TAHOE: STATE OF THE LAKE REPORT 2015

NUTRIENTS AND PARTICLES

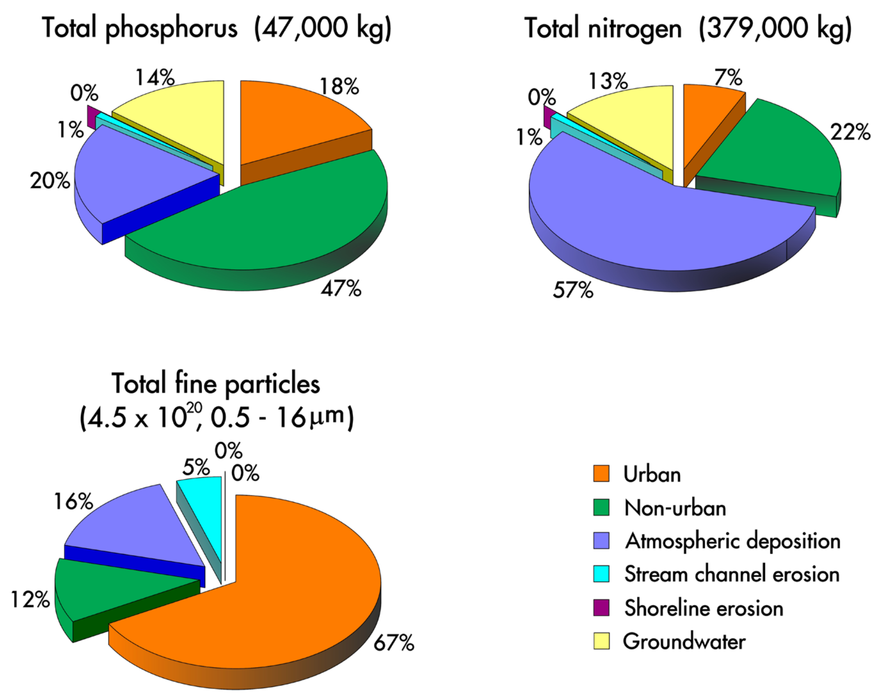
UC DAVIS
TAHOE ENVIRONMENTAL RESEARCH CENTER

NUTRIENTS AND PARTICLES

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 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 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.

The pie chart representations are based on data from the period 1994 – 2008:
Urban & Non-urban (data from 1994-2008)
Atmospheric, Stream channel erosion, Shoreline erosion, Groundwater (data from 1999-2008)



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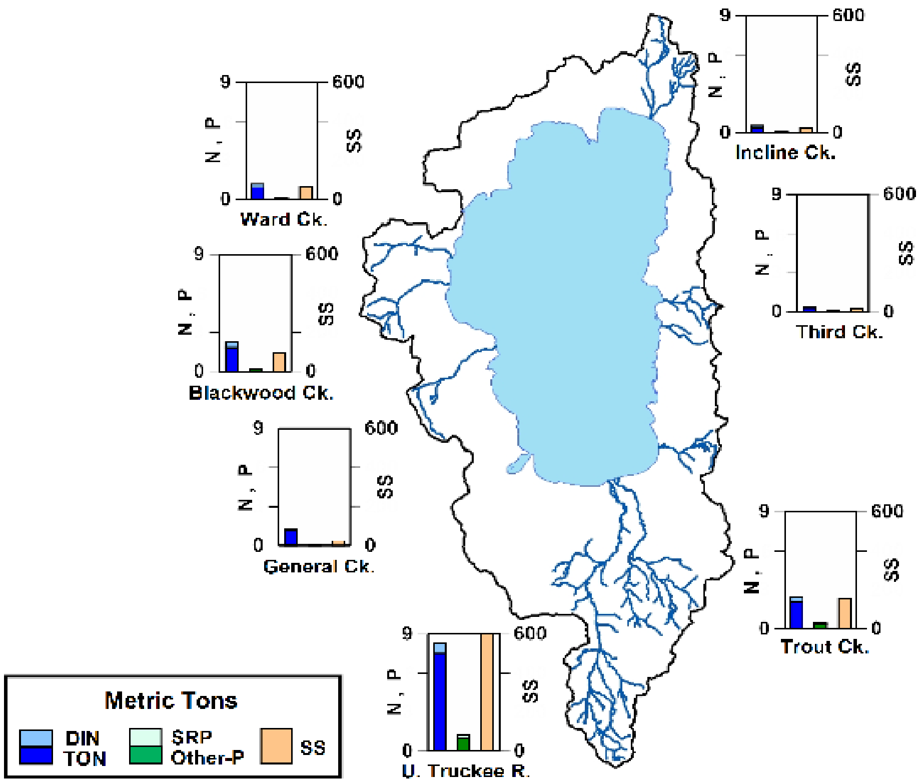
Pollutant loads from seven watersheds

