PHYSICAL PROPERTIES

Lake surface level
Daily since 1900

Lake surface level varies throughout the year. It rises due to high stream inflow, groundwater inflow and precipitation directly onto the lake surface. It falls due to evaporation, in-basin water withdrawals, groundwater outflows, and outflow via the Truckee River at Tahoe City. Overall, lake level fell during 2012. The highest lake level was 6227.68 feet on June 5, and the lowest was 6225.37 feet on November 28. In 2012, the lake level rose by only 1.3 feet during snowmelt, compared with 3.9 feet in 2011.
PHYSICAL PROPERTIES

Lake surface level, continued
Daily since 2010

Identical data as used on page 8.1 except the period displayed is shortened to 2010-2012. This more time resolved presentation of recent lake level data allows us to see the seasonal patterns in higher definition. Data clearly show the lake level below the natural rim at the beginning of 2010 as well as the timing of highest yearly lake levels in late spring following snowmelt. The effects of the very early snowmelt in 2012 on lake level are clearly evident.

![Graph showing lake level changes from 2010 to 2012 with notable peaks and troughs, illustrating seasonal patterns.]
PHYSICAL PROPERTIES

Water temperature profile
In 2012

Water temperature profiles are measured in the lake using a Seabird CTD at the times indicated by the dots along the top of the figure. The temperature is accurate to within 0.005 °F. Here the temperature in the upper 330 feet is displayed as a color contour plot. In 2012, the lake temperature followed a typical seasonal pattern. In late March, the lake surface was at its coldest but complete vertical mixing down to 1625 feet did not occur. The beginning of the 2012-2013 winter mixing is evident at the end of the plot, with the surface layer both cooling and deepening. By the end of 2012, mixing had proceeded to only 80 feet, a relatively shallow amount. Arrows indicate days on which profiles were measured.
PHYSICAL PROPERTIES

Average water temperature
Since 1970

The trend in the volume-averaged temperature of Lake Tahoe has increased by approximately 0.7 °F since 1970. The monthly temperature profile data from the lake has been smoothed and deseasonalized to best show the long-term trend. Up till the late 1990s the warming rate was considerably greater, but a high number of deep mixing years since 1997 have slowed the warming rate.
PHYSICAL PROPERTIES

Annual average water temperature

Since 1970
The volume-averaged temperature of the lake for each year since 1970 is shown. In 2012 the volume-averaged temperature increased by 0.4 °F over the previous year. The years with the largest decreases in temperature generally correspond to those years in which deep mixing occurred.
PHYSICAL PROPERTIES

Surface water temperature
Yearly since 1968

Surface water temperatures have been recorded monthly at the mid-lake station since 1968 from the R/V John LeConte. Despite year-to-year variability, water temperatures show an increasing trend. The average temperature in 1968 was 50.3 °F. For 2012, the average surface water temperature was 52.8 °F, an increase of 1.6 °F over 2011, making it the warmest year yet recorded.
**PHYSICAL PROPERTIES**

**Maximum daily surface water temperature**

Surface temperature measured since 1999 every 2 minutes

Maximum daily surface water temperatures were slightly higher in 2012 than the previous year. The highest maximum daily surface water temperature was 75.65 °F, which was recorded on August 14, 2012. The lowest maximum daily surface water temperature was 41.41 °F, which was recorded on March 18, 2012. These data are collected in real-time by NASA and UC Davis from 4 buoys located over the deepest parts of the lake.
**PHYSICAL PROPERTIES**

**July average surface water temperature**

*Measured since 1999 every 2 minutes*

Since 1999, surface water temperature has been recorded every two minutes from four NASA/UC Davis buoys. Shown here are 14 years of average surface water temperatures in the month of July when water temperatures are typically warmest. In 2012, July surface water temperature averaged 63.3 °F, compared with 62.7 °F in 2011. This increase is most likely attributable to the absence of deep lake mixing in 2012, an event that cools the surface layers of the lake. The average for the 14 year period is 64.7 °F.
Physica| Properties

Deep water temperature
Since 1970

The water temperature at a depth of 1320 feet (400 m) is indicative of conditions in the deeper waters (hypolimnion) of Lake Tahoe. Since 1970 the deep water temperature has increased by approximately 1 °F. This increase has not been steady but is punctuated by occasional drops in temperature. These coincide with times when the lake mixes all the way to the bottom, an event which allows a huge amount of heat to escape from the lake. The short spikes of temperature increase are temporary effects caused by sloshing of internal waves.
PHYSICAL PROPERTIES

Depth of mixing
Yearly since 1973

Lake Tahoe mixes each winter as surface waters cool and sink downward. In a lake as deep as Tahoe, the wind energy and intense cooling of winter storms helps to determine how deeply the lake mixes. Mixing depth has profound impacts on lake ecology and water quality. Deep mixing brings nutrients to the surface, where they promote algae growth. It also moves oxygen to deep waters, promoting aquatic life throughout the water column.

