TAHOE:
STATE OF THE LAKE
REPORT
2019

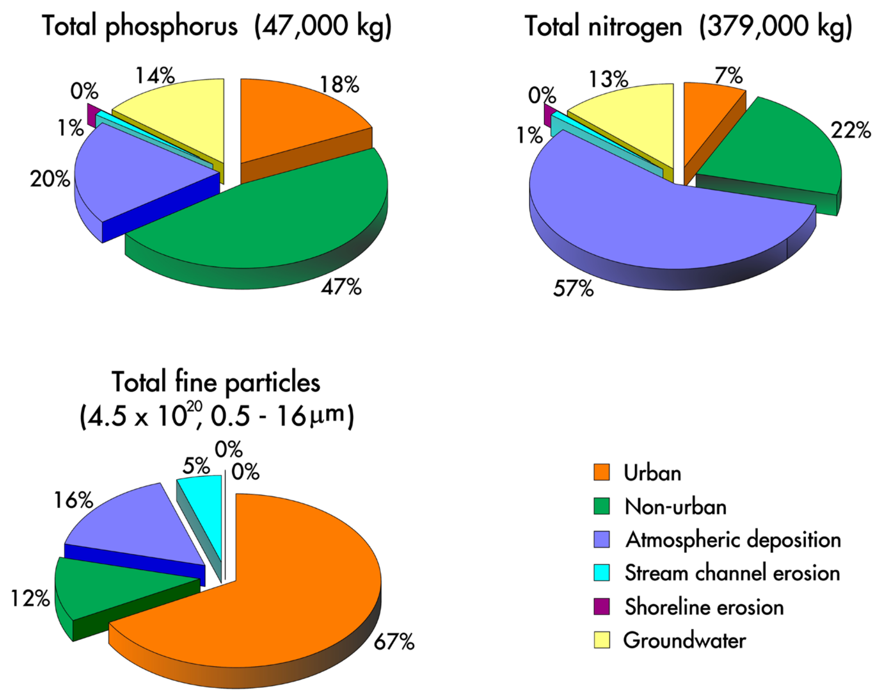
NUTRIENTS AND PARTICLES

UC DAVIS
Tahoe Environmental
Research Center

Sources of clarity-reducing and blueness-reducing pollutants

In 2018

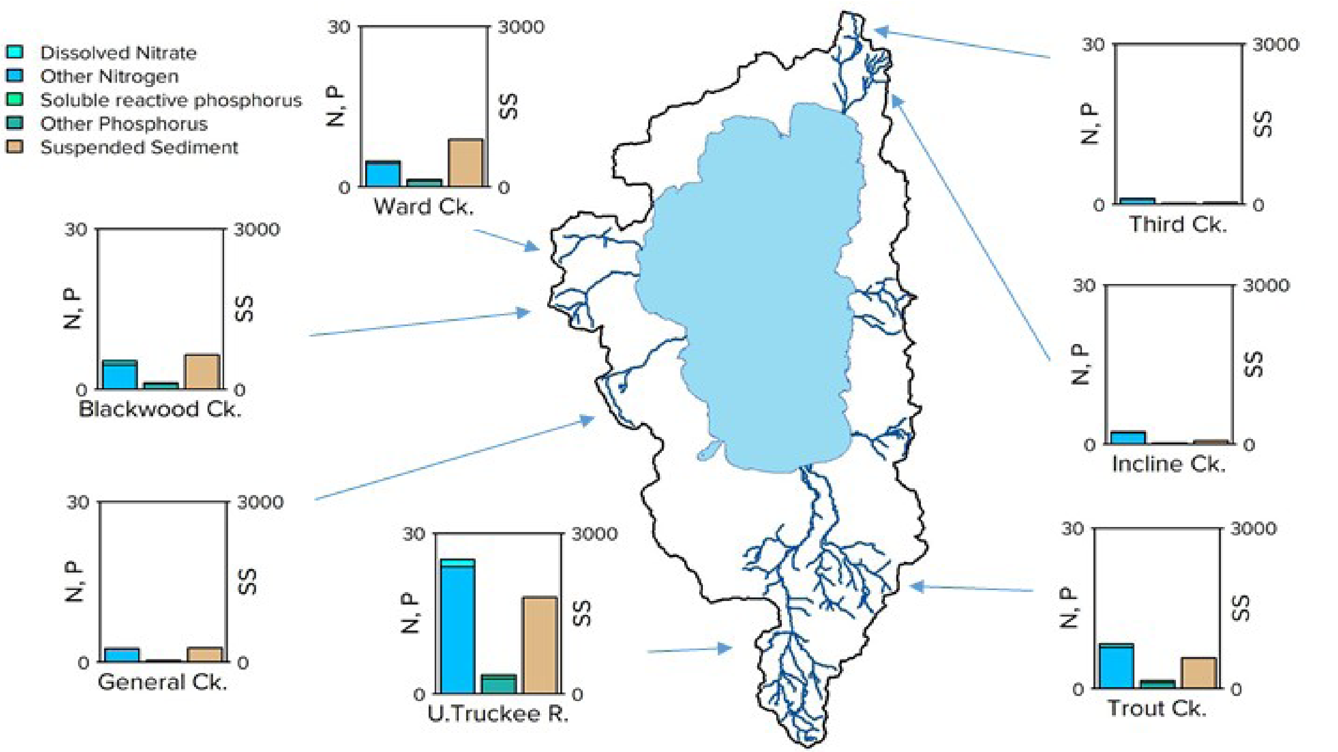
Research has quantified the primary sources of nutrients (nitrogen and phosphorus) and particulate material that are causing Lake Tahoe to lose clarity and blueness in its upper waters. One of the major contributors to clarity decline are extremely fine particles in stormwater that originate from the 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 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 agencies including the Lahontan Regional Water Quality Control Board, the Nevada Division of Environmental Protection, and the Tahoe Regional Planning Agency. Data were originally generated for the Lake Tahoe TMDL Program. These results are revised from the original estimates as they are based on a longer time series of monitoring data.



