Climate Science in the Public Interest

Snohomish Utility Salmon Habitat Improvements (SUSH
University of Washington
NOAA - NW Fisheries Center
2005

Climate and Land Use Change Impacts on the Endangered Salmon Populations in the Snohomish River Basin, WA.

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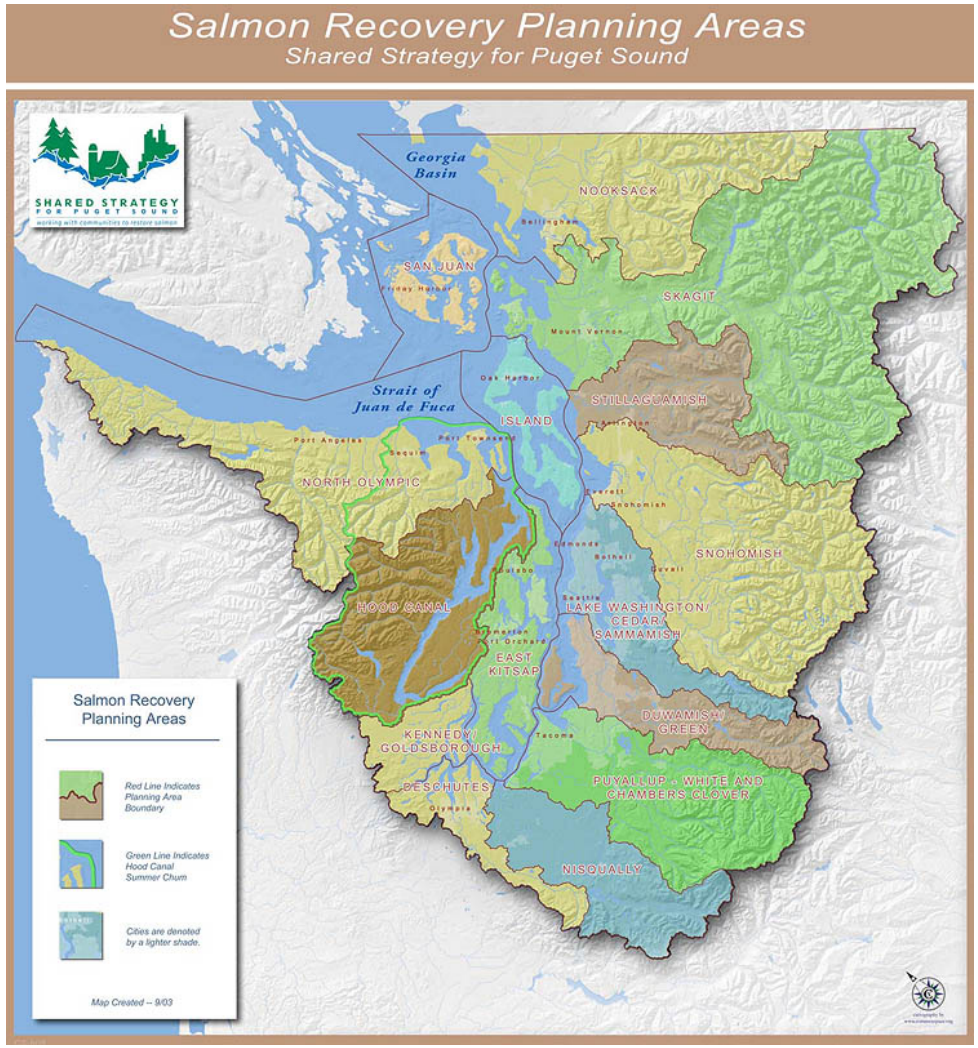
Goal of Presentation

- Provide an initial framework for the inevitable debate over the threat posed by climate change on salmon recovery plans
- Paths of Impacts:
  - ☑ Stream temperature
  - ☑ Low flows
  - ☑ Peak flows
  - ☐ Sediment transport
  - ☐ Other habitat impacts

Background

- 1999: Seven salmon species are listed as “threatened” under the federal Endangered Species Act (ESA). The listing of Puget Sound's wild chinook is the first ESA listing in the United States to affect a major urban area.
- ESA provisions require a Federally approved recovery plan
- 1998 -1999 Washington legislature passed the Salmon Recovery Act created watershed planning process to identify recovery actions



Background

- 2000: The National Marine Fisheries Service (NMFS) convened the Puget Sound Technical Recovery Team (TRT) to develop delisting criteria and provide *technical guidance* for recovery planning
- Snohomish Basin Salmon Recovery Forum (Forum) created a Salmon Conservation Plan to guide the protection and restoration of salmon habitat in the Snohomish River Basin
- University of Washington (UW) has teamed with the National Oceanographic and Atmospheric Administration's Northwest Fisheries Science Center (NOAA NWFSC) to analyze the potential impacts of climate and land use change in the Snohomish basin Wild Chinook Salmon population.

Climate Change Assumptions

- Impacts of increasing CO_2 levels can be modeled with GCMs (GFDL_A2 and HadCM3_A2 for 2000, 2025, 2050).
- GFDL and HadCM3 are roughly in the “middle of the road” in terms of temperature.
- GFDL tends toward ‘wetter,’ HadCM3 tends toward ‘drier’.
- Precipitation is highly variable in all scenarios, no significant difference in trends

