TAHOE: STATE OF THE LAKE REPORT 2022

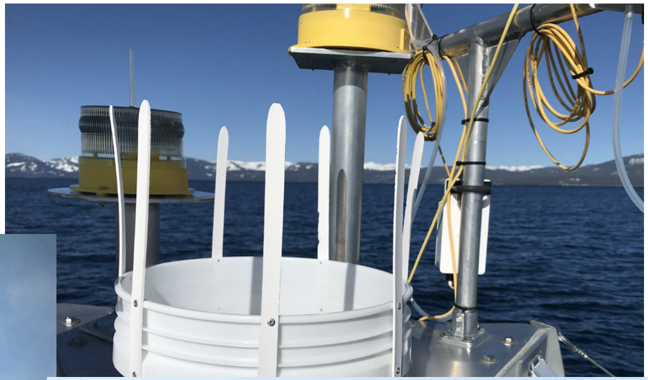
CURRENT RESEARCH

UC DAVIS
Tahoe Environmental
Research Center

Current research synthesis

This section of the State of the Lake Report describes ongoing research that is above and beyond the monitoring described in the subsequent sections, although in many cases it is predicated on that monitoring.

The changes to Lake Tahoe that were observed in 2021 and in the first part of 2022 are among the largest and most significant that have been observed in the 54-year data record. These changes are documented in the first three parts of this section, and relate to major shifts in the lake's zooplankton, phytoplankton, and nearshore algae. The extent to which these shifts are inter-related is a focus of our current research. Being able to understand what is driving these changes and what these circumstances may mean for issues like restoring lake clarity, makes them all high-priority research questions.



Clockwise from top right: Atmospheric deposition sampler on Lake Tahoe; a South Lake Tahoe beach covered in green algae and orange coloration associated with iron-oxidizing bacterial activity; Lake sampling never stops because of cold temperatures.
(Photos: B. Berry, S. Hackley, and B. Scholes)

Current research synthesis, continued

The three subsequent sub-sections describe ongoing research projects that TERC scientists and graduate students are currently involved in. They relate to studying the impacts of wildfire smoke on Lake Tahoe following the devasting fires of 2021, tracking the spread of invasive Asian clams at Sand Harbor State Park, and collecting and analyzing of microplastics from Lake Tahoe.

We also describe a new tool that has been developed with the help of a team of undergraduate students. The Lake Conditions tool allows the public to access both TERC's real-time lake temperature and wave height data and to get forecasts of lake temperatures, water currents, and wave heights for every three hours over the three following days. We hope that this will prove to be a life-saving tool as people learn how treacherous the lake can be to the unprepared and plan their fun accordingly.

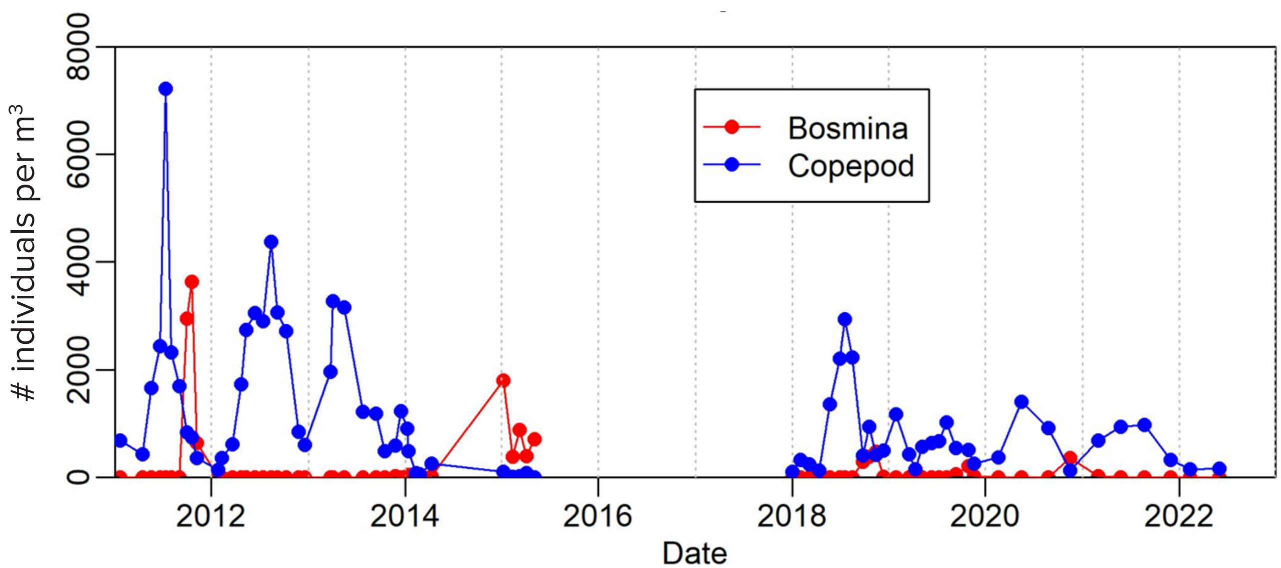
There's a way to be prepared for water conditions that can change quickly. Real-time and forecasted conditions are available for surface temperature, currents, and wave height at https://tahoe.ucdavis.edu/lake-conditions. Don't be caught in hazardous conditions by making sure to check lake conditions before heading out. (Photos: N. McMahon and A. Toy)

Dramatic decline of zooplankton species presents an opportunity to study effects on clarity

In September 2021, TERC researchers noticed a decline in the numbers of zooplankton, the tiny aquatic animals that live in Lake Tahoe. As TERC sampling extended into July 2022, we continued to see alarmingly low numbers of some zooplankton taxa.

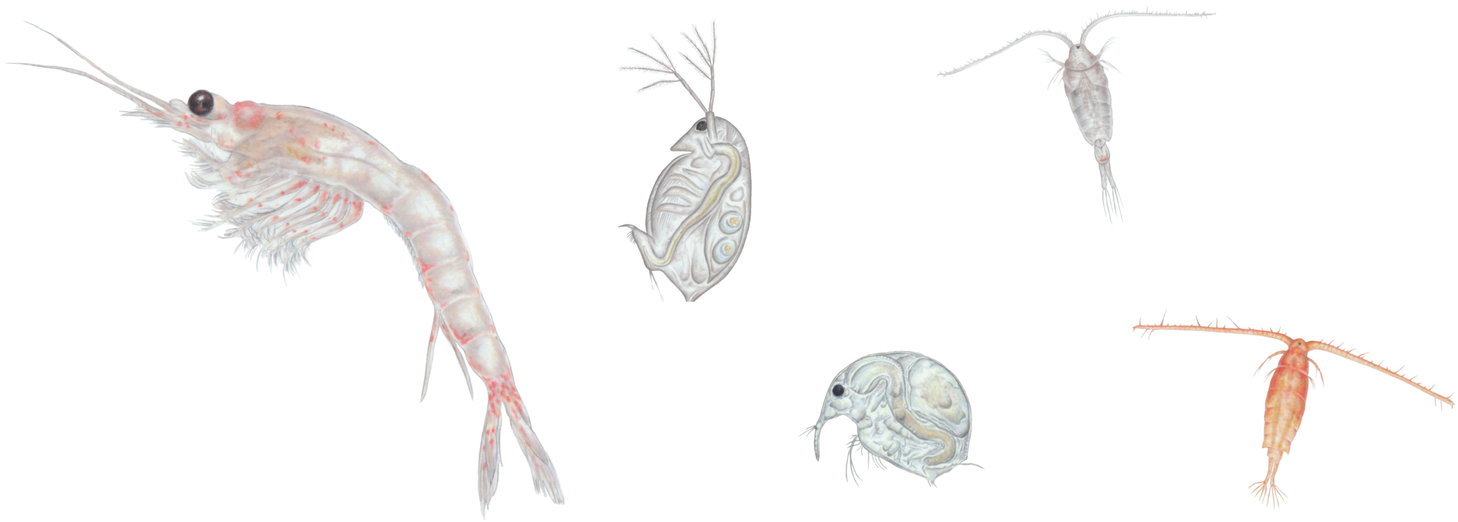
There may be serious consequences from these changes. Zooplankton occupy the middle of the food web and play an important role in the lake ecosystem. They consume algae, some of which reduce water clarity or which might otherwise accumulate in the nearshore regions and beaches. Zooplankton are also a major food source for fish, such as the popular sport fish kokanee salmon.

