Tahoe

UC DAVIS TAHOE ENVIRONMENTAL RESEARCH CENTER

SUMMER 2021

The Tahoe Environmental Research Center (TERC) is dedicated to interdisciplinary research and education to advance the knowledge of aquatic and terrestrial ecosystems and their interactions within natural and developed Earth systems, and to communicate science-informed solutions worldwide.

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

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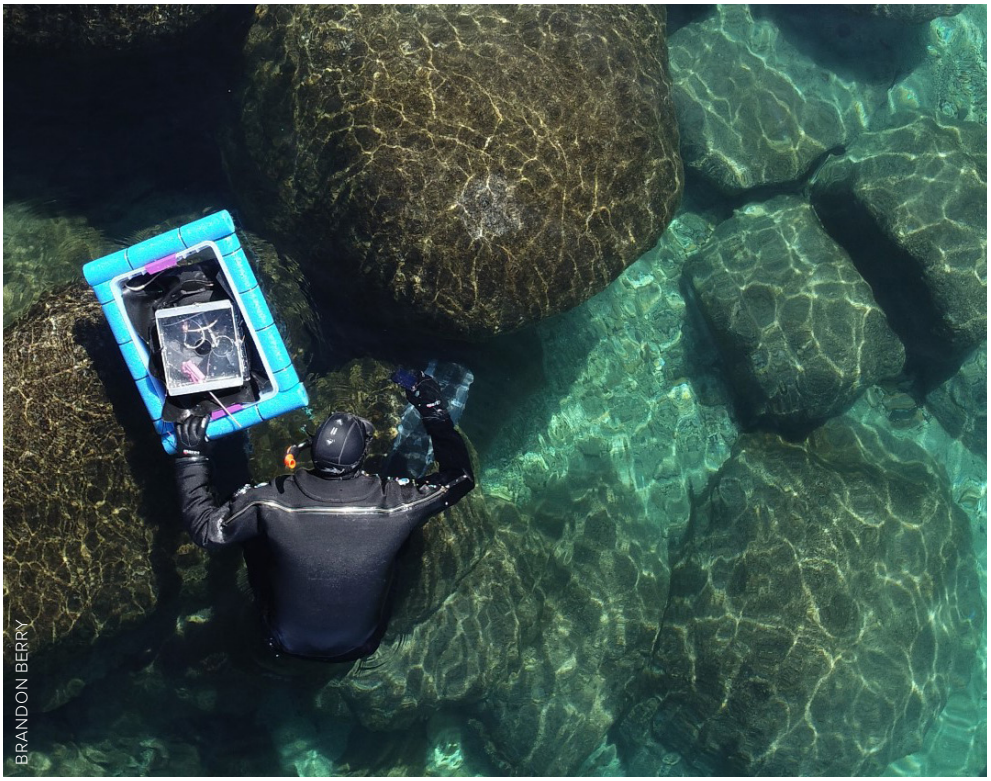


TERC researcher Brant Allen uses TERC's newest invention, a box sampler used to collect precise amounts of periphyton from rocks in the nearshore of Lake Tahoe.

RESEARCH UPDATES

FOUR DECADES OF SHORELINE ALGAE DATA

UC Davis researchers published an article in February about the long-term trends of periphyton growth in Lake Tahoe. This work was led by graduate student Karen Atkins, together with Scott Hackley, Brant Allen, Dr. Shohei Watanabe, Dr. John Reuter, and Dr. Geoffrey Schladow. The work drew upon the efforts of earlier generations of researchers who collected data over the past 37 years. Periphyton, algae attached to submerged rocks, has been found all over Lake Tahoe, and was anecdotally reported in increasing amounts since the 1960s. However, the study found that periphyton biomass has not increased since monitoring began in the 1980s, and may actually have decreased at many sites.

