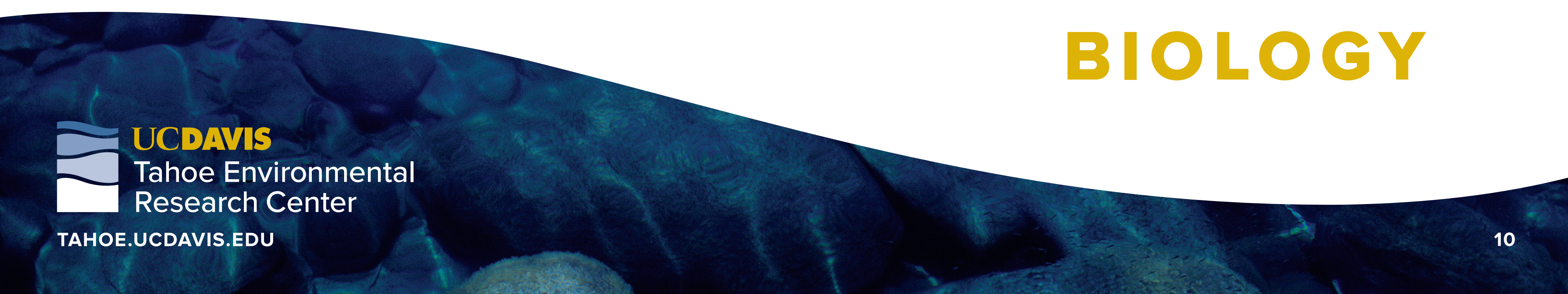
TAHOE: STATE OF THE LAKE REPORT 2018

BIOLOGY



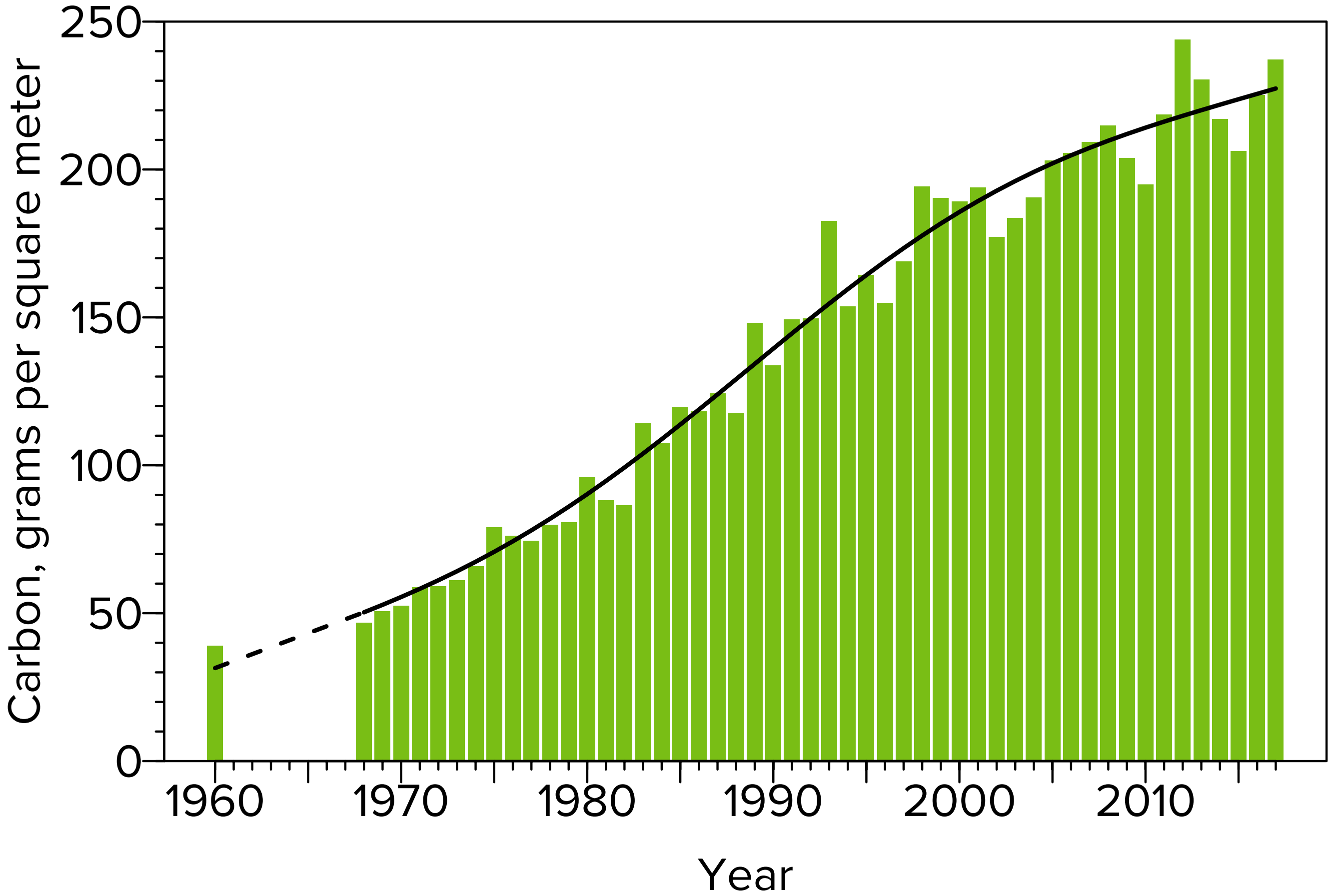
UC DAVIS
Tahoe Environmental
Research Center

BIOLOGY

Algae growth (primary productivity)

Yearly since 1959

Primary productivity is a measure of the rate at which algae produce biomass through photosynthesis. It was first measured at Lake Tahoe in 1959 and has been continuously measured since 1968. Supported by nutrient loading into the lake, changes in the underwater light environment, and a succession of algal species, the trend shows primary productivity has increased substantially over time. In 2017, there was an increase in primary productivity to 237.2 grams of carbon per square meter.

