Glacier Shrinkage and Effects on Alpine Hydrology

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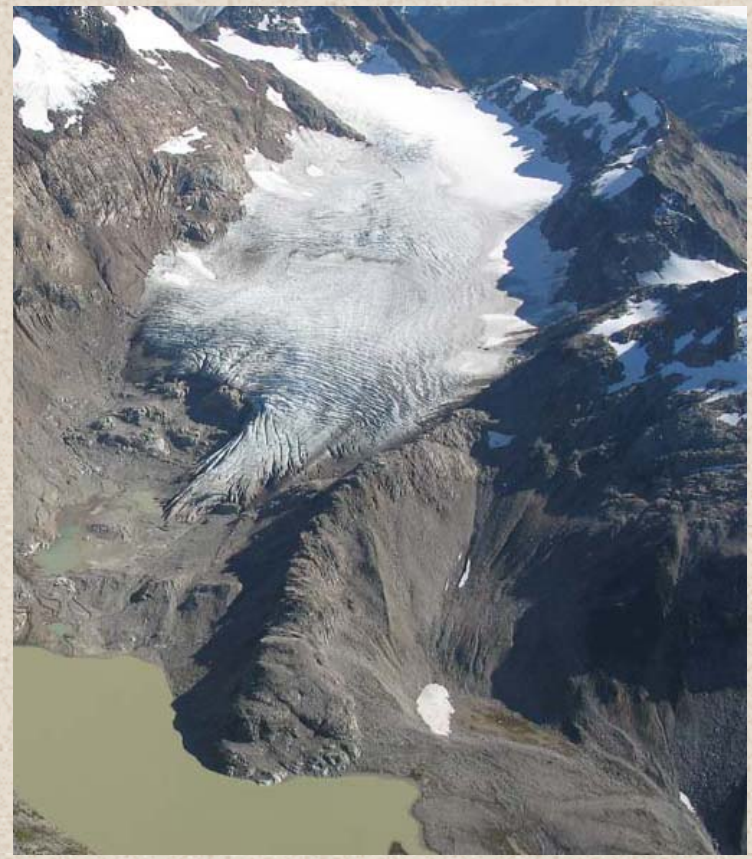
Supported by the US Geological Survey, NSF BCS-0351004; NASA NNGO4GJ41G

