# TAHOE: STATE OF THE LAKE REPORT 2018

## NUTRIENTS AND PARTICLES

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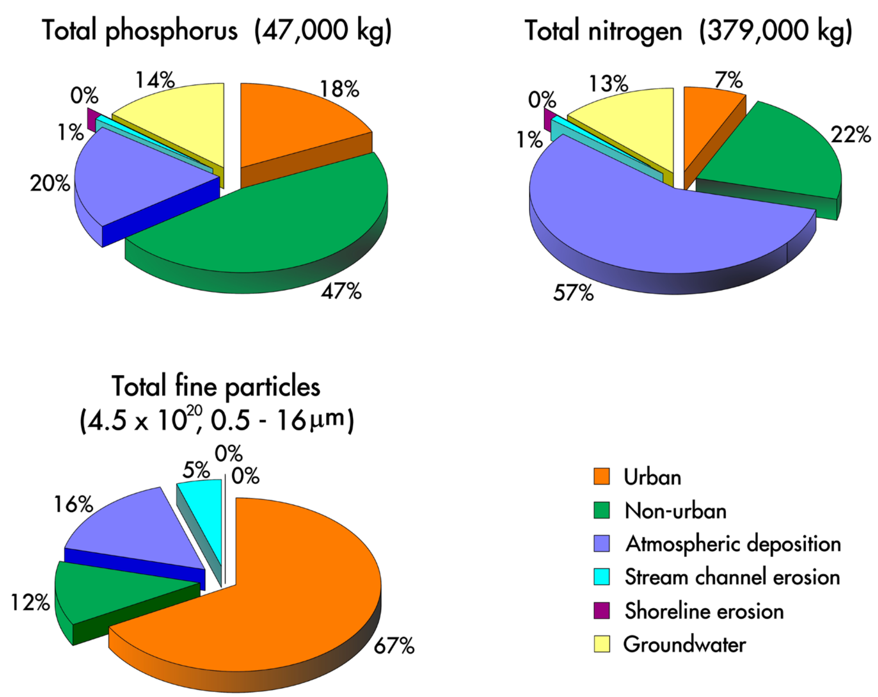
Tahoe Environmental Research Center

## NUTRIENTS AND PARTICLES

# Sources of clarity-reducing and blueness-reducing pollutants

**In 2017**

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.



