



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

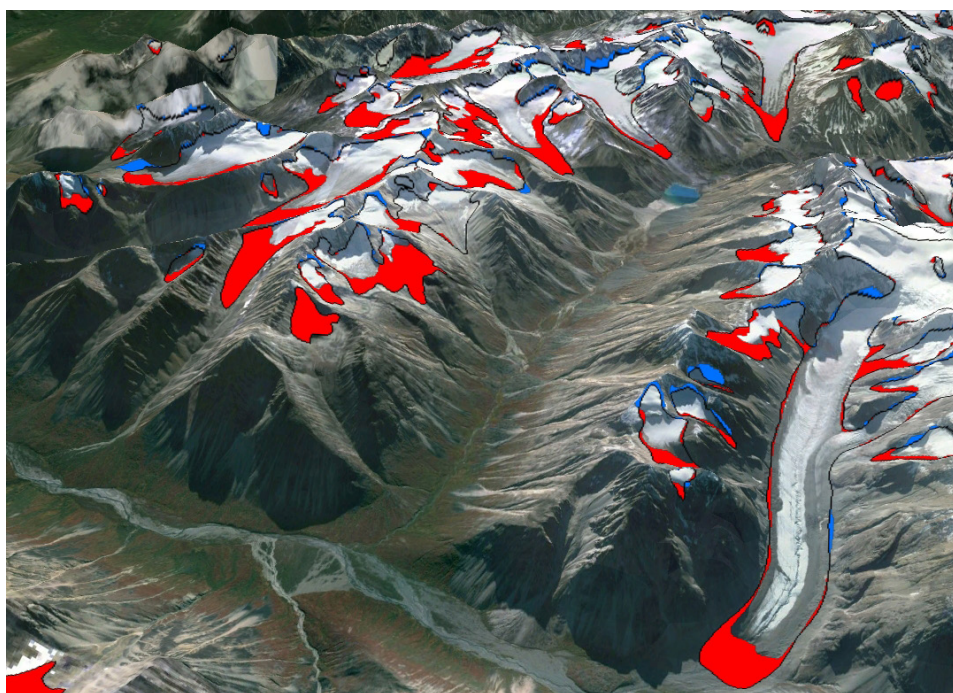
Glacier Extent

Glacier changes since 1950s documented for Katmai, Kenai Fjords, and Lake Clark

A new inventory of glaciers in national parks in Alaska by collaborators at the University of Alaska Fairbanks and Alaska Pacific University is almost finished. The inventory for Katmai, Kenai Fjords, and Lake Clark is complete and is based on glacier outlines delineated for two time intervals, the 1950s 'baseline extent' and late 2000s 'modern extent'. Results document park-wide changes in glacier

cover and the following changes are summarized for glaciers located within the administrative boundaries of SWAN parks. During the time frames examined, glacier extent in Katmai was reduced by 147.4 km² or 14.0%, glacier extent in Kenai Fjords was reduced by 149.7 km² or 10.2%, and glacier extent in Lake Clark was reduced by 328.4 km² or 12.3%. Notable glacier changes include significant ice loss at low

elevations in Katmai, particularly near the coast; minor glacier advance of some ash-covered—and therefore insulated—glaciers near the Valley of Ten Thousand Smokes; the conspicuous retreat of most large glaciers in Kenai Fjords; and the significant retreat and sometimes complete disappearance of small, but numerous higher elevation cirque glaciers in Lake Clark.

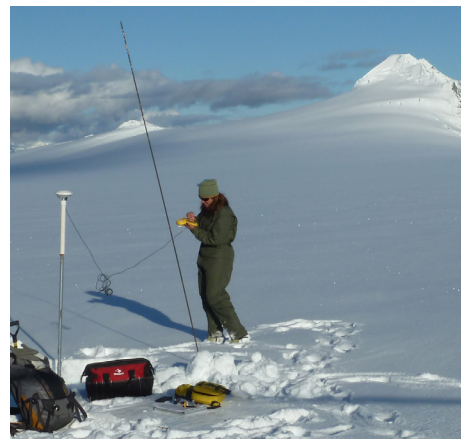


Left: Change in glacier extent near the headwaters of the Chilligan River in Lake Clark (view is to the south). Modern (2009) glacier outlines are shown in black, red indicates glacier ice that has been lost since the 1950s, and blue indicates minor ice gain or glacier ice that was not recognized in the 1950s. The late 20th and early 21st century has witnessed the significant retreat and sometimes complete disappearance of small, but numerous higher elevation cirque glaciers in Lake Clark.