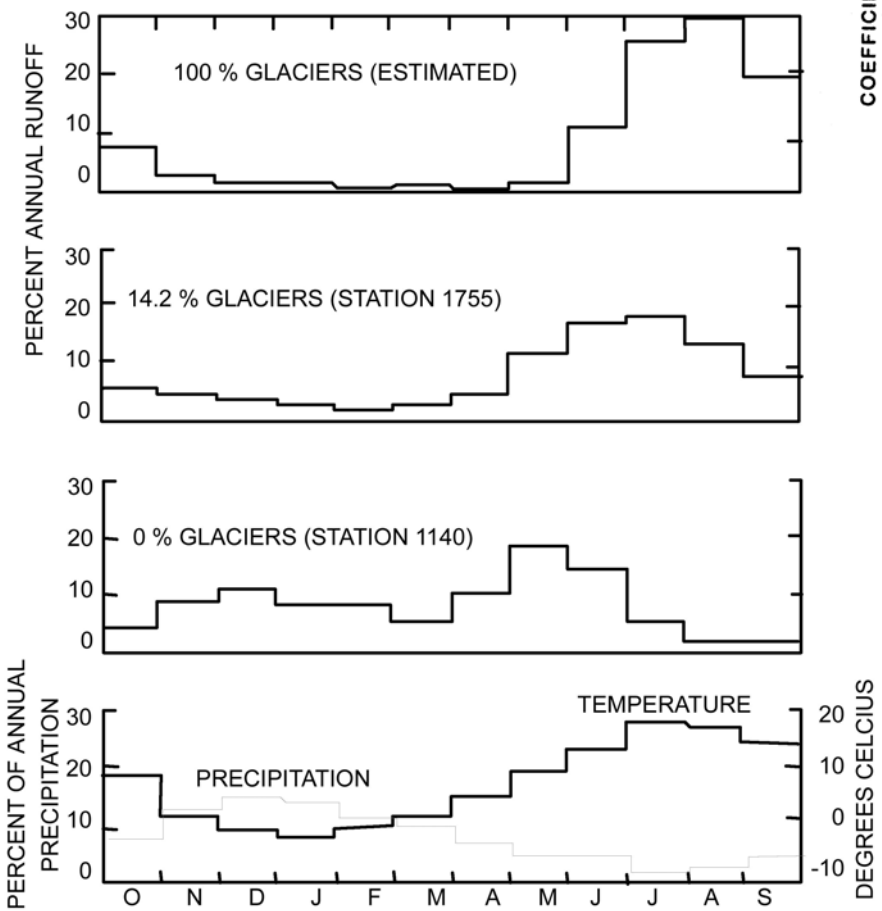
South Cascade Glacier, WA 1960 USGS



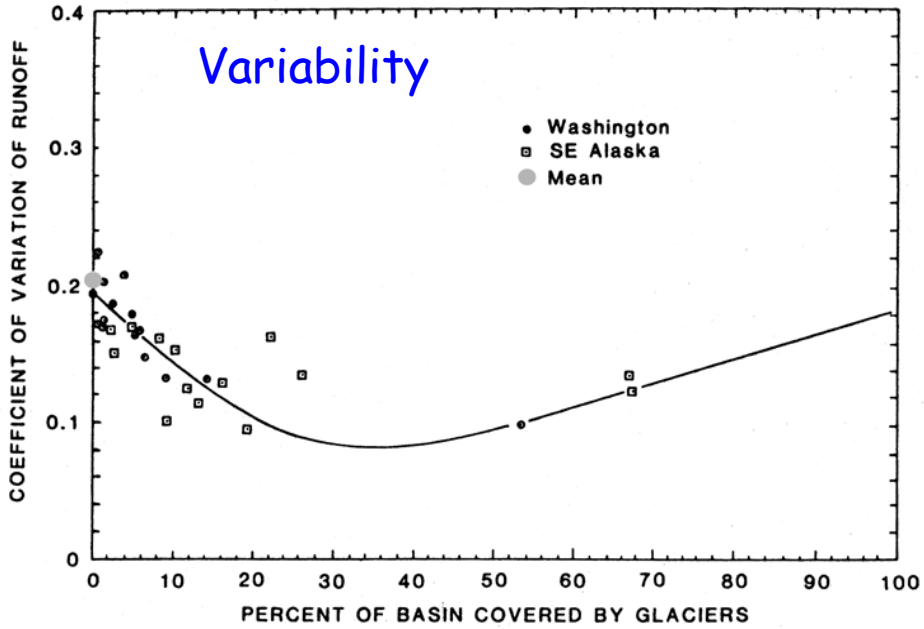
2004 John Scurlock

Glacier Effects on Basin Runoff

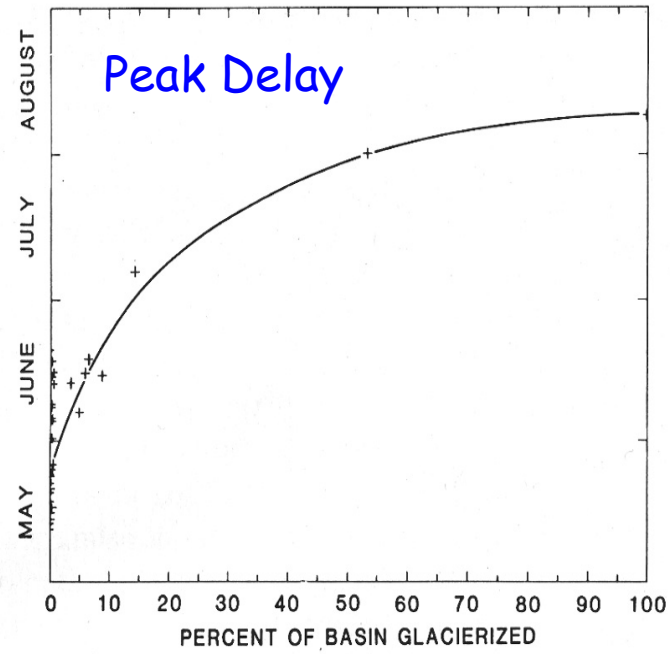