The scope of this long-term periphyton dataset is rare. There are only a few lakes around the world that have this long record of periphyton, which makes Lake

LETTER FROM THE DIRECTOR


KARIN HIGGINS, UC DAVIS

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

This week brought some good news. Effective immediately, all UC Davis research labs can begin ramping up to full research capacity by June 15. After 15 months of a severe range of restrictions, the end is hopefully in sight. Now our labs can be fully occupied, the boats can have full crews, and visitors will be welcomed back into our buildings. Albeit with care and a little trepidation.

So what will we be doing? One of our first priorities is to start looking at the formation of stringy, filamentous algae (or metaphyton). These algae, which wash up on the beaches where they decompose for months, have been particularly bad in low water years such as the one we're in now. Our first helicopter survey of the season has already shown some troubling indications.

Microplastics in the lake have been a focus for several years, but now we can ramp up again as we explore where exactly they are accumulating. Our sampling and analysis of the surface waters, the guts of kokanee salmon, the bottom sediments, and the water we drink will all be taking place this summer.

Ever wanted to know the temperature of the lake? You can find surface temperature from our website, but now you will be able to find it from the top to the bottom of the lake. After many years our real-time temperature chain off Obexers' Marina on the west shore finally gave its last reading. Sad, but inevitable for underwater instruments. This summer, with help from the Parasol Foundation, an all-new chain will be installed with water temperature being recorded from 16 depths every 10 seconds to an accuracy of one thousandth of a degree. Temperature teaches us so much about the way in which the lake is changing, minute by minute.

Another way these data will be used will be to calibrate a new three-dimensional prediction model for lake clarity. The work, a collaboration between TERC, the University of Nevada, Reno, UC Santa Barbara, and the Federal University of Rio Grande do Sul in Brazil, will focus initially on the impact of Mysis shrimp on clarity reduction.

That is just the beginning. New initiatives will see TERC researchers evaluating the impacts of our second dry winter on the fragile forests within the Tahoe basin, the broader Sierra, and the coastal range. We will be welcoming a delegation from Chile to Lake Tahoe in September, as we work to strengthen learning opportunities between lake preservation here and in the southern hemisphere.

And just so we're not seen to be all work and no play, we are kayaking all around Lake Tahoe in late June. This seven-day event welcomes kayakers of all skill levels to participate in the first of what will hopefully become an annual Circumnavigation of Lake Tahoe for Science. Check the details here.

It is going to be a great summer. We will be doing all we can to move the needle on better understanding and protecting Lake Tahoe. Please join us, and together we will make a difference.

RESEARCH UPDATES *(Continued from Page 1)*

Tahoe a great case study for how climate change is expected to impact algal growth.

Atkins, a Ph.D. candidate at UC Davis TERC and the first author of the article, also points out, "On an international scale, periphyton blooms are expanding in many oligotrophic lakes, and monitoring nearshore areas is crucial to better understand and manage these lakes."

The article explains that the 1950s and 60s brought major disturbances in the form of large-scale development of infrastructure, homes, and tourism which led to inputs of sediments and nutrients to the lake. These changes could have caused an increase in periphyton before TERC's monitoring started in 1982, but the data were never collected at the time. This is precisely why the TERC team is motivated to continue this long-term research into the future, as conditions continue to evolve.

Although periphyton growth has not been increasing in the last four decades, many people report mounds of rotting algae building up on Tahoe's beaches in low water years. TERC scientists believe that this is the result of increased amounts of metaphyton—stringy, floating clumps of algae. These have appeared simultaneously with the arrival of invasive Asian clams, and are a focus of ongoing study.

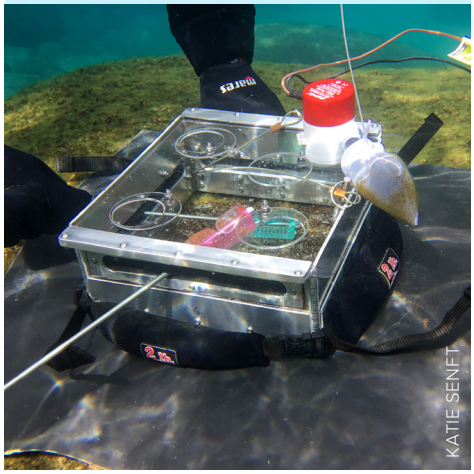
Want to be part of this ongoing research? Submit your observations using the "Algae Watch" section of the Citizen Science Tahoe app here.

