Climate Change Impacts in the Puget Sound Region

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Snoqualmie Watershed Forum
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COLLEGE OF THE ENVIRONMENT
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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

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Northwest Climate Science Center


www.ci.snoqualmie.wa.us


Steve Ringman/The Seattle Times


WARNER BROS

Reframing the “Bad News”

We need to know
– and we have the opportunity to know –
what lies ahead *if* we continue with
“business as usual”

Key Changes "Driving" Climate Change Impacts in the Puget Sound Region

Substantial warming

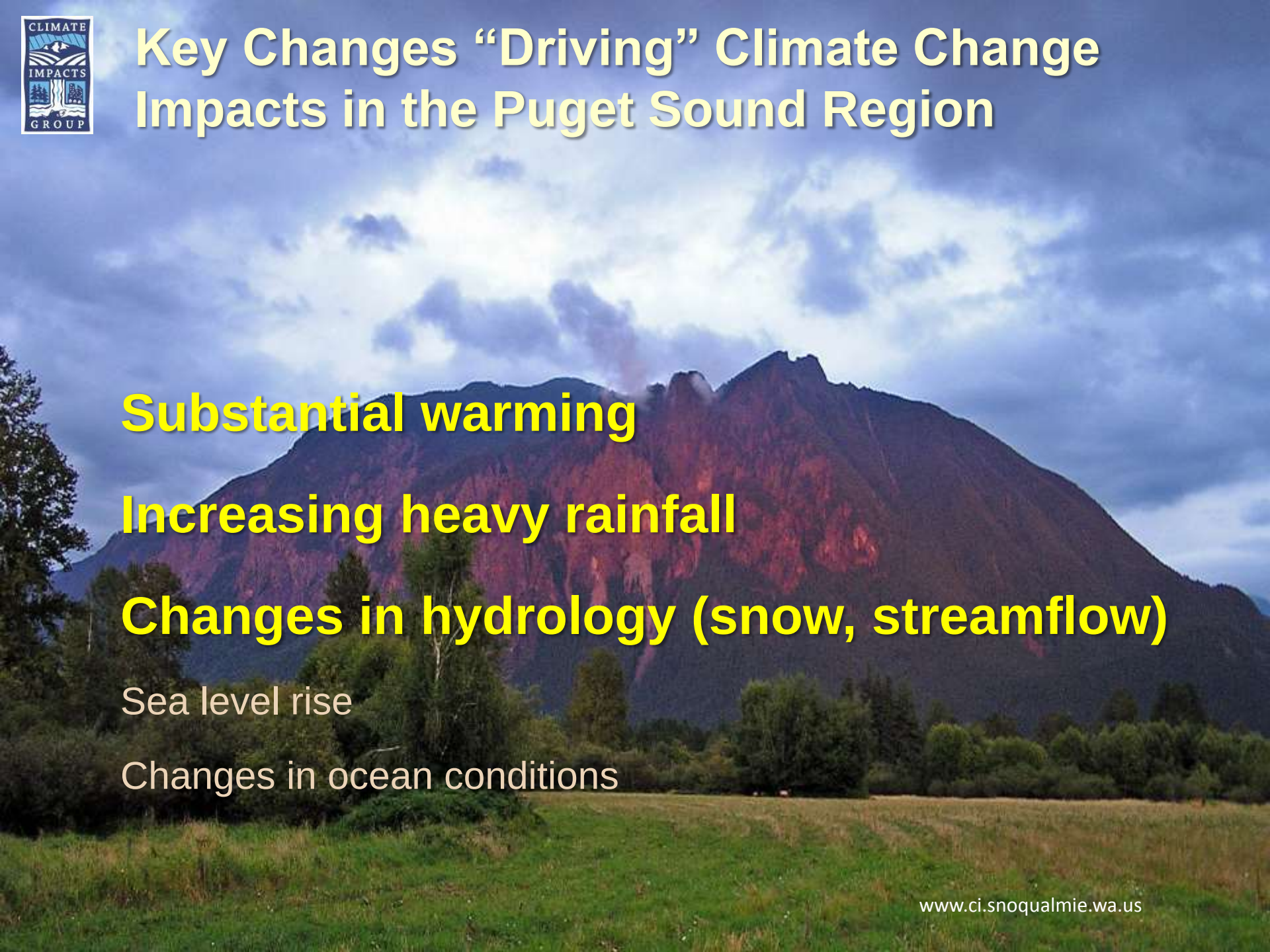
Increasing heavy rainfall

Changes in hydrology (snow, streamflow)

Sea level rise

Changes in ocean conditions

Key Changes "Driving" Climate Change Impacts in the Puget Sound Region



Substantial warming

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Projecting Future Climate:
Greenhouse Gas Emissions Scenarios

Different scenarios result in different climate change projections.

