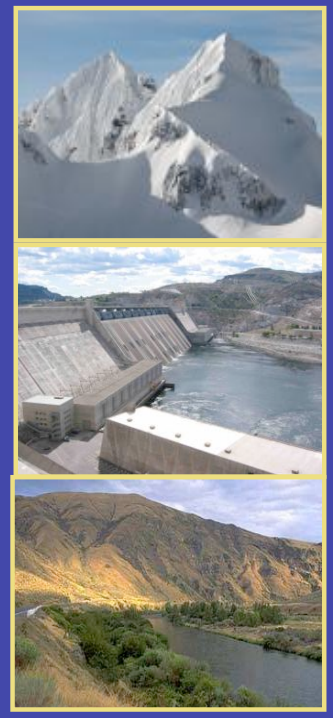
Climate change impacts on water management in the state of Washington



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Climate science in the public interest

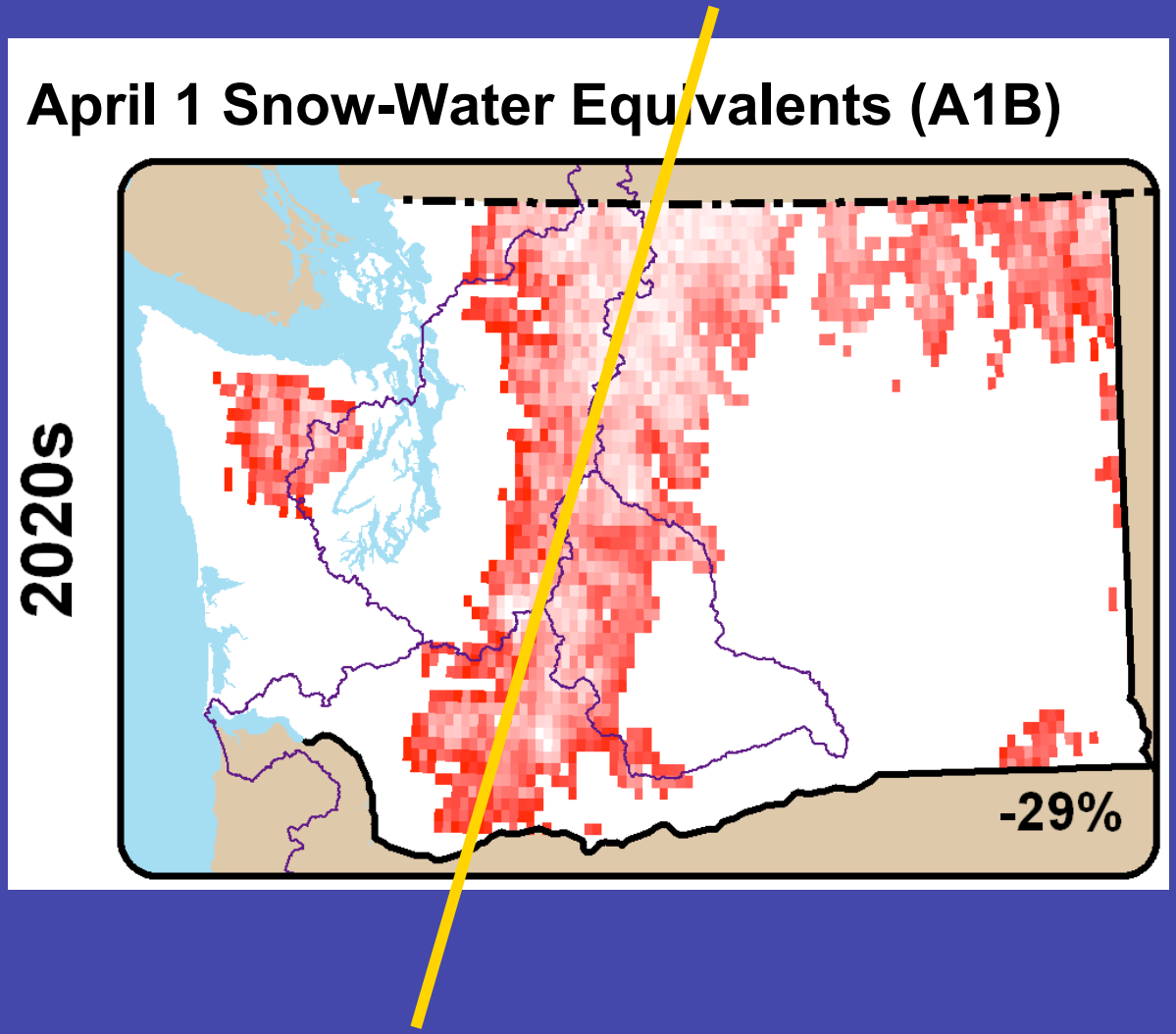
February 12, 2009
Washington State Climate Change Impacts Assessment Conference

Objectives

1) Providing information for future projections relevant (time and location) to water resource decisions
   Hydrology talk - Marketa McGuire Elsner
2) Accounting for how these projections impact system operations - an informed sensitivity analysis
   Water Management talk - Julie Vano
3) Exploring how planning and management can account for future uncertainties and climate impacts
   Panel discussion

