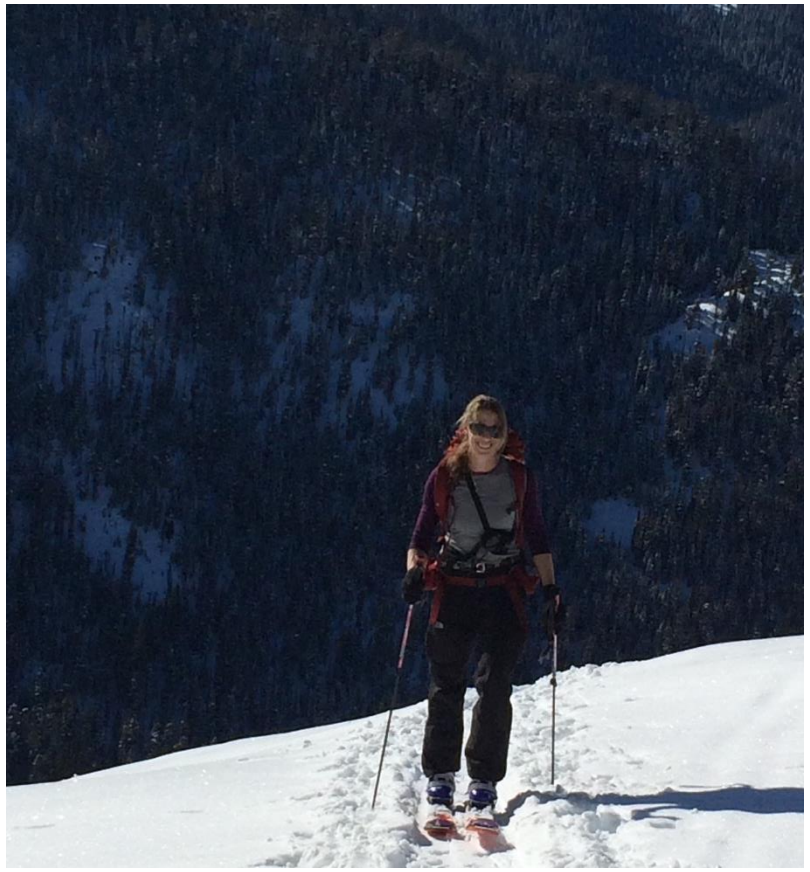
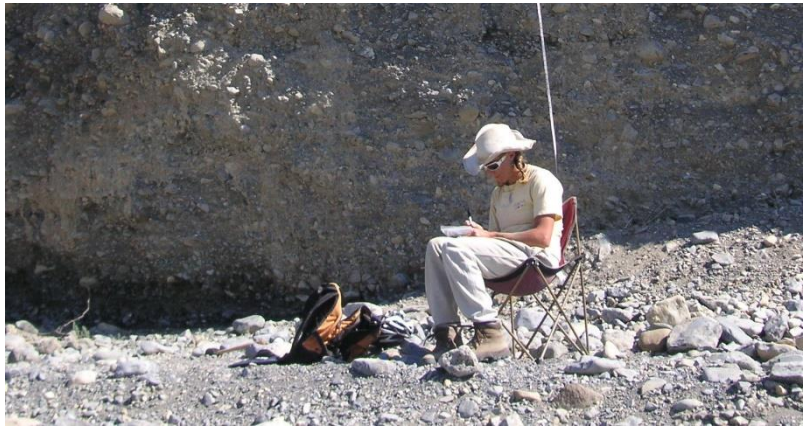
Climate Change in Idaho: Past, Present, and Future

Sawtooth Forum

August 6 2021

Dr. Jen Pierce, Boise State University, Department of Geosciences
jenpierce@boisestate.edu





Jen Pierce Boise State University

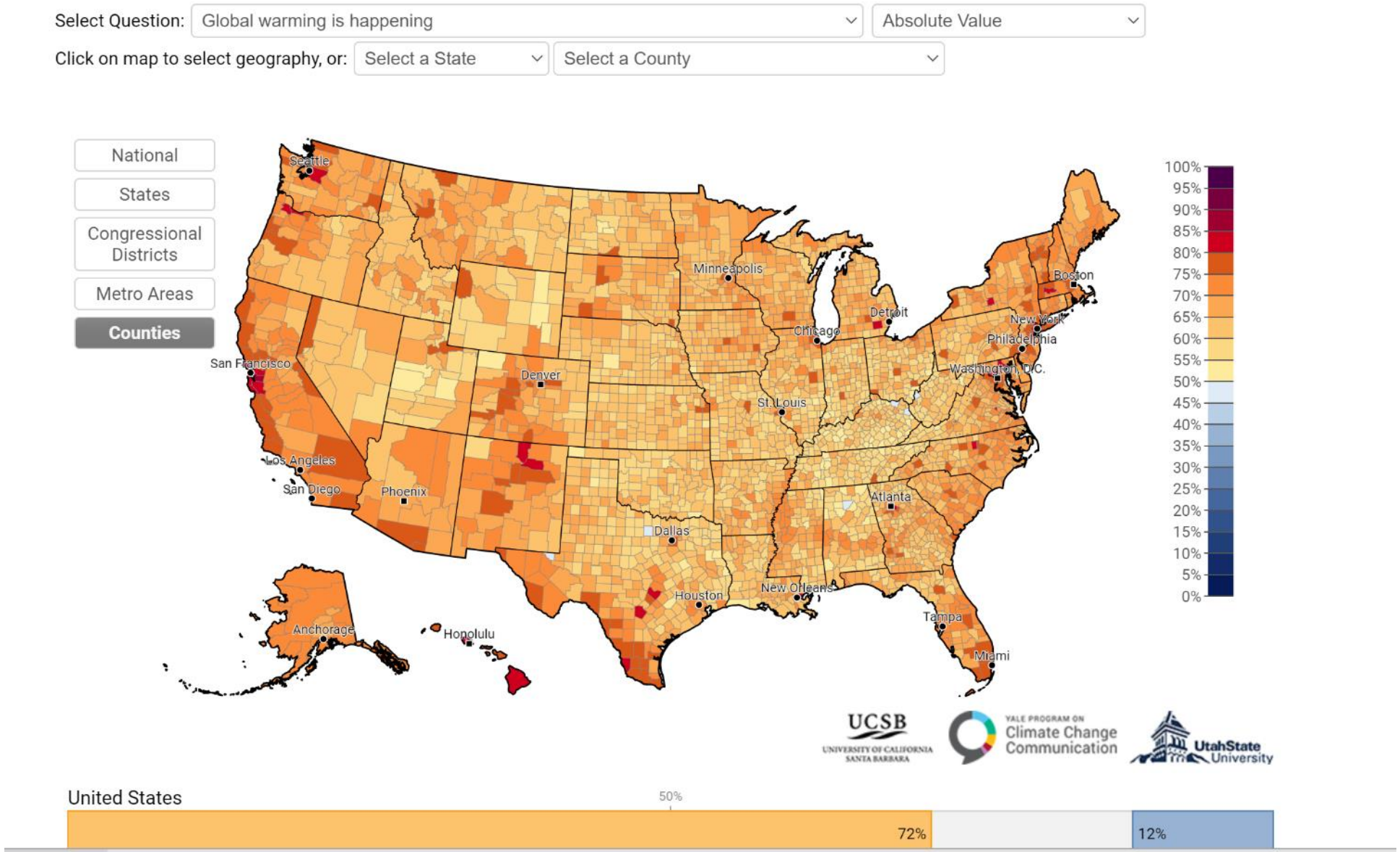
My story

My Research: Wildfires, Soils, and Climate Change

My motivation: Our kids need a functioning planet


Are we preparing our kids to meet the climate change challenge?

Estimated % of adults who think global warming is happening (72%), 2020



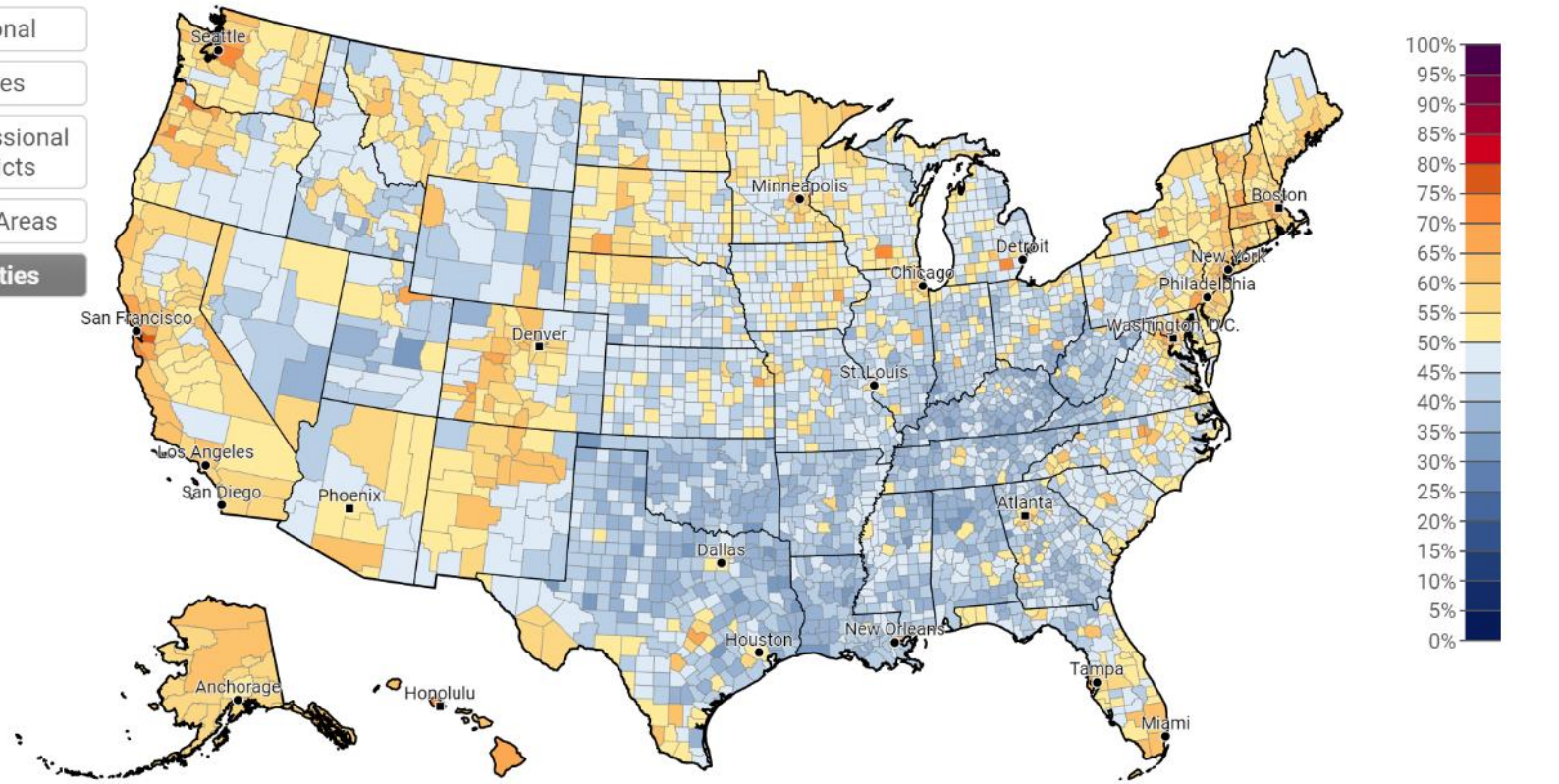
https://climatecommunication.yale.edu/

Estimated % of adults who believe most scientists think global warming is happening (55%), 2020

Select Question: Most scientists think global warming is happening | Absolute Value

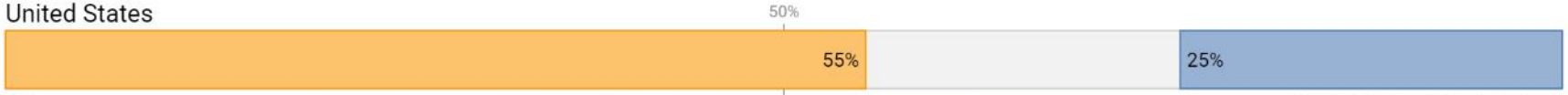
Click on map to select geography, or: Select a State | Select a County

National
States
Congressional Districts
Metro Areas
Counties



UCSB UNIVERSITY OF CALIFORNIA SANTA BARBARA
YALE PROGRAM ON Climate Change Communication
UtahState University

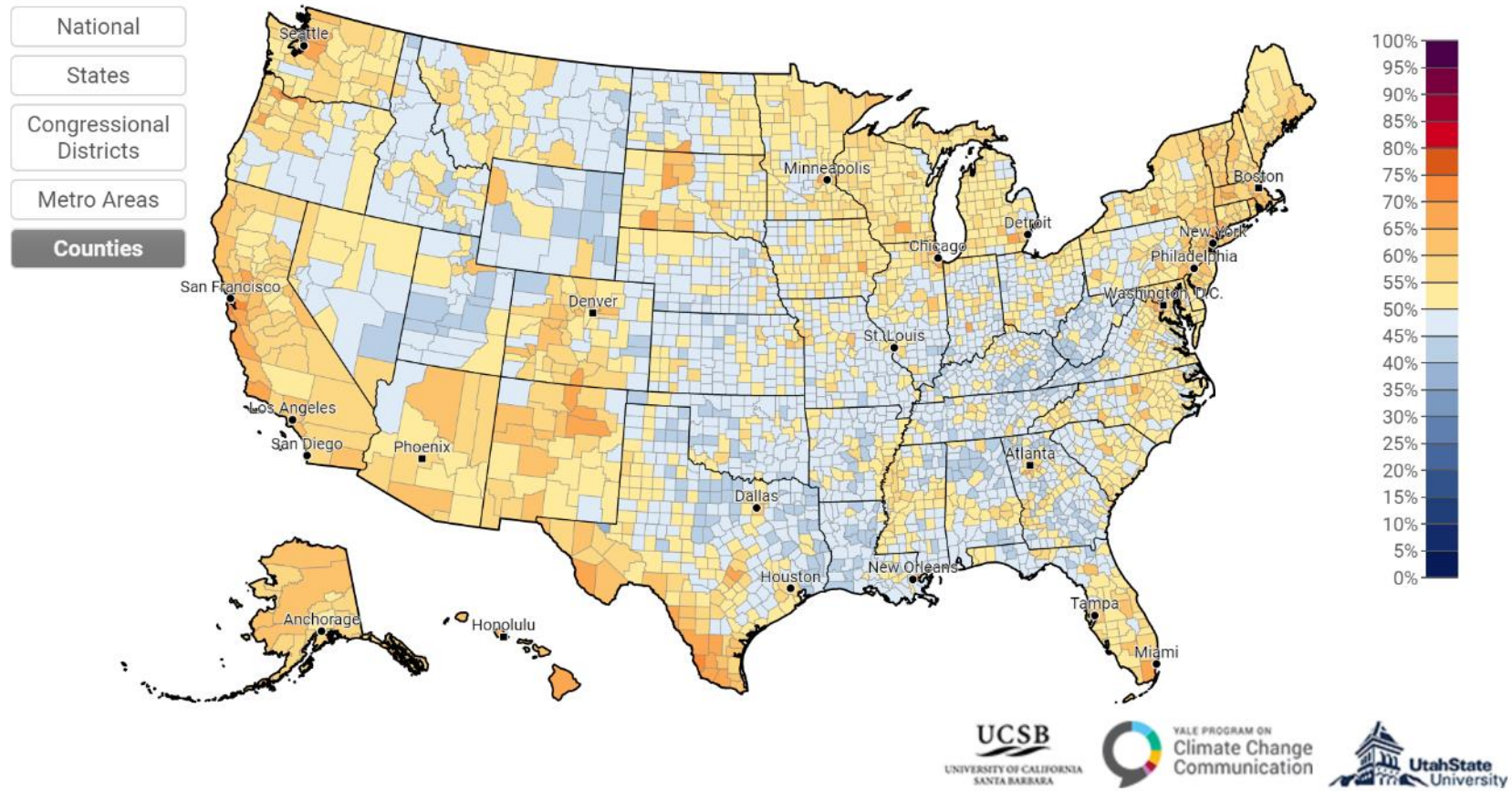
United States

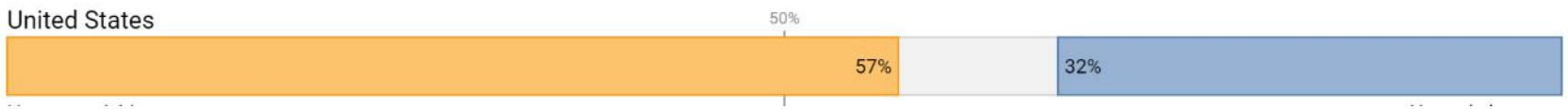


Estimated % of adults who think global warming is mostly caused by human activities (57%), 2020

Select Question: Global warming is caused mostly by human activities | Absolute Value

Click on map to select geography, or: Select a State | Select a County





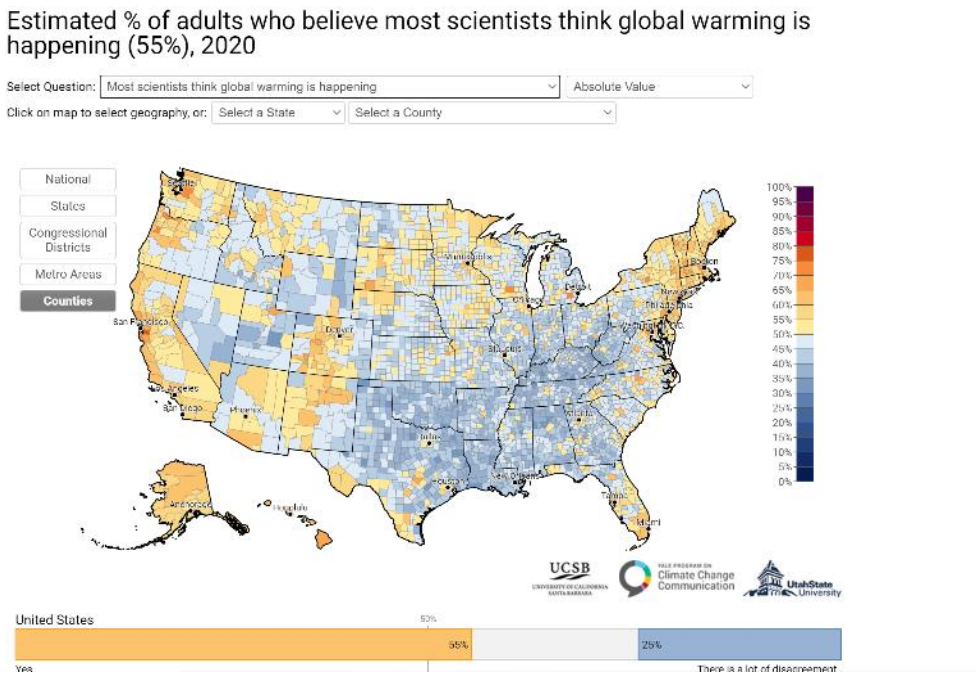
~97% of scientists agree climate change is happening and it is human caused

Cook et al., 2016, Environmental Research Letters, 'Quantifying the consensus on anthropotenic global warming in the scientific literature'

Illustration: John Cook

https://skepticalscience.com/graphics.php?g=244

Clearly, something is wrong.

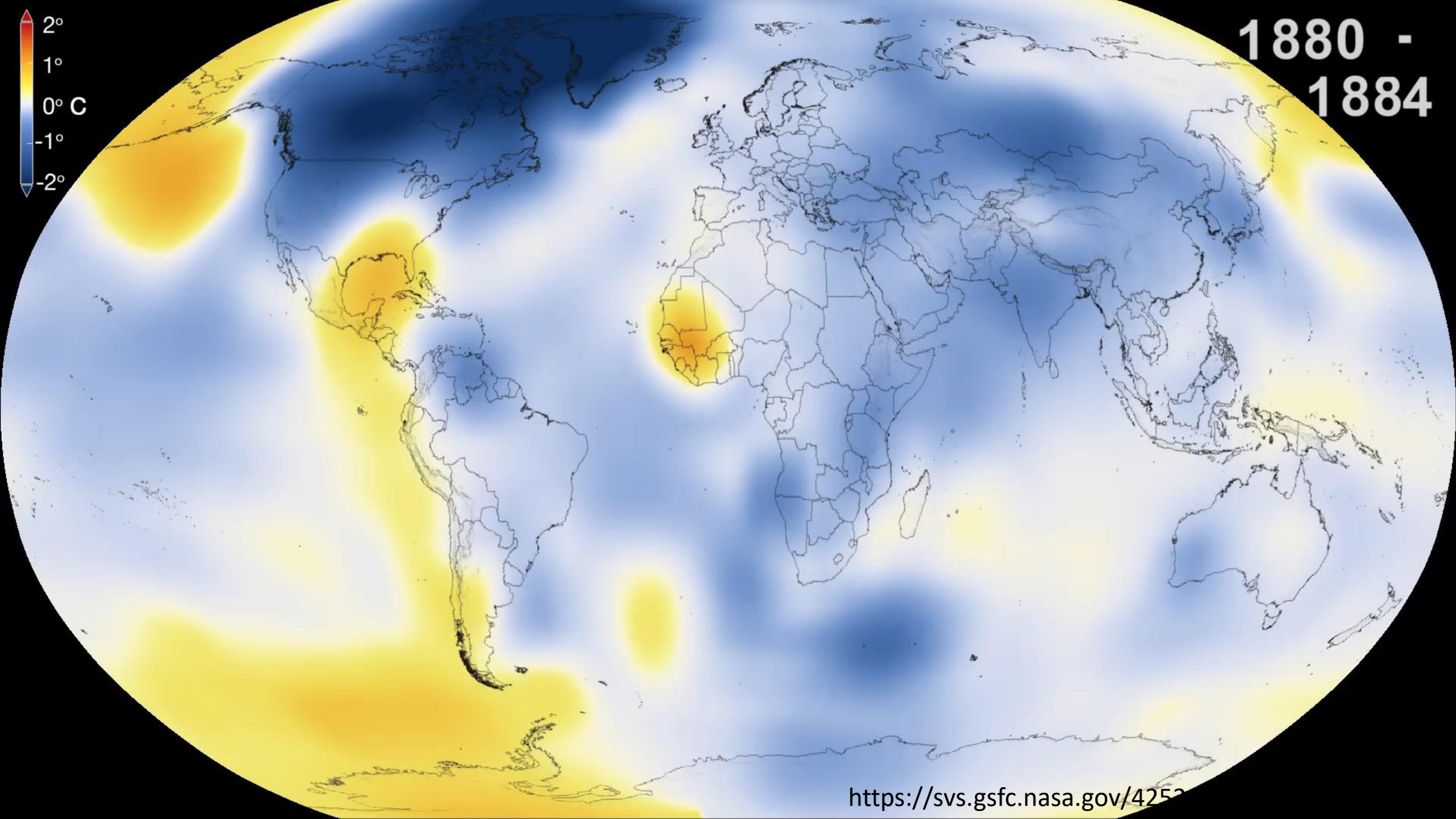


≠

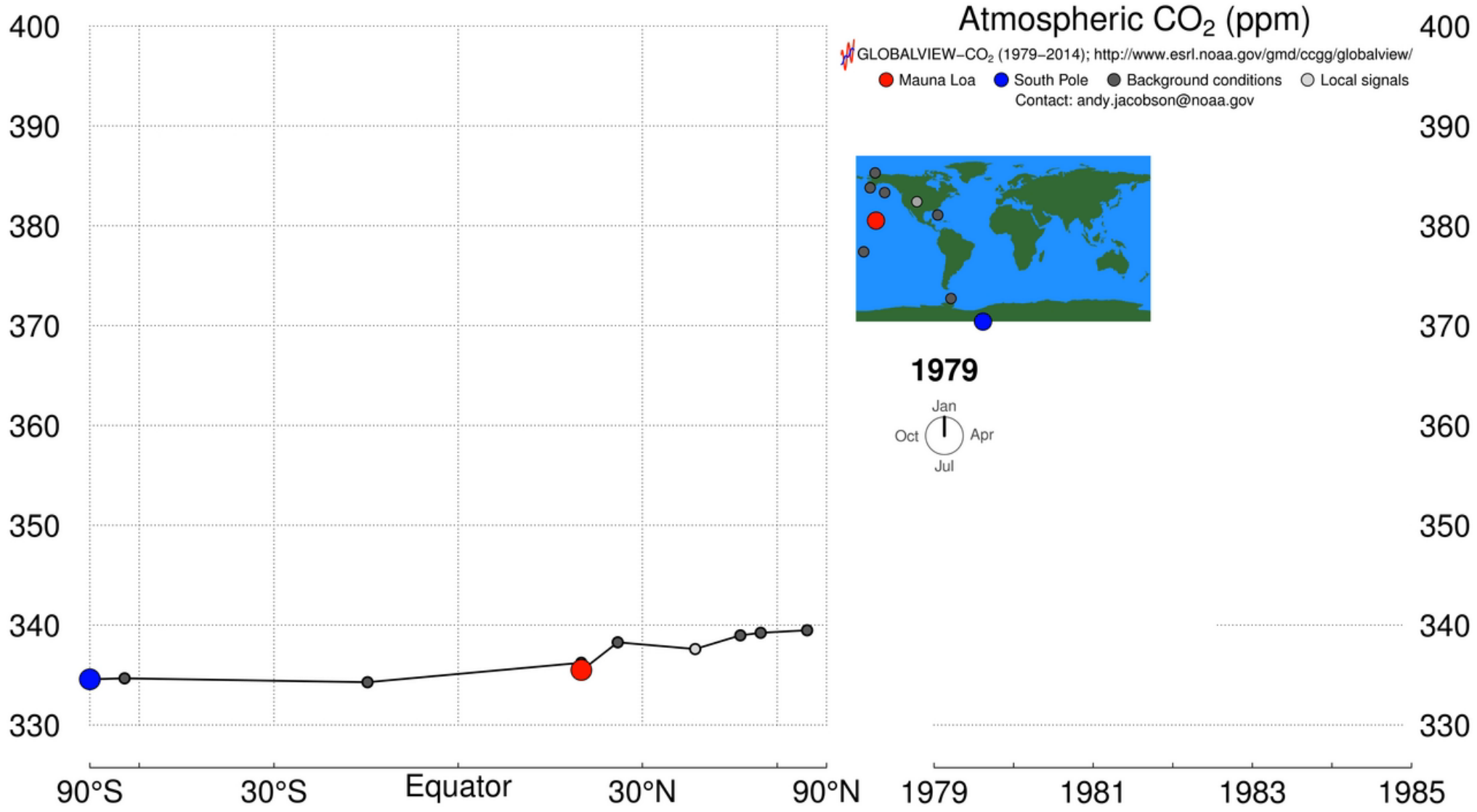
> 97% of scientists agree climate change is happening, and it is human caused


