Climate Change Has Cascading Ecological Effects on Mountain Ecosystems

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8303 permanent snow and ice bodies

Glaciers in the American West
1 : 24,000

688 km²

Andrew G. Fountain

US Forest Service lands
National Park Service lands
Glaciers
Grinnell Lake and Grinnell Glacier, 1910

Photo by Kiser, courtesy GNP Archives
USGS Repeat Photography Points in Glacier National Park

Grinnell Glacier 1910 - 1998

Sperry Glacier
Glacier National Park

Morton Elrod photo
Courtesy Glacier NP Archives

Lisa McKeon photo, USGS
2001
Shepard Glacier

W. C. Alden/ USGS photo. 1913

B. Reardon/ USGS photo. 2005
Repeat Photography

Grinnell Glacier

1940  
2006
Boulder Glacier
Glacier National Park, MT

Morton Elrod photo
Courtesy of GNP Archives

1910

Fagre/Pederson photo
USGS

2007
Fraction of Glacier Area Lost since 1900

- 66%
- 24%
- 30%
- 56%
- 31%
- 25%
- 42%
- 40%
- 56%

Fountain et al, 2007

Legend:
- US Forest Service lands
- National Park Service lands
- Glaciers
US Forest Service lands
National Park Service lands

Glaciers

66%
24%
30%
56%
40%
31%
25%
46%
13%
42%

Glaciers > 3000m affected by summer temperatures
Glaciers < 3000m affected by winter and summer temperatures

Fountain et al, 2007
Snow depth measurements

- 0 – 9+m deep

How much mass accumulates each winter?

- 560kg/m³ avg. density
- 65-95” SWE
1.7m ice loss each summer

Sperry Glacier, Aug. 8, 2005. John Newton photo

Depth in Meters
Distance in Meters

Bed surface
ACTUAL AREA for Jackson/Blackfoot Glaciers

1998 - 2.94 square kilometers

PREDICTED AREA for Jackson/Blackfoot Glaciers

2000 - 3.89 square kilometers
2010 - 2.44 square kilometers

We are approximately 10 years ahead of the predicted rate of melting for these glaciers
Aquatic invertebrate species distribution in response to stream temperature

Minimal glacial runoff

Present glacial runoff

- Parapsyche elsis
- Arctopsyche grandis
- Hydropsyche cockerelli
Threats

Invasion of the Nonnatives

Bull trout  (native)

Lake trout  (introduced)
Climate Change

[Map of climate change impacts with markers for lower limit sites and air temperature stations.]
What is the frequency of natural avalanches?
Change Detection Map

Outflow (A2 minus Control simulation)
Midslope = zone of greatest change
Trends in Timing of Spring Snowmelt

Courtesy of Mike Dettinger, Iris Stewart, Dan Cayan
Understand and predict responses of Western mountain ecosystems to climatic variability and change – emphasizing their sensitivities, thresholds, resistance, and resilience.

SCIENCE ACCOMPLISHMENTS
Regional and continental scale assessments
New understanding through syntheses of existing data and knowledge
Getting diverse disciplines and groups working together, opening up information exchanges
New capabilities with modeling
Relevance to managers (fire, drought, threatened species, forestry)
Bring a focus to mountains
Mapping New Terrain: Climate Change and the America's West