Projected Changes in Regional Climate, Hydrology, and Sea Level Rise

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Lower Columbia Estuary Partnership 2016 Science to Policy Summit
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The UW Climate Impacts Group

Science for climate resilience

Working since 1995 to….

- Produce scientific information that is both useful to and used by decision makers
- Conduct decision-relevant climate research
- Support the interpretation and application of climate science in decision making

CLIMATE IMPACTS GROUP

COLLEGE OF THE ENVIRONMENT
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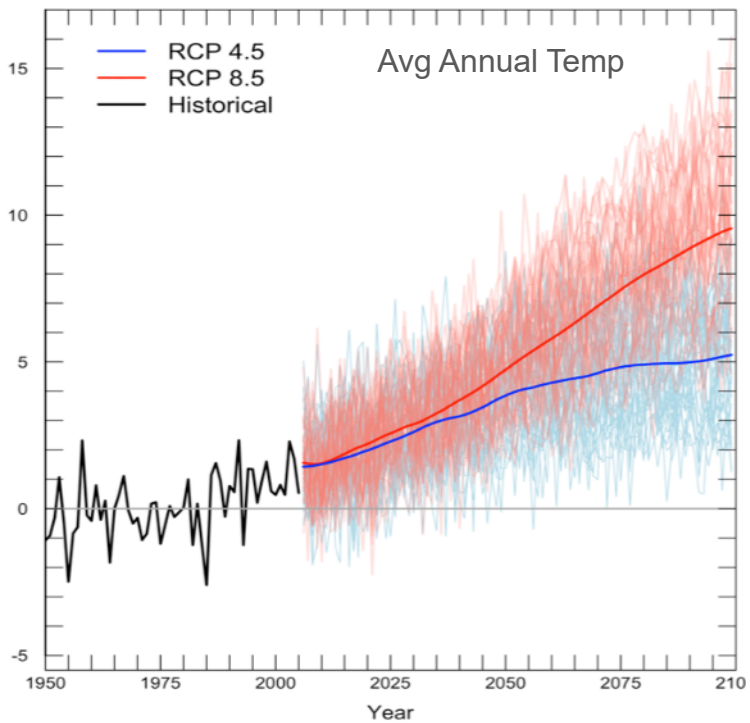
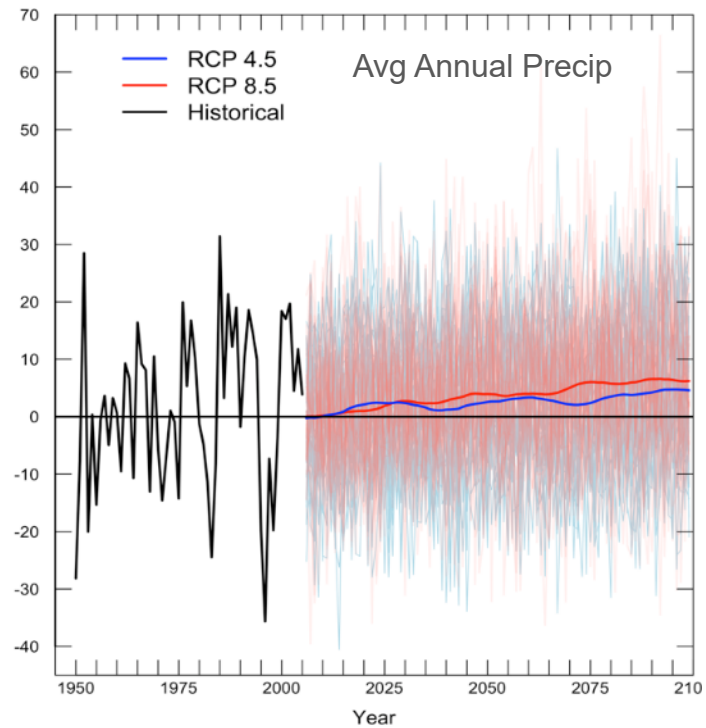
Northwest Climate Science Center

Key Climate Impact "Drivers" for Natural Systems

- Substantial warming
- Increasing heavy rainfall
- Changes in hydrology (snow, streamflow)
- Sea level rise
- Changes in ocean conditions
- Natural variability
- Human responses to climate impacts

All scenarios show warming but changes in precipitation are mixed





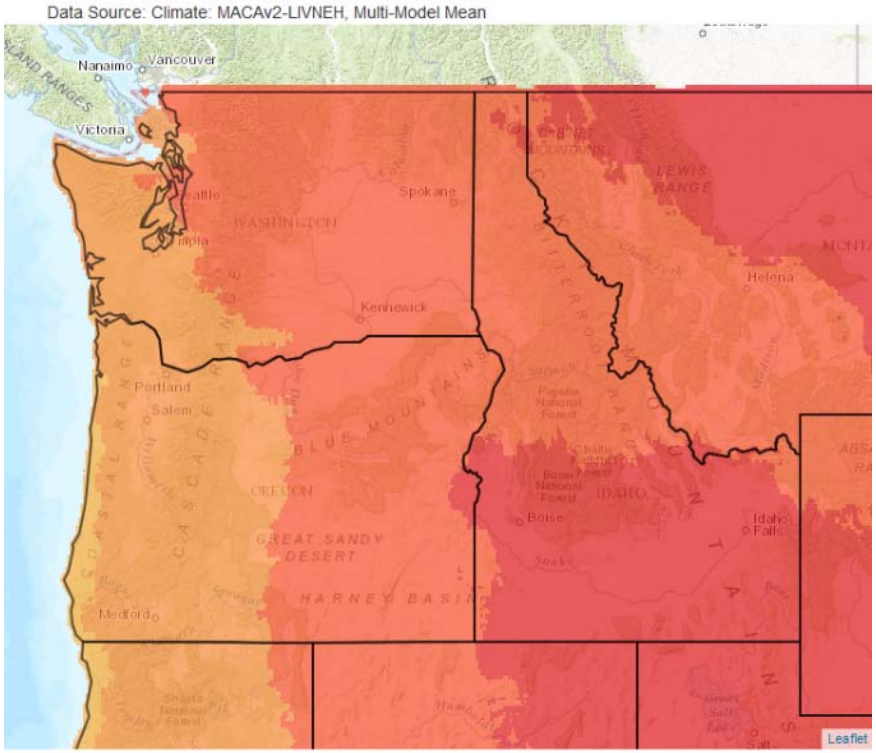
Warming: 2050s *(relative to 1950-1999)*	
Low emissions *RCP 4.5*	+4.3°F *(2.0-6.7°F)*
High emissions *RCP 8.5*	+5.8°F *(3.1-8.5°F)*

Precipitation change: 2050s *(relative to 1950-1999)*	
Low emissions *RCP 4.5*	-4.3 to +10.1%
High emissions *RCP 8.5*	-4.7 to +13.5%

Projected Change in Mean Air Temp

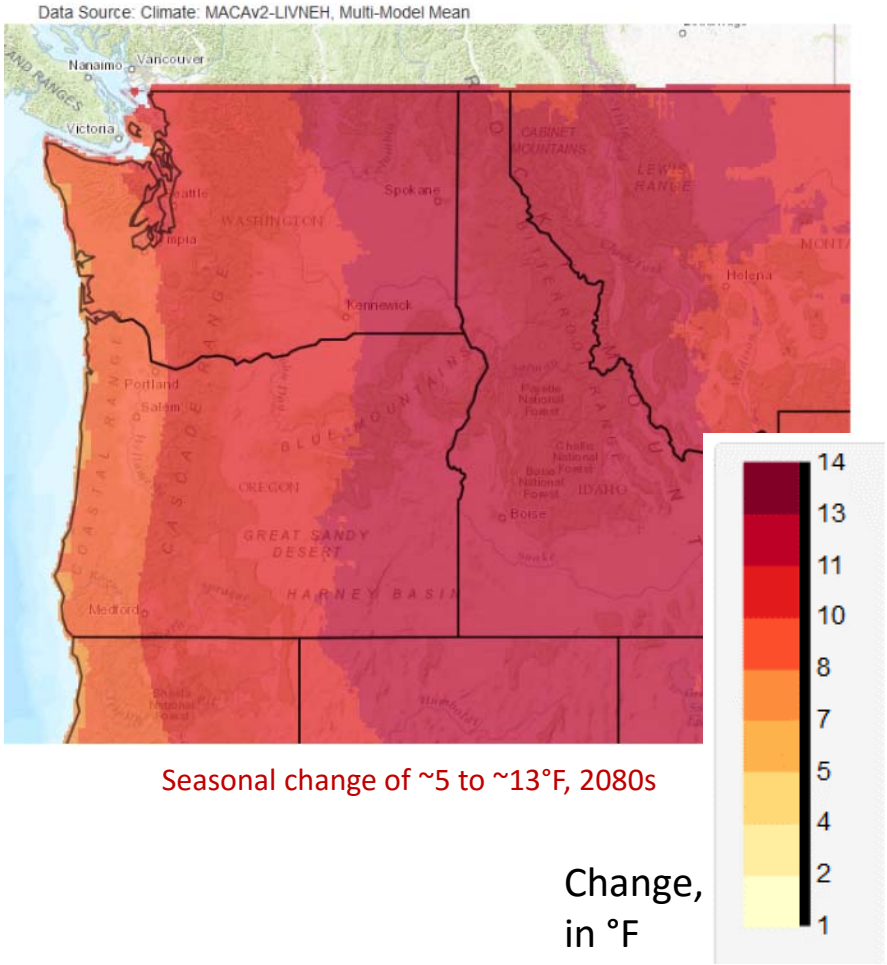
High (RCP8.5) Warming Scenario, 2070-2099 v. 1971-2000