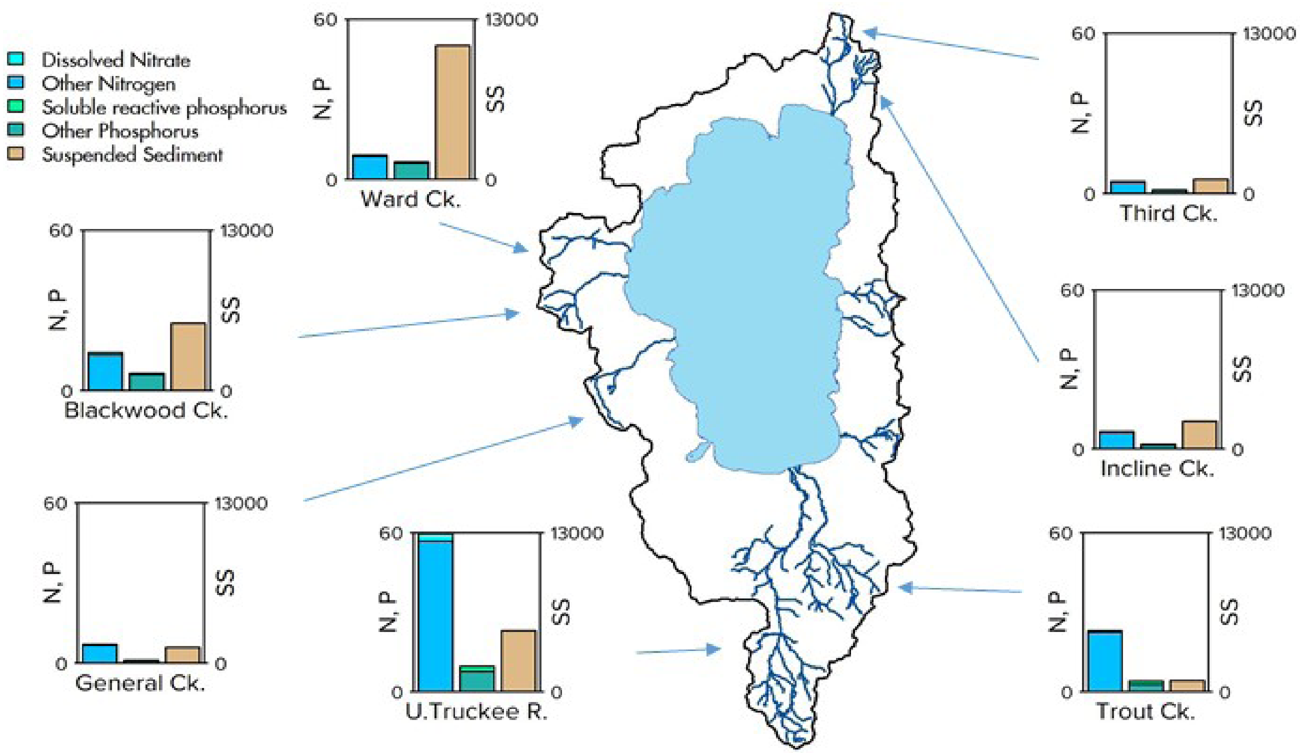
NUTRIENTS AND PARTICLES

# Pollutant loads from seven watersheds

**In 2017**

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 majority of stream phosphorus and nitrogen comes from the Upper Truckee River, Trout Creek, Blackwood Creek and Ward Creek (in that order). Suspended sediment came primarily from Ward Creek, Blackwood Creek, the Upper Truckee River, and Incline Creek (in that order). Trout Creek was markedly lower despite the high precipitation.

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.

