

*Science, Service, Stewardship*

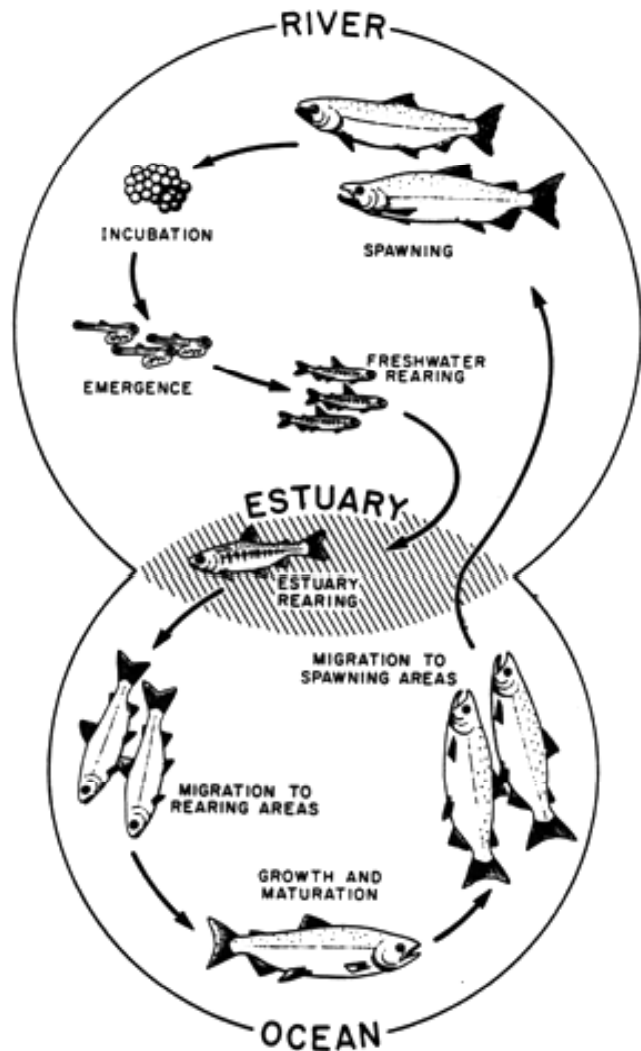


# A Brief Look At Effects of Climate Change on Columbia River Salmon

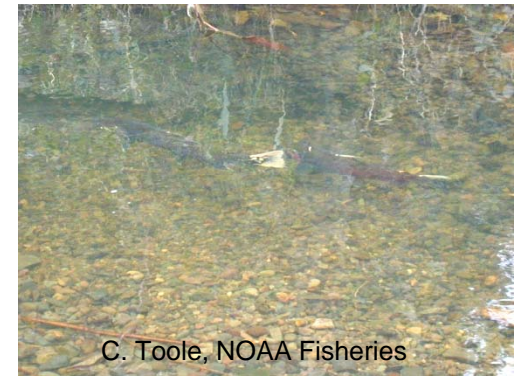
Christopher Toole  
NOAA Fisheries  
Northwest Region

*Please note that data and slides are from a variety of sources.  
Thanks to the authors who made them available.*

# Salmon & Climate Change

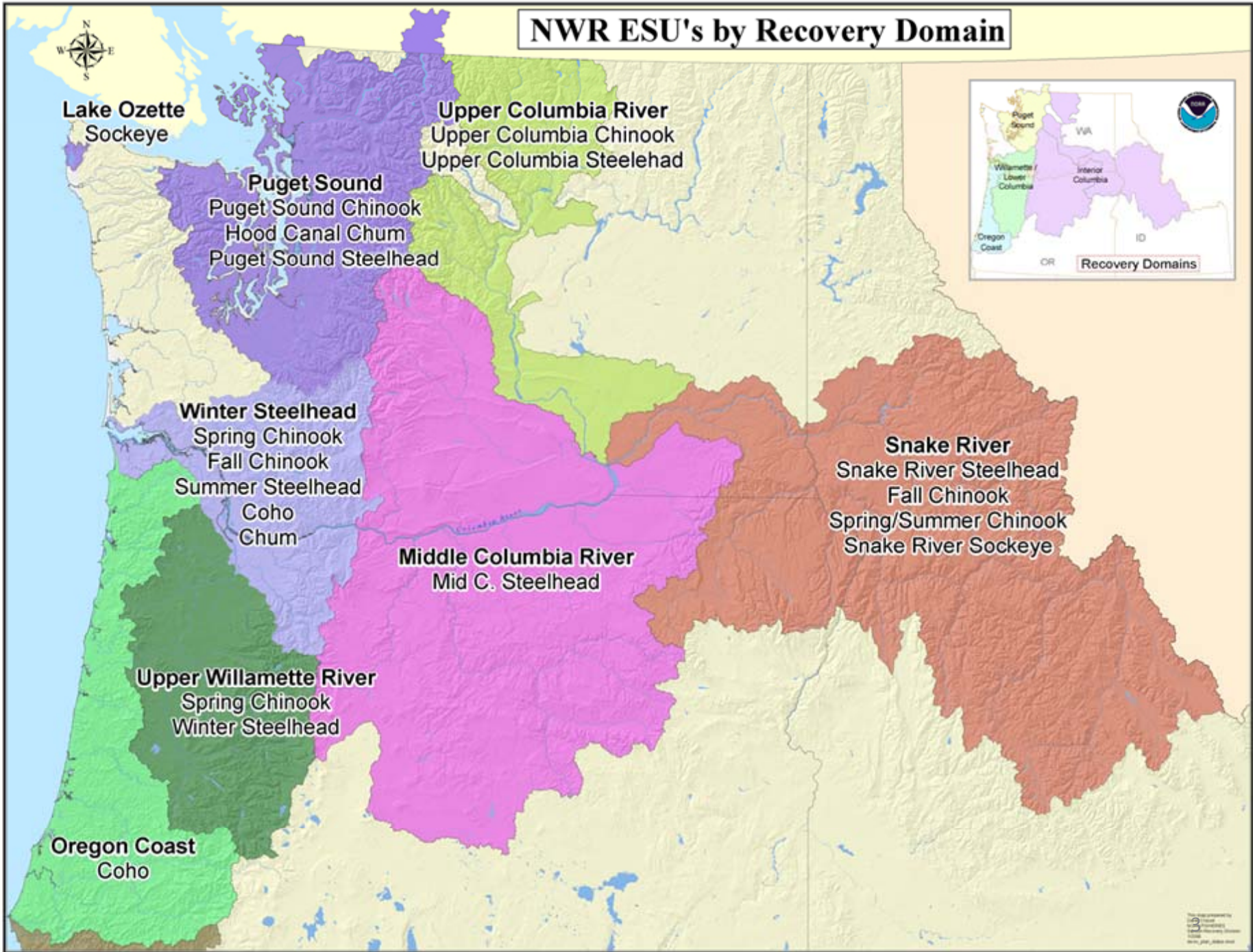


Salmon occupy freshwater, estuarine, and marine habitats during life history – susceptible to climate change effects in all habitats



Source: Nicholas and Hankin, as modified by Spence et al.