Winter (Dec-Feb)



Seasonal change of ~4 to ~11°F, 2080s

Summer (Jun-Aug)



Seasonal change of ~5 to ~13°F, 2080s

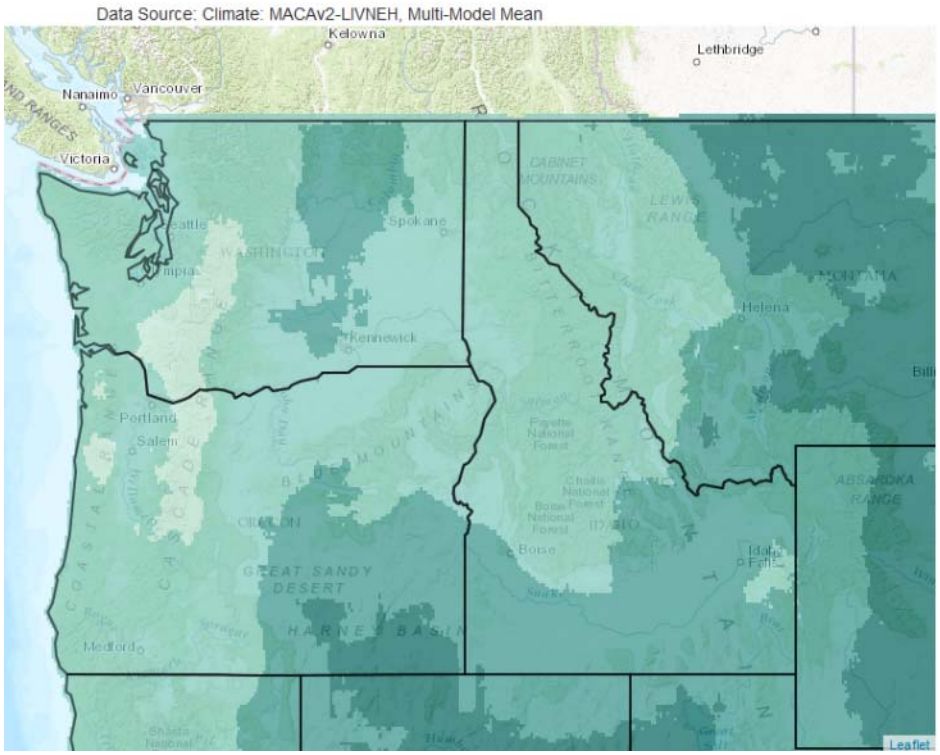
Change, in °F

Figure source: Integrated Scenarios Project

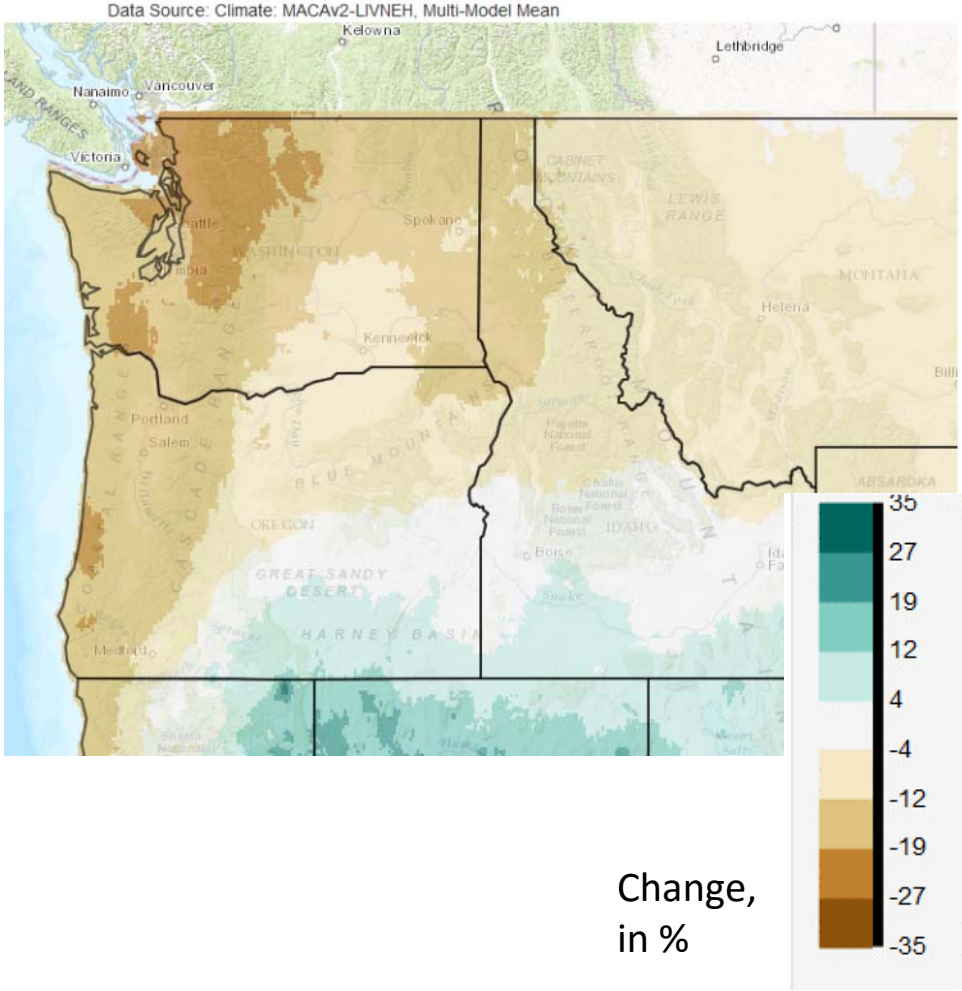
Projected Change in Mean Precipitation

High (RCP8.5) Warming Scenario, 2070-2099 v. 1971-2000

Winter (Dec-Feb)

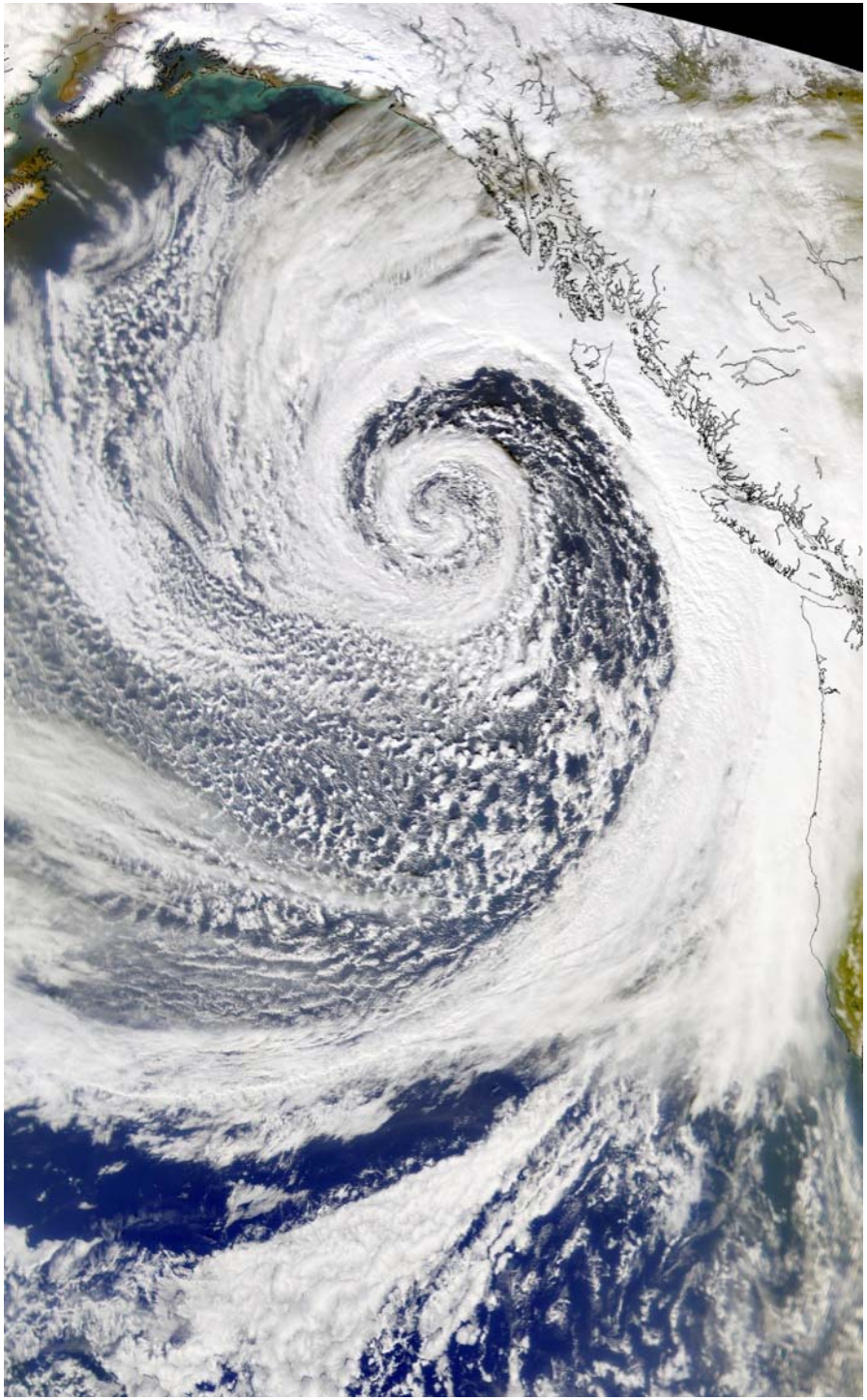


Summer (Jun-Aug)