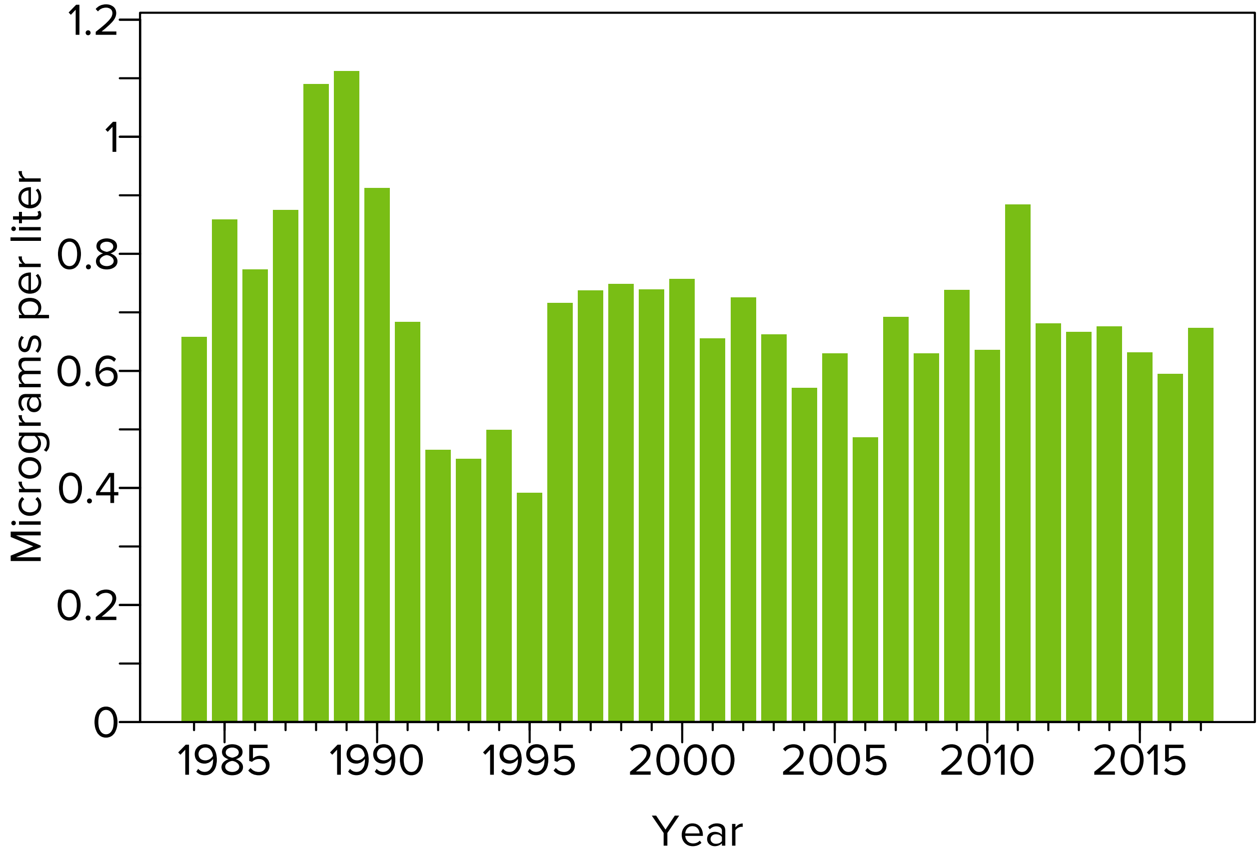


BIOLOGY

Algae abundance

Yearly since 1984

Algae (phytoplankton) are the base of the Lake Tahoe food web, and essential for lake health and the well-being of the entire ecosystem. The amount or biomass of free-floating algae in the water is determined by extracting and measuring the concentration of chlorophyll-*a*, a photosynthetic pigment that allows plants to convert energy from the sun. Though the value varies annually, aside from an increase in the later 1980s the amount has generally stayed near-constant. The average annual concentration for 2017 was 0.67 micrograms per liter, higher than the previous year's value of 0.59 micrograms per liter. For the period of 1984-2017 the average annual chlorophyll-*a* concentration in Lake Tahoe was 0.70 micrograms per liter.