Pollutant loads from seven watersheds

In 2018

The Lake Tahoe Interagency Monitoring Program (LTIMP) measures nutrient and sediment input from seven of the 63 watershed streams – a reduction of three streams since 2011. The vast majority of stream phosphorus and nitrogen comes from the Upper Truckee River, Trout Creek, Blackwood Creek and Ward Creek. The LTIMP stream water quality program is supported by the U.S. Geological Survey in Carson City, Nevada, UC Davis TERC, the California Tahoe Conservancy, the Lahontan Regional Water Quality Control Board, and the Tahoe Regional Planning Agency.

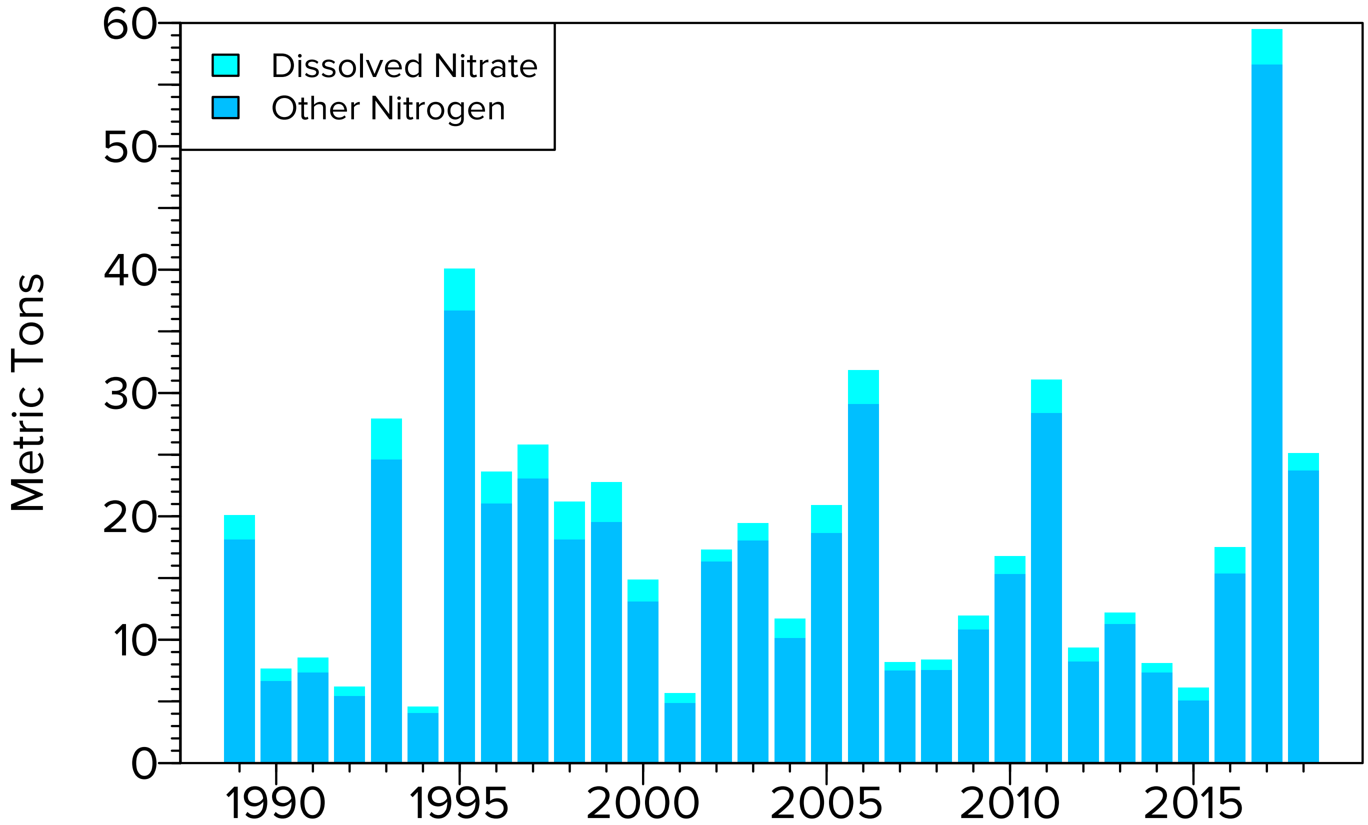


Nitrogen contribution by Upper Truckee River

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 nitrogen load of 4.6 MT, while 2017 had 68.9 inches of precipitation and a very high nitrogen load of 59.5 MT. 2018 had 32.0 inches of precipitation, and a total nitrogen load of 25.1 MT. The long-term mean nitrogen load is 14.9 MT/yr.

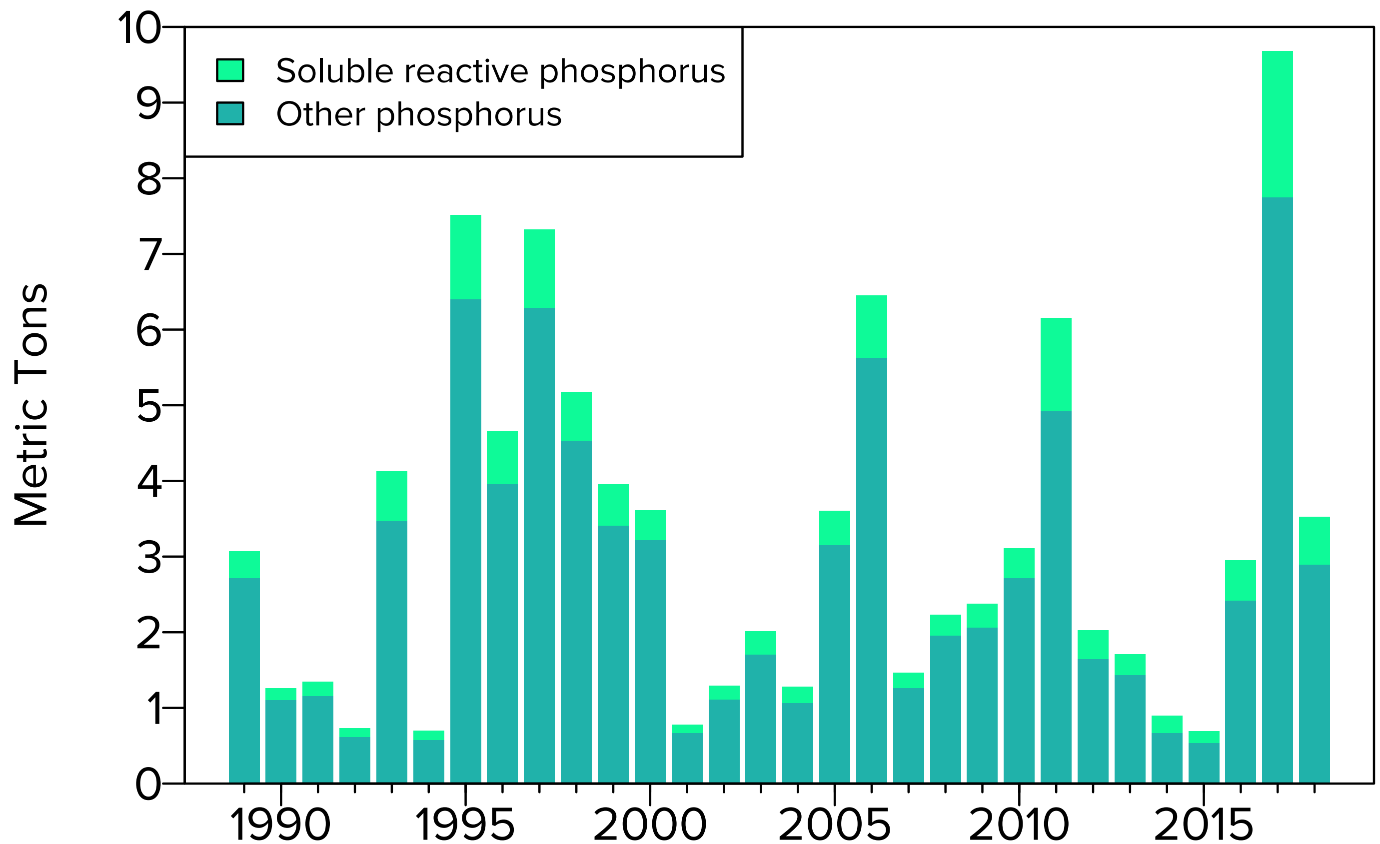
(One metric ton (MT) = 2,205 pounds.)



