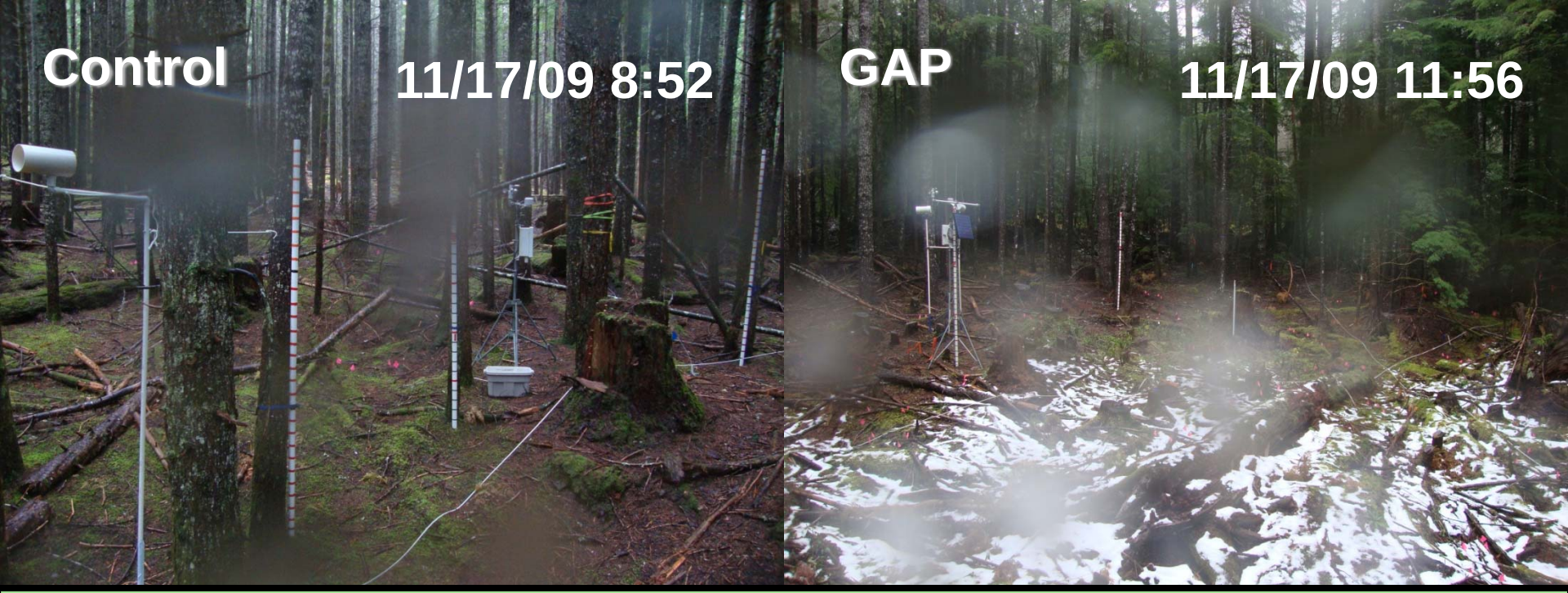

Trees and snow in Seattle's Cedar River Watershed: Can silviculture help combat climate change?

Jessica Lundquist, Jenna Forsyth, Jim Lutz, Rolf Gersonde, Nic Wayand

Outline

- Brief history of Cedar River Watershed
- How climate change is likely to affect the watershed
- Overview of interactions between trees and snow
- Our study design and very preliminary results

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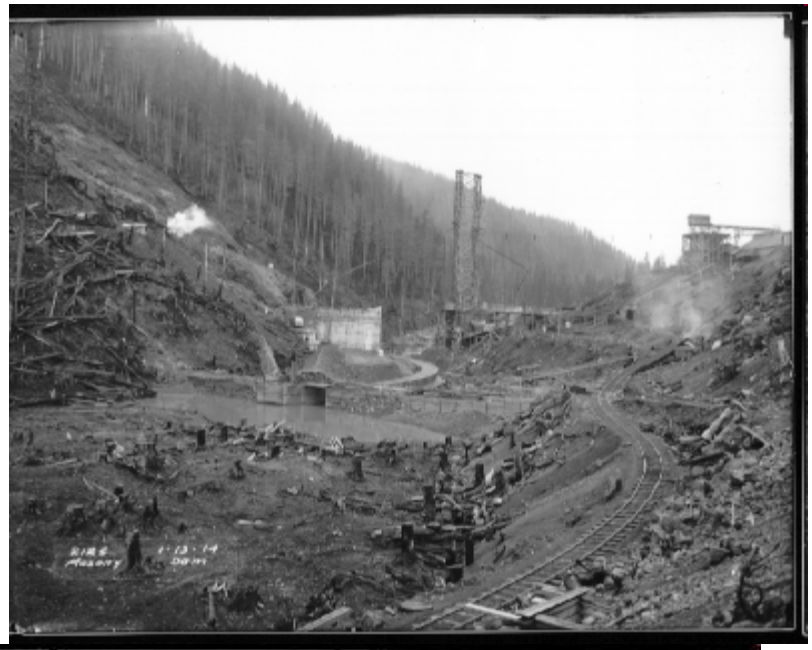
1914 = Construction of the Masonry Dam.



Photos from Seattle Municipal Archives Photograph Collection

Tree trunks reveal that Rattlesnake Lake wasn't always a lake…

Rattlesnake Lake, March 2000 *Courtesy History Ink*

Rattlesnake Lake, March 2000 *Courtesy History Ink*

Train depot at Moncton, 1900s *Postcard*

Flood at Rattlesnake Lake, June 28, 1915
Courtesy Seattle Municipal Archives

Enough water but small storage:

m. g. = million gallons

- Annual water demand = 50,800 m. g.
  (SPU 2003 Water Demand Report)
- Average annual outflow = 75,000 m. g.
- Reservoir capacity = 15,800 m. g.
  (SPU 2007 Water systems plan)

Endangered Bull Trout requiring water temperatures generally below 55 °F (13 °C)

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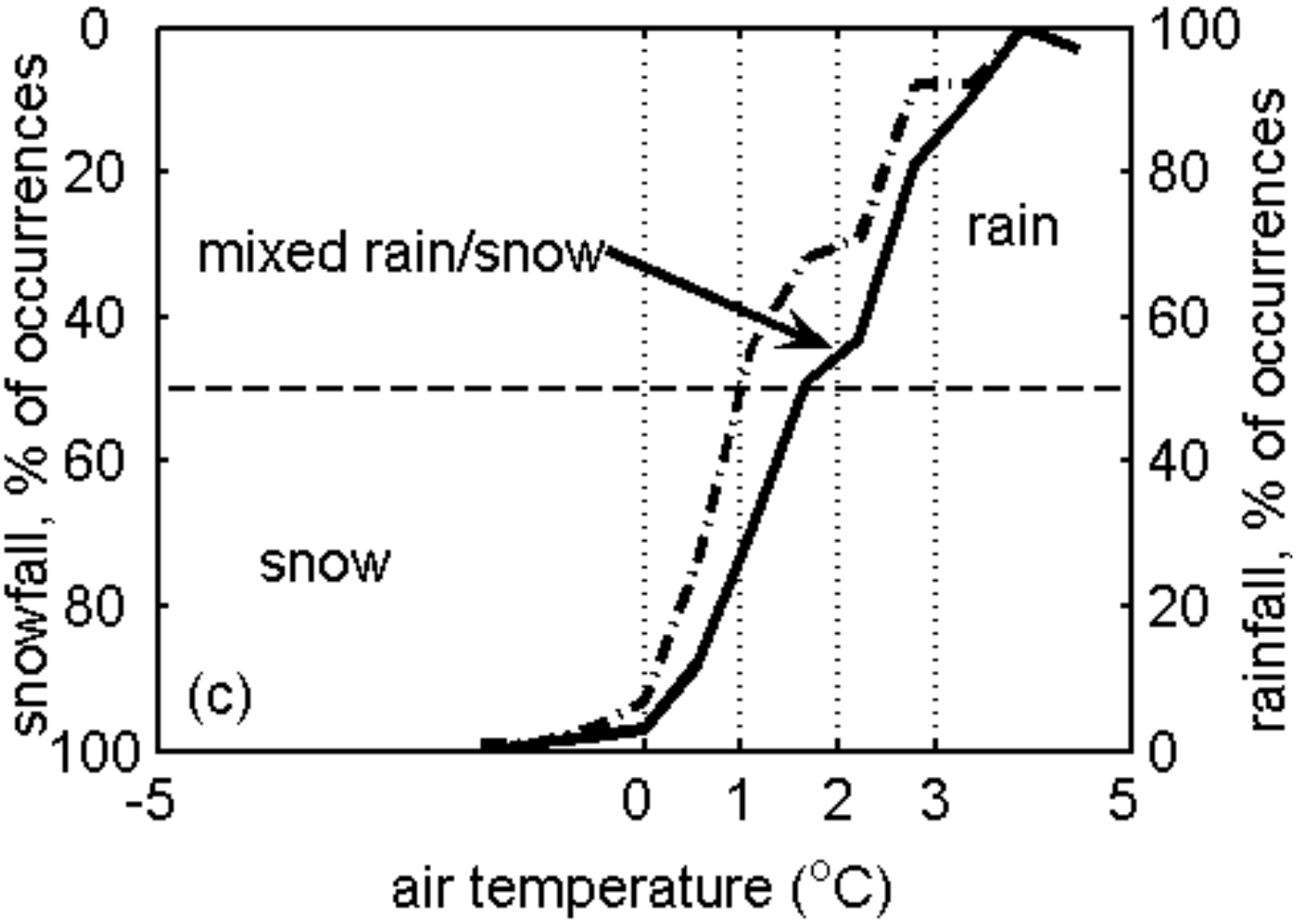
Rain vs. Snow depends on Temperature

