

# Climate Change in the PNW: What's happening, what's going to happen, and what to do about it

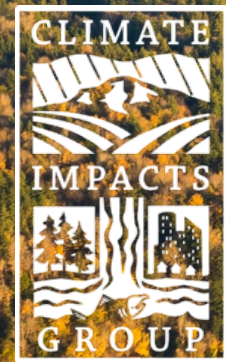
**W**  
CLIMATE IMPACTS GROUP  
UNIVERSITY of WASHINGTON  
College of the Environment

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Deputy Director  
Climate Impacts Group  
University of Washington

The Mountaineers Leadership Conference

December 7, 2019



Let's talk about climate change!



# 1. Introductions

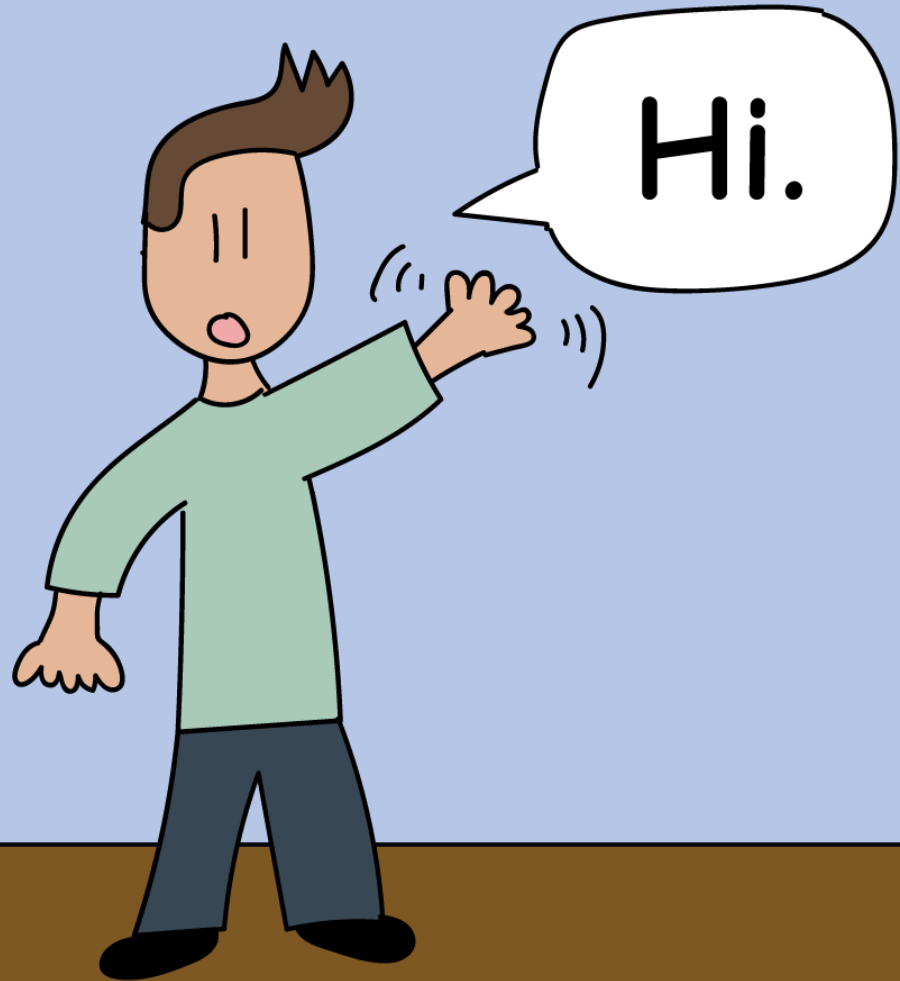
**Who are you?  
Who am I?**



1. Your Passion?

2. Why CC?

3. Last CC  
Conversation?



# Who is this guy? And why is he here?





**Honeymoon backpacking trip in Wrangell-St. Elias National Park, Alaska**

*Photo: Jason Vogel*



**AT skiing to overnight at a 10<sup>th</sup> Mt. Division Hut in CO**

*Photo: Jason Vogel*



**Bike packrafting on the Green River above Canyonlands National Park**

*Photo: Richard Hackett*





**BOULDER  
MOUNTAINBIKE  
ALLIANCE**



**INDIAN PEAKS  
TRAVERSE**



# Environmentalism, conservation, and recreation are intrinsically linked



*Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only things that ever has.*

*- Margaret Mead*



# 2. What's happening?

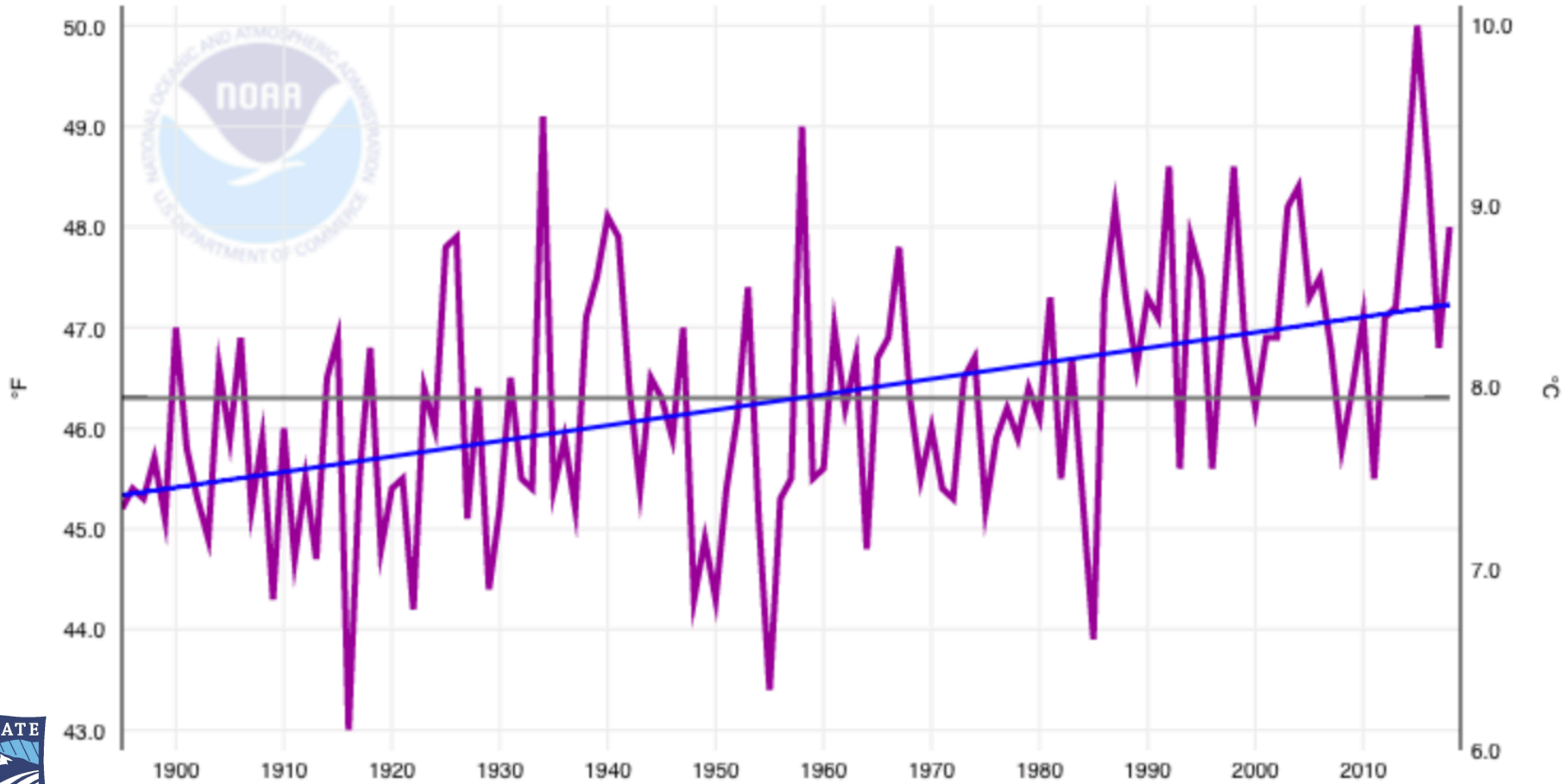
Observed changes in the PNW climate



# Temperatures in Washington have warmed

## Washington, Average Temperature, January-December

Avg Temperature      1895-2018 Mean: 46.3°F      1895-2018 Trend +0.2°F/Decade



Source: <https://www.ncdc.noaa.gov/cag/>

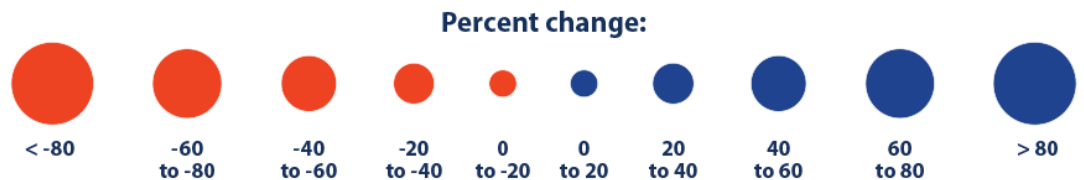
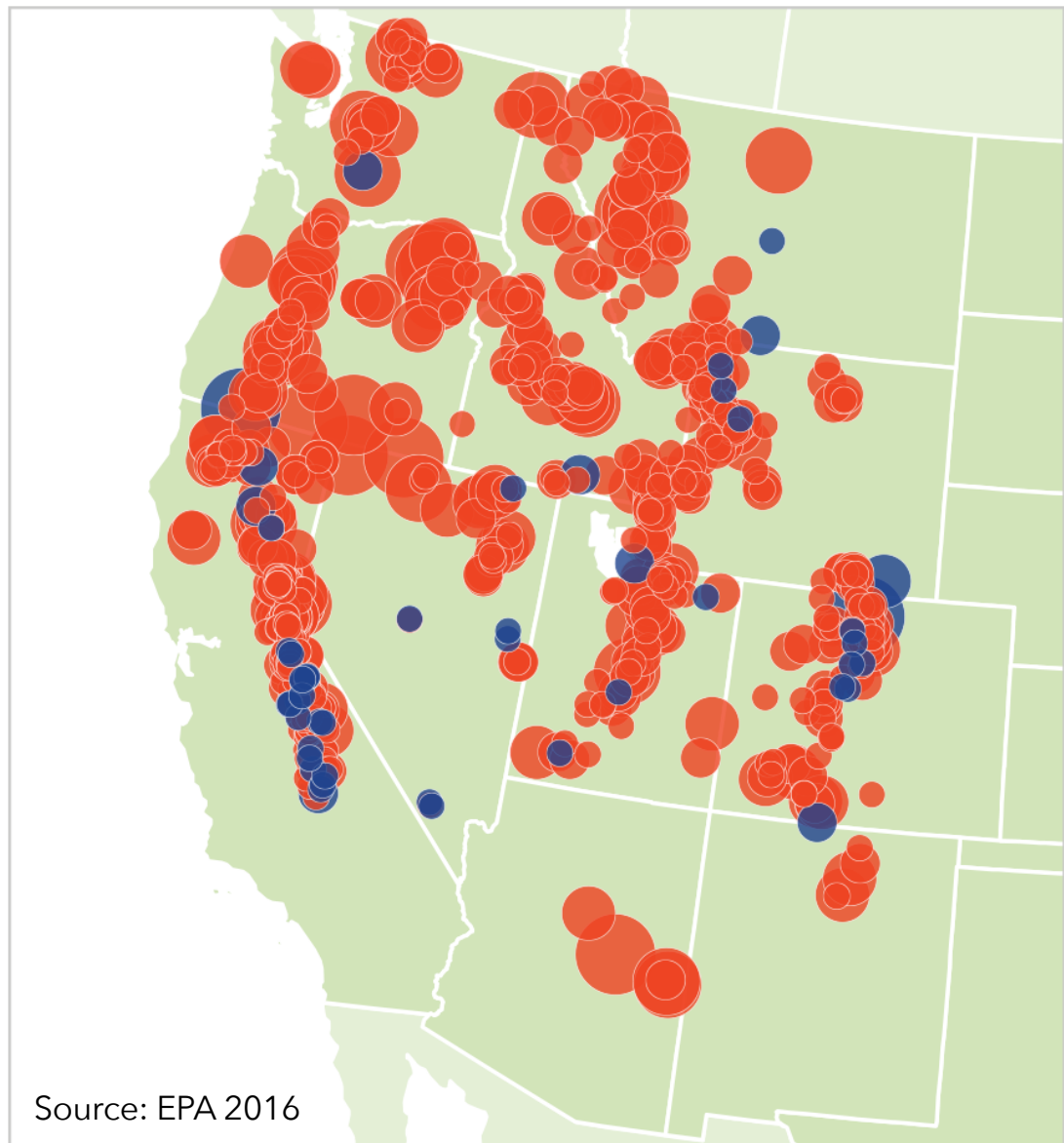
# The frost-free season has lengthened by 16 days across the Northwest

