

YAKIMA BASIN INTEGRATED PLAN BENEFIT-COST ANALYSIS

AN APPEAL FOR EVIDENCE-BASED DISCOURSE ABOUT THE

STATE OF WASHINGTON WATER RESEARCH CENTER STUDY OF THE YAKIMA BASIN INTEGRATED PLAN

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Acknowledgements: *I thank several of the co-authors of the Benefit-Cost Analysis of the Yakima Basin Integrated Plan Projects (<http://swwrc.wsu.edu/2014ybip/>) for helpful comments. However, I am solely responsible for the content of this article.*

INTRODUCTION

The Washington State Legislature charged the State of Washington Water Research Center (WRC) to carry out a benefit-cost (B-C) analysis of the Yakima Basin Integrated Plan (YBIP) projects, which it delivered in December of 2014 (hereafter the WRC report, available at <http://swwrc.wsu.edu/2014ybip/>).

The WRC research team was fortunate to be able to build upon prior work in the form of an earlier B-C analysis, called the Four Accounts (FA) analysis (ECONorthwest et al., 2012), and an extensive set of supporting studies of the YBIP and its component proposed projects. The FA analysis was commissioned by the US Bureau of Reclamation (Reclamation) and the State of Washington’s Department of Ecology Office of Columbia River (OCR), both of whom are active in the design and planning of the YBIP. The FA analysis reports that the YBIP as a whole passes a B-C test (such that benefits outweigh costs).

The FA analysis is a B-C analysis limited to a comparison of the full YBIP against a “No YBIP” alternative. In contrast, the WRC was charged to perform B-C analysis of individual projects within the YBIP. The WRC study therefore required a new careful analysis of the contribution of individual projects to the YBIP. In addition, as always in research endeavors, the WRC research team took the opportunity to update and improve on methods used in the earlier studies wherever possible.

Because of the methodological improvements and the difference in objectives, the results of the two studies differ in several ways. Based on the new WRC analysis, none of the water storage projects pass a B-C as part the YBIP, but fish passage projects do. Further, the WRC study finds that the YBIP as a whole does not pass a B-C test.

As academic researchers working on behalf of the WRC mission and respective university values of independent, science-based research, we do not have the luxury of deciding ahead of time what the results of a research study will, or should be. Results must follow from defensible methodological foundations. The WRC study includes no policy prescriptions whatsoever, and the results should not be construed to indicate a policy position held by any of the WRC study authors.

Nonetheless, it is clear and unsurprising that the WRC results have been interpreted as less supportive of the YBIP than the previous B-C work commissioned by the YBIP proposal developers. YBIP proponents have leveled several criticisms at the WRC study since its publication. Many have originated from the YBIP Implementation Committee (IPIC), and several of these are included in Malloch and Garrity’s article in *The Water Report* (this issue, hereafter referred to as MG). Garrity is a member of the IPIC, and Malloch is affiliated with the larger YBIP Workgroup.

The objective of this present article is to respond to the most salient published criticisms. It is not possible due to space limitations nor would it be effective to try to respond to all criticisms that have been forwarded by YBIP proponents. Nonetheless, this article provides evidence and explanation to show that many of the claims to date against the WRC study are unsupported or unsupportable, misleading, or falsifiable upon examination of the WRC report. My intent is not to discredit YBIP supporters or the YBIP itself, but to dispel unsupportable criticisms of WRC study, and to respond constructively to legitimate ones. My hope moving forward is to invite and participate in an evidence-based debate about the complex issues surrounding the YBIP.

The WRC study is not perfect; no study of an economic and environmental system as complex as the Yakima Basin could be. It necessarily relies on assumptions and methods deserving of debate and broad consideration of evidence. Nonetheless, my appraisal is that criticisms to date do not provide clear implications or convincing evidence to substantively alter the WRC assessment. However, recently published increases in two YBIP water storage project cost estimates are more consequential for initial YBIP development proposals.

Yakima  
 Basin Plan  
 Benefits/Costs

Legislature’s  
 Direction

Previous  
 Analysis

Science-Based  
 Research

Criticisms

Seeking  
 Evidence-Based  
 Debate

## RESPONSE TO CRITICISMS

A synopsis of some of the criticisms and my responses are provided first. Supporting evidence provided thereafter is organized to coincide with the flow of MG's commentary on the WRC report.

## SALIENT CRITICISMS

**Claim:** *"The WRC study assumed very slow rates of [fish] population growth, which strongly skews economic analysis using a time-value of money approach."*

**Response:** To the contrary, the WRC study provides a wide range of results including the high rates of growth implicitly assumed in the FA analysis. We justify lower growth rates within this range based on peer-reviewed analysis and the definition of the YBIP itself.

