

TAHOE:
**STATE
OF THE
LAKE**
REPORT
2023

PHYSICAL PROPERTIES

Lake surface level

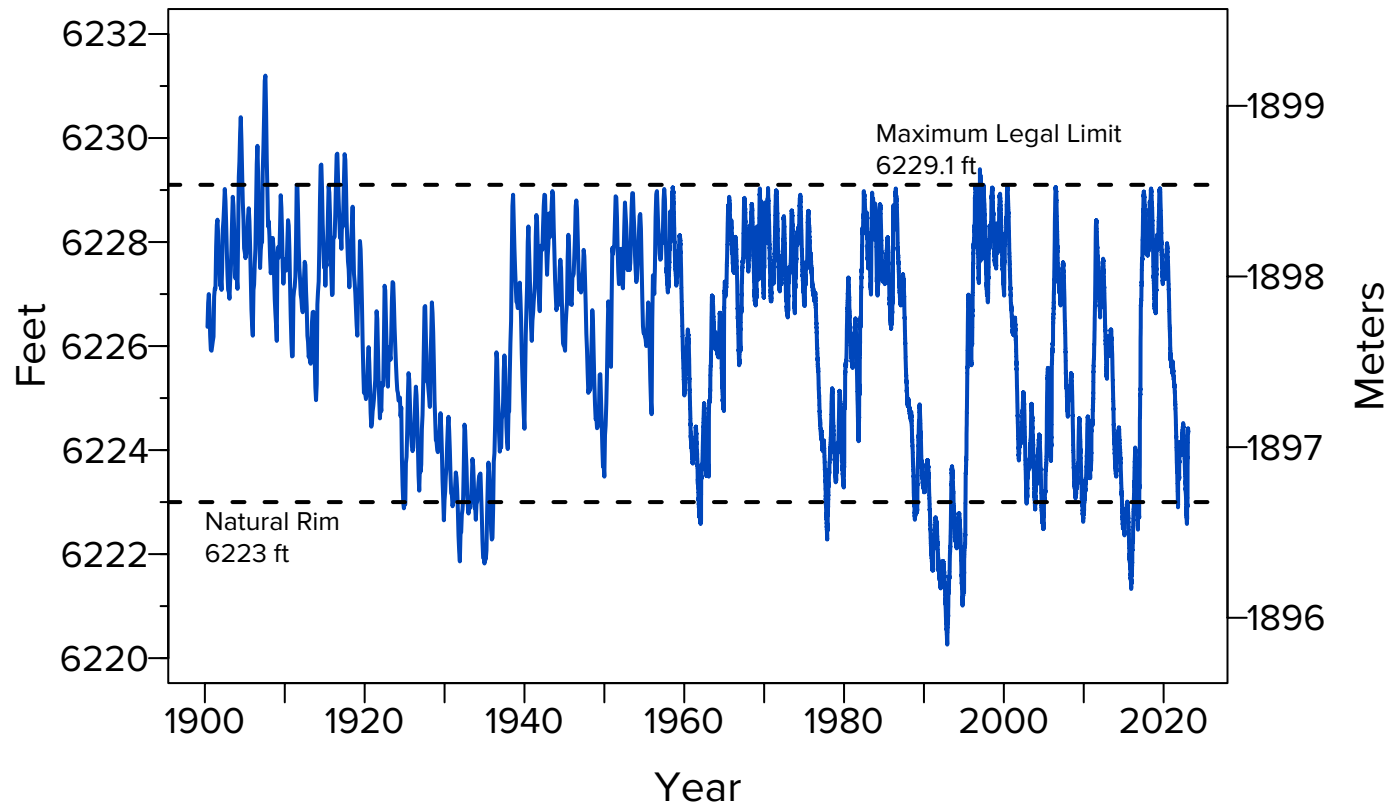
Daily since 1900

Lake surface level varies throughout the year. Lake levels rise due to high stream inflow, groundwater inflow, and precipitation of rain and snow directly onto the lake surface. It falls due to evaporation, in-basin water withdrawals, groundwater outflows, and outflows via the Truckee River at Tahoe City. In 2022, the highest lake level was 6,224.52 feet

on June 13, and the lowest was 6,222.58 feet on November 30, 2022. The natural rim of the lake is at an elevation of 6,223 feet. Lake Tahoe fell below its rim on October 24 but rose back above it on December 27. When the lake was below its rim, outflows via the Truckee River ceased. Several episodes of lake level falling below the natural rim are evident

since 1920. The frequency of low water episodes appears to be increasing. The lowest lake level on record is 6,220.26 feet on November 30, 1992 when the lake was 2.74 feet below the natural rim.

Data source: U.S. Geological Survey level recorder in Tahoe City.