In 2014

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. Most of the suspended sediment contained in the 7 LTIMP streams is from the Upper Truckee River, Blackwood Creek, Trout Creek and Ward Creek. Over 75 percent of the phosphorus and nitrogen comes from the Upper Truckee River, Trout Creek and Blackwood Creek. Pollutant loads from the west-side streams were a factor of four lower in each of the last three years, compared with 2011. This was largely due to the drier years that the basin experienced.

The LTIMP stream water quality program is supported by the U.S. Geological Survey in Carson City, Nevada, UC Davis TERC and the Tahoe Regional Planning Agency. Additional funding in 2014 was provided by the California Tahoe Conservancy and the Lahotan Regional Water Quality Control Board.



N = Nitrogen
P = Phosphorus
DIN = Dissolved Inorganic Nitrogen
SRP = Soluble Reactive Phosphorus
TON = Total Organic Nitrogen
SS = Suspended Sediment

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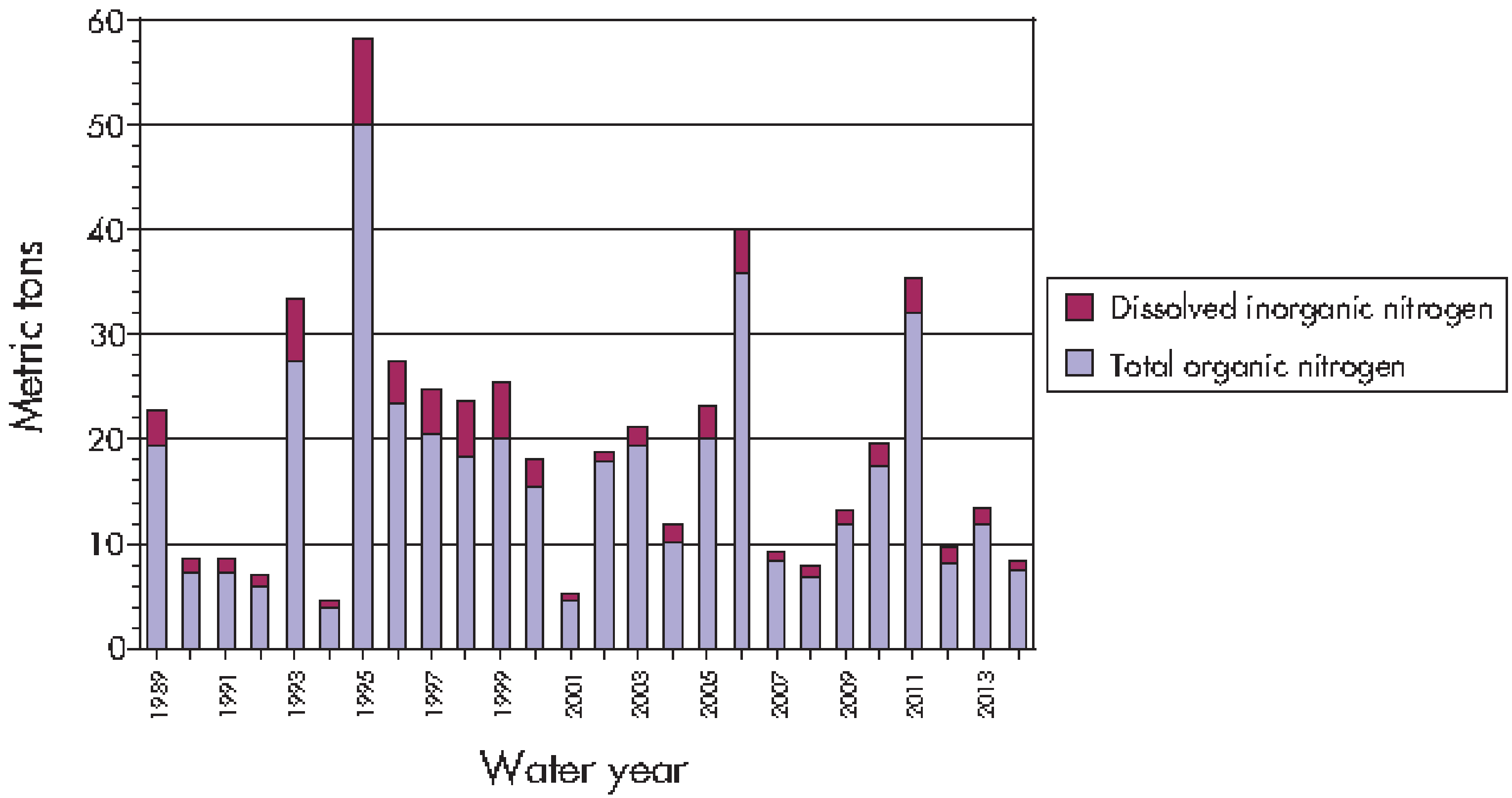
Nitrogen contribution by Upper Truckee River