1991-2012 relative to 1901-1960



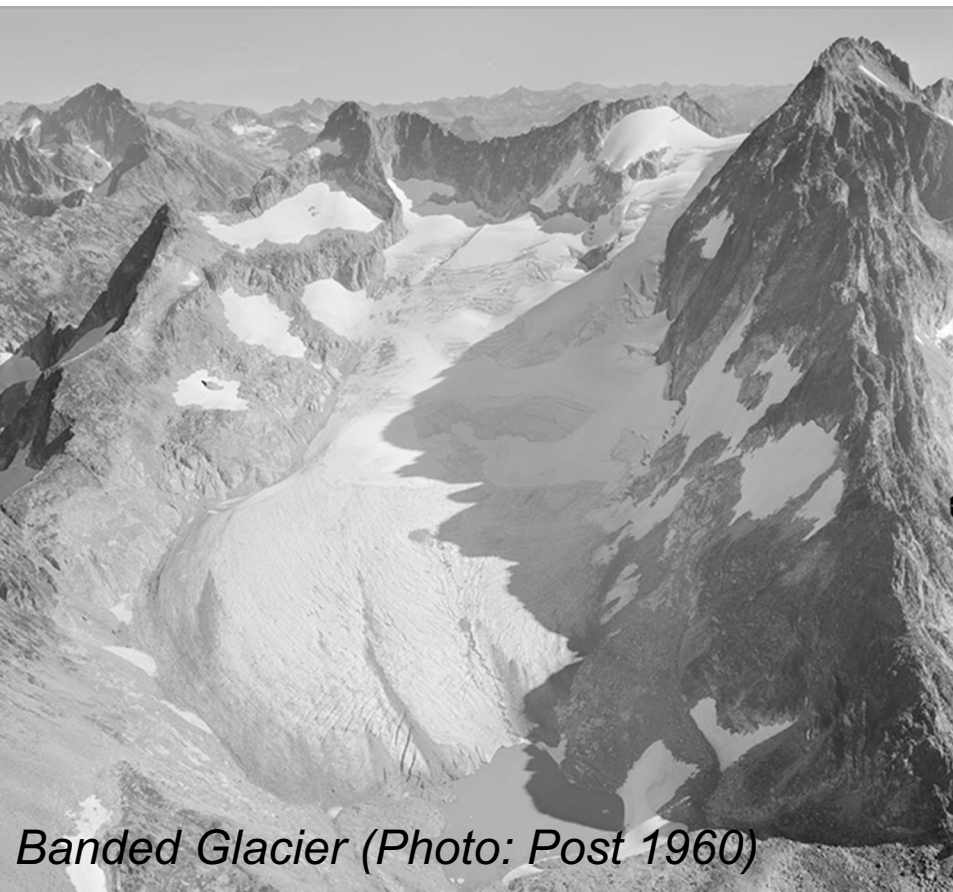
# Spring snowpack has declined

Trends in April 1 SWE  
1955-2016



# Most Northwest glaciers are in decline

- North Cascades (1900-2009): -56%
  - Olympic Mountains (1980-2009): -34%
  - Mt. Rainier (1913-1994): -27%
  - Mount Adams (1904-2006): -49%
- Source: Mauger et al. 2015





# Number of large fires and area burned in the NW increased from 1973 to 2012

Source: Abatzoglou and Williams 2016

October 15, 2018



August 20, 2018



Photo: Brad Kramer

# Human-generated CO<sub>2</sub> is increasing ocean acidification in Northwest surface waters



Source: Feely et al. 2016

Photo: Richard Vevers, The Ocean Agency



Sea level increased 8.6 inches at  
the Seattle tide gauge (1900-2008)

Alki Beach, West Seattle, January 21, 2010

Photo: Hugh Shipman

Source: Washington Dept of Ecology





# What changes have you noticed?



# 3. What's going to happen?

Projections for a future climate in the PNW



# Average Annual PNW Temperature (relative to 1950-1999)

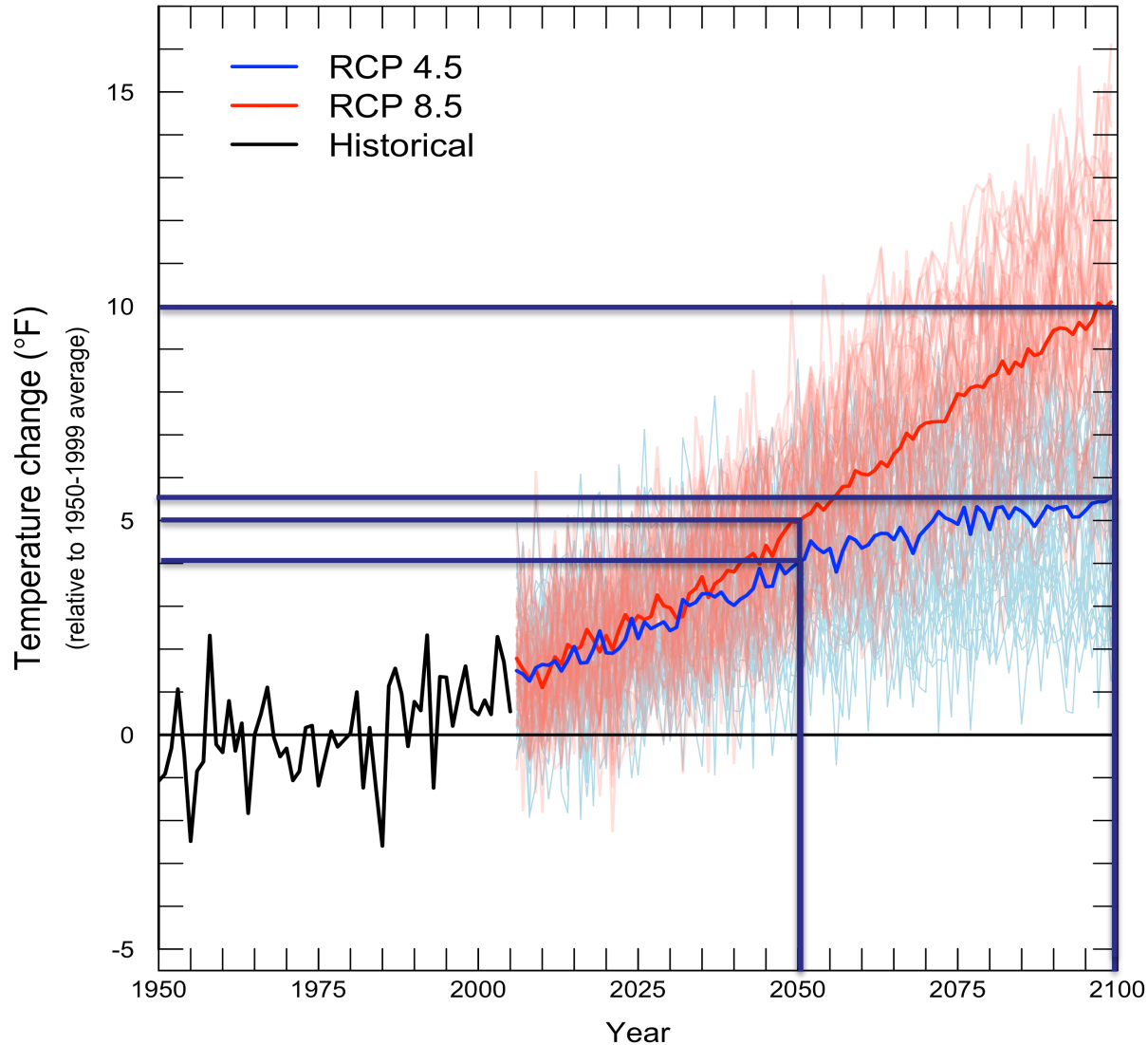


Figure source: Climate Impacts Group, based on projections used in IPCC 2013; 2050 projections from Mote et al. 2013

