PNW Climate Change and Implications for Forest Ecosystems

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Climate science in the public interest

Overview

This talk:

- Introduces the Climate Impacts Group
- Highlights projected PNW climate change impacts
- Maps key climate change impacts to general PNW forest concerns
- Provides a brief overview on adaptation

This talk does not:

- Provide a definitive list of potential forest impacts
- Provide specific suggestions on adaptive strategies

The Climate Impacts Group

1st of 8 U.S. Regional Integrated Sciences and Assessment (RISA) teams

Areas of study:

- Water resources
- Salmon
- Forests
- Coasts
- *[Agriculture, Human Health]*

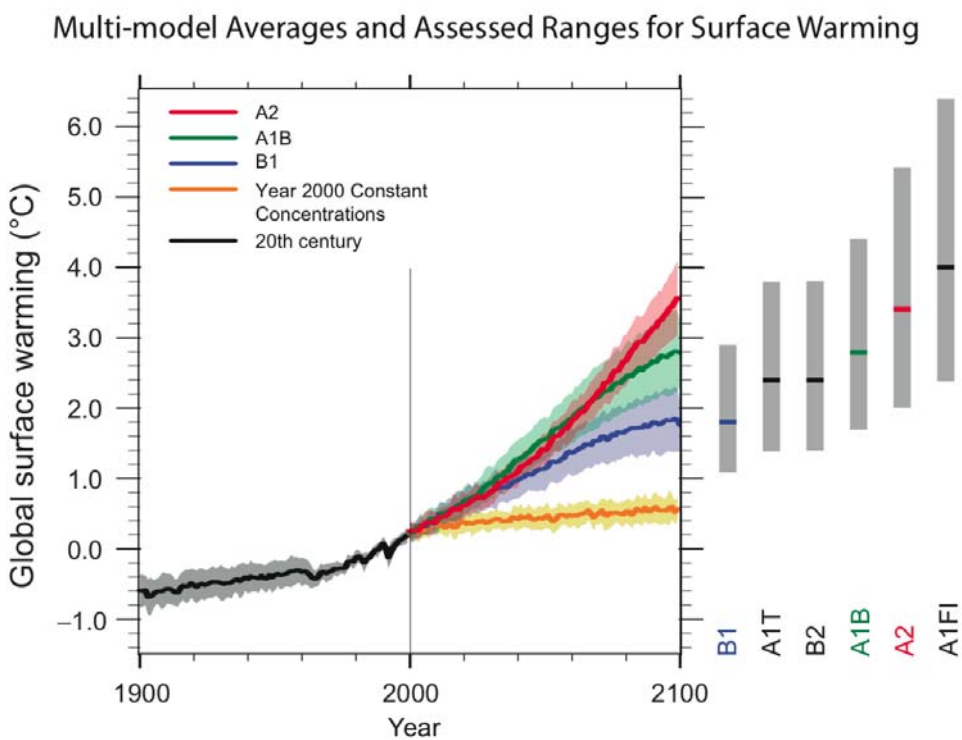
Objectives

- Increase regional resilience to climate variability and change
- Produce science useful to (*and used by!*) the decision making community

21st Century Global Warming

Projected 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.