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 inorganic nitrogen (nitrate and ammonium) and total organic nitrogen loads are shown here. The year-to-year variations primarily reflect changes in precipitation. For example, 1994 had 16.59 inches of precipitation and a low nitrogen load, while 1995 had 60.84 inches of precipitation and a very high nitrogen load. 2014 had 19.32 inches of precipitation, following 2013 with 25.19 inches and 2012 with 22.48 inches. (One metric ton = 2,205 pounds.)



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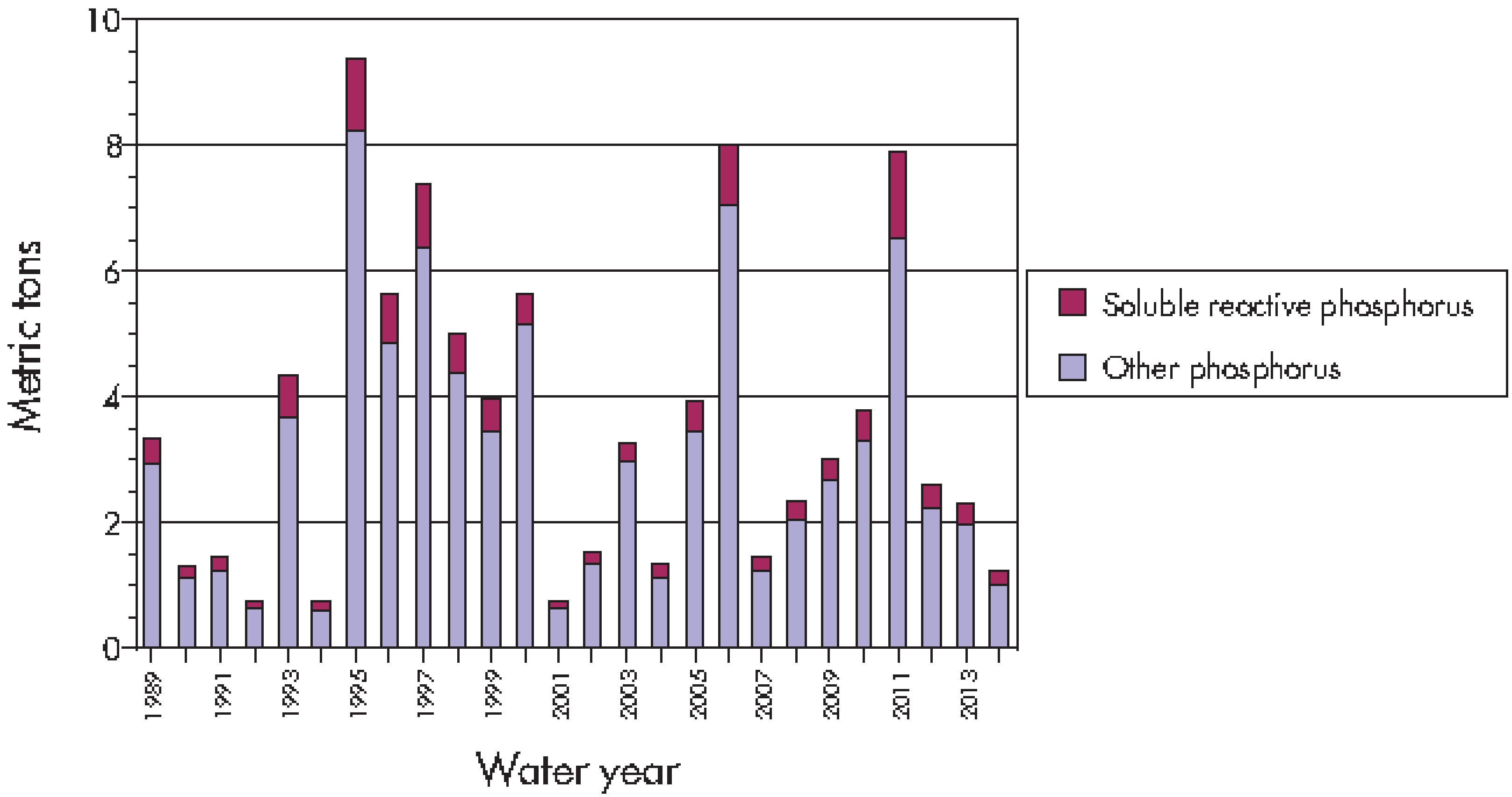
Phosphorus contribution by Upper Truckee River

