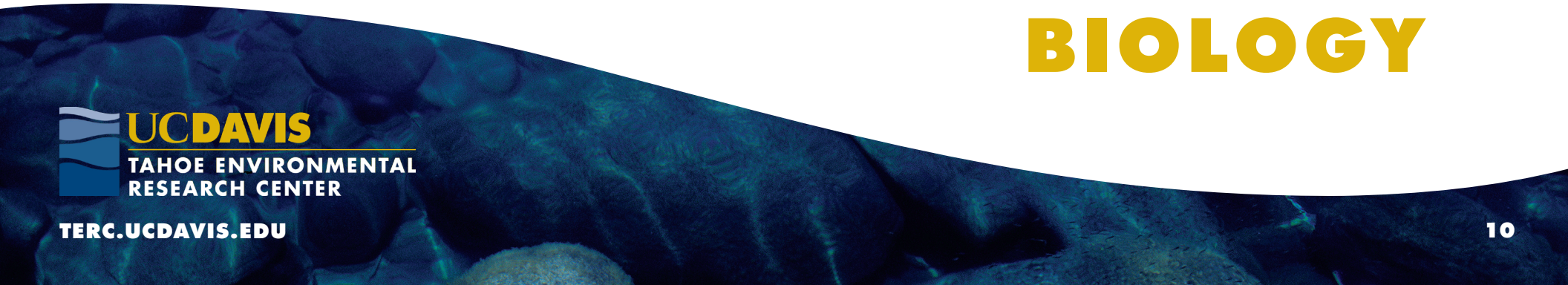
TAHOE: STATE OF THE LAKE REPORT 2017

BIOLOGY



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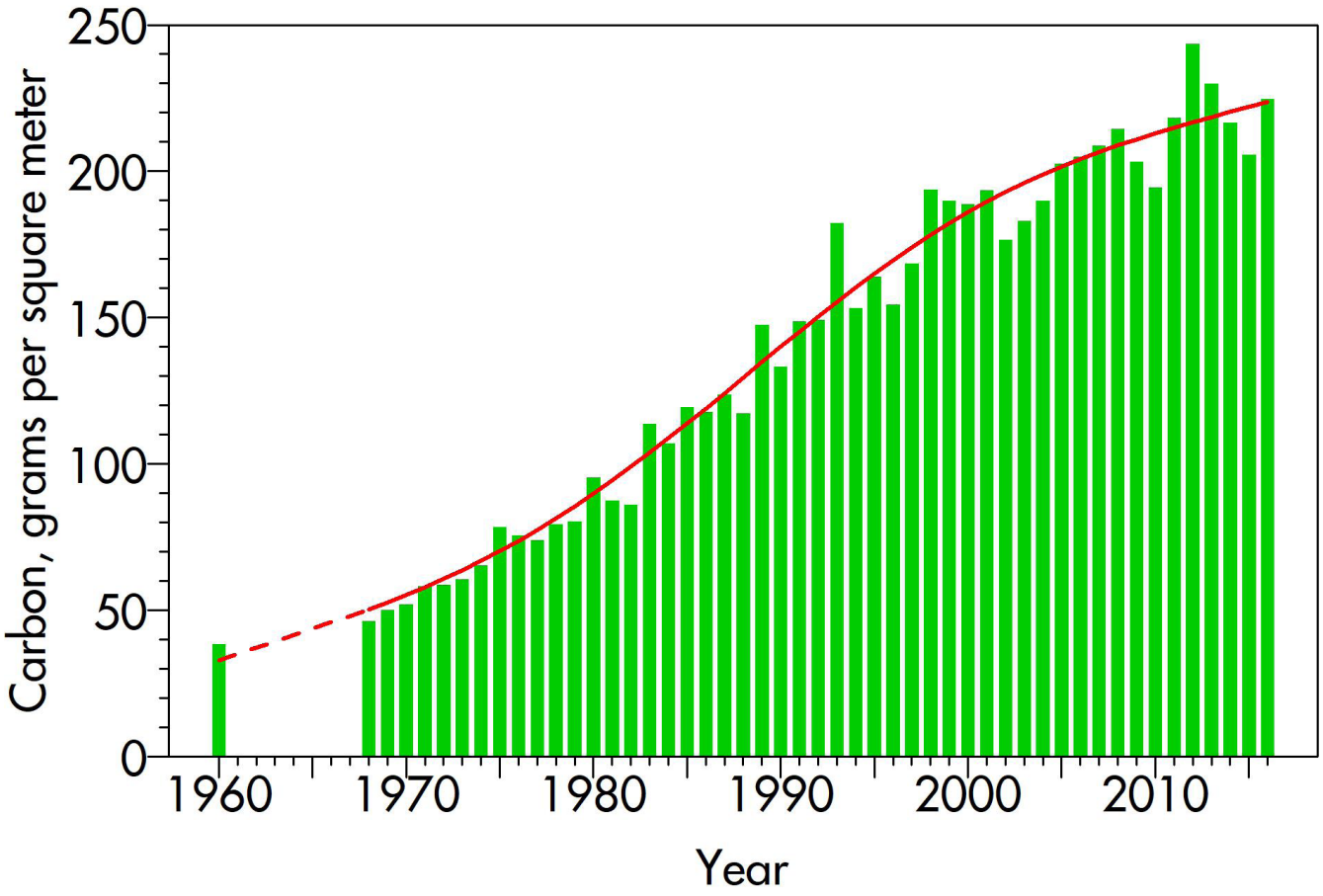
BIOLOGY

