TAHOE: STATE OF THE LAKE REPORT 2021

BIOLOGY

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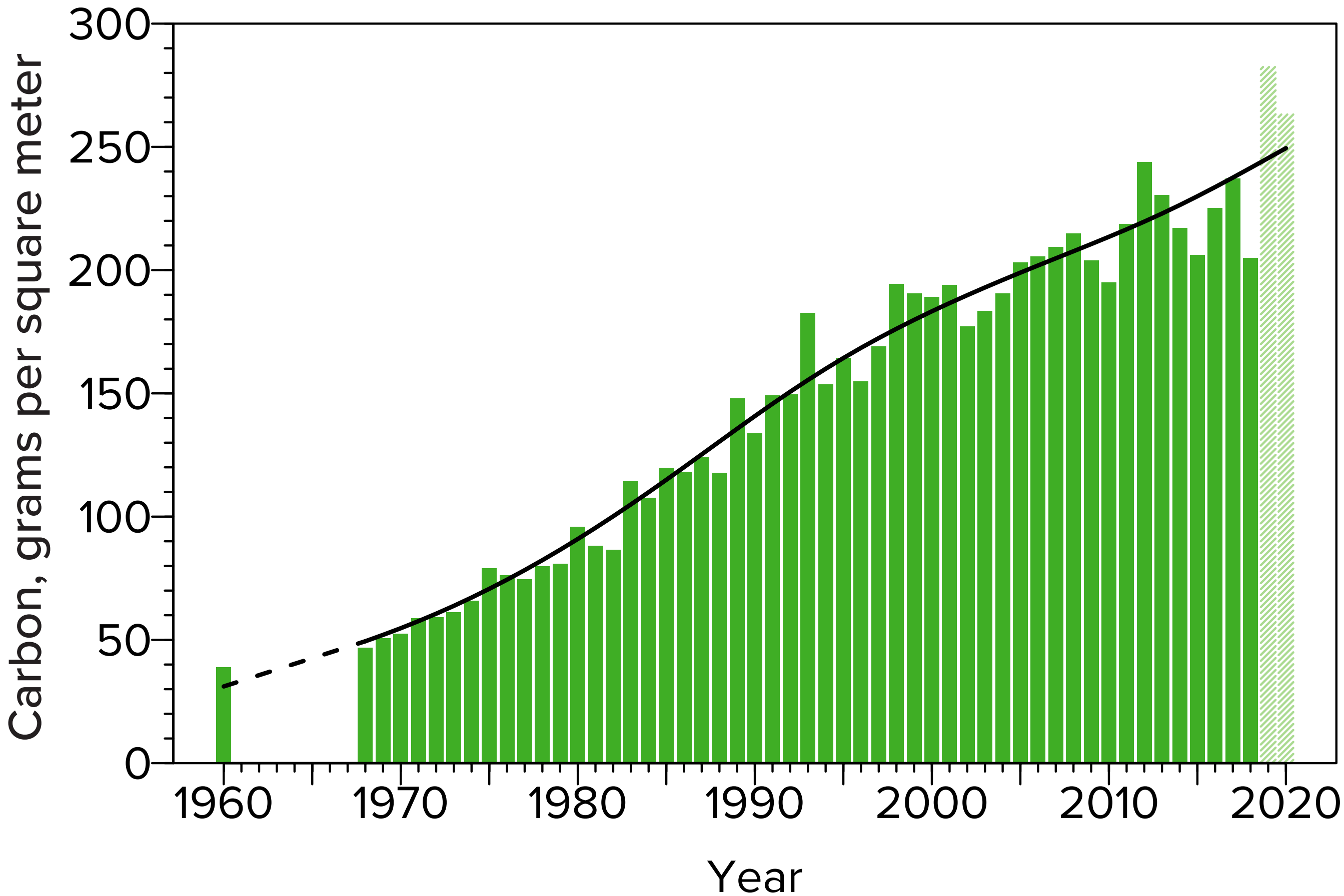
Algae growth (primary productivity)