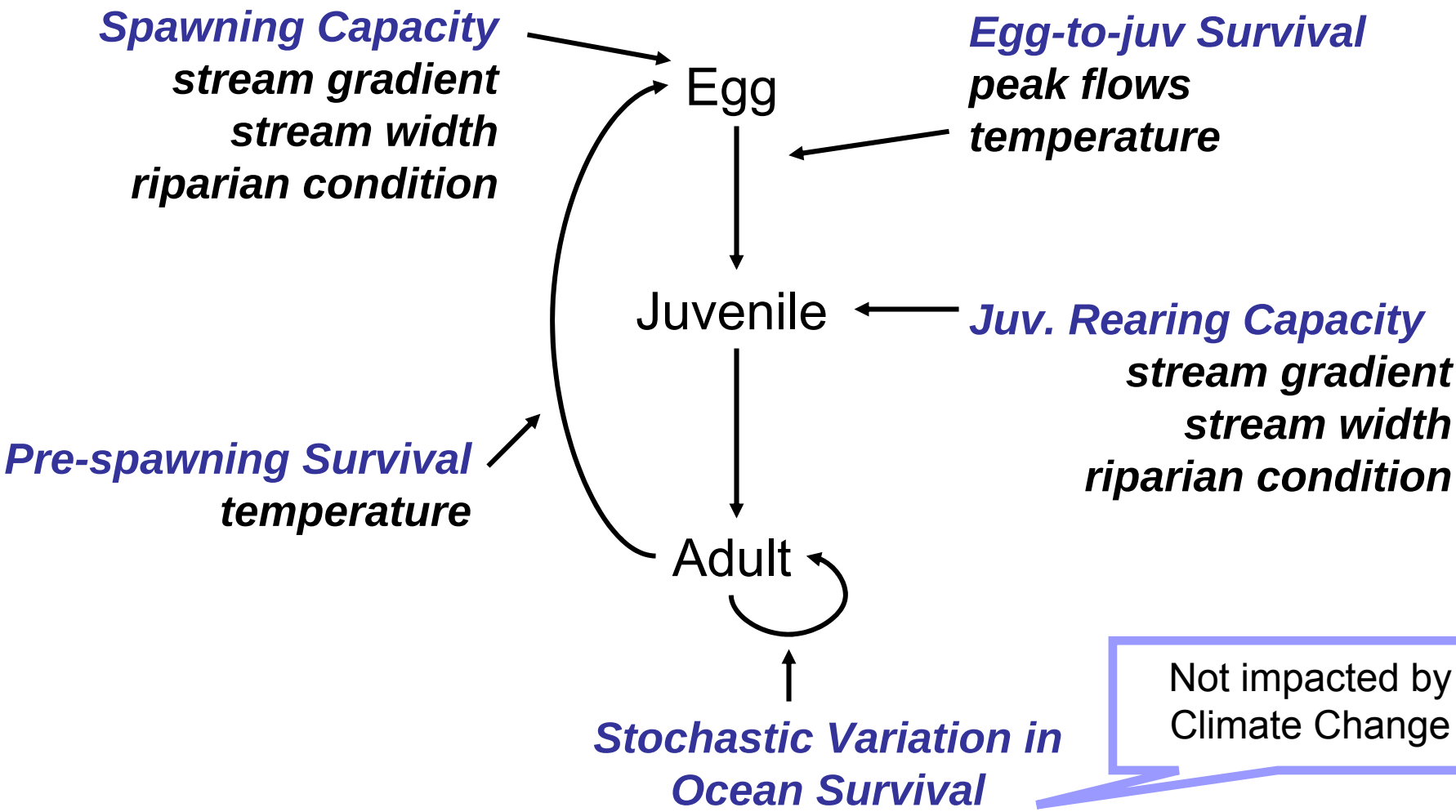
Research Approach

- Apply and calibrate river hydrology model (DHSVM)
- Apply and calibrate salmon model (SHIRAZ)
- Translate salmon recovery plans into changes in future land cover and evaluate impacts
- Evaluate Impacts

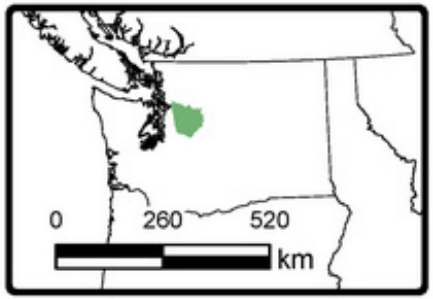
Limitations

- Sediment
- Woody debris
- River temperature assumed completely mixed
- Ocean conditions not impact by climate

Habitat Effects in SHIRAZ



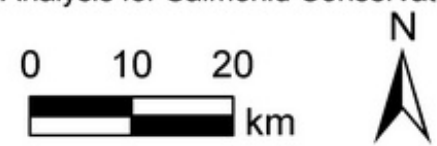
Location and Success of Snohomish Basin Chinook Salmon Populations



Location and Success of Snohomish Basin Chinook Salmon Populations

- None
- Low
- Moderate
- High
- High*
- Analysis Location
- Model Stream Network

Data Source: Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC); 2004; Snohomish River Basin Ecological Analysis for Salmonid Conservation