Importance

Glaciers are sensitive to temperature change over a range of timescales, so they are natural integrators of climate variability and provide some of the most visible evidence of climate change. Glaciers currently cover approximately one-eighth of the combined area of Katmai, Kenai Fjords, and Lake Clark National Parks in southwest Alaska. Although glacier response varies by location and elevation,

glaciers in SWAN parks have, for the most part, experienced widespread thinning and retreat since the end of the Little Ice Age (about 1900 A.D.). Changes to these glaciers have both global and local consequences with impacts ranging from their contribution to global sea level rise to the transformation of scenic and recreational values for park visitors.



Natural Resource Specialist Deb Kurtz acquires a precise GPS location at a glacier mass balance monitoring stake on the Harding Icefield in Kenai Fjords. This information is used to determine glacier rate of flow and measure changes in surface elevation.

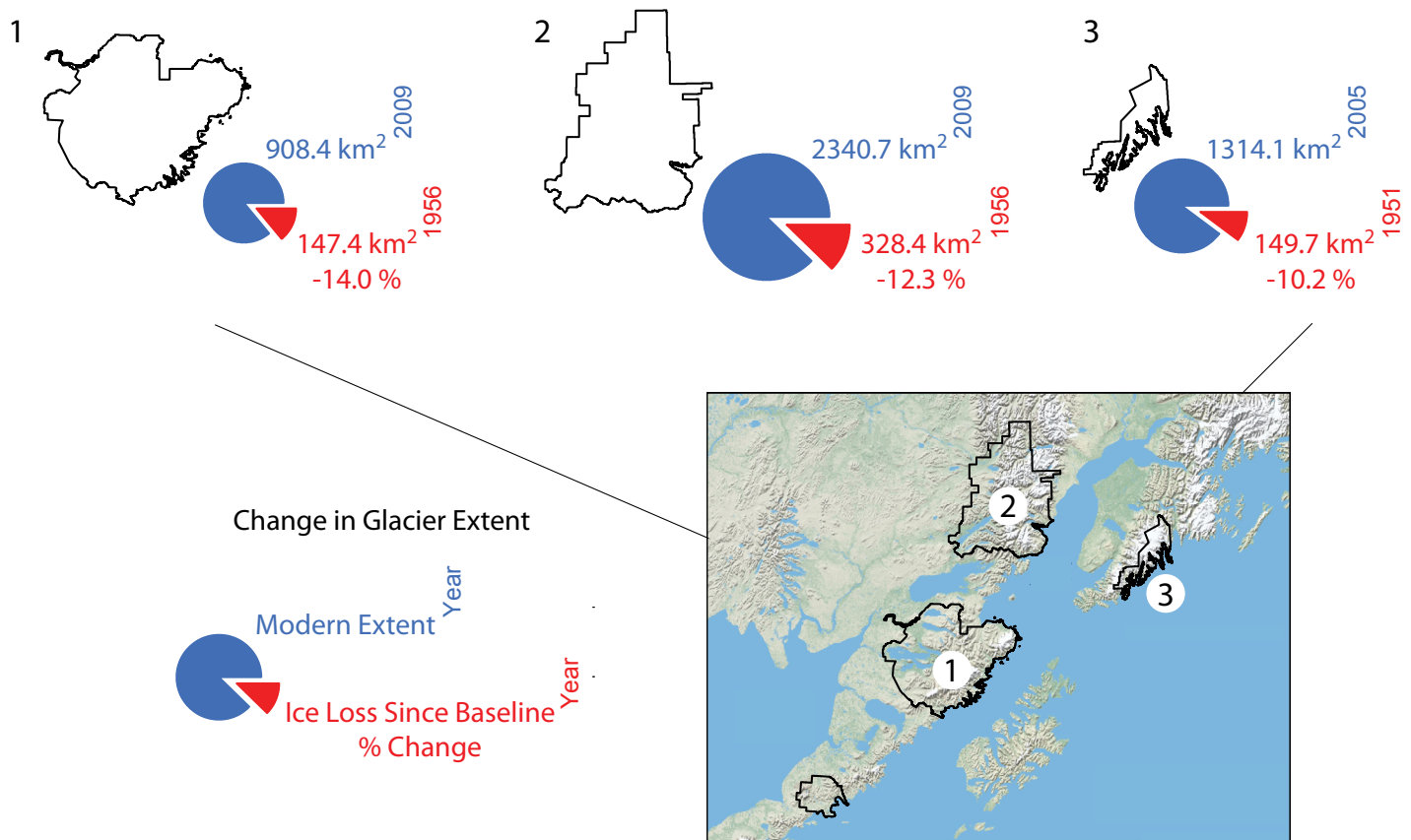
Monitoring Approach

To date, the SWAN monitoring approach has focused on refining methods for mapping glacier extent from late-season (i.e. September) Landsat satellite imagery and mapping glacier extent using a GIS on approximately decadal time series. These methods have included manual (heads-up) digitizing, supervised classification, and band-ratio techniques. We have learned that different mapping methodologies, cloud-cover, debris-covered ice, shadows, and variations in the amount of persistent snowpack and/or fresh snow are problematic and affect the accuracy of

detected change. We also have learned that some amount of manual editing of glacier margins is always required.

The results of the new inventory of glaciers in national parks in Alaska by collaborators at the University of Alaska Fairbanks and Alaska Pacific University (highlighted above) involved delineating glacier outlines for two time intervals, the 1950s and late 2000s. 'Baseline' 1950s outlines were derived from USGS topographic maps that were generated from aerial photographs acquired 1949 to 1957. 'Modern' glacier outlines were