Yearly since 1959

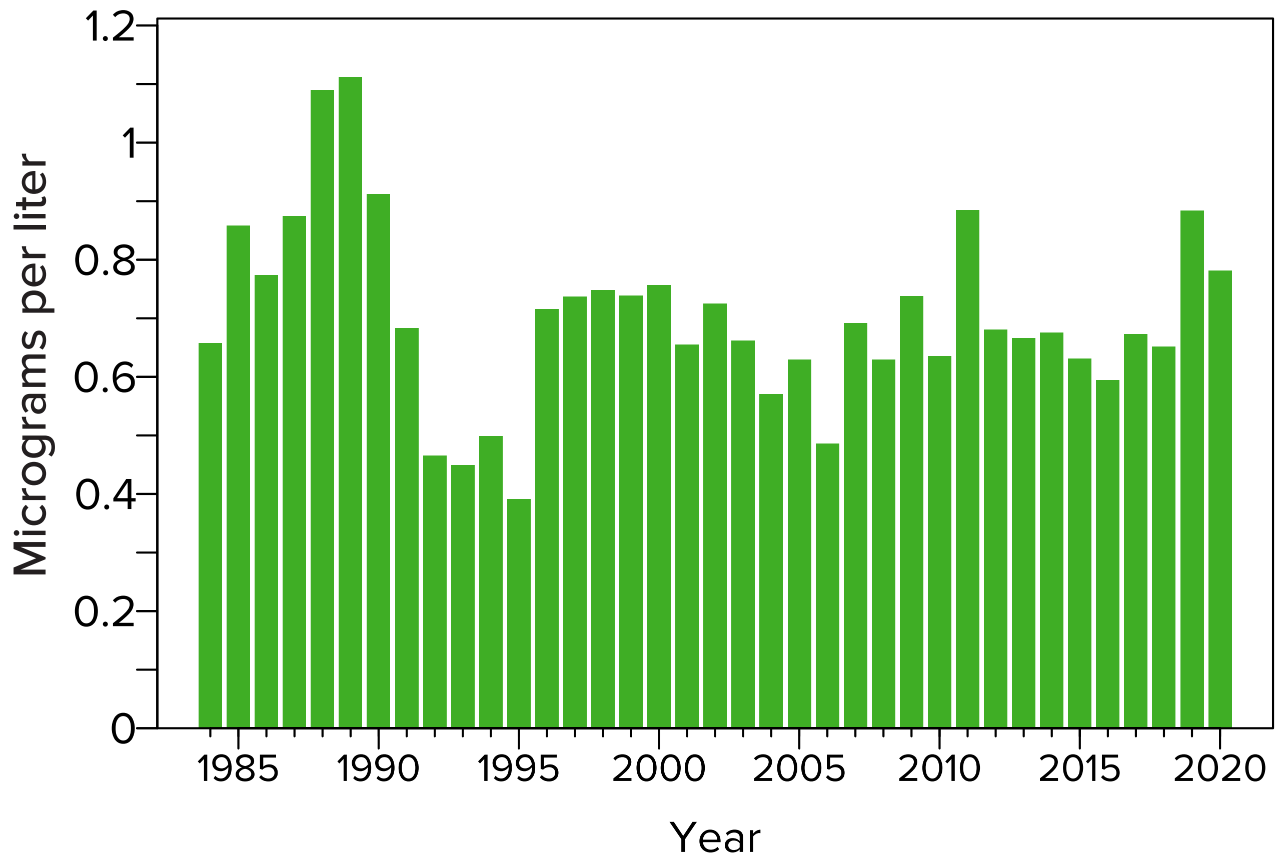
Primary productivity is a measure of the rate at which algae produce biomass through the process of photosynthesis. It was first measured at Lake Tahoe in 1959 and has been continuously measured since 1968. Supported by nutrient loading into the lake, changes in the underwater light environment, and a succession of algal species, the trend shows primary productivity has increased substantially over time. 2019 and 2020 data are considered to be "provisional" due to a change in instrumentation that started in 2019.



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 remarkable consistency over the last 35 years. The average annual concentration for 2020 was 0.78 micrograms per liter. For the period of 1984-2020 the average annual chlorophyll-*a* concentration in Lake Tahoe was 0.70 micrograms per liter.

