Preserving Assets in a Changing Environment

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Presentation Overview

- Managing transportation assets:
  Context for decision-making and planning for the future
- What does the future look like:
  The Washington State Climate Change Impact Assessment
- Current and future strategies

Governor's Climate Change Challenge

Executive Order 07-02 (2007)

- Reduce emissions
- Adapt to change
- Support our economy

Washington Governor Christine Gregiore's Executive Order 09-05 on Climate Change

Effective 05/21/2009

- Directs the Department of Ecology to invite the Washington State Association of Counties and the Association of Washington Cities to collaborate in conducting an evaluation and develop recommendations for addressing climate change impacts.

- Evaluate the potential impacts of sea level rise on the state's shoreline areas, including:

  - the potential increases in storm surge and coastal flooding;
  - increased erosion;
  - loss of habitat and ecosystems, and
  - develop recommendations for addressing these impacts.

2009 Washington State Legislature
Climate Change Adaptation Legislation

E2SSB 5560 – State Agency Climate Leadership *Effective 07/26/2009*

- Directs the Department of Ecology in consultation with the Department of Transportation and other agencies to develop an integrated climate change response strategy and plan of action to prepare for and adapt to climate change impacts

- Response strategy should include:

  • a range of scenarios for the purposes of planning in order to assess project vulnerability;

  • summarize the best known science on climate change impacts to Washington;

  • prioritize solutions that can be implemented;

  • identify recommended funding mechanisms;

  • identify barriers challenging state and local governments to take action; and

  • regional capacity to undertake actions;




Washington State Climate Change Impacts Assessment:

HB 1303 Key Findings

from

JISAO CSES Climate Impacts Group
University of Washington
Washington State University
Pacific Northwest National Laboratory

Climate science in the public interest

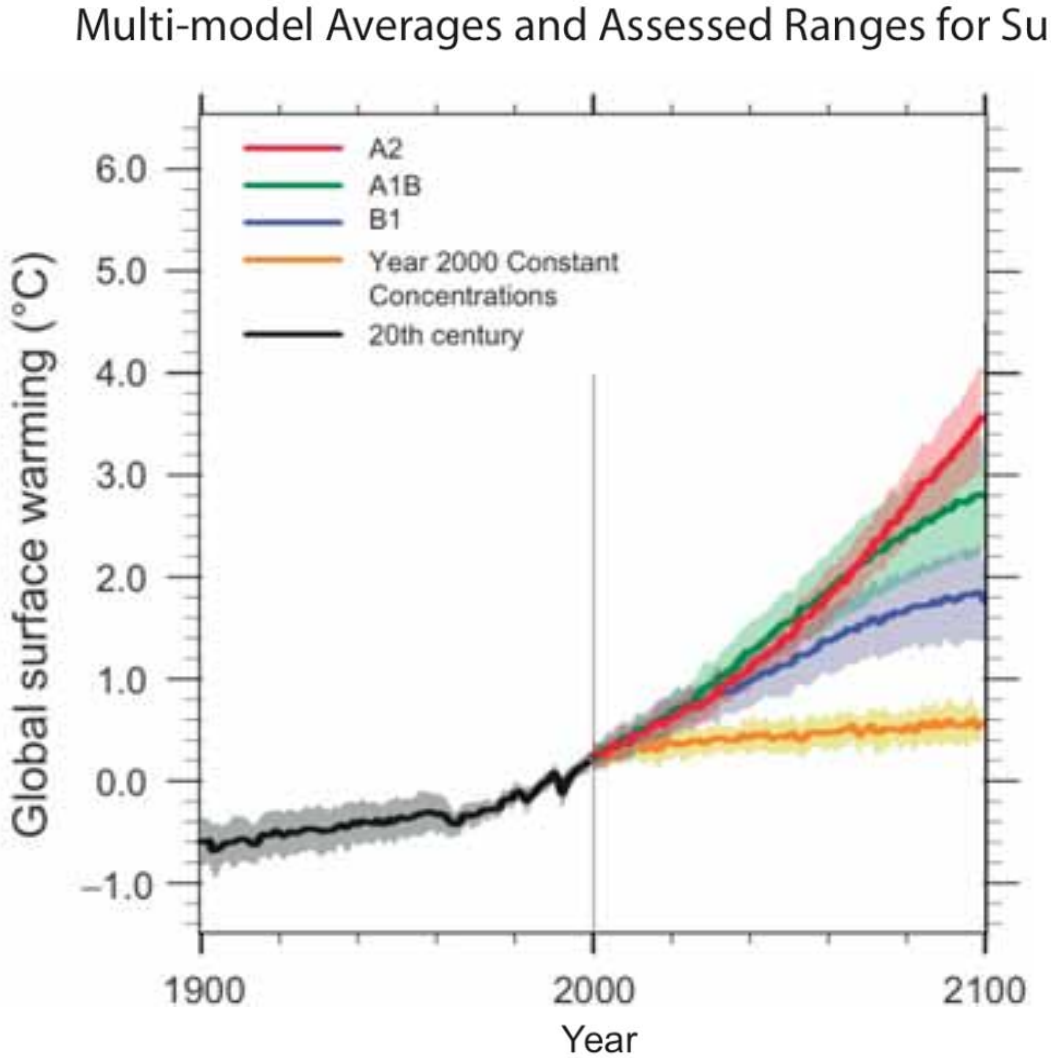




HB1303
Study Region

Focus is climate change impacts on Washington, but this requires attention to **regional** climate, hydrology, ecosystems, and economies.

