



UC DAVIS

TAHOE ENVIRONMENTAL RESEARCH CENTER

RESEARCH UPDATES

Passive “Floating Robots” Will Go Wherever Lake Currents Take Them

In collaboration with UC Berkeley, TERC recently conducted the first of a series of “drifter” experiments to better understand the surface currents of Lake Tahoe. A fleet of 64 floating drifters, each about the size of a 2-liter soda bottle, tracks the water motion at 5-second intervals by recording and transmitting their changing GPS location. They are partially submerged so that their motion is driven by lake currents. Understanding surface currents of Lake Tahoe is important because currents are responsible for the transport of contaminants, invasive species, urban storm water and floating debris. This experiment will be conducted again in the winter, spring and summer.

If anyone finds a drifter washed up on shore,



UC Davis research engineer Alexander Forrest programs the 64 drifters that will be used in the experiment to track Lake Tahoe surface currents

it would be greatly appreciated if it could be collected and returned to the UC Davis Tahoe Environmental Research Center. Information about how to send the drifter home is available on each drifter.

Researchers work to eradicate the Asian clam from Emerald Bay

Rubber lake bottom barriers were placed by divers onto a 5-acre area on the floor of Emerald Bay in November 2012.

Valves were built into the material to serve as a port, allowing TERC research divers to insert a syringe and collect water samples from under the mat without disturbing the project.

Asian clams were first noticed at the lake about a decade ago but exploded in number in 2008, the same year they caused a nasty bloom of algae in the southeast of Lake Tahoe. In that area, clams now number more than 7,000 per square yard in places, “probably the

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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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LETTER FROM THE DIRECTOR

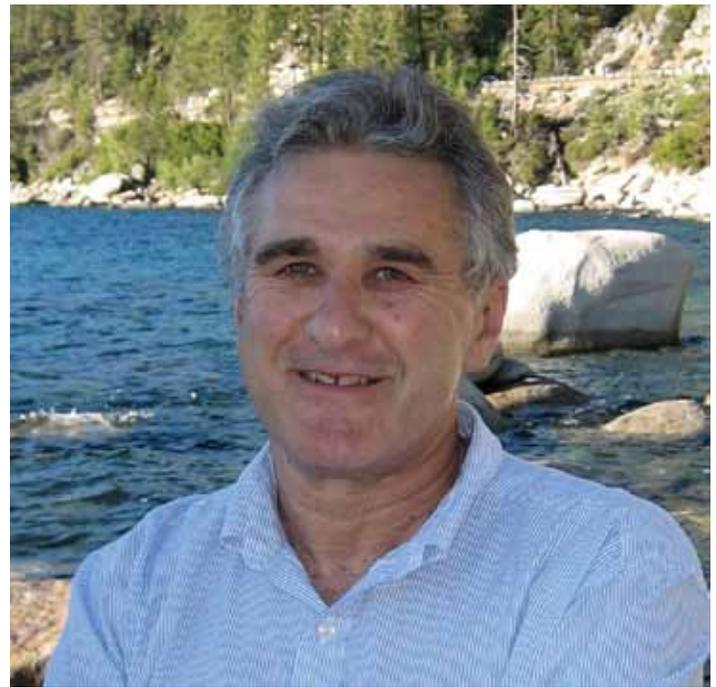
Some of the most important questions we face relate to the impact of climate change on restoration efforts at Lake Tahoe. Our past studies suggest that climate change will reduce the extent of lake mixing, and in particular the mixing of oxygen, down to deep water. How true this really is remains an open question at Tahoe and lakes world-wide.

Starting in 2013 we will have the opportunity to start answering that question. A custom-designed thermistor and dissolved oxygen “chain” will be installed in 400 feet of water off the west shore of Lake Tahoe. This instrument chain will measure tiny fluctuations in temperature and oxygen over this entire depth, allowing us to understand

how the wind and currents interact to produce mixing under continually varying conditions.

The instruments will take measurements every 10 seconds and the measurements will be instantly transferred to shore via a lake-bed cable. By having this real-time data, we will be able to observe the evolution of key mixing events as they happen and have the opportunity to dispatch boats to take a host of supplementary measurements. The data will also be used as the basis of real-time exhibits at TERC’s education centers and at other locations such as the Tahoe Maritime Museum.