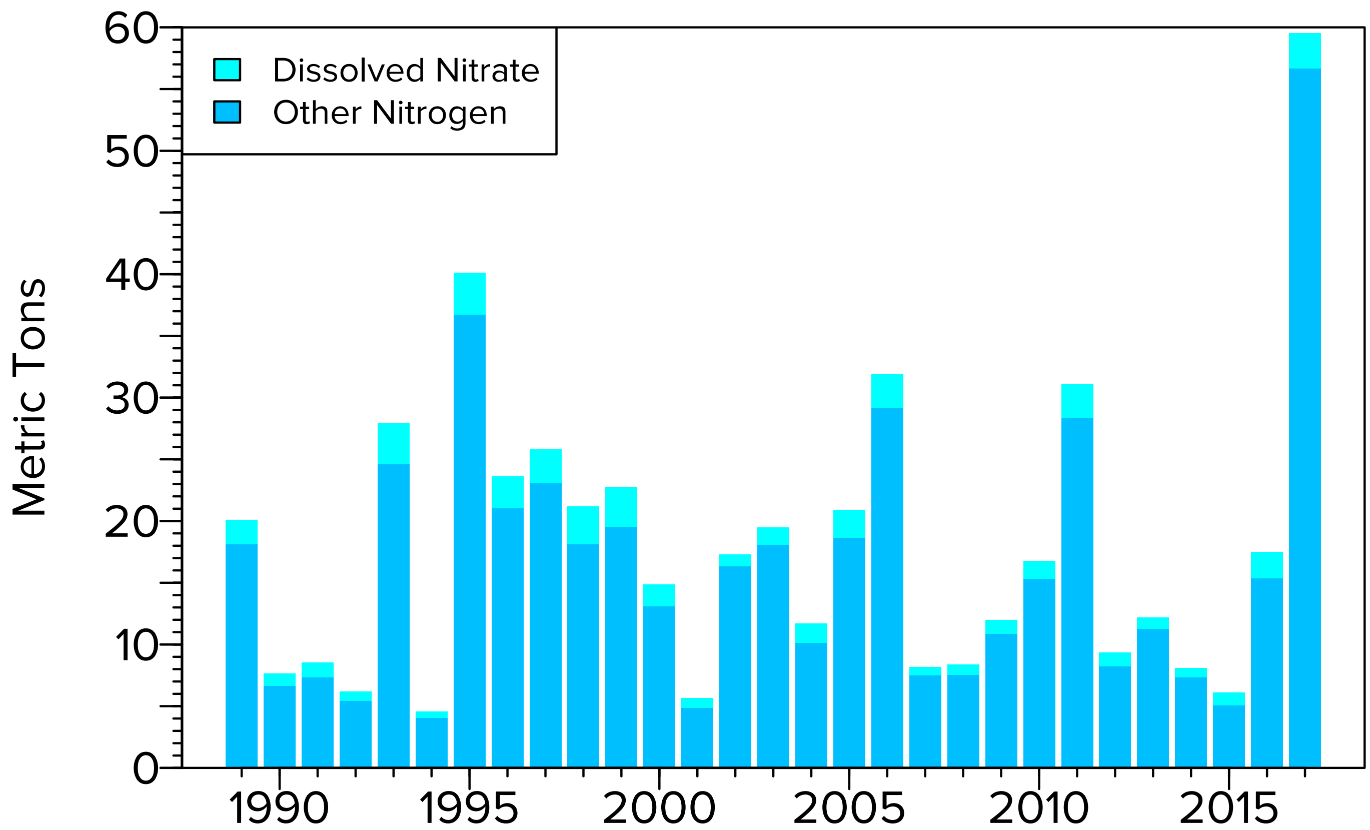


NUTRIENTS AND PARTICLES

# 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. 2017 saw the largest load of nitrogen ever recorded. This was due to the extraordinarily high flows following five years of drought.
(One metric ton = 2,205 pounds.)



