



Climate Change Effects on Aquatic Habitats

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Mt Baker Snoqualmie National Forest

Climate Change Workshop

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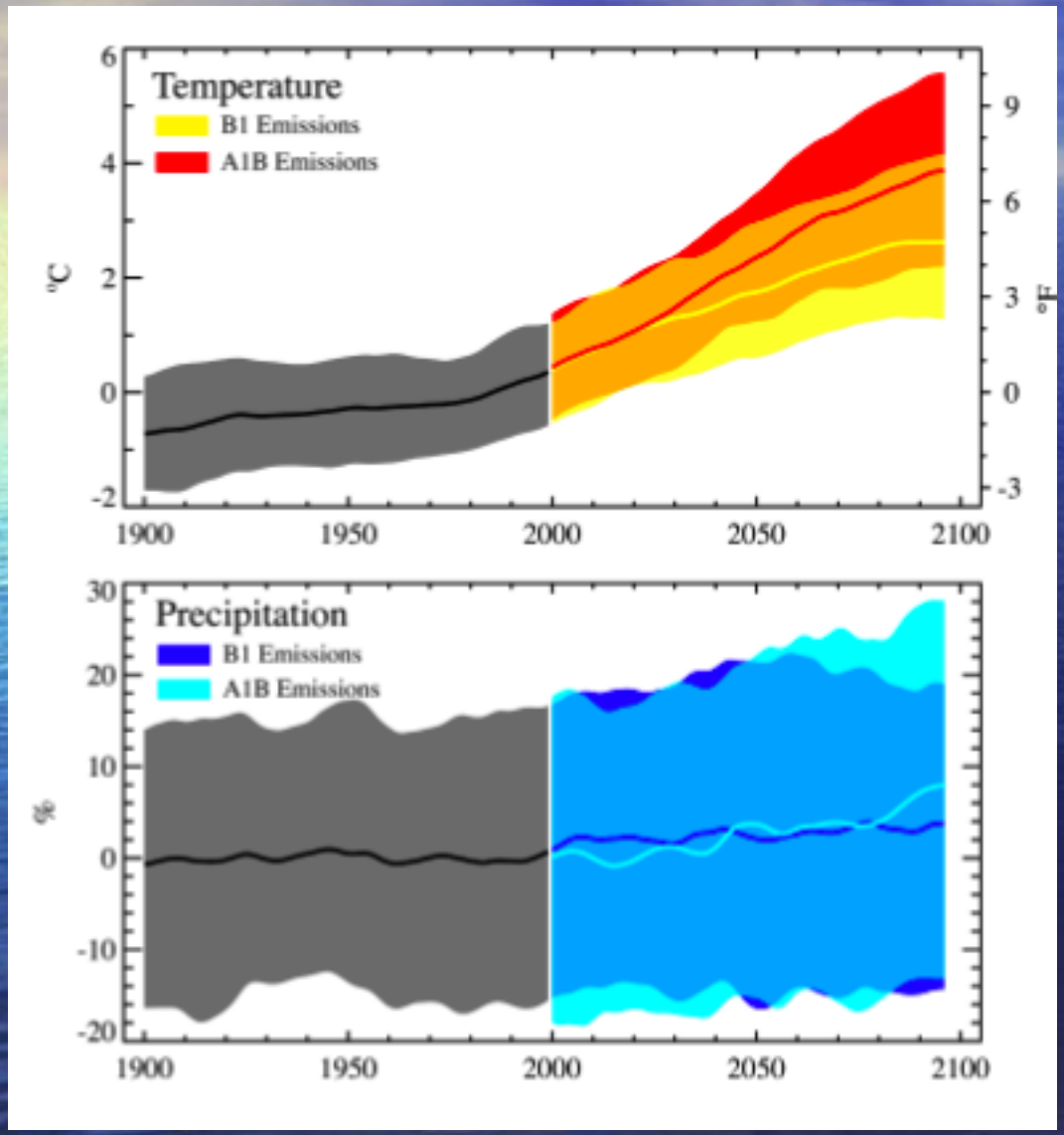
CLIMATE IMPACTS GROUP

21st Century PNW Temperature and Precipitation Change Scenarios



- Projected changes in temperature are large compared to historic variability
- Changes in annual precipitation are generally small compared to past variations, but some models show large seasonal changes (***wetter autumns and winters*** and ***drier summers***)