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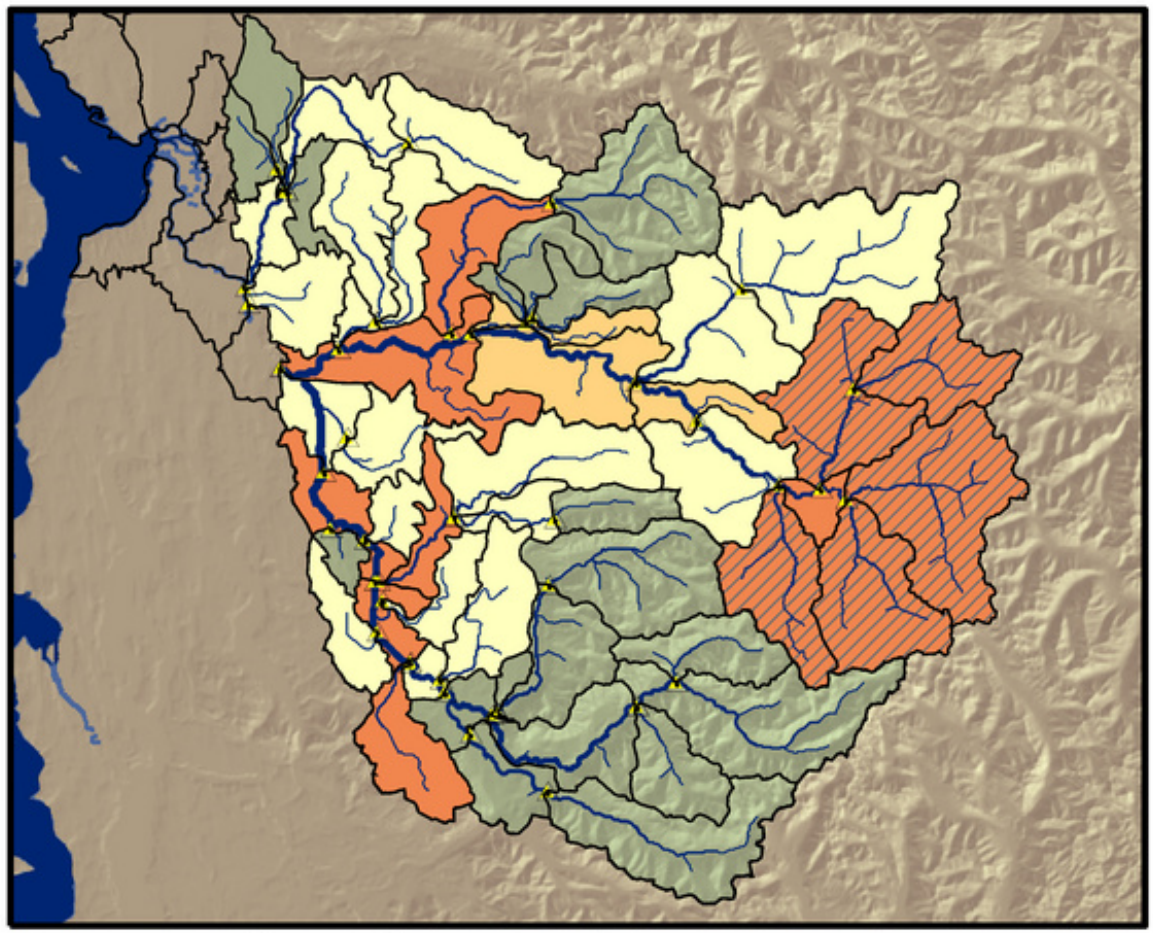
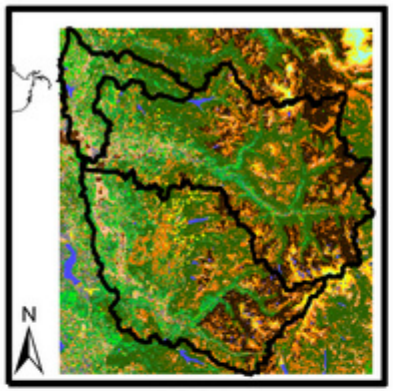
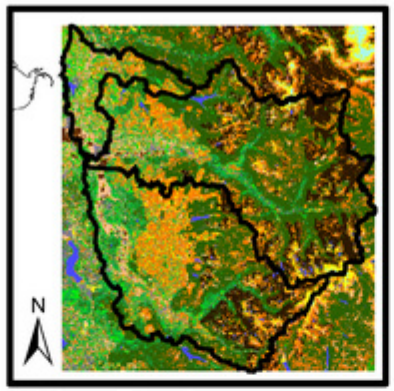


None: No Chinook Salmon Population
Low: < 8% Total Spawning Escapement
Moderate: 8 to 12% Total Spawning Escapement
High: > 12% Total Spawning Escapement
* Escapement data for South Fork Skykomish Headwater Tribuatries is reported only for the Upper South Fork Skykomish Subbasin.

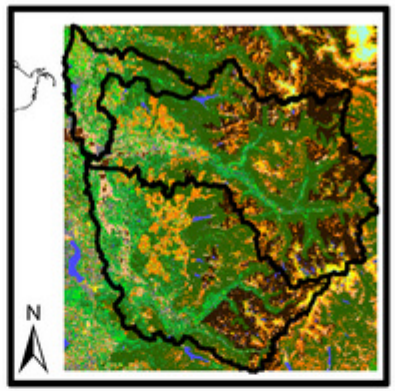
Snohomish basin landcover scenarios



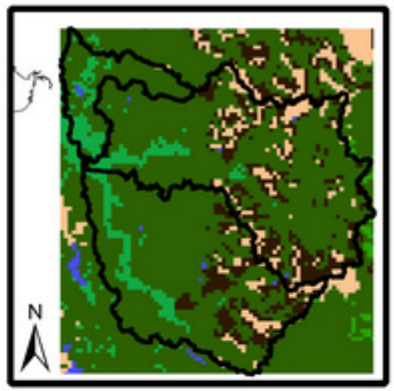
2001



2025: Busin. as usual



2025: Restoration



Pre-1800 Historic

0 15 30 60

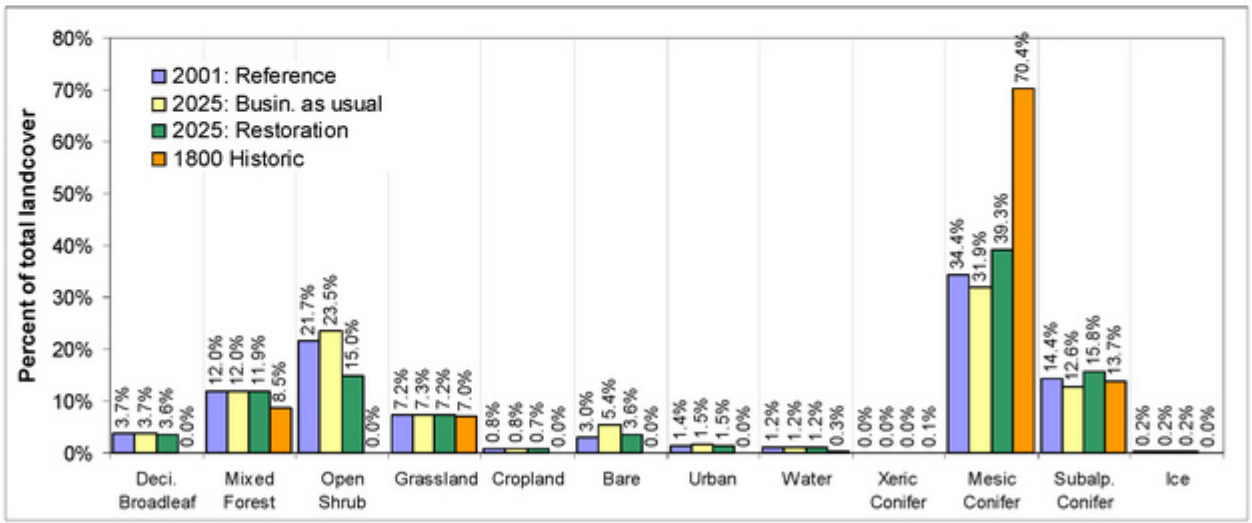
km.

