



Water Quality Monitoring at Pictured Rocks, 2008–2018

Just as water is the most basic element of life, it is also the most common characteristic of national parks in the Great Lakes Network. You can see it, you can touch it, and almost everyone comes into contact with it during a visit to a park like Pictured Rocks National Lakeshore. Because it is so important, we monitor many aspects of water quality in park lakes including water chemistry and contaminants.

This brief provides an update on some of what we have learned about water levels and contaminants in six park lakes, as well as some unique observations about the relationship between pH (water acidity) and algae and what it might mean for the rest of the aquatic community. It's all tied together, and through long-term monitoring, we hope to shed light on the basic conditions and ecology of a crucial park resource—water.

Lake Levels

Water level is perhaps one of the first things people notice when visiting a lake. In particular, people are often interested in how lake levels affect beach usability, access to docks, and water depth for boating and fishing. Water level is also important to lake ecology because it influences water chemistry and the habitat available for plants and animals in the shallower zones. In general during the open water

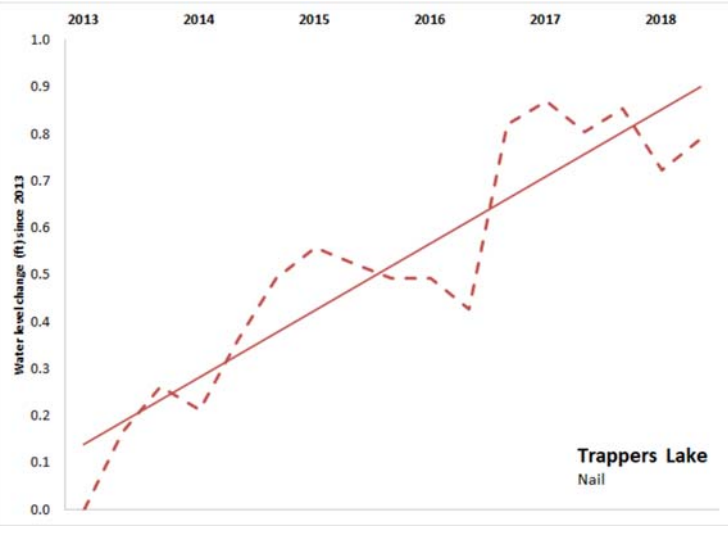
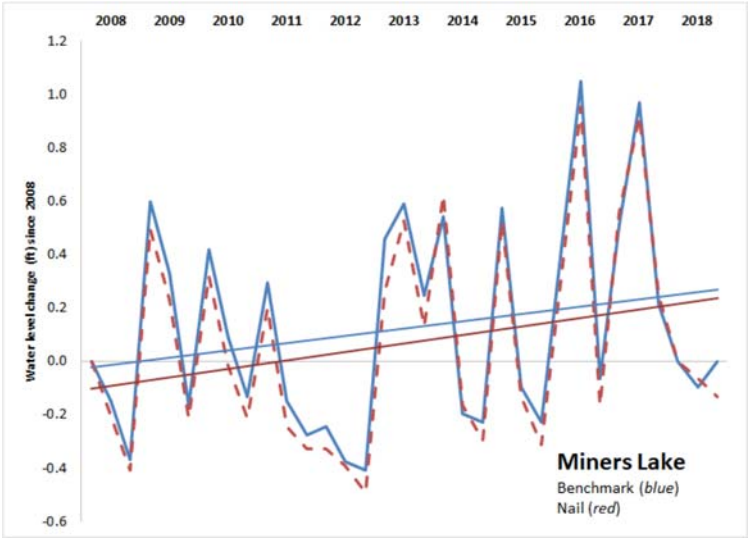
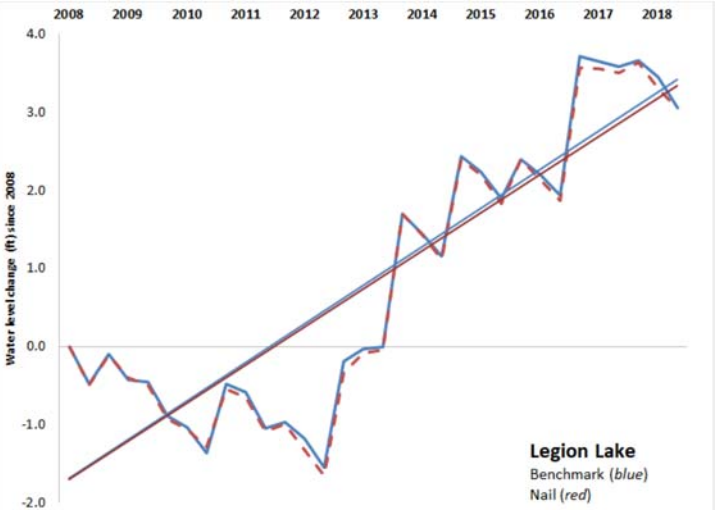
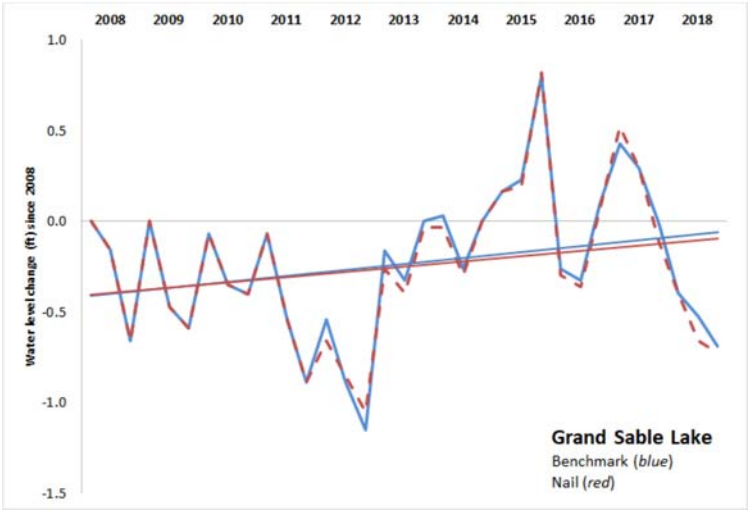
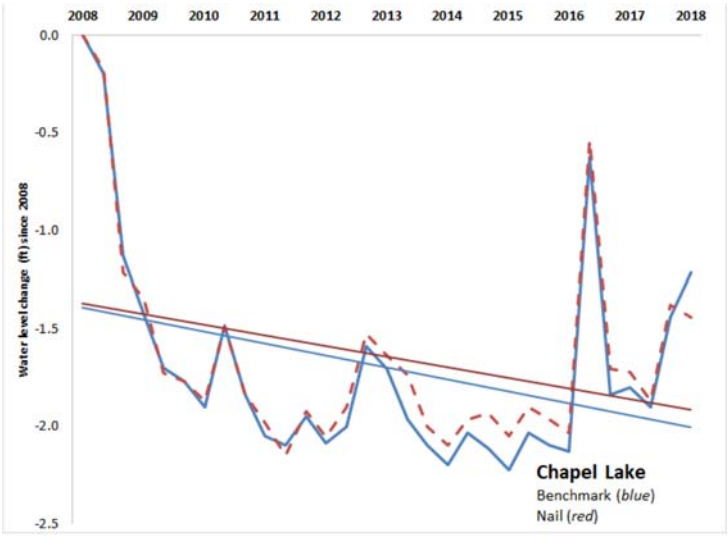
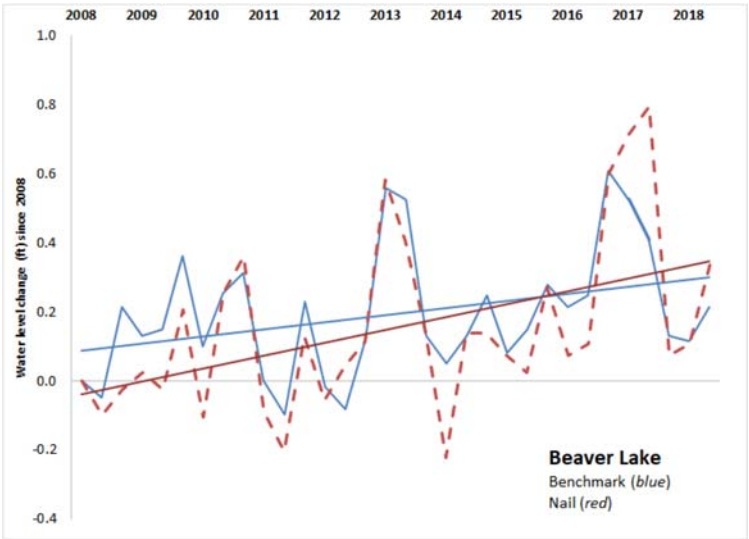
season, water levels are higher after snowmelt and drop throughout the summer, from a couple of inches to a foot or more. On a long-term (e.g., 10-year) scale, lake levels usually do not change much unless something dramatic occurs such as beavers damming a stream that flows into or out of a lake.