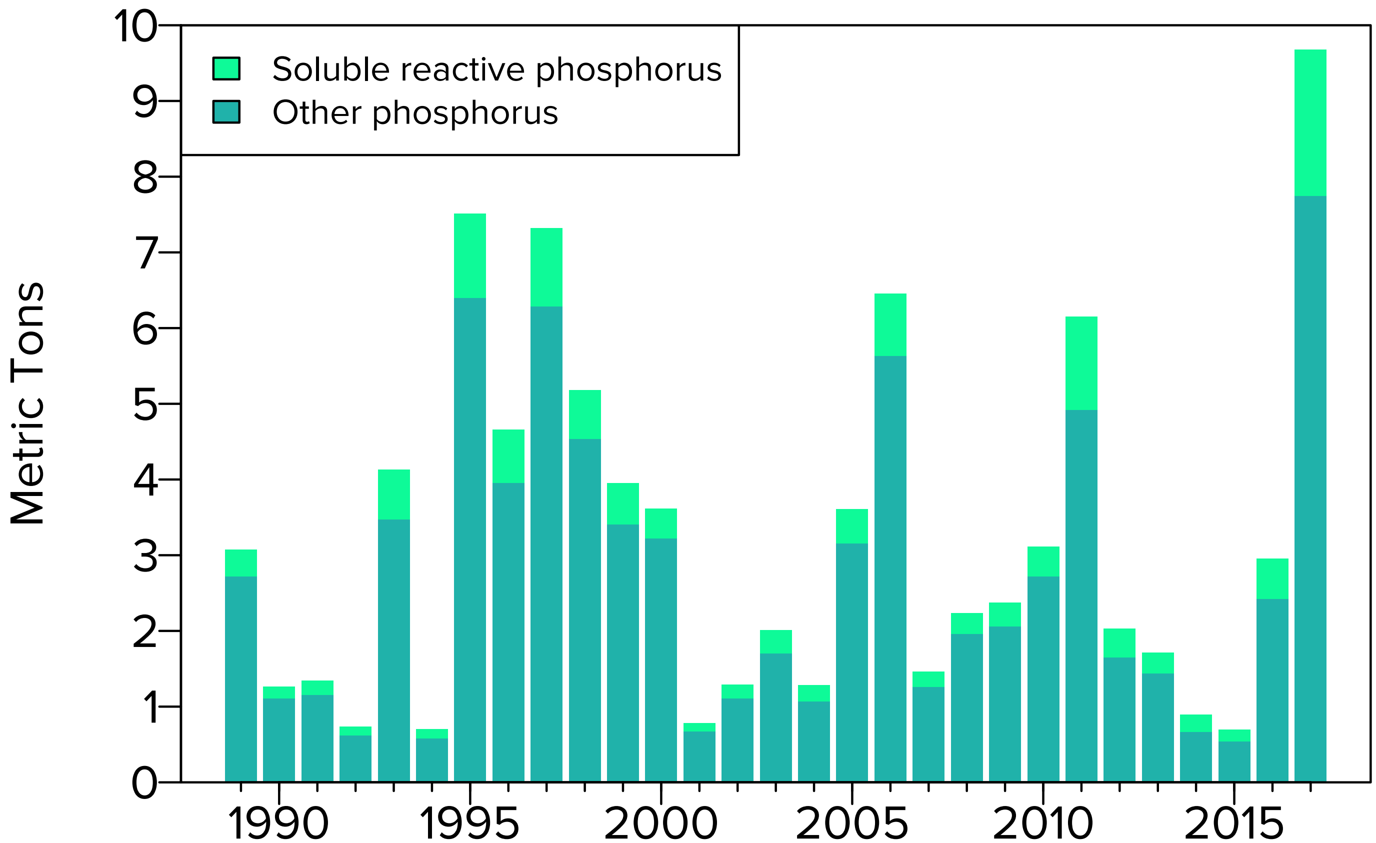
NUTRIENTS AND PARTICLES

# Phosphorus contribution by Upper Truckee River

**Yearly since 1989**

Soluble reactive phosphorus (SRP) is the fraction of phosphorus immediately available for algal growth. As with nitrogen (Page 9.3), the year-to-year variation in load largely reflects the changes in precipitation. The extremely high precipitation in 2017 resulted in a Total phosphorus level of 9.68 MT and an SRP load of 1.93 MT, both the highest values recorded. These compare with the long-term averages of 3.18 and 0.48 MT respectively. The long-term decrease in nutrient inputs is fundamental to restoring Lake Tahoe's ecosystem health.

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.)

