TAHOE:
STATE OF THE LAKE
REPORT
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NUTRIENTS AND PARTICLES

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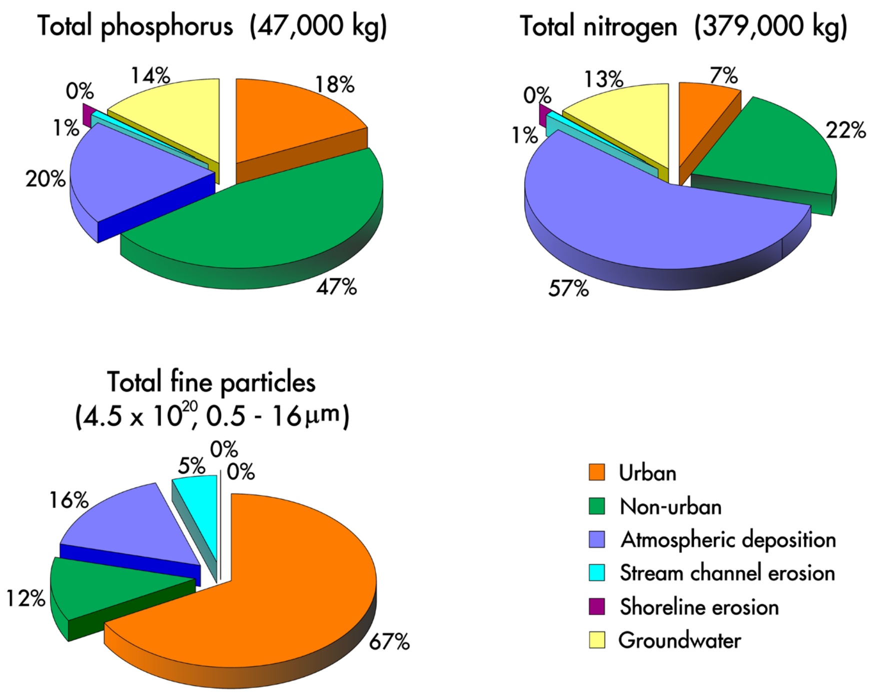
Sources of clarity-reducing and blueness-reducing pollutants

Research has quantified the primary sources of nutrients (nitrogen and phosphorus) and particulate material that are causing Lake Tahoe to lose clarity and blueness in its upper waters. One of the primary contributors to clarity decline is extremely fine particles in stormwater that originate from the urban watershed (67 percent), even though these areas cover only 10 percent of the basin's land area. Part of the atmospheric particle load is also from these urbanized areas. For nitrogen, atmospheric deposition is the major source (57 percent). Phosphorus is primarily introduced by the urban (18 percent) and non-urban (47 percent) watersheds. These categories of pollutant sources form the basis of a strategy to restore Lake Tahoe's open-water clarity by management agencies, known as the Lake Tahoe Total Maximum Daily Load (TMDL) Program.

