WASHINGTON STATE UNIVERSITY

Benefit-Cost Analysis of the Yakima River Basin Integrated Plan Projects

Jonathan Yoder, Project Lead
Professor, School of Economic Sciences
Director, State of Washington Water Research Center
Washington State University

STATE OF WASHINGTON
WATER RESEARCH CENTER

Collaborators

- Co-PIs
  - Jennifer Adam, Engineering/Hydrology, WSU
  - Michael Brady, Economics, WSU
  - Joseph Cook, Evans School for Public Policy, UW
  - Stephen Katz, School of the Environment, WSU
- Contributing authors
  - Daniel Brent, Monash University
  - Shane Johnston, UW
  - Keyvan Malek, WSU
  - John McMillan, McMillan Biological Consulting
  - Qingqing Yang, WSU

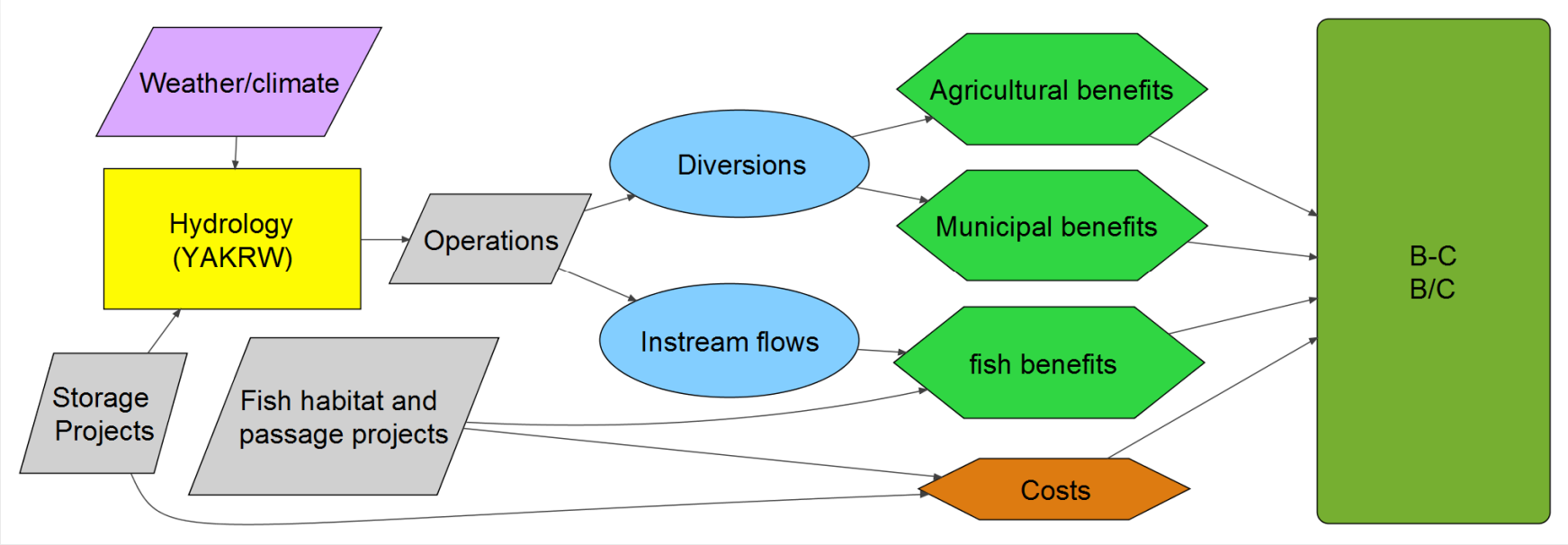
Legislative charge

- The State of Washington Water Research Center (WRC) is to prepare separate benefit-cost (B-C) analyses for each proposed project in the Yakima Basin Integrated Plan (IP).
- Focus on benefits from:
  - fish abundance increases,
  - Irrigation water reliability,
  - Municipal/domestic water supply reliability.
- Use existing studies to the greatest extent possible, supplemented by primary research
  - Primary reference and starting point: *The Four Accounts Analysis (HDR Engineering et al. 2012).*