Runoff Delay



Variability

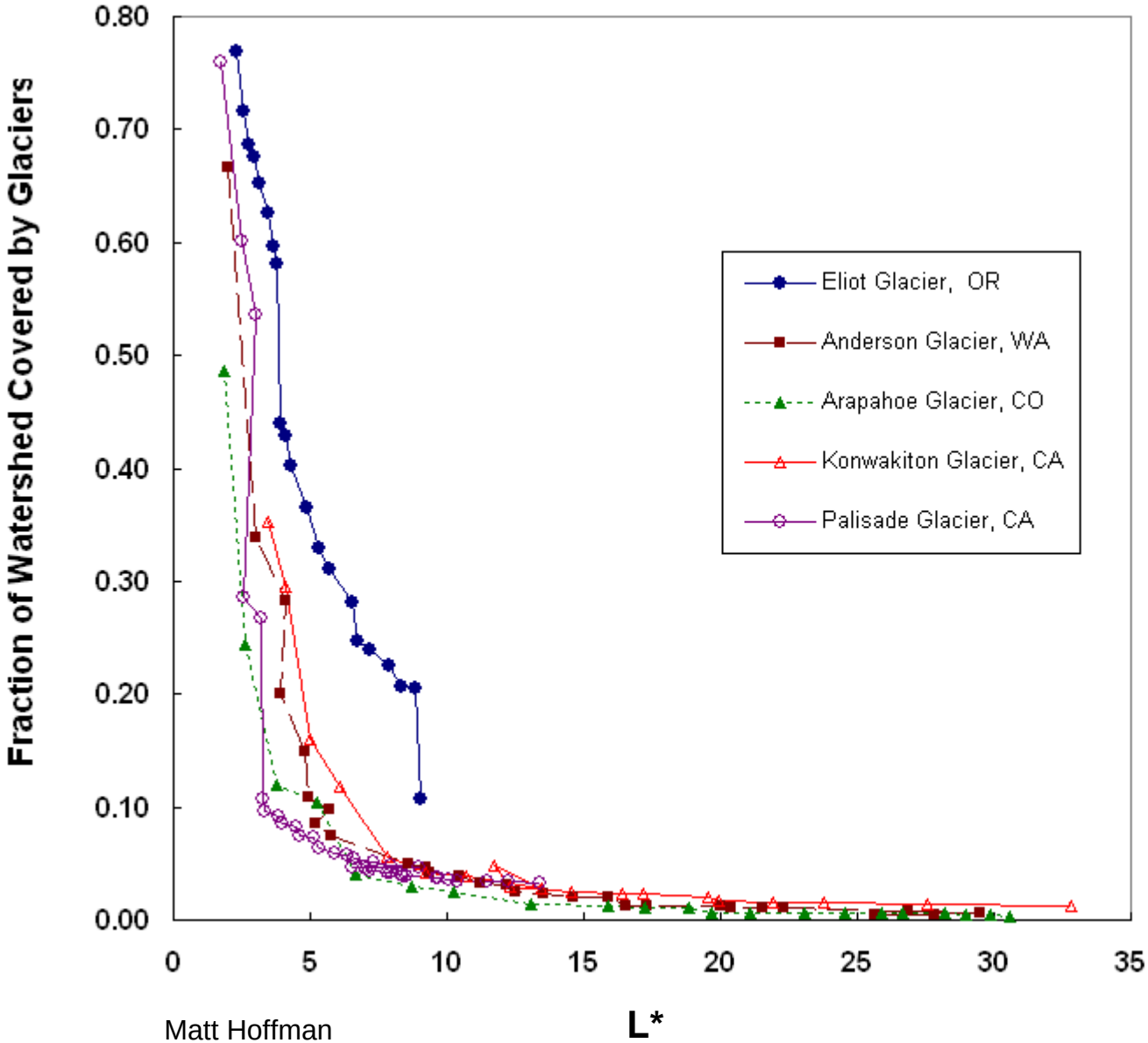


Peak Delay



Fountain and Tangborn, 1985

Limit of Downstream Effects



$$L^* = \frac{\text{CummDist}}{\sqrt{\text{GlacierArea}}}$$