Phosphorus contribution by Upper Truckee River

Yearly since 1989

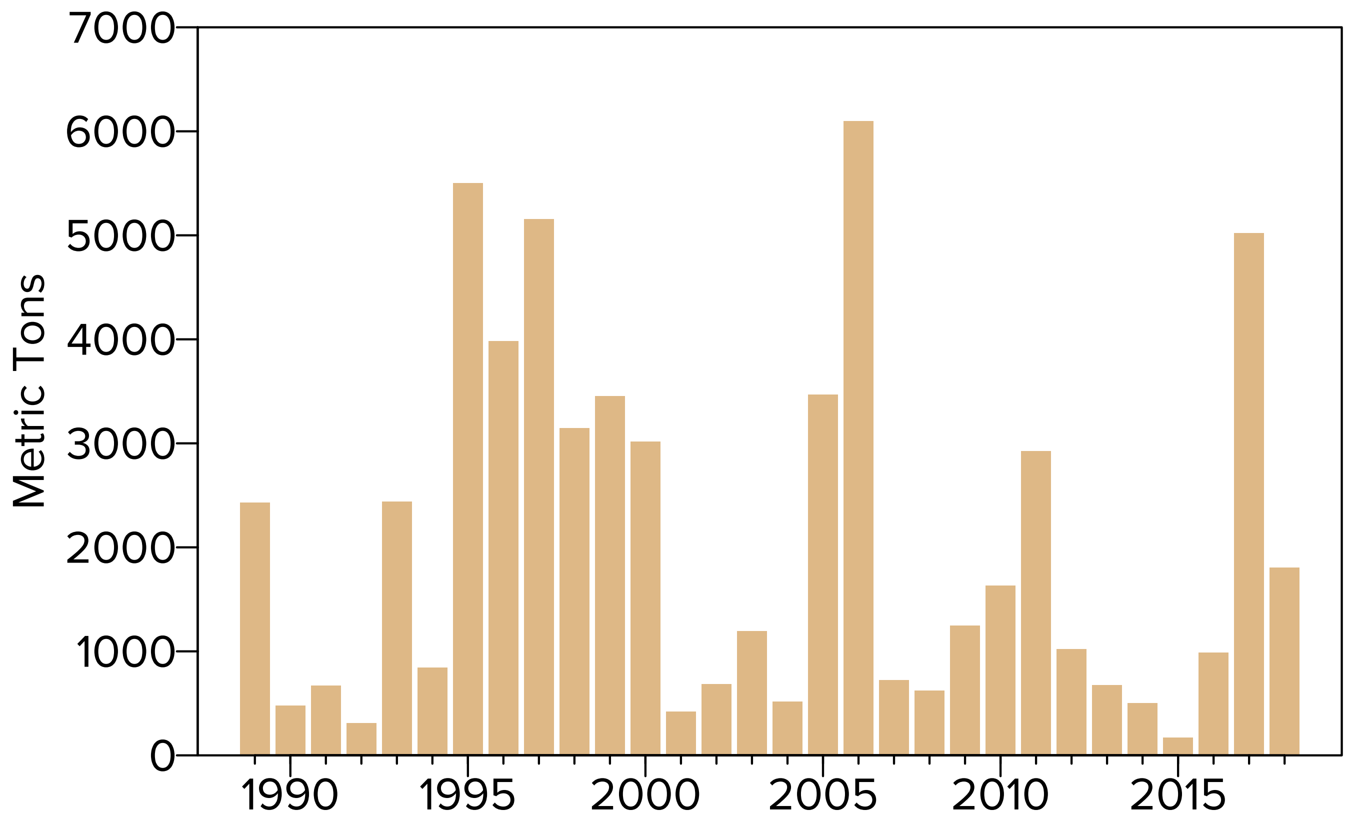
Soluble reactive phosphorus (SRP) is that fraction of phosphorus immediately available for algal growth. As with nitrogen (Fig. 9.3), the year-to-year variation in load largely reflects the changes in precipitation. Above average precipitation in 2018 resulted in a Total Phosphorus level of 3.52 MT and a SRP load of 0.63 MT. These compare with the long-term averages of 2.44 and 0.37 MT respectively. Decreasing nutrient inputs is 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