The panel below shows the abundances (individuals/m^3) of native zooplankton, *Bosmina* (a cladoceran) and the copepods *Epischura* and *Diaptomus* from measurement stations in Lake Tahoe. Since the 1970s, *Bosmina* have rarely been present in large numbers. *Daphnia*, also a native cladoceran, have been even rarer in this period. While seasonal fluctuations exist in all years for the copepods, numbers have been low for several years, especially since 2021. Similar declines are being observed in Emerald Bay.



Dramatic decline of zooplankton species presents an opportunity to study effects on clarity, continued

Over 50 years ago, a non-native zooplankton species, the *Mysis* shrimp, was introduced to Lake Tahoe. Since that time, it has dramatically altered the food web in Lake Tahoe and Emerald Bay, just as it has done in most lakes where it was introduced. One of the consequences of its introduction was the decline of native zooplankton such as *Daphnia*, which *Mysis* preferentially consume. This is important because *Daphnia* are voracious grazers of algae and are considered a harbinger of good water quality.

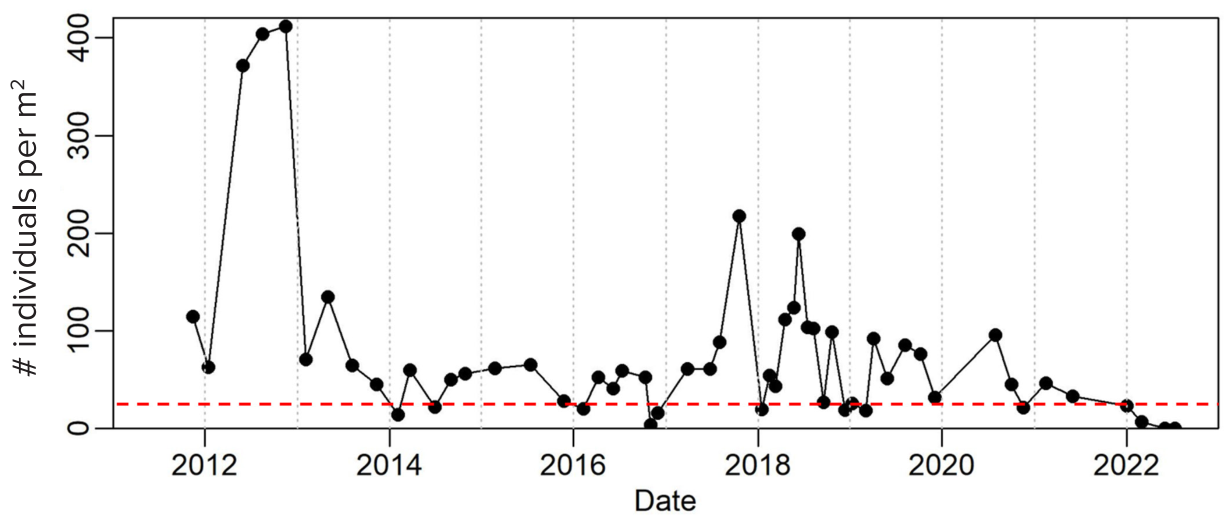


Scientific Illustrations of Lake Tahoe zooplankton from left to right: Mysis shrimp, Daphnia, Bosmina, Epischura, and Diaptomus. (Illustrations: S. Adler)

Dramatic decline of zooplankton species presents an opportunity to study effects on clarity, continued

We saw evidence of this linkage between *Mysis*, *Daphnia*, and water clarity in Emerald Bay. From 2011 to 2014, *Mysis* abundance dropped similarly in Emerald Bay, followed by an increase in *Daphnia* and a dramatic 36-foot increase in clarity. At the same time, the size of kokanee living in Emerald Bay doubled. This was not the case for kokanee residing in Lake Tahoe. When the *Mysis* returned a few years later, the process reversed itself. The *Daphnia* declined, and there was a return to the former lower water clarity. Unfortunately, at that time, the importance of what was happening was not recognized, and very little data beyond Secchi depth were collected to determine the broader changes wrought by the *Daphnia* and the impact of the absence of *Mysis* on the lake ecosystem.

Today, almost ten years later, a similar event may be occuring in Lake Tahoe itself. While a complete data record for *Mysis* since its introduction in the 1960s does not exist, the current extremely low levels are believed to be unprecedented. The red dashed line in the figure below indicates a *Mysis* abundance of 27 individuals per m^2. This level was established based on Tahoe research from the 1970s as the maximum *Mysis* abundance that would allow species such as *Daphnia* and *Bosmina* to again flourish.



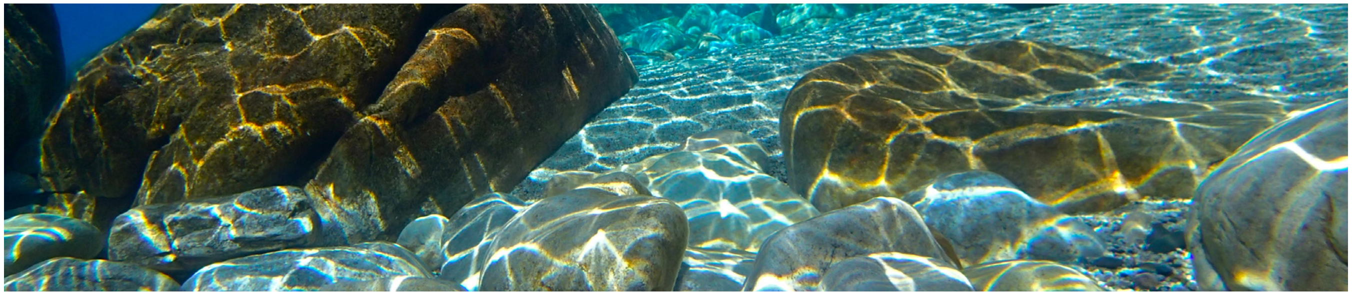
Dramatic decline of zooplankton species presents an opportunity to study effects on clarity, continued

At this point in time, we have a unique opportunity to thoroughly monitor the changes that ensue. Based on what we observed in Emerald Bay in the past, we have reason to believe similar changes might occur in Tahoe. With the expected increase in the abundance of *Daphnia* and other small zooplankton, there would be a correspondingly large increase in the Secchi depth clarity. If *Daphnia* abundance persists for two years or more, we anticipate seeing a dramatic increase in kokanee size based on the return of their preferred prey. However, the cycle will eventually repeat; *Mysis* will re-establish and consume the *Daphnia*, and the system will revert to its former, perturbed version.

What should be done? If we just keep monitoring clarity, we will see the end effect. But by investing in more complete monitoring now, we will develop a clearer understanding of the mechanisms linking zooplankton population dynamics with variations in water clarity and other ecosystem properties. This is critical information for developing and improving predictive models. Many questions could be answered:

1) What populations of *Daphnia* and *Bosmina* are required to clear contaminants from the lake?
2) Small algae such as *Cyclotella* have been prevalent since *Mysis* were introduced. Will these algae disappear and allow for a return of larger phytoplankton?
3) What size range of fine inorganic particles do *Daphnia* graze on?
4) What will the effect be on native fish and game fish? This question has already started to be answered. With the help of Tahoe's fishing guides, we are collecting fish stomach contents to record how their diets are evolving.

Eventually *Mysis* will return. The real question is whether the absence of *Mysis* from Lake Tahoe will help restore clarity and, if so, is the deliberate removal of *Mysis* in the future warranted? As clarity of Lake Tahoe has shown no sustained improvement for 20 years, this is an opportunity that should not be passed by.

