

## The Tahoe Environmental Research Center (TERC)

is a global research leader providing the science for restoring and sustaining Lake Tahoe and other treasured lakes worldwide for over 50 years.

TERC educates the next generation of leaders and inspires environmental stewardship in thousands of students, community members and visitors annually through its outreach centers in Incline Village, Nevada and Tahoe City, California.



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BRANT ALLEN, UC DAVIS TERC

**Mysis shrimp** are collected and counted as part of the ongoing night research in Emerald Bay

## RESEARCH UPDATES

### MYSIS EXPERIMENT

For the last year, TERC's tireless field crew have been focusing on their night life. When most of us are asleep, they are in Emerald Bay experimenting with the removal of the invasive Mysis shrimp. Our data has shown that if Mysis numbers are reduced, the native zooplankton return in large numbers and help clear particulates from the water. The net result is much improved water clarity. The team is now removing almost 10 pounds of Mysis per

hour, a mere 1,000,000 Mysis. Thank you Brant, Katie, Brandon, Raph, and all the volunteers for giving up so many hours of night time sleep!

### MICROPLASTICS

There's a new invasive species in our lake: microplastics. Microplastics, plastic particles less than 5 mm long, have received a lot of attention recently due to their presence in the oceans and in drinking water. While microplastics in

## LETTER FROM THE DIRECTOR

If you had the good fortune to spend the last two weeks of 2018 at Lake Tahoe, you might well have thought it to be “the fairest picture the whole earth affords,” as Mark Twain described it over 140 years ago. The lake level was high, the water was a deep cobalt blue, and fresh snow blanketed the basin. It really looked as if all the years of restoration efforts by so many people was finally paying off. But looks can be deceiving.

There is still much to be concerned about, even on a picture-perfect day. In the last two years we have been at the end of a severe five-year drought, and on the cusp of the most extreme winter recorded in the Tahoe basin. We have seen clarity drop to its lowest levels ever recorded in response to those events, yet spring back in an amazingly short time. Our lake is resilient, but is it resilient enough to withstand these extreme events and the slower, monotonic changes to our climate?

Over 50 years of data shows that Lake Tahoe has already changed considerably. Its clarity is not the same, it is warmer in all seasons, and its biota – from the algae to the fish – are changing rapidly. More to the point, the rate of climate change is accelerating, and we expect the impacts to do the same. What is abundantly clear is that Lake Tahoe will never again be the same as it was in 1960. The clarity may recover, but it will be a different lake.

Our research is focusing on understanding how the physical and ecological processes that control the lake will change in the coming decades. To do this we can't just study Tahoe, but rather look at other systems

around world. To this end, we are working in Lake Geneva in Switzerland and Clear Lake, in California. In January, we are installing instruments in Lake Panguipulli in Chile. Each of these lakes is different than Tahoe, but it is these differences that provide insights on the consequences of change.

This year saw many new firsts at Tahoe as well. A submarine expedition in the summer gave many TERC grad students their first opportunity to literally go to the bottom of the lake. Using our Nearshore Monitoring Stations as a reference, TERC led a multi-University experiment to understand the process through which deep lake water rises to the surface. With over 100 new instruments and our autonomous glider deployed for this experiment alone, Lake Tahoe had never been examined in such great detail.

As 2018 draws to a close, I want to convey my personal gratitude for the interest and support our research, education and outreach programs receive from the entire Tahoe community – residents, second-home owners, and visitors. We have established an unbroken data record for over a half a century, and are here every day of the year to keep Lake