BRANDON BERRY

High resolution drone footage shows the shorelines of Rubicon (left) and Sand Point (right). These mosaics of drone images are used as a part of visual periphyton analysis.

WHAT'S IN THAT BOX?

Periphyton sampling will be more efficient with TERC's updated "box" sampling method. Custom-built by TERC's Raph Townsend, the team designed the tool for scraping a large, accurately-known amount of algae off underwater rocks. TERC researchers Katie Senft and Brandon Berry now use the method in their regular sampling.



KATIE SENFT

The box sampler allows scientists to remove an even square of periphyton.

RESEARCH UPDATES

STEVEN SESMA

Steven Sesma works in the chemistry lab to begin sieving for microplastics, one of his ongoing projects.

A DAY IN THE LAB with chemist Steven Sesma

"Chemistry can be a very gratifying and exciting field!" Steven Sesma, a chemist working in the laboratory at TERC, said. "I am constantly learning new things about the natural world we live in. It is easy to get lost in the daily minutiae of lab work, but these activities contribute to important discoveries, especially here at Lake Tahoe."

Sesma works on many projects for Lake Tahoe and other lakes around the world. He is continuing an ongoing 60-year data set of measuring nutrient concentrations at Lake Tahoe. This includes monthly analysis of lake and stream waters, and atmospheric deposition samples.

One of the main reasons Tahoe's waters are so clear is that the lake has an extremely low nutrient concentration. This limits the available "food" for algae within the lake. When lakes experience high algae concentrations, they will eventually turn green. A key part of Sesma's job is detecting any early warning signs of changing nutrient levels in the lake.

Sesma must adhere to strict protocols to ensure nutrient detection in Tahoe's very low concentrations and to avoid contamination. He can spend up to three hours washing lab supplies before nutrient analysis can begin.

Sesma brings this level of precision to each of the projects he works on, including analyzing chlorophyll concentrations, extracting microplastics, analyzing waters from other lakes, and performing nutrient analysis on water samples from incubation chambers. Focusing on details to maintain the high accuracy of chemistry allows for greater trust of the data, and provides a solid bedrock for recommending future actions.

TREES OF TAHOE

TERC's Forest and Conservation Biology Lab will be studying the 100 surviving "mother" sugar pine trees from the Lake Tahoe Basin that were the seed sources for a sugar pine reforestation project in 2019–20. The team wants to determine if these survivors carry genes and plant traits that will allow them to be more resilient to future drought and bark beetle outbreaks.

A drought stress experiment will address the drought-bark beetle interaction in which a control group will be watered and another group will be exposed to simulated drought or dry-down conditions. Pre- and post- analyses will allow the lab to assess water efficiency and chemical defenses and identify mechanisms underlying the trees' varied responses to drought and bark beetle pressure—an important interaction that remains largely unexplored.

Having just gone through the second dry winter in a row, this research is now extremely timely.


KAT KERLIN

Dr. Maloney gathering duff and mulch around newly planted sugar pine seedlings on Lake Tahoe's north shore.

TERC CHILE PROJECT AWARDED GRANT

TERC's ongoing effort to model the pristine lakes of Northern Patagonia in Chile was selected as one of 11 projects to receive the Global Affairs Seed Grant for International Activities.

The project, "Lake Modeling to Support Sustainable Development and Climate Resilience in Northern Patagonia," headed by TERC Director Dr. Geoff Schladow, was awarded this grant for "faculty taking on innovative research, service, and engagement projects around the world."

The project aims to create models of several Chilean lakes, including Lago Llanquihue, a lake almost identical in size to Tahoe. In a partnership with AquaChile, the second largest salmon producer in the world, TERC is collecting and analyzing real-time data from nine instrument stations in the lake. After using these data to calibrate the model, results will be used to advise the Chilean government and local stakeholders on preferred development options in the face of climate change.