What we've got here is a
FAILURE TO COMMUNICATE

Challenges and Opportunities of Climate Change in Idaho's Ecosystem: Short background The Effect of Changing Climate on Wildfires, Snowpack and Water,& Ecosystems

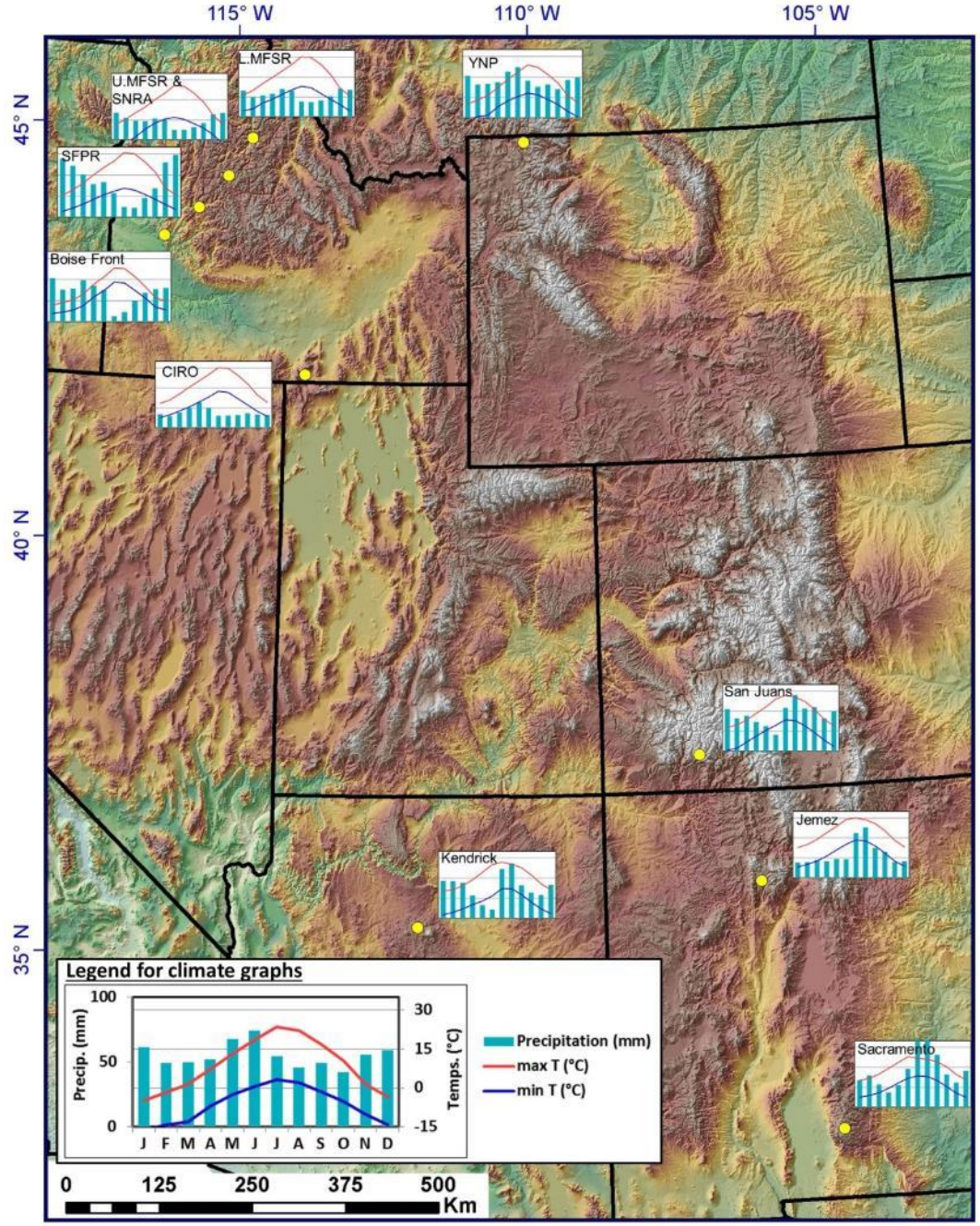

2°
1°
0° C
-1°
-2°
1880 -
1884
https://svs.gsfc.nasa.gov/425

Since 1750, the concentration of carbon dioxide in the atmosphere increased by 40% from 280 ppm to 408 ppm in February 2019



http://www.esrl.noaa.gov/gmd/ccgg/trends/global.html

Climate and Wildfire over the past ~10,000 years in Idaho



Yellowstone (Meyer et al., *GSA Bulletin*, 1995)

M.F. Salmon (Riley et al., *The Holocene*, 2015)

Sawtooths, (Svenson, Boise State MS Thesis 2010)

S.F. Payette (Meyer and Pierce, *Fire Ecology and Management*, 2003; Pierce et al., *Nature* 2004)

Boise Front (Poulos and Pierce, *in prep;* Nelson and Pierce, *The Holocene,* 2010)

City of Rocks (Weppner et al., *Quaternary Research*, 2013)

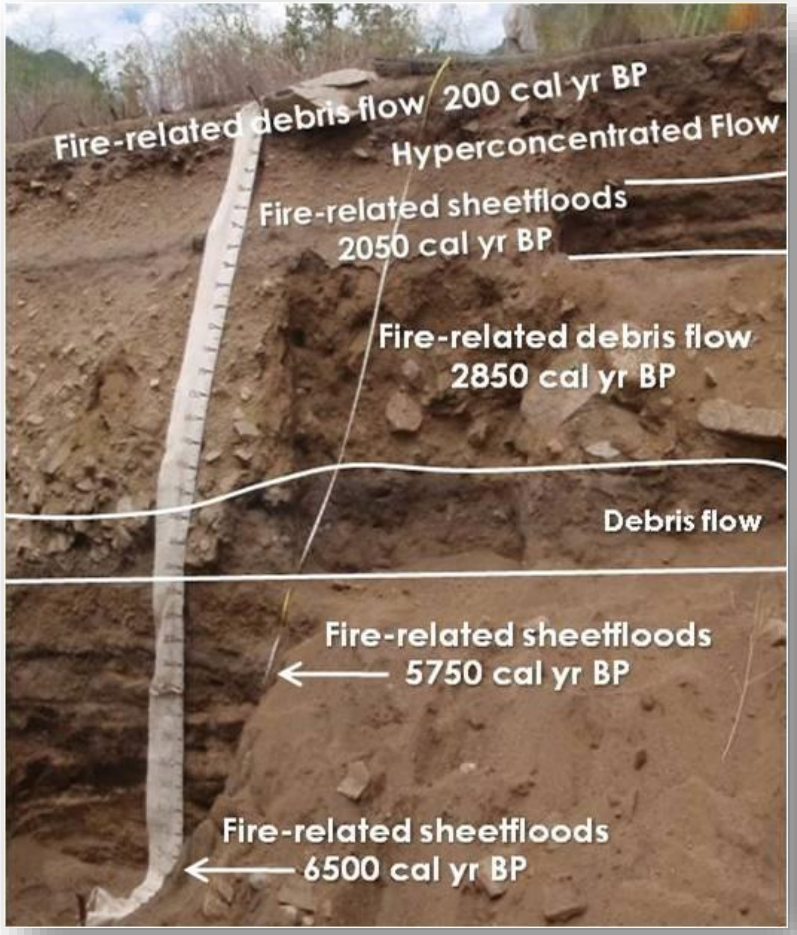
San Juans (Bigio et al., *The Holocene* 2010)

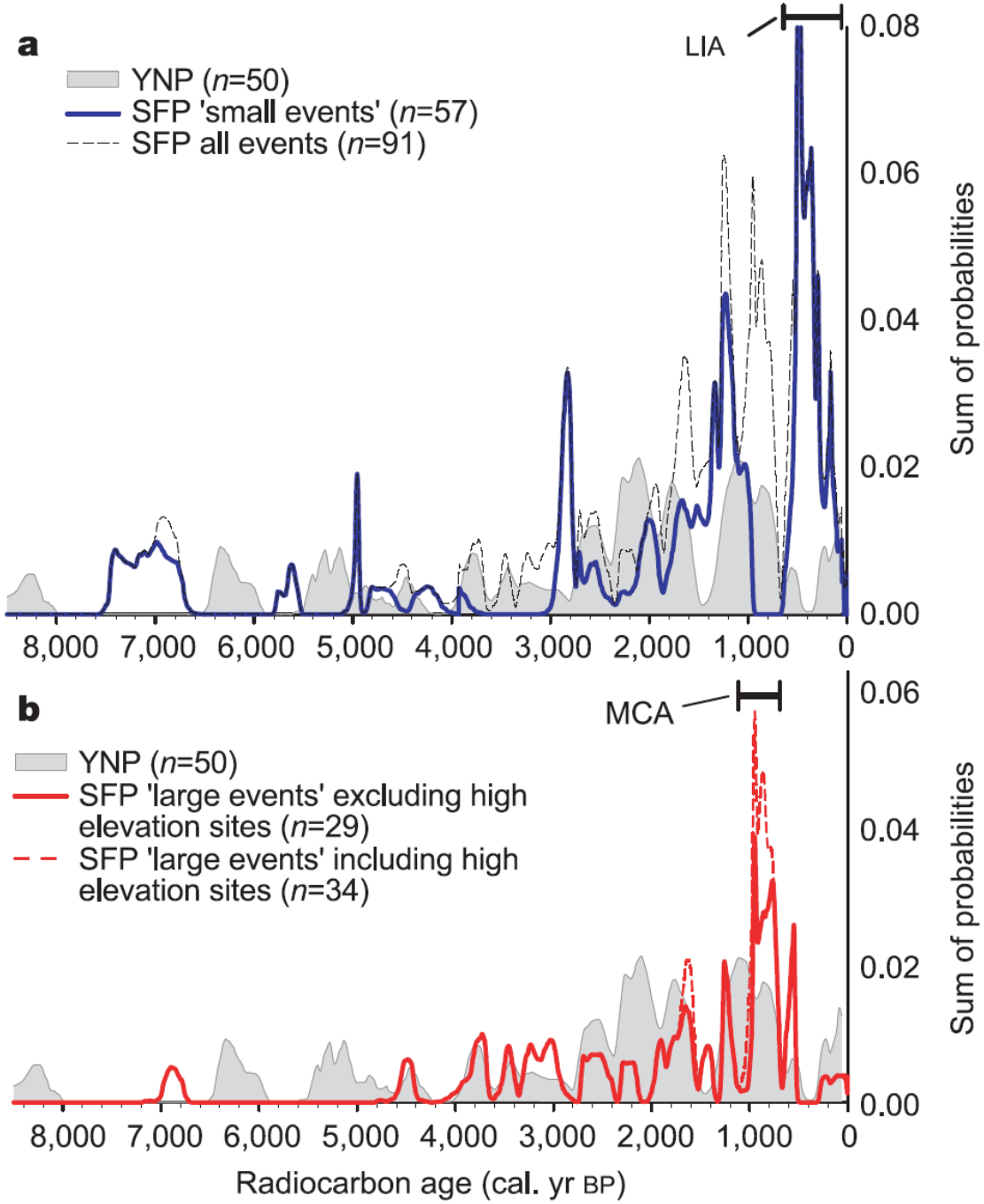
Jemez (Fitch and Meyer, *Quaternary Research* 2015)

Kendrick Mountains (Jenkins et al., *Int. Journal of Wildland Fire*, 2011)

Sacramento Mountains Frechette and Meyer, *The Holocene* 2009

Methods: radiocarbon date charcoal from alluvial deposits and use characteristics of fire-related deposits to develop longer records of fire and fire-related sedimentation events. . .



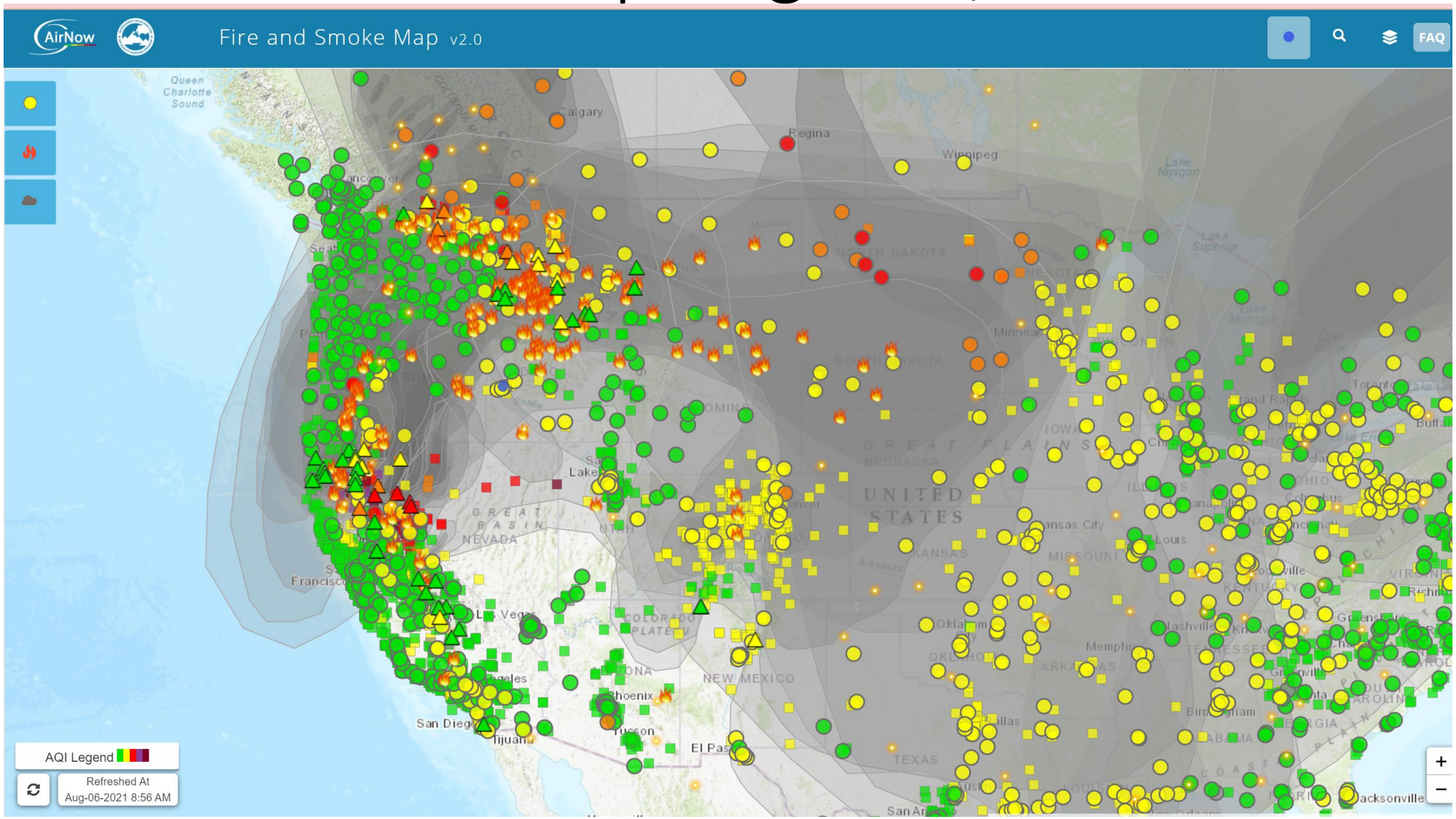


Pierce, Jennifer L., Grant A. Meyer, and AJ Timothy Jull. "Fire-induced erosion and millennial-scale climate change in northern ponderosa pine forests." Nature 432. 7013 (2004): 87.

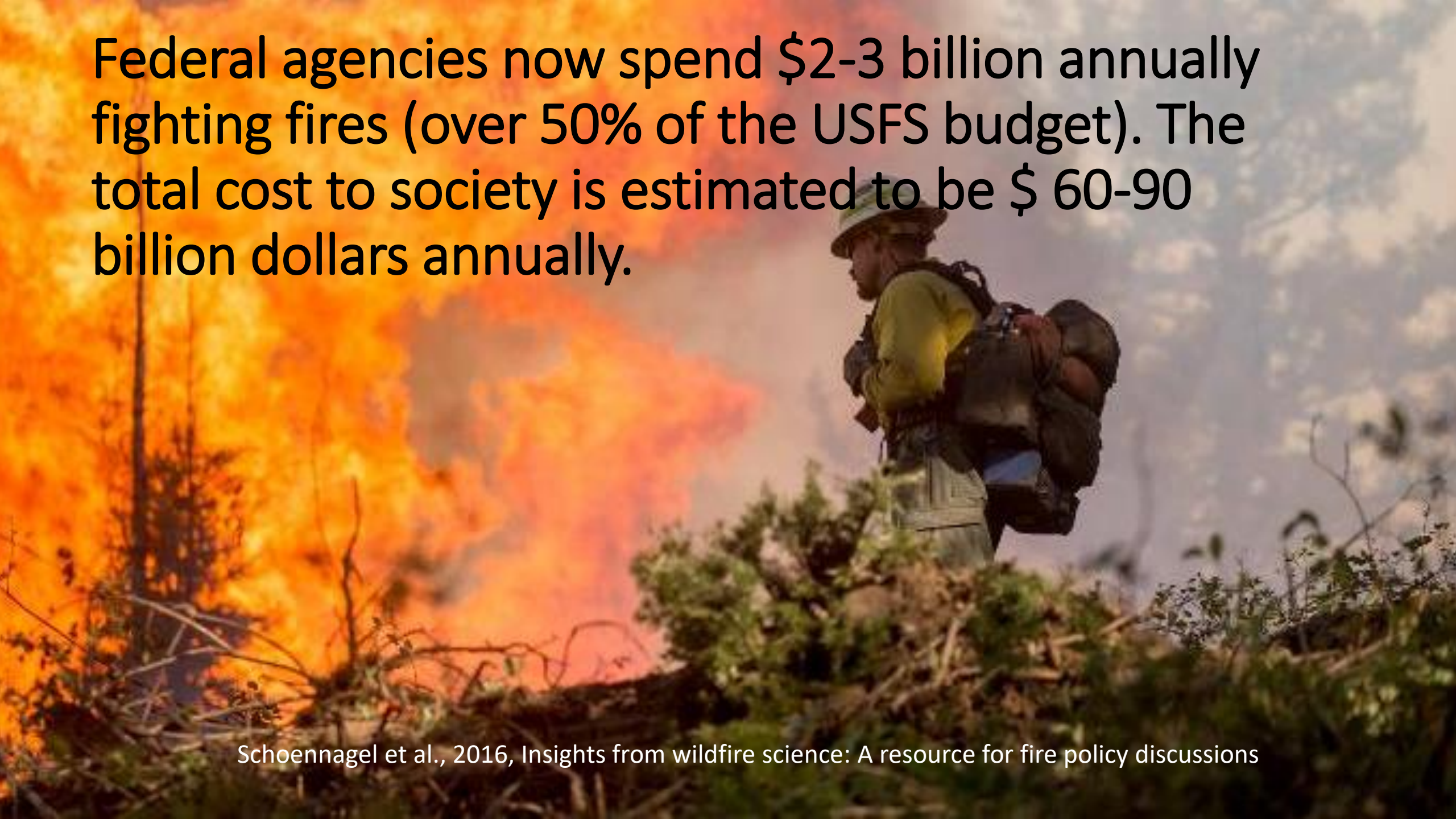
Results? Fires are bigger and more severe when it is warm and dry

Photo credit: Greta Reybus, http://www.gretarybus.com/climate-change-in-idaho

Fire and Smoke Map August 6, 2021



Federal agencies now spend $2-3 billion annually fighting fires (over 50% of the USFS budget). The total cost to society is estimated to be $ 60-90 billion dollars annually.