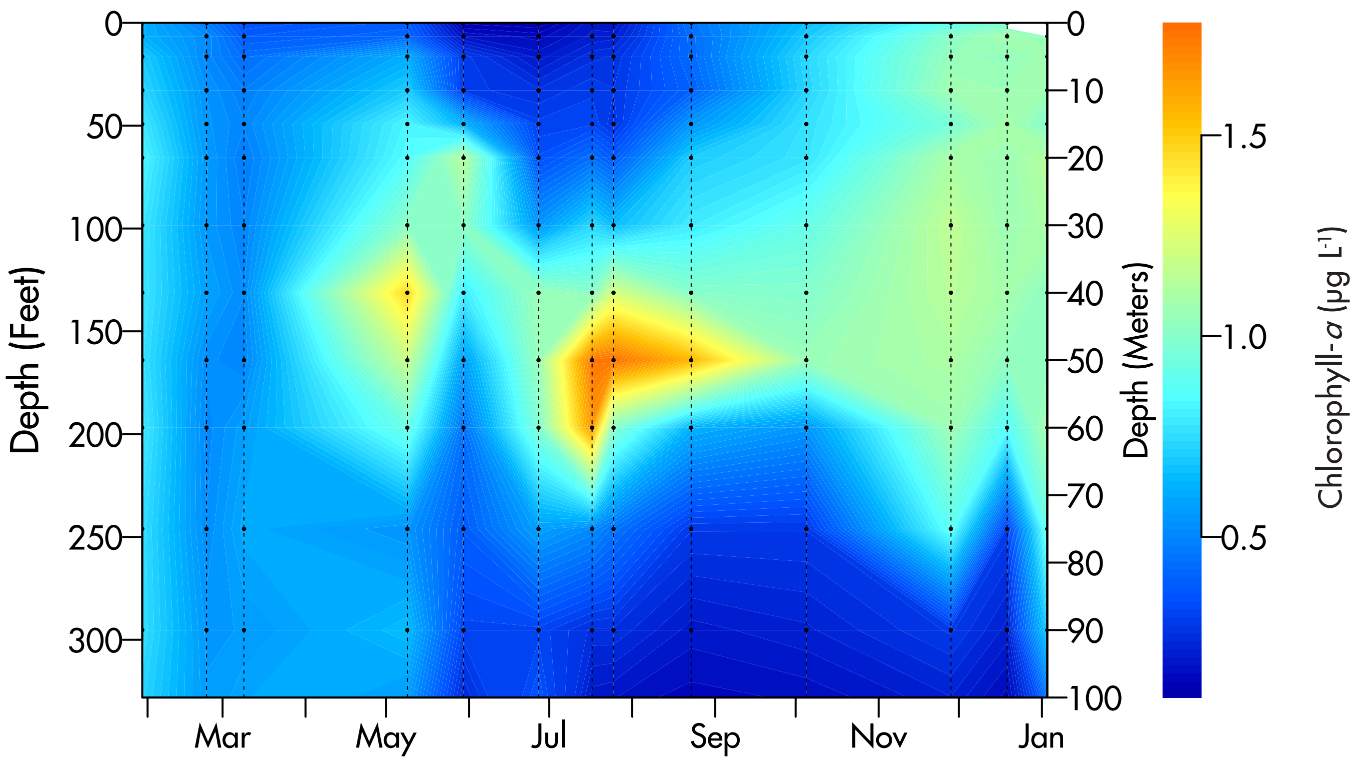
BIOLOGY

Chlorophyll-*a* distribution

In 2017

The distribution of algae (measured as chlorophyll-*a*) is the result of a combination of light availability, nutrient availability, mixing processes, and to a lesser extent, water temperature. This figure shows color contours of chlorophyll-*a* concentration down to a depth of 350 feet. Below this depth chlorophyll-*a* concentrations are near zero due to the absence of light. Lake Tahoe has a "deep chlorophyll maximum" in the summer that occupies the range of 150-300 feet in the water column. In that depth range, the light and nutrient conditions are most favorable for algal growth.

With the onset of thermal stratification in spring, the majority of the algae were confined to a discrete band. Throughout the summer and fall, concentrations decreased as nutrients were depleted. In December, the commencement of mixing again redistributed the algae over a broader depth range.