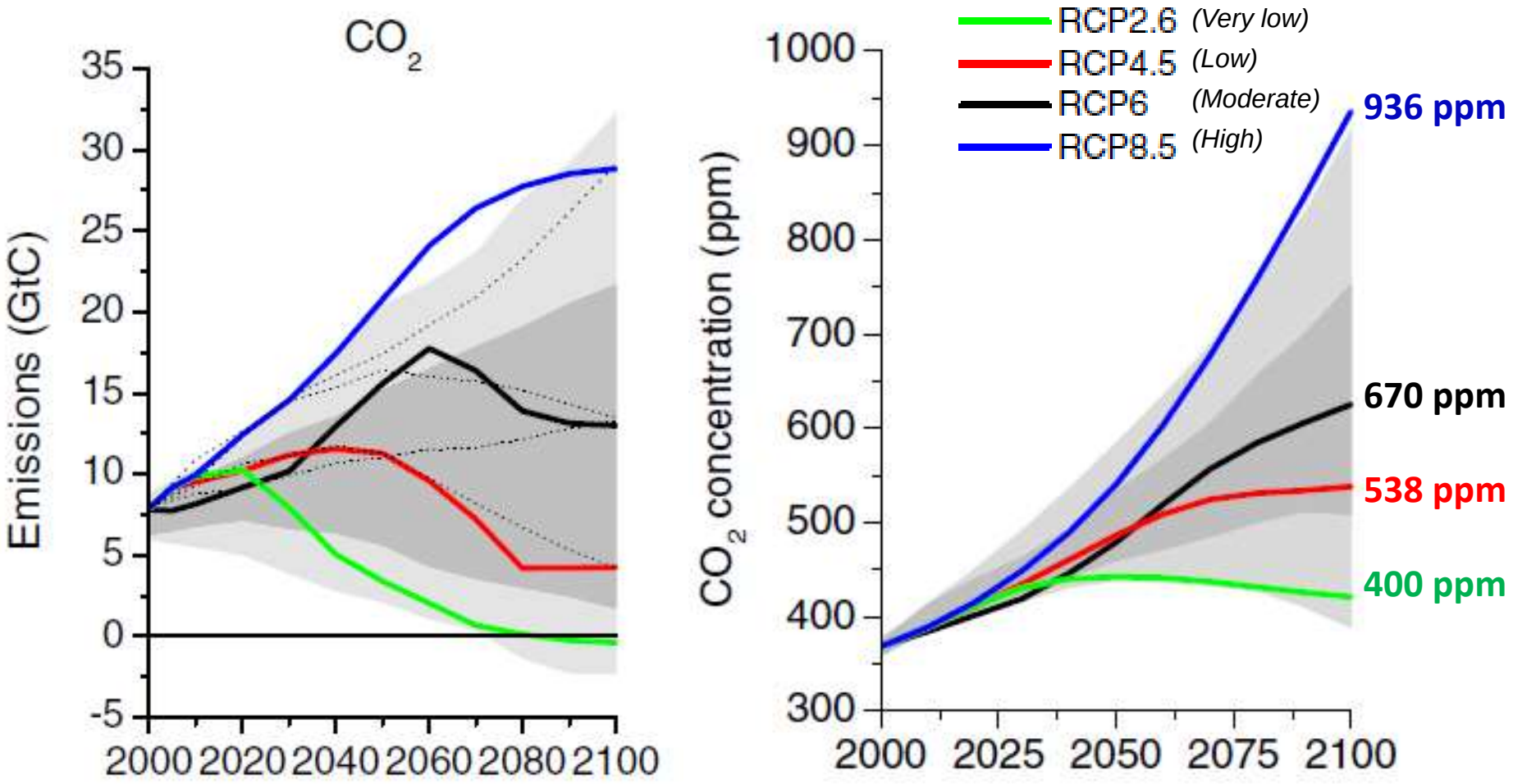


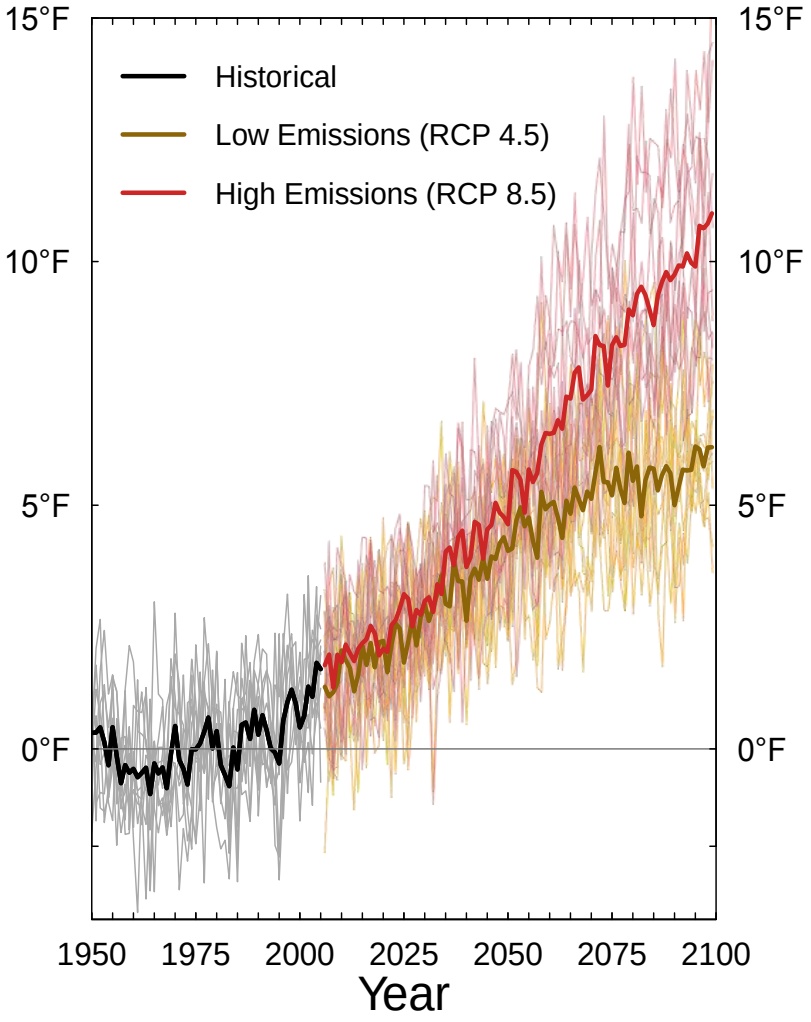
Figure source: van Vuuren 2011

Puget Sound

Substantial Warming, Variable Rainfall

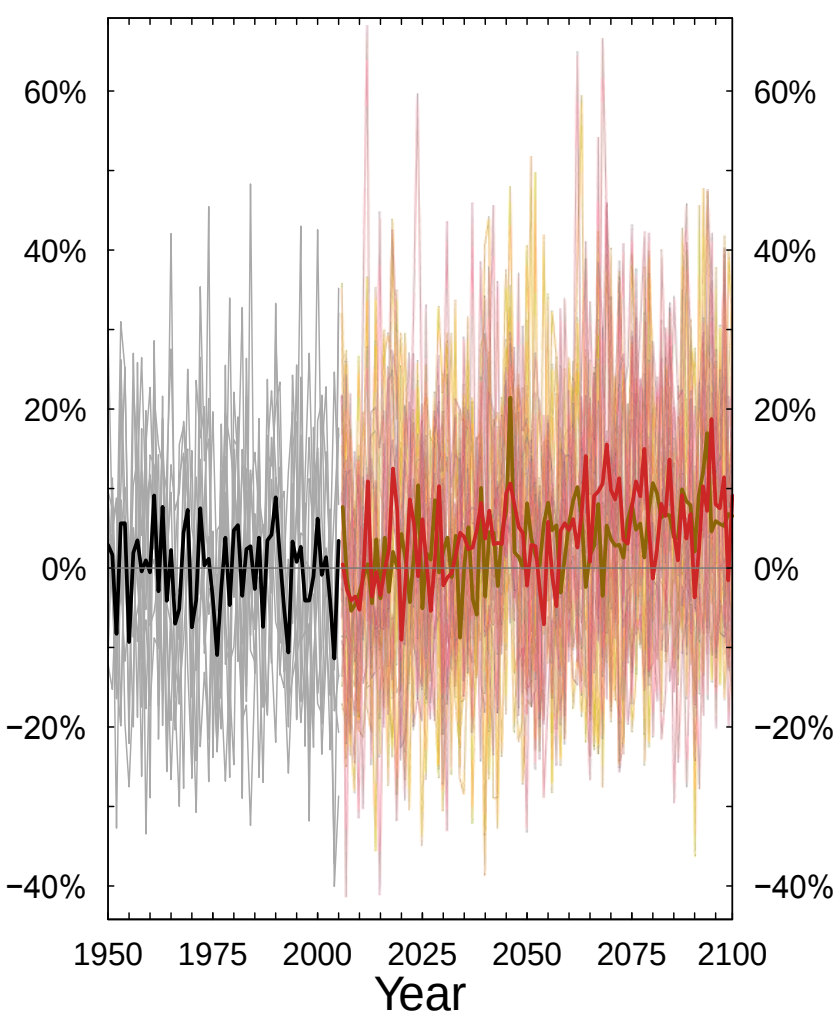
Temperature Difference

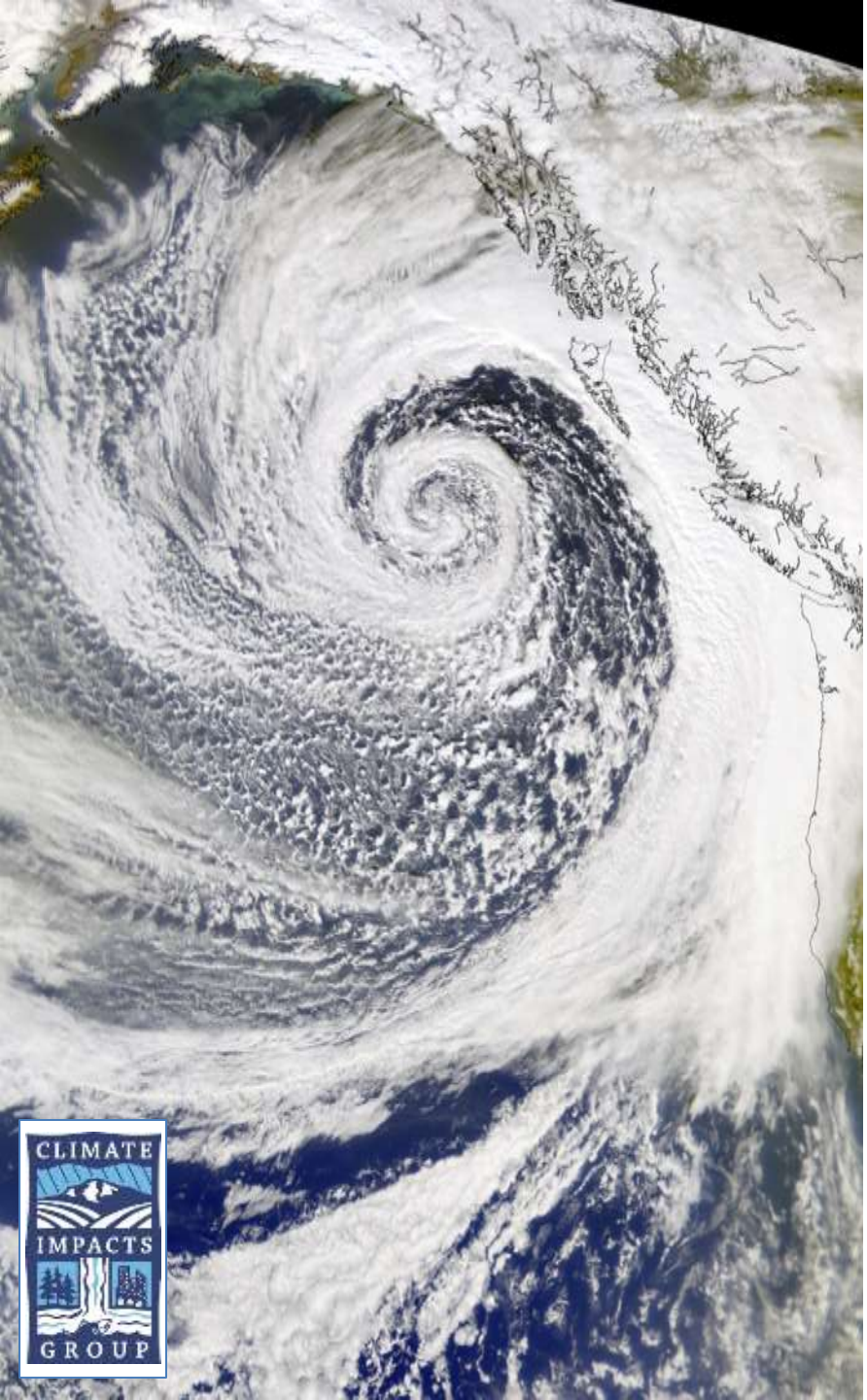
(Relative to 1950−1999 average)



Precipitation Change

(Relative to 1950−1999 average)





More Intense Heavy Rains

Heaviest 24-hour rain events, 2080s:

Higher intensity:

+22% (range: +5 to +34%)

Today's heaviest 24-hour rain events **occur more frequently**

1980s: 2 days / year

2080s: 7 days / year

Changes in Winter Atmospheric Rivers along the North American West Coast in CMIP5 Climate Models - Warner, Mass, Salathé, J Hydromet, 2014


Are these changes in climate big enough to matter?