Lake surface level

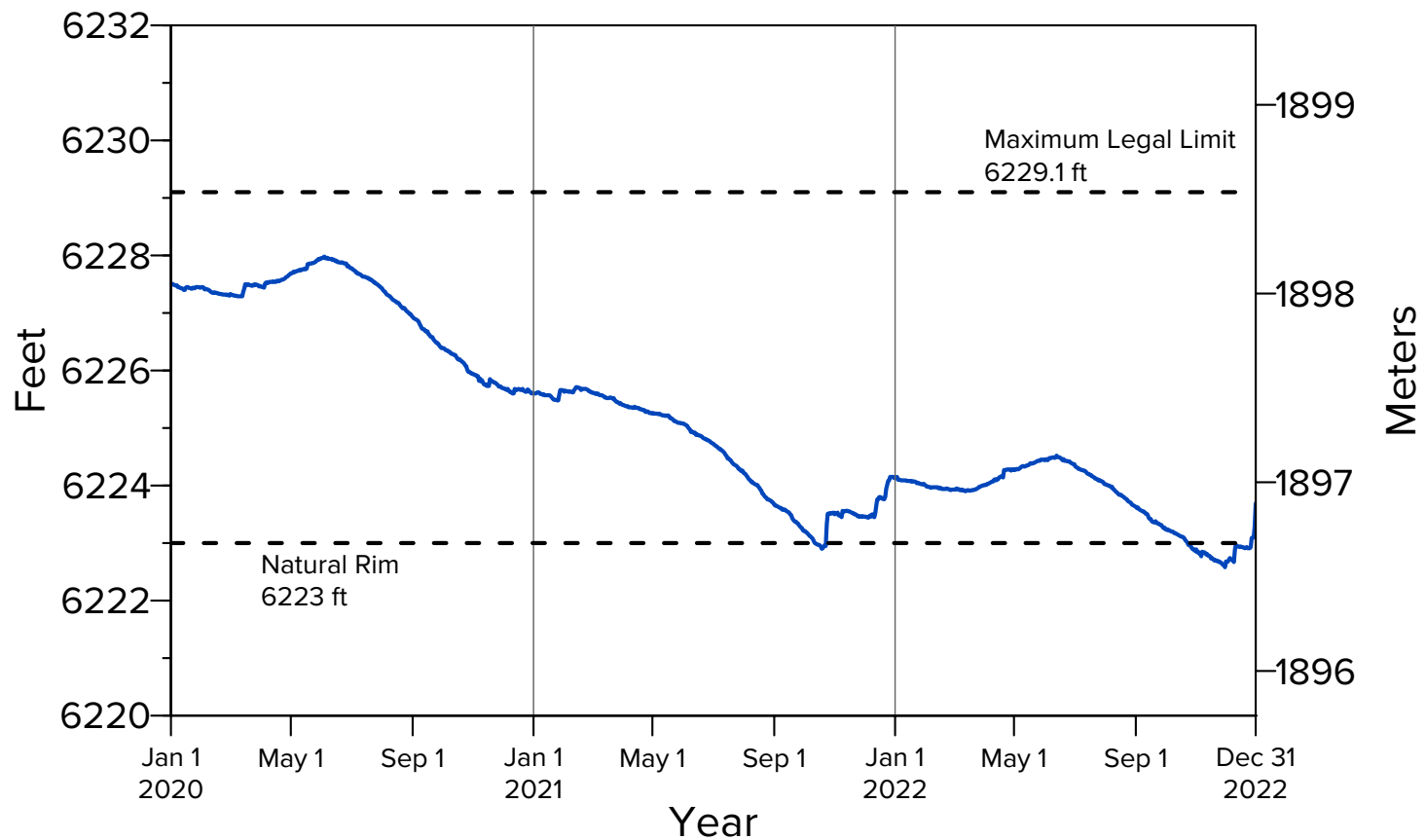
Daily in 2020, 2021, and 2022

The subset of lake surface data is extracted from the same data as in Figure 8.1 for the most recent three years from 2020–2022. This more time-restricted presentation of recent lake level data better displays the annual patterns of rising and falling lake level in greater detail.

In 2022, on account of the average precipitation, the winter and spring rises in lake level are evident. Precipitation in October and December 2021 produced sudden jumps in lake level. Snowmelt in spring continued the rise in lake level, but after June 13 the water level slowly fell

until winter precipitation again caused lake level to rise.

Data source: U.S. Geological Survey level recorder in Tahoe City.



Water temperature profile

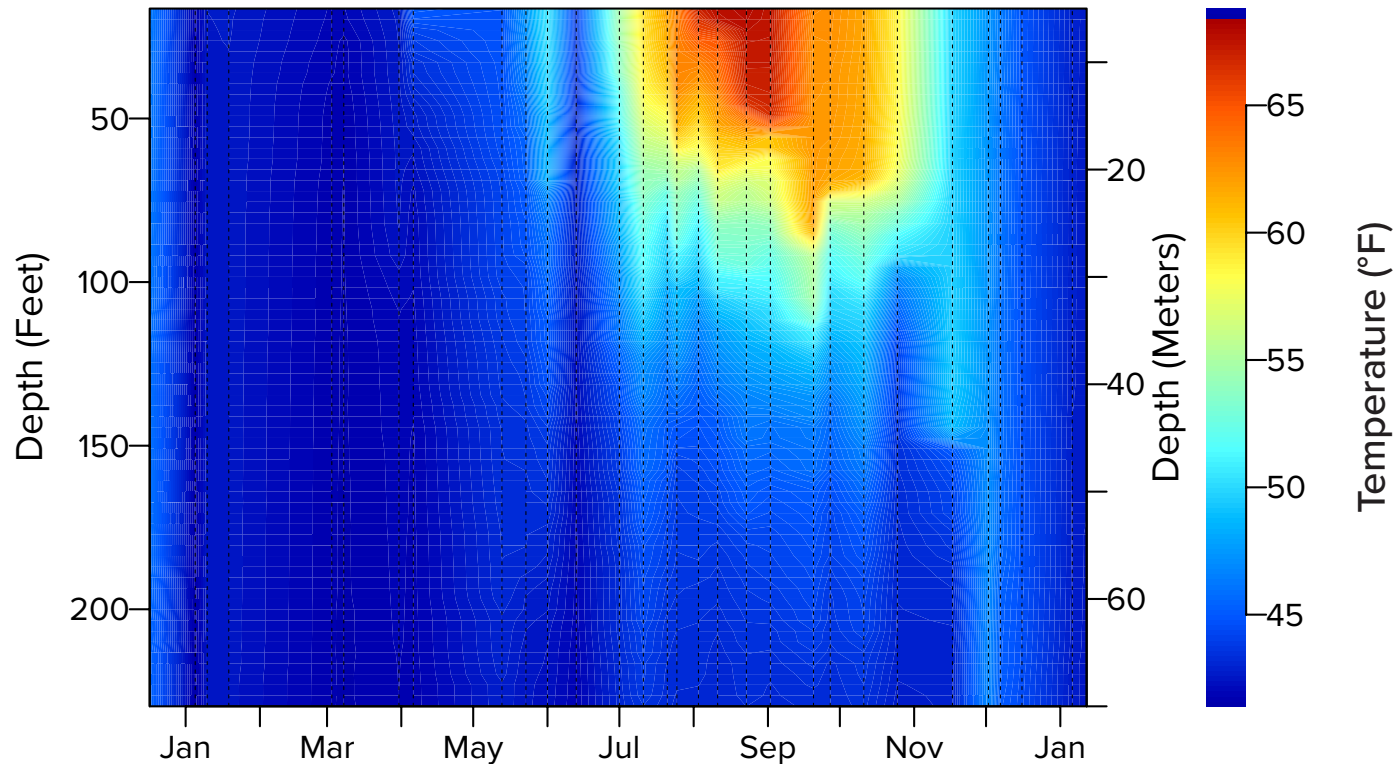
In 2022

Water temperature profiles are measured in the lake using a CTD (conductivity, temperature, depth) profiler on the days indicated by the dashed vertical lines. The measured temperature is accurate to within 0.005 °F. The vertical distribution of water temperature is a very important

lake attribute as it represents lake density. During the summer months, the warmer, lighter water remains suspended at the lake surface. The temperature in the upper 230 feet (70 m) of Lake Tahoe is displayed as a color contour plot. In the early part of 2022, the lake temperature

followed the typical seasonal pattern. In February and March, the lake surface was at its coldest, while it was at its warmest in August.

Data source: TERC lake monitoring.