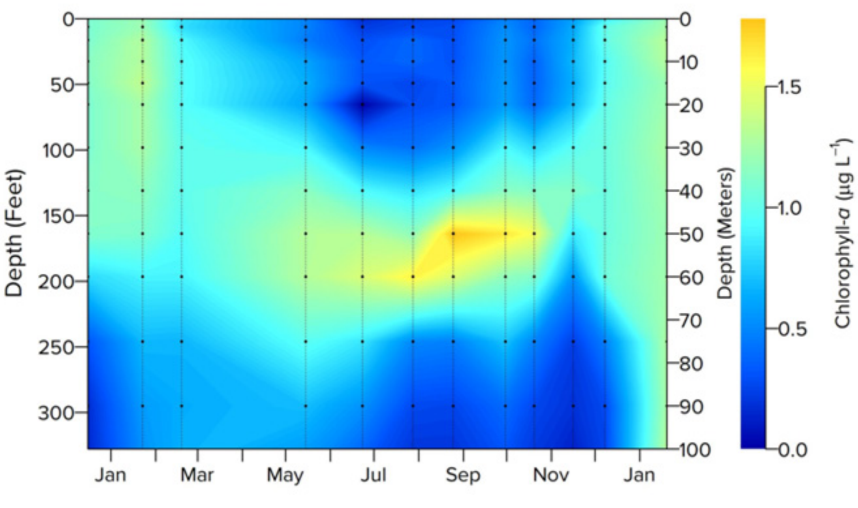


(Photo: B. Allen)

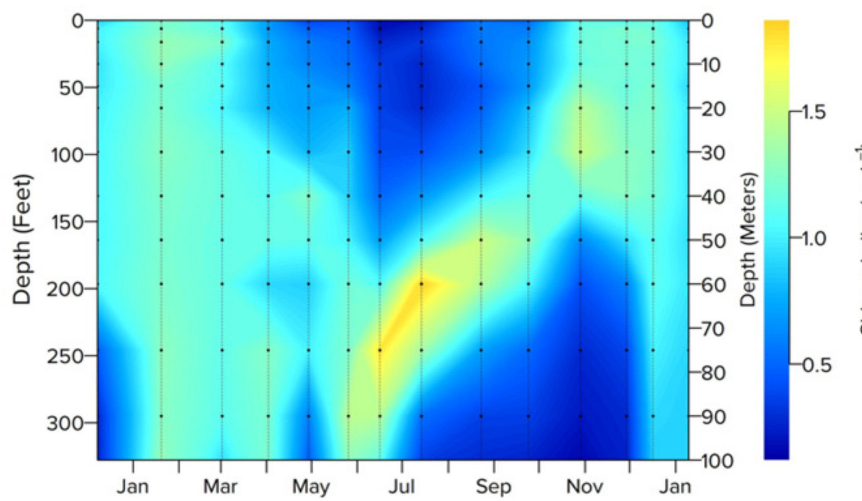
A very different year for Tahoe's phytoplankton

At the beginning of 2021, there was little reason to believe the year would be as unusual as it turned out to be for Lake Tahoe's phytoplankton. One of the first signs came mid-summer, when the Dixie, Tamarack, and Caldor wildfires continuously filled the basin with smoke. TERC researchers found it was taking far longer to filter surface water because the upper 70 feet of the lake appeared to be unusually high in phytoplankton. Due to Tahoe's exceptional clarity, algae are usually concentrated in a band at a depth of 150–250 feet, known as the "deep chlorophyll maximum" (DCM). The figure below for 2020 shows the typical annual pattern of chlorophyll distribution, with the DCM in yellow and orange tones. For 2021, the DCM can be seen starting to form at 250 feet in June and July of 2021, but then it progressively becomes shallower throughout the summer, until fall mixing occurs in late November. This pattern is unlike any previous year.

The cause of this change in phytoplankton distribution may be due in part to the reduction in sunlight and UV radiation that occurred due to wildfire smoke. Phytoplankton need sunlight to photosynthesize, so this upward shift is not unexpected.



2020

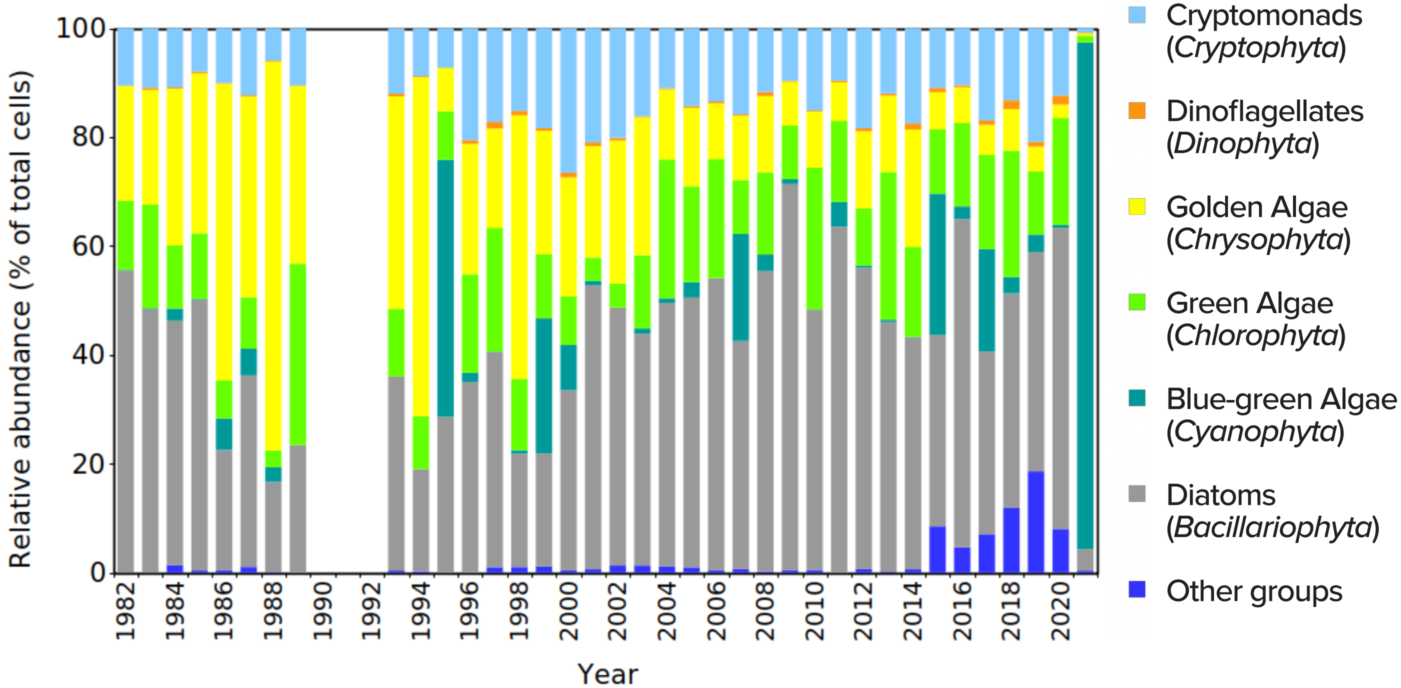


2021

A very different year for Tahoe's phytoplankton, continued

But what was surprisin was the major change in species composition. In 2021, the lake experienced a major bloom of the filamentous cyanobacteria *Leptolyngbya* sp., an alga rarely observed at Lake Tahoe. However, previous research at Tahoe (Mackey et al. 2013[1]) found that *Leptolyngbya* was strongly favored by high Nitrogen:Phosphorus ratios associated with atmospheric deposition, particularly wildfire smoke.

The figure below shows the relative abundance of different phyla of Lake Tahoe algae annually since 1982. The total dominance by *Leptolyngbya* in 2021 is evident based on the number of algal cells. This is the only recorded year in which a single taxon belonging to the cyanobacteria group has so dominated the phytoplankton assemblage.