Change, in %

Figure source: Integrated Scenarios Project



Increased frequency, intensity of extremes

For the Northwest, 2041-2070 (relative to 1971-2000):

Number of days with

- >1 inch rain: +13% (± 7%)
- >3 inch rain: +22% (±22%)

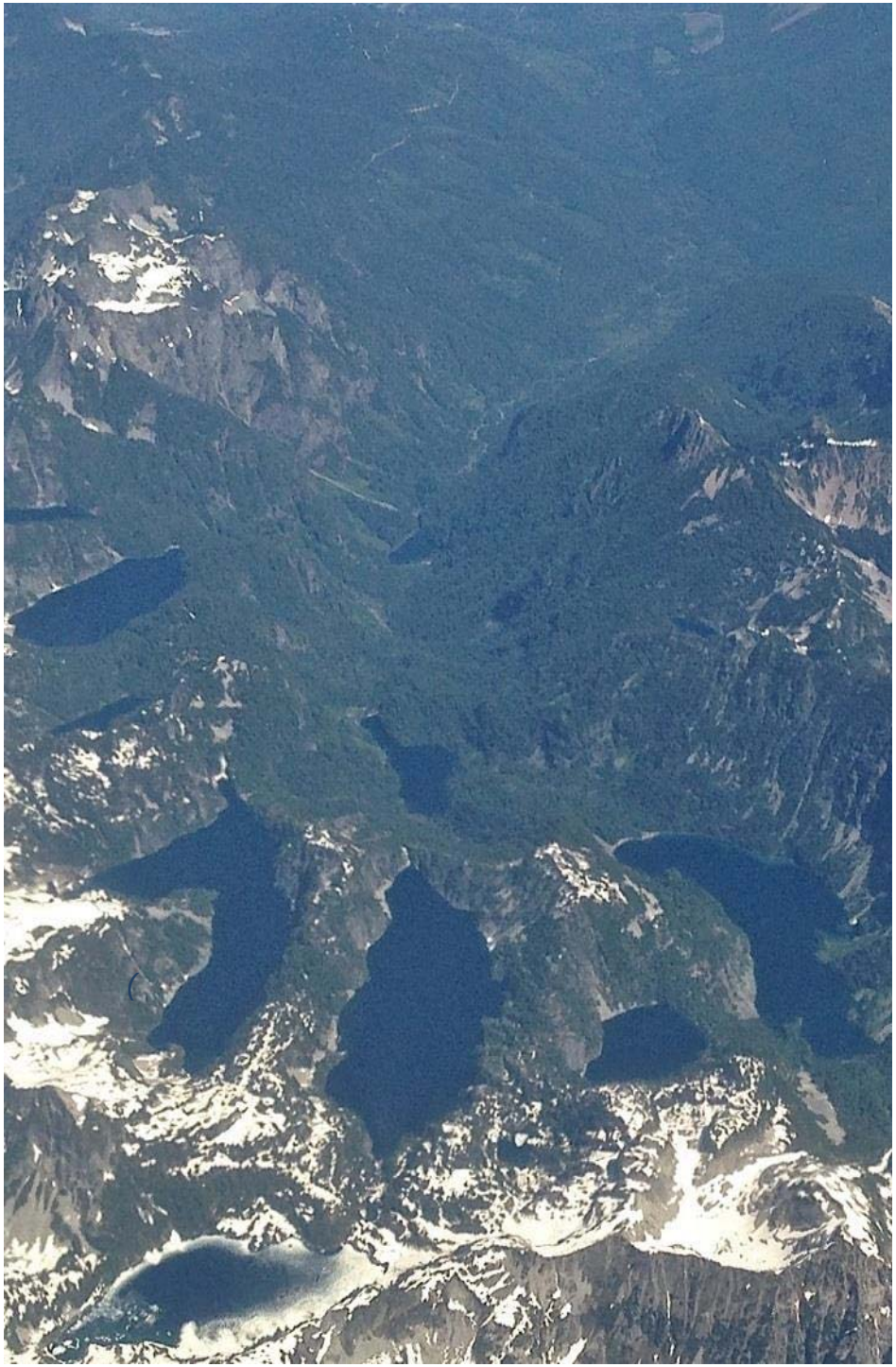
for a high greenhouse gas scenario

Kunkel et al. 2013

Our primary mechanism for storing water – snow – is sensitive to warming.

The Cascade and Olympic Mountains have the highest fraction of “warm snow” (snow falling between 27-32°F) in the continental U.S.

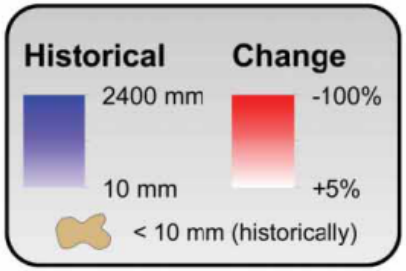
(Mote et al. 2008)



All Scenarios Indicate Less Snow

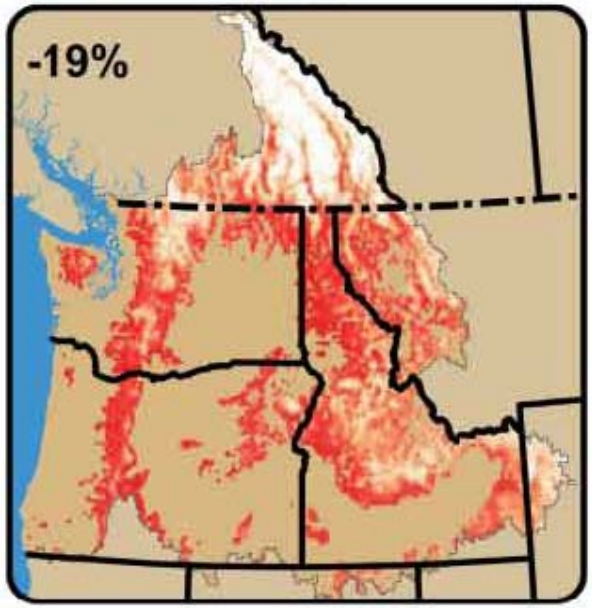
For the A1B scenario
(Medium Emissions Scenario)
Changes relative to 1916-2006

April 1 Snow Water Equivalent

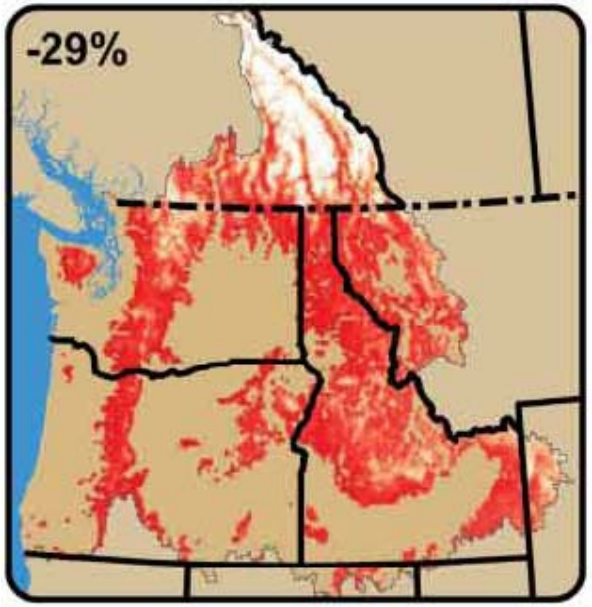


Historical

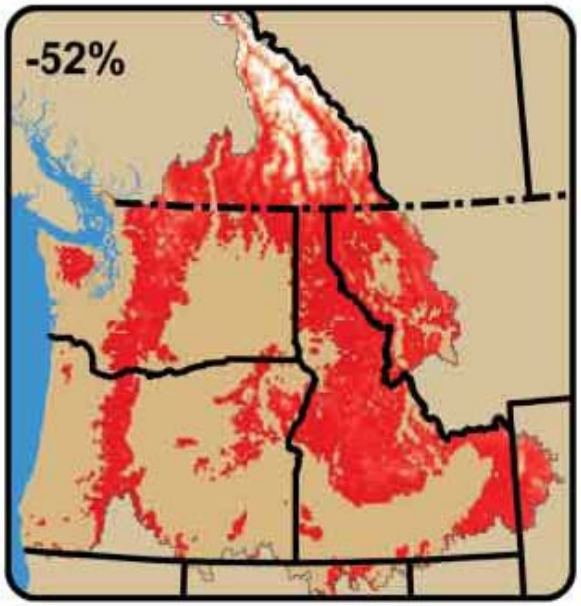
2020s (+2.0ºF)



2040s (+3.2ºF)



