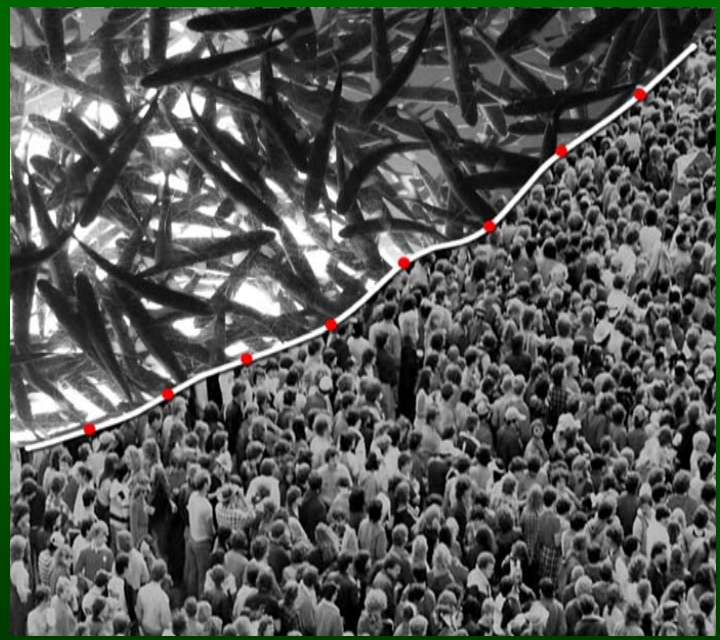
ISAB Climate Change and Population Growth Reports

Impacts on Columbia River Basin Ecosystems



Contributors to the Reports

Climate Change Report

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Human Population Report

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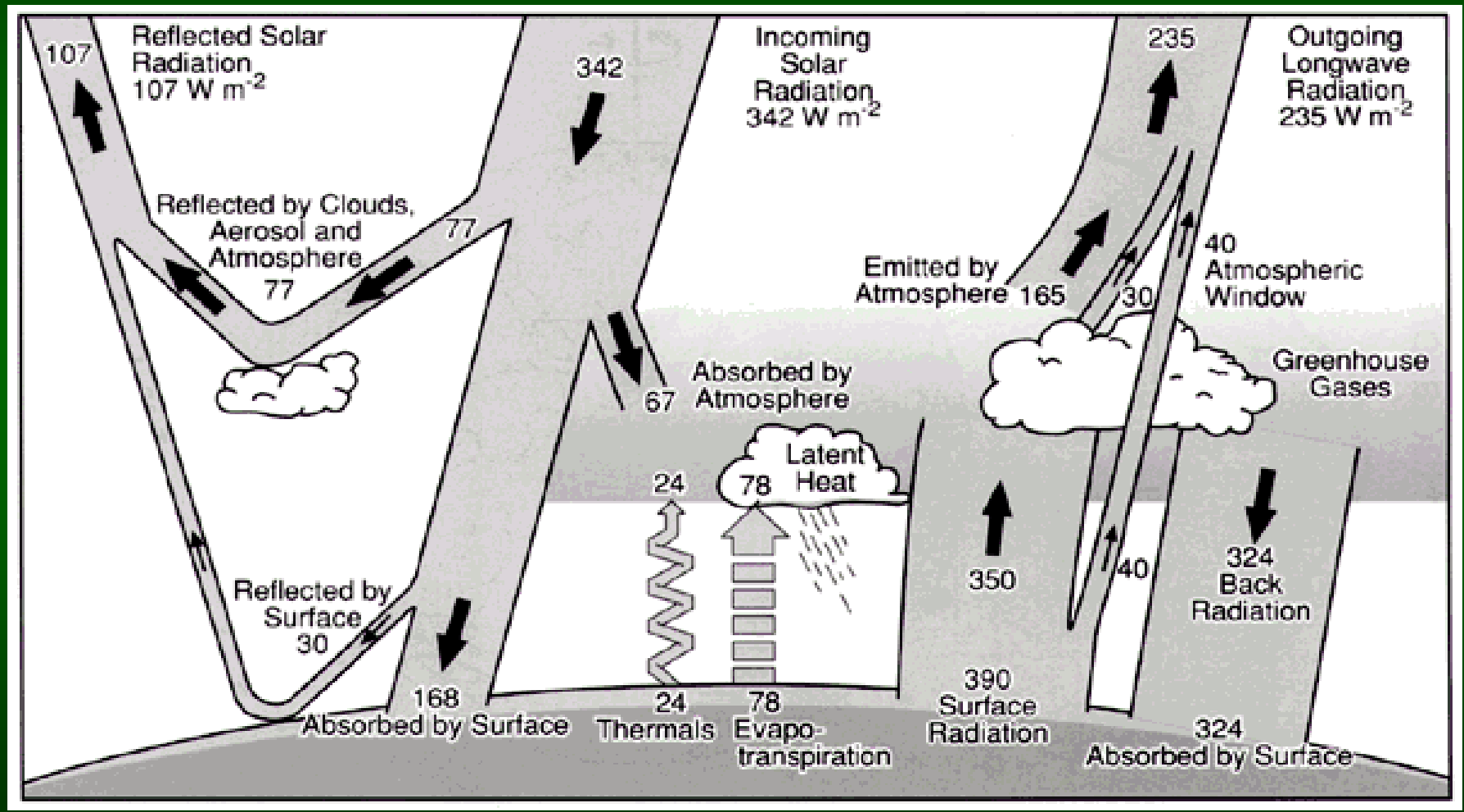
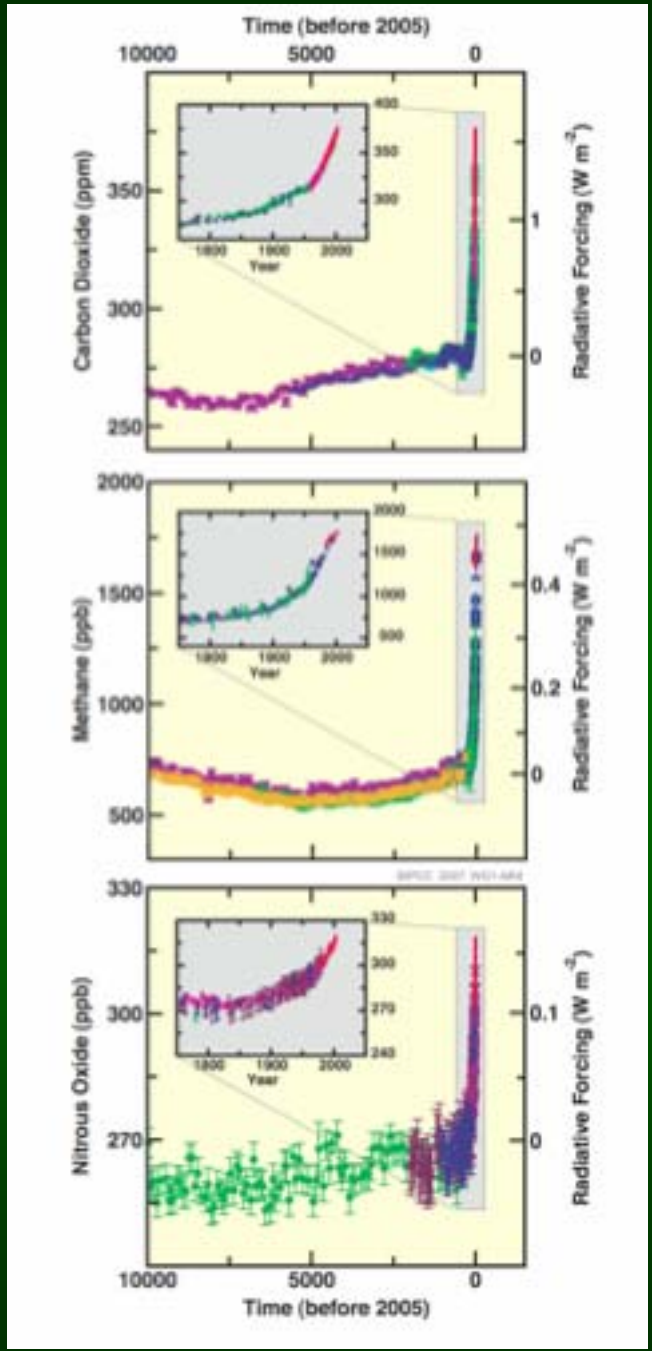
Earth's Radiation Budget and the Natural Greenhouse Effect