Photo courtesy of http://www.usbr.gov/dataweb/html/yakima.html

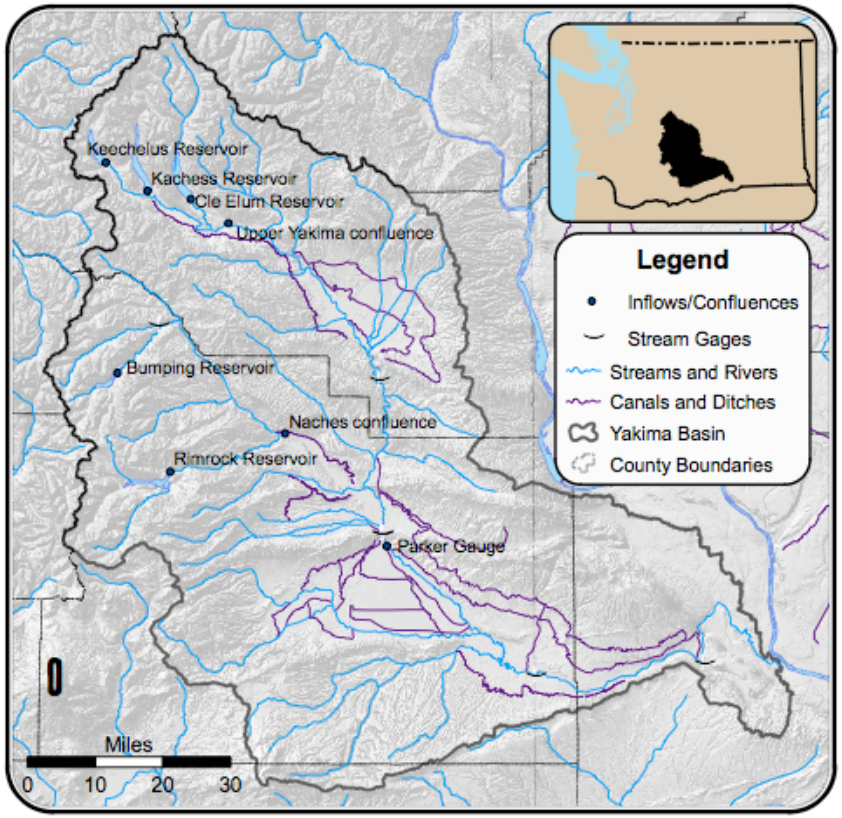
Washington Water Resources



Case study 1:
Yakima R basin
irrigated agriculture

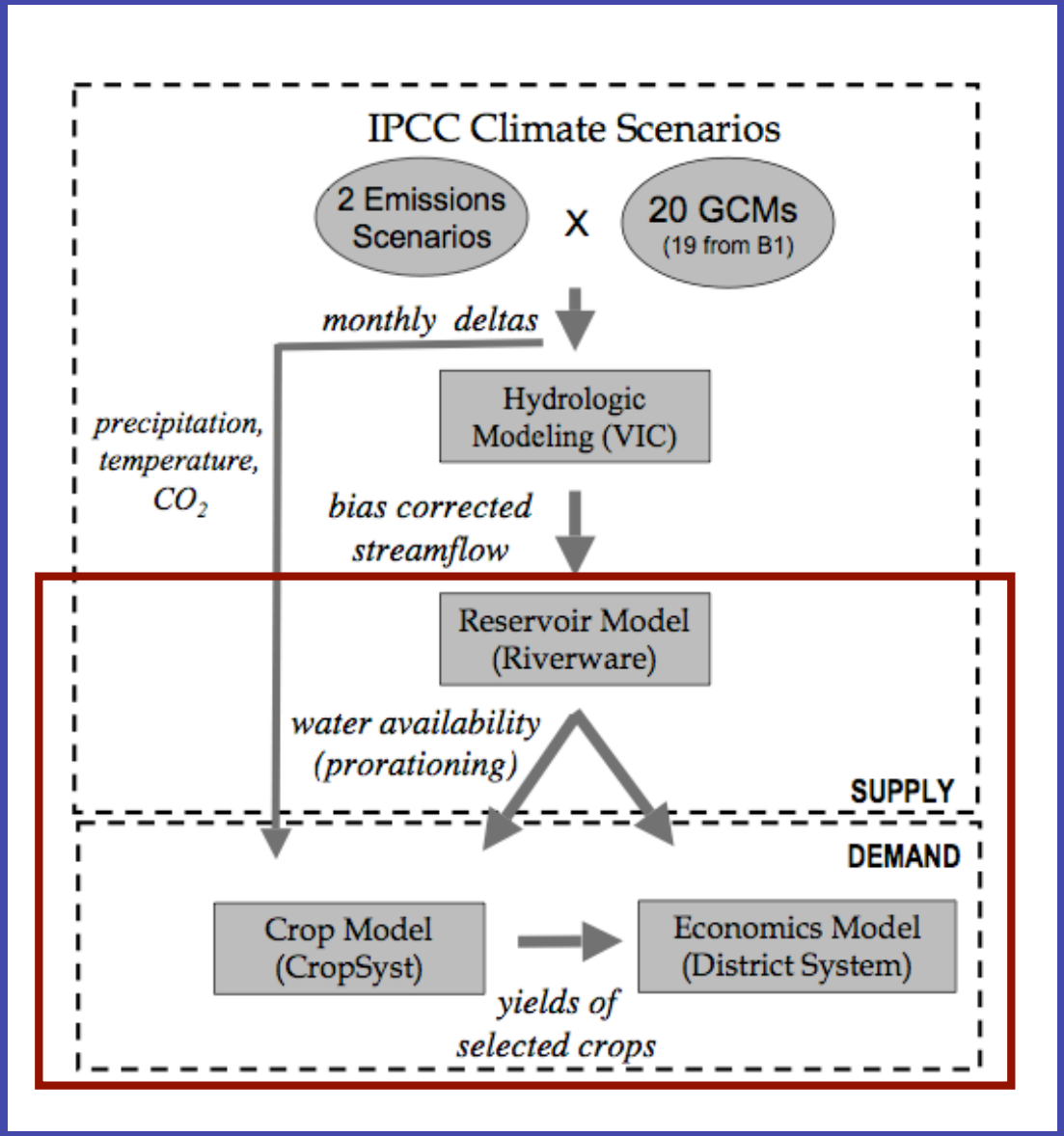
Case study 2:
Puget Sound basin
municipal

Case study 1: Yakima River Basin

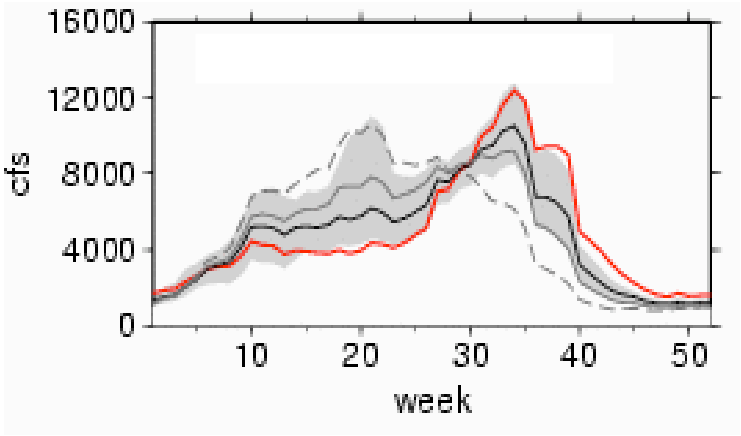


- Irrigated crops largest agriculture value in the state
- Precipitation (fall-winter), growing season (spring-summer)
- Five USBR reservoirs with storage capacity of ~1 million acre-ft, ~30% unregulated annual runoff
- Snowpack sixth reservoir
- Water-short years impact water entitlements