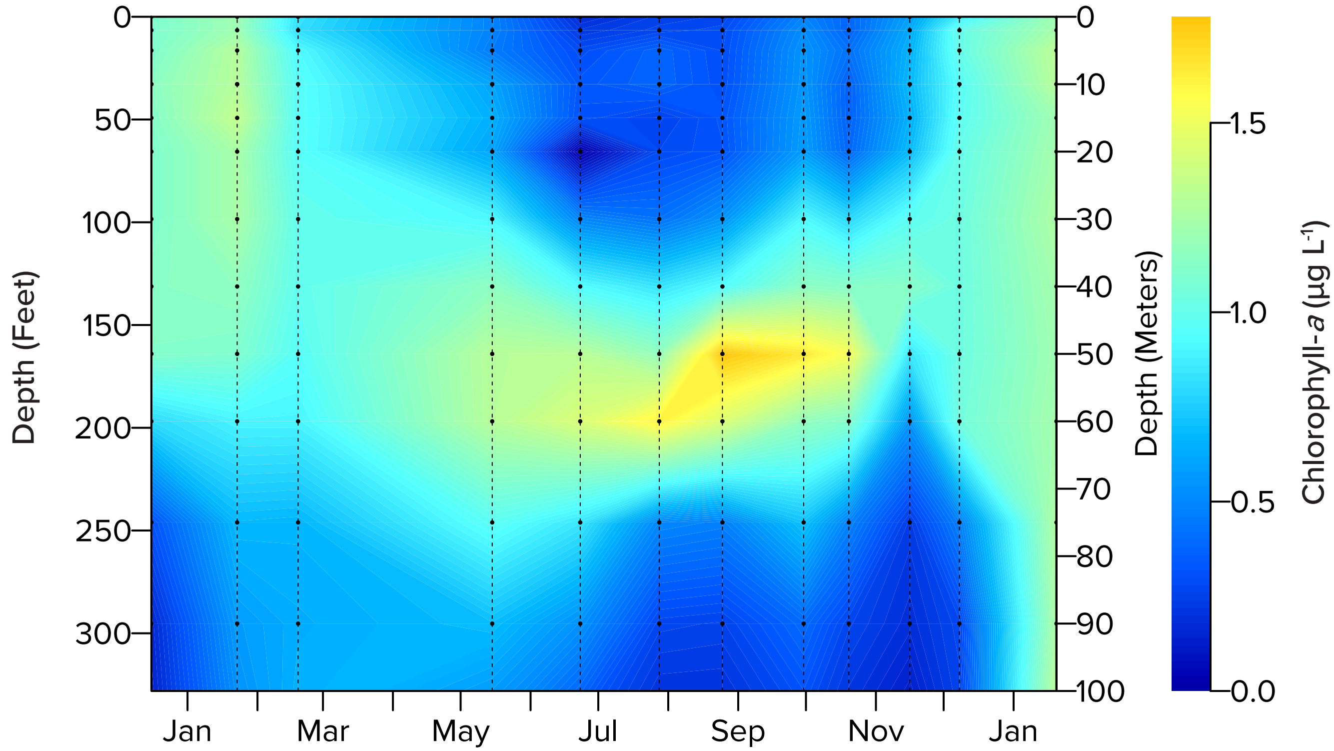


Chlorophyll-*a* distribution

In 2020

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.