Model Subbasins

- Snoqualmie
- Pilchuck
- Skykomish

Landuse Class

- Decicuous Broadleaf
- Mixed Forest
- Open Shrub
- Grassland
- Cropland
- Bare
- Urban
- Water
- Xeric Conifer
- Mesic Conifer
- Subalpine Conifer
- Ice/snow



Land cover based on NOAA CCAP-2001 dataset. Landcover types are reclassifed to match DHSVM input categories

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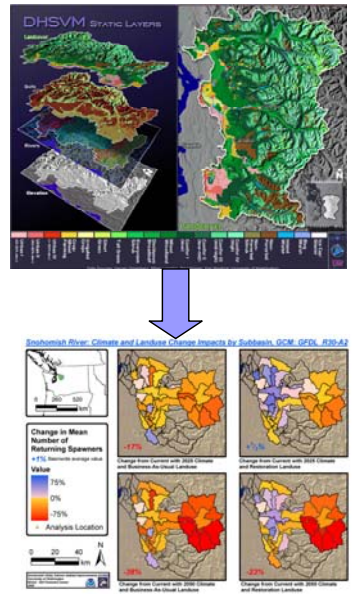
DHSVM → SHIRAZ linkage



- Incubation peak flow
  - the maximum instantaneous flow recorded between 15 September and 15 February
  - maximum mean daily flow recorded between 15 September and 15 February
- Incubation temperature
  - mean water temperature for the period 15 September to 15 February
  - mean water temperature for two subperiods:
    - 15 September-30 November
    - 1 December-15 February
- Pre-spawning temperature
  - mean of daily maximum temperatures for the period 15 July – 15 October.
  - mean of daily maximum temperatures for 3 subperiods:
    - 15 July-14 August
    - 15 August-14 September
    - 15 September-15 October
  - mean temperature for the 3 subperiods:
    - 15 July-14 August
    - 15 August-14 September
    - 15 September-15 October
- Smolt migration temperature
  - Mean of daily maximum temperatures for the period 15 March – 15 June.
  - Mean temperature for the period 15 March – 15 June.
  - Mean temperature for the following subperiods:
    - 15 March-15 April
    - 15 April-15 May
    - 15 May-15 June
- Minimum spawning flow
  - Lowest instantaneous flow between 15 September and 15 November.

Climate Impacts

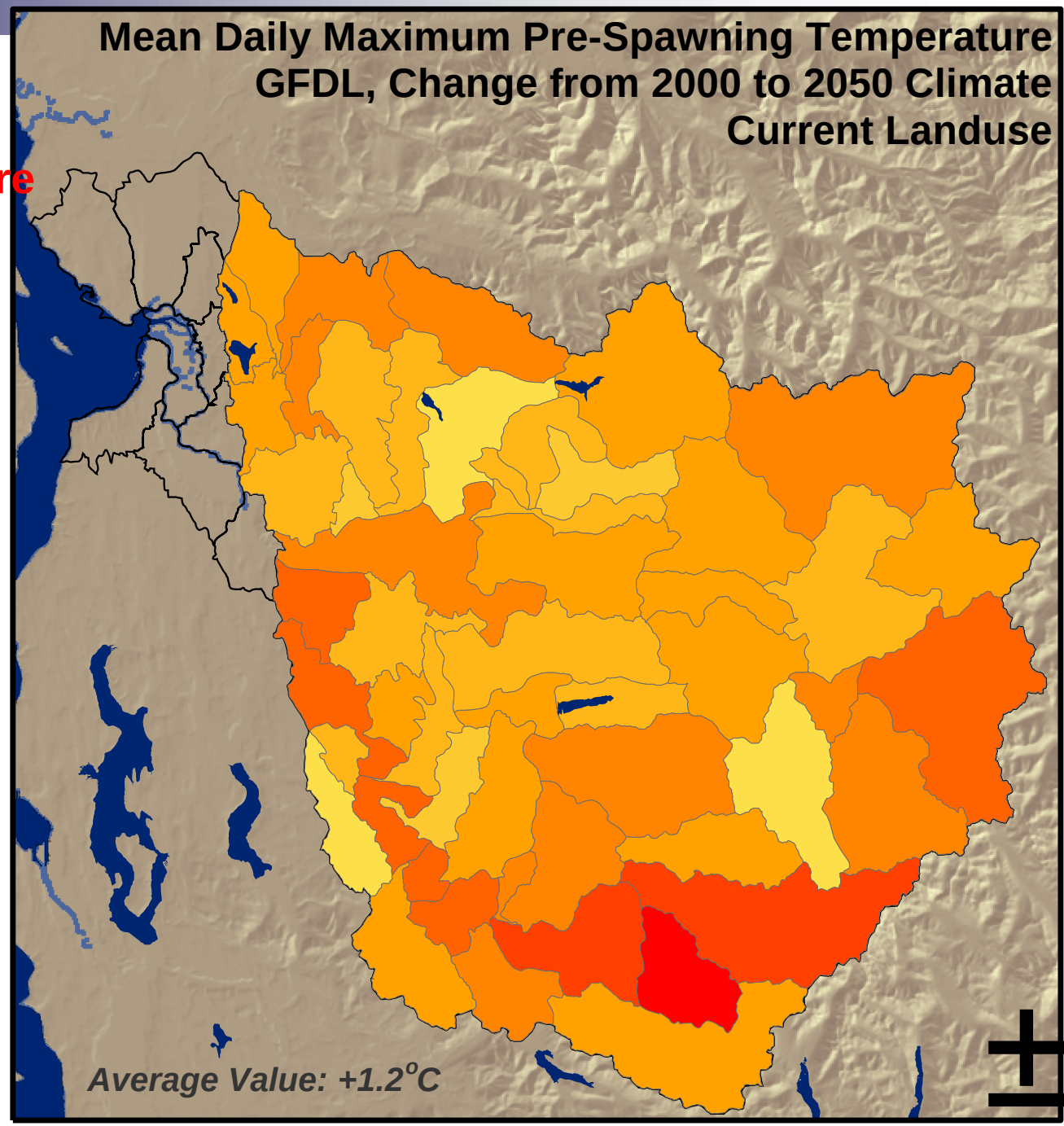
- Warmer with modest shifts in precipitation
  - Hadley (2050): temp. + 1.1^{o}C, Precip. -5.1%
  - GFDL (2050): temp. + 1.5^{o}C, Precip. -0.2%
- Winter stream flows increase
- Summer stream flows decrease
- Stream temperatures rise