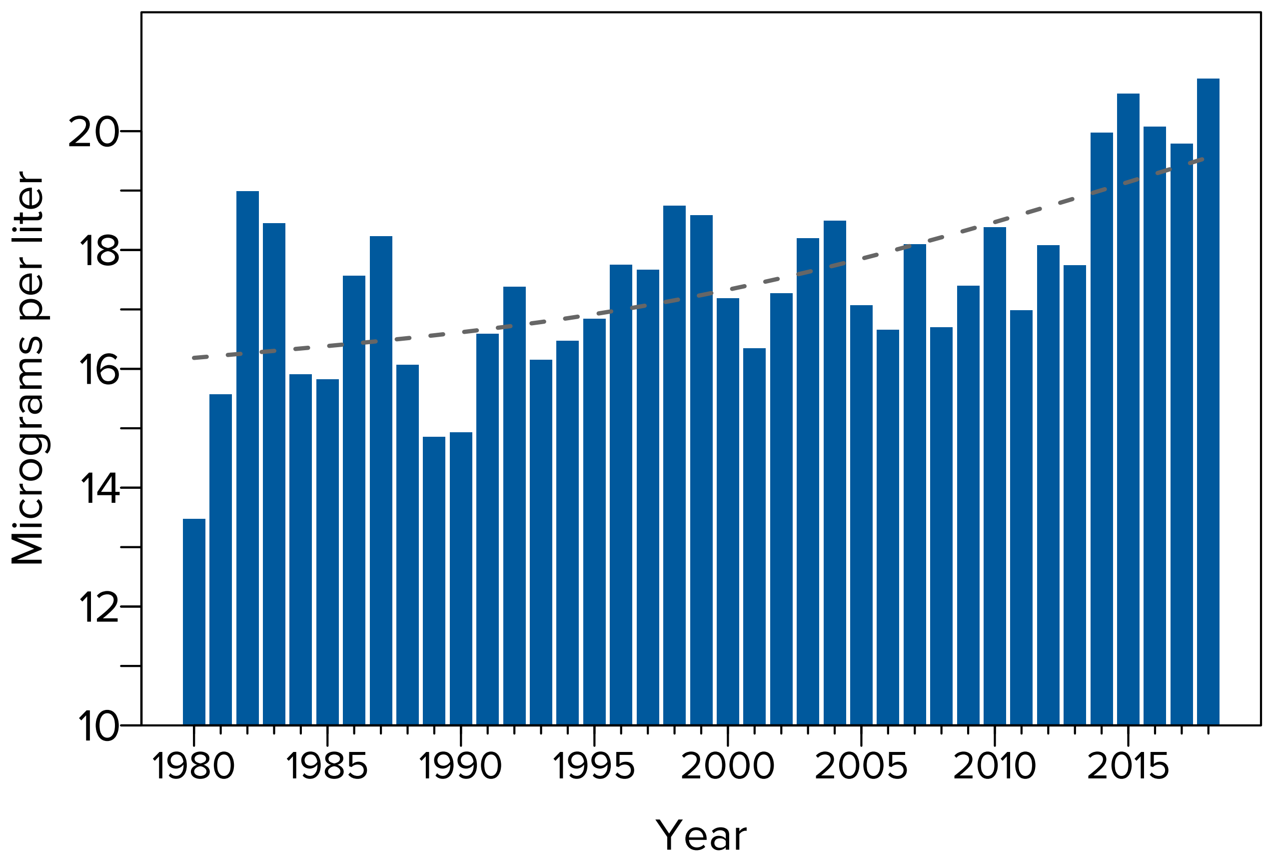
The load of total suspended sediment delivered to the lake by the Upper Truckee River is related to landscape conditions and erosion as well as to precipitation and stream flow. Inter-annual variation in sediment load over shorter time scales is more related to the latter. Plans to restore lake clarity emphasize reducing loads of very fine suspended sediment (less than 20 microns in diameter) from urbanized areas. Efforts to restore natural stream function and watershed condition focus on reducing loads of total sediment regardless of size, as well as restoration of habitat for plants and wildlife. In 2018, the suspended sediment load from the Upper Truckee River was 1,807 MT. The highest load ever recorded was 6,100 MT in 2006. The average annual load is 2,430 MT.