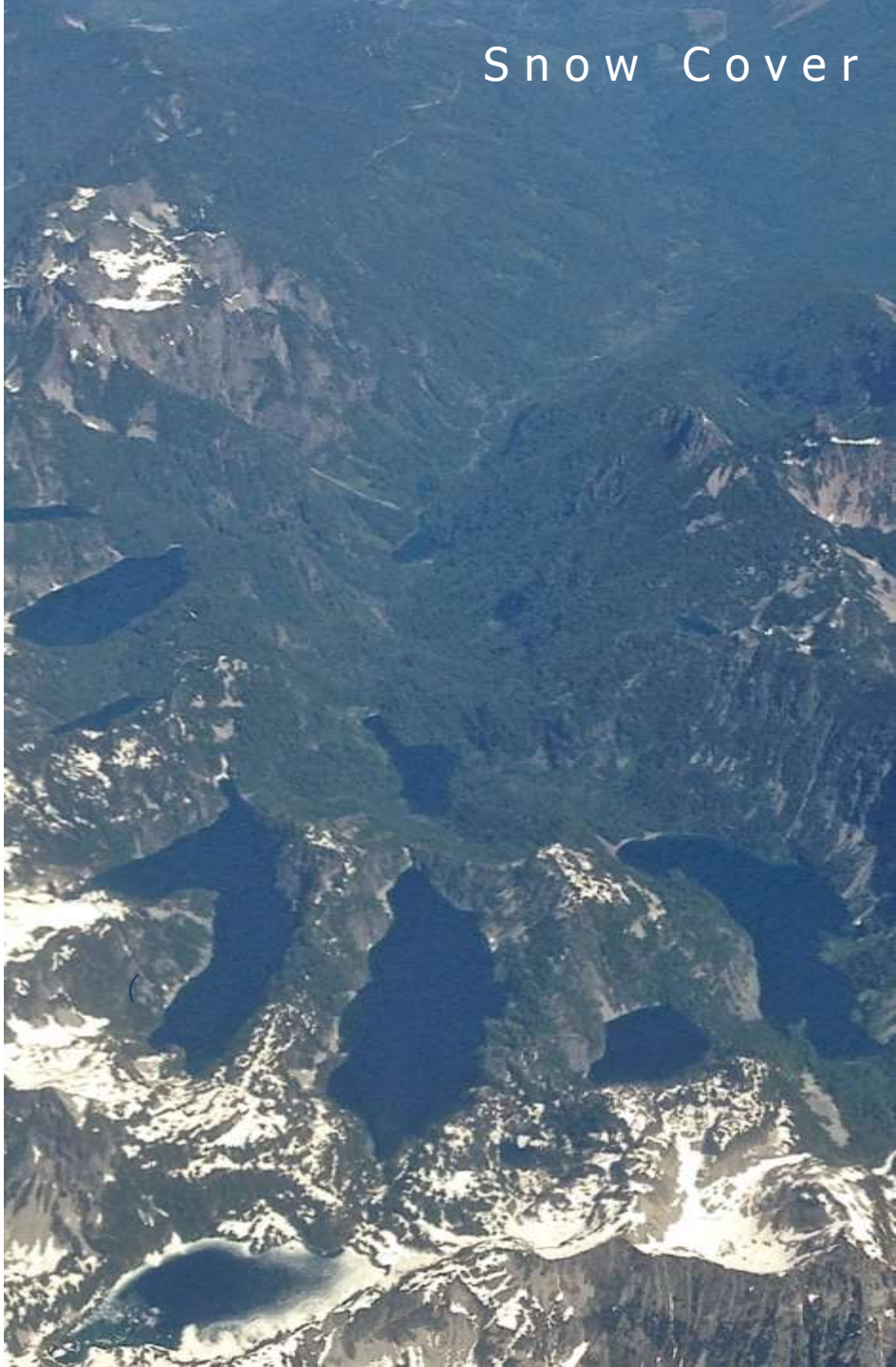
Embedded Expectations of "Normal" Climate

Land use planning
Infrastructure design
Operations and maintenance
Regulations ***(coming in and going out)***
Compliance with NPDES permits, CSOs
Non-point source management
Energy supply, transmission
Recreation & tourism
Habitat restoration
Emergency services
Risk management
Water supply

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.

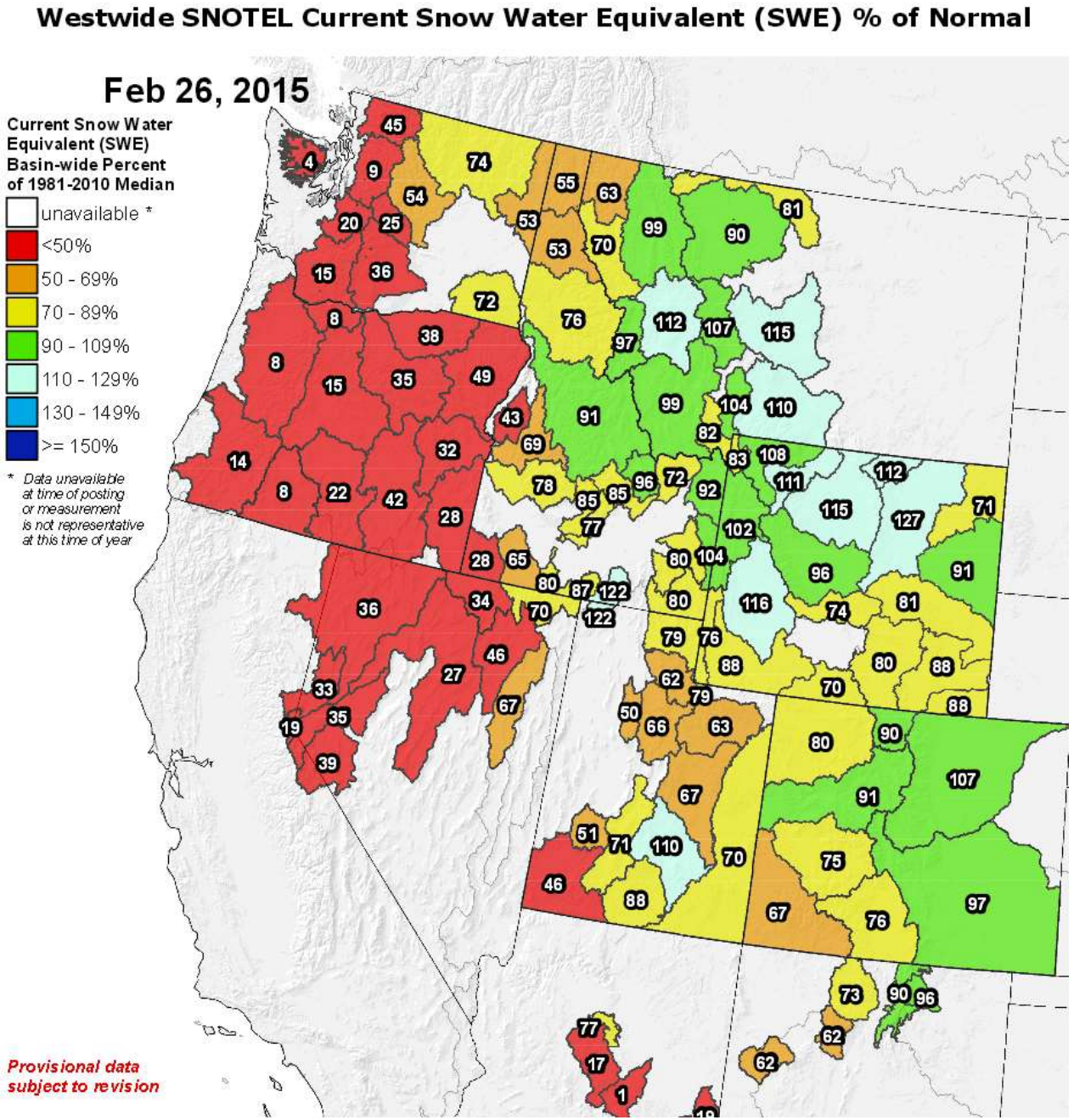
(Mote et al. 2008)



Avg temperature, October 2014 -March 2015:

+ 4.7 degrees above the 20th century long-term average (warmest on record for WA)