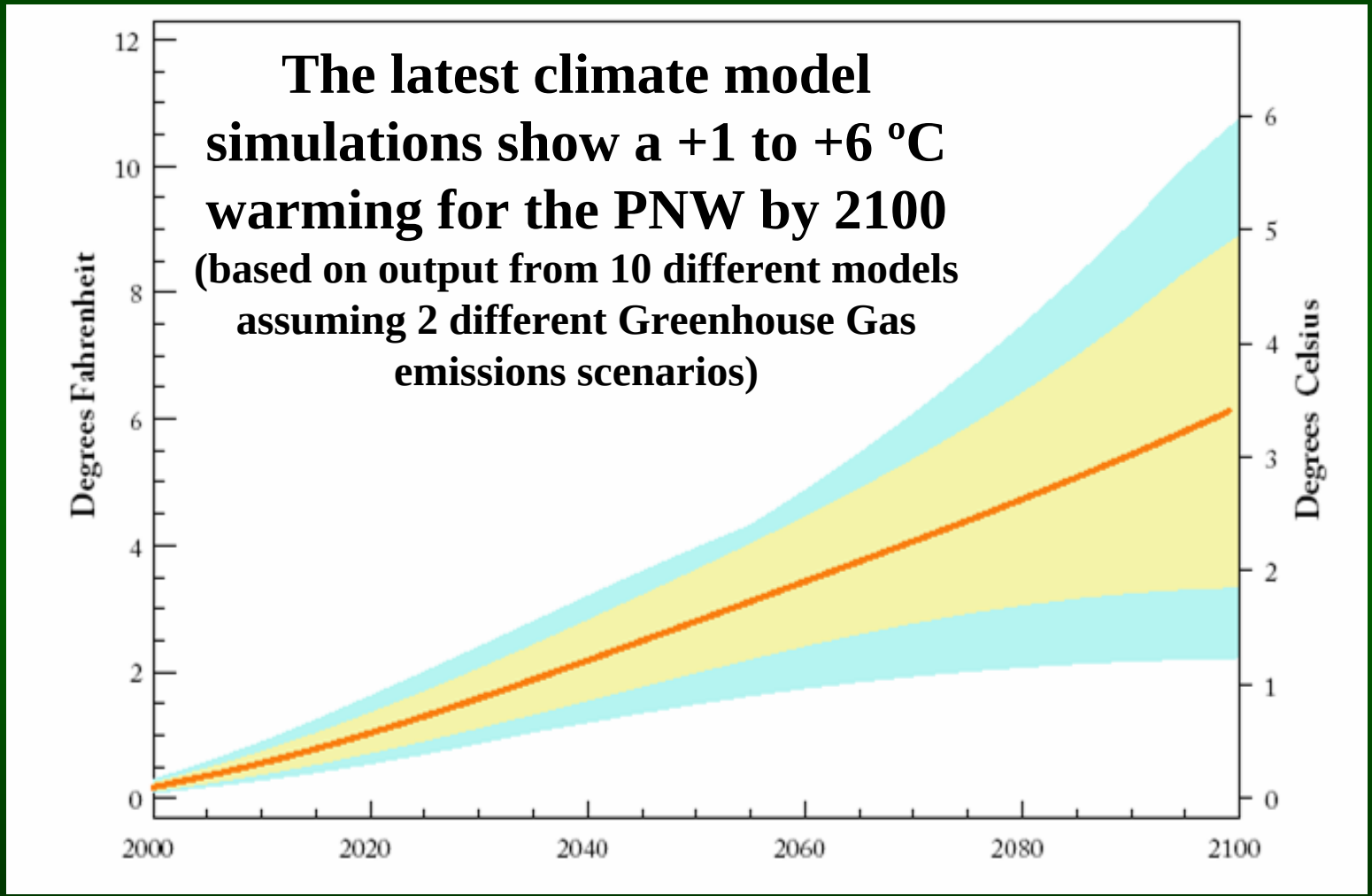
From Kiehl and Trenberth, 1996: Bull. Of the American Met. Soc.

