EXHIBIT A
TRIBAL PERSPECTIVES REPORT
PREPARED BY THE COLUMBIA RIVER TREATY TRIBES
JUNE 10, 2019

Exhibit Coversheet Only. [Paginated separately.]

The attached document, Tribal Perspectives Report, is provided to the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy, Climate, and Grid Security for the Hearing Record, dated January 30, 2024 in response to a question from the Honorable Frank Pallone, Jr.

10 June 2019

Tribal Perspectives Report

Prepared by the Columbia River Treaty Tribes

Introduction and Purpose

This Tribal Perspective is provided to the Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration [hereinafter "Co-Lead Agencies" or "Agencies"] in response to the Agencies' email dated February 14, 2019, requesting submissions of Tribal Perspectives for the Columbia River System Operation Draft Environmental Impact Statement [CRSO DEIS]. This Tribal Perspective was prepared by the Nez Perce Tribe [NPT], Confederated Tribes of the Umatilla Indian Reservation [CTUIR], Confederated Tribes of the Warm Springs Reservation of Oregon [CTWRSO] and the Confederated Tribes and Bands of the Yakama Nation [YN] with assistance by the Columbia River Inter-Tribal Fish Commission [CRITFC][collectively the "Columbia River Treaty Tribes"].

The Columbia River Treaty Tribes expect that this Tribal Perspectives Report, incorporating by reference the entirety of the 1999 Meyer Report that serves as its foundation, will be incorporated in the CRSO EIS as submitted. [1] The Meyer Report provides a useful framework for outlining and introducing tribal concerns and perspectives with the effects of the federal Columbia and Snake river dams on tribal resources, interests and culture. This Tribal Perspective draws highlights from the Meyer Report and supplements it with updated and new information. For instance, since the 1999 Meyer Report, each of the Columbia River Treaty Tribes have published plans and reports reconfirming two of the major premises of the Meyer Report:

- The baseline for tribal salmon restoration and harvest is 1855; and
- There is a large gap between current conditions and the baseline.

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[1] Meyer Resources, Inc., Tribal Circumstances and Impacts of the Lower Snake River Project on Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes (April 1999) <https://www.critfc.org/wp-content/uploads/2014/11/circum.pdf> [hereinafter Meyer Report].

After an overview of the Tribes' treaty fishing rights, the following sections of the document consider updated plans for rebuilding salmon and other species adopted by the tribes themselves as well as other institutions. These planning commitments are then discussed in the context of preliminary analyses now available from the Co-Lead Agencies for the CRSO DEIS.

A. Background on the Treaty Rights to Take Fish of the Columbia River Treaty Tribes

Since time immemorial the Columbia River and its tributaries were viewed by the Columbia River Basin tribes as "a great table where all the Indians came to partake."[2] More than a century after the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakima Indian Nation, and the Nez Perce Tribe signed the treaties which reserved their fishing rights and created their reservations, the tribes' place at the table has been subordinated to energy production and other non-Indian water development. Today, the Columbia River treaty tribes struggle to fulfill even a small fraction of their reserved fishing rights. The treaties – the supreme law of the land under the United States Constitution – promised more.

> "The right to resort to the fishing places in controversy was a part of larger rights possessed by the Indians, upon the exercise of which there was not a shadow of impediment, and which were not much less necessary to the existence of the Indians than the atmosphere they breathed."

United States v. Winans, 198 U.S. 371, 381 (1905) (*Winans* is a seminal case in Indian law. It upheld the Yakama Nation's treaty-reserved fishing rights on the Columbia River and established that treaties are "not a grant of rights to the Indians, but a grant of right from them – a reservation of those not granted.").

In the last twelve months two decisions from the U.S. Supreme Court have reaffirmed the permanence of the treaty commitments considered in the 1999 Tribal Circumstance report. These cases specifically addressed United States' treaty commitments made at the Walla Walla treaty grounds in 1855 as the tribal negotiators understood them.

In the *U.S. v. Washington* "Culverts Case", the United States Supreme Court affirmed a decision by the Ninth Circuit Court of Appeals which determined that the Columbia River Tribes' Treaties guaranteed the right to have fish to take, not just the right for the tribes to dip their nets into empty waters devoid of salmon. The language of the appeals court confirms the perspective of the Columbia River Treaty Tribes in the CRSO DEIS.

> The Indians did not understand the Treaties to promise that they would have access to their usual and accustomed fishing places, but with a qualification that would allow the government to diminish or destroy the fish runs. Governor Stevens did not make, and the Indians did not understand him to make, such a cynical and disingenuous promise.

[2] *Seufert Brothers Co. v. United States*, 249 U.S. 194, 197 (1919).

> The Indians reasonably understood Governor Stevens to promise not only that they would have access to their usual and accustomed fishing places, but also that there would be fish sufficient to sustain them. They reasonably understood that they would have, in Stevens' words, "food and drink ... forever." As the Supreme Court wrote in *Fishing Vessel*:
>
>> Governor Stevens and his associates were well aware of the "sense" in which the Indians were likely to view assurances regarding their fishing rights. During the negotiations, the vital importance of the fish to the Indians was repeatedly emphasized by both sides, and the Governor's promises that the treaties would protect that source of food and commerce were crucial in obtaining the Indians' assent. It is absolutely clear, as Governor Stevens himself said, that neither he nor the Indians intended that the latter should be excluded from their ancient fisheries, and it is accordingly inconceivable that either party deliberately agreed to authorize future settlers to crowd the Indians out of any meaningful use of their accustomed places to fish.

United States v. Washington, 827 F.3d 836, 851–52 (9th Cir. 2016), opinion amended and superseded, 853 F.3d 946 (9th Cir. 2017) (citations omitted).

The Ninth Circuit upheld the district court's order directing the State of Washington to remove culverts underneath state roads that blocked salmon access to over 1,000 miles of spawning habitat. The State of Washington had vigorously opposed the positions of the United States and the tribes, at one point claiming that the treaties would not prevent the state from blocking every salmon bearing stream entering Puget Sound. *Id.* at 849-50. The State argued that the principal purpose of the treaties was to open land for settlement. "But it was most certainly not the principal purpose of the Indians. Their principal purpose was to secure a means of supporting themselves once the Treaties took effect." *Id*. at 851. Like the dams on the Columbia and Snake rivers, the culverts in Puget Sound transferred the productive function of salmon bearing streams into transportation systems benefiting the public while sacrificing tribal cultural and economic resources. The United States Supreme Court did not accept Washington's arguments for ignoring the treaty commitments.

More recently, the United States Supreme Court spoke at length to the nature of the of the Treaty agreements made by the United States and the Yakama Nation in the 1855 Treaties. It upheld the agreement as understood by the tribal negotiators: in short, "a deal is a deal."

> [T]his Court has considered this [Yakama] treaty four times previously; each time it has considered language very similar to the language before us; and each time it has stressed that the language of the treaty should be understood as bearing the meaning that the Yakamas understood it to have in 1855. *See Winans*, 198 U.S. at 380–381, 25 S.Ct. 662; *Seufert Brothers Co. v. United States*, 249 U.S. 194, 196–198, 39 S.Ct. 203, 63 L.Ed. 555 (1919); Tulee, 315 U.S. at 683–685, 62 S.Ct. 862; *Washington v. Washington*

> *State Commercial Passenger Fishing Vessel Assn*., 443 U.S. 658, 677–678, 99 S.Ct. 3055, 61 L.Ed.2d 823 (1979).