Projected 21st Century Global Warming



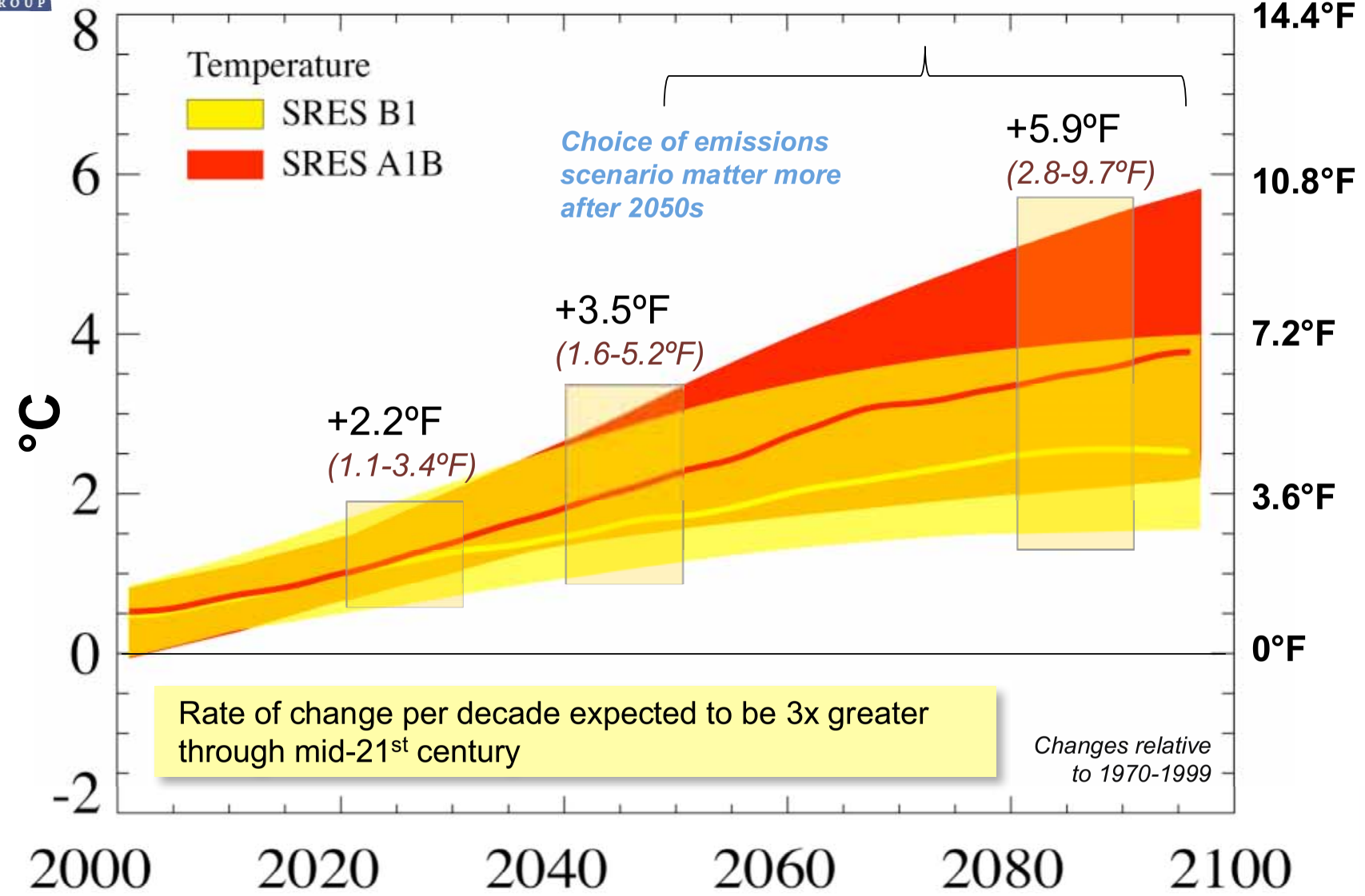
IPCC "best estimate" range of global-scale warming by the 2090s:

3.2°F-7.2°F

Warming expected through 21st century *even if CO2 emissions end today* due to persistence of greenhouse gases