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. Below average precipitation in 2014 resulted in a factor of six reduction of the phosphorus load over 2011, the last wet year. 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 = 2,205 pounds.)



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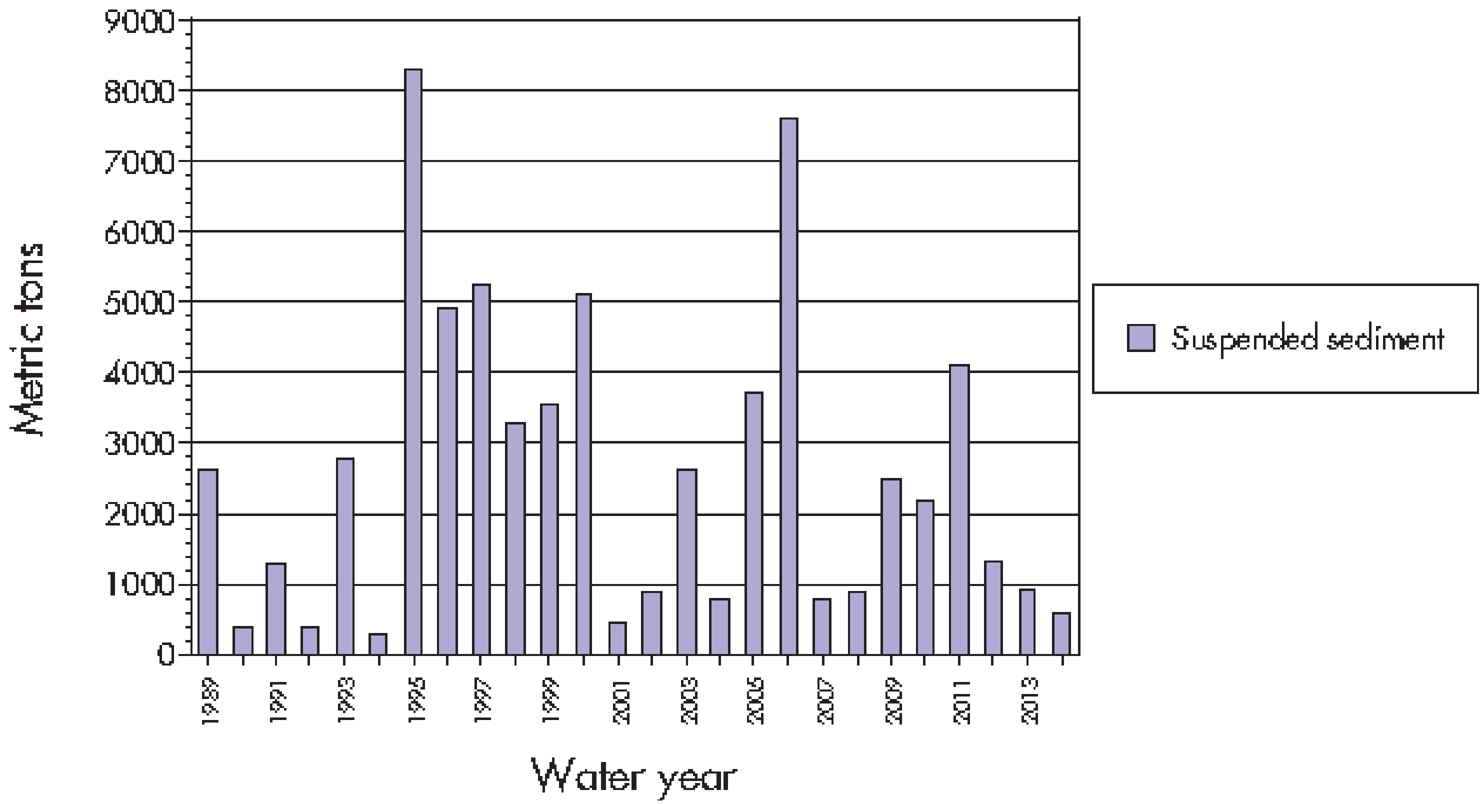
Suspended sediment contribution by Upper Truckee River