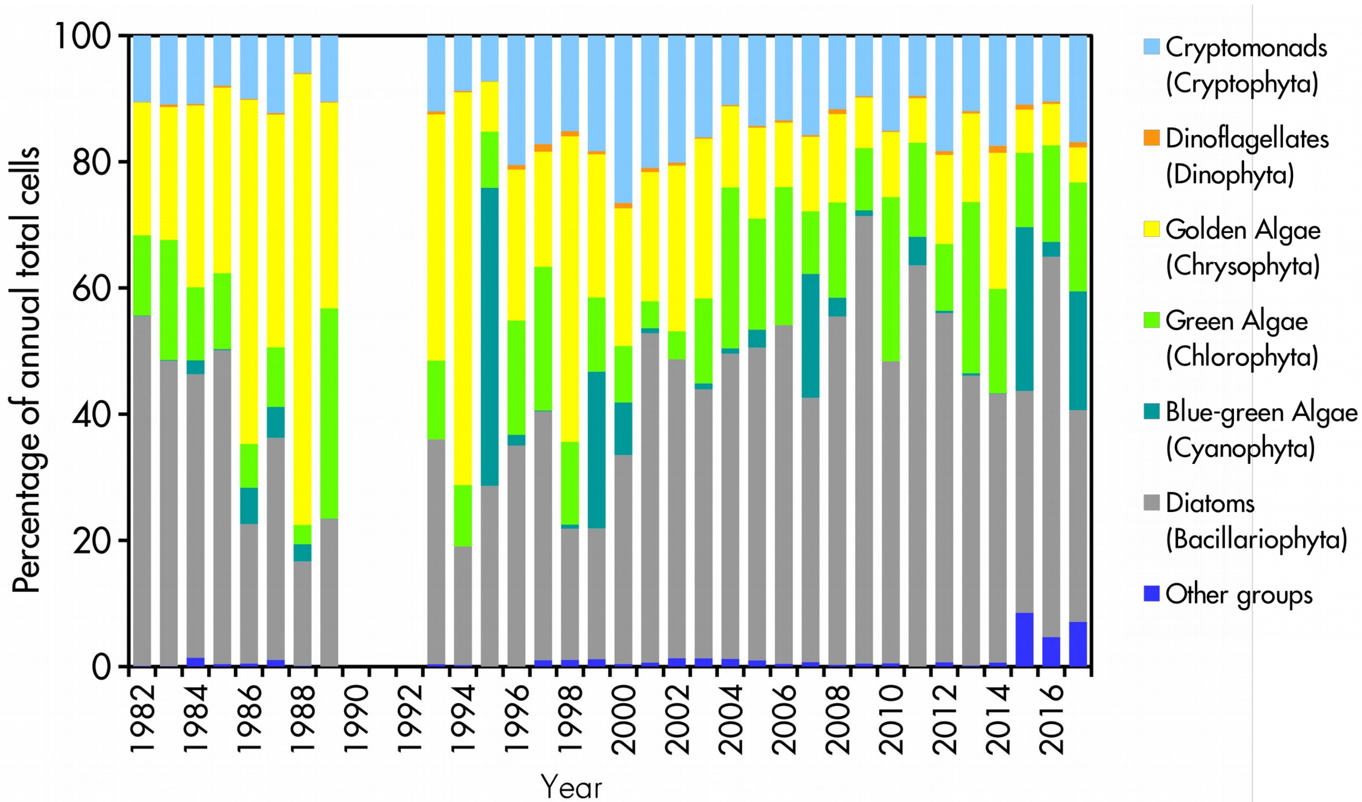


BIOLOGY

Annual distribution of algal groups

Yearly since 1982

The amount of algal cells from different groups varies from year to year. Diatoms are the most common type of alga, comprising over one-third of the total abundance of algal cells in 2017. Blue-green algae (19%), green algae (17%), and dinoflagellates (17%) were next most common in abundance. While the proportion of the major algal groups show a degree of consistency from year-to-year, TERC research has shown that the composition of individual species within the major groups is changing both seasonally and annually in response to lake conditions.