21st century PNW climate scenarios relative to past variability

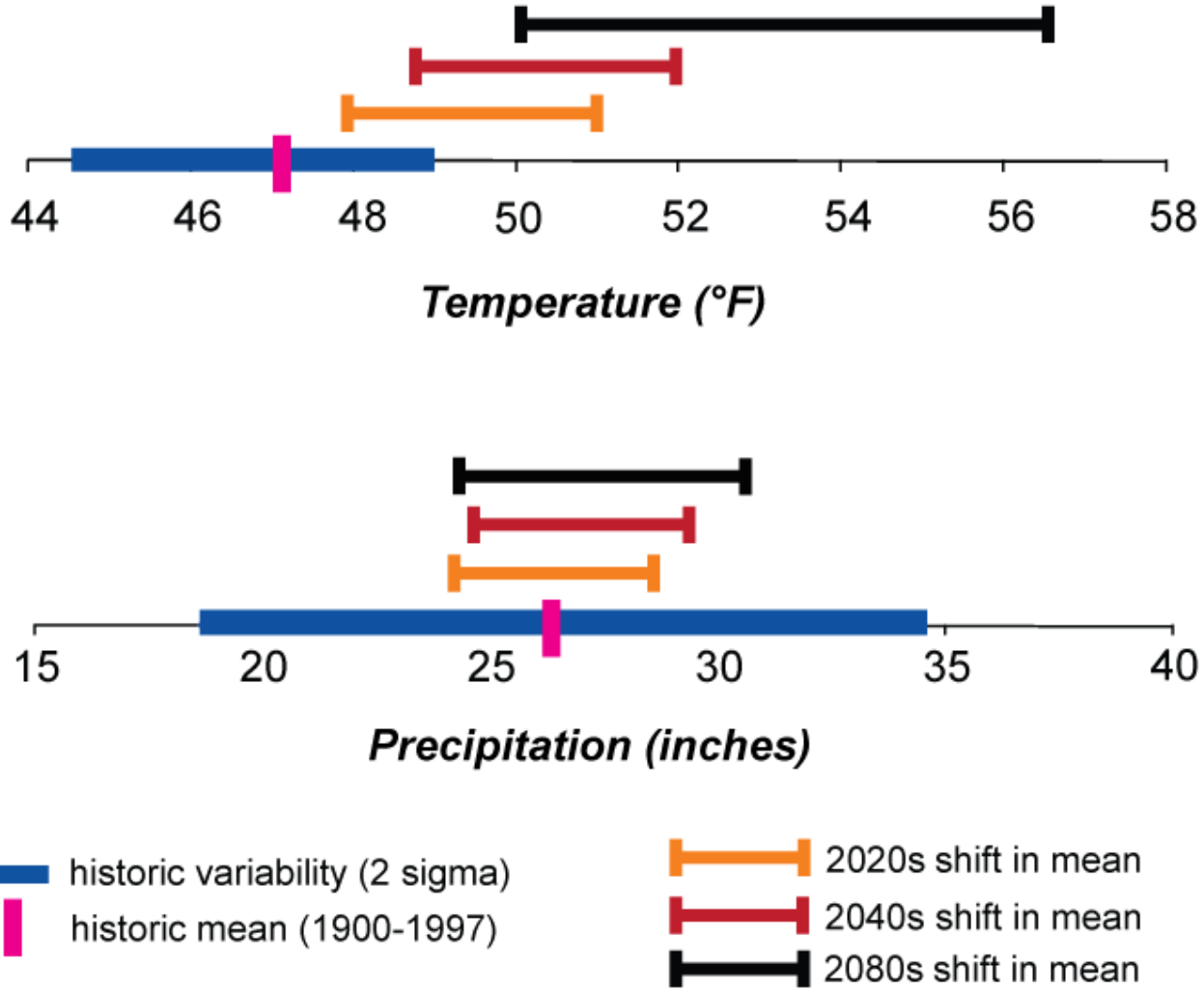
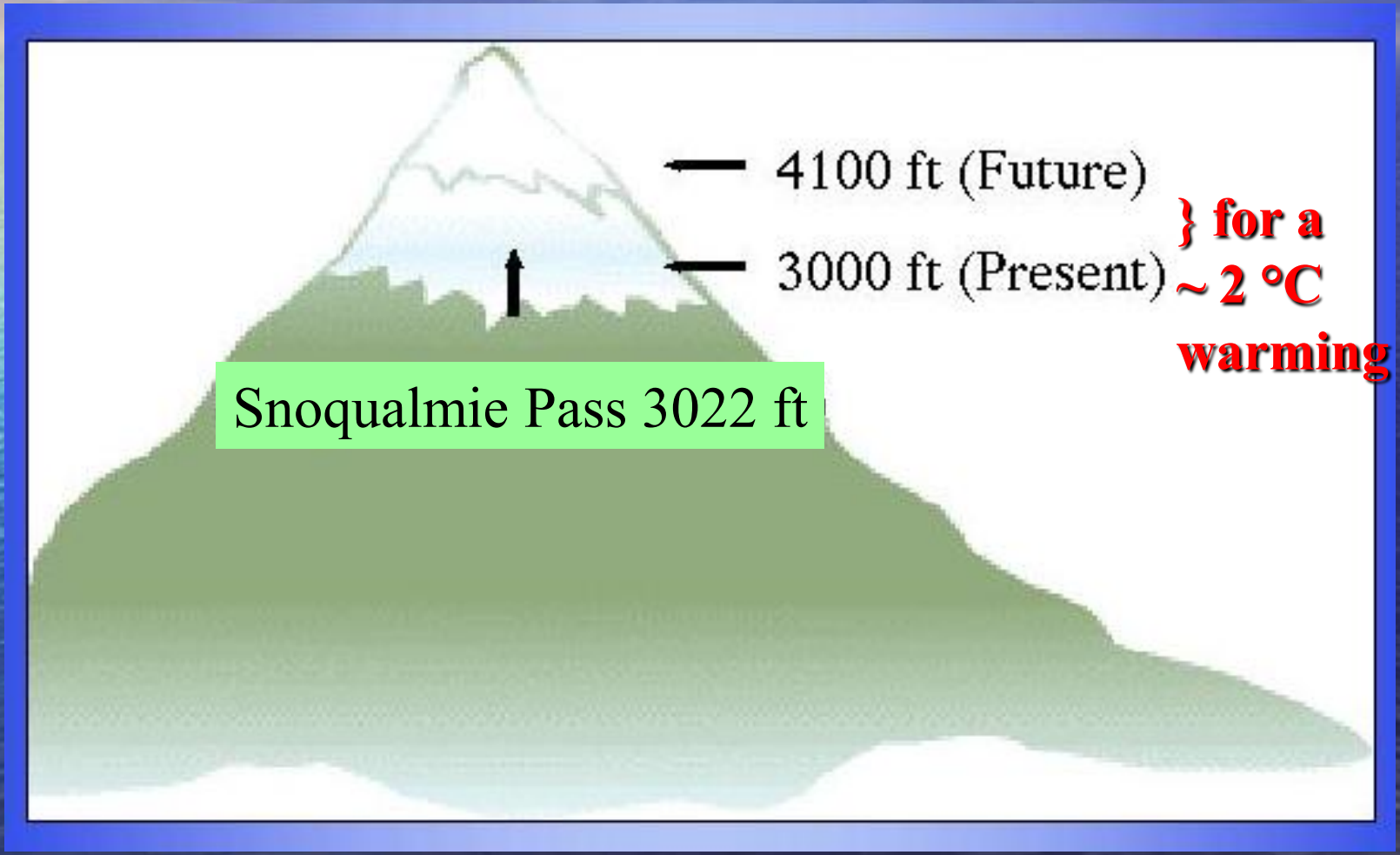
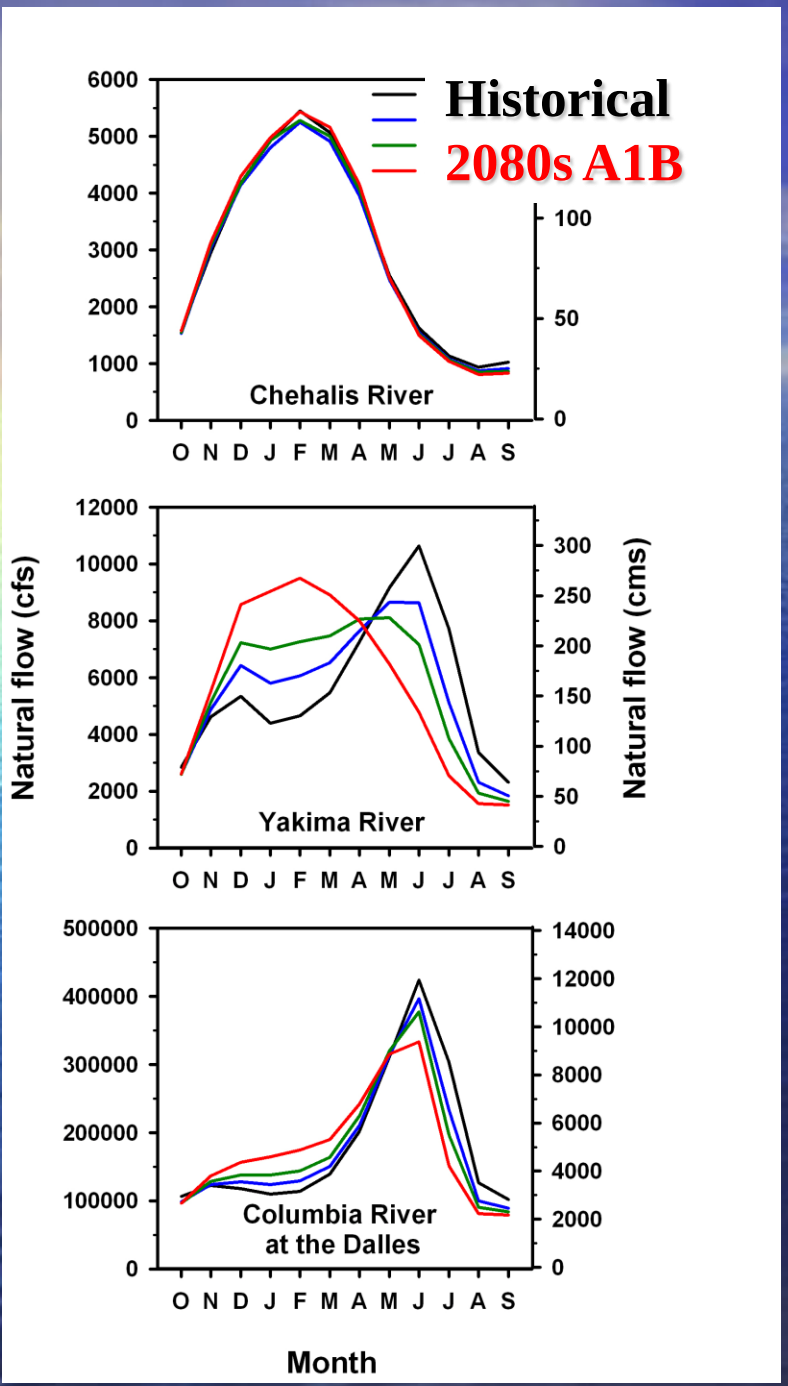