# Continued variability in NW precipitation

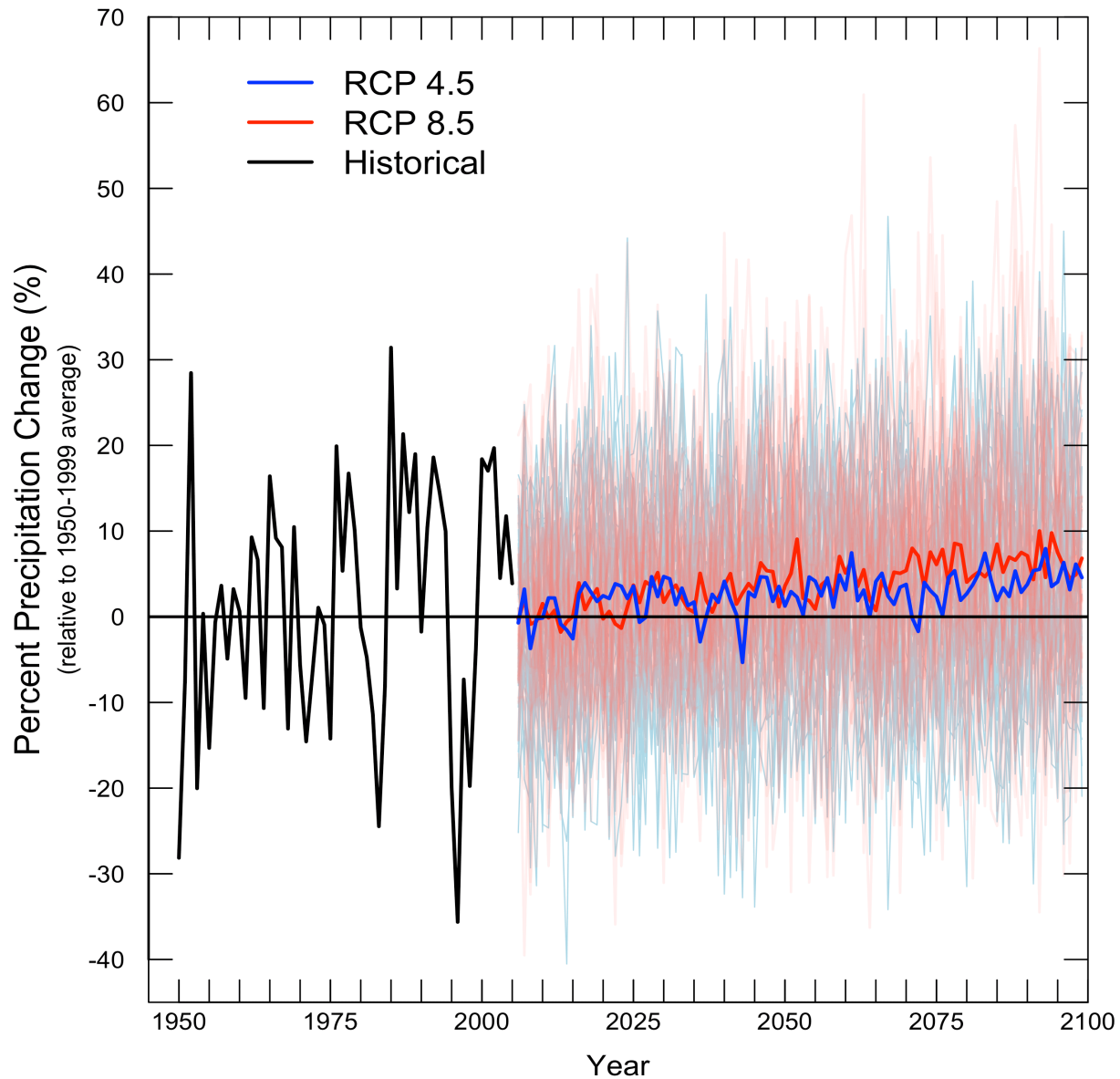


Figure source: Climate Impacts Group, based on projections used in IPCC 2013



# Projected climate changes in the NW



## Continued warming

+2-9 deg F by the 2050s



## Increasing heavy rainfall

Heaviest rain events +19% more intense by the 2080s



## Higher sea level

+4-56" by 2100, depending on location

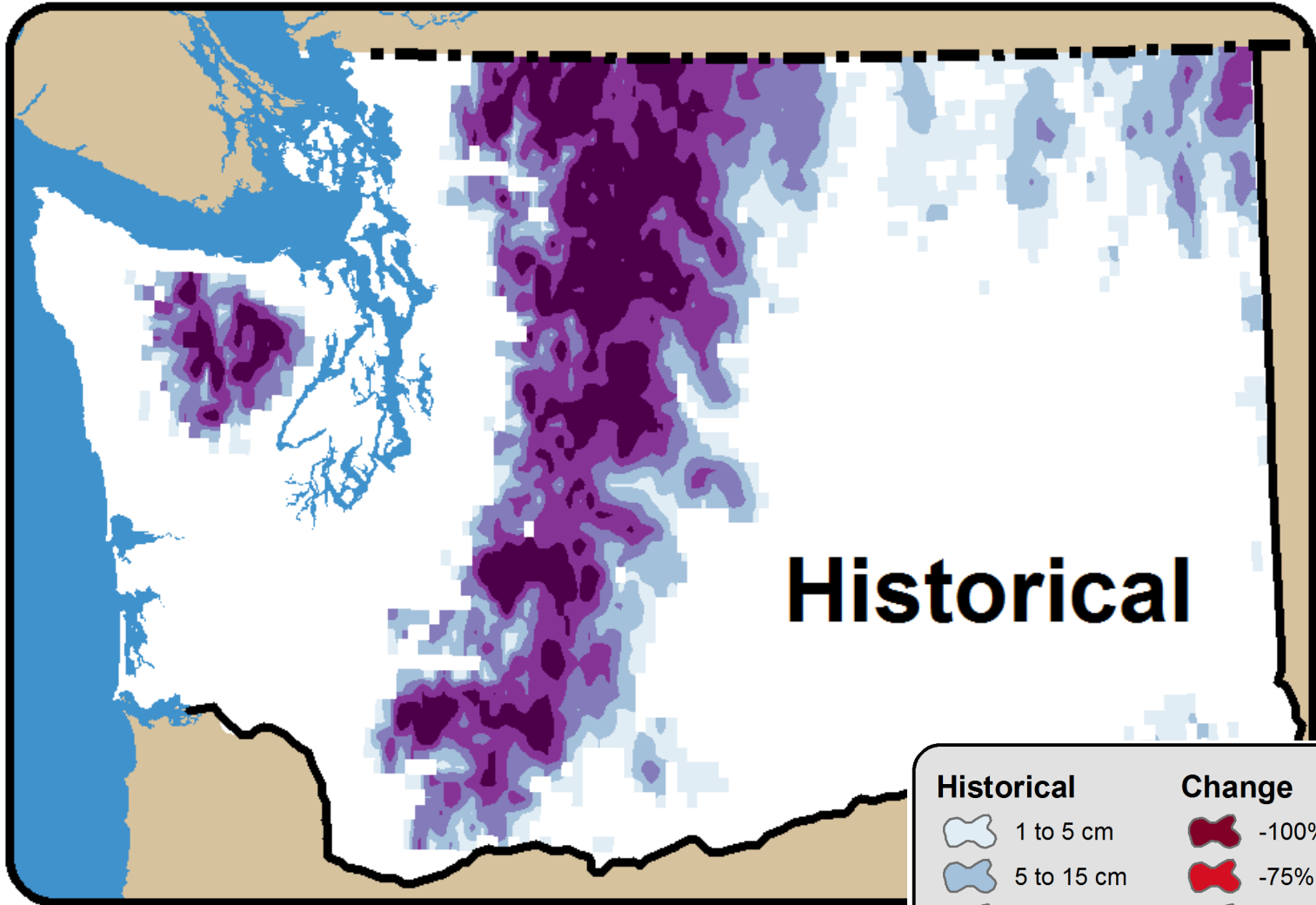


## Increasing ocean acidity

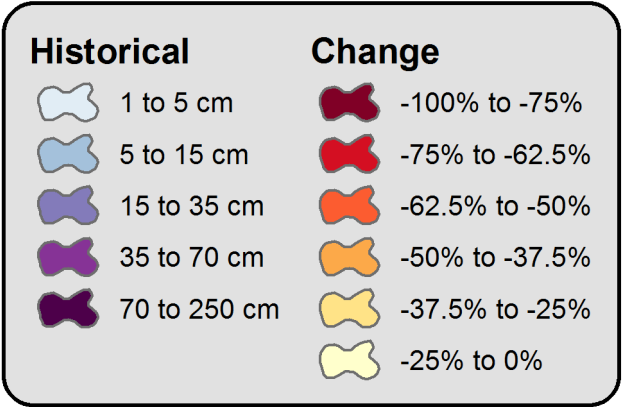
Ocean acidity is projected to increase 100-150% percent by 2100