Data source: IPCC 2001

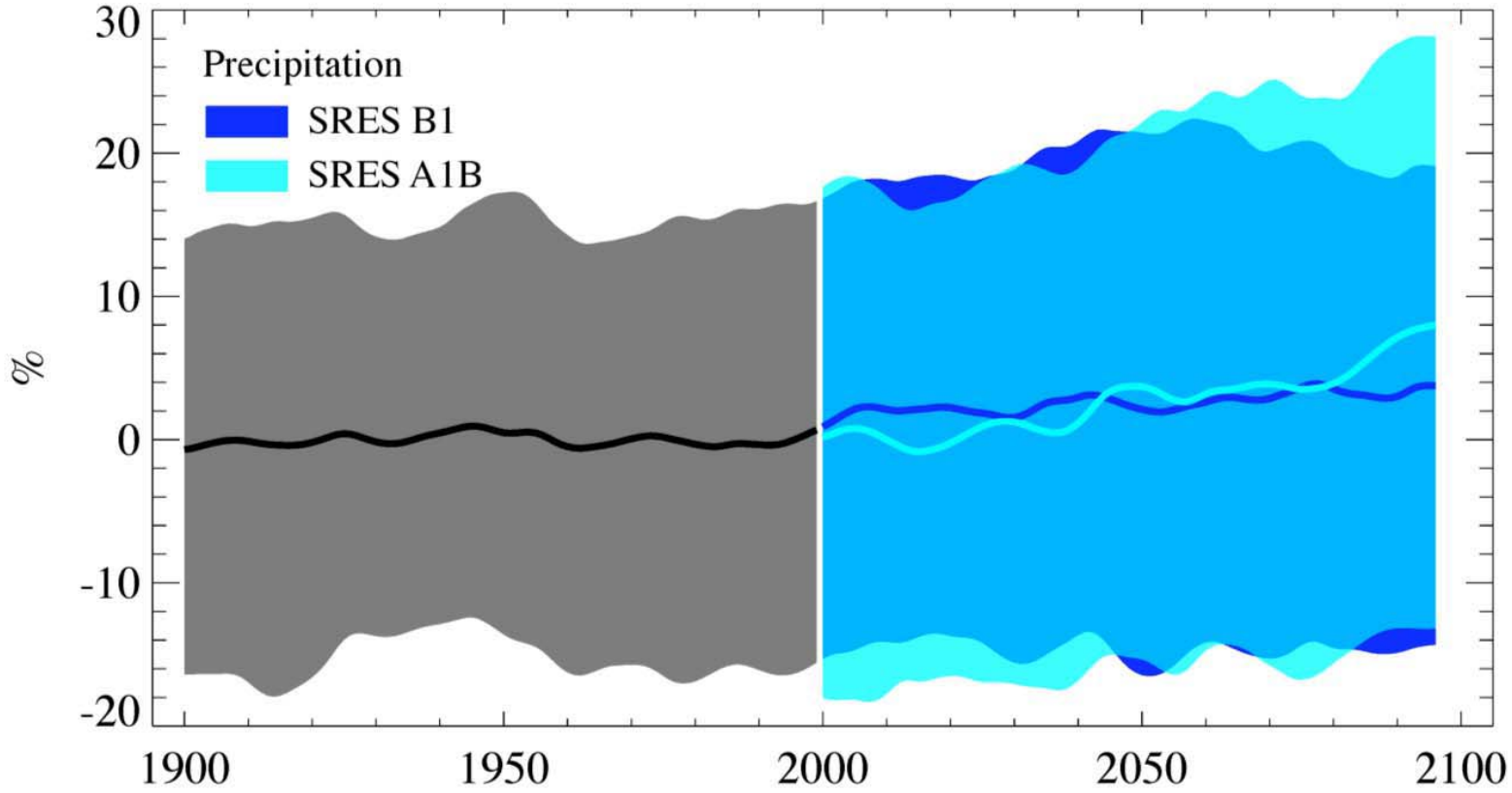
Projected Increases in PNW Temp



Mote and Salathé, 2009

Projected Changes in Annual Precipitation

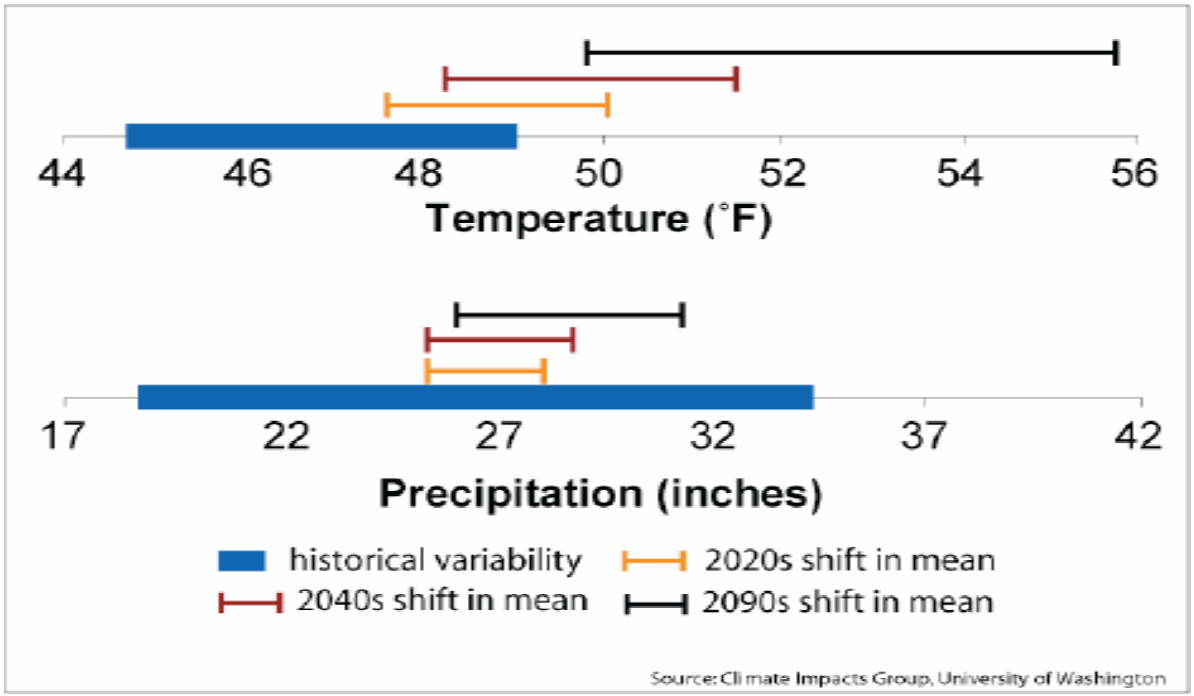
* Compared with 1970-1999 average



Changes in annual precipitation averaged over all models are small but some models show large seasonal changes, especially toward ***wetter autumns and winters*** and ***drier summers*.**

Mote and Salathé, 2009

Changes Relative to 20th Century

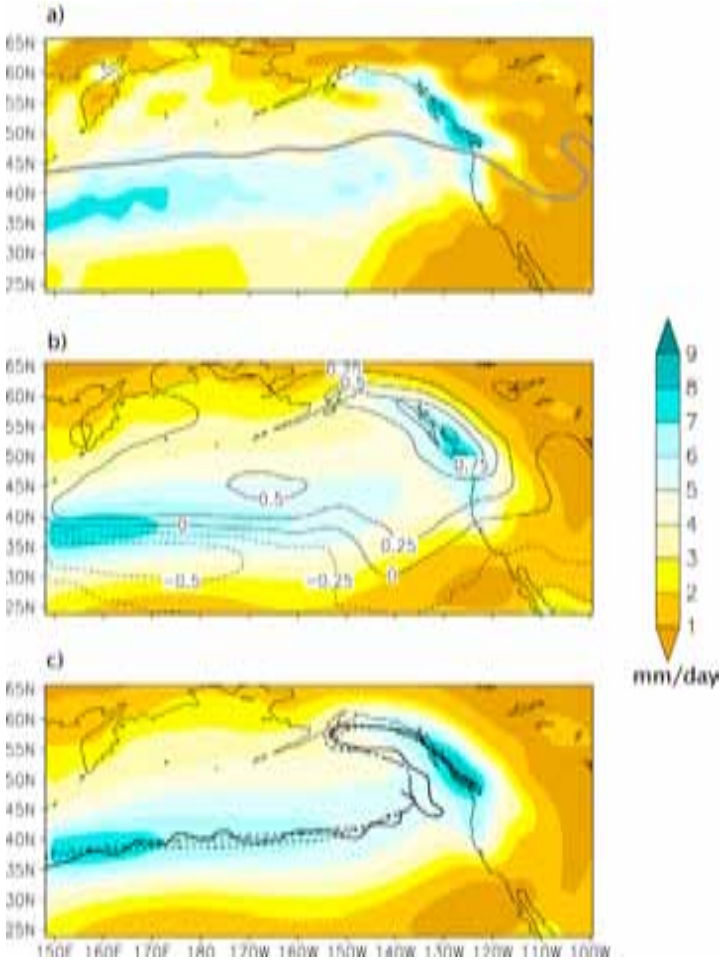


There is high confidence in projected temperature changes, less in precipitation changes.