Yearly since 1989

The load of suspended sediment delivered to the lake by the Upper Truckee is related to landscape condition and erosion as well as to precipitation and stream flow. Certainly, inter-annual variation in sediment load over shorter time scales is more related to the latter. Below average precipitation in 2014 resulted in a factor of seven decrease of the suspended sediment load compared with 2011. This and the previous two figures illustrate how greatly changes in hydrologic conditions affect pollutant loads. 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.



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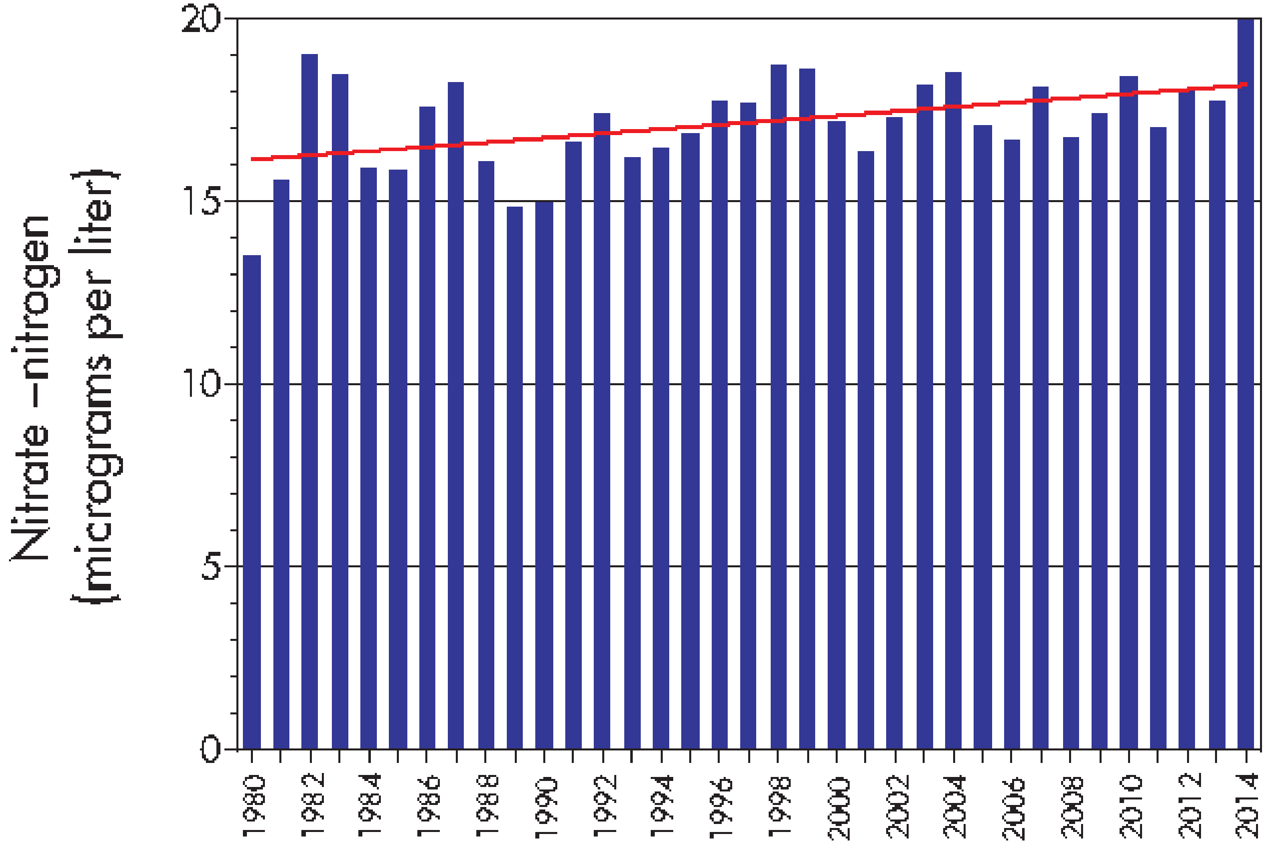
Lake nitrate concentration

