



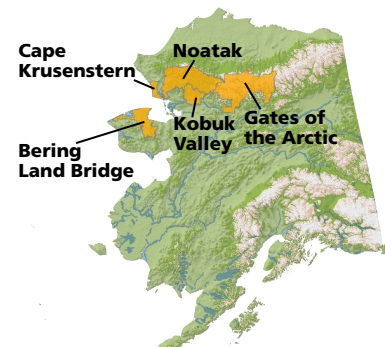
Bering Land Bridge N Pres. • Cape Krusenstern NM
Gates of the Arctic NP & Pres. • Kobuk Valley NP • Noatak N Pres.

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Permafrost Resource Brief

Permafrost is frozen ground that does not thaw in the summer due to a cold climate. The striking polygonal patterned ground so characteristic of the Arctic is due to permafrost.

The Status of Permafrost in the Arctic Network



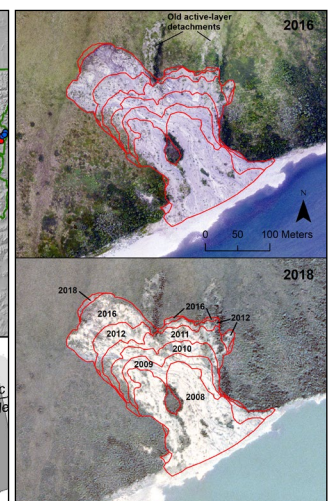
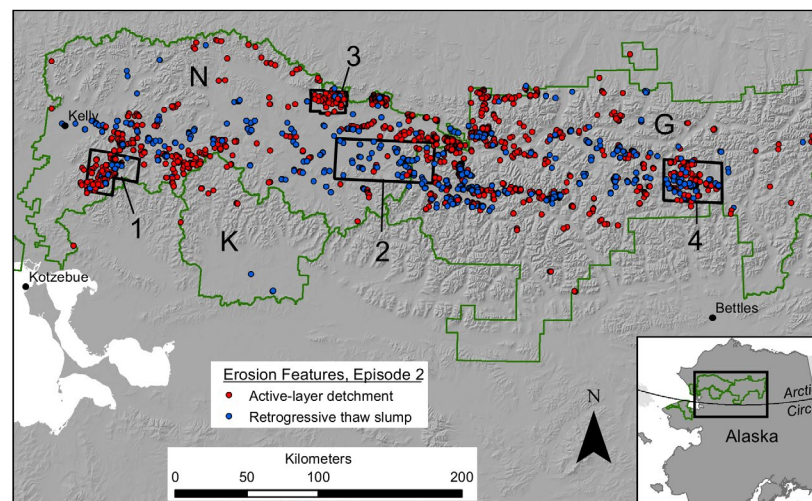
Permafrost is being monitored in all 5 Arctic Network parks: Gates of the Arctic National Park and Preserve, Noatak National Preserve, Kobuk Valley National Park, Cape Krusenstern National Monument and Bering Land Bridge National Preserve.

"A skeleton is to a human body what permafrost is to Arctic land."

-Santosh Panda, Permafrost Laboratory, UAF

Mean annual air temperatures from 2014-2019 increased in a stepwise fashion relative to the preceding 30-year period by about 2°C (3°F) over most of the Arctic parks, and as much as 3°C (5.4°F) in the far western coastal areas. As of 2019, these warm temperatures had not set off a large number of new thaw-related landslides, probably because the most vulnerable areas already slid during the unusually warm weather in

the mid-2000s decade. However, recent warm and wet conditions caused some thaw of ice masses near the ground surface that was accompanied by subsidence of the surface. This resulted in the formation of many new small pits and ponds in some lowland areas and opened up new passageways for water to run out of the shallow lakes that dot the tundra. These events led to a record number of drained lakes in 2018 and 2019.



Map (above left): An inventory of permafrost thaw slumps and slides in Arctic parks, based on satellite images from 2006-2009 (Episode 2), located hundreds, mainly in the Noatak NP (N) and Gates of the Arctic NPP (G). We have since mapped the slumps and slides on earlier aerial photos (about 1980, Episode 1) and more recent satellite images (2018-2019, Episode 3) in four study areas. In most places there were fewer erosion features in Episode 3 than in Episodes 1 or 2, despite recent record warm temperatures.