[1]*Mackey, K. R. M., D. Hunter, E. V. Fischer, Y. Jiang, B. Allen, Y. Chen, A. Liston, J. Reuter, G. Schladow and A. Paytan. 2013. Aerosol-nutrient-induced picoplankton growth in Lake Tahoe, J. Geophys. Res. Biogeosci., 118, 1054–1067, doi:10.1002/jgrg.20084.*

A very different year for Tahoe's phytoplankton, continued

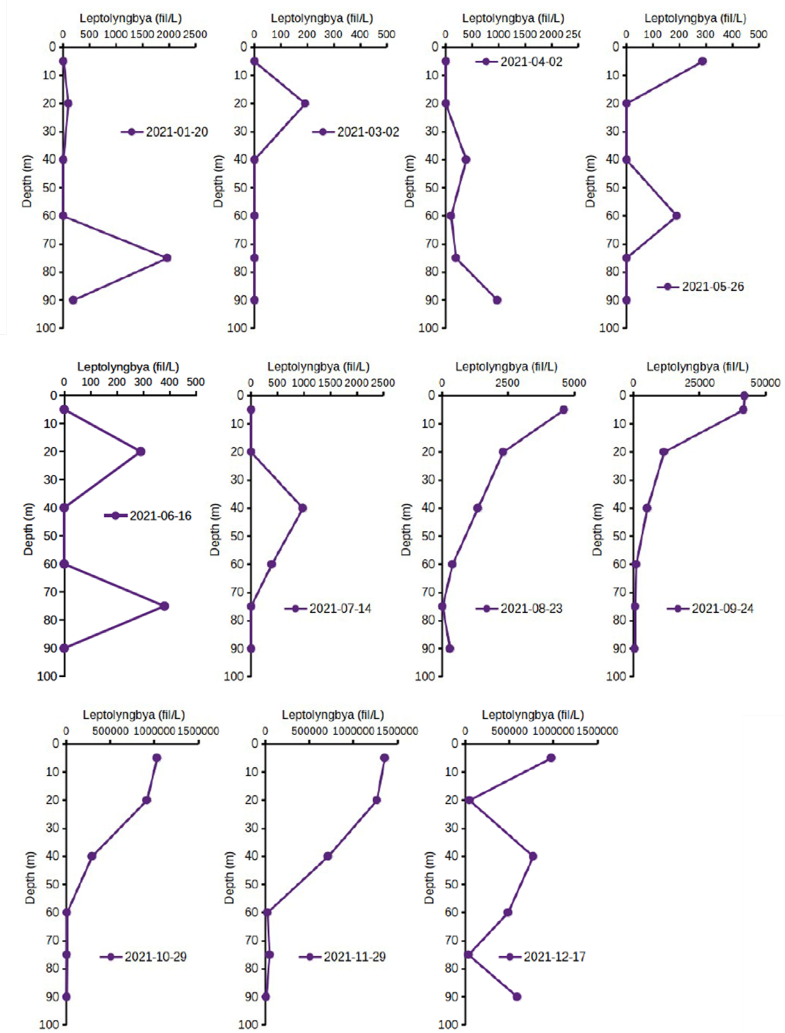
Leptolyngbya are extremely small (which makes them important for clarity). The diameter of the filaments they form are on the order of 1-2 microns. Individual filaments, comprised of dozens of individual cells, can be over 200 microns in length. Their small size also limits their contribution to algal biovolume. Based on biovolume, diatoms still dominated the phytoplankton assemblage in 2021, with *Synedra* being the dominant species in every month (see Fig.10.5 and 10.6).

Leptolyngbya filaments from a 2021 Lake Tahoe sample. (Photo: L. Tanaka)

A very different year for Tahoe's phytoplankton, continued

The monthly depth distribution of *Leptolyngbya* in 2021 provides greater detail on the evolution of this algal bloom and its possible cause, as well as accounting for the rising depth of the deep chlorophyll maximum layer.

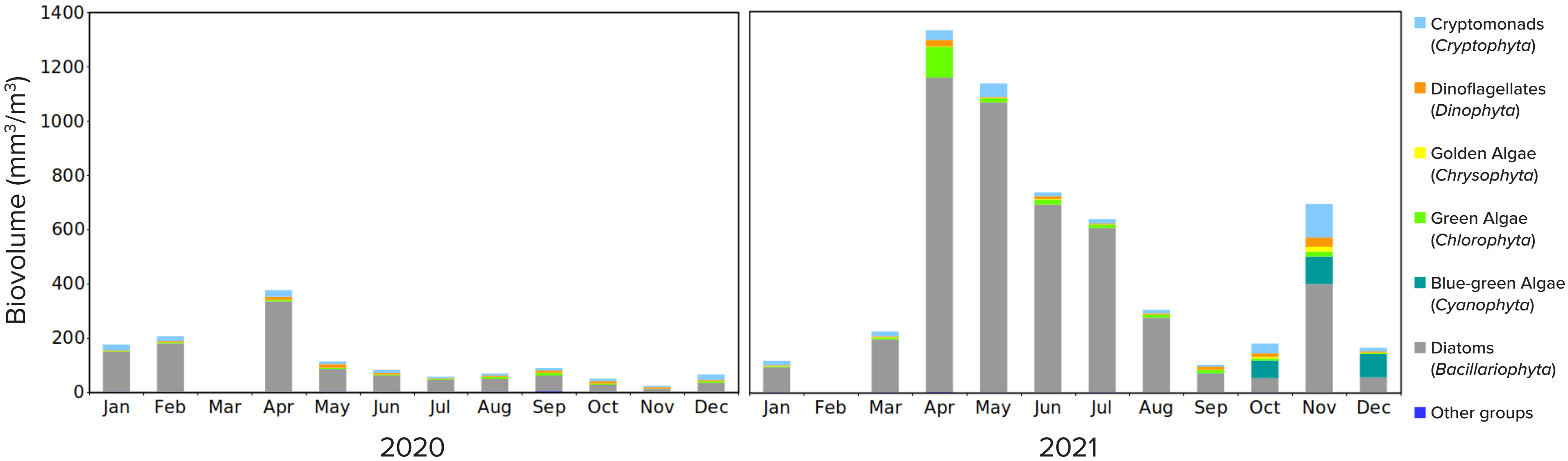
The monthly distributions had low maximum abundances from January through August, with the peak values being less than 5,000 filaments/liter. In the September sampling, peak values increased by a factor of ten, and then from October through November, they increased further by a factor of 30 to approach abundances of 1.5 million filaments/liter. The high abundances were confined to the upper 130 ft (40 m) of the lake. In December, the abundances were still high, but spread through a greater depth due to fall mixing.



A very different year for Tahoe's phytoplankton, continued

A further surprise in the phytoplankton data was the revelation that the biomass of phytoplankton far surpassed the levels that are normally observed in Lake Tahoe. In April 2021, for example, the biovolume was three times higher than the biovolume for April 2020, which itself was double the value from 2019. Most of the increase was due to the presence of the relatively large diatom *Synedra*.

Adding to the mystery is the fact that most of the 2021 high biovolume months preceded the California wildfires and their nutrient-rich smoke by five months. Additionally, 2021 was a year in which stream-derived nutrients were at record low levels. What could explain these data? That is a question that our researchers are currently exploring, while focusing specific attention to the decreasing abundance of *Mysis* that began in spring 2021.



The rapidly evolving shoreline algae

Since 2018, the TERC nearshore algae-monitoring program has been examining the entire shoreline of Lake Tahoe in a novel and powerful way. TERC flies an instrumented helicopter and a drone many times throughout the year in order to capture images and locate the spatial extent of algal blooms and specific hotspots. After each flight, TERC staff and volunteers visit specific locations to take photos and samples to establish the "ground truth" of what was seen from the air. This builds on the traditional method of monitoring, where divers would individually sample a finite number of locations at a depth of two feet, creating a more robust and meaningful dataset. Previous data suggested that the biomass was not changing over the long-term at those fixed sites. With this new method, we are now learning that the areas impacted can change radically from year to year and may be increasing spatially due to the combined effects of warming water temperatures, changing water levels, and the impacts of invasive species, specifically Asian clams.

