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

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Legislative charge

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- 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).
- Use existing studies to the greatest extent possible, supplemented by primary research.
- Focus on benefits from:
  - fish abundance increases,
  - Irrigation water reliability,
  - Municipal/domestic water supply reliability.

IP project categories

- Surface and aquifer water storage.
- Fish passage at dams.
- Structural & operational changes.
- Water market and water bank development.
- Agricultural & municipal water conservation projects.
- Tributary/mainstem fish habitat enhancements.

Methods

Built on the *Four Accounts Analysis* (FAA) B-C study (2012) and supporting studies, with modification.

- Integrated hydrologic/climate model.
- Agricultural benefits: Crop-water response model.
- Three benchmark market regimes considered.
- Municipal/domestic benefits: Avoided costs of water purchase.
- Fish benefits:
  - Fish abundance estimates from previous studies.
  - Valuation methods used in FAA, with updated data.

Results overview

- Compare WRC and FAA aggregate results.
- Discuss the source of differences.
- Summary of individual project B/C outcomes.
- Additional detail (time permitting).

Benefits of the IP: WRC and FAA results

- WRC results with moderate climate change & markets:
  - Agricultural benefits: $117 million.
  - Municipal benefits: $32 million.
  - Fish benefits: $1–$2 billion.
- FAA results
  - Agricultural benefits: $800 million.
  - Municipal benefits: $400 million.
  - Fish benefits: $5–$7.4 billion.

Differences: Agriculture

Basic differences: Climate and market assumptions.

- Climate/curtailment assumptions.
  - WRC uses historic climate and 3 climate forecasts.
  - Climate/curtailment modeling were not available for FAA.
  - Difference in average curtailment reduction due to IP is 8 times higher given FAA assumptions used.
- FAA: Very restrictive assumptions about selective water allocation during drought.
- Normandeau (2014) could only identify half of FAA ag benefits.

Differences: Municipal/domestic

Basic differences: Water prices and their use.

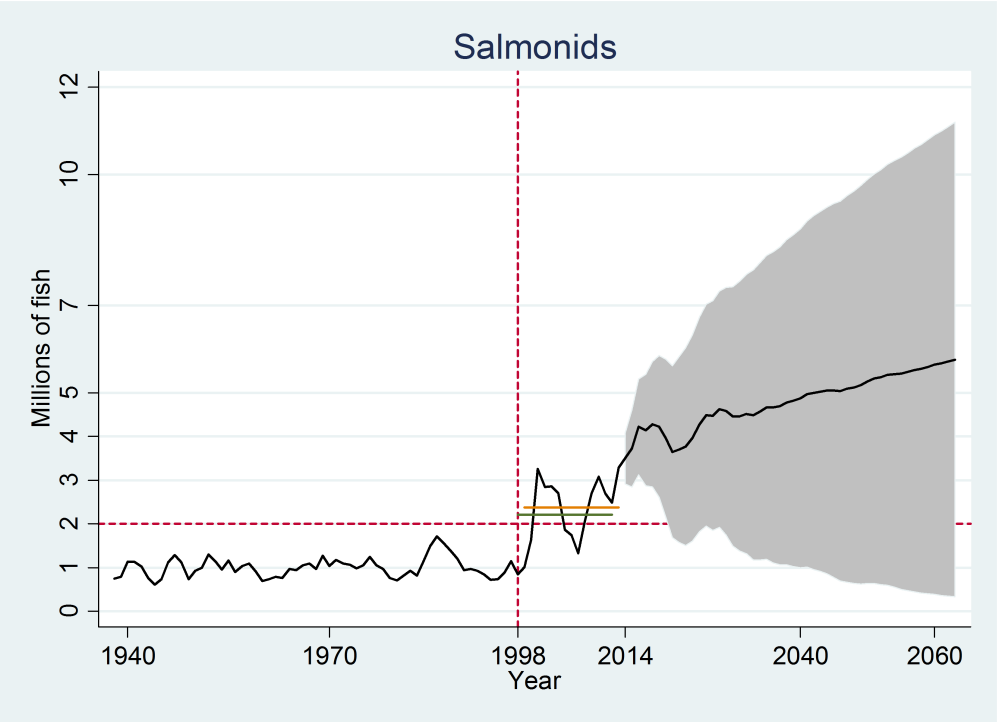
- Water security for existing users
  - FAA uses water sale price as if it were a lease price. Leads to large overestimate. Normandeau (2014) also identified this problem.
  - FAA Doesn't account for the value of existing junior rights held by municipalities.
- Water for demand growth
  - FAA uses a wholesale water price, but it includes treatment and conveyance costs, accrued regardless of the IP.
  - The opportunity cost of water to agriculture is a more defensible price to use.