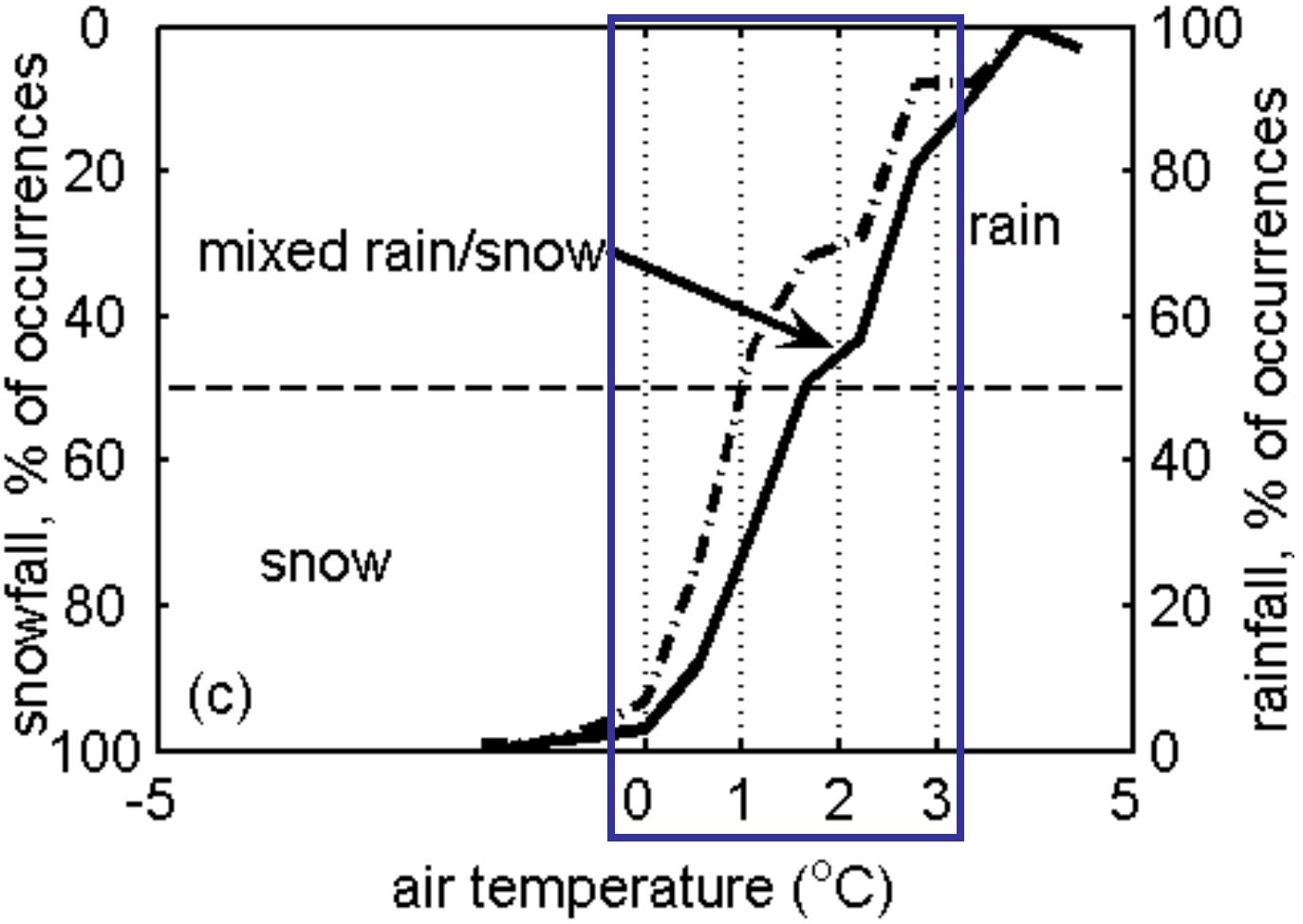
US Army Corps of Engineers in *Snow Hydrology*, 1956



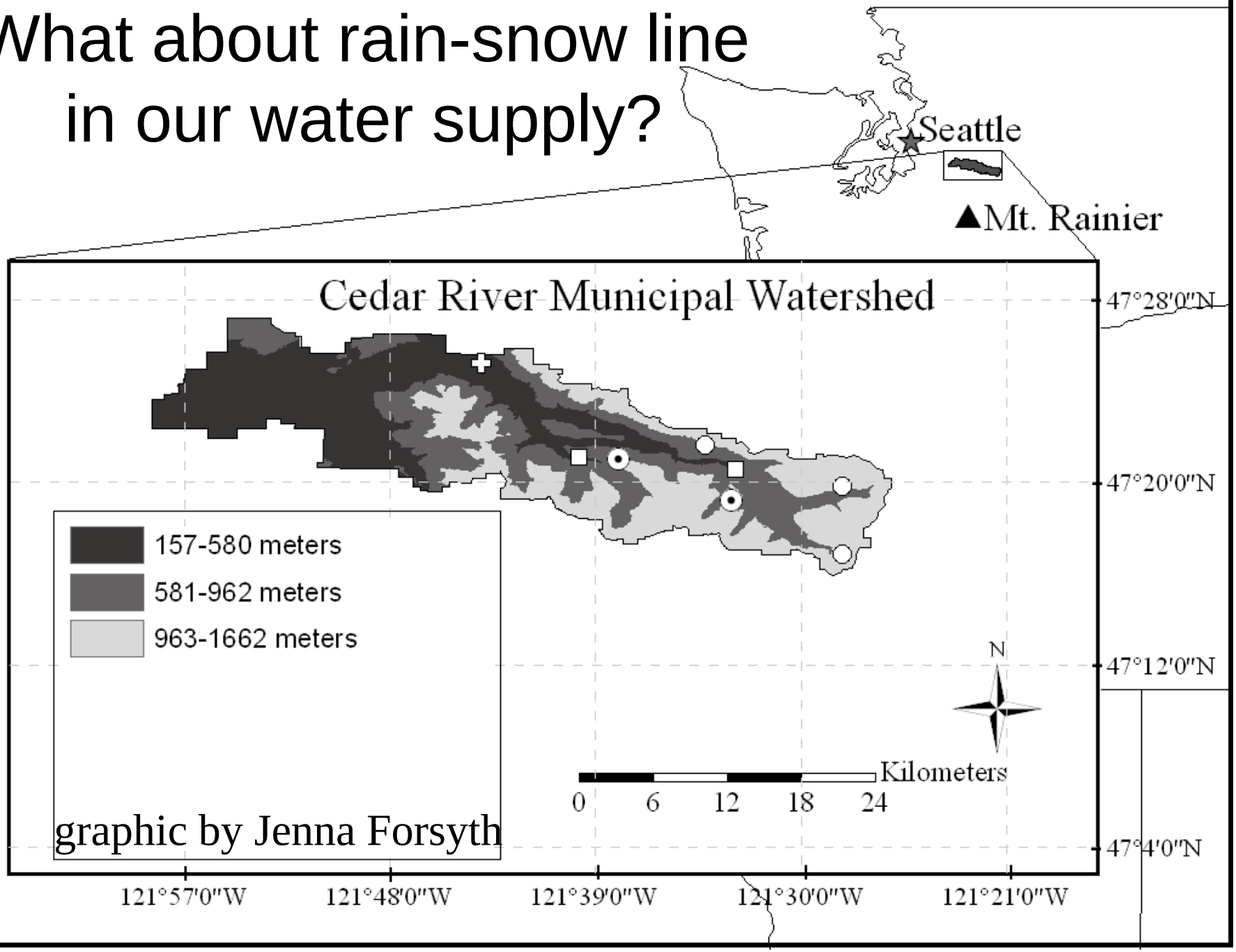
Rain vs. Snow depends on Temperature

US Army Corps of Engineers in *Snow Hydrology*, 1956

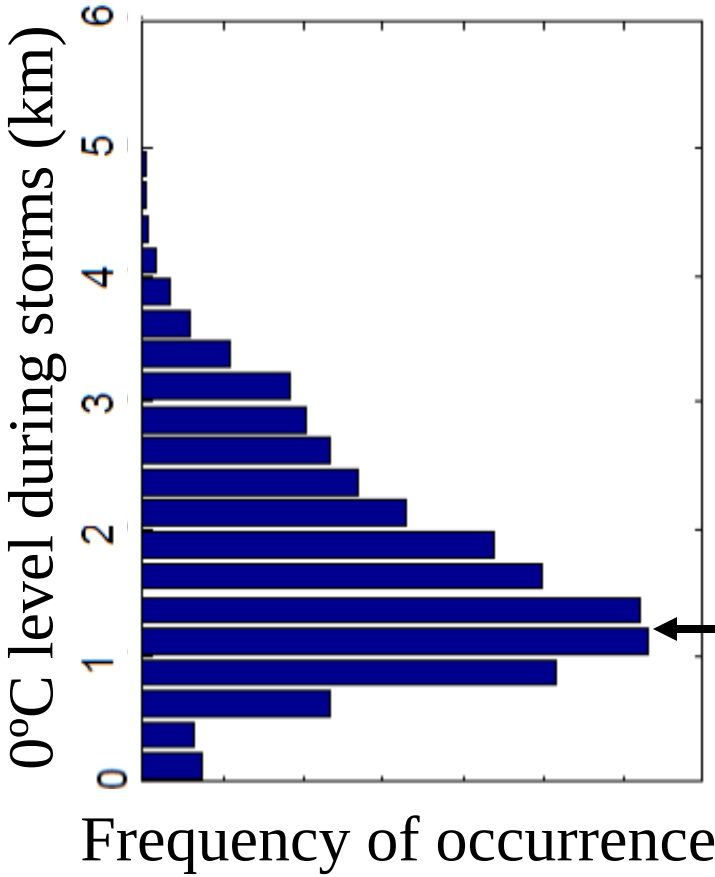
0 to 3ºC = Wintry Mix



What about rain-snow line in our water supply?



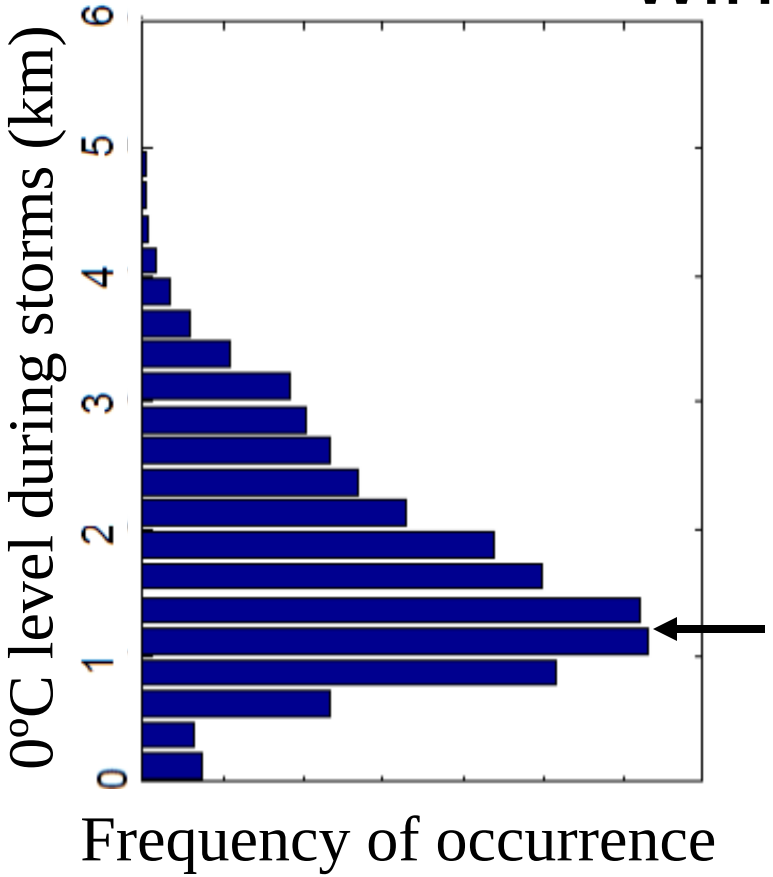
Temperature varies from storm to storm, so we consider a distribution.