Figure source: Climate Impacts Group, University of Washington

A robust impact of climate warming: **less snow**





3 basic streamflow patterns

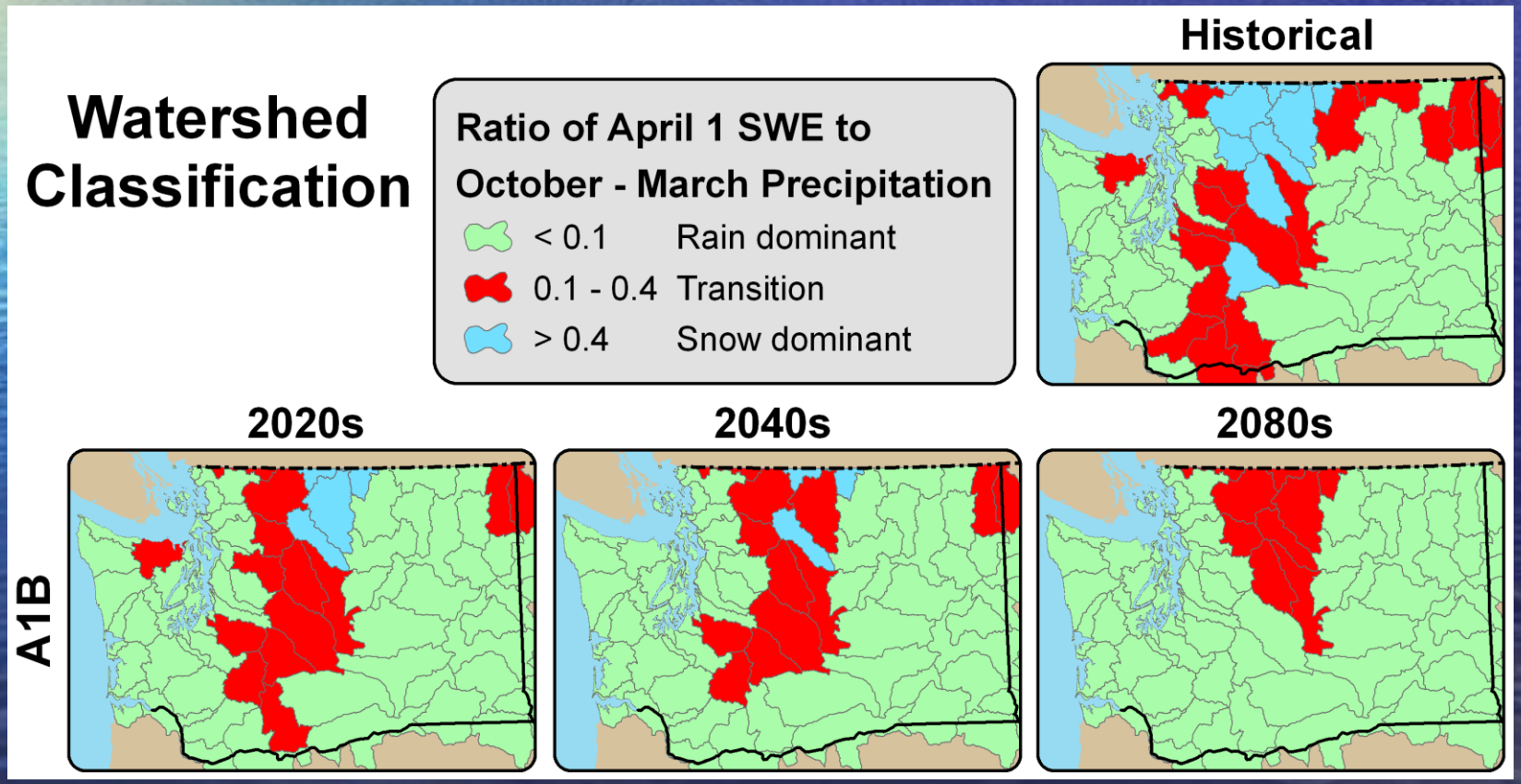
1. ***rain-dominated***

2. "***transient***" basins with an early winter peak from rainfall, and a spring peak from snowmelt