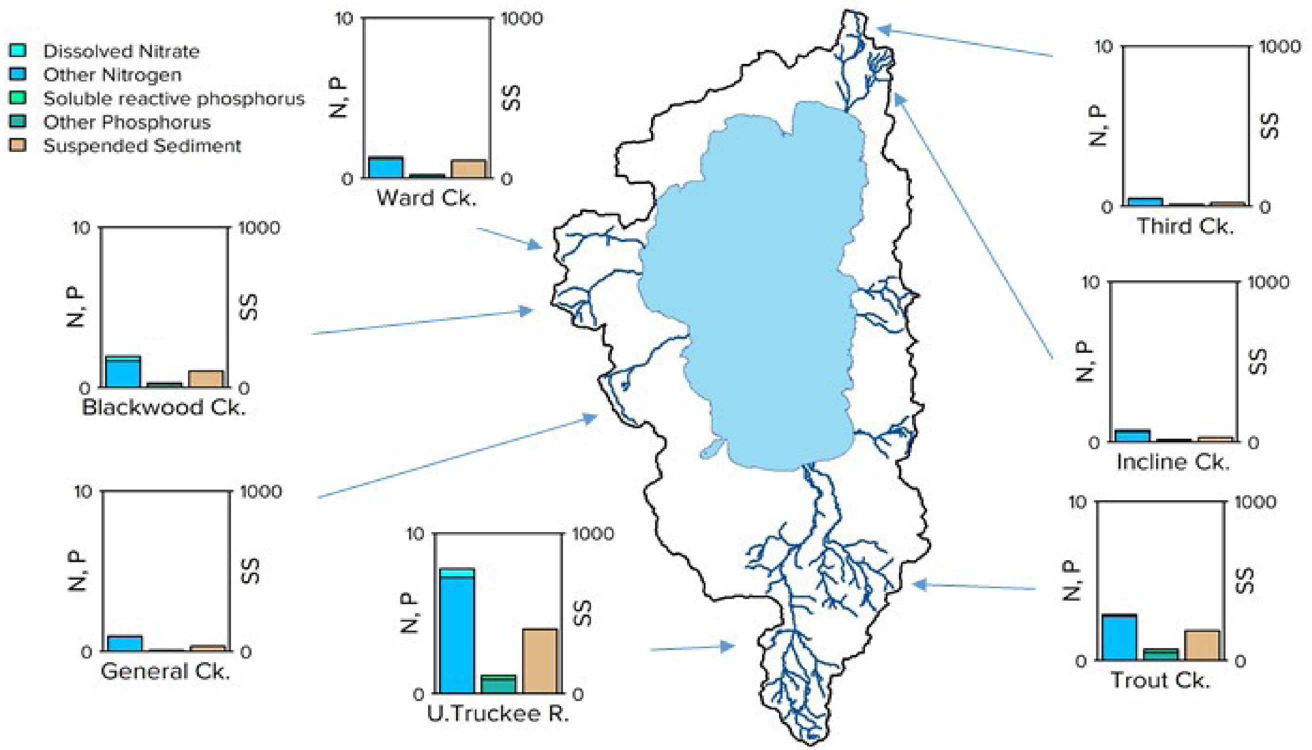


Pollutant loads from seven watersheds

In 2020

The Lake Tahoe Interagency Monitoring Program (LTIMP) measures nutrient and sediment input from seven of the 63 watershed streams. The streams are the Upper Truckee River, Trout Creek, Incline Creek, Third Creek, Ward Creek, Blackwood Creek, and General Creek. In 2020, the majority of stream phosphorus and nitrogen, as well as suspended sediments, came from the Upper Truckee River. This is often the case, but in some years, smaller streams, such as Incline Creek and Blackwood Creek, can also be very significant contributors.

The LTIMP stream water quality program is supported by the Lahontan Regional Water Quality Control Board, the Tahoe Regional Planning Agency, the California Tahoe Conservancy, the U.S. Geological Survey, and UC Davis TERC. TERC and the US Geological Survey jointly collect and analyze the stream data.