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 2016, there was a slight increase in primary productivity to 225.1 grams of carbon per square meter.

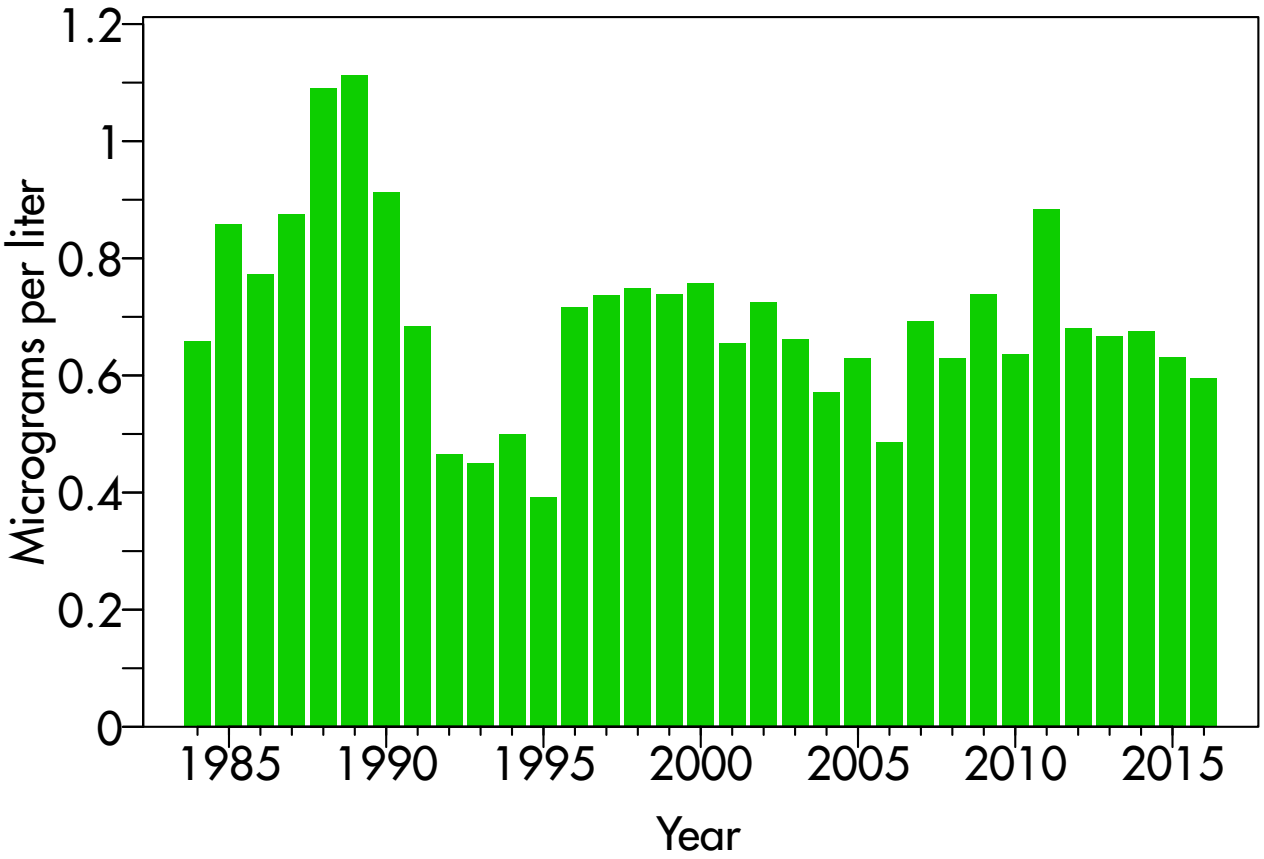


BIOLOGY

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, it has shown a significant increase since measurements began in 1984. The average annual concentration for 2016 was 0.59 micrograms per liter, lower than the previous nine years. For the period of 1984-2016 the average annual chlorophyll-a concentration in Lake Tahoe was 0.70 micrograms per liter.