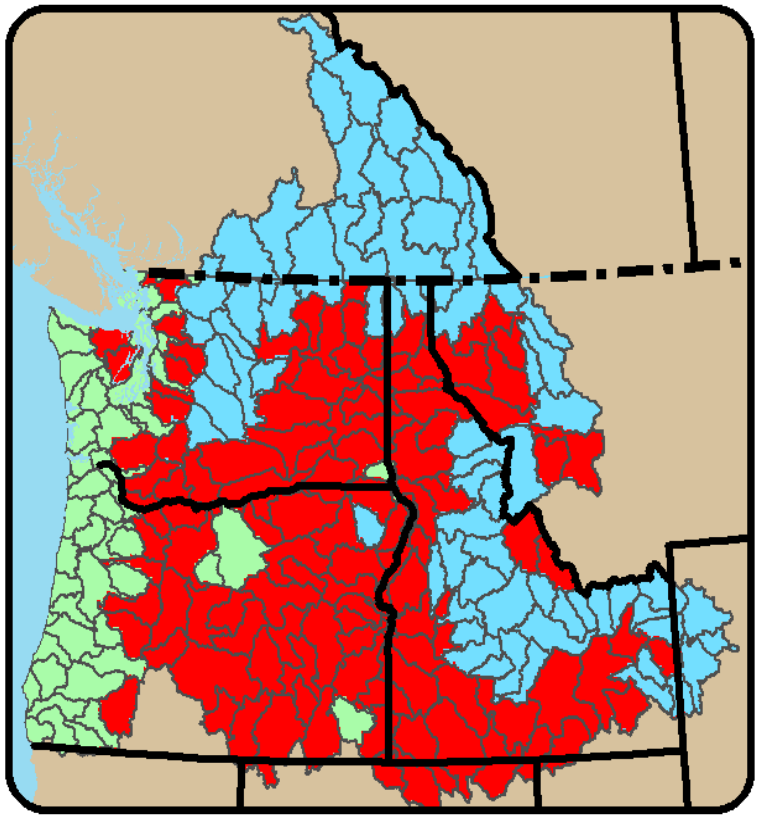
2080s (+5.3ºF)

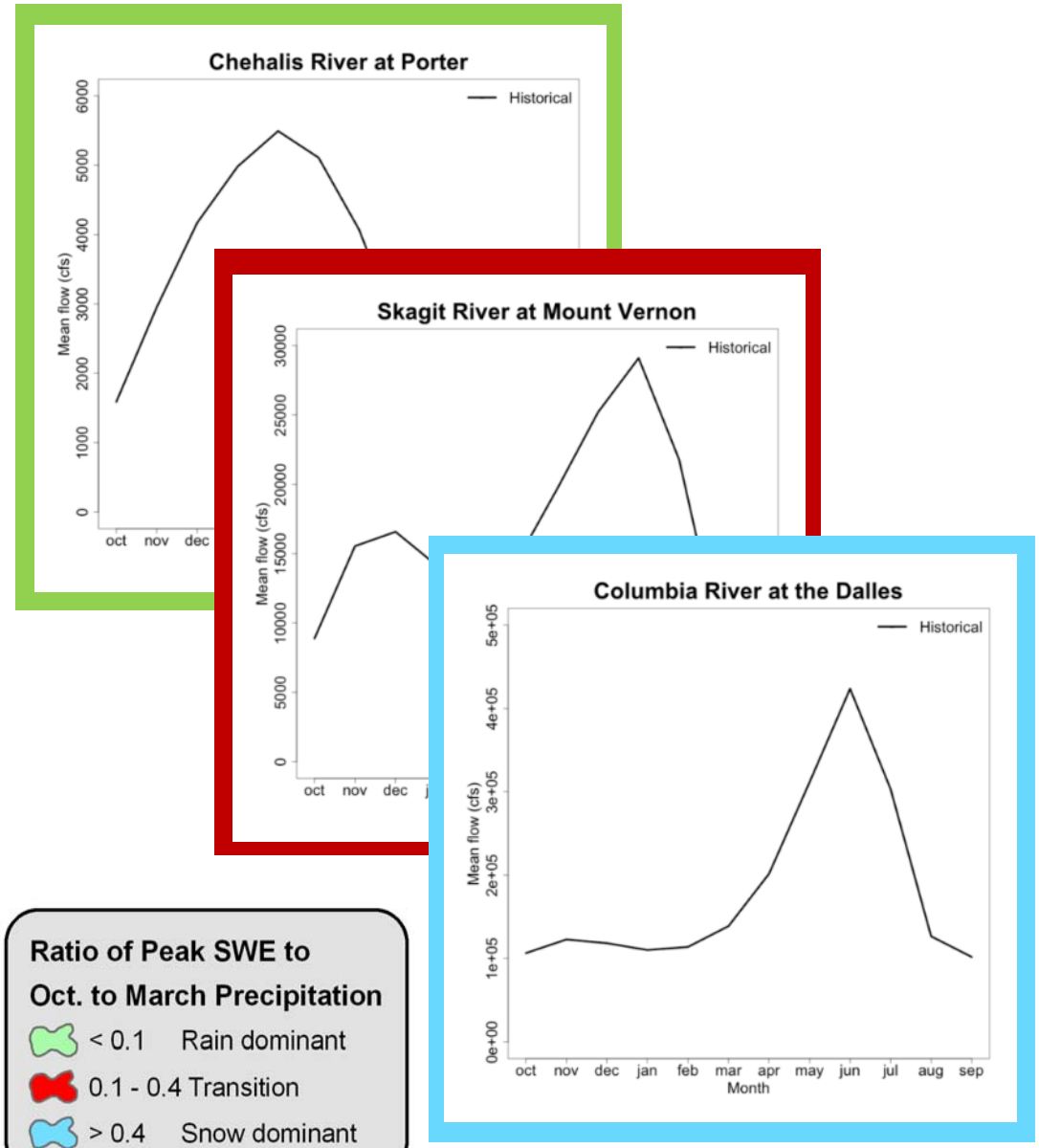


Hamlet et al. 2013; maps by Rob Norheim (CIG)