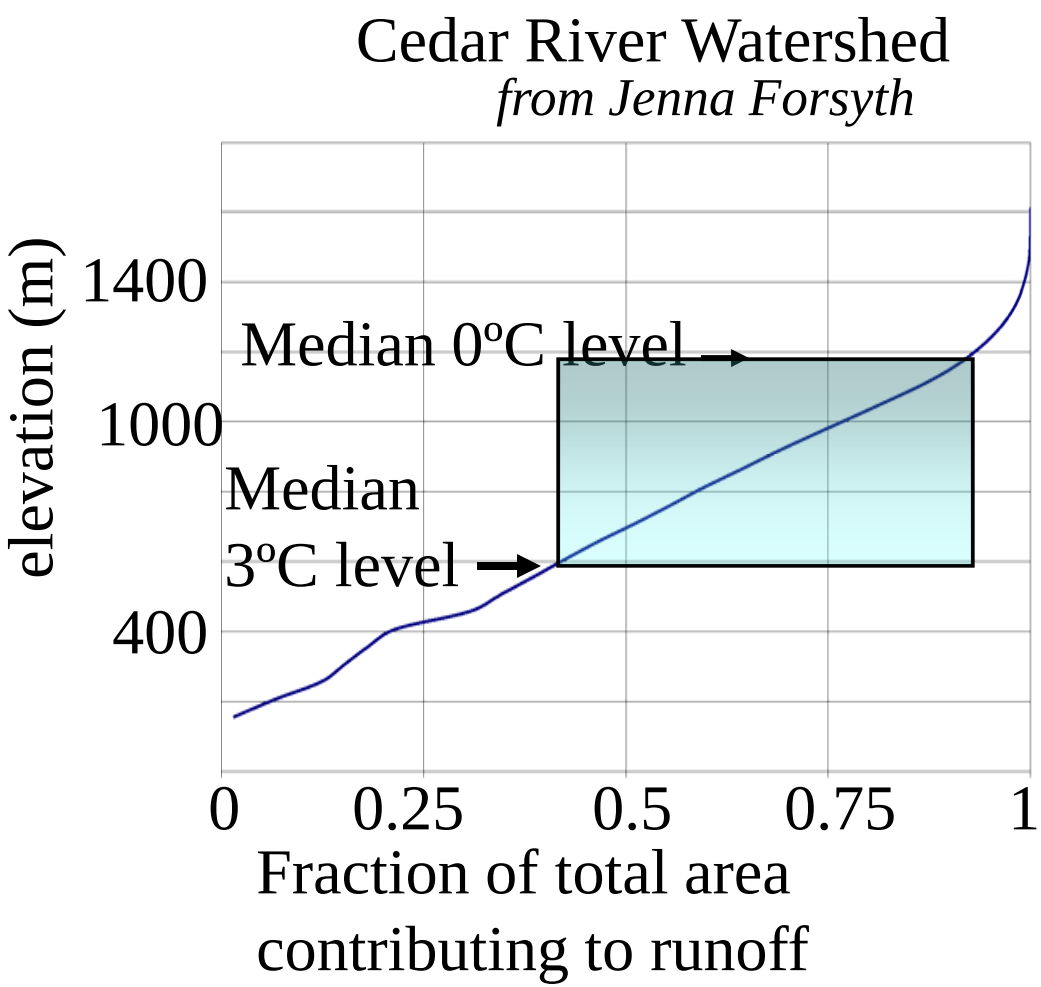


Median value (winter months) ≈ 1200 m

From Justin Minder, Quillayute Sounding Data 1973-2007

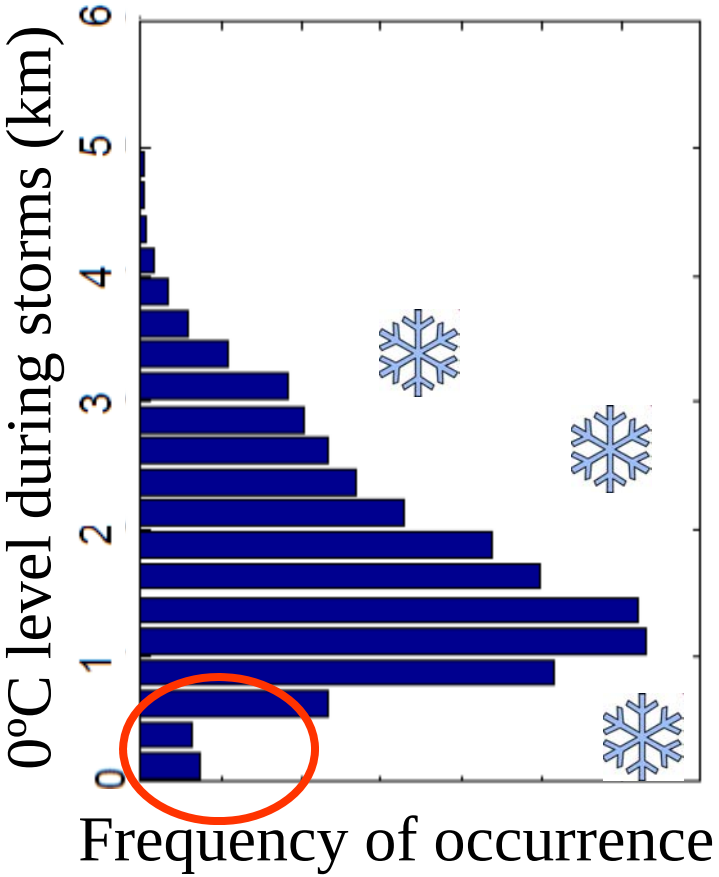
In the median, about 10% snow, 50% wintry mix, and 40% contributes to winter runoff.





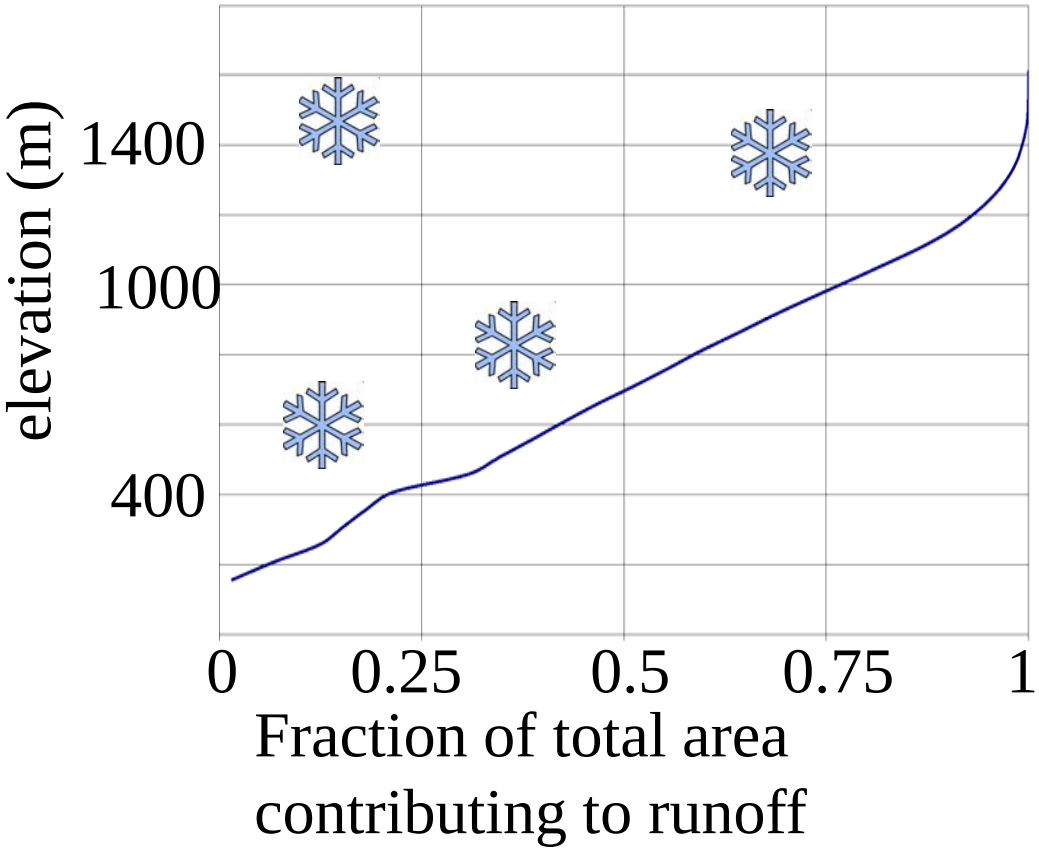
From Justin Minder, analyzing Quillayute Sounding Data