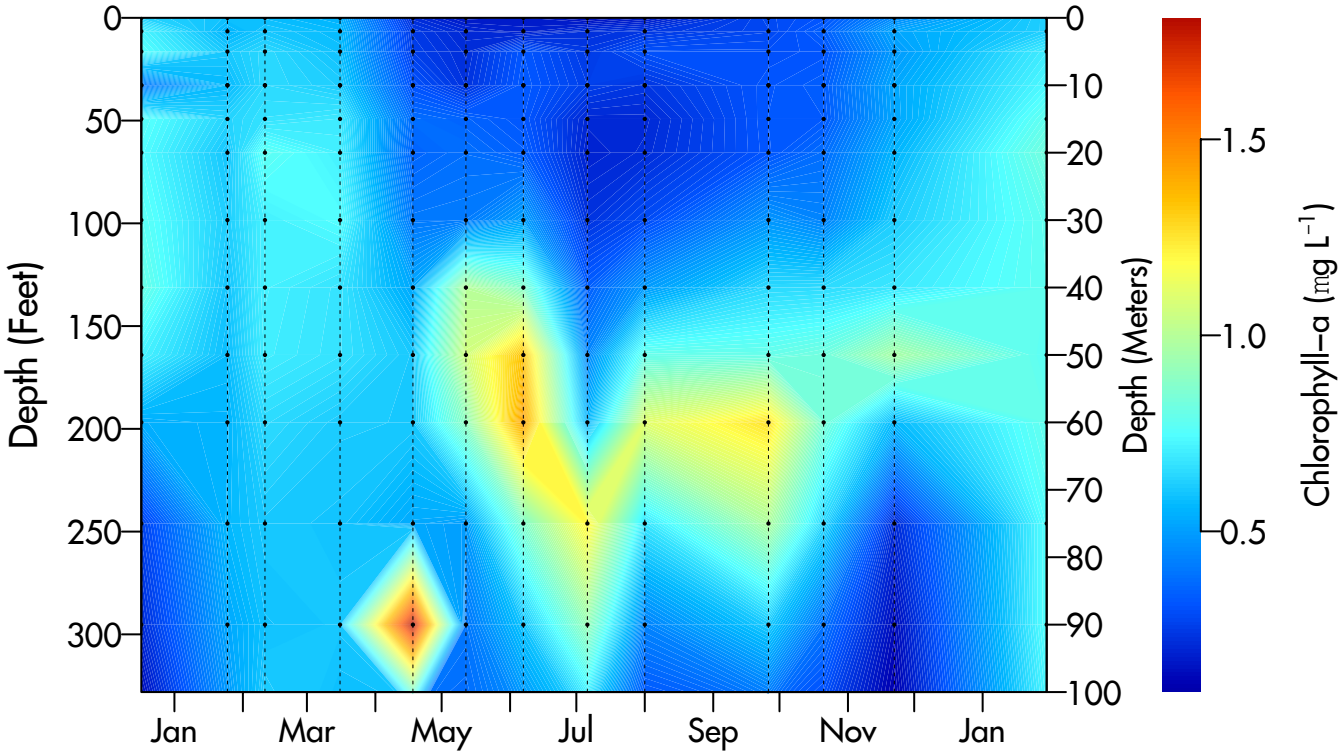
BIOLOGY

Chlorophyll-*a* distribution

In 2016

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 ft. 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 year concentrations decreased as nutrients were depleted. In November and December, the commencement of mixing again redistributed the algae over a broader depth range. Note that the *Cyclotella gordonesis* at the surface have a very small chlorophyll expression. However, the large number of these tiny cells are what matters.