Schoennagel et al., 2016, Insights from wildfire science: A resource for fire policy discussions

THE CONVERSATION
Academic rigor, journalistic flair

Western fires are burning higher in the mountains at unprecedented rates – it's a clear sign of climate change

May 24, 2021 3.13pm EDT

Warming enabled upslope advance in western US forest fires

Mohammad Reza Alizadeh[a], John T. Abatzoglou[b], Charles H. Luce[c], Jan F. Adamowski[a], Arvin Farid[d], and Mojtaba Sadegh[d,1]

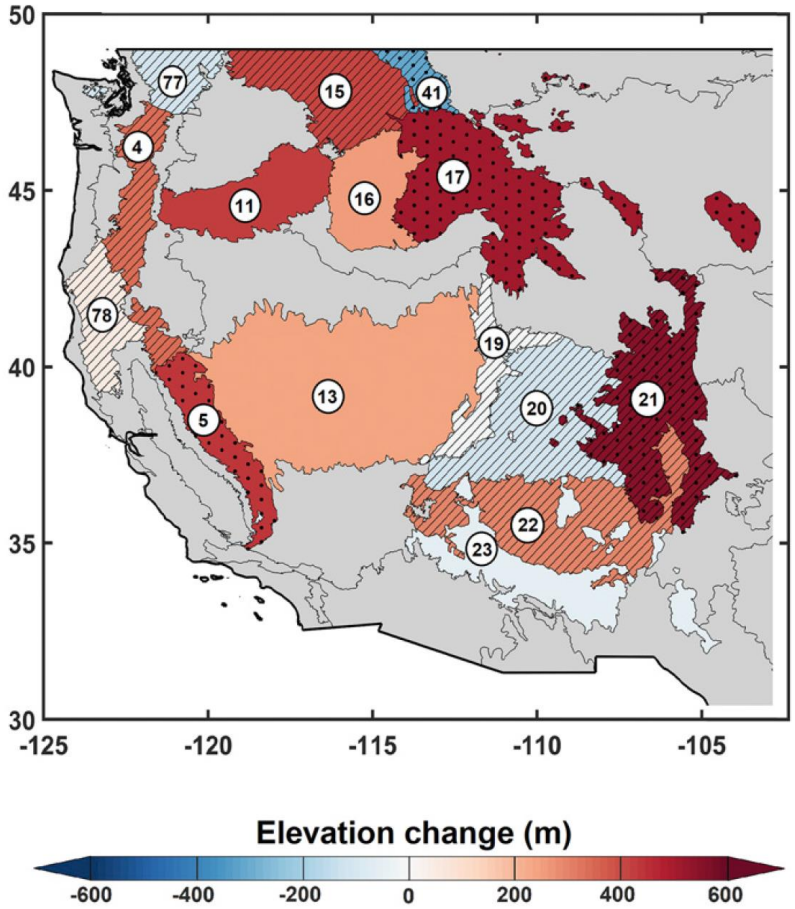
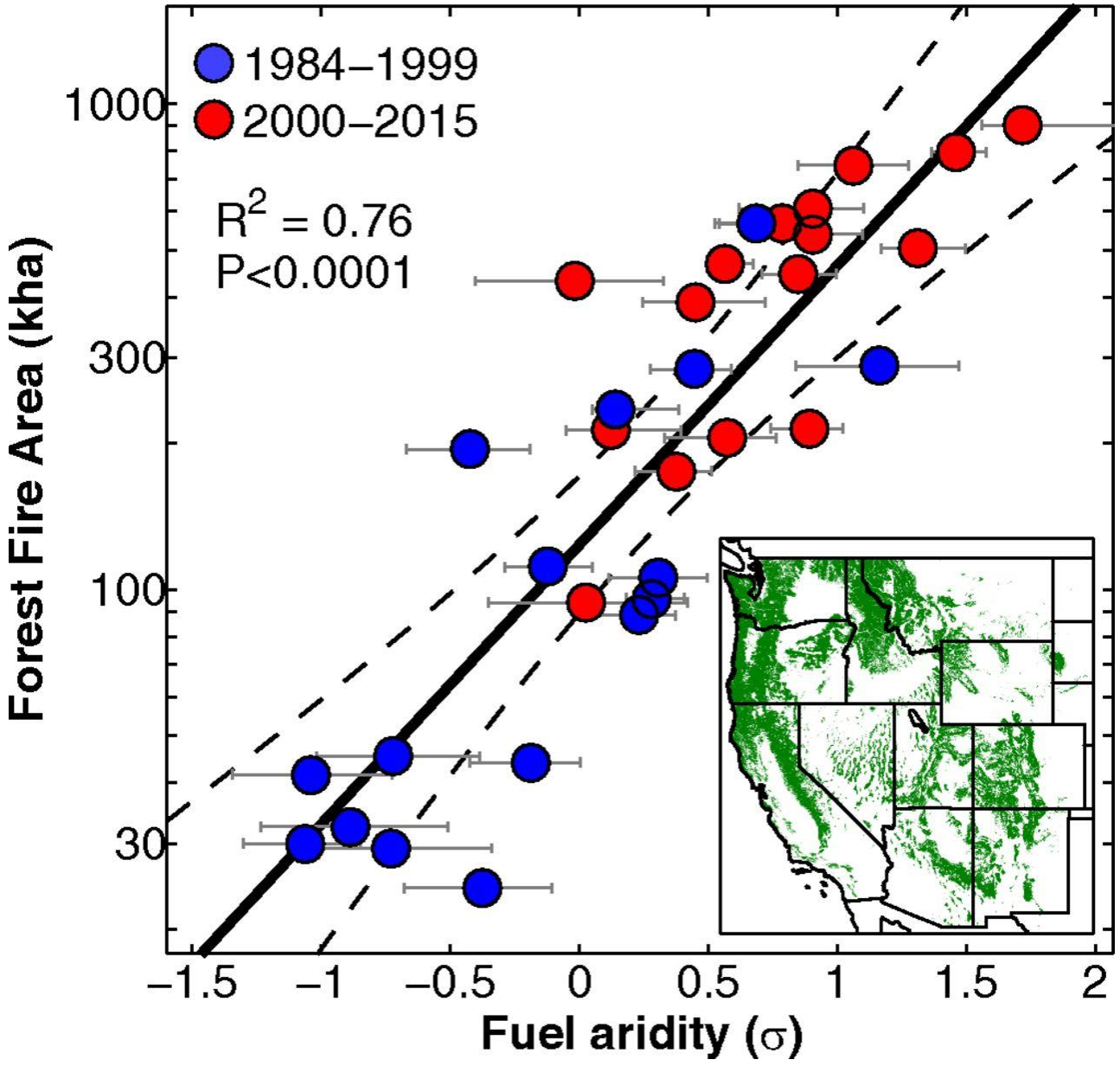


Fig. 1. High-elevation fires are generally moving upslope across mountainous western United States. Changes in Z_{90} during 1984 to 2017 are presented. The dotted area represents statistically significant monotonic trend at the 5% level using the Mann–Kendall trend test. The hatched areas are associated with ecoregions with at least 10% length of record (4 y) excluded from the analysis due to absence of fire. The gray shaded ecoregions are not included in the analysis. The ecoregion names are as follows: 4: Cascades, 5: Sierra Nevada, 11: Blue Mountains, 13: Central Basin and Range, 15: Northern Rockies, 16: Idaho Batholith, 17: Middle Rockies, 19: Wasatch and Unita Mountains, 20: Colorado Plateaus, 21: Southern Rockies, 22: Arizona/New Mexico Plateau, 23: Arizona/New Mexico Mountains, 41: Canadian Rockies, 77: North Cascades, and 78: Klamath Mountains/California High North Coast Range.


Thinning? For many of forests this is not economically or ecologically an option

Impact of anthropogenic climate change on wildfire across western US forests

Increased forest fire activity across the western United States in recent decades has contributed to widespread forest mortality, carbon emissions, periods of degraded air quality, and substantial fire suppression expenditures. Although numerous factors aided the recent rise in fire activity, observed warming and drying have significantly increased fire-season fuel aridity, fostering a more favorable fire environment across forested systems. **We demonstrate that human-caused climate change caused over half of the documented increases in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984**. This analysis suggests that anthropogenic climate change will continue to chronically enhance the potential for western US forest fire activity while fuels are not limiting.



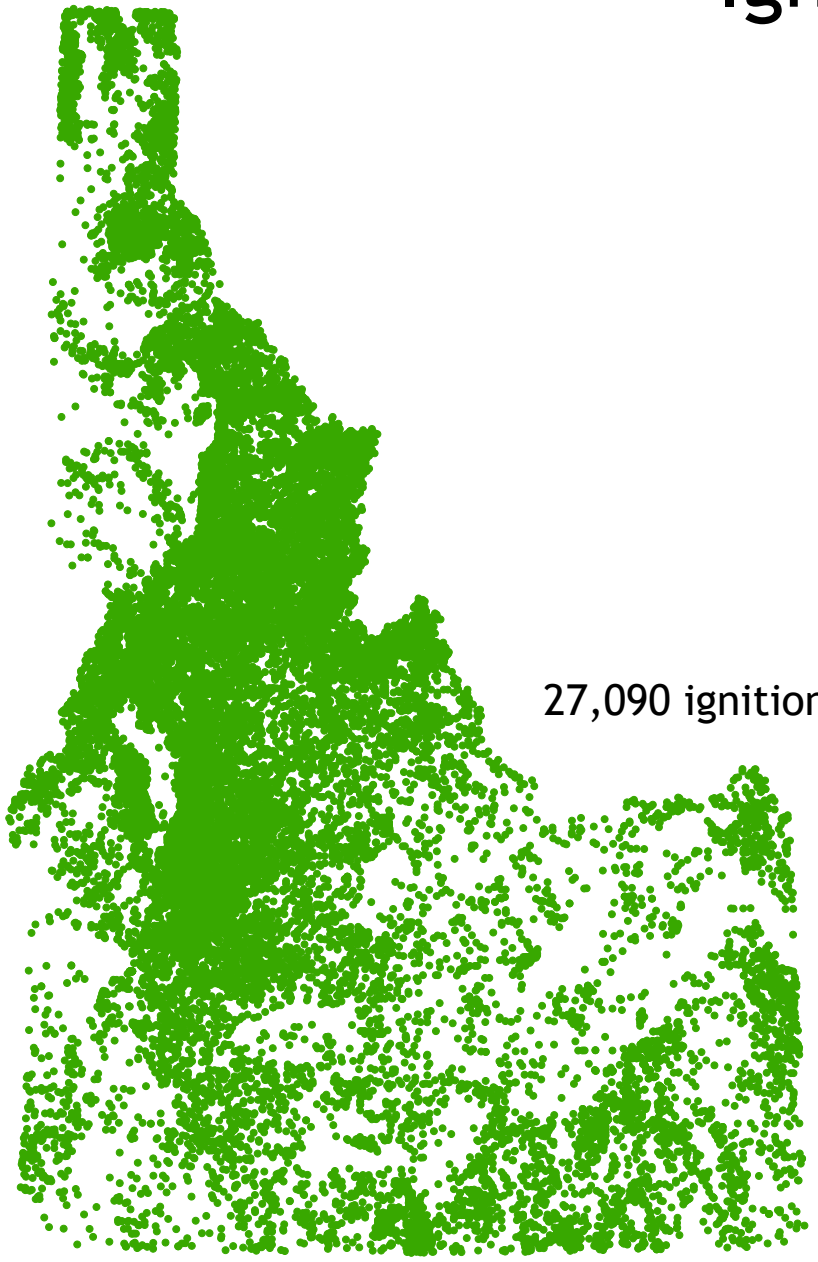
Abatzoglou and Williams, PNAS October 18, 2016 113 (42) 11770-11775;

We have the opportunity to reduce human-caused fires

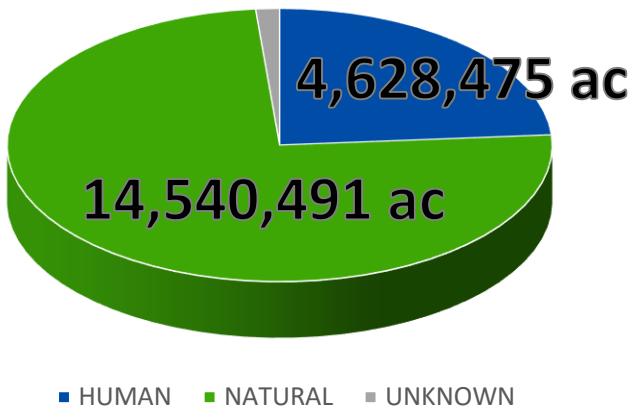
Human-started wildfires accounted for 84% of all wildfires, tripled the length of the fire season, dominated an area seven times greater than that affected by lightning fires, and were responsible for nearly half of all area burned.

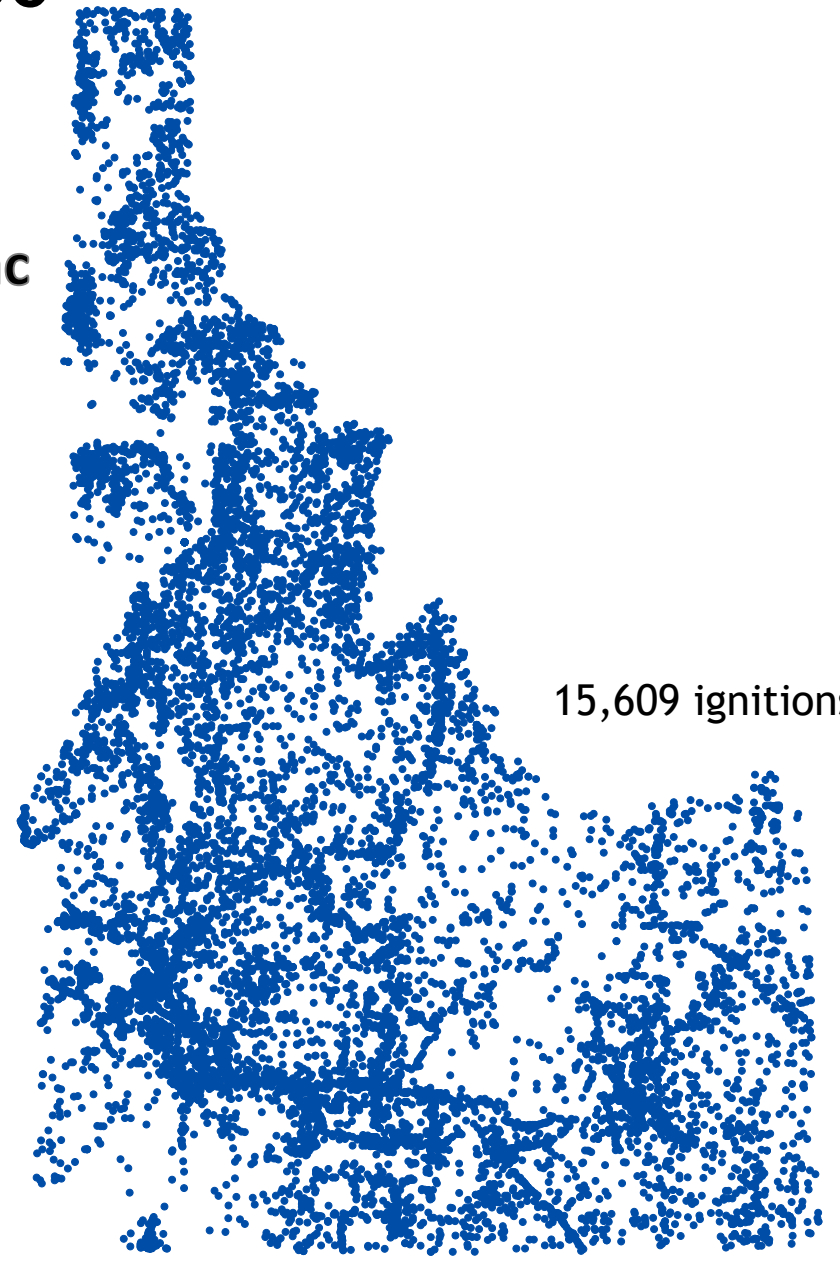
Balch et al. 2017

Ignitions since 1980



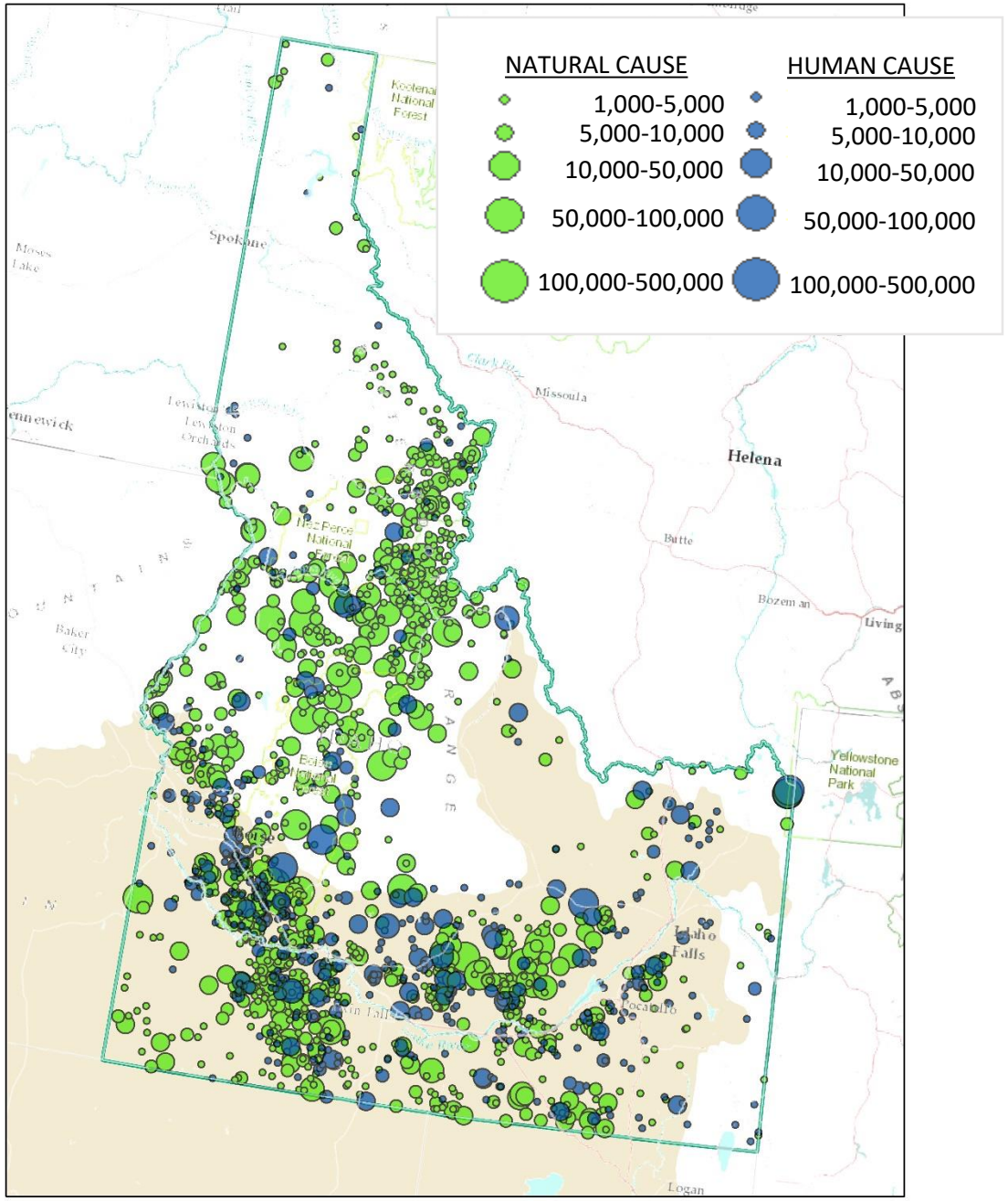
27,090 ignitions



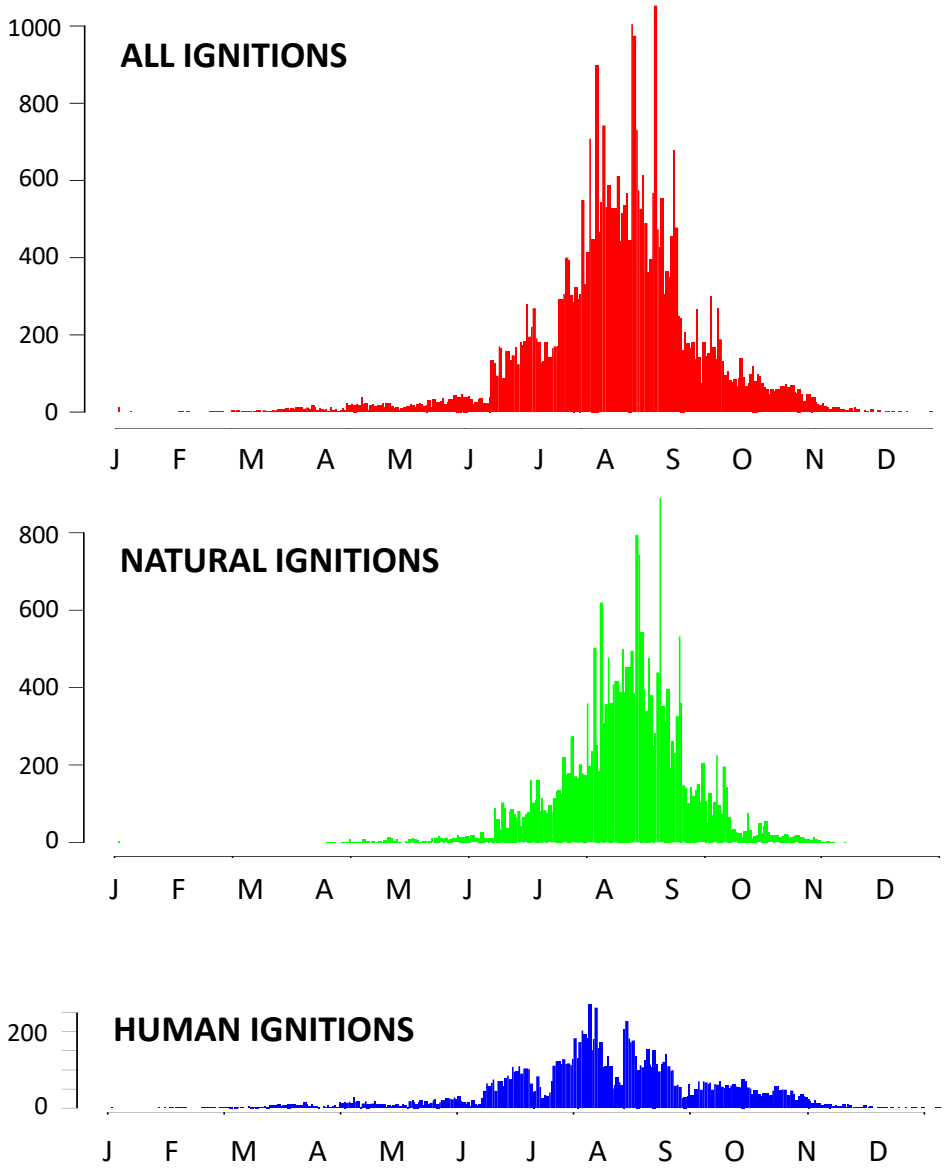


15,609 ignitions

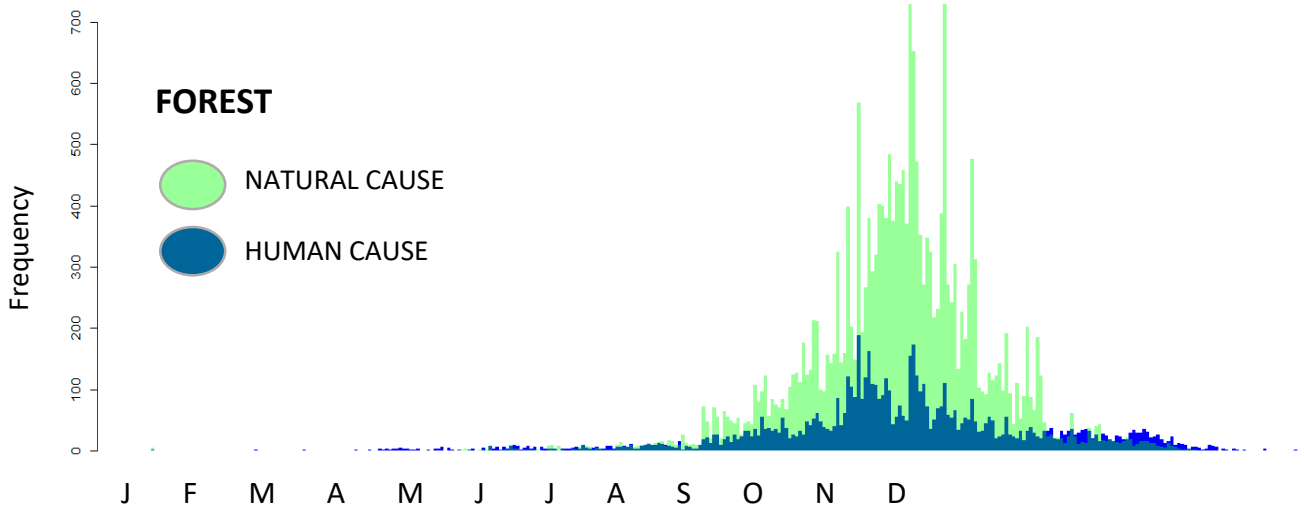
Fires >1000 acres (1980-2015)