Washington State Dep't of Licensing v. Cougar Den, Inc., 139 S. Ct. 1000, 1011 (2019).

> Really, this case just tells an old and familiar story. The State of Washington includes millions of acres that the Yakamas ceded to the United States under significant pressure. In return, the government supplied a handful of modest promises. The State is now dissatisfied with the consequences of one of those promises. It is a new day, and now it wants more. But today and to its credit, the Court holds the parties to the terms of their deal. It is the least we can do.

Id. at 1021 (Gorsuch and Ginsberg, concurring).

This year and last, the United States Supreme Court has upheld key treaty rights commitments. If there was a question in 1999 about the significance of the tribes' treaty fishing rights it has been resolved in favor of the tribes' understanding.

B. Tribal Circumstances Framework

These comments offer a perspective on the Columbia River System Operation Draft Environmental Impact Statement, including its background information, alternatives and evaluations. Because the CRSO DEIS is constantly evolving and incompletely drafted at the time these comments were prepared, the Columbia River Treaty Tribes will prepare further comments on the CRSO DEIS as it progresses. Each of the Co-Lead Agencies has adopted policies respecting the tribes' sovereignty, treaty secured interests, the Co-Leads' government-to-government relationships and their trust responsibilities to the tribes. It is important that the CRSO DEIS clearly inform the public that the tribes are not merely stakeholders, but that the tribes' interests are guaranteed by the United States.

In April 1999, the CRITFC published a report entitled "Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes" prepared by Meyer Resources, Inc. [hereinafter "Meyer Report]. The Meyer Report was prepared under a contract between Foster-Wheeler and CRITFC with funding provided by the Corps of Engineers. The principle author of the Meyer Report was Phil Meyer, an economist with years of experience working with native communities. The Meyer Report was submitted to the administrative record for the Corps' Lower Snake River Juvenile Salmon Migration Feasibility Study and Draft Environmental Impact Statement.[3] Since 1999, the Meyer Report has maintained its relevancy and is particularly pertinent to the CRSO DEIS.

[3] Army Corps of Engineers, Lower Snake River Juvenile Salmon Migration Feasibility Study and Draft Environmental Impact Statement (Dec. 1999)<http://docs.streamnetlibrary.org/USACE/LSR-FR-EIS/coemain.pdf>; Army Corps of

One of the most salient features of the Meyer Report is the many contemporary statements by leaders of the Columbia River Treaty Tribes that it ties to the socio-economic analytical framework. The tribal leaders' quotations in the Meyer Report are all still relevant and particularly to the CRSO DEIS. Moreover, the tribes' views have been consistently expressed since treaty times.

> God created this Indian country and it was like He spread out a big blanket. He put the Indians on it... Then God created the fish in this river and put deer in these mountains and made laws through which has come the increase of fish and game. ...For the women, God made roots and berries to gather, and the Indians grew and multiplied as a people. When we were created we were given our ground to live on, and from that time these were our rights. This is all true. We had the fish before the missionaries came. ...This was the food on which we lived. ...My strength is from the fish; my blood is from the fish, from the roots and the berries. The fish and the game are the essence of my life. ...We never thought we would be troubled about these things, and I tell my people, and I believe it, it is not wrong for us to get this food. Whenever the seasons open, I raise my heart in thanks to the Creator for his bounty that this food has come. [4]

George Meninock's statement reinforces the tribal understanding at treaty times that the United States was securing the tribes' food, particularly fish. The testimony of Jim Wallahe, a co-defendant of Meninock, is also particularly pertinent to the CRSO EIS. He expresses his understanding that his treaty fishing rights were not subordinated by dam building. He stated, "I do not think I do any wrong when I fish at this place my father saved for me and which the great spirit made for the Indians [Top-tut Falls where Prosser Dam now exists]. Is it right for the white man to build a dam at the falls and then say that the Indians destroy the bounty of the Creator?"[5]

A more contemporary explanation of a similar point is made in the Nez Perce Tribe's Department of Fisheries Resources Management 2013-2028 Management Plan. "Tribal harvest is not to be viewed as a "new" action that incrementally increases the survival gap of diminished Columbia and Snake River runs, but rather as a baseline that the fish runs have always encountered and that the United States secured by treaty."[6] For decades, the tribes

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Engineers, Final Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (Feb. 2002).

[4] Testimony of George Meninock before the Washington Supreme Court in 1913 in Meyer Report, *supra* note 1 at 146. An excellent description of the events leading up to and following this testimony is provided in the book, "Si'lailo Way" (see note 5).

[5]Dupris, Joseph C. et al., The Si'lailo Way: Indians, Salmon and the Law on the Columbia River at 229 (Caroline Academic Press 2006).

have shouldered the conservation burden created by dams which they eloquently opposed in formal testimony.[7]

The Meyer Report reinforces the vision of George Meninock who urged non-Indians to respect the commitments of Isaac Stevens, the United States' 1855 treaty negotiator and Governor of Washington Territory.[8] The Meyer Report describes the baseline from which to consider the effects of the Lower Snake River Dams:

> At treaty times, the salmon resource reserved by the tribes was the harvest from river systems that were biologically functional and fully productive. If the tribal treaty negotiators had perceived that they were bargaining to reserve "only a small fraction" of the salmon available to harvest in the mid-1800's, the treaty negotiations would have been much different – if they had occurred at all.
>
> The treaty signers, both tribal and non-tribal, were also clear that the Treaties were designed to take care of the needs of tribal peoples into the future without limit. Successive tribal leaders have reminded us of this intent. Consequently, there is no date in time, subsequent to 1855, that cuts off tribal Treaty entitlements.
>
> In conclusion, the Treaty tribes are entitled to a fair share of the salmon harvest from all streams in their ceded area(s) – measured at the fully functioning production levels observed in the mid-1800's. This was the tribal entitlement at Treaty times. It is still so today, and into the future. Declines in the salmon productivity of the river due to subsequent human action have not changed this entitlement.[9]

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[6] Nez Perce Tribe Department of Fisheries Management, Management Plan 2013-2028 at 45 (July 17, 2013), < http://www.nptfisheries.org/portals/0/images/dfrm/home/MgmntPlan.pdf >.

[7] *E.g.,* Comments of William Minthorn in US Army Corps of Engineers, Review Report on John Day Dam, 22-3:

> this dam [John Day] will do a lot of people some good in this community - however, our primary concern has always been fishing, that is the Indians' concern has been fishing and ancient fishing sites. Therefore, we oppose the construction of the John Day Dam. For these reasons, the main reason is that it will flood out the last remaining fishing sites that was guaranteed us by our treaty of June 9, 1855. Already through the other constructions of the developments to date, we have lost some of our best fishing sites, such as Celilo Falls. Practically the last remaining fishing sites that we have left is between the mouth of the John Day River and the McNary Dam; so by building the John Day Dam, these last remaining sites will be flooded.

Allen, Cain, *Replacing Salmon: Columbia River Indian Fishing Rights and the Geography of Fisheries Mitigation* in Oregon Historical Quarterly, Vol. 104 No. 2, pp. 196-227 at 215 (Summer 2003) <www.jstor.org/stable/20615319> [hereinafter *Replacing Salmon*].