# NWR ESU's by Recovery Domain

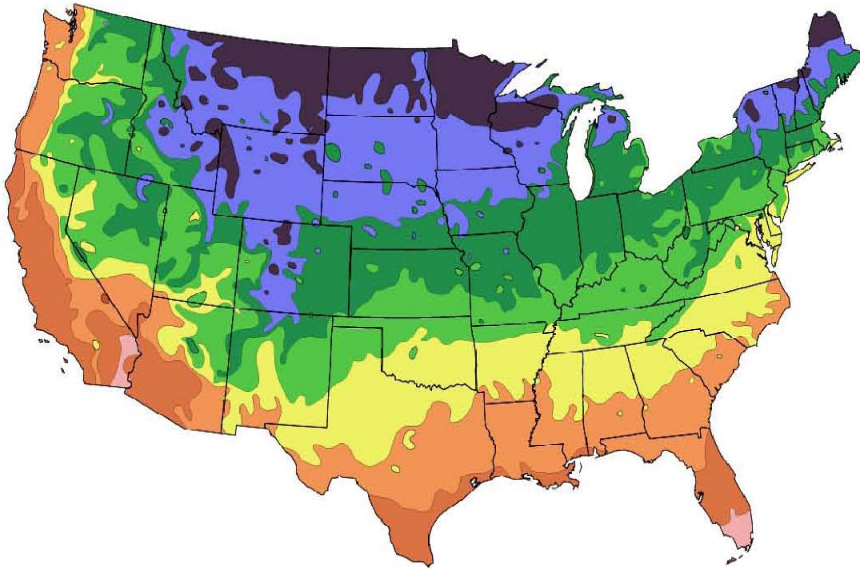




# Impacts in Freshwater

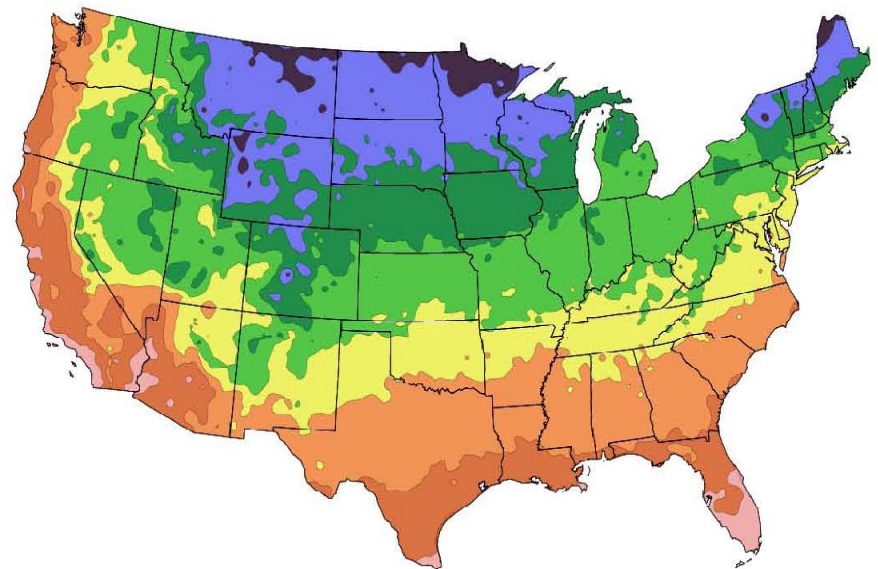
- Higher winter flows may scour redds
- Summer lethal effects in some areas
- Less habitat suitable for juvenile rearing
- Changes in migration timing
- More predation from warm-adapted species
- Migratory blocks for adults

1990 Map



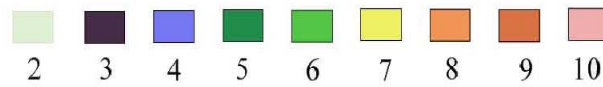
After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