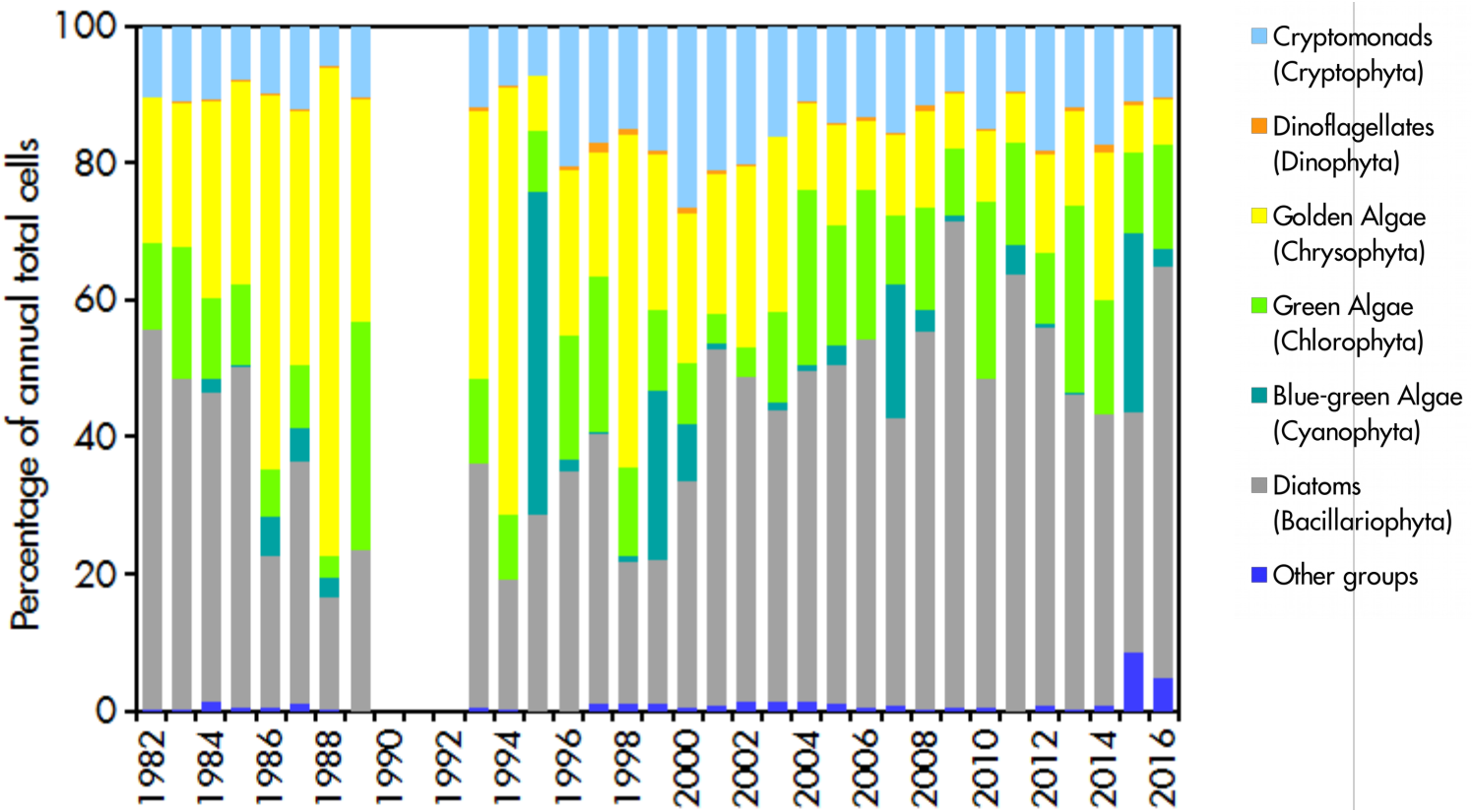


BIOLOGY

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 approximately 60 percent of the total abundance of algal cells in 2016. Chrysophytes, cryptomonads, and green algae are next, each comprising less than 15 percent of the total. 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.