[8] Isaac Stevens' military career included service with the Corps of Engineers the during the Mexican-American War.

[9] Meyer Report, *supra* note 1 at 15.

As described by a Warm Springs tribal leader in the Meyer Report:

> So there's no question that the people hold you responsible forever to manage the salmon and all of the foods that they reserved. And that's a simple answer to the concern of how long do you manage. I understand that now some people say, 'Why the fisheries resources getting small, it's so minor now. It isn't worth planning for any longer.' The industrial and economic people saying, 'Let's go another direction. To heck with the good rivers, clean rivers and the salmon. Let's go another way.' That's a question coming pretty close I understand. And that is not the case. We're going to be there to say you're going to keep your promise. Forever! [10]

No intervening circumstances have changed this important perspective, which the tribes have held prior to and since their treaty negotiations. As discussed below, events since 1999 have not diminished, but rather have reinforced, the point of view that the United States' treaty commitments are forever.

C. An updated discussion of tribal poverty and income levels of the Columbia River Treaty Tribes with reference to the Meyer Report.

The 1999 Meyer Report tied multiple expressions of tribal values to an understanding of tribal well-being measured by several different economic indicators. These economic indicators were framed in terms of a hierarchy of needs:[11]

Self Esteem
|
Belongingness and Love
|
Safety Needs
|
Food and Shelter

The Meyer Report observed linkage between the availability of traditional foods, including especially salmon, and tribal health as measured by mortality rates associated with the loss of

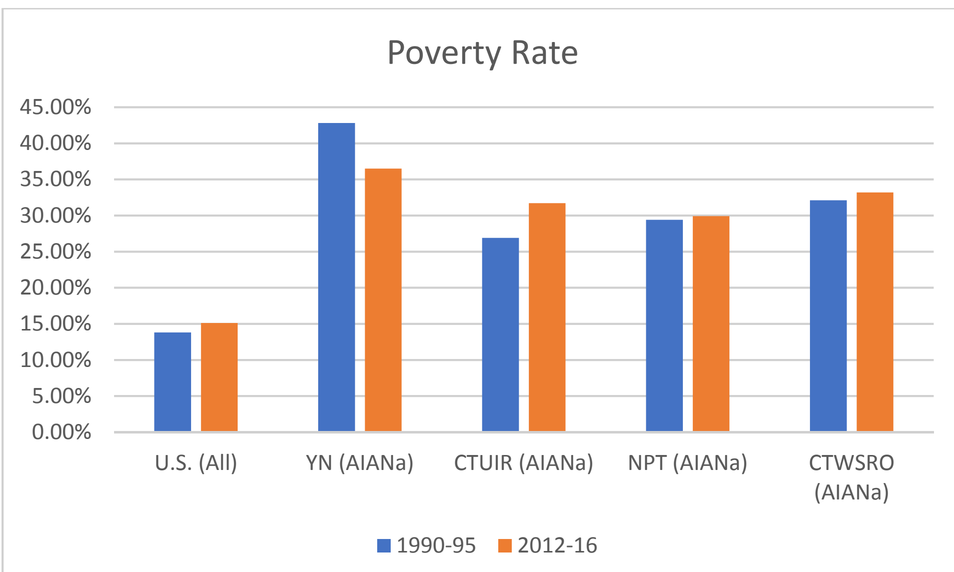
[10] Statement of Delbert Frank, Meyer Report, *supra* note 1 at 34.

[11] These needs underlie human kind's goal for "an increasing trend toward unity, integration, or synergy, within the person". For instance, someone who is absorbed totally in fulfilling ongoing hunger needs will attend less to safety needs; and, a person whose security is constantly threatened will be less able to develop intimacy with others. See Meyer Report, *supra* note 1 at 46, discussing and quoting Bachtold, L.M., Destruction of Indian Fisheries and Impacts on Indian Peoples in Meyer-Zangri Associates, The Historic and Economic Value of Salmon and Steelhead to Treaty Fisheries in 14 River Systems in Washington, Oregon and Idaho. Vol. 1. A Report to the US Bureau of Indian Affairs. Davis, CA., pp. 17-21 (1982).

healthy/traditional foods. The Report also described the importance of salmon to the cultural well-being of tribal people and their sense of belonging to their culture and being part of traditions that define themselves as Indian people as well as their self-esteem as members of their tribes and fulfilling their cultural obligations.[12]

The Meyer Report also used tribal poverty, tribal unemployment, tribal per capita income, tribal health and tribal assets as more traditional indicators of tribal well-being.[13] The Report provided relevant data for each of these indicators. In the end, the Meyer Report concluded that the impacts of the Snake River dams to the productivity of the Snake River Basin's salmon and steelhead had severely impacted the tribes' well-being.

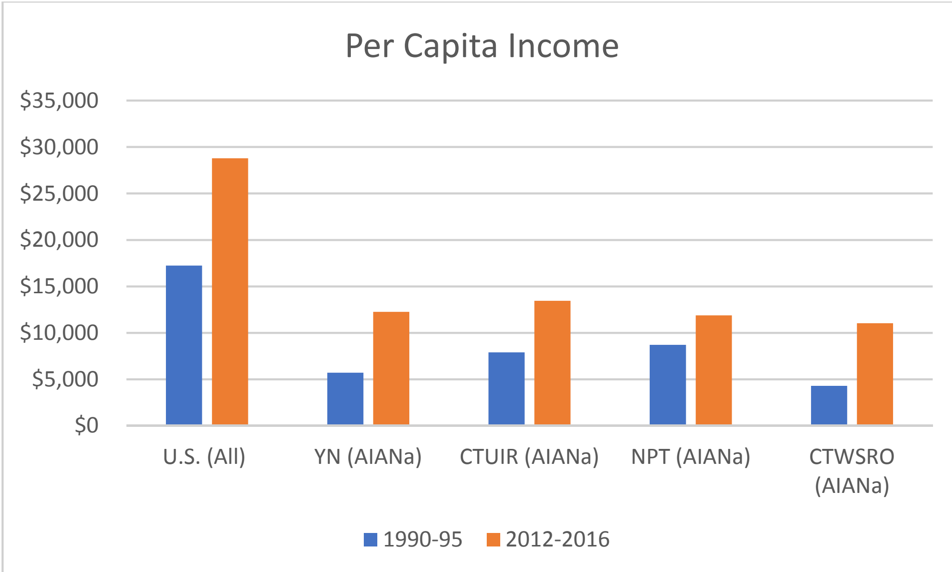
One of the ways this Tribal Perspectives Report updates the continuing relevance of those portions of the Meyer Report concerning tribal well-being is to compare the tribal poverty levels and income information from the Meyer Report with more current data. The data for this comparison were obtained from the Federal Reserve Bank of Minneapolis, which maintains a comprehensive data base through its Center for Indian Country Development.[14] The more recent data from the American Community Survey reflects the pattern observed in the Meyer Report; Tribal poverty rates for the Columbia River Treaty Tribes are still two to three times the national average and per capita income is less than half the national average.



[12] Meyer Report, *supra* note 1 at 45.

[13] *Id.* at 49.

[14] Available at https://www.minneapolisfed.org/indiancountry.