3. ***snowmelt-dominated*** basins, where streamflow peaks in late spring and early summer

Dramatic changes in snowmelt systems

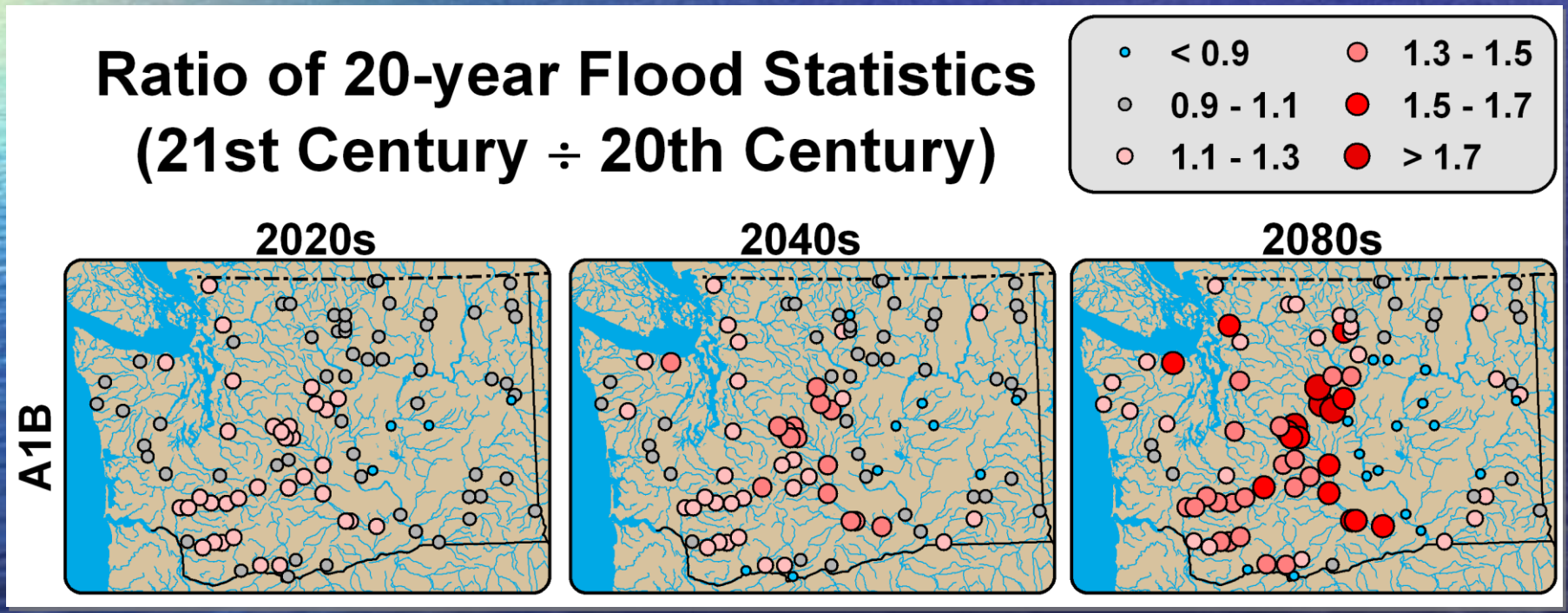
- Snowmelt rivers become transient basins
- Transient basins become rainfall dominant



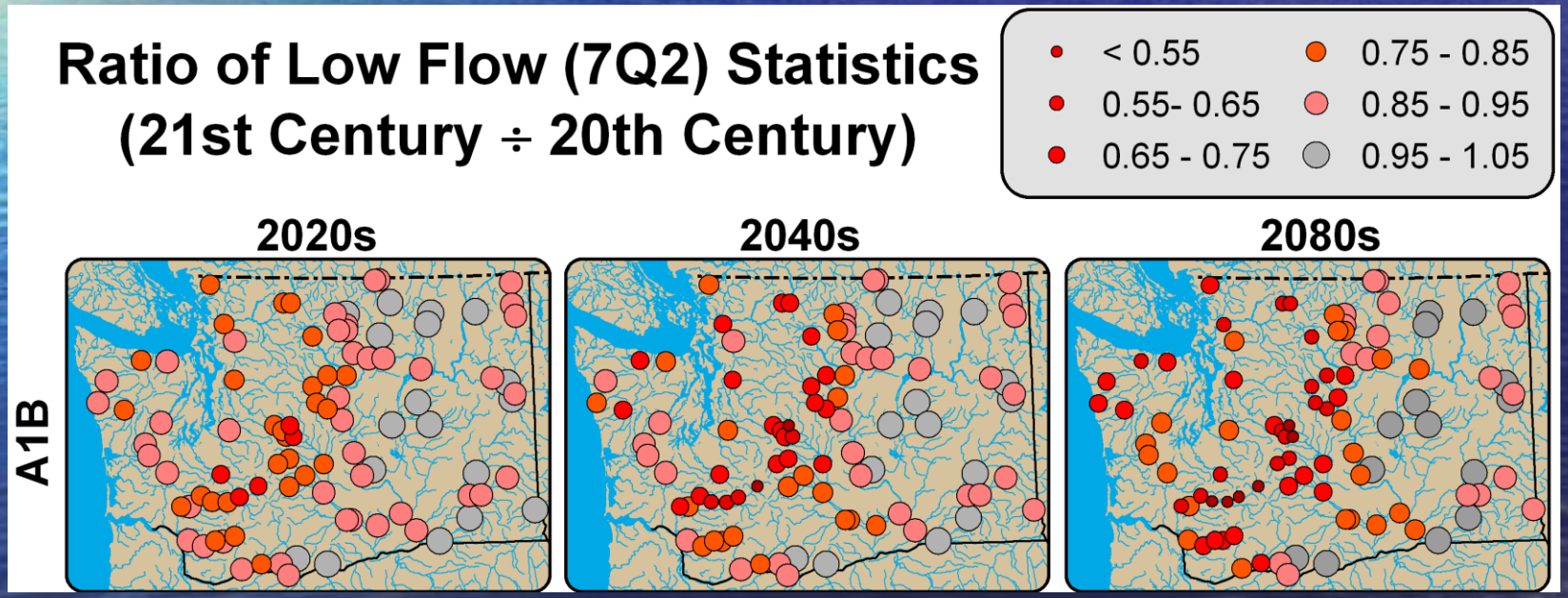
A warmer climate and flooding

- At mid-elevations, more precipitation will fall as rain and less as snow
- a warmer atmosphere holds more moisture: theory and climate models suggest an increased intensity of precipitation, stronger storm (but maybe fewer)
  - This combination points to ar increased frequency of river flooding in fall and winter

