



Trends in Water Quality of Cave Pools at Timpanogos Cave National Monument, 2008–2018



Long-term monitoring reveals the influence of human activities on cave waters.

Background

The Northern Colorado Plateau Network (NCPN) monitors water quality at 10 National Park Service units in Utah and Colorado. Most of that monitoring is done in springs, rivers, and streams. But there's one place where the job—and the water—is different from all the others: Timpanogos Cave National Monument. Here, the monitored waters are cave pools perched within a steep mountainside.

This unique situation called for a unique approach. At Timpanogos Cave, water-quality monitoring is a collaborative effort. Park staff collect the samples, State of Utah staff analyze them, and NCPN staff manage, analyze, and report on the data. It's turned out to be some of the most interesting work we do. A recent analysis of measurements collected over a ten-year period revealed some surprising results with important implications for park managers.

Less than 1,000 feet separate the two monitored pools, yet they are more different than alike. Hidden Lake has

At a Glance

- Hansen Lake and Hidden Lake are geomorphically different, have different use patterns, and changed in different ways.
- At Hidden Lake, a decrease in dissolved CO₂ corresponded to implementation of a new cave management plan, leading to conditions that favored the formation of speleothems.
- At Hansen Lake, trends in water chemistry mimicked trends that can be caused by air pollution.
- The only trend common to both pools was an increase in water temperature.

no direct connection to the surface. Previous studies suggest it responds to precipitation events with a lag of up to six months, after surface water has seeped through thin areas between rock layers. It is located in Timpanogos Cave, directly adjacent to the main cave tour route. Hansen Lake connects to the surface along rock fractures, allowing surface rain and snowmelt to enter the lake within minutes. It is located in Hansen Cave, well off the main cave tour route.

From July 2008 to September 2018, water-quality samples were taken from both pools each month from April to November (during winter and early spring, samples could not be collected due to avalanche risk on the trail leading up to the cave). Water quality and quantity were analyzed for trends over time.

Trends

Many changes were detected over the ten years of monitoring—but the two pools did not change in similar ways.

At Hidden Lake,

- Pool levels dropped precipitously before rebounding and then dropping again.
- There were decreases in calcium, specific conductance, and total dissolved solids.
- Starting in 2013, there was a reduction in dissolved CO₂, leading to conditions favorable for the formation of speleothems (“cave decorations”).

At Hansen Lake,

- Pool levels fluctuated seasonally but remained stable over time.
- There were increases in most major ions, specific conductance, and total dissolved solids.

The only trend common to both pools was an increase in water temperature.

Management Implications

At Hidden Lake, a decrease in dissolved CO_2 corresponded to implementation of a new cave management plan. In 2013, the number of visitors on each tour was reduced from 20 to 16, and the amount of time between tour starts was increased from 10 minutes to 15 minutes. The presence of fewer people (and thus, less exhaled CO_2) in the cave seems to have triggered a decrease in dissolved CO_2 in Hidden Lake (see figure), with cascading effects on water chemis-

try. Calcite and dolomite saturation indices increased, leading to conditions that favored the formation of speleothems—an important management goal in an active cave system. Decreases in calcium, alkalinity, dissolved inorganic carbon, and total dissolved solids, and an increase in pH, also followed the same timing. Due to the COVID-19 pandemic, the caves were closed to visitation in 2020. This closure will facilitate further investigation of the relationship between visitor management, carbon dioxide, and water chemistry.