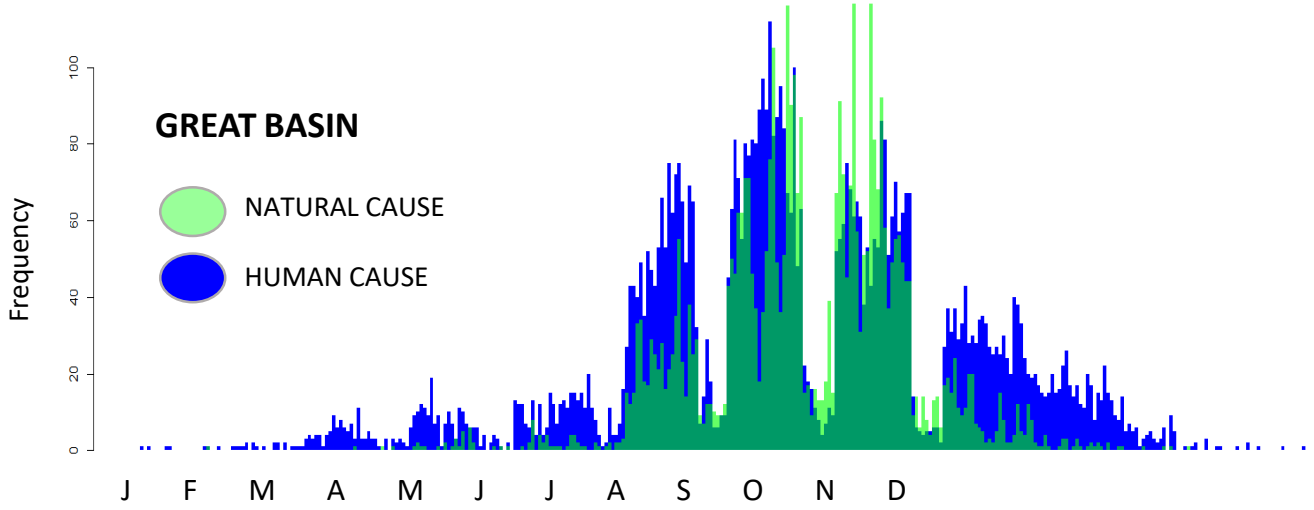


Start Date of Ignitions Reported in Idaho 1980-2015



Start Date of Ignitions Divided by Region 1980-2015

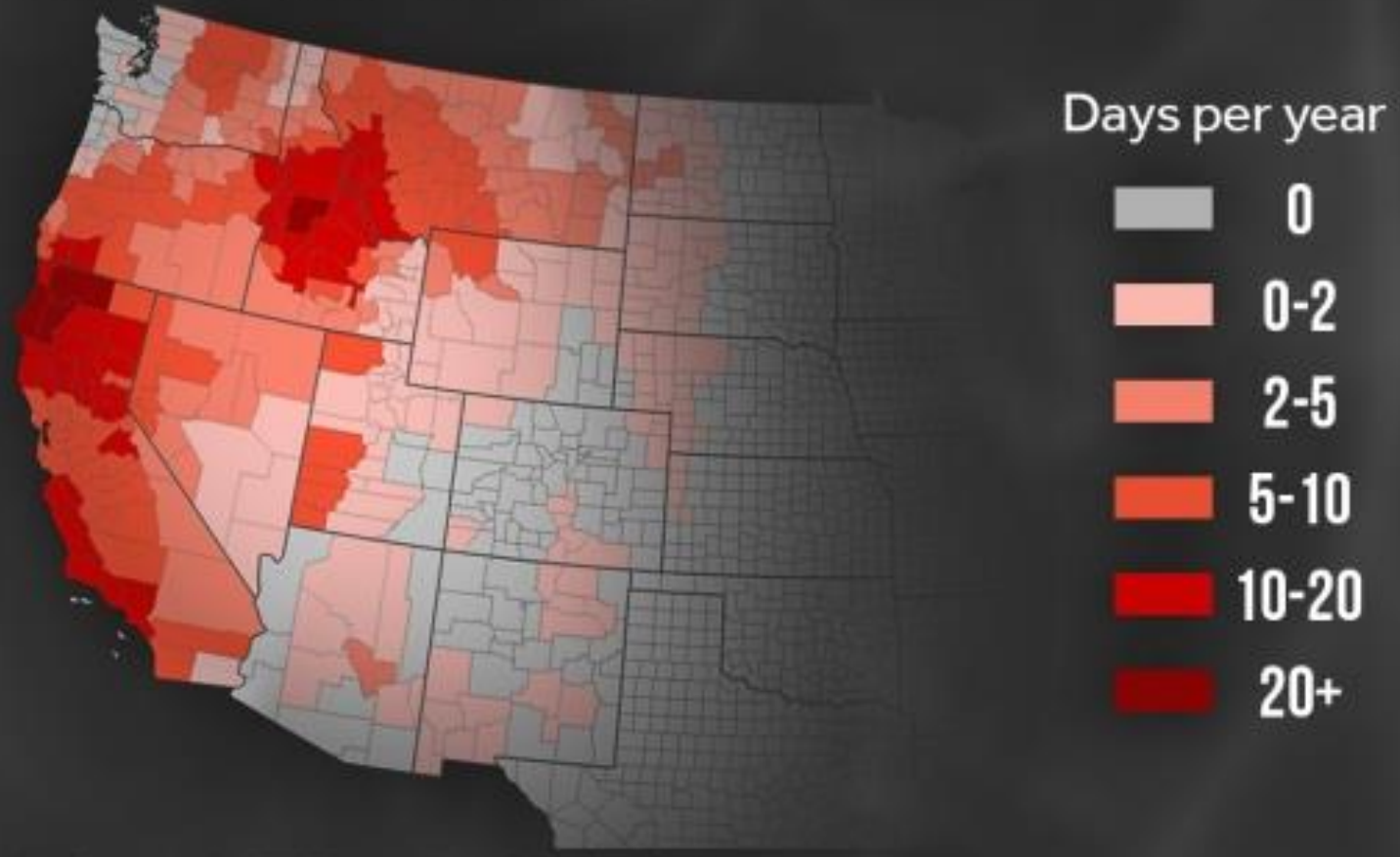




Where there’s fire. . . .there’s smoke

SMOKE WAVE DAYS

Wildfire Air Pollution

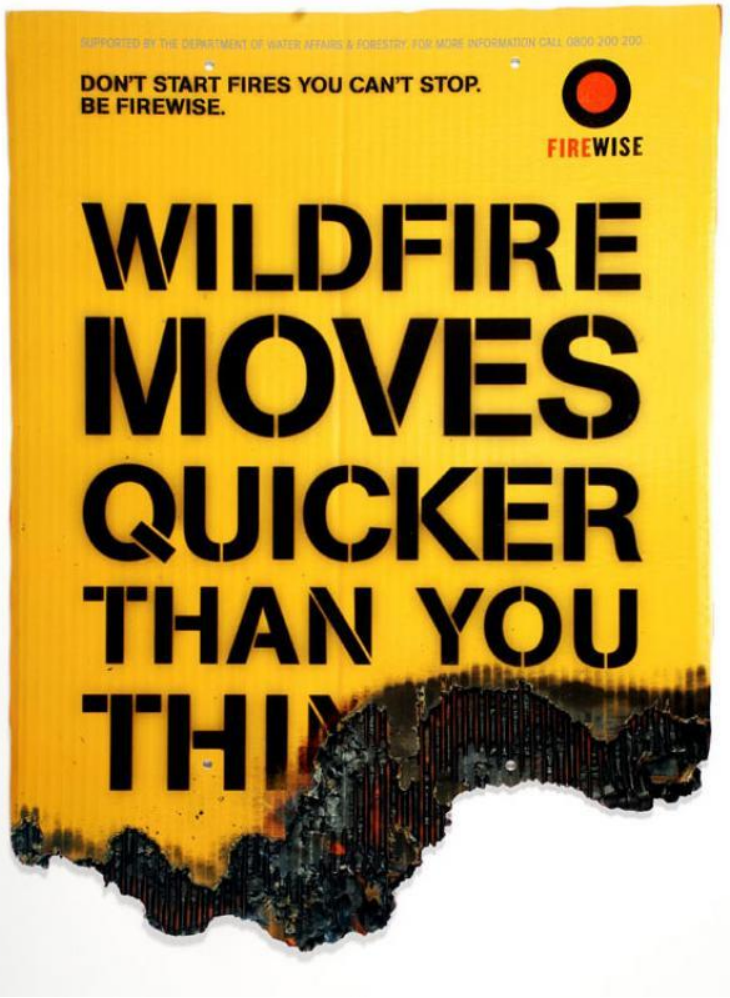


Smoke Wave Day = a day with a PM2.5 concentration of at least 20 ug/m^3
PM2.5 = Particulate matter smaller than 2.5 µm
Source: Liu et al. 2017 Data: 2004–2009

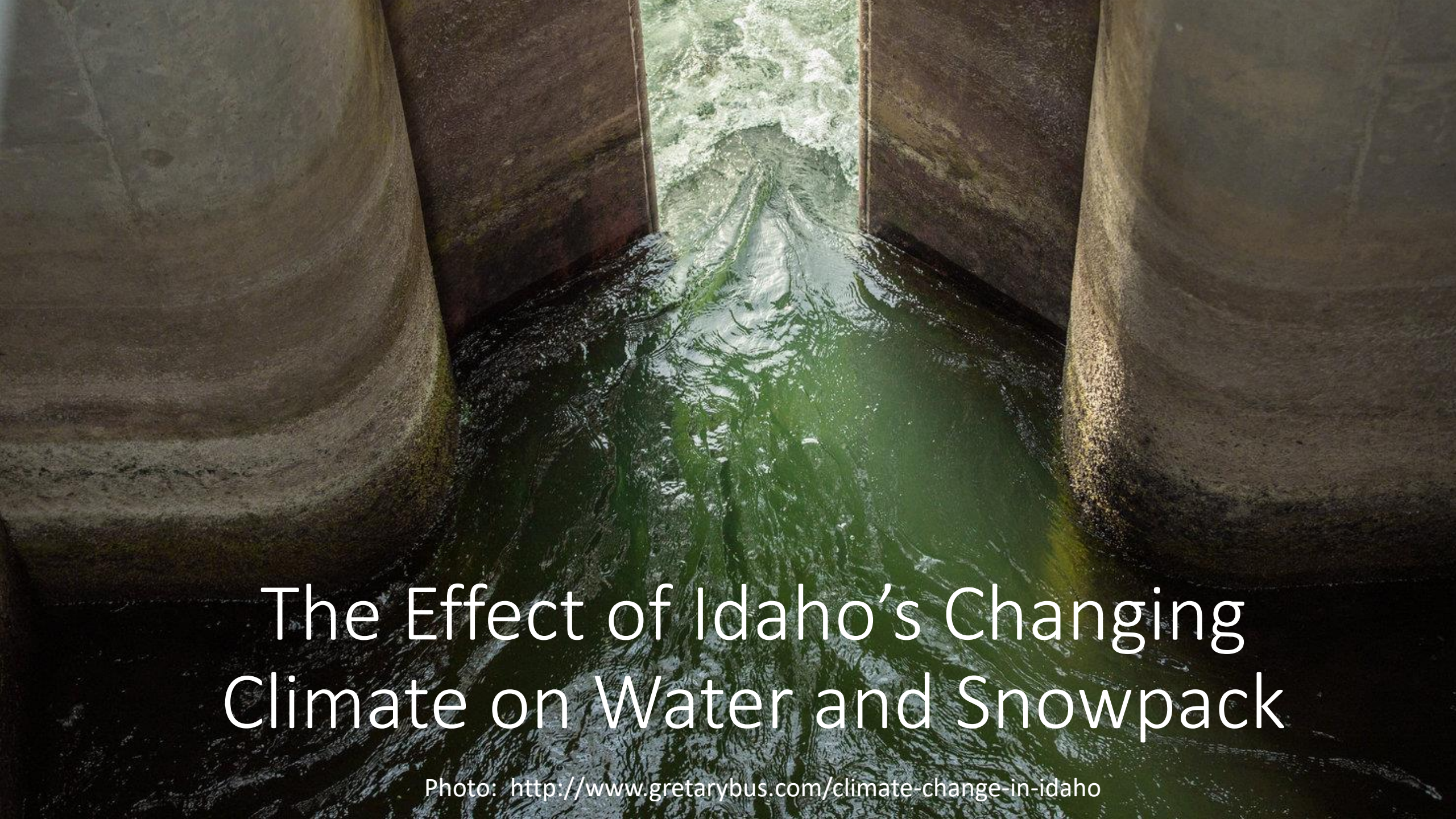
CLIMATE CENTRAL

Wildfires compromise forest and rangeland resources, and our pocketbooks

We have the opportunity to better prepare our communities for threats from wildfires and wildfire smoke



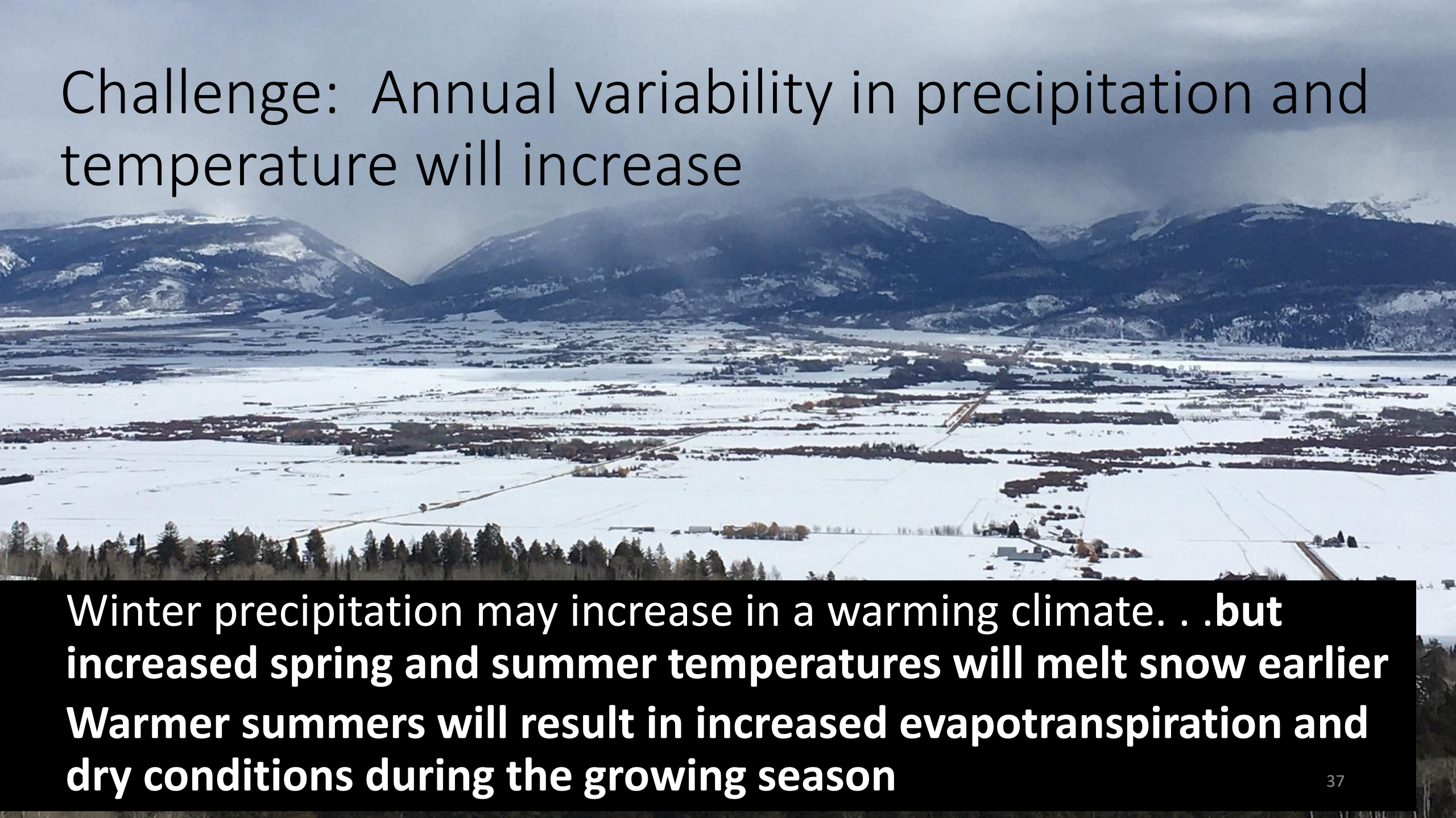
Challenges and Opportunities of Climate Change in Idaho's Ecosystem: Short background The Effect of Changing Climate on Wildfires, Snowpack and Water,& Ecosystems



The Effect of Idaho's Changing Climate on Water and Snowpack

Photo: http://www.gretarybus.com/climate-change-in-idaho

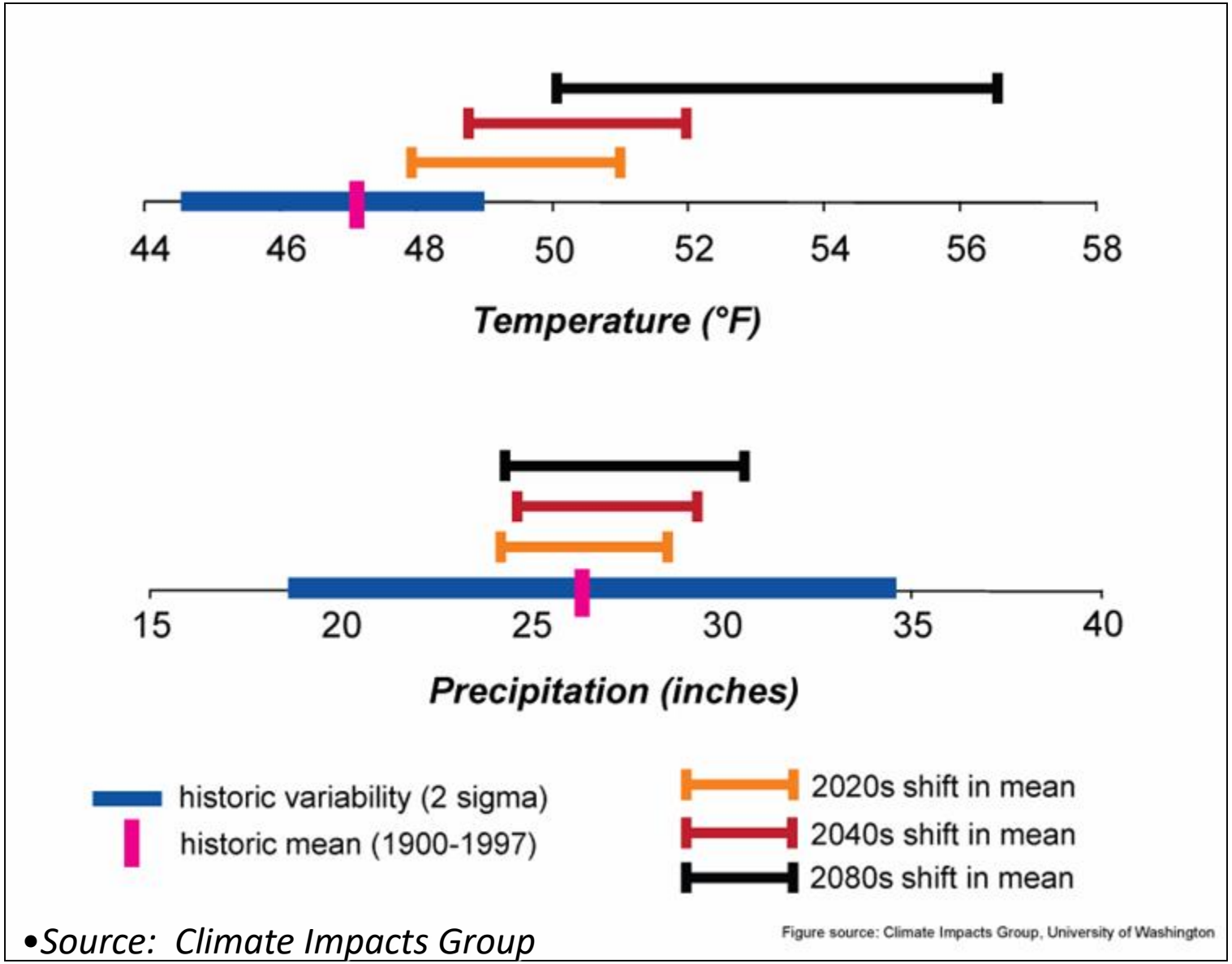
Challenge: Annual variability in precipitation and temperature will increase



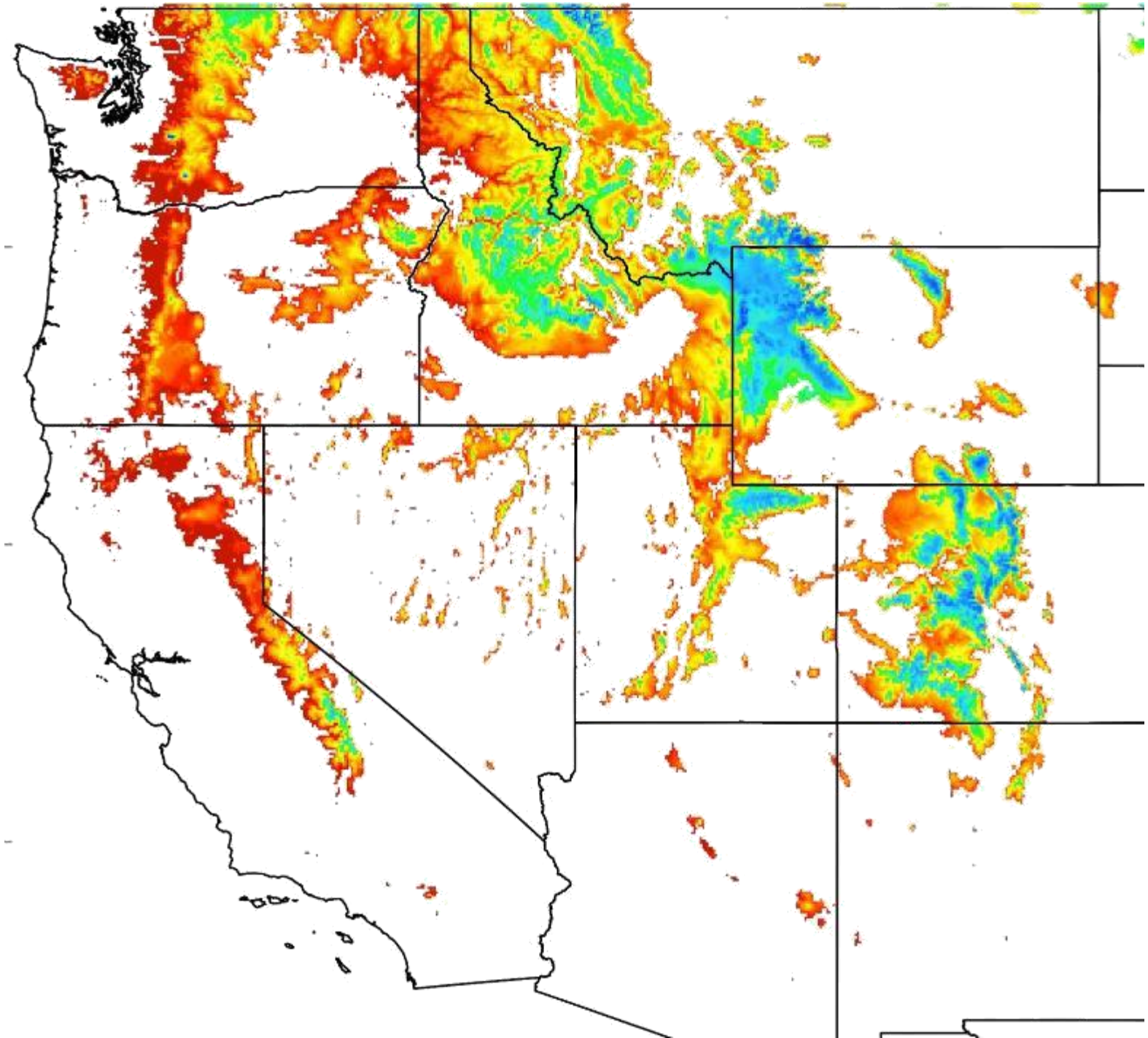
Winter precipitation may increase in a warming climate. . .**but increased spring and summer temperatures will melt snow earlier**

Warmer summers will result in increased evapotranspiration and dry conditions during the growing season

Changes in temperature and precipitation in the Pacific Northwest

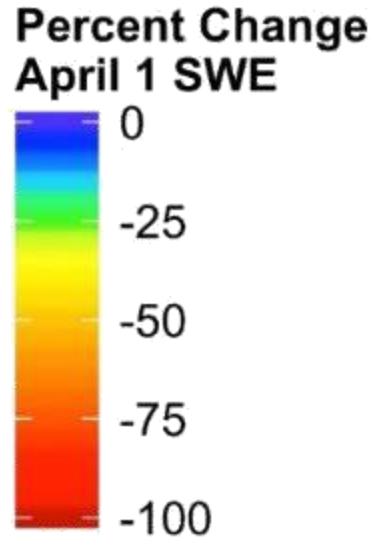


- *Source: Climate Impacts Group*



Snow Change Projections for 2080s.