http://www.ecy.wa.gov/programs/wr/cwp/YBIP.html

Modeling scope

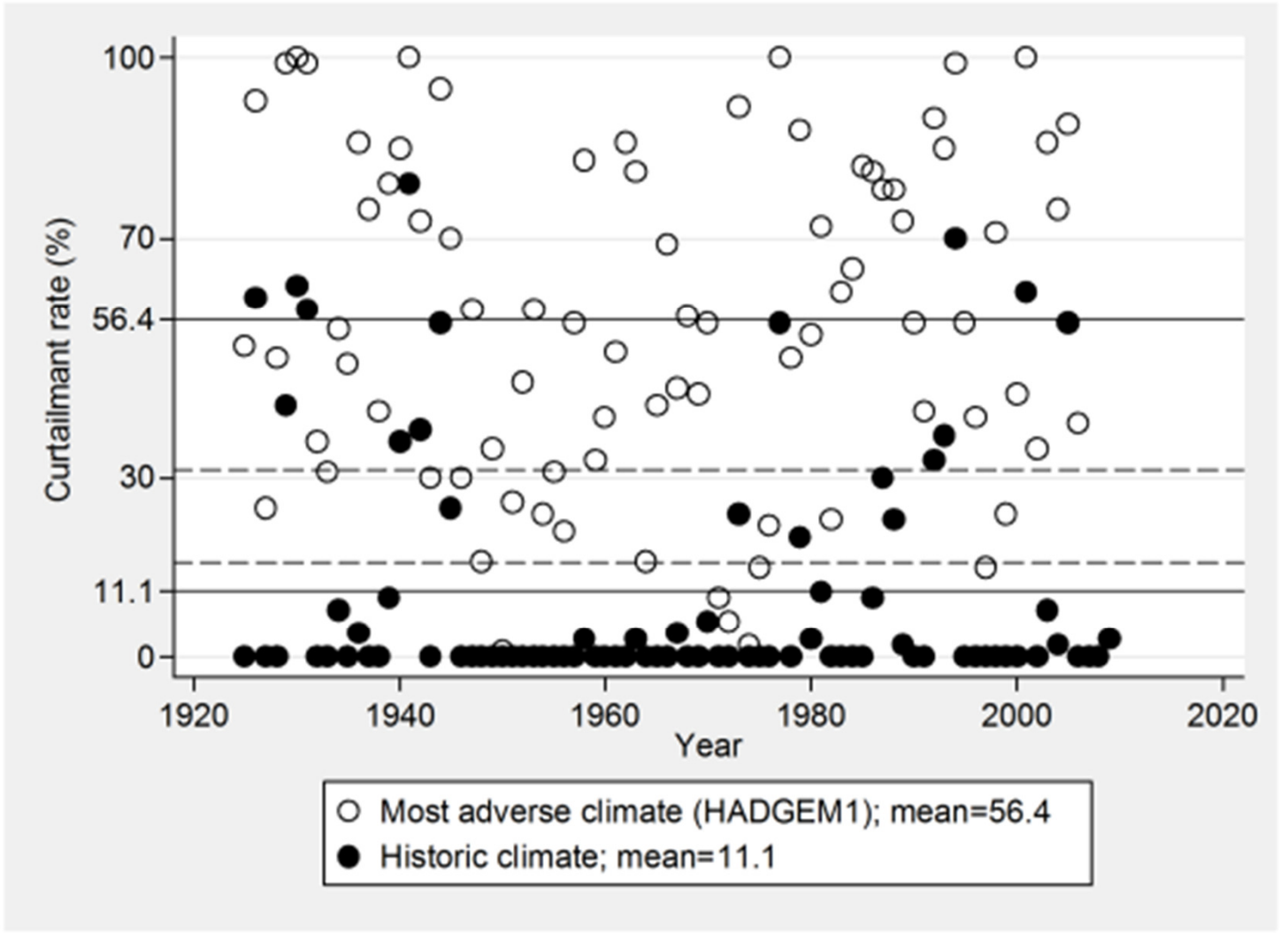
- 4 climate scenarios
- YAKRW Hydro model
- Crop/water response model
- Project costs: USBR estimates
- Municipal avoided costs model
- Fish abundance models: instream flows, habitat restoration, and fish passage
- Fish valuation: Benefits transfer