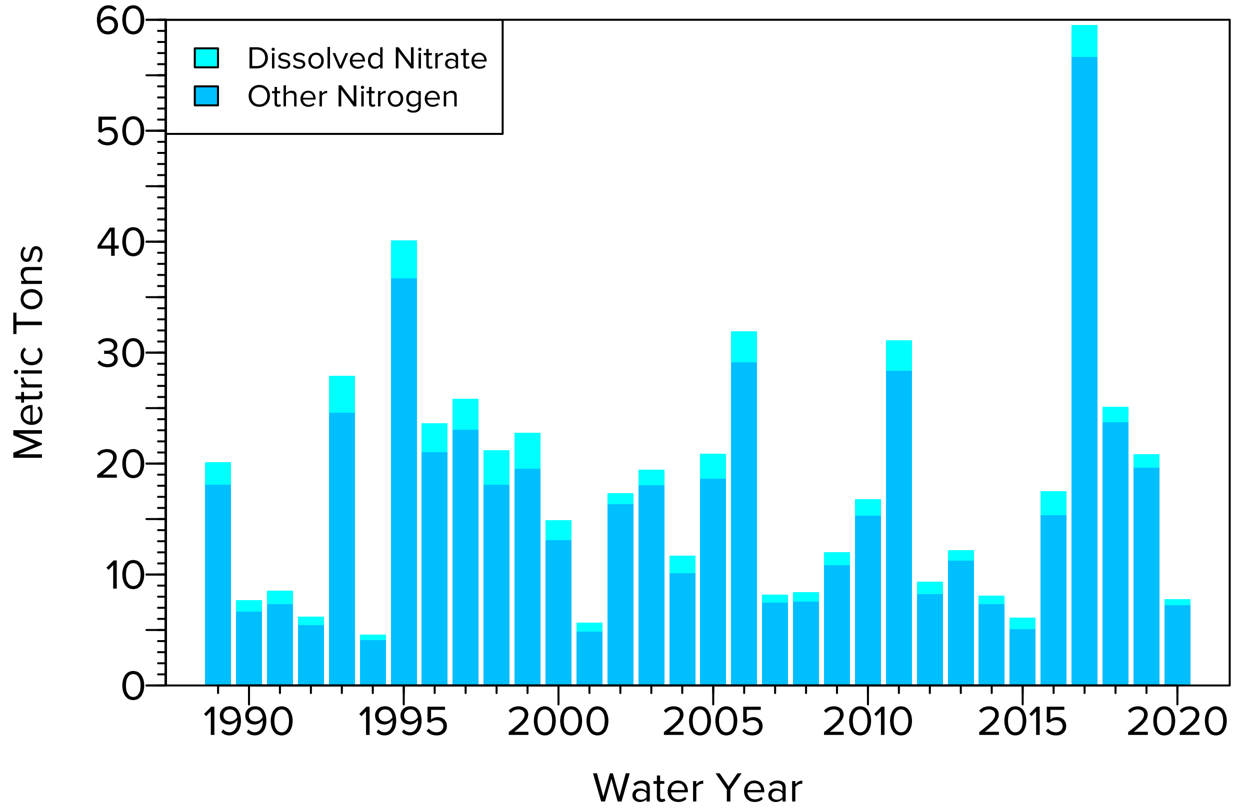


Nitrogen contribution by Upper Truckee River

Yearly since 1989

Nitrogen (N) is important because it, along with phosphorus (P), stimulates algal growth. The Upper Truckee River is the largest of the 63 streams that flow into Lake Tahoe, contributing about 25 percent of the inflowing water. The river's contribution of dissolved nitrate and the remainder of the total nitrogen load are shown here. The year-to-year variations primarily reflect changes in precipitation. For example, 1994 had 16.6 inches of precipitation and a low total nitrogen load of 4.6 MT, while 2017 had 68.9 inches of precipitation and a record high total nitrogen load of 59.5 MT. 2020 had 20.1 inches of precipitation and an above-average total nitrogen load of 7.8 MT. Nitrate load was 0.52 MT The long-term mean annual total nitrogen load is 17.9 MT/yr while the for nitrate it is 1.7 MT.

One metric ton (MT) = 2,205 pounds.