Yakima Basin Methods

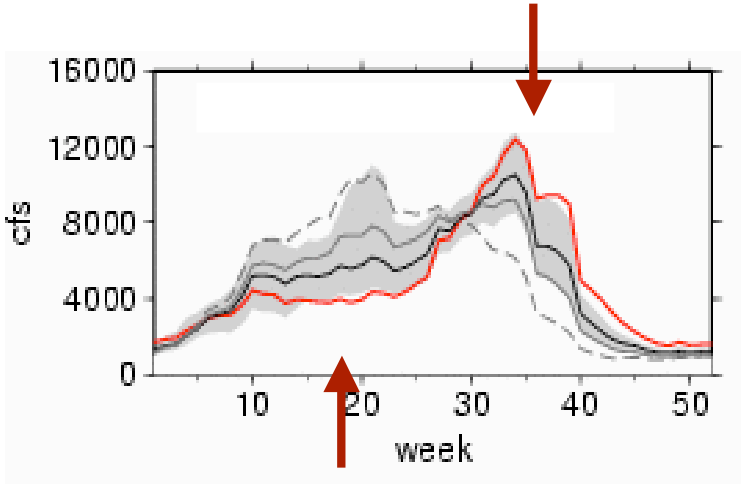


Yakima River Basin



Unregulated

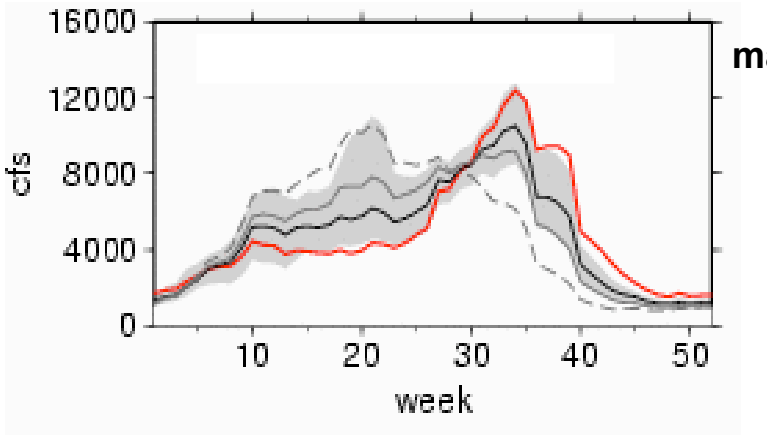
Yakima River Basin



Unregulated

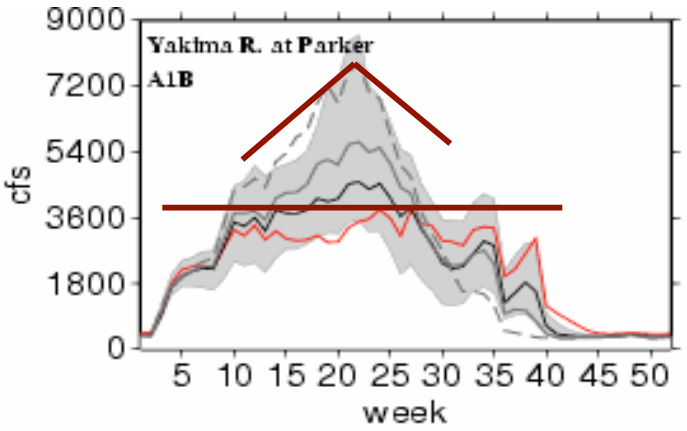
- **Basin shifts from snow to more rain dominant**

Yakima River Basin



Unregulated

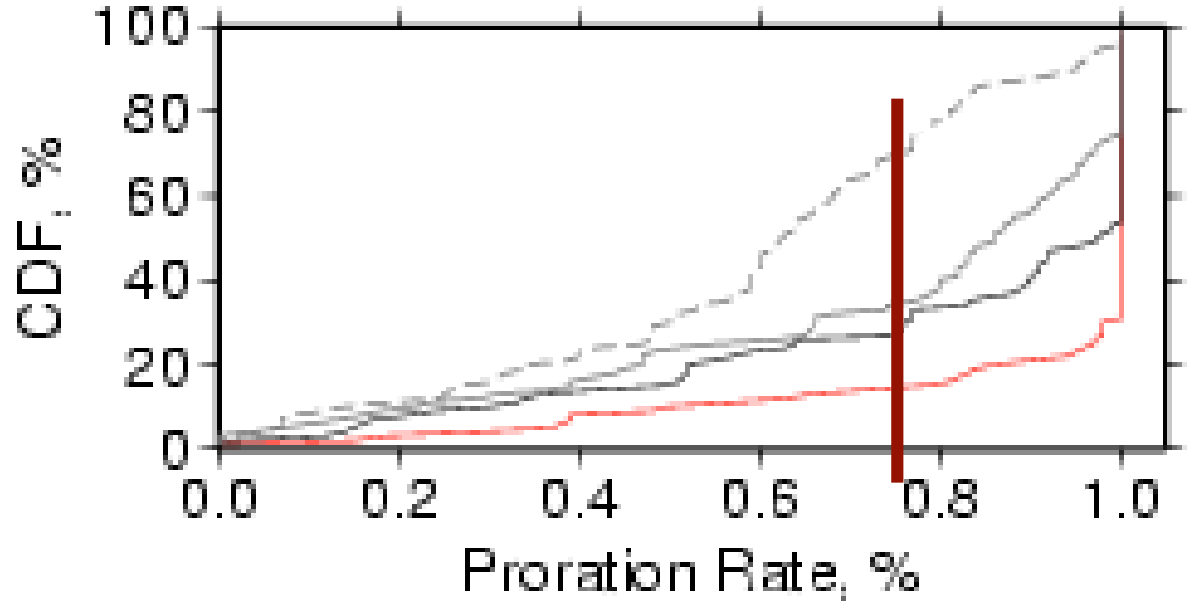
management model



Regulated

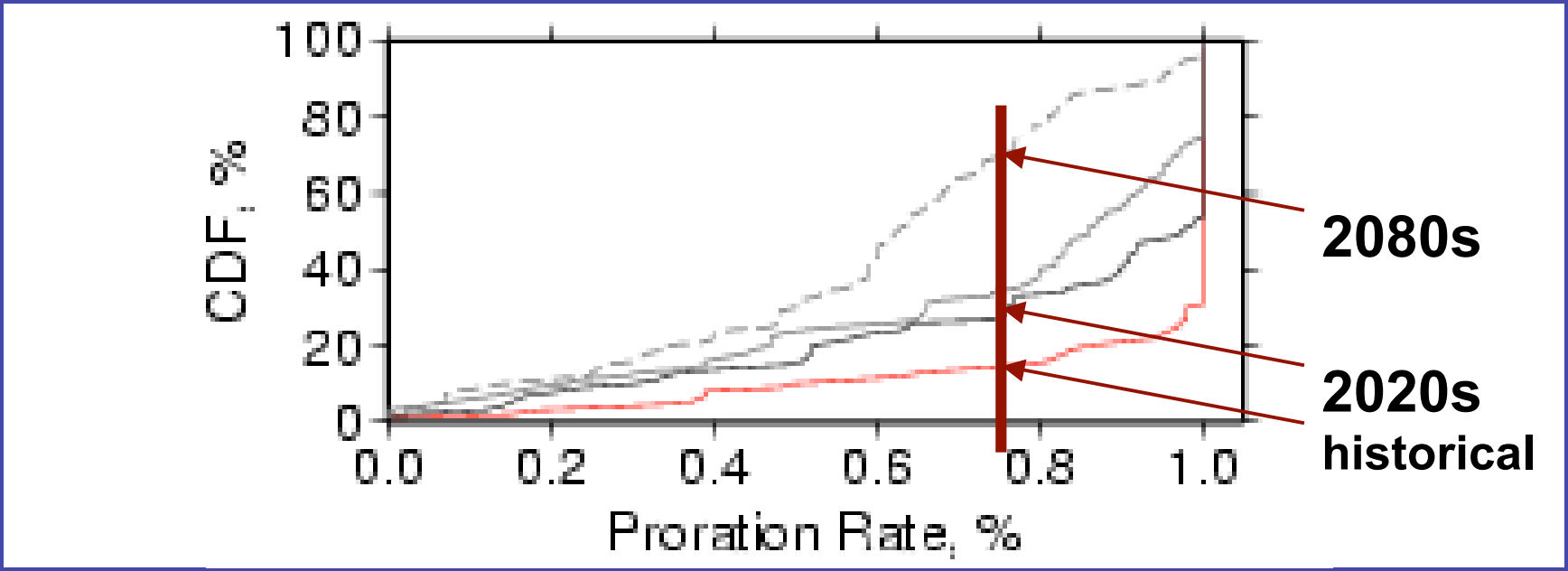
- Basin shifts from snow to more rain dominant

