

# Water Security for the Yakima River Basin's Economy, Communities, and Watersheds

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Prepared for:

Yakima River Basin Water Enhancement Project Workgroup  
Economic Subcommittee

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# 1 Executive Summary

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Current water supplies in the Yakima River Basin (YRB) cannot satisfy existing demands and limits future economic and community growth. Watersheds, and the aquatic, riparian, and terrestrial habitats and species they contain, also cannot thrive without reliable water supplies. Water conditions are expected to worsen in the future with the projected increasing frequency of droughts. In response, water users in the YRB developed a water management plan that will help improve water reliability for all water users and help protect the YRB's economy, communities, and watersheds.

## ECONOMY

Over 96,000 jobs—or approximately 40 percent of total YRB employment—depend directly on reliable water access.<sup>1</sup> This includes workers in the YRB's agricultural and food processing sectors, as well the manufacturing and commercial sectors. Total annual output from these firms is over \$13 billion.<sup>2</sup>

## COMMUNITIES

No new water rights are available to municipalities to satisfy current and future demand because water rights in the YRB are fully appropriated. Meeting current demands and supporting future growth and development of YRB's communities cannot happen without reliable water supplies. Future community growth will depend on a mix of new water storage, increased conservation, and water transfers from holders of existing senior water rights.

Members of the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) have lived in the YRB since time immemorial. Members have a spiritual, cultural, and economic connection with the YRB's water and fisheries resources.

Many of the recreational activities in the YRB involve water resources. The YRB's reservoirs, streams, and lakes are major draws. Rivers in the YRB have a national reputation for high quality fly fishing. Water is key to habitats that provide a variety of recreational wildlife viewing and hunting opportunities for waterfowl, upland birds, and big game. Total outdoor recreational expenditures in the YRB in 2015 exceeded \$1.2 billion and helped support over 14,000 job-years of employment.<sup>3</sup>

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<sup>1</sup> Ramboll Environ, 2017. *Economic Analysis of Water Infrastructure and Fisheries Habitat Restoration Needs*. Prepared for State of Washington Office of Financial Management. Project Number 3037630A. Olympia, WA. January 17. Table 8-5, page 196.

<sup>2</sup> Ramboll Environ, 2017. Table 8-5, page 196; U.S. Bureau of Labor Statistics (BLS), Consumer Price Index (CPI).

<sup>3</sup> Briceno, T., and Schundler, G. 2015. *Economic Analysis of Outdoor Recreation in Washington State*, Appendix F, County Economic Expenditures and Contribution Results for All Recreational Lands.

## WATERSHEDS

Salmon, steelhead, and other species support recreational and commercial harvests in the YRB, the Columbia River, and ocean catch. Water is a major factor for the YRB's aquatic and riparian critical habitats, which have high priority locally and statewide. The quantity and quality of ecosystem services from the YRB's fresh water, wetland, grassland, and forest habitats depend on water.

## Drought Vulnerability

The YRB's economy, communities, and watersheds are vulnerable to drought, and competing demands among water users reduces water security for all. The region is susceptible to drought because the population centers and agricultural production areas receive very little rainfall—approximately 10 inches annually. Furthermore, the five main reservoirs in the YRB capture relatively little of the runoff volume (see Chart 1 in Section 4).

Snowpack (known as the “sixth reservoir”) is critical because it provides up to one-half of the YRB's total water supplies.<sup>4</sup> A “snowpack drought” occurs when precipitation falls as rain rather than snow, and the diminished snowpack melts earlier in the year. The 2015 drought was such an event. Past droughts in the YRB caused hundreds of millions of dollars of economic losses.

The YRB's current water deficit will worsen in the future with the projected increasing frequency of drought. Water users need a water management plan that will improve water reliability under these conditions.

## Integrated Plan

Since 2009, the Washington Department of Ecology (Ecology) and U.S. Bureau of Reclamation (Reclamation) have collaborated with the Yakama Nation and other stakeholders to formulate a comprehensive strategy to address the YRB's critical water resource needs. This collaboration focused on expanding the work of the 1979 Federal Yakima River Basin Water Enhancement Project (YRBWEP) and the 1994 Congressional Amendment that created Phase 2 of YRBWEP to improve water reliability for irrigators and municipalities, instream flows for fish, and other conservation measures. The strategy took shape in mid-2011, when a unique collaboration of stakeholders, the YRBWEP Workgroup, reached consensus for a comprehensive solution to the basin's water problems. This led Ecology and Reclamation to develop the *Yakima River Basin Water Resource Management Plan* (Integrated Plan).

The Integrated Plan is a comprehensive and forward-thinking plan that addresses current and anticipated threats to the YRB's water security. The combination of projects in the Integrated Plan address multiple objectives including: reduced water

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<sup>4</sup> Pihl, K. 2014. “Snow shortage worries Yakima River water users,” *Tri-City Herald*. February 16. <http://www.tri-cityherald.com/news/business/article32167212.html>.

insecurity and enhanced water supply, especially during drought years; improved instream flows; improved fish habitats; and improved access to upstream fish habitat currently blocked by dams.

This report highlights these various objectives and the potential outcomes of the projects described in the Integrated Plan. The Yakima River Basin Water Enhancement Project (YRBWEP) Workgroup's Economic Subcommittee commissioned this report, which will analyze the economic importance of the Integrated Plan.

## **The Integrated Plan's Economic Benefits**

From an economic perspective, the Integrated Plan makes sense as the benefits exceed costs. Every dollar spent on the Plan produces benefits of \$1.40 to \$3.20.<sup>5</sup> The total cost of the Plan over 30 years compares favorably with a number of measures of economic output it will support. For example, the cost of the Integrated Plan over 30 years is approximately equivalent to the value of one year of the YRB's agricultural production and food processing output.<sup>6</sup> Looking beyond agriculture to include other water-dependent manufacturing and commercial sectors, the annual economic output of these sectors is approximately two-and-one-half times the 30-year cost of the Integrated Plan.<sup>7</sup> In addition to providing direct economic benefits, the Integrated Plan will also help avoid drought-related economic losses in the YRB's agricultural sector of approximately \$400 million per severe drought year.<sup>8</sup> Losses in YRB's agricultural sector ripple through the YRB and the state's economies causing losses in other sectors of approximately \$830 million in economic output, \$218 million in personal income, and 10,800 job-years of employment.<sup>9</sup>

Construction projects in the Integrated Plan will generate over \$2.5 billion in economic output, \$1.4 billion in personal income, and support 27,000 job-years of employment in the YRB and an additional 15,000 job-years of work elsewhere in Washington.<sup>10</sup> The Yakama Nation, federal and state agencies, private land owners, and nonprofits have invested millions of dollars in restoring and protecting aquatic and riparian habitats in efforts to increase anadromous fish populations. These efforts have had a positive effect, fish populations are on the rise, and the Integrated Plan projects will help protect these investments.

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<sup>5</sup> U.S. Bureau of Reclamation. 2012b. Figure 2, page 7.

<sup>6</sup> Yakima Basin crop and livestock production has a market value and food processing gross sales of \$4.481 billion (Washington Department of Agriculture. *Agriculture—A Cornerstone of Washington's Economy*). Estimated cost of the Integrated Plan \$2.81 to \$4.85 billion (Reclamation & Ecology, 2012b. Table 2, page 7).

<sup>7</sup> Ramboll Environ, 2017. Table 8-5, page 196; BLS CPI.

<sup>8</sup> Ramboll Environ, 2017. Table 25, page 74. Unless otherwise stated, all dollars in this report are in 2016 dollars.

<sup>9</sup> Ramboll Environ, 2017. Table 24, page 73; BLS CPI.

<sup>10</sup> Ramboll Environ, 2017. Table 10, page 32; BLS CPI.

Municipalities will benefit from more water security and will save over \$400 million by not having to buy expensive senior water rights in drought years.<sup>11</sup> Integrated Plan projects that promote and protect water supply, water quality, and water-related natural habitats, will also help protect the basin's natural resource-based recreational and tourism assets, and the basin's billion-dollar recreational economy.<sup>12</sup> These projects will also help protect and restore the riparian and related habitat ecosystem services and their associated economic values, which can range up to \$15 billion.<sup>13</sup>

## Integrated Plan Benefits Extend Beyond the Yakima Basin

The YRB is regionally and nationally significant in a number of areas that will benefit from the Integrated Plan. For example, apples are the highest valued agricultural product from Washington State and producers in the YRB lead the state and the nation in apple production.<sup>14</sup> Milk is second only to apples in value of agricultural production from Washington. Yakima County leads the state in milk production and ranks seventh nationally.<sup>15</sup> The YRB leads the state, the nation—and the world—in hops production.<sup>16</sup> Across the country, sales of organic foods are growing at twice the rate of all food sales.<sup>17</sup> Approximately 80 percent of Washington's organically produced food comes from the east side of the Cascades.<sup>18</sup> With eighty-eight certified organic farms, Yakima County ranks second in the state only to Grant County, which has 90.<sup>19</sup>

Projects in the Integrated Plan that benefit agricultural production will also benefit firms in the transportation sector that move goods from the YRB to overseas markets. Crop production and food manufacturing accounts for approximately 75 percent of the over \$1.8 billion in export value from the YRB in 2015. These goods travel all over the world (see Map 2 in Section 6). These exports support jobs and economic activities in the region's transportation sector including for Columbia River rail and barge transport to Puget Sound ports.

Salmon and steelhead that originate in the YRB travel downstream through the Columbia River Basin and into the Pacific Ocean. The increased fish populations

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<sup>11</sup> Ramboll Environ, 2017. Page 50-53; BLS CPI.

<sup>12</sup> Briceno and Schundler 2015; Recreation.gov.

<sup>13</sup> Malloch, S. and M. Garrity. 2012. "Yakima River Basin Integrated Water Plan." *The Water Report*. Issue #106. December 15.

<sup>14</sup> US Department of Agriculture. No date. *2012 Census of Agriculture, County Profile Yakima County*. [www.agcensus.usda.gov](http://www.agcensus.usda.gov).

<sup>15</sup> Washington Farm Bureau. No date. *Agriculture's Contribution to Washington's Economy*. <http://wsfb.com/agricultures-contribution-to-washingtons-economy/>.

<sup>16</sup> Glover, J. 2016. "Washington Tops in Hops," *The Spokesman-Review*. November 25. <http://www.spokesman.com/stories/2016/nov/25/washington-tops-in-hops/#/0>.

<sup>17</sup> Turrell, B. 2016. "Local Farmers and the Organic Revolution." *Yakima Herald Magazine*. November 6.

<sup>18</sup> Turrell, B. 2016.

<sup>19</sup> Kriby, E. and D. Granatstein. No date. *Current Status of Certified Organic Agriculture in Washington State: 2015*. December. Washington State University.



supported by the Integrated Plan will help increase Tribal, commercial, and recreational harvests throughout this area, and fishery-related incomes and jobs.

The Integrated Plan addresses concerns shared by many in regions throughout the arid West—reducing water insecurity in times of declining water supply and increasing demand. Many outside the YRB acknowledge the Integrated Plan as a case study for finding common ground on water management and other, oftentimes contentious, natural resource issues.<sup>20</sup>

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<sup>20</sup> Muir, P. 2016. "Yakima Basin water plan cited as a model for others to follow," *Yakima Herald*. March 22. <http://www.yakimaherald.com/news/local/>.