Lake nitrate concentration

Yearly since 1980

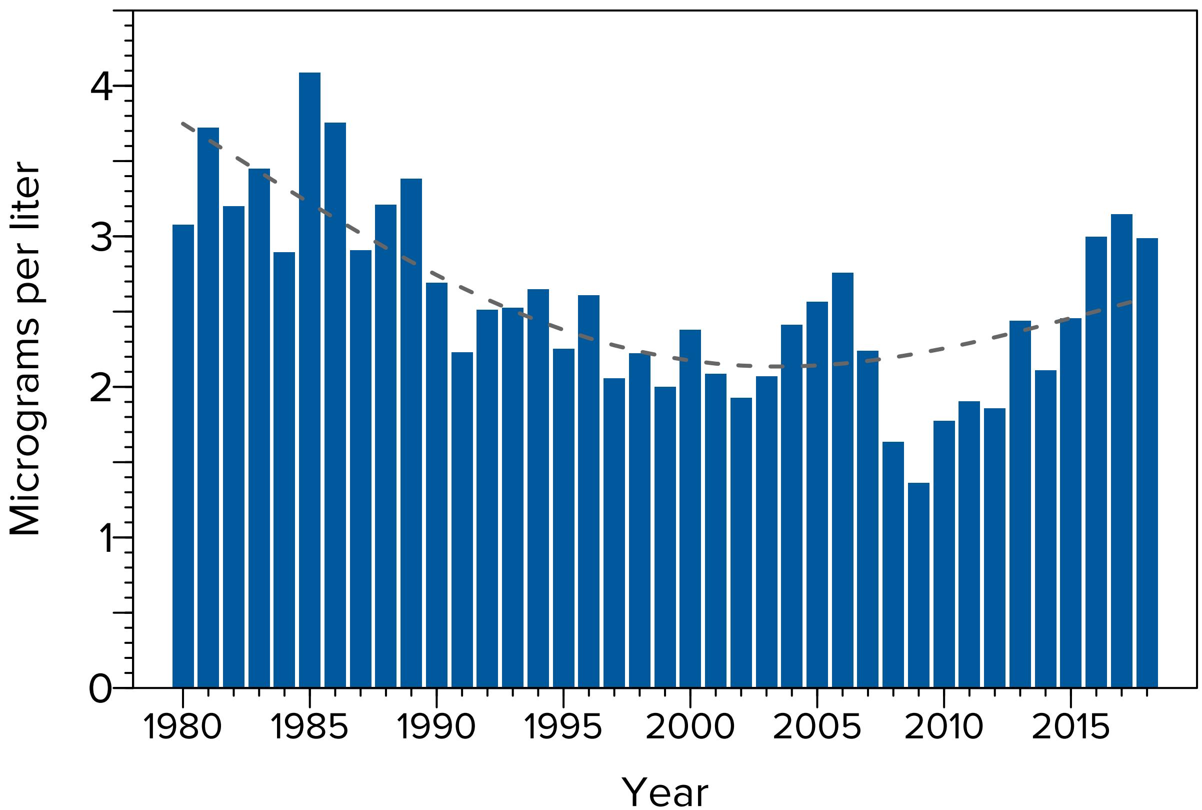
Up through 2012, the volume-weighted annual average concentration of nitrate-nitrogen has remained relatively constant, ranging between 13 and 19 micrograms per liter. Since that time, however, the lake's nitrate concentration has been increasing. In 2018, the volume-weighted annual average concentration of nitrate-nitrogen was 20.9 micrograms per liter, the highest value on record. This high value is in part due to the seventh successive year in which deep mixing did not take place, allowing for a continued buildup of nitrate in the deep water. The average annual concentration is 16.8 micrograms per liter. Water samples are taken at the MLTP (mid-lake) station at 13 depths from the surface to 450 meters.