Water levels for most of the park's lakes have increased since 2008 (*see graphs on next page*). Beaver Lake has risen by 2½ inches (6 cm) and Legion Lake has come up a whopping three feet (about one meter)! Trappers Lake, which we began monitoring in 2013, has risen by 9½ inches (24 cm) in those six years. Trappers and Legion are both seepage lakes, meaning they are fed by rain, runoff, and groundwater. But the influence of precipitation on Legion Lake is particularly important because its small drainage area and underlying bedrock provide limited inputs from runoff and groundwater. So the dramatic change for Legion is probably due to very dry conditions from 2010–2012 followed by higher than usual precipitation.

Miners Lake happens to be the exact same level today as it was in July 2008, but it has varied quite a bit between then and now. Chapel Lake is lower by almost 14 inches (35 cm), but the trend is strongly influenced by a much higher water level in 2008. Otherwise Chapel's water level has changed relatively little in the past decade.



Water level measurements are made using an eye level and stadia rod. NPS PHOTO



Water level changes (in feet) on the six lakes monitored at Pictured Rocks, as measured at a permanent benchmark in bedrock (*blue line*) and a nail placed in a tree near the benchmark (*red line*). The number 0.0 on the vertical axis indicates the baseline water level on the first day of monitoring at each lake in 2008 (2013 on Trappers Lake). Solid trend lines represent the average annual rate of change in water level across the 11-year time period. Two to three measurements are made each year.

Grand Sable Lake’s average water level increased by a slight eighth of an inch per year, but it is currently about 8 inches (21 cm) lower than 11 years ago. This paradoxical condition is due to beavers building a dam on Sable Creek in 2015. The creek is the lake’s outlet to Lake Superior, and as often as the

beavers build it up, people break it apart to keep the creek flowing. Thus, the lake level goes through an annual yo-yo effect as two of nature’s foremost engineers struggle for the upper hand.

Contaminants

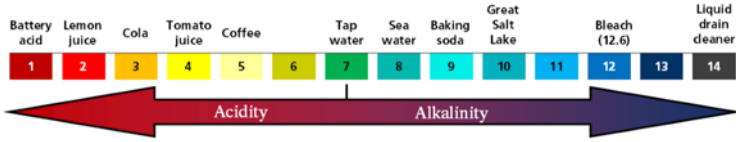
Inland lakes with clear water and abundant aquatic life are easy to find at Pictured Rocks. However, there can still be unseen factors influencing water quality.

Contaminants of emerging concern (CECs) are broad categories of pharmaceuticals, personal care products, and pesticides. Water samples from Miners, Chapel, Legion, Beaver, Trappers, and Grand Sable lakes were tested for over 200 of these CECs in 2016 and fortunately only three were detected. The insecticide *DEET* was found in more than half (55%) of the samples, while *atrazine* (an agricultural pesticide) and *gabapentin* (an anti-seizure medication) were each found in one sample from different lakes. Compare this to two urban parks—Mississippi National River and Recreation Area and Indiana Dunes National Lakeshore—where 52 and 59 chemicals were detected, respectively.