## 2 Introduction

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Water influences almost all aspects of the YRB's economy, communities, and watersheds. The YRB's water-dependent economic sectors account for approximately 40 percent of this area's total employment.<sup>21</sup> YRB's population is growing about 1.1 percent each year, and municipalities depend on reliable domestic water supplies to support growing communities.<sup>22</sup> Water also protects areas designated under the Endangered Species Act as critical habitats, which are a high priority locally and statewide. Adequate streamflows support salmon and steelhead runs, which are especially important cultural resources to members of the Yakama Nation, and contribute to the YRB's vibrant economy and quality of life via recreation and tourism. Moreover, the quantity and quality of ecosystem services from freshwater wetlands, grasslands, and forest habitats depend on water.

Water shortages have become a problem in the YRB during drought years, which are occurring more often and cause disputes and entanglements among water users. These water insecurities, along with the severe reductions or elimination of major salmon and steelhead runs, create an imperative need for improved water and aquatic resources in the YRB.

The State of Washington (State), Reclamation, and other water managers and users wrestled with solving water problems throughout the YRB for years. The State and Reclamation studied and evaluated several proposals for more water storage along with conservation measures, but until recently, they were not proven economically justified and did not adequately address the YRB's water demands.

In 2011, Reclamation and Ecology, with the unprecedented collaboration and contributions of the YRBWEP Workgroup, released a comprehensive solution to the YRB's water problems with the Integrated Plan.

The Integrated Plan is designed to achieve water reliability, especially in drought years by implementing a range of projects including the following:

- Increase reservoir storage capacity to capture early season excess flows, thereby providing additional water later in the year for instream flows, irrigated agriculture, and municipal use.
- Increase groundwater storage projects to provide water for municipalities and other water users.
- Greater instream flows, combined with habitat and wetland enhancement and protection, and fish passage at Reclamation's five major reservoirs will benefit

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<sup>21</sup> Ramboll Environ, 2017; Rosaen, A, 2014.

<sup>22</sup> See Table A-9.

anadromous fish populations and associated Tribal, commercial, and recreational harvests.

- Projects that support water banking and trades will facilitate water allocations from willing sellers to willing buyers, including irrigators and municipalities.

Since 2013, the Washington State Legislature approved more than \$160 million to begin some of the water infrastructure and related projects. The State also pledged to cover half of the approximately \$3.4 billion total cost of implementing the Integrated Plan over the next 30 years.<sup>23</sup> The YRBWEP Workgroup continues providing input and guidance on proposed projects. The YRBWEP Workgroup's Economic Subcommittee commissioned this study to analyze the economic importance of the Integrated Plan.

In Section 3, we describe the significance of water to YRB's economy, municipalities, and watersheds. In Section 4, we describe the economic toll that droughts take on the YRB. Section 5 includes data that shows the economic benefits of the Integrated Plan to the YRB, and Section 6 shows how some of the economic benefits extend beyond the YRB and Washington State.

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<sup>23</sup> The Office of Columbia River. 2016. *Implementation Status Report for The Yakima River Basin Integrated Water Resource Management Plan*. Washington Department of Ecology. Publication Number: 16-12-002. July. Page 2. Retrieved from: <https://fortress.wa.gov/ecy/publications/SummaryPages/1612002.html>.

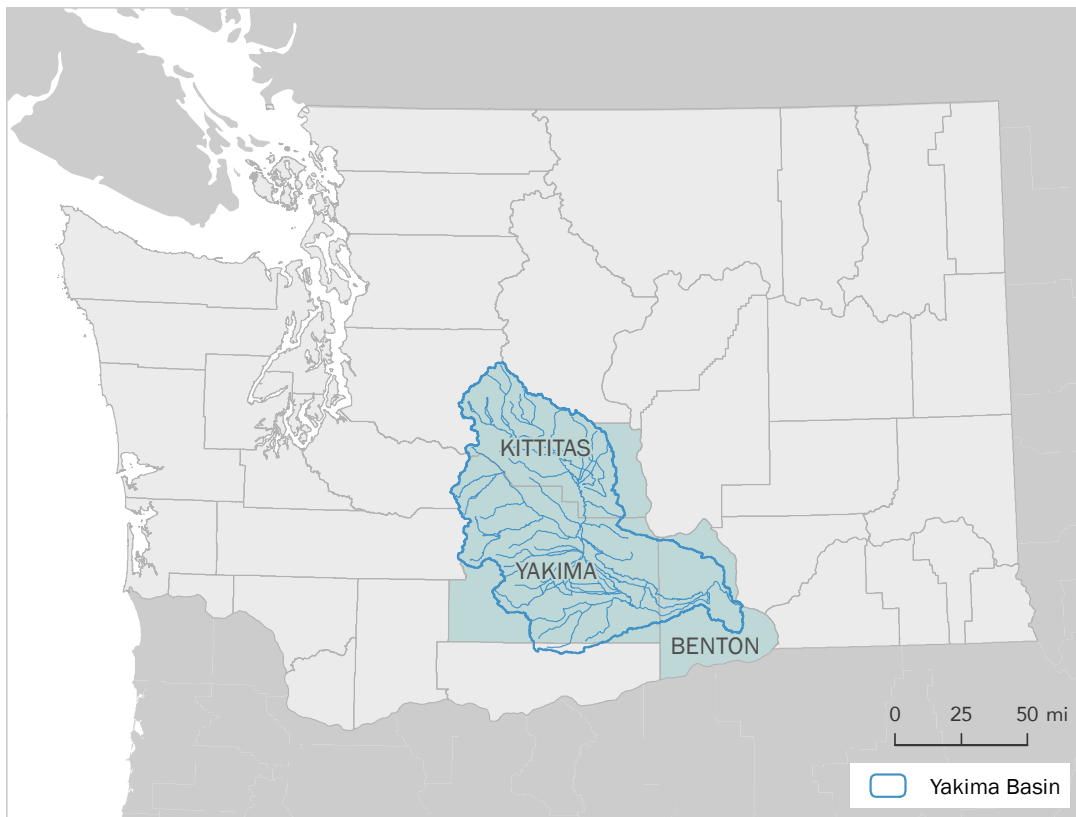
### 3 Water and the Yakima Basin

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The YRB contains the counties of Yakima, Kittitas, and Benton (see Map 1 below). Continued growth and development of the YRB's communities could not occur without reliable water supplies. The reliable availability of water to irrigators, water-dependent firms and business, recreation and tourism drives the YRB's economy. Healthy streamflows and riparian habitats support fish species that have spiritual and cultural significance for members of the Yakama Nation. Salmon, steelhead, and other species support recreational and commercial harvests not only in the YRB, but also throughout the Columbia River Basin and into the Puget Sound and the ocean catch. Many recreational activities, such as wildlife viewing and hunting for waterfowl, upland birds, and big game involve water resources. The quantity and quality of ecosystem services from freshwater wetlands, grasslands, and forest habitats depend on water and support the quality of life in this region.

In this section, we describe the characteristics of the YRB's economy, communities, and watersheds that depend on reliable water supplies.

**Map 1: Yakima River Basin Counties in Study**



Source: ECONorthwest

## A Diverse and Productive Agricultural Economy

Water provides the YRB's agricultural producers with a unique competitiveness that yields regional, state, and national benefits. The YRB has the largest agricultural economy in Washington State and is one of the most agriculturally diverse and productive regions in the United States.<sup>24</sup> The following confluence of factors provides the region with competitive advantages:

- Deep, fertile soils
- Optimal growing seasons
- Ample supply of affordable land relative to other growing regions
- Low humidity during growing seasons and freezing temperature in winter that help minimize pest and disease infestations

Producers in the YRB export approximately \$1.8 billion in goods through the ports of Seattle and Tacoma annually. Agricultural production and food manufacturing account for approximately 75 percent of this value.<sup>25</sup> Supplying inputs to the agricultural sector and exporting agricultural goods from the YRB employs workers and supports firms throughout Washington State and the rest of the United States. Examples of how the region's agricultural production benefits firms and workers in other areas include the following:

- Every dollar of economic output from the agricultural and food processing sector (AFPS) yields \$0.82 of economic output in the rest of the state.<sup>26</sup>
- Every job in the AFPS supports 0.71 jobs in the rest of the state.<sup>27</sup>
- Every dollar of labor income in the AFPS supports \$1.16 in labor income in the rest of the state.<sup>28</sup>
- Every dollar of labor income from apple production supports \$0.72 of labor income in the rest of the state.<sup>29</sup>
- Every dollar of economic output from apple production supports \$0.53 in the rest of the state.<sup>30</sup>
- Every job in the dairy industry supports an additional 1.4 jobs in the rest of the state.<sup>31</sup>

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<sup>24</sup> Ramboll Environ, 2017.

<sup>25</sup> U.S. Department of Commerce. International Trade Administration.

<sup>26</sup> Community Attributes, Inc. (CAI). 2015. *Washington State Agriculture & Food Processing Economic/Fiscal Impact Study*. Ex. 5.7, page 78. January.

<sup>27</sup> CAI, 2015.

<sup>28</sup> CAI, 2015.

<sup>29</sup> Bunting, D., D/P. Jones, and M. Wagner. 2011. *The Economic Impact of Washington Tree Fruit Industry*. Eastern Washington University, Institute for Public Policy & Economic Analysis. Table 11.2, page 62. October.

<sup>30</sup> Bunting, Jones and Wagner, 2011.

- Every dollar of direct labor income paid in the dairy industry supports an additional \$3.08 of labor income in other sectors of Washington’s economy.<sup>32</sup>
- Exporting agricultural goods from the Yakima Basin supports jobs and income in the state’s transportation sector including at Puget Sound ports.<sup>33</sup>

## Food Production and Processing Firms

In addition to irrigated agriculture and related food processing, a significant portion of manufacturing and commercial firms rely on the YRB’s water supplies and employ thousands of residents.

In 2016, all firms in the YRB employed approximately 220,000 workers. Agricultural production and processing firms directly employed 28,600, or 13 percent of these workers. Purchases by these firms supported an additional 15,700 workers at other firms in the YRB, bringing the total impact on the workforce to 44,300 workers, or 20 percent of the total workforce (see Table A-1).

- Yakima County is No. 1 in Washington State *and* in the country for the production of apples and hops.<sup>34</sup>
- Benton County is No. 1 in Washington State for the production of grapes.<sup>35</sup>
- With more than 90 dairies and 110,000 cows, the YRB is one of the largest dairy-producing regions in the country.<sup>36</sup>
- The Yakima Valley American Viticulture Area is the oldest and largest in the state. The YRB’s 12,000 acres of vineyards produce more than one-third of the state’s grapes, and juice from these grapes are a part of more than half of all wine produced in Washington.<sup>37</sup>

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<sup>31</sup> Neiberghs, J.S. and M. Brady. 2013. *2011 Economic Contribution Analysis of Washington Dairy Farms and Dairy Processing: An Input-Output Analysis*. Washington State University Extension. Farm Business Management Report. Page ii. May.

<sup>32</sup> Neiberghs and Brady, 2011.

<sup>33</sup> Sandison, D. 2015. *Written Testimony Submitted to the United States Senate Committee on Energy and Natural Resources On S. 1694 Yakima River Basin Water Enhancement Project Phase III Act of 2015*. July 7.

<sup>34</sup> U.S. Department of Agriculture. No Date. *2012 Census of Agriculture. County Profiles*. [www.agcensus.usda.gov](http://www.agcensus.usda.gov).

<sup>35</sup> U.S. Department of Agriculture, No Date.

<sup>36</sup> Washington State Dairy Federation. No Date. *Facts About Washington’s Dairy Industry*. [wastatedairy.com/category/dairy-facts/pages/2/](http://wastatedairy.com/category/dairy-facts/pages/2/).

<sup>37</sup> American Viticultural Areas are wine growing regions with distinct climate, soil, elevation and physical features. Washington State Wine. No Date. *Regions & AVAs of Washington*. <http://www.washingtonwine.org/wine/facts-and-stats/regions-and-ava>; Wine Yakima Valley. No Date. *Yakima Valley Wine County An Overview of Washington’s Premier Wine Country*.