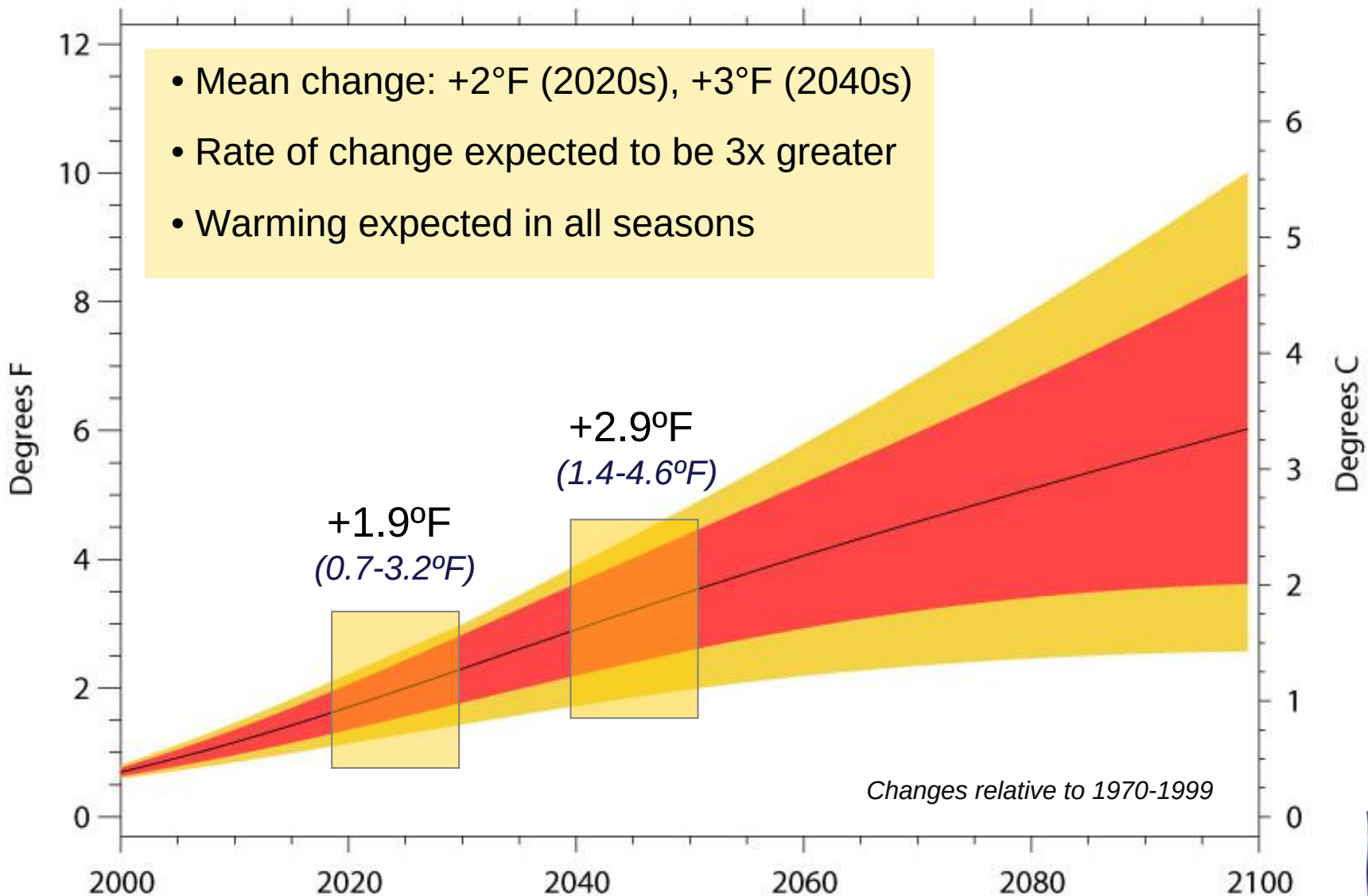


Estimated atmospheric lifetime of major greenhouse gas (per molecule)

Carbon Dioxide	~60% of warming from GHG	5 to 200 years
Methane	~20% of warming from GHG	8 to 12 years
Nitrous Oxide	~6% of warming from GHG	~120 years
CF4 (Perfluoromethane)		>50,000 years