Yearly since 1980

Since 1980, the volume-weighted annual average concentration of nitrate-nitrogen has remained relatively constant, ranging between 13 and 19 micrograms per liter. In 2014, the volume-weighted annual average concentration of nitrate-nitrogen reached an all-time high of 20.0 micrograms per liter. This increase is in part due to the absences of deep mixing this year, allowing for a continued build up of nitrate in the deep water.

Water samples are taken from the R/V John LeConte at the MLTP (mid-lake) station at 13 depths from the surface to 450 meters. The nutrient analysis is performed at the TERC laboratory in Incline Village, Nevada.



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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 tended to decline. In 2014, the volume-weighted annual average concentration of THP was approximately 2.1 micrograms per liter, a decrease over the previous year.

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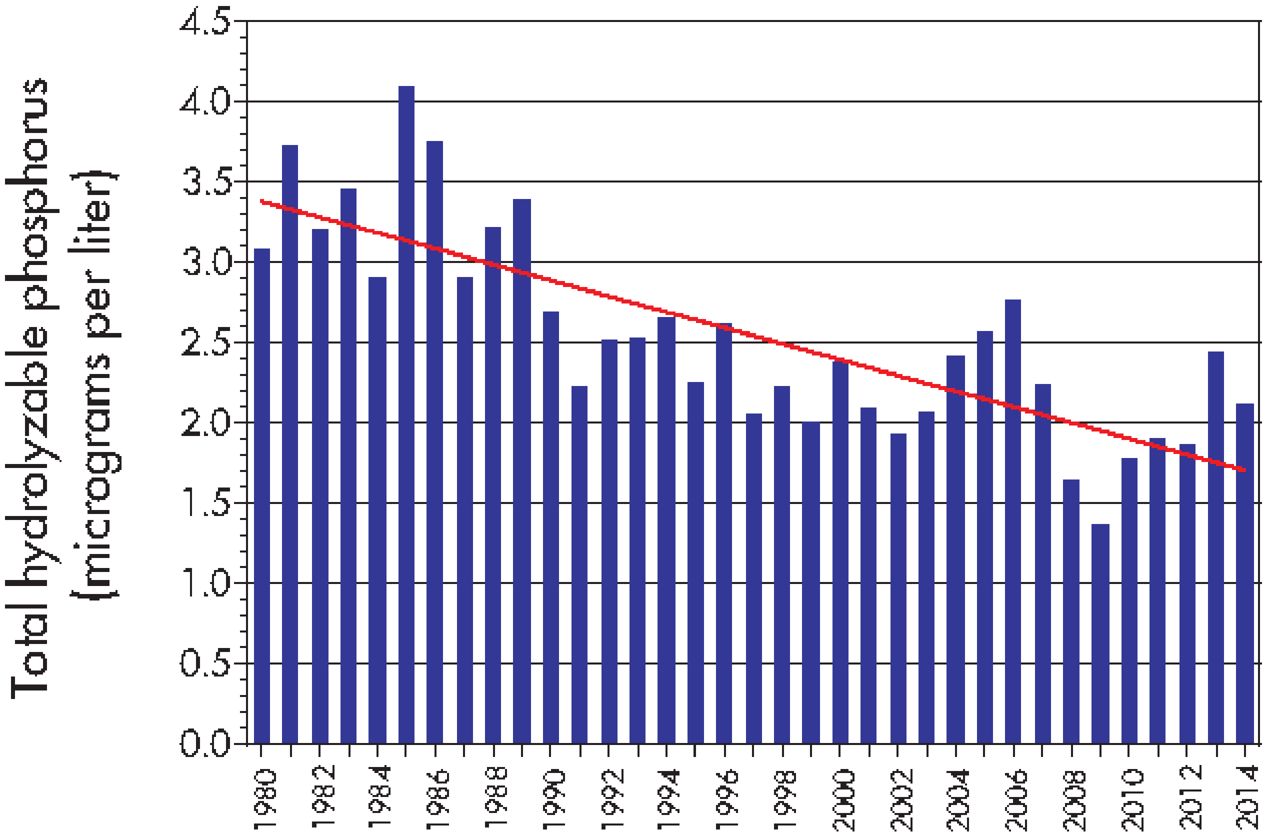