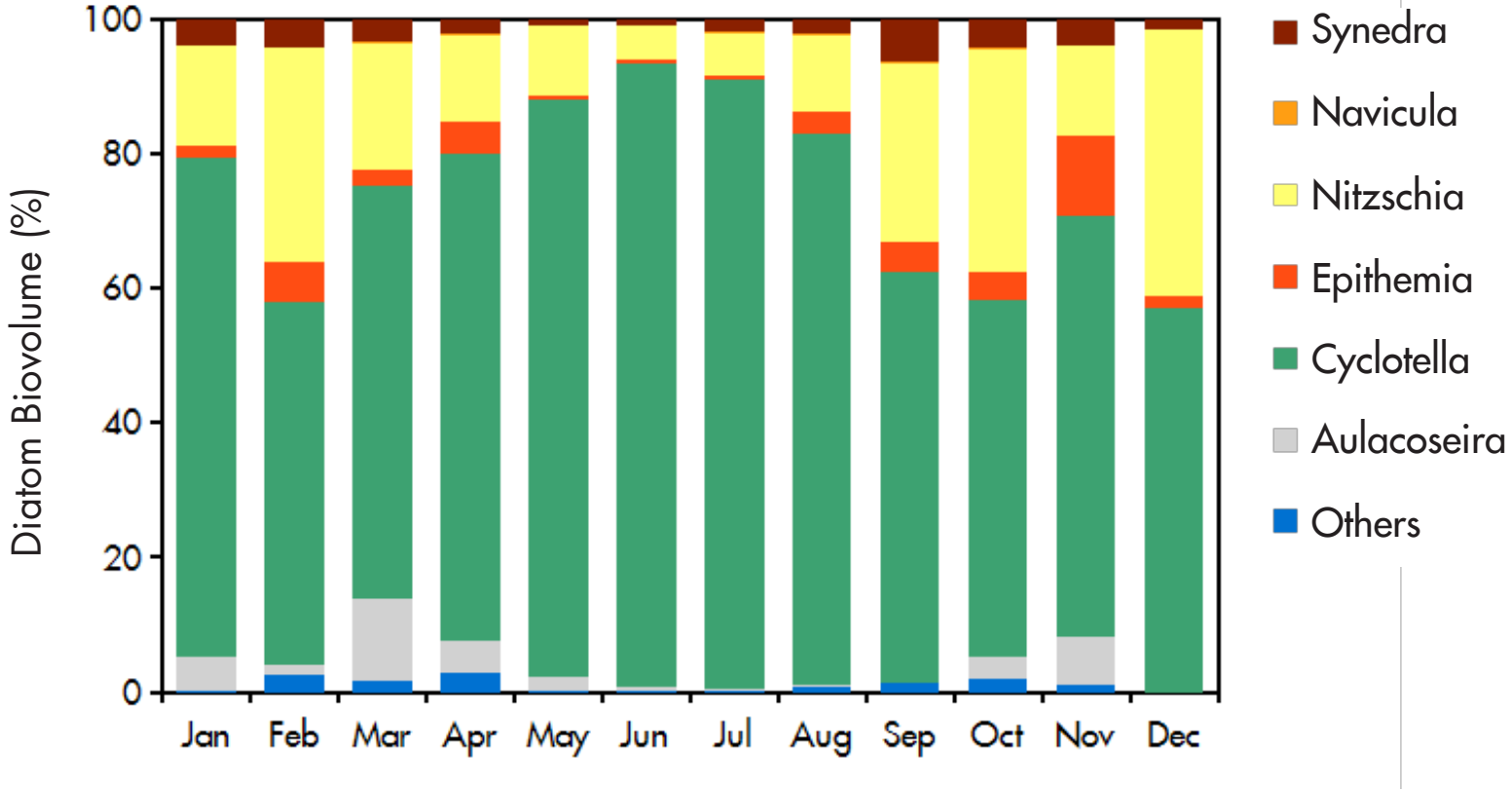
BIOLOGY

Abundance of dominant diatom species

Monthly in 2016

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 2016 are shown. Large variations are evident by month in the relative composition. Generally, *Cyclotella gordonensis* is the dominant diatom species during every month of the year. This recent increase in *Cyclotella gordonensis* reduced clarity in 2016.

