TAHOE: STATE OF THE LAKE REPORT 2020

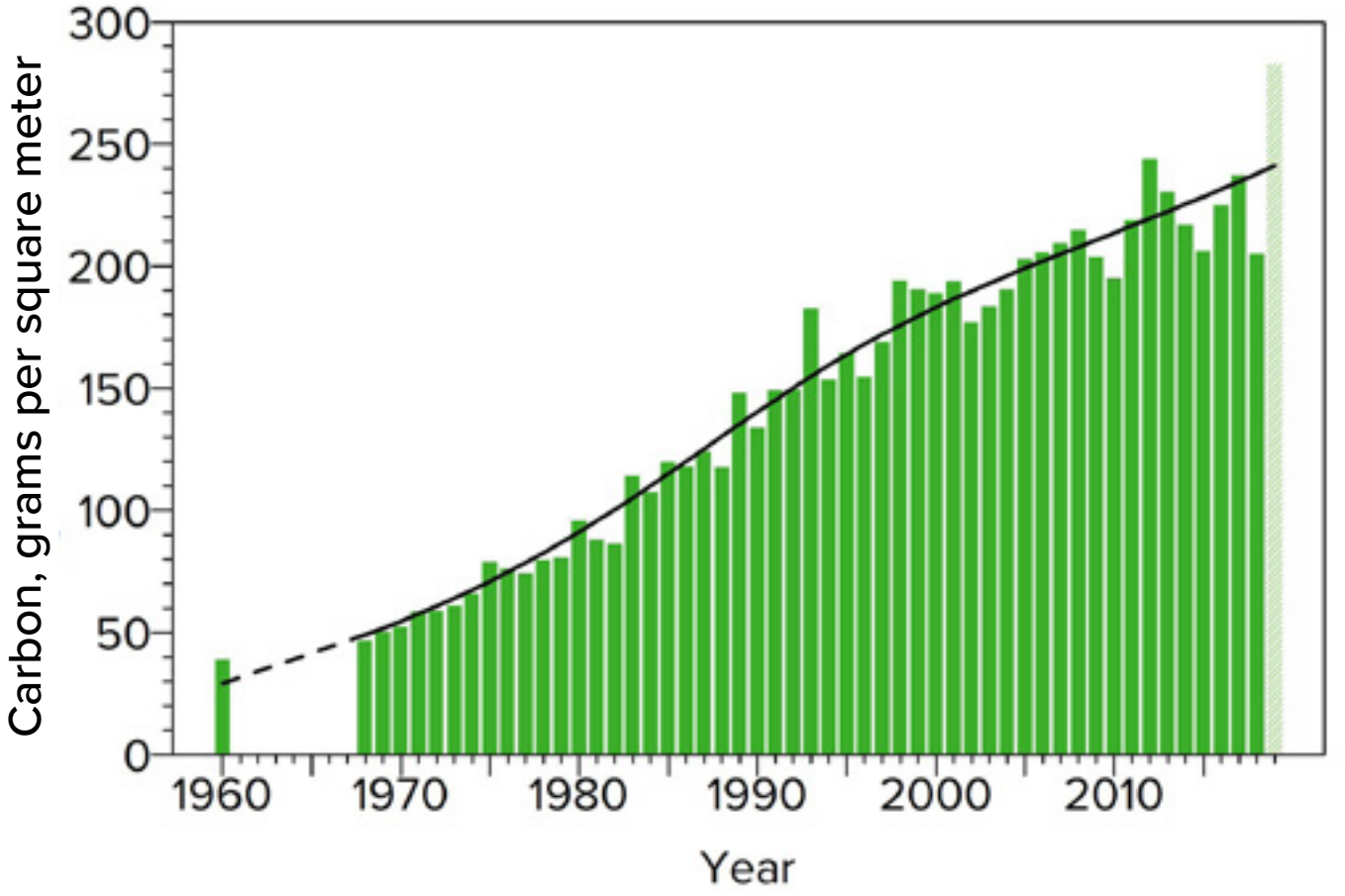
BIOLOGY

UCDAVIS
Tahoe Environmental
Research Center

Algae growth (primary productivity)

