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A 450-year record of environmental change from Castle Lake, California (USA), inferred from diatoms and organic geochemistry

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Abstract

A 39-cm sediment core from Castle Lake, California (USA) spans the last ~ 450 years and was analyzed for diatoms and organic geochemistry ($\delta^{15}N$, $\delta^{13}C$, and C:N), with the goal of determining sensitivity to natural climate variation and twentieth century anthropogenic effects. Castle Lake is a subalpine, nitrogen-limited lake with ~ 5 months of annual ice cover. Human impacts include light recreational use, past fish stocking, and experimental use by the Castle Lake Research Station. The base of the core (below 32 cm; pre mid-1700s) represents the period of maximum ice cover. In contrast, the end of the Little Ice Age (mid 1700s–early 1800s) is dominated by cyclotelloids (mostly *Discostella stelligera*), indicating significant open-water periods, a condition that persisted into the early 1900s. Cyclotelloids began to decline in the 1960s and were replaced by the *Fragilaria tenera* grp. (peak in 1970s), succeeded by *Asterionella formosa* (peak ~ 2010), and accompanied by a reduction in $\delta^{15}N$ values and a decrease in C:N that may represent increased atmospheric nitrogen deposition. Another anthropogenic signal was discerned in the core and was interpreted to be the result of an ammonium nitrate fertilization experiment of the epilimnion that was conducted in 1980 and 1981. This signal was manifested in the core largely by a negative excursion in $\delta^{15}N$, possibly caused by fractionation during denitrification in surface sediment. A phytoplankton monitoring dataset collected by the Castle Lake Research Station from 1967 to 1984 corroborates the timing of increased araphid euplanktonic species in the 1970s, and increases in two benthic diatoms (*Staurosirella pinnata* and *Tabellaria fenestrata)*, entrained in the phytoplankton tows during the experimentation years. Both ice cover and nitrogen addition appear to be strong drivers that affected the lake diatoms, although additional drivers, such as fish stocking and associated cascade effects need further exploration. These data will be helpful for interpreting longer core records from Castle Lake, should the opportunity arise, as well as cores from similar systems in the region.