Changes in Greenhouse Gas Concentrations over last 10,000 Years

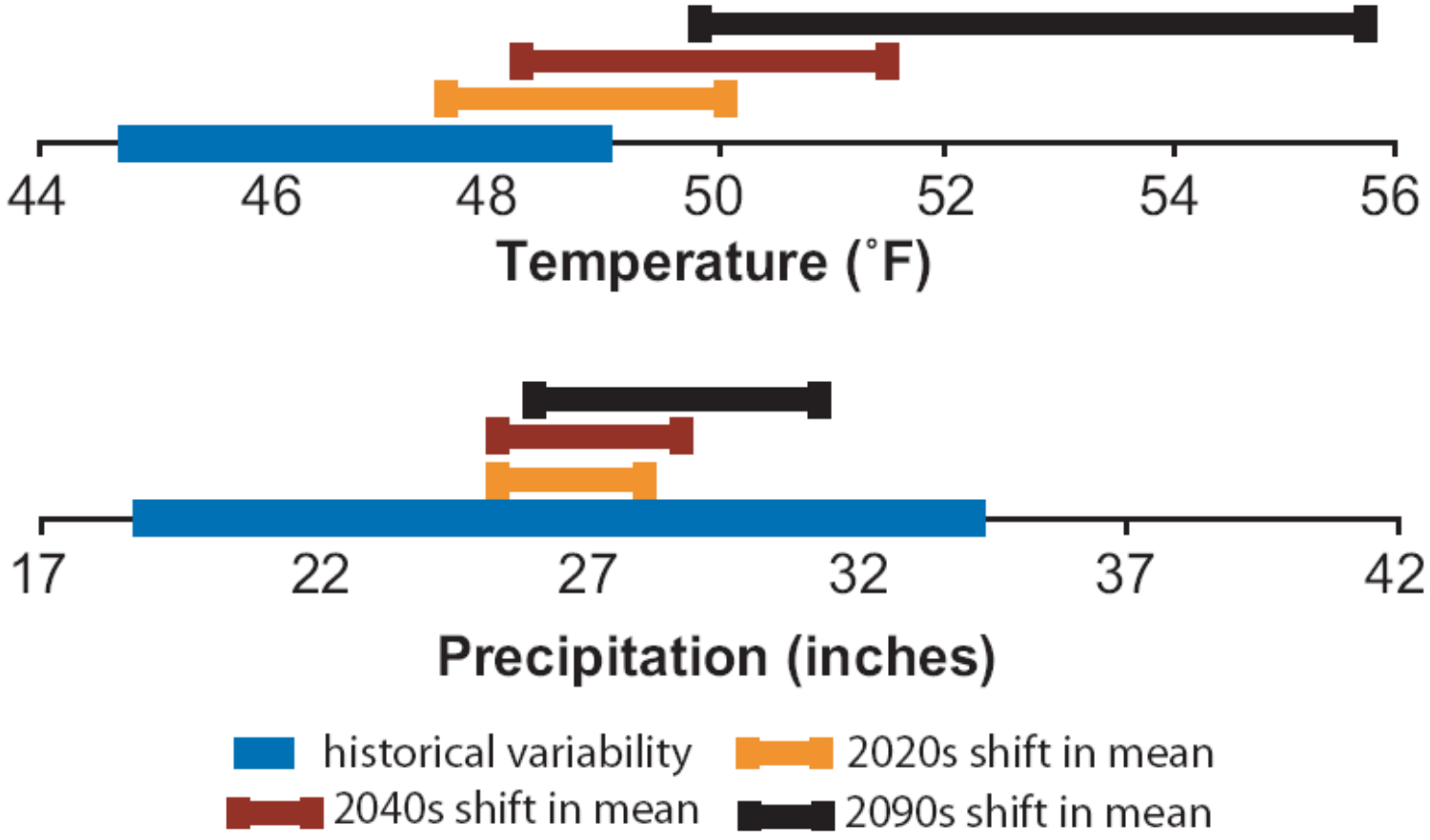
- Concentrations of key greenhouse gases have increased rapidly and substantially due to human-caused emissions, mostly since the mid-20th century



21st Century PNW Temperature Change Scenarios



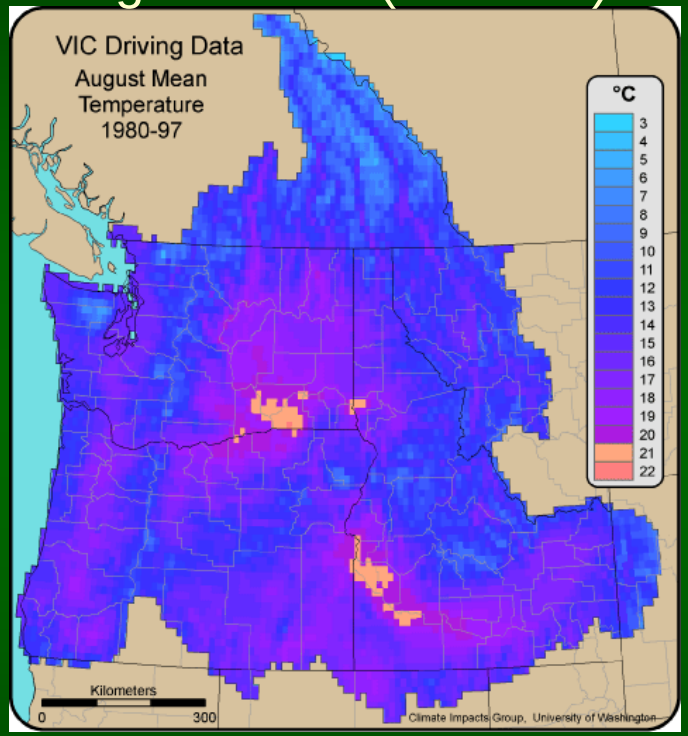
Source: UW Climate Impacts Group, also see Salathé et al. 2007: Int'l J. of Clim.



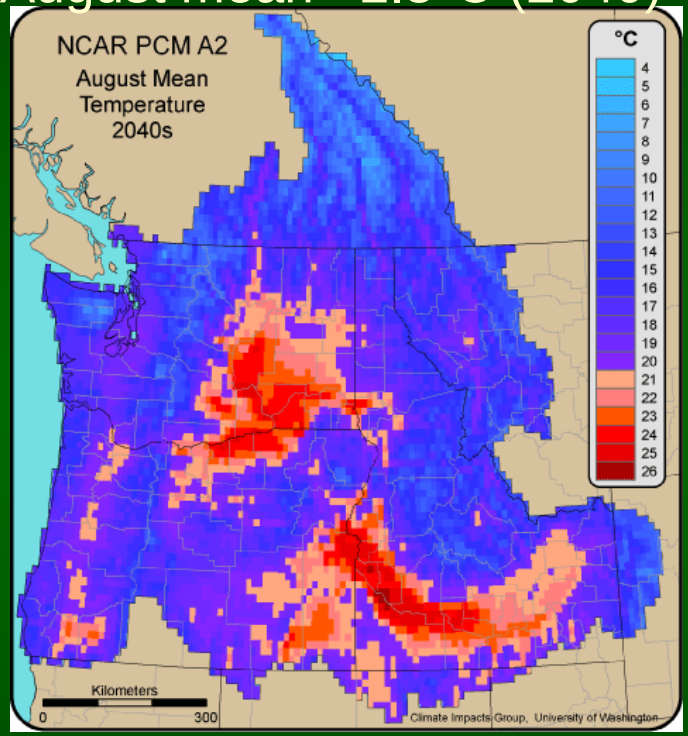
Comparison of observed year-to-year variability and projected shifts in temperature and precipitation from climate models

Temperature Changes in the CRB

August mean (1980-97)



August mean +2.3°C (2040)



- With a 2.3 °C warming, ~ 20% of the region has August average temperatures > 21 °C (compared with an average of < 2% for 1980-97)

Hamlet et al., *J. Hydrometeor*. (in press)