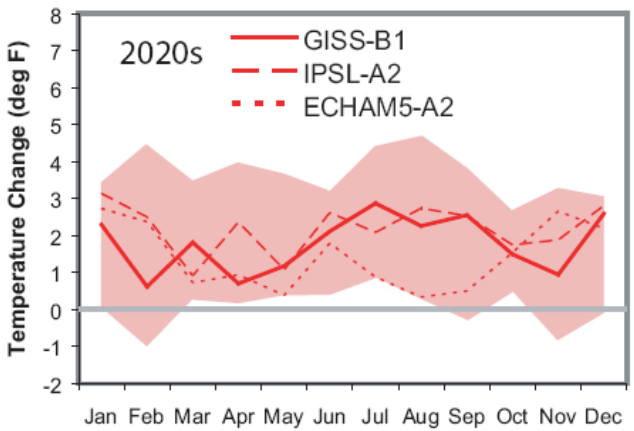
Data source: IPCC 2001

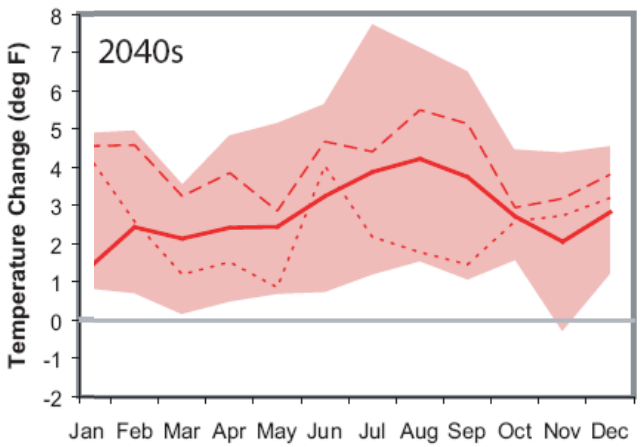
Projected 21st Century PNW Warming



More detail on the CIG scenarios is available at: http://www.cses.washington.edu/cig/fpt/ccscenarios.shtml

Projected Changes in PNW Temperature





Projected changes in monthly PNW temperature. The lines show changes associated with warm (IPSL-A2), cool (GISS-B1), and "middle-of-the-road" (ECHAM5-A2) climate change scenarios