The 1990-95 data (blue) were obtained from the 1999 Meyer Report, which presented information from the 1990 Special Tribal Run U.S. Census. The source and nature of these data are described in section 2.1.5.2. of the Meyer Report. The 2012-2016 data (orange) were obtained from the Center for Indian Country Development, which is a project of the Federal Reserve Bank of Minneapolis. The Center aggregates data from the American Community Survey (ACS), which is conducted every year to provide up-to-date information about the social and economic conditions within the United States. The long form decennial Census and the ACS forms are very similar and responses to both are required by law. The ACS data are aggregated into five-year periods, which is considered best practice for small communities.[15]

Current poverty and income levels among the four Columbia River Treaty Tribes present very challenging circumstances from which tribal members can develop improved well-being. The absence of salmon underlies and compounds these challenges. Tribal members often prefer fishing-related economic means of support, which preserve their cultural ties to prior generations, the tribes' traditions and the fisheries resources themselves.

The eight Columbia and lower Snake river dams transformed the production functions of the federally impounded portions of the Columbia and Snake rivers - taking substantial treaty-protected wealth in salmon away from the tribes. At the same time, the dams increased the wealth of non-Indians through enhanced production of electricity, agricultural products,

[15] Personal communication (email), April 19, 2019, from Donna Feil, PhD. Research Economist CICD <https://www.minneapolisfed.org/indiancountry >.

transportation services, flood control, and other associated benefits. As thoroughly documented in the Meyer Report, tribal peoples have not shared in this increased wealth on a commensurate basis. Moreover, the tribes did not share commensurately in the fisheries mitigation that did occur. As discussed below, the burdens of the dams and failed mitigation policies fell disproportionately on tribal fisheries.[16]

D. Discriminatory Effects of Mitigation and the Importance of "In-Place, In-Kind"

The Meyer Report briefly describes the history of hatchery development in the Columbia Basin.[17] This history deserves expansion in this Perspective on the CRSO DEIS. Failures to implement "in-place, in-kind" mitigation illustrate the cumulative effects the tribes have experienced resulting from the development of the Columbia River System dams and past inappropriate mitigation efforts.

Since 1938, the U.S. Army Corps of Engineers conducted two separate programs to mitigate for the loss of salmon spawning grounds due to the construction of the Bonneville, The Dalles, John Day and McNary dams. Between 1946 and 1980, the Columbia River Fisheries Development Program (CRFDP), also referred to as the Mitchell Act, funded the construction and expansion of twenty-six hatcheries to mitigate for mid-Columbia River dams, twenty-four of them below the Long Narrows and Celilo Falls where the tribes had fished for millennia. Like the CRFDP, John Day Fishery Mitigation for the construction of The Dalles and John Day dams exhibited a spatial discontinuity between impact and mitigation, with all of the proposed hatchery sites located well below the dam.[18]

For the Columbia River Treaty Tribes whose fishing places were inundated by the dams (along with their primary homes and important sites to tribal culture and religion), the location of hatchery mitigation added further injury to their losses. The hatchery mitigation implementation was clearly intended to benefit non-Indian fisheries in the lower Columbia River and the coastal locations where non-Indian fisheries predominated. "In other words, fish that had been returning to the Indians' usual and accustomed fishing places for generations

[16] The US Environmental Protection Agency (EPA) defines Environmental Justice (EJ) as:

> The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Fair treatment means no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences from industrial, municipal and commercial operations or the execution of federal, state, local, and tribal programs and policies.

US EPA, Environmental Justice (visited June 7, 2019) <https://www.epa.gov/environmentaljustice>. Relevant tribal information is presented below and will be added to the record for the CRSO DEIS in the future.

[17] Meyer Report, *supra* note 1 at 147.

[18] Allen, *Replacing Salmon,* supra note 7 at 199.

were destroyed by the dam, but only a fraction of those fish that were produced as mitigation returned to an area where Indians are allowed to fish commercially."[19]

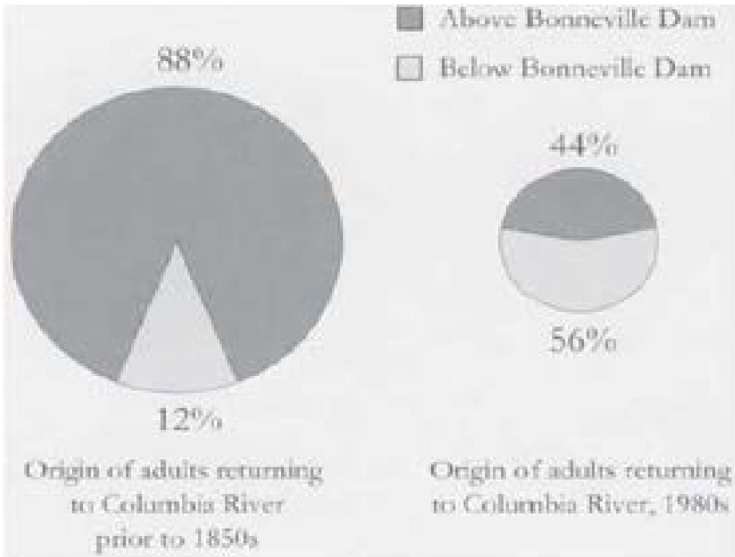


Figure 1: Changes in the distribution of salmon production in the Columbia River Basin (Northwest Power Planning Council, Columbia River Basin Fish and Wildlife Program, *Portland, Ore., 1987, app. E, table 6)*

For decades, the Treaty Tribes have vigorously objected to the injustice of this situation. In recent years the parties to the *U.S. v. Oregon* proceedings and the Corps of Engineers have agreed to implement a portion of the mitigation requirements for John Day and The Dalles dams at locations above McNary Dam. That work is pending approval by the Assistant Secretary of the Army for Civil Works, appropriations necessary to carry out the work, regulatory compliance, and construction.[20] It has taken the Corps of Engineers more than 40 years to address the Tribes concerns that salmon production mitigate impacts to their fisheries.

E. Tribal Restoration Initiatives Published Since 1999

Since 1999, the Columbia River Treaty Tribes have published multiple plans, documents and reports that add important context to the tribes' perspectives. Several of these publications are highlighted below. They should all be carefully considered in the CRSO DEIS and each are herein fully incorporated by reference.

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[19] *Id.* at 221.

[20] *See,* Letter to Col. Eisenhauer, USACE Portland District, and Steve Wright, Administrator Bonneville Power Administration, from Guy Norman, vice chair *U.S. v. Oregon* Policy Committee dated September 7, 2011 (describing in-kind mitigation commitments); Letter to BG Funkhouser, USACE Northwestern Division, from Guy Norman, vice chair *U.S. v. Oregon* Policy Committee, dated March 7, 2013 (escribing agreement on total adult production goal).

1. In 2014, CRITFC and its member tribes updated Wy-Kan-Ush-Mi Wa-Kish-Wit, the Columbia River Treaty Tribes' Spirit of the Salmon Plan. The tribes originally published Wy-Kan-Ush-Mi Wa-Kish-Wit in 1995.[21] This tribal salmon restoration plan outlined the cultural, biological, legal, institutional and economic context within which the region's salmon restoration efforts are taking place. This long-term plan addresses virtually all causes of salmon decline and roadblocks to salmon restoration for all anadromous fish stocks: Chinook, coho, sockeye, steelhead, chum, eels (Pacific lamprey)[22] and sturgeon, above Bonneville Dam.