TERC graduate student Micah Swann is working on the modeling and data analysis. With support from the Eivind Lange Fellowship fund and the Seed Grant, Swann plans to return to Chile this year to continue his monitoring and modeling efforts. "I hope these models will be employed to guide proactive lake management, showing how these systems will be impacted by changing watershed and climatic conditions," Swann said.

STORM OVER TAHOE

In February, TERC researcher Dr. Shohei Watanabe met Dr. Gayle Dana for the first time. Until then, she had just been a photograph in the book *Storm Over Mono* that he read in 1999 as a university senior in Japan. The book was so compelling that Dr. Watanabe and his fellow students, who were dedicated to lake environmental issues, began translating the book into Japanese. Dr. Watanabe credits this book as the reason he studied limnology, eventually ending up at TERC.

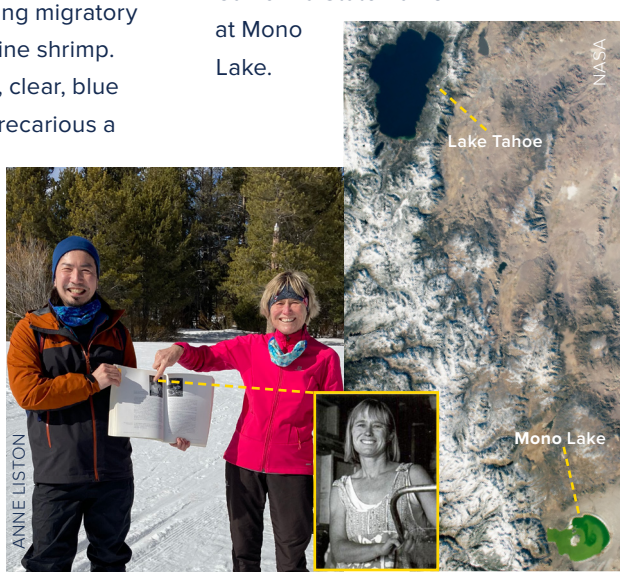
Storm Over Mono: The Mono Lake Battle and the California Water Future by John Hart, tells the restoration story of a lake at the eastern edge of the Sierra about 100 miles south of Lake Tahoe.

At first glance, Mono Lake may bear very little resemblance to Lake Tahoe: it is a shallow, salty, alkaline lake home to countless nesting migratory birds, brine flies, and brine shrimp. However, Tahoe's deep, clear, blue waters hang in just as precarious a balance as Mono's since both have been threatened by human development.

Mono Lake's ecosystem was threatened by the diversion of its stream water to Los Angeles in the 1940s, a fate that had befallen Owen's Lake in earlier decades. This diversion made the lake much shallower and saltier. By the late 1970s, a research team including Dr. Dana, wanted to know how low the lake could go before it would cease to support its bird populations. Their research resulted in a call to action in *Storm Over Mono*, which sparked court orders and restoration efforts that have brought Mono Lake back to a healthy balance.

When TERC scientist Anne Liston noticed a copy of the book on Dr. Watanabe's bookshelf, she offered to introduce him to Dr. Dana, a friend of hers in Truckee. The three scientists met at a social distance in February.

The current effort to restore Lake Tahoe has the potential to inspire future generations of scientists just as the fight to save Mono Lake inspired Dr. Watanabe. TERC researcher Dr. Alex Forrest is now collaborating with Dan Shaw of California State Parks at Mono Lake.



Left: Dr. Watanabe with brine shrimp expert Dr. Dana, who was featured in *Storm Over Mono*. Right: NASA satellites show Lake Tahoe in relation to Mono Lake.

EDUCATION AND OUTREACH

Visit the Tahoe Science Center in person this summer to see the newly installed "Tahoe's Plastic Problem" exhibit. From left to right: Education and Outreach Director Heather Segale and Education Programs Associates Elise Matera and Anne Graham

TAHOE SCIENCE CENTER REOPENS

With the entire staff fully vaccinated, the team at the Tahoe Science Center (TSC) is taking a much-awaited step toward normalcy by reopening for scheduled tours on June 15.