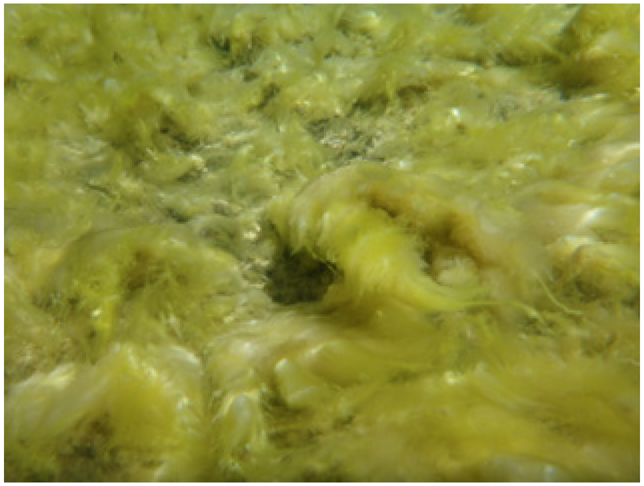
An orthomosaic of individual helicopter images (right) along Northwest shore of Lake Tahoe around Tahoe City from June 1, 2022. The red box shows the area around the inlet to the Truckee River. The yellow and brown coloration is from luxuriant growth of stalked diatoms on rocks and cobbles. (Photos: M. Bruno)

The rapidly evolving shoreline algae

Nearshore algae blooms are a growing ecological threat to the lake, as they seriously degrade water quality and cover large areas of beach with mats of decomposing algae, with certain types being toxic. The blooms also occur where the greatest numbers of people—residents and visitors—directly interact with the lake. To date they have been most prevalent in South Lake Tahoe and Tahoe City. For example, a large and toxic bloom occurred in fall 2021 near the mouth of the Upper Truckee River in South Lake Tahoe, and a much larger bloom of attached algae occurred in spring 2022 along six miles of shoreline at Tahoe City.

By actively monitoring the spatial extent, type, and intensity of nearshore algal blooms, we can better understand the underlying causes of the blooms and develop appropriate mitigation measures. The project also serves as a warning system to alert public and government agencies to these unattractive and potentially dangerous situations and to guide cleanup crews to hotspots.

The aerial monitoring approach was initially developed through funding from State agencies, but for the last three years it has received minimal support. COVID-19 disruptions also interrupted this critical project at the worst possible time—just as some of the largest algal and bacterial blooms were occurring in the lake. Currently, private funding is supporting this program. Learn more about it and how you can help maintain and expand it to include more research into the best cleanup and mitigation methods by visiting https://tahoe.ucdavis.edu/algae

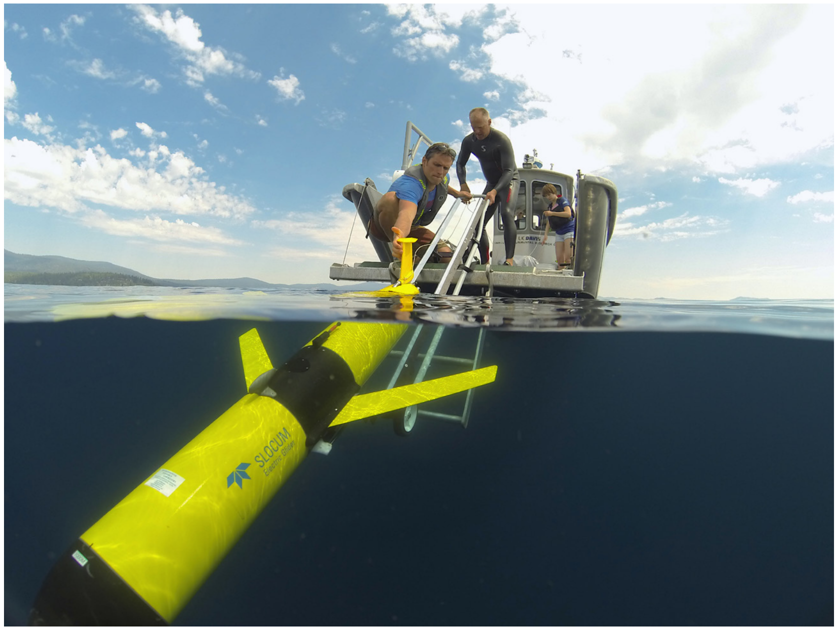


Images of stalked golden diatoms and filamentous green algae on June 1, 2022, during ground-truthing near the outlet of the Truckee River in Tahoe City. Left image underwater and right image from the surface. (Photos: S. Hackley)

Underwater gliders track the fate of wildfire smoke particulates within Lake Tahoe

As part of a Tahoe Science Advisory Council study, TERC's Slocum G2 autonomous underwater glider "Storm Petrel" was deployed to continuously map the distribution of lake water quality variables. The glider measured electrical conductivity, temperature, depth, chlorophyll-*a* fluorescence, dissolved organic matter, and optical backscatter. It was also equipped with a LISST 200X, a laser diffraction instrument used to measure particle size distributions.

The glider was deployed on September 3, 2021, when atmospheric fine particulate matter concentrations from the Caldor Fire in the Lake Tahoe Basin were at peak levels, and it continued to operate until September 25, 2021.

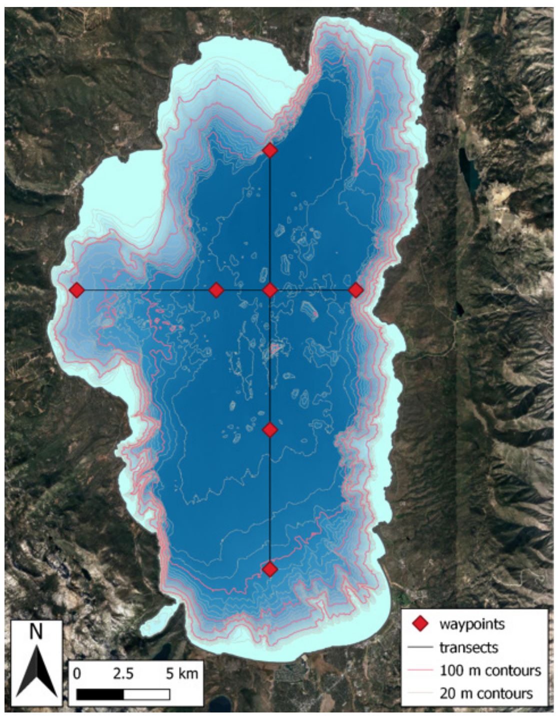


Launching the glider on its monitoring jouney (left) and getting pulled from the lake after completing its Lake Tahoe mission (right). (Photos: B. Berry [left] and B. Allen [right])

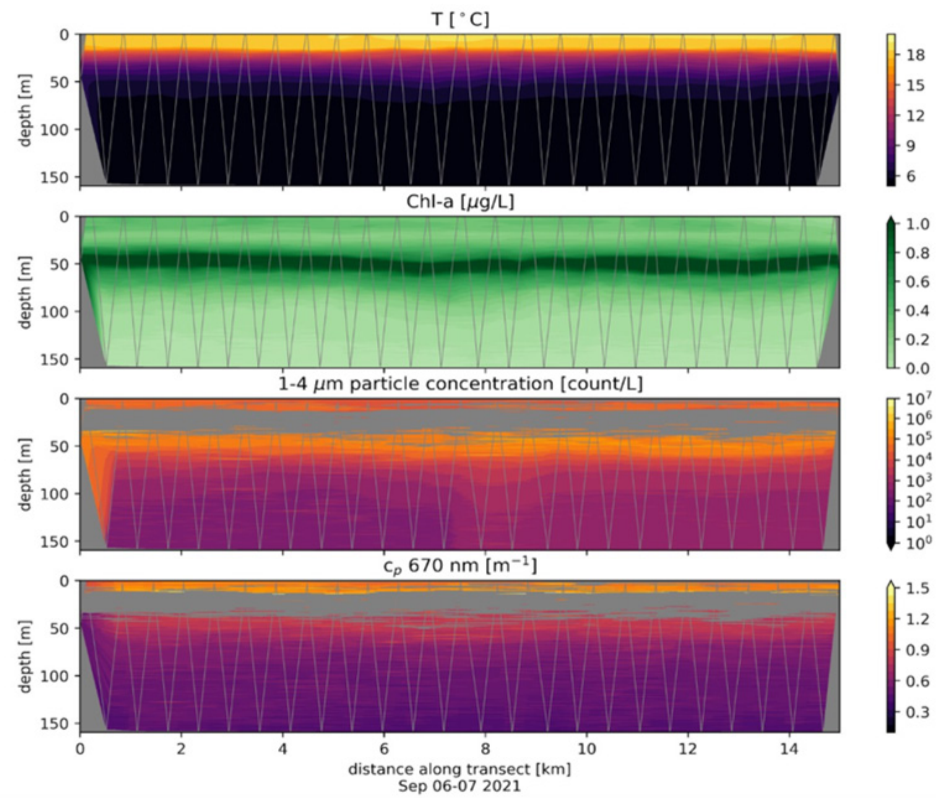
Underwater gliders track the fate of wildfire smoke particulates within Lake Tahoe, continued

The glider was pre-programmed to repeat transects across Lake Tahoe (both East-West and North-South transects). While navigating along the programmed transects, the glider continuously repeated dive/climb cycles between the water surface and 150 m (500 ft) depth.