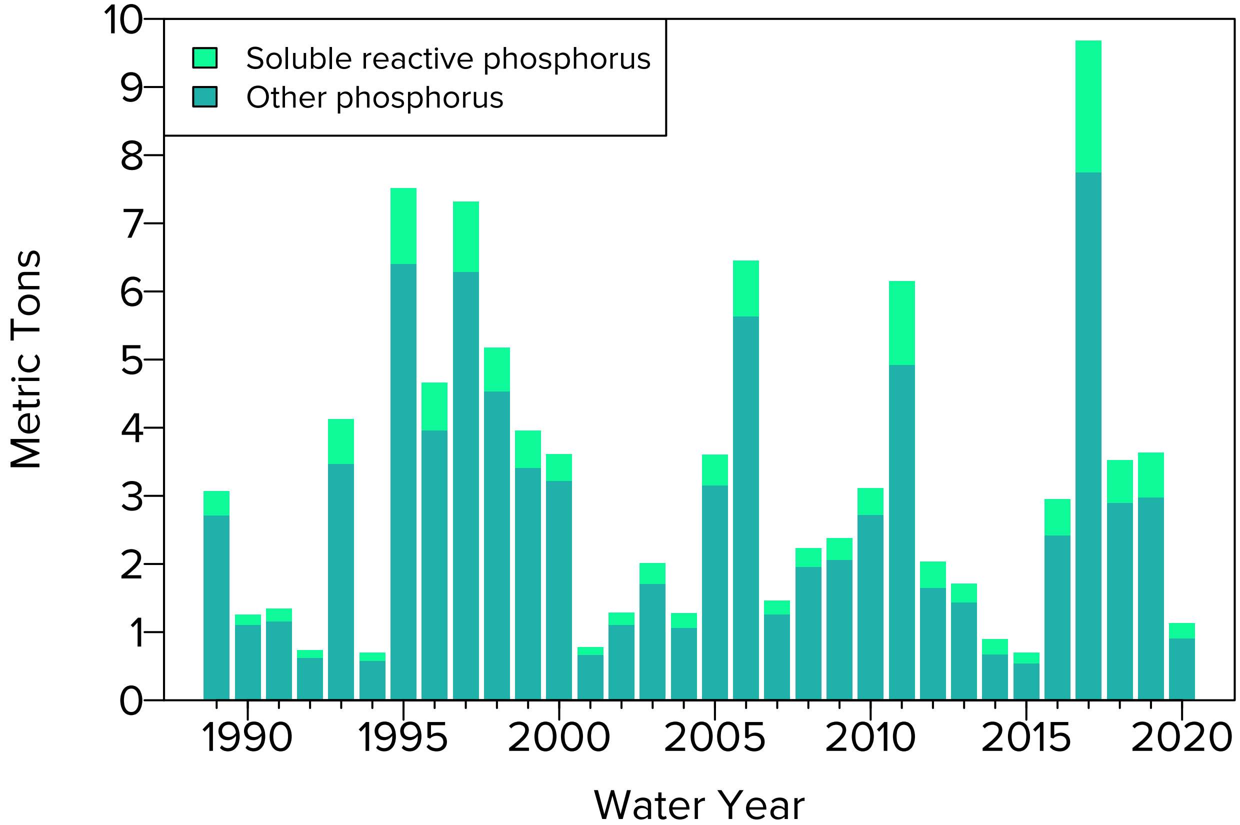


Phosphorus contribution by Upper Truckee River

Yearly since 1989

Soluble reactive phosphorus (SRP) is the fraction of total phosphorus immediately available for algal growth. As with nitrogen (Fig. 9.3), the year-to-year variation in load largely reflects the changes in precipitation. Below average precipitation in 2020 resulted in a total phosphorus level of 1.1 MT and SRP load of 0.23 MT. These compare with the long-term averages of 3.1 and 0.49 MT respectively. Decreasing nutrient inputs are fundamental to restoring Lake Tahoe's iconic blueness. Total phosphorus is the sum of SRP and other phosphorus, which includes organic phosphorus and phosphorus associated with particles.

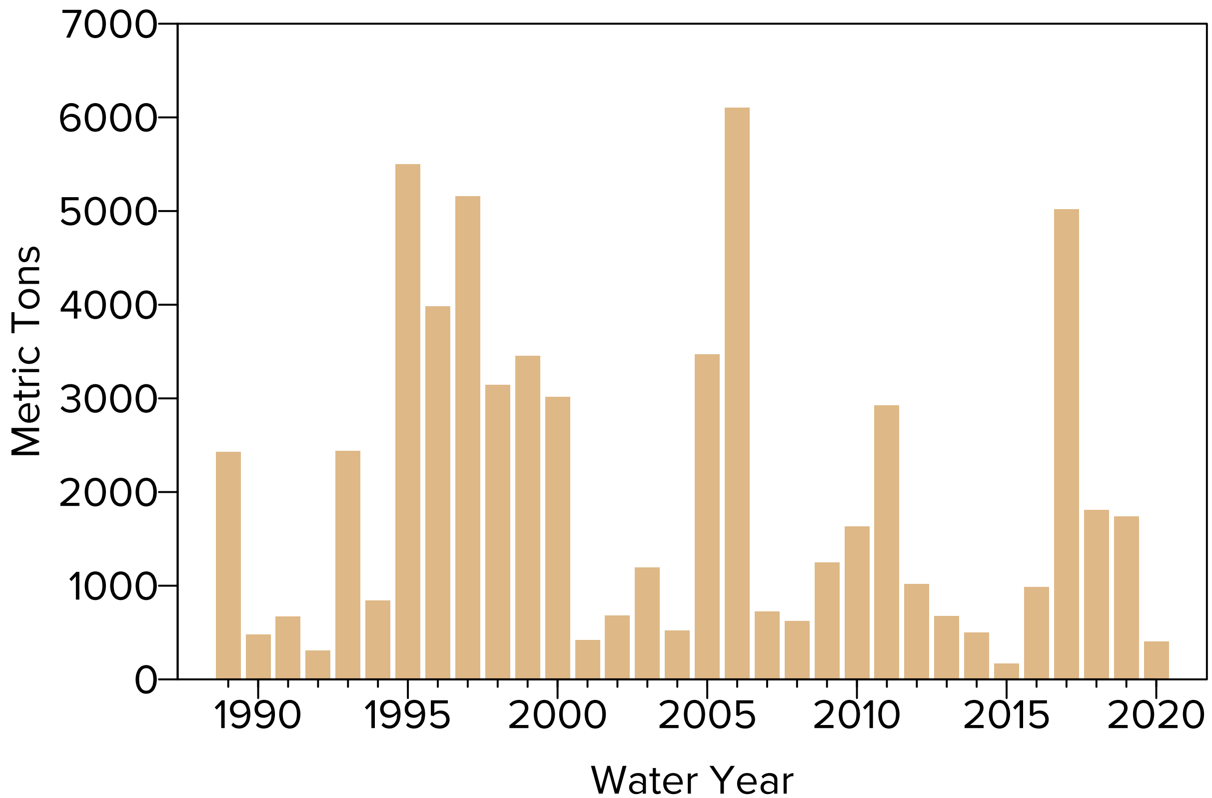
One metric ton (MT) = 2,205 pounds.