Since closing its doors in March 2020, the TERC staff has been working hard to make this moment a reality. Visitors can expect to see several new exhibits when they come to TSC in Incline Village. The "Tahoe's Plastic Problem" exhibit was fully installed in January and new baby Lahontan Cutthroat Trout are in residence in the fish tank of the interactive laboratory exhibit.

Docents are excited to take on tours of small groups who make reservations for a one-hour personalized tour. Make your reservation here.

DOCENTS RETURN

TERC's extensive education and outreach would not be possible without the support and dedication of their wonderful team of docents. TERC hopes to inspire more members of the community to become docents who can help educate visitors and residents into becoming environmental stewards of the Tahoe Basin. There will be a three-part docent training program on the afternoons of June 17, 22, and 24.

These training sessions are open to all community members who want to join the team as well as past docents who want a refresher course. Featured lecturers at the training include TERC Director Dr. Geoffrey Schladow, and local Tahoe experts Dr. Charles Goldman, David Antonucci, and Dr. Annie Kell. Check out the agenda and find more information on the TERC website.

ASSESSING AND IMPROVING THE SCIENCE CENTER

The Tahoe Science Center (TSC) has been selected to participate in the Museum Assessment Program (MAP), which is administered by the American Alliance of Museums. MAP helps museums strengthen operations, plan for the future, and meet standards through self-study assessment and a consultative site visit from an expert peer reviewer. The program is funded by the Institute of Museum and Library Services and includes guided strategic planning and site consultation with external museum professionals.

The year-long project will help refine and bolster TSC's effectiveness as the only science center in the Tahoe Basin. The program also aligns with an effort at TERC to re-engage with their commitments to diversity, equity, and inclusion in all their activities. The TERC team is excited to implement these new changes and insights to better serve and work with all in the Tahoe Basin.

The TERC education team reached

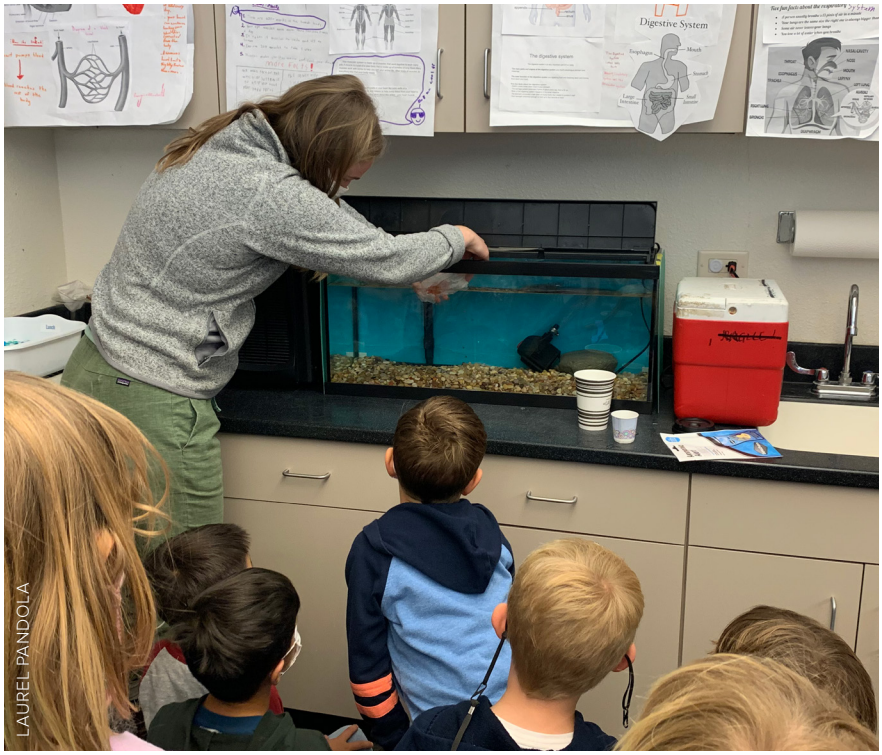
1,058

students and conducted

69

field trip sessions in 2020–21.