**Claim:** *"...the WRC study assumed few significant constraints to water marketing."*

**Response:** This is untrue. The WRC study provides results for a full spectrum of market outcomes, from completely ineffectual markets to fully efficient markets. Although we provide extensive discussion of water market frictions and constraints and their likely impacts, we justify an emphasis on intermediate market outcomes less restrictive than those assumed in the FA analysis.

**Claim:** *"The WRC relied on a longer data set [than the FA analysis] that included less frequent and less severe droughts, because drought has occurred more often in recent years, and used a different standard for drought."*

**Response:** This is true, but the implication that the WRC study simply assumes a less adverse climate is false. We provide results based on a broad range of climate scenarios, from a historical climate regime to climate regimes substantially more adverse than that assumed in the FA analysis.

**Claim:** *If irrigation districts propose to pay the cost of storage projects, the WRC results must be suspect.*

**Response:** This claim misconstrues a misquoted statement I made to suggest that I concede doubt in our results. My intent was not to convey doubt in our results, but to convey doubt in the claim that irrigation districts will pay the full costs of YBIP water storage projects.

**Claim:** *"The WRC study found water conservation literally valueless, because it does not create 'new water' — the water in this fully appropriated basin is already claimed, including conserved water."*

**Response:** This is easily falsifiable by reading the WRC report. Further, the WRC clearly and openly delineates data limitations that limit our ability for a full accounting of conservation benefits. Ancillary claims in MG (discussed below) misconstrue the nature of the limitations of our study with respect to conservation benefits.

**Claim:** *"A disaggregated analysis divides the plan into individual components and evaluates the efficacy of those components in isolation," and it is inappropriate to perform B-C analysis in the component parts of the YBIP." (Garrity et al. 2015).*

**Response:** This claim is logically unsupportable. The WRC study goes to great length to account for the interrelationships among projects in order to assess individual components in a logically defensible way.

## CATAGORIZED CRITICISMS: SUPPORTING EVIDENCE &amp; DISCUSSION

The section headings below correspond to those in MG.

## FISH RECOVERY

**Claim:** *"The WRC study assumed very slow rates of [fish] population growth, which strongly skews economic analysis using a time-value of money approach."*

**Response:** Please refer to the WRC report discussion beginning on page 93. The salmonid population growth rates relied on in the WRC study (5 percent, and for comparison 10 percent) are based on the most comprehensive meta-analysis published in a peer-reviewed journal article to date (McClure et al. 2003). A 5 percent growth rate is higher than 85 percent of the population growth rates estimated for Columbia River Salmonids. The FA analysis did not report population growth rates, however, the lower and upper bound estimates for sockeye abundance in the timeline demand 20 to 40 percent growth rates, the latter of which is higher than any reported in McClure et al. (2003). Although instantaneous or single-year rates may approach and even exceed these higher values in special circumstances, such as at the initiation of a recolonization (e.g. Pess et al. 2014), expecting population growth rates to be sustained at 40 per cent for the duration of the YBIP planning period is inconsistent with current understanding of salmon population biology (Milner et al. 2003), and therefore unreasonable. Thus, relative to the existing peer-reviewed literature, the growth rates we assume are not "very slow" as MG claim, but are more reasonably described as optimistic. Given the way in which we rely on peer-reviewed literature on population growth rates, we dispute MG's claim that we assume return rates much lower than previous analyses by other fisheries biologists.

**Yakima  
Basin Plan  
Benefits/Costs**

**Fish Run  
Growth**

**Marketing  
Restrains**

**Data Set Range**

**Irrigation  
Payments**

**Conservation  
Worth**

**Disaggregated  
Analysis**

**Fish Recovery  
Rates**

**Yakima  
Basin Plan  
Benefits/Costs**

**Hatchery  
Considerations**

**Water  
Marketing  
Spectrum**

That said, the growth estimates used in the WRC analysis based on McClure et al. (2003) do not account for additional importation and/or hatchery investments in the Yakima Basin beyond that which has supported the existing populations, which act as the baseline for our growth estimates. Future importation and/or hatchery investments would support higher abundance growth rates (*see* WRC analysis Appendix discussion starting on p. 162, and specifically pp. 164-166). We did not include further hatchery and introduced fish in our calculations because these planned future restoration activities are not part of the YRBWEP’s definition of the YBIP, and our legislative charge was to consider YBIP projects. If the YBIP is to be credited for fish abundance increases supported by hatchery and importation (thereby making the comparison to sockeye growth in the Okanogan as cited by MG more legitimate), then the costs of these programs should be included in the B-C analysis. The FA analysis relied on these high growth rates but did not account for the cost of activities to support them, which skews the B-C estimates for fish benefits upward.