## Water-Dependent Employment

A recent study for the State of Washington's Office of Financial Management reports that water-dependent firms and business in the YRB (including agricultural production and processing) employ over 96,000 workers, or approximately 40 percent of the YRB's total workforce (see Table A-2, Table A-3, and Table A-4). This percentage is double the statewide average of water-dependent employment at 20 percent, and two-and-a-half times the national average of 16 percent. The annual economic output from water-dependent firms in the YRB is over \$13 billion.<sup>38</sup> These figures underestimate the total impact of water on the YRB's economy, because they do not include those indirectly employed by the water-dependent firms such as those in landscape and horticultural services, apparel and textile production, chemical manufacturing, and accommodations.

Out of the eight river basins in Washington State, the YRB ranks third in the percentage of water-dependent employment. Only the Upper Columbia River Basin, at 43 percent, and Middle Columbia River Basin, at 42 percent, has a higher percentage of water-dependent employment.<sup>39</sup> For regions with higher percentages of water-dependent employment, projects such as the Integrated Plan that strengthen water-dependent sectors would benefit a larger portion of an economy than in regions with a lower water-dependent share.<sup>40</sup>

## The Yakama Nation

Members of the Yakama Nation have lived in the YRB since time immemorial.<sup>41</sup> Under the Treaty of 1855, members of the Yakama Nation have the right to fish, hunt, gather, and other rights "at all usual and accustomed places."<sup>42</sup> The Yakama Nation's reservation is located in the southwest portion of the YRB and occupies approximately 23 percent of the YRB's land area.<sup>43</sup> The Yakama Nation manages over 1.1 million acres, including 600,000 timber acres. The Tribe also irrigates 90,000 acres in the Wapato Project.<sup>44</sup>

Members of the Yakama Nation have a spiritual, cultural, and economic connection with the YRB's water and fisheries resources.<sup>45</sup> In years past, the YRB had the second

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<sup>38</sup> Ramboll Environ, 2017; Rosaen, Table 2, page 10. 2014.

<sup>39</sup> Ramboll Environ, 2017, Table 8-11, page 201.

<sup>40</sup> Ramboll Environ, 2017, page 201.

<sup>41</sup> Yakama Nation. Yakama Nation History. <http://www.yakamanation-nsn.gov/history.php>.

<sup>42</sup> [yakamafish-nsn.gov/harvest](http://yakamafish-nsn.gov/harvest).

<sup>43</sup> U.S. Bureau of Reclamation (BoR) and Washington Department of Ecology (BoR Reclamation & Ecology). 2012a. Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement. March. Page 1-14.

<sup>44</sup> NPAIHB. Yakama Indian Nation. <http://www.npaihb.org/member-tribes/yakama-indian-nation/#1462218325145-e95360ba-7db6>.

<sup>45</sup> Yakama Nation. Yakama Nation History. <http://www.yakamanation-nsn.gov/history.php>.

largest salmon and steelhead runs in the Columbia River Basin.<sup>46</sup> Historical salmon runs ranged from 300,000 to 950,000 fish per year in the late 1800s.<sup>47</sup>

Over time, a variety of factors contributed to fish population decline and extirpation including dam construction; degradation of riparian habitats and vegetation; reduced stream flows; urbanization and increased areas of impervious surface; and floodplain development.<sup>48</sup> By the 1970s and 1980s, all native salmon species were either extirpated or barely surviving, and fish populations were reduced to approximately 1 percent of historical populations. Even though Tribal treaty rights protected the Yakama Nation's access to fish resources, fish were all but gone.<sup>49</sup>

Started in 1983, the Yakama Nation Fisheries program employs 200 people and focuses on restoring habitats and fish species culturally significant to Tribal members including Chinook, sockeye, steelhead, Coho, Pacific lamprey, and white sturgeon.<sup>50</sup> The Tribal fisheries program combines sound science with traditional ecological knowledge to restore habitat and develop hatchery and species reintroduction projects that help restore culturally significant fish populations to sustainable and harvestable levels.

The Yakama Nation collaborates with other Tribal, federal, state, and regional governments to protect and improve fish habitats and increase populations in the Columbia and Yakima River Basins. Their partnering efforts include the following:<sup>51</sup>

- Forming the Columbia River Intertribal Fish Commission in 1977 with the Warm Springs, Umatilla, and Nez Perce Tribes.
- Joining with counties and the Colville Tribes to form the Upper Columbia Salmon Recovery Board in the 1990s.
- Signing the Columbia Basin Fish Accords in 2008 with the Bonneville Power Administration and other federal partners.

The Yakama Nation reintroduced Coho salmon beginning in the 1980s, using hatchery fish. The Yakama Nation and the Washington Department of Fish and Wildlife began reintroducing sockeye in the Cle Elum Reservoir in 2009, and recently began reintroducing summer Chinook.<sup>52</sup> These programs are having an effect. Recent successes include the following:<sup>53</sup>

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<sup>46</sup> The Office of Columbia River, 2016.

<sup>47</sup> Inslee, J. 2013. *Yakima River Basin: Water Jobs and Fish*. 2013 Policy Brief. January.

<sup>48</sup> Reclamation & Ecology, 2012b; Yakima Nation Fisheries. No date. *Status and Trends Project Annual Progress Report Columbia River Fish Accord Focus 2008-2016*.

<sup>49</sup> Malloch, S. and M. Garrity. 2012. "Yakima River Basin Integrated Water Plan." *The Water Report*. Issue #106. December 15.

<sup>50</sup> Yakama Nation, No date.

<sup>51</sup> yakamafish-nsn.gov/protect/partnerships.

<sup>52</sup> BoR & Ecology, 2012a.

<sup>53</sup> Yakama Nation. *Yakama Nation Fisheries Status and Trends Project*.



- Fall Chinook escapement above Prosser Dam in 2014 and 2015 were the highest on recent record.
- Populations of fall Chinook are at levels that support Tribal, Columbia River, and ocean harvests.
- Coho returns in 2014 were the highest on recent record.

The Yakama Nation Wildlife program focuses on restoring floodplain habitats along anadromous fish-bearing streams that traverse the reservation's agricultural lands. Goals of the program include protecting, restoring, and managing 27,000 acres of floodplain lands along the Yakima River and the Satus and Toppenish Creeks.<sup>54</sup>

## Salmon and Steelhead Restoration Needs

In addition to restoration projects described above, conservation efforts by private and non-profit entities including the Cascade Conservation Partnership, the Mountains to Sound Greenway Trust, the Cascade Land Conservancy, Washington Water Trust, and the Washington Water Project of Trout Unlimited have benefited fish populations. These efforts include purchasing lands for habitat protection and purchasing water rights to increase instream flows.<sup>55</sup>

Despite recent improvements in fish populations, the YRB has a large unmet need for fish-related streamflow and habitat investments. Since 2011, approximately \$10 million has been spent in the YRB on fisheries and habitat restoration. This amount falls far short of the estimated cost to complete planned or needed fisheries and habitat restoration projects. This estimate (for the combined Yakima and Middle Columbia River Basins<sup>56</sup>) is more than \$500 million over the next 20 years, with the large majority of these projects in the YRB.<sup>57</sup> The streamflow, habitat, and fish-passage projects in the Integrated Plan will address some of this unmet need. These projects will also help protect past fish restoration and population investments by the Yakama Nation, state and federal agencies, private and non-profit conservation groups, and private landowners.

## Recreation

Lakes, reservoirs, rivers, wetlands, and forests in the YRB provide public and private recreation destinations that support a wide range of outdoor activities. A large

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<sup>54</sup> Yakama Nation. Yakama Wildlife, Range & Vegetation Resources Management Program. <https://www.ynwildlife.org/>.

<sup>55</sup> BoR & Ecology, 2012a.

<sup>56</sup> The available data do not allow disaggregating recommended expenditures by basin.

<sup>57</sup> Ramboll Environ, 2017, page 167.

majority of recreation visitors come from outside the region, bringing recreation and tourism dollars into the basin's economy.<sup>58</sup>

Many recreational activities involve water resources, and the reservoirs, streams, and lakes are a major draw. As described in a recent Reclamation report,

"... [recreation] surveys indicate the number one preferred recreation setting is water oriented. Public demand for access to rivers, streams, and reservoirs continues to increase yearly. .... Recreationists are attracted to the [Yakima River] basin by the quality of the scenery, water, and recreation opportunities."<sup>59</sup>

Rivers in the YRB have a national reputation for high quality fly-fishing. According to Reclamation, fly-fishing is one of the fastest growing recreation activities on the Yakima River, which is known as the place to "Chase Rainbows." The Yakima River is Washington's only "blue ribbon" trout fishery.<sup>60</sup> Kittitas County is developing a system of water trails that will provide day-use and overnight access for kayak, canoe, floats, and other hand-carry watercrafts.<sup>61</sup> In general, the demand for water-based recreational activities is expected to increase at a rate faster than the rate of population increase through the year 2050.<sup>62</sup>

In addition to water-based recreation, other activities popular in the YRB include camping, hiking, picnicking, mountain biking, horseback riding, and wildlife viewing. During summer weekends, picnic sites and campgrounds are near or exceed capacity, and exceed capacity on holiday weekends. The YRB has a reputation as a destination for motorized recreation including trailbikes, all-terrain vehicles, jeeps, and snowmobiles. The Suncadia resort development located along the Cle Elum River includes plans for 3,000 residential units and three golf courses.<sup>63</sup>

The YRB's diverse water, grassland, and upland forest habitats provide a variety of recreational opportunities for wildlife viewing and hunting for waterfowl, upland birds (e.g., pheasant and quail), and big game (elk and deer). The YRB provides the best elk hunting in the state. The Yakima elk herd is one of the largest in the state at over 11,000 animals. The Colockum herd has an additional 5,000 elk. Yakima County ranks first in the state for quail harvests, second for dove, third for duck and chukar, fourth for pheasant, and fifth for goose. Washington Department of Fish and Wildlife

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<sup>58</sup> See Table A-5; Recreation.gov; Kittitas County. No date. *Kittitas County, Washington Park, Recreation & Open Space Plan*.

<sup>59</sup> U.S. Bureau of Reclamation and Aukerman and Haas Associates. 2007. *Recreation Demand and User Preference Analysis, Yakima River Basin Water Storage Feasibility Study, Washington Pacific Northwest Region*. Bureau of Reclamation Technical Series No. TS-YSS-10. February.

<sup>60</sup> Reclamation, Aukerman and Haas, 2007, page 41.

<sup>61</sup> Kittitas County. No date. *Kittitas County, Washington Park, Recreation & Open Space (PROS) Plan*.

<sup>62</sup> Reclamation, Aukerman and Haas Associates, 2007.

<sup>63</sup> Reclamation, Aukerman and Haas Associates, 2007.

Region 8, which includes Yakima and Kittitas counties, contains over 70 percent of the state's bighorn sheep.<sup>64</sup>

The YRB's water and other recreational resources draw visitors from other areas. For example, visitors from the Puget Sound accounted for approximately 63 percent of campground reservations in 2015 (see Table A-5),<sup>65</sup> and 51 percent of tourists visiting Kittitas County live on the west side of the state.<sup>66</sup>

Spending by recreational visitors from outside the region brings revenues into the YRB's economy that helps support local businesses. Total outdoor recreational expenditures in the YRB in 2015 exceeded \$1.2 billion and helped support over 14,000 job-years of employment.<sup>67</sup> Spending specific to recreation on public waters exceeded \$280 million in 2015 (see Table A-7).<sup>68</sup> A Reclamation analysis notes the economic importance of recreation demands,

“Accommodating and satisfying the State's demand for outdoor recreation activities within the Yakima River basin is an important factor in the region's overall economy.”<sup>69</sup>

General tourism expenditures in the YRB also measure in the hundreds of millions of dollars. In 2014, tourists spent over \$870 million, supported approximately 9,500 workers, and provided over \$80 million in local and state tax revenues (see Table A-8).<sup>70</sup> Given the probability of overlap between outdoor recreation and general tourism spending, we do not sum these categories of spending impacts.