Snowpack at High Elevations Less Sensitive to Warming

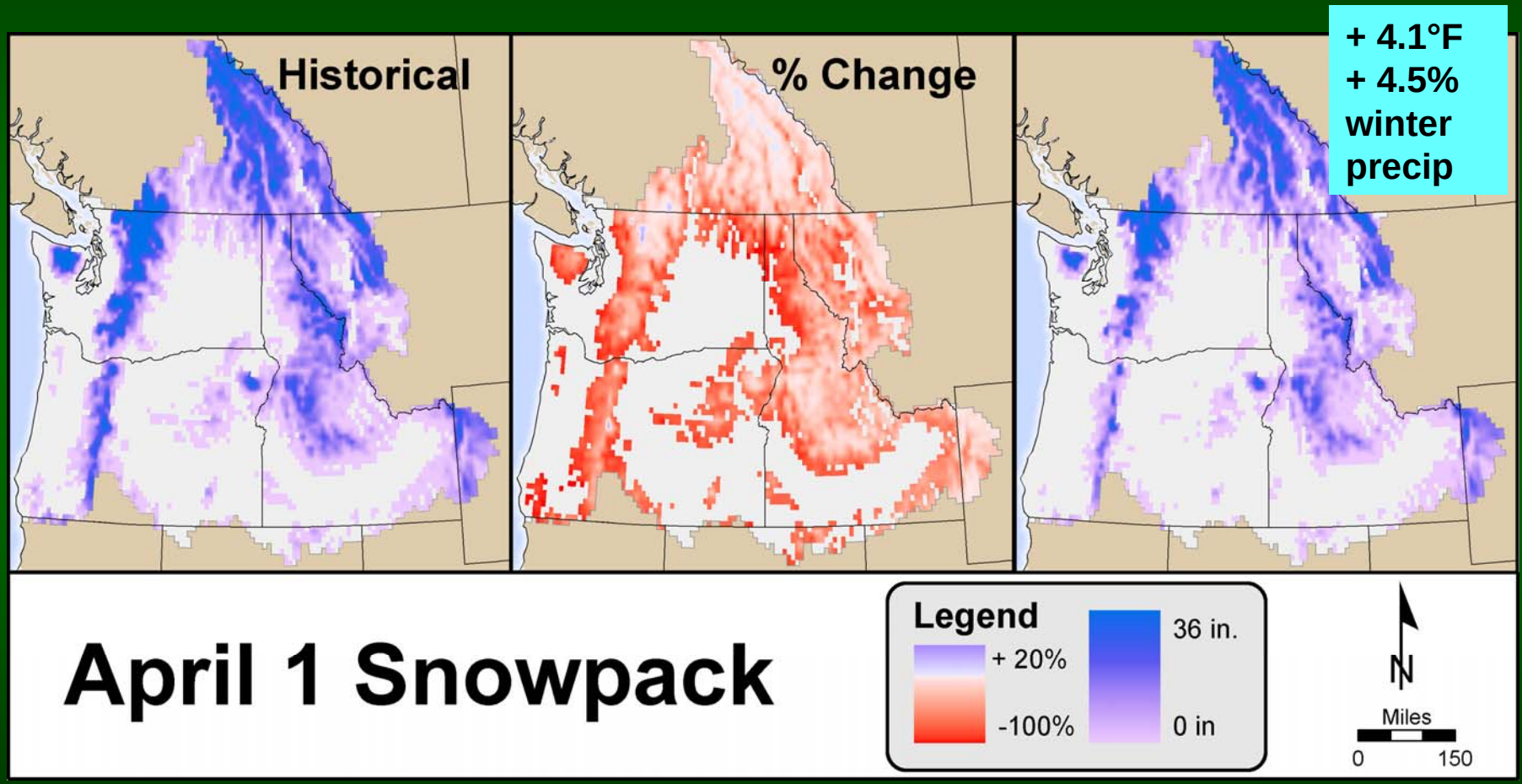
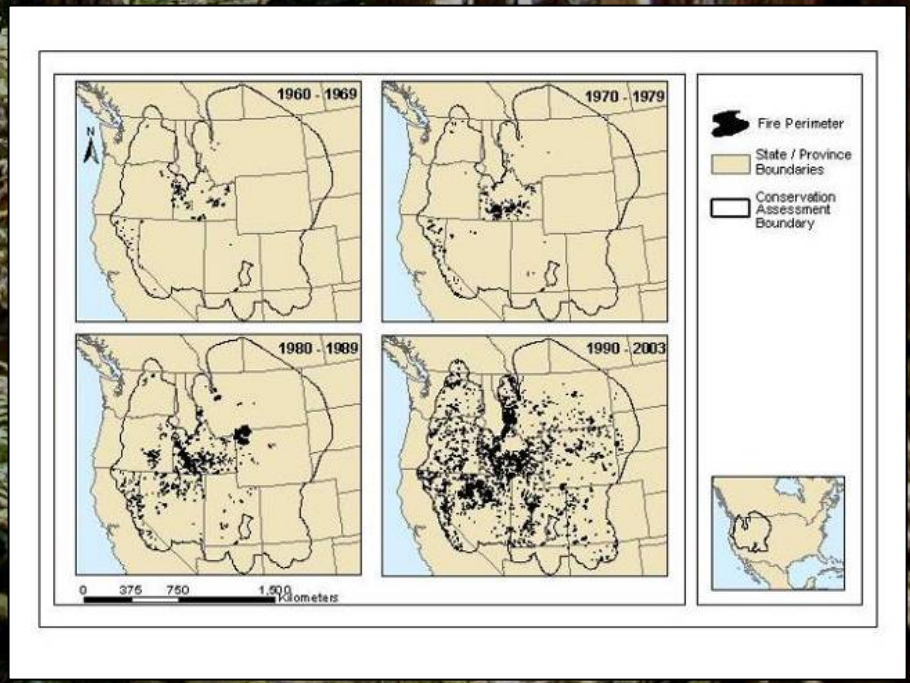


Figure courtesy of Alan Hamlet, UW Climate Impacts Group

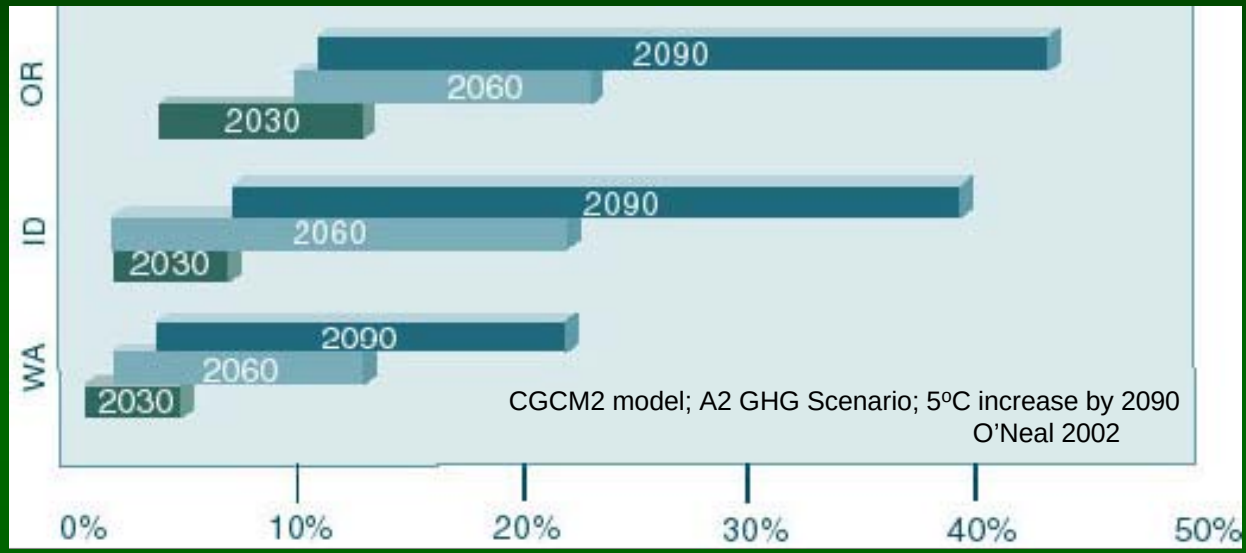
Climate Change Impacts on Terrestrial Systems