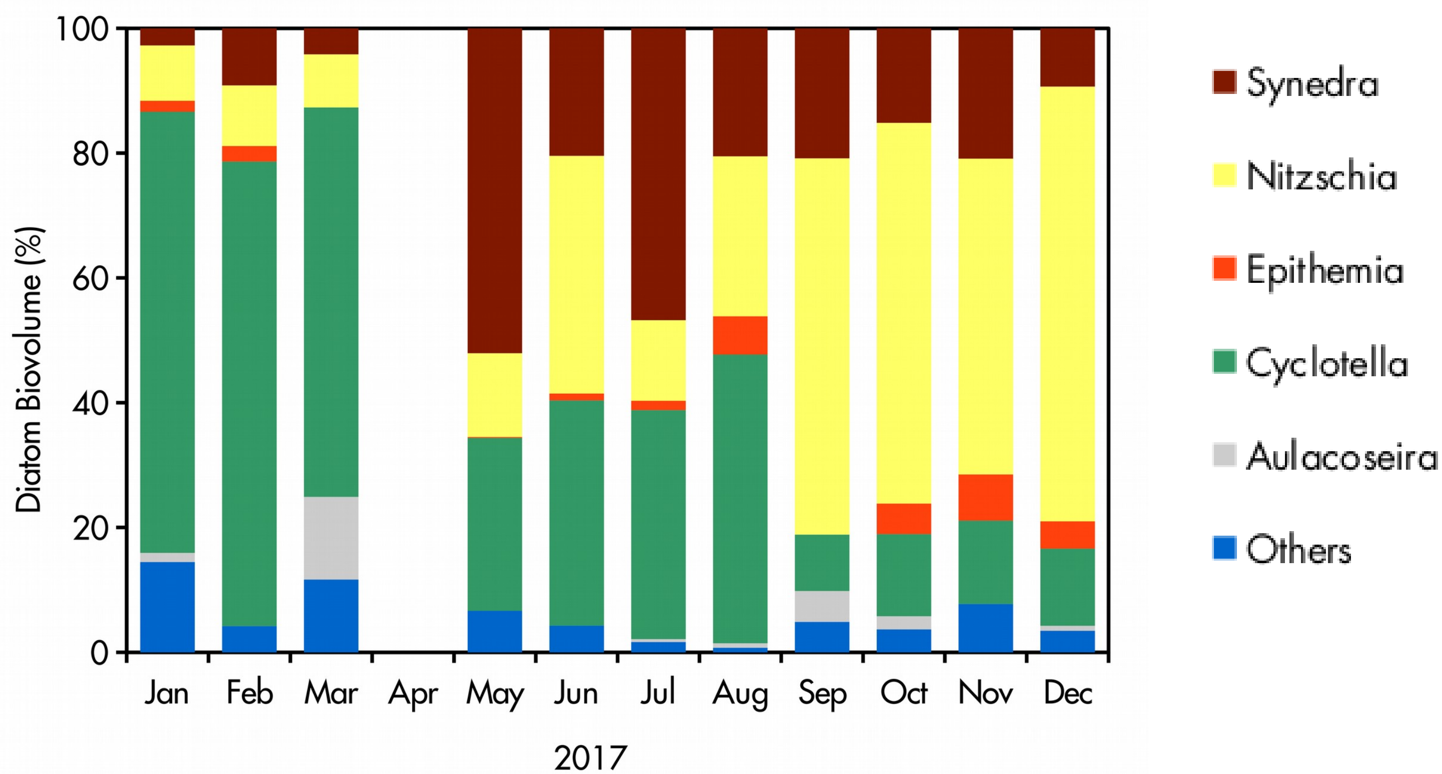


BIOLOGY

Abundance of dominant diatom species

Monthly in 2017

Diatoms have been the dominant algal group at Lake Tahoe for all but a few years since 1982. Diatoms are unique in that they are enclosed within a cell wall made of silica, called a frustule. Here the dominant diatom species at Lake Tahoe in 2017 are shown. Large variations are evident by month in the relative composition. Throughout the year, the dominant species varies from *Cyclotella* to *Synedra* to *Nitzschia*. Of note is the fact that *Cyclotella*, which has been responsible for clarity decreases in Lake Tahoe, was only a minor contributor to clarity reduction in the second half of 2017.

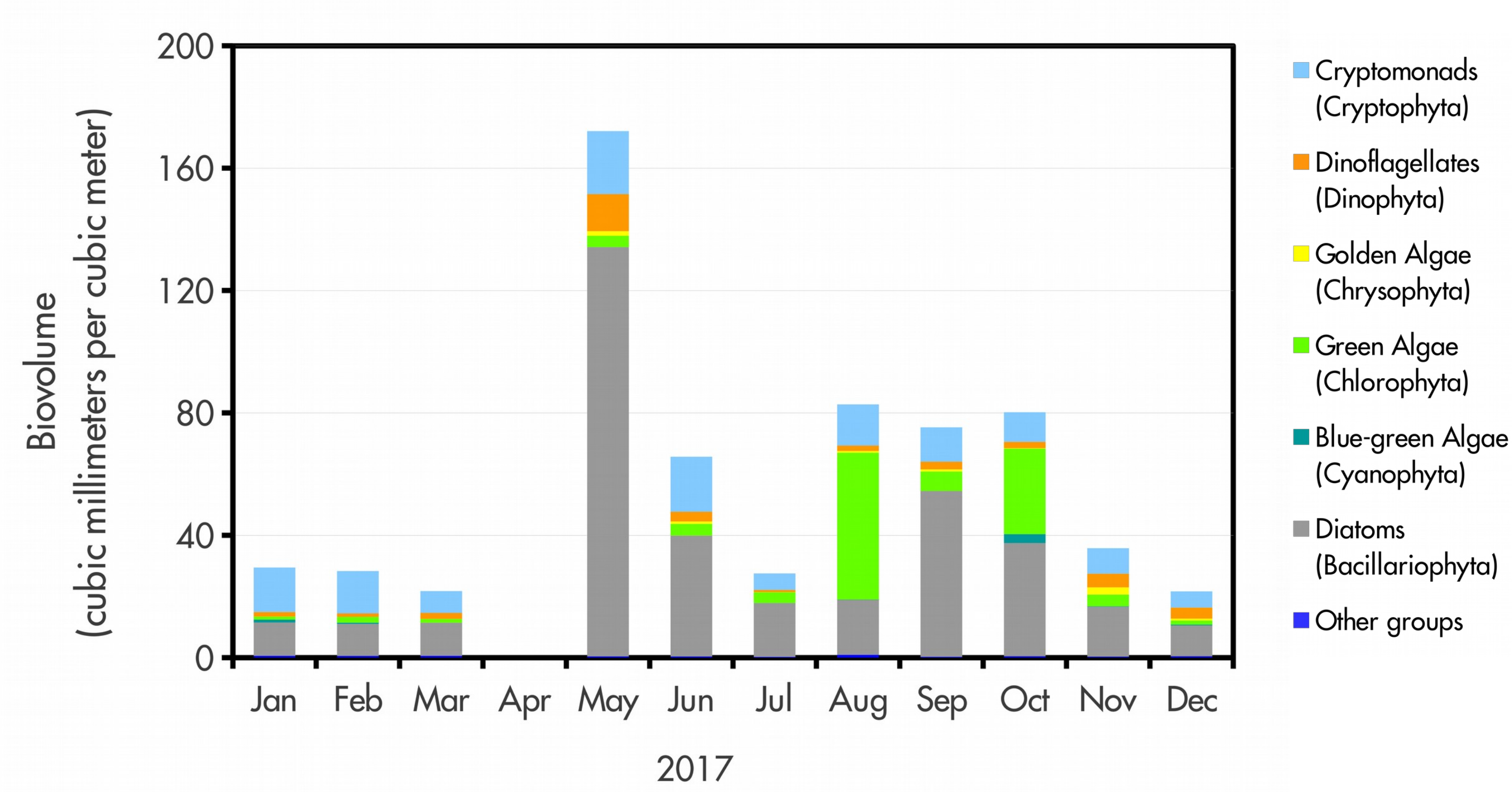


BIOLOGY

Algal groups as a fraction of total biovolume

Monthly in 2017

The biovolume of algal populations vary month to month, as well as year to year. In 2017, diatoms again dominated the biovolume of the phytoplankton community, especially in the summer. The peak in the biovolume (the "spring bloom") occurred a month earlier in May rather than June. The large influx of stream nutrients may have contributed to this early high point. Even at the peak of the bloom, algal cells occupied only one ten-millionth of the water in the lake. The peak biovolume in 2017 was 170 cubic millimeters per cubic meter.