   The 2014 Update did not alter the tribal goals and objectives for restoring anadromous fishes to the rivers and streams that support the historical, cultural and economic practices of the tribes. The objectives are to:

   - Within 7 years, halt the declining trends in salmon, sturgeon and lamprey populations originating upstream of Bonneville Dam.
   - Within 25 years, increase the total adult salmon returns above Bonneville Dam to 4 million annually and in a manner that sustains natural production to support tribal commercial as well as ceremonial and subsistence harvests.
   - Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
   - Restore anadromous fishes to historical abundance in perpetuity.

The EIS must consider the technical recommendations presented in Wy-Kan-Ush-Mi Wa-Kish-Wit, which address twenty different subject matter areas, framed in terms of the salmon life cycle, including watershed restoration, juvenile fish migration, estuary protection and restoration, adult fish migration, climate change and more.[23] These recommendations relate directly to the CRSO operations and mitigation measures for those operations.

2. Pacific lamprey are just as important to tribal peoples as salmon. For over 10,000 years the people of the Nez Perce, Umatilla, Yakama and Warm Springs tribes depended on lamprey (commonly referred to as "eels") alongside of the salmon, roots and berries. The tribal people used the eel for food and medicine, and many stories and legends surrounding the eel were passed down from generation to generation. Before the

[21] Columbia River Inter-Tribal Fish Commission [Columbia River Treaty Tribes], Wy-Kan-Ush-Mi Wa-Kish-Wit, the Spirit of the Salmon, 1995 Tribal Restoration Plan and 2014 Update, available at https://plan.critfc.org/ [hereinafter Wy-Kan-Ush-Mi Wa-Kish-Wit].

[22] Wy-Kan-Ush-Mi Wa-Kish-Wit also addresses Pacific lamprey in the Willamette Basin.

[23] Summary and link to Wy-Kan-Ush-Mi Wa-Kish-Wit Technical Recommendations available at https://plan.critfc.org/2013/spirit-of-the-salmon-plan/technical-recommendations/.

construction of The Dalles Dam in 1957, the river at Celilo Falls was often black with eels. Tribal members took just what their families needed for a year. Eels were plentiful in many Columbia basin waters including the Walla Walla River, Asotin Creek, Clearwater River tributaries, the South Fork of the Salmon River, Swan Falls, the upper portions of the Yakima River and the tributaries of the upper Columbia. Now many of these great rivers have no eels or at best remnant numbers. "The Creator told the people that the eels would always return as long as the people took care of them, but if the people failed to take care of them, they would disappear."[24]

The Tribal Pacific Lamprey Restoration Plan is the most inclusive plan for Pacific lamprey to date. Published in 2011, the plan looks to halt the significant decline of lamprey and reestablish lamprey populations throughout the mainstem Columbia River and its tributaries.[25] The plan seeks to improve mainstem and tributary passage for juvenile and adult lamprey, restore and protect mainstem and tributary habitat, reduce toxic contaminants, and consider supplementation programs to aid re-colonization throughout the basin. The Tribal Lamprey Plan, including all of its recommendations, must be carefully addressed in the CRSO DEIS.

3. No mitigation has occurred benefitting either the abundance or productivity of sturgeon populations affected by the construction and operation of the eight lower Columbia and Snake river federal dams. In 2015, CRITFC published a 360-page master plan for development of a hatchery to supplement sturgeon populations in the mainstem lower Snake and Columbia rivers.[26] The master plan describes the current conditions of sturgeon with particular relevance to the Columbia River Treaty Tribes. While sturgeons occur throughout most of their historical range, current production is far below the historical levels. Unlike salmon and lamprey, passage of sturgeon upstream is no longer possible and the dams have taken anadromy away from some of these fish. Low numbers severely limit sturgeon harvest opportunities throughout the basin, particularly for impounded populations upstream from Bonneville Dam. Small tribal subsistence, tribal commercial fisheries, and non-tribal recreational fisheries occur upstream from Bonneville Dam. Current fisheries are highly regulated in order to maintain small levels of harvest consistent with current productivity. In addition, because they are no longer anadromous, many sturgeon are now more contaminated by pollution than they were previously. The master plan is designed to help mitigate impacts of development and operation of the Federal Columbia River Power System on

[24] Remarks of Ron Suppah, Vice Chair, Warm Springs Tribes in CRITFC, Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin, (December 19, 2011) <https://critfc.org/wp-content/uploads/2012/12/lamprey_plan.pdf>.

[25] *Id.*

[26] CRITFC, White Sturgeon Hatchery Master Plan: Lower Columbia and Snake River Impoundments, Step 1 Revised (December 15, 2015), available at https://www.critfc.org/blog/documents/white-sturgeon-hatchery-master-plan/.

sturgeon population productivity and fishery opportunities in lower mid-Columbia River and lower Snake River reservoirs. The master plan's information and mitigation proposals should be carefully considered in the CRSO DEIS.

4. The Yakama Nation publishes a Status and Trends Annual Report (STAR) that describes the progress it is making in restoring anadromous fish in its reservation lands and ceded territories.[27] The STAR reports confirm that the Yakama Nation's expectations are grounded in its 1855 treaty reserved rights.

> "In the Treaty of June 9, 1855, the Yakama Nation reserved the right to maintain its culture and the natural resources on which its culture depends, including rights to water, land, and natural foods and medicines at all usual and accustomed places. Subsequent federal court rulings assured the Yakama Nation the right to self-regulation of their own fish management and take, a fair share of all allowable harvest, and the restoration of fish historically present and/or mitigation for losses."[28]

The STAR reports are not so much a mitigation plan, per se, as they are a reflection of the mitigation actions that are occurring pursuant to the Tribe's inherent sovereignty exercised in planning coordination with various federal authorities such as the Northwest Power Act, Endangered Species Act, Yakima Basin Water Enhancement legislation and multiple others.[29] The mitigation actions specified in the Yakama STAR reports will continue for decades to come. These mitigation measures must be addressed in the CRSO EIS as ongoing mitigation for the CRSO.

5. In 2013, the Nez Perce Tribe adopted a Fisheries Management Plan, 2013-2028.[30] The Plan is intended to formally establish and describe the desired fishery resource conditions and the management framework that will be applied by the Nez Perce Tribes'

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[27] Yakama Nation Fisheries, Status and Trends Annual Report (2017) available at http://yakamafish-nsn.gov/restore/projects/star [hereinafter 2017 STAR Report].

[28] *Id.* at 52.

[29] For example, fish passage improvements in the Yakima Basin have been funded in significant part by the Bonneville Power Administration (> $500 M) as offsite mitigation for the FCRPS and were implemented by the Bureau of Reclamation. Section 109 of the Hoover Power Plant Act of 1984 (P.L. 98-381, 98 Stat. 1333) gave Reclamation authority to design, construct, operate, and maintain fish passage facilities within the Yakima River Basin and to accept funds from BPA. The relationship of Bonneville's funding and the Reclamation's authorizations has been described in multiple publications, including the Council's Fish and Wildlife Program. A good summary is contained in the Bureau of Reclamation's 2009 Summary of the Fish Passage Program in the Yakima Basin <https://www.usbr.gov/pn/programs/yrbwep/reports/fishscreen/completionreport.pdf>.

[30] Nez Perce Tribe Department of Fisheries Resources Management, 2013-2028 Management Plan (July 17, 2013) <http://www.nptfisheries.org/portals/0/images/dfrm/home/fisheries-management-plan-final-sm.pdf>.