2006 Map

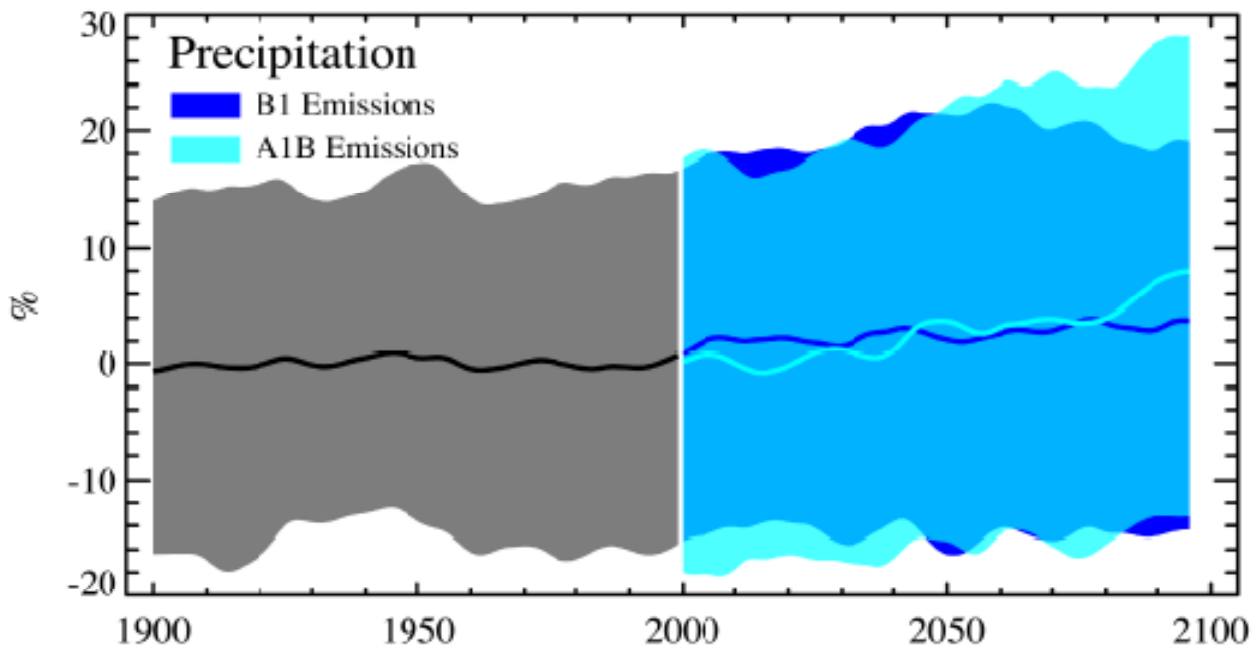
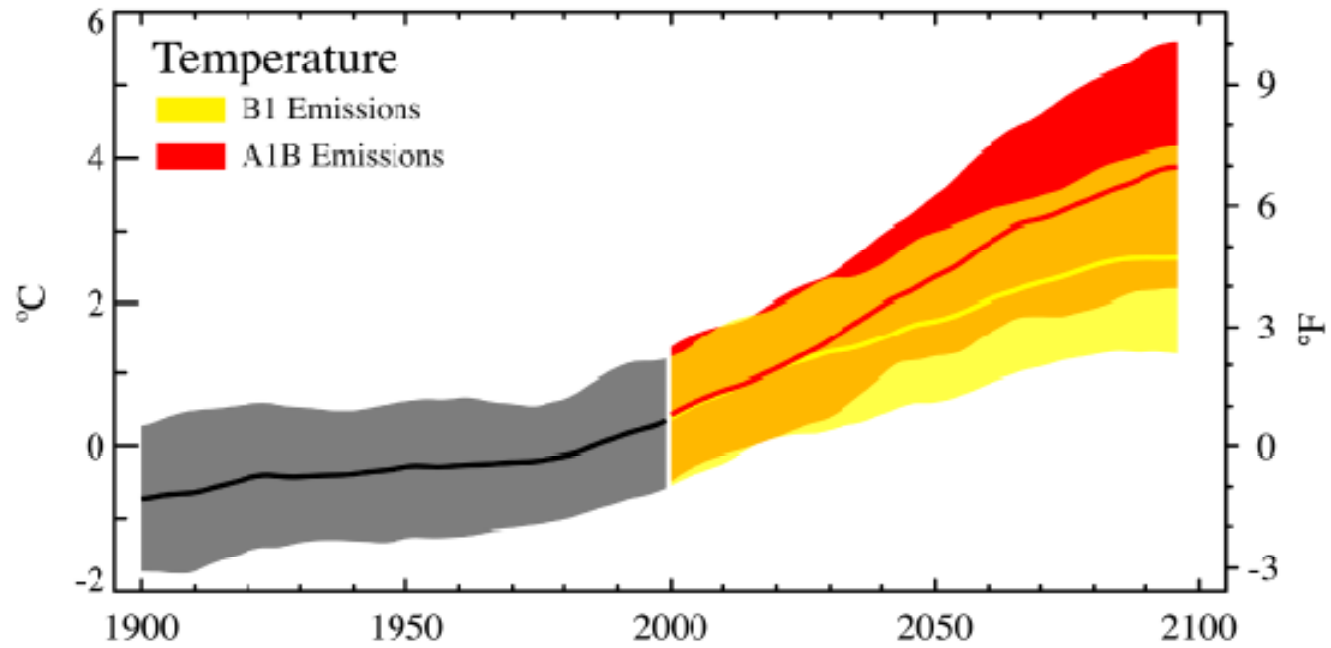