How does TERC fund this kind of project? Part of the support for this cutting edge research is from a



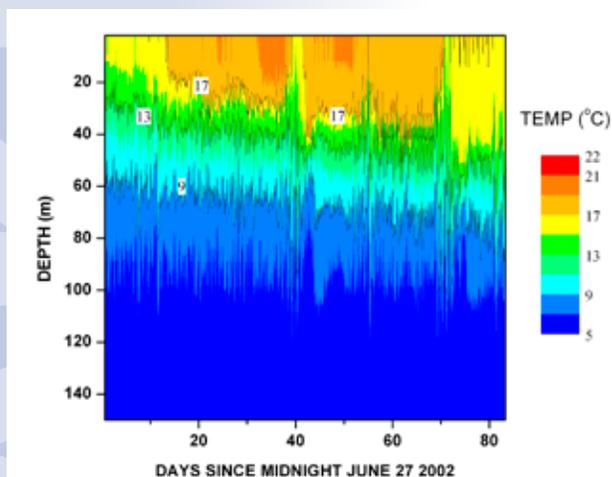
Geoffrey Schladow, Ph.D., Director Tahoe Environmental Research Center

new initiative by the UC Center for Information Technology Research in the Interest of Society (CITRIS). Part is through philanthropic support that TERC receives from private donors who have a desire to invest in science to save Lake Tahoe. And part is through in-kind support provided by our many partners around the lake. In this case we are particularly grateful to Obexer’s Boat Company, who are working with us to originate the lake-bed cable at their marina and providing the power to run the instruments.

All of these groups are essential to making science happen at Lake Tahoe and to keep the restoration efforts firmly based on science.

I want to thank all those who helped us with the many things we were able to accomplish this year. This ranges from our incredibly dedicated staff, our volunteer docents, the many students and interns that work through TERC, our partners in other research institutions and in the numerous Tahoe agencies, those who visit our education centers, and those of you who have helped fund our research and education programs and partnered with us in unique ways. I wish you all a safe and peaceful holiday season, and look forward to seeing you in 2013.

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



Temperature data such as this 3-month record will be available in real-time, allowing additional measurements during critical periods (such as Day 40)

RESEARCH UPDATES, CONTINUED

Continued from Page 1

highest in the world,” in terms of population concentrations, according to Geoff Schladow.

Scientists from UC Davis and the University of Nevada, Reno first devised and tested the concept of using rubber barriers to smother Asian clams in 2010, when they placed an acre of the barriers on the lake bottom. This first-of-its-kind method killed 100 percent of the clams. The success of those efforts and additional research led to this bigger project, which involves a team of interagency partners.

The goal of the Emerald Bay Asian clam control project is to treat a relatively small, isolated population of Asian clams before they spread to an unmanageable level. Currently, the clams live on a shallow, gravel sill roughly 15 feet below the surface that partially separates Emerald Bay from Lake Tahoe. Treatment will be accomplished by covering the infested lake bottom with the thin rubber barriers, augmented with organic material, that reduce the available oxygen and smother the clams.

Controlling the Asian clam population in Lake Tahoe is critical as the clams have a variety of negative impacts. The clams could increase the potential for other species, such as quagga mussels, to establish in Lake Tahoe. They also promote the growth of algae by releasing highly concentrated nutrients. Increases in algae impact the scenic beauty of the shoreline by changing the water color, reducing water quality, and washing rotting materials onto the beaches. Perhaps most significant, Asian clams compete with native animals for habitat and food, which causes a disruption in the food web.

Lake Tahoe and TERC In the News

Several articles highlighted the effort to manage Asian clams in Emerald Bay:

- *Tahoe project to eliminate Asian clams* (San Francisco Chronicle, <http://www.sfgate.com/science/article/Tahoe-project-to-eliminate-Asian-clams-3995026.php>)
- *Project attempts to smother invasive clams*



UC Davis research divers Katie Webb and Brant Allen jump into Emerald Bay in Lake Tahoe to install rubber barriers on the lake bottom. The Emerald Bay Asian Clam Control Project will treat and monitor approximately five acres of Emerald Bay lake bottom to reduce an Asian clam infestation and the harmful impacts this animal has on the local ecology.