The projects in the Integrated Plan that promote and protect water supply and quality, and water-related natural habitats, such as riparian areas and adjacent forestlands, will also help protect the YRB's natural resource-based recreational assets.

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<sup>64</sup> Bernatowicz, J. 2016. *District 8 Hunting Prospects Yakima and Kittitas Counties*. Washington Department of Fish and Wildlife; Fidorra, J. 2016. *District 4 Hunting Prospects Benton and Franklin Counties*. Washington Department of Fish and Wildlife.

<sup>65</sup> Recreation.gov.

<sup>66</sup> Kittitas County. No date. *Kittitas County, Washington Park, Recreation & Open Space (PROS) Plan*.

<sup>67</sup> Briceno and Schundler, 2015.

<sup>68</sup> Briceno and Schundler, 2015.

<sup>69</sup> Reclamation, Aukerman and Haas Associates, 2007, page 40.

<sup>70</sup> Dean Runyan Associates. 2015. *Washington State County Travel Impacts & Visitor Volume 1991-2014p*. April. Prepared for Washington Tourism Alliance.

## Ecosystem Services

Ecosystem services are generally defined as the benefits that people receive from ecosystems.<sup>71</sup> These services include a mix of goods or products, such as lumber from trees, and berries and fish harvested for food. Ecosystem services also include natural processes that benefit humans including water filtration, air purification, pollination, and habitat provision for fish and terrestrial species. Economists value some of these products and processes using market prices (e.g., price per thousand board feet of timber) and derive values for the products and processes not traded in markets using a range of analytical methods.<sup>72</sup>

The Yakima River, its tributaries, and the YRB's diverse landscapes, ranging from high elevation, high rainfall alpine forests to the dry shrub-steppe vegetation of the arid lowlands, provide a range of ecosystem services.<sup>73</sup> We found no studies that estimated the values of ecosystem services for the YRB. Such estimates exist for ecosystem-service values for the Columbia River Basin, which includes the YRB. We estimated the values for ecosystem services in the YRB based on its percentage of the Columbia River Basin land area. We stress that our calculated values for the YRB are estimates. Readers should consider them as information on the *economic significance* of these ecosystem services rather than as *precise values*. We expect that even though the supply of all ecosystem services in the YRB are not proportional to land area relative to the Columbia River Basin, the low-high range of ecosystem values reported for the larger basin captures some of this variability.

The YRB accounts for approximately 2.4 percent of the Columbia River Basin's land area.<sup>74</sup> We adjust the values reported for the entire Columbia River Basin by this percent.<sup>75</sup> Using this method we estimate the annual value of ecosystem services provided by YRB's freshwater, wetlands, grasslands, and forests ranges from \$350 million to \$15.179 billion.<sup>76</sup>

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<sup>71</sup> Millennium Ecosystem Assessment. 2005. *Millennium Ecosystem Assessment*. Washington, D.C.: Island Press; Cotter, A., and S. Sihota. No date. *Valuing Ecosystem Goods and Services in the Columbia River Basin*. Adaptation to Climate Change Team, School of Public Policy, Simon Fraser University.

<sup>72</sup> See Cotter and Sihota (no date) for information on these analytical methods.

<sup>73</sup> Simmons-Rigdon, 2012.

<sup>74</sup> Cotter and Sihota, no date; BoR & Ecology, 2012a.

<sup>75</sup> The Columbia Basin report lists values in 2013 Canadian dollars. We first converted from Canadian to US dollars using the 2013 currency conversion rate (The Organization for Economic Co-operation and Development. 2017. Exchange Rates, <https://data.oecd.org/conversion/exchange-rates.htm>) then inflated to 2016 dollars using the U.S. Bureau of Labor Statistics' Consumer Price Index Inflation Calculator. (<https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1&year1=2013&year2=2016>). We then multiplied the total low and high values for ecosystem services in the Columbia Basin by 2.4 percent.

<sup>76</sup> These figures include economic values reported elsewhere in this report for recreation and fisheries. That is, these values for ecosystem services are inclusive of fisheries and recreation values and should not be added to these values. The analysis in the source we cite for the values of ecosystem services relied on a

The habitat restoration, instream flow, and water quality projects in the Integrated Plan will help protect and restore the YRB's riparian and related habitat ecosystem services and their associated economic values.

## Municipalities

Municipalities in the YRB rely on water supplied from a mix of water rights and sources. Some receive water through original or purchased senior water rights, while most rely on junior water rights or leased-senior water rights that are less secure. No new water rights are available to municipalities to satisfy current and future demand because water rights in the YRB are fully appropriated.<sup>77</sup> Complicating supply conditions for some municipalities is the recent understanding of the hydraulic connectivity between surface and groundwater. Taken together, these conditions mean that municipalities can only access new groundwater resources by mitigating their use by purchasing or leasing additional senior surface-water rights or through a water banking and transfer transaction.<sup>78</sup>

Purchased senior water rights would divert water from irrigated agriculture to municipal use. Reducing flows to agriculture will reduce agricultural production, economic output, and employment. Such diversions could also reduce land values as irrigated lands convert to low-value grazing lands. In turn, reduced land values could reduce property tax revenues to local governments.

Existing supplies of municipal water cannot support current demands, and lack of water availability constrains the growth and development of YRB communities.<sup>79</sup> In rural areas outside municipalities, older and shallower domestic wells are drying up. Drilling new wells can cost property owners between \$5,000 and \$10,000.<sup>80</sup> When asked which areas of the YRB have been hit particularly hard by failing domestic wells, one well driller declined to comment over concerns that such information could affect clients trying to sell homes or their concerns over impacts on property values.<sup>81</sup> Constraints of water supply on community growth and development can also limit housing construction, which negatively affects the YRB's construction sector.

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range of per unit (e.g., per acre) values for each ecosystem service, which accounts for the low-high range of values we report above.

<sup>77</sup> BoR & Ecology, 2012a.

<sup>78</sup> Dandison, D. 2015. *Written Testimony Submitted to the United States Senate Committee on Energy and natural Resources On S. 1694 Yakima River Basin Water Enhancement Project Phase III Act of 2015*. Director of the Washington State Department of Agriculture. July 7. [http://www.energy.senate.gov/public/index.cfm/files/serve?File\\_id=485dd083-b13d-41bd-a4ea-8fca76707647](http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=485dd083-b13d-41bd-a4ea-8fca76707647); Office of Columbia River, 2016.

<sup>79</sup> Washington Department of Ecology, 2015.

<sup>80</sup> Prengaman, K. 2015. "Drought drying up some private wells in Yakima Basin." Yakima Herald. August 2. [http://www.yakimaherald.com/news/local/drought-drying-up-some-private-wells-in-yakima-basin/article\\_db2b4a2c-39a8-11e5-ac28-57012e802qc7.html](http://www.yakimaherald.com/news/local/drought-drying-up-some-private-wells-in-yakima-basin/article_db2b4a2c-39a8-11e5-ac28-57012e802qc7.html).

<sup>81</sup> Prengaman, 2015.

Populations in the YRB are projected to grow faster than the state or national averages (see Table A-9).<sup>82</sup> Without additional supplies, these population pressures and the increasing frequency of drought will further constrain municipal growth.<sup>83</sup>

Ecology lists 13 water banks currently operating in the YRB.<sup>84</sup> Kittitas and Yakima counties are developing procedures whereby water acquired through water banking and trades support property development in their counties. Water banking and transfers have limitations in that transfers must happen within the same hydrological area.<sup>85</sup> This limits the extent to which water trades can minimize municipal water constraints.

The Integrated Plan includes projects, such as increasing surface storage and groundwater recharge, which will increase water reliability for municipal water users. Completing these projects will allow municipalities and rural domestic water users to plan for future growth and development with greater water security.

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<sup>82</sup> Ramboll Environ, 2017.

<sup>83</sup> We address drought frequency in the YRB in the following subsection of this report.

<sup>84</sup> Washington Department of Ecology. No data. *Tracking Washington Water Banks*. <http://www.ecy.wa.gov/programs/wr/market/trk-wawtrbnks.html#yakima>.

<sup>85</sup> Office of Columbia River, 2016.

## 4 Drought and the Yakima River Basin

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The YRB's economy, communities, and watersheds are vulnerable to drought; moreover, competing demands among users reduces water reliability for all. Current water supplies cannot satisfy water demands—especially during drought years. Past droughts caused devastating economic losses. Researchers expect droughts will occur with increasing frequency. When droughts happen in the YRB, food production declines, workers lose jobs, and increasing unemployment puts pressure on government support services at a time when tax revenues are in decline. Droughts increase costs to municipalities to purchase additional water supplies and makes planning for future growth and development uncertain. Droughts also threaten past investments by the Yakama Nation and others in habitat restoration and salmon repopulation efforts.

### Threat of Drought

Because water rights are fully appropriated, YRB water users and habitats must manage with existing supplies. A deficit exists because water supplies cannot satisfy current or future demands from food production and other economic activities, instream flows and fish populations, and municipal and industrial uses.

Approximately one-half of eastern Washington's out-of-stream water needs and one-third of its unmet instream flow needs are in the YRB.<sup>86</sup> Given that the overall resiliency of the YRB's economy, communities, and watersheds relies on water, droughts pose a serious threat to the region.

A combination of factors contributes to the region's water insecurity. The arid lowlands that include the major population, business centers and agricultural production and processing areas, receive approximately 10 inches of rainfall per year. The YRB's five major reservoirs, which were built between 1909 and 1925,<sup>87</sup> have a relatively low capacity to capture runoff volumes compared with reservoir capacity in other basins in the West (see Chart 1 below). This low capacity limits the extent to which water can be made available later in the year for instream flows, irrigated agriculture, or municipal use. It also prevents the YRB's reservoirs from carrying water over from one water year to the next.

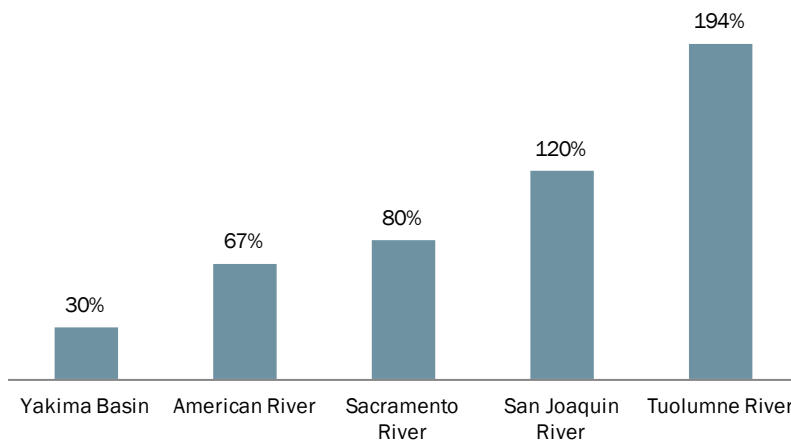
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<sup>86</sup> Sandison, 2015.

<sup>87</sup> Dick, T. 1993. *Yakima Project*. Bureau of Reclamation. Page 15.  
<https://www.usbr.gov/projects/pdf.php?id=211>.