Lake phosphorus concentration

Yearly since 1980

Phosphorus naturally occurs in Tahoe Basin soils and enters the lake from soil disturbance and erosion. Total hydrolyzable phosphorus, or 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 has tended to decline, although in the last nine years the values have been increasing toward levels that were present in the 1980s. In 2018, the volume-weighted annual average concentration of THP was 3.0 micrograms per liter. Water samples are taken at the MLTP (mid-lake) station at 13 depths from the surface to 450 meters.



Nitrate distribution

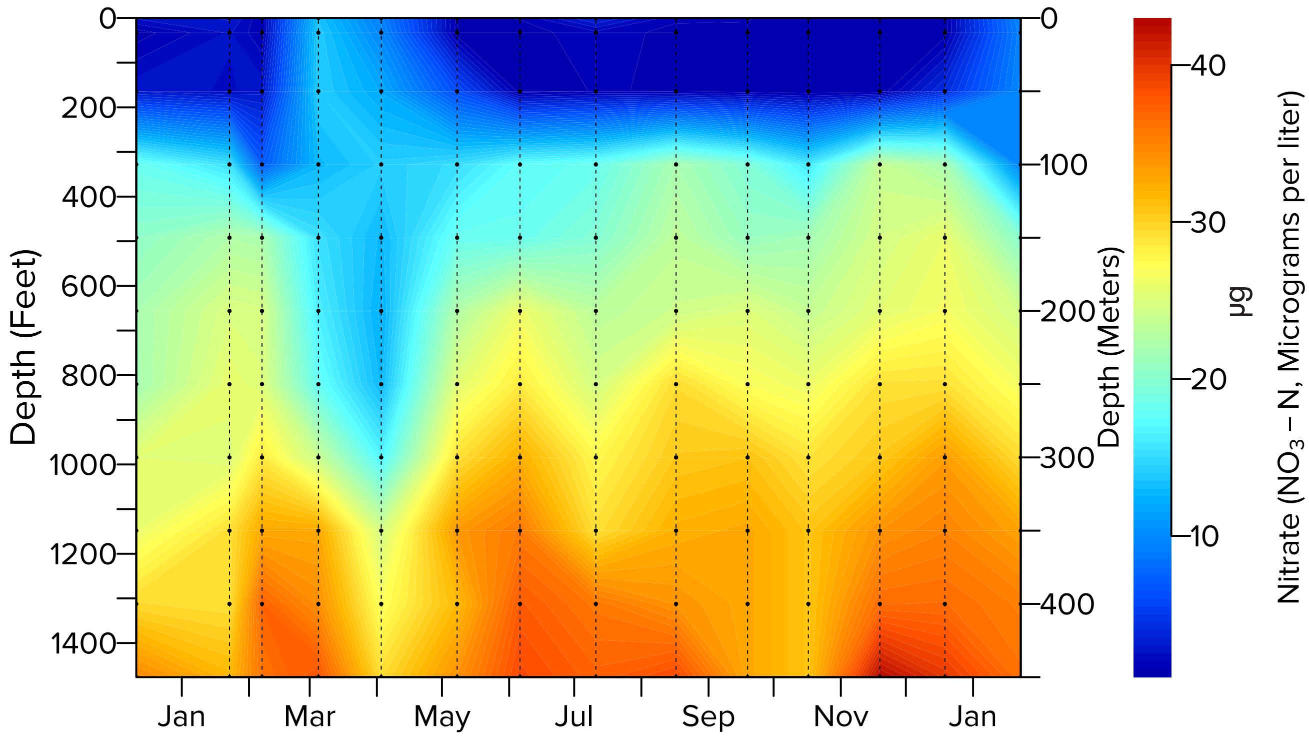
In 2018

Water samples are collected approximately every month (on dates indicated by the dashed lines) at 13 depths (indicated by the dots) at the middle of the lake, 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 vertical distribution of nitrate. Concentrations below a depth of about 350 feet are generally elevated. The surface waters, where there is sunlight to enable algae to grow, usually have low concentrations of nitrate.

Although most of the nitrate enters at the surface through atmospheric deposition, it is rapidly taken up by the algae and surface concentrations are 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 use these nutrients.

Deep lake mixing will bring the deep nitrate back to the surface. 2018 was a year with only partial mixing, and so most of the nitrate remained trapped in the deep water.