Yakima River Basin



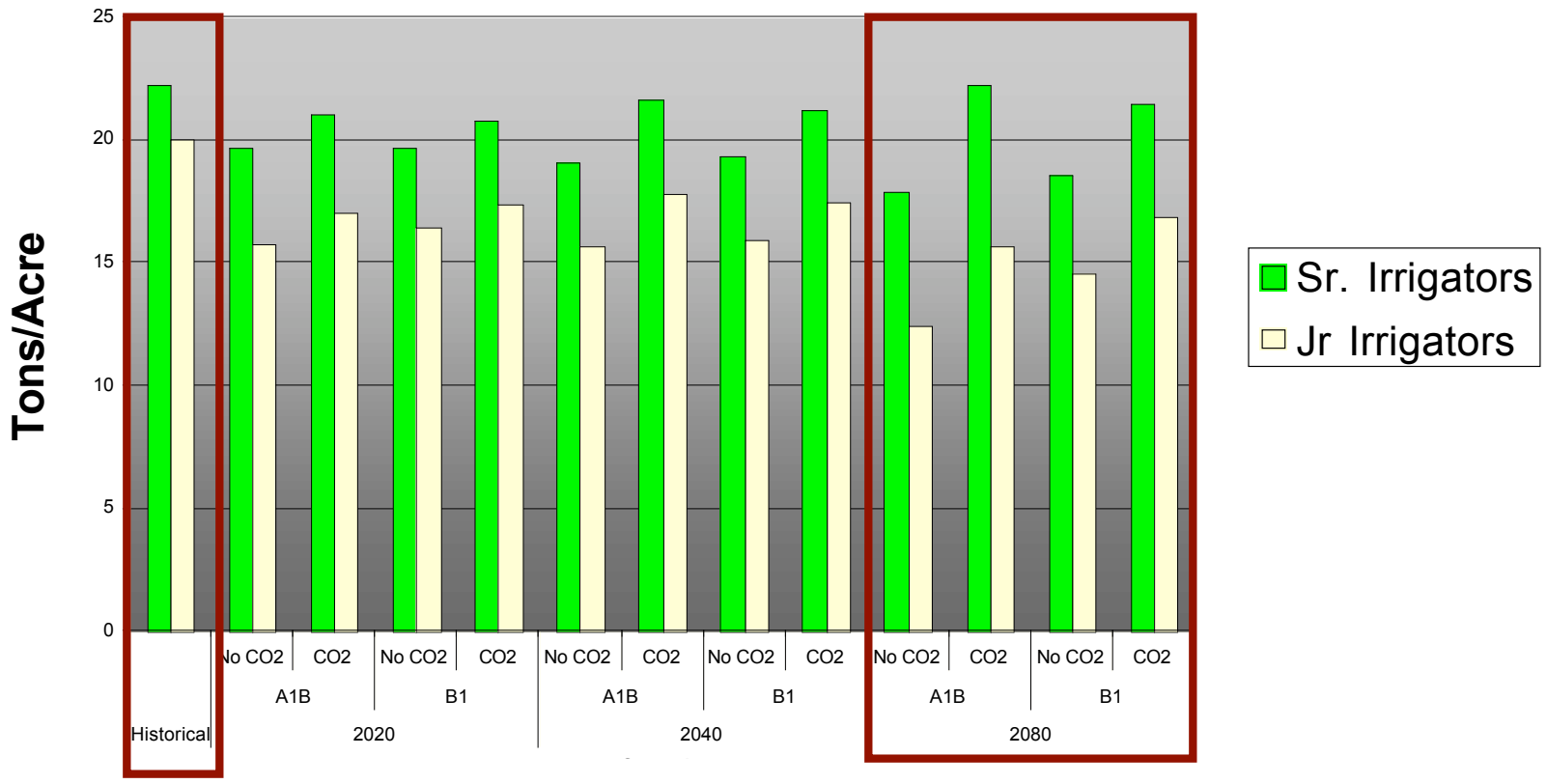
- Basin shifts from snow to more rain dominant
- Water prorating, junior water users receive 75% of allocation

Yakima River Basin



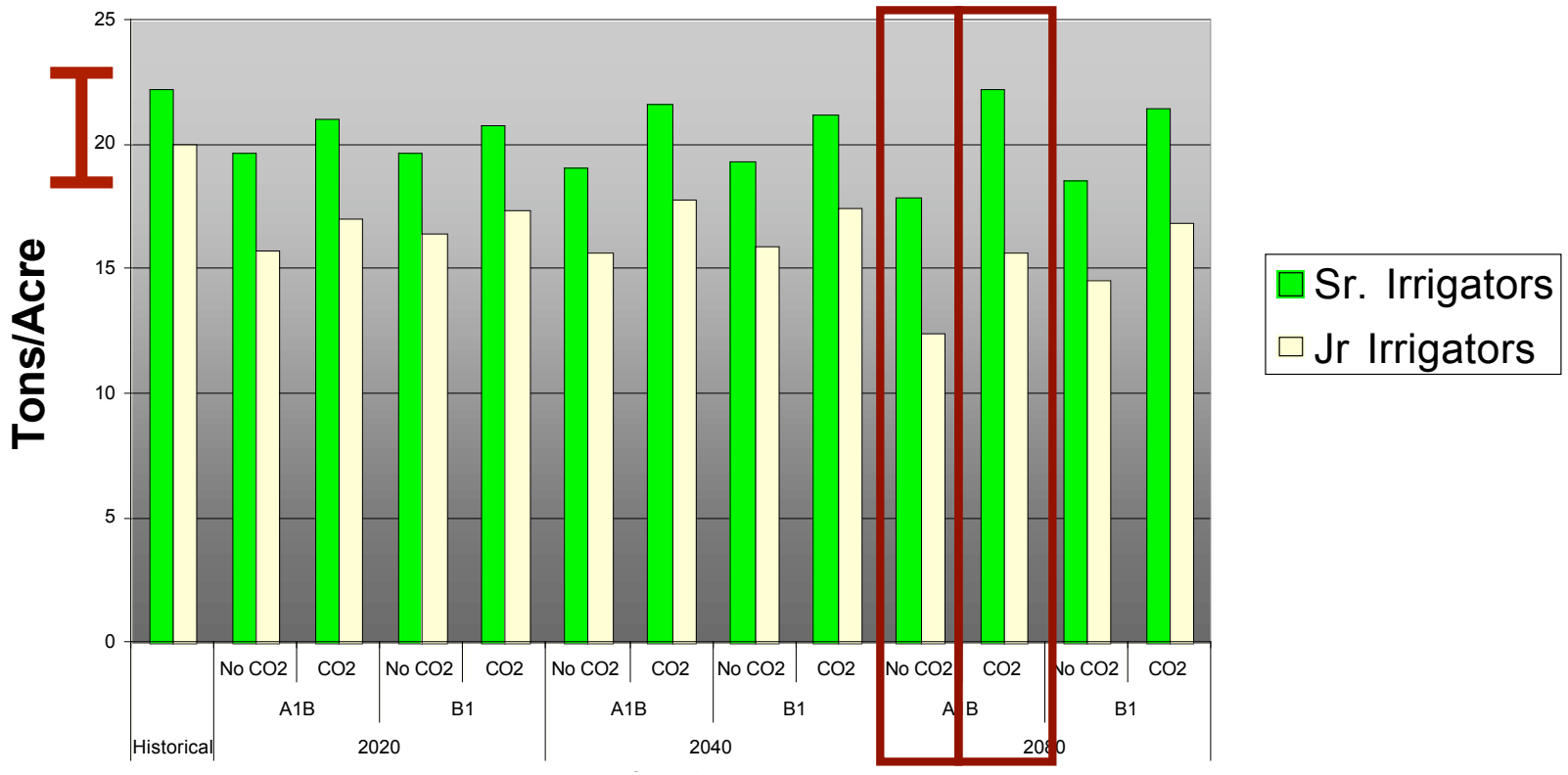
- Basin shifts from snow to more rain dominant
- Water prorating, junior water users receive 75% of allocation
- Junior irrigators less than 75% prorating (current operations):
  - 14% historically
  - 32% in 2020s A1B (15% to 54% range of ensemble members)
  - 36% in 2040s A1B
  - 77% in 2080s A1B