Suspended sediment contribution by Upper Truckee River

Yearly since 1989

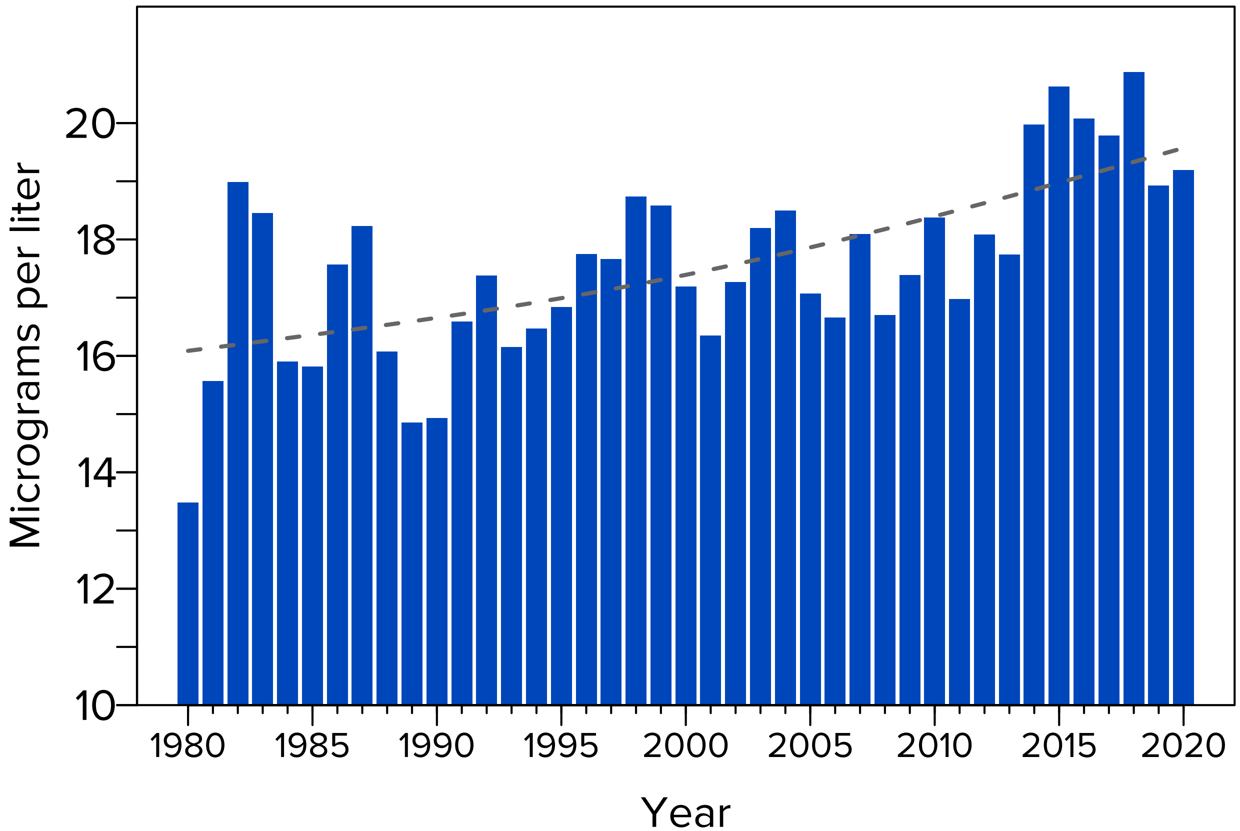
The load of total suspended sediment delivered to the lake by the Upper Truckee River is related to landscape condition and erosion as well as to precipitation and stream flow. Inter-annual variation in sediment load over shorter time scales is more related to the latter. Plans to restore lake clarity emphasize reducing loads of very fine suspended sediment (in the size range of 1–4 microns in diameter) from urbanized areas. By contrast, efforts to restore natural stream function, watershed condition and restoration of habitat for plants and wildlife, focus on reducing loads of total sediment regardless of size. In 2020, the suspended sediment load from the Upper Truckee River was 404 MT. The highest load ever recorded was 6100 MT in 2006. The average annual load is 1,977 MT.



