National Park Service
U.S. Department of the Interior

Rocky Mountain National Park

Nitrogen Deposition Correlated with Changes in Lake Organisms

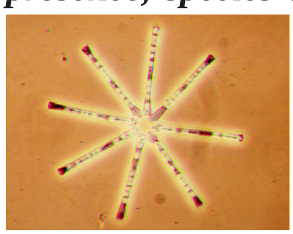
The Question: *Is atmospheric deposition of nitrogen to park lakes changing algae communities?*

The alpine lakes of RMNP are generally thought of as undisturbed ecosystems. There is, however, considerable evidence based on more than twenty years of study that a significant amount of anthropogenic (i.e., originating from human activities) nitrogen is being deposited through rain and snow falling on the park. Sources of nitrogen include motor vehicles, power plants, factories, oil and gas wells, fertilizer, and animal feedlots. Significant emissions from all of these sources are transported in air masses from the Front Range urban corridor and other locations to the park. Past research efforts have linked changes in the chemistry of park soils and Engelmann spruce needles to rising anthropogenic nitrogen inputs.

Snowdrift Lake, shown here, was one of the five lakes included in the study.

The study summarized here investigated whether changes in diatom species and abundance have occurred as a result of anthropogenic nitrogen deposition. Diatoms, a type of algae, have cell walls made from silica (just like window glass). Individual species are very sensitive to specific changes in water chemistry, making them excellent indicators of water quality. They can remain in lake sediments as identifiable organisms for thousands of years. Distinctive shapes make species identification relatively easy. Dr. Alex Wolfe of the University of Alberta, Edmonton,Canada, was the lead investigator for this project.

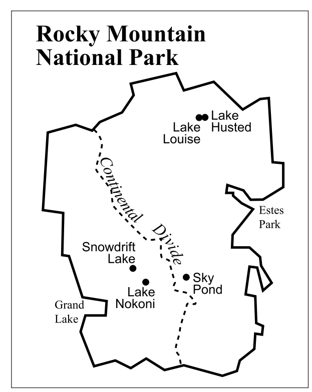
The Project: *Analyze sediment cores from five alpine lakes in the park for diatom species presence, species abundance and overall diatom abundance.*



Diatoms such as this *Asterionella* have distinctive shapes that make them easy to identify.

Cores were taken from the deepest points in five lakes. Three lakes were on the east side of the continental divide (Sky Pond, Lakes Louise and Husted) and two were on the west (Lakes Nokoni and Snowdrift). Each three-foot long core was sliced into quarter-inch increments and freeze-dried for study and archiving. Individual diatom species were identified and counted using standard laboratory procedures.

In addition to the five cores described above, one 12 foot long core was taken from Sky Pond to document changes in diatom assemblages back to the end of the last period of glaciation, ~14,000 B.P., when diatoms were first colonizing park alpine lakes.



Diatoms were sampled in three lakes on the east side of the continental divide and two lakes west of the divide.

The age of the sediments at any given depth was determined with a dating technique that uses the activity of naturally-occurring lead isotopes (^{210}Pb).

Results: *Evidence strongly suggests that lake diatom assemblages have changed in response to increased nitrogen deposition.*

Two diatom species that are considered indicators of nutrient rich water abruptly increased in abundance beginning around 1950. This sudden explosion of *Asterionella formosa* and *Fragilaria crotonensis* accounts for much of the sharp increase (8-25 times pre-1950 levels) in overall diatom abundance documented in the sediment. These once rare diatoms now make up 40% of the total diatom community.

The rate of change in diatom assemblages since 1950, when human population growth, and regional agricultural and industrial activities began to increase rapidly, is 10 times greater than what is seen in the long-term sediment record. This makes it highly unlikely that the change is due to some natural event such as changing climate or precipitation. Change in diatoms was most marked in lakes on the east side of the Continental Divide, the side most affected by anthropogenic nitrogen inputs.