NUTRIENTS AND PARTICLES

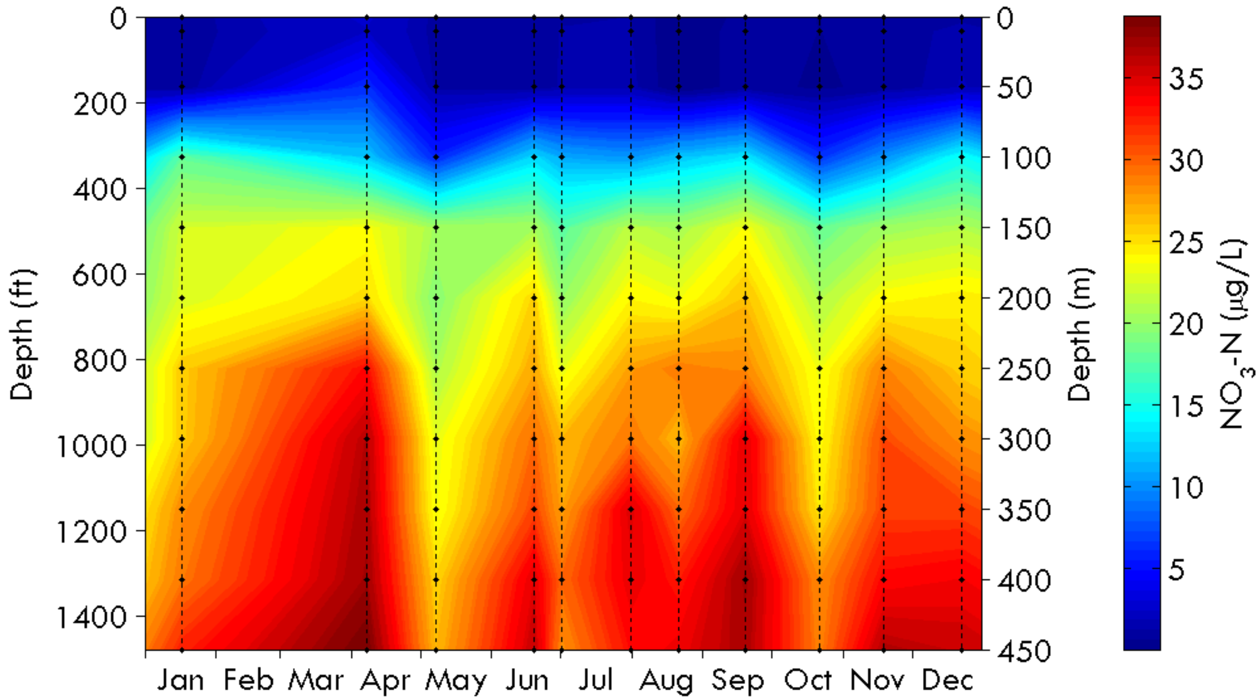
Nitrate distribution

In 2014

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 in this figure is the vertical distribution of nitrate. Concentrations below a depth of about 350 feet are generally high. 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 used up by the algae. 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.