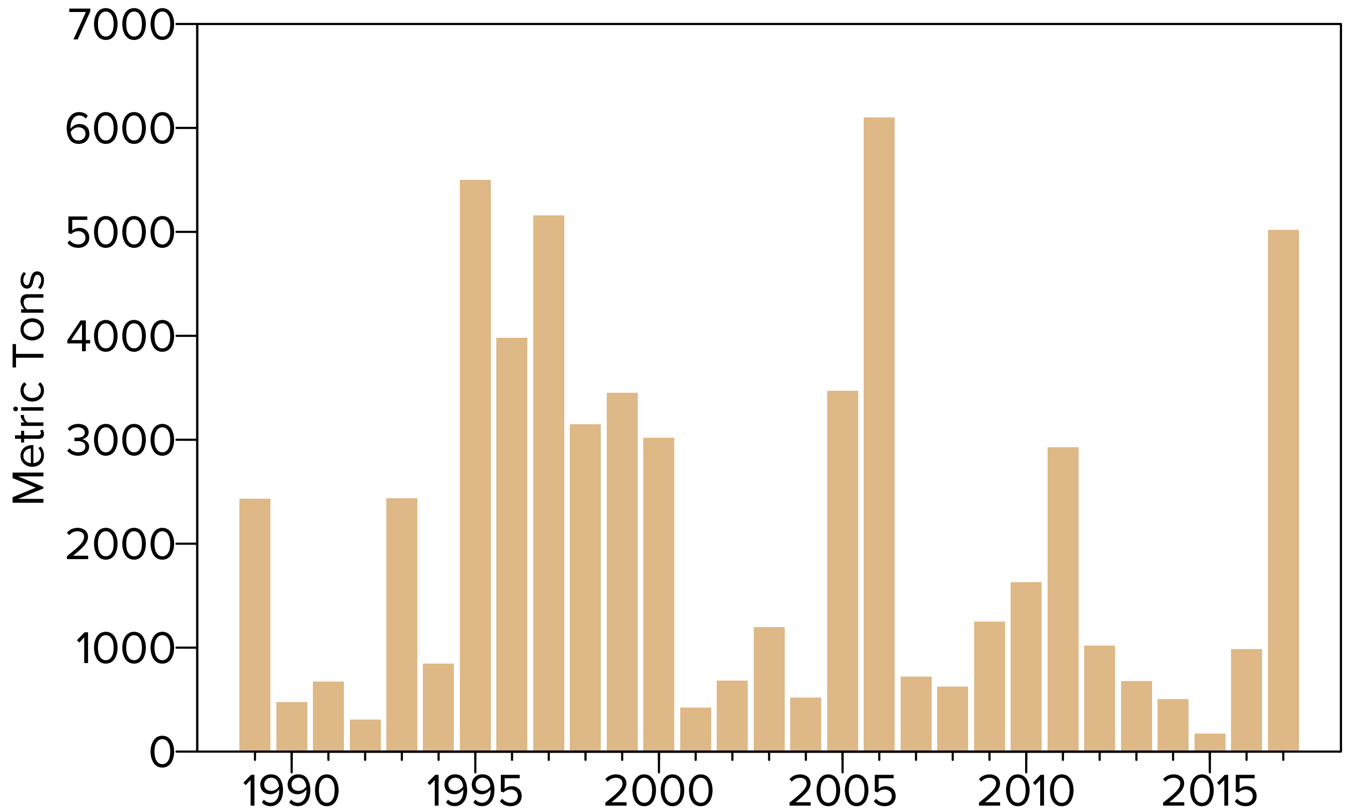


NUTRIENTS AND PARTICLES

# Suspended sediment contribution by Upper Truckee River

**Yearly since 1989**

The load of 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 (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 2017, the suspended sediment load from the Upper Truckee River was 5,019 metric tons, the fourth highest load recorded. The load greater than the sum of all annual loads from the previous five years. The high loads were the result of the high precipitation ending a five-year drought. The average annual load is 2,046 metric tons.