Source: Climate Impacts Group, University of Washington

Potential Shift in Pacific Storm Track?

Observed



Increases in winter precipitation (Nov/Dec/Jan) likely in the 2nd half of the 21st century due to projected:

-- Intensification and widening of the Pacific storm track, and

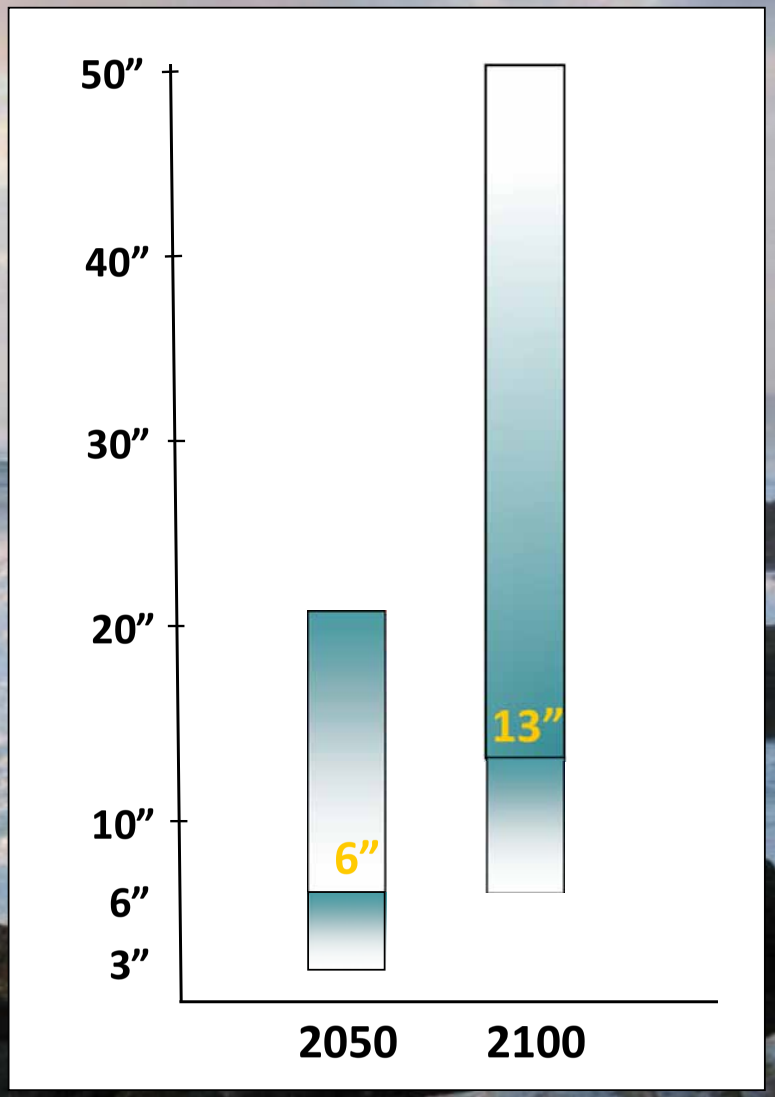
-- Shift northward of the storm track and Aleutian Low

Salathé, Geophys Res Lett, 2006

Coasts

Rising sea levels will increase the risk of flooding, erosion, and habitat loss along much of Washington's 2,500 miles of coastline.

- **Global SLR: 7-23" by 2100**
- **Medium** estimates of SLR for **2100:**
  +2" for the NW Olympic Peninsula
  +11" for the central/southern coast
  +13" for Puget Sound
- Higher estimates (up to 4 feet in Puget Sound) cannot be ruled out at this time.



Projected sea level rise (SLR) in Washington's waters relative to 1980-1999, in inches. Shading roughly indicates likelihood. The 6" and 13" marks are the SLR projections for the Puget Sound region and effectively also for the central and southern WA coast (2050: +5", 2100: +11").