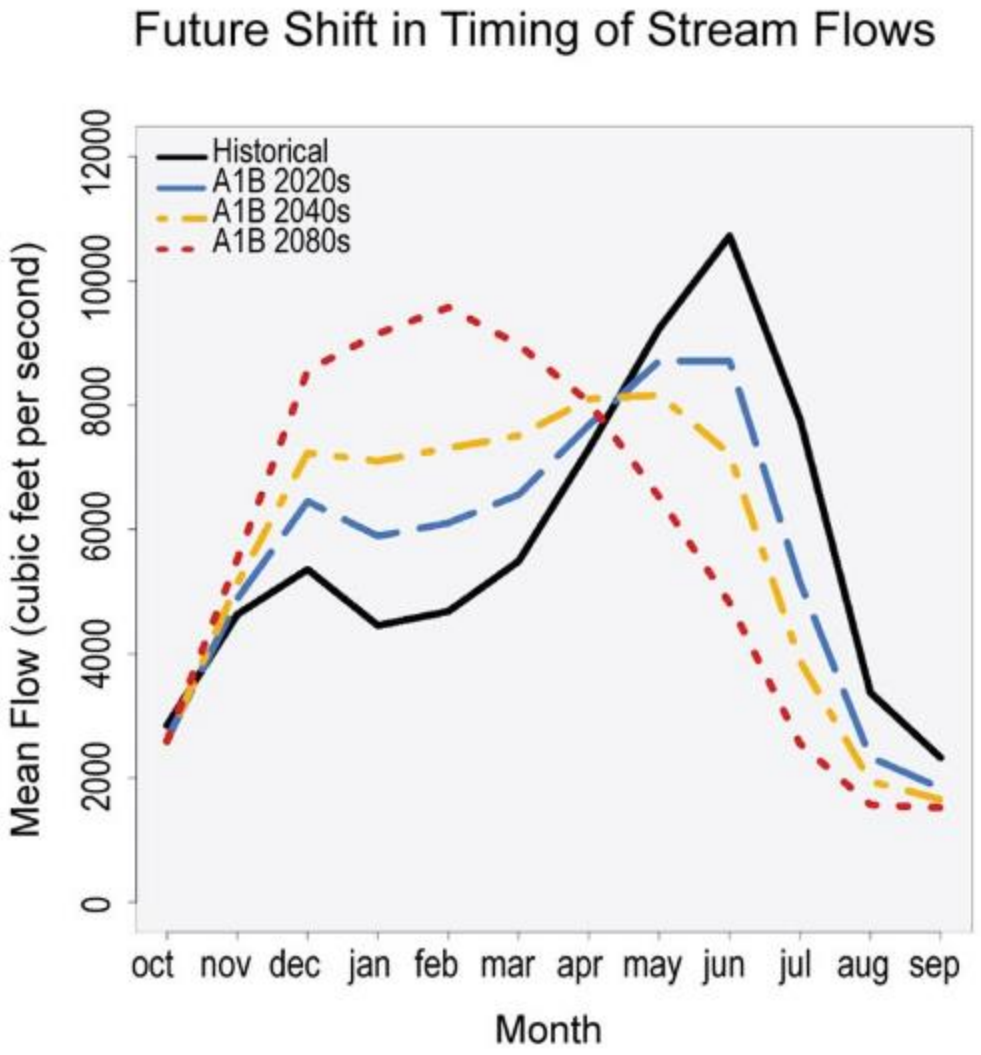
Idaho's snow-covered area is going to shrink.

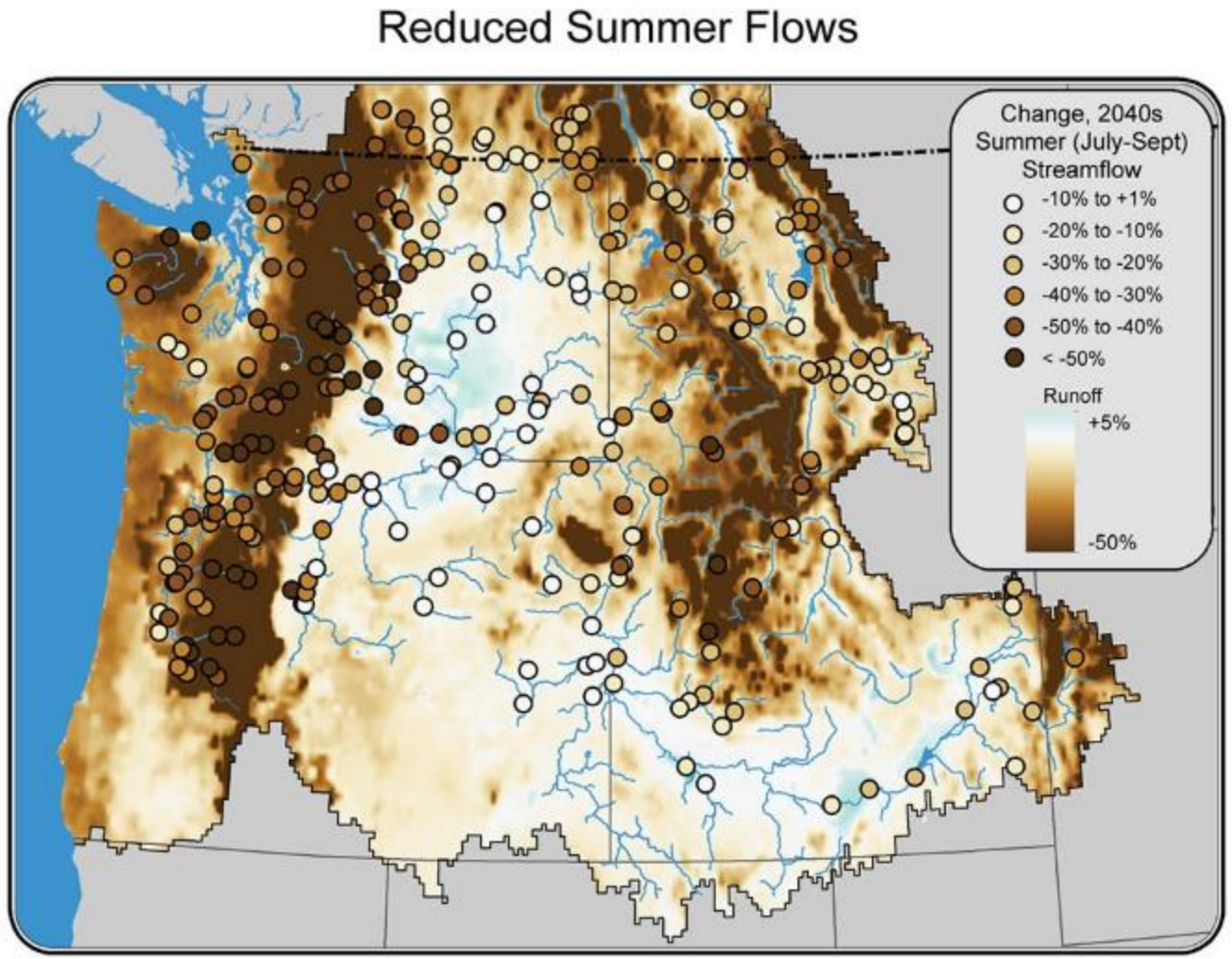


Luce et al. 2014

Lute and Luce, 2017

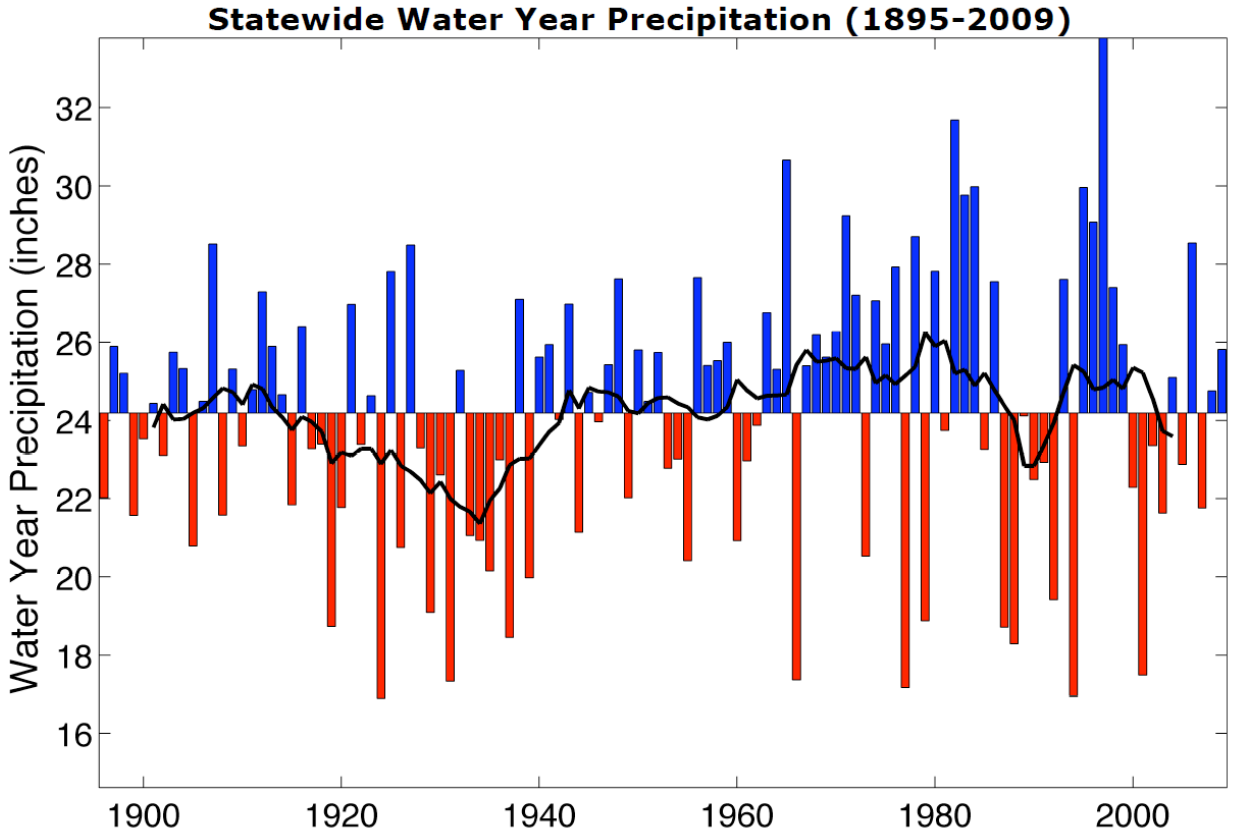
Challenge: Low flows will get lower





https://nca2014.globalchange.gov/report/regions/northwest

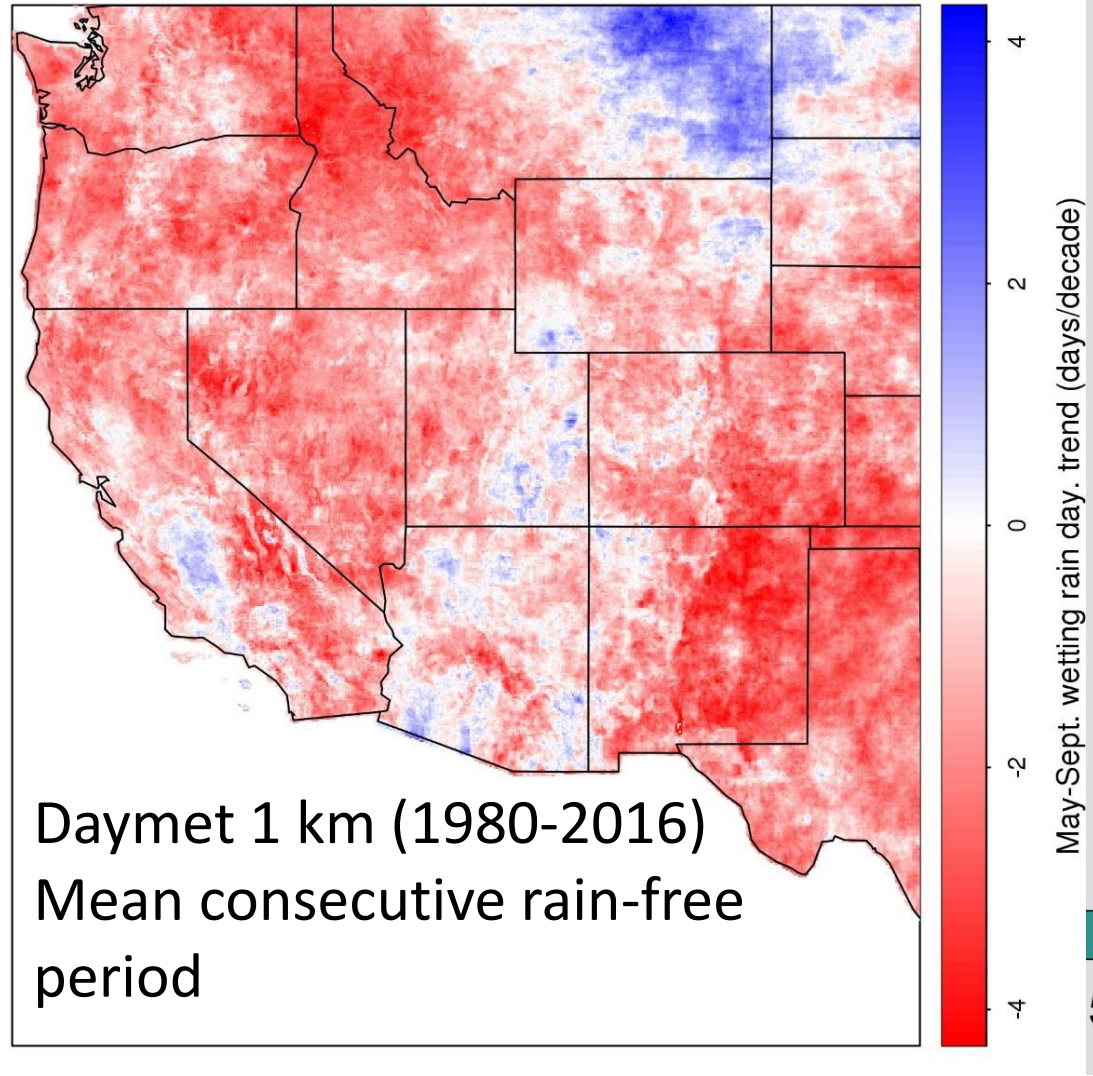
Challenge: Annual variability in precipitation and will increase



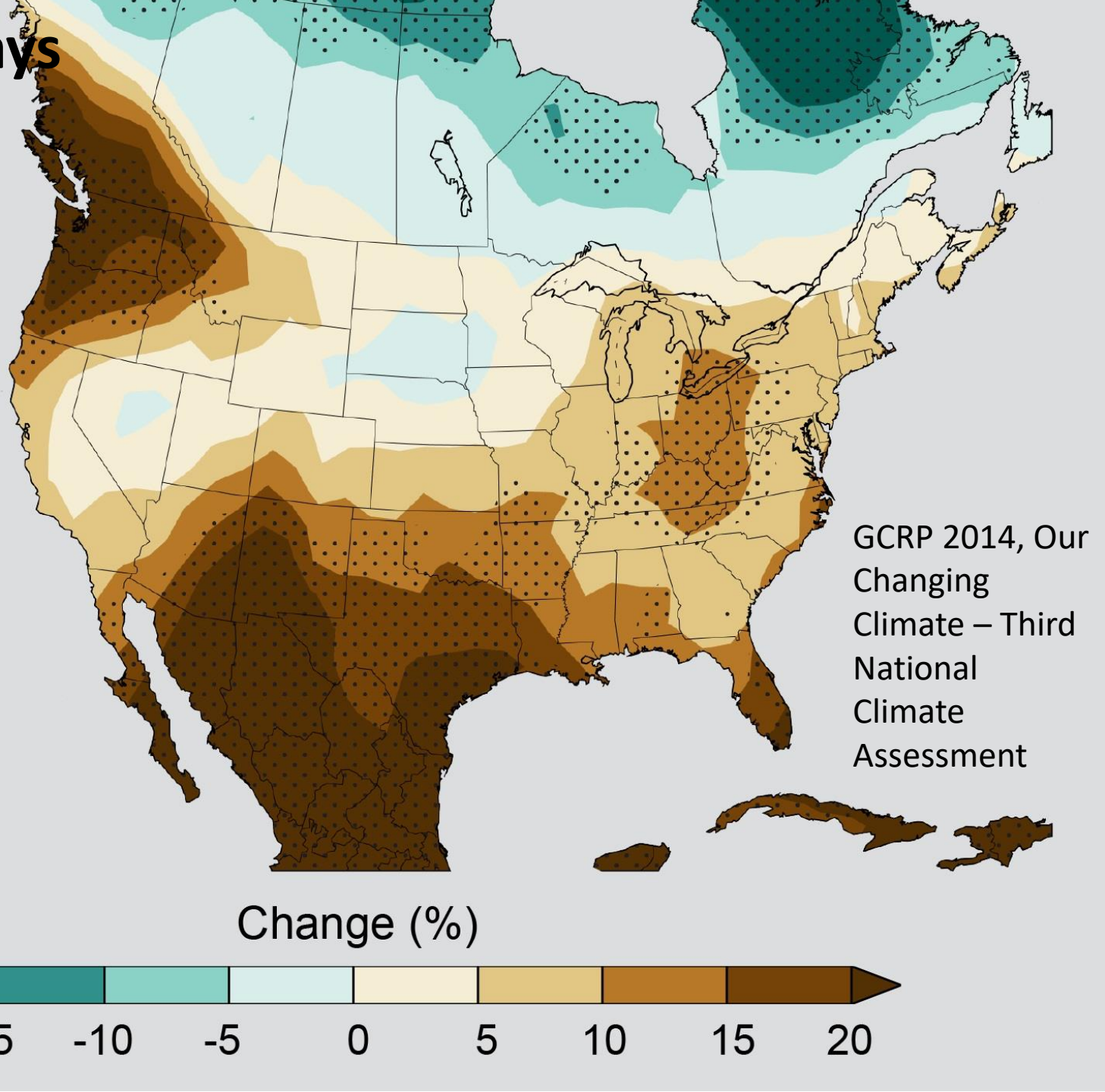
Indicators of Climate Change in Idaho, 2011, University of Idaho

Agriculture

Number of Consecutive Dry Days will increase



Daymet 1 km (1980-2016)
Mean consecutive rain-free period

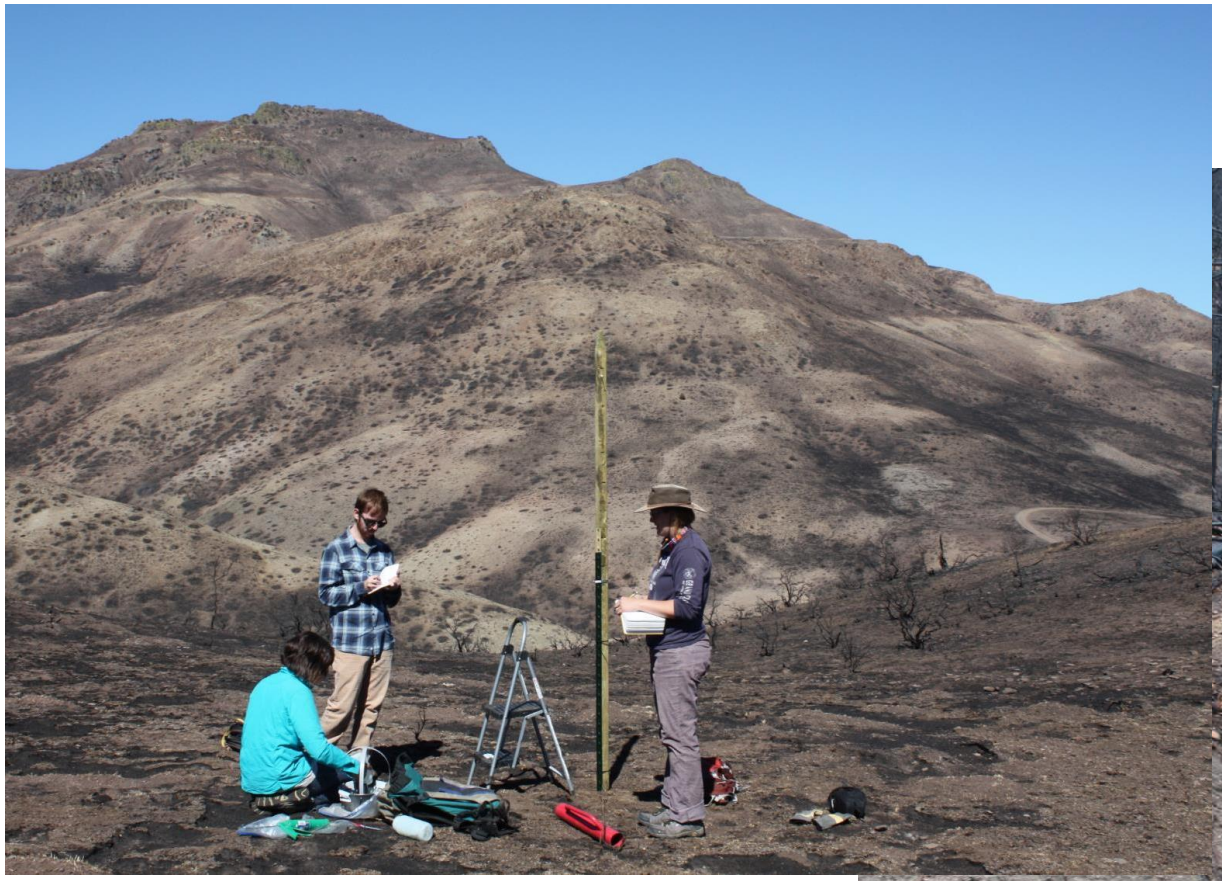


GCRP 2014, Our Changing Climate – Third National Climate Assessment

Challenges and Opportunities of Climate Change in Idaho's Ecosystem: Short background The Effect of Changing Climate on Wildfires, Snowpack and Water,& Ecosystems

