

Science Notes

Understanding lake drainage in northern Alaskan national parks

Impacts of a warming climate

By Amy Larsen

IN 2003, NATIONAL PARK SERVICE PILOT

Kevin Fox flew over a lake in the vast Yukon–Charley Rivers National Preserve. Days earlier the lake had been teeming with life, but what Fox saw as he gazed down on the landscape looked more like

a muddy lunar landscape than a lake (fig. 1, facing page). In just three days the lake had drained completely. This was the first of dozens of catastrophic lake drainages that have since been documented in Alaska's national parks.



Figure 1. Catastrophically drained lake in Yukon–Charley Rivers National Preserve.



NPS/AMY LARSEN

Aerial photographs and satellite images allow network resource managers to look back in time to see how these lakes have changed over the past 50 years.

Drainage events such as this typically are brought on by the natural movement of a stream across its floodplain. If a lake is encountered during this lateral movement, the stream erodes the lake shoreline, the lake is breached, and lake water rapidly drains into the stream or a nearby lake. Recent drainage events, however, have shown no evidence of this type of drainage. Instead, many of the lakes appeared as if their “plug” had simply been pulled and the water drained away.

Understanding how and why these ecosystems are disappearing in this manner is important to park managers because shallow lakes are productive and support a diverse array of plants and animals. In turn, they are important to the people who hunt and trap subsistence resources such as moose, waterfowl, and furbearing mammals within the boundaries of Alaska’s national parks. Thus,

preserving these ecosystems is a concern for park managers.

Studies ensue

The Central Alaska and Arctic networks (fig. 2) of the Inventory and Monitoring Program began monitoring shallow lakes in 2003 in order to understand these important ecosystems and the changes that were occurring. One of the primary objectives is to detect changes in the number, area, and distribution of park lakes, and remote sensing is the most effective way to measure this type of lake change. Aerial photographs and satellite images allow network scientists to look back in time to see how these lakes have changed over the past 50 years (fig. 3, next page). Analysis of historical lake change conducted to date reveals that lake surface area has been reduced by as much as 28% across north-central Alaska (fig. 4, next page).

One of the most impacted national parks is Kobuk Valley, where lake area has declined by about 20% and 12 lakes have drained catastrophically over the past five years. Catastrophic lake drainage occurs very rapidly taking only a few days or weeks. Understanding the environmental conditions found in Kobuk Valley can help scientists and resource managers determine why this region is changing so quickly. Park scientists believe the changes here are due to regional geographic and soil conditions.

Findings

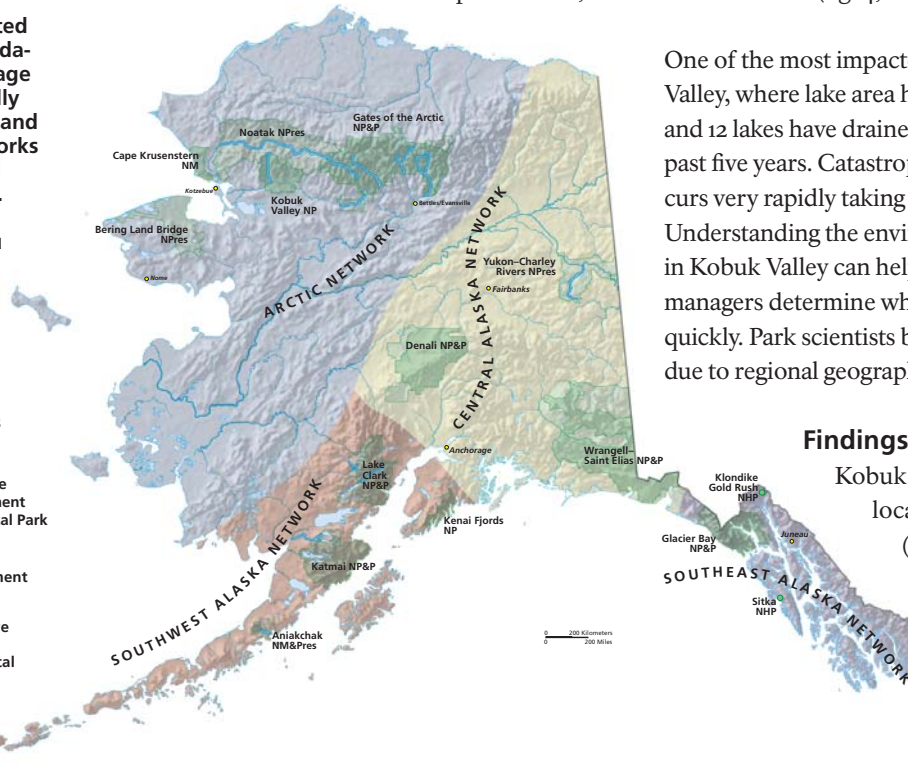
Kobuk Valley National Park is located in northwestern Alaska (see fig. 2) on the southernmost edge of the continuous permafrost zone. Permafrost is peren-

Figure 2. Parks affected by permafrost degradation and rapid drainage of lakes are principally located in the Arctic and Central Alaska networks of the Inventory and Monitoring Program.