National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Zone

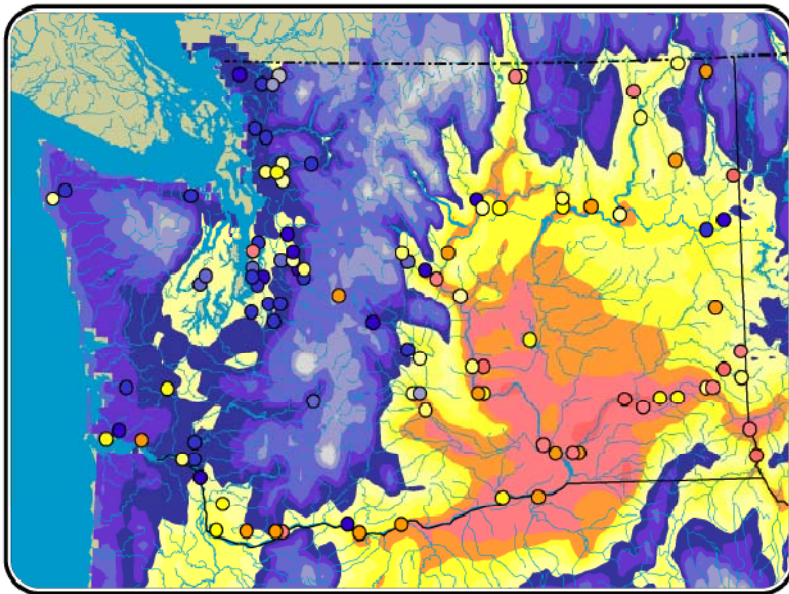


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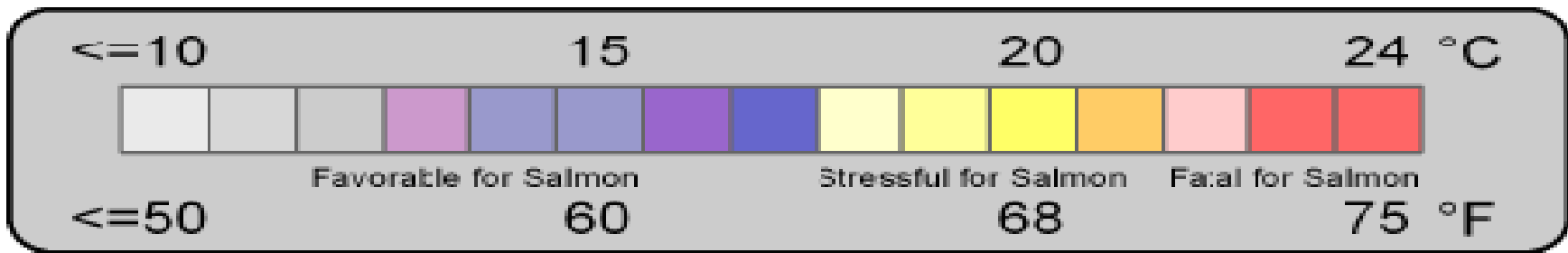
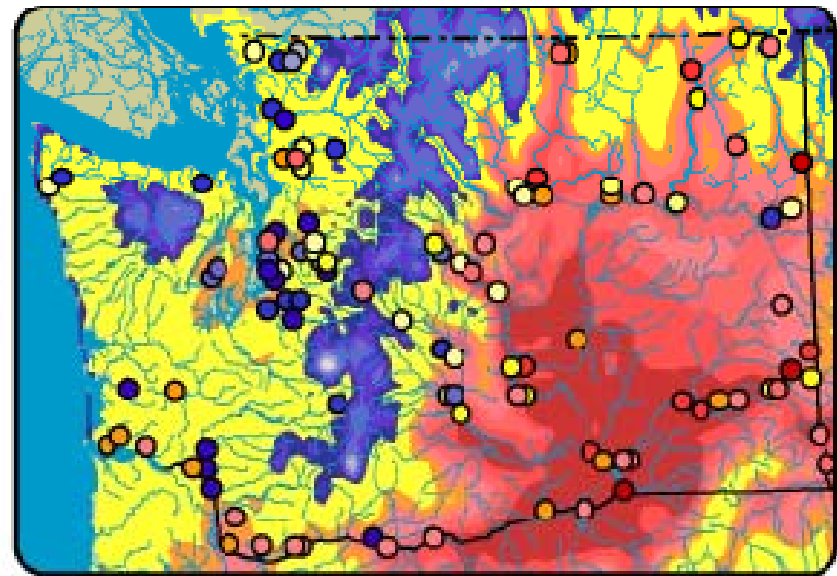
# Late Summer Stream Temperatures Expected to Increase 3°F By 2040s