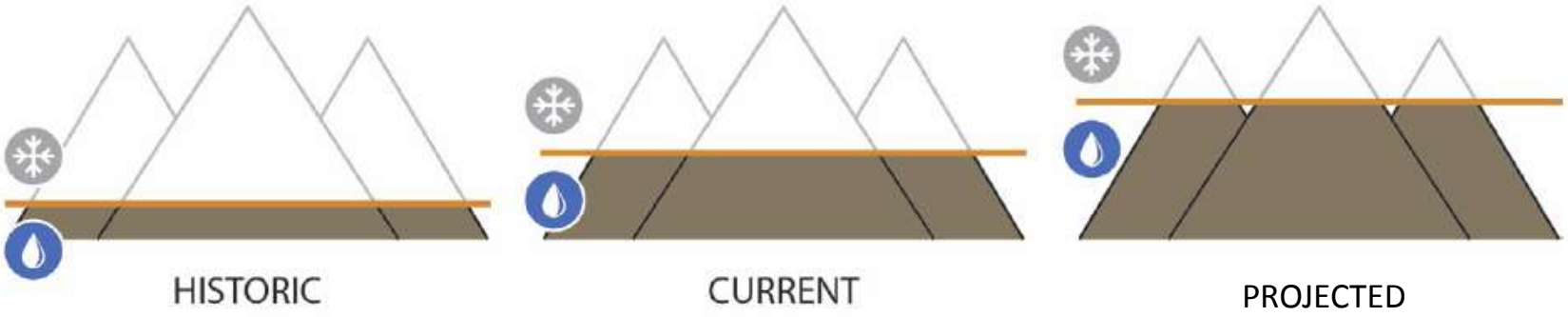
Office of the WA State Climatologist



USDA NRCS

http://www.wcc.nrcs.usda.gov/ftpref/support/drought/dmrpt-20150226.pdf

All Scenarios Indicate Less Snow



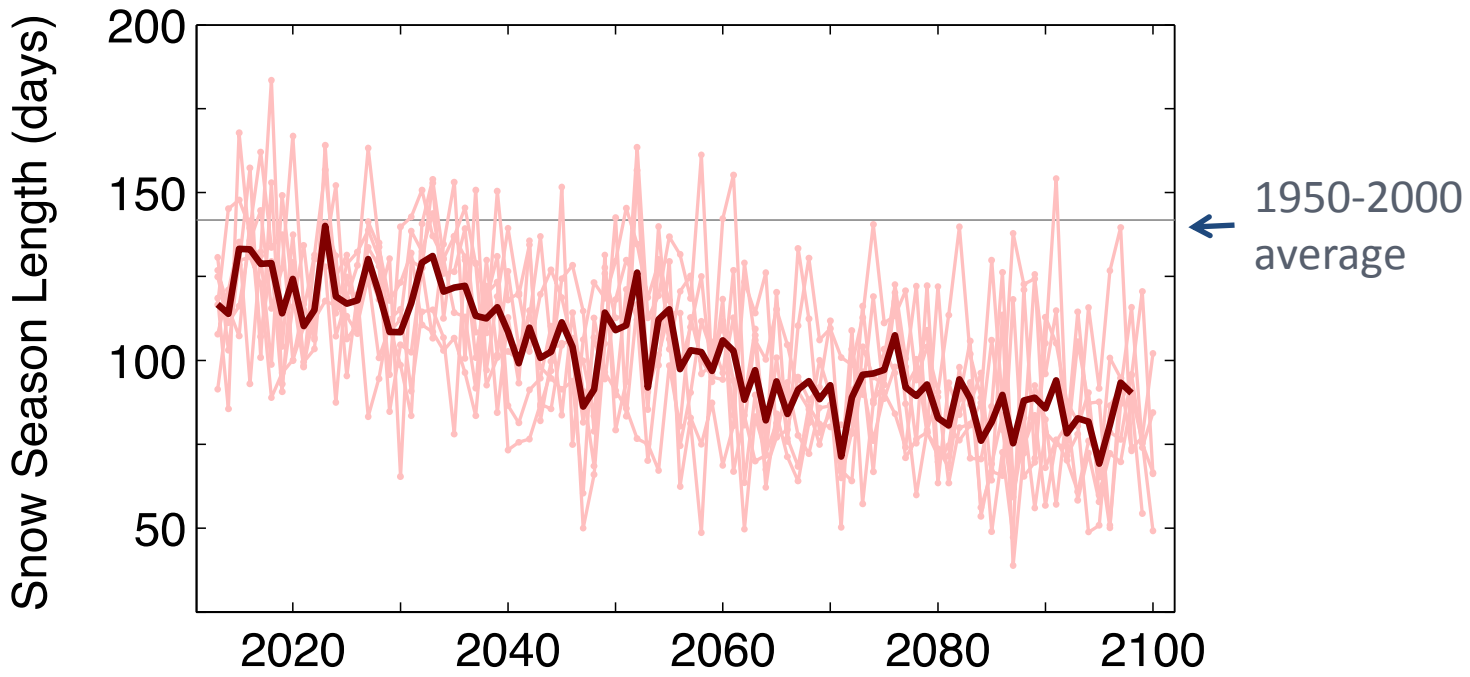
Projected loss in April 1 snowpack,
Puget Sound region:

2050s: -29%
2080s: - 55%

Mauger et al. 2015; figure source: Skagit Climate Science Consortium;

Variability Remains Part of the Story: Continued Fluctuations in the Long Term Trend

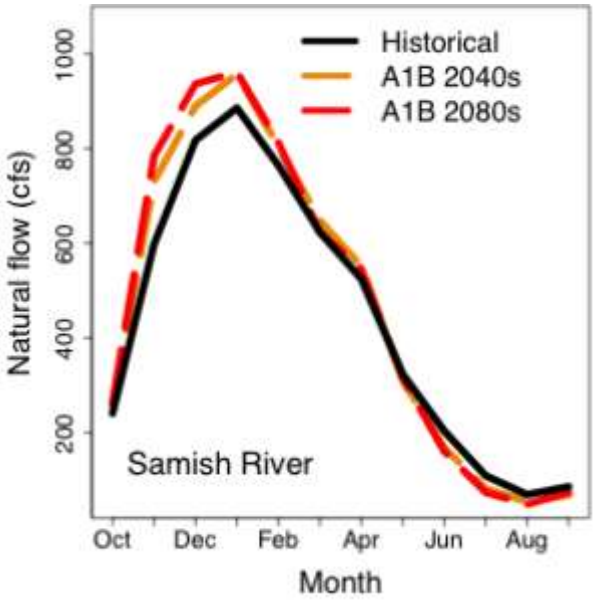
Length of Snow Season at 4000-5000 ft. in the Cascades
(Approx. elevation of Baker, Stevens, Crystal)



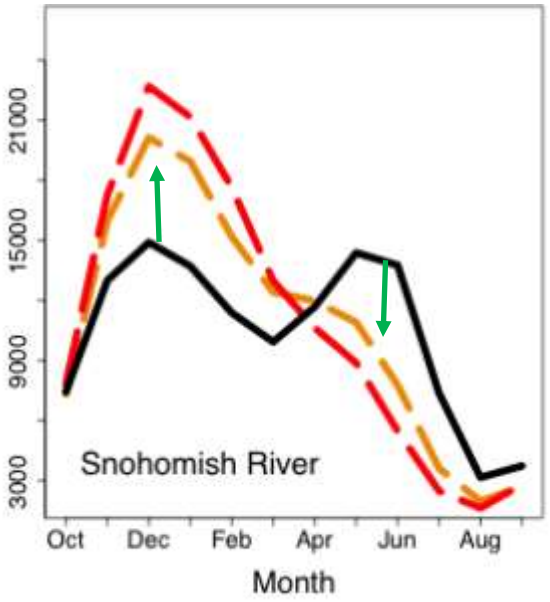
Source: Hamlet et al. 2013, http://www.hydro.washington.edu/2860/.

Hydrology is most affected in basins that historically accumulated snow

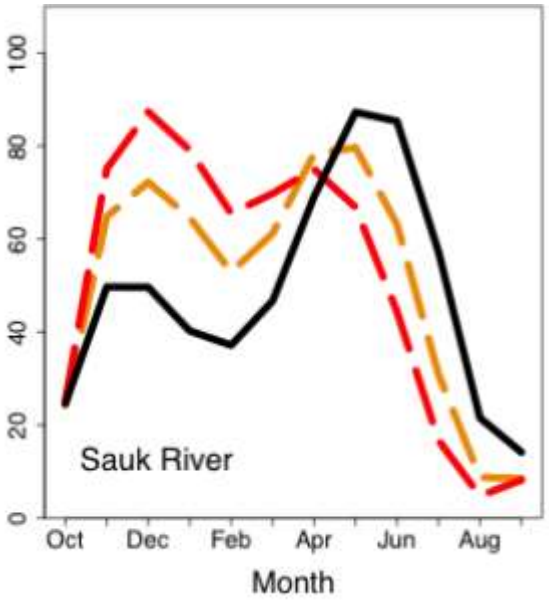
Rain dominant



Mixed rain and snow



Snow dominant



<u>Important caveats:</u>

Naturalized flows (flows without the influence of dams)

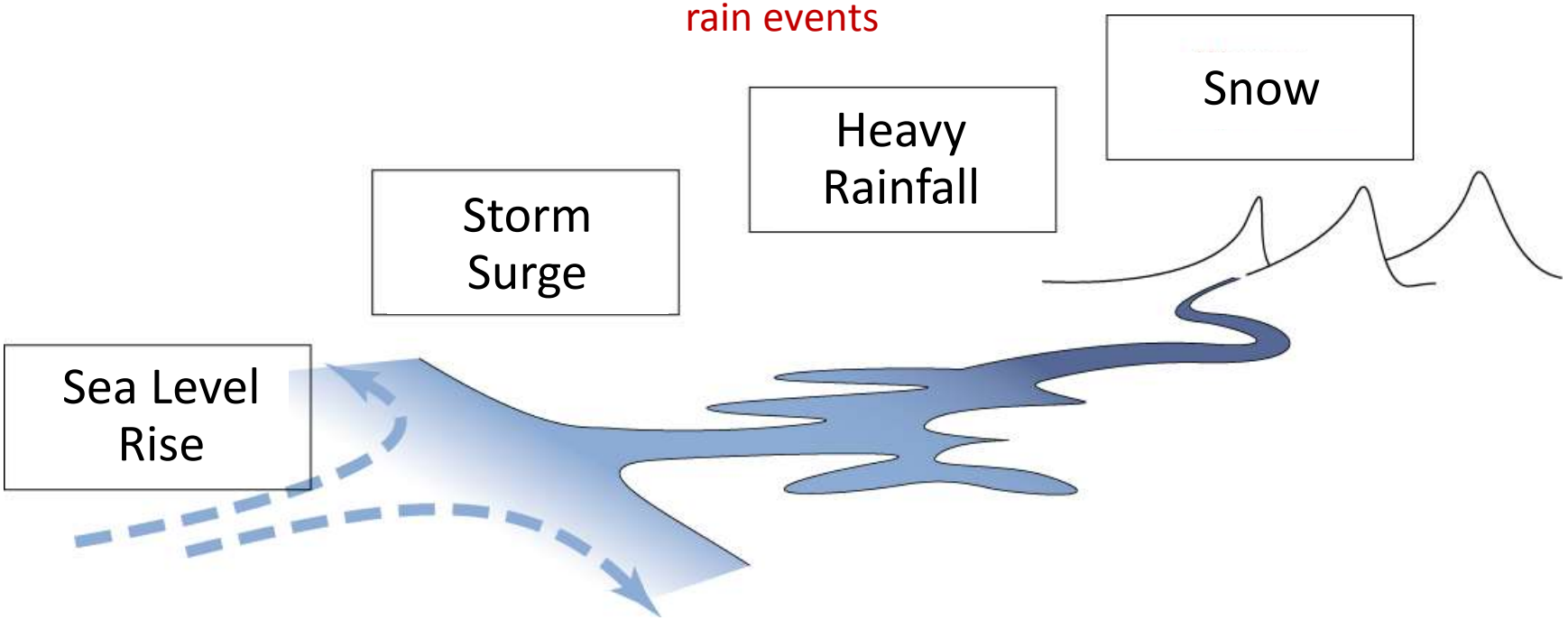
Does not include atmospheric river events (important in rain, mixed rain-and-snow basins)