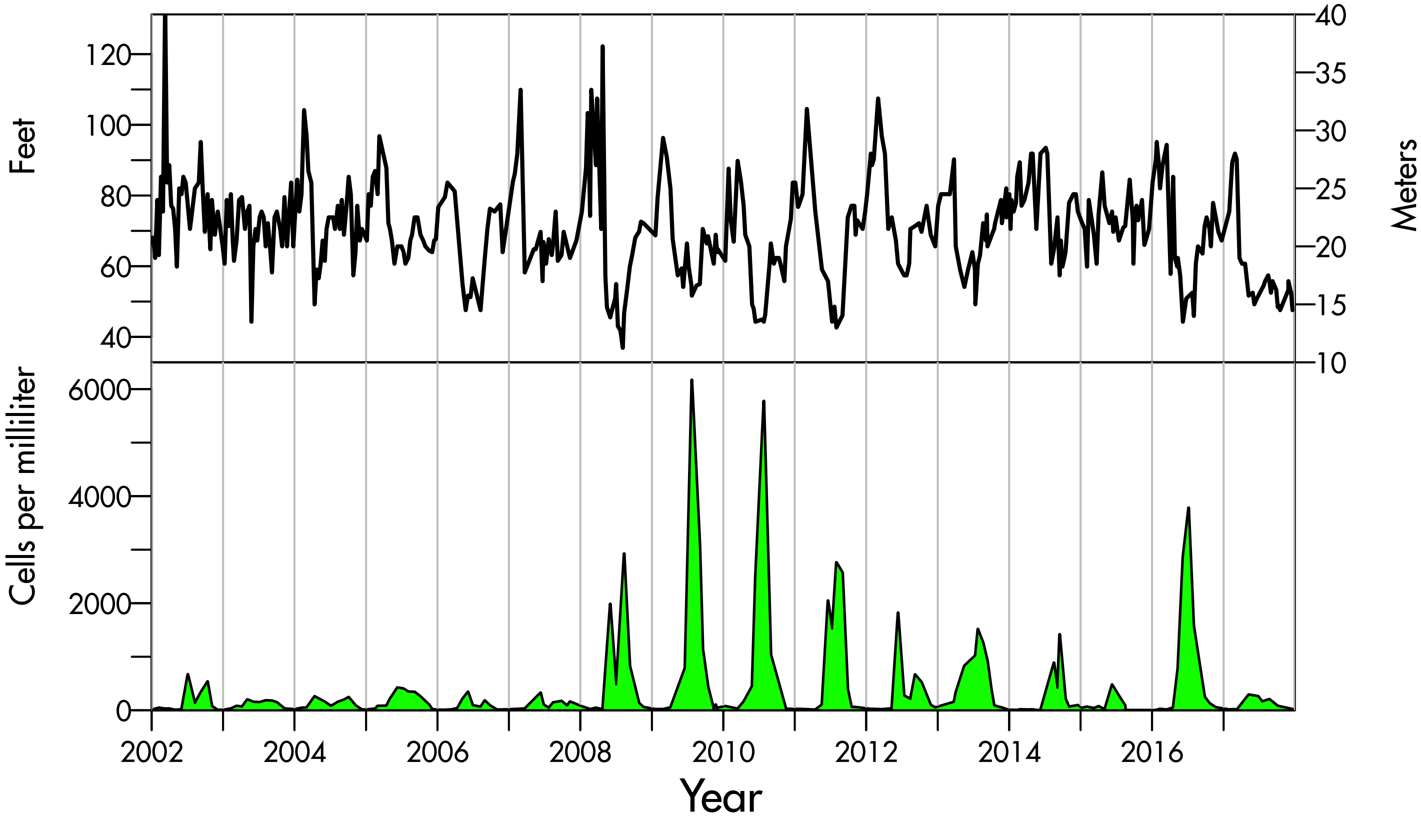


BIOLOGY

Predominance of *Cyclotella gordonensis*

From 2002 through 2017

In 2008, one species of algae, *Cyclotella* gordonensis, started to dominate the make-up of algae at Lake Tahoe. The cells range in size from 4-30 microns in diameter. During the summer, the smallest cells, 4-5 microns, control the community in the upper euphotic zone. This size range, which is similar to inorganic particles, is ideal for light scattering. The growing numbers of *Cyclotella* between 2008-2011 were believed to be responsible for the major decline in summer clarity in those years. In 2017, the concentration of *Cyclotella* cells returned to their pre-2008 range, where they had little impact on the lake's clarity. The lower panel indicates the concentrations of *Cyclotella* at a depth of 16.5 feet (5 m). The black line in the upper panel indicates the individual Secchi depths taken since 2002. While 2017 clarity levels were very low, it is clear that *Cyclotella* was not a major factor.