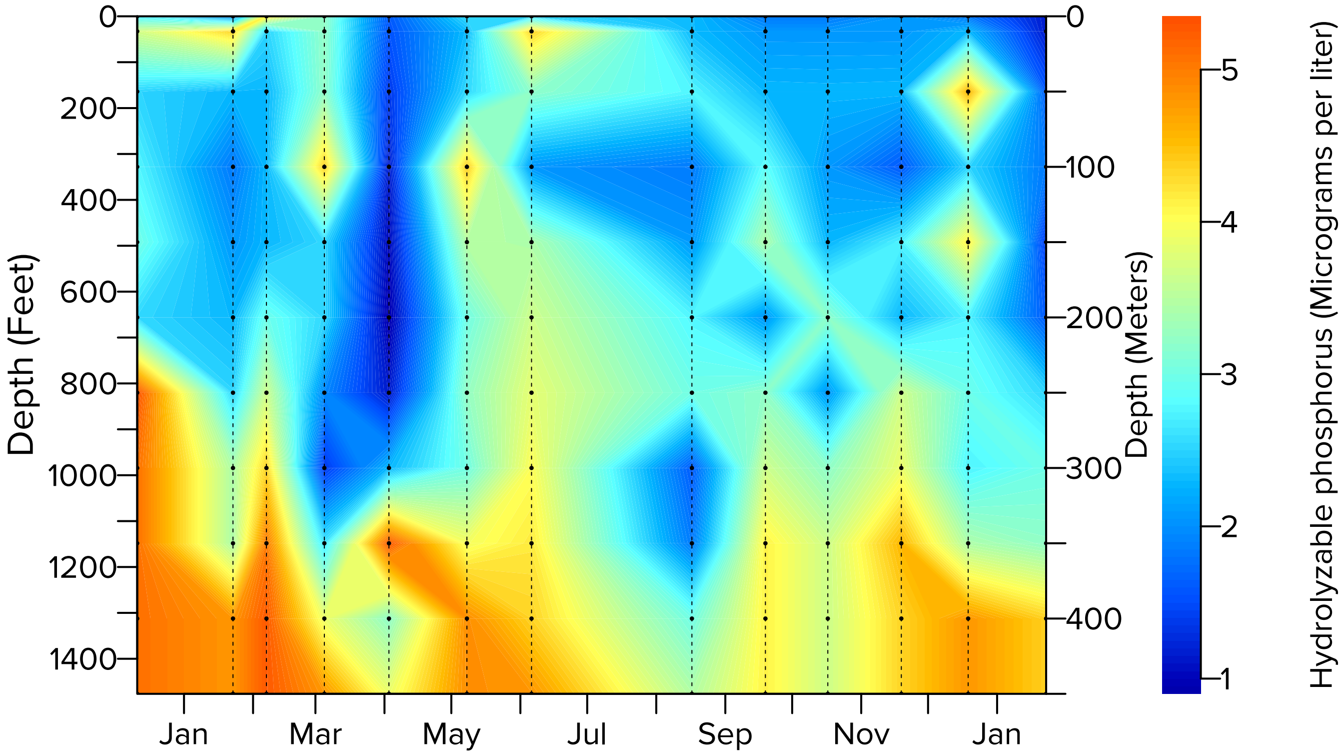


Orthophosphate distribution

In 2018

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

Phosphorus mainly enters the lake in association with fine particles during runoff events. The higher values near the surface in spring and summer suggest that in 2018 nitrogen was the nutrient that limited algal growth. The high concentrations of phosphorus deep in the lake during summer are the result of algae sinking and then decomposing. Eventually the THP attaches to particles and settles to the lake bottom.



Fine particle distribution

In 2018

Water samples are collected approximately monthly (on dates indicated by the dashed lines) at 13 depths (indicated by the dots) at the middle of the lake, and analyzed in the TERC laboratory for the concentration of fine particles in 15 different bin sizes. Here the distributions of the finest particles (in the range of 0.5 to 8 microns) are shown in the form of color contours.

Clearly evident is that the highest concentrations of fine particles (orange tones) are concentrated in the upper part of the lake. In March (winter), when mixing is at its peak, clarity is generally greatest, as the surface concentration of particles is the lowest due to mixing and dilution. The particle concentration is highest in May, July and August, which coincides with the annual variation in Secchi depth this year. The fine particles gradually clump together (aggregate) and allows them to more rapidly settle to the lake sediments at the bottom.