Of course, we still have days when it's snowing in Seattle

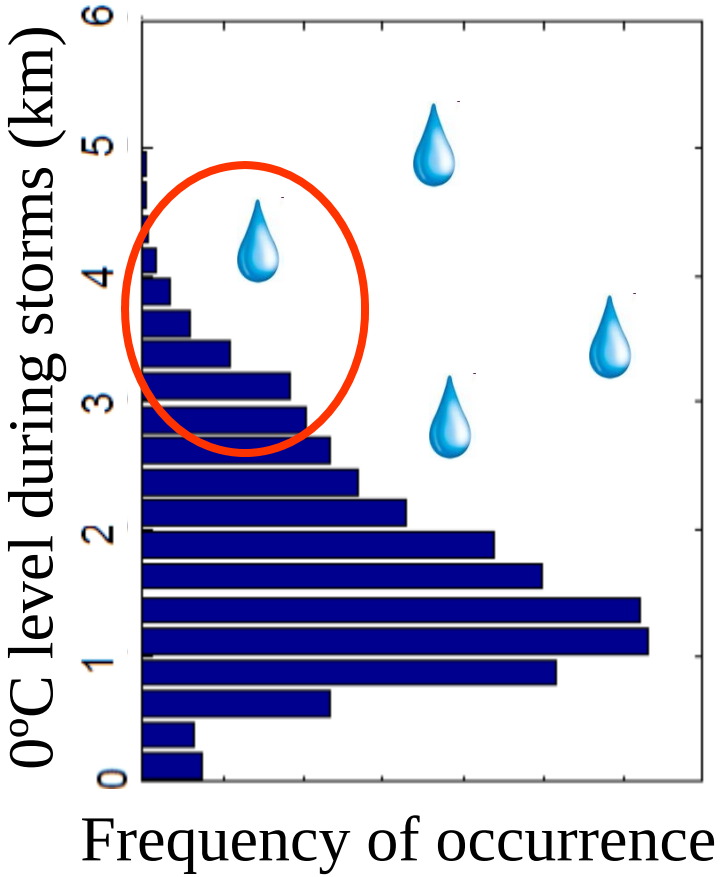


From Justin Minder, analyzing Quillayute Sounding Data

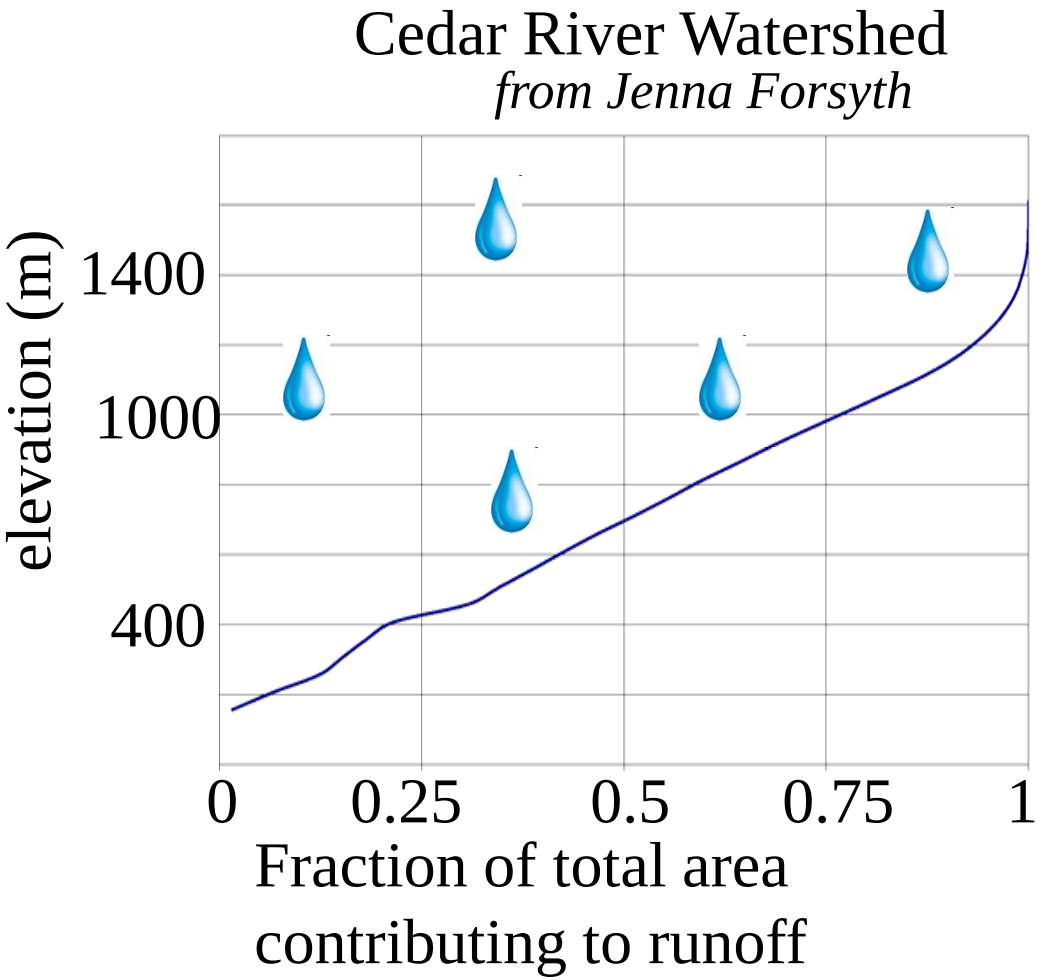
Cedar River Watershed
from Jenna Forsyth



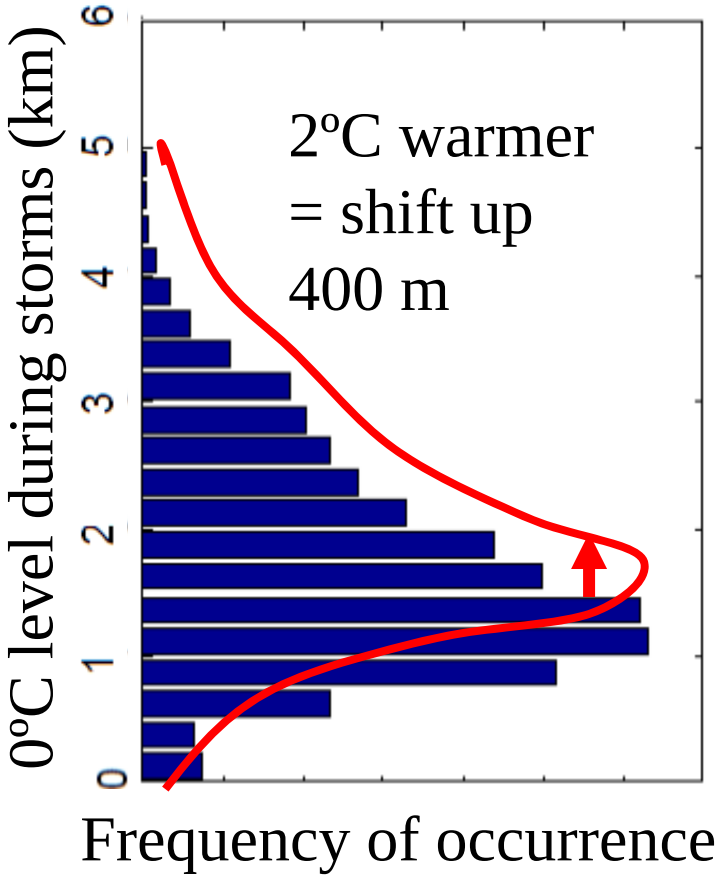
Or when it's raining over the entire watershed.



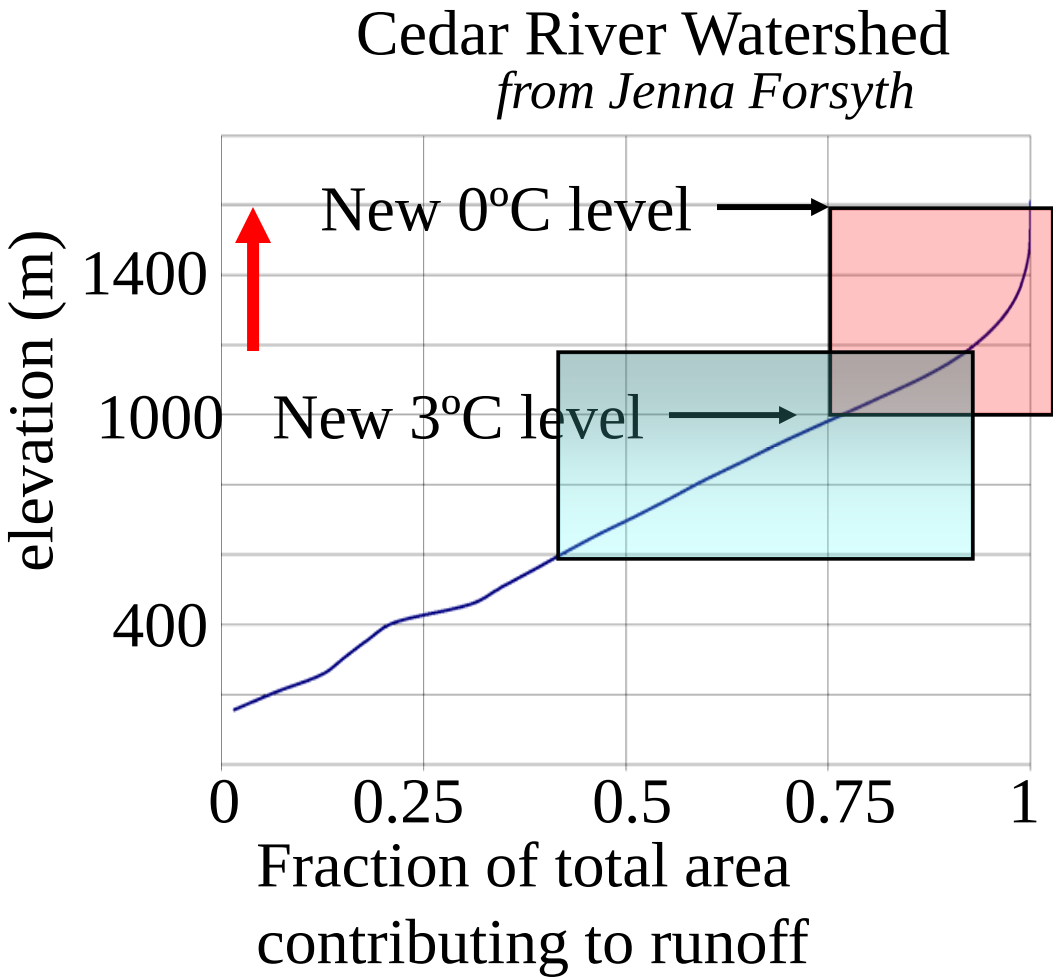
From Justin Minder, analyzing Quillayute Sounding Data



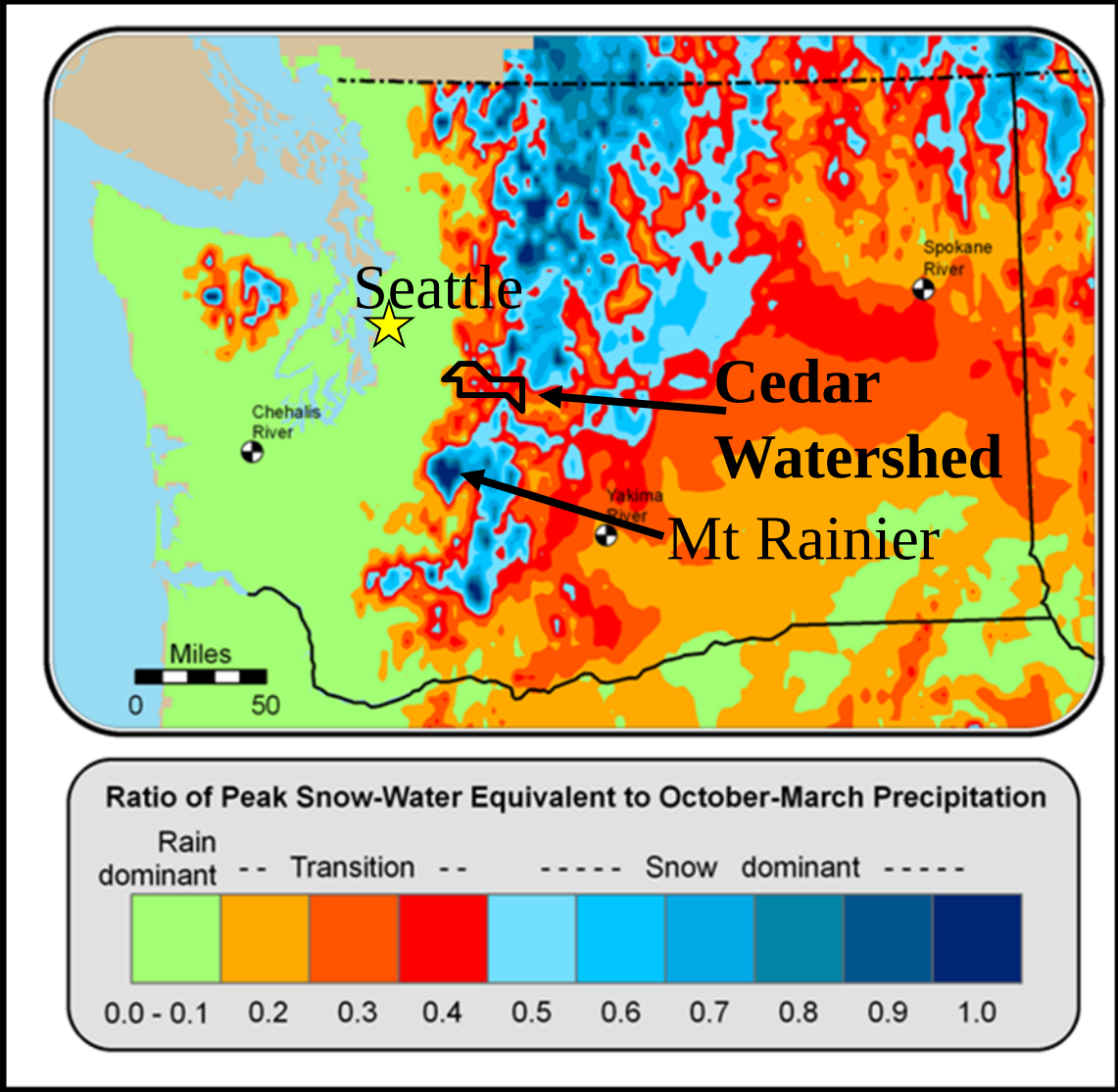
In a warmer world, the highest 25% of the Cedar River gets a wintry mix, and 75% contributes to winter runoff.