Lake nitrate concentration

Yearly since 1980

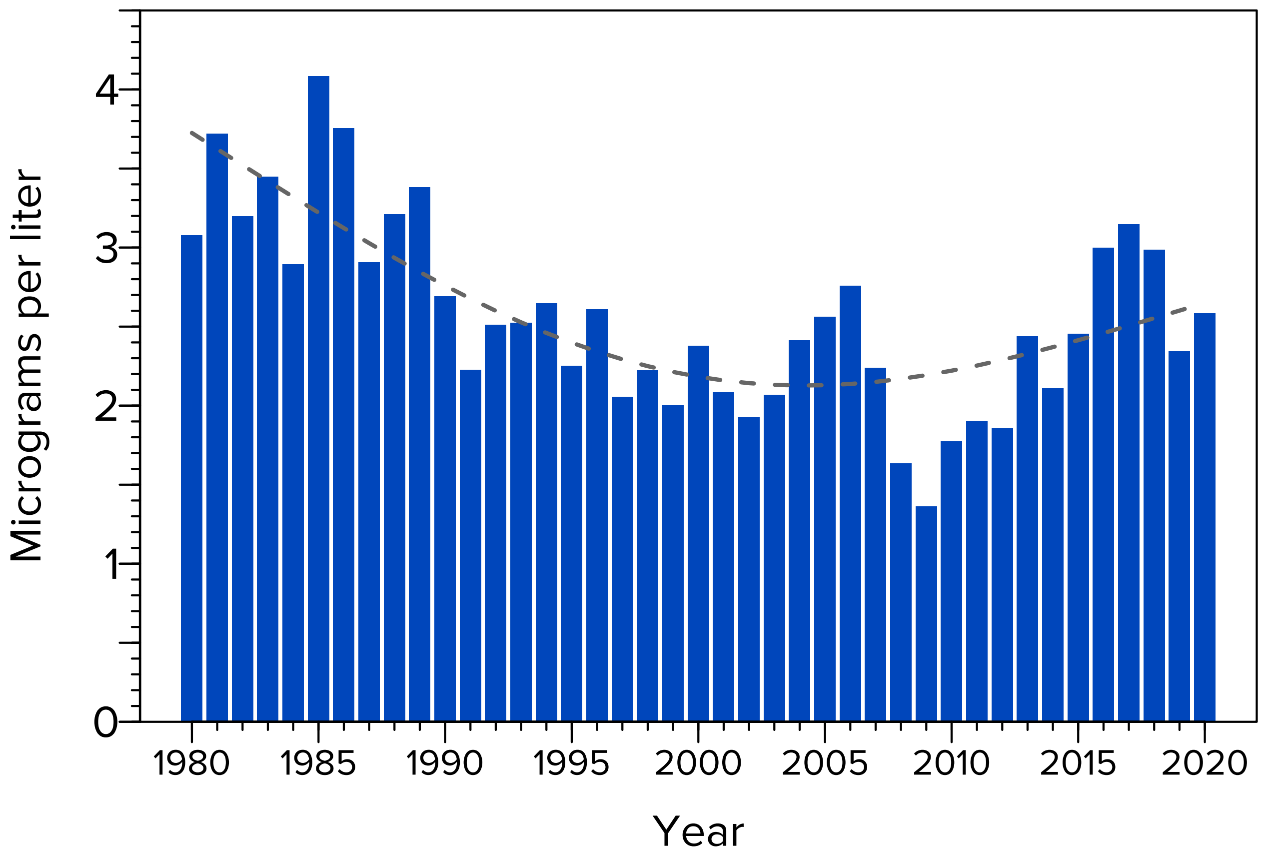
Until 2012, the volume-weighted annual average concentration of nitrate-nitrogen had remained relatively constant year-to-year, ranging between 13–19 micrograms per liter. Since that time, however, the lake's nitrate concentration has been increasing, as evident in the trend line produced with a Generalized Additive Model. In 2020, the volume-weighted annual average concentration of nitrate-nitrogen was 19.2 micrograms per liter. The previous year (2019), lake nitrate concentration declined due to the deep mixing that occurred and redistributed the nitrate that had been accumulating at the bottom of lake for the previous eight years, making it available for algal uptake. In 2020, with only shallow mixing, nitrate has recommenced accumulating, resulting in an increase in lake nitrate concentration. Water samples are taken at the MLTP (mid-lake) station at 13 depths from the surface to 1,480 feet.



Lake total hydrolyzable phosphorus concentration

Yearly since 1980

Phosphorus naturally occurs in Tahoe Basin soils and enters the lake from soil disturbance and erosion. Total hydrolysable phosphorus (THP) is a measure of the fraction of phosphorus that algae can use to grow. It is similar to the SRP that is measured in the streams. Since 1980, THP had been declining although in the last 16 years the values have been increasing. In 2020, the volume-weighted annual average concentration of THP was 2.59 micrograms per liter. Water samples are taken at the MLTP (mid-lake) station at 13 depths from the surface to 1,480 feet.



