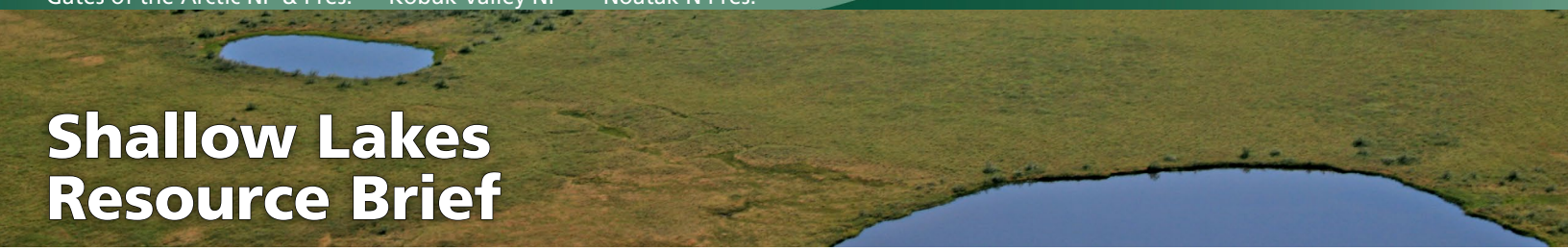
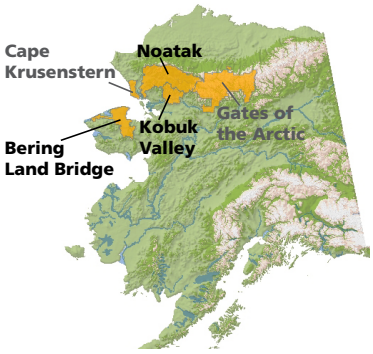
Shallow Lakes Resource Brief



Shallow lakes in Kobuk Valley National Park. NPS Photo.

The Status of Shallow Lakes in the Arctic Network



Map: Shallow lakes are being monitored in 3 of 5 Arctic Network parks: Noatak National Preserve, Kobuk Valley National Park, and Bering Land Bridge National Preserve.

Currently, lakes in the Arctic Network are being negatively affected by climate warming—lake surface area has significantly declined since the 1980's due to warming temperatures, and rapid change has happened over the last five years (Swanson 2019). The biggest declines have occurred in Bering Land Bridge National Preserve where numerous lakes have partially or completely drained. This area has changed the most because the soil there contains large amounts of ice-rich permafrost that is thawing. When ground ice thaws it triggers lake drainage events by expanding lake outlets and creating small pathways around the lake, these pathways allow the lake water to leak out of the lake.

When lakes drain it not only changes the amount of water but can affect how much sediment is in the water column, as well as the nutrient, carbon, and ion concentration of the water. Lake drainages also impact the vegetation, plants that like drier conditions such as trees and shrubs move into the area changing the habitat.

New discoveries on water chemistry in shallow lakes:

We have been monitoring lakes since the late-2000's, and the data indicate that both lake temperature and specific conductance (a measure of salinity) have increased significantly over time (Figure 1). Not surprisingly, lake temperatures have warmed with ambient air temperature, somewhat surprising is that they have also increased with wind speed. This could be due to increased lake mixing or be due to stronger storms that result from a reduction in the extent of sea ice in the Bering and Chukchi seas.

Specific conductance, a measure of lake salinity, has also increased over time. One explanation is that more sediment is getting into the lake either from erosion caused by the thawing permafrost or increased wind events which suspend small soil particles in the water. Another possibility is that warmer soil conditions allow runoff to soak deeper into the ground, and as the water filters through the soil it picks up minerals that are transported to the lake.

Not all lakes are changing in the same way. We have identified 10 common types of lakes in Alaska's northern parklands, eight of which are commonly found in the Arctic Network. These lakes differ in shape and size as well as in chemistry. They also differ in the type of sediment that is on the lake bottom which determines how productive the lakes are and what kind of animals might be living there. Sandy and gravelly lakes tend to have few plants and animals while lakes with more mineral rich sediments are more diverse and productive.