derived from late-summer Landsat and Ikonos satellite imagery acquired 2004 to 2010. Digitizing was done at a scale appropriate to the base imagery (Landsat 1:10,000 to 1:20,000; Ikonos 1:1,500 to 1:5,000). A basin delineation algorithm was used to isolate specific glacier basins. Geostatistics (ID No., geographic name, date of imagery used, centroid latitude and longitude, glacier area, and area-weighted minimum, maximum, mean, median glacier elevations) and hypsometry (frequency distribution of elevations using 50m bins) were determined for each basin.



Change in glacier extent between the 1950s and late 2000s in Katmai (1), Lake Clark (2), and Kenai Fjords (3). Pie charts show the modern extent of ice within each park (in blue) and the extent of ice that has been lost since the 1950s baseline (in red).

Recent Reports

Arendt, A., C. Larsen, M. Loso, N. Murphy, and J. Rich. 2012. Alaskan National Park glaciers: Status and trends – second progress report. Natural Resource Data Series NPS/AKR/NRDS-2012/404. National Park Service, Fort Collins, Colorado.

Arendt, A., C. Larsen, M. Loso, N. Murphy, and J. Rich. 2013. Alaskan National Park glaciers: Status and trends – fourth progress report. In Press. National Park Service, Fort Collins, Colorado.

Giffen, B., D. Hall, J. and Chien. 2011. Alaska: Glaciers of Kenai Fjords National Park and Katmai National Park and Preserve. NASA Technical Reports Server Document ID 20120003718, Goddard Space Flight Center, available online.

LeBris, R., F. Paul, H. Frey, and T. Bolch. 2011. A new satellite-derived glacier inventory for western Alaska. *Annals of Glaciology* 52(59):135-143.

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More information on glacier monitoring in SWAN available at: <http://science.nature.nps.gov/im/units/swan/monitor/landscape.cfm?tab=1>