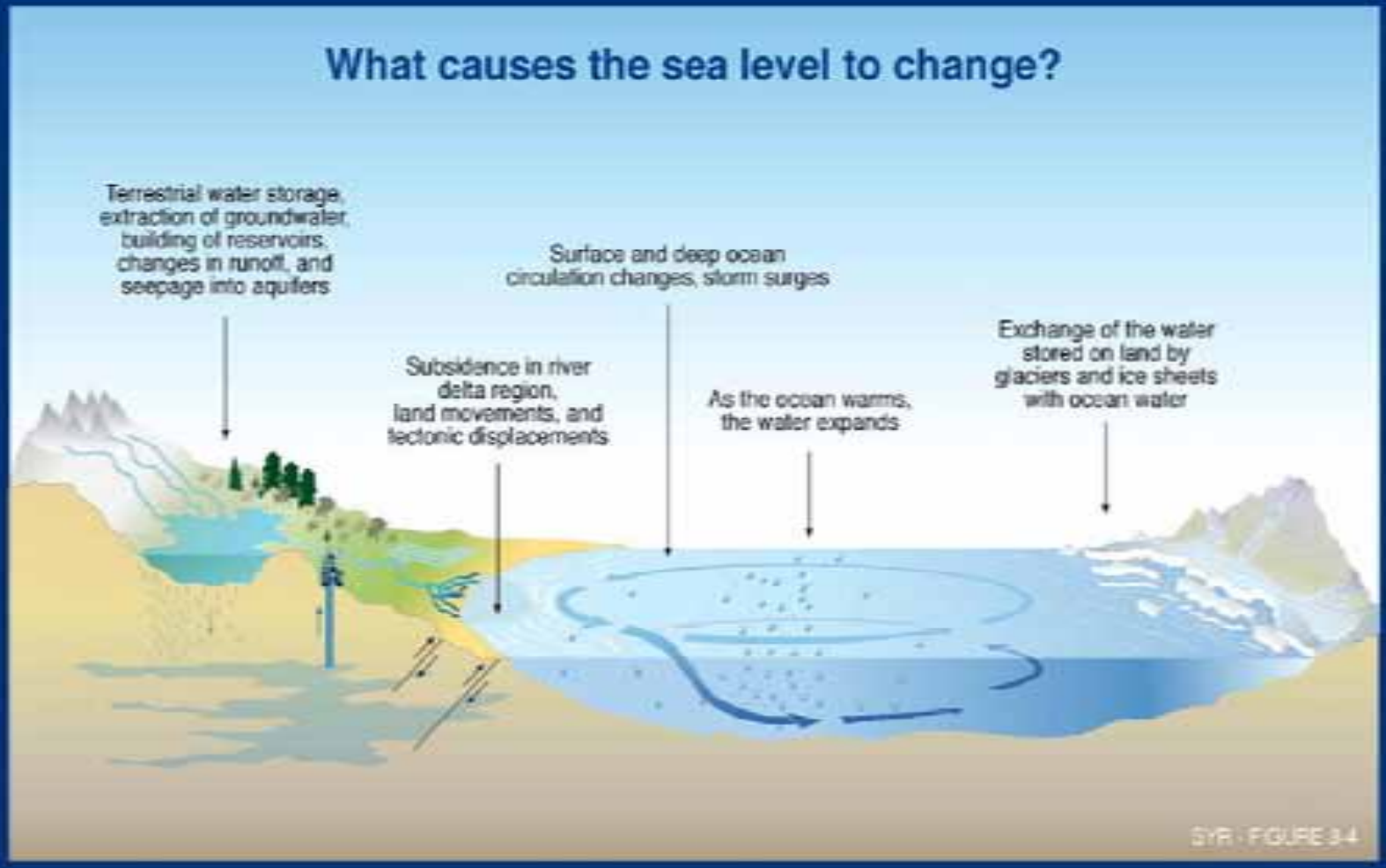


Figure source: IPCC, adapted by Climate Impacts Group

Sea Level Rise in the Pacific NW

Relative sea level rise affected by

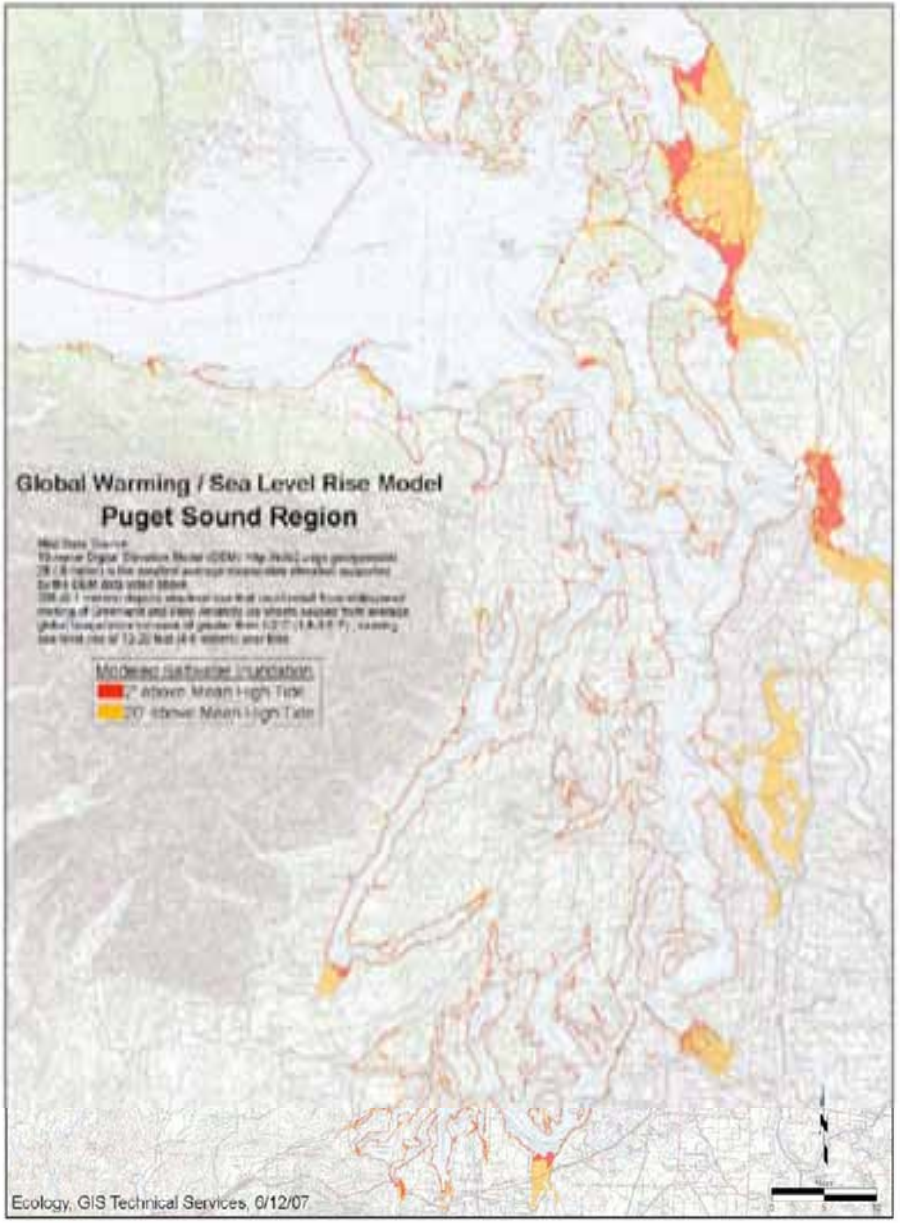
- Global sea level rise *(thermal expansion, freshwater inputs)*
- Tectonic processes *(subsidence and uplift)*
- Interannual climate variability *(El Nino, La Nina events)*
- Ocean/coastal winds *(can increase regional se level about +8 inches)*
- Topography/geology *(gently sloping beach vs. bluffs)*
- Short-term events *(low pressure storms)*