(USA Today, <http://www.usatoday.com/story/news/nation/2012/10/31/lake-tahoe-invasive-clams/1671959/>)

- *Scientists try to rid Lake Tahoe's iconic Emerald Bay of invading clams* (Reno Gazette Journal, http://www.rgj.com/article/20121030/NEWS/310300072/Scientists-try-rid-Lake-Tahoe-s-iconic-Emerald-Bay-invading-clams?nclick_check=1)

- *Asian clams being suffocated to protect Emerald Bay* (Lake Tahoe News, <http://www.laketahoenews.net/2012/10/asian-clams-being-suffocated-to-protect-emerald-bay/>)

- *At Tahoe, research gets spotlight* (The Davis Enterprise, <http://www.davisenterprise.com/>)

[local-news/ucd/at-tahoe-research-receives-spotlight-treatment/](http://www.local-news/ucd/at-tahoe-research-receives-spotlight-treatment/))

Lake Tahoe and TERC research were recently highlighted in two National Geographic Water Currents news articles about warming lakes by Lisa Borre:

- *Warming Lakes: Barometers of Climate Change?* (<http://newswatch.nationalgeographic.com/2012/10/05/warming-lakes-barometers-of-climate-change/>)

- *Warming Lakes: Effects of Climate Change Seen on Lake Tahoe* (<http://newswatch.nationalgeographic.com/2012/10/17/warming-lakes-effects-of-climate-change-seen-on-lake-tahoe/>)

LOCAL-GLOBAL CONNECTION: LAKE TEMPERATURE RESEARCH

Using satellite data to measure the surface temperatures of 167 large lakes worldwide NASA researchers have determined Earth's largest lakes have warmed during the past 25 years in response to climate change.

Lake Tahoe is one of the hundreds of lakes around the world in the midst of this warming trend.

The data from in-lake measurements confirm that water temperatures are warming more rapidly than air temperatures for many lakes around the world.

The local-global connection for lake temperature research is perhaps best exemplified on Lake Tahoe, which was used to calibrate the satellite data in a global assessment of lake temperatures.

Buoys deployed for that and other joint studies with NASA's Jet Propulsion Laboratory (JPL) continue to measure lake temperature every two minutes, 24 hours a day.

"Tahoe is unique because there are very few places where all of this data is recorded on a lake of