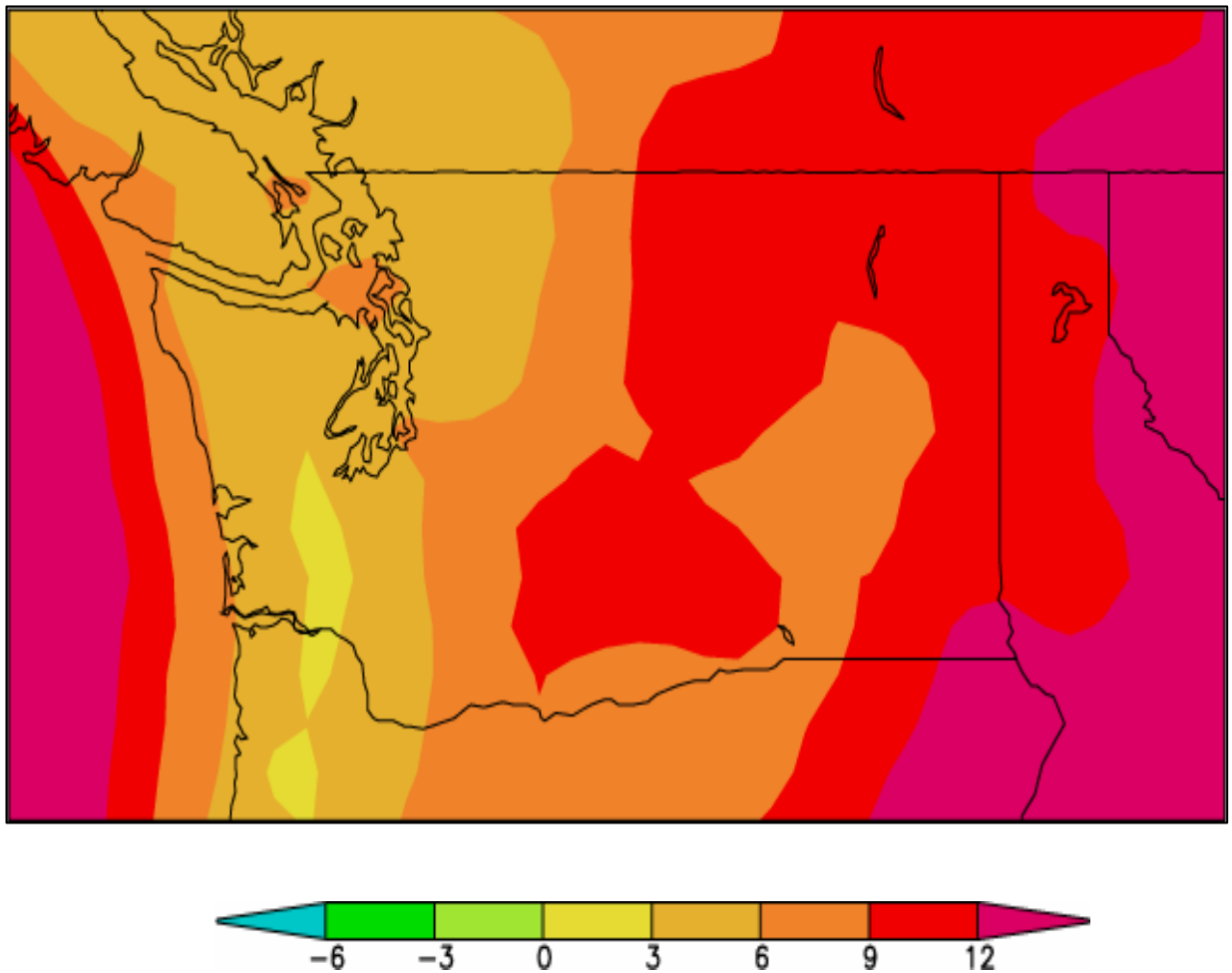
Temperature change			
	Annual	**Oct-Mar**	**Apr-Sept**
2020s			
Low	+ 0.7ºF *(0.4ºC)*	+ 0.4ºF *(0.2ºC)*	+ 0.8ºF *(0.5ºC)*
Avg	**+ 1.9ºF *(1.1ºC)***	**+ 1.7ºF *(0.9ºC)***	**+ 2.1ºF *(1.2ºC)***
High	+ 3.2ºF *(1.8ºC)*	+ 2.6ºF *(1.5ºC)*	+ 3.8ºF *(2.1ºC)*
2040s			
Low	+ 1.4ºF *(0.8ºC)*	+ 1.1ºF *(0.6ºC)*	+ 1.4ºF *(0.8ºC)*
Avg	**+ 2.9ºF *(1.6ºC)***	**+ 2.5ºF *(1.4ºC)***	**+ 3.3ºF *(1.8ºC)***
High	+ 4.6ºF *(2.6ºC)*	+ 4.1ºF *(2.3ºC)*	+ 5.4ºF *(3.0ºC)*

All changes are benchmarked to average temperature and precipitation for 1970-1999