Streamflow impacts: *Basin type matters*

Historical

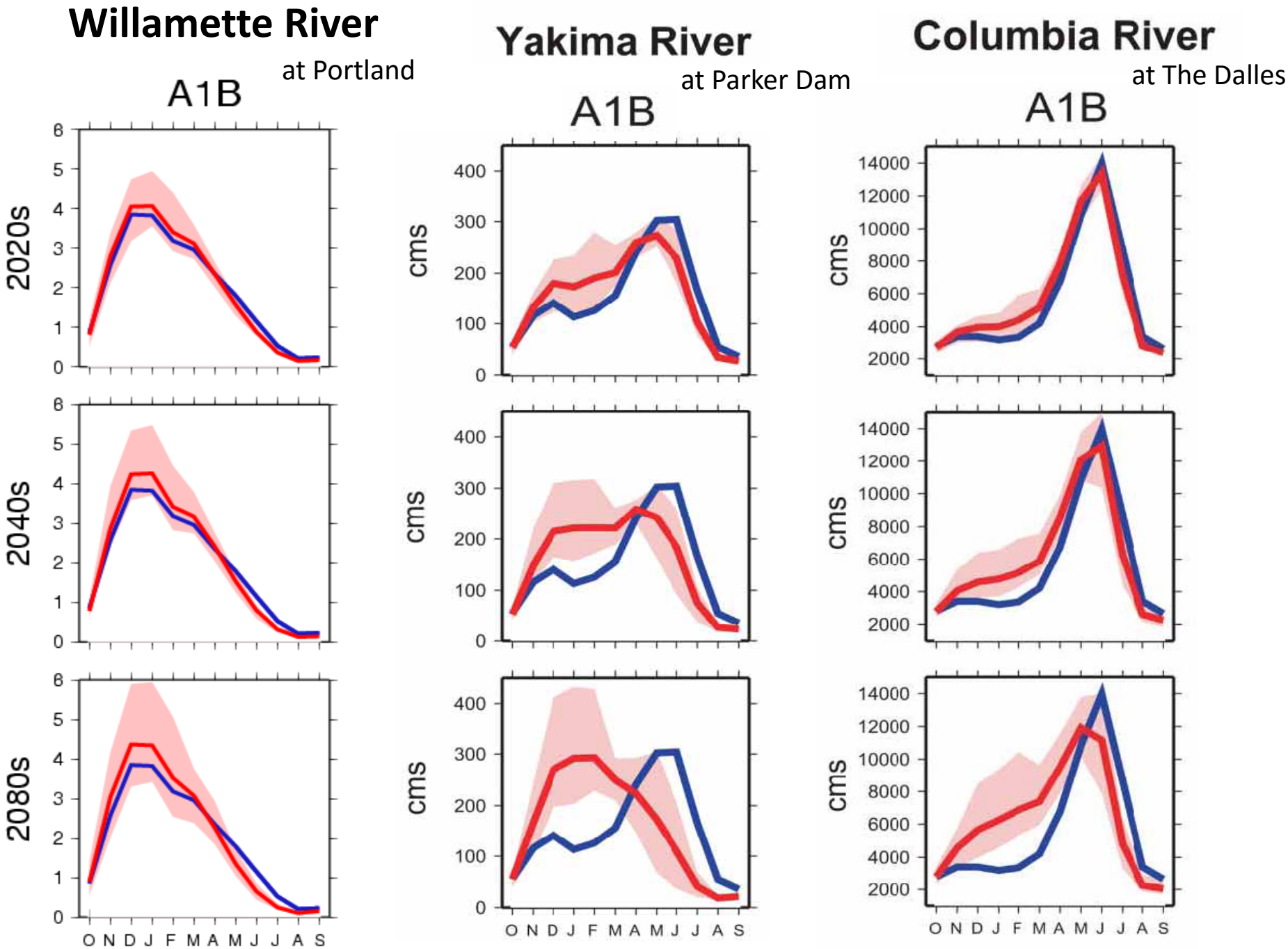




Ratio of Peak SWE to Oct. to March Precipitation

- < 0.1 Rain dominant
- 0.1 - 0.4 Transition
- > 0.4 Snow dominant

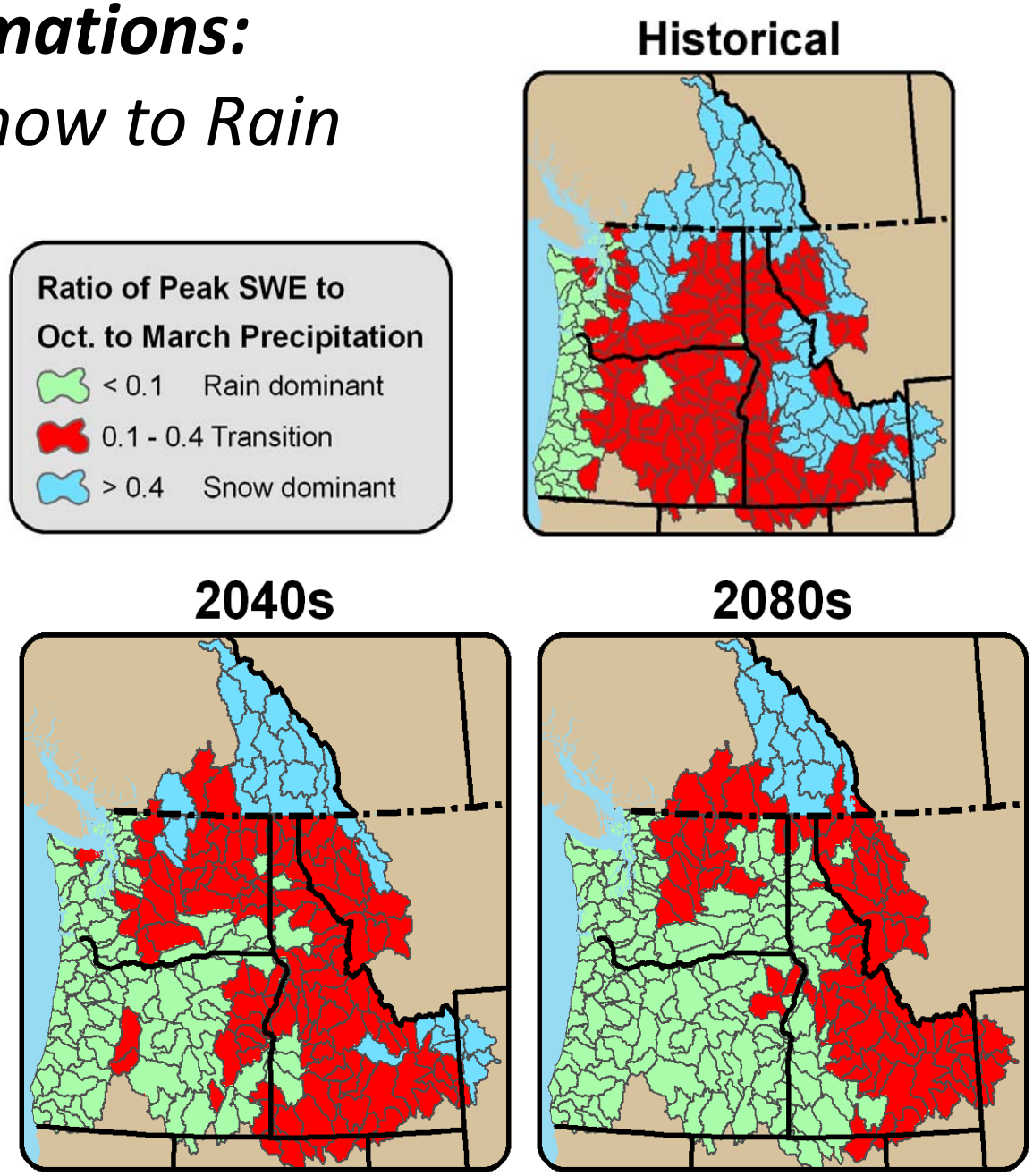
Hamlet et al. 2013; map by Rob Norheim (CIG)



Naturalized flows; blue line = historical (1916-2006)

Hamlet et al. 2013

Basin Transformations:
Shifting from Snow to Rain



Hamlet et al. 2013; map by Rob Norheim (CIG)

Decreasing summer (but increasing winter) hydropower production

Decreased irrigation supply reliability & increased competition for summer supplies

More intensive management of municipal water supplies
(groundwater - unknown)

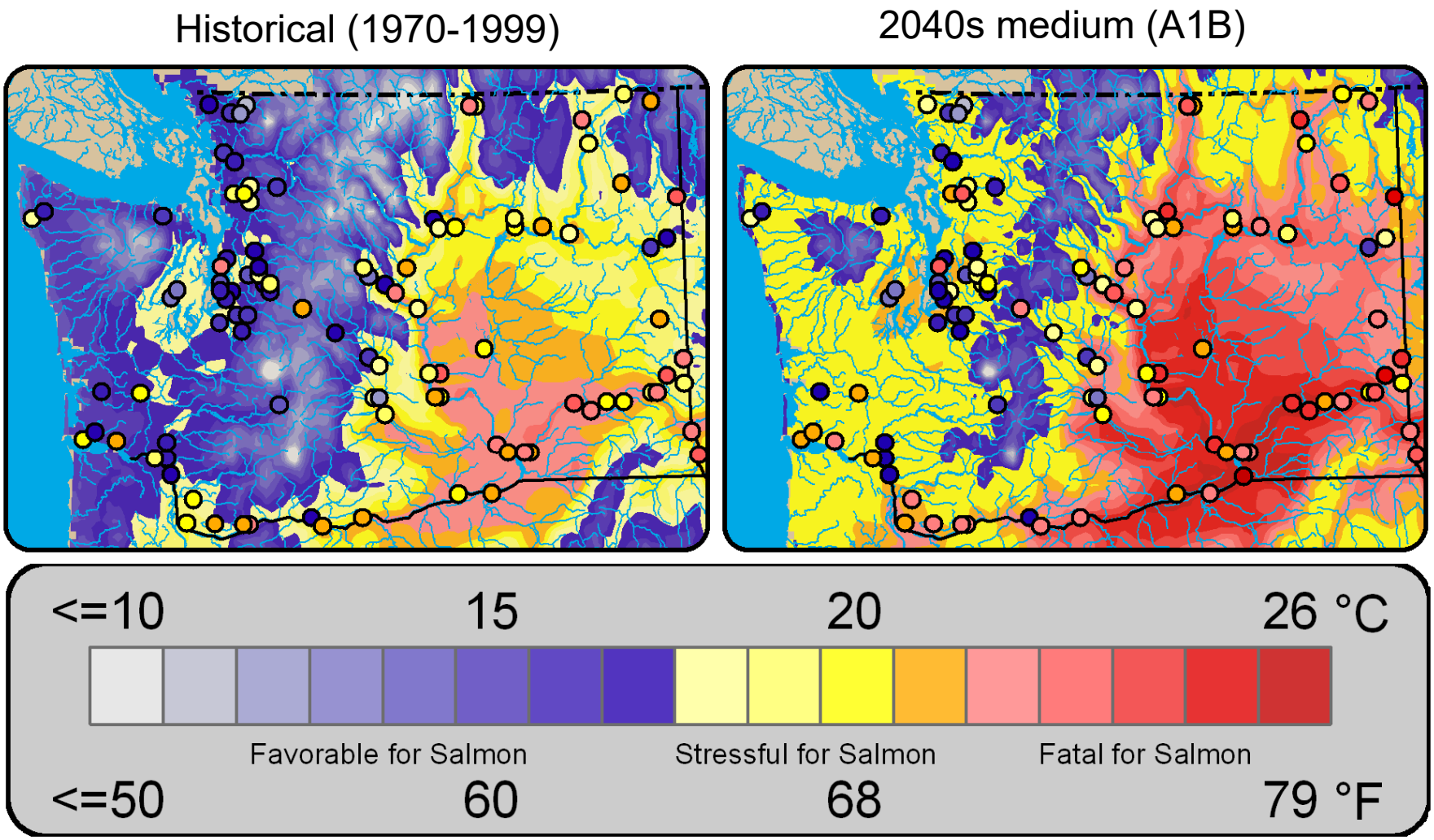
Flood risk increases. In coastal drainages, sea level rise will compound increasing flood risk.