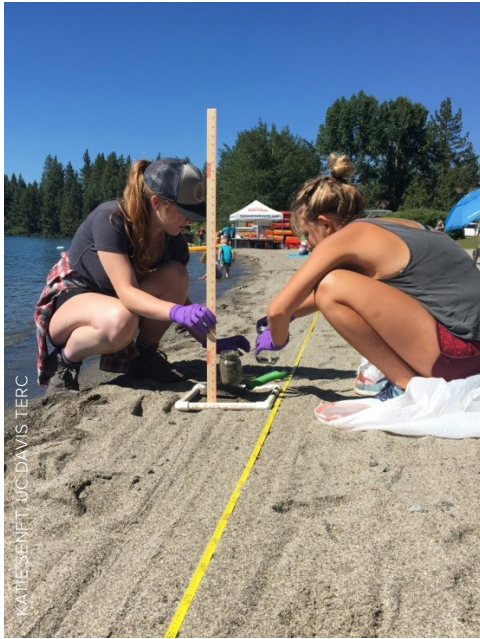


**Geoffrey Schladow, Ph.D., Director,**  
UC Davis Tahoe Environmental Research Center

Tahoe “the fairest picture the whole earth affords,” albeit a different one in the future. My thanks also go out to our amazing faculty and staff, both at Tahoe and in Davis, our family of volunteer docents, our tireless students, and those of you who stop by our Incline Village or Tahoe City facilities just to say hello.

On behalf of all of our faculty, staff, and students, best wishes for a safe and peaceful holiday season. We look forward to seeing you at Tahoe and at TERC next year.

## RESEARCH UPDATES *(Continued from Page 1)*



**Hannah Kranz and Maddie Maffia** working at Commons Beach

marine environments has been extensively studied, their impact on freshwater systems is not well known.

Microplastics can come as fibers (like those from synthetic fleece jackets), microbeads (found in some exfoliating face and body washes), fragments (smaller bits of larger plastic items), foam (from coolers or takeout containers), and nurdles (the pelletized raw material used in the manufacture of plastic goods). Fibers and microbeads typically originate from residential wastewater and nurdles can enter water systems through spills during shipment. Since no wastewater flows into Lake Tahoe and no shipping operations occur on the water, the main types of microplastics found here are likely to be fragments and foam.

In Summer 2018, TERC interns Hannah Kranz and Maddie Maffia worked with TERC researcher Katie

Senft to investigate the presence of microplastics on Lake Tahoe beaches. The study looked at sand samples from Hidden Beach, Commons Beach, D.L. Bliss State Park, and Baldwin Beach. Sand samples were collected along a transect on each beach and analyzed for plastic content in the lab.

The results confirmed the presence of microplastics in the lake and surrounding beaches. This was not surprising as we have all seen large quantities of plastic trash on Tahoe's beaches. Microplastics were confirmed to be trash fragments, like discarded plastic wrappers.

These materials photodegrade when exposed to UV light from the sun, breaking down into smaller and smaller pieces. Eventually, they can be easily ingested by organisms throughout the ecosystem.

"Microplastics in Lake Tahoe are completely avoidable," says Katie Senft. Their presence is a direct result of litter and mismanaged waste. The good news is that we can all take part in fixing this problem. Here's how to start: refuse single-use plastic that you do not need (like straws or bags), reduce the amount that you do use (bring a refillable coffee mug or food container),

and ensure that plastics are disposed of properly or recycled whenever possible. If you do see trash on the beach, pick it up to prevent it from breaking down further.

Another common source of plastic in the lake is mylar balloons. "We find at least one balloon on the lake almost every day," says Katie, who collects the deflated remnants out of the lake when out on the research vessel. The metallic coatings on the balloons pose an additional hazard to lake organisms.

Currently the team is analyzing the results of plastics found inside lake organisms.

### IMPACTS OF WILDFIRE ON LAKES

Almost three-quarters of the watershed of Indian Valley reservoir in Yolo County, was burned during the devastating Mendocino complex fire of 2018. The impact on erosion and sediment accumulation is the focus of a new study. Using our Edgetech Backscatter and Side Scan Sonar instrument, Samantha Sharp,

*Continued on Page 4*



**The survey vessel** on Indian Valley Reservoir

## RESEARCH UPDATES *(Continued from Page 3)*

Micah Swann, Drew Stang, and Raph Townsend surveyed the bottom of the reservoir to a precision of less than 1 inch. The precise bottom shape can now be rendered in 3-D. Next year, after the erosion that is expected from the winter rains has ended, the team will return to resurvey the reservoir and calculate how much sediment and contaminants entered the reservoir and how they are distributed.