Source: Climate Impacts Group, University of Washington

Vulnerability of Puget Sound to Rising Sea Level

- Inundation maps draw attention to large, low-lying areas where extensive flooding is possible/
- These maps downplay high risk areas where flooding is not the primary hazard (downtown waterfront, bluff landslides, contaminated shoreline sites)

Source: Hugh Shipman, Dept. of Ecology



Areas of Concern

Coastal Processes

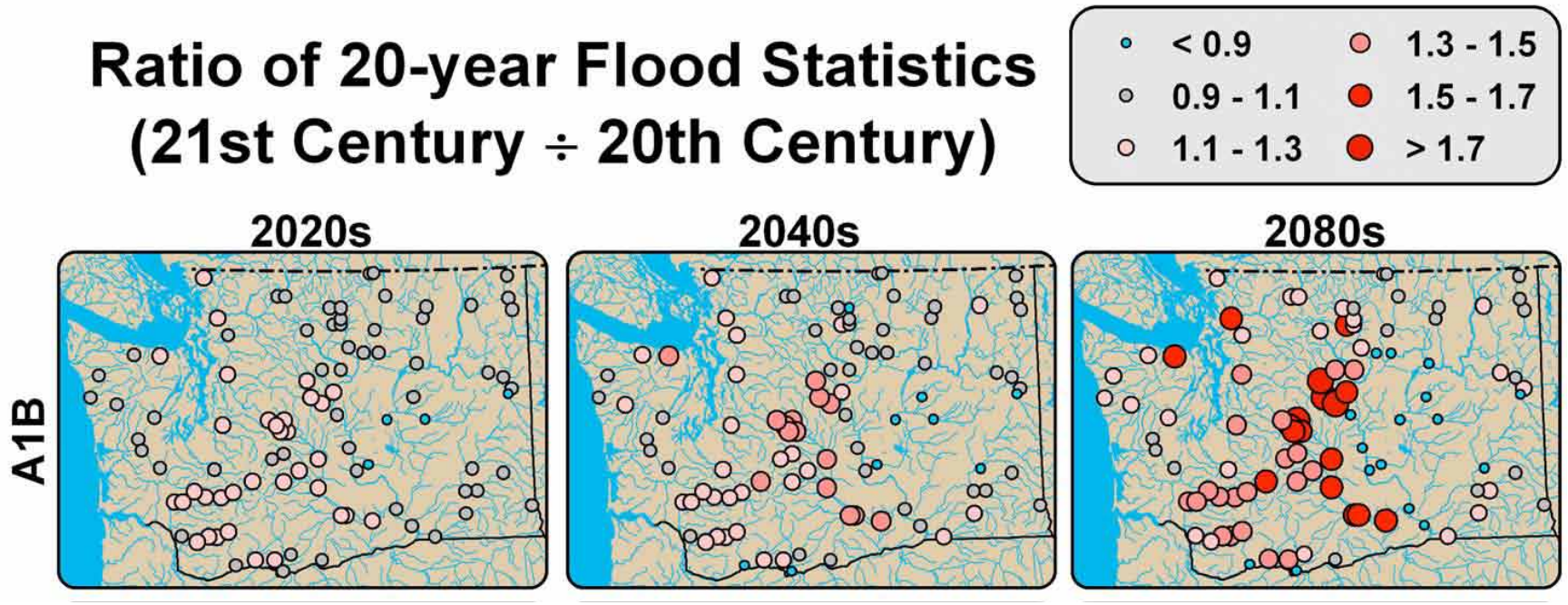
- Sea level rise
- Erosion
- Flooding
- Inundation
- (landslides)

Coastal Ecosystems

- Salmon
- Salt marsh habitat
- Shellfish

Source: Climate Impacts Group, University of Washington

Models project **more winter flooding,** particularly in temperature sensitive "transient" (rain/snow mix) river basins that are common in the Cascades



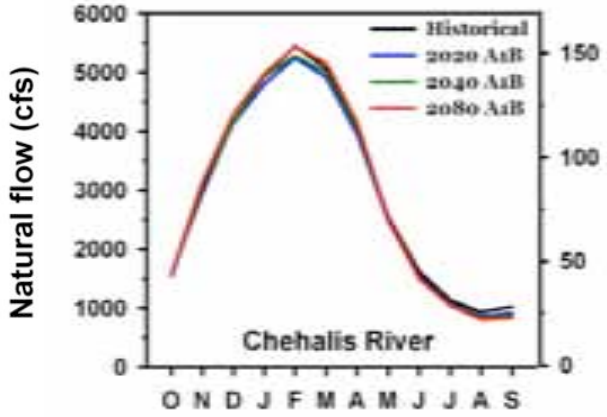
Mantua et al. 2009 (WACCIA report)

Changes in Flood Risks

- Floods in western WA will likely increase in magnitude due to the combined effects of warming and increasingly intense winter storms.

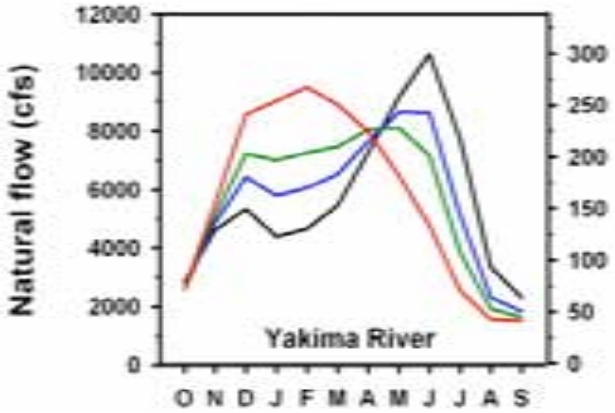
- In other parts of the State, changes in flooding are mixed, and in eastern WA projected *reductions* in spring flood risk are common due to loss of spring snow cover.