**Chart 1: Reservoir Capacity as a Percentage of Annual Flows**



Source: Malloch, S. and M. Garrity. 2012. "Yakima River Basin Integrated Water Plan," *The Water Report*. Issue #106. December 15.

Snowpack in the Cascade Mountains in the headwaters of the YRB is known as the "sixth reservoir" because it provides flows later in the growing season as it melts. Snowpack is a critical water source because it provides, on average, approximately 1 to 1.5 million acre-feet of water per year, which can account for more than half of the YRB's water supply.<sup>88</sup> The YRB's snowpack sits at mid-elevation, which makes it more vulnerable to warming temperatures.<sup>89</sup> A "snowpack drought" happens during water years when warmer than normal temperatures cause more moisture to fall as rain rather than snow, and the snow that does fall melts earlier in the year. The result is more water flowing down rivers and streams earlier in the year. This, combined with relatively low reservoir capacity, means less water for food production, municipalities, and fish later in the year. The 2015 drought was such an event.

Snowpack droughts are especially catastrophic for landowners with prorated or junior irrigation water rights. The Prior Appropriation Doctrine, a foundation of Western water law, governs the access to water in Washington.<sup>90</sup> Those with senior water rights get first access. Those with junior water rights access their water allotment only after those with senior rights receive their full allotment. That is, those with junior water rights receive zero water until those with senior rights receive 100 percent of their water. During years when insufficient water exists to satisfy full allotments for senior and junior water rights holders, those with junior rights receive prorated or less than full allotments.

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<sup>88</sup> Pihl, K. 2014; Gable, E. 2009. *Yakima River Storage Dies—Or Does It?* <http://www.eenews.net/stories/76606>.

<sup>89</sup> Malloch and Garrity, 2012.

<sup>90</sup> Gregoire, C., J. Pharris, and P. T. McDonald. 2000. *An Introduction to Washington Water Law*. Office of Attorney General. January. <https://fortress.wa.gov/ecy/publications/documents/0011012.pdf>.

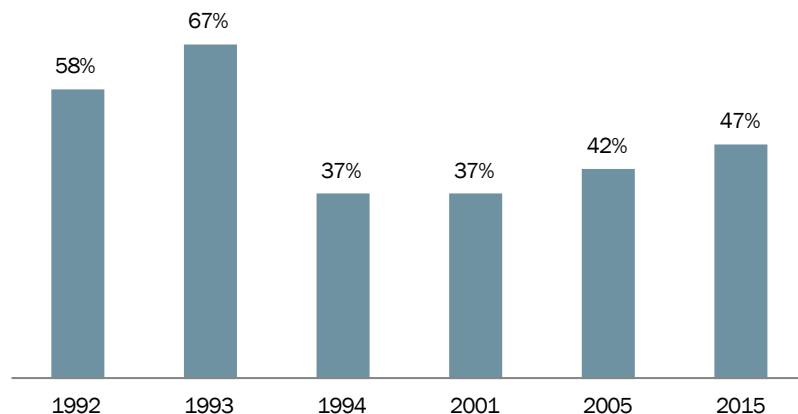


For the six irrigation districts served by Reclamation’s five reservoirs, approximately 66 percent of deliveries are governed by junior, proratable water rights (see Table A-10). All water rights for two of the districts, the Roza Irrigation District and the Kittitas Reclamation District, are proratable. The Wapato Irrigation District also has a significant percentage and volume of proratable water rights.

## Economic Impacts of Drought

Since the early 1990s, droughts that reduced water deliveries to those holding junior water rights happened every fourth year on average (see Chart 2).

**Chart 2: Yakima River Basin Proration Percent, by Water Year**



Source: Reclamation and Ecology. 2012a, Table 3-8; Revell, S. 2015. *Memo Re: Kachess Temporary Floating Emergency Drought Relief Pumping Plant*. Roza Irrigation District.

During the 2001 drought, landowners with junior water rights received 37 percent of their allotted water deliveries. An economic analysis of the 2001 drought impacts on agricultural production estimated the lost value of agricultural output at \$176 million (all damages in 2016 dollars). Total lost economic output for the YRB’s economy was \$265 million, and lost employment income was \$75 million. The drought also caused a loss of 4,800 job-years of employment.<sup>91</sup>

The 2015 water year was one of the driest on record with 85 percent of the state designated as “extreme drought” status. The Washington Department of Agriculture estimated statewide economic damage from the drought to agricultural production at \$639 million to \$780 million. These figures underestimate the drought’s total economic impact, because the analysis did not include losses from all agricultural producers, and it did not include secondary or indirect impacts, such as losses or increased costs to packinghouses.<sup>92</sup>

The analysis of economic impacts of the 2015 drought did not include losses for subregions of the state, but included impacts for three of the irrigation districts in the

<sup>91</sup> Northwest Economic Associates, 2004, Table 30, page 82; Table 31, page 83; US BLS CPI data.

<sup>92</sup> McLain, et al., 2017, pages 6 and 9.

YRB—Kittitas Reclamation District, Roza Irrigation District, and Wapato Irrigation Project.<sup>93</sup> The study focused on these areas because either all or a high percentage of their water rights are proratable. The economic losses by irrigation district are listed below:

Kittitas Reclamation District<sup>94</sup>

- \$11.4 million in direct agricultural losses
- Largest impacts on timothy hay, alfalfa, and pasture
- Many growers anticipate 25 percent reduction in 2016 yields due to the 2015 drought

Roza Irrigation District<sup>95</sup>

- \$74.4 million in direct agricultural losses
- Largest impacts on apples, wine grapes, and hops
- \$2.66 million to purchase water rights for supplemental water
- \$1 million to maintain and operate drought wells
- Additional increased costs associated with pest control

Wapato Irrigation Project<sup>96</sup>

- \$32.7 million in direct agricultural losses
- Largest impacts on apples, alfalfa, and mint

The total losses for these three areas are more than \$122 million. This underestimates the drought's full impact on YRB agriculture, because it does not include impacts on producers in other irrigation districts and does not include indirect impacts on food processing and other sectors of the YRB's economy that supply goods and services to the agricultural sector.

In general, permanent crops such as apples, cherries, pears, and hops yield higher values than annual crops such as grains or alfalfa. Permanent crops, however, require long-term investments and greater water reliability. During times of drought, growers will divert water to their permanent crops when possible to protect this investment. During the 2015 drought, growers that did not already have drought wells in place were reluctant to plant permanent crops.<sup>97</sup> The increasing acreage of permanent crops also reduces the flexibility of growers to defer planting annual crops and sell water

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<sup>93</sup> McLain, et al., 2017.

<sup>94</sup> McLain, et al., 2017, page 28; Table 1, page 29.

<sup>95</sup> McLain, et al., 2017, page 31; Table 5, page 34; page 35.

<sup>96</sup> McLain, et al., 2017, Table 8, page 38.

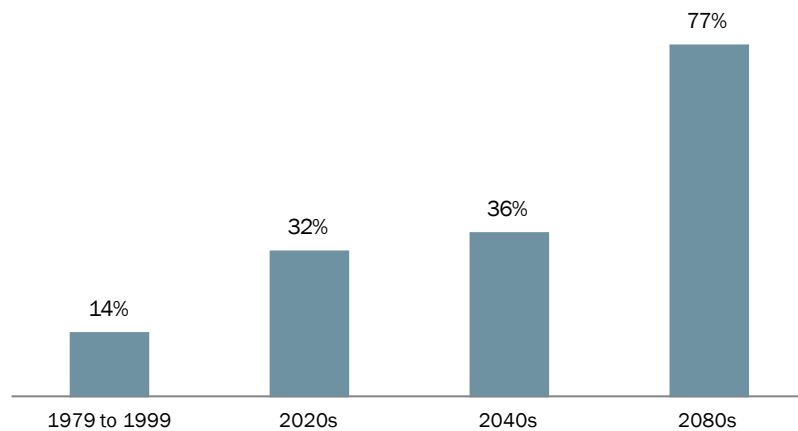
<sup>97</sup> McLain, et al., 2017.

instead.<sup>98</sup> This places some limits on the volume of water potentially available for water transfers during drought years.

## Planning for Increasing Drought Frequency

The YRB's current water deficit is projected to get worse in the future. Researchers at the University of Washington estimate that by the 2020s, the frequency of drought will be double that compared with recent history (see Chart 3). That is, the number of water years during which droughts cause prorated water deliveries will double by the 2020s.<sup>99</sup>

**Chart 3: Anticipated Drought Frequency in Yakima River Basin**



Source: Tohver, I. 2015. *Climate Change in the Yakima Basin: Implications for Aquatic Habitat and Water Management*. Yakima Basin Science & Management Conference 2015. Climate Impacts Group, University of Washington.

Water conservation efforts help, but they will not be enough. For years, irrigated agriculture and municipalities have improved the efficiency of their water use and conservation practices. These efforts continue; however, conservation alone cannot make up for the diminished snowpack and the anticipated increase in drought frequency.<sup>100</sup> Recent experience in the Columbia River Basin found that while conservation projects can provide instream flow benefits, these projects are less effective than water acquisition and storage projects at providing increased out-of-stream supplies.<sup>101</sup>

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<sup>98</sup> Chasan, D.J. 2015. "Cantwell measure allows more irrigation in return for fish, land protections." *Crosscut*. November 30. <http://crosscut.com/2015/11/cantwell-measure-allows-more-irrigation-in-return-for-fish-land-protections/>.

<sup>99</sup> Tohver, I. 2015. *Climate Change in the Yakima Basin: Implications for Aquatic Habitat and Water Management*. Yakima Basin Science & Management Conference 2015. Climate Impacts Group, University of Washington.

<sup>100</sup> Malloch and Garrity, 2012.

<sup>101</sup> The Office of Columbia River. 2017. *2016 Columbia River Basin Water Supply Inventory Report*. Publication No. 16-12-007. Washington Department of Ecology.

The YRB needs a forward-looking plan to improve water security that anticipates increased drought frequency. The YRB's future without such a plan includes reduced food production, lost economic output, reduced water-based recreational activity, negative impacts on supplies of ecosystem services, constrained municipal development, and harm to fish populations.

## 5 Integrated Plan's Economic Benefits and Return on Investment

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The Integrated Plan is forward-thinking in that it addresses current and anticipated future threats to water security, especially during drought years. The purposes of the Integrated Plan are to:

- Implement a comprehensive program of water resource and habitat improvements in response to existing and forecasted needs of the YRB; and
- Develop an adaptive and flexible approach for implementing these initiatives and for long-term management of YRB water supplies that contribute to the vitality of the regional economy and sustain the health of the riverine environment.

Work on the Integrated Plan has already begun. Once fully implemented, the YRB's economy, communities, and watersheds will all benefit. This section presents data on the cost of the Integrated Plan and describes the economic benefits to this region.

### INTEGRATED PLAN BENEFITS EXCEED COSTS

Analyses conducted for Reclamation show that the benefit-cost ratios for the Integrated Plan range from approximately 1.4—every dollar spent on the plan yields \$1.40 in economic benefits—for the low benefit vs. high cost scenario, to approximately 3.2—every dollar spent on the plan yields \$3.20 dollars in economic benefits—for the high benefits vs. low cost scenario.<sup>102</sup>

The Integrated Plan's estimated fish-related benefits over 30 years range from \$5.2 to \$7.7 billion (all benefits and costs in 2016 dollars). The estimated irrigation benefits are \$0.83 billion, and municipal and domestic water supply benefits are \$0.42 billion. Totaled, these benefits outweigh the estimated costs range of \$2.81 to \$4.58 billion. These calculations are based on an analysis that compared conditions during drought years with prorated water deliveries of no less than 70 percent to landowners with junior water rights, with conditions that would exist during a drought with prorationing at 30 percent.<sup>103</sup>

### INTEGRATED PLAN COSTS EQUIVALENT VALUE: 1-YEAR AGRICULTURAL PRODUCTION

The cost of the Integrated Plan over 30 years is approximately equivalent to the value of 1-year of agricultural production and food processing in the YRB. A recent estimate of the market value of YRB crop and livestock production and gross sales from food

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<sup>102</sup> U.S. Bureau of Reclamation. 2012. Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan. October. Figure 2, Page 7.