Crop Model - Apple Yields



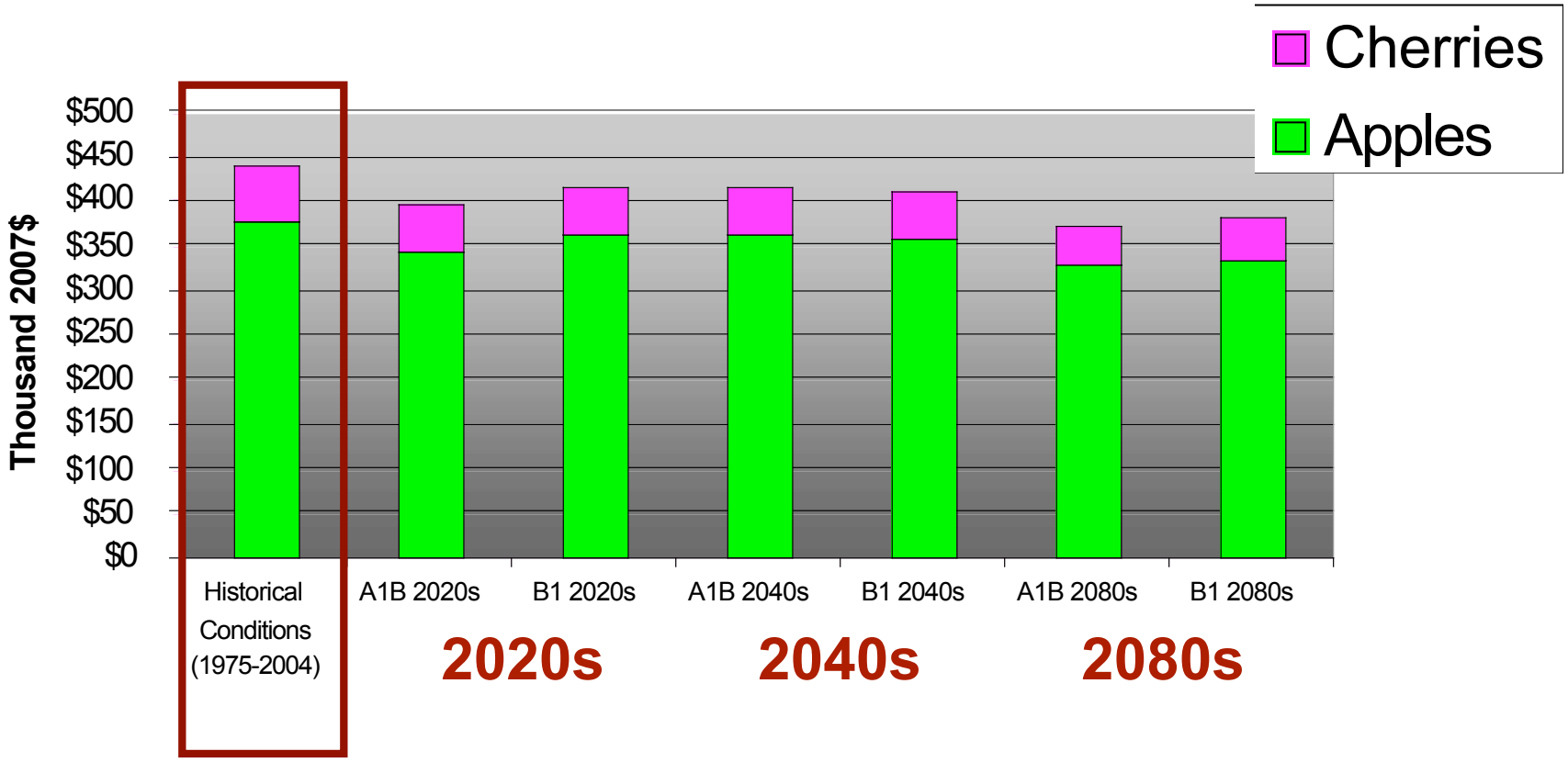
- Yields decline from historic by 20% to 25% (2020s) and 40% to 50% (2080s)

Crop Model - Apple Yields



- Yields decline from historic by 20% to 25% (2020s) and 40% to 50% (2080s)
- Yields less impacted with CO_2 fertilization effects
- Similar impacts for cherry producers

Economics - Production Value

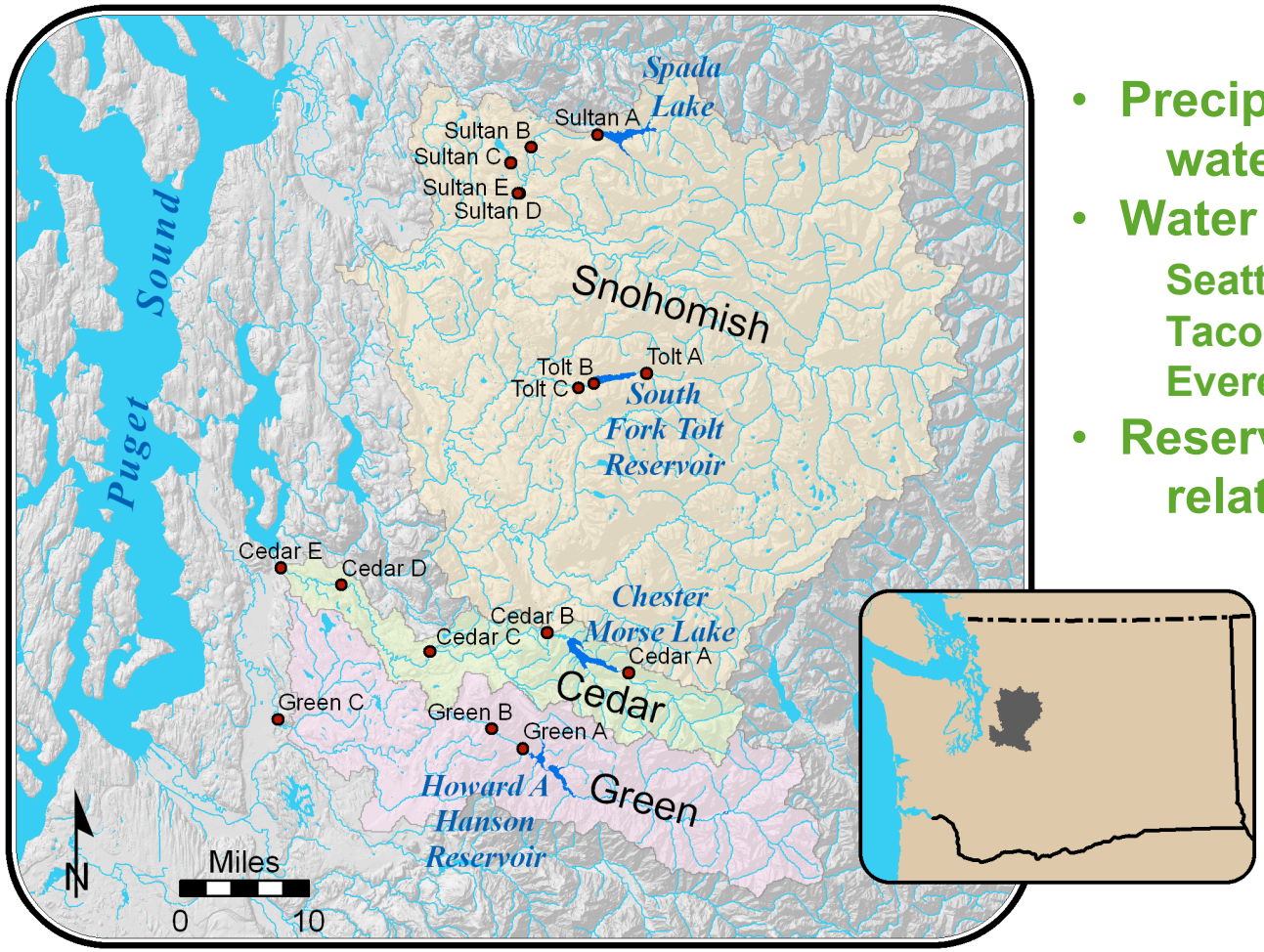


- Junior and senior water user, impacts with CO_2 fertilization
- Production decreases by 5% in 2020s, 16% in 2080s.
- Production values are buffered somewhat by price increases and largely unchanged production on senior water user lands