August Mean Surface Air Temperature and Maximum Stream Temperature, 1970-1999

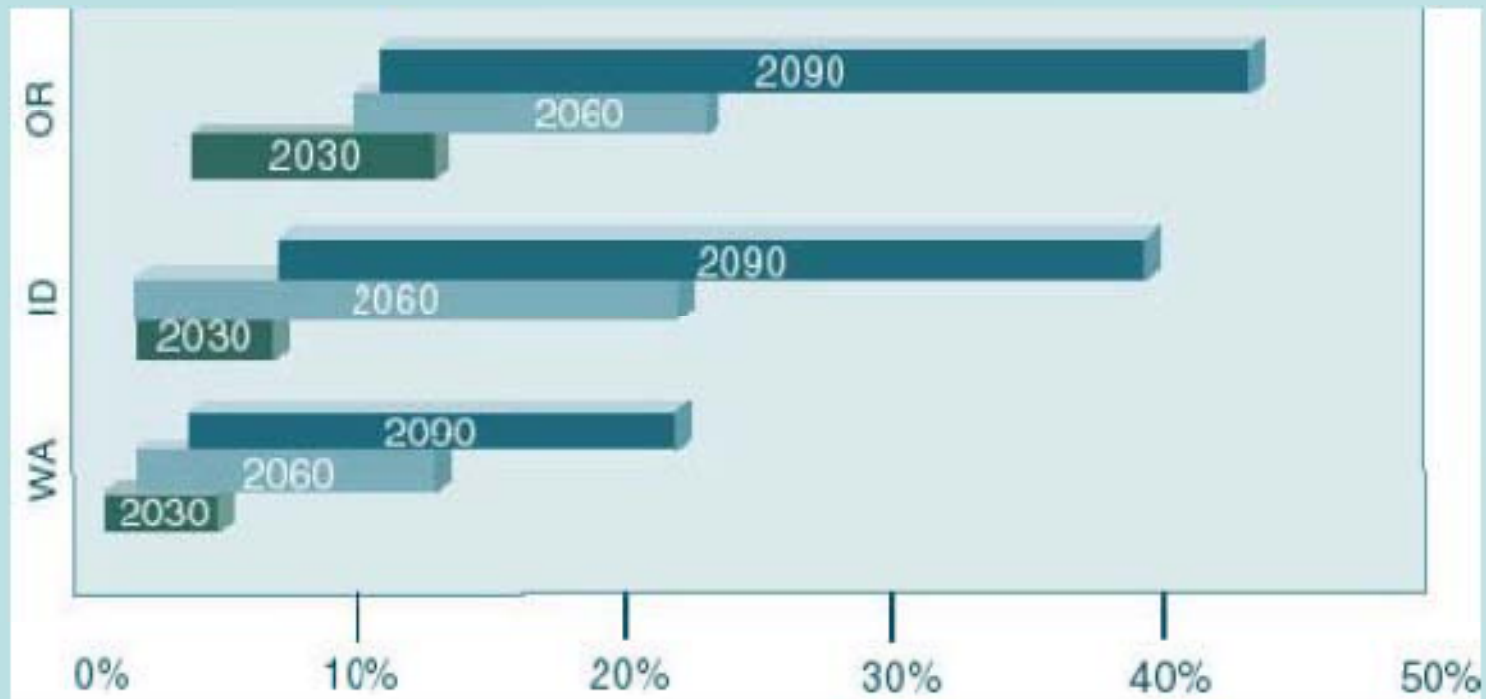


2040s: A1B Scenario

2040s



# Projected Loss of PNW Salmon Habitat over the Next Century

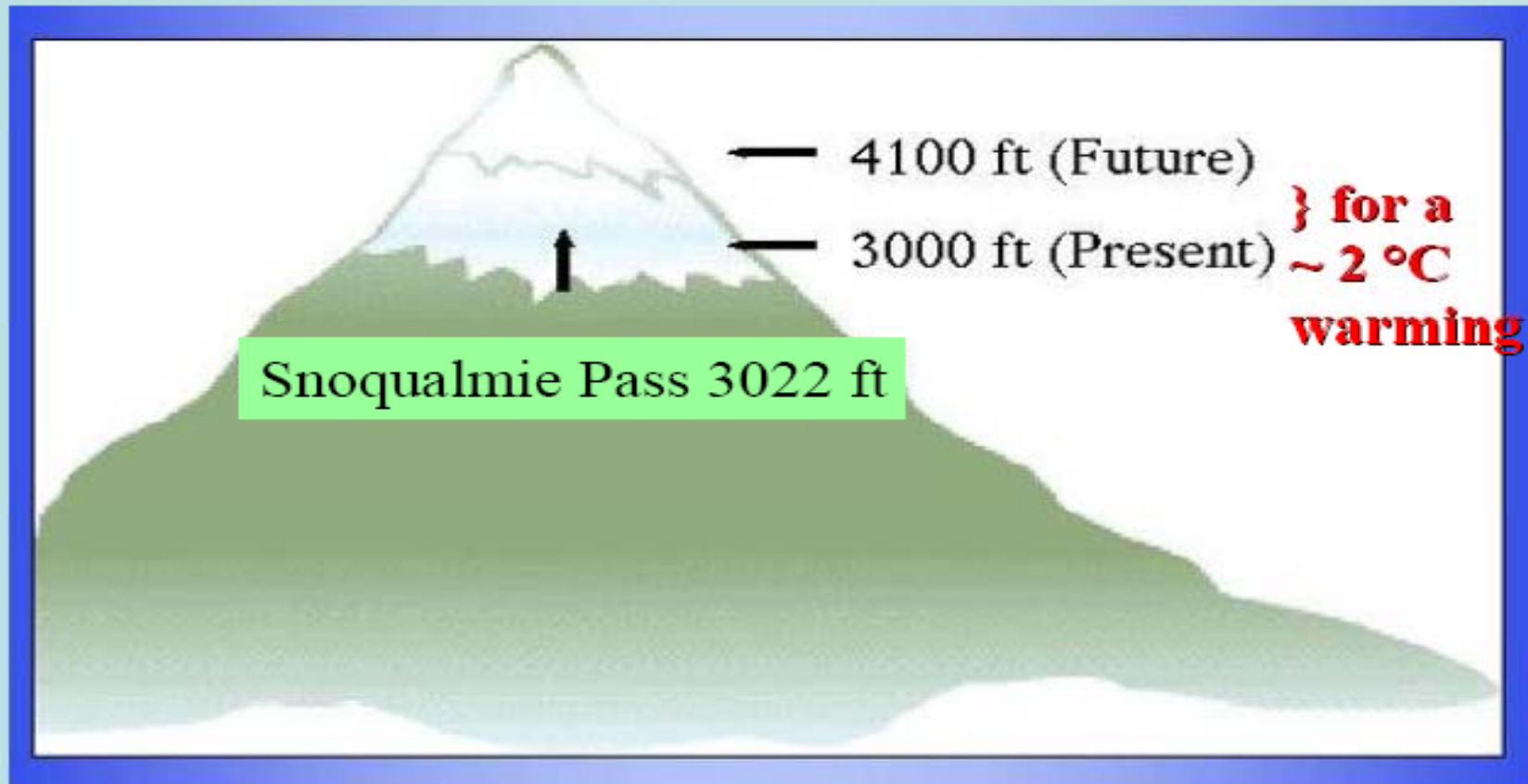


CGCM2 model; A2 GHG Scenario; 5°C increase by 2090

O'Neal 2002

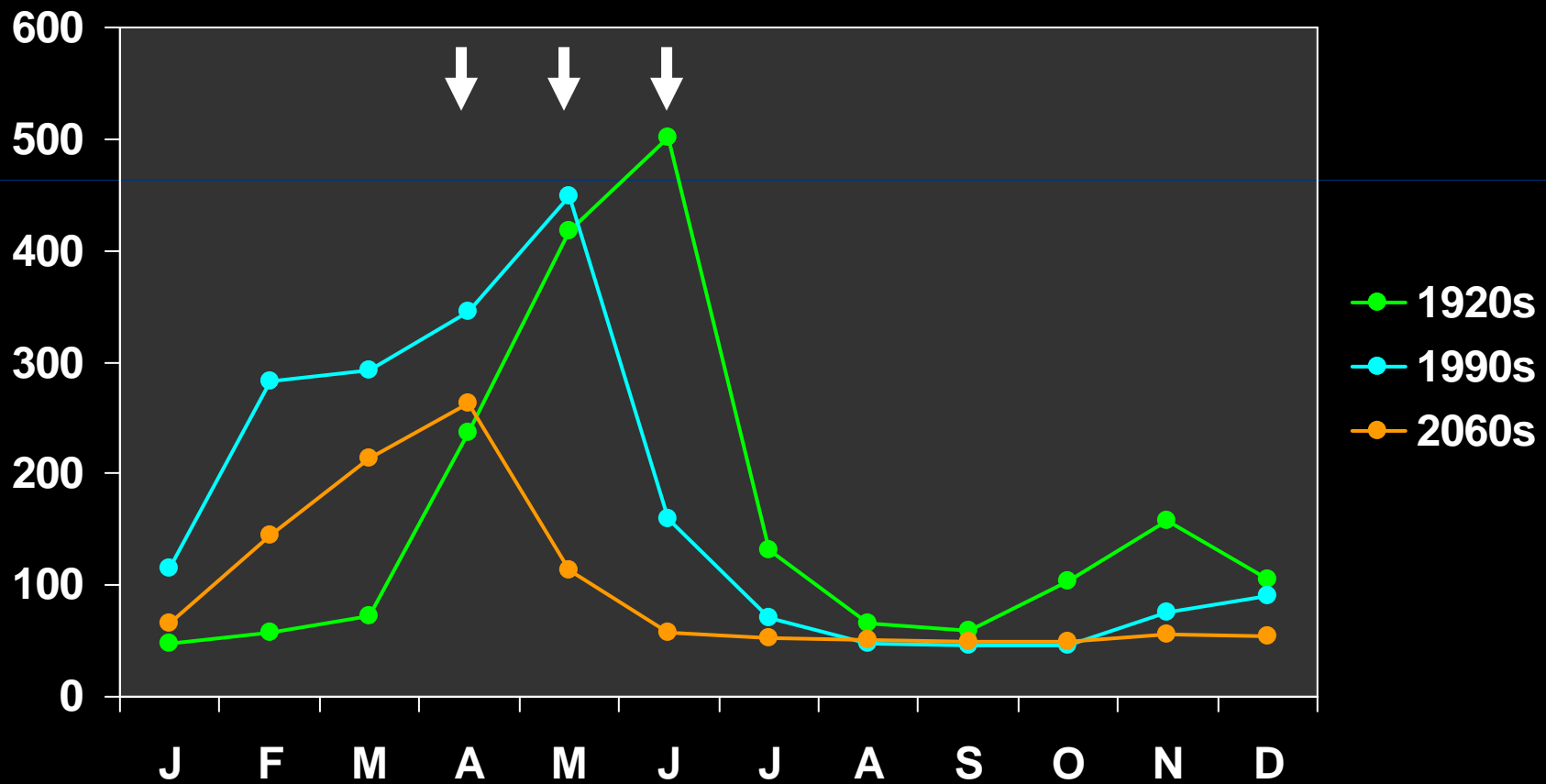
# Freshwater - Flows

The main impact: less snow



# Runoff regimes are shifting:

- Most runoff in winter and early spring
