EXECUTIVE SUMMARY

The long-term data set collected on the Lake Tahoe ecosystem by the University of California, Davis, and its research collaborators is a valuable tool for understanding ecosystem function and change. It has become essential to public agencies tasked with restoring and managing the Tahoe ecosystem, in part because it allows us to monitor progress toward reaching Tahoe's restoration goals and desired conditions.

This annual Tahoe: State of the Lake Report presents 2008 data in the context of the long-term record. While the focus is on data collected as part of ongoing, long-term measurement programs, this year we have also included data related to the discovery of a major invasion of *Corbicula fluminea*, or Asian clam, in Lake Tahoe. If any single factor had to be identified as the most important change in the state of Lake Tahoe in 2008, it would be the dramatic increase of Asian clam. The report also includes data about changes in the algae composition and concentration, lake clarity and the effects of climate change on snowmelt timing, lake water temperature and density stratification.

The UC Davis Tahoe Environmental Research Center has developed sophisticated computer models that help scientists more accurately predict how Lake Tahoe's ecosystem behaves. Long-term data sets are essential to refine the accuracy of those models. In these times of rapid change, reliable predictive models are indispensable tools for Lake Tahoe Basin resource managers.

This report is available on the UC Davis Tahoe Environmental Research Center website (terc.ucdavis.edu). Here are some of the highlights presented in the following pages.

ASIAN CLAMS

- In parts of the southeast of Lake Tahoe, Asian clams now comprise almost 50% of the benthic (sediment-dwelling) organisms (Fig. 6.3) and are present in concentrations greater than 1500 per square meter. (Fig. 6.7)
- The green filamentous algae *Zygnema* is co-located with the beds of Asian clam and is present at concentrations sufficient to be considered a nuisance. High concentrations of nutrients that are excreted by the clams are believed to be driving the growth and accumulation of the large Zygnema biomass. (Figs. 6.4 and 6.5)

METEOROLOGY

The Lake Tahoe ecosystem is highly influenced by meteorology. In the short term, meteorological conditions are expressed as daily variations in weather. In the long term, they are expressed as normal cyclical variations such as wet and dry cycles, and long-term trends related to global climate change.

Historical record:

- The nightly minimum temperatures recorded at Tahoe City have increased by more than 4 degrees F since 1910. (Fig. 7.1)
- Days when air temperatures averaged below freezing have generally decreased by 30 days per year since 1910, although 2008 was a cold year with the greatest number of freezing days in the last 16 years. (Figs. 7.2 and 7.3)
- Since 1910, the percent of precipitation that fell in the form of snow decreased from 52 percent to 34 percent. (Fig. 7.7)
- Peak snow melt averages 2 ½ weeks earlier than in the early 1960s. (Fig. 7.8)

Previous year[1]:

- Solar radiation in the Tahoe basin was reduced by up to 20% during one week in July on account of smoke from the California wildfires. (Fig. 7.4)
- Precipitation during both 2007 and 2008 was low, with 2008 being the 12th driest year on record in 98 years. (Figs. 7.5 and 7.6)

PHYSICAL PROPERTIES

Lake Tahoe's physical properties

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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, for this 2009 report, water year data are from Oct. 1, 2007 through Sept. 30, 2008. Calendar year data are from Jan. 1, 2008 through Dec. 31, 2008.*

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are largely a response to external factors, especially meteorology. Physical properties, in turn, determine the environment for all the lake's chemical and biological processes (see next sections).

Historical record:

- Water temperature (volume averaged) rose by more than 1 degree F in the past 38 years. (Fig 8.3)
- Winter surface water temperatures were the coldest measured in the last 10 years, with the lowest maximum surface water temperature of 41.02 degrees F. (Fig. 8.5)
- Density stratification of Lake Tahoe has increased over the last 38 years as surface water warmed due to climate change. (Fig. 8.8)

Previous year:

- In 2008, lake level fell to a low of 6223.07 feet in December, within 1 inch of the natural rim. (Fig. 8.2)
- Lake Tahoe mixed all the way to the bottom in 2008, repeating the deep mixing event of the previous year. (Fig. 8.9)

NUTRIENTS AND PARTICLES

Lake Tahoe's clarity is determined especially by fine sediment particles, and also by nutrients. Tahoe's urban areas contribute 72% of fine particles, despite representing only 10% of the land base. Nutrients affect lake clarity by promoting algae growth. Offshore, algae make the water greenish and less clear. Along the shoreline, algae are a problem because it coats rocks with green slime.

The two nutrients that most affect algal growth are nitrogen and phosphorus. These nutrients are measured at various depths at TERC's mid-lake and western lake stations. One form of nitrogen that is readily available to algae—nitrate—enters the lake through stream and urban runoff, groundwater and atmospheric deposition. Phosphorus occurs naturally in Tahoe Basin soils and enters the lake from soil disturbance and erosion, as well as atmospheric deposition.

Historical record:

- Stream inputs of particles, nitrogen and phosphorus are directly linked to the annual amount of precipitation to the annual amount of precipitation via runoff and stream flow. (Figs. 9.3 to 9.5)
- Atmospheric deposition of nutrients, both in concentration and total loads, are also linked to precipitation. (Figs 9.6 and 9.7)
- Nitrogen concentrations in the lake have remained generally constant for many years. (Fig. 9.8)
- Phosphorus concentrations have been generally declining. (Fig. 9.9)

Previous year:

- The watersheds that contributed the most particles and nutrients to Lake Tahoe were the Upper Truckee River, Blackwood Creek, Trout Creek, Ward Creek and Incline Creek. (Fig. 9.2)
- In 2008, the volume-weighted, annual average concentration of phosphorus was just under 2.0 micrograms per liter (parts per billion); the lowest value since monitoring began in 1980. (Fig. 9.9)

BIOLOGY

The longest data sets for lake biology come from the base of the food web—the free-floating algae (or phytoplankton). This algae influences the lake's food web, clarity and aesthetics.

Historical record:

- Primary productivity, the rate at which algae produce biomass through photosynthesis, has been increasing since 1959. (Fig. 10.1)
- Since 1984, the annual average depth of the deep chlorophyll maximum has declined. (Fig. 10.4)
- Diatoms remain the dominant algal species and provide high quality food for aquatic species. (Fig 10.6)

Previous year:

- Primary productivity in 2008 was

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the highest on record. (Fig. 10.1)

- The depth of the maximum chlorophyll concentration decreased in 2008 to a mean of 115 feet. (Fig. 10.4)
- Periphyton (attached algae) concentrations were similar to values recorded in 2007, with the exception of Zephyr Point, which experienced a 2-3 fold increase to the highest values ever recorded at that site. (Fig. 10.9)

CLARITY

Clarity remains the indicator of greatest interest for Lake Tahoe because it tracks both degradation and the community's efforts to restore clarity to historic levels. Secchi depth (the point below the lake surface at which a 10-inch white disk disappears from view) has been measured continuously since 1968, and is the longest continuous measure of Lake Tahoe's water clarity.

In 2008, the annual average Secchi depth was 69.6 feet, virtually identical to the value recorded in 2007. In the last eight years, Secchi depth measurements have been better than predicted by the long-term linear trend. There is statistical support that Lake Tahoe's clarity decline has slowed significantly, and is now best represented by a curve. (Fig. 11.1)

EDUCATION AND OUTREACH

The public can learn about the science behind Lake Tahoe restoration at TERC's Incline Village education center (the Thomas J. Long Foundation Education Center). In 2008, over 9,200 people participated in our education and outreach activities. (Fig. 12.1)