



Plumes and Blooms in the Apostle Islands



Have you ever seen what looks like a muddy river flowing through Lake Superior? This coloration is due to a combination of bank erosion and river plumes, which enter the lake from clay-rich tributaries along the lake's south shore. They are especially common following spring snowmelt and storms.

Warmer plumes often stay near the lake's surface, "riding" over the top of the colder lake water. Such plumes can be visible from shore, from boats, and even from satellites (*Figure 1*). Depending on the strength and direction of wind or lake currents, the plumes can stay close to shore or become widely distributed throughout the western arm of the lake.

The National Park Service (NPS) and Partners from the University of Wisconsin-Milwaukee School of Freshwater Sciences recently confirmed that river plumes can have far-reaching and long-lasting effects on water quality in the lake.

Sea Change

Although river plumes are a natural occurrence in this region, analysis of historical satellite imagery suggests they have become more frequent since 2005. Additionally, historical records of Secchi depth (a simple measure of water clarity) show that the water near Sand Island has become less clear since the 1990s (*Figure 2*). These changes are likely due to increased rainfall, higher storm intensity, and warmer surface waters over the past several decades.

Figure 1. Satellite image taken several days after a historic flood event on 19–20 June 2012, showing widespread sediment plumes on Lake Superior extending from the head of the lake east along the entire Wisconsin shore. Image courtesy of A. Kirschbaum, NPS Great Lakes Inventory and Monitoring Network, via the USGS/Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota (<https://lance-modis.eosdis.nasa.gov>).

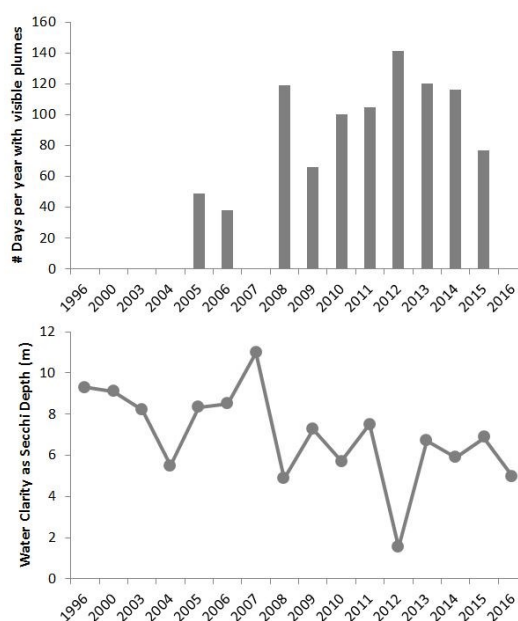


Figure 2. Trends in water clarity at Sand Island, 1996–2016 (*bottom*), compared to the number of days per year with visible plumes present at Sand Island from 2005–2015 (*top*). Water clarity based on Secchi depth measurements taken by the National Park Service and U.S. Geological Survey. Days with visible plumes based on visual analysis of satellite imagery. The years 1996–2004 and 2007 are not included in the visible plume count data due to gaps in the satellite imagery record.

First a Plume, Then a Bloom

River plumes and the sediments they carry affect our outdoor experience and the lake's health. They have also been associated with the emergence of harmful algal blooms. These blooms are made up of naturally-occurring cyanobacteria (also known as blue-green algae) that under certain conditions create nuisance "blooms".

Recent experimental work by the NPS and partners from the University of Minnesota's Large Lakes Observatory suggests that these blooms may originate in rivers and harbors. Fed by nutrient-rich plumes, the blooms are further stimulated by unusually warm nearshore waters (Figure 3).

Unsightly and unsettling, these algal blooms may also be dangerous. The species of cyanobacteria found in the Apostle Islands blooms can potentially produce toxins hazardous to humans and wildlife.

Visible algal blooms occurred near Meyers Beach and the Mawikwe Bay Sea Caves (Figure 4) following extensive flooding events in 2012 and 2016.

One Water, Many Solutions

It is clear from this recent work that the health of our land, rivers, and lake are linked. The National Park Service is working with a team of university and agency experts to better monitor the lake's health and investigate the causes and potential consequences of sediment plumes and associated harmful algal blooms.

As citizens, we can take steps to address these issues by "slowing the flow" of water from the land to the lake (<https://dnr.wi.gov/files/pdf/pubs/fr/FR0385.pdf>) and limiting nutrient releases to waterways (see: <https://www.epa.gov/nutrientpollution/sources-and-solutions>).

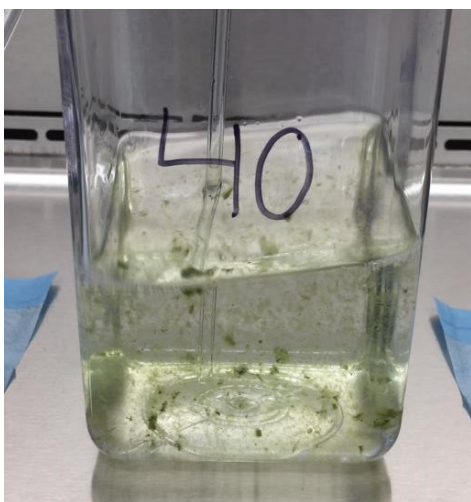


Figure 3. A sample of south shore river water, subjected to a combination of relatively high phosphorus (nutrient) concentrations and warm water temperatures, produced a bloom of *Dolichospermum lemmermannii*, an algal species found in previous algal blooms in the Apostle Islands. PHOTO: KAIT REINL AND BOB STERNER, UNIVERSITY OF MINNESOTA LARGE LAKES OBSERVATORY.

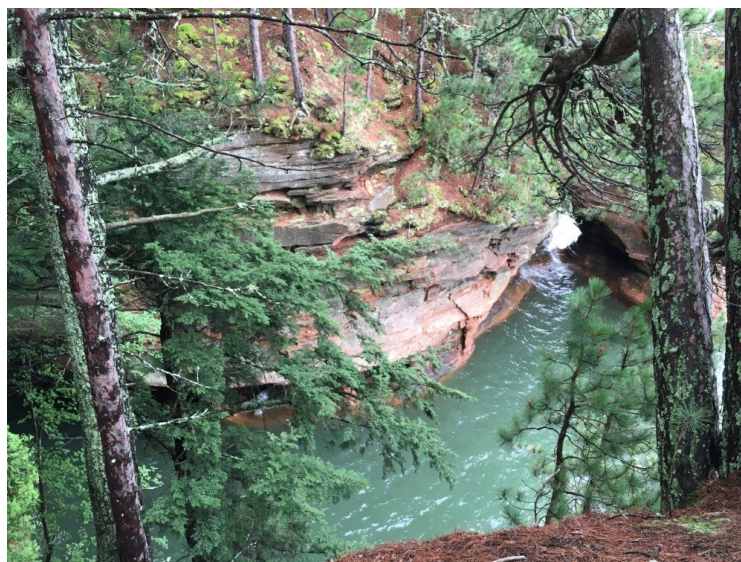


Figure 4. Greenish water was observed during a mild algal bloom near the Mawikwe Bay Sea Caves in summer 2016.

NPS PHOTO / B. LAFRANCOIS



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