### LAKE PANGUIPULLI, CHILE

TERC has been working with a new non-profit, Chile Lagos Limpios, to bring the “Tahoe Model”, a process through which science is used to guide science-based management and government actions, to the lakes of Chile. Through this effort we would work in partnership with Chilean Government scientists and



GEOFF SCHLADOW, UC DAVIS TERC

#### Lake Panguipulli, Chile

the Universidad Austral de Chile. In January, Geoff Schladow along with Devin Middlebrook (TRPA), Jesse Patterson (League to Save Lake Tahoe), and Patrick Wright (California Tahoe Conservancy) will be traveling to Chile to help launch the effort. While there, TERC will install the first long-term monitoring station in Lake Panguipulli.

### NEW LATH HOUSE CONSTRUCTED AT TAHOE CITY FIELD STATION

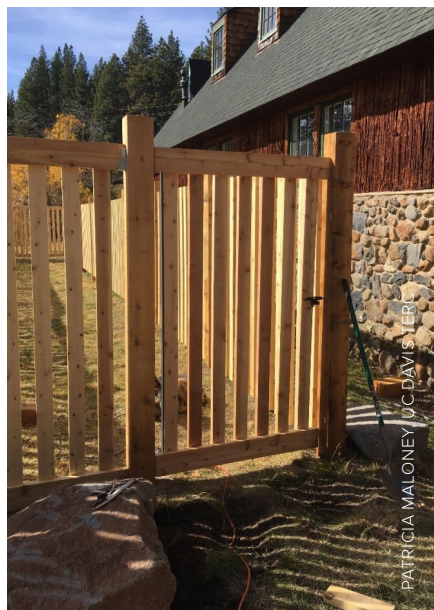
Dr. Patricia Maloney, with the help of Tom Burt and Raph Townsend, recently completed the new lath house at the Tahoe City Field Station. Funding for the structure was provided by the Tahoe Fund and the California Tahoe Conservancy.

A lath house is similar to a greenhouse, but more exposed to

the environment. They are commonly used to raise seedlings to an age at which they can be integrated into a garden or the natural environment. The laths, or slats, that form the structure, provide protection for the plants while still allowing for exposure to the surrounding climate. The young plants receive the necessary air circulation and sunlight but are shielded from strong winds and other threats.

The lath house will be used to raise sugar pine seedlings. These seedlings have been cultivated at the U.S. Forest Service Placerville Nursery and will be relocated in spring 2019. Bringing the seedlings to the lath house will enable them to acclimate to the altitude and weather in Tahoe, increasing the likelihood of growth once planted throughout the basin. The trees will be cared for and tended in the lath house until they are ready to be planted in 2020.

*Continued on Page 5*



PATRICIA MALONEY, UC DAVIS TERC

**The Tahoe City lath house** will be home to sugar pine seedlings

## Research Updates *(Continued from Page 4)*

While the sugar pine seedlings will be the lath house's first residents, there is room for more. The structure can accommodate 20,000 seedlings, opening up possibilities for additional projects aimed at restoring threatened tree populations.

Dr. Maloney, who has done extensive research on forest health and ecological genetics, says that "Local and diverse matters," when it comes to seed sources. "Having locally sourced plant material is critical to restoration and reforestation efforts." The lath house will provide a space for projects aimed at studying and enhancing the resiliency of the local ecosystem through genetic diversity.

It will also provide visitors to the Tahoe City Eriksson Education Center and Demonstration Garden a chance to learn about the threats

to the sugar pine population and the importance of biodiversity to the Tahoe region. Stop by the Field Station next spring to check out the great work of Tricia and her crew!