While data are still being analyzed, preliminary results are showing that the behavior and impacts of particulates from wildfire smoke are more complex than originally thought.



Glider transects and waypoints used for the wildfire study. Bathymetric contours of Lake Tahoe are shown for context.

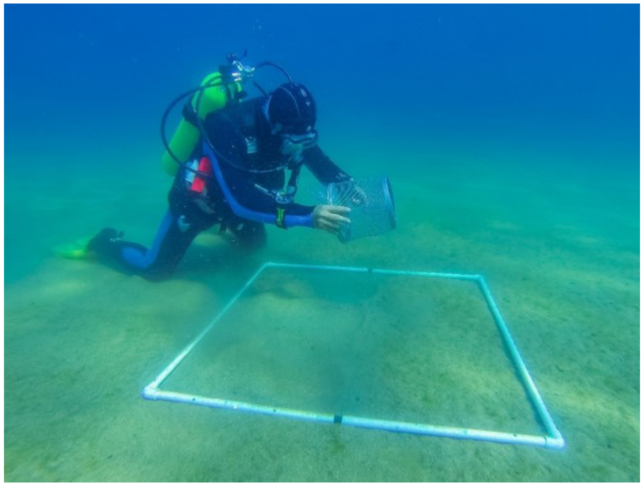


Data from a single west to east transect. The grey lines indicate the yo-yo pattern the glider follows as it traverses the lake.

Tracking the spread of invasive species at Sand Harbor State Park

The invasive bivalve, the Asian clam (*Corbicula fluminea*), was first documented at the southeast corner of Lake Tahoe in 2002. It wasn't until 2012 that the first non-connected population was discovered on the sill of Emerald Bay State Park, California. This was soon followed in 2014 by the discovery of an isolated population at the boat ramp in Sand Harbor State Park, Nevada.

Treatment of Asian clams at Sand Harbor State Park was implemented from 2017 to 2020 in the vicinity of the Sand Harbor Boat Ramp. Following the multi-year control project, a comprehensive survey was conducted in summer 2021 by TERC with funding provided by the Nevada Division of State Lands (NDSL). The goal of the survey was to assess clam density throughout the aquatic portion of Sand Harbor State Park.



TERC researcher, Kian Bagheri, collects clams during the survey at Sand Harbor State Park. (Photos: B. Berry)

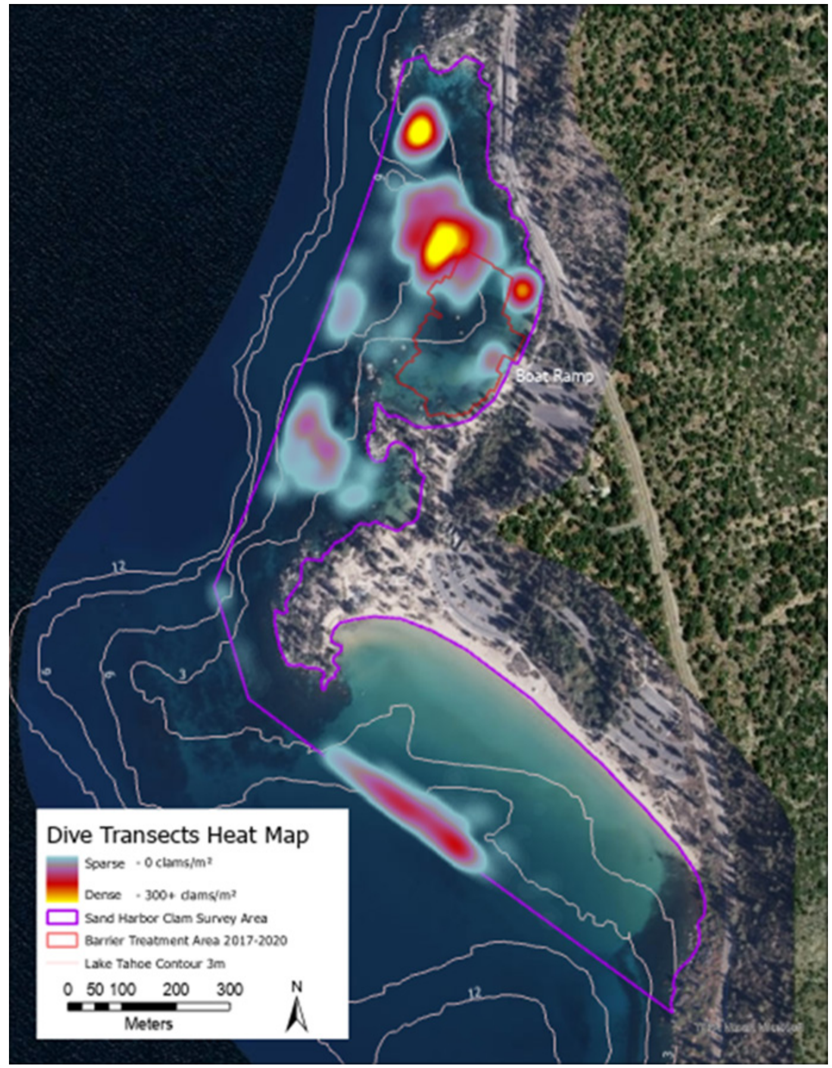
Metaphyton patches observed north of the boat ramp at Sand Harbor State Park. (Photos: B. Berry)

Tracking the spread of invasive species at Sand Harbor State Park, continued

The survey area was approximately 130 acres, and it encompassed the lakeward areas surrounding Sand Harbor State Park. A systematic scuba survey was designed to cover the entire region while simultaneously quantifying clam abundance and distribution. Generally, clams were found distributed throughout the entire survey area at depths greater than 10 ft (3 m). Despite the large area with a viable clam population, densities were generally low (0–30 clams/m^2) except for select areas that contained densities over 100 clams/ m^2. A color contour map of clam population abundance at Sand Harbor is displayed.

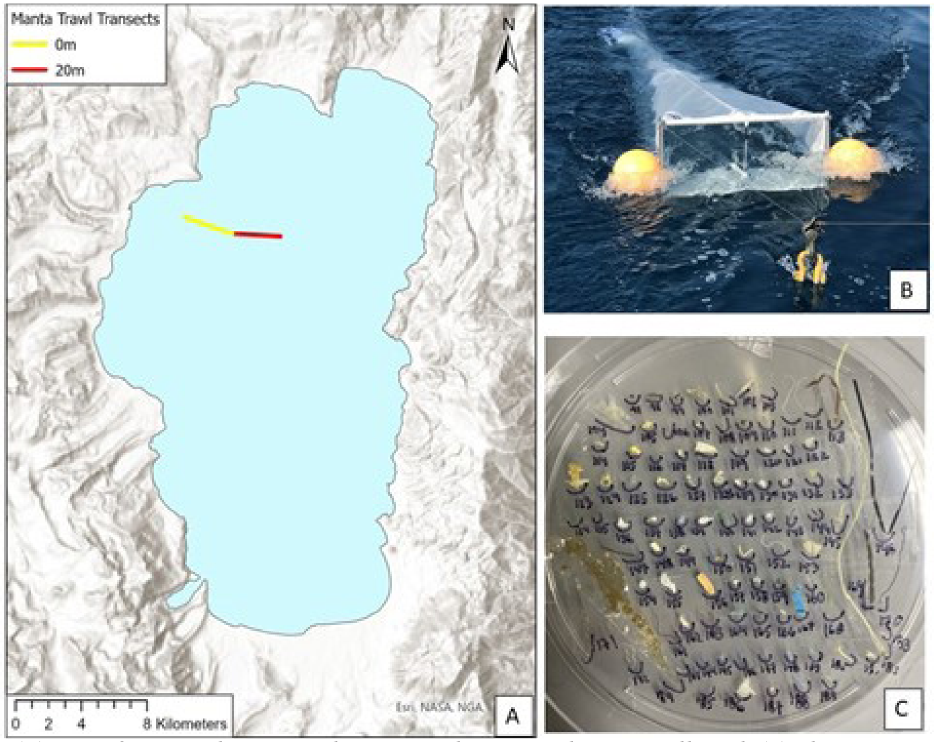
An impact of Asian clams at Lake Tahoe is the correlated enhanced metaphyton growth. Metaphyton are unattached drifting patches of green filamentous algae. Metaphyton were observed at Sand Harbor State Park during the surveys. While the extent is still relatively small, numerous metaphyton patches up to two feet in diameter were observed over the highest clam densities in the area. An unregulated expansion of the existing clam population would be expected to lead to heavier metaphyton mats over larger areas of Sand Harbor in future years. The timing of and the potential for these mats to create nuisance algae on beaches is unknown.