**WATER MARKETING**

**Claim:** “...the WRC study assumed few significant constraints to water marketing.”

**Response:** This statement is incorrect. The WRC study reports results representing a full spectrum of water market outcomes, described in substantial detail (e.g. p. 38-41, and p. 144-148). We also spend three pages (p. 41-44) describing market frictions that can lead to attenuated market outcomes. The market outcomes we consider range from what we call “no trade” (or “proportional curtailment”) to full trade (with and without transaction costs). “No trade” in our working definition is extremely restrictive. It mean that no markets function at all, and that irrigators ignore differences in economic returns to water across crops and curtail water to all crop types regardless of return (*see* p. 38-39). The no trade and full trade scenarios are unrealistic “bookends” that we use to define the full range of possible outcomes. In addition, we subtract liberal estimates of transaction costs based on existing literature from the estimated gains from trade. Although we provide results for this full range of market regimes, we justify and focus on intermediate market outcomes, which we show are remarkably similar to estimates in the FA analysis, all else being equal.

**ESTIMATED COSTS FOR YAKIMA INTEGRATED PLAN DEVELOPMENT  
30 YEAR IMPLEMENTATION PERIOD**

<b>INTEGRATED PLAN ELEMENT</b>	<b>INITIAL DEVELOPMENT PHASE (Decade 1)</b>	<b>INTERMEDIATE DEVELOPMENT PHASE (Decade 2)</b>	<b>FINAL DEVELOPMENT PHASE (Decade 3)</b>	<b>FULL DEVELOPMENT COSTS (3 Decades)</b>
Habitat/Watershed Protection and Enhancement	\$201,700,000	\$139,400,000	\$139,400,000	\$480,500,000
Fish Passage (6 projects)	\$186,400,000	\$133,600,000	\$108,400,000	\$428,400,000
Surface Water Storage	\$413,900,000	\$1,003,600,000	\$999,000,000	\$2,416,500,000
Groundwater Storage - Regional and Municipal	\$6,400,000	\$58,400,000	\$58,400,000	\$123,200,000
Structural and Operational Changes	\$150,000	\$63,500,000	\$63,500,000	\$127,150,000
Enhanced Water Conservation	\$87,500,000	\$171,000,000	\$171,000,000	\$429,500,000
Market Driven Reallocation	\$850,000	\$1,050,000	\$1,050,000	\$2,950,000
Integrated Plan Update Costs		\$1,500,000	\$1,500,000	\$3,000,000
<b>TOTAL</b>	<b>\$896,900,000</b>	<b>\$1,572,050,000</b>	<b>\$1,542,250,000</b>	<b>\$4,011,200,000</b>

*Adapted from: Yakima River Basin Integrated Water Resource Management Plan Cost Estimate and Financing Plan  
WA Dept of Ecology Legislative Report, December 2014  
See: [www.ecy.wa.gov/programs/wr/cwp/images/pdf/YBIP\\_LEG\\_REPORT\\_2014.pdf](http://www.ecy.wa.gov/programs/wr/cwp/images/pdf/YBIP_LEG_REPORT_2014.pdf)*

**Yakima  
Basin Plan  
Benefits/Costs**

**Market  
Effectiveness  
Questioned**

**Market  
Development**

**“Need”  
&  
Pricing**

**Water Storage  
Cost Impacts**

**Drought  
Frequency  
Considerations**

**Adverse  
Climate Change**

It is also noteworthy that FA analysis assumptions are empirically very nearly equivalent to our “no trade” scenario (bottom of p. 70, top of page 71). This assumption leads to the highest possible range of YBIP benefit estimates. Thus, while the WRC study does not “assume few constraints” as MG claim, the FA analysis in contrast is based on untenable implicit and very restrictive assumptions about markets and on-farm economic decisions, that assume uneconomic behavior on the part of irrigators and happen to maximize the estimated potential benefits of YBIP infrastructure projects relative to all other possible market assumptions.

The Yakima River Basin Integrated Plan Implementation Committee (2014) makes a corollary to the above claim by stating in various ways that the WRC study overestimates the extent to which markets can alleviate water scarcity issues in the basin:

“Actual experience during the 2005 drought, when most barriers to transfer of water were greatly reduced or eliminated, demonstrated that quantities of water generated from marketing approaches paled in comparison to actual water needs.”