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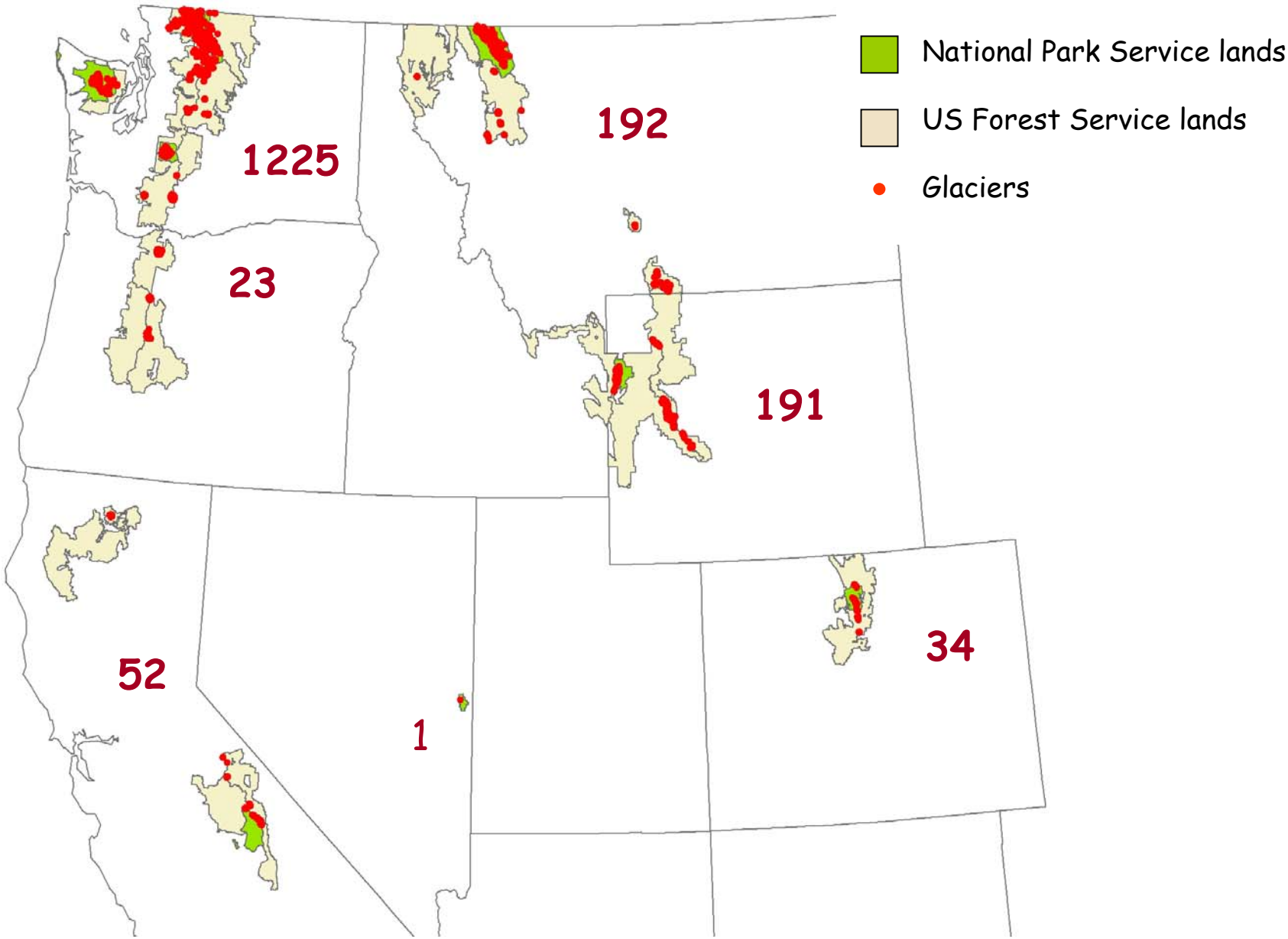
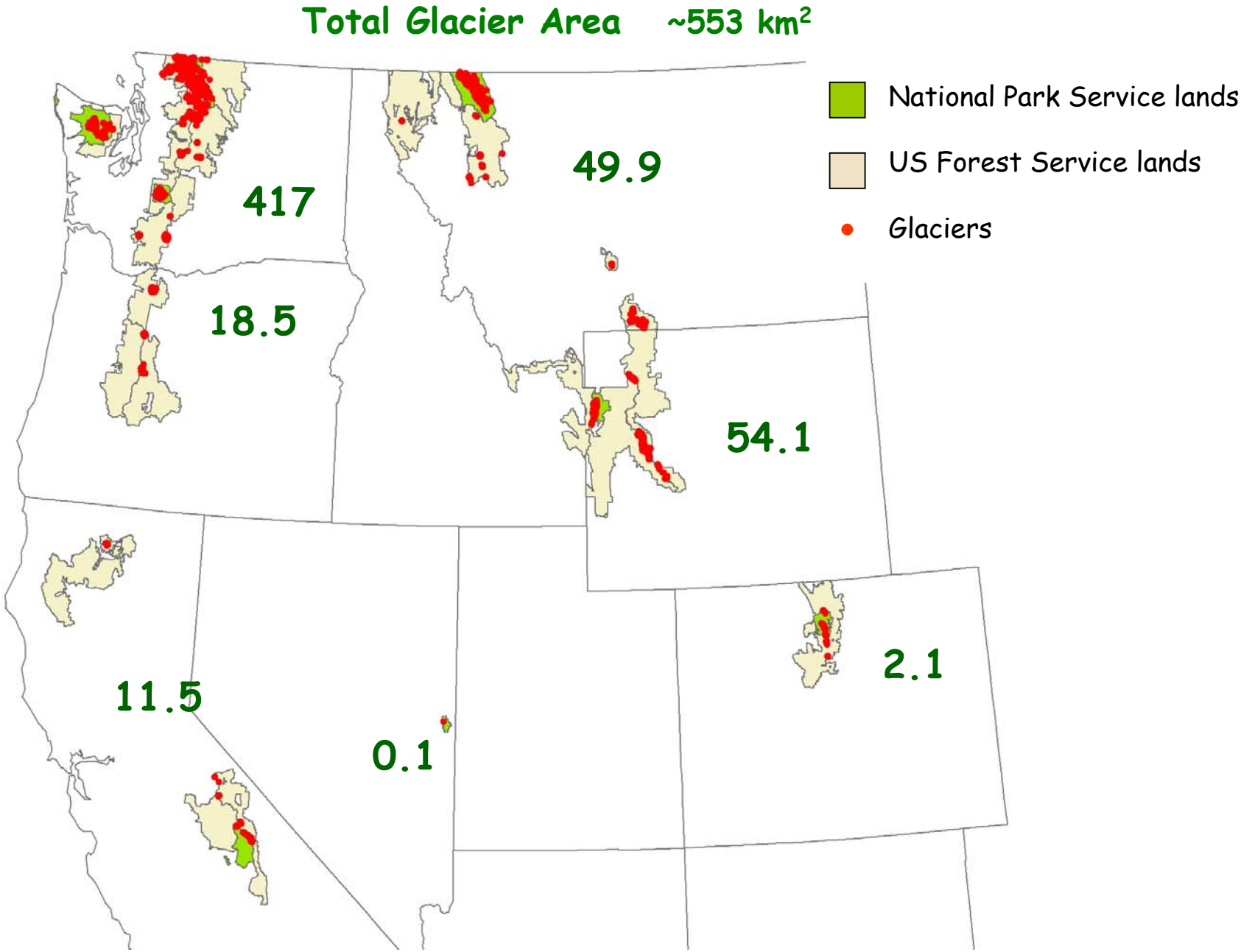
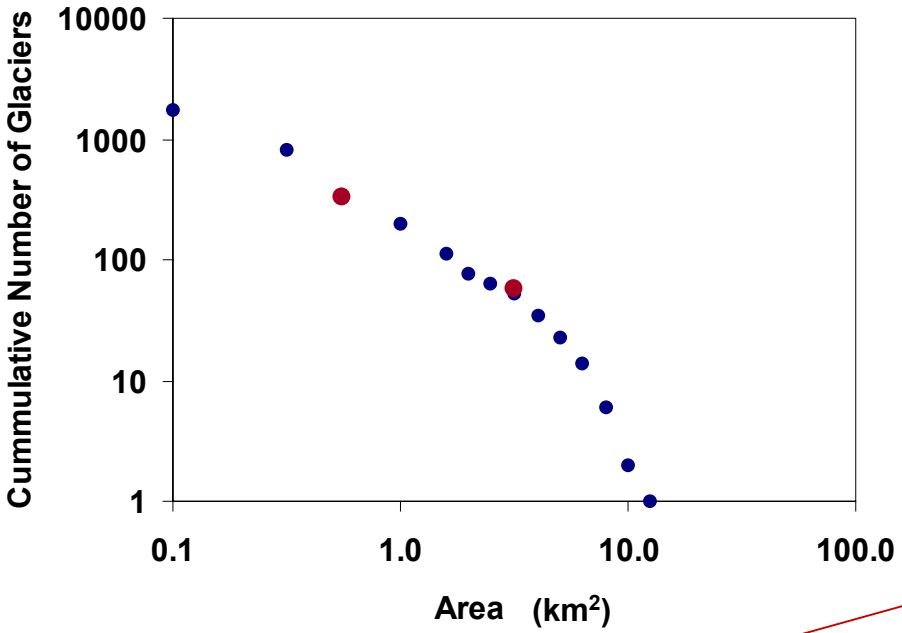
Number of Glaciers in the American West