EDUCATION AND OUTREACH



Young students observe Education Programs Associate and Trout in the Classroom Coordinator Anne Graham deposit trout eggs in their class's tank.

PUTTING TROUT BACK IN THE CLASSROOM

After a year-long hiatus, Trout in the Classroom is back! TERC and Sierra Watershed Education Partnerships teamed up to support teachers in the Truckee-Tahoe area in raising Lahontan Cutthroat Trout (LCT) eggs in their classrooms.

TERC delivered LCT eggs to Tahoe schools on April 19. The goal of Trout in the Classroom is not only to teach students about the life cycle of a native fish but to actively restore the ecosystem by returning them to their original home. Students observed the trout develop from eggs to fry before releasing them into creeks, streams, and Lake Tahoe in May.

ZOOMING THROUGH THE SCHOOL YEAR

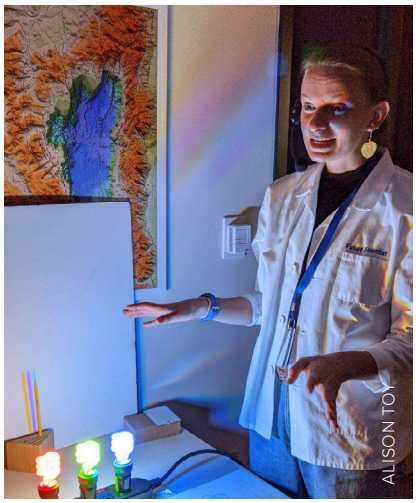
The annual Science Expo took place virtually for the second year in a row. Over a week in May, more than 500 third- through fifth-grade students joined TERC educators in exploring some of their favorite Zoom-friendly science experiments with the theme "All About Tahoe."

TERC educators presented on-location at the Tahoe Science Center and allowed students to explore the physical properties of water and light that make Tahoe so blue and the creatures that live in Lake Tahoe. The virtual event is recorded for the public here.

Fifth-grade teacher Janice Pearson of North Star Online School participated in the Virtual Science Expo for the first time. She said, "This was definitely a well-planned and thoughtful presentation from the UC Davis TERC. Thank you for sharing such a strong example of quality science education for our students!" Ms. Pearson's class has participated in TERC's virtual field trips as well, giving her students access to STEM education in a local context that would otherwise have been inaccessible during this last school year.

AmeriCorps members successfully led students through six different virtual field trip themes developed over the past year. The majority of students came from Truckee-Tahoe area schools, but with a handful of field trips for schools in Sacramento and the Bay Area.

While TERC eagerly look forward to the return of in-person education, they will keep their virtual field trip curricula active to ensure accessibility here.



Education Programs Associate Elise Matera teaches about the properties of light at this year's Virtual Science Expo.

EDUCATION AND OUTREACH

STUDENTS TAKE THE LEAD ON PLASTIC REDUCTION

Students from environmental clubs at four high schools in the Tahoe region partnered with TERC and local nonprofits to learn about plastic pollution and how they can help Take Care of Lake Tahoe. On Earth Day 2021, their efforts came to fruition when the CEO of Raley's agreed to create lasting, sustainable changes at their grocery stores in the Basin.

When the initiative began in 2019, TERC Education Programs Associate Elise Matera and staff members at Sierra Watershed Education Partnerships (SWEP) and the Tahoe Water Suppliers Association (TWSA) educated students from North Tahoe, Truckee, Incline and South Tahoe High Schools about the challenge of microplastics at Lake Tahoe. This was funded by the Nevada Division of Environmental Protection.

The North Tahoe and Truckee Envirolution Club members were inspired to make a difference and formed a plastics subcommittee to assess which of these problems could be solved. The students surveyed their local Raley's stores to come up with ways in which plastic waste could be reduced. The group also toured the Truckee Raley's O-N-E Market and developed a four-part action plan for Raley's executive team to consider how they could reduce plastic waste locally.