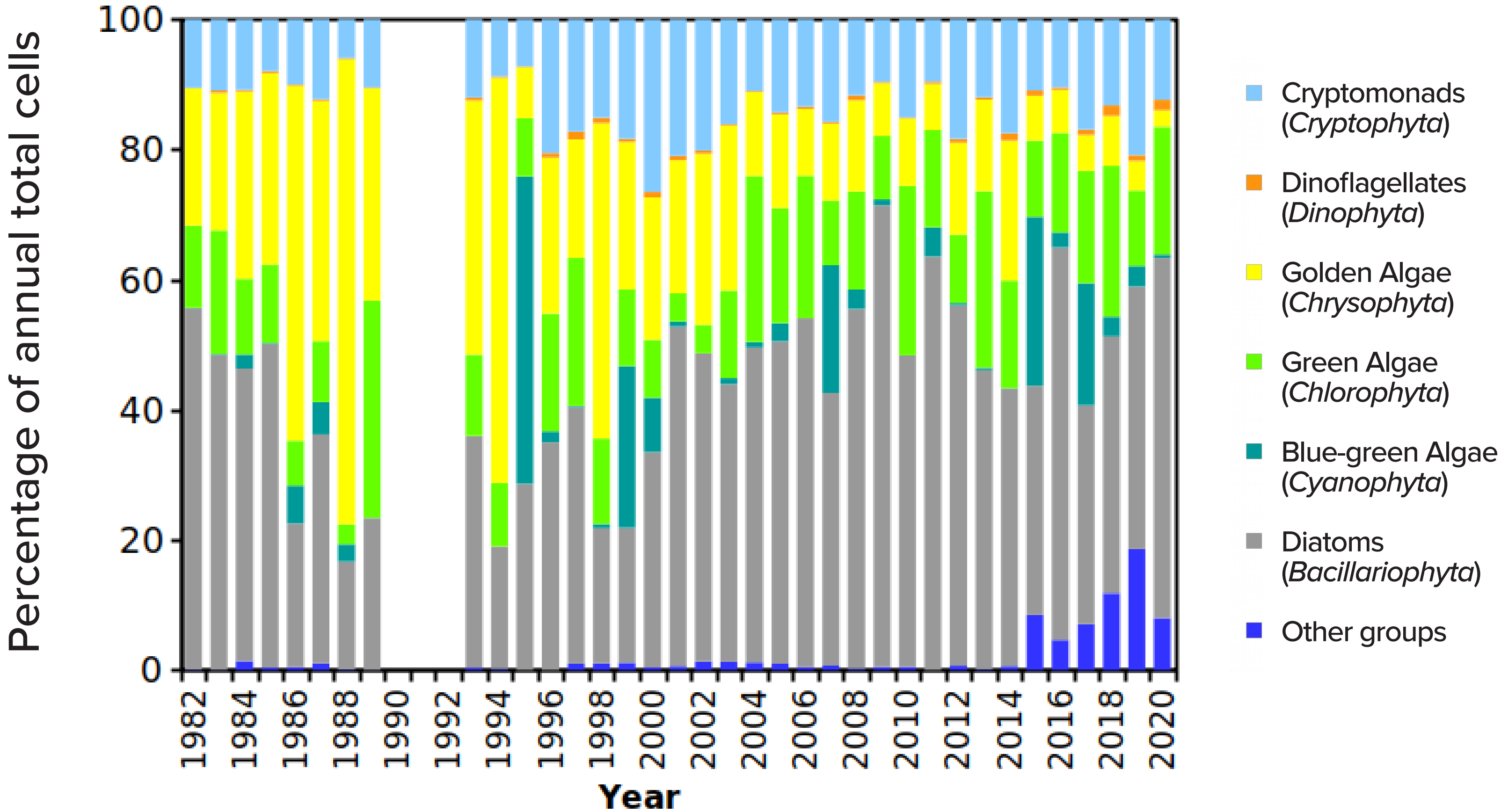
With the onset of thermal stratification in spring, the majority of the high chlorophyll-*a* algae were confined to a discrete band. The time of maximum chlorophyll-*a* concentration was relatively late in 2020, occurring in the August–September period, and centered at a depth of 150–200 feet. In November and December, the commencement of annual vertical mixing redistributed the algae over a broader depth range.