The clam surveys at Sand Harbor are planned to continue for the next two summers. During this time, TERC will be working with NDSL staff to consider a range of mitigation measures.



Plastics, plastics everywhere

Microplastic pollution is a growing environmental concern, as plastics have become a ubiquitous part of our daily lives. Once released into the environment, larger pieces of plastic often mechanically break into smaller and smaller pieces over time. This has led to increasing concerns about the impact of plastics on the environment, ecosystems, water quality, and human health. In August 2020, TERC began quantifying and characterizing microplastics in the waters of Lake Tahoe. A manta trawl was towed alongside a research vessel to filter plastics from the lake surface. These plastics were then isolated in the lab and analyzed with Raman microspectroscopic imaging to confirm plastic type and chemical composition of particles.



(A) Map of transect locations where microplastic samples were collected. (B) The manta trawl tow net. (C) Particles suspected to be plastic were isolated for subsequent Raman microspectroscopic analysis. (Photos: K. Senft (B) and S. Sesma (C))

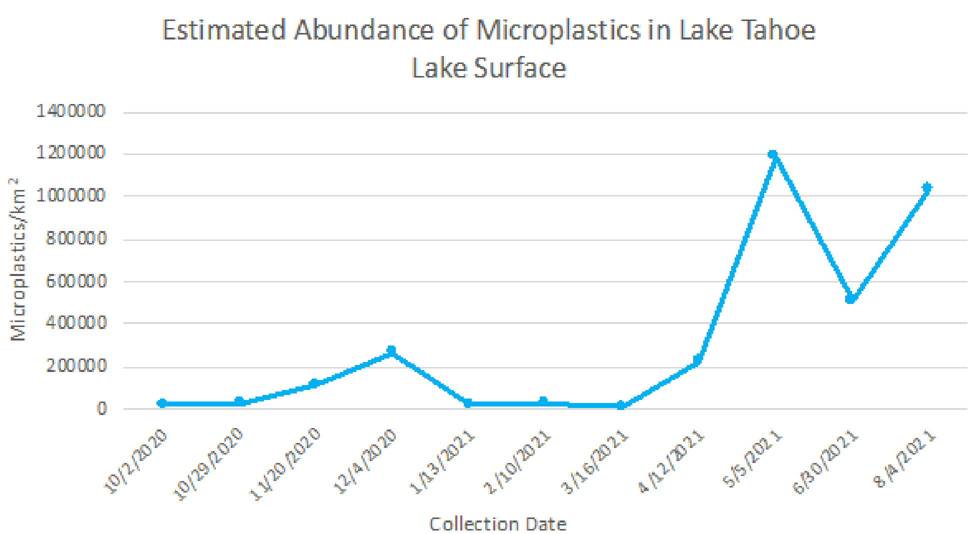
Plastics, plastics everywhere, continued

Preliminary data analysis has shown an average abundance of 312,000 plastic particles per square kilometer at the lake surface during the sampling period, with peak abundances exceeding 1,200,000 particles per square kilometer. Samples collected during May, June, and August had the highest numbers of microplastics at the lake surface.

Raman microspectroscopy was used to identify the synthetic polymer composition (plastic type) of each confirmed microplastic particle. The majority of analyzed plastic particles from surface waters were identified as polyethylene (41 percent) and polypropylene (40 percent) with a smaller proportion of particles identified as polyesters (14 percent). Additional synthetic polymers, including polystyrene, nylon, acrylics, and co-polymer mixtures, were also identified but made up only five percent of all analyzed particles.

Polyethylene is the most widely produced plastic polymer in the world and is used in the production of everything from food packaging and water bottles to plastic bags and toys. Polypropylene is found in carpeting, outdoor furniture, clothing, and upholstery. Most plastic items in our everyday lives are composed of one or both of these plastic polymers.

This work was undertaken as a collaboration between TERC and the UC Davis School of Veterinary Medicine. Funding has been provided by the Nevada Division of Environmental Protection.



The desiccation of Tahoe's forest—the last straw

From Lake Tahoe looking up to the west shore forests, one can see yet another impact of the decadal drought that the western U.S. is experiencing—thousands of dead and dying trees.

Currently in Tahoe, we are seeing areas of moderate-to-high fir mortality. In some locations, incense cedars are being impacted as well. The lack of sufficient water adds to the stress that the trees are enduring and makes them more prone to insect and pathogen attacks.

This trend is also being observed more broadly throughout California and the west. Many of the impacted stands are where tree densities are in excess of the natural carrying capacity, particularly in times of drought.

What is the solution? Nature is currently enacting a solution by killing off some of the excess trees. Unfortunately, the stands of dead trees only compound the fire risk. A better solution may be to more aggressively implement the various forest management plans that have been developed over the last decade. Neither our current or future climate can support the current tree densities.

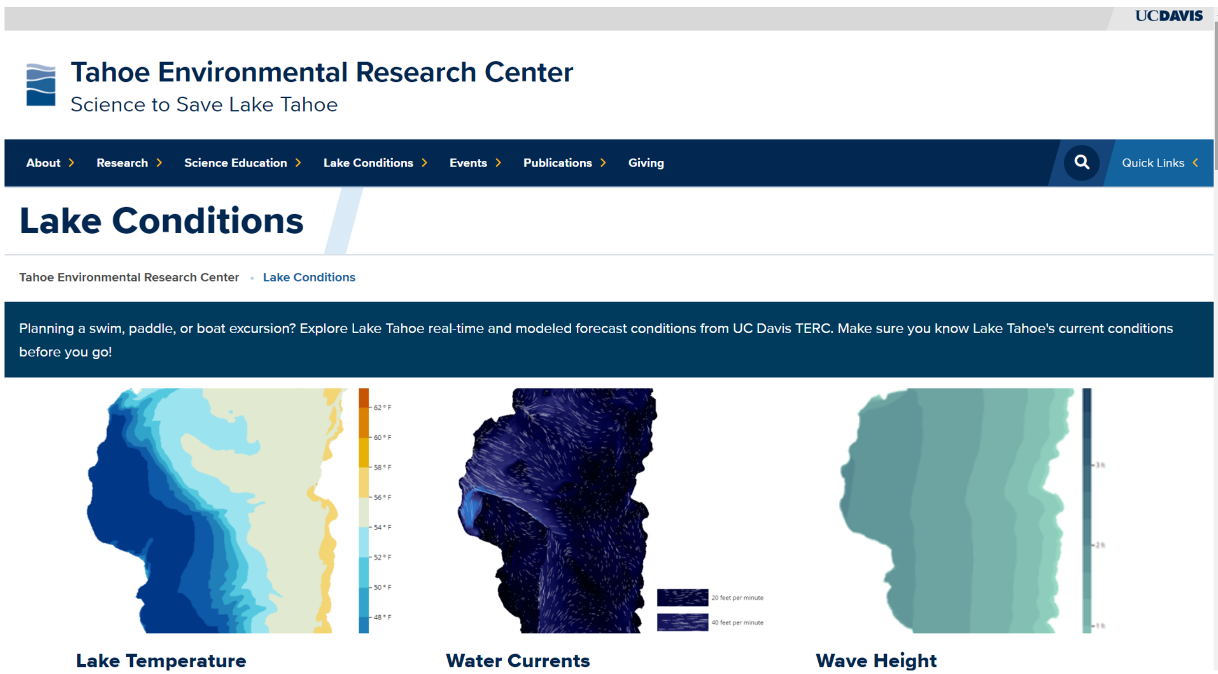
The extent of dead trees on Tahoe's west shore during the TERC 2022 Lake Circumnavigation event. (Photo: G. Schladow)

A stark contrast of dead, dried brown trees. (Photo: A. Toy)

Lake conditions website

Along with the bliss of being on Lake Tahoe during a hot summer day, there are hidden dangers lurking. The weather in the Sierra can be fickle, and conditions can change quickly, potentially presenting a hazard to the unprepared. But there are other lesser known dangers, that can place a swimmer, paddleboarder, or boater in jeopardy.