<sup>103</sup> U.S. Bureau of Reclamation. 2012. Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan. October. Section 2.

processing is approximately \$4.5 billion. The estimated cost of the Integrated Plan is \$2.8 billion to \$4.6 billion.<sup>104</sup>

### WATER DEPENDENT ANNUAL ECONOMIC OUTPUT 2 ½ TIMES COST OF INTEGRATED PLAN

The approximately \$13 billion in annual economic output from YRB's water-dependent economic sectors is two-and-one-half times the cost of the 30-year Integrated Plan.

### CONSTRUCTION PROJECTS INJECT MILLIONS INTO ECONOMY AND SUPPORTS JOBS

Over 30 years, construction projects and other work associated with implementing the Integrated Plan will generate over \$2.5 billion of economic output and \$1.4 billion of personal income in the YRB.<sup>105</sup> Total economic output benefits for the State of Washington (including the YRB) are more than \$4.9 billion, and total personal income benefits in the state are more than \$2.2 billion. Integrated Plan projects will also support 27,000 job-years of work in the YRB and an additional 15,000 job-years of work elsewhere in the State of Washington (see Table A-11).<sup>106</sup> The average number of job-years supported by the Integrated Plan each year over the life of the plan is approximately 1,400.

### AVOIDS MILLIONS OF DOLLARS IN LOST AGRICULTURAL PRODUCTION

The water projects in the Integrated Plan are designed to keep prorated water deliveries to agricultural producers with junior water rights to no less than 70 percent during drought years. Relative to conditions that would exist during a drought year that causes prorated water deliveries to drop to 30 percent without the Integrated Plan, such an outcome would avoid drought-related agricultural losses of \$128 million (all avoided losses in 2016 dollars) in grain production; \$169 million in vegetables and melon production; and \$151 million in fruit production, *per severe drought year* (see Table A-12 and Table A-13).<sup>107</sup>

These figures likely underestimate the full economic benefits of increased water security to the YRB's agricultural producers because they exclude benefits of the Integrated Plan during water years when landowners receive less than their full allotment but more than 70 percent. It also excludes benefits to water users who do not

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<sup>104</sup> YRB crop and livestock production market value and food processing gross sales of \$4.481 billion. Washington Department of Agriculture. *Agriculture—A Cornerstone of Washington's Economy*. Estimated cost of the Integrated Plan \$2.81 to \$4.87 billion, Bureau of Reclamation and Washington Department of Ecology. 2012b. *Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan*.

<sup>105</sup> Reclamation's economic analysis of the Integrated Plan's estimated impacts in the YRB included four counties: Yakima, Benton, Kittitas, and Franklin counties. Our description of the YRB includes three counties: Yakima, Benton, and Kittitas. Data were not available that would allow separating out results for Franklin County. Thus, the economic output, personal income, and employment impacts from the Integrated Plan's analysis will overstate the impacts for our three-county region.

<sup>106</sup> Reclamation and Ecology 2012. *Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan*. Bureau of Reclamation Contract No. 08CA10677A ID/IQ. October.

<sup>107</sup> Reclamation and Ecology, 2012.

have water rights and would receive more water with the Integrated Plan than otherwise.

### PROTECTS IRRIGATION FLOWS DURING DROUGHT YEARS, NO INCREASE OF ACRES IRRIGATED

The Integrated Plan is designed to provide a floor below which the proration of irrigation flows will not fall during drought years. By keeping prorated irrigation flows to 70 percent or above, the Integrated Plan will help reduce water uncertainty for growers, so they can plan for future investments and crop plantings. The Integrated Plan will not provide water supply to support plantings in areas currently unserved by irrigation or to increase irrigated acres during non-drought years.

### IRRIGATORS SHARE COST FOR SURFACE STORAGE PROJECTS

The irrigation districts will pay their share of the costs for the projects that provide additional surface storage based on their water use. The Washington Water Research Center at the University of Washington assessed the individual water storage projects in the Integrated Plan and found that, when considered in isolation, the benefits of some of the water storage projects did not exceed the costs.<sup>108</sup> Some look to these results and conclude that these parts of the Integrated Plan should not be implemented. The public-private partnership aspect of the Integrated Plan, with irrigators funding their portion of the water storage projects, addresses this issue directly. If irrigators do not believe the benefits exceed the costs of the projects, they would not agree to pay their share, and the projects would not be built.

### AVOIDS NEARLY \$1 BILLION IN LOST ECONOMIC OUTPUT

Economic losses in YRB's agricultural sector would ripple through the Washington State economy causing losses in other sectors as well. During a severe drought year, Washington State would avoid \$830 million in lost economic output, \$218 million in lost personal income (all economic losses in 2016 dollars), and 10,800 job-years of employment<sup>109</sup> because of implementing the Integrated Plan.

### INCREASES ANADROMOUS FISH POPULATIONS AND HARVESTS

Hundreds of millions of dollars in needed fish habitat and population-enhancement programs have been identified for the YRB.<sup>110</sup> The fish and habitat projects in the Integrated Plan will help address some of this need by increasing fish populations over the life of the plan. Current anadromous fish returns to the basin number approximately 25,000 per year.<sup>111</sup> Reclamation estimates that projects in the Integrated Plan that increase instream flows, add fish passage at the five major reservoirs, and

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<sup>108</sup> Yoder, J., et al. 2014. *Benefit-Cost Analysis of the Yakima Basin Integrated Plan Projects*. Report to the Washington State Legislature. December 15.

<sup>109</sup> Reclamation and Ecology, 2012.

<sup>110</sup> Ramboll Environ, 2017.

<sup>111</sup> Malloch and Garrity, 2012, page 8.

improve habitats, will increase anadromous fish recruitment between 181,650 and 472,450 by 2042, and fish harvests between 37,997 and 102,603.<sup>112</sup>

There are multiple ongoing Integrated Plan fish and habitat-related projects including the following:

- The Yakama Nation and other regional groups received a \$7.5 million Regional Conservation Partnership Program Grant in 2016. The grant will support restoring fish habitat, riparian vegetation, fish access, grazing management, irrigation efficiency, and conservation stewardship practices.<sup>113</sup>
- Temporary use of the Kittitas Reclamation District canal system during the summer of 2015 enhanced flows in nine Kittitas Valley tributaries, avoided dewatering of these tributaries, and supported spawning for anadromous and resident fish species.<sup>114</sup>
- Adding fish passage facilities to the Cle Elum Dam will open 29 miles of fish habitat upstream of the dam. This project will help restore and enhance anadromous fish populations and support what was once the largest sockeye salmon run in the lower 48 states.<sup>115</sup>
- Purchasing over 50,000 acres of forestland designated as the Teanaway Community Forest protected high-elevation habitat critical to anadromous and resident fish.<sup>116</sup> The purchase also protected the forest's recreation resources and access.

As described in Reclamation and Ecology's Final Programmatic Environmental Impact Statement on the Integrated Plan, the fish and habitat-related investments that would exist without the plan, while beneficial, would likely be insufficient to have a significant effect on fish populations.

"These [fish related actions taken without the Integrated Plan], although beneficial, would provide slow and partial progress in addressing the fish resource problems in the Basin. ... [E]xisting problems with water availability and habitat quality would likely worsen with current land use activities, increased population ... Anadromous fish would continue to have no access to headwater streams because no fish passage facilities

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<sup>112</sup> Reclamation and Ecology, 2012, Table 3, page 10.

<sup>113</sup> Office of Columbia River. 2017. *2016 Report to the Legislature Columbia River Basin Water Supply Inventory Report*. State of Washington Department of Ecology. Publication No. 16-12-007. Page 7. January. <https://fortress.wa.gov/ecy/publications/SummaryPages/1612007.html>.

<sup>114</sup> Office of Columbia River, 2016, page 21.

<sup>115</sup> Office of Columbia River, 2016, page 12.

<sup>116</sup> Office of Columbia River, 2016, page 9.



would be provided at major reservoirs. Stream flow conditions would continue to be unfavorable to enhancing fish populations.”<sup>117</sup>

### PROTECTS MILLIONS OF DOLLARS ALREADY INVESTED IN FISH HABITAT RESTORATION

The Yakama Nation, federal and state agencies, local governments, and non-profits have invested millions of dollars in habitat restoration and protection efforts to increase anadromous fish populations. These efforts have had an effect and populations are on the rise. The instream flow, habitat, and fish-passage projects in the Integrated Plan will help protect the millions of dollars in current and past investments and population gains throughout the YRB.

### INCREASES RECREATIONAL AND COMMERCIAL FISH HARVESTS

The value of increased recreational and commercial fish harvest supported by the Integrated Plan ranges between \$104 million to \$313 million (in 2016 dollars).<sup>118</sup> These fishery benefits underestimate the total fishery-related benefits because they do not include the cultural and spiritual values that members of the Yakama Nation associate with anadromous fish populations. These values are unquantifiable.<sup>119</sup>

### MUNICIPALITIES AVOID SPENDING MILLIONS TO PURCHASE WATER RIGHTS

Insufficient water exists during drought years to support current and expected future basin populations. Without the Integrated Plan, municipalities would need to spend approximately \$412 million purchasing senior water rights to satisfy demands.<sup>120</sup> This assumes senior water rights would be available for purchase.

As part of the Integrated Plan, the City of Yakima received a temporary permit from the Washington Department of Ecology that allows the city to begin storing water from the Naches River in underground aquifers. The city will eventually install recovery wells to access the stored aquifer water.<sup>121</sup>

The Integrated Plan can help users of groundwater avoid an adjudication process similar to the adjudication happening for surface water. That process, known as Acquavella, began in the late 1970s.<sup>122</sup> A comparable process for groundwater would likely impose significant costs on water users and local government entities

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<sup>117</sup> Reclamation and Ecology. 2012a. Yakima River Basin Integrated Water Resource Management Plan, Final Programmatic Environmental Impact Statement, Benton, Kittitas, Klickitat and Yakima Counties. March. Page x.

<sup>118</sup> Reclamation and Ecology, 2012.

<sup>119</sup> U.S. Department of the Interior, Bureau of Reclamation and State of Washington, Department of Ecology (BoR & Ecology). 2012b. *Yakima River Basin Integrated Water Resource Management Plan, Four Accounts Analysis of the Integrated Plan*. U.S. Bureau of Reclamation Contract No. 08CA10677A ID/IQ. October.

<sup>120</sup> Reclamation and Ecology, 2012, pages 50-53; US BLS CPI Data.

<sup>121</sup> Office of Columbia River, 2016.

<sup>122</sup> Washington Department of Ecology. No date. *Water Right Adjudications*. <http://www.ecy.wa.gov/programs/wr/rights/adjhome.html>.

responsible for managing the adjudication process and implementing adjudication orders.