Annual distribution of algal groups

Yearly since 1982

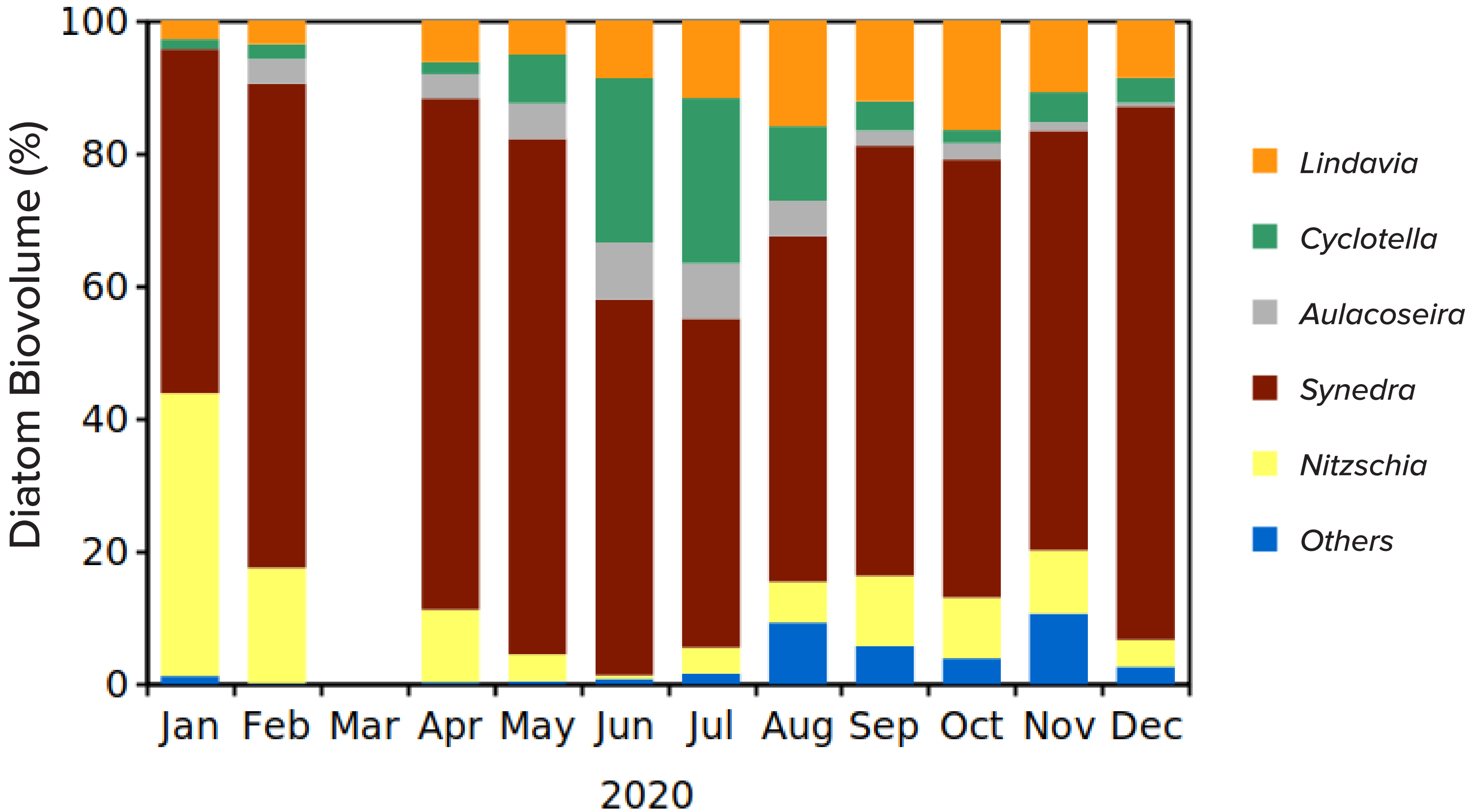
The amount of algal cells from different groups varies from year to year. Diatoms are the most common type of alga, comprising almost 60 percent of the total abundance of algal cells and green algae (Chlorophytes) are next, comprising 15 percent of the total. Interestingly, over the last six years, there has been a sustained presence in the total fraction of "minor" algal groups. 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. From 1990–1992 a lack of funding precluded measurements.