Differences: Fish benefits

Basic differences: Fish population growth and baseline fish population assumptions.

- FAA assumptions consistent with long-term fish growth rates of approximately 40%/year.
- Only 14% of populations have growth rates of 5% or more (McClure et al. 2003). WRC study assumes 5% growth.
- FAA assumes flat baseline salmonid populations in the Columbia River.
- The baseline assumption matters a lot economically.

Baseline fish populations



- FAA assumes no increase in Columbia River salmonid fish abundance since 1998.
- Avg. increase from 1998 is $> 200K$ fish (but high variance).
- Baseline & growth rates are the source of difference in results.

Individual projects: summary

- Individual storage projects do not pass a B/C test as part of a full IP implementation.
- Storage projects fail B-C test when implemented alone, with two exceptions:
  - Cle Elum Pool Raise approaches B-C viability *alone* in the most adverse climate scenario.
  - KKC+KDRPP borderline, but with more caveats.
- Fish passage projects are the most likely projects to satisfy a B-C test.
- Proposed IP instream flows less costly if purchased than "built" with storage.
- Water market gains from trade are potentially substantial with active market development.

Additional detail: Time permitting

- Out-of-stream benefits
- Instream flow: break even and opportunity costs.
- Individual project net benefits
  - Alone (with no other projects implemented)
  - Implemented along with full IP
- Fish passage
- Instream flows and habitat restoration

Out of stream benefits

Out of stream benefits of water storage and conservation (incl. municipal). $Millions.

run	Cost	Benefits	Net benefits	B/C
IP, CGCM climate	2,850	123	-2,727	0.04
IP, HADGEM climate	2,850	351	-2,499	0.12

Estimated instream + restoration benefits combined of $50 to $300 million cannot cover these out-of-stream losses of around $2.5 billion.

Cost of purchasing instream flows

The cost of proposed IP instream flows in terms of agricultural production value. Present value, $ millions.

run	Climate	$m	diversion reduction
Base+Instream	CGCM	128	71,604
Base+Instream	HADGEM	490	114,043

Less expensive to purchase instream flows than to "build them" for around $2.5 billion (in terms of opportunity cost of water).

Each project implemented alone. Out-of-stream net benefits.

		moderate climate			adverse climate		
Project	Cost	TB	NB	B/C	TB	NB	B/C
KKC+KDRPP	334	98	-236	0.29	340	5.5	1.02
CEPR	16	10	-6	0.62	21	5.5	1.34
ASR	126	45	-82	0.35	112	-13.9	0.89
Conservation	257	11	-246	0.04	0̃	-268	0.00
Bumping	452	81	-371	0.18	293	-159	0.65
Wymer	1,331	115	-1,217	0.09	524	-808	0.39

Individual project benefits as part of the full IP, most adverse climate (HADGEM).

Project	NB	B/C
KKC+KDRPP	-188	0.44
CEPR	-16	0.00
ASR	-19	0.85
Conservation	-243	0.05
Bumping	-348	0.23
Wymer	-1,106	0.17

- Net benefits & B/C ratios lower for other climate scenarios.
- How to allocate instream flow benefits? Difficult to answer, but can't double count.

Potential gains from trade for with and without the IP. $ millions.

run	intra-district	+inter-district	Full trade	Net of TC
Baseline, CGCM	287	153	439	317
Full IP, CGCM	189	110	299	216
Baseline, HADGEM	1,212	787	1,999	1,436
Full IP, HADGEM	946	639	1,585	1,138

Fish passage benefits

Fish passage benefits by reservoir.

	Contribution to total		Cost $mill	Benefits $mill		B/C	
Reservoir	low	high		low	high	low	high
Keechelus	12	16	79.9	114	205	1.43	2.56
Kachess	29	31	79.9	276	495	3.46	6.19
Cle Elum	27	23	81.5	257	461	3.15	5.65
Tieton	13	17	79.9	124	222	1.55	2.78
Bumping	18	14	26.3	171	307	6.52	11.68
Total	100	100	347.5	952	1,706	2.74	4.91

Questions?

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Report available at
http://swwrc.wsu.edu/category/research/