Mauger et al. 2015

Climate Change and Flooding: Physical Drivers

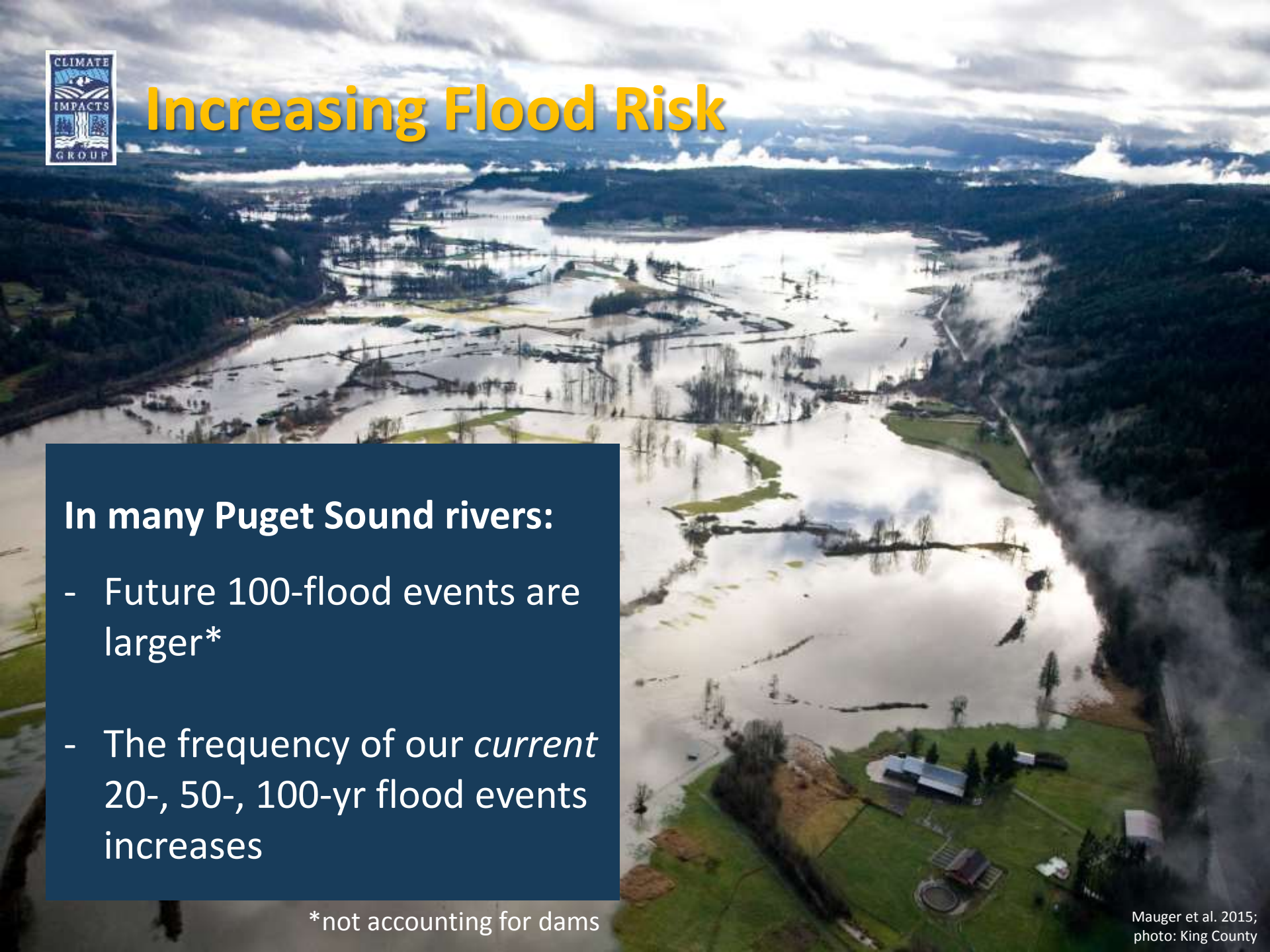
Extreme events:
More frequent heavy rain events

Seasonal changes:
Less snow, more rain



"Triple Whammy"

Increasing Flood Risk



In many Puget Sound rivers:

- Future 100-flood events are larger*

- The frequency of our *current* 20-, 50-, 100-yr flood events increases

*not accounting for dams

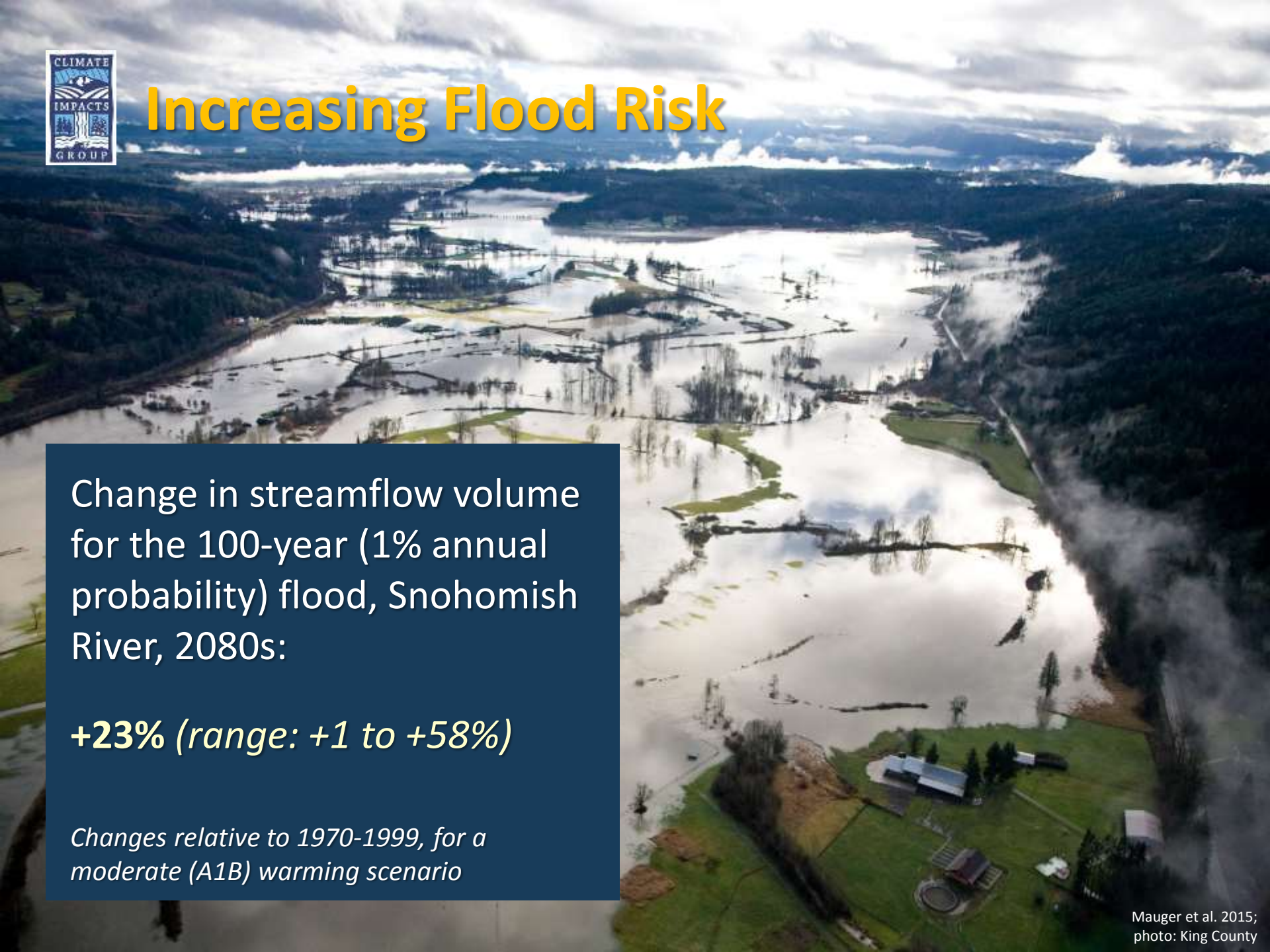
Mauger et al. 2015;
photo: King County

Increasing Flood Risk

Change in streamflow volume for the 100-year (1% annual probability) flood, Snohomish River, 2080s:

