Status and Trends of Alaska NPS Glaciers: Workplan and Early Results

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About the Project

➢ Glaciers cover about 75,000 km² of Alaska's land surface and approximately one-quarter of those glaciers are located within National Park boundaries. To develop a more comprehensive understanding of the glacier resource in Alaskan National Parks and to assess the extent and impacts of recent changes to that resource, NPS recently initiated a collaborative 3-year project with investigators from Alaska Pacific University and University of Alaska Fairbanks. We recently presented our first progress report, available on request. The project will be completed in December 2013.

➢ The project has **three major components**:

1. map **changes in areal extent** of **all** NPS glaciers in the 1950s (from topographic maps) and the 2000s (from satellite imagery)
2. use existing repeat laser altimetry to estimate **volume changes** in a geographically **diverse subset** of the NPS glaciers
3. more thoroughly characterize historic changes to and landscape-scale impacts of **1-3 "focus glaciers"** per glaciated park unit

➢ Here, we use early results from Southwest Area and other statewide glaciers to document our ongoing methodology and seek feedback on the projected outcomes of the project.

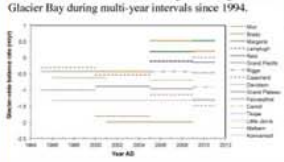
Volume Changes

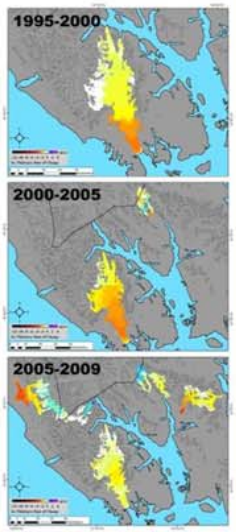
➢ Using laser altimetry, we measured 32 distinct intervals of elevation change distributed among sixteen glaciers in **Glacier Bay** between 1995 and 2011. Results from other parks, including SWAN parks (see map below of existing laser altimetry flightlines to be analyzed), will follow.

1. Of the measured intervals, all had negative glacier-wide mass balance rates (overall thinning) with five exceptions: positive rates on Muir Glacier 2005-2009 and 2009-2011 and Margerie Glacier 2005-2009, 2009-2011, and one neutral interval (Lamplugh Glacier 2009-2011).
2. The lowest measured balance rate (greatest thinning) was on Grand Pacific Glacier from 2001-2009: ice loss average 1.99 m/yr over the entire glacier surface.

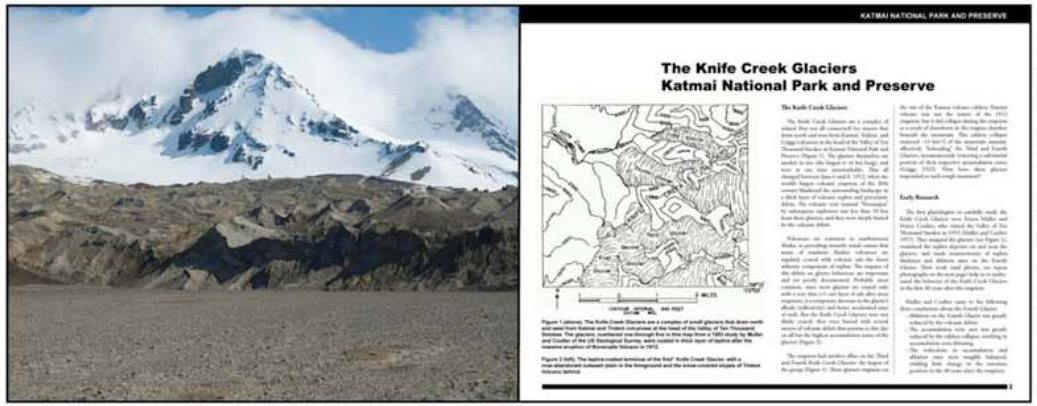
Above: Existing laser altimetry flightlines yet to be analyzed in SWAN parks.

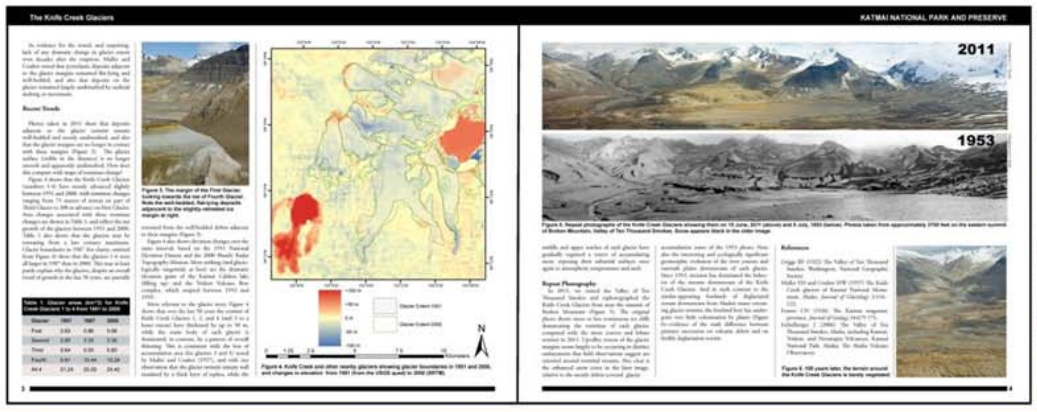
Below: Annual ice thickness change for 16 glaciers in Glacier Bay during multi-year intervals since 1994.