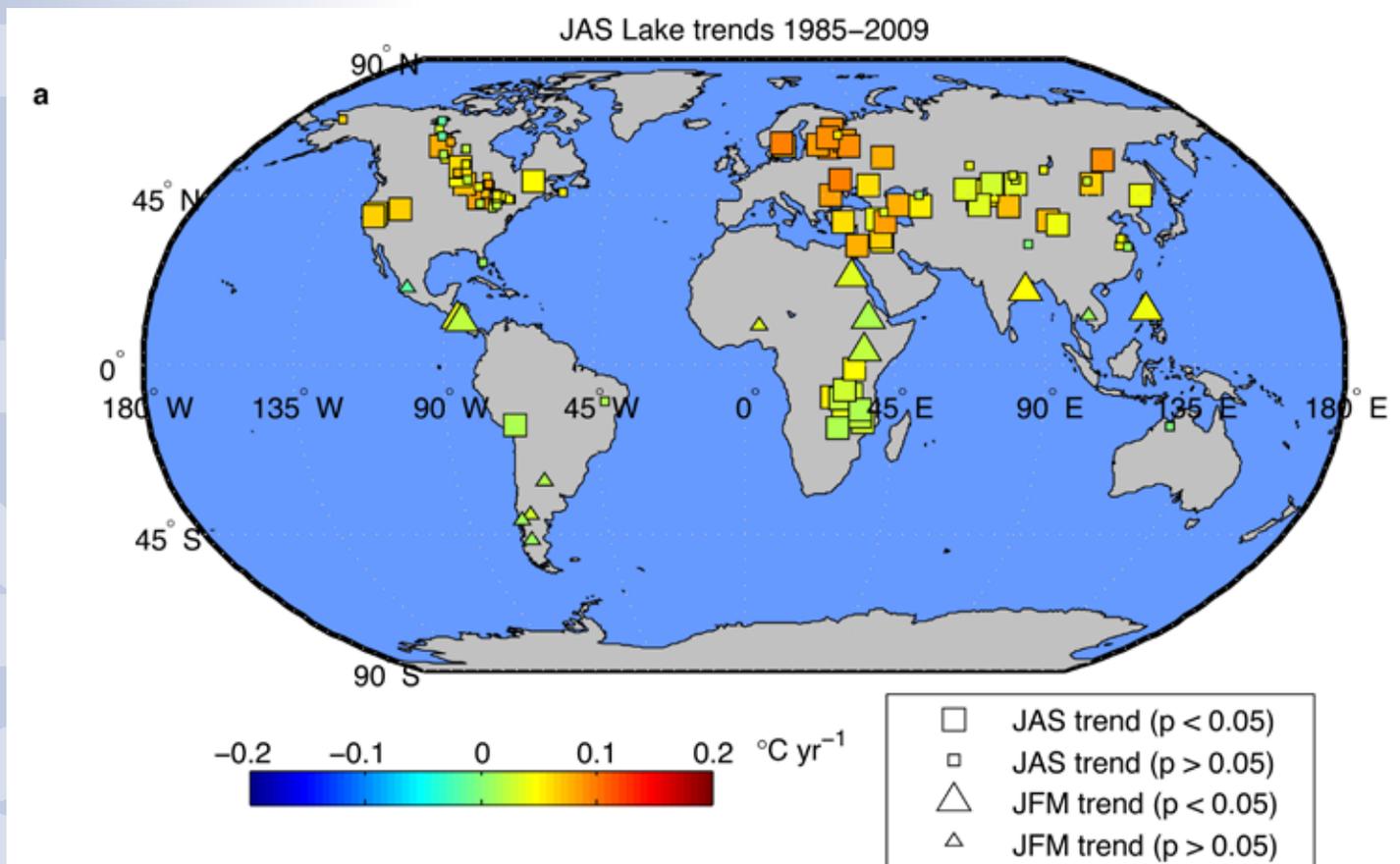
sufficiently large size that it can be compared with satellite data," said Simon Hook, a researcher at JPL who led the global assessment. "It is why places like Lake Tahoe are so important to understanding the trends and ecological consequences."

Tahoe's unique characteristics make it an ideal study site. "Because Lake Tahoe is still very clean and relatively pristine, it has a high signal to noise ratio," explained TERC director Geoff Schladow. "We can often see things that are

happening in other lakes but are just harder to tease out there."

Hook and Schladow are part of a team of researchers working with the Global Lake Temperature Collaboration to gain a better understanding of the effects of climate change on lakes.

Adapted from National Geographic Water Currents article by Lisa Borre at <http://newswatch.nationalgeographic.com/2012/10/05/warming-lakes-barometers-of-climate-change/>.



Global trends in seasonal nighttime lake surface temperatures, 1985-2009. Yellow and orange symbols indicate lakes that warmed over this time period. Image credit: NASA/JPL-Caltech. Originally published at newswatch.nationalgeographic.com.

EDUCATION AND OUTREACH

New Exhibit Prototype Gains Momentum with More Than 1.5 Million Hits on YouTube

One exhibit that has grown out of the NSF-funded Informal Science Education project is the “I Dig Watersheds” Augmented Reality (AR) sandbox (see <http://www.youtube.com/watch?v=j9JXtTj0mzE>). This hands-on exhibit teaches geographic, geologic, and hydrologic concepts by combining a real sandbox with Microsoft Kinect 3D camera and a projector.

Users construct landforms in actual sand, and in real-time the sand surface is scanned, and a colored elevation map with topo-

graphic contour lines is projected onto the sand surface. Users can also simulate rain to see how landforms influence water flowing through a watershed. The actual exhibit will be installed at TERC during 2013.

TERC is working with partners from UC Davis KeckCAVES, UC Berkeley Lawrence Hall of Science, ECHO Lake Aquarium and Science Center, and Audience Viewpoints Consulting on this project for developing 3D visualization tools and tabletop interactive exhibits for enhancing awareness, understanding, and stewardship of freshwater ecosystems.