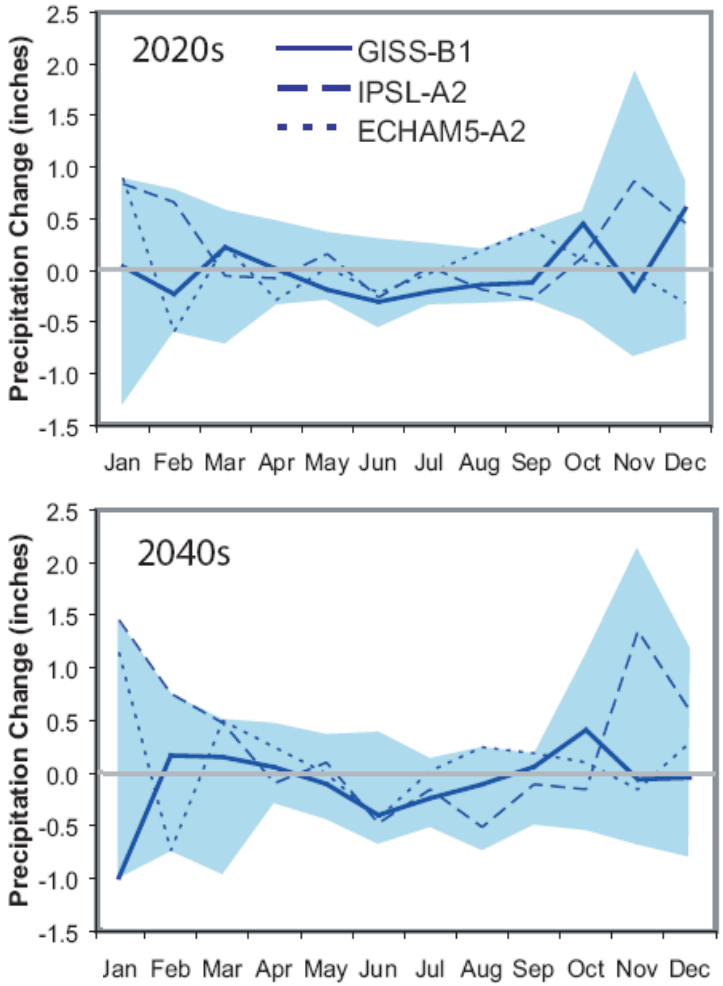
Projected Changes in Extreme Temp

Figure 2. Change in number of days in 2055-2075 with daily maximum temperature (TMAX) exceeding the 90th percentile TMAX of the present. The number of extreme hot days in Washington State is expected to increase by mid-century relevant to current climate. The increase is likely to be most significant in eastern Washington.

Figure Source: Leung and Qian (2005)