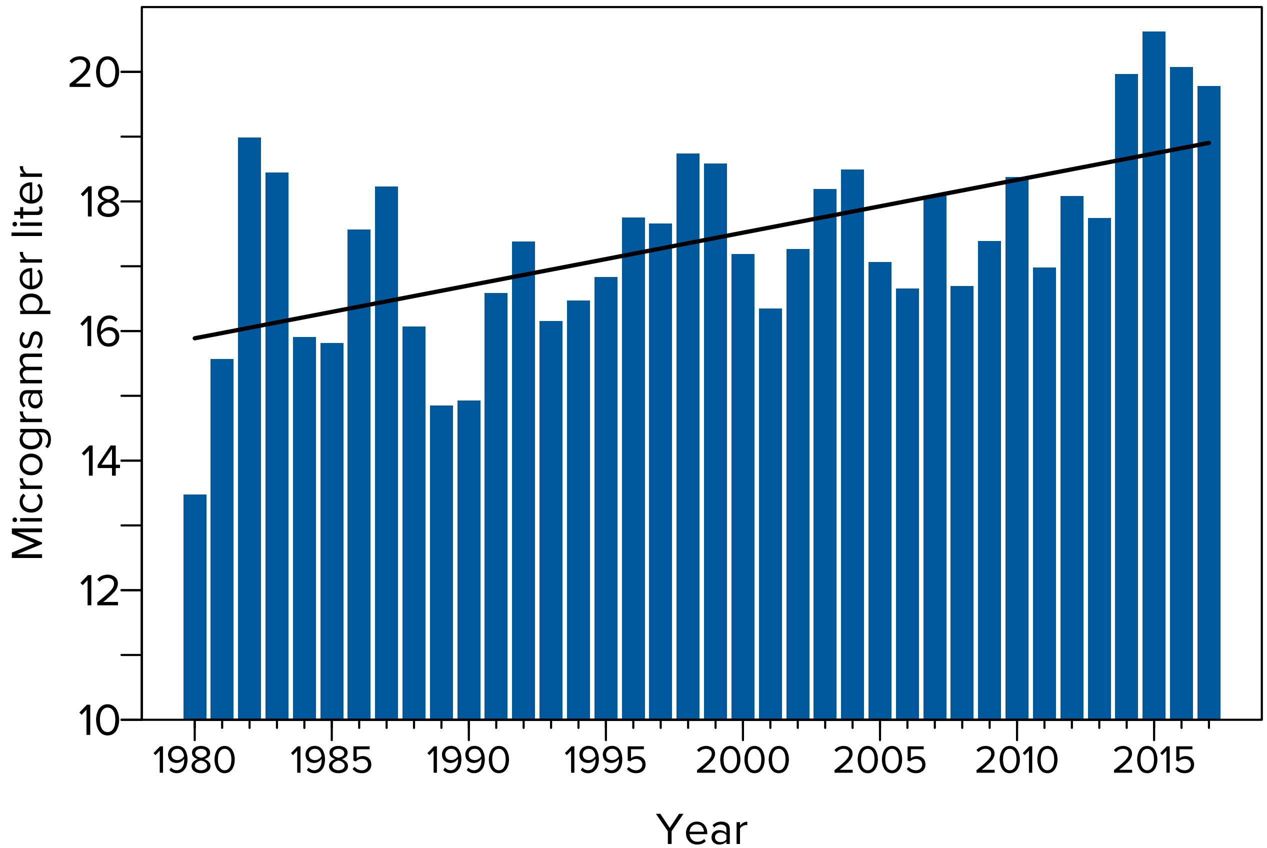


## NUTRIENTS AND PARTICLES

# Lake nitrate concentration

**Yearly since 1980**

Since 1980, the volume-weighted annual average concentration of nitrate-nitrogen has gradually been increasing, ranging between 13 and 20 micrograms per liter. In 2017, the volume-weighted annual average concentration of nitrate-nitrogen was 19.8 micrograms per liter. This high value is in part due to the sixth 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 17.4 micrograms per liter. Water samples are taken at the MLTP (mid-lake) station at 13 depths from the surface to 450 meters.



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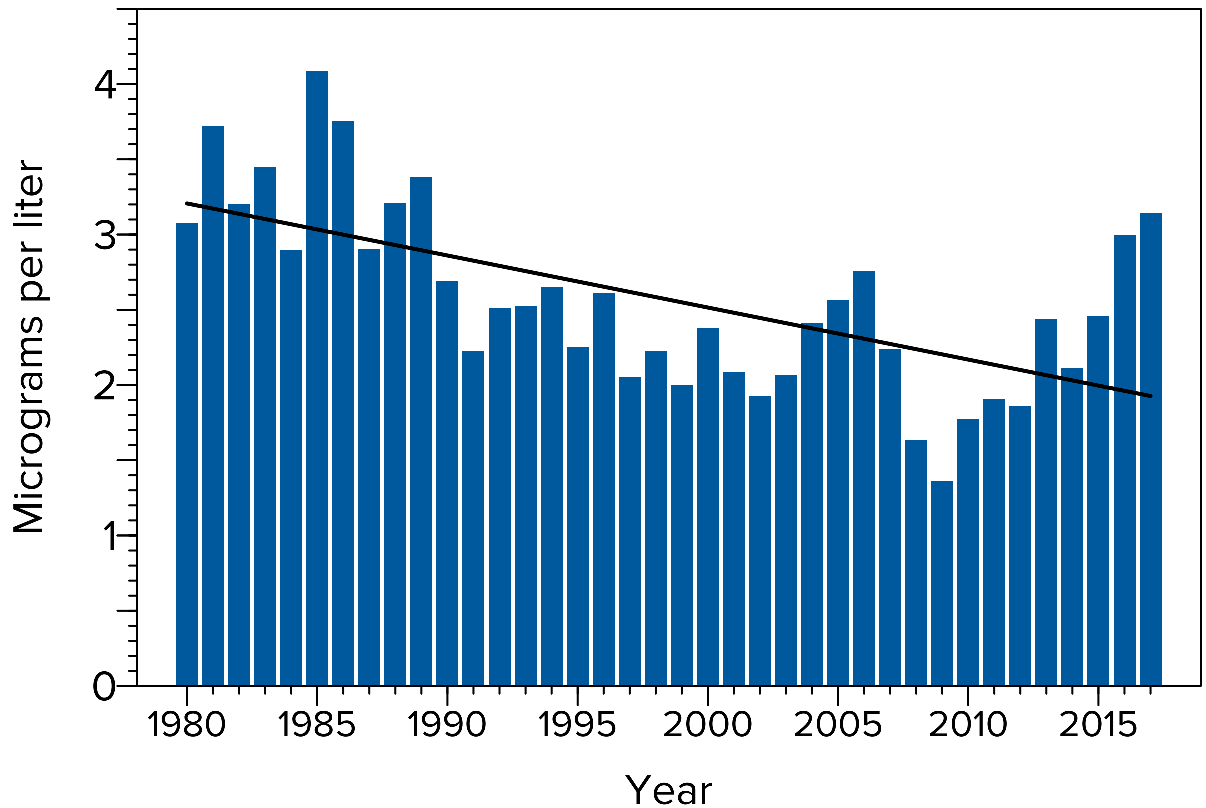
## Lake phosphorus concentration