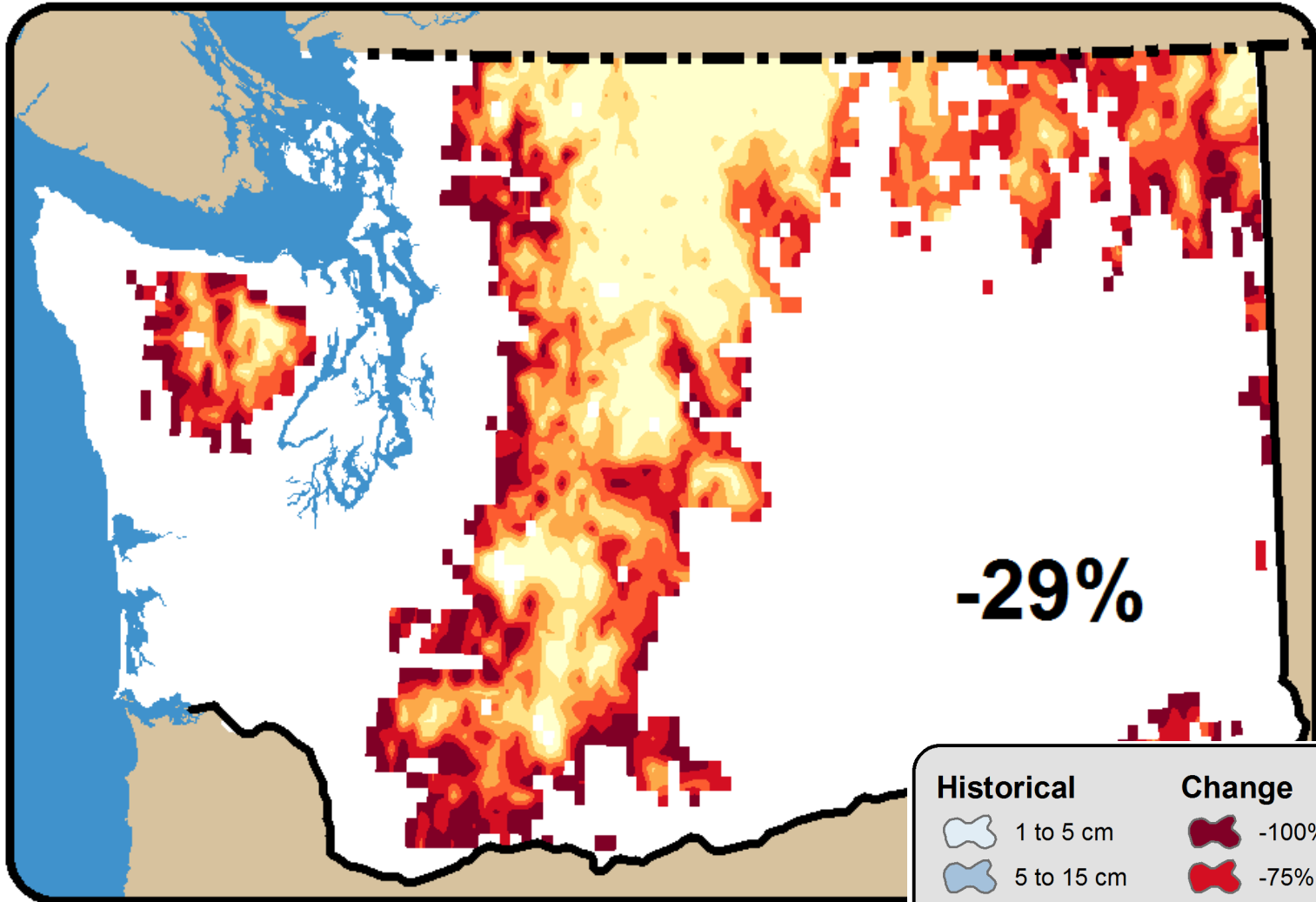
## Ongoing natural variability



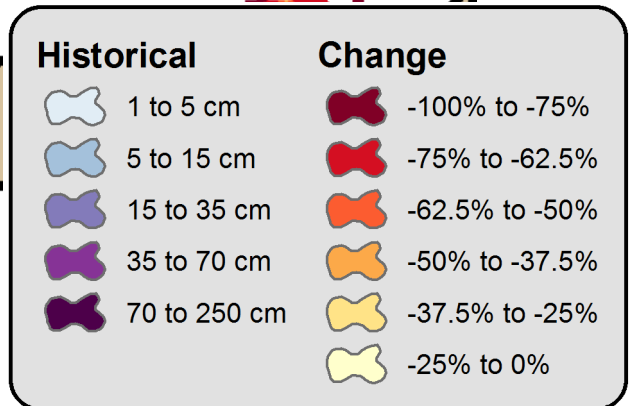
April 1 Snow Water Equivalent



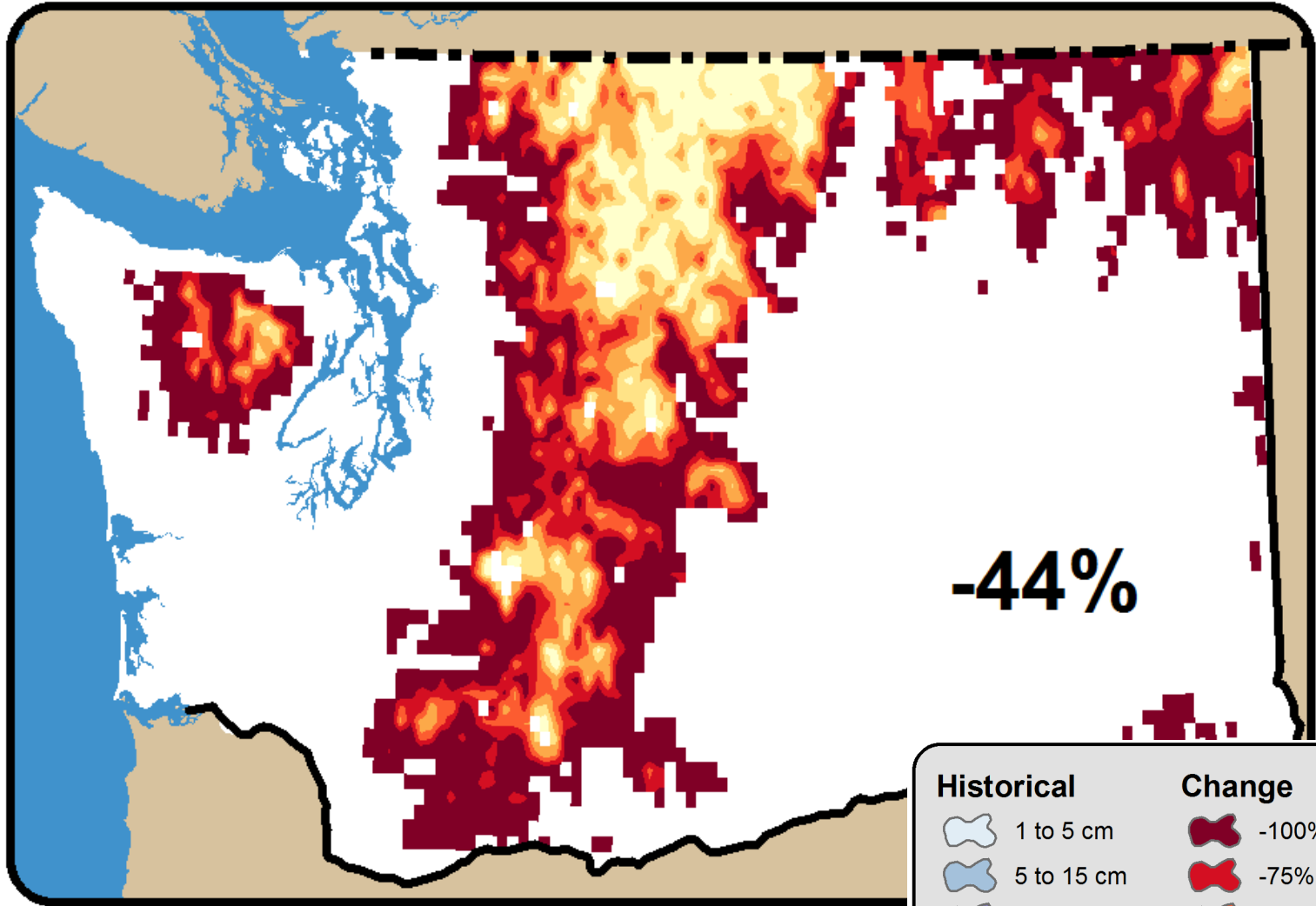
# 2020s



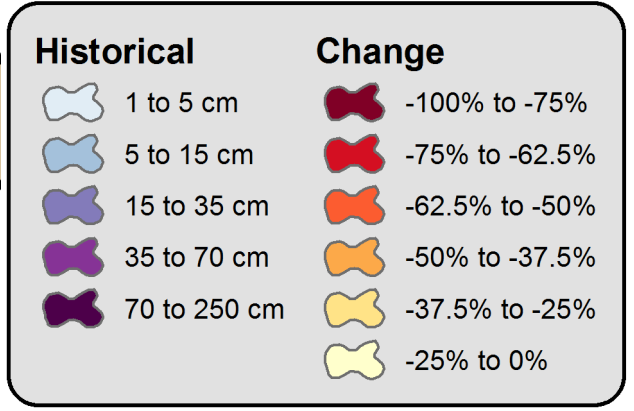
April 1 Snow Water Equivalent



# 2040s



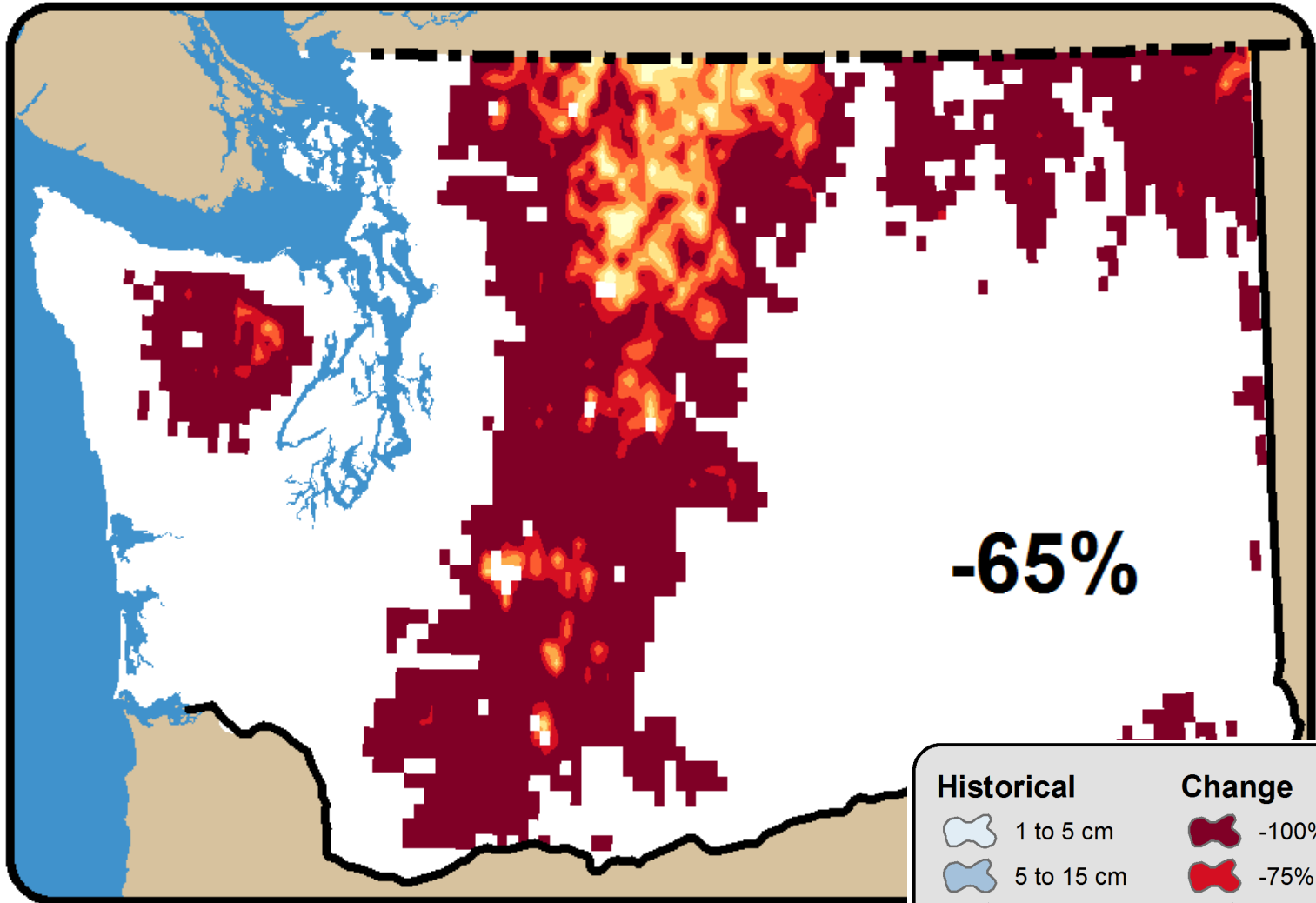
**-44%**



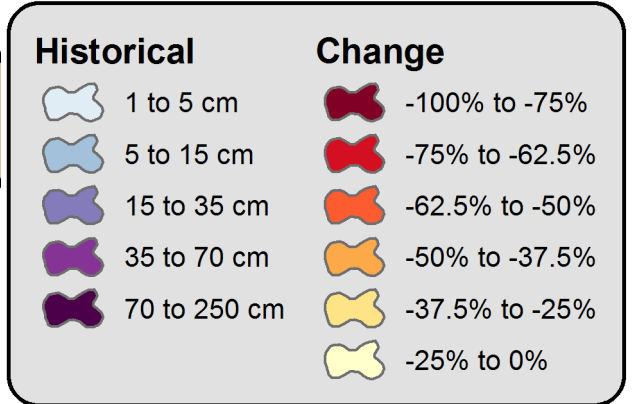
April 1 Snow Water Equivalent



# 2080s

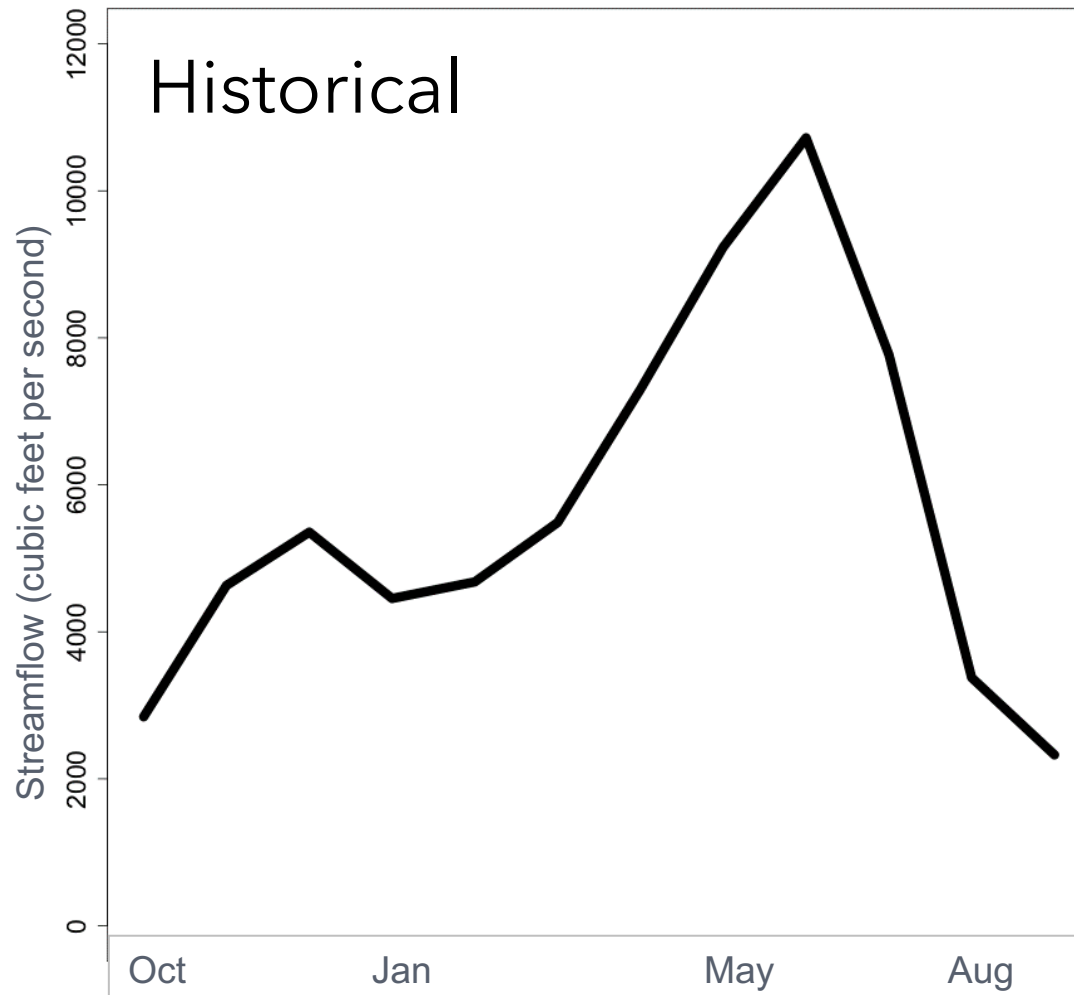


April 1 Snow Water Equivalent



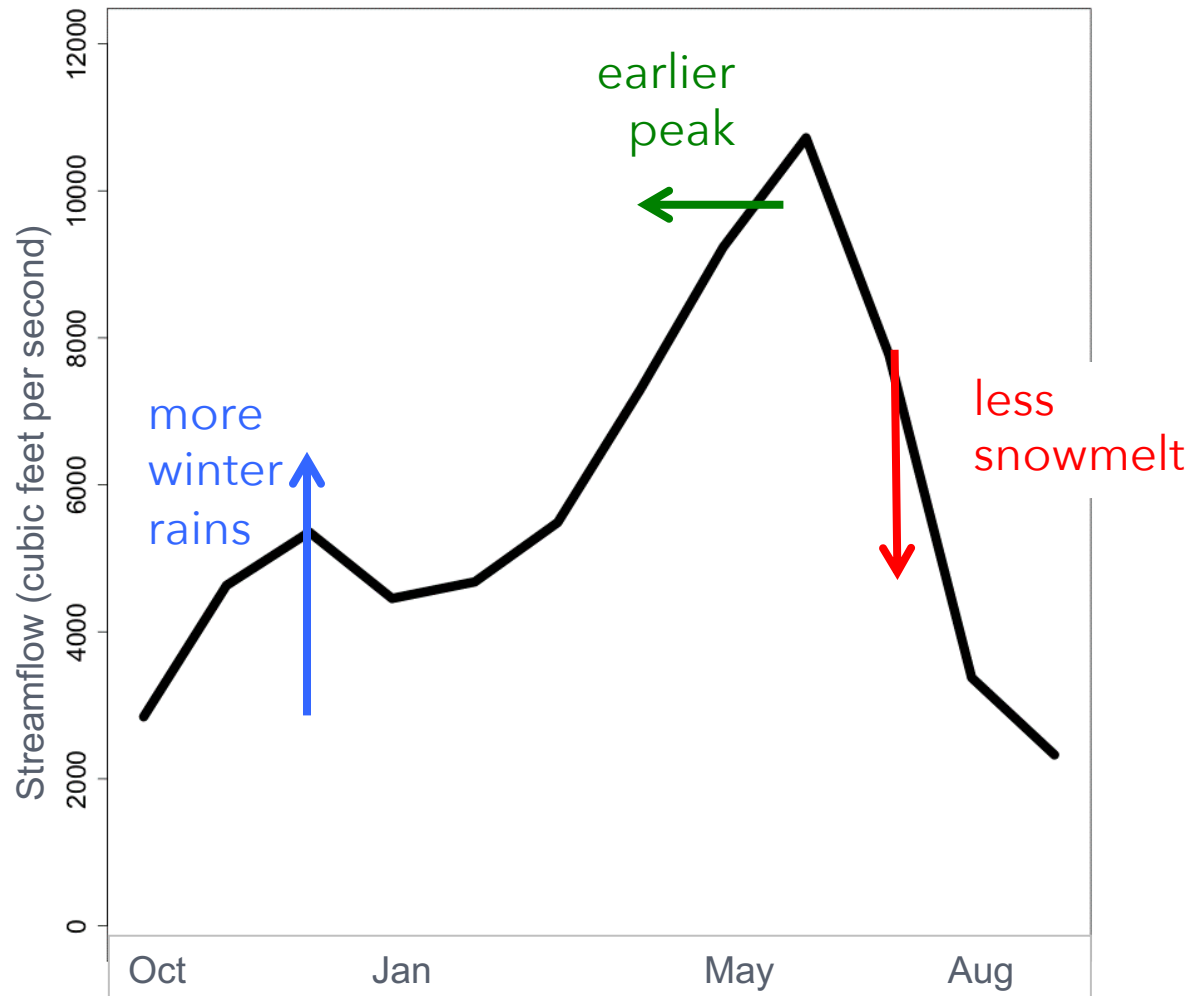


# Mid-elevation streams flow when it rains and when the snow melts



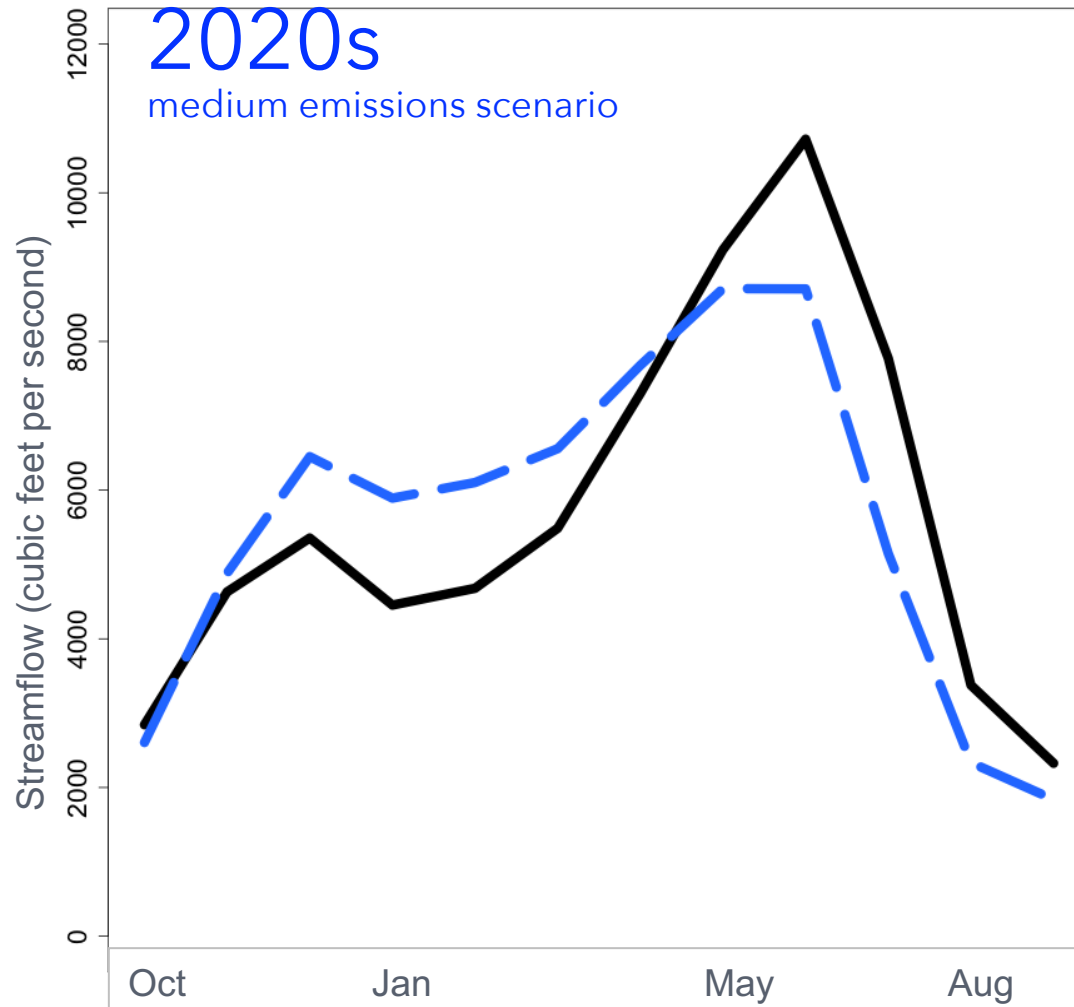


# Warming shifts streamflows



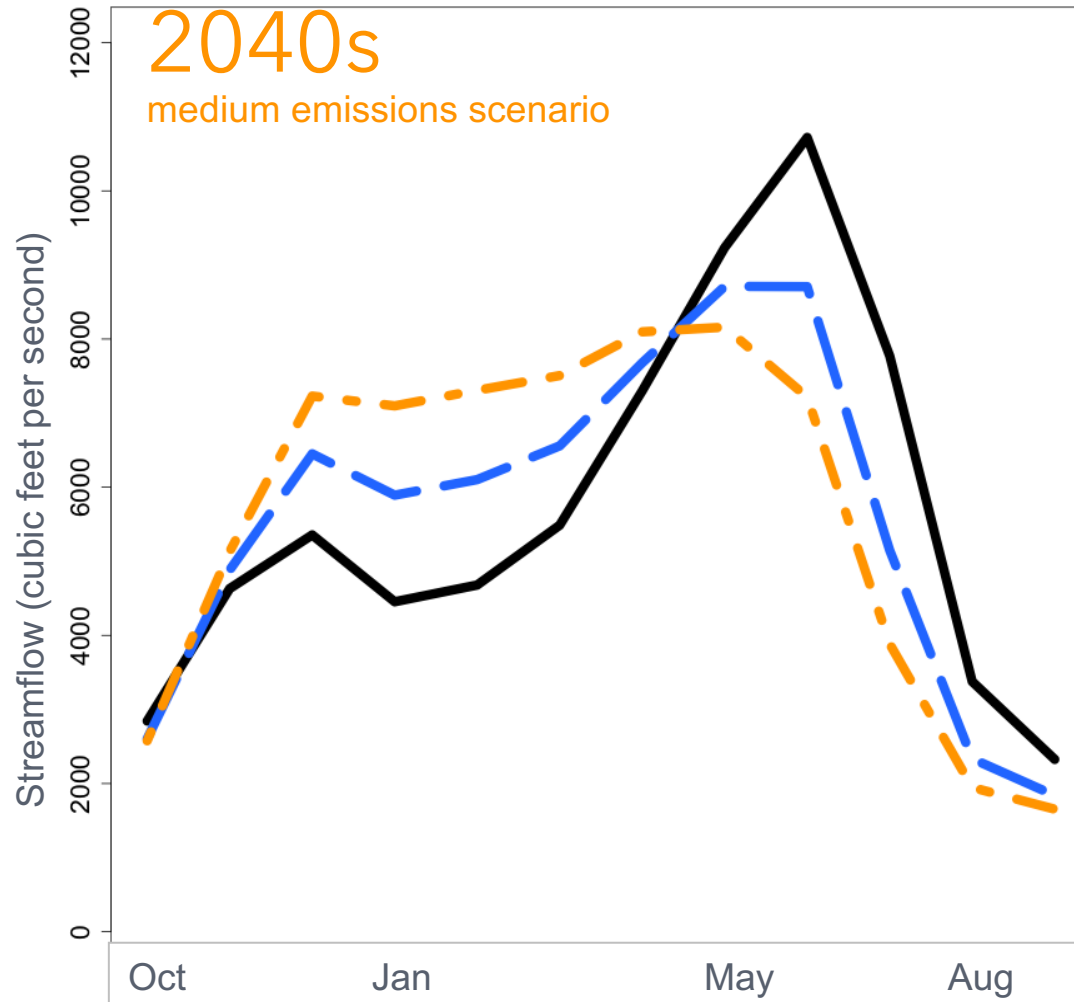


# Warming shifts streamflows



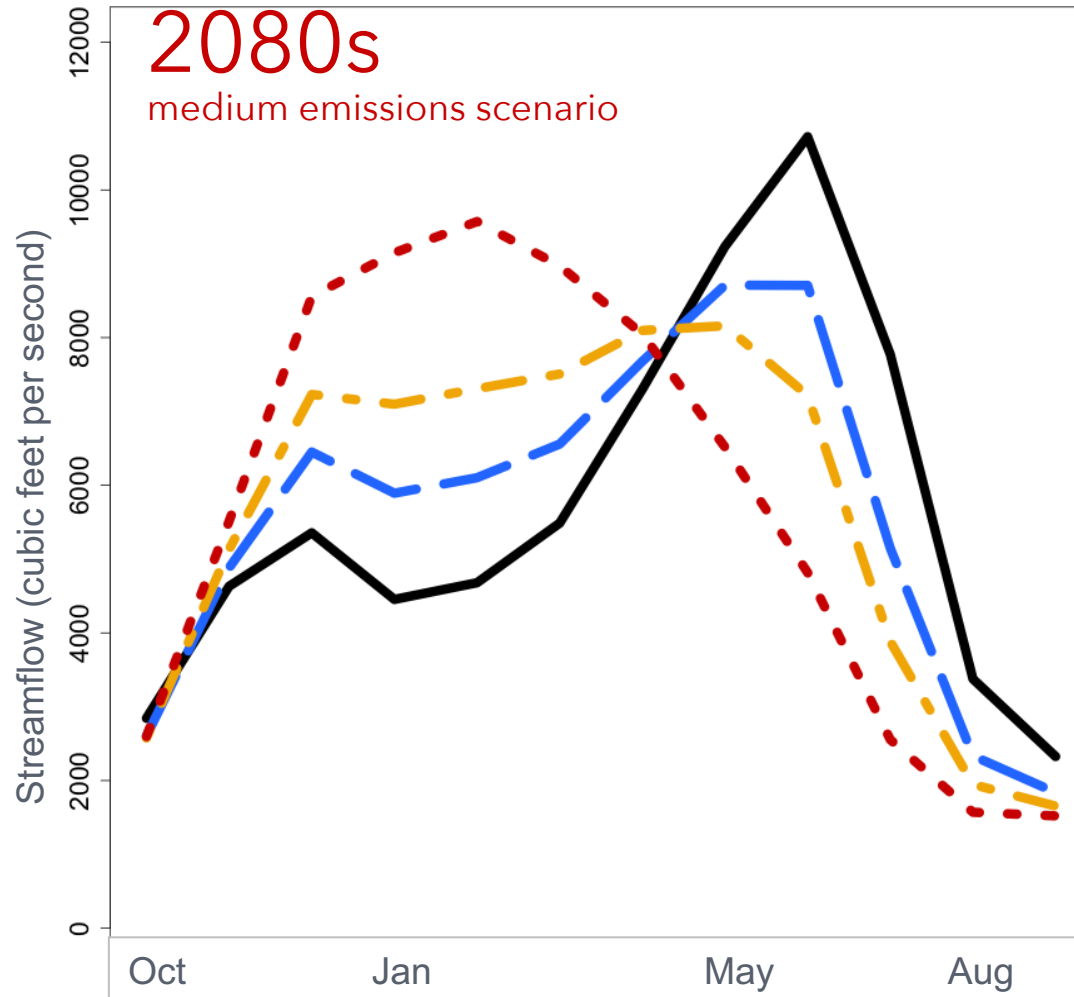


# Warming shifts streamflows

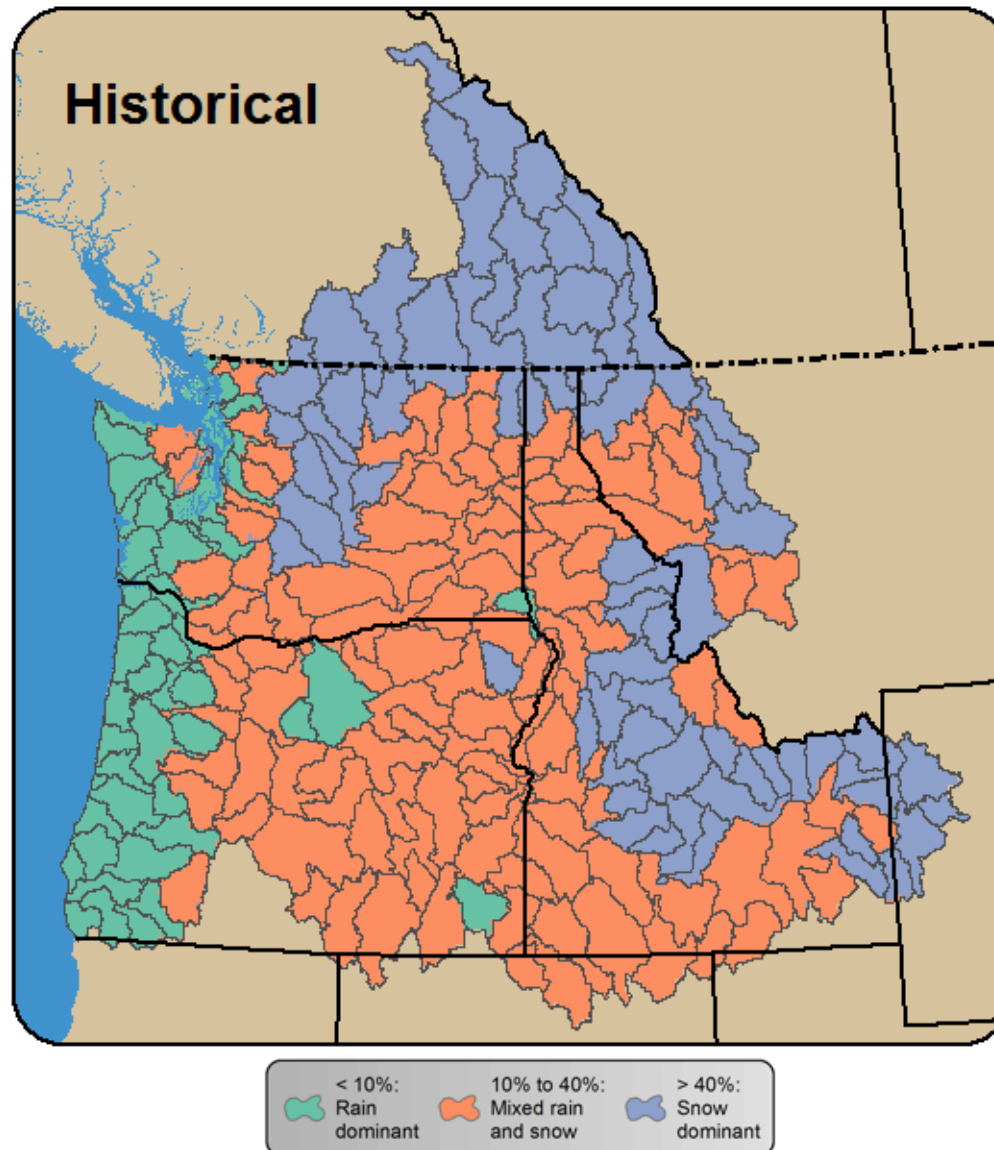




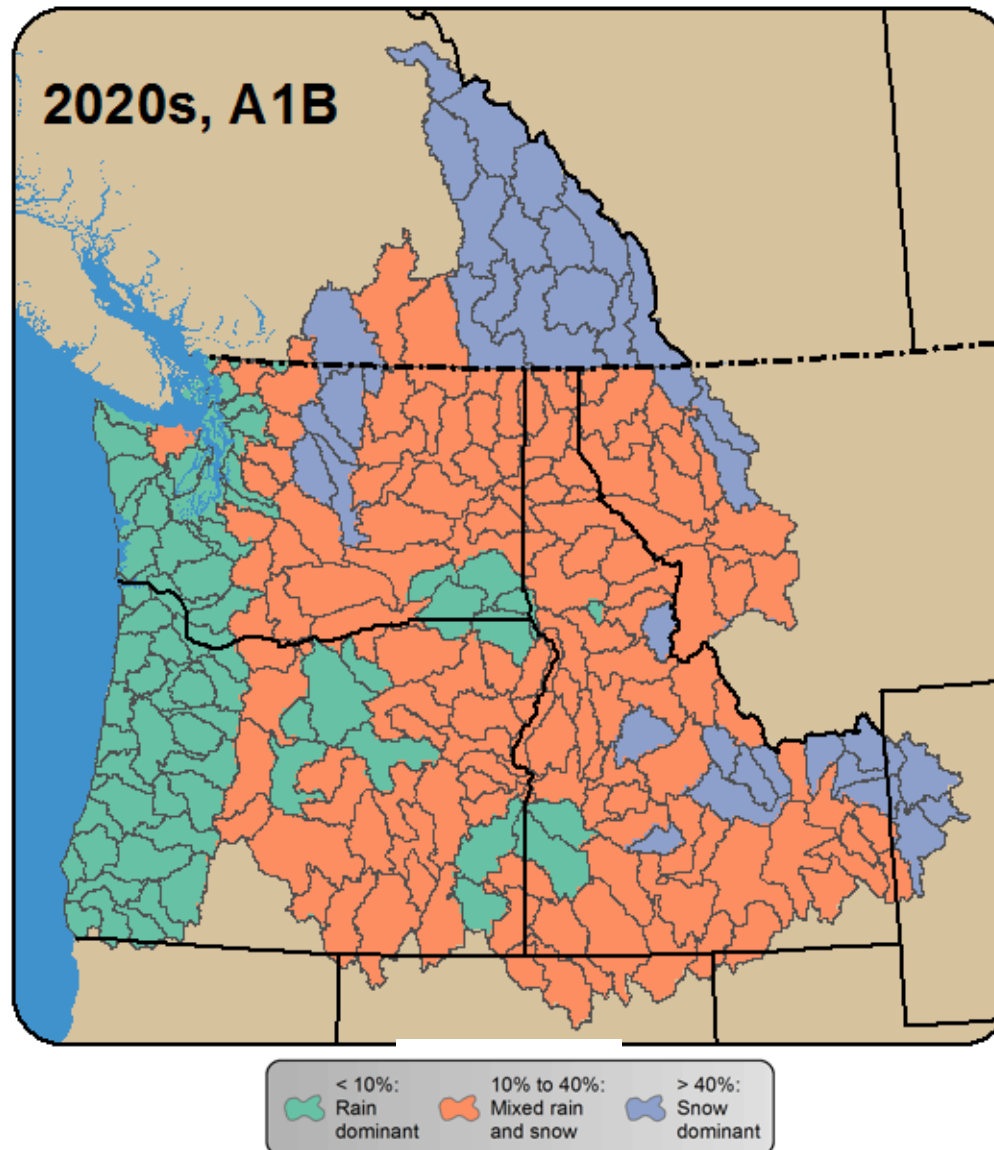
# Warming shifts streamflows



# Mid-elevation basins are most sensitive to warming

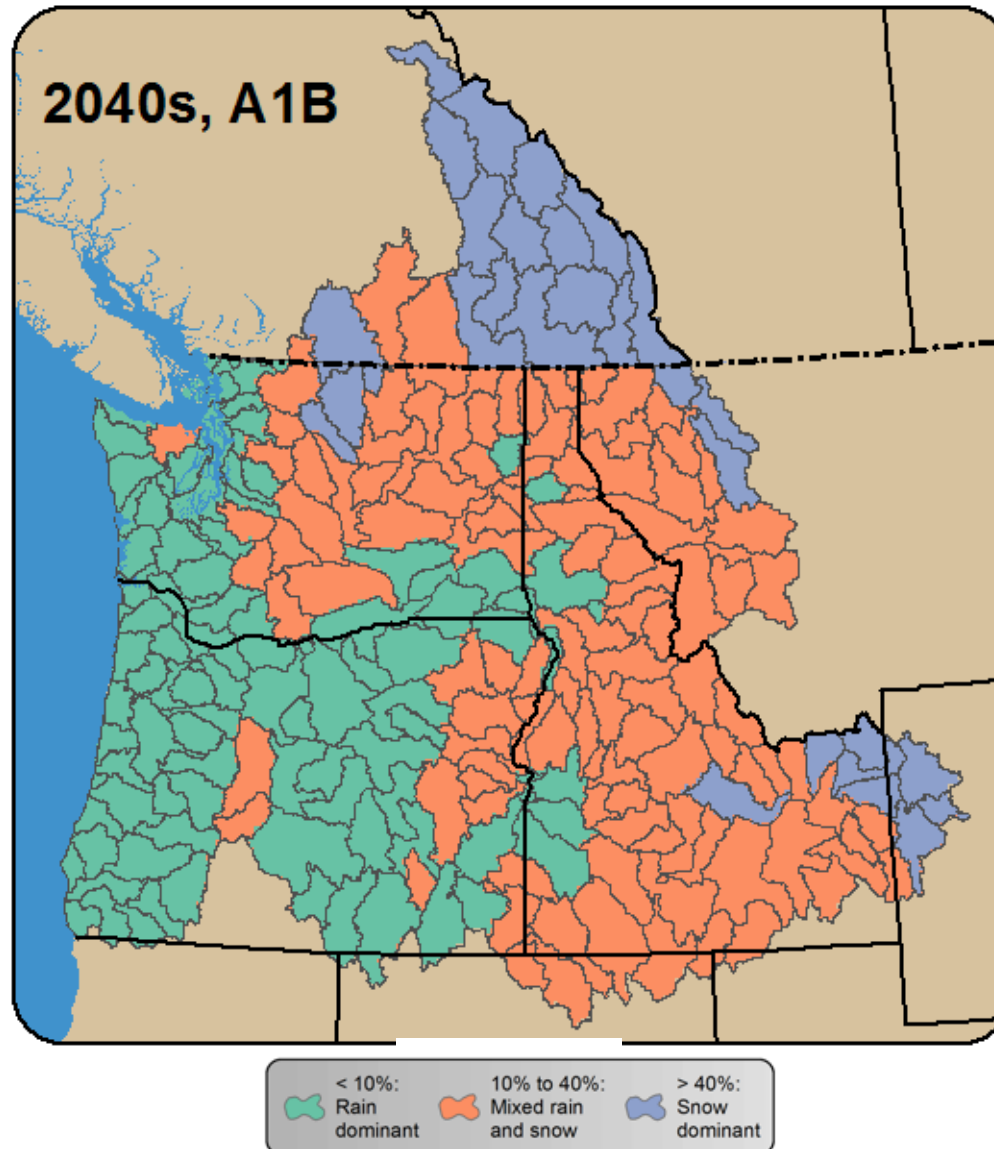


# Mid-elevation basins are most sensitive to warming

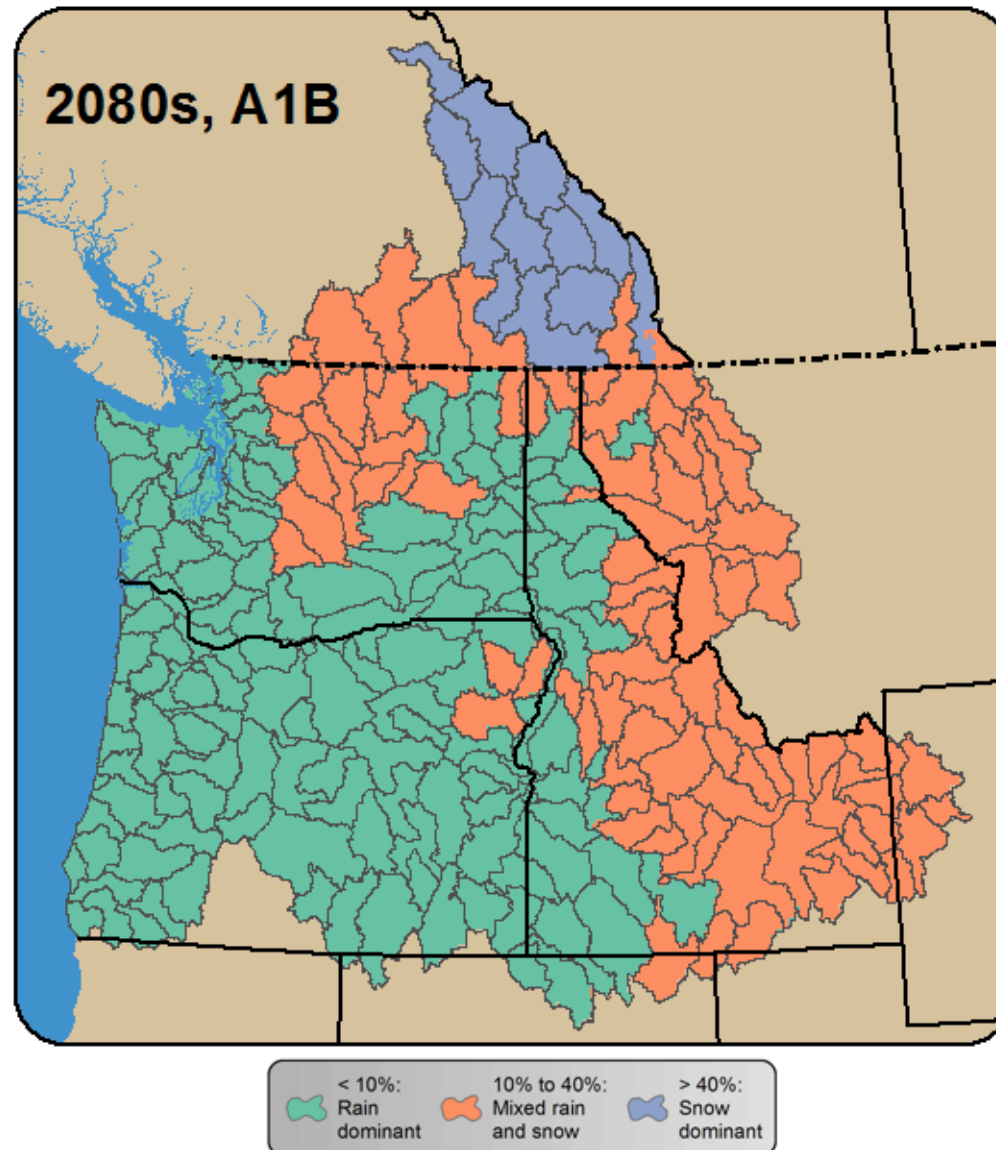




