EXECUTIVE SUMMARY

The long-term data set collected on the Lake Tahoe ecosystem by the University of California, Davis, and its research collaborators is an invaluable tool for understanding ecosystem function and change. It has become essential for responsible management by elected officials and public agencies tasked with restoring and managing the Tahoe ecosystem. This is in large part because it provides a basis for monitoring of the progress toward attainment of Tahoe's restoration goals and desired conditions.

This annual Tahoe: State of the Lake Report presents data from 2012 in the context of the long-term record. While the focus is on data collected as part of our ongoing, decades-long, measurement programs, this year we have also included sections summarizing current research on using autonomous gliders for examining the detailed distribution of water quality across the lake; projected 21st century trends in Tahoe's hydroclimatology; drought adaptation by forests; our addition of real-time water quality monitoring in deep water off the west shore; measuring the blueness of Lake Tahoe; and the possible changes in shoreline position on account of extended droughts.

The UC Davis Tahoe Environmental Research Center (TERC) has developed sophisticated computer models that help scientists better predict and understand how Lake Tahoe's water moves and how the entire ecosystem behaves. Long-term data sets are essential to refine the accuracy of those models and to develop new models as knowledge increases and new challenges arise. In times of rapid change, reliable predictive models are indispensable tools for Lake Tahoe Basin resource managers.

With respect to weather 2012 was not a particularly unusual year for Lake Tahoe. The winter of 2011- 2012 was relatively dry (seventy one percent of the long term average). The fraction of precipitation that fell as snow continued the downward trend at 41 percent. Temperatures were closer to normal, with the exception of the fall months that were distinctly warmer than the long-term average. The number of days with below freezing temperatures fell precisely on the long-term trend line of declining below-freezing days. As a consequence, the peak in the timing of the snowmelt was again earlier than historical conditions, occurring on May 4.

Lake level rose by only 1.3 feet during the snowmelt, compared with 3.9 feet the previous year. During summer and fall, lake level fell by 2.3 feet, producing a net loss for the year. The rate of increase of the volume-averaged lake temperature rose in 2012, although the long term rate of increase has slowed in recent years. The annual average surface temperature (based on monthly readings) was 52.8 deg F in 2012, the highest value ever recorded for Lake Tahoe. Most of this increase came after the summer, as July surface temperatures were relatively cool at 63.3 deg F. Other consequences of climate change could also be seen in the rising temperature of the deep waters of the lake. In the last 37 years bottom temperatures have increased by one deg. F.

Lake Tahoe did not mix to its full depth in 2012. Instead, the maximum depth of mixing was only 820 feet, reached in March. Oxygen levels in the deepest part of the lake are currently being monitored to determine the rate at which oxygen is being lost when

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[1]*"Previous year" for some parameters means data collated in terms of the water year, which runs from October 1 through September 30; for other parameters, it means data for the calendar year, January 1 through December 31. Therefore, water year data are from Oct. 1, 2011 through Sept. 30, 2012. Calendar year data are from Jan. 1, 2012 through Dec. 31, 2012.*

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mixing does not occur. The lack of mixing was due to the high stability index the lake had during 2012, the highest recorded in 45 years. The upper 330 ft of the lake stayed stratified for 203 days, a month longer than what was typical when the record began.

River releases from Lake Tahoe to the Truckee River occur at the dam in Tahoe City. Water temperature has been monitored there by the USGS since 1993. Though the data set is incomplete, there is evidence that the summer time release temperatures have increased significantly over that period, suggesting potential impacts on downstream fish spawning.

The input of stream-borne nutrients to the lake declined significantly in 2012 due to the lower precipitation. On the west side of the lake, the pollutant loads were reduced by a factor of four from 2011.

Biologically, the primary productivity of the lake continued its long-term increase in 2012, with the annual average value of 243.98 grams of carbon per square meter being the highest value ever recorded. The reasons for this increase are believed to be linked to a long term shift towards smaller algal species that have the ability to process nutrients faster. Despite the increase in productivity, the concentration of chlorophyll in the lake has remained relatively constant. In 2012, there was a reduction in the species Cyclotella. A large increase in the numbers of this species over the last five years has been linked to climate change and has resulted in summertime clarity reductions. This year's reduction coincided with an improvement in clarity.

For the second straight year clarity improved in Lake Tahoe. The annual average clarity improved by 6.4 feet over the previous year to 75.3 feet. This value is within 3 feet of the interim clarity target of 78 feet. However, it is important to recognize that year-to-year fluctuations are the norm, and the target must be seen as being a value that can be sustained over several years. This improvement occurred in both summer and winter. The reasons for the improvement are three-fold: it was a dry year meaning watershed pollutant loads were low, the lake did not undergo deep mixing which limits the transport of deep stored nitrogen, and the numbers of Cyclotella decreased to their lowest levels in five years.

The summertime clarity improved by over 13 feet. While certainly encouraging, examination of the long term trend shows that there have been many periods of apparent improvement only to be overtaken by continued decline.

In new research, some valuable new tools are beginning to provide new insights into the processes that drive change in Lake Tahoe. An underwater glider that operated in the lake for 11 days in May provided the first ever "snapshots" of water quality across an east-west transect. What the data confirmed was the presence of giant "internal waves" deep in the lake, that could move algae and pollutants vertically over 150 feet. Possibly more important was the successful installation of a water quality monitoring station in 360 feet of water off the west shore. Connected to shore by an underwater cable, this station provides data from top to bottom every 30 seconds. This is the first such station in any lake worldwide.

This report is available on the UC Davis Tahoe Environmental Research Center website (http:// terc.ucdavis.edu).