The students presented their findings to the Raley's executive team on April 22 and highlighted three areas for improvement: plastic water bottles, plastic grocery bags, and plastic sleds and toys that break apart easily. Other suggestions the team made included moving away from distribution of straws, plastic to-go ware, and plastic souvenirs.

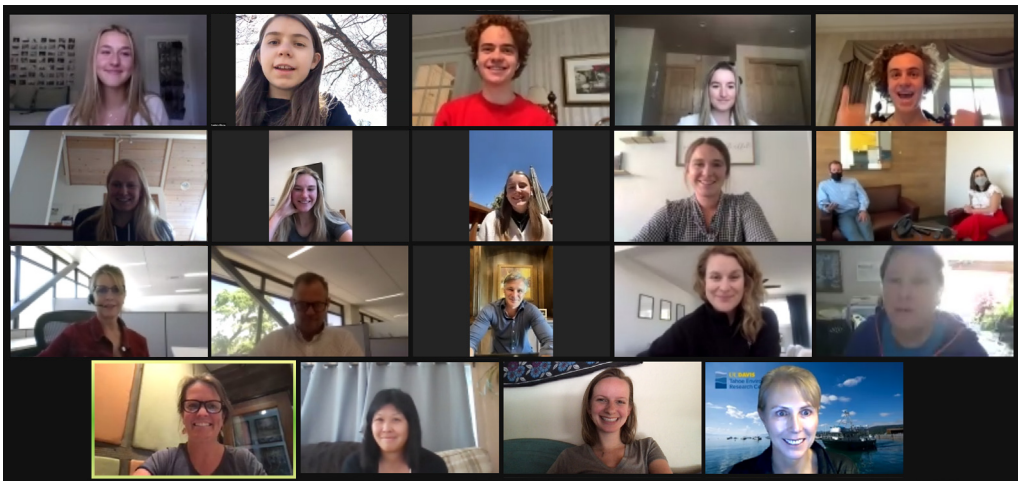
Inspired by the presentation, Raley's President and CEO Keith Knopf said, "We appreciate the students' hard work and dedication to reduce microplastics and their thoughtful solutions for Raley's to consider." He continued, "We commit to several changes: eliminating plastic straws by switching to paper and reusable options and eliminating single use plastic silverware."

Knopf also said his team would look into an email receipt system, consider implementing a refill station in the plastic water bottle aisle, and explore options to reduce plastic grocery bag use—perhaps by offering reusable totes for their loyalty members. They will also look into alternatives to plastic sleds, toys, and souvenirs.

"We appreciate the work Raley's has done to implement sustainability initiatives in their stores and business model," said Envirolution Club Co-President Ben Anderson. "We are grateful to have the opportunity to work with them now and in the future."

The Envirolution Club plastic reduction project won second place in the local Shane McConkey EcoChallenge which "challenges kids to identify and help resolve and eco issue in their school or community."

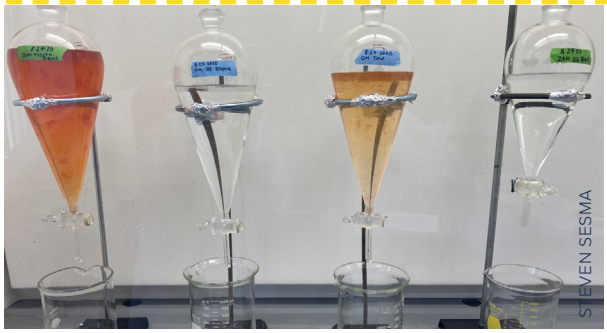
Learn more about the microplastics problem at Lake Tahoe at tinyurl.com/TahoesPlasticProblem or by booking a tour to visit the microplastics exhibit at the Tahoe Science Center in Incline Village, NV.



Envirolution Club Members Jade Bullock, Sophia Phillips, Ben Anderson, Lily Murnane, Evan Anderson, Kili Lehmkuhl, Alani Powell, and Amelia Swanson; Raley's Executives Sarah England, Mark Koppang, Chelsea Minor, Laura Croff, Kevin Konkel, Keith Knopf, and Megan Riggs; Madonna Dunbar (TWSA); Ashley Phillips (SWEP); and TERC Educators Alison Toy, Elise Matera, and Heather Segale.