- Potential for restructuring of plant communities: species ranges generally shift northward and to higher elevation
- Forest productivity altered – effect varies with elevation
- Elevated forest mortality from insects and fire
- Range of wildlife species may shift north or to higher elevation
- Strong interaction with population change as habitat fragmentation may preclude range shifts for some species



Effects of Climate Change on Tributary Habitats

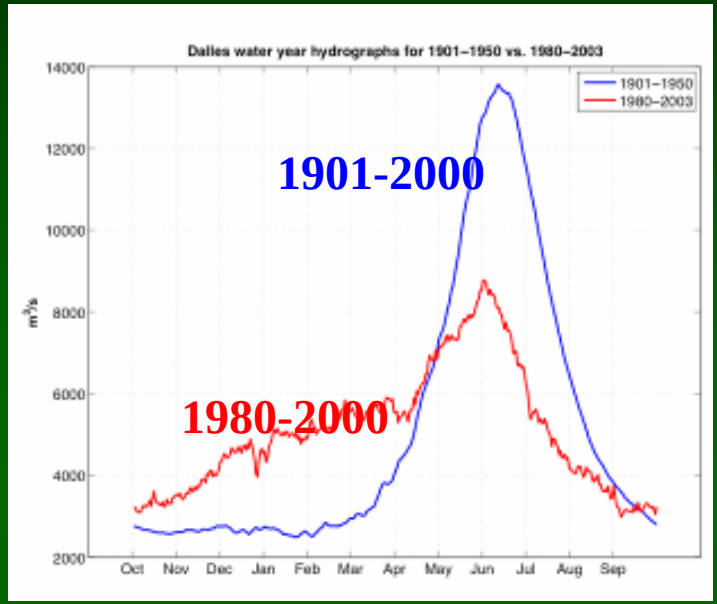
Projected impact of elevated summer temperature

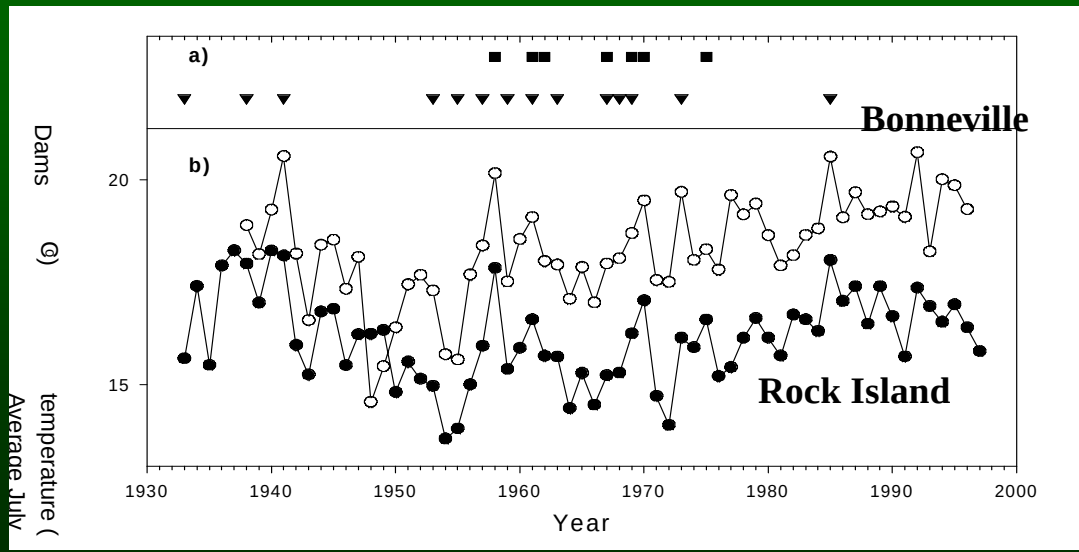


- More frequent winter flood flows
  - egg mortality
  - reduced overwinter habitat quality
- Lower summer flow – reduced rearing habitat
- Higher temperatures in all seasons
  - higher predation rates
  - higher metabolic maintenance requirements

Flow at the Dalles

- Hydrosystem operations have already caused substantial reductions in peak summer flows, increases in winter flows, and rising summertime water temperatures – the same type of responses expected from climate change