This claim requires a two-part response. First, the 2005 experience represents the market status quo ten years ago. A good deal of water market development has happened since then. The implication that water markets can’t be more effective than they were in 2005 is therefore questionable at best. History is rife with examples of market development in the face of increasing potential gains from trade. You need only look to the Upper Kittitas water market for exempt well mitigation that has developed since then as an example (Cronin and Fowler 2012).

Now I will pick on the word “need” as used by both MG and the Yakima Basin Integrated Plan Implementation Committee. If buyers had offered more than they did (reportedly around \$158 per acre-foot), they likely would have been able to purchase more water. But their offer suggests that they did not need the water enough to pay a higher price. This is not to denigrate the economic hardship that a drought can create; these economic hardships are real. The point is that satisfying a “need” always comes at a cost. One can purchase summer water by purchasing more storage at the cost of infrastructure. Or one can purchase water based on existing water infrastructure at the opportunity cost of that water for competing uses. The question is, which approach (or combination of approaches) provides the highest net benefits?

Further, to imply that water markets would not move as much water around as would be provided by the YBIP water storage projects hints at the fact that the benefits of more water storage are overshadowed by the costs of more water storage. Thus, MG’s statement “We are less convinced that water marketing eliminates the need for any additional storage in the basin...” is not a meaningful statement in the real world of tradeoffs. Of course markets will not eliminate wants for more water storage, but they can alleviate the economic impact of drought. Another statement made by an IPIC member in testimony to the Washington State Senate Ways and Means Committee is that the “bulk of the water that was identified in that study [for market transfer] is absolutely not transferable” — (beginning at minute 45:10 Sandison et al. 2015). There are many facets of this broad statement (and preceding statements in this testimony) that I could address constructively, but I will note only that no evidence whatsoever was given to support this claim.

**INFRASTRUCTURE PROJECTS**

**Claim:** “The WRC relied on a longer data set that included less frequent and less severe droughts, because drought has occurred more often in recent years, and used a different standard for drought.”

**Response:** We did indeed use a longer dataset than the FA analysis, and it does make a big difference in the value of YBIP storage projects. However, a quick look at the WRC analysis Figure 14 illustrates the first reason why this statement is misleading at best: we use the data from 1925 onward, and there is a series of droughts and concomitant curtailments between 1925 and 1945 that is as adverse as the recent years since 1970. To the extent that the hydrological cycle is stationary, this series should indeed provide more information than the data relied on in the FA analysis, and it should therefore be used.

Despite the implication of MG, use of the longer dataset does not imply that we ignored the potential for (non-stationary) adverse climate change. To the contrary: we ran four climate scenarios ranging from historical to adverse. We chose to emphasize one particular climate scenario (CMIP3 CGCM 3.1, which is more adverse than historic in terms of curtailments) precisely because the average annual curtailment rates matched the FA curtailments most closely (but slightly more adverse) under baseline (no YBIP) conditions.

Now consider the climatological assumptions used in the FA analysis: one-year droughts happen every five years, and three-year droughts happen every 20 years. Without the YBIP, proratable rights are assumed to be prorated to 30 per cent of entitlements in each drought year. Figure 14 of the WRC analysis includes simulated average curtailments that are very similar to actual curtailments, and shows that curtailment reached 70 per cent (30 per cent proration) just once in recent years. FA then does a sensitivity analysis assuming proration rates of 20 per cent and 40 per cent.

**Yakima Basin Plan Benefits/Costs**  
**Curtailment**

The more important difference between the WRC and FA analyses is that the FA assumes that the full YBIP would guarantee a minimum of 70 per cent proration, so that for every drought year, the YBIP is assumed to reduce curtailment from 70 per cent to 30 per cent (again, with sensitivity analysis based on 20 per cent and 40 per cent proration during drought years). The empirical/theoretical basis of this assumption of the impact of the YBIP on curtailment is weak to nonexistent (*see* the FA analysis section 2.2.2.1 and onward for details), yet this is a big difference in curtailment. So big, in fact, that the reduction in average curtailment due to the YBIP in the FA analysis is eight-times the difference in average curtailment shown in the WRC study to results from YBIP implementation based on YAKRW hydrological simulations (*see* p. 66-68 in the WRC analysis).