Yearly since 1959

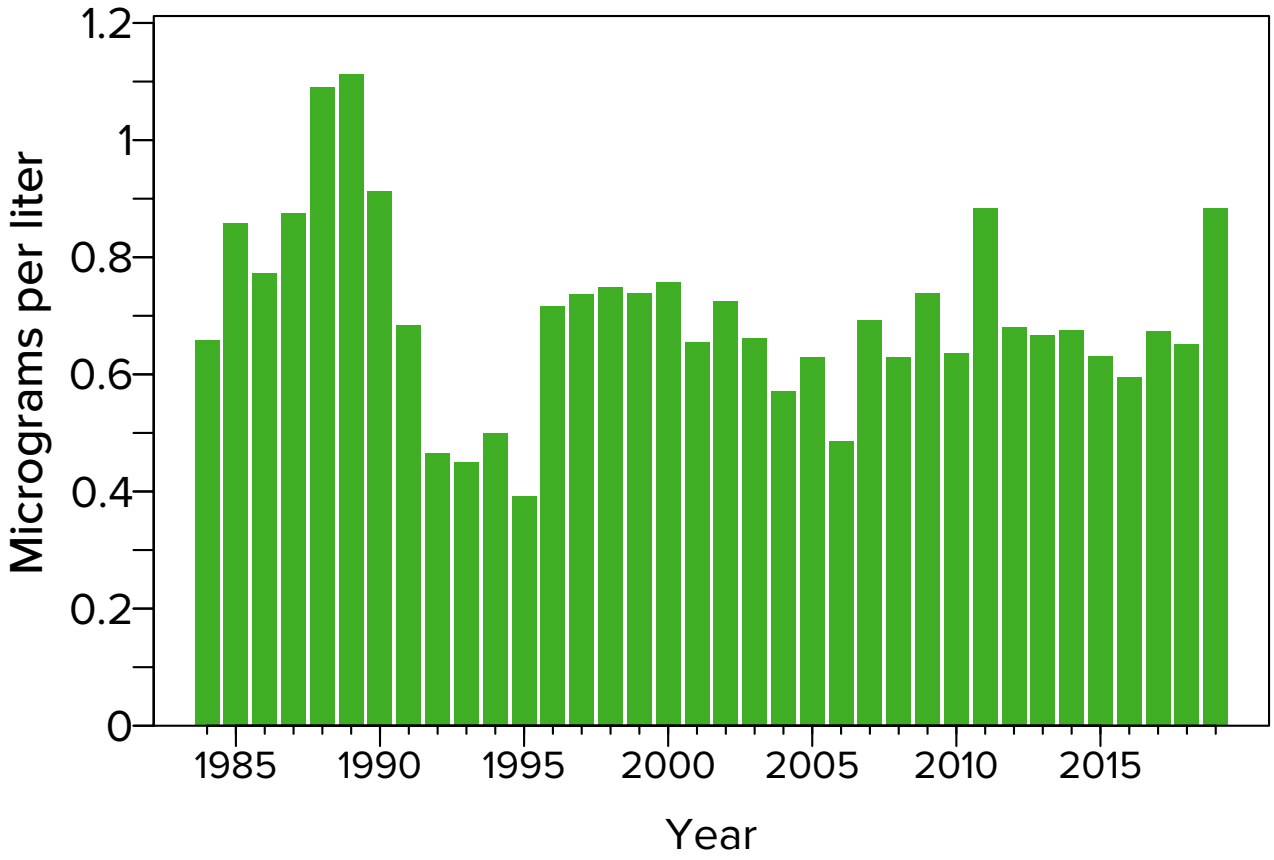
Primary productivity is a measure of the rate at which algae produce biomass through photosynthesis, and is measured at a number of depths at monthly intervals. It was first measured at Lake Tahoe in 1959 and the annual average value has been continuously measured since 1968. Supported by nutrient loading 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 data displayed an unusually large increase in the rate of primary production. The data are currently being reviewed and the 2019 value (shown cross-hatched) should be considered provisional.



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 (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 2019 was 0.88 micrograms per liter. For the period of 1984-2019 the average annual chlorophyll-*a* concentration in Lake Tahoe was 0.70 micrograms per liter. The 35 percent increase in 2019 over the previous years is believed to be due to the infusion of nitrate as a result of deep mixing. A similar observation was made in 2011 following a deep mixing event.