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National Park Service areas

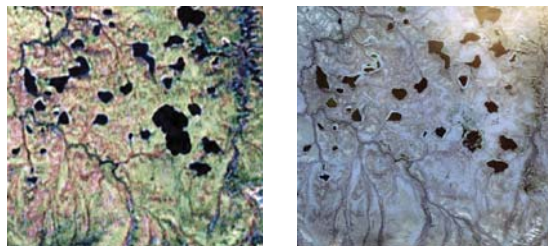
- NP National Park
- NPres National Preserve
- NM National Monument
- NHP National Historical Park
- National Park or National Monument
- National Preserve
- National Historical Park



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Figure 3. Remote sensing is used to track historical changes in lake surface area. These photographs show changes in surface area of the large lake over the past six years.

LEFT: 2003 LANDSAT THEMATIC MAPPER. MIDDLE: 2007 IKONOS. RIGHT: 2009 LOW ALTITUDE AERIAL PHOTO NPS/AMY LARSEN.



nially frozen ground that, when intact, prevents seepage of water, leaving it trapped near the soil surface or within depressions such as lakes. As permafrost melts, lake water is allowed to infiltrate the sediment underlying the lake and ultimately seeps out the lake bottom. Permafrost degradation surrounding lakes is common because soil temperatures tend to be warmer than in the surrounding upland terrain. The impacts of permafrost degradation are most severe in areas where the permafrost is ice rich; when ice-rich permafrost melts, the terrain subsides, creating new stream channels, and frequently results in catastrophic lake drainage. The ice content of permafrost varies greatly across northern Alaska and is high along the Nigerruk Plain in Kobuk Valley. Our aerial photography shows permafrost degradation in Kobuk Valley is concentrated in these ice-rich regions. Historically, annual average air temperature readings throughout the park have been well below freezing (20°F [-7°C]) and the permafrost has been stable; however, in the past 50 years average annual air temperature has increased 6°F (3.3°C). This temperature increase is likely the principal cause of permafrost degradation and the subsequent lake drainage.

Other soil characteristics, including thin organic layer, coarse soil particles, and fire, also affect the integrity of permafrost. Thick organic material common in other regions of northern Alaska protects permafrost by forming an insulating barrier that helps keep soil cold. In much of Kobuk Valley, however, the organic layer is thin and does not effectively protect permafrost. In addition, many of the lakes in the park lie between the two active sand dunes and are underlain by sand; therefore, when permafrost melts, water quickly infiltrates the sand and lake level drops. The southern portion of the park is occupied largely by boreal forest, where fire periodically removes the organic layer, reducing insulation of the permafrost. The vast majority of catastrophic drainage in the park has occurred

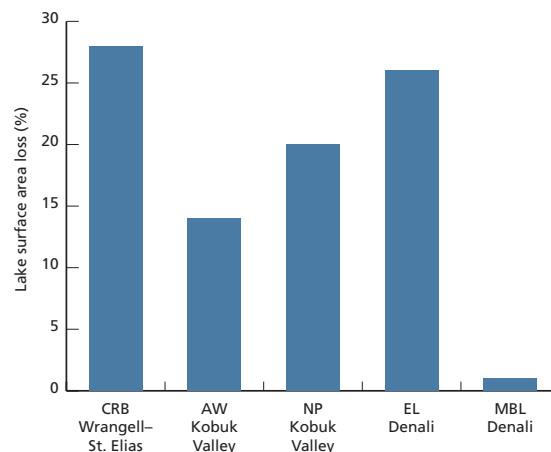


Figure 4. Change in lake surface area over the past 30–50 years in national parks located across north-central Alaska. CRB = Copper River Basin, AW = Ahnewetut Wetlands, NP = Nigerruk Plain, EL = Eolian Lowlands, MBL = Minchumina Basin Lowlands. Source: M. Necsoiu et al. 2009; Riordan et al. 2006; Verbyla 2007.

within the boreal forest zone. These geographic and soil characteristics contribute to the high degree of lake change observed in Kobuk Valley.

Information for managers

Field surveys planned for August 2010 will measure permafrost and soil characteristics in drained lake beds in Kobuk Valley to help park managers further understand the mechanisms contributing to lake drainage. Scientists studying the changes plan to model lake vulnerability in the park from the data gathered. This information will help managers track and forecast potential lake changes. These data, combined with other data on muskrat, moose, and beaver, will be used to make management decisions related to hunting, trapping, and fishing. At this time it is not feasible to mitigate the impacts of climate warming in these remote and otherwise pristine ecosystems. Educating the public is the strongest tool managers have to ameliorate the impacts of climate warming. Scientists are working to inform the public of the dramatic changes that are occurring in these remote regions of Alaska so they can affect legislation to reduce global emissions of gases known to contribute to global warming.

About the author

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