Concentrations of the chemicals found at Pictured Rocks ranged from 10–115 parts per trillion (one drop of chemical in one trillion gallons of water) and were far below levels known to affect human health. When it comes to protecting aquatic life such as fish and invertebrates, the risk appears minimal. Because of the remoteness of many lakes in national park units, these chemicals are probably moving into them via atmospheric transport and deposition, or in the case of DEET, from park visitors and staff using insect repellent. This information establishes baseline levels for chemicals of concern in park lakes, contributing to our understanding of potential effects on aquatic ecosystem health. In 2018, testing was expanded to include four streams within Pictured Rocks; preliminary results indicate very few chemicals detected, and those that were found were at very low levels.

Planktonic Algae and pH of Legion Lake

Legion Lake is 35 acres (14 hectares) and sits along the watershed divide between Lake Superior and Lake Michigan. It has three basins, likely formed from three blocks of melting glacial ice, and there are no streams flowing into or out of it. Since Legion Lake has a small watershed and little connection to groundwater, precipitation is how it gets most of its water—a situation that influences water chemistry, including its acidity. Acidity is measured as *pH* on a scale of 1 to 14, but the difference between one level and the next is a factor of 10.



The pH scale ranges from 1 to 14, with 7 being neutral. The change from one level to the next is a factor of 10.

Legion Lake has historically been acidic (measuring 4.8 in the 1980s) due to the pH of rainwater (approx. 5.5), with some influence by adjacent bogs (pH 4.0–5.0). However, the pH has moved toward more neutral conditions in recent years, and since 2016 it has sometimes been above 7.0. Since 2014, pH in the top 3 ft (1 m) of surface water has been more variable from June to August. This shift from acidic and nutrient-poor to neutral and moderately nutrient-rich changes the fish, insect, and algae species that can live in it. One such shift is already occurring in Legion Lake.

In past decades, algae observed in Legion Lake were species that live on solid surfaces such as submerged logs, emergent plants near shore, and mosses on the lake bottom. Recently a *planktonic (free-floating) green algae from the group Desmidi ales* (desmids, for short) has become the dominant algae in Legion Lake. The most abundant desmid is *Staurastrum bieneanum*, a species found in lakes around the world but about which little is known. This species accounted for 70% of a plankton sample collected from Legion Lake in July 2018 and 98% of a sample collected one month later. Conversely, the desmid *Staurastrum ophiura* accounted for 20% of the July plankton sample and less than 1% of the sample the next month.

What’s allowing these planktonic algae to thrive? It may be that intense rainfall events are diluting the acidity of the upper water layers. Or it could be small increases in water temperature and nutrients, and the desmids themselves are absorbing carbon dioxide through photosynthesis, thereby reducing the pH.



The desmid algae *Staurastrum ophiura* (left) and *Staurastrum bieneanum* (right) are planktonic (free-floating) green algae that have become the dominant algal species in Legion Lake. PHOTOS © JOHN KINROSS, [HTTP://ALGALWEB.NET](http://ALGALWEB.NET).

Why is this important? Because the change in algae is the first physical sign we see of a change in the lake. Also, the free-floating algae have become dense enough to limit how far sunlight can penetrate the water column. The Secchi depth—a measure of water clarity—on Legion Lake was 16–22 ft (5–7 m) in 2007–2008, but only 6–10 ft (2–3 m) in 2017–2018. This will affect the lake’s water chemistry, but it will also cause a change in the aquatic plant community and the amount of dissolved oxygen the water can hold. In turn, we could see a shift in the types and numbers of fish in the lake. Is this “good” or “bad”, or is it just change? These changes in Legion Lake are just one of the things we will watch with interest in coming years. ●



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Annual water quality monitoring is accomplished at Pictured Rocks National Lakeshore because of the dedication of the following people:

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