What are the changes on:

Daily Max Temperature

Peak Flows

Low Flows



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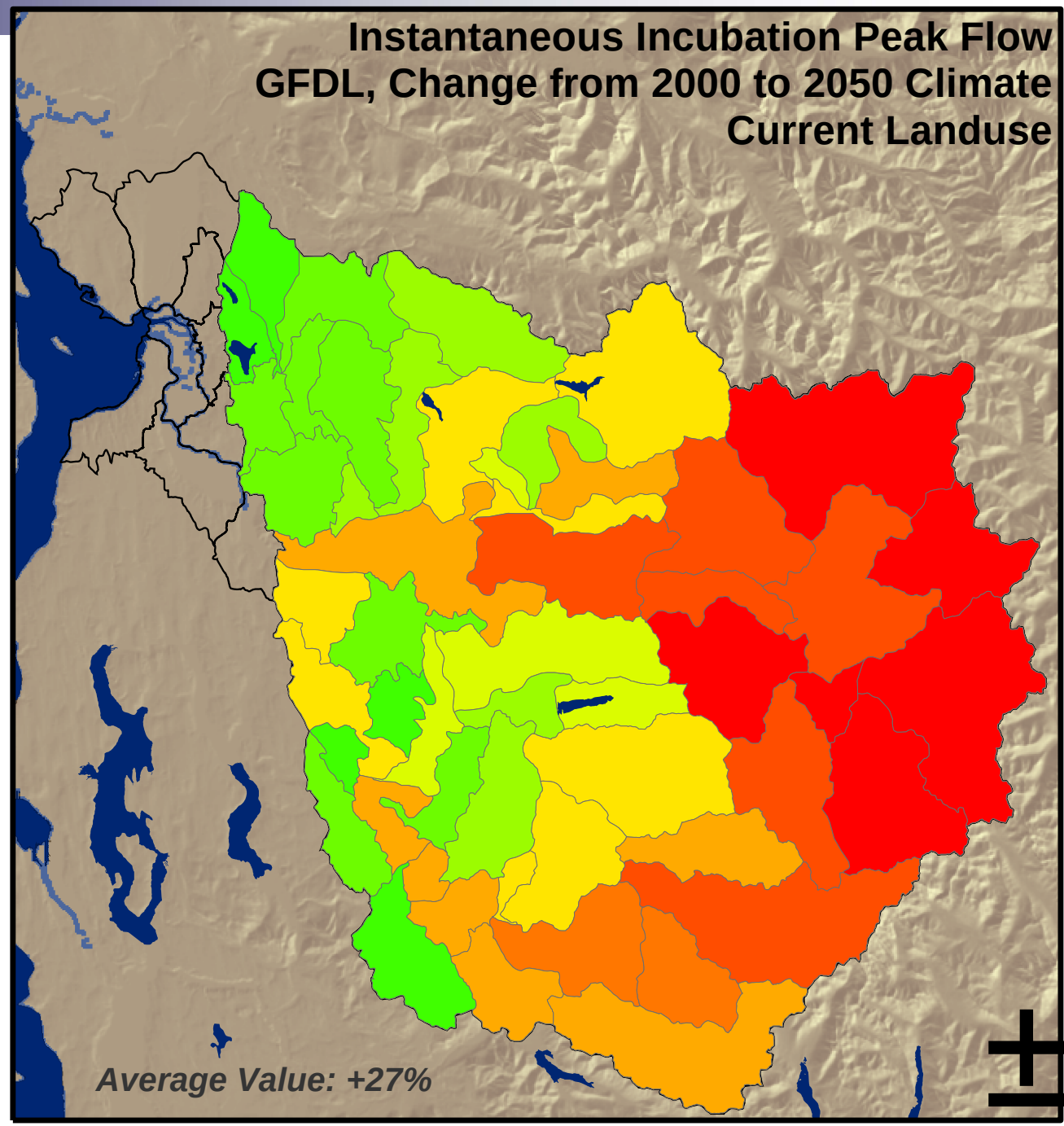