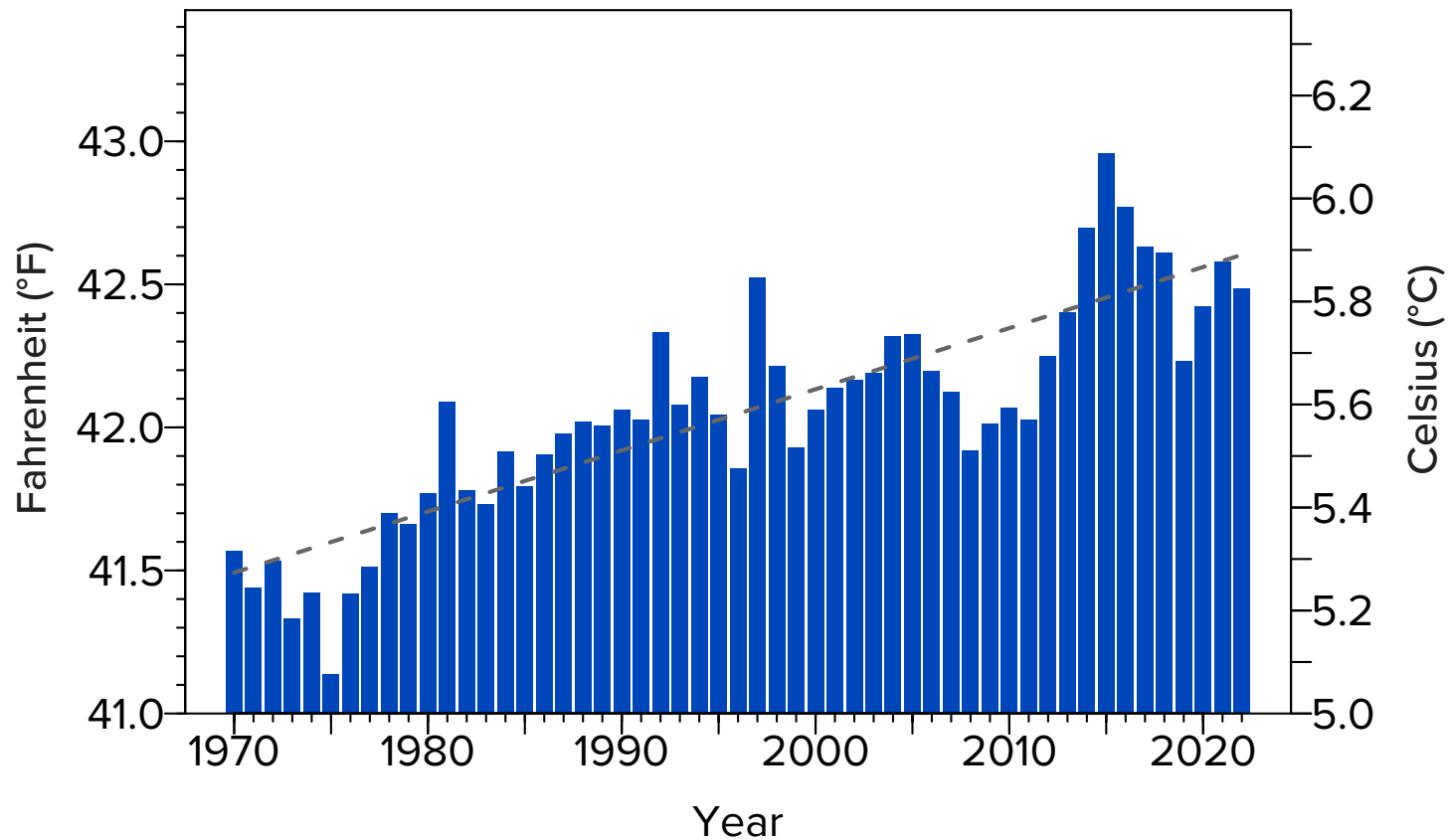
Annual average water temperature

Since 1970

The volume-averaged temperature of the lake for each year since 1970 is shown. The trend line indicates that water temperature has increased by approximately 1.1 °F (0.62°C) since 1970. The annual rate of warming is

0.21 °F/decade (0.12 °C/decade). The monthly temperature profile data from the top to the bottom of the lake has been smoothed, and any seasonal influences were removed to best show the long-term trend.

Data source: TERC lake monitoring.



Annual surface water temperature

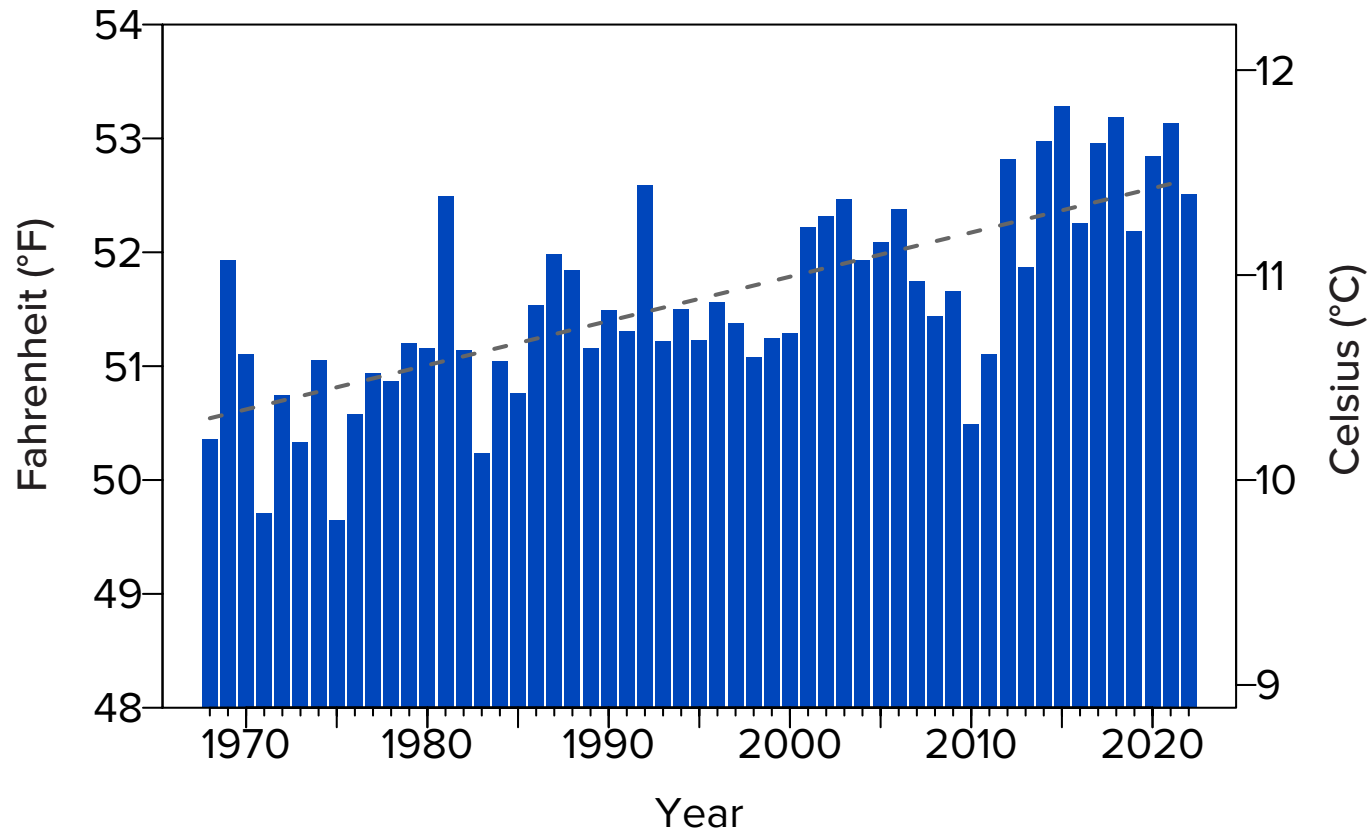
Yearly since 1968

Surface water temperatures (measured at a depth of 5 feet) have been recorded monthly at the Mid-lake and Index stations from TERC's research vessels since 1968 and from four research buoys since 2007. Despite year-to-year and

longer cyclical variability, the annual average surface water temperatures show an increasing trend. The average temperature in 1968 was 50.4 °F (10.2 °C). For 2022, the average surface water temperature was 52.5 °F (11.4 °C),

slightly below the long-term trend line. The overall rate of warming of the lake surface is 0.39 °F (0.22 °C) per decade.

Data source: TERC lake monitoring.