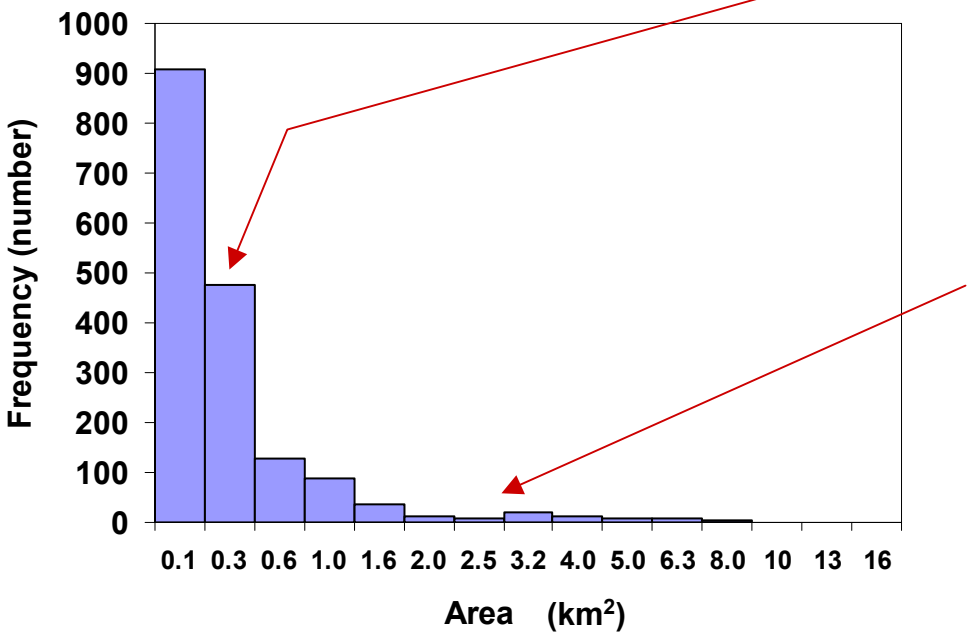
~1712

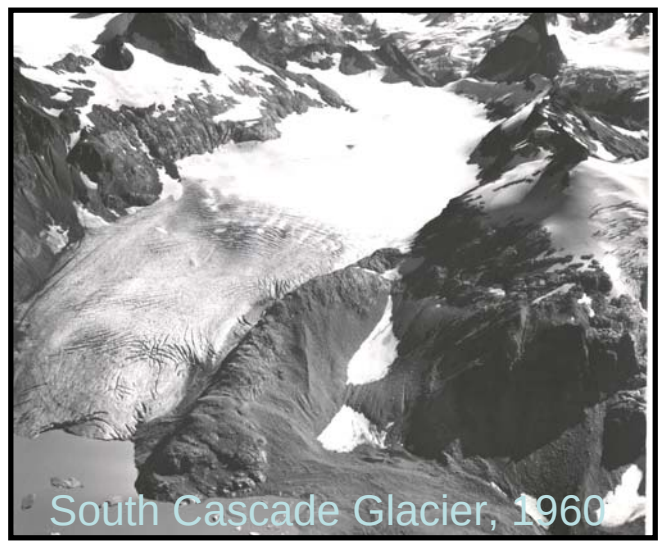



Total Glacier Area ~553 km²
National Park Service lands
US Forest Service lands
Glaciers
417
49.9
18.5
54.1
2.1
11.5
0.1