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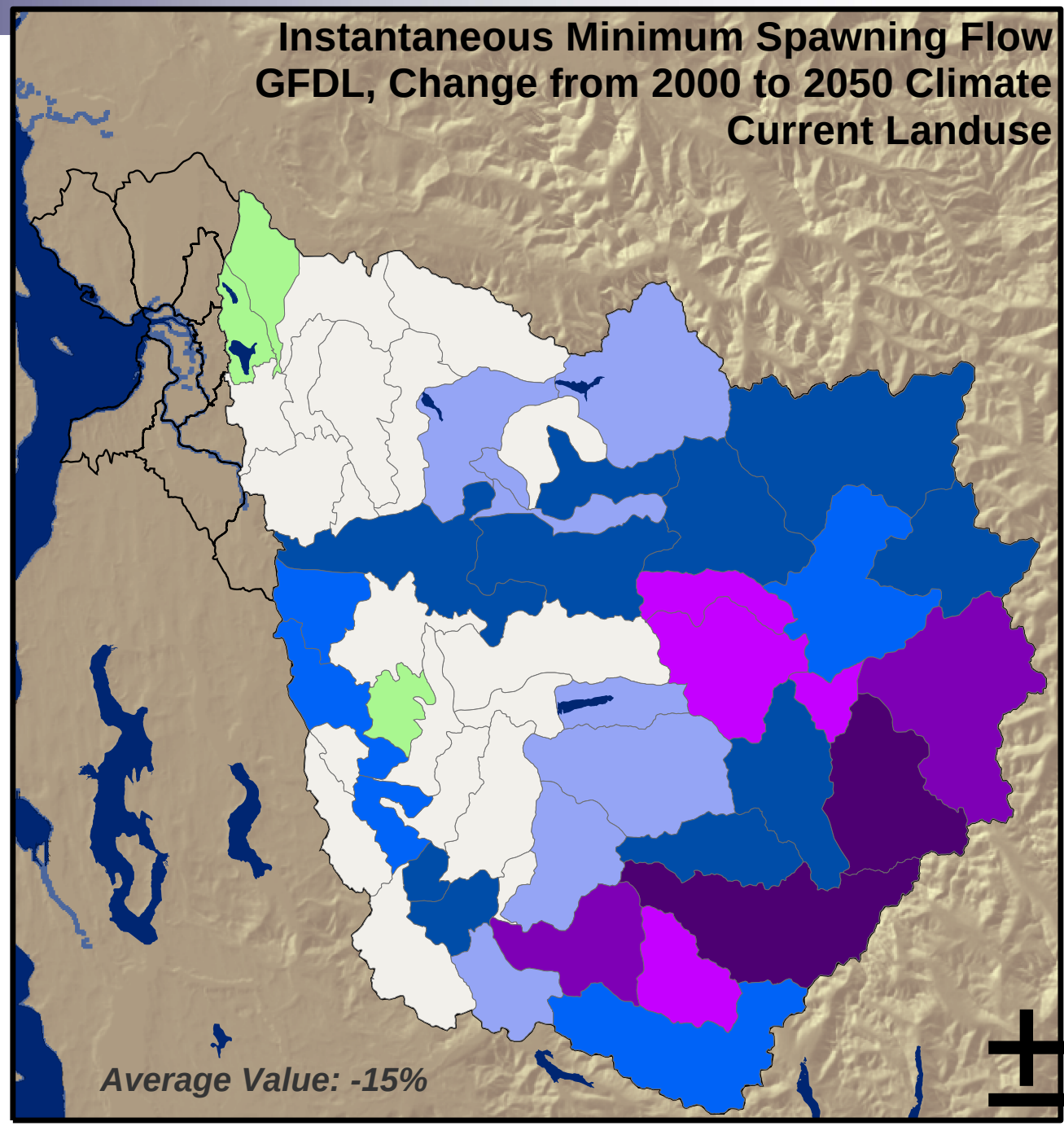
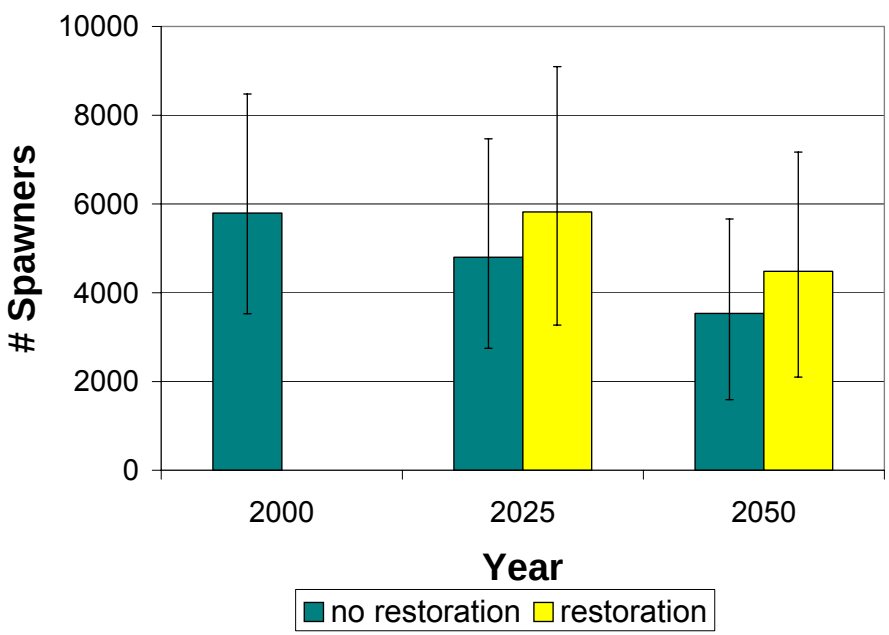
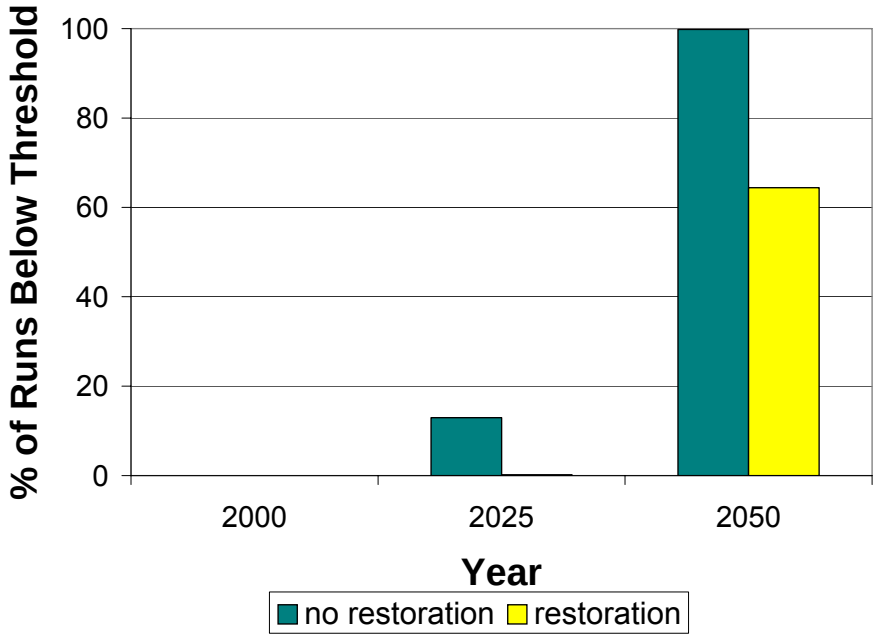