Rain Dominant



Chehalis River (Western WA)

Mixed Rain/Snow



Yakima River (Eastern WA)

Mantua et al. 2009, Elsner et al. 2009

Extreme Precipitation Considerations

- Globally, more extreme precip projected
- For PNW, increase in monthly average precip projected for Nov-Dec as you move later into the century
- *Issue: still have to have the storms that bring the precip*
- 2009 Washington Assessment projects increase in the 25-year, 24-hour design storms in the central Puget Sound Region for 2020-2050
- Implications for flood, stormwater management

Urban Stormwater Infrastructure

- **Precipitation intensity and the magnitude of extreme precipitation events are projected to increase in western Washington,** according to two regional climate model simulations.

- **Drainage infrastructure designed using historical rainfall records may not meet future required capacity** as precipitation intensity and extremes become more severe.

Rosenberg et al. 2009

Changing Coastal Flood Risk

Increased storm surge and related episodic flooding will present a greater near-term challenge.

For much of Puget Sound…

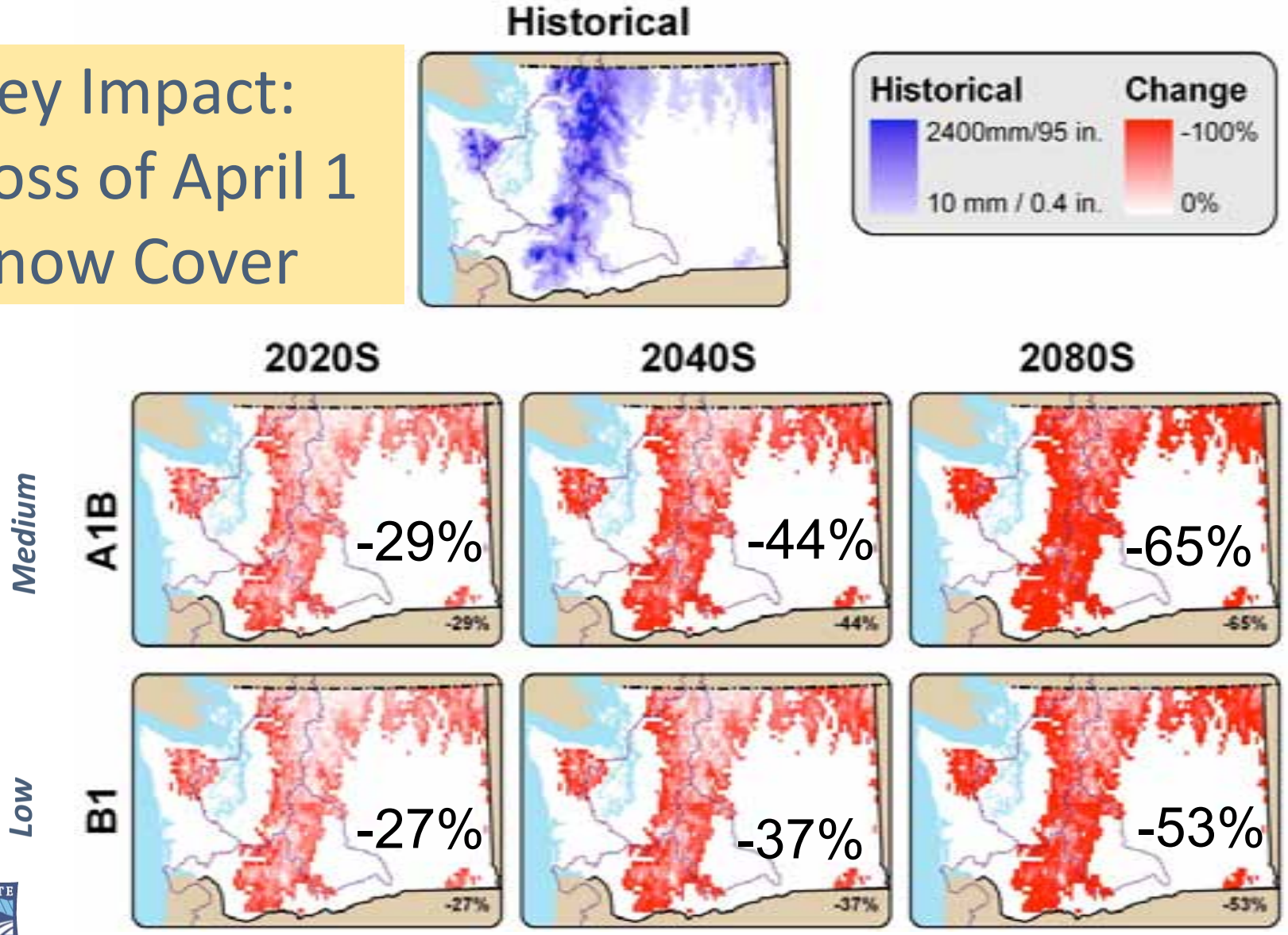
- A one foot sea level rise turns a 100 year flood event into a 10 year event.
- A two foot sea level rise turns a 100 year flood event into an annual event.