TERC TEAM UPDATES

The TERC staff is works on a diverse array of projects around the Sierra Nevada and beyond. Take an inside look into their work through their voices and camera lenses.



TERC chemist Steven Sesma places microplastics within a density separation funnel, where salt water allows microplastics to float to the top.

"I have been working on creating a continuity plan for TERC, recharge rates for TERC lab analyses, and numerous grant proposals. The constant policy changes and implementations with the pandemic have kept me on my toes." –Carmen Bedke, Business Unit Manager

"I'm passionate about working in the field of limnology as I have always been concerned about the health of lakes and other water bodies. My job allows me to make a difference regarding the health of lakes and watersheds. " –Tina Hammel, Staff Research Associate

Dr. Holly Oldroyd's lab is working on a project to monitor methane and carbon dioxide release to understand physical mechanisms impacting these system in collaboration with Dr. Alex Forrest. Left: Research teams doing a 24-hour sampling deployment at Uvas Reservoir. From left to right: undergraduate Matthew Lawrence, masters student Wilton "Bill" Gray IV, and undergraduate Jeremy Inducil. Right: The diffusive flux chamber used to measure gasses.

"My main efforts are focused on a Regional Stormwater Monitoring Program. We work with all the local jurisdictions to quantify the efforts of water quality improvements being made in response to stormwater runoff. The new site will monitor water quality before and after improvements are made in the neighboring areas that include residential, commercial, and highway runoff." –Raph Townsend, Staff Research Associate

"I am looking forward to continuing what I am doing and seeing what this summer has in store for us here at Lake Tahoe. New this year is I am participating in three common lab processes where I help get samples ready for analysis." –Aaron Vanderpool, Forest Lab Associate

"This summer I am looking forward to exploring more of the Sierra outside the Tahoe basin." –Brant Allen, Field Lab Director and Boat Captain

"I am helping with Justin Reis's project while pursuing some of my own, related questions. My dissertation primarily looks at how species interact via the modification of seawater chemistry. To do this, I have characterized the way habitat-forming species modify chemistry within the habitat they create while teasing apart the mechanistic drivers of shell formation in organisms that can utilize those habitats." –Aaron Ninokawa, graduate student

UC DAVIS TERC BY THE NUMBERS

6 **DECADES** OF MONITORING LAKE HEALTH

OVER **ONE-HUNDRED FIFTY**

GRADUATE STUDENTS

OVER **600** SCIENTIFIC PUBLICATIONS

84

MONITORED FOREST PLOTS ARE HELPING US UNDERSTAND **FOREST RESILIENCE**

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

THOUSANDS

OF CLARITY AND WATER QUALITY SAMPLES MEASURED

SIXTY

SCHOOL FIELD TRIPS AND OVER

ONE THOUSAND

STUDENTS REACHED ANNUALLY

159,000

PEOPLE REACHED BY EDUCATIONAL PROGRAMS

2 **SCIENCE CENTERS** AROUND

Tahoe City, CA

Incline Village, NV

1 LAKE TAHOE

GIVING TO THE TAHOE ENVIRONMENTAL RESEARCH CENTER

Private Support is critical to continuing the Tahoe Environmental Research Center's legacy of groundbreaking 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!

- o **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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» **Consider a gift via an IRA.** Visit http://plannedgiving.ucdavis.edu/ira-charitable-rollover for more details.

UPCOMING EVENTS

June 15: Science Center Reopening

June 17, 22, & 24: Docent Training

June 21–27: Circumnavigation of Lake Tahoe

July 15: Wine Tasting with Dr. Andrew Waterhouse

July 21: Beer Tasting with Dr. Charlie Bamforth

July 28: Science Speakeasy

July 29: State of the Lake with Geoffery Schladow

July 12–August 5: Lake Tahoe Science Camps

For more information visit: https://tahoe.ucdavis.edu/events/