**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 trended towards a decline, although in the last eight years the values have been increasing toward levels that were present in the 1980s. The high stream loads in 2017 contributed to this increasing trend. In 2017, the volume-weighted annual average concentration of THP was 3.15 micrograms per liter, the highest level since 1989. The average annual value is 2.57 micrograms per liter. Water samples are taken at the MLTP (mid-lake) station at 13 depths from the surface to 450 meters.



NUTRIENTS AND PARTICLES

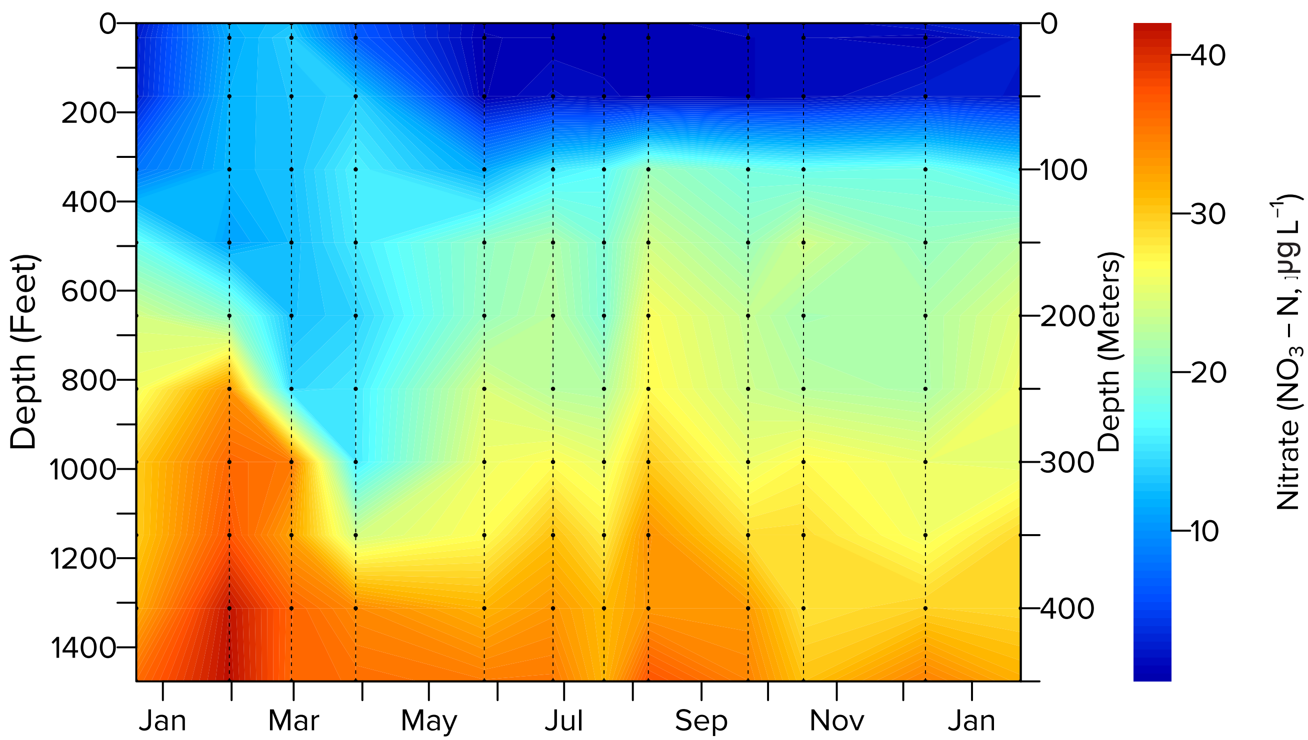
# Nitrate distribution

**In 2017**

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 300 feet are generally high. The surface waters, where sunlight enables algae to take up nitrogen as they 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, there is insufficient light for algae to grow and to use these nutrients.