From Justin Minder, analyzing Quillayute Sounding Data



Areas like the Cedar Watershed (transition basins with “at-risk snow”) are likely to lose their snow if storm temperatures warm.



Elsner et al., 2009: Implications of 21st Century climate change for the hydrology of Washington State (in review)

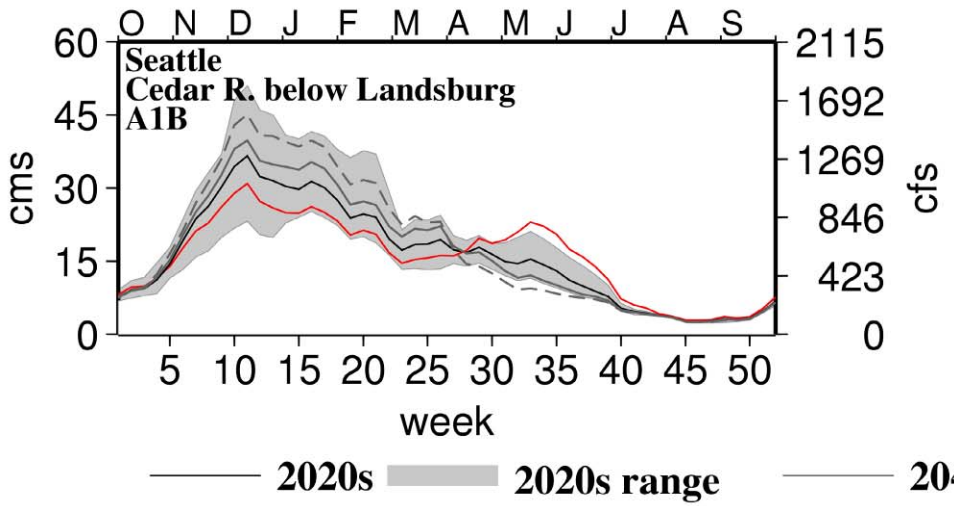
From Alan Hamlet

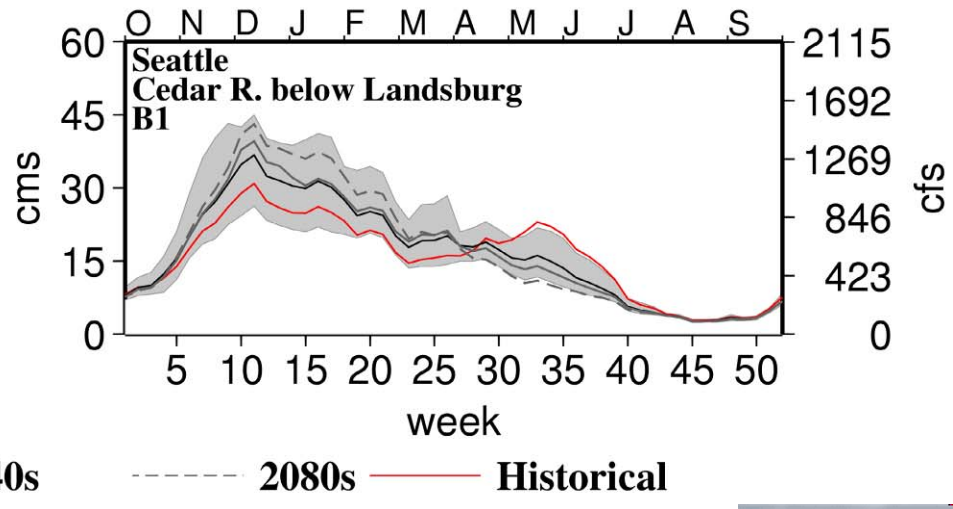
CLIMATE IMPACTS GROUP

Climate Science in the Public Interest

Huge changes in runoff timing.

City doesn't need more total water, but fish and hydropower benefit from anything that can shift more runoff to later in the year.





From: Climate Change Impacts on Water Management in the Puget Sound Region, Washington, USA

Julie A. Vano, Nathalie Voisin, Lan Cuo, Alan F. Hamlet, Marketa McGuire Elsner, Richard N. Palmer, Austin Polebitski, and Dennis P. Lettenmaier

CLIMATE IMPACTS GROUP

Climate Science in the Public Interest

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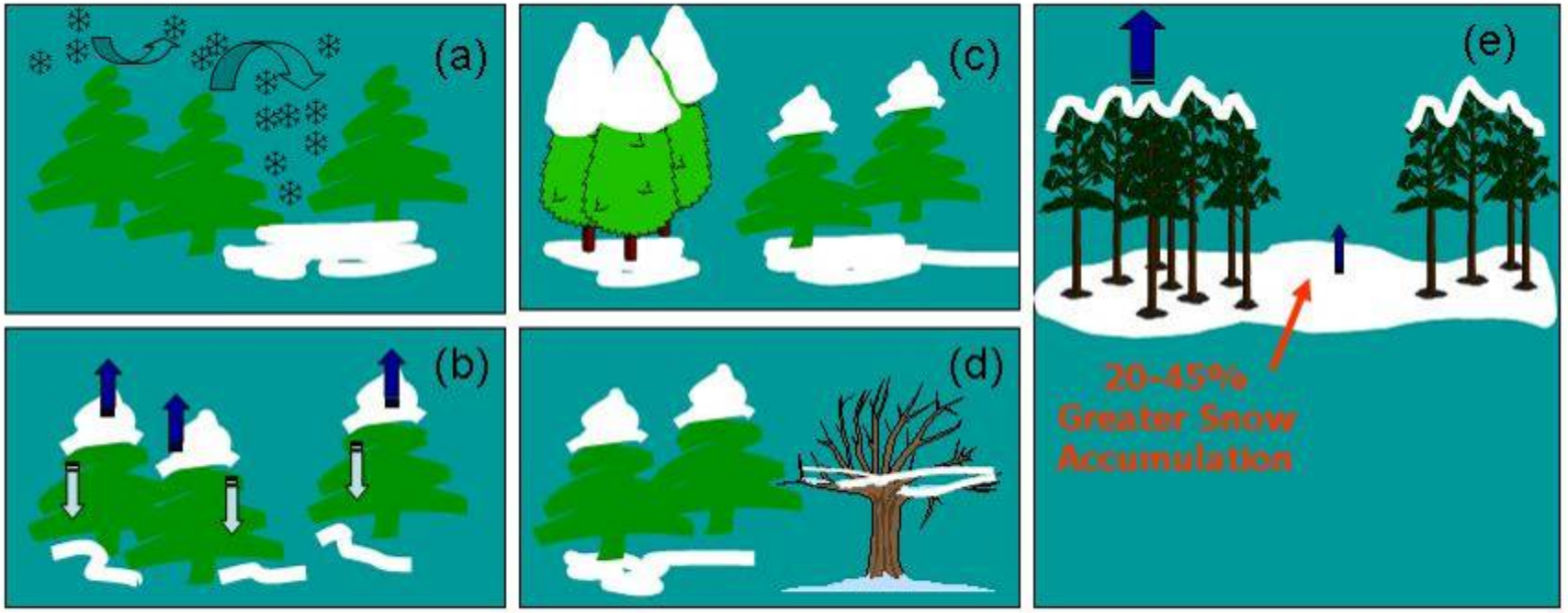
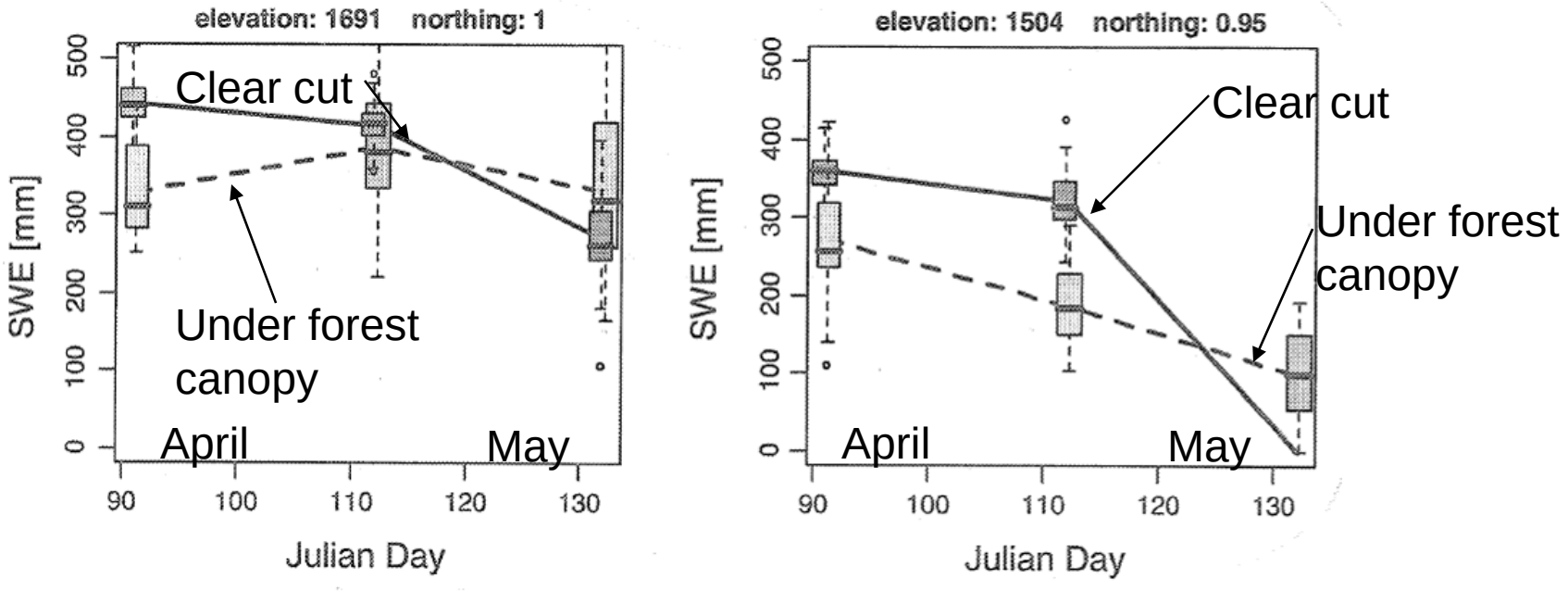
Trees **intercept snow**, which then sublimates or melts much faster than snow on the ground