- Models project **more winter flooding** in sensitive “transient runoff” river basins that are common in the Cascades
  - Likely reducing survival rates for incubating eggs and rearing parr

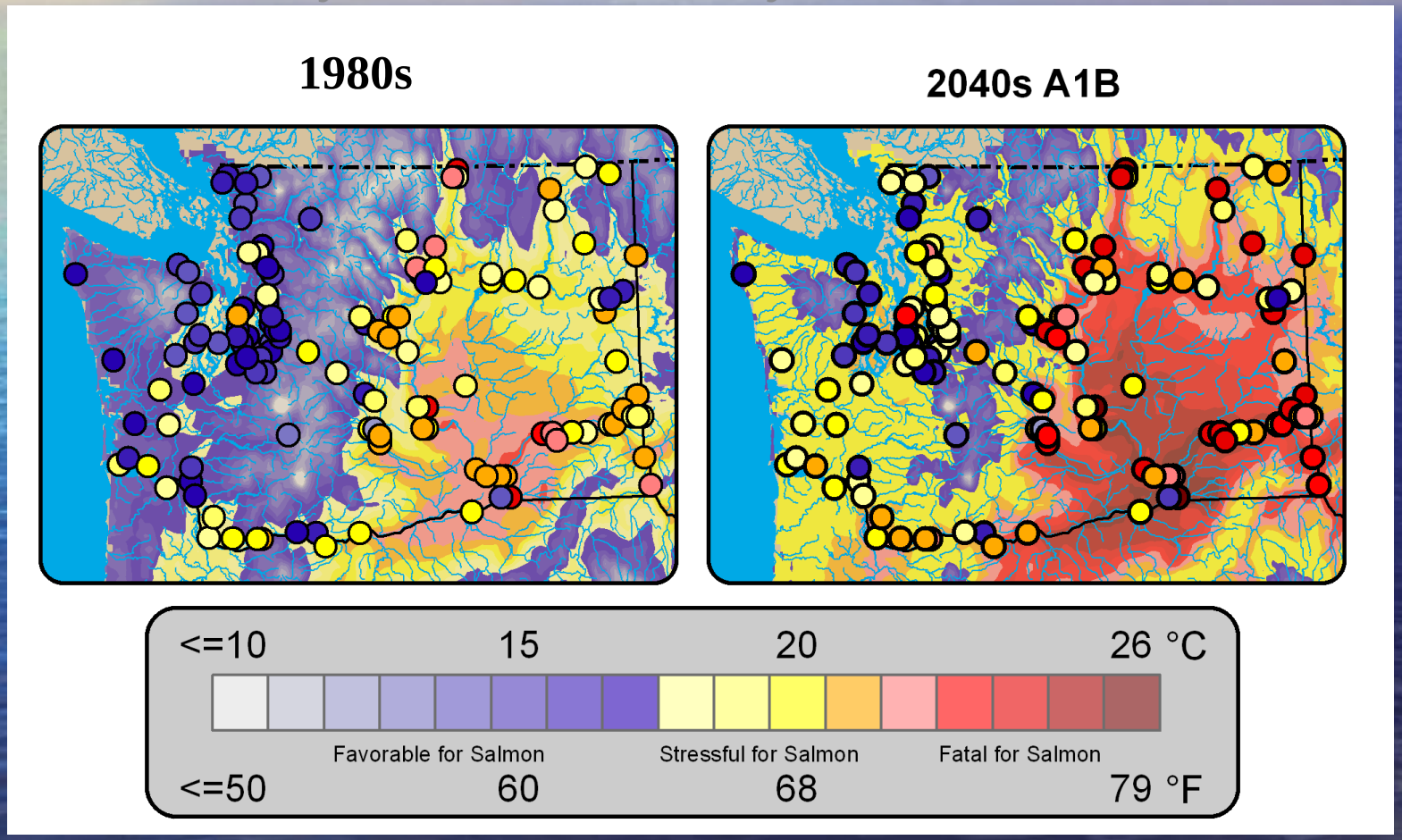


- **Summer base flows are projected to drop substantially** (5 to 50%) for most streams in western WA and the Cascades
  - The **duration of the summer low flow season is also projected to increase in snowmelt and transient runoff rivers**, and this reduces rearing habitat