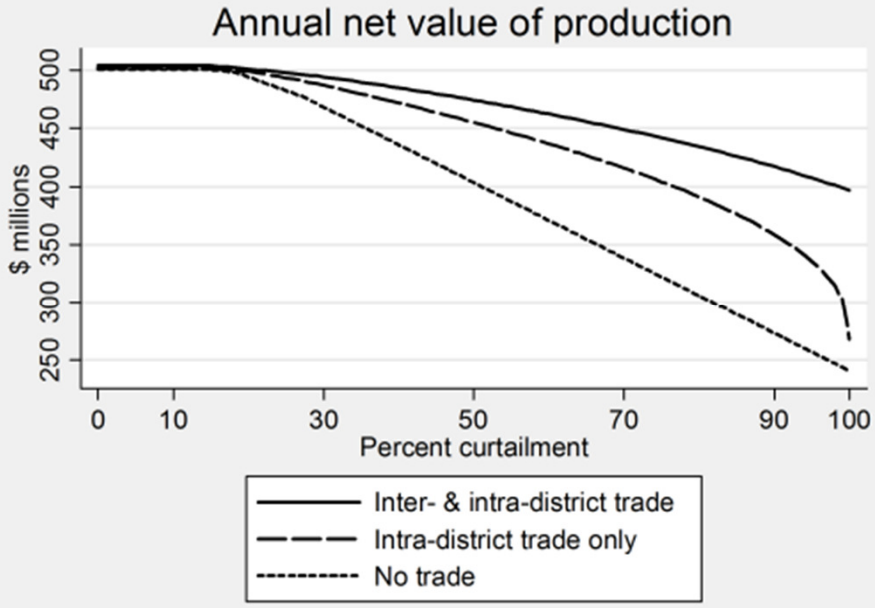
Modeling methods

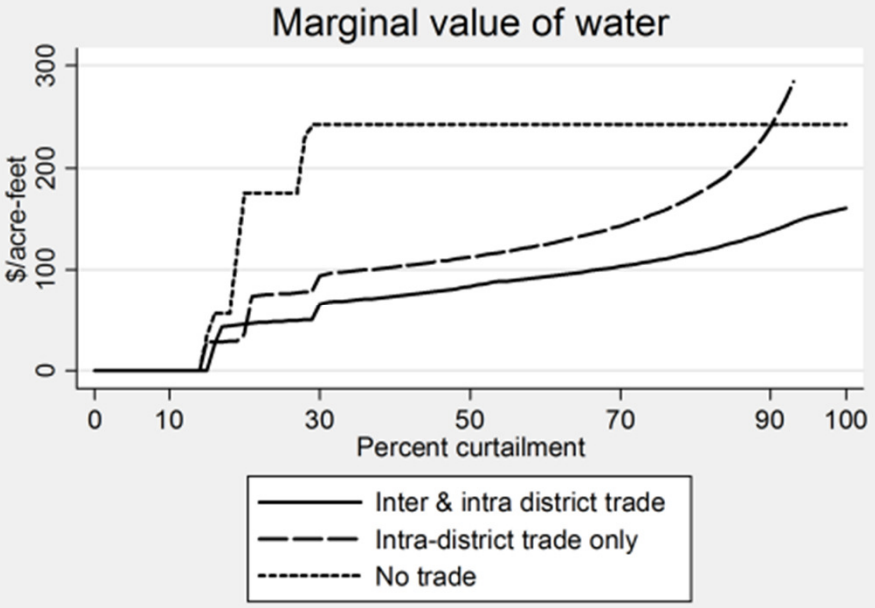
- Agricultural benefits:
  - Crop-water model developed by Scott (2004).
  - Climate translates into basin-wide irrigation curtailments.
  - Storage projects translate into lower curtailments.
  - E[NPV(benefits)] of a suite of storage projects is the difference between the E[NPV] of ag production with v. without projects.
  - Water market assumptions: from None to Frictionless.
- Municipal benefits, two types of avoided costs:
  - Water security for existing uses
  - Water to cover increasing municipal demand
- Fish:
  - Abundance: sockeye benefit mainly from fish passage; non-sockeye from habitat restoration and instream flows.
  - Valuation: Benefits transfer using Layton, Brown, and Plummer (1999).