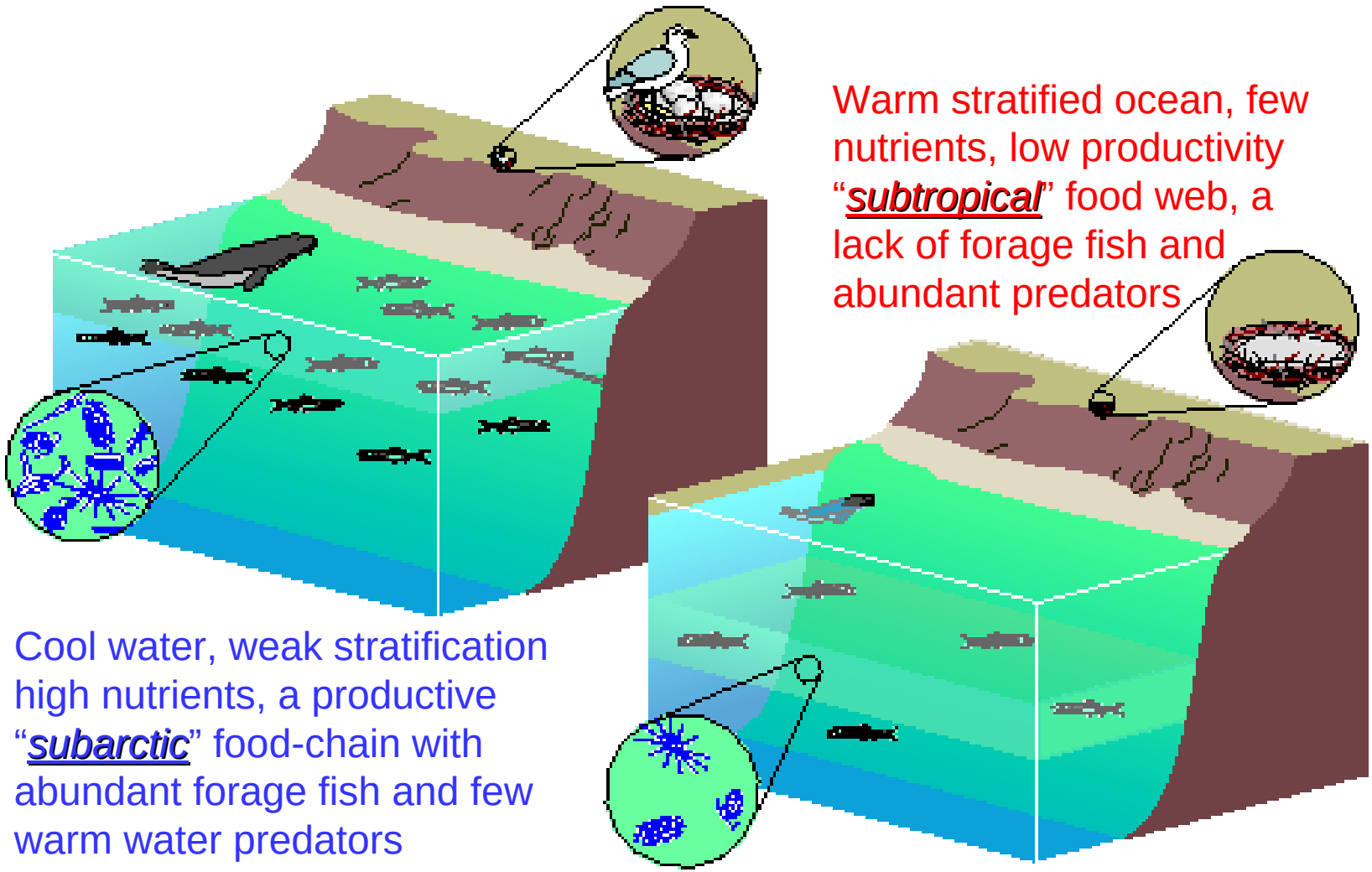




Effects on the Estuary

- Sea level rise in conjunction with higher winter river flow may lead to increased storm damage to estuarine habitats
- Upstream extension of the salt wedge during periods of lower flow in late spring through summer may alter trophic dynamics in the estuary
- These impacts are predicated on climate-induced changes in river flow but flow levels from the river will be determined primarily by hydrosystem operation, not climate change
- Warmer water temperature in the estuary may favor warm-adapted species, including invasive species

Upwelling and Coastal Food Web Productivity



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

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

Upwelling in a Warmer Future?

In one climate modeling study, springtime upwelling is delayed, while summertime upwelling intensifies (comparing the monthly averages from the 2080-2099 and 1980-1999 simulation periods)