Direct and indirect impacts of climate on salmon

- Stream temperature
- Streamflow volume
- Sediment
- Food availability, quality
- Predation
- Disease
- Ocean conditions
- Habitat quality, connectivity
- Reservoir management
- Floodplain management
- Community responses to sea level rise
- Changes in land cover
- Toxics

Increasing Water Temperature

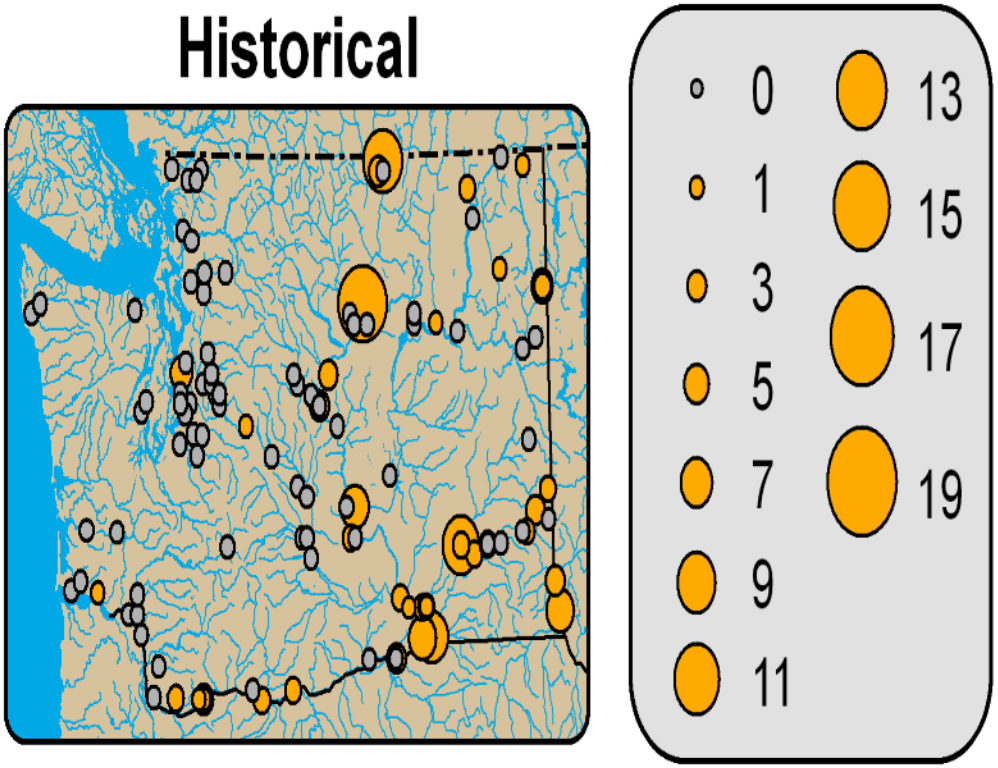
August Mean Surface Air Temperature and Maximum Stream Temperature

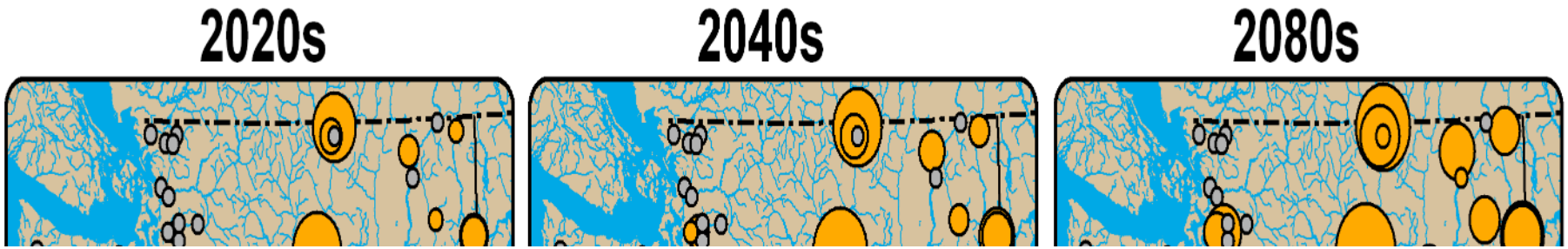


* Projections are compared with 1970-1999 average

Mantua et al. 2009

Average Number of Weeks per Year Stream Temperatures Exceed 21°C/70°F





Source: Mantua et al. 2009

And don't forget…

Increasing wildfire risk

Area burned by fire in the Columbia River Basin is projected to double by 2020s, triple by 2040s, x5 by 2080s (relative to median for 1916-2006). *(Littell et al. 2010, 2012)*

Discovery Fire burns near volatile stands of insect-damaged trees, 2009, DNR

Sea level change at any given location and point in time is determined by many factors

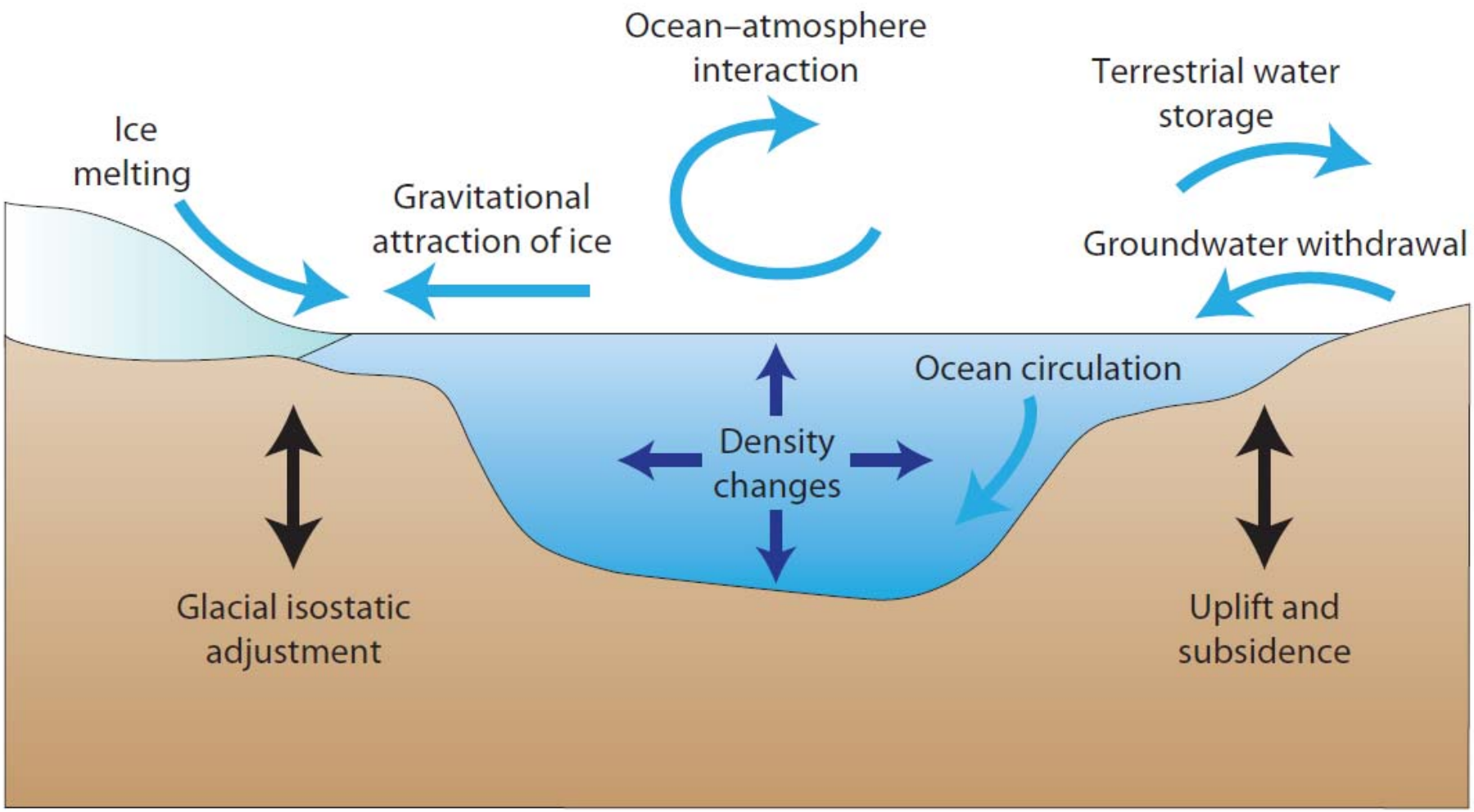


FIGURE 1.4 Processes that influence sea level on global to local scales. SOURCE: Modified from Milne et al. (2009).