Maximum daily surface water temperature

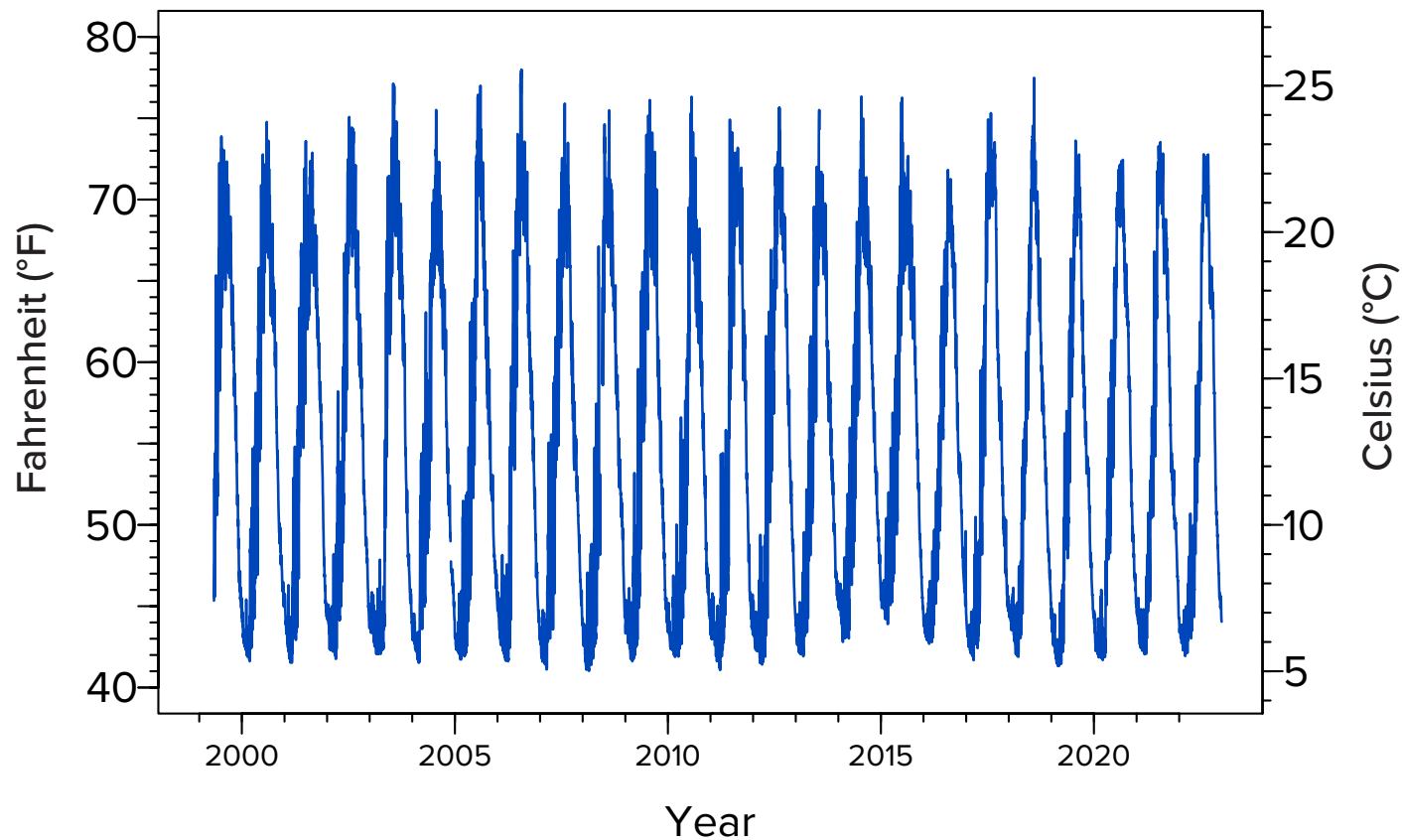
Surface temperature measured since 1999 every 2 minutes

The maximum daily surface water temperature follows a sinusoidal pattern, with the temperature being in equilibrium with the air temperature and other meteorological variables. In 2022, the highest maximum daily surface water temperature (summer) was 72.8 °F (22.7

°C), recorded on July 30, 2022. The lowest maximum daily surface water temperature (winter) was 41.9 °F (5.5 °C), which was recorded on February 22. This was relatively warm, due in part to the absence of deep mixing.

These data are collected from

thermistors at a depth of 5 feet (1.5 m) that are attached to four research buoys located over the deepest parts of the lake. The highest daily value from among the four buoys is considered as the daily maximum.



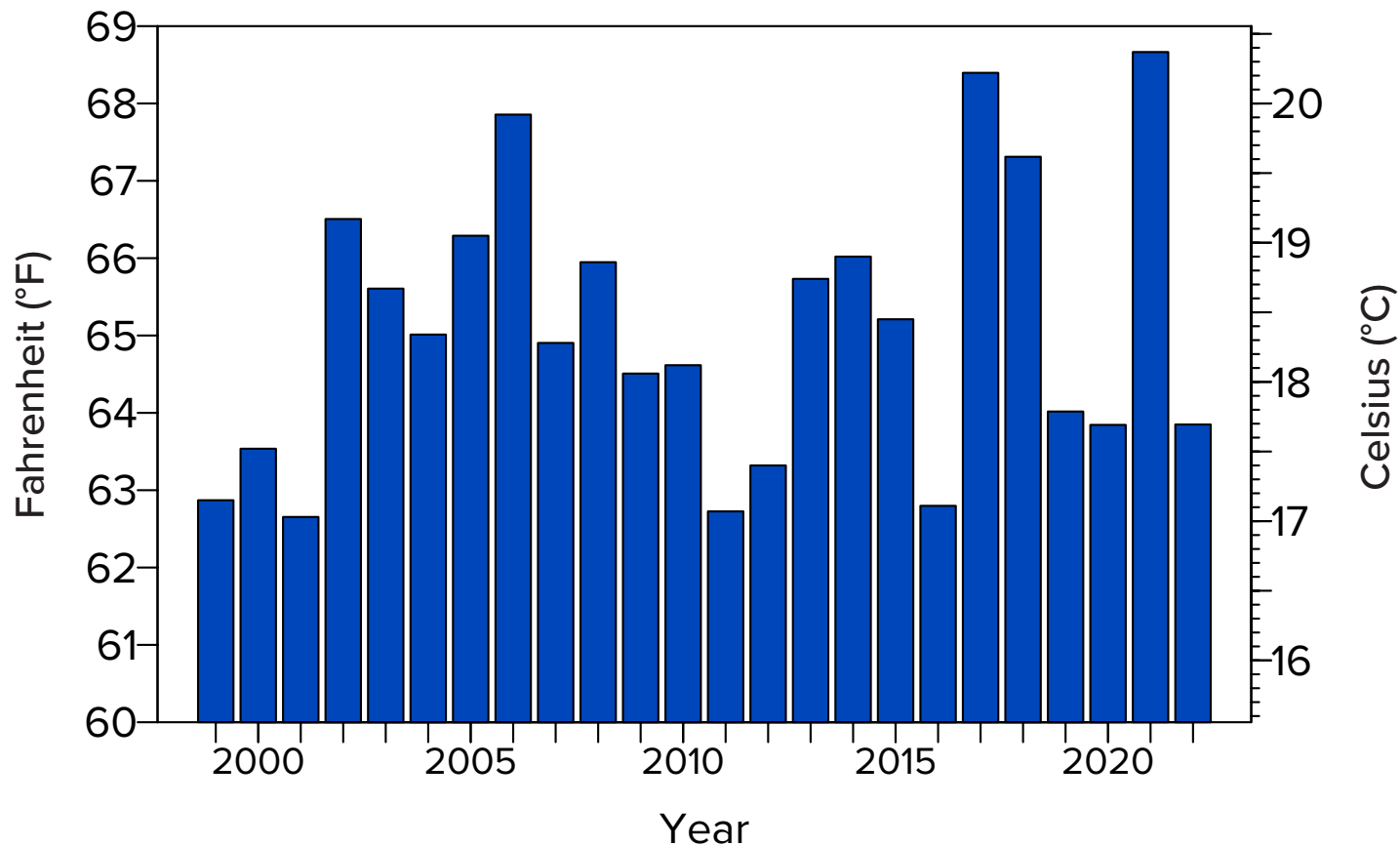
July average surface water temperature

Measured since 1999 every 2 minutes

Surface water temperature has been continuously recorded since 1999 from four NASA/UC Davis buoys in the center of the lake. Shown here are 24 years of average surface water temperatures in the month of July when water temperatures are typically at their warmest and the

greatest number of people are recreating on the lake. In 2022, July surface water temperature was relatively cool. It averaged 63.8 °F (17.7 °C). This was a decline of over 4.8 °F from the record setting value of the previous year. The long-term average is 65.1°F (18.4°C) for

the 24-year period of record. These data are collected from thermistors at a depth of 5 feet (1.5 m) that are attached to four buoys located over the deepest portions of the lake.