Above: Annual rate of ice thickness change, by elevation, for selected glaciers in Glacier Bay National Park and Preserve in three intervals: 1995 to 2000, 2000 to 2005, and 2005 to 2009.





Focus Glaciers

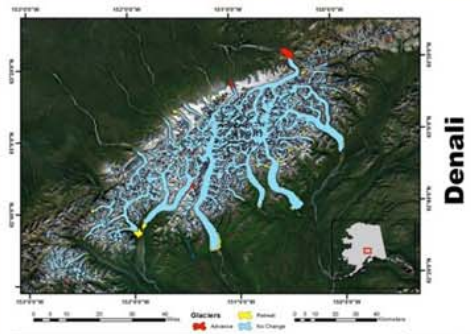
➢ **"Focus Glaciers" provide additional information about a small subset** of glaciers in each glaciated park. The goal: demonstrate unique ways in which A) glaciers change in response to climate and other forcings, and B) landscapes respond to glacier change. This portion of the report will include narrative descriptions, photos, maps, figures, and other graphical information.

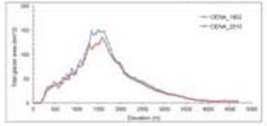
➢ This component of this project focuses on interpretation and synthesis. No new data will be acquired. For each glacier, these materials will ultimately be presented as a "vignette" in the final document. **At right**: a **mock-up** vignette, focused on the **Knife Creek Glaciers**. Note the use of an *Alaska Park Science*-style format. The final project publication will be longer, more focused, and more in-depth than the short articles in that journal, but will be published in a similar graphic format.

➢ Criteria for inclusion in the list of focus glaciers includes relative accessibility to visitors, an existing history of documentation including published and unpublished research, and representation of one of the many unique ways that glaciers respond to climatic change.

Below: mapped centroids of all selected focus glaciers in the Alaska region. Image courtesy Google Earth.

Changes in Areal Extent



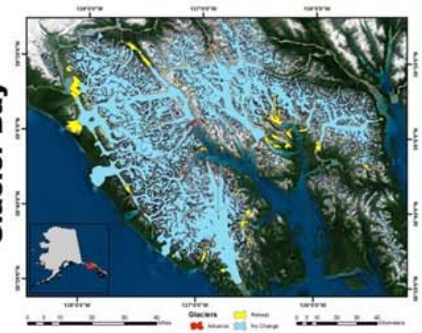


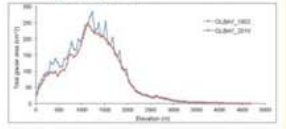
➢ Here we present results from mapping of all glacier extents in **Glacier Bay NP&P** and **Denali NP&P**. Other parks will follow in similar fashion. Significant early results:

1. Glacier Bay was 53.5% glaciated in 1952, but ice cover diminished 11% by 2010, to become 48.4% glaciated (6427 km²).
2. Denali was 16.9% glaciated in 1952, but ice cover diminished 8% by 2010, to become 15.5% glaciated (3817 km²).
3. The vast majority of glaciers in both parks have shrunk considerably, mainly by terminus retreat, in that time.
4. A few glacier termini advanced in Glacier Bay since 1952. All these advances are by tidewater or recently-tidewater glaciers in retracted positions that may indicate a resumption of normal tidewater glacier expansion.
5. Only two significant glacier expansions occurred in Denali since 1952. Both were surge-type glaciers: Muldrow and Peters Glaciers.

Time Period	Number of glaciers	Total glacier area (km²)	Estimated volume (km³)*
Map date (1952)	1103	4149	1051
Modern (2010)	754	3817	996
Absolute Change	-249	-332	-55
Percent Change	-23%	-8%	-5%

*volumes and volume changes are preliminary and subject to change. They are derived from area/volume scaling (Bahr, 1997) using exponent/coefficient values of 0.2055/1.375 from Radic and Hock (2010).





Time Period	Number of glaciers	Total glacier area (km²)	Estimated volume (km³)*
Map date (1952)	1120	7106	1729
Modern (2010)	1283	6427	1507
Absolute Change	163	-779	-222
Percent Change	15%	-11%	-13%

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