### UPWELL EXPERIMENT

In spring of 2018, three universities collaborated on a major study of upwelling in Lake Tahoe, the process through which wind vertically transports cold water from the bottom of the lake to the surface. The huge data set that was obtained from over 100 instruments is being analyzed by graduate student Derek Roberts. In January 2019, researchers from TERC will hold a workshop at UC Davis with colleagues from the UC Davis Bodega Bay Marine lab, Stanford University, and the University of British Columbia to

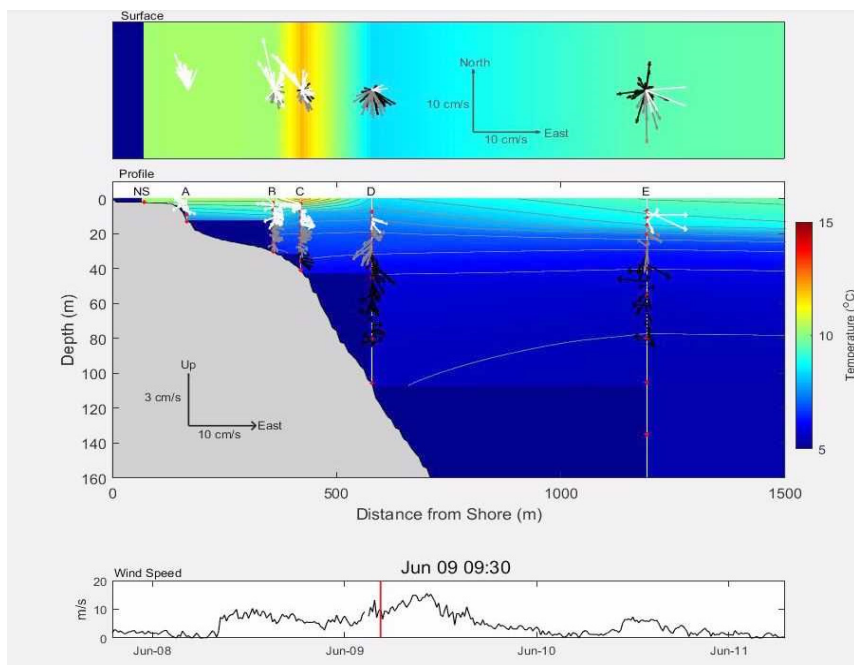
discuss the analysis results to date.

### GRADUATE STUDENTS

TERC welcomed three new graduate students in 2018. Samantha Sharp, Micah Swann and Andrew Stang. All three have been working as part of the team studying the ecology and water quality in Clear Lake, California. With funding from the California Department of Fish and Wildlife, the team is setting up a 3-year measurement and modeling study.

Graduate students Drew Friedrichs, Cordie Goodrich and Jasmin McNerney are headed down south... all the way to Antarctica. The trio have been preparing the TERC Glider for missions exploring ice shelves with the Korean Polar Research Institute (KOPRI). A major focus of their research will be to understand the processes behind the accelerated melting and collapse of ice shelves. Expect lots of tweets with penguins!

Katie Stagl is planning an under-ice deployment of instruments in a frozen lake in Ontario. Closer to home, Sean Trommer is continuing the modeling of Pyramid Lake, the large lake at the opposite end of the Truckee River to Lake Tahoe. Sean is focusing on how Pyramid Lake may change with the consequences of climate change. Within Lake Tahoe itself, Sergio Valbuena is preparing to measure and model the delta formation processes at the outlet of the Upper Truckee River, the lake's largest inflowing stream. Kyungwoo Lee has been modeling and measuring the gyres that form in Lake Tahoe, and how they move contaminants within the lake.



**Data from the UPWELL Experiment** show the lake response to the June 9, 2018 upwelling event along a transect perpendicular to the shore in the Homewood area

## EDUCATION AND OUTREACH

### WELCOME NEW AMERICORPS MEMBERS

Please join us in welcoming our three new AmeriCorps members, Brooke Boeger, Karen Hagerman, and Siya Phillips, onto the TERC Education and Outreach Team!