Deep lake mixing will bring the deep nitrate back to the surface. 2014 was a year with very shallow mixing, extending to only 400 feet, and so most of the nitrate remained trapped in the deep water. The annual nitrate concentration at 1485 feet was a record high value of 34 micrograms per liter.



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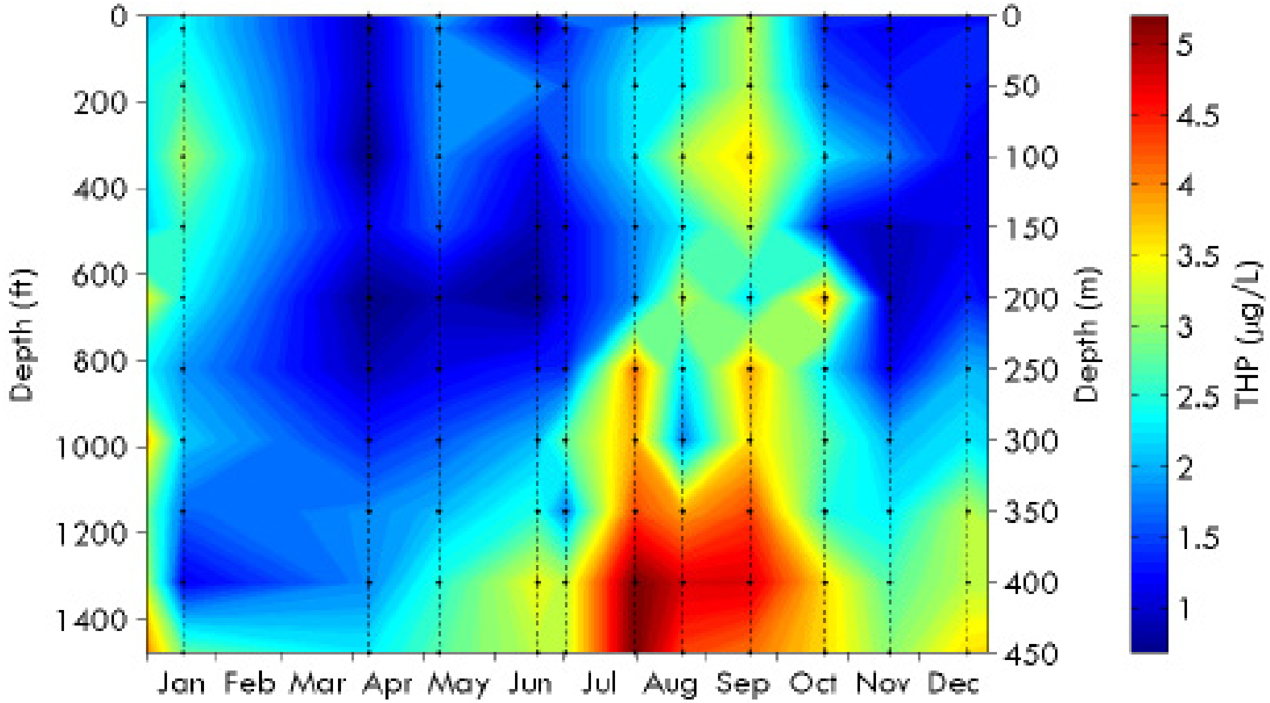
Orthophosphate distribution

In 2014

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.

Unlike nitrate distribution, there is little vertical distribution of THP. Phosphorus mainly enters the lake in association with fine particles during runoff events. Because of the low snowmelt volumes in 2014, there were very low concentrations of phosphorus at the surface in Spring, with available phosphorus rapidly taken up by algae. 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.



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Fine particle distribution

In 2014

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 in the figure is that the highest concentrations of fine particles (red tones) are concentrated in the upper part of the lake. In the early part of the year (winter), when clarity is generally highest, surface concentration of particles is the lowest. The particle concentration is highest after July, which coincides with the annual variation in Secchi depth this year. The fine particles gradually clump together (aggregate) which causes them to have less impact on clarity and allows them to more rapidly settle to the lake bottom.