# Mid-elevation basins are most sensitive to warming



# Mid-elevation basins are most sensitive to warming



**What does this mean to you?**



# 4. What to do about it?

Thanks for  
thorough  
depressing to  
any good



# So what can we do?



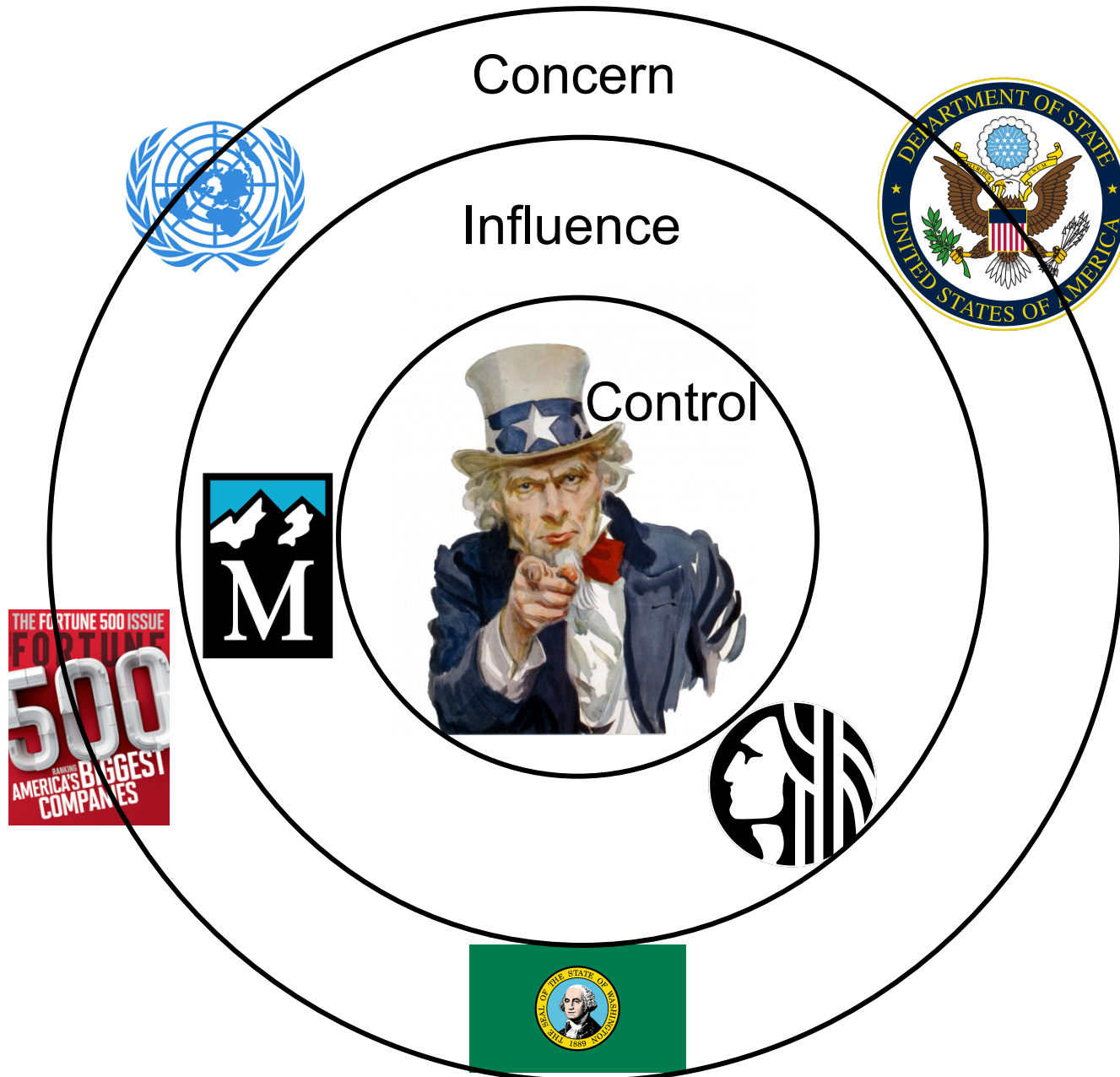
## Mitigation

Reduce emissions of greenhouse gases

## Adaptation

Identify, prepare for, and manage the change

# Who is going to do it?

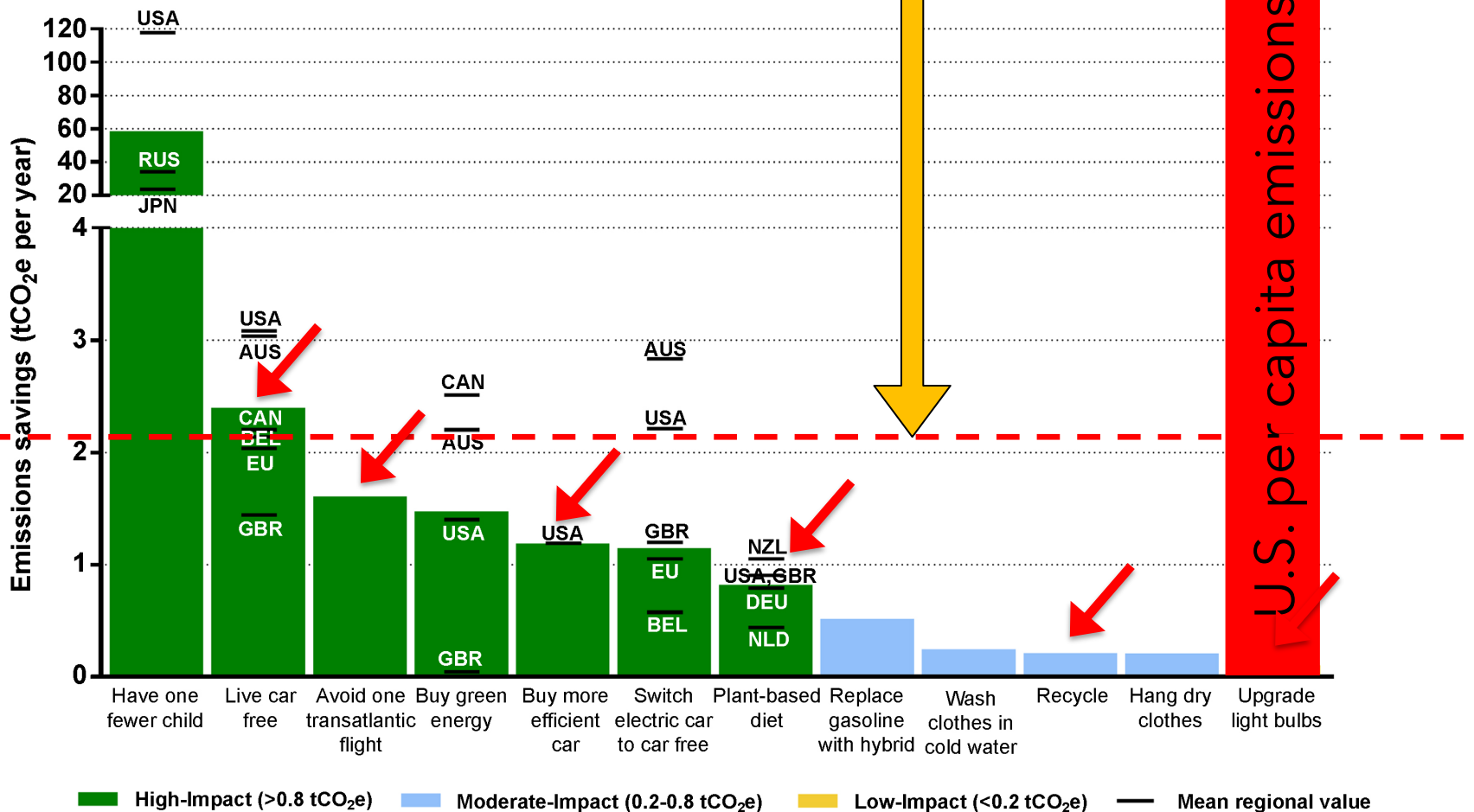


# Who is going to do it?



# Just how much do we need to do?

- Global avg per cap budget required: 2.1 tCO<sub>2</sub>/yr
- U.S. per capita emissions: 16.5 tCO<sub>2</sub>/yr







# TSUNAMI EVACUATION MAP

- IF YOU FEEL AN EARTHQUAKE:**
- Drop, cover, and hold
  - Move immediately inland to higher ground
  - Do not wait for an official warning
- SI USTED SIENTE EL TREMOR:**
- Tírese al suelo, cúbrase y espere
  - Déjase de inmediato en lugar más alto que el nivel del mar
  - No espere por un aviso oficial



Photo: Jason Vogel

Photo: Jason Vogel



**What can you do?**

# Who is going to do it?



FEEL

# The communications conundrum

- 69% of Americans think global warming is happening (16% not).