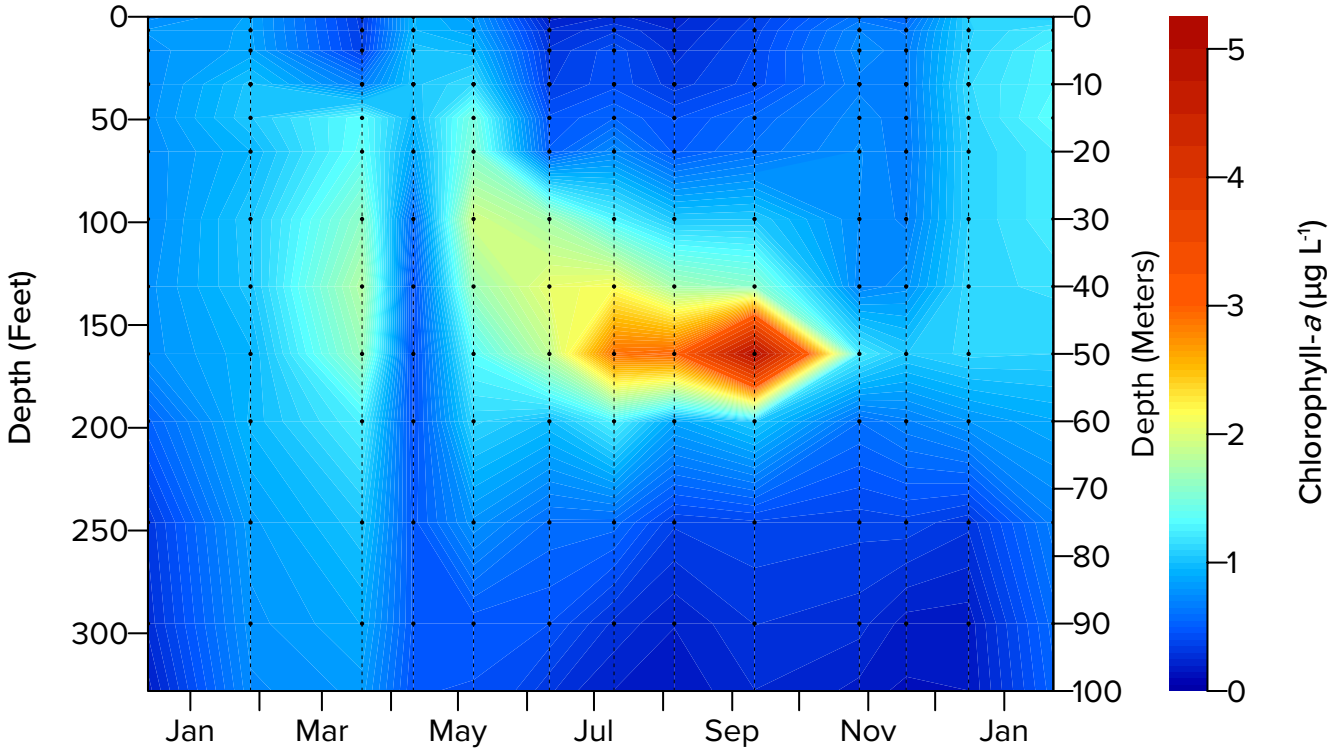


Chlorophyll-*a* distribution

In 2019

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.