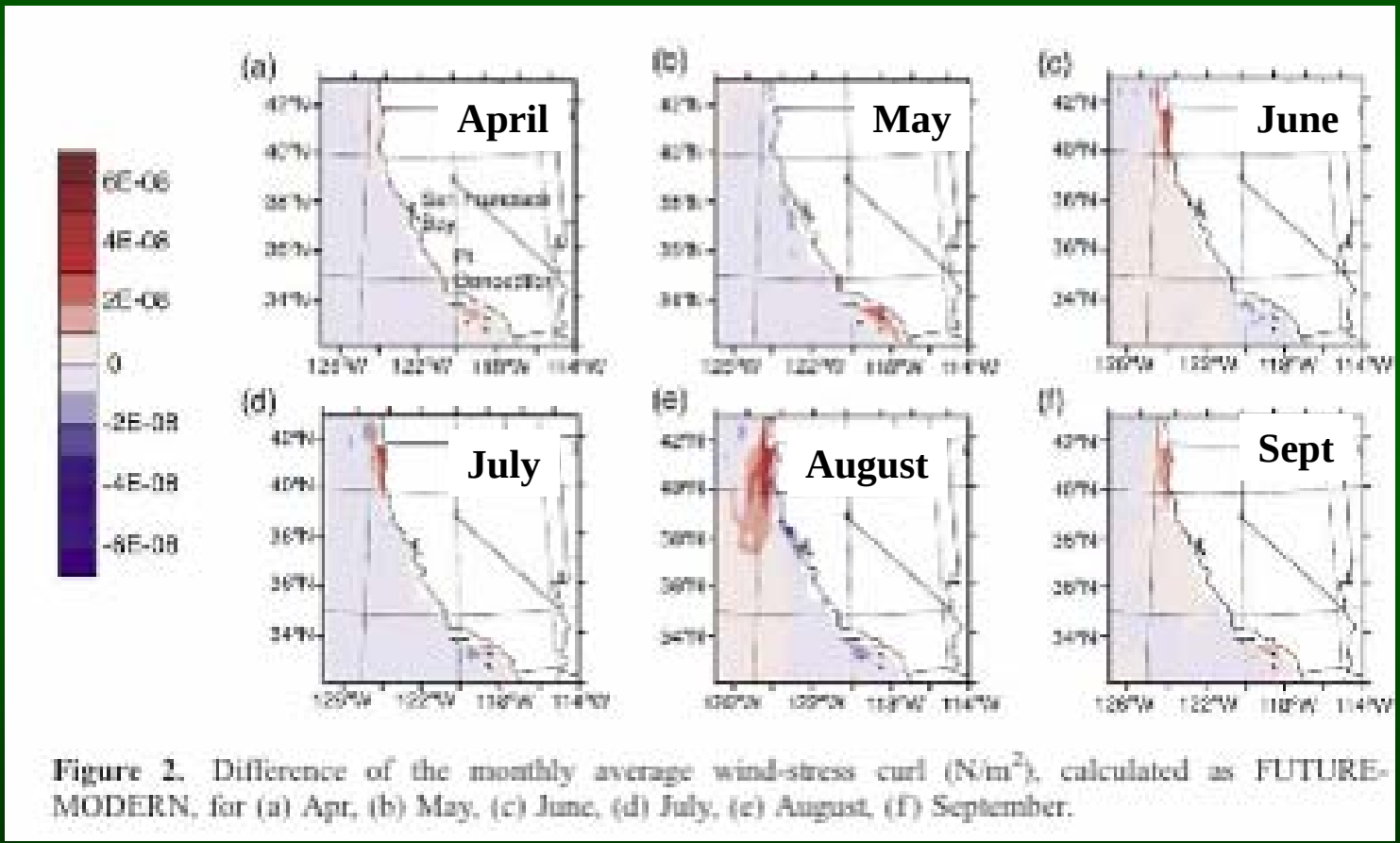


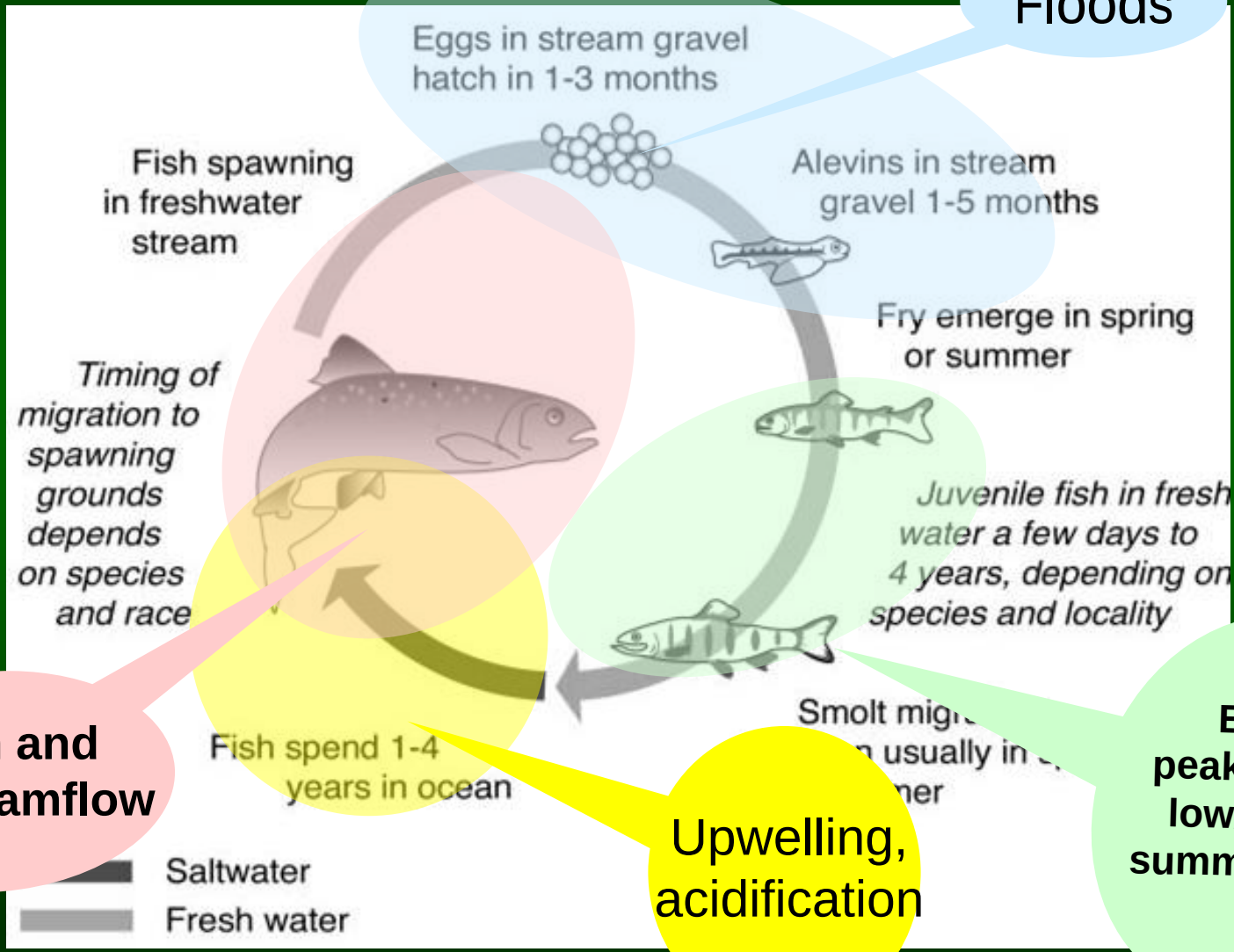
Figure 2. Difference of the monthly average wind-stress curl (N/m^2), calculated as FUTURE-MODERN, for (a) Apr, (b) May, (c) June, (d) July, (e) August, (f) September.

(Snyder et al. 2004, GRL)

Ocean Acidification

- Increased atmospheric CO_2 lowers ocean pH
- Reduces availability of $CaCO_3$ for shell-forming organisms
- Pteropods may be especially affected – an important in the diet of many salmon species in the subarctic ocean and for juvenile coho in coastal waters of Oregon and Washington

Climate Change Effects on Salmon



Floods

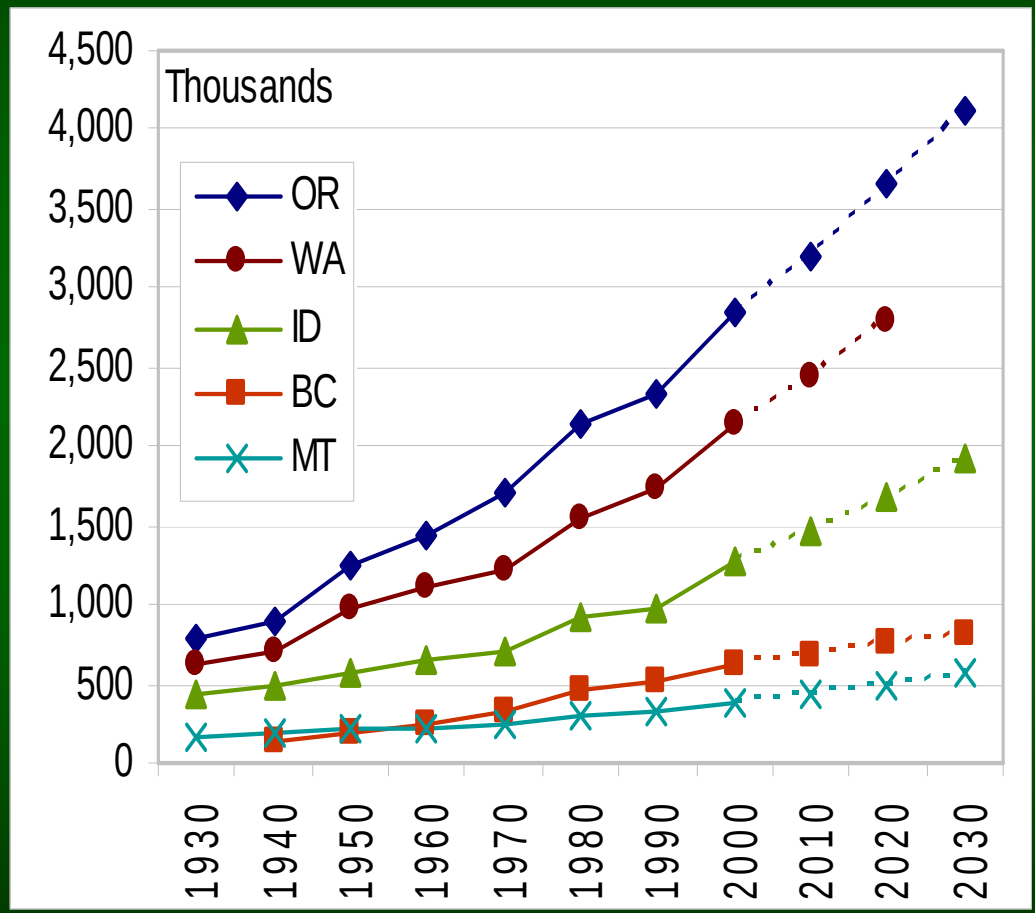
Warm and low streamflow

Upwelling, acidification

Early peak flows, low/warm summer flows

Columbia River Basin Population Growth
OR, WA, ID, BC, MT

- Population increase from 1.9 million to 7.2 million from 1930 to 2000
- Predicted to reach about 9.9 million by 2030



US and Canada censuses. State and regional district projections for 2010 and 2020

Water

Demand

- Changes in land use will affect water use and management
- Demand for surface and groundwater will increase – all uses; domestic, industrial and agricultural