The deepest mixing typically occurs in February to March. In 2012, Lake Tahoe mixed to a depth of only 820 feet (250m). This lack of deep mixing most likely contributed to the warmer surface temperature and the improved clarity.
PHYSICAL PROPERTIES

Lake stability

Since 1968

When the lake has a vertical distribution of temperature, it has a corresponding density distribution, with warm and lighter water at the surface, and colder, denser water at depth. The stability index is a measure of the energy required to fully mix the lake when its density is stratified. Plotted here is the average stability index for the upper 100 meters (330 feet) of Lake Tahoe for the period of May through October each year. The values are derived from temperature profiles taken at the Index Station at approximately 10-20 day intervals. There has been an overall increase in lake stability in the last 45 years. In 2012, the lake stability was at an all time high.
PHYSICAL PROPERTIES

Stratified season length
Since 1968

The stability index, a measure of the energy required to fully mix the lake, can be evaluated for every day of the year. We define the stratification season as the length of time when the stratification index exceeds a value of 600 kilograms per square meter. Since 1968 the length of the stratification season has lengthened, albeit with considerable year-to-year variation. Overall the stratification season has lengthened by approximately three weeks.
PHYSICAL PROPERTIES

Beginning of the stratification season
Since 1968

The length of time that Lake Tahoe is stratified has lengthened since 1968 by approximately three weeks. The commencement of stratification appears to occur earlier in the year by approximately three days on average.
End of stratification season

Since 1968

The length of time that Lake Tahoe is stratified has lengthened since 1968 by approximately three weeks. The end of stratification appears to have been extended by approximately 18 days on average. In other words, the fall season for the lake has been considerably extended.
PHYSICAL PROPERTIES

Peak stratification value
Since 1968

The maximum value that the stability index obtains for each year has been plotted. As can be seen, the strength of the stratification has not changed significantly since 1968. However, as the previous figures indicate, the length of time for which the lake remains density stratified has increased.
**PHYSICAL PROPERTIES**

**Mean daily streamflow of Upper Truckee River vs. Truckee River**

*Water Year 2012*

The Upper Truckee River, the largest inflow into Lake Tahoe, has a natural annual hydrograph for a snow-fed stream. The small peaks in the hydrograph represent rain events or short warm periods in winter or spring. The major peak in the hydrograph represents the maximum spring snowmelt. The peak in 2012 was 678 cubic feet per second on April 26, two-thirds of the previous year's peak. The Truckee River is the only outflow from Lake Tahoe. It is a regulated flow, with release quantity controlled by the Federal water master. The release rates are set according to downstream demands for water and concerns for flooding. The maximum discharge in 2012 was 368 cubic feet per second on June 26 (50% higher than the previous year), and the peak temperature of the discharge was 72.7 °F on August 15. Streamflow data are collected by the US Geological Survey under the Lake Tahoe Interagency Monitoring Program (LTIMP).
PHYSICAL PROPERTIES

Truckee River summer discharge and lake elevation

Since 1980

Flow into Lake Tahoe (e.g. Upper Truckee River) and discharge out of Lake Tahoe (Truckee River at Tahoe City) have shown considerable variation since 1980. The large peaks in discharge from the lake correspond to years when precipitation (and therefore total inflow) was the greatest, e.g. 1982-1983, 1986, 1995-1999. Similarly, the drought-like conditions in the early 1990s and the low precipitation years in the beginning of the 2000s also stand out. Since many of the pollutants of concern for Lake Tahoe’s clarity enter along with surface flow, year-to-year changes in clarity are influenced by precipitation and runoff.

In 2012 discharges into and out of the lake were well below the long-term averages. The Upper Truckee River inflow volume was 1.80 billion cubic feet (long-term average 3.09). The Truckee River discharge was 5.65 billion cubic feet (long-term average 7.29).
PHYSICAL PROPERTIES

Truckee River Summer Water Temperatures
Since 1993

Water temperature of the Truckee River as it departs Lake Tahoe in the summer months (July-September) is measured by the US Geological Survey. Data gaps prevent a complete pattern, but the measurements suggest that a 4-5 °F rise in the average temperature has occurred during the period since 1993. Average air temperatures from Lake Tahoe for the same period also suggest a temperature rise but at a lower rate. Rising river temperatures impact downstream fish spawning.
**Annual Discharge Volume for Upper Truckee River and Truckee River**

*Since 1980*

Flow rate of the Truckee River as it departs Lake Tahoe in the summer months (July-September) and lake level is measured by the US Geological Survey. Here the relationship between these two variables is evident, with mean daily river discharge typically showing a one year lag from the mean lake elevation. Gage height is measured relative to a datum of 6,220 feet. Release of water from Lake Tahoe is controlled by the Federal Water Master.