NRC 2012

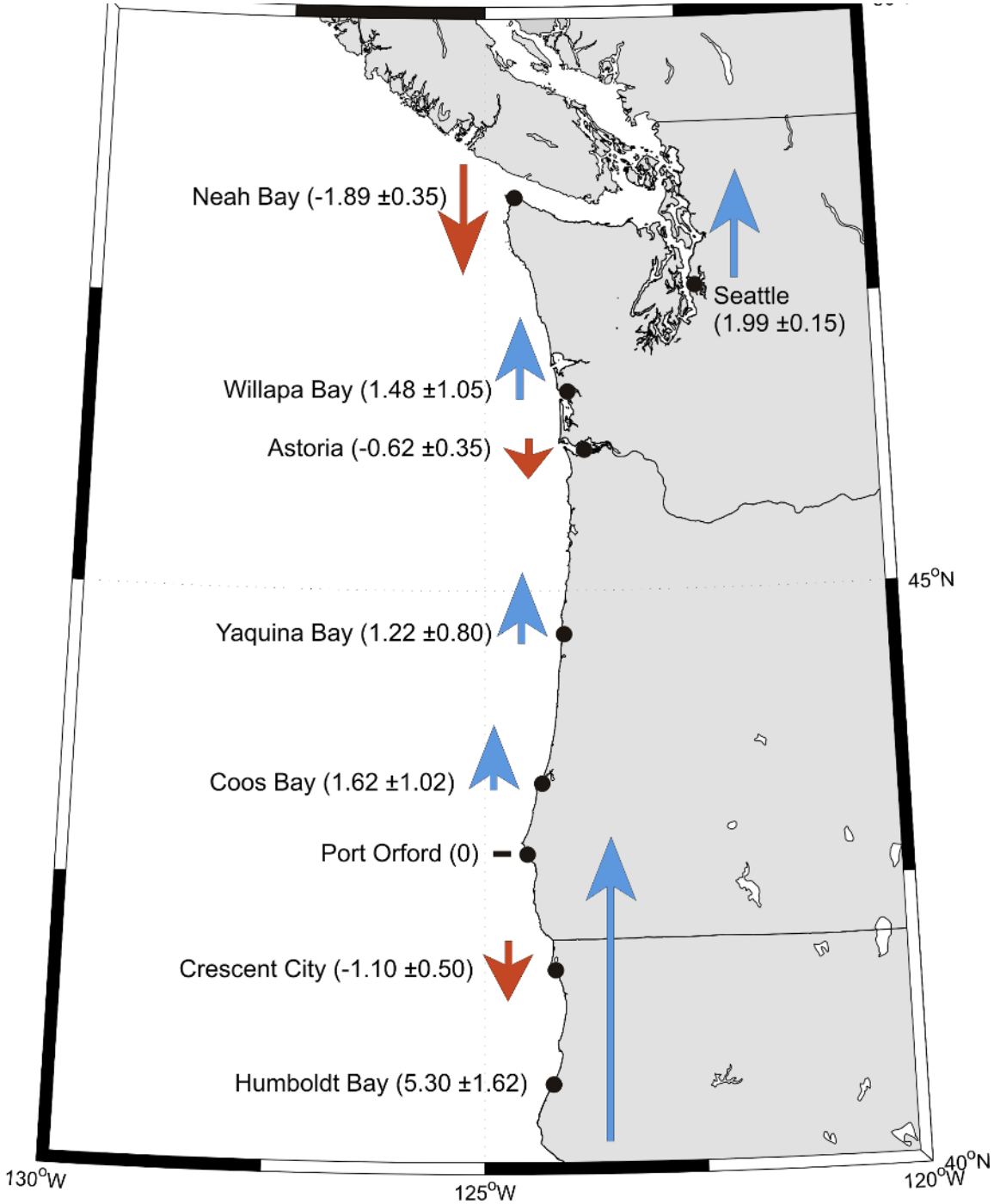
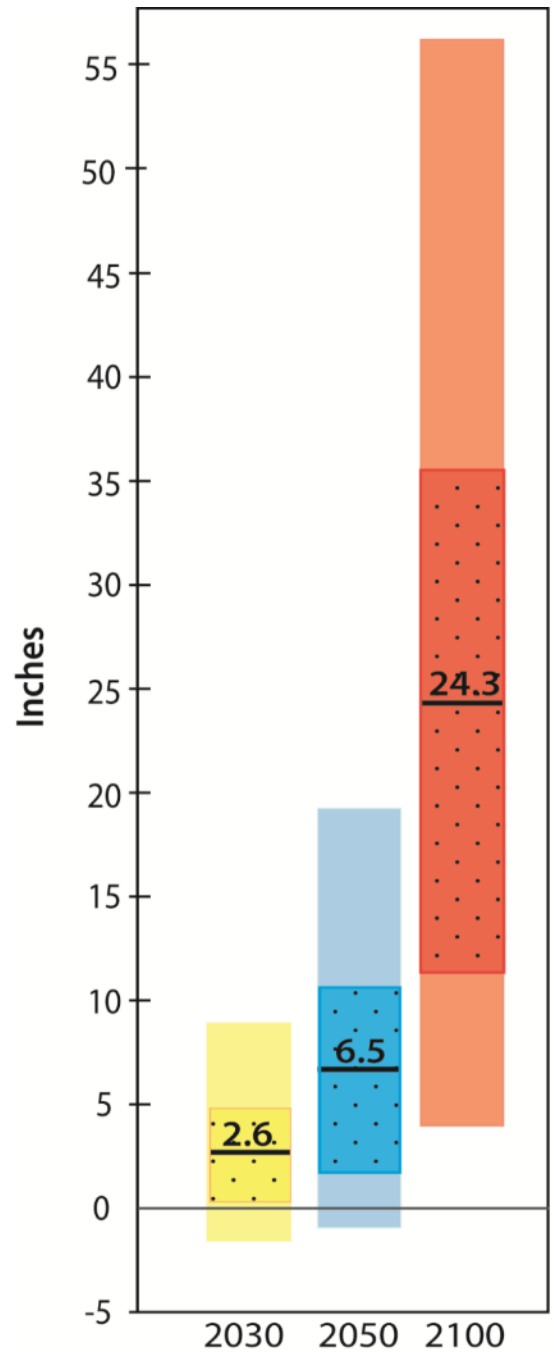


Figure 6.3 - Analysis of NOAA tide gauges to assess changing sea levels along the coast of the PNW. Colored arrows represent the rates of change in relative sea levels (mm/yr), along with their uncertainty, generated using summer data only (OCCRI 2010, Ch 6)

Sea Level Rise Projected in All Scenarios by 2100

Projected Range – Seattle & Newport *Relative to 2000 (NRC 2012)*	
2030	-1.5 to +8.8 in. (Seattle) *-1.5 to +8.9 in. (Newport)*
2050	- 1.0 to +18.8 in. (Seattle) *-0.8 to +18.9 in. (Newport)*
2100	+3.9 to +56.3 in. (Seattle) *+4.6 to +56 in. (Newport)*



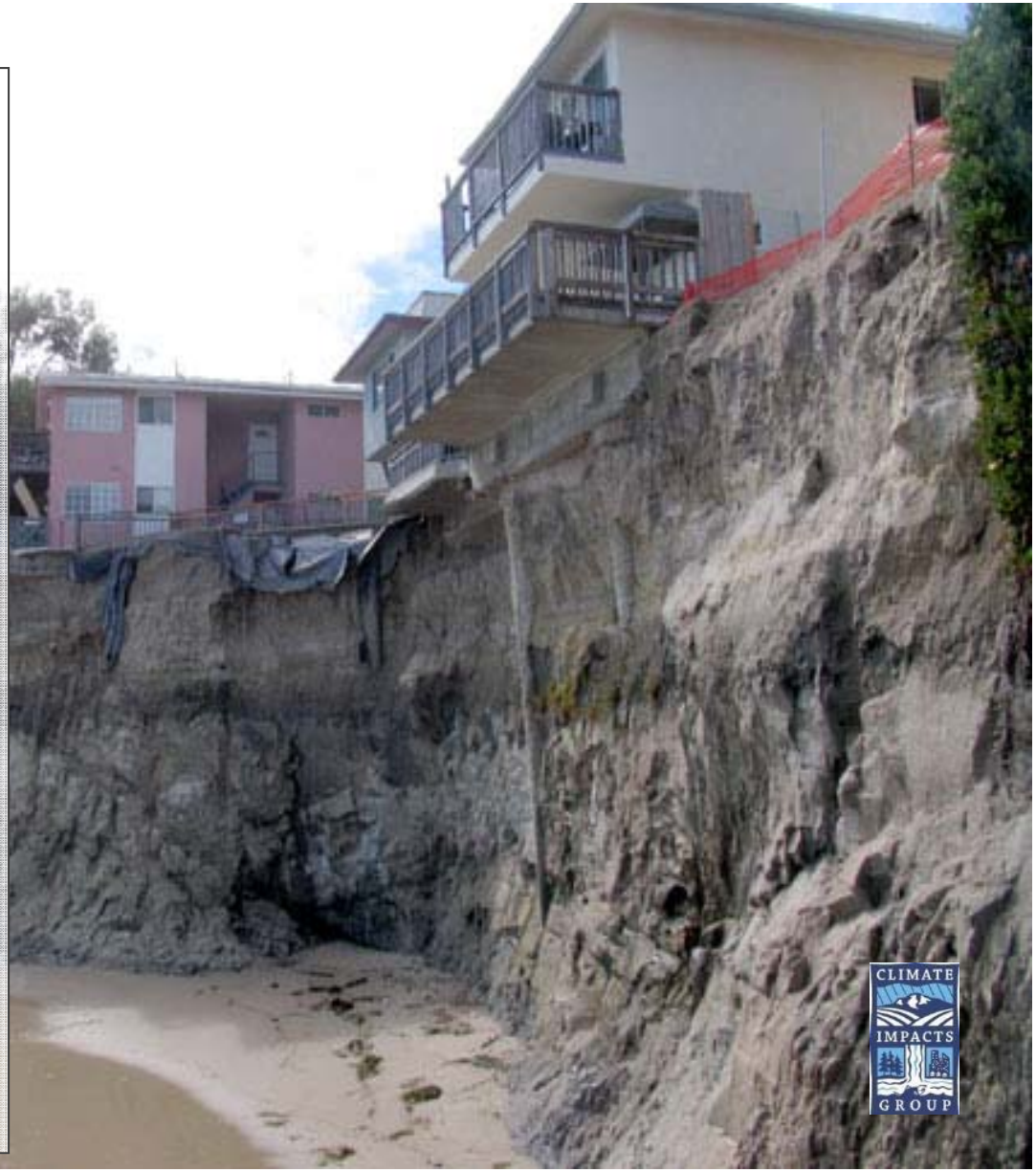
National Research Council. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press, 2012.

