Lake, educate the next generation of

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