CARA HARWOOD

The new Augmented Reality Sandbox “I Dig Watersheds” was designed to be used as a hands-on exhibit in science centers and museums



HEATHER SEGAL

Youth Science Institute participants extract DNA during a science lab

LAKE TAHOE: STATE OF THE LAKE

DECEMBER 13, 2012 | NO-HOST BAR AT 5:30 PROGRAM BEGINS 6 PM | \$5 DONATION SUGGESTED

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. 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.

GEOFF SCHLADOW
Geoffrey Schladow is a Professor of Civil and Environmental Engineering at UC Davis, and Director of the Tahoe Environmental Research Center. He is an expert in the areas of environmental fluid mechanics, water quality modeling, and the dynamics of lakes, reservoirs, rivers and estuaries.

Join TERC Director Geoff Schladow for a presentation on the State of the Lake on December 13, 2012, beginning at 6 p.m. in Incline Village, NV

Youth Science Institute Now Accepting Applicants

The sixth-annual Youth Science Institute (YSI) program is now accepting applicants for 2013. Twenty high school students will have the opportunity to participate in this 16-week afterschool program January through May, 2013.

Participating students develop Science, Technology, Engineering and Math (STEM) skills, specifically science familiarity and

confidence, learn about career opportunities in STEM fields, interact and work with scientists of various fields, conduct science experiments, work in the laboratory, ride the UC Davis research vessel, and share science activities with other students.

Information and applications are available at http://terc.ucdavis.edu/education_outreach/education_programs/youthscienceinstitute.html. Applications are due January 4, 2013.

STAFF UPDATES

Farewell to Andrea Parra, Nicole Shaw, and Collin Strassenburgh who have all found exciting new employment in the region and will continue to support science in the Tahoe Basin.

Post-doctoral researcher Alex Forrest is finishing up his research at TERC and will be moving to Tasmania in December as a professor of environmental engineering.

We also say goodbye to visiting researchers Marina Arbat-Bofill from Polytechnic University of Catalonia, Spain; Luciana de Souza Cardoso from Federal Univ. of Rio Grande do Sul, Brazil; Adam Laister from Plymouth University, United Kingdom; Keisuke Ono from Tohoku Univer-

sity, Japan; Azuma Masaki from Kyoto University, Japan; and Sebnem Elci from Izmir Institute of Technology, Turkey.

TERC would like to welcome new AmeriCorps members Hannah Leigh from Whitman College in Walla Walla, Washington; Kelsey Poole from American University in Washington, DC; and Kylee Wilkins from UC Santa Barbara. This group of new AmeriCorps members will be providing much of the education and outreach programs for TERC during 2012-2013.

Alison Toy is finishing up the final month of her AmeriCorps year of service. These young professionals give so much energy and enthusiasm to our programs each year

and we thank them for their service.

We also welcome Professor Bruce Hargreaves and

Stephanie Katz from Lehigh University, who will be spending the next 9 months at TERC.



Farewell Nicole Shaw and good luck with graduate school



Congratulations and thank you Alison Toy (shown with Pepper)



Farewell Alex Forrest and good luck in Tasmania



New AmeriCorps members Hannah Leigh, Kelsey Poole and Kylee Wilkins

STAFF AWARDS: EDUCATION DIRECTOR WINS LAKE SPIRIT AWARD



Heather Segale receives the 2012 Lake Spirit Award presented by Joanne Marchetta, executive director of Tahoe Regional Planning Agency

Congratulations to Heather Segale

TERC's education and outreach director, Heather Segale, was the winner of a 2012 Lake Spirit Award in the Agency Representative/Scientist Category representing the North Shore. While TERC

has long recognized and appreciated Heather's tremendous contributions to instilling a passion for science in people of all ages, it is great that she has also achieved public recognition of her efforts.

BILL COMBS MEMORIAL BOATHOUSE DEDICATION

On August 12th, the newly refurbished boathouse at the Tahoe City Field Station was dedicated in memory of Mr. Bill Combs, a civic and business leader with deep ties to Lake Tahoe and the UC Davis program. Mr. Combs was a veteran executive at Longs Drugs Stores and former executive director and vice president of the Thomas J. Long and J. M. Long Foundations, respectively. Friends and family of Mr. Combs and trustees from both foundations joined Dr. Geoff Schladow and staff in a ceremony to honor and celebrate Mr. Combs' contributions. In his volunteer leadership role, he was instrumental during the Campaign for Tahoe in establishing the landmark Thomas J. Long Foundation Education Center at Incline Village

to help the public become more informed and responsible lake stewards. The Foundation's gift also supported the restoration of the historic fish hatchery at Tahoe City.