Deep water temperature

Monthly since 1970

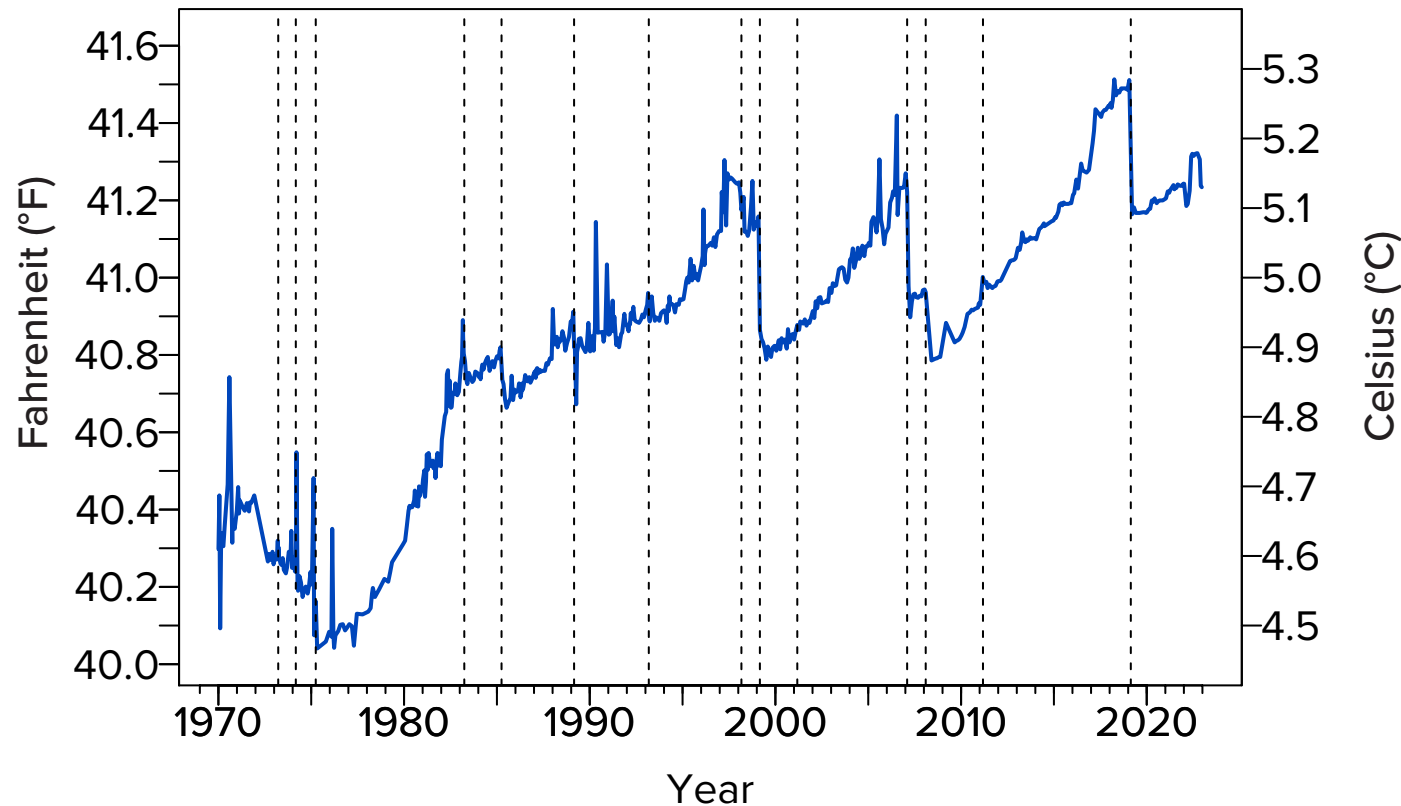
The water temperature at a depth of 1,320 feet (400 m) is indicative of conditions in the deeper waters (hypolimnion) of Lake Tahoe. The deep-water temperatures show a complex pattern of warming and sudden cooling. During deep mixing events (the dashed vertical lines), the temperature can drop “precipitously” over a short period of time, although these drops are

generally less than 0.3 °F. The heating of the bottom water along with the fluctuations when deep mixing does not occur is an area of current research.

In general, bottom temperatures are warming. In 2022, there was no deep mixing (see Fig. 8.9) and water temperatures rose slightly. Between the last two deep mixing events in 2011 and

2019, the rate of water warming was 0.07 °F/yr. During the deep mixing of 2019, the water temperature fell over 0.3 °F in just a few weeks. Complete vertical mixing is an event that allows a huge amount of heat to escape from the lake.

Data source: TERC lake monitoring.



Depth of mixing

Yearly since 1973

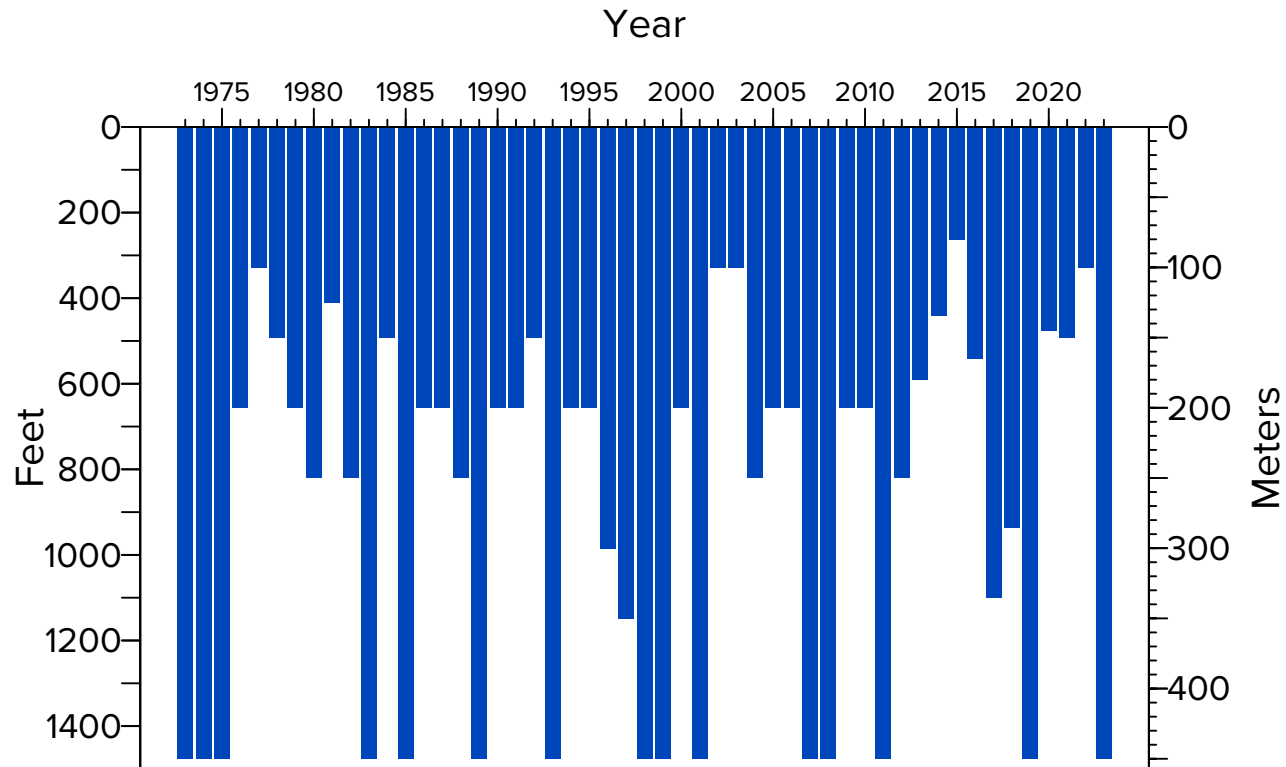
The water of Lake Tahoe vertically mixes each winter as surface waters cool and sink downward. In a lake as deep as Tahoe, the intensity of cooling in winter determines how deep the lake mixes vertically. Mixing depth has profound impacts on lake ecology and water quality. Deep mixing brings nutrients that promote algal growth to the surface. It also carries oxygen downward to deep waters, promoting aquatic life throughout