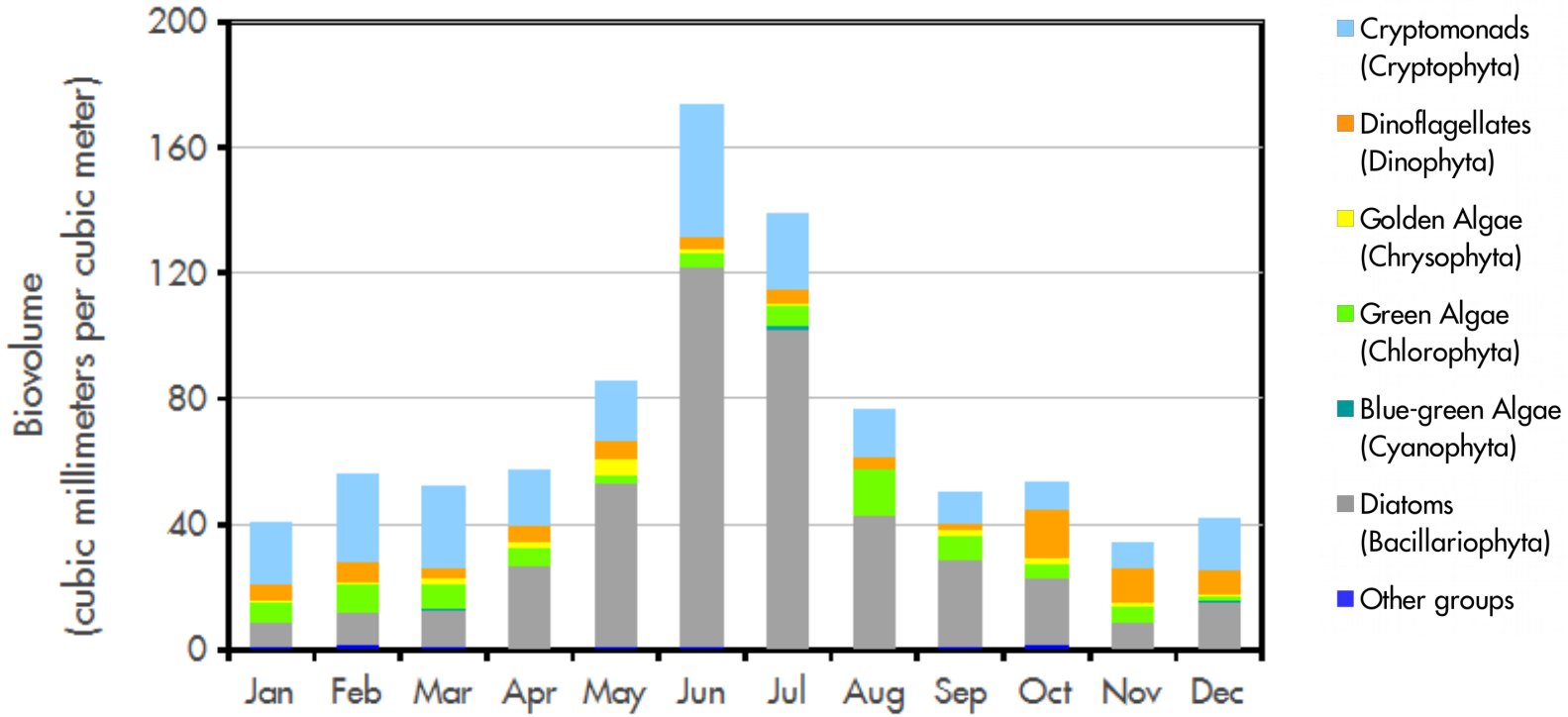


BIOLOGY

Algal groups as a fraction of total biovolume

Monthly in 2016

The biovolume of algal populations vary month to month, as well as year to year. In 2016, diatoms again dominated the biovolume of the phytoplankton community, especially in the summer. The peak in the biovolume occurred later in 2016, occurring from May to July (the "spring bloom"). Even at the peak of the bloom, algal cells occupied only one ten-millionth of the water in the lake. The peak biovolume in 2016 (170 cubic millimeters per cubic meter) was almost double the biovolume in 2015, a reflection of the increase in *Cyclotella gordonensis*.

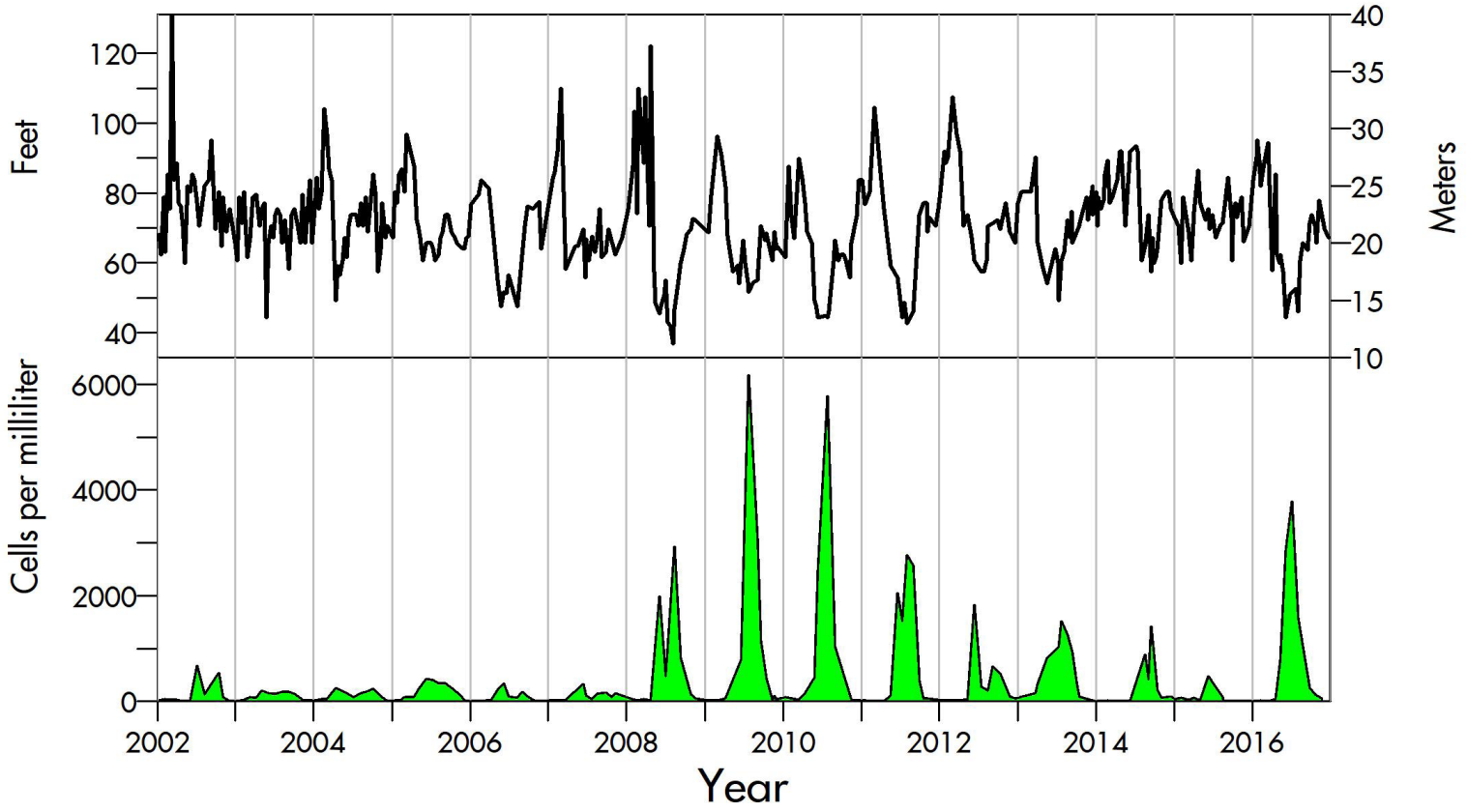


BIOLOGY

Predominance of *Cyclotella gordonensis*

From 2002 through 2016

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 2016, the high concentration of *Cyclotella* cells returned. 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. The summer decrease of Secchi depth coincides perfectly with the increase in *Cyclotella* concentration.