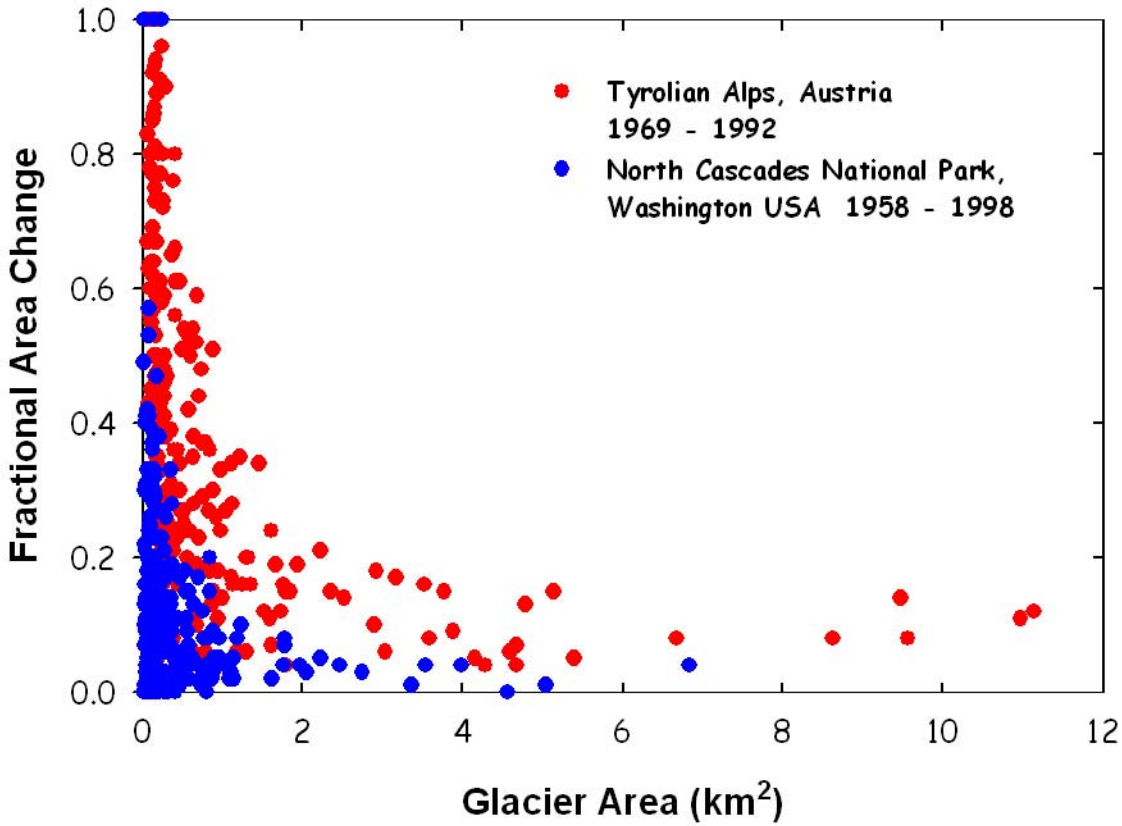
Size Distribution of Glaciers



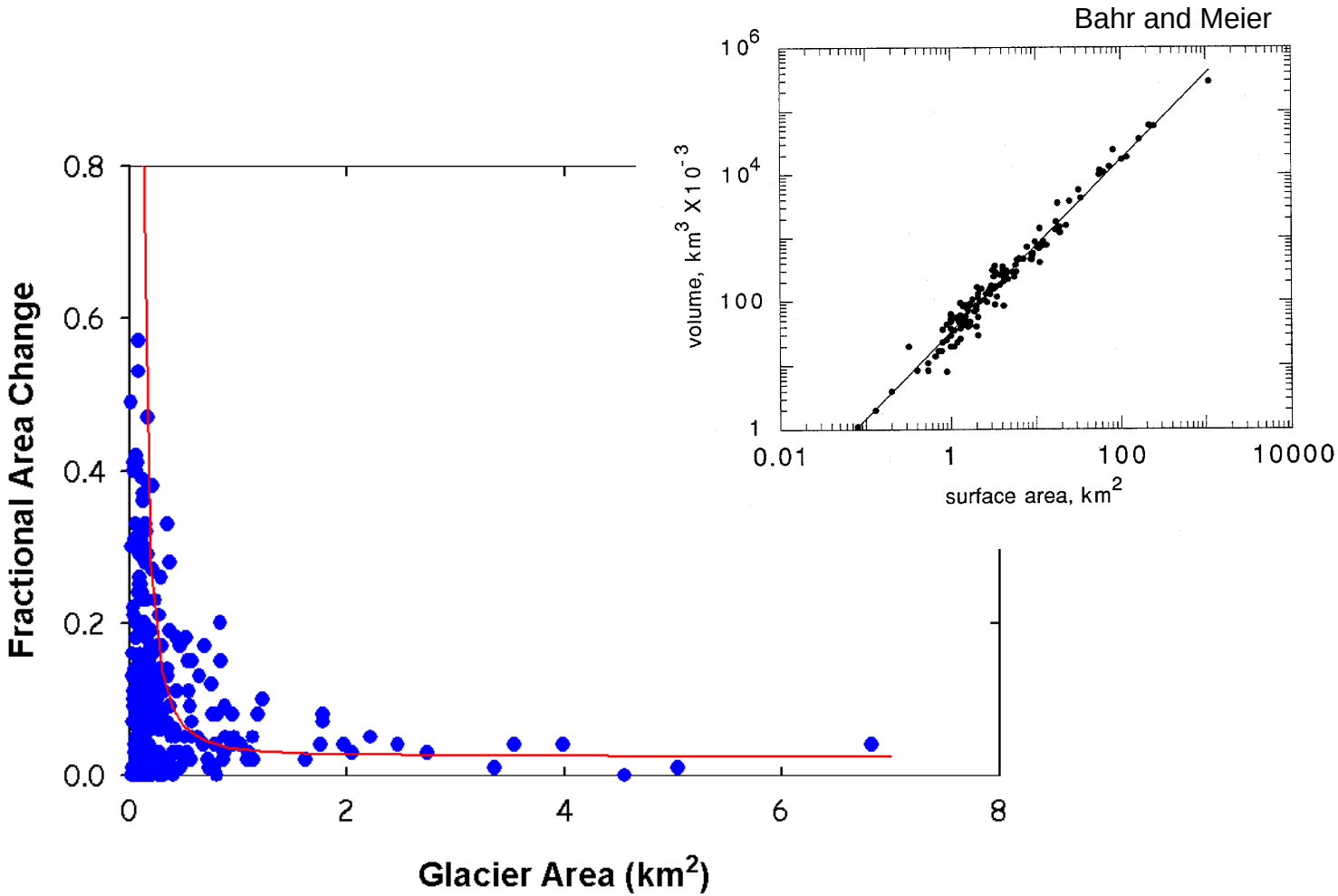




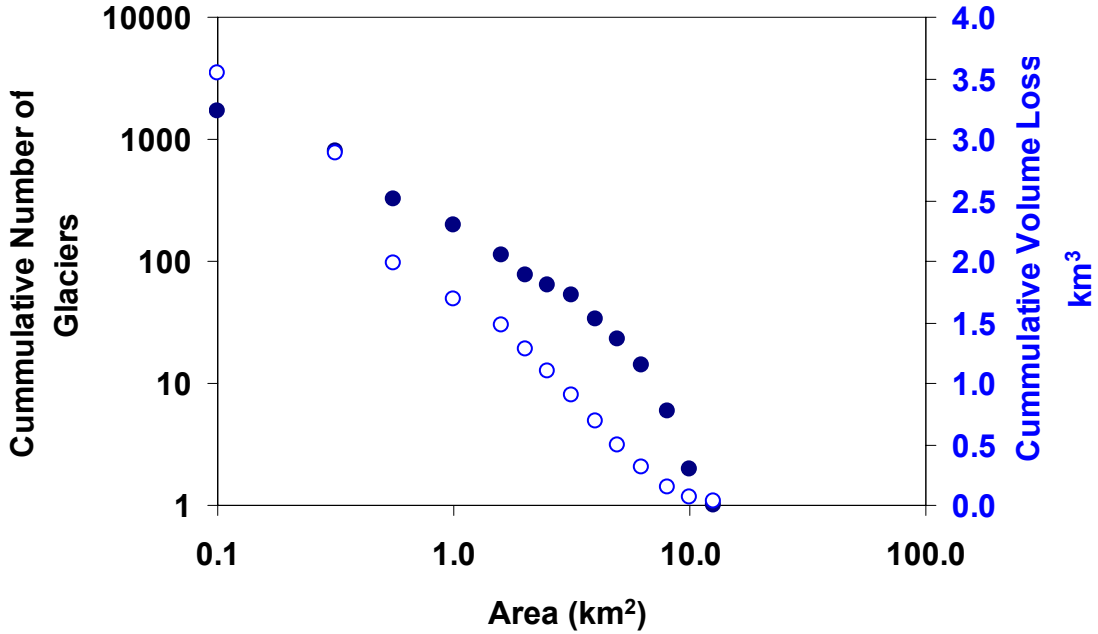
Glacier Shrinkage

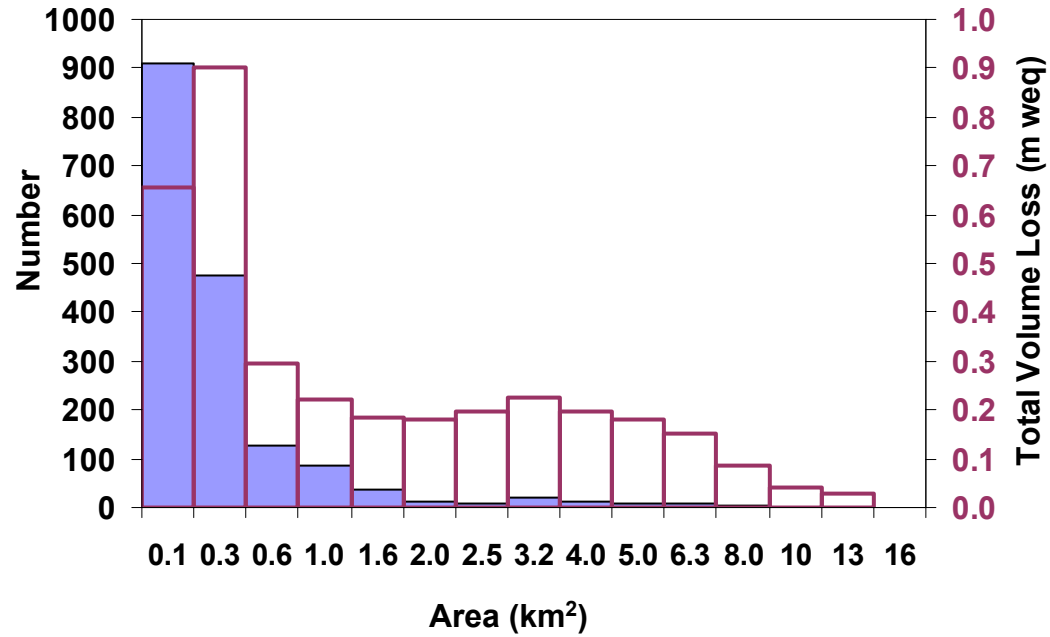


Tyrolian data courtesy of F. Paul
Geography, University Zurich-Irchel


Bahr and Meier
Fractional Area Change
0.0
0.2
0.4
0.6
0.8
0
2
4
6
8
Glacier Area (km2)
volume, km3 X10-3
10^6
10^4
100
1
0.01
1
100
10000
surface area, km2