### PROTECTS VALUABLE ECOSYSTEM SERVICES

The habitat restoration, instream flow, and water quality projects in the Integrated Plan will help protect and restore the riparian and related habitat ecosystem services and their associated economic values.<sup>123</sup> The estimated annual value of ecosystem services provided by the YRB's freshwater, wetlands, grasslands, and forests range from \$350 million to \$15 billion (2016 dollars).<sup>124</sup>

### PROTECTS BILLION-DOLLAR RECREATIONAL ECONOMY

Much of the recreational activities in the YRB involve water resources; its reservoirs, streams, and lakes are a major draw. Researches expect the demand for water-based recreational activities to increase at a rate faster than the rate of population increase through the year 2050. Total outdoor recreational expenditures in the YRB in 2015 exceeded \$1.2 billion. Total tourism spending exceeded \$870 million.<sup>125</sup> The projects in the Integrated Plan that promote and protect water supply and quality, and water-related natural habitats, will also protect the YRB's natural resource-based recreational assets.

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<sup>123</sup> Reclamation and Ecology, 2012; Cotter and Sihota, no date.

<sup>124</sup> See footnotes 67, 71, and 72.

<sup>125</sup> Briceno and Schundler, 2015; Recreation.gov.

## 6 Economic Benefits Beyond the Basin

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The YRB is regionally and nationally significant in a number of areas that will benefit from the Integrated Plan.

Agricultural producers in the YRB lead the state and the nation in apple production.<sup>126</sup> At approximately \$2.2 billion per year, apples are the highest-valued agricultural product from Washington State,<sup>127</sup> and producers in the YRB lead the State's production.<sup>128</sup> Washington also accounts for 66 percent of total U.S. apple production; the next closest states are New York and Michigan, with 8 percent each.<sup>129</sup>

Milk is second only to apples in value of agricultural production from Washington State, and Yakima County leads the state in milk production and ranks seventh nationally.<sup>130</sup> The YRB's concentration of dairy operations makes it one of the largest dairy producing regions in the nation.<sup>131</sup> In addition to supporting on-farm jobs, the YRB's dairy producers help support jobs in the state's transportation sector because on average approximately 50 percent of the state's dairy production is exported to Asia and other international destinations.<sup>132</sup>

The YRB leads the state, the nation, and the world in hops production. In 2015 and 2016, growers in the YRB produced more hops than anywhere else in the world, including Germany.<sup>133</sup> The YRB has ideal climate and growing conditions for hops, and growers in this area produce the large majority—79 percent—of the nation's total hop output.<sup>134</sup> The explosive growth in demand for craft beers drives the U.S. and international demand for the YRB's hops. While demand for traditional beers in the U.S. declined recently by 0.2 percent, demand for craft beer increased 12 percent, and now accounts for approximately 25 percent of the total value of beer consumed in the

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<sup>126</sup> US Department of Agriculture. No date. *2012 Census of Agriculture. County Profile Yakima County*. [www.agcensus.usda.gov](http://www.agcensus.usda.gov).

<sup>127</sup> Washington Farm Bureau. No Date. *Agriculture's Contribution to Washington's Economy*. <http://wsfb.com/agricultures-contribution-to-washingtons-economy/>.

<sup>128</sup> US Department of Agriculture. No date.

<sup>129</sup> Cargill, C. 2016. *Agriculture: The Cornerstone of Washington's Economy*. Washington Policy Center. Policy Note. March.

<sup>130</sup> Washington Farm Bureau. No Date; *2012 Census of Agriculture. County Profile Yakima County*. [www.agcensus.usda.gov](http://www.agcensus.usda.gov).

<sup>131</sup> Washington State Dairy Federation. No Date. *Facts About Washington's Dairy Industry*. <http://wastatedairy.com/category/dairy-facts/pages/2/>.

<sup>132</sup> Dairy Farmers of Washington. No Date. *Economic Impact*. <http://www.wadairy.com.beyond-farm/economic-impact>.

<sup>133</sup> Glover, J. 2016. "Washington Tops in Hops," *The Spokesman-Review*. November 25. <http://www.spokesman.com/stories/2016/nov/25/washington-tops-in-hops/#/0>.

<sup>134</sup> Wheat, D. 2015. "Craft Brewers Boost Demand for Hops," *Capital Press*. April 23; Wheat, D. 2014. "Hop Growers Adjust to Meet Demand of Craft Brewers," *Capital Press*. December 22.

U.S.<sup>135</sup> Also driving the demand for YRB hops is the fact that craft beers can use up to five times the quantity of hops as traditional beers.<sup>136</sup> In 2016 there were over 5,300 craft breweries in the U.S., and this number is expected to grow by 20 percent by 2020. These 5,300 breweries employ approximately 129,000 workers.<sup>137</sup> The YRB's hops help support domestic craft breweries and their employees across the country. Given that approximately two-thirds of the U.S. hop harvest is exported to breweries around the world, the YRB's hop production also helps support workers in the U.S. transportation sector.<sup>138</sup>

Across the country, sales of organic foods are growing at twice the rate of all food sales.<sup>139</sup> The YRB's rich soils, long growing season and dry summer climate are ideal for growing crops without chemical fertilizers or pesticides, and help support a thriving center for organic production.<sup>140</sup> Washington ranks first in the production of a number of organic foods including apples, cherries, pears, and grape juice.<sup>141</sup> Approximately 80 percent of the state's organically produced food comes from the east side of the Cascades.<sup>142</sup> With eighty-eight certified organic farms, Yakima County ranks second in the state only to Grant County, which has 90. According to the US Department of Agriculture, organic apples have the highest export value of any organic crop<sup>143</sup>, and YRB producers lead the country in apple production. Washington also leads the nation in production of organic blueberries, and Benton County, in the YRB, is a major center for organic blueberry production.<sup>144</sup>

Projects in the Integrated Plan that benefit agricultural production will also benefit firms in the transportation sector that move goods from the YRB to overseas markets. Crop production and food manufacturing accounts for approximately 75 percent of the

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<sup>135</sup> Glover, J. 2016; Helmer, J. 2016. "Hop Growers Cheer Craft Brewers For Saving An Ailing Industry," The Salt, NPR. August 2. <http://www.npr.org/sections/thesalt/2016/08/02/488236990/hop-growers-cheer-craft-brewers-for-saving-an-ailing-industry>.

<sup>136</sup> Helmer, J. 2016.

<sup>137</sup> Brewers Association. 2017. *Steady Growth for Small and Independent Brewers*. Press Release. March 28. <http://www.brewersassociation.org/press-releases/2016-growth-small-independent-brewers/>; Wheat, D. 2014. "Hop Growers Adjust to Meet Demand of Craft Brewers," *Capital Press*. December 22.

<sup>138</sup> Carpenter, D. 2017. "The Business of Hops," *Craft Beer & Brewing Magazine*. January 27. <https://beerandbrewing.com/the-business-of-hops/>.

<sup>139</sup> Turrell, B. 2016. "Local Farmers and the Organic Revolution." *Yakima Herald Magazine*. November 6.

<sup>140</sup> Turrell, B. 2016.

<sup>141</sup> Tilth Producers of Washington. 2017. *Snapshot of Organic Farming 2016*. January 27. <http://tilthproducers.org/quarterly/2017-27-1-snapshot-of-organic-farming-2016/>.

<sup>142</sup> Turrell, B. 2016.

<sup>143</sup> Kirby, E. and D. Granatstein. 2015. *Recent Trends in Certified Organic Tree Fruit Washington State 2014*. Washington State University Center for Sustaining Agriculture & Natural Resources. August 27.

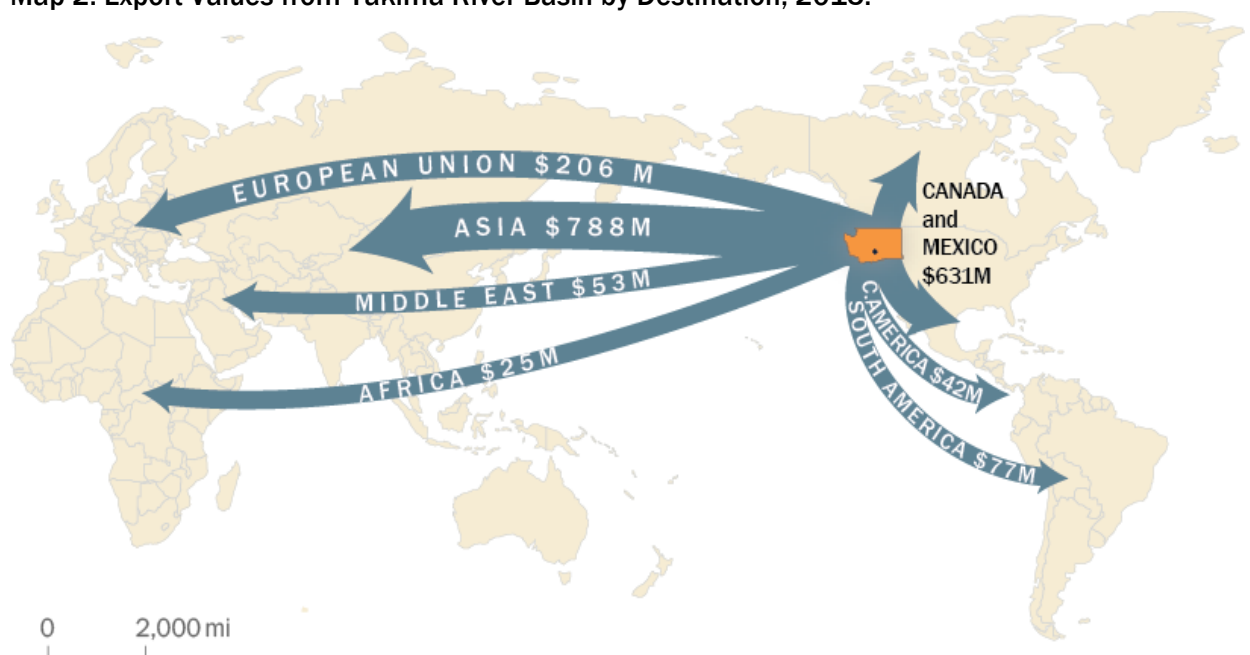
<sup>144</sup> Washington State University. No Date. *Trends and Economics of Washington State Organic Blueberry Production*. Washington State University Extension Fact Sheet FS154E.

over \$1.8 billion in export value from the YRB in 2015.<sup>145</sup> These goods travel all over the globe (see Map 2 below) including:

- Asia
- Europe
- Canada
- Mexico
- Central America
- South America
- The Middle East
- Africa

Moving these goods to export markets supports jobs and economic activities in Columbia River rail and barge transport and at Puget Sound Ports.<sup>146</sup>

**Map 2. Export Values from Yakima River Basin by Destination, 2015.**



Source: U.S. Department of Commerce, International Trade Administration.

Anadromous fish that originate in the YRB travel downstream through the Columbia Basin and out into the Pacific Ocean. Improved habitat and increased fish populations supported by the Integrated Plan will help increase Tribal, commercial, and recreational harvests throughout this area. Increased harvests will help support fishing incomes and employment, as well as incomes and employment at businesses that support the fishing sector.

<sup>145</sup> U.S. Department of Commerce, International Trade Administration.

<sup>146</sup> Cargill, C. 2016. *Agriculture: The Cornerstone of Washington's Economy*. Washington Policy Center. Policy Note. March.

The Integrated Plan addresses concerns shared by many in regions throughout the arid West—reducing water insecurity in times of both declining water supply and increasing water demands. Many outside the YRB see the Integrated Plan as a case study for finding common ground on water management and other, oftentimes contentious natural resource issues.<sup>147</sup> Such issues abound throughout the West—be they water scarcity concerns, endangered species issues, or development pressures on riparian habitats. Implementing the Integrated Plan over the next 30 years will help improve water reliability in the YRB, but it has already helped those outside the YRB and outside Washington see a better, less contentious, and more effective approach to making natural resource management decisions.