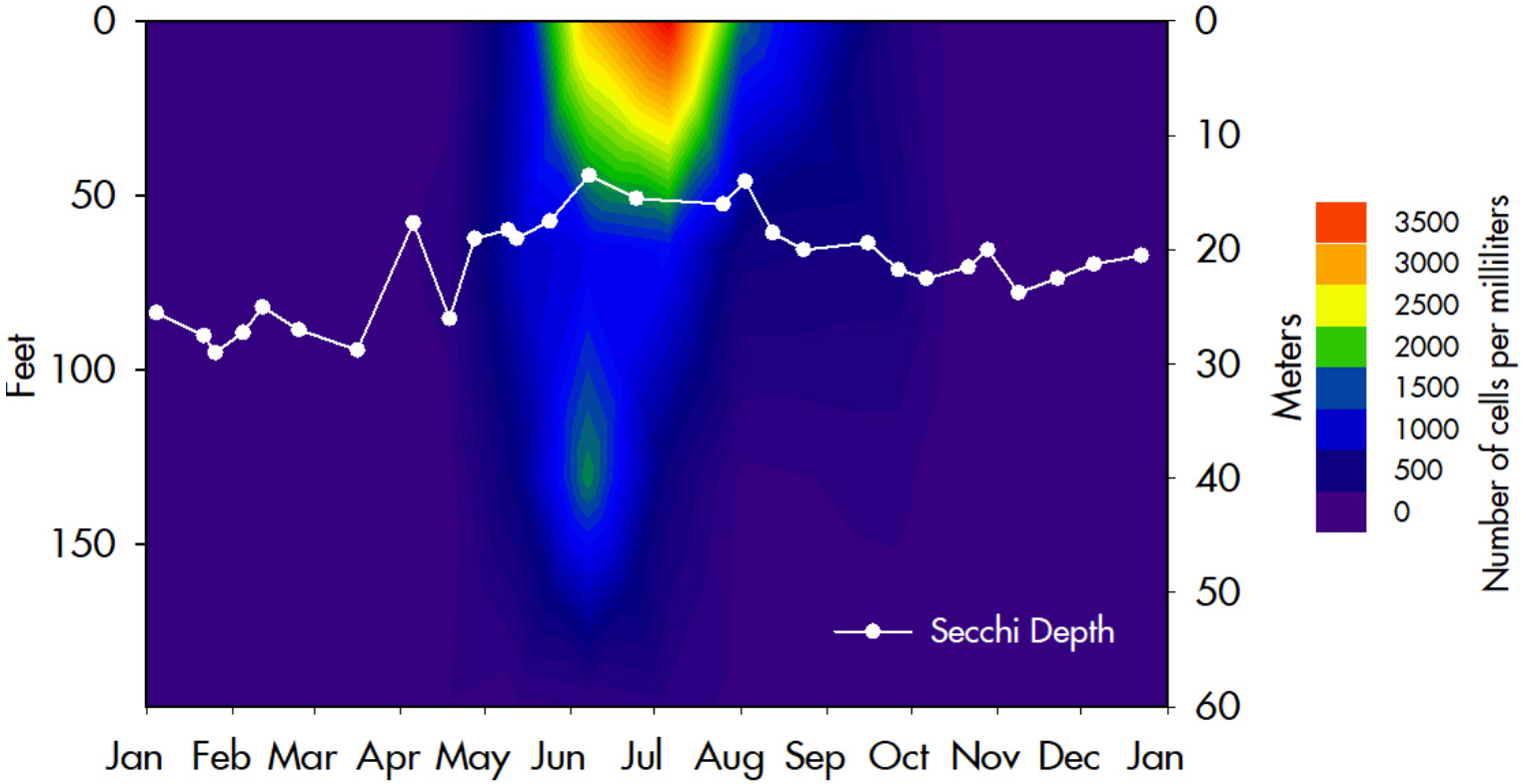


BIOLOGY

Distribution of *Cyclotella gordonensis*

In 2016

This year *Cyclotella gordonensis* returned to Lake Tahoe in high numbers. The color contours of the number of cells per milliliter are shown along with the individual Secchi depth measurements. The very high concentration of cells during June, July, and August, together with their location in the upper 50 feet of the water column produced low summer clarity readings.