Total
Glacier Volume Loss





Colorado Front Range - John Achuff

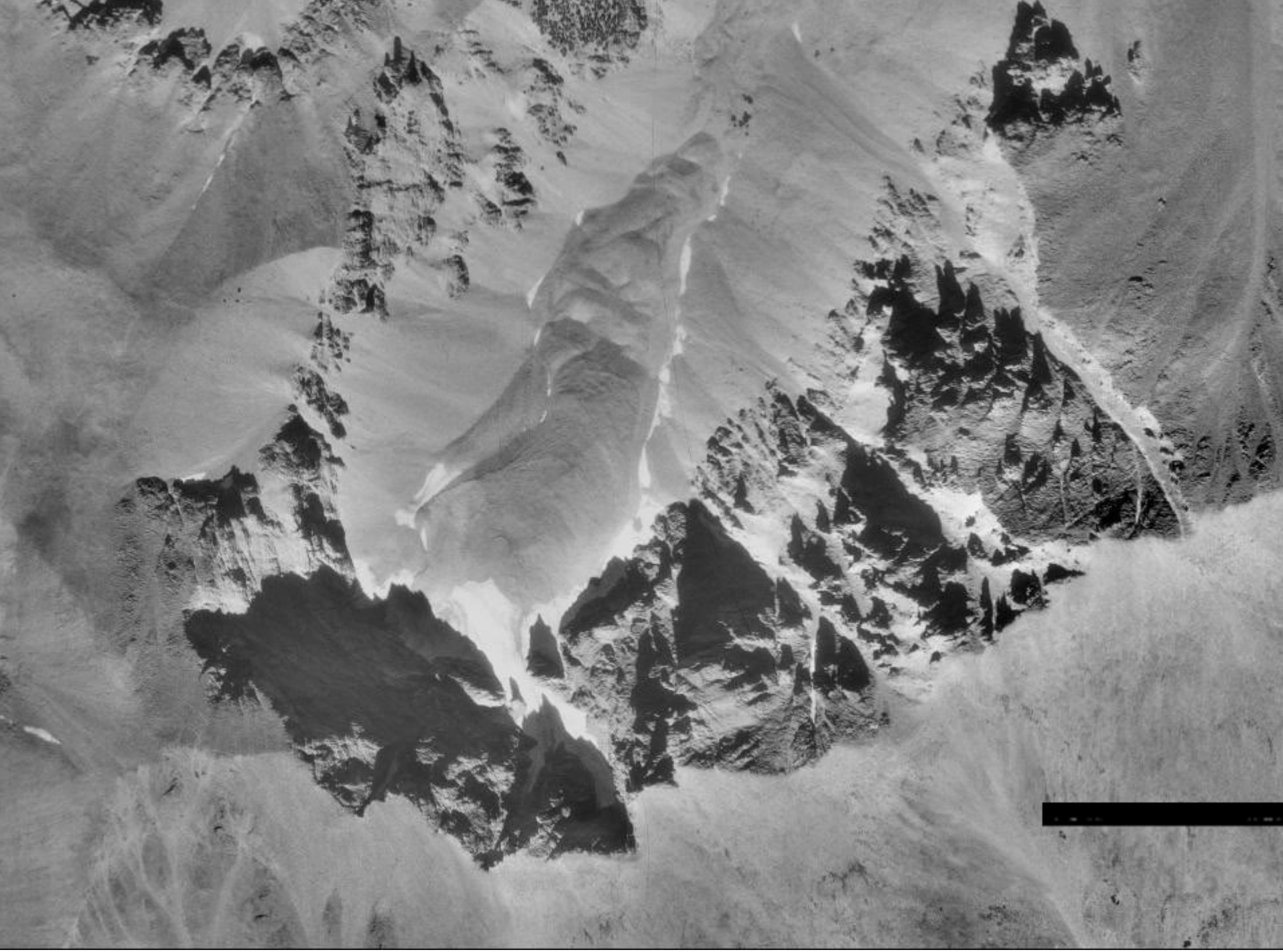
Norrland Sweden

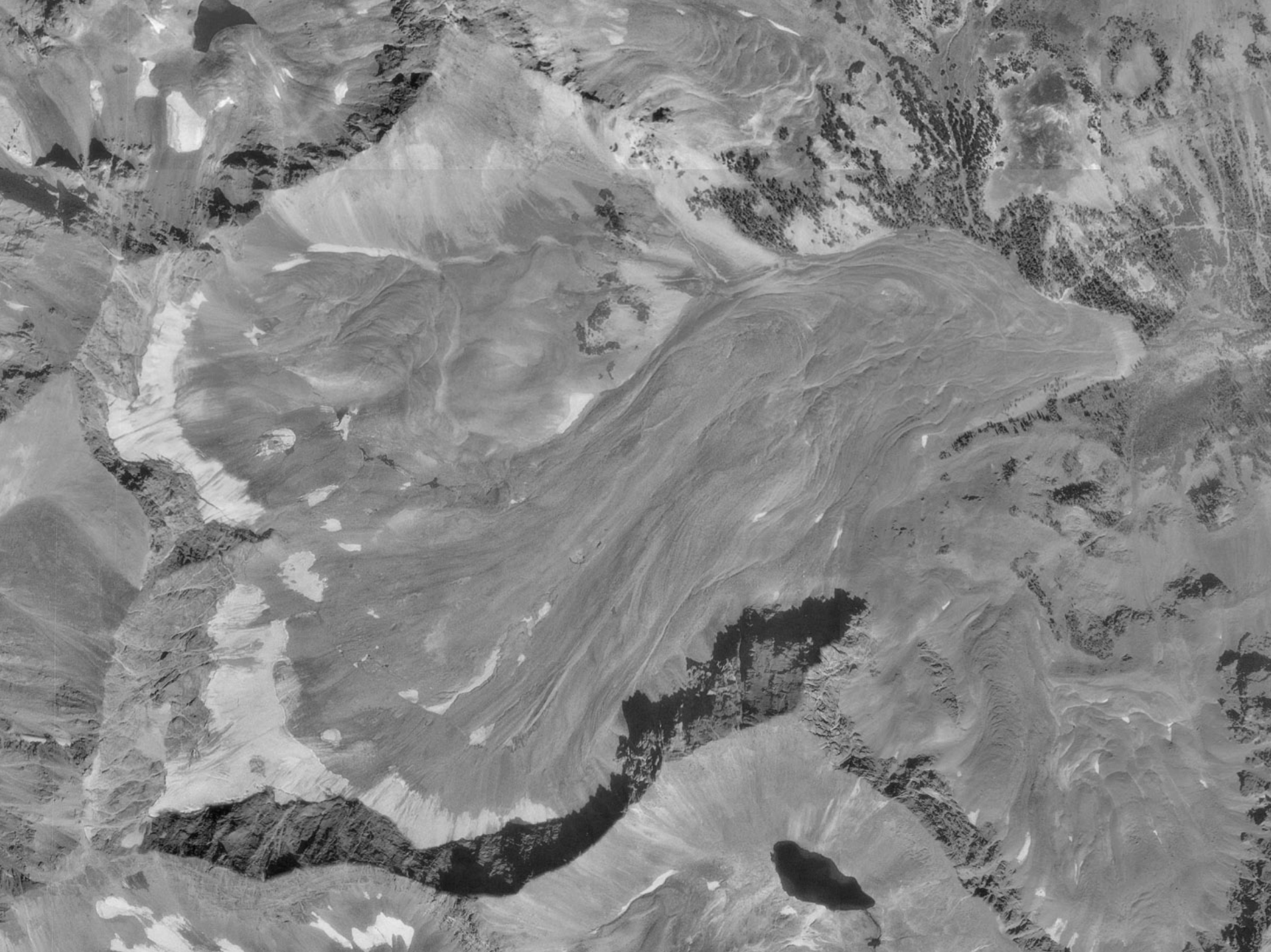
Approximate Values of Glacier Change

1960's to current

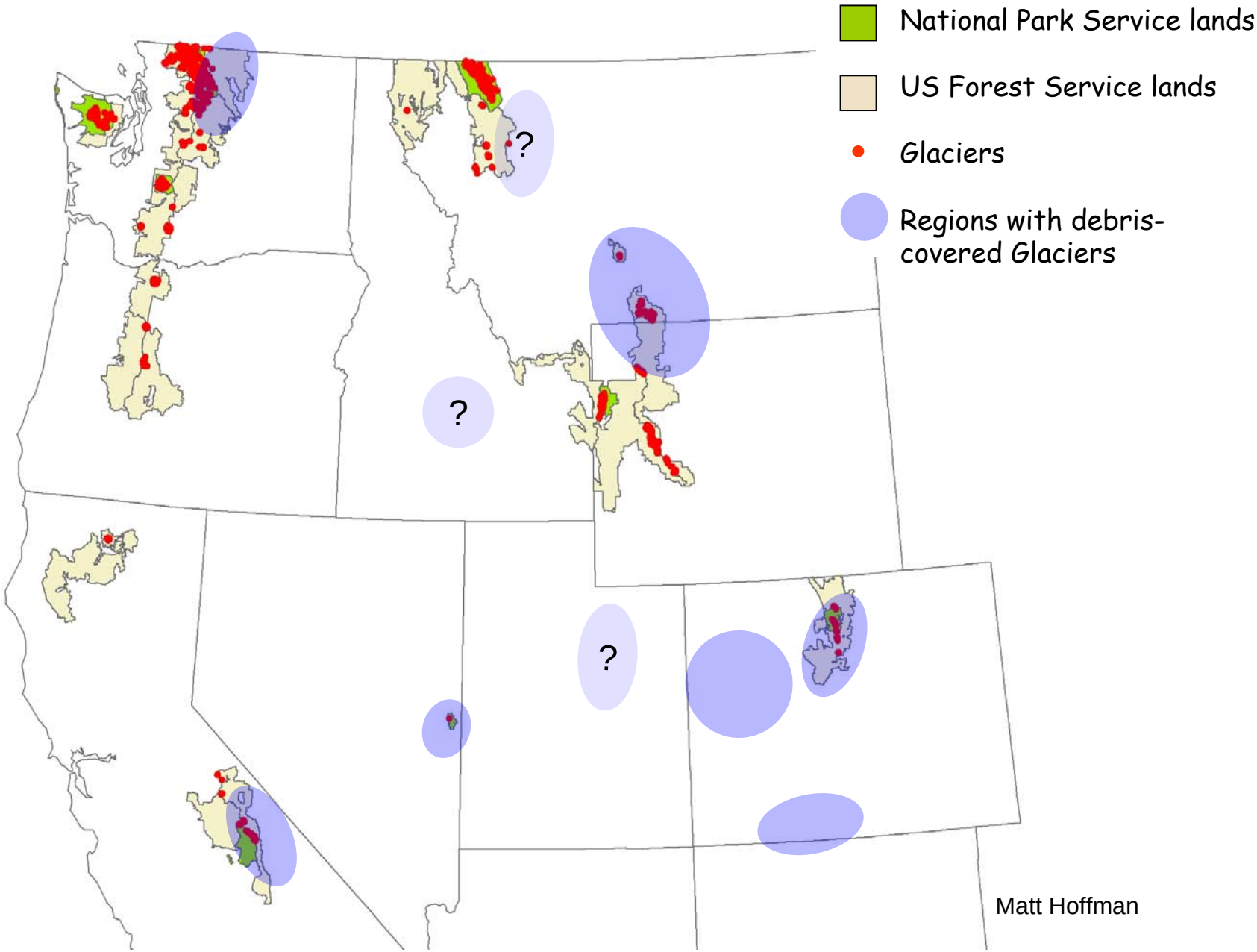
National Park	Number of Glaciers	Area km^2	Δ Area km^2	Δ Volume km^3	m
North Cascades	321	117 ±1	-8 ±1	-0.8 ±0.1	7
Mount Rainier	100 (26)	93	-2	-0.18	2
Olympic	165	34	-2	-0.07	2
Yosemite-Sequoia -Kings	45	6	-2	-0.03	5
Glacier	127	33	-3	-0.08	2
Rocky Mountain	28	1.4	-0.3	-0.003	2


Wheeler Peak
Great Basin National Park
Wheeler Peak Campground
Stella Lake
Teresa Lake
Brown Lake
Jeff Davis Peak
Wheeler Peak 13063
Moraine
1 km
GREAT
North Fork
Creek





Rock Glacier Distribution



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Rock Glaciers / Buried Ice
(population not well known, effects not well known)