Projected Changes in PNW Precipitation

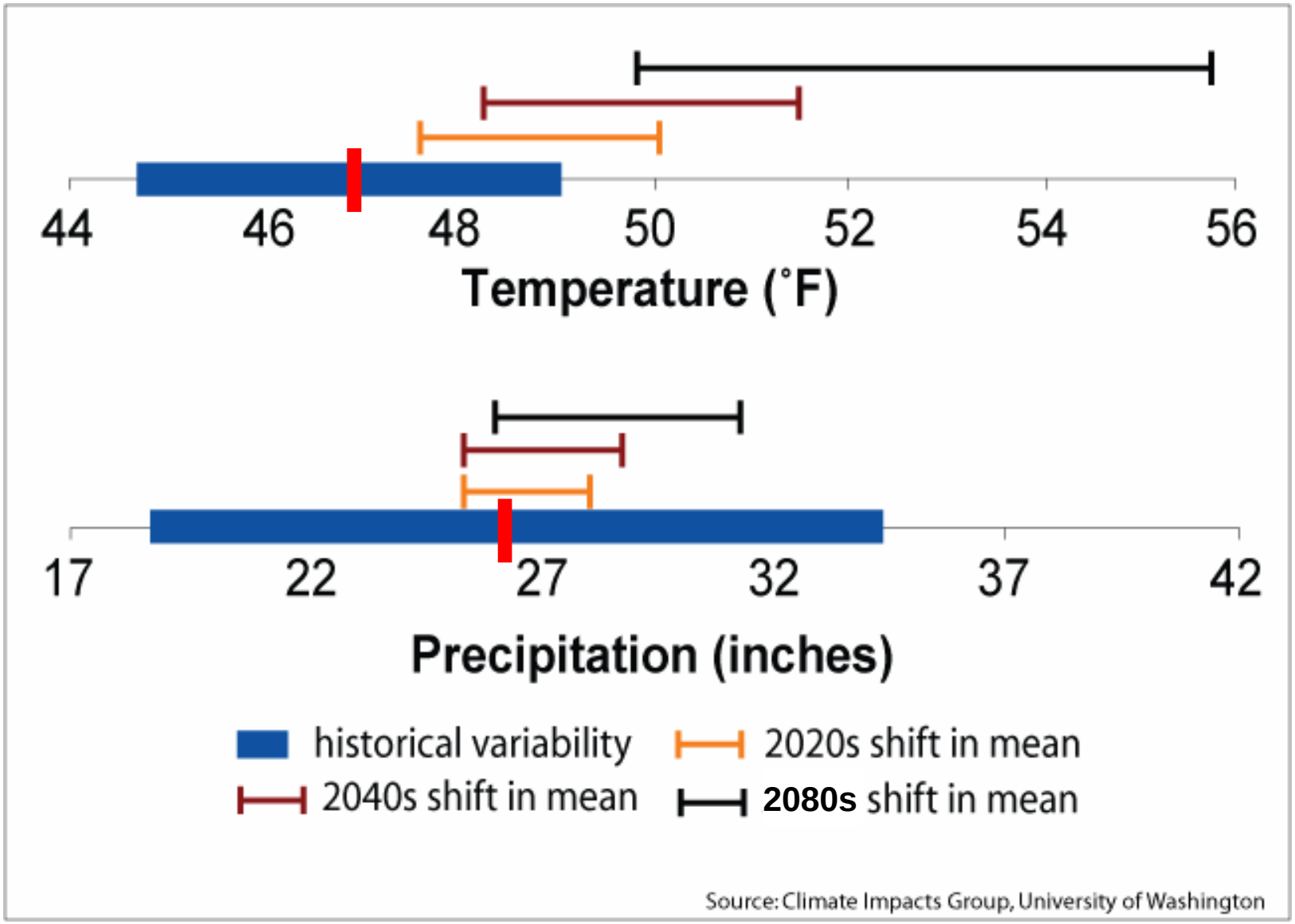


Projected changes in monthly PNW precipitation. The lines show changes associated with warm (IPSL-A2), cool (GISS-B1), and "middle-of-the-road" (ECHAM5-A2) climate change scenarios

- Modest increases (+2%) in annual avg precipitation
- Most of the increase comes in the winter months *(but in what intensity?)*
- Projected increase in average does not exceed 20th century averages

Note: there is high confidence in projected temp changes, less in precipitation changes