**Editor's Note: YAKIMA BASIN'S PRORATABLE WATER RIGHTS**

A 1945 Consent Decree created an unusual water rights structure in the Yakima River Basin (the decree was issued in *Kittitas Reclamation District v. Sunnyside Valley Irrigation District*, Civil Action No. 21 (Eastern District of Washington, Southern Division, Jan. 1945)). Pursuant to the 1945 Consent Decree, Reclamation annually determines the Total Water Supply Available (TWSA). Pre-1905 rights amounting to about half of the Basin's surface water rights receive their full water supply before junior right holders receive any. Next up are users whose rights date to the 1905 Reclamation appropriation. These rights are termed "proratable" and are cut back equally in any shortage. Post-1905 rights receive no water if the proratable rights are shorted and there is a "call" for water (i.e., a senior water right owner requests regulation of junior users so that the senior user receives the full amount of their right). The most senior rights holders thus had little concern about their water supplies because they historically have never been shorted. However, the largest and most economically productive water districts rely in large part on proratable rights. Prior to the regionally historic 1977 drought, proration was of only modest concern for the Reclamation irrigators — there had not yet been a serious shortage of water that resulted in significant proration. Since the Seventies, however, there have been several years where proratable rights holders received less than 70% of their water, the threshold irrigators see as causing very serious economic pain. Adapted from Garrity and Malloch, *TWR* #106.

**Climate Inputs**

**Irrigators' Payments**

**Federal Funding Requirements**

**State Funding**

After implying that we chose to emphasize less adverse climate results, MG cite the Cliff Mass Weather Blog (<http://cliffmass.blogspot.com/2015/02/the-winter-of-2070.html>). Interestingly, a careful comparison of the contents of this blog (based on the first map and graph and accompanying text) and the climate regime summary statistics reported in WRC study Table 3 (p. 28) shows that the HADGEM climate regime for which we report results is substantially more adverse in terms of both temperature and precipitation change than that favored in the Cliff Mass Weather Blog. Like the IPCC, we make no claims as to which scenario to rely on beyond the more frequent use of CGCM 1 for comparison to the FA analysis. Thus, we do not assume a benign climate — we report a range of results for a range of climates for readers to assess for themselves.

To be fair, the FA analysis did not have access to the modeling data used in the WRC analysis, and we do not fault them for that. One of the consulting firms who contributed to the FA analysis and subsequently helped develop the YAKRW modeling framework is now using YAKRW for further analysis commissioned by Reclamation. It is somewhat surprising that MG suggest continued reliance on old modeling assumptions when the authors themselves have moved on to more scientifically defensible data methods.

**Claim:** *"The irrigation districts involved are proposing to pay essentially full cost for KDRPP — minus only the small subsidy involved in using federal cost of funds rather than borrowing on the municipal bond market."*

**Response:** In testimony at the Washington State House Ways and Means Committee work session (Sandison et al. 2015, starting at about minute 44.20), another IPIC committee member stated that irrigators have included in draft legislation at the Federal level that they will pay their share of the construction, operation, maintenance costs, and interest, of the Kachess Drought Relief Pumping Plant (KDRPP) proportional to their share of the irrigation benefits, and that the WRC study failed to account for this fact. I will make several points about these claims.

First, no matter how the project costs are divided up among irrigation beneficiaries, these "fair shares" would still sum up to more than the benefits except under the most adverse climate and restrictive market conditions (WRC study, Table 29, page 107). Although *see* below: the higher KDRPP cost estimates always outweigh the out-of-stream benefits. Because federal water infrastructure investments have been required to satisfy a B-C test such that the benefits are larger than costs, the relevance of this draft legislation is questionable (Hahn and Sunstein 2002; US Water Resources Council 1983; Council on Environmental Quality 2014), because the project would not be eligible for federal funds. Needless to say, signed and binding service contracts with Reclamation would be more convincing.

Second, to the extent that funding is provided by the State of Washington and not the Federal government, it is likely to be funded at least in part under RCW 90.90, which does not require full or even partial cost recovery of water supply development (RCW 90.90.100 (6); <http://apps.leg.wa.gov/rcw/default.aspx?cite=90.90.100>). So, I am skeptical about the likelihood of full construction cost recovery without credible evidence of contractual commitment to full cost recovery by the Federal and/or State governments.

## Yakima Basin Plan Benefits/Costs

## Cost Estimate Developments

## Irrigators' Cost Share Implications

## Conservation Valuation

Third, construction, operation, maintenance costs, and interest, are not the full cost of these projects. For example, as noted in the WRC analysis (p. 107), the Draft Environmental Impact Statement (DEIS) for the Kachess Drought Relief Pumping Plant and the Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC) recognizes that property values around Kachess may be harmed (Reclamation 2015). A full accounting of costs would include these costs potentially imposed on Kachess property owners. I doubt these costs are being considered by the irrigation districts, but they should be if they are going to make claims of full cost repayment.