the water column.

The deepest mixing typically occurs between February and March. On February 18, 2022, Lake Tahoe was observed to have mixed to a maximum depth of 330 feet (100 m), the second lowest value on record. On March 3, 2023, Lake Tahoe mixed fully to a depth of 1476 feet (450 m). The duration of the 2023 mixing period is one of the longest recorded.

Since 2013, the depth of mixing has been determined with high-resolution temperature profiles rather than nitrate concentration sampled at discrete depths. Continuous temperature measurements off Glenbrook provided additional confirmation data.

Data source: TERC lake monitoring.



Lake stability index

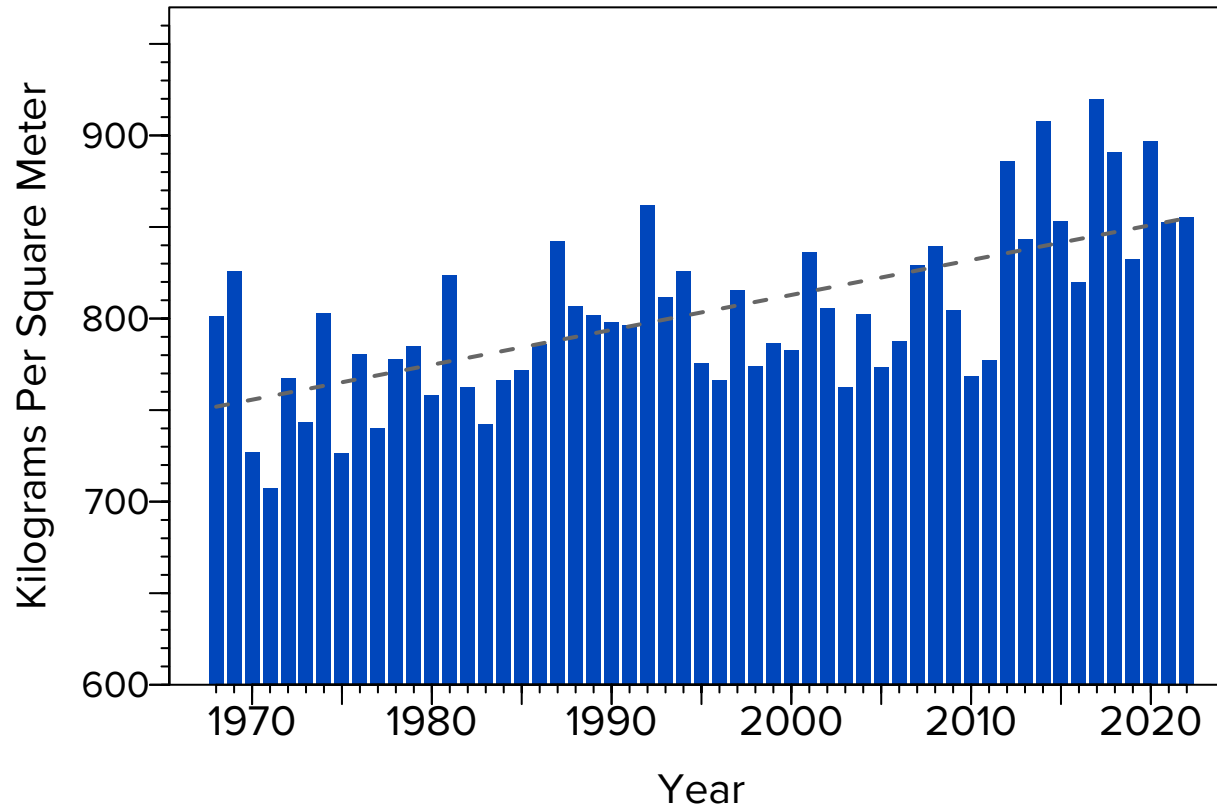
Since 1968

When the lake has a vertical distribution of temperature, it has a corresponding distribution of density. Warmer and lighter water remains at the surface above the colder and denser water below. As the temperature difference between top and bottom increases, the lake is said to become more stable. Increasing stability

poses a potential threat to all lakes. The stability index is a measure of the energy required to vertically mix the lake when it is density stratified. The average stability index for the upper 330 feet (100 m) of Lake Tahoe is plotted for the period of May through October each year. The values are derived from temperature

profiles taken at the Index Station at approximately 10- to 20-day intervals. There has been an overall increase in lake stability by 13.4 percent in the last 55 years.

Data source: TERC lake monitoring.