Climate matters for curtailment rates



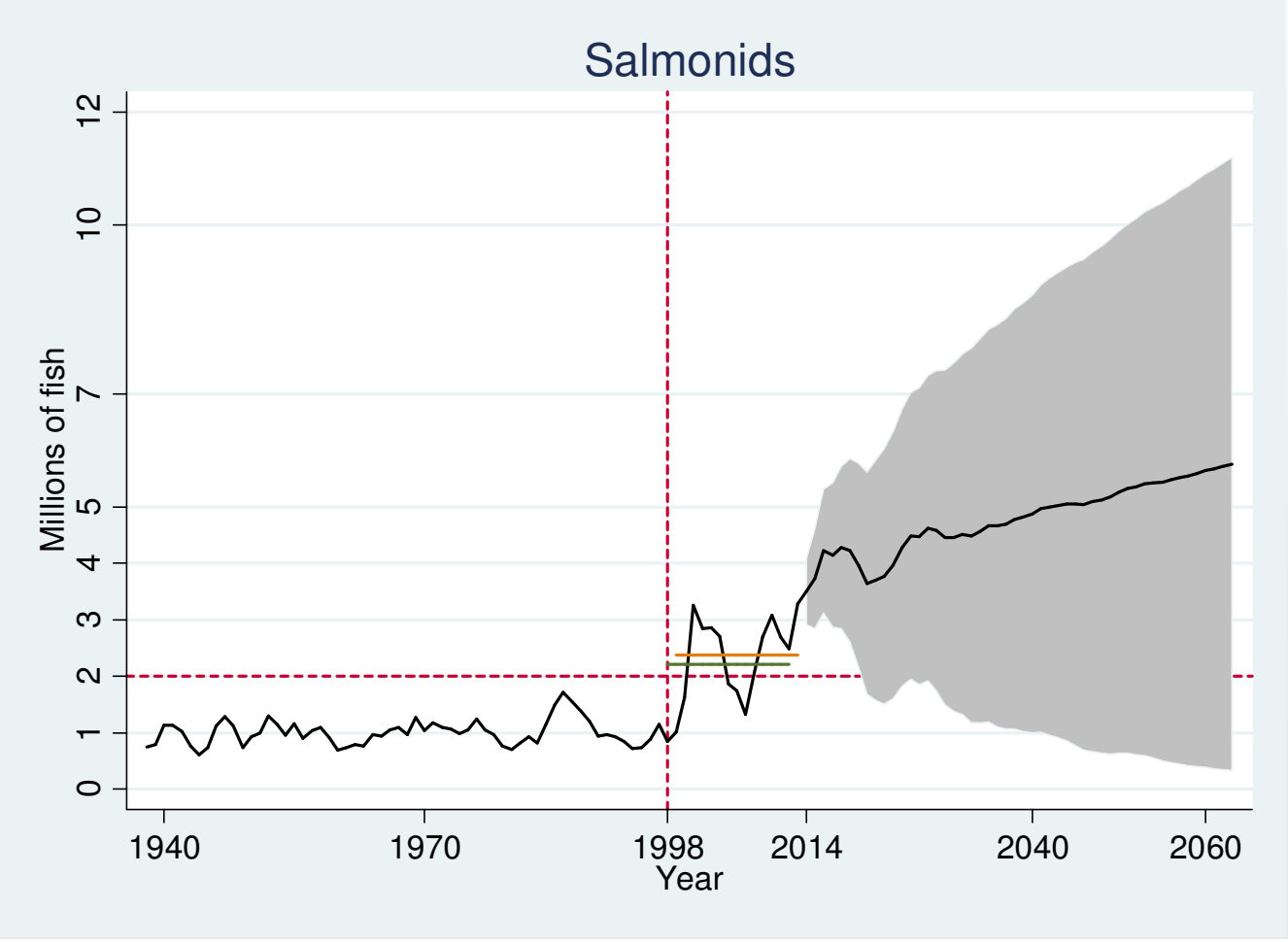
Water markets matter for drought impact





Columbia River salmonid abundance matter for fish valuation

- Higher CR salmonid abundance reduces MV of Yakima salmon recovery



Results: Full IP

- Full IP: moderate climate change and market assumptions
  - Agricultural benefits: $117 million.
  - Municipal benefits: $32 million.
  - Fish benefits: $1-2 billion.
  - Total E[NPV(B)]: $1.1-$2.1 billion
  - Costs: $2.7-4.4 Billion.
  - B/C range from 0.26 to 0.79: Full IP fails to pass a B-C test for economic viability.
- Contrary to 2012 analysis, which finds :
  - Agriculture: $800 m
  - Municipal: $400 m
  - Fish: $5-$7.4 b
  - Total E[NPV(B)]: $6.2-8.6 Billion
  - Costs: same
  - B/C ratios of 1.3 and higher

Results: Biggest sources of difference

- Agricultural benefits: Assumptions about curtailment rates with and without IP
- Municipal: various price and calculation differences
- Fish: Assumptions about baseline fish populations and fish growth rates.

Some general economic outcomes

- Diminishing returns to water storage: value of a project lower if others are implemented too.
- Storage and markets as "technical substitutes"
  - Improving markets reduces the value of additional water storage.
  - Adding water storage reduces the gains from trade associated with expanding market transactions.
- Columbia River Salmonid abundance increases has a big impact on estimated fish values

Results: Project categories

- No water storage projects pass B-C test under moderate climate change and market conditions
  - KDRPP and CPR may pass under adverse climate and market conditions if implemented alone.
  - But: with new cost estimates, KDRPP never passes even if implemented alone
  - No storage project passes a B-C test as part of the full IP
- All fish passage projects pass B-C tests
- Habitat and instream flows
  - Instream flows could be purchased at lower cost than "built" with water storage.
  - Habitat restoration is costly and is unlikely to pass a B-C test as designed.