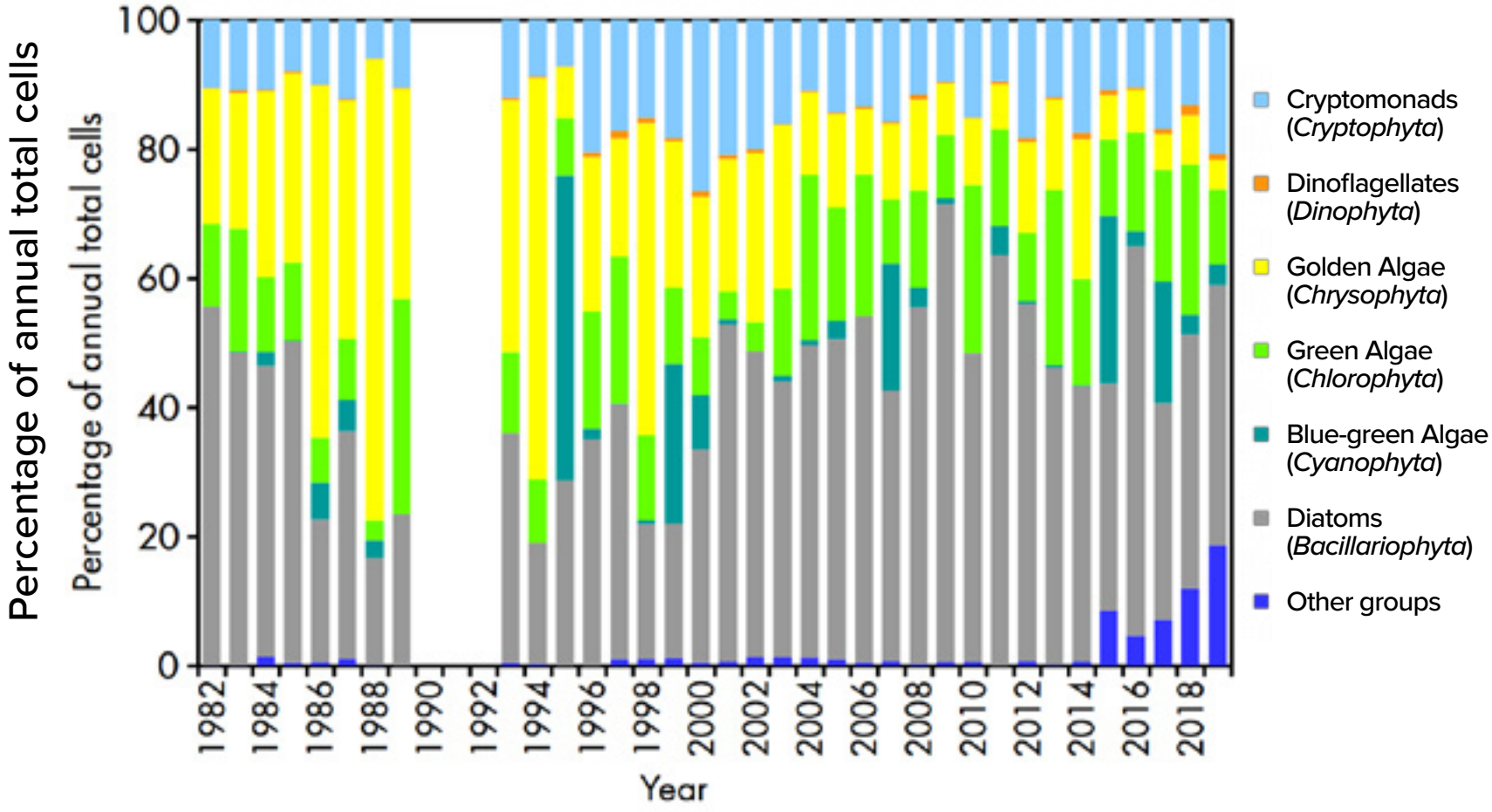
With the onset of thermal stratification in spring, the majority of the high chlorophyll-*a* algae were confined to a discrete band. The time of maximum chlorophyll-*a* concentration was during late June, and centered at a depth of 150-200 feet. Later in the year concentrations decreased as nutrients were depleted. In November and December, the commencement of mixing again redistributed the algae over a broader range of depth. Note that small *Cyclotella* cells at the surface have a very small chlorophyll-*a* expression. However, the large number of these tiny cells have a major impact on clarity.