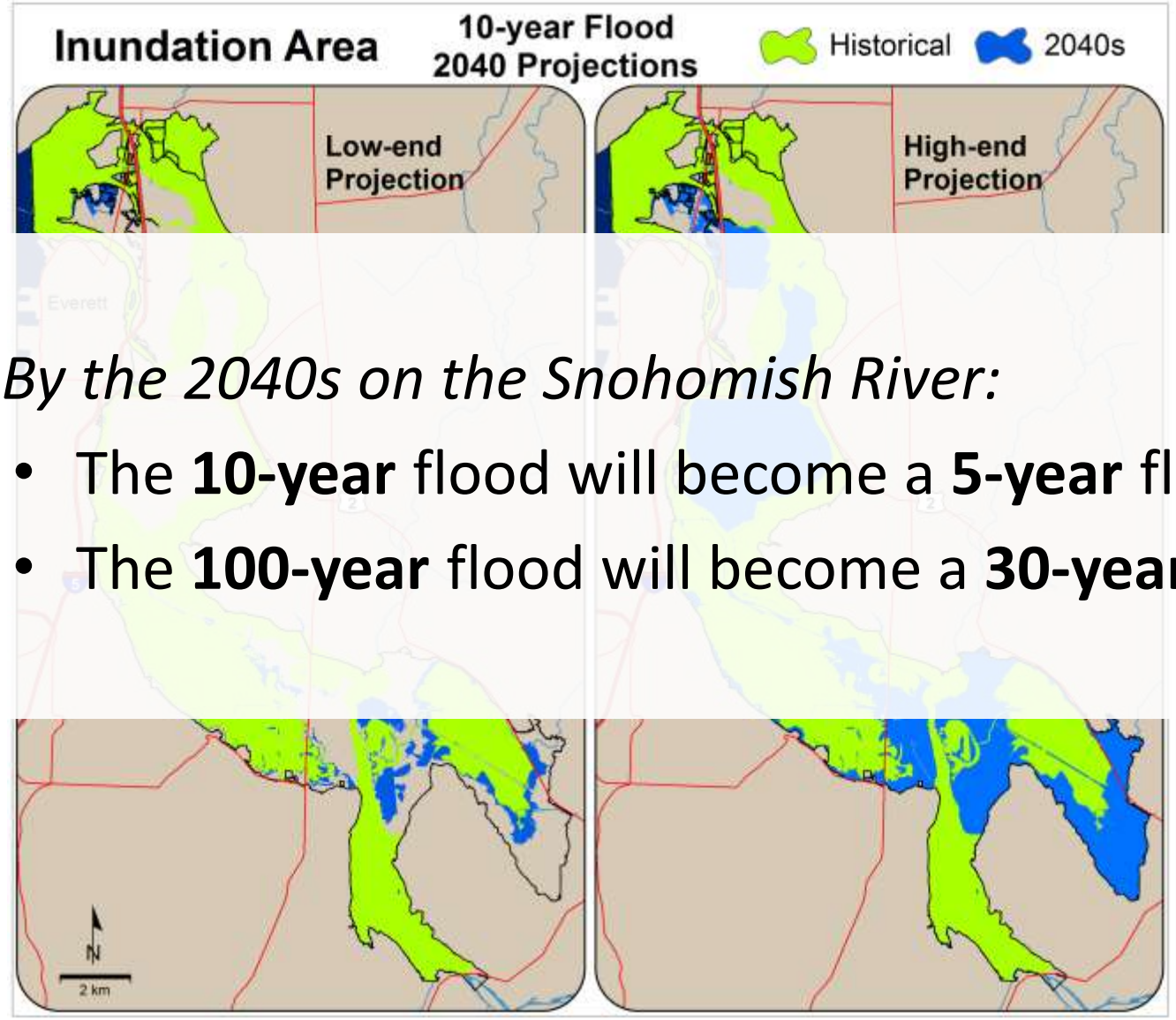
+23% *(range: +1 to +58%)*

Changes relative to 1970-1999, for a moderate (A1B) warming scenario



Mauger et al. 2015;
photo: King County

Flooding: Snohomish River



By the 2040s on the Snohomish River:

- The **10-year** flood will become a **5-year** flood
- The **100-year** flood will become a **30-year** flood

Change in Flooded Area: 100-yr event (2080s)

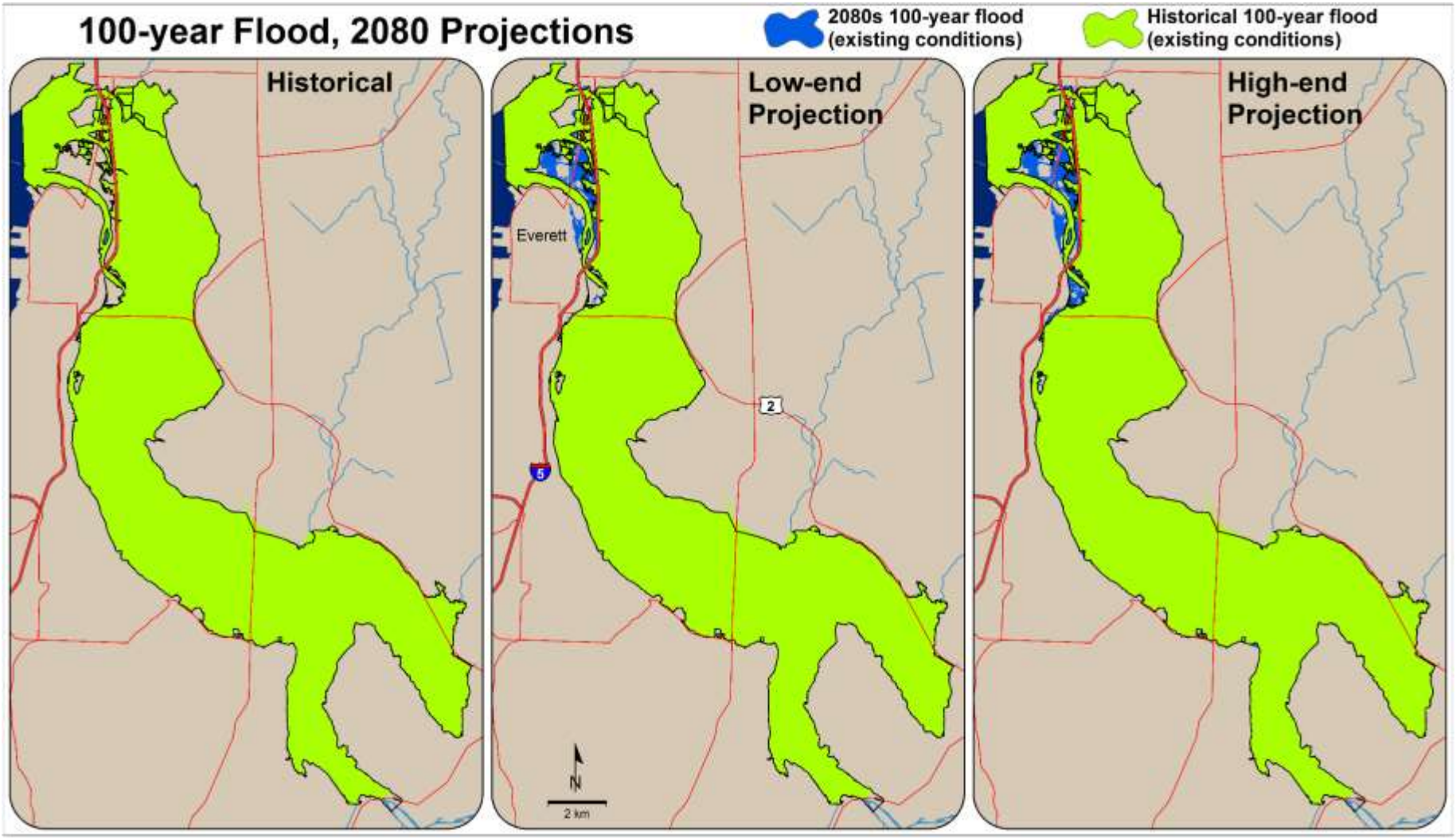
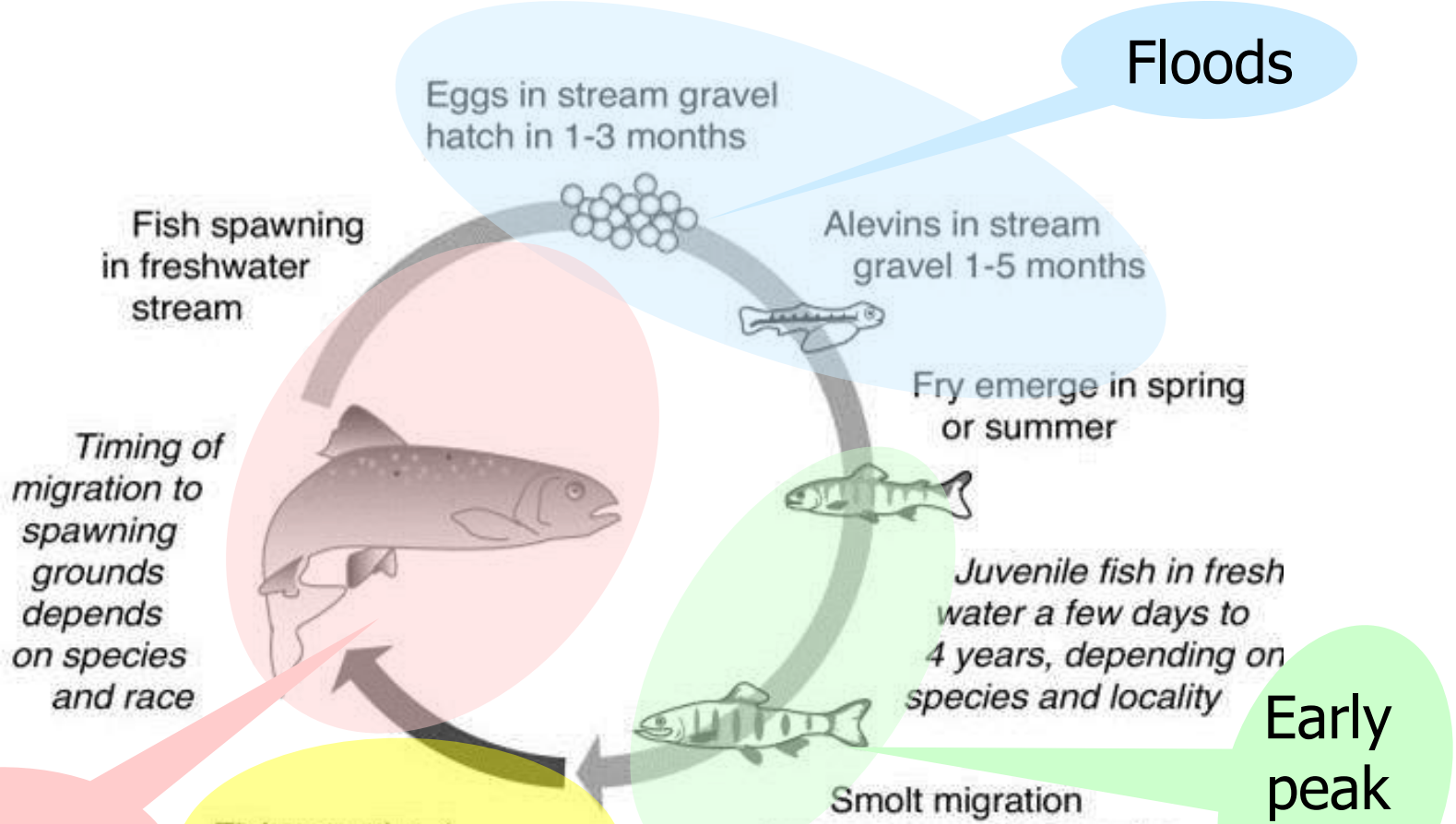