Individual projects: Water storage, out-of-stream benefits

- Cle Elum Pool Raise (C=$12 m.)
  - Alone: B/C=0.62
  - With full IP: B/C=0.26
- Kachess Drought Relief Pumping Plant
  - Less adverse climate, alone: B/C=0.29.
  - More adverse climate, alone: B/C=0.91.
  - New cost estimates in DEIS are double, so B/C much lower.
- Wymer
  - With IP, moderate climate: B/C=0.03
  - Without IP, adverse climate: B/C=0.39
- Aquifer Storage and recovery:
  - With IP, moderate climate: B/C=0.13
  - Without IP, adverse climate: B/C=0.89

Individual projects: Water markets

- Potential gains from trade for improved water markets, moderate climate
  - without the IP: $317 m
  - With the IP: $216 m
- Potential gains from trade for improved water markets, adverse climate
  - without the IP: $1,436 m
  - With the IP: $1,138 m
- Cost of purchasing IP instream flows:
  - Moderate climate: $128 m
  - Adverse climate: $490 m
- The comparable net cost of providing instream flows as part of the full IP: 2,500 m to 2,700m

Individual projects: Fish passage and habitat

- All fish passage projects pass B-C tests
  - B/C ratios ranging from 1.43 to 11.68
  - Low cost (<$100m each), high return
- Fish habitat restoration and instream flows
  - Cannot separate the productivity of these independently given available data.
  - Together, cannot make up the shortfall of the IP
  - Together cost at least about $450m (if instream flows purchased)
  - Estimated benefits together from $48m to $300m. Do not pass B-C test based on this estimated range.
  - However, lots of uncertainty.
- Issues with complementarity between instream flows, restoration: hard to discern contributions to totals given data.

Summary

- Previous B-C analysis of the IP focused on the full IP against a "no IP" alternative. Found B/C ratios >1.
- The WRC study found B/C ratios <1
  - Water storage projects generally fail a B-C test.
  - Water market improvements have potential to mitigate drought impacts.
  - Instream flow purchases would be cheaper than "building" instream flows with storage.
  - Fish passage projects generally pass a B-C test.