Fourth, the estimated costs in the KDRPP and KKC have been updated in the KDRPP/KKC DEIS, which was published very shortly before the WRC report was due. The WRC analysis relies on earlier engineering cost estimates for the proposed YBIP projects, but the new cost estimates are higher, and this has important implications for the B-C analysis. A B-C test is satisfied if the B/C ratio (benefits divided by costs) is 1 or larger, such that benefits are at least as large as the costs. The WRC analysis finds that KDRPP provides a B/C ratio of 1.27 (Table 29, p. 107) based on out-of-stream uses under the most restrictive market and climate conditions, if implemented alone without other YBIP water storage projects, and assuming the old KDRPP cost estimate of \$196 million. Under those same conditions, KDRPP combined with KKC provides a B/C ratio of 1.53 at an estimated cost of \$334 million. The new KDRPP cost estimates reported in the DEIS (alternatives 2A and 2B) are \$434.4 million and \$380.7 million, respectively — which are about double that of the earlier KDRPP estimates. Given these costs, the maximum B/C ratio provided for KDRPP alone is 0.65, which means KDRPP alone never satisfies a B-C test based on out-of-stream uses. KKC costs are also higher, at \$221.3 million to \$254.4 million for alternatives 3A and 3B. The consequence is that KDRPP+KKC now also fails to satisfy a B-C test under any market and climate conditions, with a maximum B-C ratio of 0.84 under the most adverse climate and restrictive market assumptions. It should be noted, as we do in the WRC report, that these B-C ratios do not include potential instream flow benefits, but the analysis and caveats that we provide about instream flow benefits in the WRC report still holds (e.g. p. 100-103). However, they also do not include the potential property value diminution that may be incurred due to these projects.

Finally, as noted by MG, I was asked at a Yakima River Basin Watershed Enhancement Workgroup meeting (the workgroup tasked with developing the YBIP, which includes the IPIC) if I would reassess the WRC results if irrigation districts paid the full cost of their projects. The Workgroup meeting minutes state that I said if the irrigation districts fully cover the costs of the water supply projects, this would indeed demonstrate that the benefits estimated in the WSU study indeed are too low (Reclamation 2014b). I am virtually certain this paraphrases and misconstrues what I said (note that there are no quotation marks in the meeting minutes), but my misrepresented response has now apparently become a talking point for YBIP proponents as a foundation to attempt to dismiss the WRC study.

Whatever my exact language, my response was an attempt to be forthright but diplomatic. As an applied, empirically-minded professional economist, intellectual honesty requires me to admit that if a person or group puts their money where their mouth is and actually pays the full cost for something, this is strong evidence that the benefits may outweigh the costs. However, my language was intended to convey doubt about the irrigation districts' claims about repayment rather than to indicate doubt in our results.

It remains true that if the irrigation districts really pays the full economic costs of these water infrastructure costs or even the share of the full economic costs equal to their share of the benefits, it would give me pause in light of my general professional experience as an economist that leads me to take actual investment seriously as an indicator of value. But this outcome seemed then to be unlikely, and even more so now. Even if irrigation districts did pay the full costs, assenting to reassessment does not imply fault in our report beyond what we already state as limitations of our study.

### WATER CONSERVATION

**Claim:** *“The WRC study found water conservation literally valueless, because it does not create ‘new water’ – the water in this fully appropriated basin is already claimed, including conserved water.”*

**Response:** This is a misstatement of our findings. We report B/C ratios as high as 0.16 for agricultural conservation based on out-of-stream uses (Table 36 on page 113), which means that we do not, literally, find them valueless. In addition, while we cannot effectively quantify instream flow benefits, we clearly state on page 113 that our reported benefits for agricultural conservation are underestimates in this regard.

Secondly, nowhere do we, nor would an economist, state that water conservation or any other movement of water within a system is “valueless, because it does not create ‘new water’.” Markets themselves move water from one use to another without “creating new water” and provide gains from trade, as we show extensively on the WRC analysis. Put another way, water reallocation by conservation practices or by water markets is not a “zero sum game” as has been suggested (Yakima River Basin Integrated Plan Implementation Committee 2014).

## Yakima Basin Plan Benefits/Costs

### Endangered Species Act Delisting Effects

### Recreation Benefits

### Flood Risk Costs

### Treaty Considerations

### Assessing Collaboration's Product

Thirdly, the other factor that we do not quantify is that the type of water reallocation that may result from the agricultural conservation activities proposed under the YBIP may impose costs on others. Indeed, the Kennewick Irrigation District submitted a comment to the WRC stating concern that the YBIP conservation activities may negatively affect the return flows that they rely on for irrigation. Unfortunately, as stated in the WRC, the hydrological model upon which we rely does not capture these potential effects below the Parker Gage, so we are unable to quantify these impacts.