Changes Relative to the 20th Century

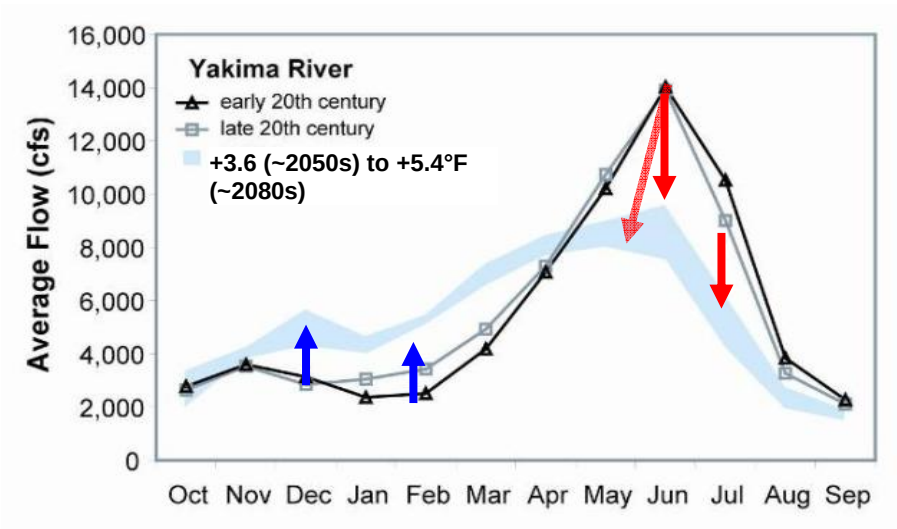


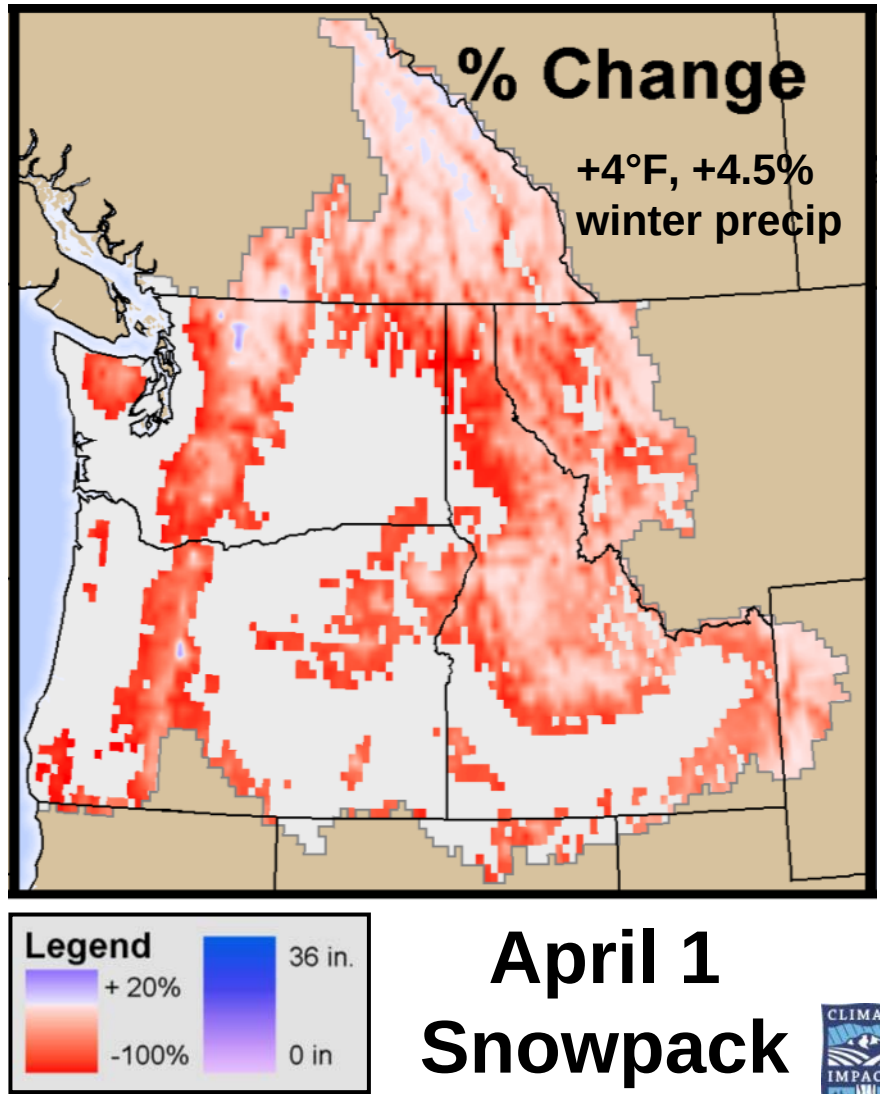
Implications for PNW Resources

Lower Spring Snowpack and Altered Streamflow

Spring snowpack declines as more winter precipitation falls as rain rather than snow, *especially in warmer mid-elevation basins*

Warmer temperatures affect the timing and volume of spring and summer streamflow in temperature-sensitive basins





April 1 Snowpack

Overview of PNW Impacts

Water supply

- Increased competition from competing water uses, particularly during summer months
- Increased vulnerability to drought
- Decreased water quality (varies with location and parameter)

Flooding and stormwater management:

- Increased risk of winter flooding and combined sewer overflows in low and mid-elevation basins. Changes in urban flooding less certain.

Salmon:

- Increased stress from winter floods, warmer water temperature, lower summer streamflows

Overview cont'd

Forests:

- Increased risk of wildfire
- Increased vulnerability to insects
- Decreased growth & regeneration in drier low elevations (with opposite at high elevations)

Coasts

- Increased inundation, erosion, habitat loss, and flooding from sea level rise

Agriculture:

- Increased production from CO2 fertilization effect and warmer spring temps?
- Opportunities for new crops, decreased irrigation supply, increased heat stress/insects

…and Forest Ecosystems?