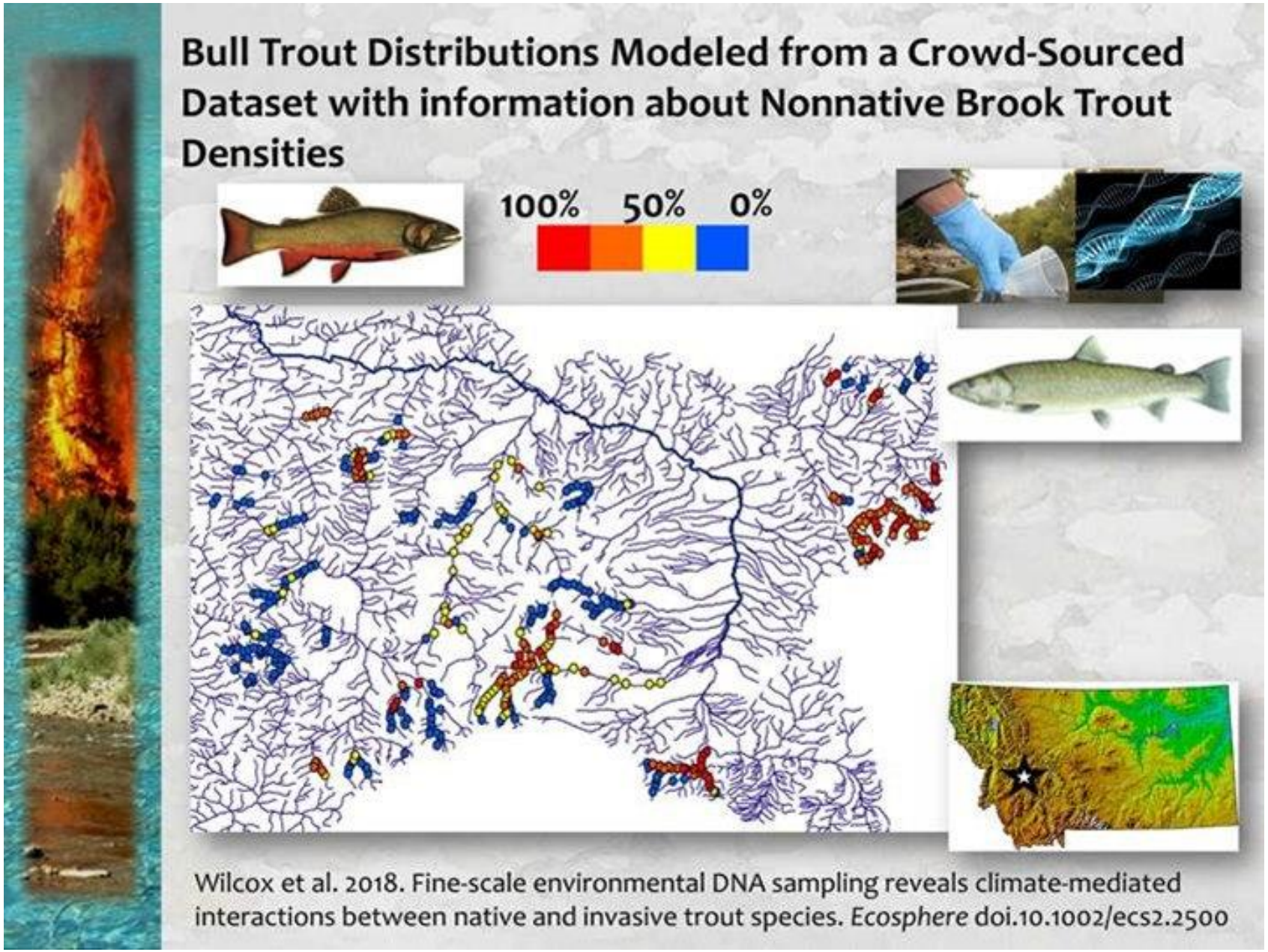
Ecological response to Climate Change

Ecosystem Response: Non-replacement following fire



Reduced habitat for salmonids

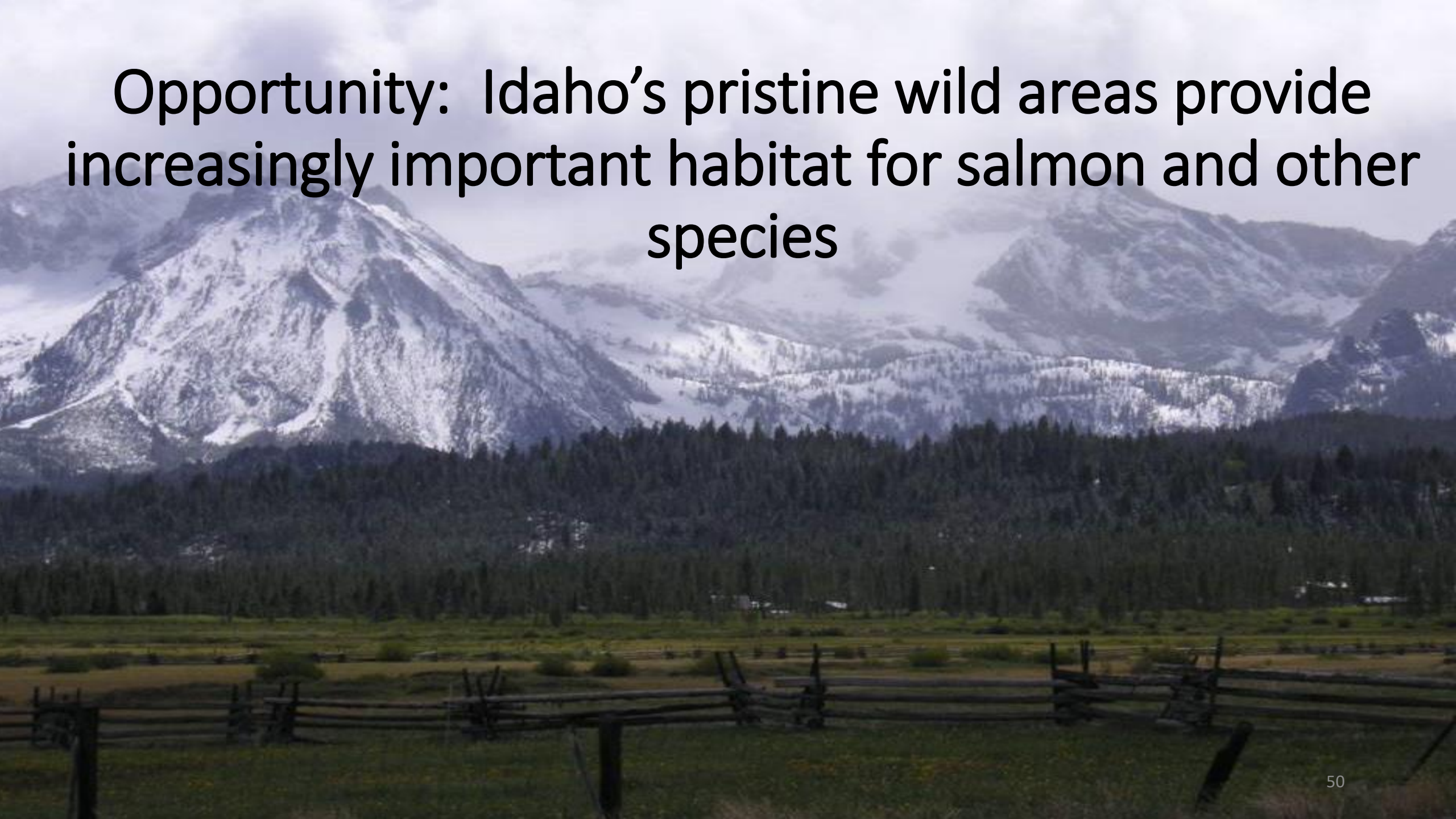
- Dan Isaak, USFS
- Rob VanKirk, Mike Lien, Bryce Contour, Max Lewis. . .
- (ask your Henry's Fork and Friends of Teton River Scientists!)



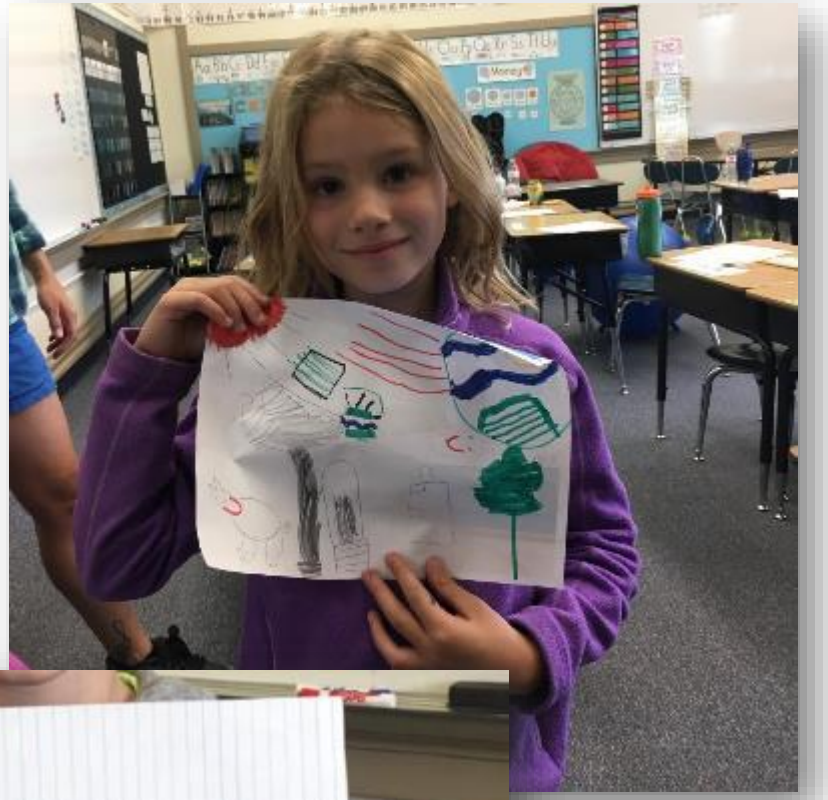
Opportunity: The pristine wild areas in our state provides increasingly important habitat for salmonids and other species

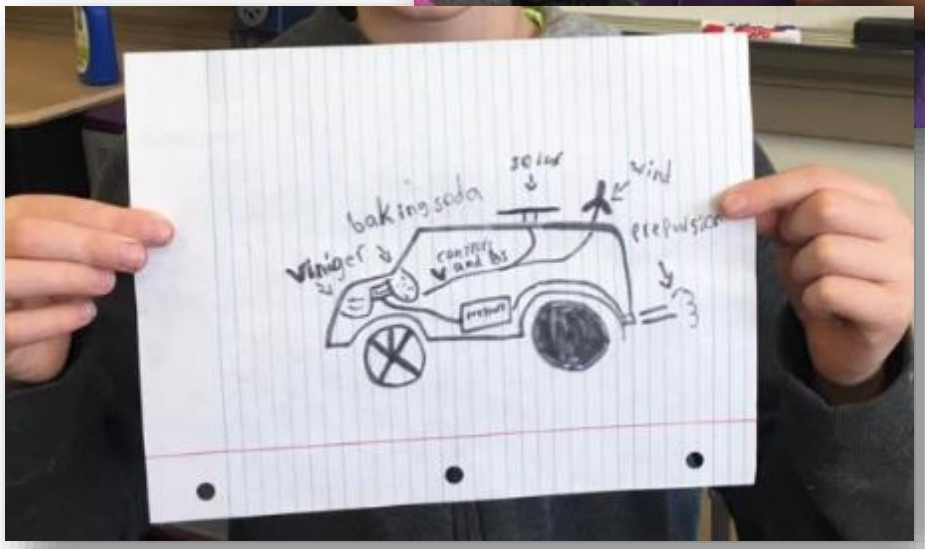
Opportunities: Renewable Energy

Opportunity: Idaho's pristine wild areas provide increasingly important habitat for salmon and other species



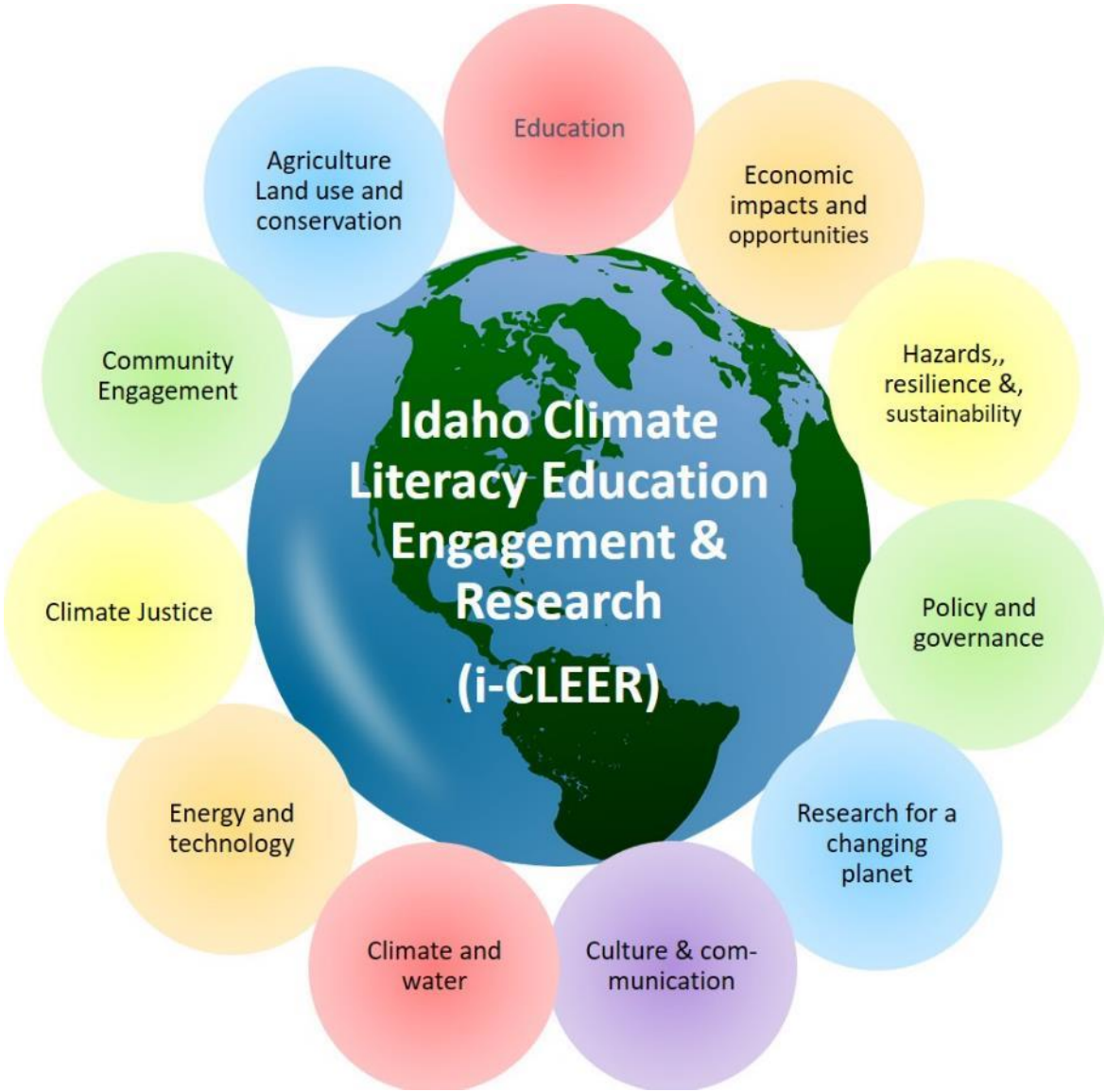
Opportunities: The next generation of Idahoans





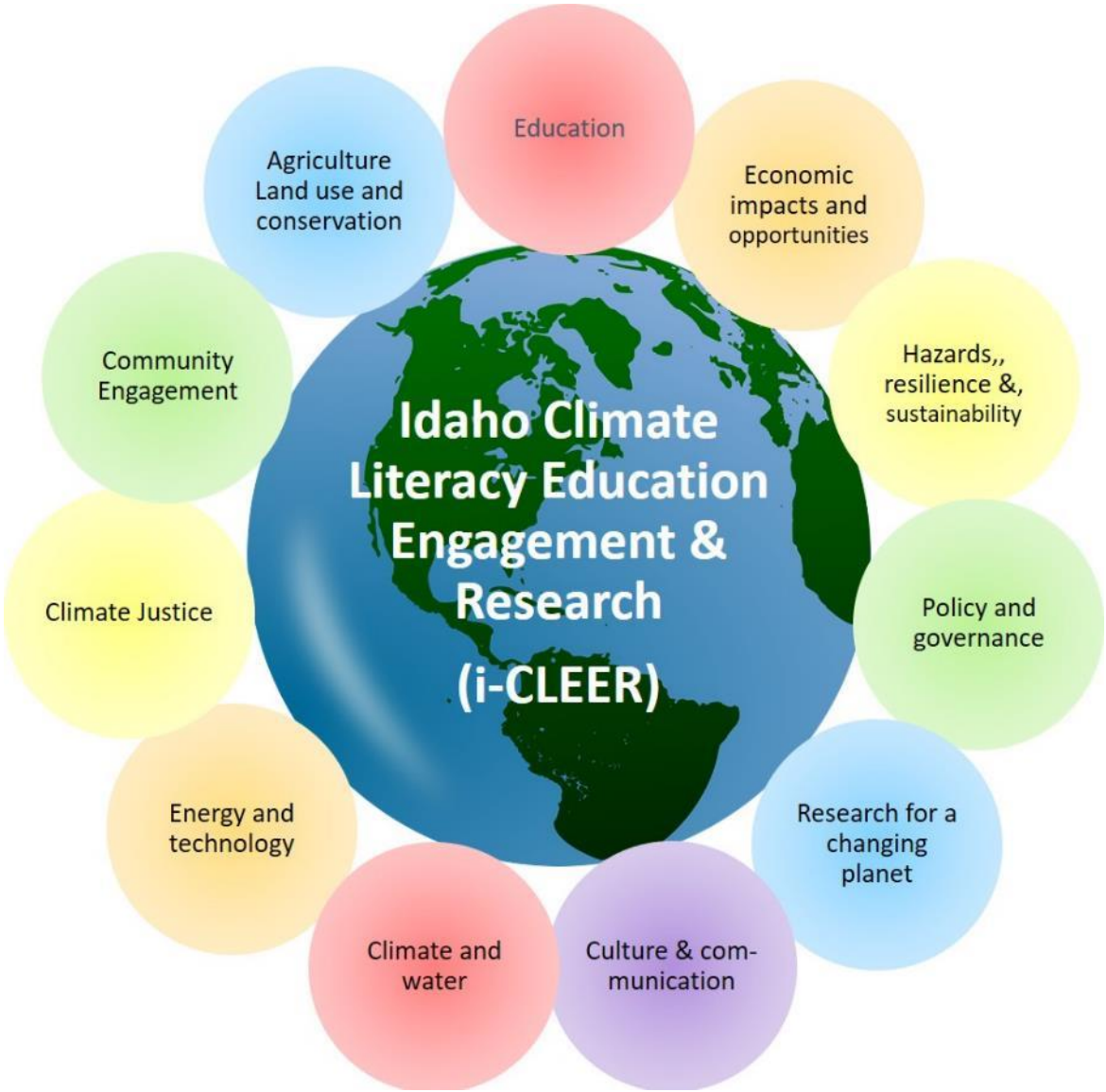
Questions?
jenpierce@boisestate.edu

i-CLEER (Idaho Climate Literacy Education Engagement and Research)



Meetings: 2nd Wednesday of each month, 6-7 pm.

Contact Jen Pierce for more information jenpierce@boisestate.edu



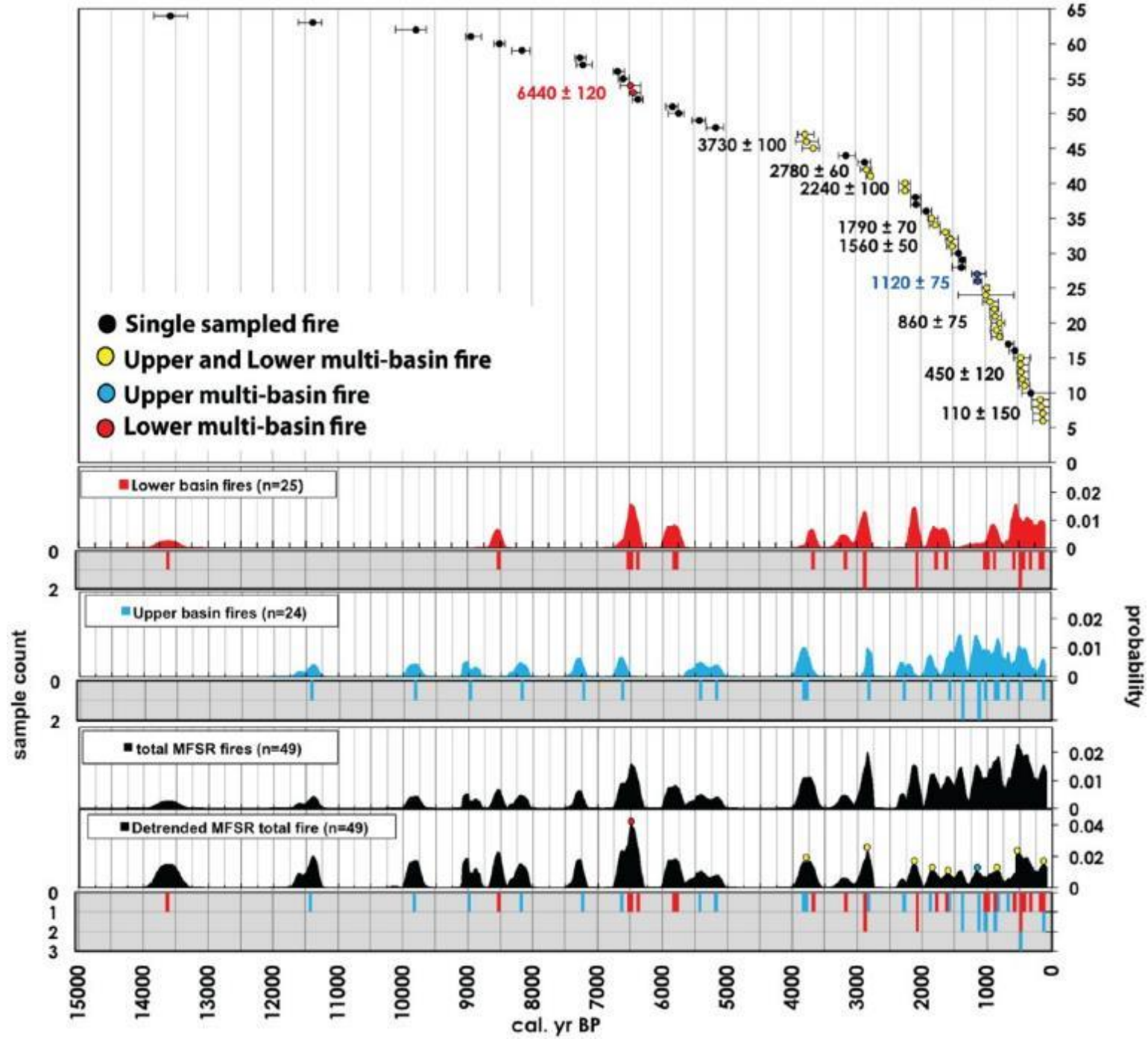
Thank you!