- Lower flows in late spring and summer



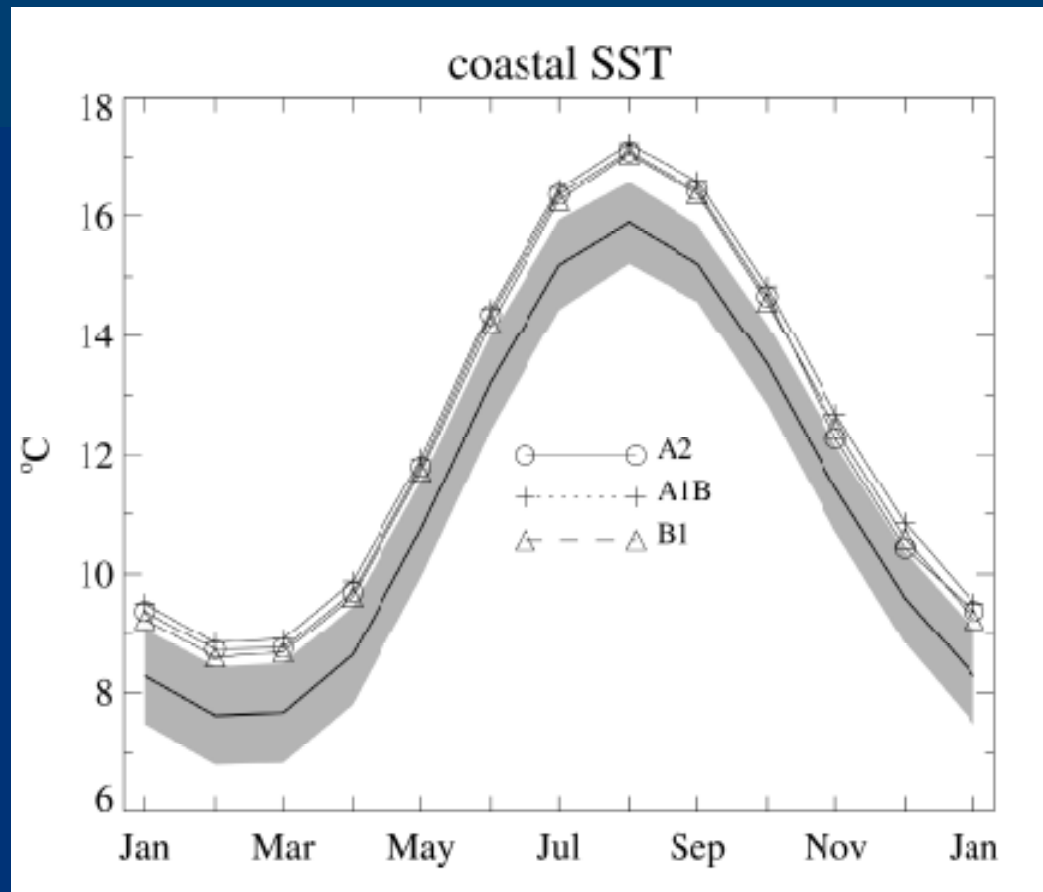


# Overall Freshwater Impact

- Some species and runs will be more susceptible than others:
  - Spring and summer Chinook, steelhead most susceptible
    - populations in transitional snow- vs rain-fed systems most affected
  - Chum salmon and fall Chinook less affected
  - A few runs may benefit
- NOAA analyses suggest spring/summer Chinook in Snake River will have significantly reduced survival by 2040