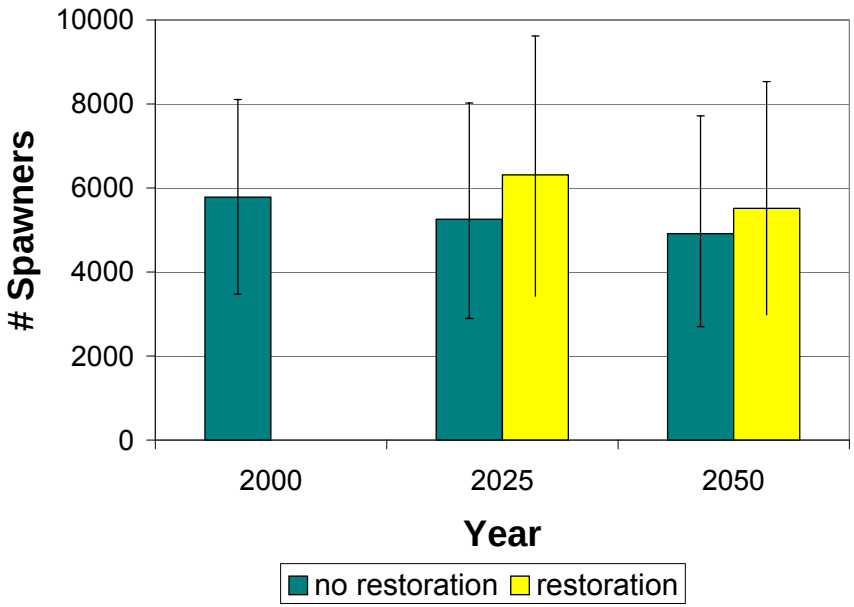
Chinook Population Impacts-GFDL

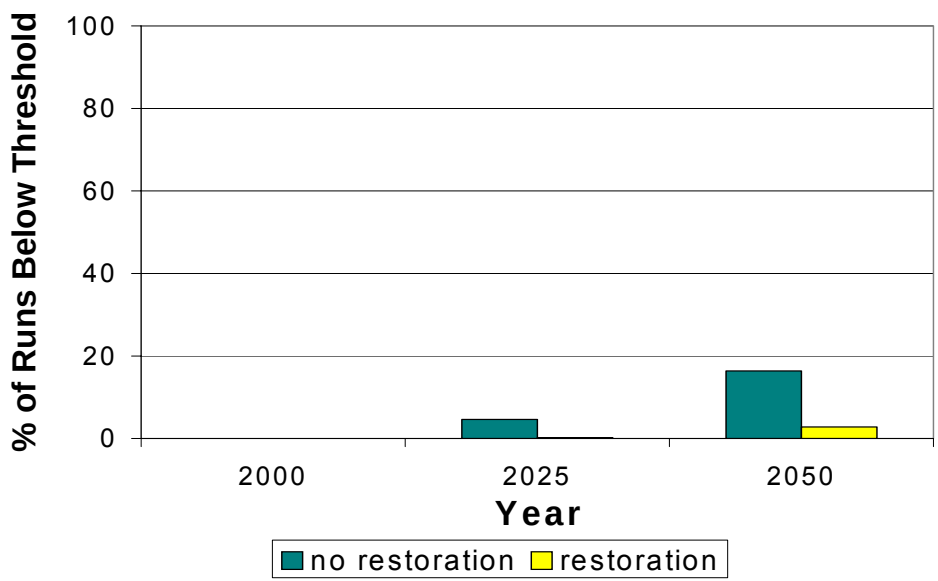




Mean population of wild spawners and percent falling below the threshold in GFDL Model

Chinook Population Impacts-Hadley





Mean population of wild spawners and percent falling below the threshold in Hadley Model

Conclusions

- Climate Impacts- Increasing temp, less summer precipitation
- Hydrologic – Increasing winter peaks lower summer runoff, higher water temperatures
- Salmon Impacts -
  - 15-39% reduction in Chinook #'s without restoration
  - 5-23% reduction in Chinook #'s with restoration.
- Restoration efforts offset climate impacts
- Planning without climate change may result in overly optimistic estimate of benefits

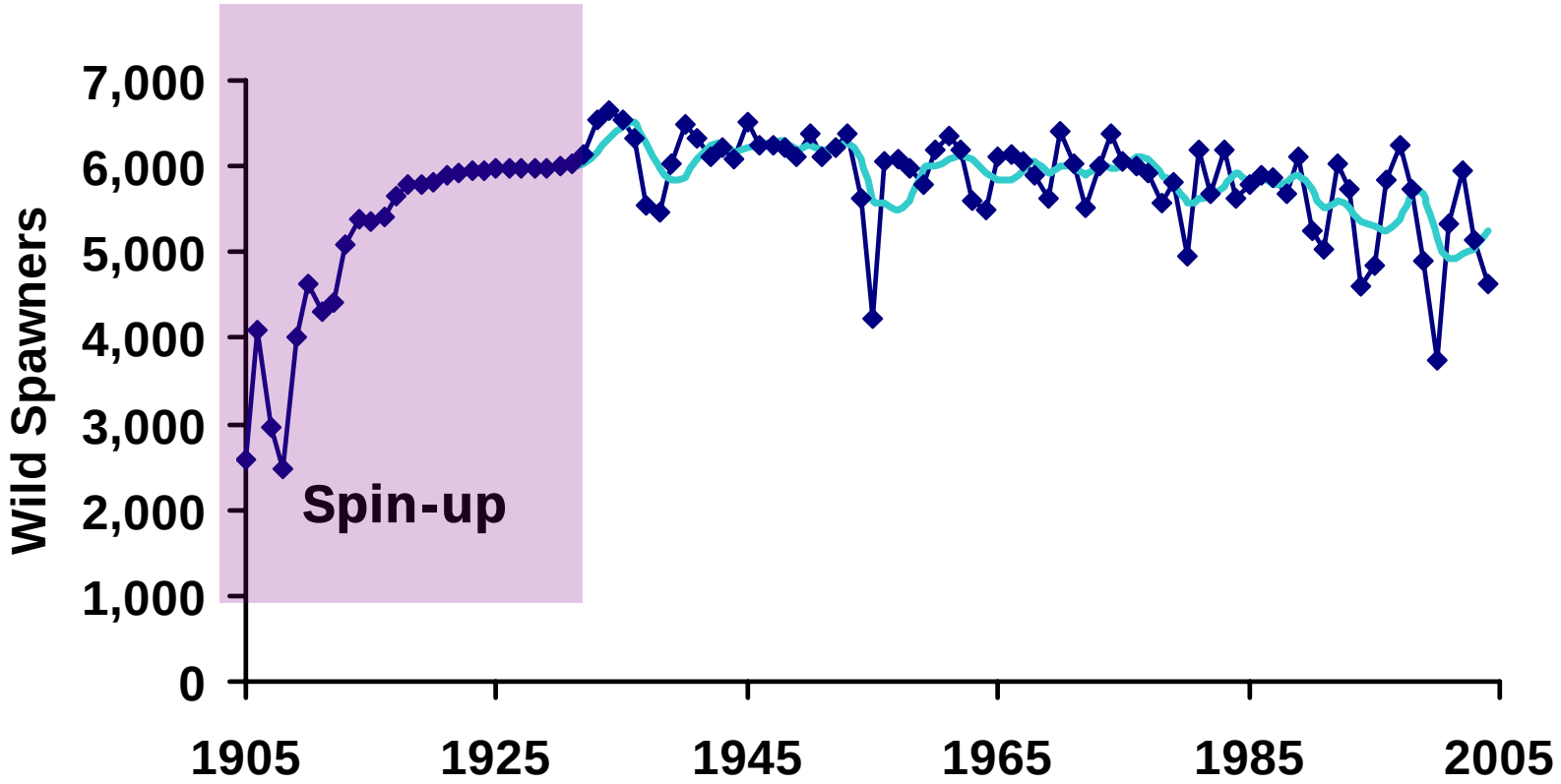
- You cannot plan the future by the past.