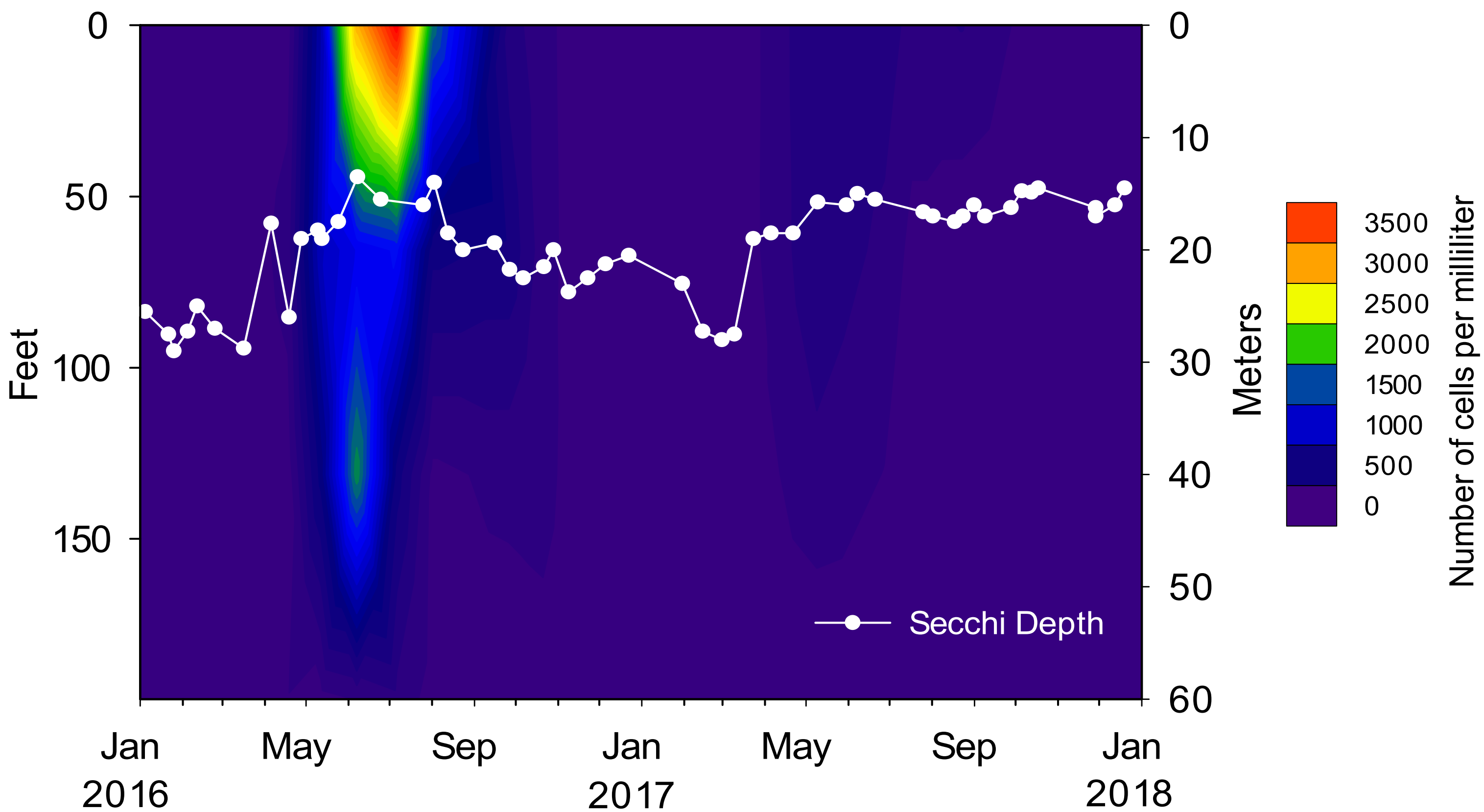


BIOLOGY

Distribution of *Cyclotella gordonensis*

In 2016 and 2017

In 2017, *Cyclotella gordonensis* was found in Lake Tahoe in low numbers especially when compared to 2016. These numbers were so low that the data are barely visible in the color contour plot. The color contours of the number of cells per milliliter are shown along with the individual Secchi depth measurements. In 2017, lake clarity was consistently low from May through the end of the year. As described in other sections of the report, the main contributor to low clarity was the exceptionally large influx of fine, inorganic particles.