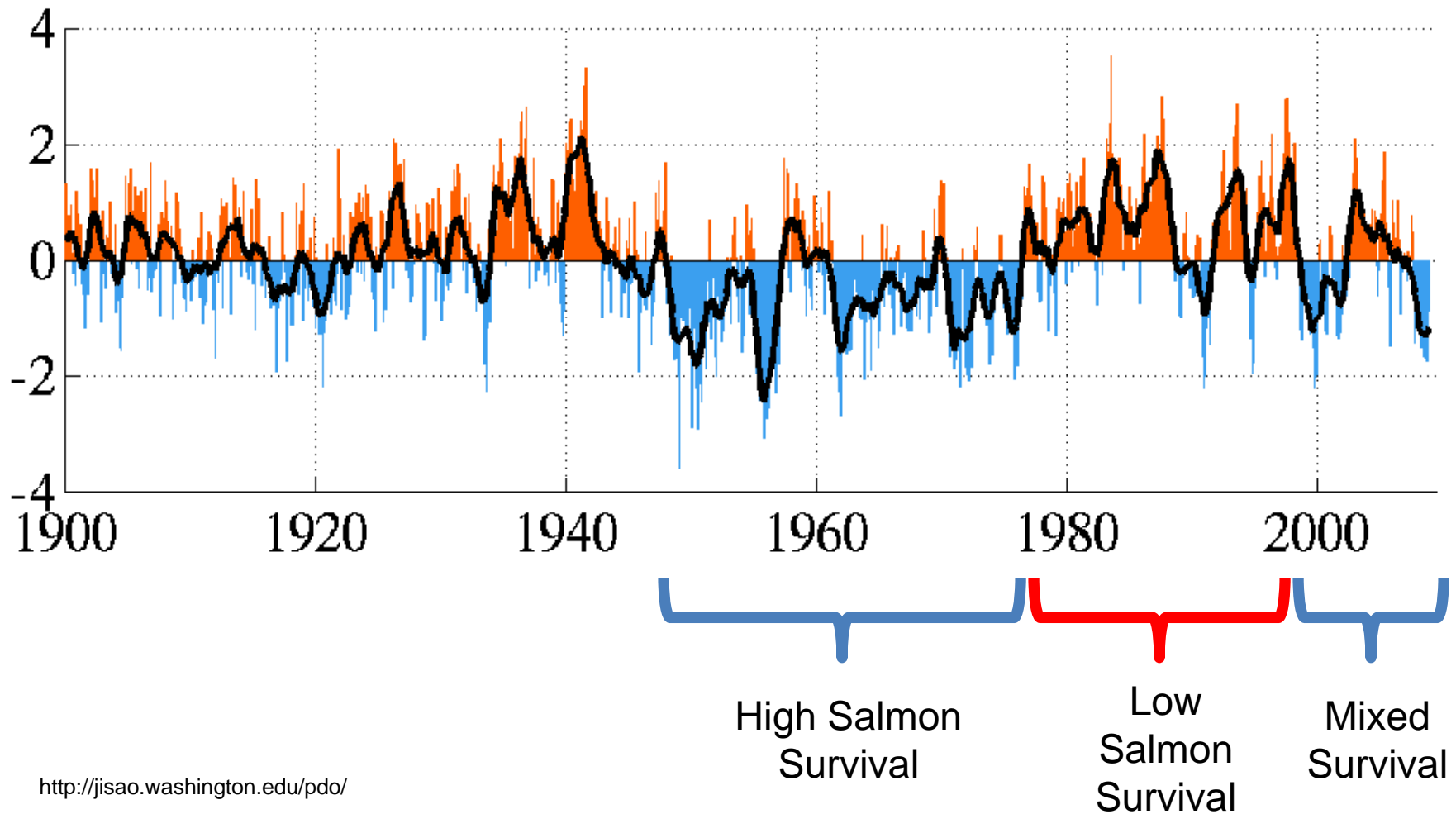
# Ocean Warming



Mote and Salithe (2009)

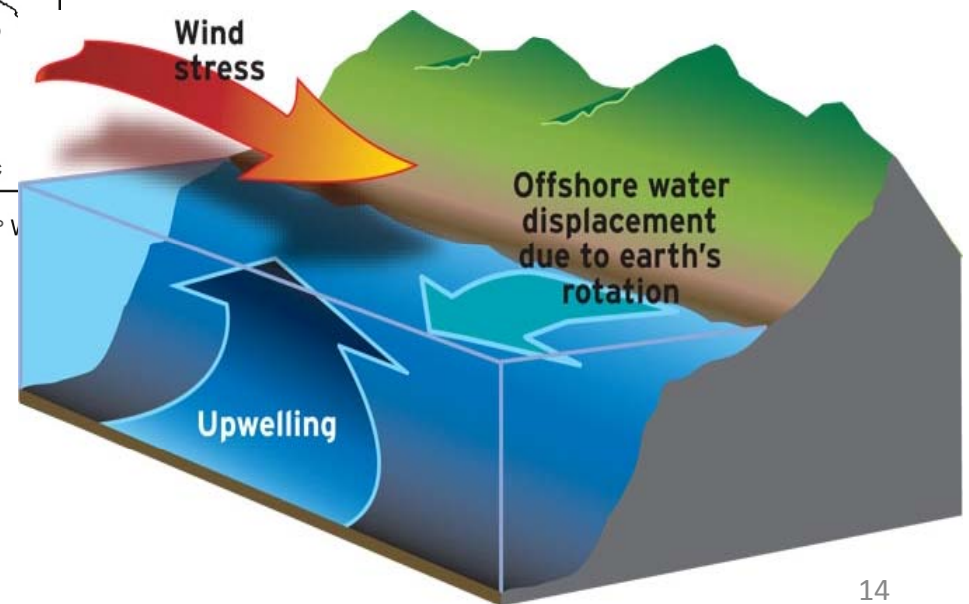
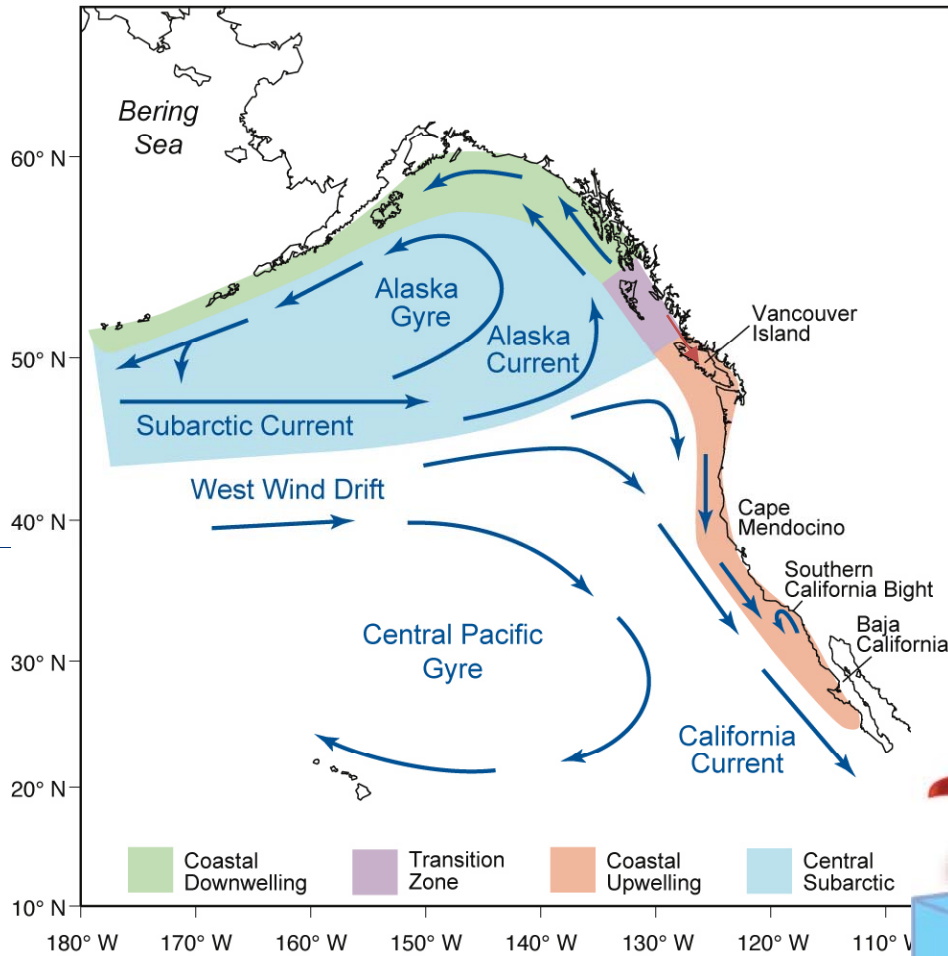
# Salmon Survive Best Under Cool Temperature Regimes