Stratified season length

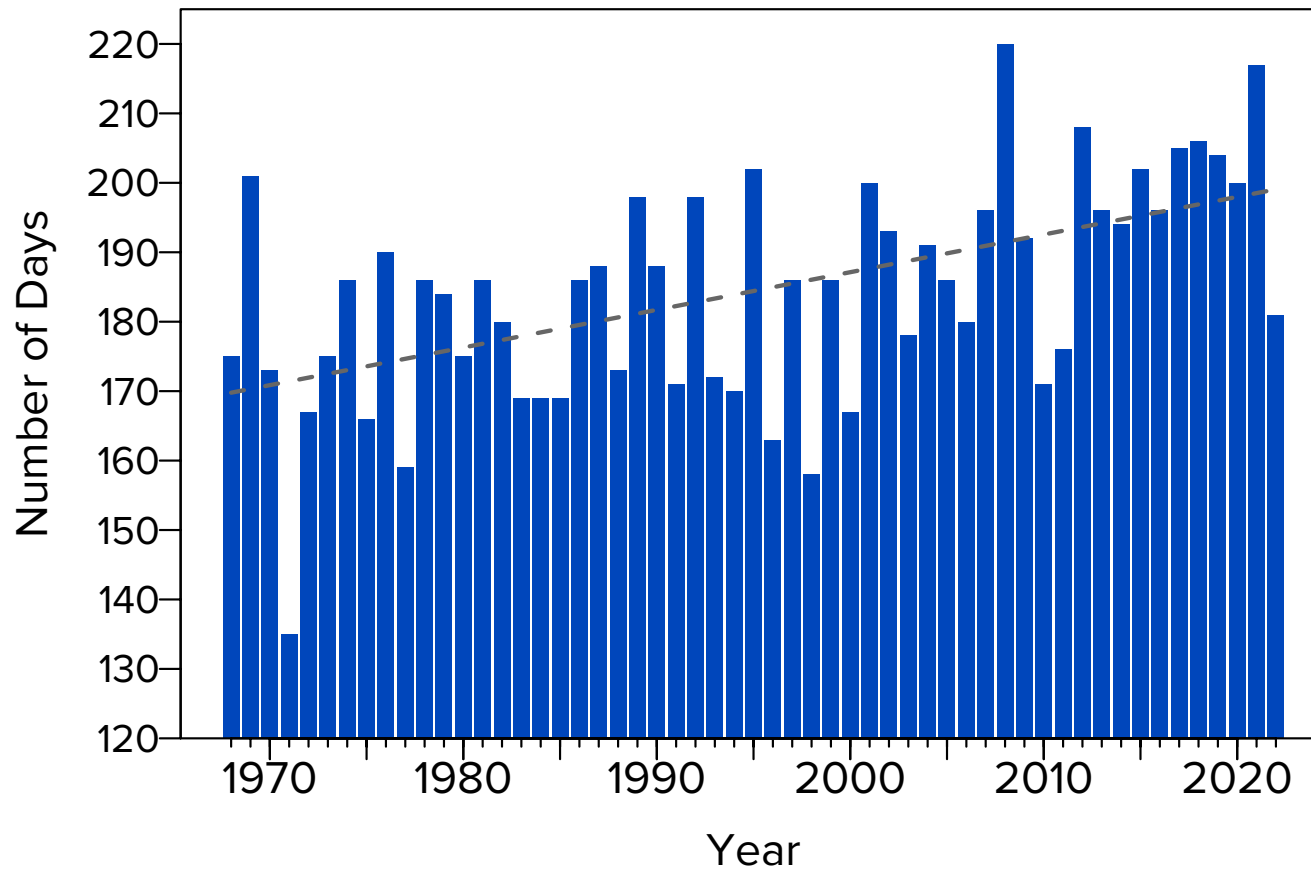
Since 1968

The stability index is a measure of the energy required to vertically mix the lake that can be evaluated for every day of the year. We define the stratification season as the number of days when the

stratification index exceeds a value of 600 kilograms per square meter. Since 1968, the length of the stratification season has increased by 29 days, albeit with considerable year-to-year variation.

In 2022, the length of the stratified season was only 181 days, the lowest value in over ten years.

Data source: TERC lake monitoring.



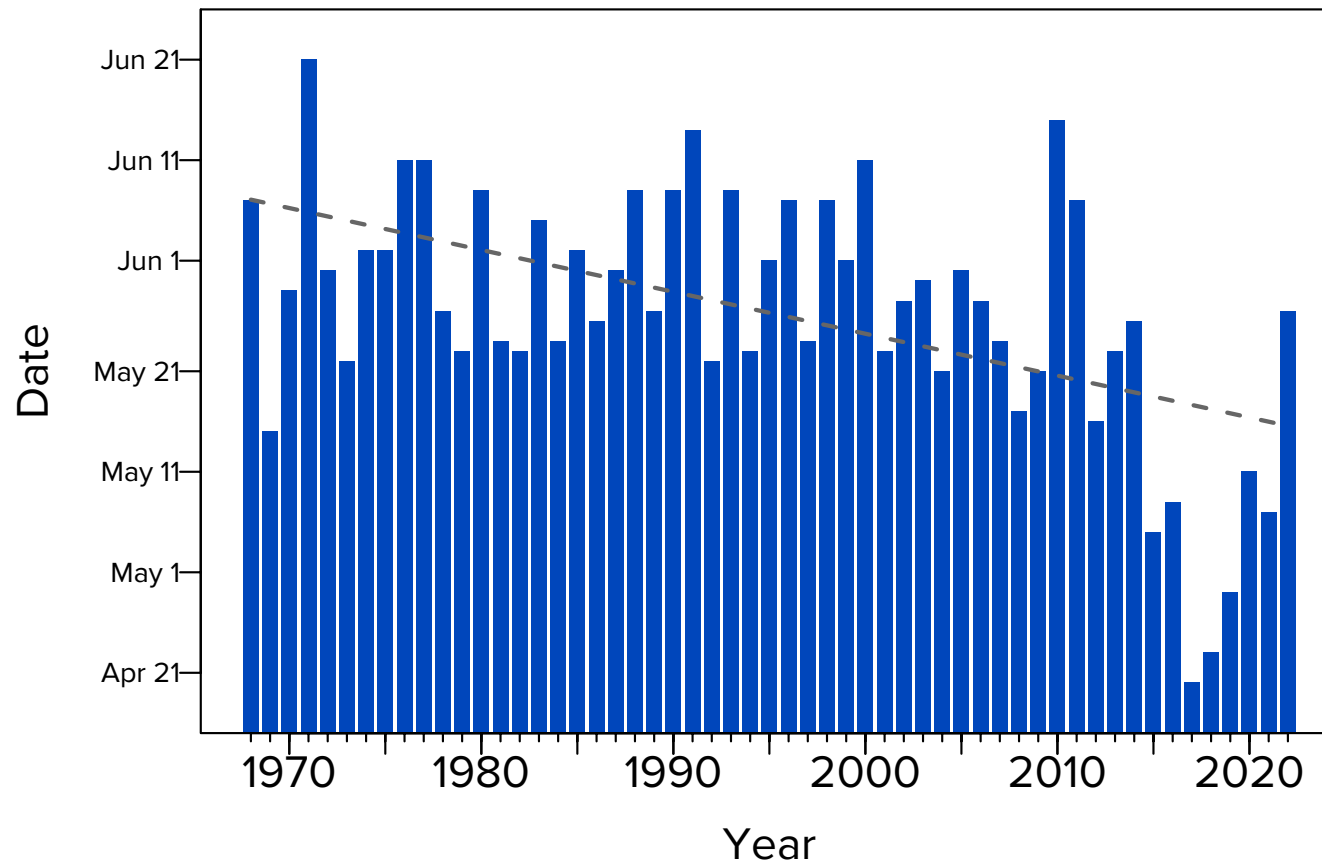
Beginning of the stratification season

Since 1968

The amount of time that Lake Tahoe is stratified has been increasing since 1968. One reason for this is the increasingly early arrival of spring as evidenced by the earlier commencement of stratification.

In 2022, the stratification commenced relatively late, on May 27 (Day 147). This was almost two weeks later than the long-term trend line would have suggested.

Data source: TERC lake monitoring.