Numbers and photos courtesy of Hugh Shipman, Washington Dept. of Ecology

Anacortes (4 February 2006)

Whidbey Island (4 February 2006)

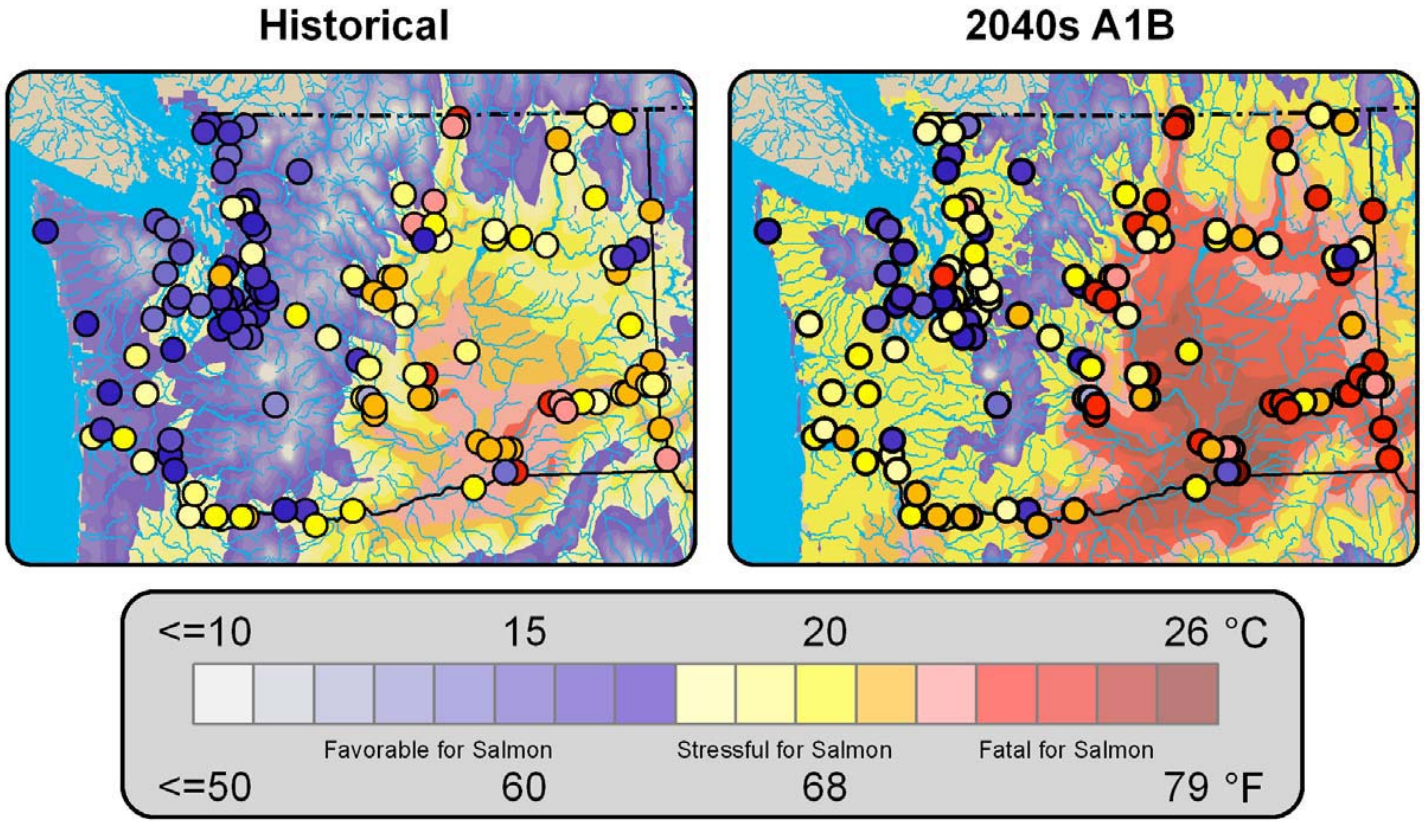
Key Impact: Loss of April 1 Snow Cover



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

Warming trends of air and water temperatures across Washington State will affect salmon

August Mean Surface Air Temperature and Maximum Stream Temperature



Source: Mantua et al. 2009, in press

Salmon and Aquatic Ecosystems

- **Rising stream temperature will reduce the quality and quantity of freshwater salmon habitat substantially.**

- The duration of temperatures causing thermal migration barriers and extreme thermal stress (where weekly water temperatures exceed 70°F) are predicted to ***quadruple*** **by the 2080s**.

- Western Washington stream temperatures are generally cooler, so are further from stress thresholds than streams in eastern Washington.

Mantua et al. 2009

Forest Ecosystems

- **The area burned by fire regionally (in the U.S. Columbia Basin) increases by 100% to 200%** (medium scenario, A1B). The average area burned in 2080 is equivalent to the highest one or two fire years in the observed record.

- **Mountain pine beetle outbreaks are projected to increase in frequency and to cause increased tree mortality due to increasing climatic stress on host trees**.

- Climatically suitable habitat for Douglas-fir declines by 2060, even in western Washington.

Littell et al. 2009

Human Health

- In Washington, **climate change will lead to larger numbers of heat-related deaths due mainly to hotter summers and population growth**. For example in Seattle a medium climate change scenario projects 101 additional deaths for people over 45 by 2025 and another 50% increase by 2045

- Although better control of air pollution has led to improvements in air quality, **warmer temperatures threaten some of the sizeable gains that have been made in recent years.**

Jackson et al. 2009 (WACCIA report)

Transportation Adaptation Issues

- Rail lines run near water in many areas
  - Both oceans and rivers
- Bridge heights
- Bridge scour from flood events
- Flood prone roadways
  - Are the roadways in the right place?
- As we think of infrastructure for the future, is it in the right place?

Increasing Resilience

- Limit armoring
- Restore shorelines
- Remove dikes
- Improve processes for siting new construction
- Set back development
- Protect key geomorphologic processes (sediment supply)
- Identify critical natural and built environments
- “When engineering is inevitable, be imaginative”

Source: Hugh Shipman, Dept. of Ecology

Challenges and Next Steps

- Vulnerability assessments
- Developing reliable science
- Scenario planning
- Policy and coordination with multiple governmental entities

Preserving Assets in a Changing Environment: Summary

- Global and regional climate is already changing.
- These changes are expected to continue to accelerate in the coming decades.
- Sea level rise will be experienced as a series of escalating disasters.
- Awareness of adaptation needs will result in better long-term decisions.

Source: Climate Impacts Group, University of Washington

Climate Impacts Group (CIG) Information

- Summary information on PNW climate and climate impacts
- Climate change scenarios
- CIG publications
- Quarterly electronic newsletter
- “climateupdate” list serve

http://cses.washington.edu/cig/

Questions or comments?

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