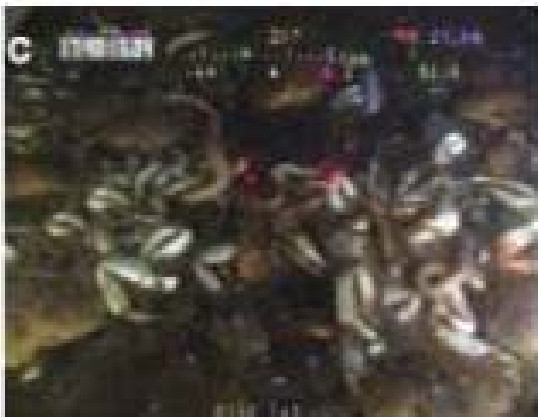
monthly values for the PDO index: 1900-2008



# Good Salmon Conditions:

1. Atmospheric circulation patterns to drive water flow from the north
2. Winds during spring and summer to cause coastal upwelling

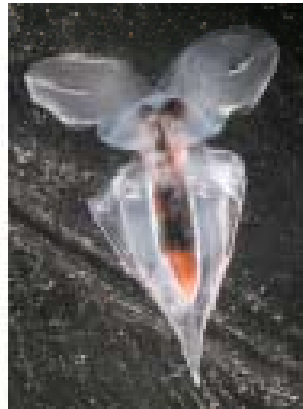
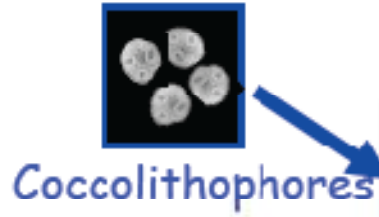
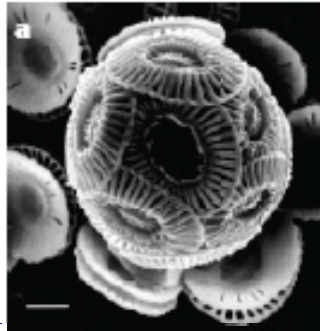




The geographic extent of hypoxia in 2006 and 2007. Light blue shows the extent of hypoxia ( $<1.4\text{ ml/l}$ ) and purple shows the region of severe hypoxia ( $<0.5\text{ ml/l}$ ). Waters closest to the shore remain high in oxygen due to breaking waves. Dots represent sampling sites. Data made available by PISCO and NOAA-Fisheries, NWFSC.

Hypoxic areas (“dead zones”) off Oregon may be related to changes in wind patterns and upwelling resulting from climate change.

# Ocean Acidification

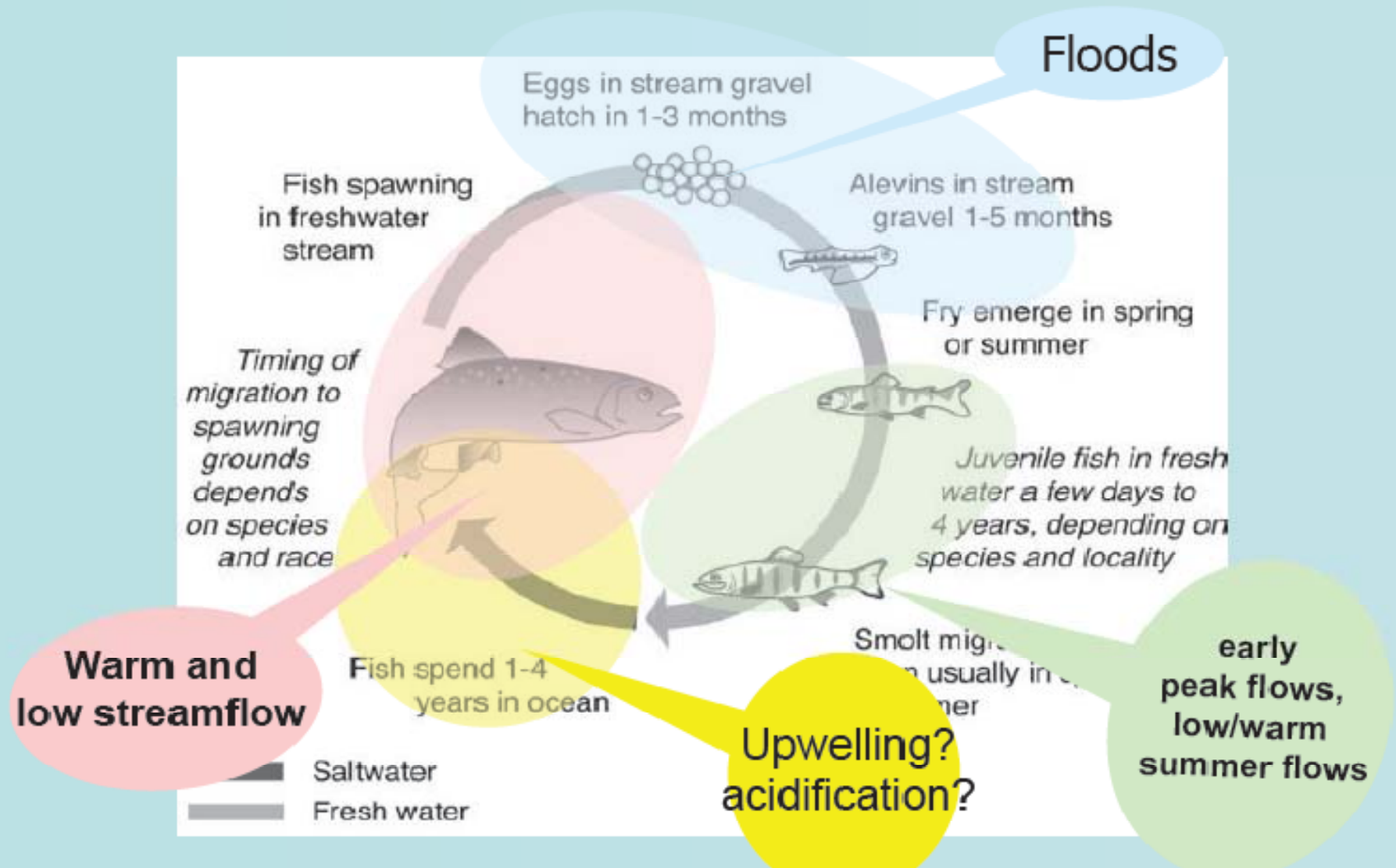


Pteropods



Pacific Salmon

# Climate change impacts summary





# What Should We Do?

- ISAB 2007 Recommendations
- Reserves, buffer zones, protect cold-water refuges
- Manage surface and groundwater
- Mainstem passage improvements and predator reduction
- Incorporate climate change into restoration strategies

# Can we modify habitat restoration to increase salmon resilience to climate change?