Fishery Management Department to achieve those conditions. Communicating this fundamental mission to co-managers and the public is a key object of the Management Plan. The Management Plan must be addressed in the CRSO DEIS. "Eventually, the goal would be to achieve a harvest consistent with pre-Treaty harvest levels." The plan sets forth salmon and steelhead abundance goals for individual tributaries throughout the Nez Perce's ceded lands and its' usual and accustomed fishing places.

6. The 2008 Umatilla River Vision sets forth a First Foods management context for the Umatilla River Basin.[31] Its innovation and important cultural context has been recognized by other co-managers, including tribes, states and federal agencies. The First Foods are considered by the CTUIR Department of Natural Resources to constitute the minimum ecological products necessary to sustain CTUIR culture. The CTUIR DNR has a mission to protect First Foods and a long-term goal of restoring related foods in the order to provide a diverse table setting of native foods for the Tribal community. The mission was developed in response to long-standing and continuing community expressions of First Foods traditions, and community member requests that all First Foods be protected and restored for their respectful use now and in the future.[32]

7. The Warm Springs Fisheries Department is dedicated to the research, management, and enhancement of fisheries and fishery resources on the reservation, ceded lands and usual and accustomed stations of the Confederated Tribes of the Warm Springs. The Department actively maintains a website describing its monitoring and research, fish habitat, production and harvest management.[33] Through the Warm Springs, John Day, and Parkdale offices the Fisheries Department employed over 70 professional, technical, and temporary staff. The Warm Springs Fisheries Department has implemented over 200 projects for management and enhancement of spring and fall Chinook, summer and winter steelhead, sockeye/kokanee, bull trout, and Pacific lamprey populations and their habitat.

F. Non-Tribal Plans Affirming the goals of the Tribes.

Multiple plans have been published by governments in the Northwest that are consistent with or otherwise support the visions set forth in the tribal plans. Three of them are highlighted below.

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[31] Jones et al., Umatilla River Vision (2008) <http://www.ykfp.org/par10/html/CTUIR%20DNR%20Umatilla%20River%20Vision%20100108.pdf >.

[32] Webster, James, CTUIR River Vision for Floodplain Management (Powerpoint Presentation) (June 1, 2001) <http://www.salmonforall.org/wp-content/uploads/2013/02/webster_rivervision.pdf >.

[33] Warm Spring Fisheries Department website <https://fisheries.warmsprings-nsn.gov/about-the-fisheries-department/ >.

1. Columbia Basin Partnership (CBP) 2019 Provisional Goals

Over the past two years, the 28 members of the Columbia Basin Partnership Task Force (Task Force), representing a diversity of managers and stakeholders across the Columbia Basin, have worked to develop a shared vision and goals for Columbia Basin salmon and steelhead. The Task Force forwarded recommendations on these goals, in the form of a Phase 1 Report,[34] to the Marine Fisheries Advisory Committee (MAFAC) for their consideration and that of the NOAA Fisheries Administrator.

The recommendations include qualitative and quantitative goals. The quantitative goals translate into a total increase of naturally produced salmon and steelhead from the current average of 400,000 to as high as 3.6 million adults. This represents an eightfold improvement from current levels but is considerably less than the number of salmon and steelhead that the basin produced historically. The goals also reflect available information on habitat production potential. The corresponding average total Columbia River run (natural-plus hatchery-origin fish) would be projected to increase from 2.3 million to approximately 11.4 million fish.

Importantly, the Task Force acknowledged that "[t]he tribal nations are not willing to accept the normalization of the status quo and do not concede our long-term tribal goals for salmon and steelhead restoration, including restoring passage to blocked regions of the Columbia River basin that historically supported anadromous fish."[35]

2. Northwest Power and Conservation Council, 2014 Columbia Basin Fish and Wildlife Program (F&WP)

The Northwest Power Act requires the Northwest Power and Conservation Council (NPCC) to adopt and renew at least once every five years a Fish and Wildlife Program "to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries."[36] The Council is currently in a one-year cycle to consider modifications to the Program, based on its statutory requirements to base the Program on the recommendations of tribes and other fish and wildlife co-managers.[37] Bonneville, Reclamation and the Corps must take the Program adopted by the Council "into account at each relevant

[34] Columbia Basin Partnership Task Force, A Vision for Salmon and Steelhead: Goals to Restore Thriving Salmon and Steelhead to the Columbia River Basin (Phase 1 Report to the NOAA Fisheries Marine Fisheries Advisory Committee), Final Draft Report (March 28, 2019) [hereinafter Phase 1 Report].

[35] *Id.* at 25.

[36] 16 U.S.C. 839b (h)(1).

[37] *NRIC and Yakama Nation v. NPPC*, 35 F.3d 1371, 1385 (9th Cir. 1994).

stage of decision making processes to the fullest extent practicable."[38] The 2014 Columbia River Basin Fish and Wildlife Program includes the following objectives:

> As an interim objective, increase total adult salmon and steelhead runs to an average of 5 million annually by 2025 in a manner that emphasizes the populations that originate above Bonneville Dam and supports tribal and non-tribal harvest.
>
> As an interim objective, achieve smolt-to-adult return rates in the 2-6 percent range (minimum 2 percent; average 4 percent) for listed Snake River and upper Columbia salmon and steelhead. Within 100 years, achieve population characteristics that, while fluctuating due to natural variability, represent full mitigation for losses of fish.[39]

The Independent Scientific Advisory Board (ISAB) has consistently recognized the importance of the 2-6% SAR goal and recommended that the Comparative Survival Study (CSS) conduct analyses to verify and validate the 2-6% SAR goal in terms of population rebuilding.[40] The 2014 CSS Annual Report is the first which included analyses of 2-6% SAR regional goal. SARs versus productivity for major population groups has been analyzed in each CSS Annual Report since 2014, adding additional population groups each year. The results of these analyses confirm the validity of the 2-6% SAR goal for Chinook and steelhead as necessary to rebuild major population groups.[41]

3. **The Accords Extension signed by the Co-Lead Agencies, CTUIR, CTWSRO, YN and CRITFC broadly affirms the Parties support for the Columbia River Basin Fish and Wildlife Program.**

The Accords Agreement was initially negotiated in 2007-2008 and signed by the Co-Lead Agencies, three of the Columbia River Treaty Tribes and CRITFC. After several more years of negotiation, this landmark agreement was renewed in 2019. This Extension affirms support for the Columbia River Basin Fish and Wildlife Program and continues to address direct and indirect effects of construction, inundation, operation, and maintenance of the fourteen federal multiple-purpose dam and reservoir projects in the Federal Columbia River Power System that

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[38] 16 U.S.C. 839b (h)(11)(A)(ii).

[39] Northwest Power and Conservation Council, 2014 Columbia River Basin Fish and Wildlife Program at 157.

[40] Independent Scientific Advisory Board, Review of the Comparative Survival Study's Draft 2013 Annual Report, ISAB 2013-4 at 1 (October 14, 2013) <https://www.nwcouncil.org/sites/default/files/ISAB2013-4_0.pdf >.