Brooke was born and raised in Yuba City, CA. She attended UC Santa Cruz, where she studied Anthropology and Environmental Studies. Brooke is an avid dog petter, mushroom forager, and an amateur sailor seeking a boat ride. She enjoys spending her time outside with her two dogs Yeti and Winnie, skiing with her friends, and riding her bike along the West Shore. Brooke is interested in learning and interpreting people's stories as told through the environment.

Karen is originally from Silver Spring, MD. She grew up with a great appreciation and love of all things outdoors. Karen received her undergraduate degree from the Naval Academy and since then has lived in Virginia, Florida, Texas, North Carolina, and now Nevada. This is her first time living out west and she is excited to experience all that the Sierra Nevada has to offer. Karen is passionate about changing the way we interact with the environment and believes that a sustainable future starts with connecting people to nature. She is excited to work at TERC and be a part of fostering environmental stewardship around the lake. In her free time, you can find her on a trail, on a beach, or on the water.

Siya is serving her second term with the Sierra Nevada AmeriCorps



**Karen, Brooke, and Siya on the Research Vessel John Le Conte**

Partnership program. Her first term was spent with the South Yuba River Citizen League in Nevada City, CA. Siya has a degree in Environmental Studies and Sociology and loves inspiring others to care for and protect this small planet we call home. Some of her favorite activities include snowboarding, spending time outdoors with friends, and working with kids. She is a people person, so if you see her, be sure to say hi.

### NOW ACCEPTING APPLICATIONS FOR ANNUAL YOUTH SCIENCE INSTITUTE

The Youth Science Institute (YSI) is now accepting applications for the 2019 program. This engaging after-school program enables high school students in grades 9, 10, and 11 to explore science through hands-on activities and interactions with experts. From building robots to conducting research experiments in

the chemistry lab, students will learn about potential careers in different Science, Technology, Engineering, and Math (STEM) fields. This 16-session program provides students with job skills, lab proficiency, and leadership experience.

YSI meets weekly each Wednesday from 4 pm to 6 pm, January 23 through May 22, 2019. Information and applications are available at <http://tahoe.ucdavis.edu/ysi>. Applications are due by Friday, January 4, 2019.

If you are interested in sponsoring a YSI student, contact Siya Phillips at [slyphillips@ucdavis.edu](mailto:slyphillips@ucdavis.edu) for details.

### 2019 SCIENCE EXPO

The 14th annual Science Expo is right around the corner. The event includes nine days of science activities for third-, fourth-, and

*Continued on Page 7*

## EDUCATION AND OUTREACH *(Continued from Page 6)*

fifth-grade students from the greater Lake Tahoe and Truckee region and evening public nights for families. The event will feature dozens of hands-on, interactive science experiments, activities, and demonstrations emphasizing Physical Science concepts such as physical and chemical properties of matter, density, gravity, forces and motion, energy, magnetism, light and sound waves, and electricity.

The 2019 North Lake Tahoe Science Expo will be held March 18 - 22 at the UC Davis Tahoe Science Center in Incline Village with the public night on Wednesday, March 20 from 4 to 6 p.m. The 2019 South Lake Tahoe Science Expo will be held April 2 - 5 at Lake Tahoe Community College in South Lake Tahoe with the public night on Thursday, April 4 from 4:30 to 6:30 p.m. If interested in volunteering at either event, please contact Heather Segale at 775-881-7562 or [hmsegale@ucdavis.edu](mailto:hmsegale@ucdavis.edu).

### **VAIL'S EPICPROMISE GIVES BACK TO THE TAHOE CITY DEMONSTRATION GARDEN**

On September 19, 2018, dark clouds and a chilly breeze were no match for the determined group that gathered at the Tahoe City Field Station and Demonstration Garden.

This work team was composed of the TERC education crew and Vail's EpicPromise volunteers. Representing TERC was Program Coordinator and Garden Manager Alison Toy, AmeriCorps members Liz Bronson and Bre Harris, and TERC docents Dave Long and Steve Klukkert. The Vail EpicPromise group was a mix of Vail employees and their family members, and is part of Vail Corporation's dedication to supporting the local community.