Deep lake mixing will bring the deep nitrate back to the surface. 2017 was a year where mixing extended to 1,099 feet, just two-thirds of the full depth. Consequently, a substantial amount of nitrate remained trapped in the deepest water. The annual nitrate concentration at a depth of 1,485 feet was 35.7 micrograms per liter.



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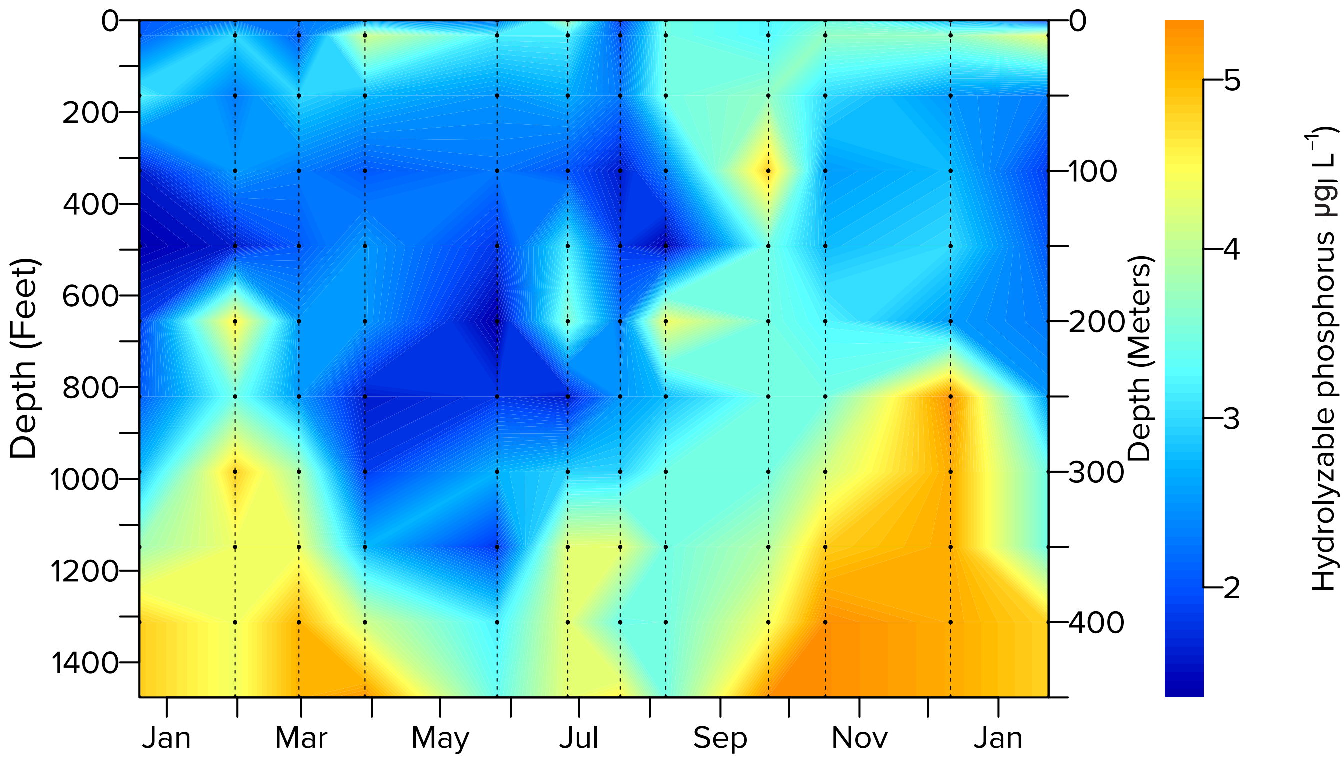
# Orthophosphate distribution

**In 2017**

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 high values near the surface between June and September, and then again in December correspond to the timing of inflows. 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. The annual THP concentration at a depth of 1,485 feet was 4.6 micrograms per liter.



NUTRIENTS AND PARTICLES

# Fine particle distribution

**In 2017**

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 (red tones) are concentrated in the upper part of the lake. This high concentration band of particles persists through the end of the year, and at concentrations higher than previous years. The particle concentration is highest from September onwards, which coincides with the annual variation in Secchi depth n 2017