When the Thomas J. Long and J. M. Long Foundation trustees wished to honor the late Mr. Combs at Tahoe, the hatchery site and boathouse were particularly fitting given the education outreach focus and tie to the lake he loved. Thanks to the Foundations' generous naming gift, the boathouse has now been retrofitted to accommodate the housing of critical scientific equipment for lake studies aboard UC Davis research vessels – including such key research as eradicating Asian clams from Emerald Bay.

RESEARCH AT LAKE TAHOE

View from the bow of the research vessel John Le Conte

The Role of the Boathouse in Research

UC Davis researchers have been studying Lake Tahoe since 1958, beginning with Dr. Charles R. Goldman. The research has led to many fundamental discoveries about Lake Tahoe and about lakes in general. Research on the catastrophic impact of sewage on the lake was instrumental in having all sewage diverted out of the basin in the 1960s. The impacts of the Mysis shrimp introduction on the lake's zooplankton, the increasing growth of algae around the lake's shoreline, and the root causes of the decline in Lake Tahoe's legendary clarity are studied using boats and equipment housed in this facility. The long-term data record that has been amassed is now proving invaluable in trying to better understand the role of global changes on water quality and ecosystem health.

In Memory of Bill Combs – Business and Civic Leader, Lake Tahoe Advocate

Bill Combs' successful career at Longs Drugs Stores spanned over 50 years. Upon retirement, he continued to serve for many years as a Board member, President of The Thomas J. Long Foundation and Vice President of The J. M. Long Foundation. When Bill was not working or giving back to the community through his many civic leadership roles, he relished time at Lake Tahoe with good friends and family. Bill keenly understood the importance of UC Davis' efforts to protect the lake. He was instrumental in helping the university raise needed funds for research and public education so that future generations will enjoy the lake he loved.

With appreciation to The Thomas J. Long Foundation and The J. M. Long Foundation for their generous contribution to the boathouse restoration in memory of Bill Combs (1930 – 2010).

Interpretive sign at Tahoe City Field Station Boathouse honors Bill Combs

UPCOMING EVENTS

Join TERC for our monthly lectures and special events:

• **December 5, 2012:**

Project Learning Tree Workshop, 10 a.m. - 4 p.m. at D. W. Reynolds Community Non-profit Center, Incline Village, NV

• **December 13, 2012:**

State of the Lake with Dr. Geoff Schladow, UC Davis TERC, 5:30 - 7 p.m.

• **February 12, 2012:**

Winter Birds of the Region, with Kirk Hardie, Tahoe Institute for Natural Science, 5:30 - 7 p.m.

• **March 18-21, 2013:**

Annual Science Expo with

a focus on physical science.

This year's Science Expo is supported by a generous grant from the Rotary Club of Tahoe-Incline and Rotary District 5190.

• **August 10, 2013:**

Children's Environmental Science Day is a free community event held annually for children (ages 6

and up) and their families.

Visit <http://terc.ucdavis.edu/calendar/> to learn more about the upcoming events or to subscribe for TERC event announcements. All events are held at the Tahoe Center for Environmental Sciences building in Incline Village unless otherwise indicated.

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.
- Please contact me about how I can make a deferred or estate gift to UC Davis.
- I wish this gift to remain anonymous.

Mail to: *UC Davis Tahoe Environmental Research Center
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Enclosed is my tax-deductible contribution.

Please make checks payable to *UC Regents.*

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The University is grateful for the support it receives from alumni and friends. One of the ways our thanks is expressed is through listing the names of donors in various

publications. Should you wish that your name not appear as a donor, please notify us if you have not already done so.

It is the policy of the University of California, Davis and the UC Davis Foundation to utilize a portion of the gift principal and/or the short-term investment income on current gifts and grants to support the cost of raising and administering funds.

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