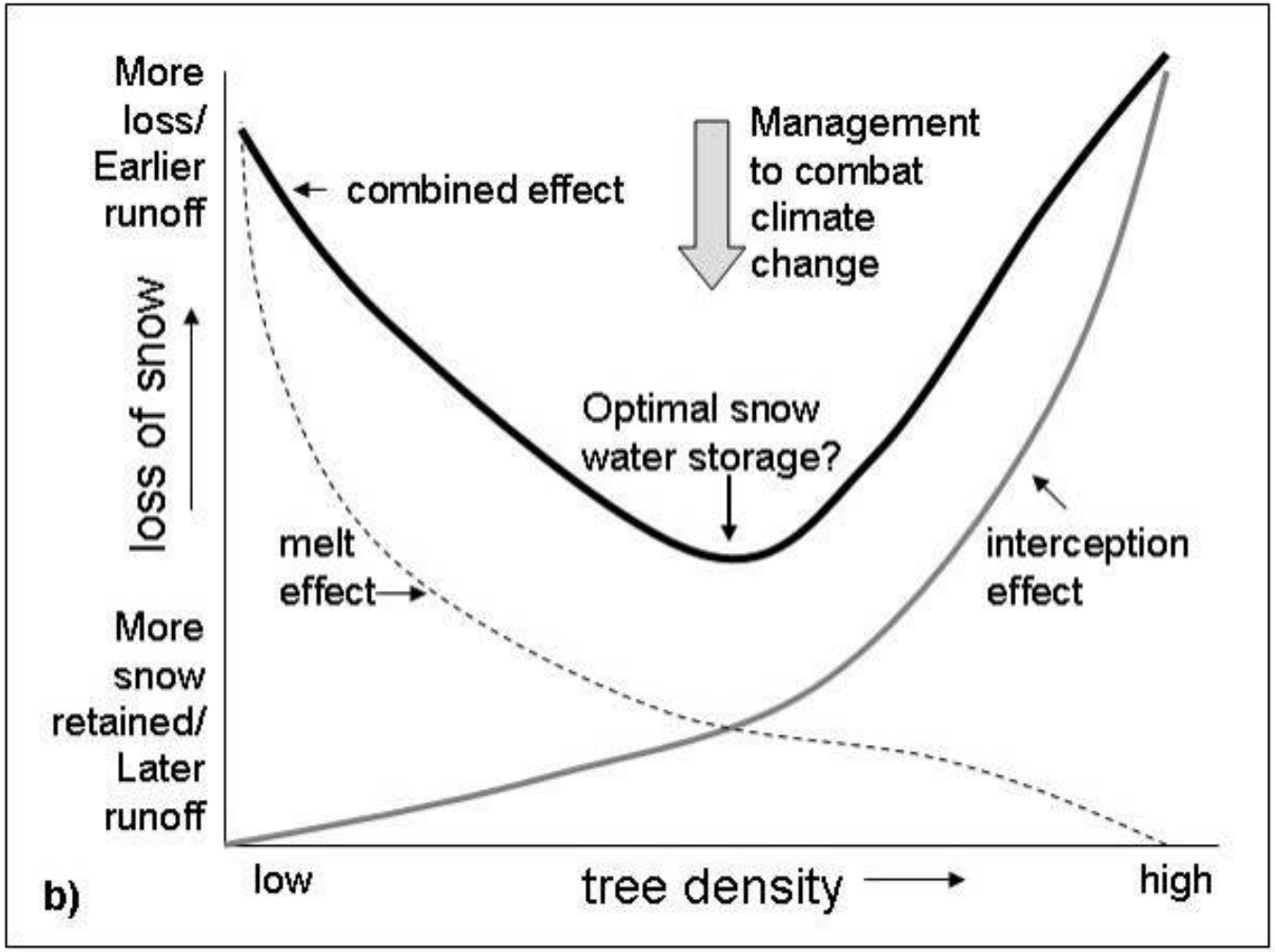
Graphic from Mark Williams, CU Boulder, illustrating results of many years of research in Frasier Experimental Watershed in Colorado

However, snow on the ground lasts longer if trees protect it from sun and wind.



From Jost et al. 2007; field work in British Columbia

How can we minimize interception losses but maintain shading and snow retention?



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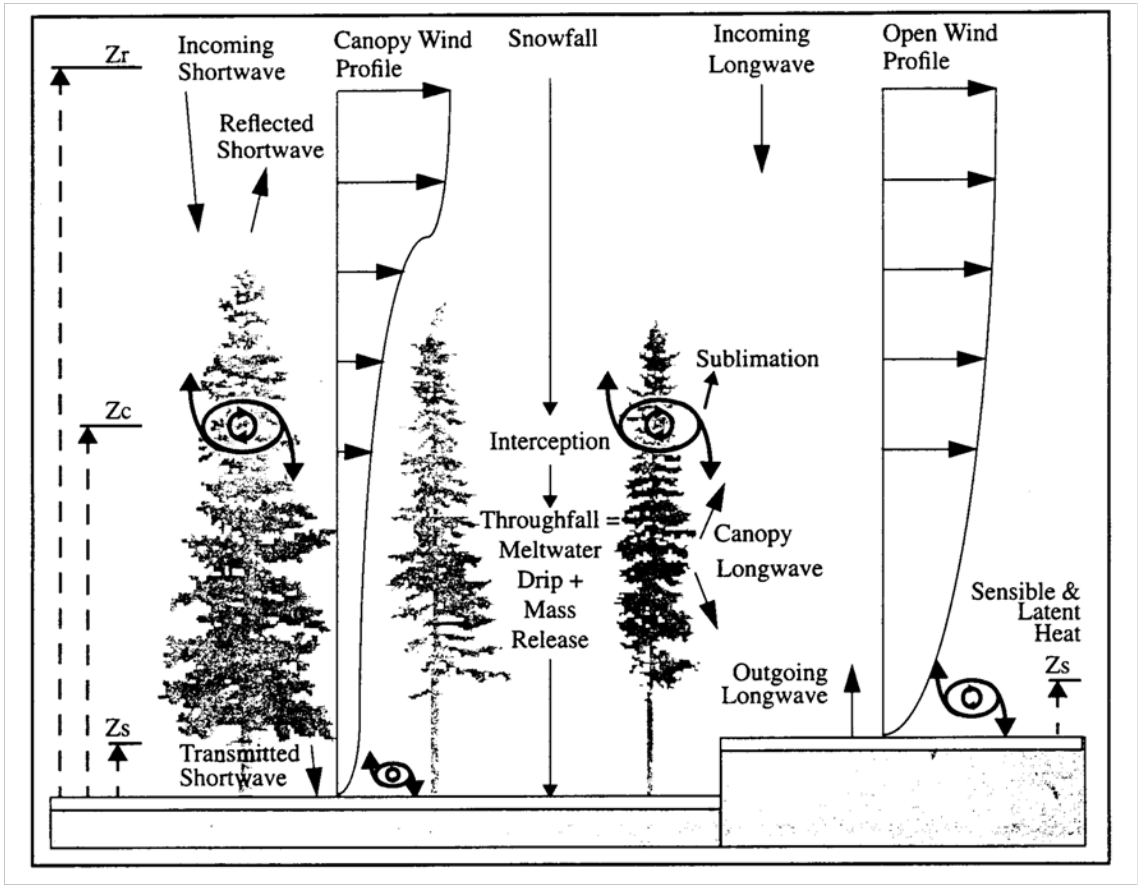
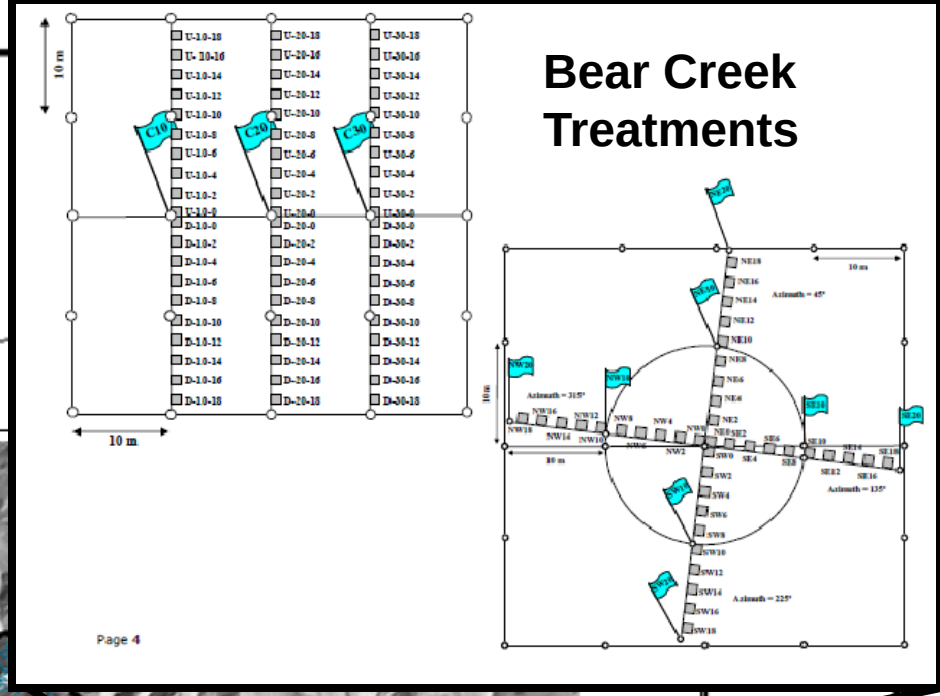
Snow model from VIC/DHSVM, based on Pascal Storck's work