Sir Edmund Burke

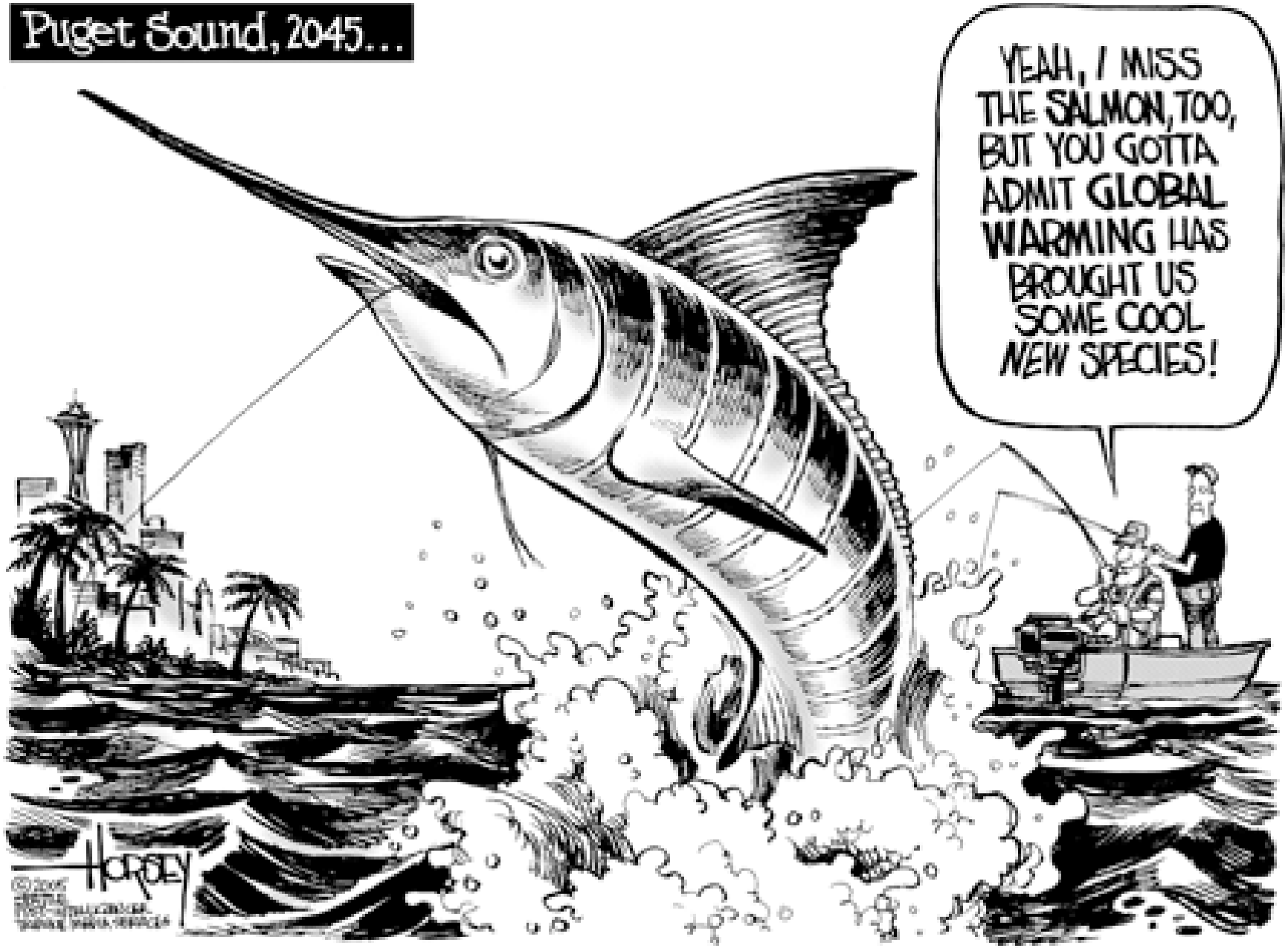
- The future ain't what it used to be.

Yogi Berra

SHIRAZ output using DHSVM run over 75 years of historic climate



- All survival, land use, hatchery, harvest, and other parameters held constant
- Driven with modeled 75-year freshwater flow and temperature time series



From the Seattle Post-Intelligencer, October 20, 2005