Annual distribution of algal groups

Yearly since 1982

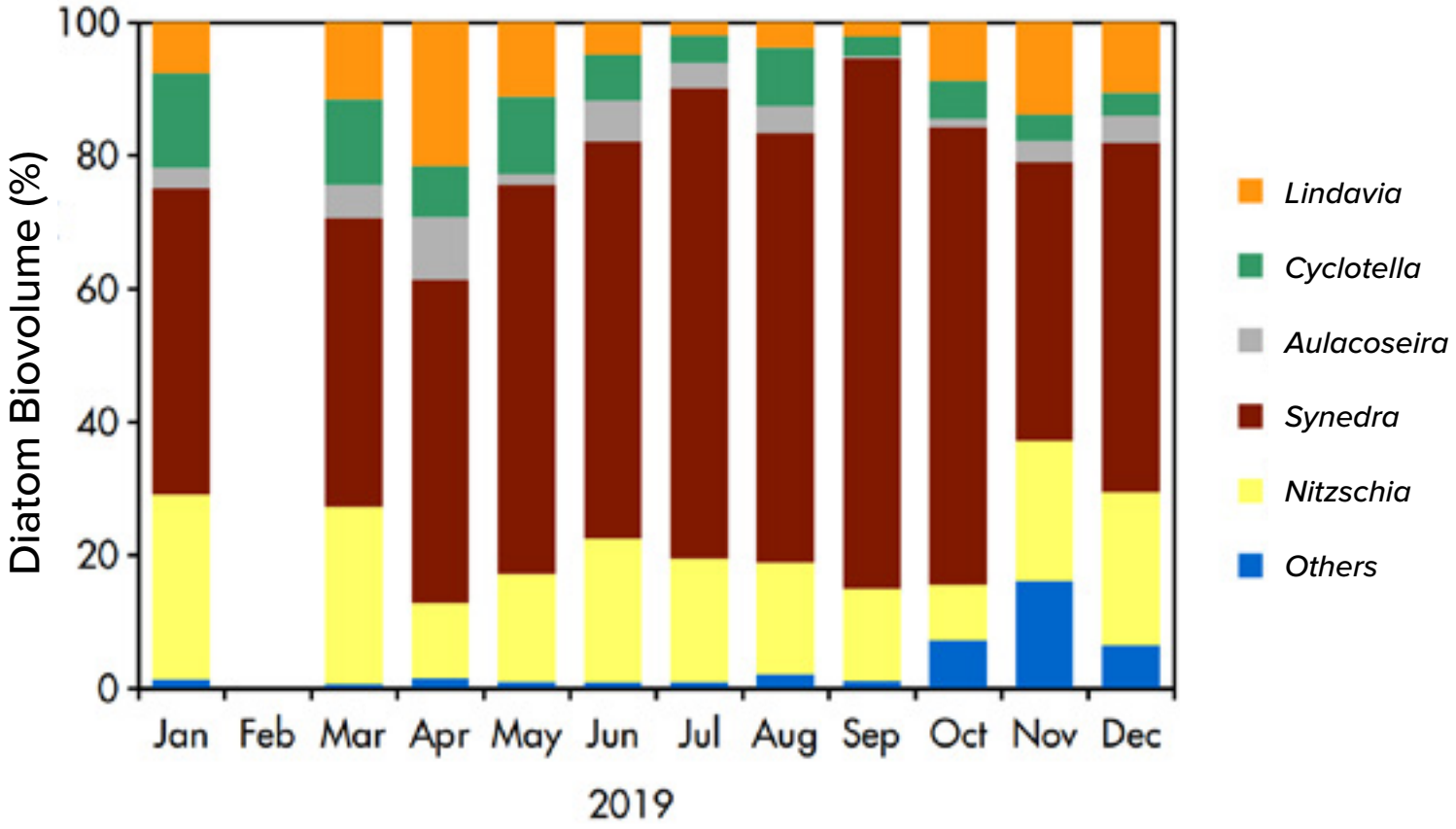
The amount of algal cells from different groups varies from year to year. Diatoms are the most common type of alga, comprising approximately 50 percent of the total abundance of algal cells and Chrysophytes are next, each comprising less than 15 percent of the total. Interestingly, over the last five years, there has been an increasing trend 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 2019