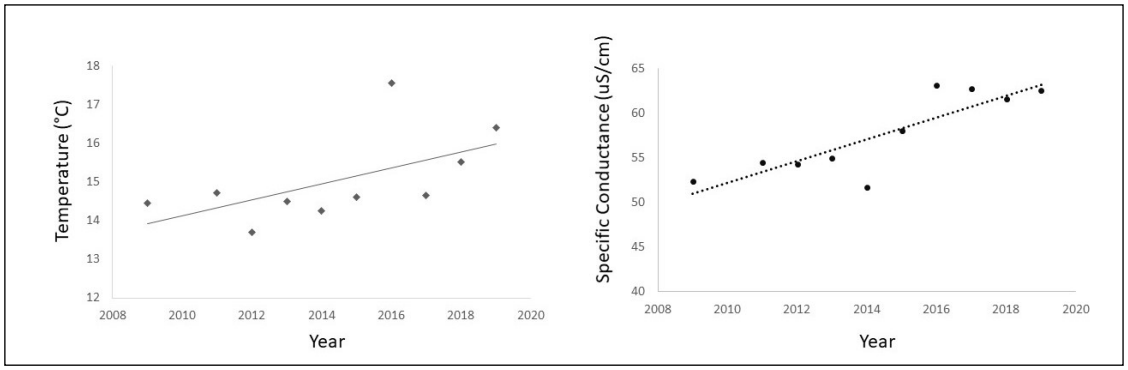


Figure 1 (right): Mean annual water temperature and specific conductance have increased significantly in one of the lakes used for continuous lake monitoring in Kobuk Valley National Park. Monitoring in this lake began in 2008 but was suspended in 2020 due to the COVID-19 pandemic, monitoring will resume in 2022.

Why Shallow Lakes and Ponds are Important

Shallow lakes and ponds are a common feature of the Arctic landscape and were formed by a variety of geological forces including glaciers, volcanic activity, meandering rivers and thermokarst. Lakes are important landscape features because their varied size, depth, and chemistry creates a mosaic of habitats utilized by a diverse array of organisms. Wildlife such as furbearers, waterbirds, and fish are especially important to indigenous people who commonly collect waterfowl and gull eggs, harvest white fish and salmon, and use small mammal hides for garments and household items. They also use wetland plants to produce baskets and other ornamental objects such as dance fans. Berries are used for food and many wetland plants are used for medicine. Lakes and wetlands are often referred to as the "kidneys of the landscape" because they clean the water by trapping sediment, nutrients, and organic material like leaves.

What We Want to Know About Shallow Lakes

- How much of the landscape is covered with lakes and is that changing?
- Is the chemistry of the lakes changing?
- Is vegetation surrounding lakes changing?

How We Monitor Shallow Lakes

We use a two-pronged approach to monitoring shallow lakes: remote sensing to track changes in lake surface area and site visits to track changes in chemistry and vegetation in individual lakes. Every year we visit the same six lakes in the network (Figure 2). We deploy continuous water quality monitoring equipment at each of the six lakes to track hourly changes in temperature, pH, oxygen concentrations and salinity. In a larger set of lakes, visited a couple times each decade, we track large scale shifts in nutrient, carbon, and ion concentrations (Ca, Mg, Na, and K), as well as changes in temperature, pH, vegetation and general characteristics about the lake such as depth and size. Since 2009 we have visited 337 lakes throughout the Arctic Network.

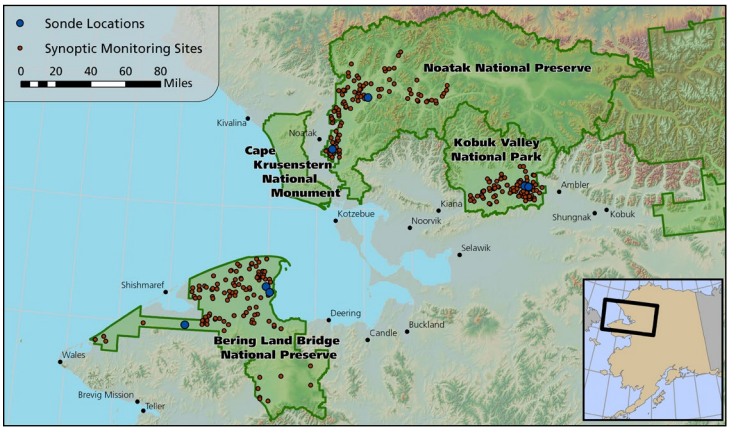


Figure 2: ARCN monitors lakes at two temporal scales, six of the lakes (blue dots) are monitored hourly during the open water season, while others (red dots) are only visited a couple times every decade. Together the data provide information about how the lakes are changing on the landscape scale as well as how the seasonal lake cycle is changing.

How Monitoring Shallow Lakes Can Help Park Managers

Regardless of what drives the changes we observe in shallow lakes, the changes can significantly affect lake food webs. Warmer temperatures can reduce the quality of fish habitat, alter insect populations and vegetation, and affect when ice forms on the lakes. All these factors impact people's ability to forage for plants and animals that they need to maintain their subsistence lifestyle, and they affect visitor's ability to enjoy these wild and scenic landscapes.

Monitoring shallow lakes helps inform managers who ultimately can work to protect the habitat by educating visitors, legislators, and stakeholders, and by acquiring new land or changing regulations in order to minimize the impacts due to development. To protect shallow lakes in the Arctic Network, the most critical action we can take is to help reduce carbon emissions to slow climate warming.

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