Key Findings
Yakima River Basin

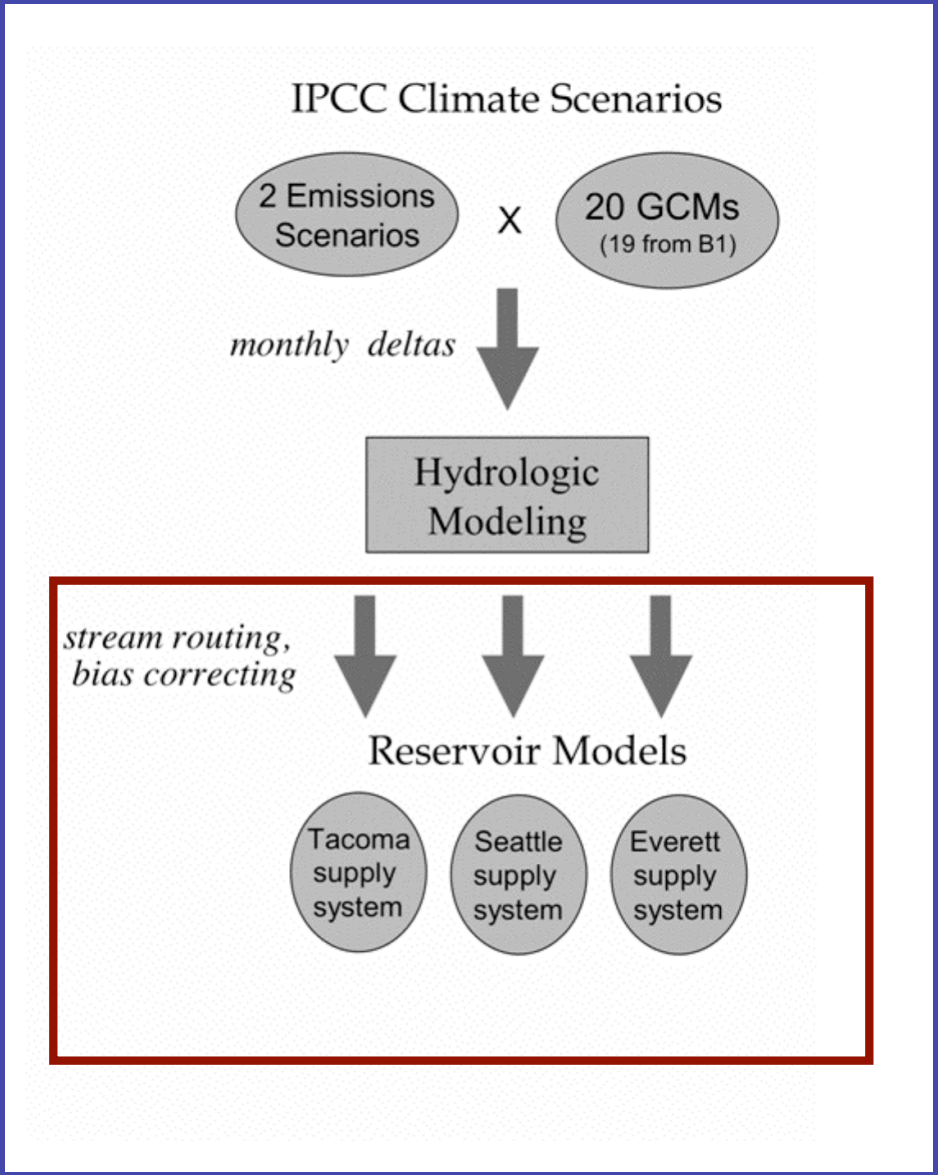
1) Future projections indicated that reservoir system will be less able to supply water to all users, especially those with junior water rights
2) Earlier and shorter growing season - apples 12 days earlier, cherries 22 days earlier season start, month earlier harvest
3) Yields decline - under A1B emissions scenario, average apple and cherry yield are likely to decline by 20% to 25% (2020s) and 40% to 50% (2080s) for junior water holders
4) Crop values decline - value of apple and cherry production is likely to decline by 5% ($20 million) in 2020s,16% ($70 million) in the 2080s

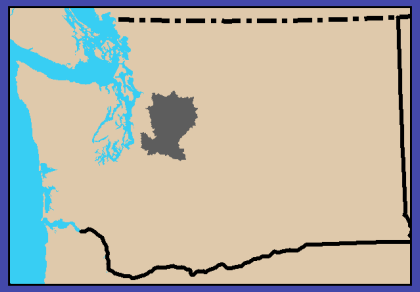
Case study 2: Puget Sound Basin



- Precipitation in fall-winter, water demand in summer
- Water management systems:
  - Seattle - municipal, fish
  - Tacoma - municipal, flood control
  - Everett - municipal, hydropower
- Reservoir capacities small relative to annual flow