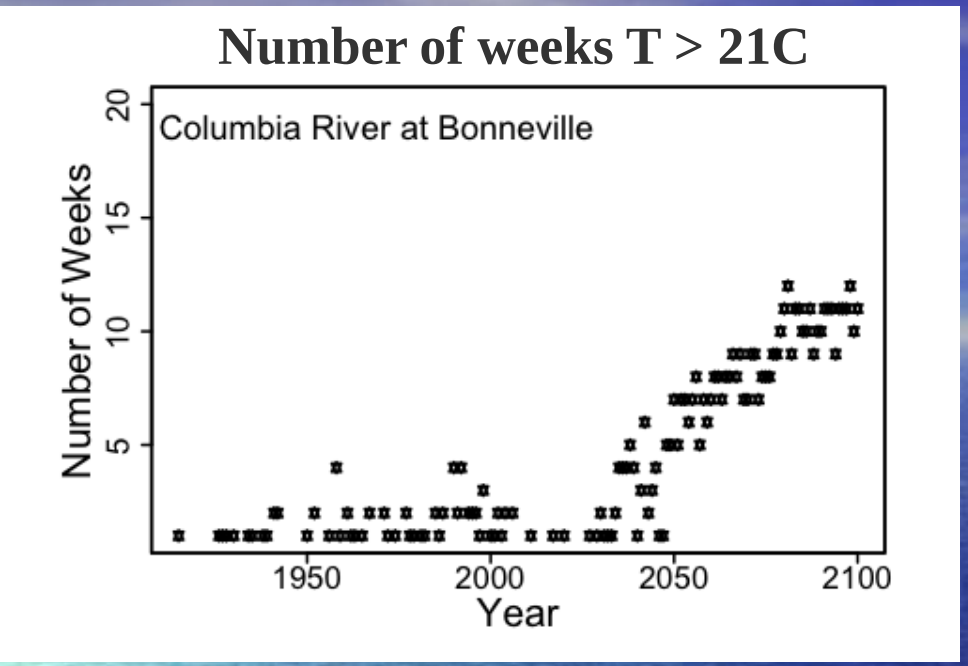


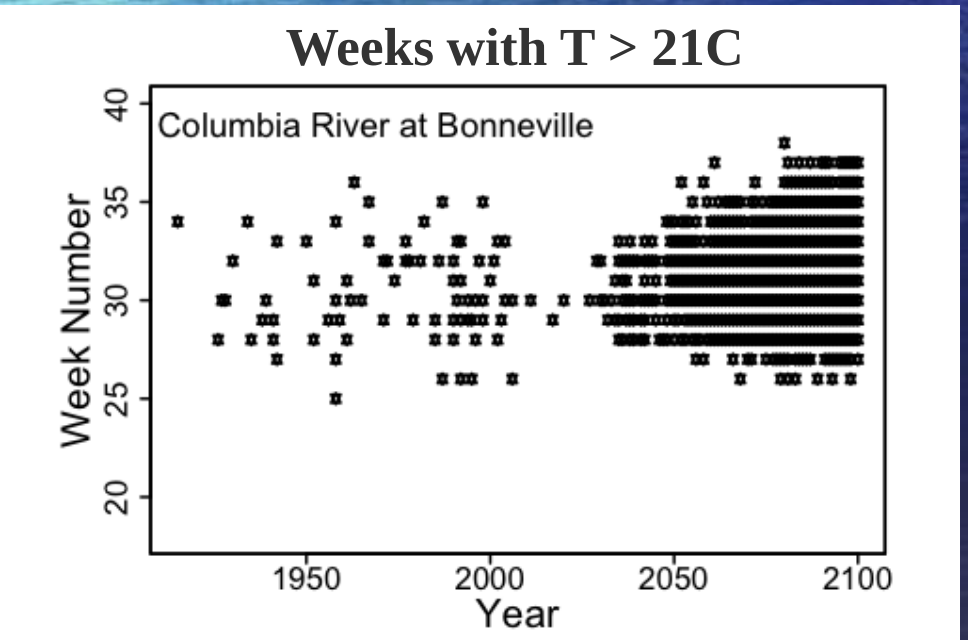
Mantua et al. 2010: **Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State** (Climatic Change)

Western Washington's "maritime" summer climate becomes as warm as today's interior Columbia Basin, temperatures in the interior Columbia Basin become as warm as today's Central Valley in California



Mantua, Tohver and Hamlet 2010: *Climatic Change*

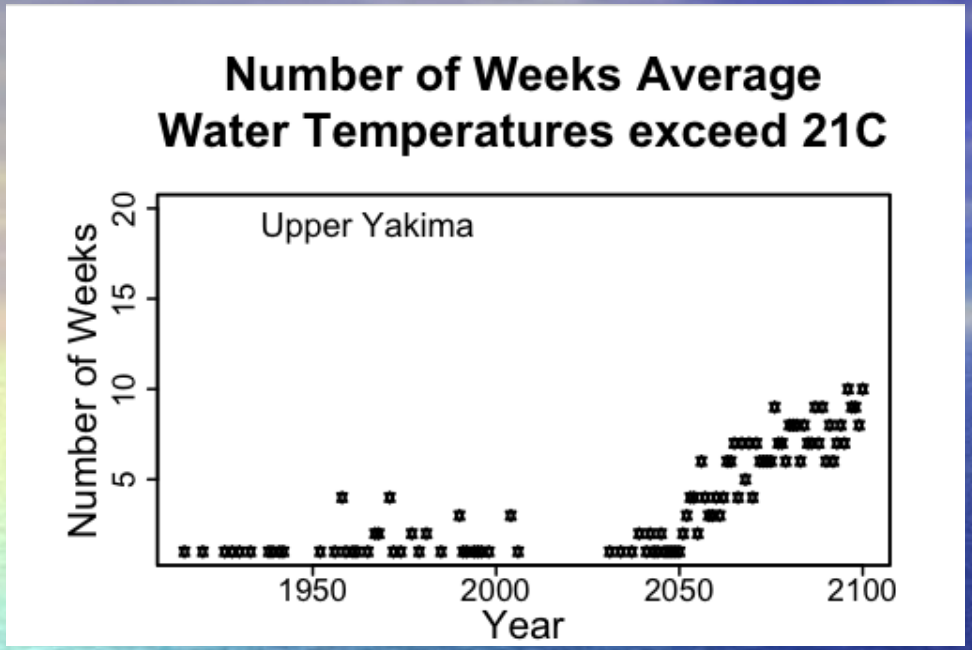


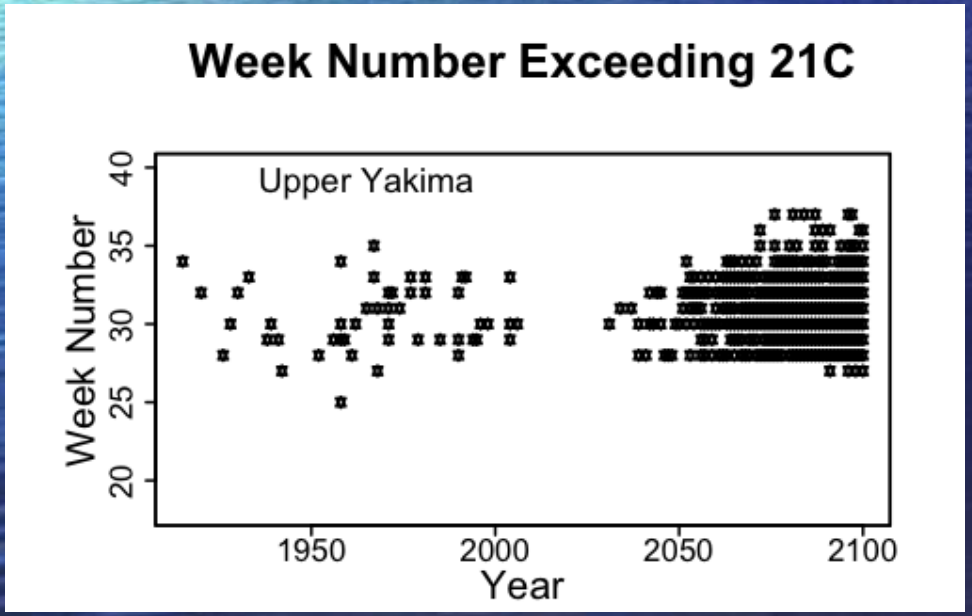


Thermal stress season

- Extended periods with weekly average water temperatures > 21C
  - the season of thermal migration barriers for migrating salmon predicted to last up to 12 weeks in the mainstem Columbia River