EpicPromise provided funding for materials that were purchased in advance of the event by the TERC education team. After a quick

introduction of TERC's mission and programs, the 30 volunteers were broken into teams, and each team was assigned a list of tasks. Larger tasks included construction and installation of two raised beds to be used for garden phenology and a labor-intensive removal of large, thick bushes of thorny Woods' rose that, even with the thickest leather gloves, respond with a piercing prick.

Volunteers not intent on back-breaking labor had the opportunity to assist with pruning, weeding, dead-heading, raking, cleaning, aquarium maintenance, citizen science, and breaking down pallet wood to be used for future garden workshops. While all volunteers were instructed to go at their own pace and hydrate consistently, many volunteers, eager to accomplish as much as possible, chose to work with little to no breaks.

After three and a half hours of non-stop work, the group was able to step back and survey a beautifully manicured native plant demonstration garden, over 20 bags of green waste, two sparkling clean aquariums, two raised beds that tiered off of the original raised beds, and no shortage of splinters, bent screws, and sore hands. Just as TERC began thanking the Vail group profusely and gathering everyone and all of the the equipment in the parking lot, the gray clouds above broke to reveal rays of sunlight that shone bright on the faces of all participants who, though a little weary with exhaustion, were beaming proudly with satisfaction of a job well done.



**Vail's EpicPromise volunteers** work alongside the TERC education team to construct raised beds at the Tahoe City Demonstration Garden

## FACULTY AND STAFF HIGHLIGHTS

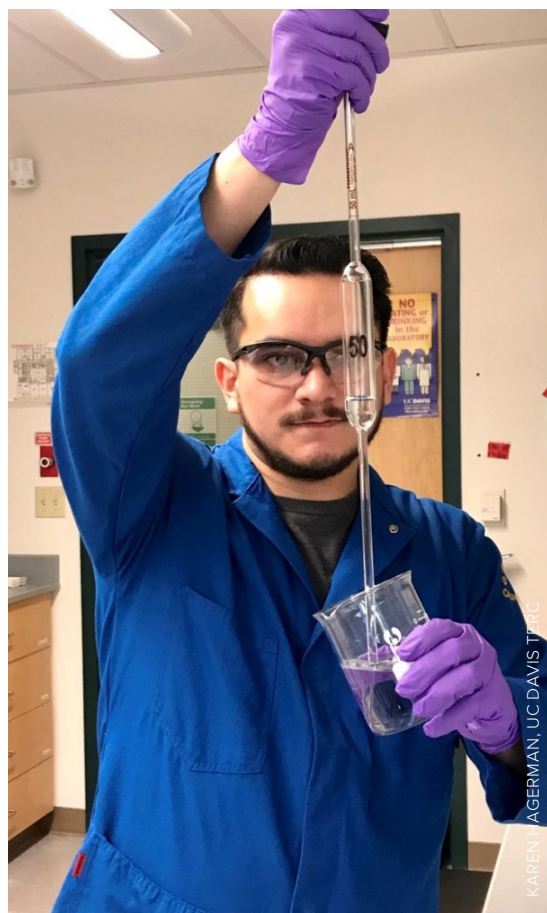
### STEVEN SESMA

Steven Sesma, one of TERC's chemists, is originally from southern California. A graduate of Sierra Nevada College, Steven originally worked as a student intern for TERC. He was an integral part in researching the Asian clam population within the lake and helped design and implement experiments to manage several invasive species. Steven relocated to Iowa, where he worked for Solum Incorporated in the development of a new soil analytics laboratory. He also integrated, developed, and tested new methods and analytical robots for the soil analytics community.

Steven returned to Lake Tahoe in 2016, first teaching science at Incline Elementary School, and later joining TERC in April of 2018. Here at TERC, Steven uses chemical analysis to study lake water nutrients. Drawing from his past analytical experience, he has also been part of the team studying the microplastics on Lake Tahoe beaches.