[41] McCann, J., et al., Comparative Survival Study (CSS) of PIT tagged Spring/Summer Chinook and Summer Steelhead. 2018 Annual Report. Project No. 199602000 (December 2018) <http://www.fpc.org/documents/CSS/2018_Final_CSS.pdf > [hereinafter 2018 CSS Annual Report].

are operated by the Co-Lead Agencies as a coordinated water management system for multiple congressionally authorized public purposes and referred to as the Columbia River System, as well as Reclamation's Upper Snake River Projects on fish and some wildlife resources of the Columbia River Basin.

G. Comparing Aspects of Affected Environment in the Meyer Report 1999 versus the CRSO DEIS Analyses

This section of the Tribal Perspectives Report addresses two topics that underpinned the 1999 Meyer Report: the abundance of focal fish species and effects of the federal hydro system on anadromous fish survival. Adult salmon, sturgeon and lamprey abundance, and tribal harvest, are still far removed from historical levels. Juvenile salmonid reach survival in the mainstem sections of the Snake and Columbia rivers impounded by the FCRPS dams is still similar to and sometimes less than the reach survival levels that occurred in the 1990s.

1. Salmon Abundance

During the intervening years between 1999 and 2019, salmon abundance improved somewhat. Based on ten-year averages, the most recent ten-year average returns of salmon to Bonneville Dam from 2008 to 2018 are greater than the ten-year average from 1990 to 1999 that were considered in the Meyer Report. As noted below, the most recent two years of adult returns from 2017 and 2018 however have declined to run sizes similar to those that occurred in the 1980s.

To place recent adult salmon abundance in perspective, however, data for selected tributaries from the Columbia Basin Partnership Phase 1 Report (CBP Report) provide a synopsis of current context. Appendix A of the CBP Report is particularly useful in this regard. It displays recent and historic salmon abundance in tributaries throughout the Columbia Basin. The data show that the reductions in salmon abundance in these subbasins are still very significant, one to three orders of magnitude less than historic conditions that would have existed in 1855 at the time of the treaty negotiations.

The following abundance comparisons for naturally spawning populations of salmon and steelhead from Appendix A of the CBP Report are shown below for regions within the Columbia Basin. Naturally spawning populations in the Upper Columbia[42] and Snake[43] River regions have been often two orders of magnitude less than the historic naturally spawning abundance levels.

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[42] The Upper Columbia Region comprises the Columbia mainstem and its tributaries above the confluence of the Yakima and Columbia Rivers, including Canadian portions of the Basin.

[43] The Snake River stocks are those located with the Snake River Basin from the headwaters to the confluence of the Snake River with the Columbia River.

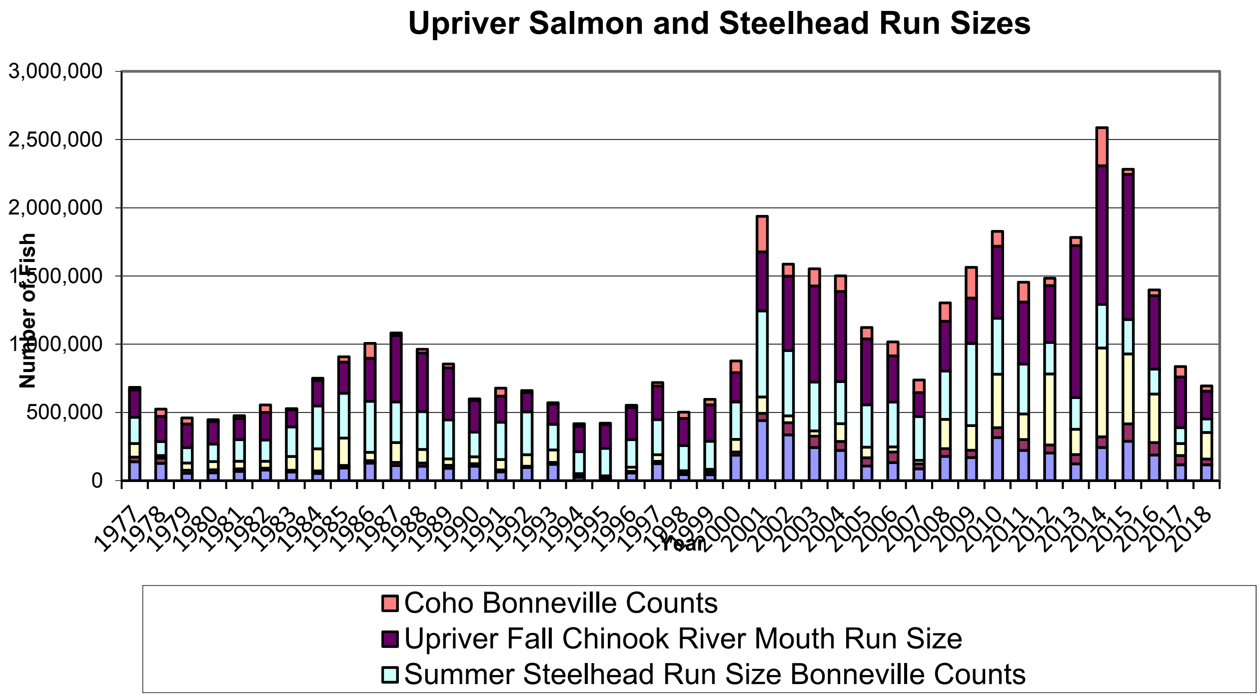
In the Mid-Columbia[44] region, current naturally spawning populations are roughly an order of magnitude less than the historic naturally spawning abundance levels.

Tributary Abundance	Recent	Historical
Upper Columbia Sockeye	80,750	2,000,000
Upper Columbia Steelhead	1,480	1,121,400
Upper Columbia Spring Chinook	1,430	259,432
Upper Columbia Summer Chinook	16,290	694,000
Upper Columbia Fall Chinook	92,400	680,000
Snake River Sockeye	100	84,000
Snake River Steehead	28,000	114,800
Snake River Spring/Summer Chinook	6,988	1,000,000
Snake River Fall Chinook	8,360	500,000
Mid-Columbia Sockeye		
Mid-Columbia Spring Chinook	9,600	103,700
Mid-Columbia Summer/Fall Chinook	11,500	17,000
Mid-Columbia Steelhead	18,155	132,800
Total naturally spawning populations	275,053	6,707,132

The following graph depicts recent adult salmon returns of both natural and hatchery spawned fish observed since 1977. The graph is consistent with the foregoing table comprised of naturally spawning fish. While there was a period of improved returns from 2001 through 2016, returns in 2017 and 2018 were similar to returns from 1984 to 2000.[45]

[44] The Mid-Columbia region is the area from Bonneville Dam upstream to and including the Yakima River Basin.

[45] Graph compiled by Stuart Ellis, CRITFC, using data available from the Fish Passage Center at http://www.fpc.org/adults/adult_queries/Q_adultcoequeries_adultrunsum_queryv2.php .



These run sizes are far short of the interim goals set forth in Wy-Kan-Ush-Mi Wa-Kish-Wit, the Columbia Basin Fish and Wildlife Program and the provisional goals of the Columbia Basin Partnership. For instance, the Council adopted a goal in 2000 to increase returning salmon and steelhead to an average of five million adults returning above Bonneville Dam by 2025 in a manner that supports tribal and non-tribal harvest. In 2018, less than one million salmon and steelhead returned above Bonneville Dam.