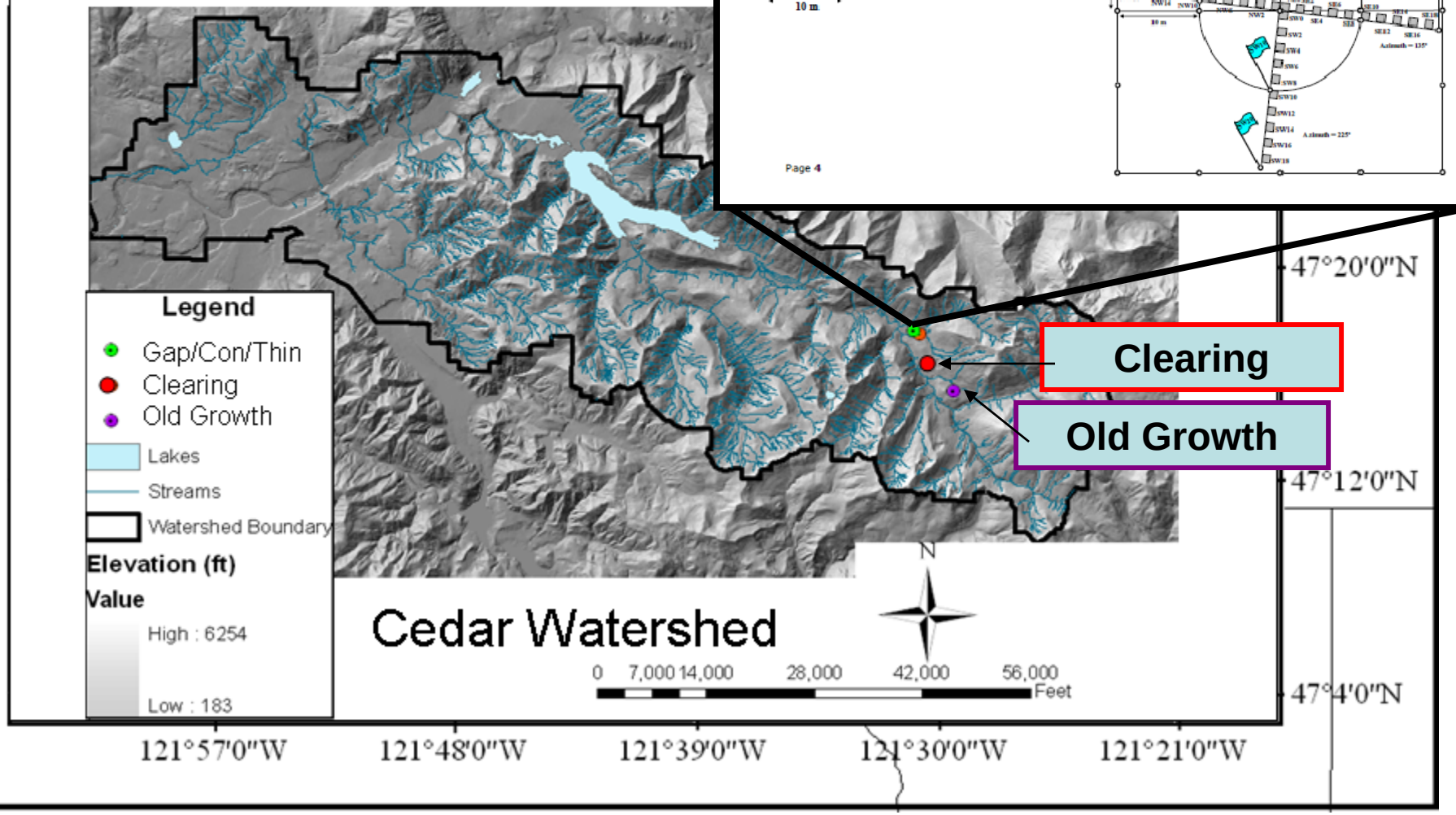


Model Parameters related to canopy processes:

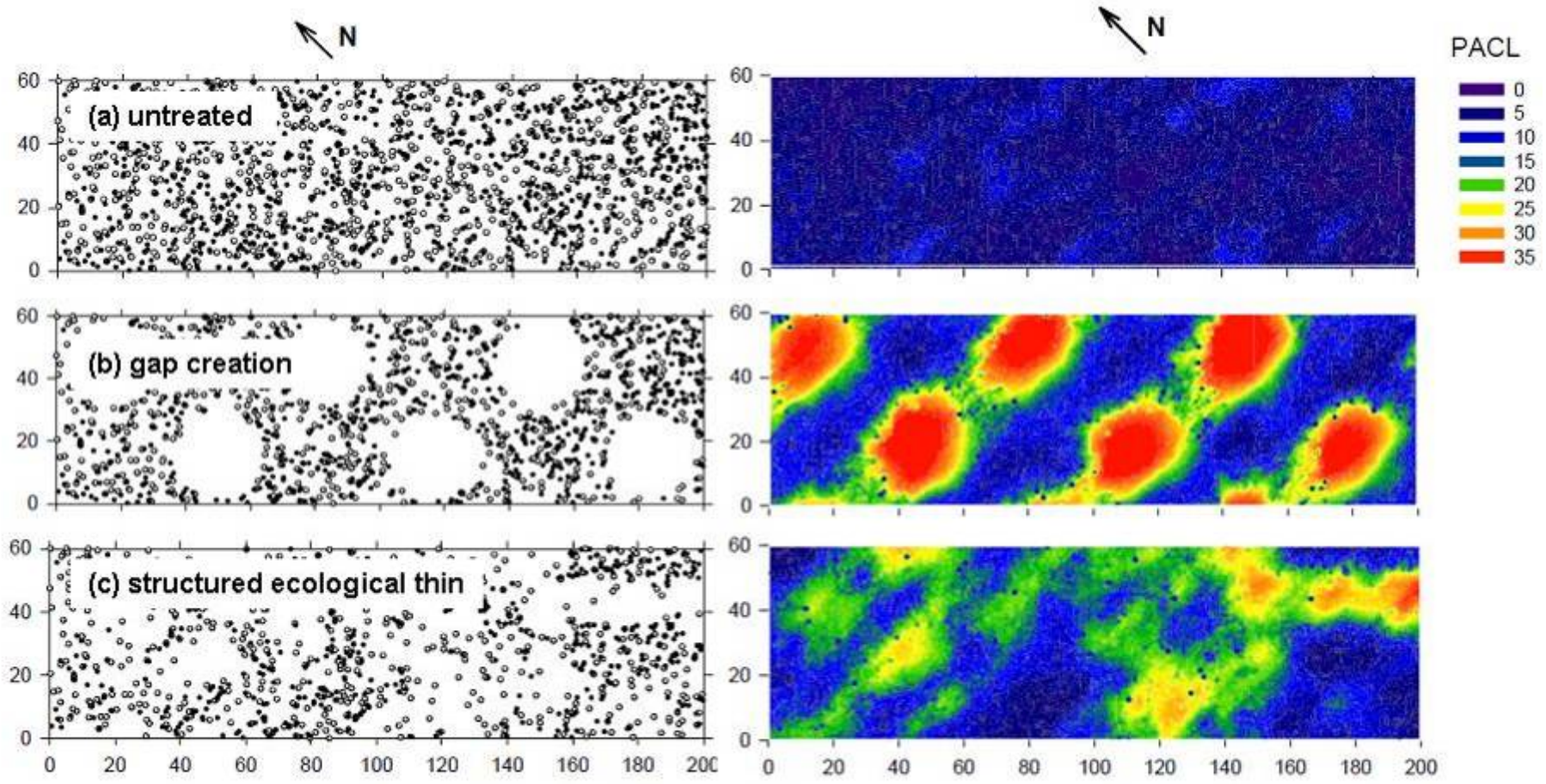
*LAI
*Max interception
*Fraction covered by top veg layer
*Albedo table
*T canopy transmittance coefficient
*Zr above-canopy ref. ht.
*Zc canopy ref. ht.
*Zs near-surface ref. ht.
*surface roughness
*canopy roughness

Charlie Halpbern and UW Forestry examining growth patterns under different forest treatments





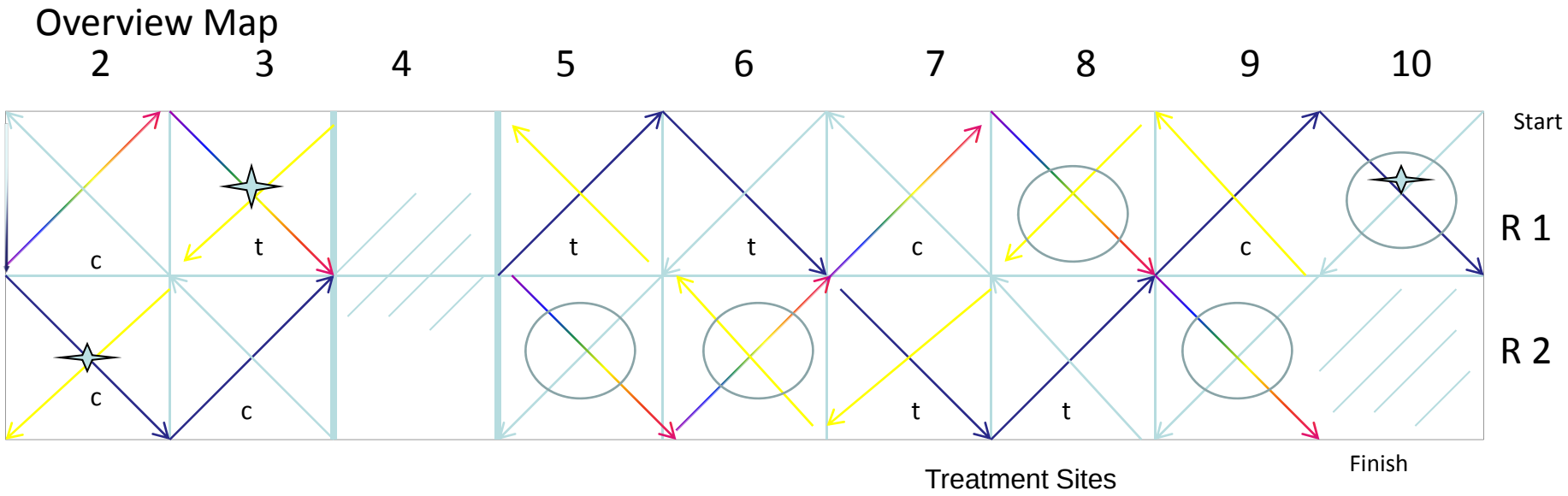
Light transfer varies greatly with forest treatment

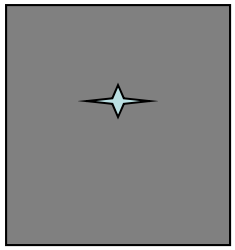


Sprugel et al., 2009*, Ecological Modeling*.

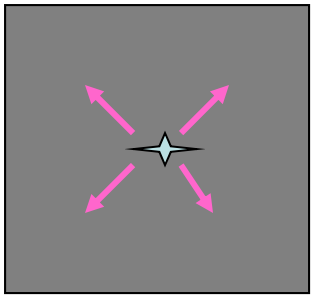
Cedar River Transects

We put out 5 weather stations, 10 snow depth sensors, 5 digital cameras, a snake of fiber optic cable, and 50 ground temperature sensors