Jen Pierce, Boise State University

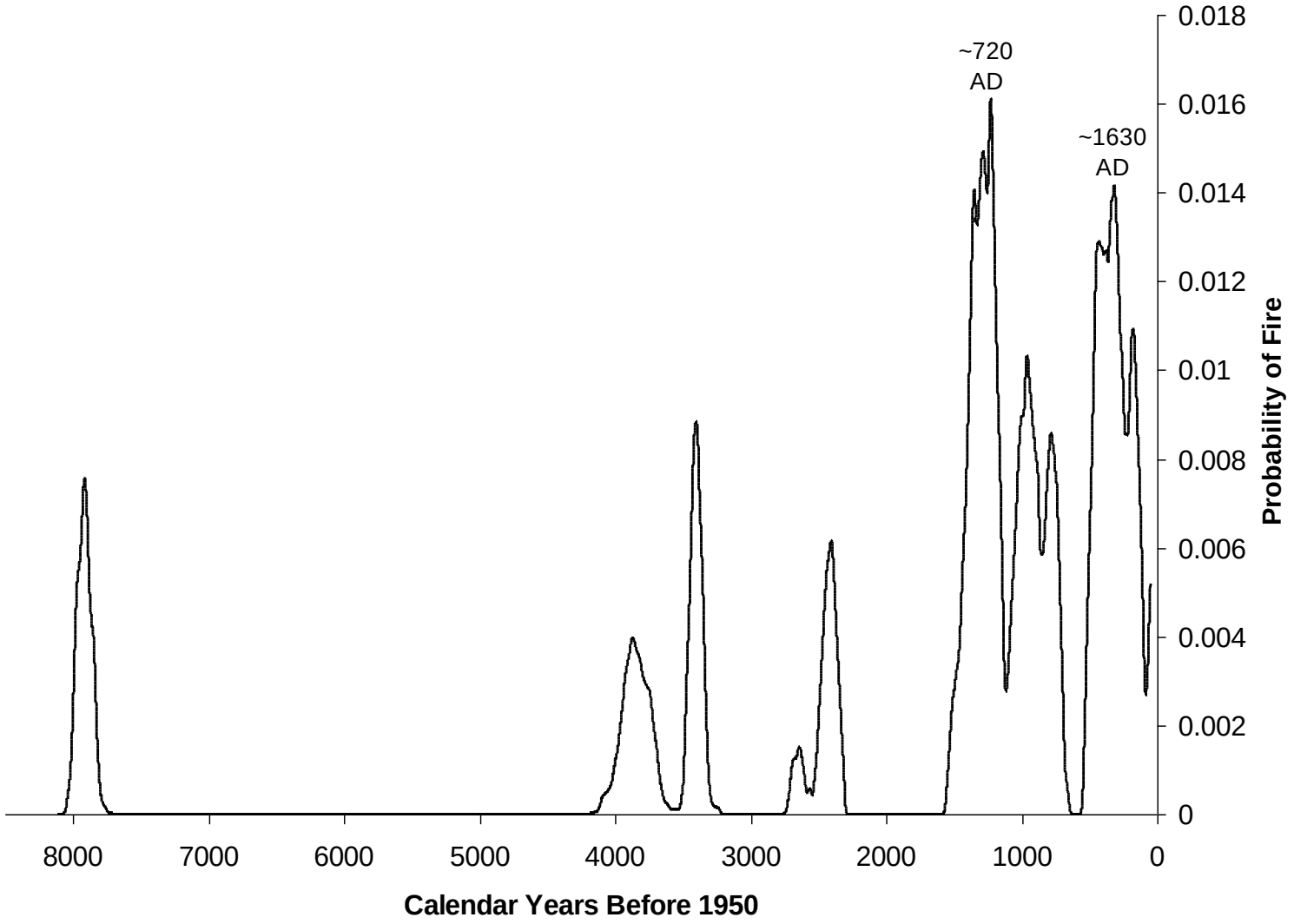
jenpierce@boisestate.edu 208-426-5380

Additional slides

Climate and Wildfire over the past ~10,000 years in Idaho

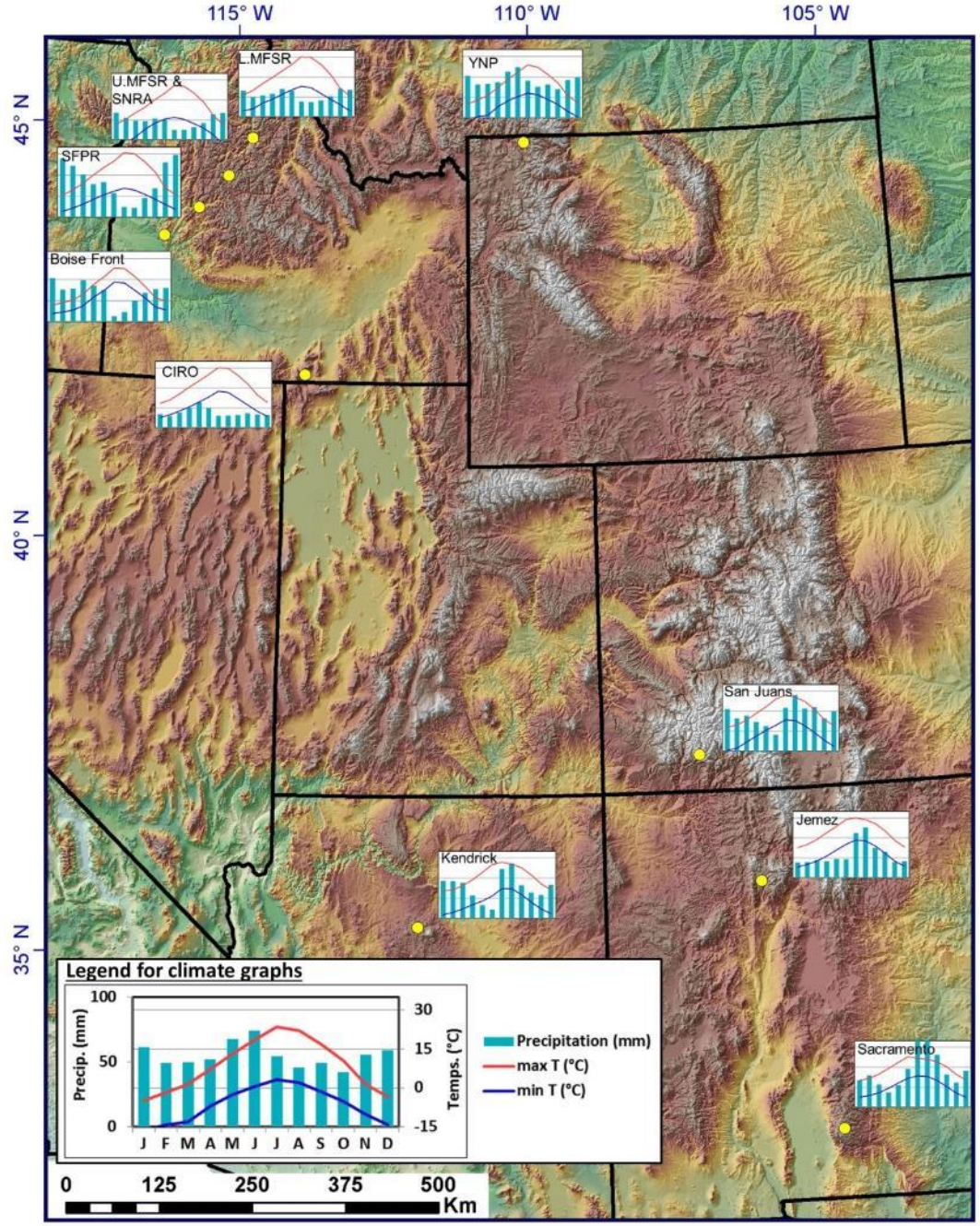

6440 ± 120
3730 ± 100
2780 ± 60
2240 ± 100
1790 ± 70
1560 ± 50
1120 ± 75
860 ± 75
450 ± 120
110 ± 150
Single sampled fire
Upper and Lower multi-basin fire
Upper multi-basin fire
Lower multi-basin fire
Lower basin fires (n=25)
Upper basin fires (n=24)
total MFSR fires (n=49)
Detrended MFSR total fire (n=49)
sample count
probability
cal. yr BP

Radiocarbon ages from the White Clouds



Burning Questions

- Are recent (~1985-2012) large fires really extraordinary?
- Are large fires fueled by prior fire suppression and land management?
- What is the role of climate in fire?
- How can past records of fire inform future management?
- Are we facing a future of type transition? (e.g. transition from forests to shrubland)



Yellowstone (Meyer et al., *GSA Bulletin*, 1995)

M.F. Salmon (Riley et al., *The Holocene*, 2015)

Sawtooths, (Svenson, Boise State MS Thesis 2010)

S.F. Payette (Meyer and Pierce, *Fire Ecology and Management*, 2003; Pierce et al., *Nature* 2004)

Boise Front (Poulos and Pierce, *in prep;* Nelson and Pierce, *The Holocene,* 2010)

City of Rocks (Weppner et al., *Quaternary Research*, 2013)

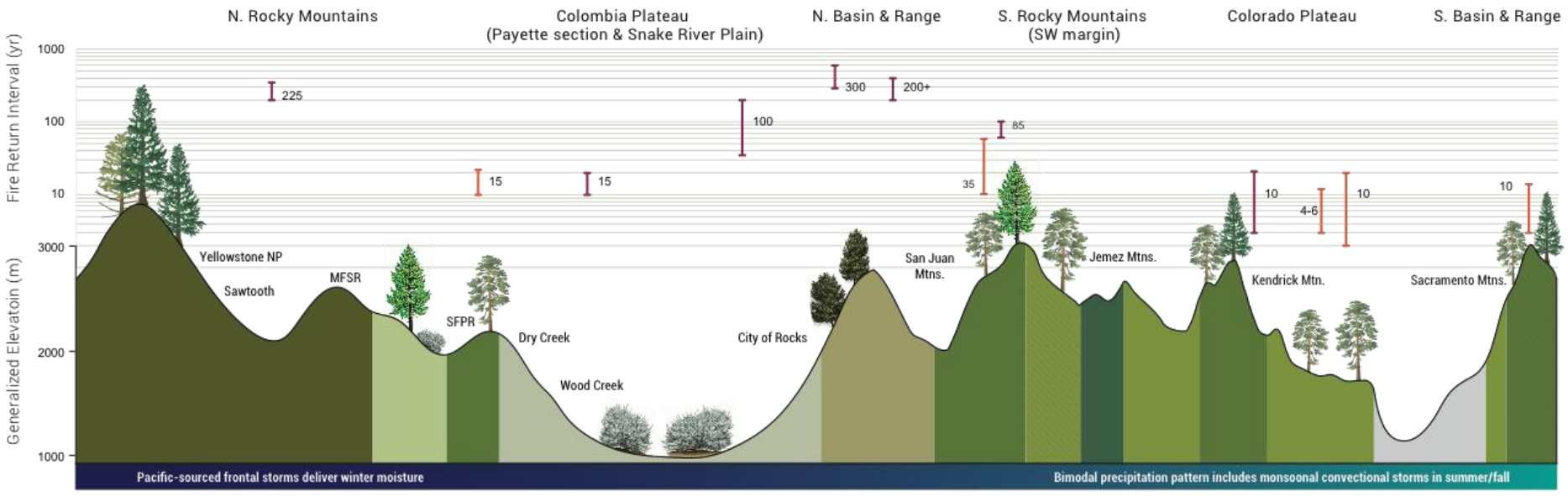
San Juans (Bigio et al., *The Holocene* 2010)

Jemez (Fitch and Meyer, *Quaternary Research* 2015)

Kendrick Mountains (Jenkins et al., *Int. Journal of Wildland Fire*, 2011)

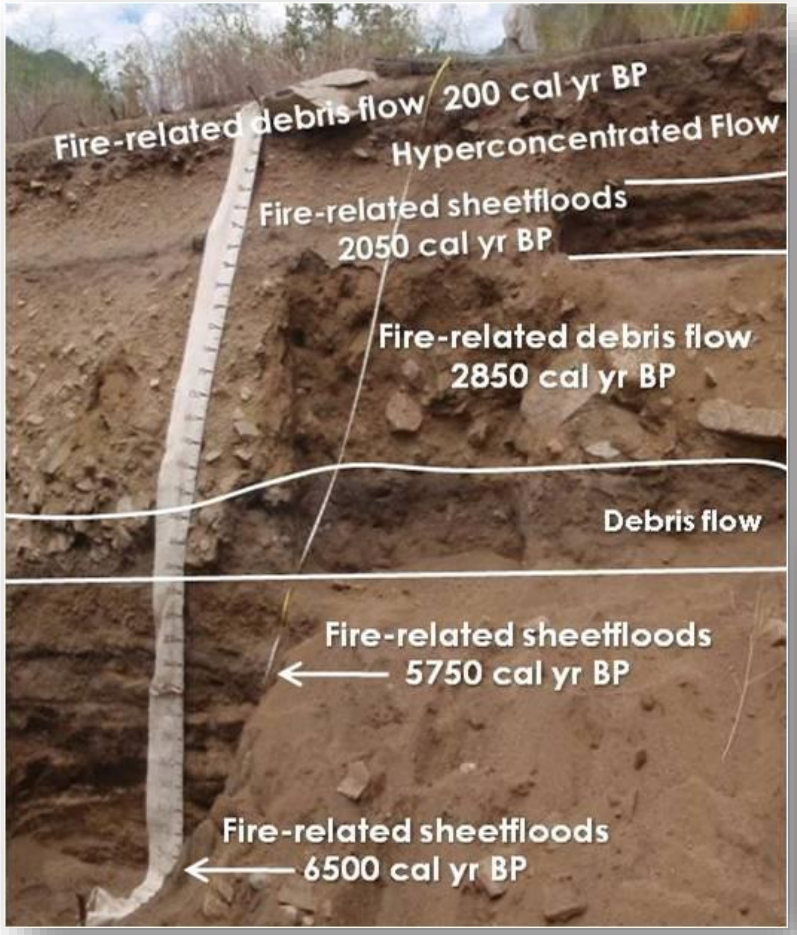
Sacramento Mountains Frechette and Meyer, *The Holocene* 2009

Study areas span an ecological spectrum: high elevation moist lodgepole pine and mixed conifer forests, mid-elevation ponderosa and Douglas fir forests, and pinon/juniper sage steppe



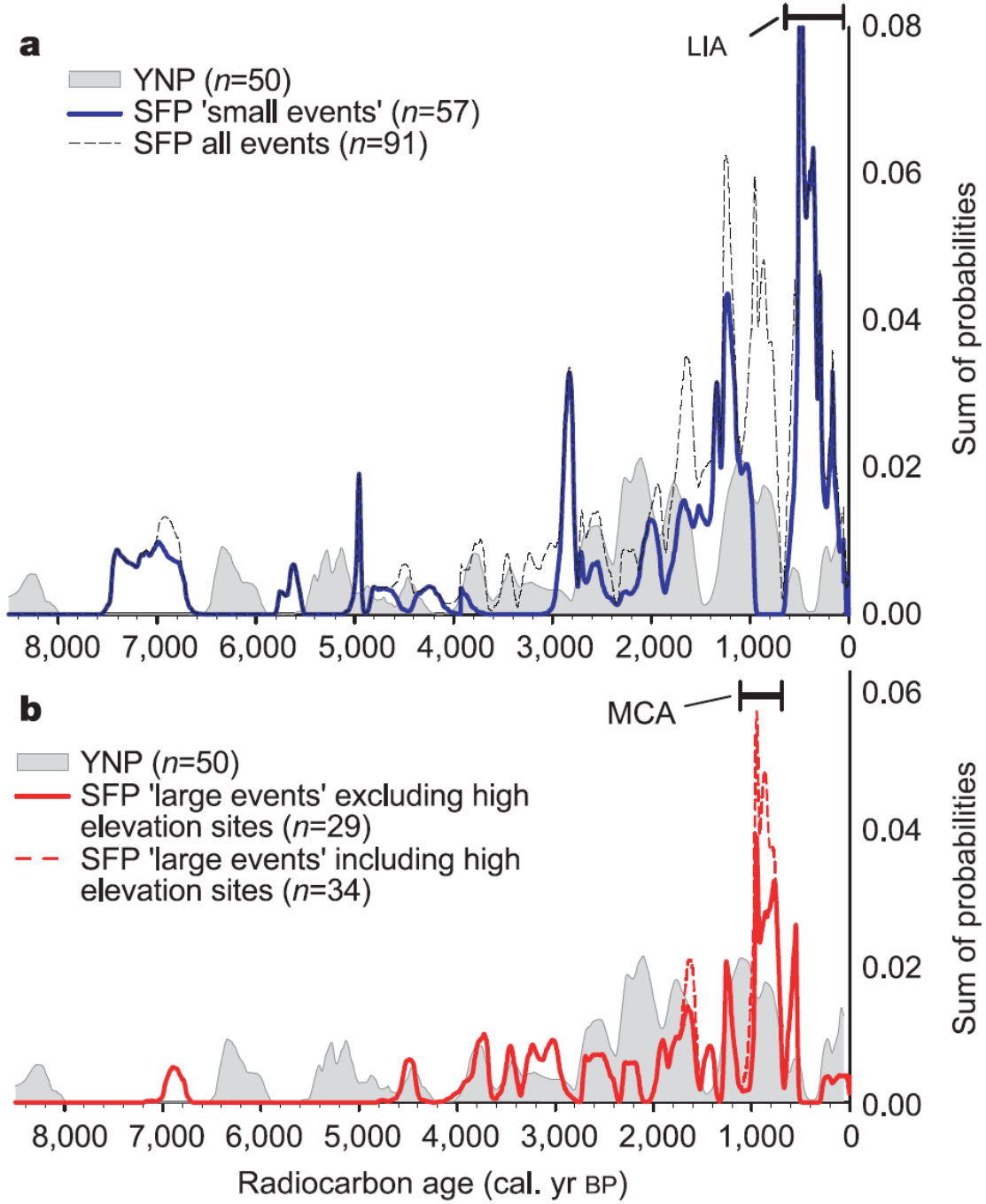
Pierce et al., in prep for *Quat. Sci. Reviews*

Methods: radiocarbon date charcoal from alluvial deposits and use characteristics of fire-related deposits to develop longer records of fire and fire-related sedimentation events. . .



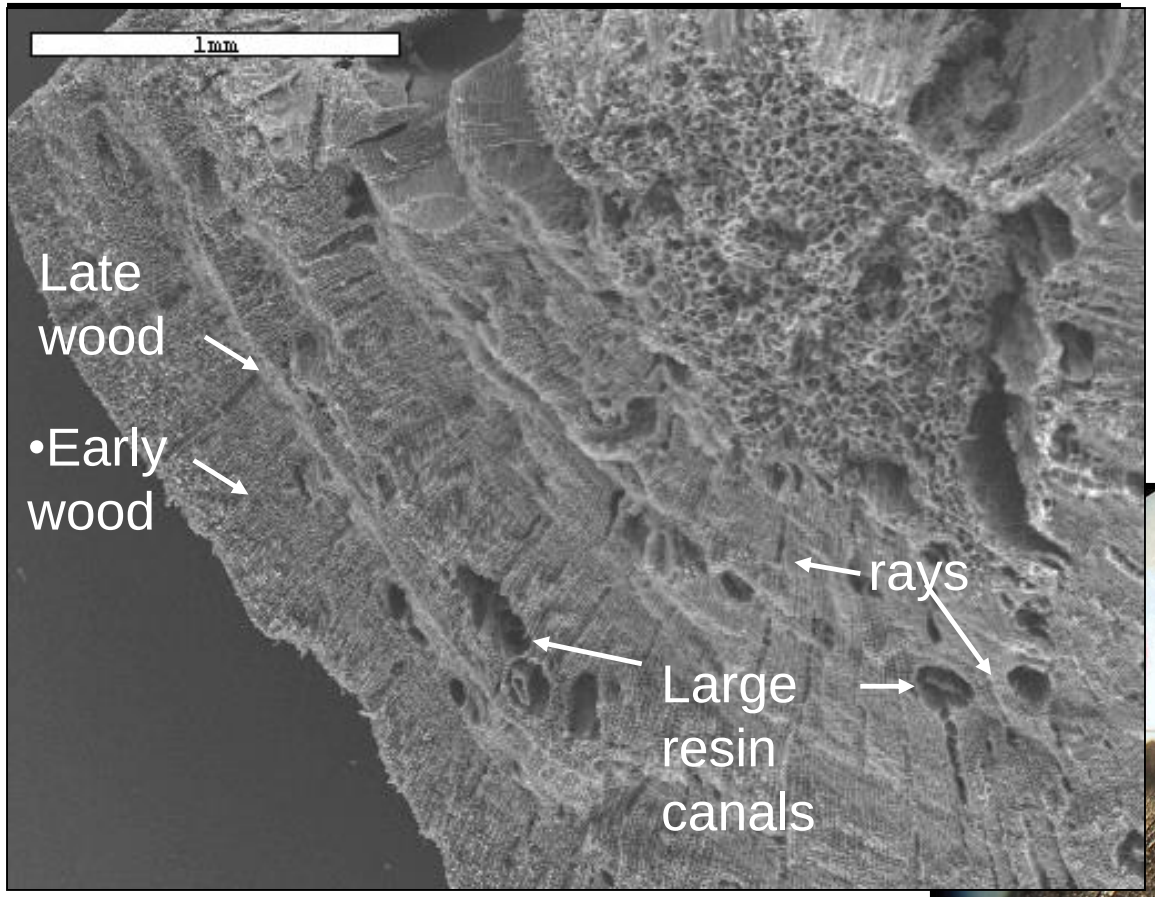
Results? Fires are bigger and more severe when it is warm and dry

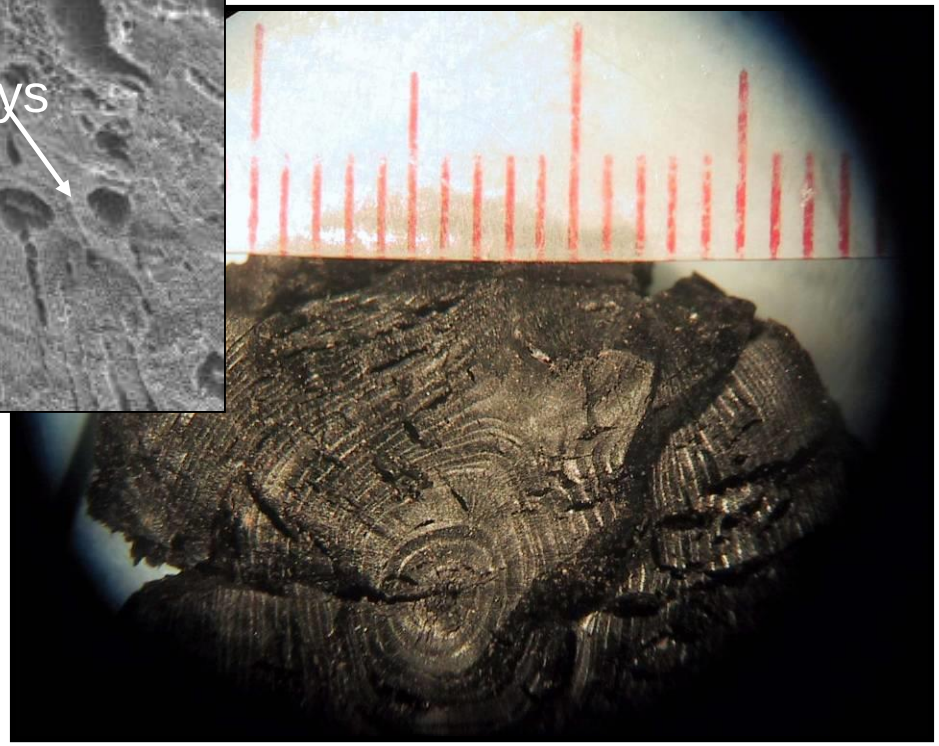
Photo credit: Greta Reybus, http://www.gretarybus.com/climate-change-in-idaho



Pierce, Jennifer L., Grant A. Meyer, and AJ Timothy Jull. "Fire-induced erosion and millennial-scale climate change in northern ponderosa pine forests." Nature 432.7013 (2004): 87.