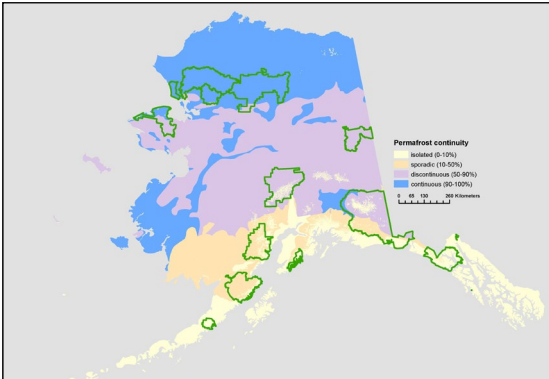
Stacked photos (above right): A large retrogressive thaw slump on the Noatak River near Akikukchiak Creek is the most significant slump in the Noatak National Preserve in terms of impacts. The slump grew steadily in area from 2008 through 2016 but grew little after 2016. Perimeters of the slump in various years are shown in red and labeled by year on the lower image. The old active-layer detachments that probably initiated the slump are labeled on the upper image.

Why is Permafrost Important

Permafrost underlies most of the Arctic Network and affects nearly everything in the arctic ecosystem, from soils and vegetation to water and wildlife. Permafrost prevents water from soaking deep into the ground, which makes soils wet and runoff fast. Ice can build up in the ground and then thaw, producing pits, ponds, lakes, and landslides.

Permafrost stores about half of all soil organic carbon on Earth. When it warms and thaws, this carbon is released from the soil as carbon dioxide and methane (greenhouse gases). Permafrost thaw increases soil erosion and creates ground slumps and landslides. Thawing permafrost also changes the local hydrology by changing soil wetness, nutrient cycling, sediment loads and siltation

of streams and lakes, and can form and drain lakes. It creates the second-greatest disturbance to boreal forests, after wildfires.



Permafrost extent across Alaska with boundaries of national parks in green. Data: Brown et al. 2002 [National Snow and Ice Data Center \(nsidc.org\)](http://NationalSnowandIceDataCenter.nsidc.org). Cartography: Michael Loso/NPS.

What We Want To Know About Permafrost

- Trends through time in ground temperatures at representative sites in the Arctic Network. This will indicate whether the permafrost is stable or thawing.
- Trends through time in the abundance and area of landforms caused by thaw of permafrost, such as landslides and pits from melting ice wedges.
- The growth rate of large slumps caused by thaw of permafrost and the rate of sediment loss from slumps.

How We Monitor Permafrost

- Monitor ground temperatures at strategically chosen locations around the Arctic Network, to determine if ground temperatures are rising and if so, how much and how fast. Ground temperature monitoring is co-located with air climate monitoring stations.
- Monitor the area occupied by landslides caused by thaw of permafrost. Map these features on satellite images and historical aerial photographs to determine if they are becoming more or less abundant.
- Create 3-dimensional models of selected high-impact slumps caused by thaw of permafrost and track their growth over time. 3D models are made from aerial photographs with special computer software. Repeat the photos every few years to track the growth of slumps.
- Monitor the degradation of ice wedges by mapping the appearance of the small ponds that form as the wedges melt. These ponds are visible on high-resolution satellite images and aerial photographs. Ice wedges are a common form of ground ice in the arctic and produce distinctive polygonal patterns.

How Monitoring Permafrost Can Help Park Managers

Results of permafrost monitoring will help us understand broad changes in ecosystems that could occur as a result of climate change, such as changes in the area of lakes, the turbidity of streams, and the density of vegetation. This in turn could affect decisions in management of wildlife, fish, and fire. Knowledge of permafrost stability could inform decisions about road corridors and engineering. Mapping of erosion features from permafrost thaw could be used to protect cultural sites. Interpretive products from permafrost monitoring will educate the public about how permafrost and climate change affect arctic ecosystems.

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