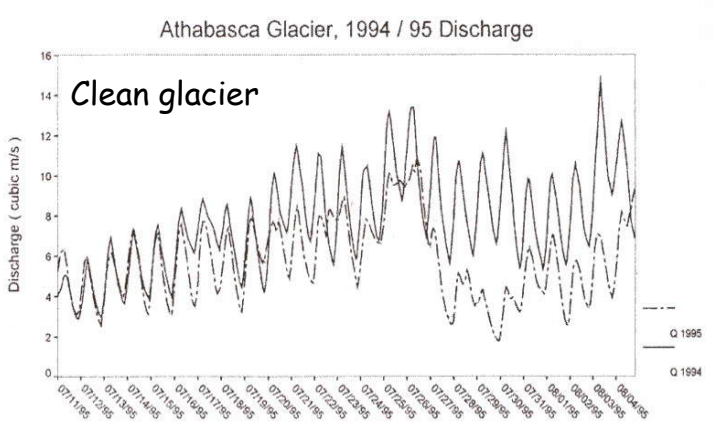


Fig. 2 Discharge for the Sunwapta River from 11 July to 5 August 1994 and 1995.

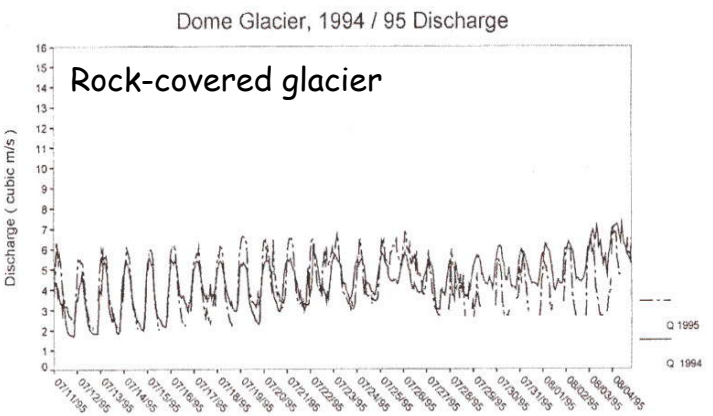
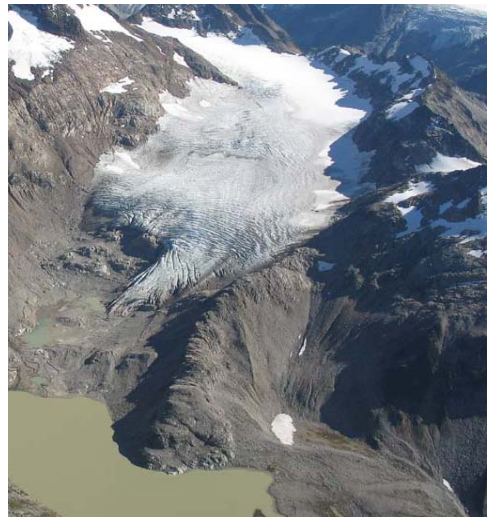


Fig. 3 Discharge records for the Dome River from 11 July to 5 August 1994 and 1995.

L. Mattson



Conclusions

1. Hydrologic influence (variability, delay of seasonal peak) imposed by glaciers extend roughly 5 glacier "lengths" downstream. Effects melt volume and water quality can extend much further.

2. The "small" glaciers (<1 km^2) account for almost half of the glacier area in the west and half of the melt water volume. They seem to be changing the most, yet are the least studied and hardest to define.

3. Debris-covered glaciers appear to be very common and are largely unrecognized sources of melt water. They may effectively double the area of ice present in a given region.