Supply

- Climate change will affect quantity and seasonal pattern of water supply

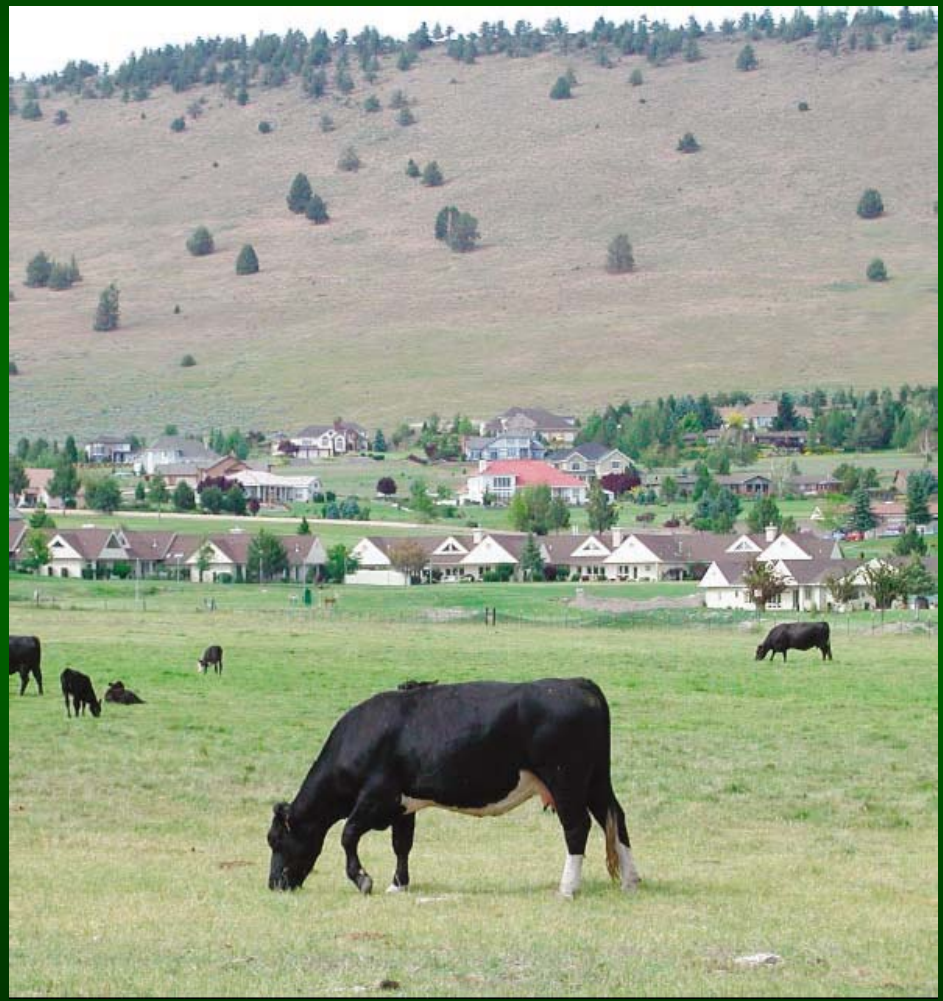
Forests

- Conversion of forestland to residential, recreational and commercial development is accelerating

Willamette Partnership

Exurban Development

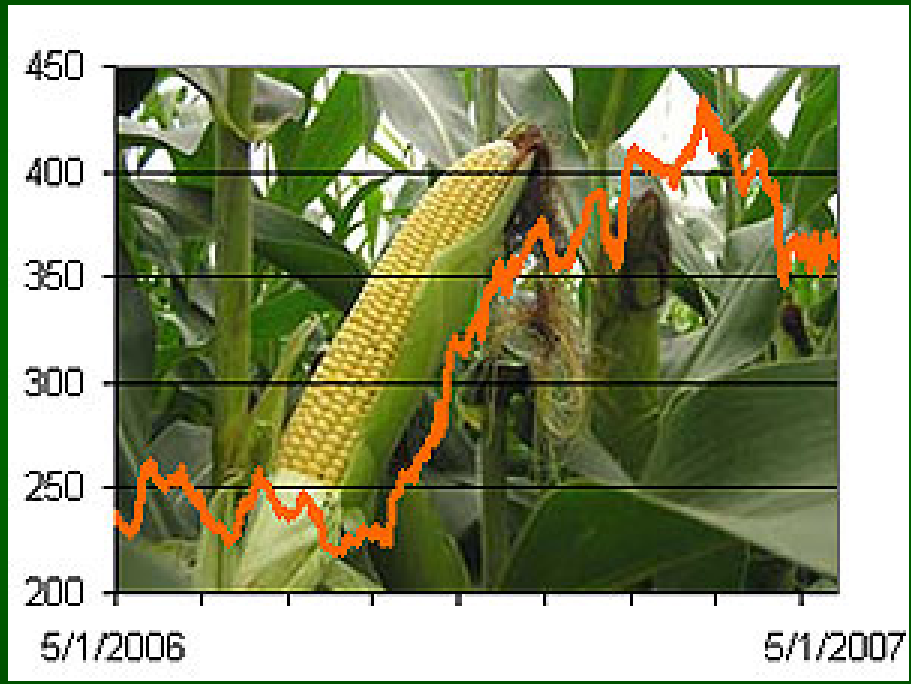
- Low-density outside suburbs
- Fastest growing form of land use - projected to increase in CRB
- Conversion of forests and farmland
- Concentrated near large areas of public land
- Habitat alteration and loss
- Wildlife declines
- Wildlife-human conflicts



1000 Friends of Oregon

Agriculture

- Agricultural land is being converted to suburban, rural and exurban
- Elevated land prices and ageing farm population accelerate this process
- Interaction with climate change
  - Biofuel production has increased grain prices
  - Land is being removed from various CRP



Corn Futures Prices

Bloomberg Professionals. Minnesota Public Radio

Urbanization

- More impervious surfaces
- Altered channel networks
- Chemical pollution
- Changes in invertebrate communities
- Altered aquatic and terrestrial habitat
- Decline in diversity and abundance of fish and wildlife
- Little evidence that habitats altered in this manner can support native fish and wildlife

Willamette River Portland

Port Expansion
Direct Effects on the Estuary

- Aquatic invasive species
- Fish stranding
- Loss of habitat
- Dredging
- Hazardous materials transport
- Loss of habitat with increased port infrastructure

Columbia River/Columbia City, Oregon P. Gilston 2006

Combined Effects

- Climate change and population growth will create challenges to meeting fish and wildlife goals for the Columbia Basin
- In many instances, mechanisms for adaptation by plants, fish and wildlife to changes caused by one process will be compromised by impacts related to the other

Recommendations

- Population growth and climate change will impact efforts to restore ecosystems and fish and wildlife populations in the CRB
- Climate change and population growth need to be incorporated into restoration planning
  - Projects assessment should include the long-term viability in light of changing climate and increasing human population
  - Incorporate mitigation measures, where possible
  - Projects proposed for locations where future impacts from climate change or population growth will reduce their effectiveness should be assigned lower priority
- Measures to partially mitigate effects exist
  - Integrated land and water use plans
  - Stronger water quality protections
  - Regulation of development – especially in areas of high ecological value
  - Promote efforts to reduce conversion of ranchland, farmland and forestland
  - Establish permanent “strongholds” to minimize interactions - land purchase/easements
  - Protection of headwater areas
  - Operate hydropower system to reduce flow and temperature impacts on mainstem and estuary
  - Focus on private incentives: protect habitat, conserve water, manage irrigation
  - Evaluate the potential of ecosystem service markets