#### UNQUANTIFIED BENEFITS

##### Delisting of Listed Salmonids due to YBIP Development

The WRC did not have the time or capacity to consider the net benefits of delisting steelhead and/or bull trout. This would indeed have economic consequences, but I am not so sure the net benefits “cannot be low” — as MG suggest. Delisting may likely reduce landowner habitat maintenance and offset requirements and associated costs. But reducing these requirements would presumably have negative consequences on further potential recovery to the extent that continuing these activities support abundance (unless they are worthless in the first place). These impacts should be accounted for in such an analysis. Further, delisting would reduce or eliminate federal support for restoration actions. There have been 349 habitat restoration projects since 1991, with expenses reported for 71 per cent of those totaling \$63 million, with a rapid increase in annual funding in the post-1999 period (Katz et al. 2007). For the five-year period from 2005-2009 the total expenses on habitat were \$33 million or \$6.6 million/year unadjusted for inflation (NOAA 2013). All of this represents capital inflows into the Yakima basin, which would largely disappear upon delisting. Further, to the extent that there is interspecies competition for resources in the basin, what impact would the reintroduction of so many sockeye to the basin have on steelhead abundance? I do not have answers to any of these questions, but the net result is less obvious to me than it apparently is to MG.

##### Recreation

MG imply that the WRC study does not account for increased recreation benefits due to the predicted increase in salmon abundances due to the YBIP. In fact, the fish valuation approach used in both the FA analysis and the WRC analysis captures these benefits in principle by estimating both use and non-use values for fish in an integrated way. While there are certainly weaknesses to this approach that we discuss in substantial detail (see Section 3 starting on p. 55 and Appendix Section f), the approach's breadth of scope — which includes recreation benefits among others — is its primary strength, not one of its weaknesses.

##### Ecosystem Services

As MG note, there are several aspects of these complex systems that neither the WRC analysis nor the FA analysis capture. In response to MG, a brief note on flood costs and the potential for YBIP flood benefits is worthwhile, with some very back-of-the-envelope calculations using what is probably incomplete data. Based on the Upper Yakima River Comprehensive Flood Hazard Management Plan (Otak, Inc. and KCM inc. 2007), reported flood damage from 1909 to 2003 sums to \$34.75 million, in nominal dollars, or \$369,741/year on average. Deflated by the CPI (base year = 2012), this amounts to an average of \$1.21 million/year in damage. The discounted net present value of an annuity over 100 years (assuming the same flood risk distribution) would be \$29.7 million. Thus, if the same flood regime and damage risk remains into the future, one would expect a net present value of \$29.7 million in losses without the YBIP (there are many caveats to the interpretation of this number). It is unclear how much the YBIP could reduce flood risk below the new dam configurations, in part because this would depend on dam operations in response to flood risk. However, it is likely that the YBIP would reduce only a fraction of this risk (such that flood risk is not zero if the YBIP is implemented). As such, any flood risk reduction benefits would be lower than \$29.7 million (probably substantially so). In relation to the out-of-stream use shortfalls above \$2 billion (WRC analysis, table 19), this is unlikely to make much of a difference.

##### Treaty Rights

MG claim that we do not quantify the value of the Yakima Nation's 1855 treaty rights. The fish valuation benefit estimates capture the value of improving fisheries, and so in principle would include the value of fish, and therefore exercise of treaty rights in relation to those fish. Again, however, the valuation methods used, while they are the best available for this specific case (a conclusion also arrived at by the FA analysis authors), do not address these treaty-related values explicitly or independently.

##### Getting Things Done

The development of a collaboration between groups who were in the past at odds with each other is indeed commendable, productive, and even inspirational to the extent that it has been inclusive and comprehensive (a point of contention in YRBWEP meeting public comments; Reclamation, 2014a). However, from the perspective of a B-C analysis, process leads to results — or at least a proposal — and in this case, the proposal is the YBIP. I do not discount the enthusiasm, satisfaction, and even spillover effects of participants in this process, but from the perspective of the legislative charge of the WRC, effectiveness of the collaboration is defined by the product of its efforts with respect to the YBIP, which the WRC was charged to assess in benefit/cost terms.

## Yakima Basin Plan Benefits/Costs

### Interdependency Recognition

### Conditionality

### Conditional Costs

### Synergy Accounting

### Conditional Analysis

#### Disaggregation

The YBIP is a set of projects designed to work together to address a number of issues interrelated through water in the basin (Garrity et al. 2015). YBIP proponents have argued that because of this interconnectedness, it is nonsensical and/or misleading to evaluate the individual component parts of the YBIP. Analogues to this claim have been made several times, and I will use some of them as a basis of response.