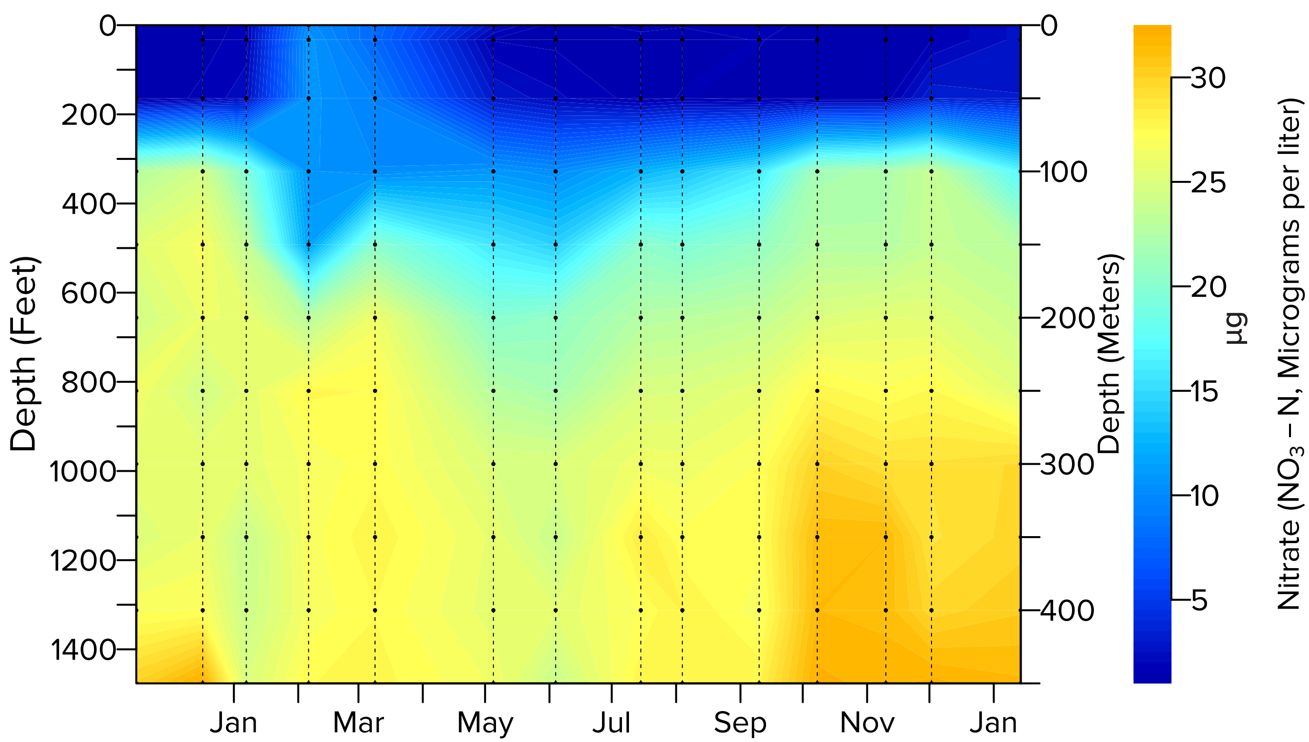
Nitrate distribution

In 2020

Water samples are collected from the middle of the lake approximately every month (on dates indicated by the dashed lines) at 13 depths (indicated by the dots) and analyzed in the TERC laboratory for nutrient concentrations. Here the nitrate concentration is shown in the form of color contours.

Most evident is the persistence of the high nitrate region in the lower part of the lake. It is evident that the limited extent of mixing did not homogenize the nitrate distribution. Instead, a sharp "nitricline" is evident between depths of 300 and 600 feet throughout the year.

Although most of the "new" nitrate enters at the surface through atmospheric deposition, it is rapidly taken up by the algae and surface concentrations remain generally low. As algae sink and decompose, the nitrate they consumed reappears deep in the lake. At these depths, however, there is insufficient light for algae to grow and to use these nutrients.