The National American Water Resources Association recognized the Integrated Plan’s Workgroup for outstanding teamwork and contributions to water resources management, which they describe as an “unprecedented achievement” in a region that struggled for years with efforts to reach agreement on water-policy issues.<sup>148</sup>

In 2016, the U.S. Department of the Interior and the U.S. Department of Agriculture proclaimed the success of the Integrated Plan and the improvements the Plan’s projects will make to the health and resiliency of the YRB.<sup>149</sup>

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<sup>147</sup> Muir, 2016.

<sup>148</sup> Bateman, B. and R. Rancier (eds). 2012. *Case Studies in Integrated Water Resources Management: From Local Stewardship to National Vision*. American Water Resources Association Policy Committee. November. <http://www.awra.org/committees/AWRA-Case-Studies-IWRM.pdf>.

<sup>149</sup> U.S. Senate Committee on Energy and Natural Resources. 2016. *Yakima Water Plan is a “Model” and “Holistic.”* <http://www.energy.senate.gov/public/index.cfm/2016/2/departments-of-the-interior-yakima-water-plan-is-a-model-and-holistic>.

# Appendix: Data Tables

**Table A-1: Crop and Animal Production, Employment, and Output, Yakima River Basin, 2016**

	Direct	Indirect	Induced	Total
Employment	28,576	11,115	4,596	44,287
Sales/Output (\$ billions)	\$3.961	\$1.065	\$0.414	\$5.439

Source: JobsEQ. Data as of third quarter, 2016.

**Table A-2: Water-Critical Economic Sectors, by NAICS Code**

Water Critical Agricultural and Mining	Water Critical Manufacturing	Water Critical Commercial
111 Crop Farming	<b>Food and Kindred Products</b>	<b>Hotels</b>
112 Livestock	311 Food Products	721 Accommodations
113 Forestry & Logging	312 Beverage & Tobacco	<b>Water Intensive Consumer</b>
114 Fishing - Hunting, & Trapping	<b>Stone/Clay/Glass Products</b>	469 Landscape & Horticultural Services
115 Agricultural & Forestry Services	327 Nonmetal Mineral Production	505 Car Washes
212 Mining	<b>Electronic Components Manufacturing</b>	511 Dry-Cleaning & Laundry Services
	334 Computer & Other Electronics	713 Amusement - Gambling & Recreation
	335 Electrical Equipment & Appliances	<b>Other Commercial</b>
	<b>Other Manufacturing</b>	621 Ambulatory Health Care
	313 Textile Mills	622 Hospitals
	314 Textile Products	623 Nursing & Residential Care
	315 Apparel	711 Performing Arts & Spectator Sports
	316 Leather & Allied Products	712 Museums & Similar
	321 Wood Products	722 Food Services & Drinking Places
	322 Paper Manufacturing	
	323 Printing & Related Manufacturing	
	324 Petroleum & Coal Production	
	325 Chemical Manufacturing	
	326 Plastics & Rubber Production	
	331 Primary Metal Manufacturing	
	332 Fabricated Metal Production	
	333 Machinery Manufacturing	
	336 Transportation Equipment	
	337 Furniture & Related Products	
	339 Miscellaneous Manufacturing	

NAICS = North American Industry Classification System

Source: Ramboll Environ. 2017. *Economic Analysis of Water Infrastructure and Fisheries Habitat Restoration Needs*. Prepared for State of Washington Office of Financial Management. Project Number 3037630A. Olympia, WA. January 17.

**Table A-3: Yakima River Basin Water Dependent Sectors**

Economic Sector	Employment		Output		Weighted Average	
	Total	Share of Total	Total (\$ billions)	Share of Total	Employment	Output
Water Dependent Agricultural and Mining	39,066	16.0%	\$3.442	9.8%	1.31	1.43
Water Dependent Manufacturing	13,547	5.5%	\$5.866	16.8%	2.2	1.44
Water Dependent Commercial	44,032	18%	\$3.791	10.8%	1.35	1.56
Total Water Dependent	96,645	39.5%	\$13.099	37.4%	--	--
All Other	148,146	60.5%	\$21.888	62.6%	1.56	1.52

Source:

Ramboll Environ. 2017. *Economic Analysis of Water Infrastructure and Fisheries Habitat Restoration Needs*, Table 8-5: Yakima Basin Water Dependent Sector Strength, page 196.

**Table A-4: Water Dependent Employment as a Percentage of Total Employment, By Water Basin**

Water Basin	Water-Dependent Employment as a Percentage of Total Employment
Washington Coastal	36.2%
Lower Columbia	29.8%
Middle Columbia	42.2%
Upper Columbia	42.6%
Puget Sound	26.7%
Lower Snake	29.1%
Kootenai-Pend Oreille-Spokane	28.8%
Yakima	39.5%

Source: Ramboll Environ. 2017. *Economic Analysis of Water Infrastructure and Fisheries Habitat Restoration Needs*, Table 8-11: Basin Comparison of Water Dependent Multipliers and Industry Details, page 201.

**Table A-5: Percentage of Campground Reservation in Yakima River Basin Made By Puget Sound Residents**

Fiscal Year 2015	Estimate
Total Number of Campground Visitors	42,860
Number of Visitors from Puget Sound Region	26,963
Percent of Visitors from Puget Sound Region	63%

Source: Recreation.gov.

**Table A-6: Outdoor Recreation Expenditures in Yakima River Basin, 2016**

County	Economic Spending	Employment (job-years)
Benton	\$457,019,540	7,074
Kittitas	\$120,303,740	1,762
Yakima	\$678,382,270	5,398
Total	\$1,255,705,550	14,234

Source: Briceno, T., and Schundler, G. 2015. *Economic Analysis of Outdoor Recreation in Washington State*, Appendix F, County Economic Expenditures and Contribution Results for All Recreational Lands, page 83-4.

**Table A-7: Outdoor Recreation Expenditures Associated with Public Waters in Yakima River Basin, 2016**

County	Economic Spending
Benton	\$140,773,760
Kittitas	\$34,203,100
Yakima	\$109,201,430
Total	\$284,178,290

Source: Briceno, T., and Schundler, G. 2015. *Economic Analysis of Outdoor Recreation in Washington State*, Appendix F, County Economic Expenditures and Contribution Results for All Recreational Lands, page 84-5.



**Table A-8: Tourism Expenditures in Yakima River Basin, 2016 dollars**

County	Tourism Spending	Employment	Local and State Tax Revenues
Benton	\$325,821,954	3,700	\$30,621,604
Kittitas	\$173,724,547	2,230	\$16,169,824
Yakima	\$370,794,277	3,580	\$32,339,648
Total	\$870,340,778	9,510	\$79,131,076

Source: Dean Runyan Associates. 2015. Washington State County Travel Impacts & Visitor volume 1991-2014p. April. Prepared for Washington Tourism Alliance

**Table A-9: Average Annual Population Growth, 2015 through 2036**

	Average Annual Rate of Population Growth
Yakima Basin	1.1%
State of Washington	0.8%
U.S.	0.7%

Source: Ramboll Environ. 2017. *Economic Analysis of Water Infrastructure and Fisheries Habitat Restoration Needs*, Table 6-43: OFM Population Projections for YRB, page 158.

**Table A-10: Water Rights for Yakima River Basin Irrigation Districts**

Irrigation District	Non-proratable Water Rights (acre feet)	Proratable Water Rights (acre feet)	Total Water Rights (acre feet)
Wapato Irrigation Project	305,613	350,000	655,613
Sunnyside Division	289,646	157,776	447,422
Roza Irrigation District	0	393,000	393,000
Kittitas Reclamation District	0	336,000	336,000
Yakima-Tieton Irrigation District	75,865	30,425	106,290
Kennewick Irrigation District	18,000	84,674	102,674
Total	689,124	1,351,875	2,040,999
Percent	33.8%	66.2%	

Source: U.S. Department of the Interior, Bureau of Reclamation, and Washington Department of Ecology. 2012. *Yakima River Basin Integrated Water Resource Management Plan: Final Programmatic Environmental Impact Statement*, Table 3-7: Yakima Project Irrigation District Water Rights (acre-feet per year), page 3-20. March.

**Table A-11: Economic Impacts from Construction Expenditures, 2016 dollars**

Region / Impact Measure	Direct	Indirect	Induced	Total
4-County Study Area				
Output	\$1,827,000,000	\$217,350,000	\$418,950,000	\$2,463,300,000
Personal Income	\$1,185,450,000	\$70,350,000	\$126,000,000	\$1,381,800,000
Job Years	21,700	1,700	3,500	26,900
Rest of Washington				
Output	\$956,550,000	\$406,350,000	\$1,081,500,000	\$2,444,400,000
Personal Income	\$472,500,000	\$103,950,000	\$302,400,000	\$878,850,000
Job Years	6,000	2,000	7,100	15,100
Total Washington State				
Output	\$2,783,550,000	\$622,650,000	\$1,501,500,000	\$4,907,700,000
Personal Income	\$1,657,950,000	\$174,300,000	\$428,400,000	\$2,260,650,000
Job Years	27,700	3,600	10,700	42,000

Source: ECONorthwest; U.S. Department of the Interior, Bureau of Reclamation, and Washington Department of Ecology. 2012. *Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan*, Table 19: Summary of Economic Impacts, by Type, from Construction Expenditures, page 65. October.

**Table A-12: Impacts of Integrated Plan On Gross Farm Earnings, 2016 dollars**

Type of Crop	Gross Farm Earnings (30% of Proratable Entitlements Received)	Gross Farm Earnings (70% of Proratable Entitlements Received)	Difference
Grains (wheat, other grain, miscellaneous grain)	\$58,800,000	\$186,900,000	\$128,100,000
Vegetables and Melons (asparagus, potatoes, sweet corn, other vegetables)	\$30,450,000	\$200,550,000	\$169,050,000
Fruits (apples, concord grapes, wine grapes, other tree crops)	\$495,600,000	\$646,800,000	\$151,200,000
All Other Crops (alfalfa hay, hops, mint, other hay, pasture, timothy hay)	\$249,900,000	\$221,550,000	(\$28,350,000)
<b>Total</b>	<b>\$835,800,000</b>	<b>\$1,255,800,000</b>	<b>\$420,000,000</b>

Source: ECONorthwest; U.S. Department of the Interior, Bureau of Reclamation, and Washington Department of Ecology. 2012. *Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan*, Table 19: Summary of Economic Impacts, by Type, from Construction Expenditures, page 65. October.

**Table A-13: Economic Impacts of Changes in Agricultural Production During Severe Drought Year, 2016 dollars**

Region / Impact Measure	Direct	Indirect	Induced	Total
<b>4-County Study Area</b>				
Output	\$420,000,000	\$143,850,000	\$160,650,000	\$724,500,000
Personal Income	\$91,350,000	\$54,600,000	\$48,300,000	\$194,250,000
Job Years	7,200	1,500	1,400	10,100
<b>Rest of Washington</b>				
Output	\$0	\$67,200,000	\$37,800,000	\$105,000,000
Personal Income	\$0	\$14,700,000	\$9,450,000	\$24,150,000
Job Years	0	500	200	700
<b>Total Washington State</b>				
Output	\$420,000,000	\$211,050,000	\$198,450,000	\$829,500,000
Personal Income	\$91,350,000	\$69,300,000	\$57,750,000	\$218,400,000
Job Years	7,200	2,000	1,600	10,800

Source: ECONorthwest; U.S. Department of the Interior, Bureau of Reclamation, and Washington Department of Ecology. 2012. *Yakima River Basin Integrated Water Resource Management Plan. Four Accounts Analysis of the Integrated Plan*, Table 25: Summary of Economic Impacts of Changes in Agricultural Production, Severe Drought Year, page 74. October.