"My goal here at TERC is to devote myself to providing the world with a better quality of life through the sciences," Steven says. He is excited to be part of an organization that leads the way in research on water quality, physical processes, and lake ecology. He believes in the importance of the work he does here, knowing that it supports policy decisions at Lake Tahoe and aids in research efforts at other lakes around the world.

When not in the lab, Steven is an active member of the community, helping to maintain local parks, volunteering at youth softball and baseball events, and assisting at Incline Elementary.



Steven Sesma in the TERC chemistry lab

## UPCOMING EVENTS

**Feb. 1:** Science of Cocktails: A fundraiser dedicated to enhancing braincells through cocktails

**Feb. 7:** Monthly Lecture: Building Resiliency in Youth, with Dr. Mark Servis, Dr. Kathleen Tebb, and Peter Mayfield

**Mar. 18-22:** North Lake Tahoe Science Expo at the UC Davis Tahoe Science Center

**Apr. 2-5:** South Lake Tahoe Science

Expo at Lake Tahoe Community College

**Apr. 25:** Monthly Lecture: Mountain Lakes and Climate Change, with Dr. Adrienne Smits, UC Davis Environmental Science and Policy

**May 23:** Monthly Lecture: U.S. Human Spaceflight - Past, Present, and Future, with former astronaut Dr. Stephen Robinson, UC Davis Mechanical and Aeronautical Engineering

**Jun. 17, 20, 26, 29:** Docent Training (tentative dates)

**Jun. 20:** Monthly Lecture: Forest Health and Tree Mortality, with Dr. Tricia Maloney, UC Davis TERC

**Jul. 25:** Monthly Lecture: State of the Lake, with Dr. Geoff Schladow, UC Davis TERC

For more information visit <http://tahoe.ucdavis.edu/events/>

## UC DAVIS TERC BY THE NUMBERS

**6** DECADES OF  
MONITORING  
LAKE HEALTH



**84**

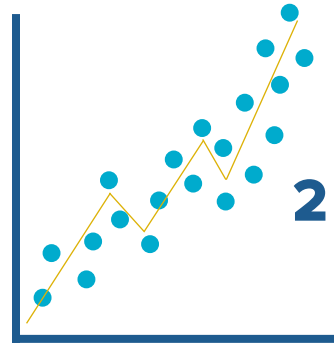


MONITORED FOREST PLOTS  
ARE HELPING US UNDERSTAND  
FOREST RESILIENCE

OVER **ONE-HUNDRED FIFTY**  
GRADUATE  
STUDENTS



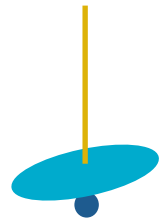
OVER  
**600**  
SCIENTIFIC PUBLICATIONS



ADVANCED  
TECHNOLOGIES  
COLLECTING  
**20 MILLION**  
DATA POINTS  
ANNUALLY

**THOUSANDS**

OF CLARITY AND WATER QUALITY SAMPLES MEASURED



**EIGHTY**  
SCHOOL FIELD  
TRIPS AND OVER

**FIVE THOUSAND**  
STUDENTS REACHED  
ANNUALLY

**130,000**

  
PEOPLE REACHED BY  
EDUCATIONAL PROGRAMS



**2** SCIENCE  
CENTERS  
AT THE LAKE



**LAKE  
TAHOE**

# GIVING TO THE TAHOE ENVIRONMENTAL RESEARCH CENTER

**Private Support** is critical to continuing the Tahoe Environmental Research Center's legacy of ground-breaking work in restoring and sustaining Lake Tahoe. Gifts at every level support research, education and outreach, and give the flexibility to address emerging needs and opportunities. Every gift makes a difference and there are many ways to give. Thank you!

- ☐ YES, I wish to support the Tahoe Environmental Research Center with the gift amount shown below.
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## Enclosed is my tax-deductible contribution.

Please make checks payable to UC Regents.

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