Near-term Challenges of SLR

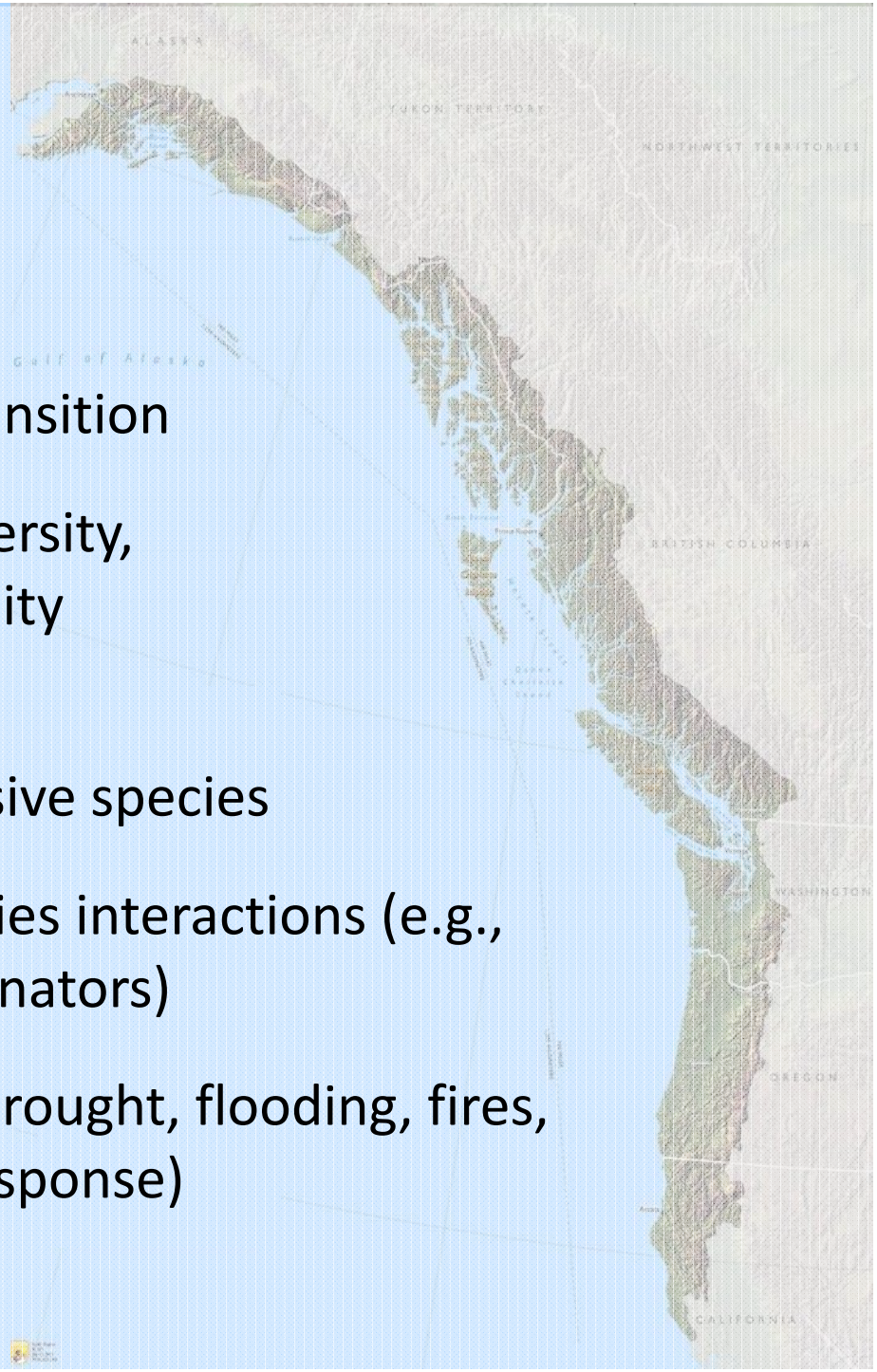
Sea level rise increases storm surge and the risk of:

- flooding,
- erosion,
- habitat loss,
- toxics mobilization
- saltwater intrusion

These impacts will affect coastal areas *long before permanent inundation.*



Broadly speaking, we can expect….



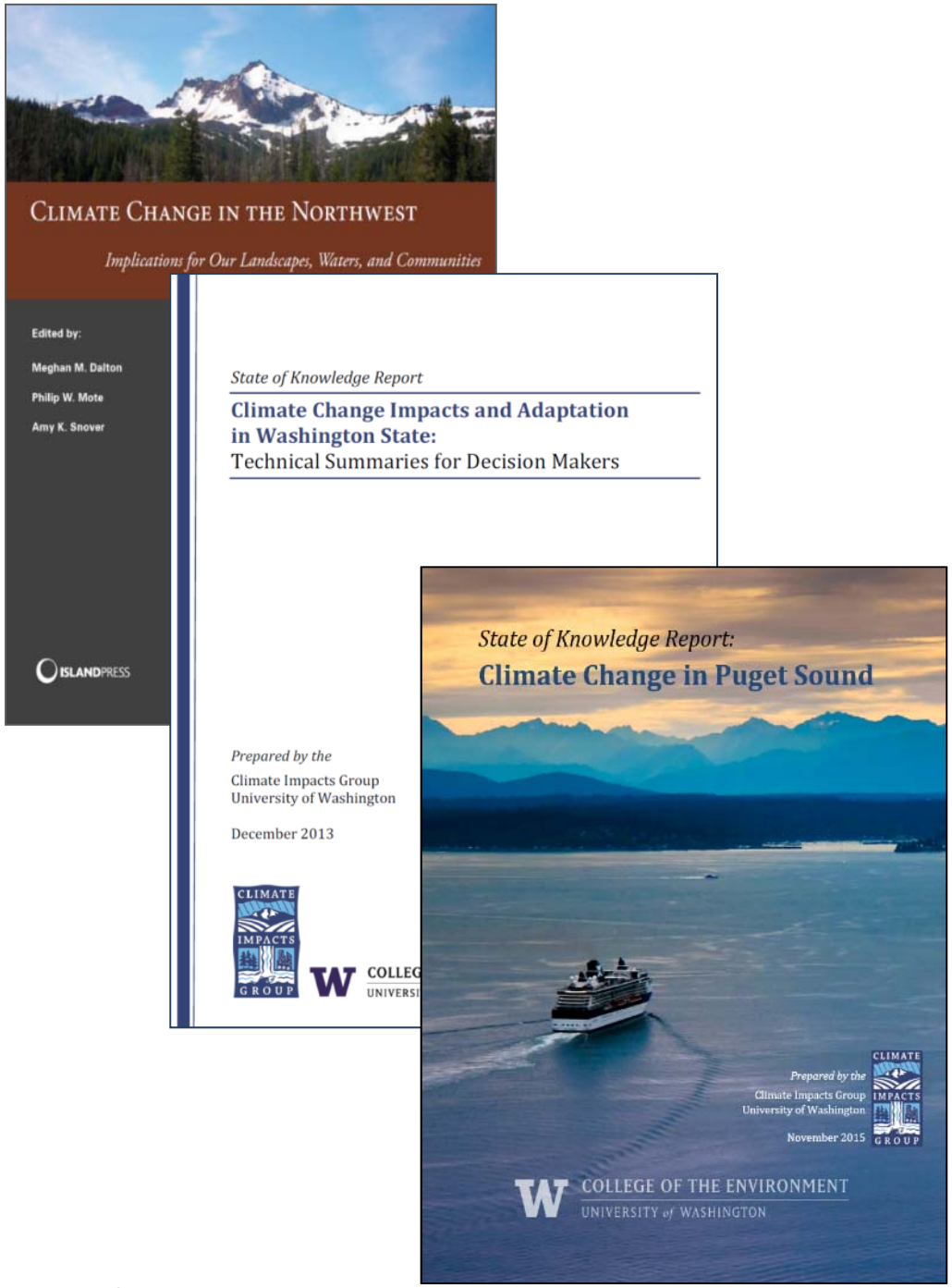
- Habitat loss, degradation, and transition
- Gains, losses, and shifts in biodiversity, ranges, abundance, and community composition
- Increased competition from invasive species
- Potential decoupling of interspecies interactions (e.g., predator/prey relationships, pollinators)
- Changes in ecological stressors (drought, flooding, fires, pollutant loading + the human response)

…and we can also expect…

- Exacerbation of many existing management challenges (along with new challenges)
- Changing policy, management, and fiscal priorities
- Changing goals and objectives (or at least changes in
- New species listings
- Changing stakeholder needs and priorities
- Changes in management approaches

New Meaning in a Changing Climate?

- **Maintain** – as it stands today? May require more effort, resources
- **Protect** – Protect as they exist today?
- **Preserve** – e.g. Mission Statement "*…conduct and apply research to preserve the areas ecological integrity…*"
- **Restoration** – to what conditions? At what cost?



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For more information…

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