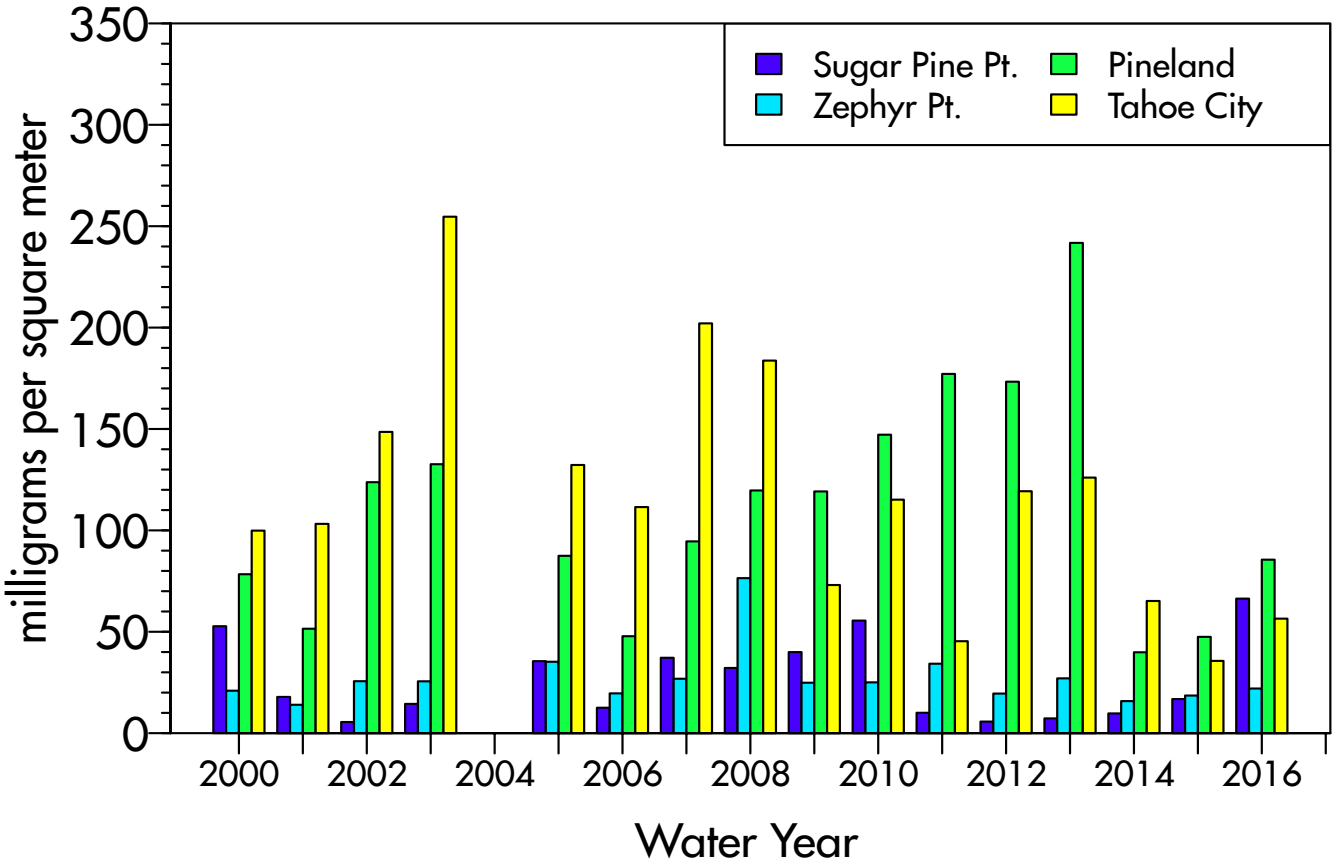


BIOLOGY

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 2016, concentrations at the four sites shown were close to their historic lows. The two most urbanized sites, Tahoe City and Pineland, were less than half of their values in comparison with 2013. While monitoring periphyton is an important indicator of near-shore health, these data do not shed information on what is controlling year-to-year changes.



BIOLOGY

Shoreline algae distribution

In 2016

Periphyton biomass was surveyed around the lake during the spring of 2015, when it was at its annual maximum. Nearly 45 locations were inspected by snorkel survey in 1.5 feet (0.5 m) of water. A Periphyton Biomass Index (PBI) is used as an indicator to reflect what the casual observer would visually detect looking into the lake from the shoreline. The PBI is defined as the fraction of the local bottom area covered by periphyton multiplied by the average length (cm) of the algal filaments. The PBI had fewer very high occurrences (PBI > 1.5) in 2015, possibly due to the low lake levels that prevailed. Instead there was a greater number of moderate areas (PBI = 0.51 -1.0), especially on the east shore. As lake level falls during low lake level years, the 1.5 ft. measurement depth is increasingly dominated by blue-greens at many sites including the east shore sites resulting in moderate biomass index values (in contrast, the east shore often has relatively low growth of algae at higher lake levels).

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 0.5m Depth, Spring 2016