Clearing Site



Old Growth Site

Weather Station

Blue transect

Orange transect

Yellow transect

Pink/yellow bow transect

Pink + green transect

c control

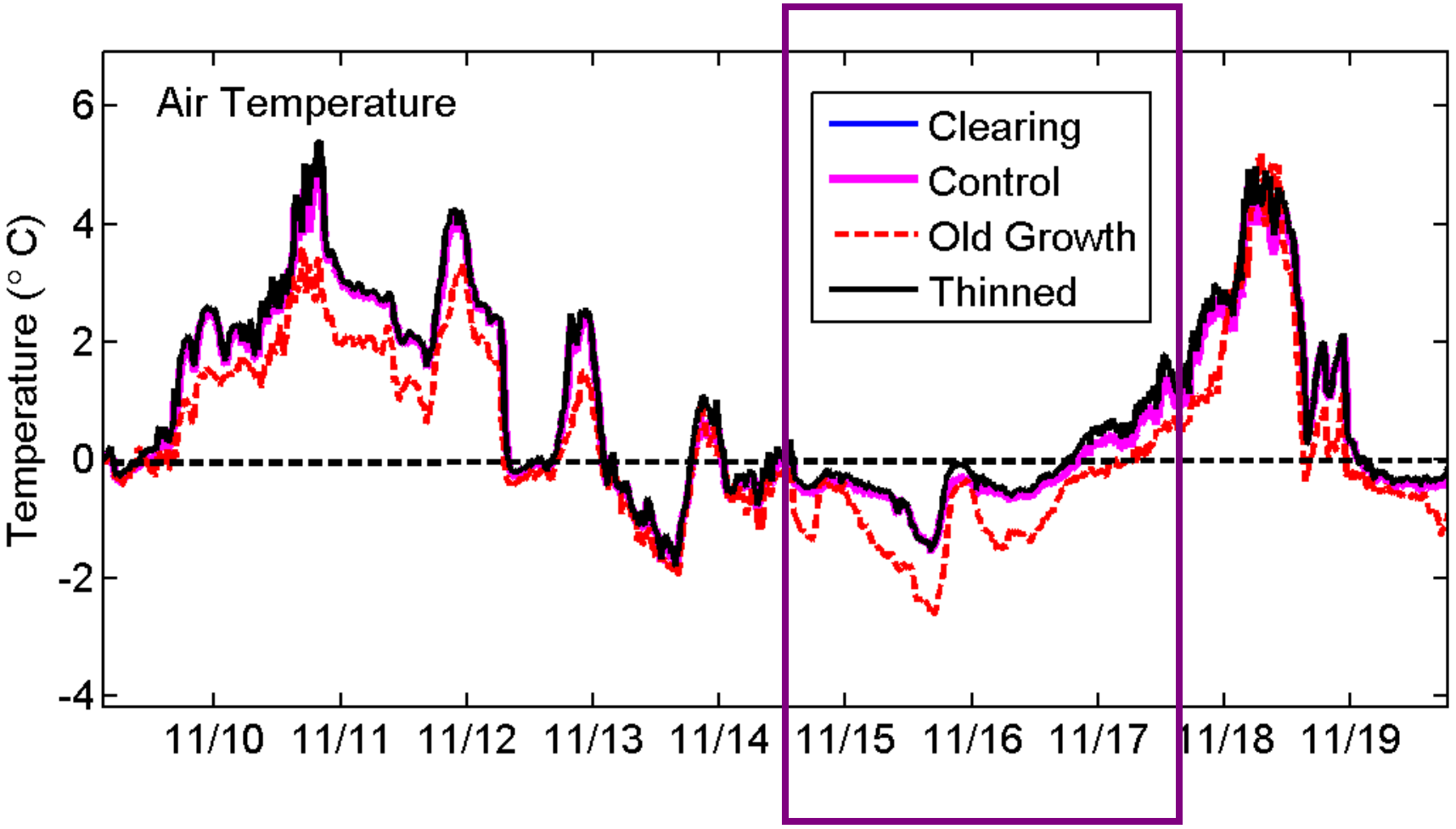
t thinned

gap

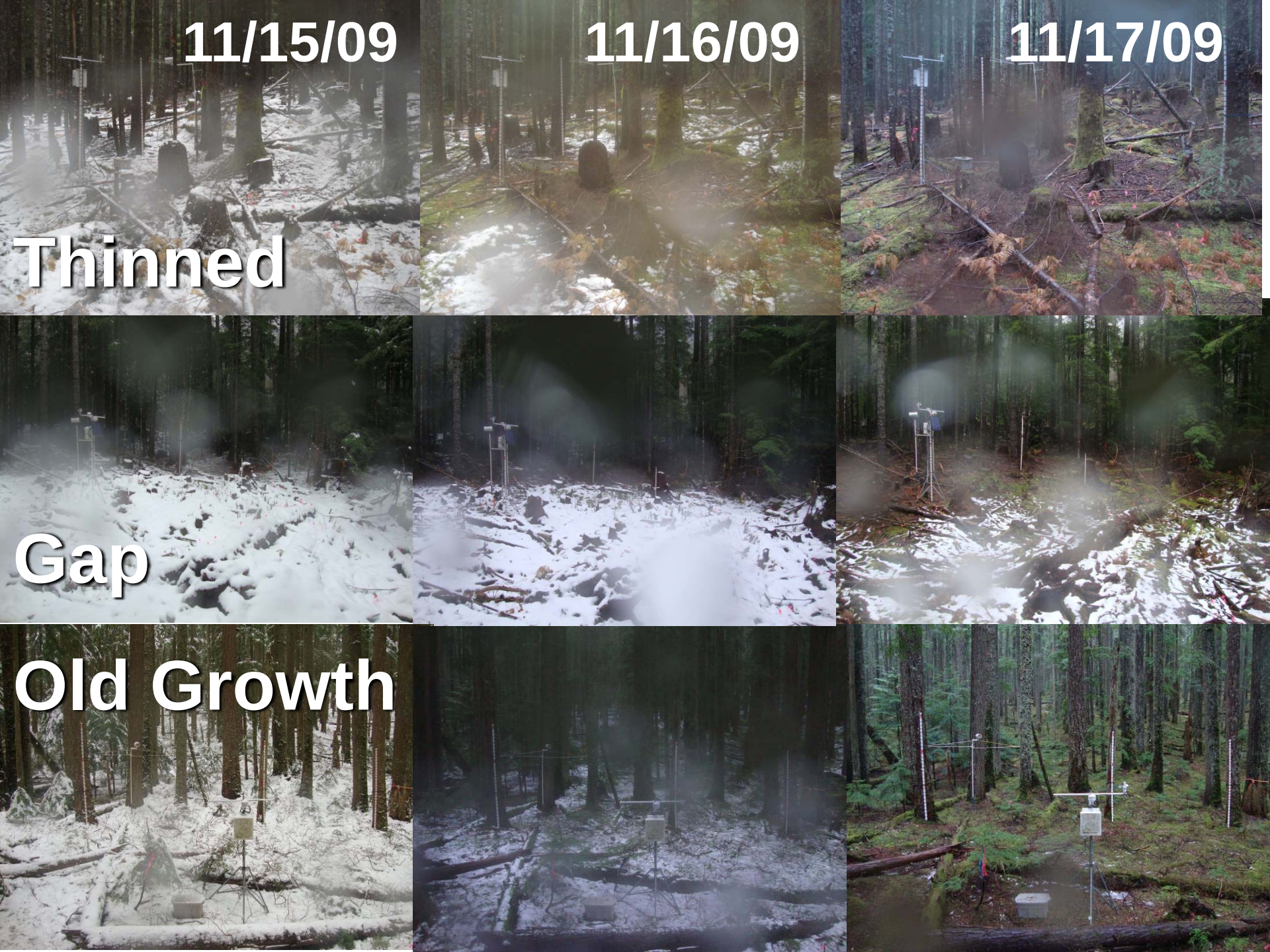
not in site

Period of snow changing to rain

Note: Old growth is slightly higher (100 m) and cooler than other sites.

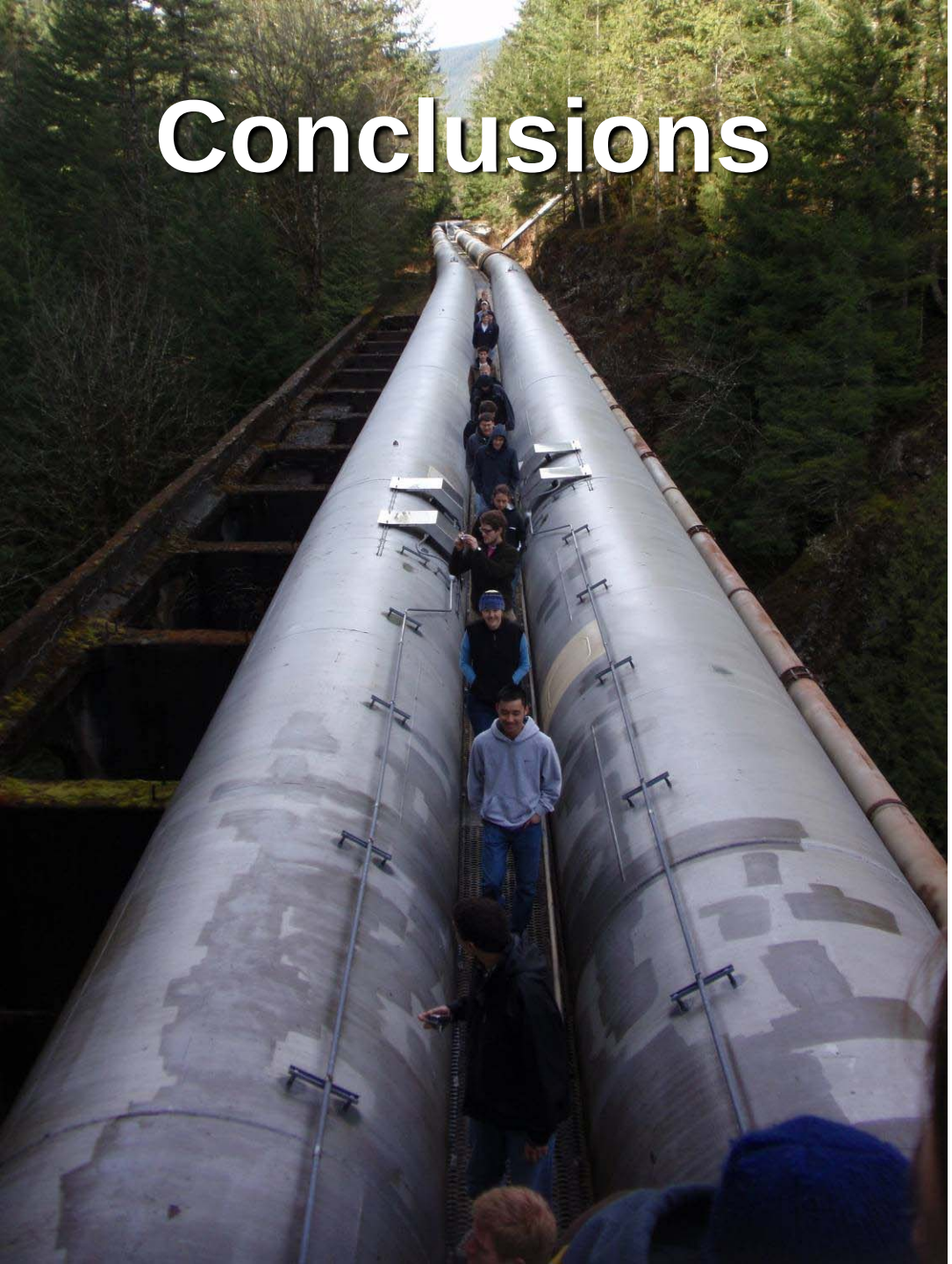



11/15/09
11/16/09
11/17/09
Thinned
Clearing
Control


11/15/09
11/16/09
11/17/09
Thinned
Gap
Old Growth

Old Growth Site, last November

Conclusions



Perhaps trees can help us retain snow on our landscape, but we have to get that snow onto the landscape first….

Many thanks to: Steve Burges, Claudia and Jeff Deems, Matthew Marineau, Kael Martin, Gerald Lisi, Andrey Shcherbina, Melanie Richmond, Bart (Cambell Scientific), Andreas (University of British Columbia), Scott Tyler (U. Reno)