Thermal stress season

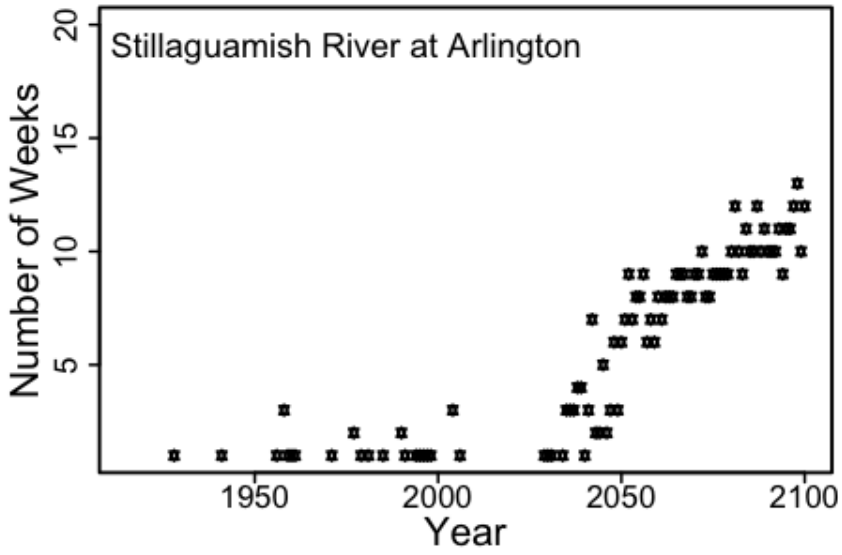




- Under this scenario, the season of thermal migration barriers for migrating salmon projected to last up to 11 weeks in the upper Yakima River

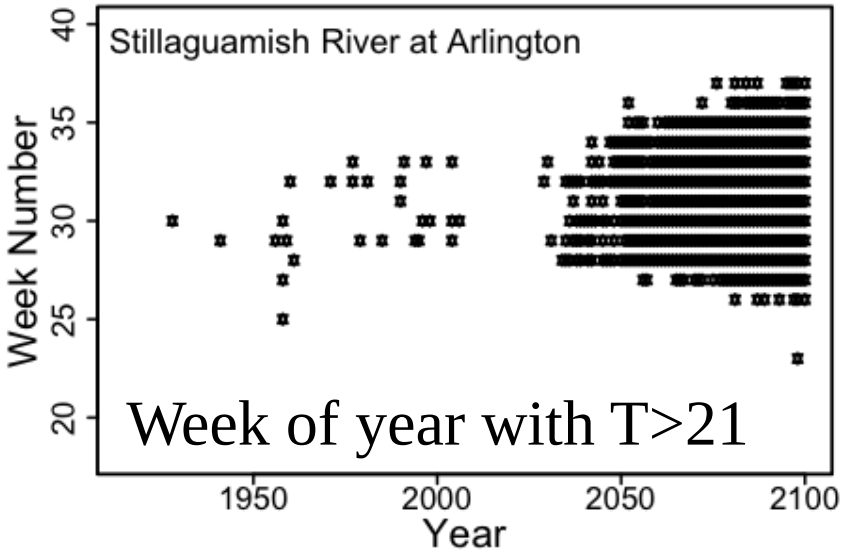
Mantua, Tohver and Hamlet 2010: Climatic Change

Number of weeks T>21



Thermal stress season

- Under this scenario, the season of thermal migration barriers for migrating salmon projected to last up to 12 weeks in the lower Stillaguamish River