**Claim:** “A disaggregated analysis divides the plan into individual components and evaluates the efficacy of those components in isolation. That approach is contrary to the essence of integrated planning, which seeks to capture the synergy of a comprehensive [set, sic] interrelated set of projects and actions that are intended to operate in unison.” (Garrity et al. 2015).

**Response:** To the contrary, it is indeed logically supportable and possible to estimate the benefits of individual components of a system of projects such as the YBIP, in which the outcomes are interdependent. The key is to recognize that the benefits of any given project are dependent on whether or not other projects are implemented.

Benefits from fish passage projects in the basin are likely to be dependent to some degree on instream flows and habitat quality above and below the fish passage project. The benefits from one water storage project are likely to depend on which of the other storage projects are implemented. Accounting for this conditionality is logically equivalent to accounting for the interconnectedness in the system. Economists frequently apply this sort of analysis when modeling multi-input and multi-output production relationships.

Unfortunately, interdependence of project impacts means that there cannot be just one answer to the question: “what are the benefits of the Wymer Dam and Reservoir?” The value of the Wymer Dam depends on which other water storage projects are also built. The entire WRC analysis is built around accounting for this conditionality, thereby accounting for interconnectedness. For example, the Methods section of the WRC analysis begins with a discussion of how to address this interdependence (WRC analysis, p. 16-17). In the Executive Summary (p. ii-iv), we summarize a set of estimates that represent benefits of water storage projects implemented alone, and another set that represents the benefits when implemented as a part of the full YBIP implementation. These two sets of benefits are different from each other for each respective project precisely because the system is economically and physically integrated.

Thus, accounting for conditionality in our “disaggregated analysis” by definition means that the components are not being considered in isolation from each other in the WRC analysis. Instead, we are accounting for interdependencies that YBIP proponents contend lead to synergies, as the following quote suggests:

“This is clearly a case where the whole is greater than the sum of the parts, but we’re always going to have the challenge to explain that to people.”

(Prengaman 2013, quoting the Director of the Office of Columbia River, State of Washington Department of Ecology).

Interestingly, to make this claim requires the ability to assess both the parts, and the whole — a comparison that the first claim (above) against disaggregation suggests is inappropriate. And more interestingly, while this adage is often used, it is not always true. To illustrate, the WRC analysis estimates the value of water storage projects conditional on whether the other storage projects are implemented. Our results show that if all storage projects are implemented, each provides lower benefits than if any of them were to be implemented alone (*see* for example, Table 12). The last water storage project provides less insurance value per acre-foot of water it provides than does the first. In other words, one might instead say the whole is worth less than the sum of its parts.

Granted, using only the water storage projects to illustrate this point ignores the contribution that instream flows, fish habitat restoration, and fish passage contribute to the YBIP as a whole. So, where do these synergies lie? I illustrated above conceptually (and we discuss in the WRC report) that there may be physical and therefore economic synergies between instream flows, habitat conservation, and fish passage. To the extent that adding storage makes it easier (less costly) to provide instream flows, then there is an indirect synergy between storage and other fish-related investments, through instream flow augmentation. The problem is that: (a) WRC analysis results suggest that any synergies are not sufficient to support positive B/C ratios for the water storage projects; and (b) purchasing rights for instream flows would be less costly than YBIP water storage development if the market infrastructure were to develop to do so.

In summary, the claim that individual projects within an integrated system cannot be assessed simply does not hold up. Conditional analysis of outcomes from decisions about one of many interdependent projects can be done in an economically meaningful way, and is not contrary to understanding the contributions of individual components to an integrated system.



## Yakima Basin Plan Benefits/Costs

### Individual Project Contributions

This fact does not negate the concept of Integrated Water Resource Management processes and goals, and I recognize that benefit-cost analysis results are not the only factor that are or should be considered in policy decisions regarding complex economic-environmental systems. However, I am convinced that a clear understanding of the contributions of each project are knowable (or at least legitimately estimable), and are an important part of the body of information useful for such decisions. Indeed, in the context of political process, and even from an economic perspective, the question about what to do when B-C analysis does not support individual components of an integrated plan that might satisfy a B-C test as a whole is a legitimate problem, but it should be confronted head-on rather than by dismissing conditional contributions of each of the components (for pithy comment on this point, *see* Campana (2015) — “References” appear below).

In the last sentence of their article MG state that “A study that disaggregates YBIP actions can help refine future choices... .” I agree with them on this point; except why must we wait for the future?

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