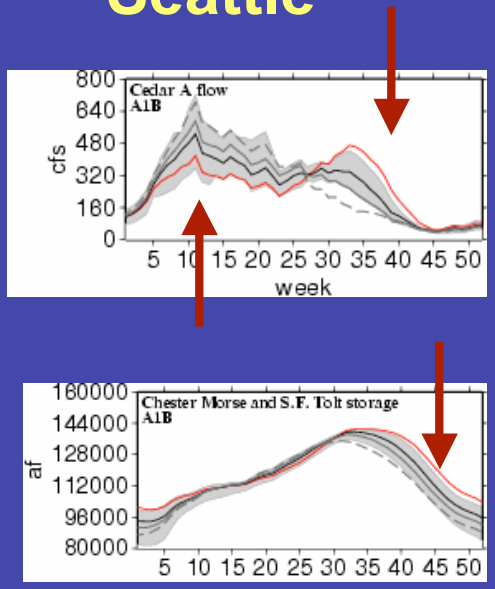
Puget Sound Methods



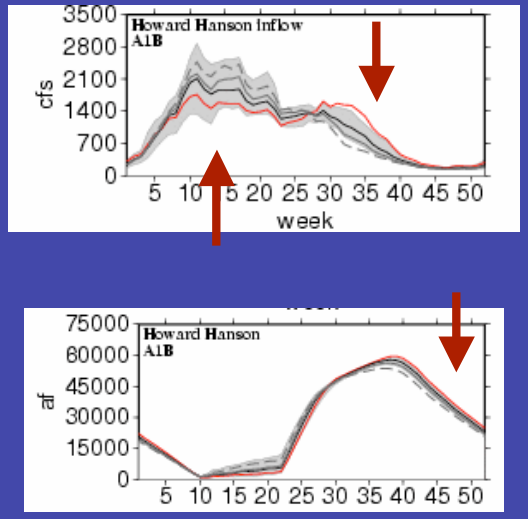


Puget Sound Basin

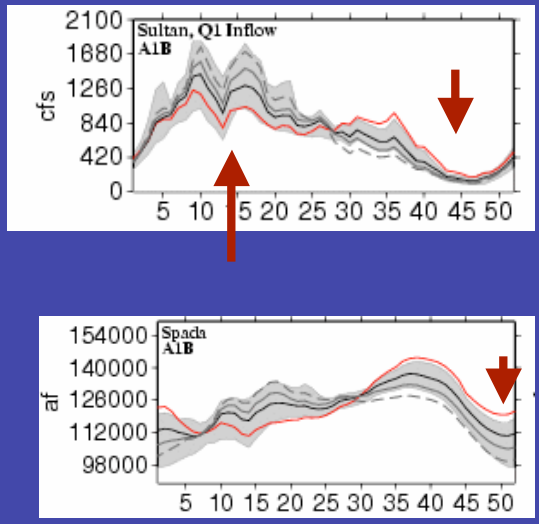
Seattle



Tacoma

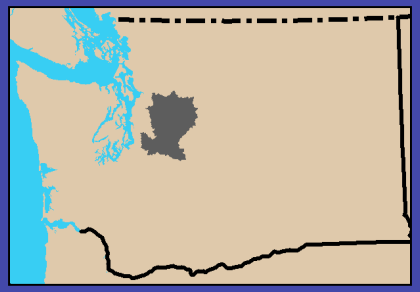


Everett



Variations in impacts within and between systems (A1B)

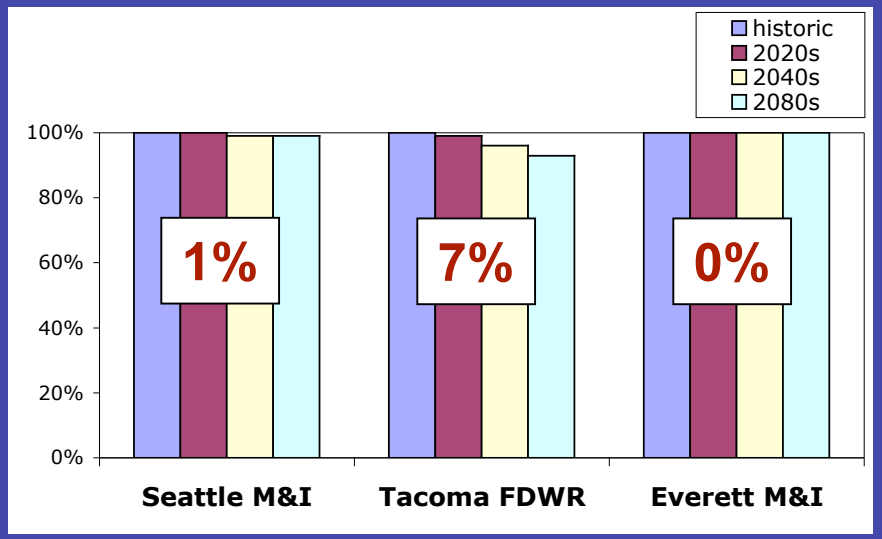
- **Seattle, M&I and environmental flows**
- **Tacoma, flood control, more constrained storage**
- **Everett, hydropower, more interannual variability**

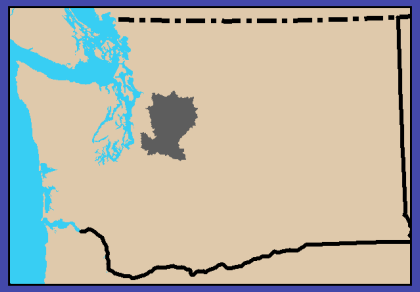


Puget Sound Basin

municipal supply - current demand

- M&I reliability measures, differ for all systems
- Current demand, reliability little impact from future change (A1B)
- Tacoma, water allocations closer to current system capacity
- Everett, largest system capacity
- Note: simulations prior to adaptations

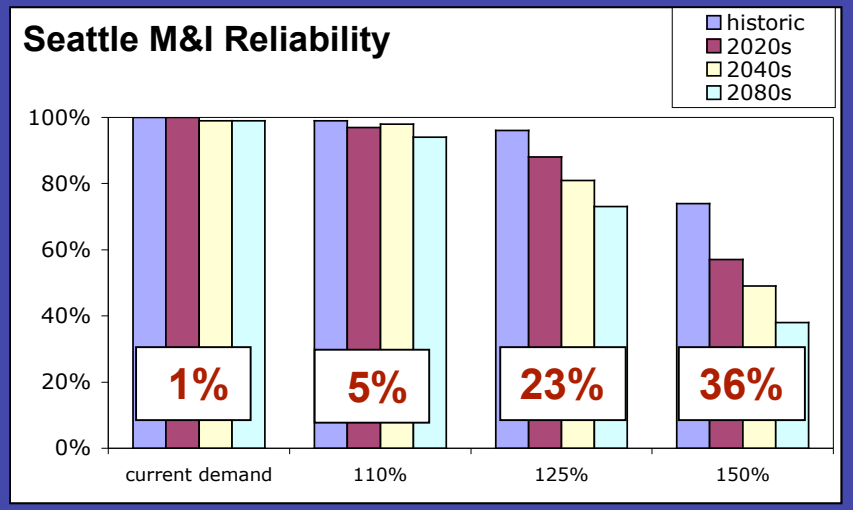


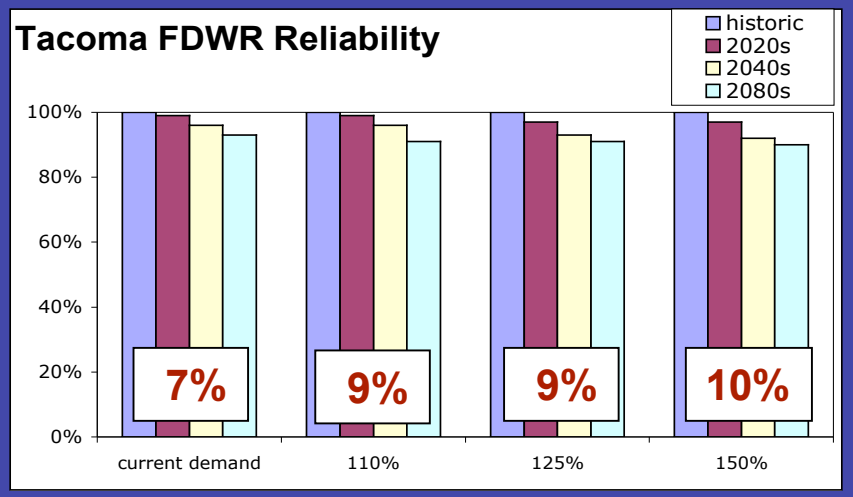


Puget Sound Basin

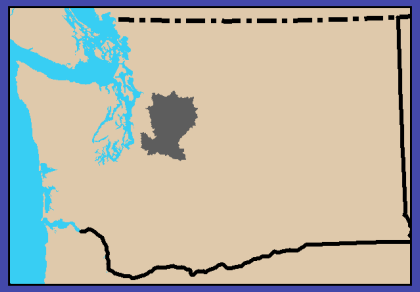
municipal supply - changing demand

- With demand increases, climate change has more impact reliability
- Importance of conservation measures/reduced demand
- Systems respond different depending on storage capacity, basin transitions, system demands, adaptive capacity
- Note: simulations prior to adaptations