End of stratification season

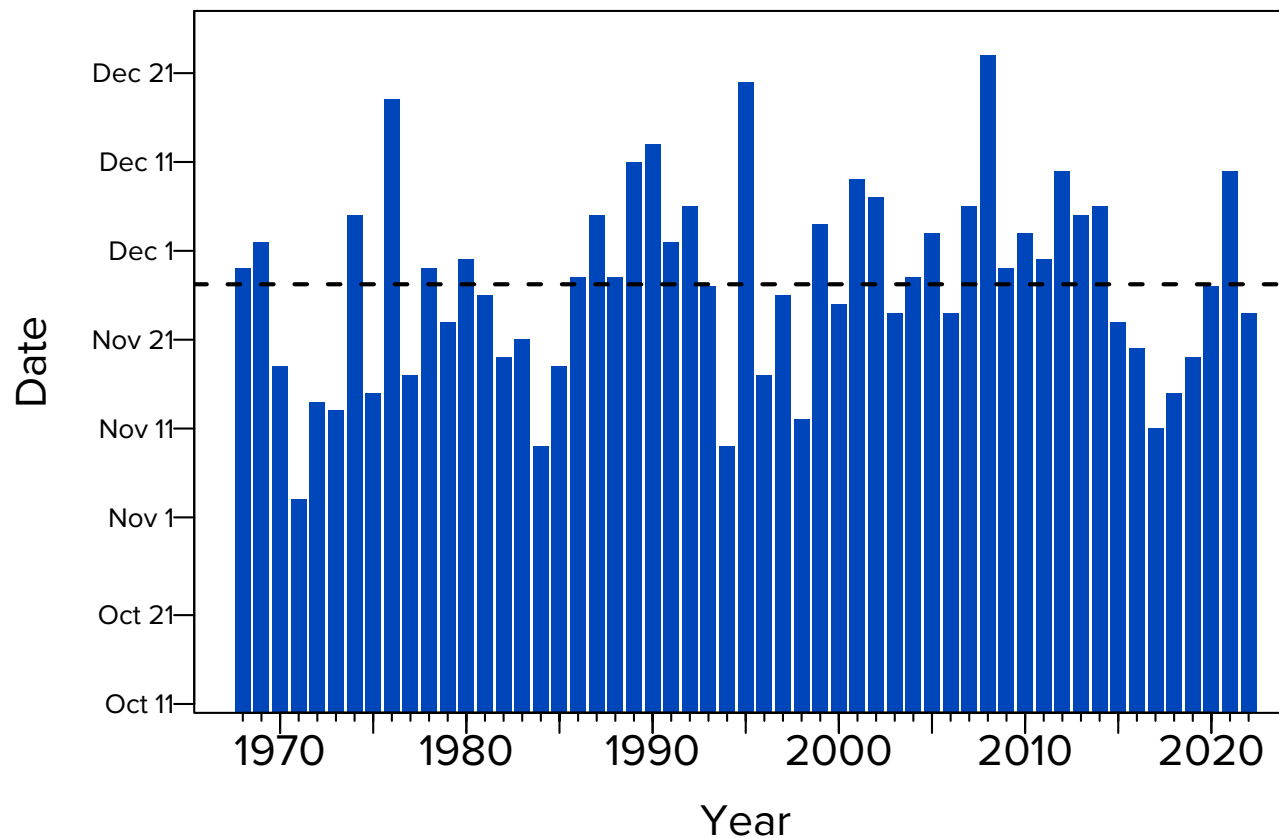
Since 1968

The amount of time that Lake Tahoe is stratified appears to have increased by almost a month since 1968. The end of the stratification season has been extended, but not as much as the onset of stratification (See Fig. 8.12). Over the 55-year record, the end of stratification

appears to have been extended by approximately one week. Although the trend is not statistically significant, extended duration of stratification can have important implications for lake mixing and water quality, such as the buildup of nitrate at the bottom of the

lake. The dashed black line indicates the long-term mean for the end of stratification date. In 2022, the end of stratification was seven days earlier than the long-term mean.

Data source: TERC lake monitoring.



Peak of stratification season

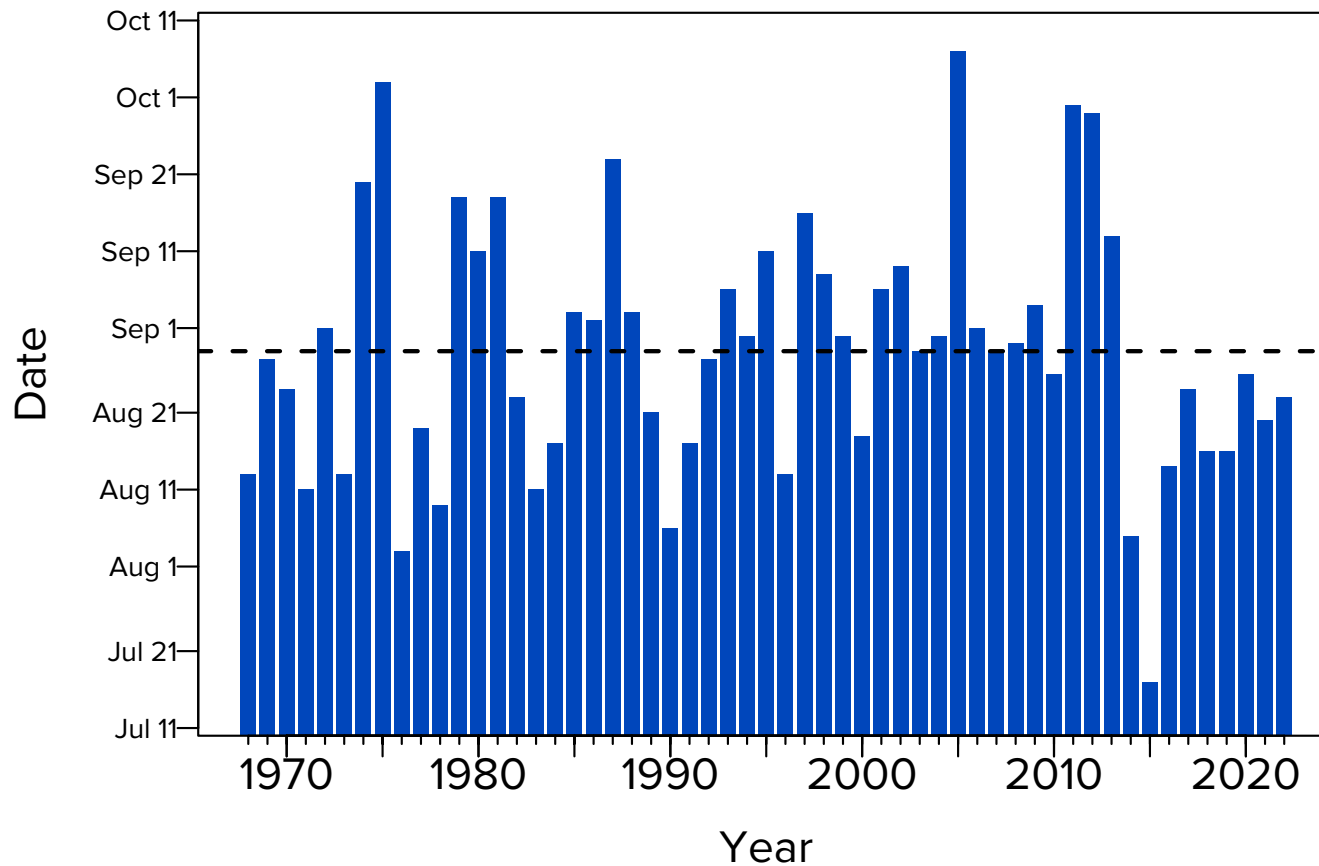
Since 1968

The day of the year when lake stratification reaches its maximum value is the peak of the stratification season. There is considerable year-to-year variation, but over time there has been no

statistically significant change in when the peak occurs. The dashed line shows the long-term mean. In 2022, the peak occurred on August 29. Over the last nine years the occurrence of the peak of

stratification has been earlier than the long-term mean date.

Data source: TERC lake monitoring.



Onset of snowmelt pulse

Yearly since 1961

Although the date on which the onset of snowmelt commences varies from year to year, since 1961 it has shifted earlier by an average of over 16 days. The snowmelt pulse is calculated and averaged for five streams—the Upper Truckee River, Trout Creek, Ward Creek, Blackwood Creek, and Third Creek. This shift is statistically

significant and is one effect of climate change at Lake Tahoe. In 2022, the onset occurred on March 21, nine days earlier than the previous year. According to the regression line, since 1961, the onset of the snowmelt pulse has occurred earlier by 19 days than it did in 1961. The onset of the pulse is calculated as the day when

flow exceeds the mean flow for the period January 1 to July 15. In the past, the peak of the stream hydrograph was used to estimate this metric.

Data source: U.S. Geological Survey stream monitoring.