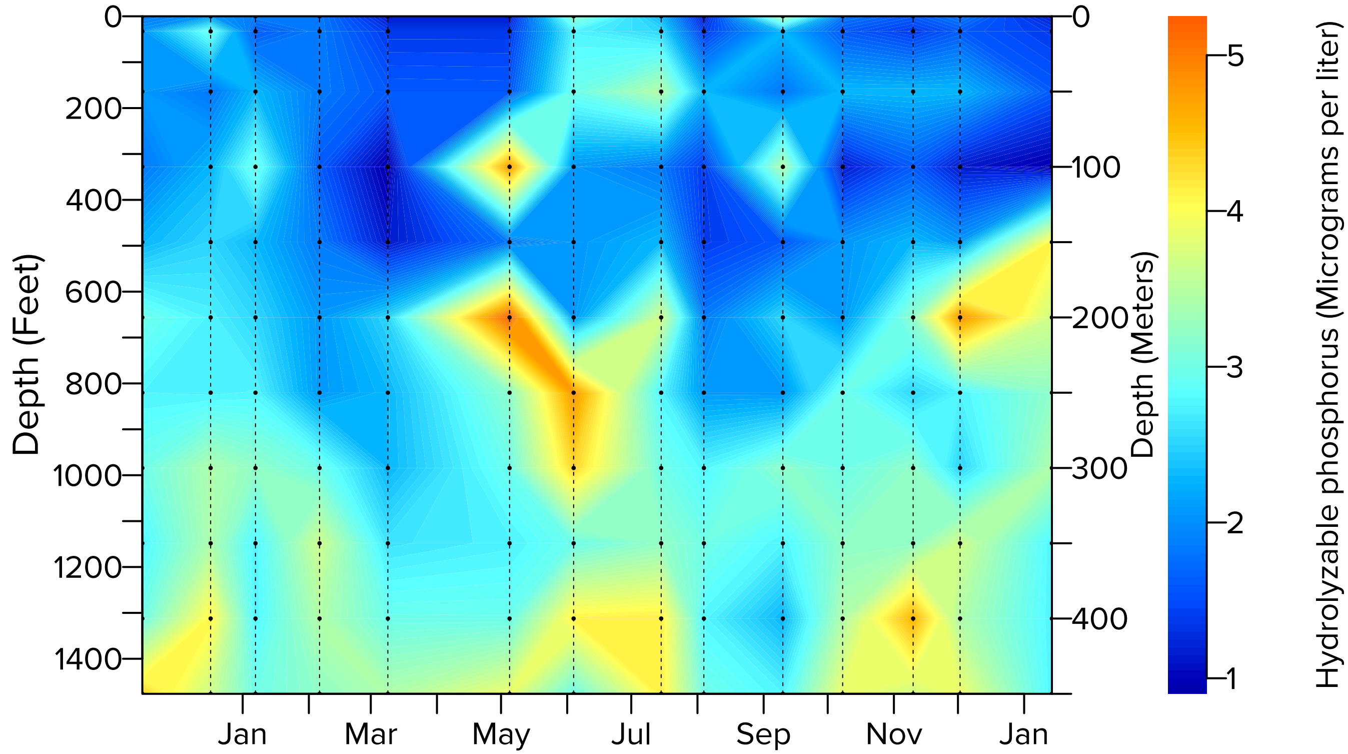


Total hydrolyzable phosphorus distribution

In 2020

Water samples are collected from the middle of the lake approximately every month (on dates indicated by the dashed lines) at 13 depths (indicated by the dots) and analyzed in the TERC laboratory for nutrient concentrations. Here the total hydrolysable phosphorus (THP) concentration, the fraction of phosphorus that can be readily used by algae, is shown in the form of color contours.

Phosphorus mainly entered the lake in association with fine particles during runoff events in April through June. The relatively elevated values near the surface in spring and summer suggest that in 2020, nitrogen was the nutrient that limited algal growth, rather than phosphorus during that time period. The elevated concentrations of phosphorus deep in the lake throughout the year were the result of the absence of deep mixing in 2020.



Fine particle distribution

In 2020

Water samples are collected from the middle of the lake approximately every month (on dates indicated by the dashed lines) at 13 depths (indicated by the dots) and analyzed in the TERC laboratory for the concentration of fine particles in 15 different bin sizes.

Here the distributions of fine particles (in the size range of 1–4 microns) are shown in the form of color contours. Particles can be both inorganic particles (such as clay or silt) or very small algal diatom particles.

Unlike the nutrients in Figs. 9.8 and 9.9, fine particles are in low concentrations deep in the lake throughout the year. The entry of particles in the upper part of the lake (above 300 ft.) associated with spring snowmelt is evident in May through July. The particles do not decrease in the upper layer as quickly as nitrogen or phosphorus, as they are not taken up by algal growth. The fine inorganic particles gradually clump together (aggregate) which allows them to more rapidly settle to the lake sediments at the bottom.