Figure source: Rob Norheim, Climate Impacts Group

Hydrologic Changes Affect Salmon Across Full Life-Cycle











PNW agriculture is fairly adaptable, although some crops and locations are more vulnerable

Key drivers of impacts (can be + or -):

- More winter precip – wetter fields?
- Increased summer heat stress
- Decreased summer water supply
- Longer growing season
- CO2 fertilization effect (initially?)
- Changes in plant diseases, pests, weeds
- Increased fire risk in rangelands
- Reduced nutritional quality and decreased digestibility

Potential Declines in Berry Production?

Chilling temperatures, water supply are key

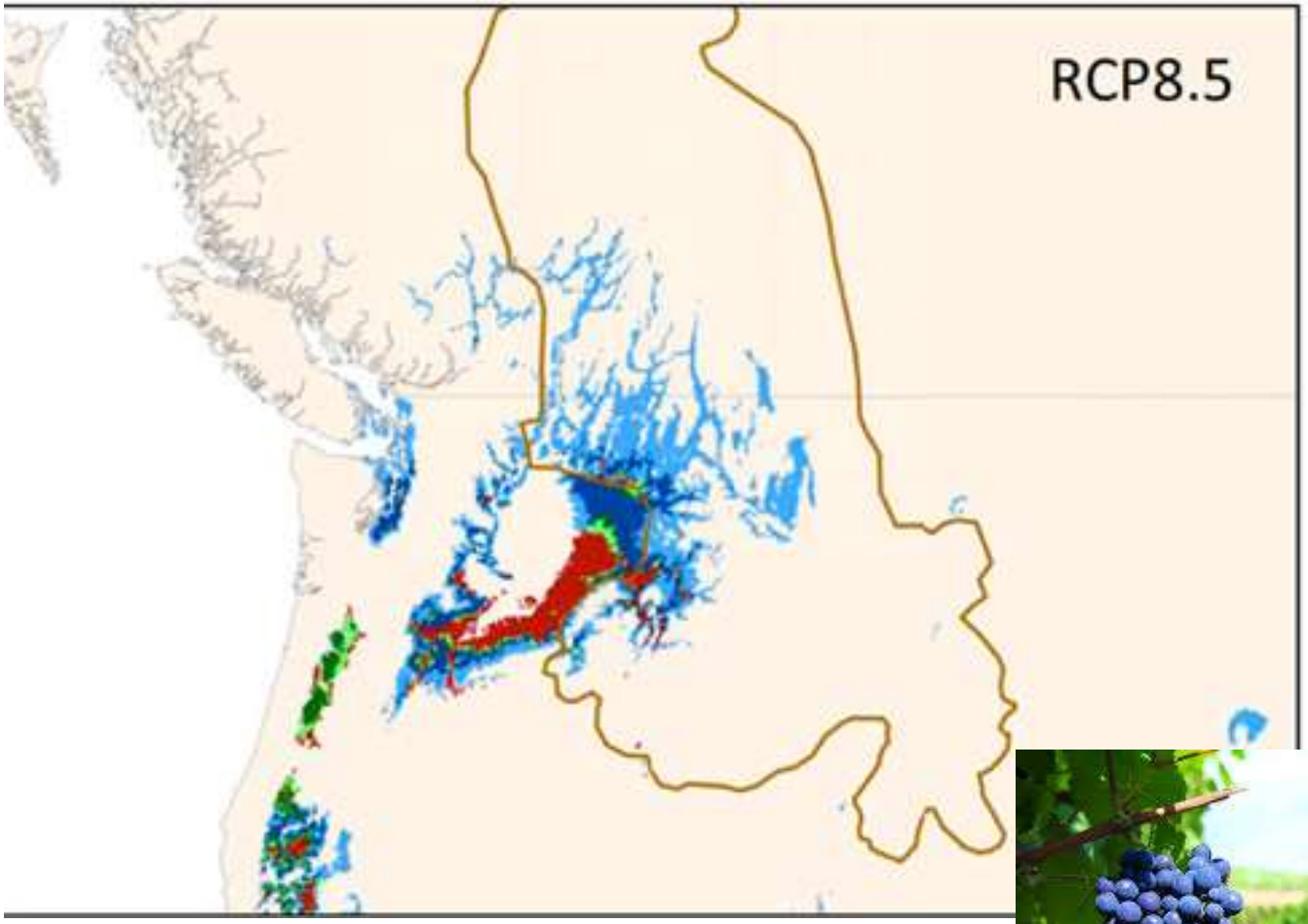
Extended periods between 32°F and 45°F are ideal for raspberry chilling

Warm air temperatures during winter may result in lower raspberry yields.

Changes in cultivars? Impacts on blueberries?

Mauger et al. 2015. Ch 8, Agriculture

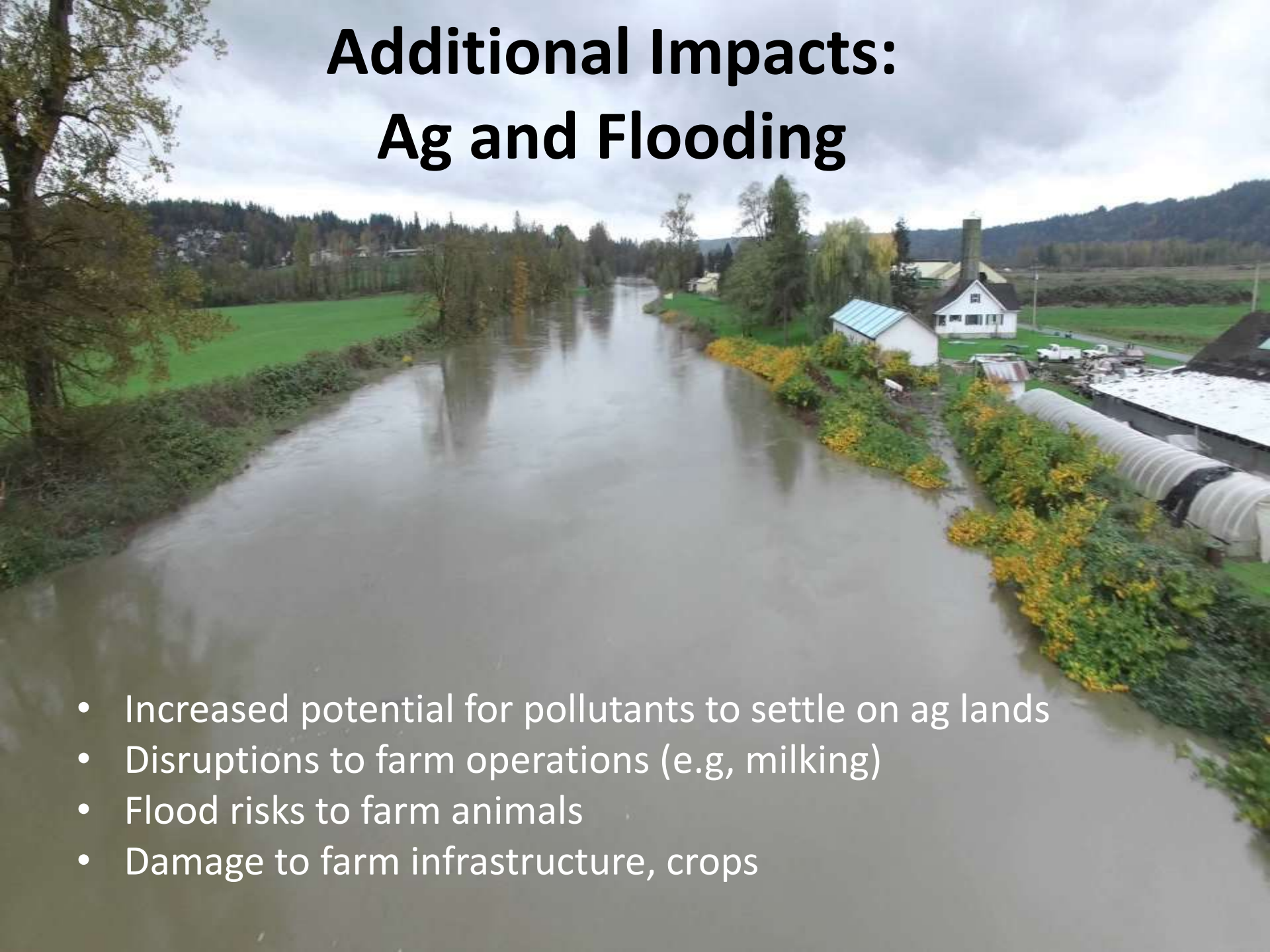
Growing Opportunities?