Abundance of dominant diatom species

Monthly in 2020

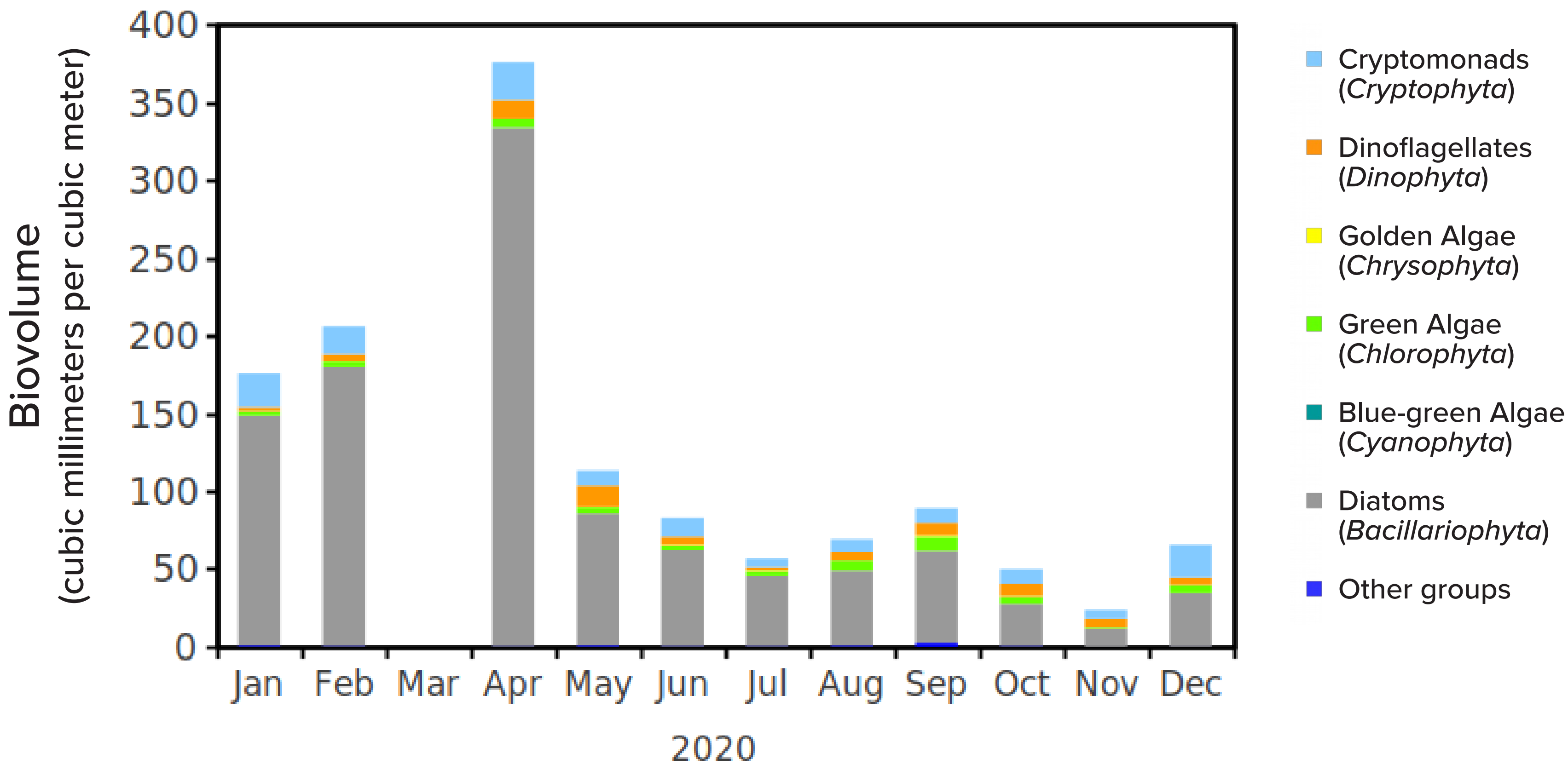
Since 1982, diatoms have been the dominant algal group at Lake Tahoe for all but a few years. Diatoms are unique in that they contain a cell wall made of silica, called a frustule. The dominant diatom species at Lake Tahoe in 2020 are shown below. Large variations in the relative composition are evident by month. *Synedra* was the dominant diatom species during every month of the year, forming over 80% of the diatoms during spring, summer, and fall. Although *Cyclotella* was a relatively low fraction of the percentage of biovolume of diatoms in 2020, it was the second most dominant species in June and July and still had a large impact on clarity. Its very small size means that while its contribution to the biovolume may be small, the actual number of light scattering cells can be extremely large. March sampling could not occur on account of COVID-related stay-at-home orders.