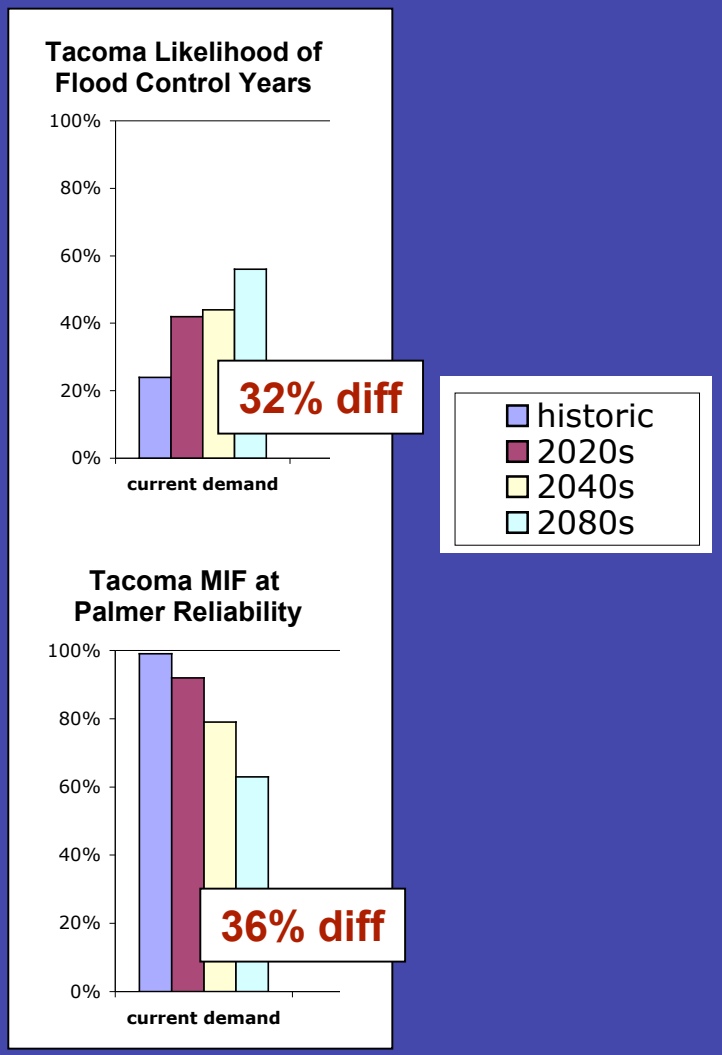
Everett M&I Reliability — **0% diff, all 100%**

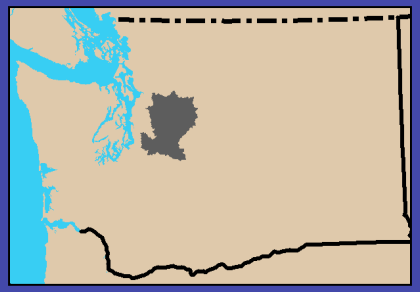


Puget Sound Basin

operations beyond municipal supply

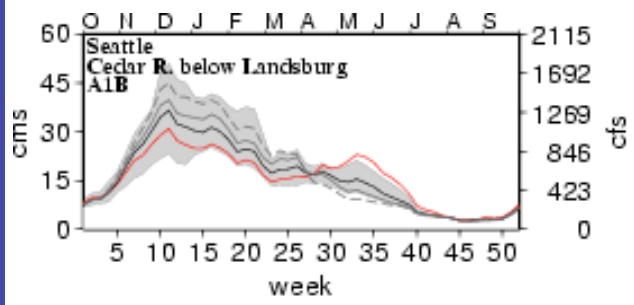
- Range of operating goals that must be balanced
- Tacoma, likelihood of flood control years
- Tacoma, minimum instream flow reliability
- Note: current demand and simulations prior to adaptations



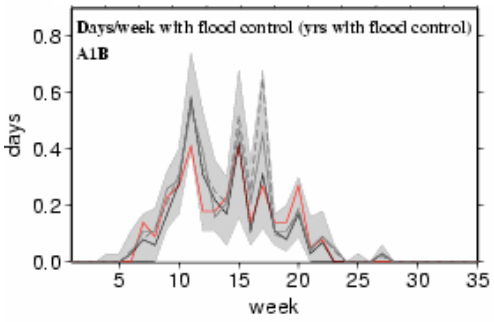


Puget Sound Basin

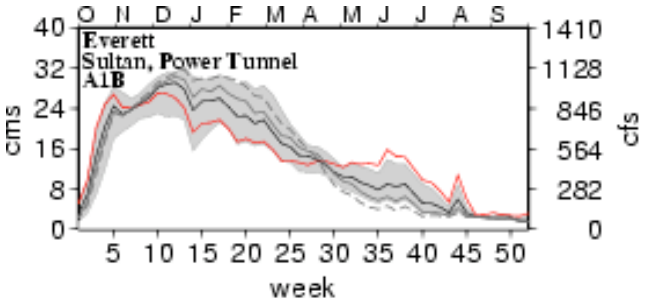
operations beyond municipal supply



Seattle
environmental flows



Tacoma
flood control



Everett
hydropower

Reservoir storage projected to be lower in late spring through early fall and ancillary operating objectives may be impacted.

Key Findings
Puget Sound Basin

1) Primary impacts of climate change will be a shift on average in the timing of peak river flow from late spring to winter
2) With current demands, systems able to accommodate changes from future climate
3) With demand increases, systems less able to accommodate changes from future climate, conservation measures matter
4) Other aspects of system performance complicate management decisions such as environmental flows, flood control, and hydropower

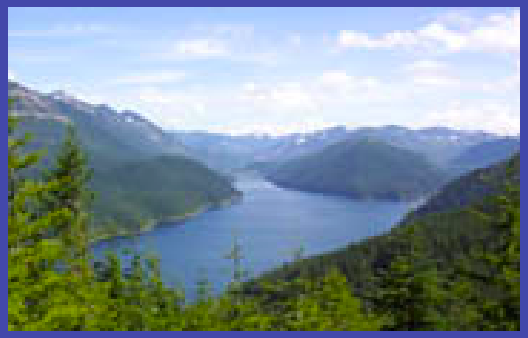
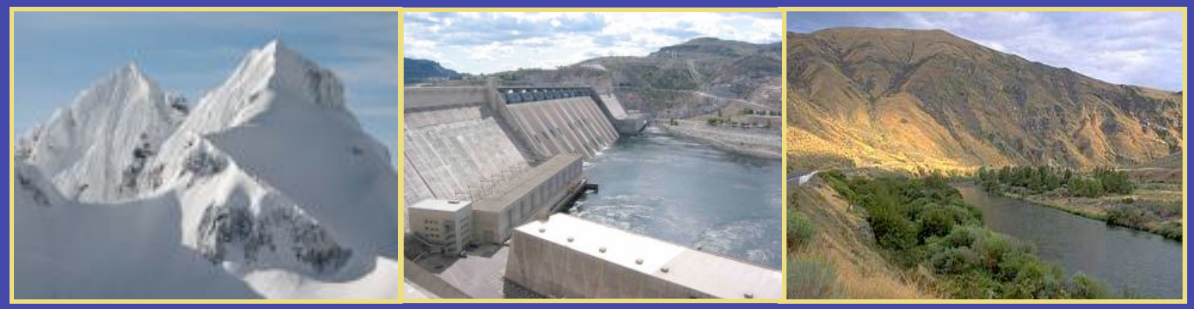


Photo courtesy of http://www.seattle.gov

Ongoing and Future Adaptations through Washington State

- Expand and diversify existing water supplies
- Develop new or alternate water supplies
- Reduce demand/improve efficiency
- Implement operation changes
- Increase ability to transfer water between uses and users
- Increase drought preparedness
- Reduce winter flood impacts



Acknowledgements

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- Tacoma Water
- US Army Corps of Engineers, Howard Hanson Project
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- Snohomish County Public Utility District

The Climate Impacts Group

www.cses.washington.edu/cig

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