Current Suitability (lost 2050)
Suitability Retained >50% GCMs
Suitability Retained >90% GCMs
Novel Suitability >50% GCMs
Novel Suitability >90% GCMs

From Mauger et al 2015, see: Hannah et al. 2013

Additional Impacts: Ag and Flooding



- Increased potential for pollutants to settle on ag lands
- Disruptions to farm operations (e.g, milking)
- Flood risks to farm animals
- Damage to farm infrastructure, crops

Increased fire risk

Increased risk of insect outbreaks

Reduced suitability for key pine species

An aerial photo of the Paradise Fire shows smoke rising near the Queets River Sunday in the Olympic National Park. (U.S. Forest Service)

What are our choices for dealing with this reality?

[Not a recommended course of action]

Mitigation *and* adaptation are required

+

Mitigation

Reducing emissions of greenhouse gases

Adaptation

Preparing for and managing the change that occurs as mitigation strategies are implemented.

Adaptation Planning: Answering "The Climate Question"

How does climate change affect what I am trying to accomplish?

Question relates to activities at any scale…

More specifically….

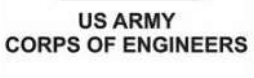
- Can we **achieve our goals** in a changing climate?
- How do we **protect our investments** as the climate changes?
- What is necessary to **reduce risks** associated with a changing climate?
- How do we **avoid creating new risks**?
- What **opportunities** should we prepare for?

General Adaptation Tools

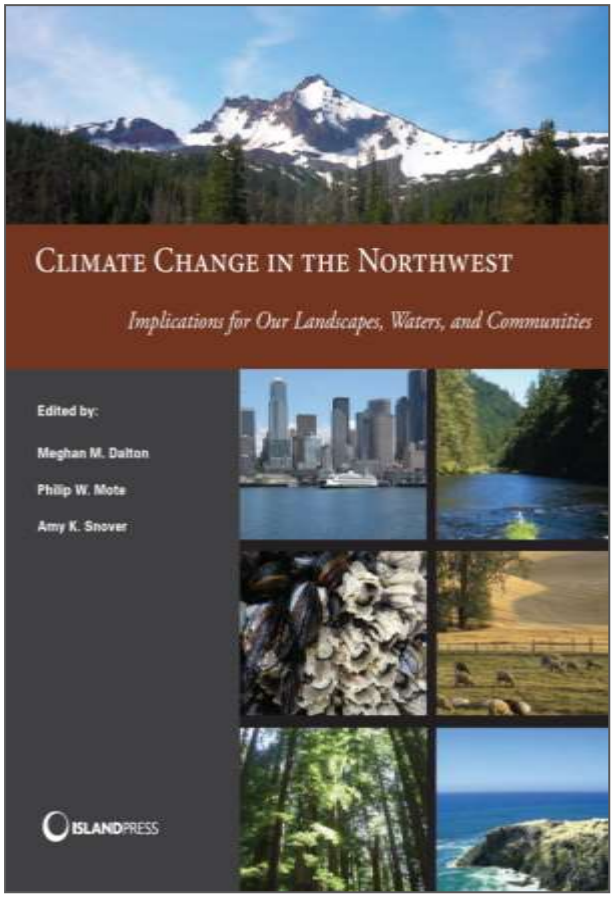
- Zoning rules and regulations
- Taxation (including tax incentives)
- Building codes/design standards
- Utility rates/fee setting
- Public safety rules and regulations
- Issuance of bonds
- Infrastructure development
- Permitting and enforcement
- Best management practices
- Outreach and education
- Emergency management powers
- Partnership building with other communities



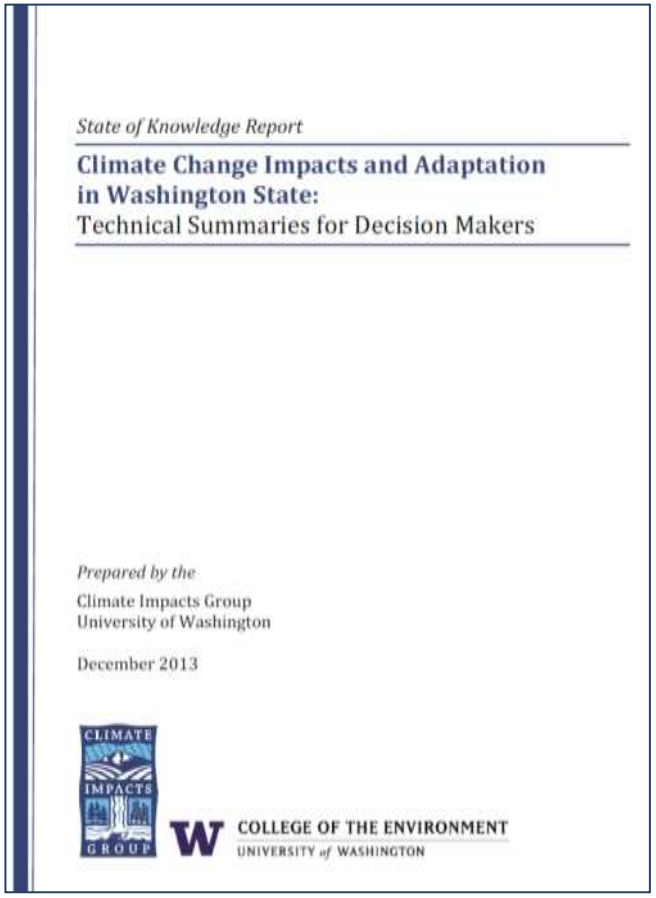
Who is Working on Climate Resilience in WA? (sample)



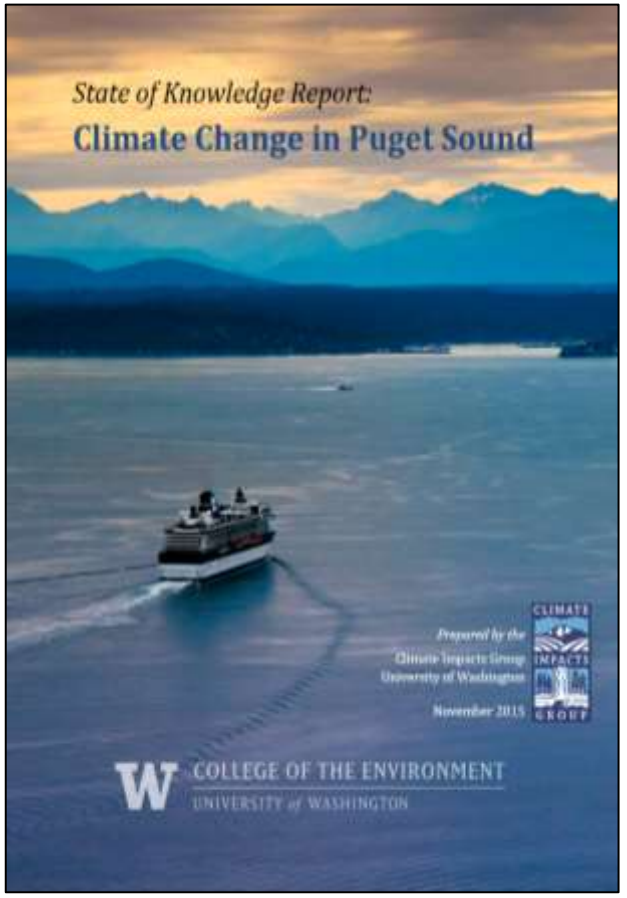
Resources to support decision making



Dalton et al. 2013



Snover et al. 2013



Mauger et al. 2015

Available for download at https://cig.uw.edu/

Final take-aways….

Regional climate is changing and continued rapid change is expected, absent significant reductions in greenhouse gas emissions

Climate change will have important implications for the build and natural environment in the Puget Sound region.

We have the knowledge, tools, data, and need to start preparing for climate change.

The Climate Impacts Group

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Sea Level Rise Projected in All Scenarios by 2100

Projected Range, Seattle *Relative to 2000 (NRC 2012)*	
2030	+2.6 in. *(range: -1.5 to +8.8 in.)*
2050	+6.5 in *(range: - 1.0 to +18.8 in)*
2100	+24.3 *(range: +3.9 to +56.3 in)*