Algal groups as a fraction of total biovolume

Monthly in 2019

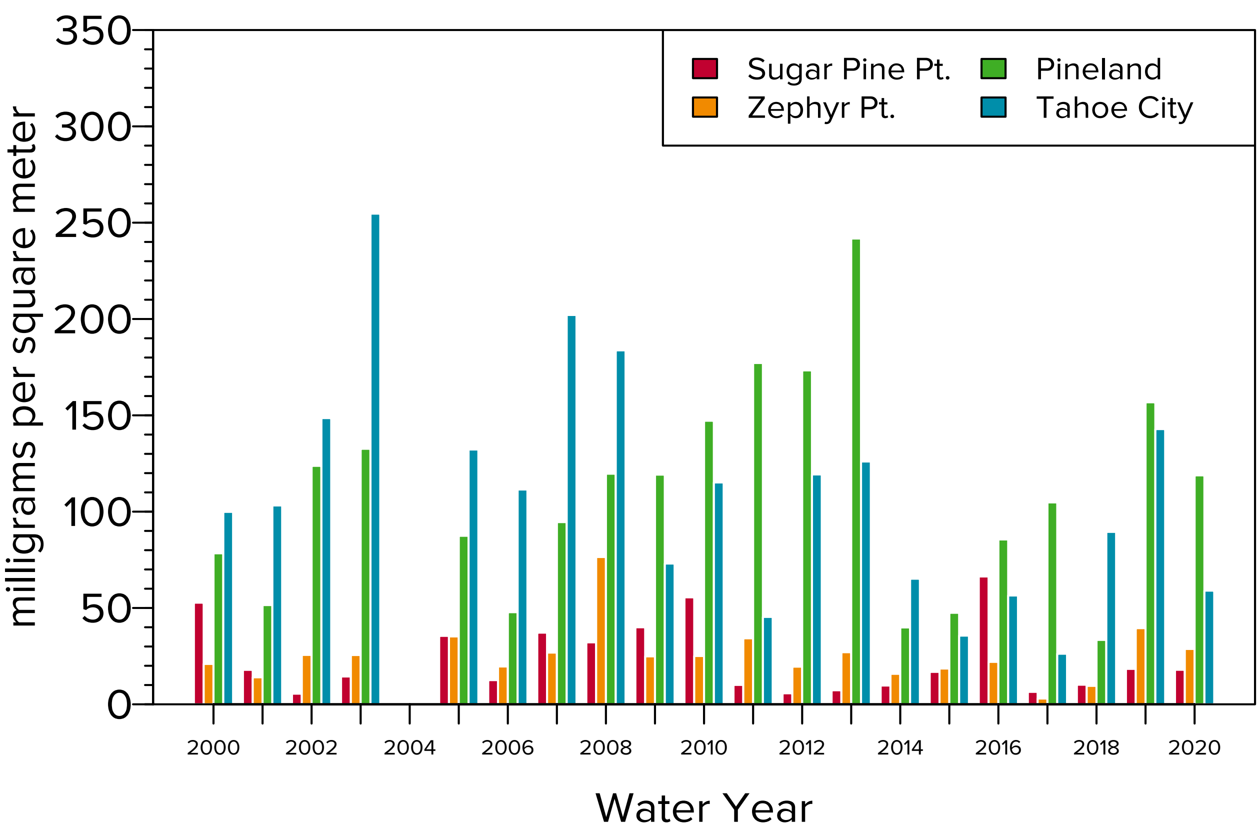
The biovolume of different algal genera vary month to month, as well as year to year. In 2020, diatoms again dominated the biovolume of the phytoplankton community in every month. The peak in the biovolume occurred in April 2020. This "spring bloom" was earlier than the usual May timeframe. The peak biovolume in 2020 was 370 cubic millimeters per cubic meter, almost double the usual biovolume. The typical "fall bloom" was absent in 2020.



Peak shoreline algae concentrations

Yearly since 2000

Periphyton, or attached algae, makes rocks around the shoreline of Lake Tahoe green and slimy, or they sometimes form a very plush white carpet after being sun-bleached. This graph shows the maximum biomass measured at 1.5 feet (0.5 m) below the surface at four sites from January to June. In 2020, concentrations at the four sites were close to their long-term average, with the exception of Tahoe City which was only half its long-term average. Sugar Pine Point, part of a State Park, had its typical, low values. Monitoring periphyton is an important indicator of near-shore health, but it is very challenging to characterize on account of both the temporal and spatial variability inherent in the system.