UC Davis TERC's new online Lake Conditions tool provides both real-time and forecasted water temperatures, wave heights, and water current information. These indicators provide an early warning of some of the major lake hazards that can exist at Lake Tahoe. The Lake Conditions webpage (https://tahoe.ucdavis.edu/lake-conditions) provides a direct link to TERC's temperature and wave measurement stations around the lake. It also provides present conditions and forecasts of water temperature, currents, winds, and waves across the entire lake every three hours for up to three days day into the future.

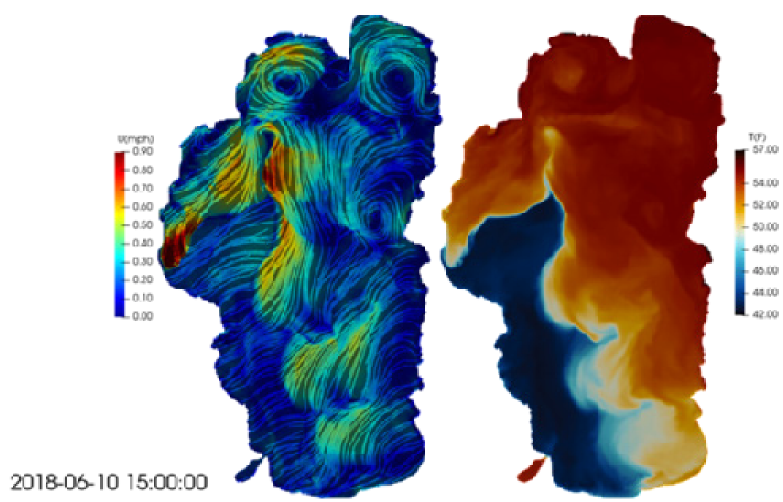


Screenshot from the UC Davis TERC Lake Conditions website showing lake temperature, water currents, and wave height.

Lake conditions website, continued

What are the special hazards to be aware of at Lake Tahoe? During strong, persistent winds the lake may experience an “upwelling.” This is when the warm surface water gets pushed downwind, and cold, frigid water from deep in the lake rises on the upwind side of the lake. Fortunately, during such windy and rough conditions, very few people venture out on the lake. The real danger comes after the wind subsides and people get back in the water. Because the lake is so massive, the cold upwelled water can remain at the surface for several days before returning to the lake bottom. This may come as an unwelcome and dangerous surprise to people diving off a boat, expecting normal warm summer surface waters. To make matters worse, when in the water, people may also experience very strong currents that are generated as the lake returns to its initial state.

The righthand map below shows the modeled surface water temperature under calm conditions shortly after an upwelling event. While most of the lake is a brisk 55 °F, the water in the southwest quadrant is a hypothermia-inducing 42 °F. At that temperature, a person in the water could lose dexterity in minutes and lapse into unconsciousness in less than 30 minutes. The lefthand map below shows the corresponding surface current patterns. The red coloration indicates currents of over one mph. That may not seem very fast but imagine falling off a paddleboard into 42 °F water and, while trying to catch your breath, you notice your paddleboard being carried away at two feet per second.



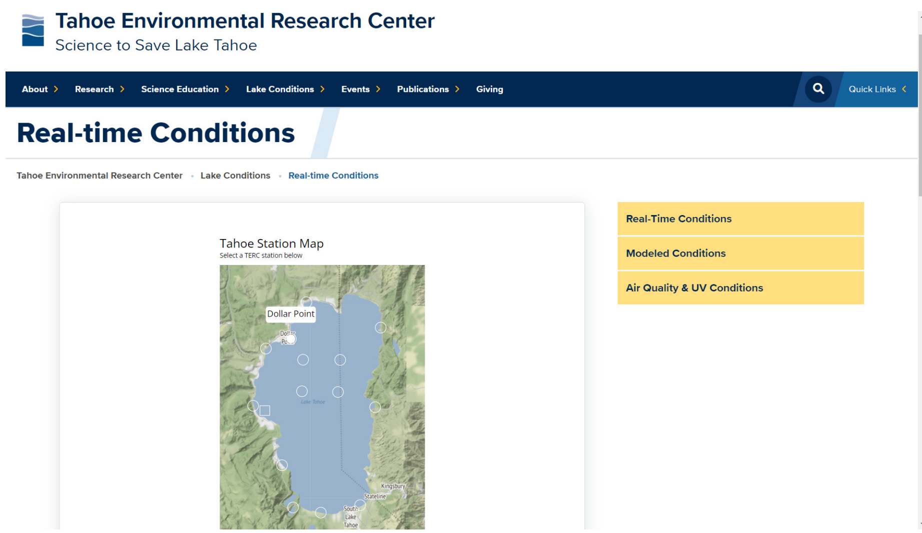
High velocity (>0.7 mph) jets and cold (<42 °F) water temperatures following an upwelling event in Lake Tahoe

Current conditions webpage, continued

The real-time data come from TERC's Nearshore Network of stations located along the shoreline all around the lake. These stations are funded and supported by TERC donors, lakeshore property owners, and the Lahontan Regional Water Quality Control Board. The stations provided valuable research data for the last eight years and are now providing lake users with the most current, up-to-the-minute lake conditions information. Water temperature data from the middle of the lake are also provided from research buoys that are operated in partnership with the NASA Jet Propulsion Laboratory.

The forecast conditions are from computer models developed by TERC researchers. The model for lake temperatures and currents is a complex three-dimensional model that TERC has used on many lakes around the world to better understand complex motions and water quality challenges. Another model, first developed by the U.S. Army Corps of Engineers, was adapted to forecast the wave heights across Lake Tahoe.

A team of UC Davis Computer Science students comprised of Sam Maksimovitch, Julian Nguyen, Suryakiran Santhosh, and Simperpal Whala created this life-saving resource as part of a two-quarter project with TERC. The models were developed by TERC graduate student Sergio Valbuena and alum Dr. Patricio Moreno. Funding for the project was provided by the Tahoe Fund and UC Davis.



Screenshot from the UC Davis TERC website showing the locations of the real-time sensors.

Find Tahoe Tessie

Tahoe Tessie isn't real, but climate change is.

As part of an alternative approach to climate change education, TERC has been developing the Find Tahoe Tessie app. This app is part of a larger project, "Understanding Change at Lake Tahoe Augmented Reality (AR) Experiences," funded by the Institute of Museum and Library Services. This AR app allows players to place Tahoe Tessie around Lake Tahoe.

The biological stressors that this mythical creature faces are similar to those of aquatic organisms native to Lake Tahoe such as the Lahontan cutthroat trout. Like other organisms, Tahoe Tessie's health is affected by water temperature, dissolved oxygen levels, lake clarity, algal concentrations, and human activity.

Using the app, users can compare Tahoe Tessie's health and well-being under future climate scenarios and learn how rising air temperatures can affect many of the variables that aquatic organisms everywhere depend upon.

The app is planned for release in fall 2022.

See Lake Tahoe's mythical lake creature in augmented reality. Tahoe Tessie isn't real, but climate change is. (Photo: A. Toy)