Mapping Changes to Potential Forest Impacts

Projected Change	Potential Forest Impact	+ or - impact?
Warmer summer air temperatures (Higher potential evapotranspiration)	Increased growth and regeneration for trees/forests that are temperature limited (high elevation / subalpine forests)	Positive
	Decreased growth, vigor, and regeneration for trees/forests that are water limited (all low elevation / montane forests)	Negative
	Lower fuel moisture	Negative
	Increased incidence of fires, and increased area of fires that occur	Negative
	Increased respiration and declines in carbon assimilation	Negative

Projected Change	Potential Forest Impact	+ or - impact?
Warmer winter temperatures	Longer growing season	Positive or negative (depending on elevation)
	Longer fire season due to shorter snowpack persistence	Negative
	More favorable over-wintering conditions for insects with episodic population dynamics	Negative
Higher winter streamflows	Riparian flooding and erosion (road impacts?)	Negative
	Flooding impacts to other resources forest managers consider, such as spawning habitat, campgrounds, recreation, etc.	Depends

Projected Change	Potential Forest Impact	+ or - impact?
Warmer spring temperatures and lower snowpack	Longer fire season due to earlier soil moisture depletion	Negative
Lower summer streamflows	Indirect effects for forest managers charged with protecting anadromous and resident fish populations	Negative
Synergistic effects and multiple stressors	Increased winter favors insects + increased summer temperature decreases tree vigor = more successful insect attacks and more insect disturbance	Negative
	Increased disturbance + changes in climatic zones = potential for rapid shifts in species ranges (or genetic variability within species)	Depends

Other PNW Forest Impact Considerations

- Changes to hydrology associated with changes in forest cover or in soil properties affected by fire
- Changes in disease pathogen ranges and/or tree susceptibility (e.g., Phytophera, “sudden oak”, which is currently not an issue in WA)
- Some unknowns:
  - Will extreme events (late season or early spring frosts, severe windstorms, severe fire weather) have different frequencies or different impacts than currently?
  - Will increased carbon dioxide lead to increases in water use efficiency sufficient to offset warmer temperatures and potentially lower summer precipitation?

What Is Adaptive Planning?

"Adaptation is not one activity or decision, but rather a continuous set of activities, actions, decisions, and attitudes undertaken by individuals, groups, and governments."

-- Adger et al. 2005

…with the objective of

Increasing community and ecosystem **resilience** to climate change impacts

What Do We Mean By Resilient?

A *climate resilient community* is one that has taken proactive steps to reduce the risks associated with known climate change impacts while increasing its capacity to quickly recover from or adapt to those impacts it cannot avoid or anticipate at this time.

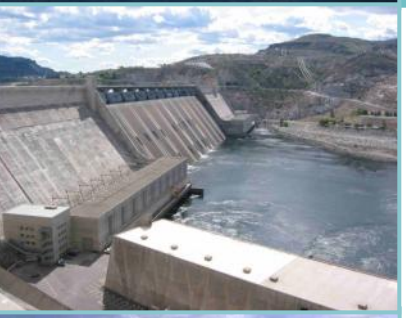
Why Adaptive Planning?

- Significant climate change impacts are projected, and the impacts expected within the next few decades are largely unavoidable.

- Decisions with long-term impacts are being made every day. Today's choices will shape tomorrow's vulnerabilities, especially in long-lived systems such as forests.

- Significant time is required to motivate and develop adaptive capacity, and to implement changes

- Increasing evidence that it will cost more to retrofit for climate resilience than to build it in in the first place.



General Goals in Planning for Climate Change

- Improve community awareness of and preparedness for global warming impacts.
- Build in recognition of a changing climate.
- Reverse trends that increase vulnerability to climate.
- Increase the robustness of long term climate-sensitive decisions and investments.
- Increase the flexibility and adaptability of vulnerable managed systems.
- Enhance the adaptability of vulnerable natural systems.

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Summary

- Global and regional climate is already changing.
- These changes are expected to accelerate in the coming decades.
- Potential forest impacts are tied to changes in summer and winter temperature and precipitation, snowpack duration, and regional hydrology.
- Information on the specific magnitude of these potential impacts has been explored for some locations and process in the PNW, but there is much yet to be done.

More information on PNW climate impacts and planning for climate change is available from

The Climate Impacts Group

www.cses.washington.edu/cig

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