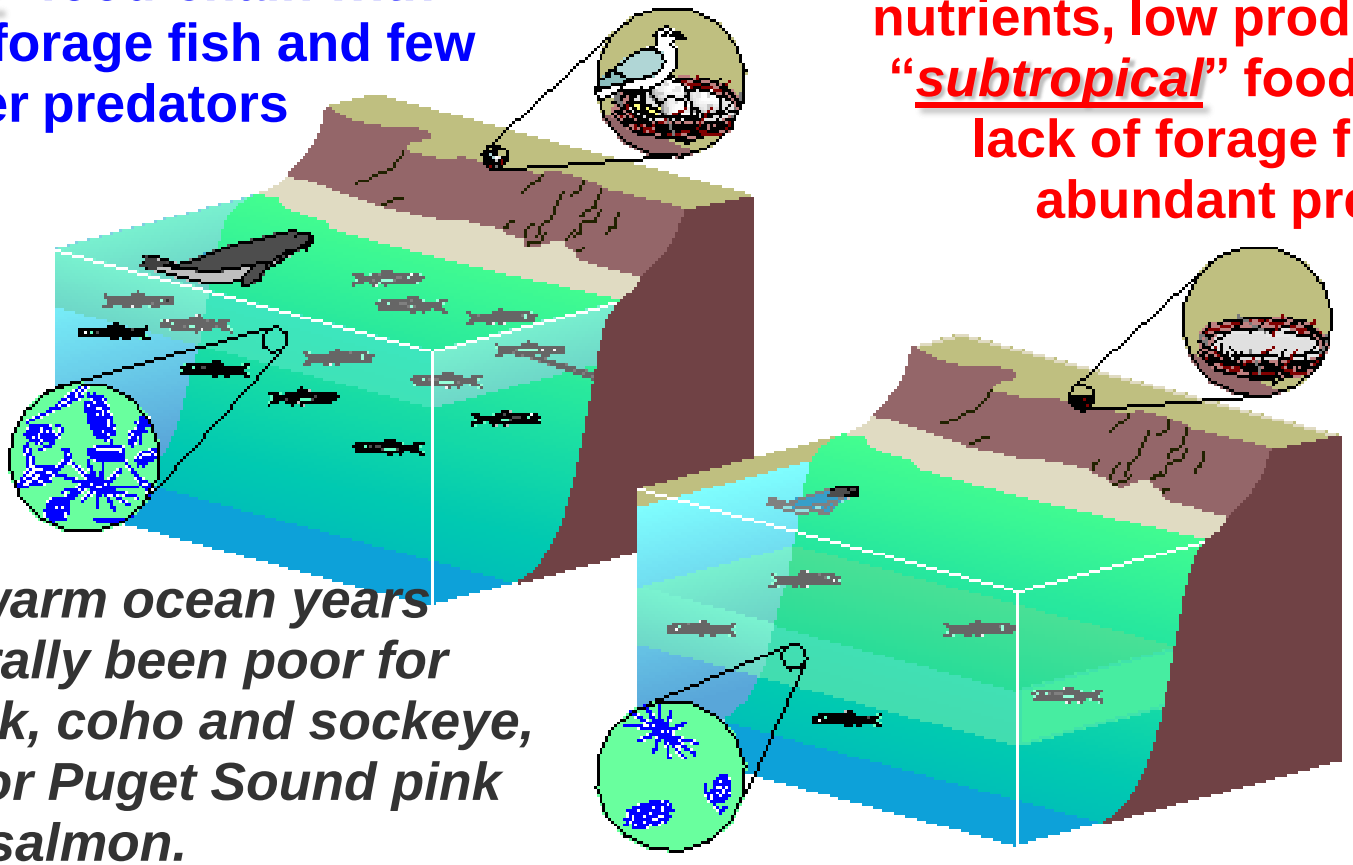
Week of year with T>21

Mantua, Tohver and Hamlet 2010: Climatic Change

Upwelling food webs in our coastal ocean

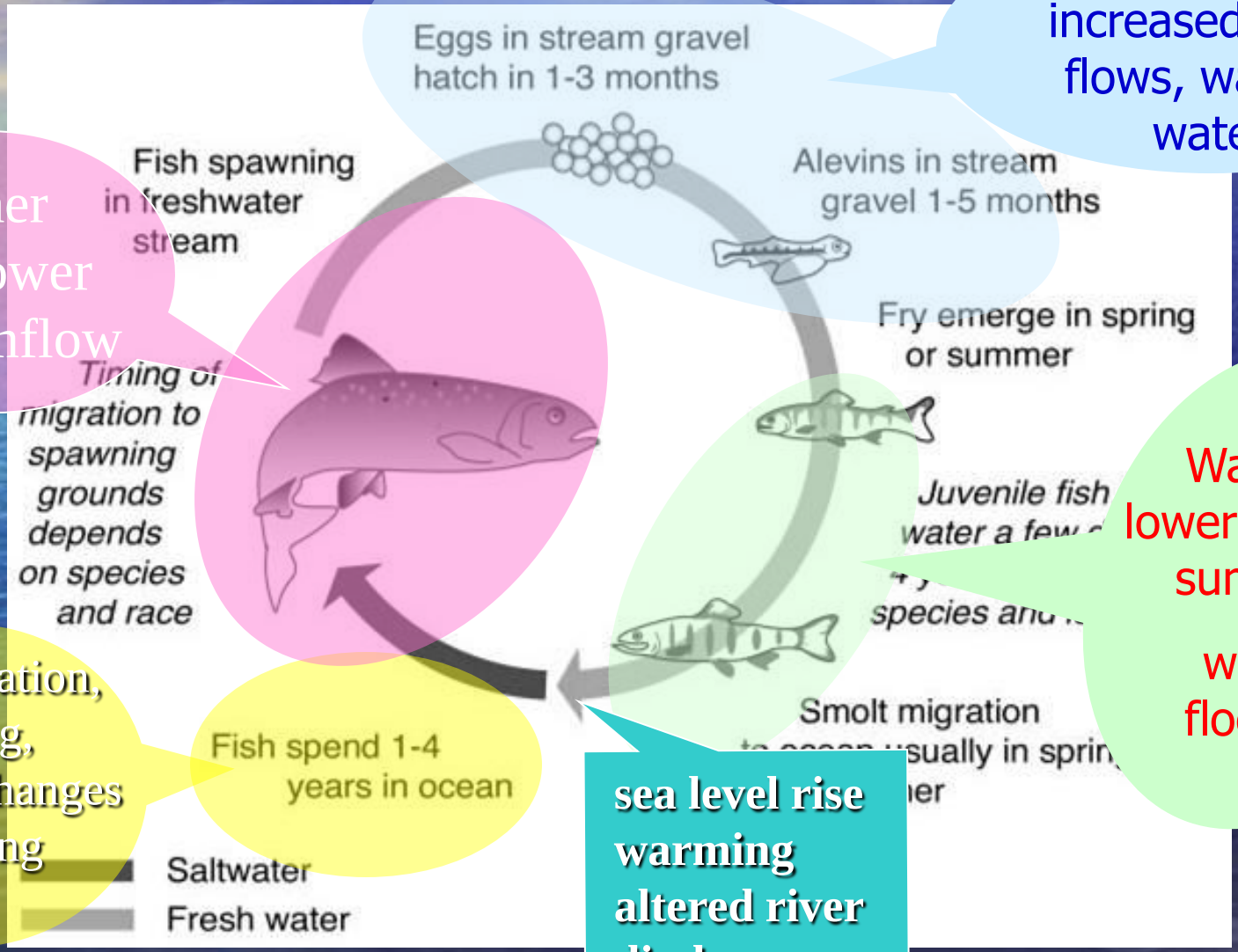
Cool water, weak stratification high nutrients, a productive "*subarctic*" food-chain with abundant forage fish and few warm water predators

Warm stratified ocean, few nutrients, low productivity "*subtropical*" food web, a lack of forage fish and abundant predators



Recently, warm ocean years have generally been poor for NW chinook, coho and sockeye, but good for Puget Sound pink and chum salmon.

Impacts summary for PNW salmon



Flooding and increased mean flows, warmer water

Warmer and lower streamflow

Warmer lower flows in summer;

winter flooding

acidification, warming, range changes upwelling winds?

sea level rise warming altered river discharge

Impacts will vary depending on life history and watershed types

- **Low flows+warmer water = increased pre-spawn mortality for summer run and stream-type salmon and steelhead**
  - Clear indications for increased stress on Columbia Basin sockeye, summer steelhead, summer Chinook, and coho more generally

Harley Soltes/Seattle Times

- **Increased winter flooding in transient rain+snow watersheds**
  - a limiting factor for egg-fry survival for fall spawners + yearling parr overwinter survival in high-gradient reaches