- 62% of Americans are "somewhat worried" or "very worried" about global warming.
- 64% of Americans say global warming is "extremely," "very," or "somewhat" important to them personally.

DO

- 
- 63% of Americans "rarely" or "never" discuss global warming with family and friends.
  - 51% of Americans hear about global warming in the media at least once a month compared to 23% for people they know.



# The key to turning climate concern into climate action

- *Simple, clear messages*
- *Repeated often*
- *By a variety of trusted sources*

- Ed Maibach

# JMV experiment: Step 1 (talk CC, hope)



Jason Michael Vogel

November 7 at 12:56 PM · 🌐



Clifton Ewing

November 7 at 3:56 PM · 👤



ange;  
et is at

Jason Michael Vogel  
change. It comes  
Fear that I am no  
climate change. I  
animals. I hope a



Marcus Popetz

November 8 at 6:01 AM · 🌐



From a friend who never cries wolf: 11,000 scientists showing that  
climate  
things to  
less and

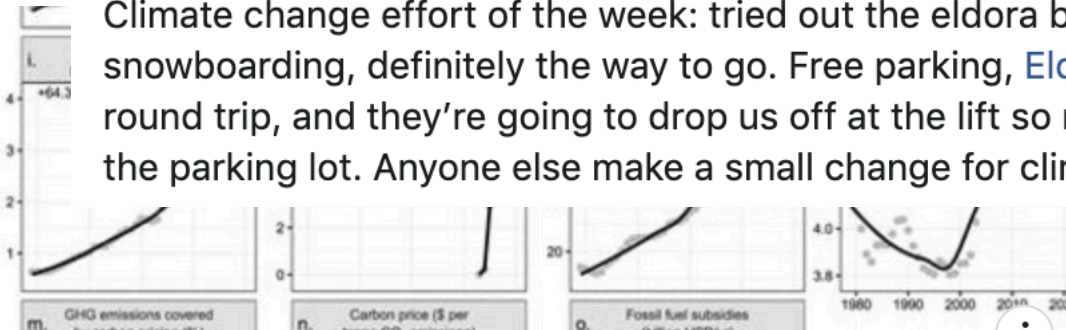


Marcus Popetz

November 9 at 8:34 AM · 🌐