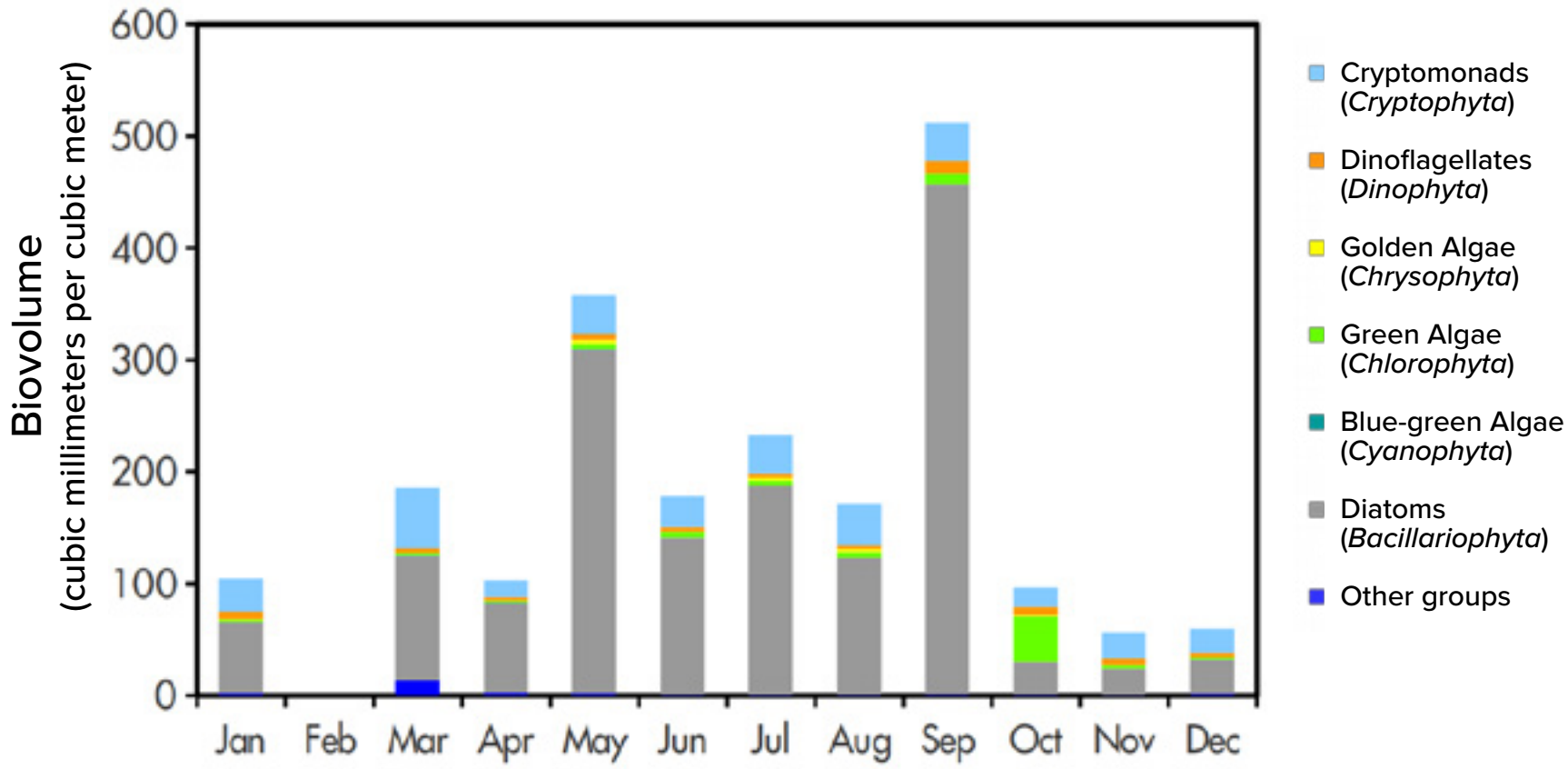
Since 1982, diatoms have been the dominant algal group at Lake Tahoe for all but a few years. Diatoms are unique in that they contain a cell wall made of silica, called a frustule. The dominant diatom species at Lake Tahoe in 2019 are shown below. Large variations in the relative composition are evident by month. *Synedra* and *Nitzschia* were again the dominant diatom species during every month of the year, forming over 80% of the diatoms during summer. Although *Cyclotella* was a relatively low fraction of the percentage of biovolume of diatoms in 2019, it still had a large impact on clarity. Its very small size means that its biovolume can be small, but the actual number of light scattering cells can be extremely large. February sampling could not occur on account of the weather.