Macrofossil Identification



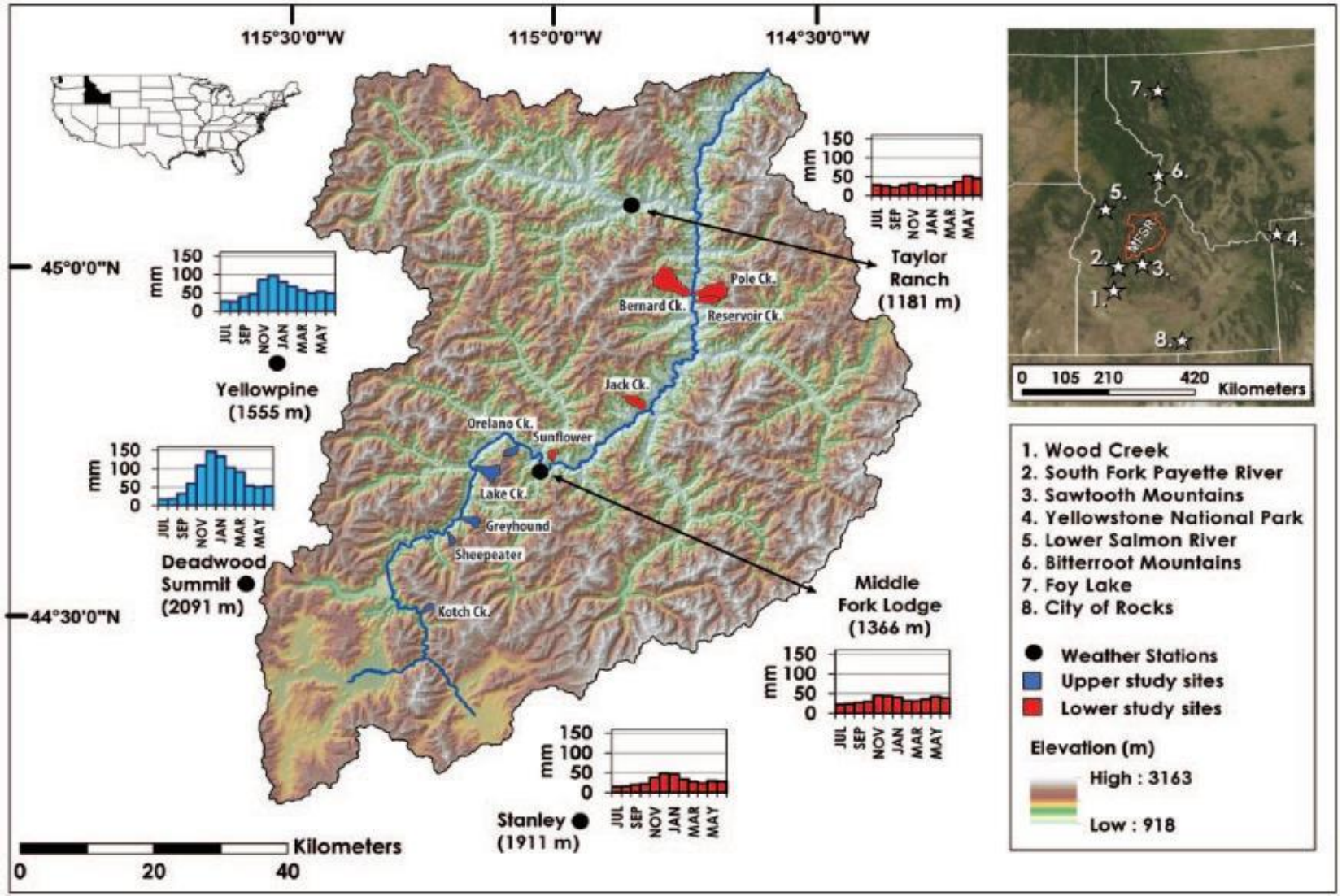


Variations in Conifer Distribution in the SF Payette Inferred from Charcoal Macrofossil Identification

Take home points: South Fork Payette

- Lower elevation ponderosa sites burn in frequent small fires when the climate is cool and wet (LIA); upper elevations (Yellowstone, upper sites) don’t record fires.
- BOTH areas burn in large fires when it is warm and dry (~1000 years ago during the Medieval Climate Anomaly)
- No fire suppression or management 1000 years ago=climate was primary control over large fires
- No records of ponderosa pine older than ~ 2,000 years ago.

Fire history in the Middle Fork Salmon



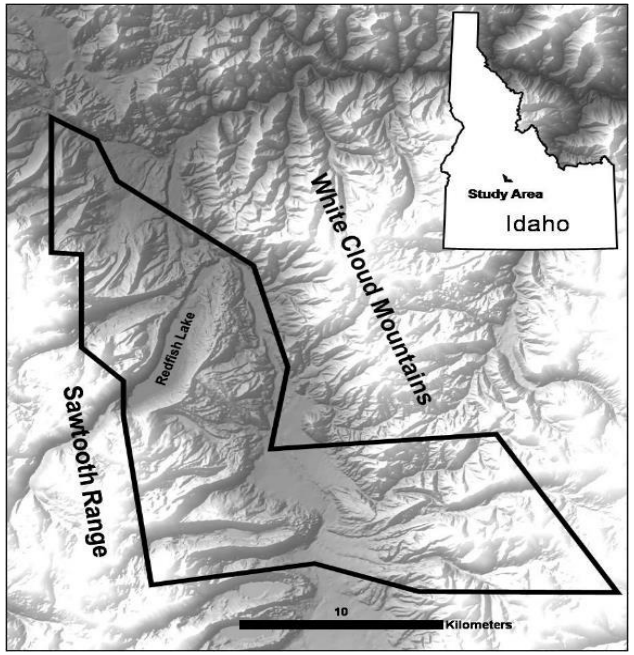
Riley, Kerry, Jennifer Pierce, and Grant A. Meyer. "Vegetative and climatic controls on Holocene wildfire and erosion recorded in alluvial fans of the Middle Fork Salmon River, Idaho." The Holocene 25.5 (2015): 857-871.

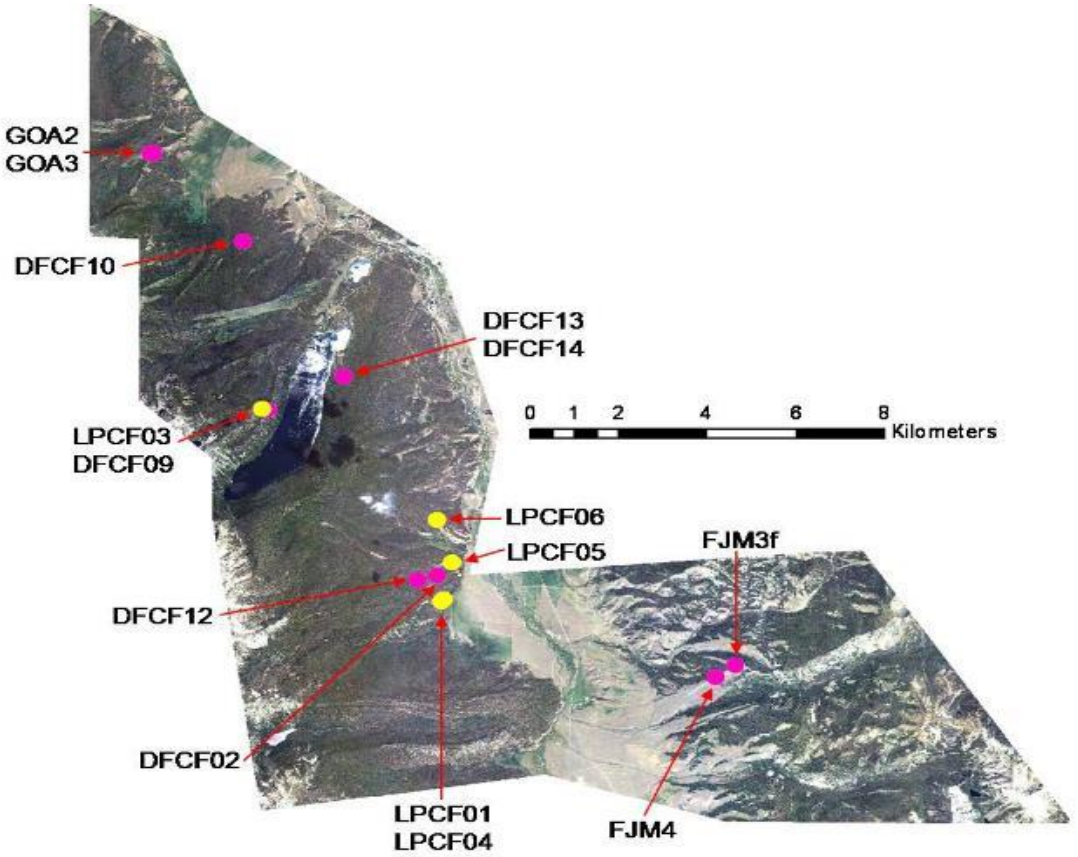
Middle Fork Salmon:

Have large wildfires occurred in the past or are recent increases in fire frequency, duration, and size an anomaly over Holocene (1000's of years) timescales?

- 14,000-8,000 years ago-infrequent severe fires. Wetter, cooler climate.
- 7,000-5,500 years ago-more frequent, likely less severe fires. Dry and stable climate
- 3,000 years ago: INCREASE in fire frequency severity and arrival of lodgepole pine. Cooler, wetter and variable climate
- 1985-today: Much warmer climate, large stand replacing fires

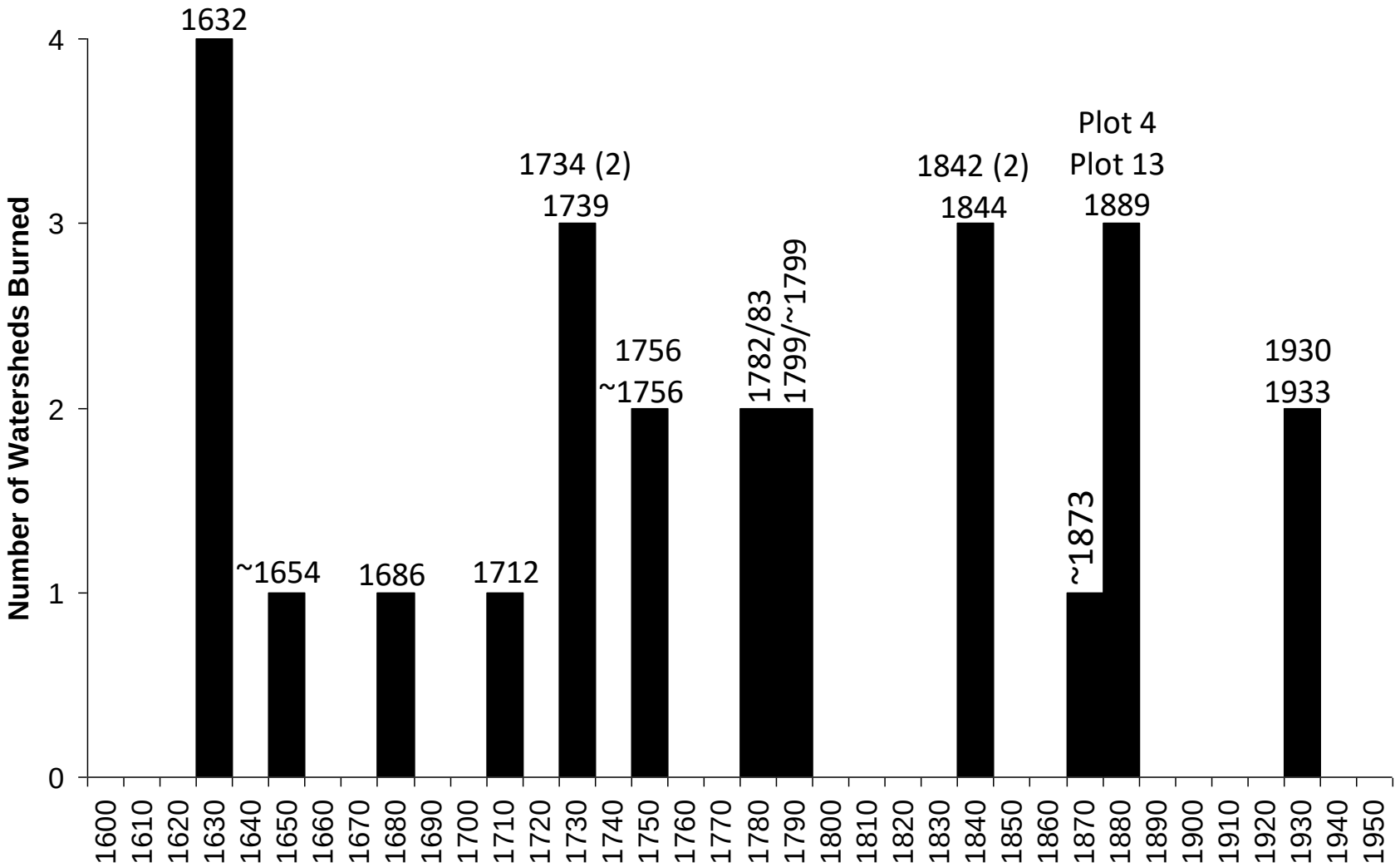
Sawtooth Fire History





Svenson, 2010, Fire and climate in a lodgepole pine forest of central Idaho: Annual, decadal, centennial, and millennial perspectives. MS Thesis, Boise State

Number of Watersheds burned 1600-1930: Sawtooth Mountains



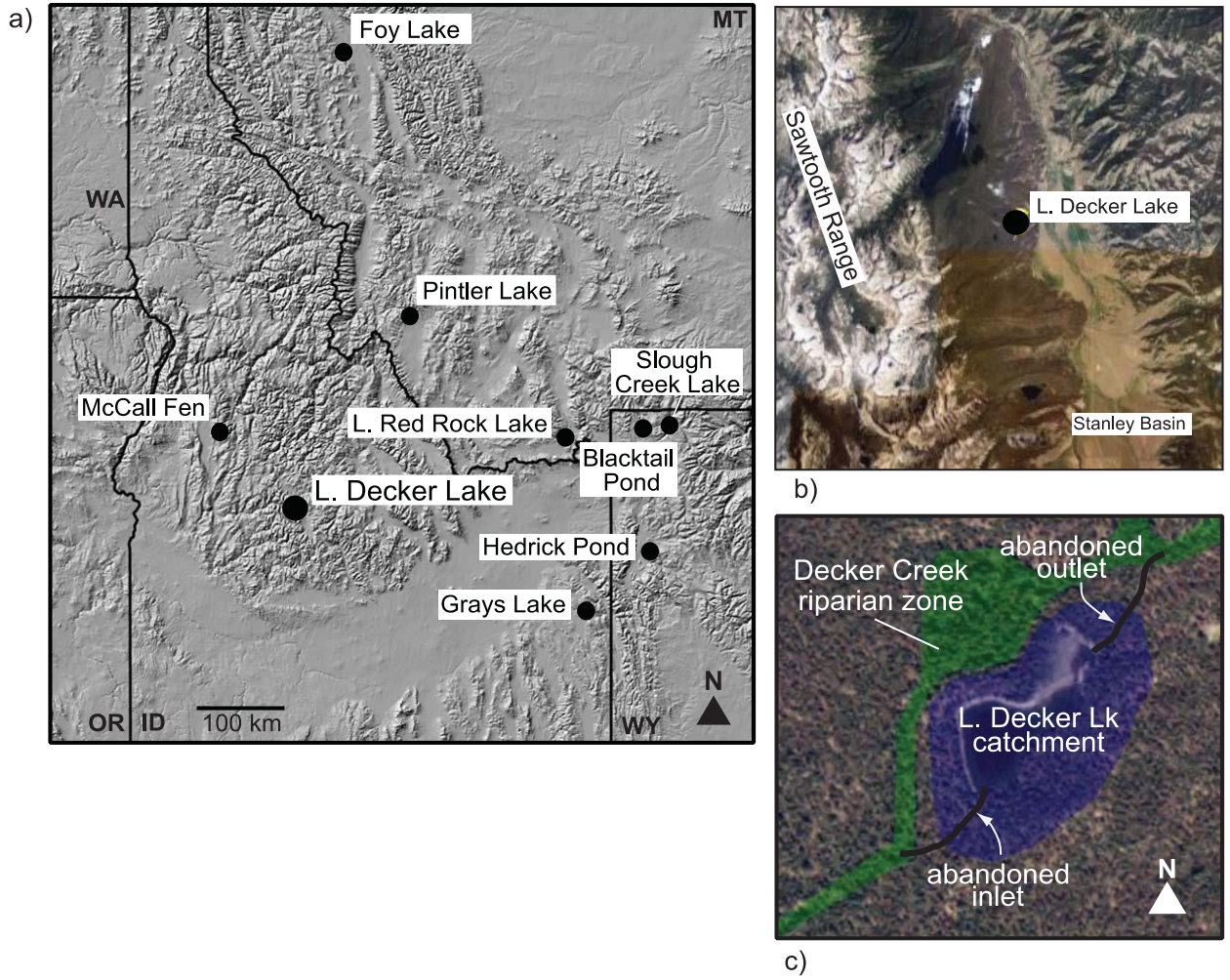
Sawtooths: take home points

- Fourteen annually resolved fires were reconstructed between 1632 and 1933 AD from fire-scarred Douglas-fir and lodgepole pine.
- Lodgepole-pine stand-ages indicate that at least five fires in the ~25,000 ha study area were stand-replacing.
- Multi-watershed stand-replacing fires burned in 1632 and 1842, and single-watershed stand-replacing fires burned in 1739, 1783, and 1933.
- Charcoal samples were collected from nine soil sites and two incised alluvial sites. Summed probabilities from radiocarbon dates show peaks in ~720 AD and ~1630 AD.

Sawtooths: what climate conditions correlate with past fires?

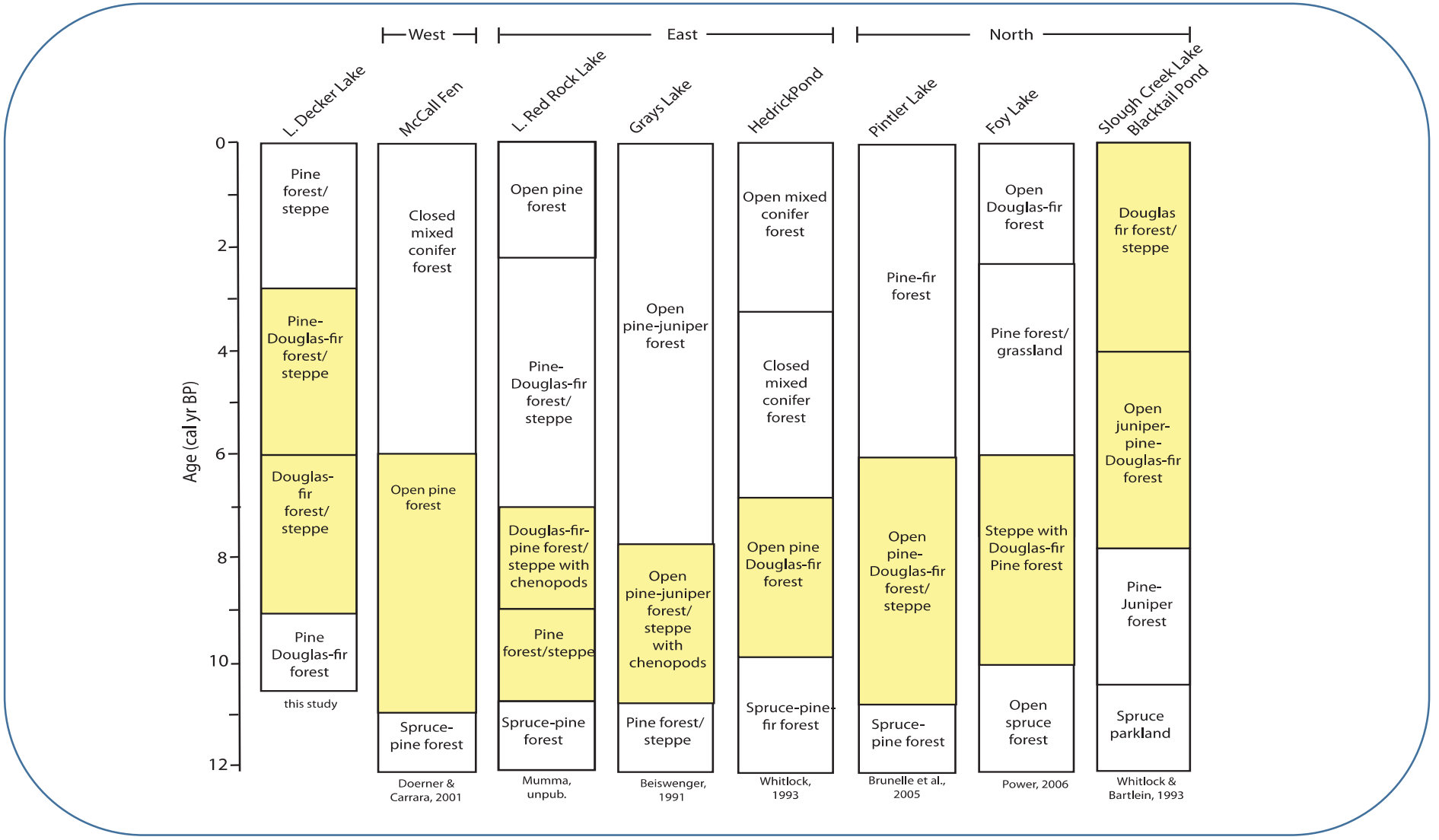
- Comparison of fire dates with reconstructed drought (PDSI) and July temperature indicates that most fires burned during years that were significantly warm and dry.
- Drought-induced fires (PDSI < -1) were preceded the year before by significantly positive (exceeding the 95% confidence level) spring Pacific Decadal Oscillation (PDO).
- The multi-watershed SR fires of 1632, the most extensive (at least 4 watersheds) reconstructed in this study, were preceded by the longest protracted La Niña event (11 years) reconstructed for the past 484 years.

Long-term changes in vegetation



Whitlock C, Briles CE, Fernandez MC, Gage J. 2010. Holocene vegetation, fire and climate history of the Sawtooth Range, central Idaho, USA. *Quaternary Research* 75, 114-124

Long-term changes in vegetation



Whitlock C, Briles CE, Fernandez MC, Gage J. 2010. Holocene vegetation, fire and climate history of the Sawtooth Range, central Idaho, USA. *Quaternary Research* 75, 114-124

Take home points: vegetation

- Lodgepole pine is a relative newcomer to the Sawtooth Valley (arrived ~2,500 years ago).
- Pine is a relative newcomer to many sites in the Northern Rockies.