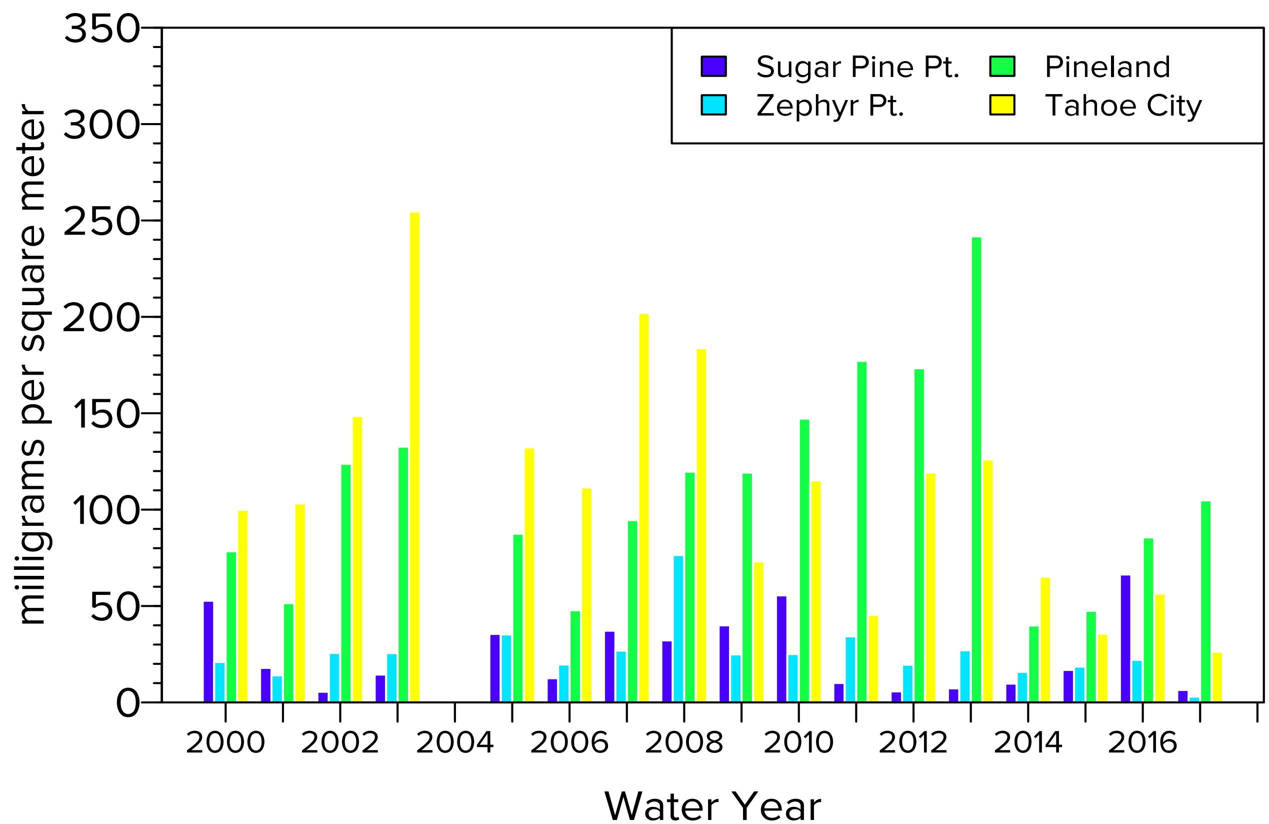


BIOLOGY

Peak shoreline algae concentrations

Yearly since 2000

Periphyton, or attached algae, makes rocks around the shoreline of Lake Tahoe green and slimy, or sometimes like a very plush, white carpet. Periphyton is measured five to eight times each year, and this graph shows the maximum biomass measured at four sites for the period from January to June. In 2017, concentrations at the four sites shown were again close to their historic lows. The two most urbanized sites, Tahoe City and Pineland, were less than half of their values in comparison with the period 2011-2013. Part of the reason for the low values in 2017 was the rapidly rising lake level during spring. These data were from a depth of 1.5 feet below the water surface on substrate that had been above water for two years. While monitoring periphyton is an important indicator of nearshore health, these data do not shed information on what is controlling year-to-year changes.



BIOLOGY

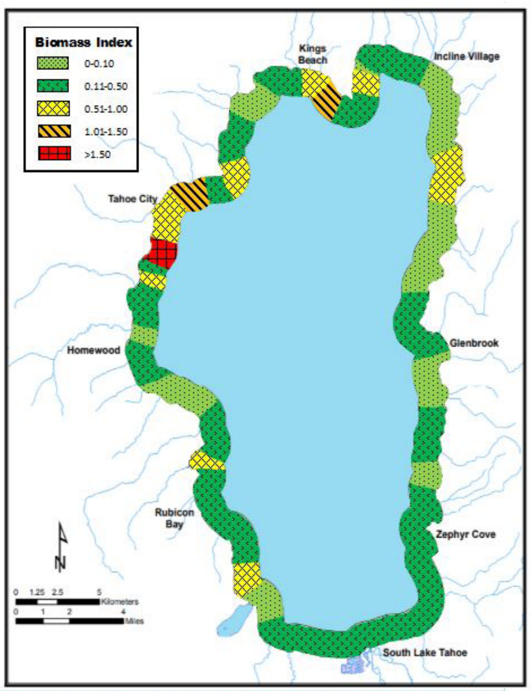
Shoreline algae distribution

In 2017

Periphyton biomass was surveyed around the lake during the spring of 2017, the time of the annual maximum. Nearly 45 locations were inspected by snorkel and scuba survey at depths of 1.6 feet (0.5 m) and 3.3 feet (1.0 m). A Periphyton Biomass Index (PBI), defined as the fraction of the local bottom area covered by periphyton multiplied by the average length of the algal filaments, is assessed at each location. During spring 2017, water level rose rapidly and submerged substrate at 1.6 feet which had been out of the water for several years and therefore supported little periphyton growth. By contrast, the PBI was much higher at a 3.3 feet depth, with many sites having a PBI > 1.5. This variation in lake level and the impact of prior conditions are part of what makes quantifying periphyton growth so challenging.

Note: The width of the colored band does not represent the actual dimension of the onshore-offshore distribution. Similarly, its length does not represent the precise longitudinal extent.

Distribution of Periphyton Biomass at 1.6 feet Depth, Spring 2017



Distribution of Periphyton Biomass at 3.3 feet Depth, Spring 2017