Algal groups as a fraction of total biovolume

Monthly in 2019

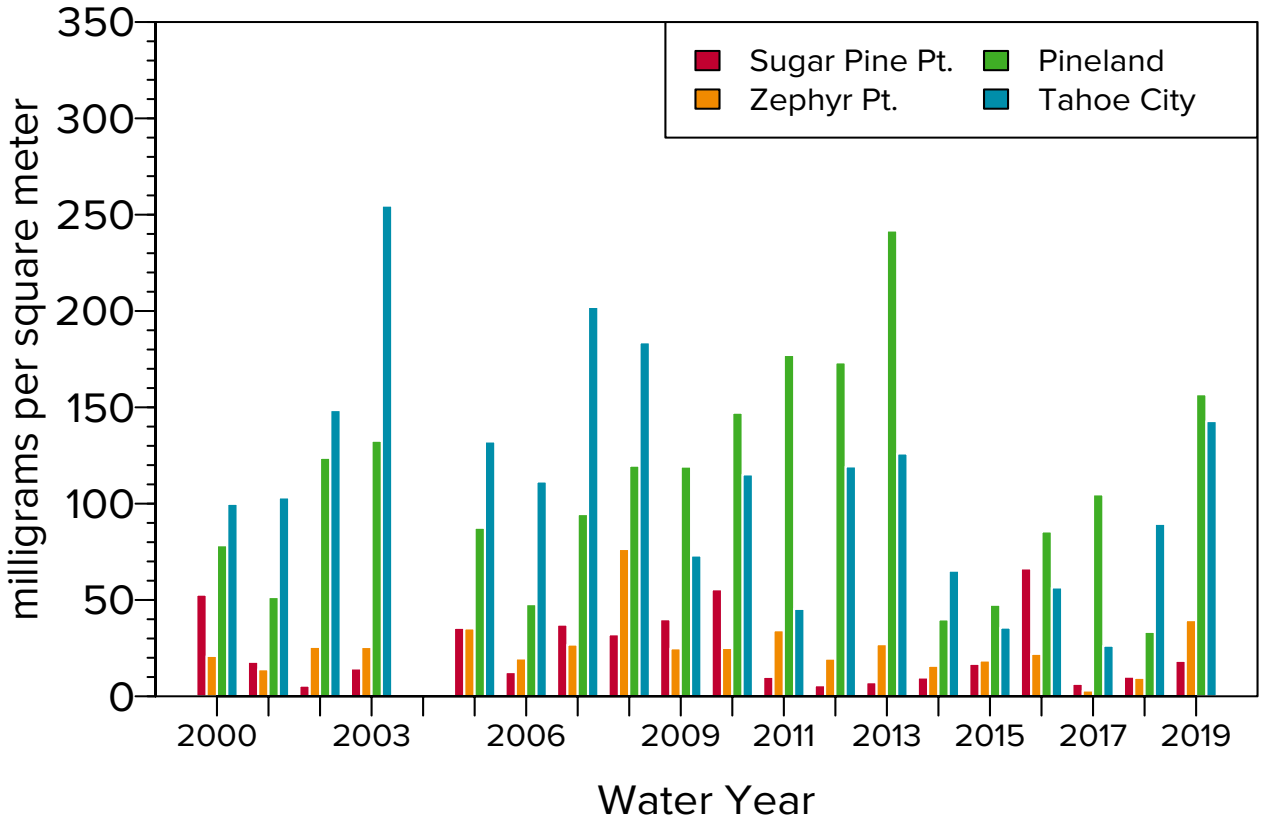
The biovolume of algal populations vary month to month, as well as year to year. In 2019, diatoms again dominated the biovolume of the phytoplankton community in every month, with the exception of October, when green algae seem to dominate most years. Peaks in the biovolume occurred in May and September in 2019. The "spring bloom" in May is a common occurrence at Lake Tahoe, but the magnitude of the late "summer bloom" was unusually high. The peak biovolume in 2019 was 500 cubic millimeters per cubic meter, almost three times greater than the biovolume of recent years, a reflection of the increase of *Synedra* and *Nitzschia*.



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 after they have been sun-bleached. Periphyton is measured five to eight times each year, and this graph shows the maximum biomass measured 1.5 feet (0.5 m) below the surface at four sites from January to June. In 2019, concentrations at the four sites shown were above their long-term average. One of the most urbanized sites, Pineland, historically one of the heaviest periphyton locations, was again heavily impacted by periphyton, compared to its record low level last year. Zephyr Point, though seemingly low, had its second highest value on record in 2019. Monitoring periphyton is an important indicator of near-shore health, but it is very challenging to characterize it on account of both the temporal and spatial variability inherent in the system.



Shoreline algae distribution

In 2019

Periphyton biomass was surveyed around the lake over a three-week period during the spring of 2019, when it was estimated to be at its annual maximum. 54 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 rapidly 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. A large number of sites had high PBI in 2019 (i.e. about half of the sites had PBI > 1.5 indicated by red-shaded sections of shoreline in the map). The majority of these sites were on the California side. Compared to previous years, this is considered to be a relatively heavy periphyton year, although specific measurements of chlorophyll concentration at four sites (Fig. 10.7) would suggest otherwise. Most of the east shore has 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 2019