Climate change effort of the week: tried out the Eldora bus to go snowboarding, definitely the way to go. Free parking, Eldora gave us a free round trip, and they're going to drop us off at the lift so no schlep through the parking lot. Anyone else make a small change for climate change?



ACADEMIC.OUP.COM

**World Scientists' Warning of a Climate Emergency**

Scientists have a moral obligation to clearly warn humanity of any...



Kevin Bracy Knight, Lester Binegar and 29 others 4 Comments 13 Shares



# JMV experiment: Step 2 (gauntlet thrown!)



Jason Michael Vogel

November 12 at 9:15 PM · 🌐 ▼



So I posted recently about the [#climatecrisis](#). A few friends and family members listened. A couple of friends, including [Marcus Popetz](#) and [Clifton Ewing](#), posted specific things they were doing to take the issue seriously. Gauntlet thrown! In the spirit of keeping the good deeds rolling I did two things today: 1) I purchased my first ever carbon offset for a personal flight I took back in September (grand total \$13.77, lots to say about this); and 2) I swore off Justin's peanut butter (which if folks knew how much I ate would cause their stock to drop one quarter of a point, oh because palm oil). Now I have to mix my peanut butter by hand to get the oil back in, but at least I'm not choosing smooth creamy peanut butter over my childrens' future! Starting small, aiming high! Let's save the 🏁 planet people!



Andria Bilich, Robert M Geraci and 33 others

80 Comments



# Adaptation as a conservation priority



Photo: High Country News

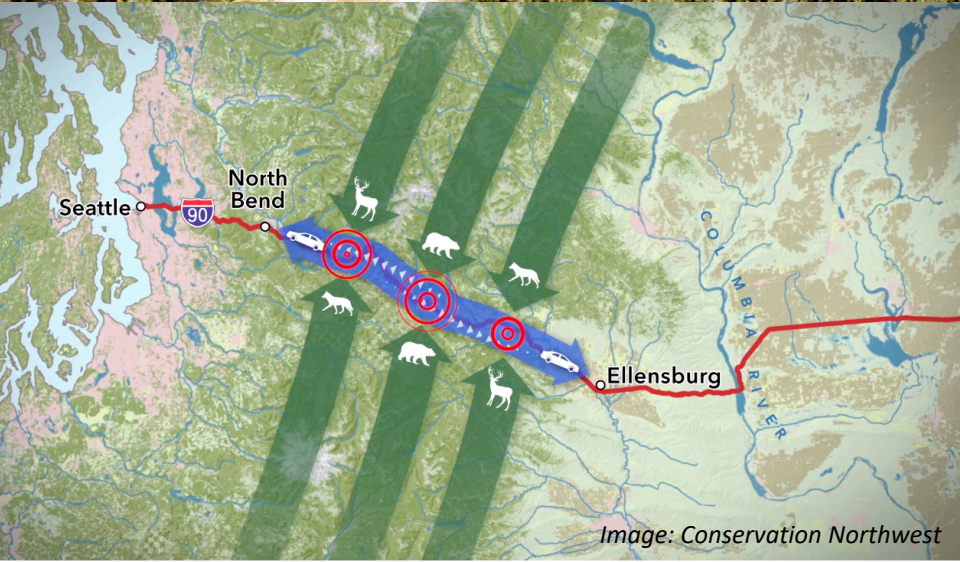


Image: Conservation Northwest

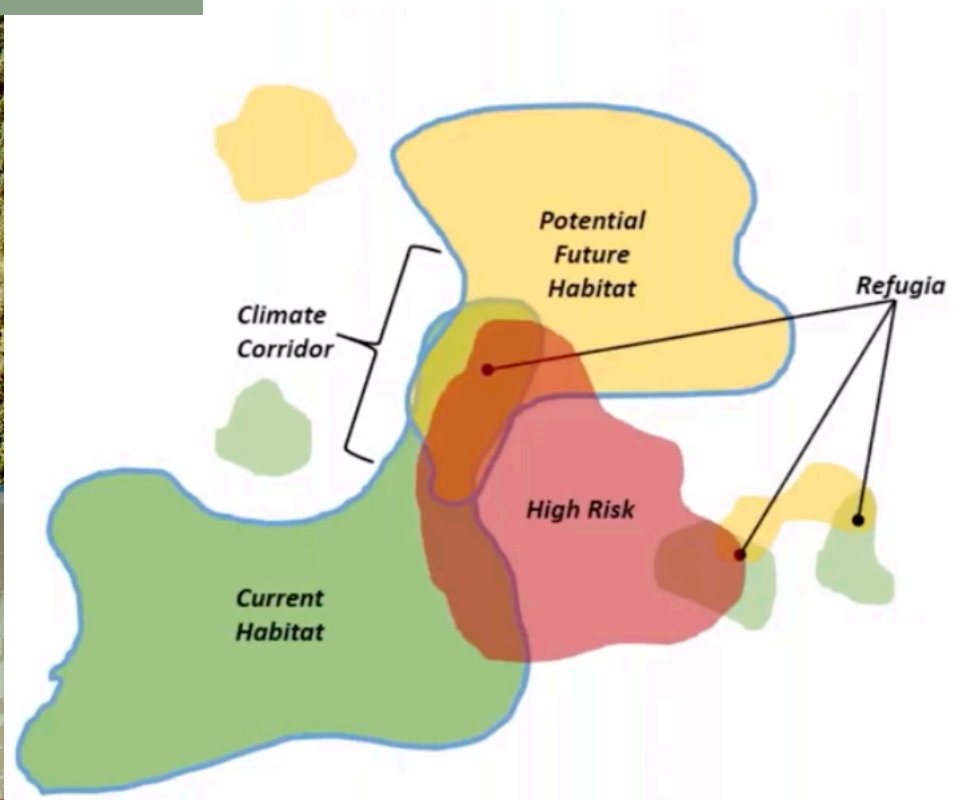


Image: Andrew Shirk





**What can The Mountaineers do?**

# What are they going to do?



# What are they going to do?



Heliogen, backed by Bill Gates, has achieved a breakthrough that could allow cement makers to transition away from fossil fuels. The company uses artificial intelligence and an array of mirrors to create vast amounts of heat, essentially harnessing the power of the sun.

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The Mountaineers Conservation  
and Advocacy Director  
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**Jason Vogel, PhD**

**W**

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