At Hansen Lake, trends in water chemistry mimicked trends that can be caused by air pollution—particularly, dust deposition. Up-canyon transport of dust from the Wasatch Front urban area and beyond have been noted regionally, and may have contributed to increases in sulfate, magnesium, calcium, sodium, and chloride in Hansen Lake. The monu-

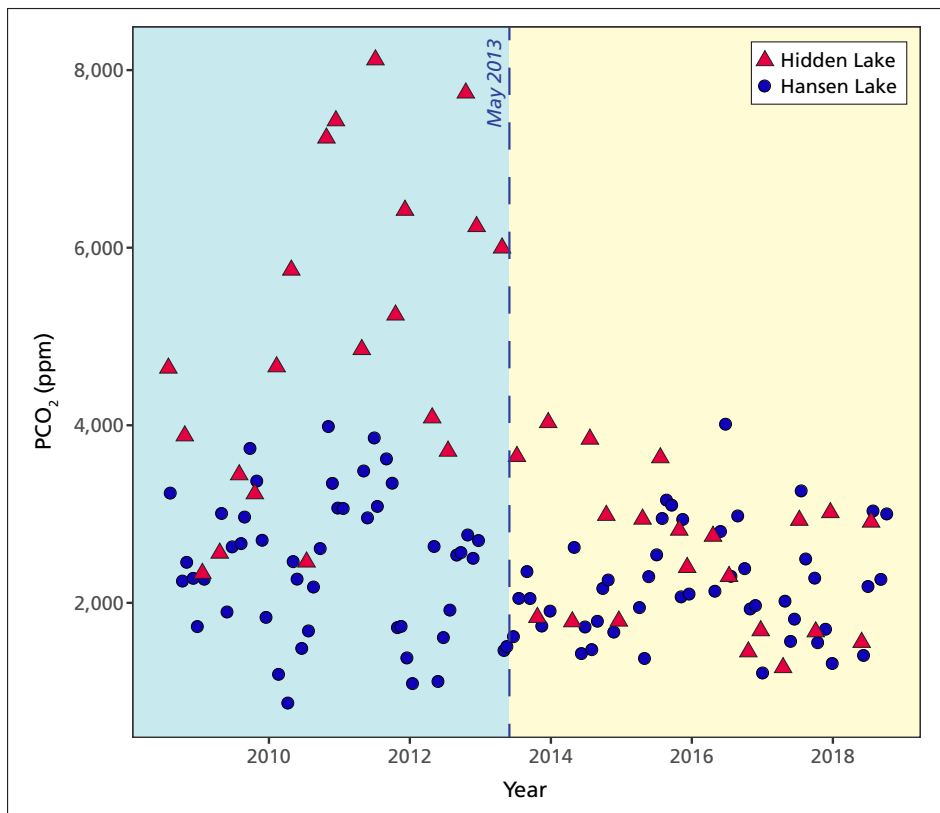
ment recently installed an air-quality monitoring station that will help managers track local atmospheric flows of particulate matter. Additional research could help managers better understand how atmospheric conditions, surface deposition, and the timing and amount of precipitation affect the chemistry of Hansen Lake.

Increasing surface air temperatures are reflected in increasing water temperatures in both pools. Future changes in the amount and timing of precipitation are also likely to play an important role in cavewater recharge. In May 2020, instrumentation at the Timpanogos Cave weather station was updated with new sensors and an internet connection for real-time reporting. These improvements should help minimize future gaps in weather data to better track the influence of climate change on the cave system.

Importance of Long-Term Monitoring at Timpanogos Cave

Long-term cavewater monitoring is not well-represented in the body of scientific literature on caves. The ten-year record at Timpanogos Cave NM shows the value of such monitoring by revealing unanticipated trends in water quality. These trends hint at important changes in the cave watershed and cave system, suggesting that cave-water quality is an important indicator of the health of cave resources at the park.

The divergence—and convergence—of results obtained from the two different pools highlight the importance of context on the monitoring process. The two pools selected serve as sensitive “instruments” that respond to various environmental conditions. In this way, they can help track the effectiveness of management actions and point us in the direction of future research questions.



Dissolved CO_2 dropped in Hidden Lake after a new management plan was implemented in May 2013.

Information in this brief was summarized from R. Weissinger, A. Armstrong, K. Bahr, and C. Groves. 2020. Trends in water quality of cave pools at Timpanogos Cave National Monument, July 2008–September 2018. <https://irma.nps.gov/DataStore/Reference/Profile/2279316>