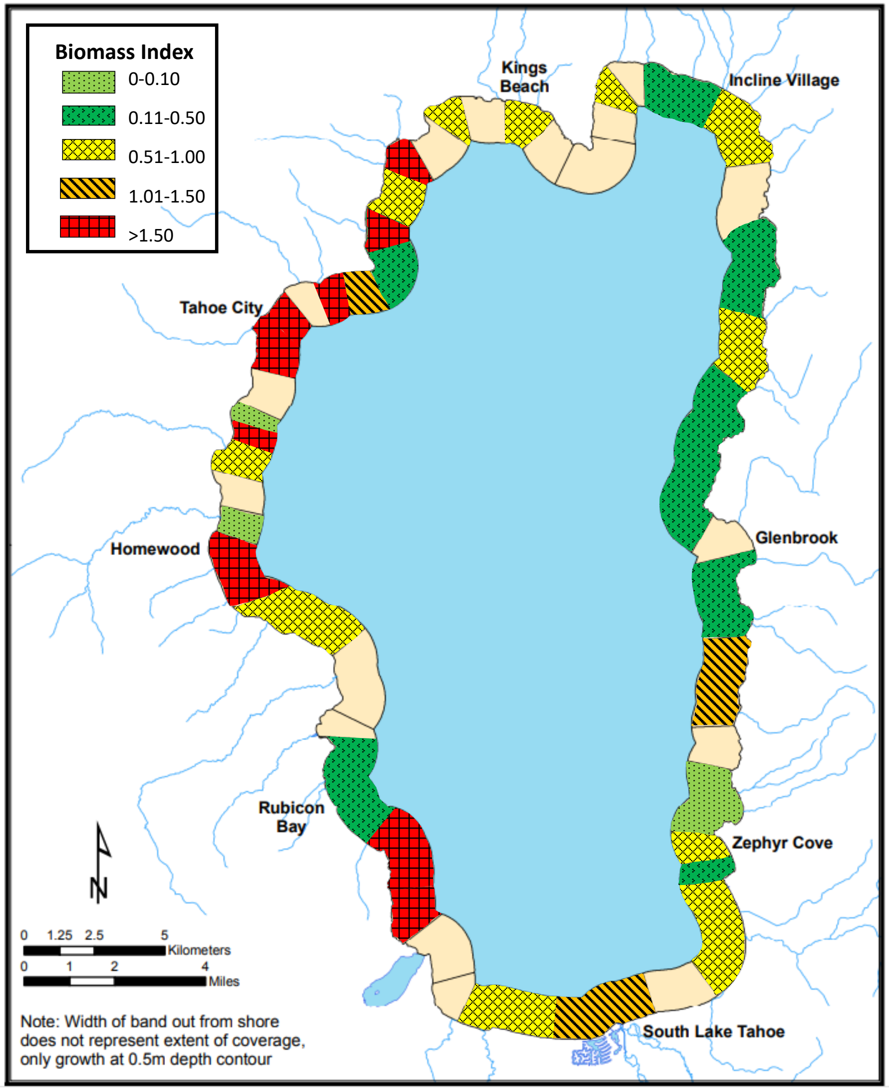
Shoreline algae distribution

In 2020

Periphyton biomass was surveyed around the lake over a three-week period during the spring of 2020, when it was estimated to be at its annual maximum. Over 50 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 assess levels of periphyton. 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. Fewer sites had high PBI in 2020 than the previous year. The majority of the high PBI sites were on the California side. Compared to previous years, this is considered to be a near-average year. Most of the east shore had relatively low growth. This is in part a reflection of the high wave activity that causes the periphyton to slough, as well as generally lower amounts of precipitation and runoff along the east shore.

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 2020



Mysis population

Since 2012

Mysis shrimp were introduced to Lake Tahoe in the 1960s in an attempt to improve the size of game fish in the lake. The intended result did not occur, and instead the *Mysis* upset the existing lake food web. Within four years of their introduction they had decimated the populations of the native *Daphnia* and *Bosmina*. Since that time these zooplankton have been rarely observed. *Daphnia* and *Bosmina* were an important food source for native minnows, which in turn provided food for kokanee salmon and rainbow trout.

Research on *Mysis* essentially stopped in the 1980s. Since 2012, regular surveys have recommenced in Lake Tahoe and in Emerald Bay, albeit it at a baseline scale. Because *Mysis* migrate to the bottom of the lake during the day, they are sampled at night. The sampling net is pulled vertically through the water from the tow depth (TD) indicated at three sites at 3-monthly intervals. South Shore Deep (TD = 200m), LTP Index (TD = 100m) and MLTP (TD = 200m).

The mean *Mysis* densities (expressed as number of individuals collected divided by the net opening area) show large interannual variability. It is not possible to ascertain the extent to which this is due to the low number of sampling sites. The green dashed line at 27 individuals per square meter represents the *Mysis* population level below which *Daphnia* and *Bosmina* could once again become established and thrive.