2. Smolt to Adult Survival Rates, PITPH, Reach Survival and the CRSO DEIS Alternatives

Smolt-to-Adult return ratio (SAR) is measured as the survival from a beginning point as a smolt to an ending point as an adult. This metric has been reported in hundreds of scientific studies in the Columbia Basin. Observed differences in SARs at the population level by year have been attributed to differences in river conditions, hydroelectric dam operational strategies and ocean conditions. Individual-level variables related to fish condition also play an important role in survivorship.

The success of any hydro system mitigation strategy will require achievement of SAR survival rates sufficient to meet recovery and rebuilding objectives, in combination with a program to maintain or achieve adequate survival in other life stages.[46] By 1994, an independent peer

[46] Throughout the 1980s, "TIRs", the ratio of adult returns for transported juvenile fish compared to in-river migrating juvenile fish, was a metric typically reported by the Corps of Engineers as a measure of the success of

review of the Corps' juvenile fish transportation program concluded: "[u]nless a minimum level of survival is maintained for listed species sufficient for them to at least persist, the issue of the effect of transportation is moot."[47] As Mundy et al. and others observed, transportation did not remove 100% of the effects of hydro system passage. [48] As one of its major outcomes, Mundy et al. recommended establishing a minimum survival standard for juvenile salmon in the hydroelectric system tied to biological recovery of the affected species.

By 1998, expert scientists through the Plan for Analyzing and Testing Hypotheses (PATH) found that median SARs of 4% were necessary to meet the NMFS interim 48-year recovery standard for Snake River spring/summer Chinook; meeting the interim 100-year survival standard required a median SAR of at least 2%.[49] The Northwest Power and Conservation Council (NPCC 2003, 2009, 2014) subsequently adopted a goal of achieving overall SARs (including jacks) in the 2%–6% range (4% average; 2% minimum) for federal ESA-listed Snake River and upper Columbia River salmon and steelhead. Notably, life cycle analyses have compared John Day River and Yakima River population SARs to Snake River SARs.[50] The data time series show that middle Columbia Stocks that pass 4 or less dams, such as John Day River, Deschutes River, Yakima River, and Umatilla River, consistently meet the 2-6% SAR goal, but Snake River populations passing five to eight dams generally do not meet this SAR goal. In the 20 years since 1997, SARs have significantly exceeded the 2% minimum in only two years for Snake River wild Chinook and four years for wild steelhead.[51]

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hydro system mitigation measures. While the metric considered survival to adulthood, it only *compared* the efficacy mitigation measures, it did not consider what survival was needed as a biological matter.

[47] Mundy, P.R., D. Neeley, C.R. Steward, T. Quinn, B.A. Barton, R.N. Williams, D. Goodman, R.R. Whitney, M.W. Erho, and L.W. Botsford. 1994. Transportation of juvenile salmonids from hydroelectric projects in the Columbia River Basin; an independent peer review. Final Report. U.S. Fish and Wildlife Service, 911 N.E. 11th Ave., Portland, OR. 97232-4181 [hereinafter Mundy, et al.].

[48] *Id.* The report raised the possibility that latent mortalities associated with hydro system passage, including the effects of bypass system collection and transportation, were being experienced by the fish.

[49] Marmorek, D.R., C.N. Peters and I. Parnell (eds.). 1998. PATH final report for fiscal year 1998. Compiled and edited by ESSA Technologies, Ltd., Vancouver, B.C. Available from Bonneville Power Administration, Portland, Oregon < http://www.efw.bpa.gov/ Environment/PATH/reports/ISRP1999CD/PATH%20Reports/WOE_Report >.

[50] *Which juvenile survival values (if any) achieve 4% average SARs?*, Comparative Survival Study (CSS), 2013 Workshop Report at 79-80 (March 7th and 8th, 2013) <http://www.fpc.org/documents/CSS/CSS_2013_Workshop_Report_-_FINAL_w_presentations.pdf >.

[51] McCann et. al, 2018 CSS Annual Report, *supra* note 41. The conclusion from Chapter 4 of the 2018 CSS Annual Report is:

> Neither Snake River wild spring/summer Chinook nor wild steelhead populations appear to consistently meet the NPCC 2%–6% SAR objective. Geometric mean SARs (LGR-to-GRA) were 0.8% and 1.4% for PIT-tagged wild spring/summer Chinook and steelhead, respectively. In the 20 years since 1997, SARs have

The Mundy et al. report also recommended using PIT tag technology "to design and implement a program to measure the contribution of hydroelectric survival by route of passage in population numbers by major river system (e.g. Clearwater, Salmon, Imnaha, Grand Ronde) for listed species…"[52] Such a program using PIT tags was initiated in 1997 with funding from the Bonneville Power Administration.

By 2015, scientists participating in the Comparative Survival Studies (CSS) observed that survival to adulthood varied by route of juvenile passage through the hydro system, in particular survival of PIT-tagged salmon as returning adults differed depending on whether as juveniles the fish had encountered a powerhouse, either a bypass or turbine, or did not (PITPH).[53] Juvenile salmon survived at higher rates in years where PIT tag detections indicated lower encounter rates with powerhouses (low PITPH). The PITPH index has been developed in subsequent annual CSS reports and has been used to forecast SARs for Snake River spring/summer Chinook and steelhead resulting from alternative hydro system configurations and operations.[54]

The 2017 CSS Annual Report, at the suggestion of the Independent Science Advisory Board, considered alternative spill and breach scenarios at the eight dams from Lower Granite to Bonneville. The analysis forecasted SARs that would be likely to result from four different spill levels under two alternative dam configurations; first with the current configuration of the eight federal dams from Lower Granite to Bonneville and second assuming that the four lower Snake River dams were breached and the four lower Columbia River dams remained in their current physical configuration.[55] PITPH values were the lowest in the breach and highest spill scenario. For SARs the results were similar in that higher spill levels and breach scenarios result in higher SARs. The Report concludes: "In a fully impounded river, we predict a 2-2.5 fold increase in return abundance above BiOp spill levels when spill is increased to 125% TDG. If the lower four Snake River dams are breached and the remaining four lower Columbia dams operate at BiOP spill levels, we predict approximately a 2-3 fold increase in abundance above

significantly exceeded the 2% minimum in only two years for Snake River wild Chinook and four years for wild steelhead. SARs of both species have been well short of the NPCC objective of an average 4% SAR.

[52] Mundy, et al. *supra* note 47, Introduction at p. X.

[53] All transported fish encounter a minimum of one powerhouse at the point where they are collected for barge or truck transportation and release below Bonneville Dam.

[54] McCann et. al, 2017. Comparative Survival Study of PIT-Tagged Spring/Summer/Fall Chinook, Summer Steelhead and Sockeye, 2017 Annual Report at Chapter 2 (December 2017) <http://www.fpc.org/documents/CSS/CSS_2017_Final_ver1-1.pdf > [hereinafter CSS 2017 Annual Report].

[55] *Id.* at 25.

that predicted at BiOp spill levels in an impounded system, and up to a 4 fold increase if spill is increased to the 125% TDG limit."[56]

For purposes of the CRSO DEIS, the Co-Lead Agencies requested that the CSS models be used to predict the effects on Snake River yearling Chinook and steelhead resulting from the no action alternative and four alternatives labeled MO1 through MO4. While the alternatives contain many different features, in terms of dam operations and configurations the major differences can be described in terms of breach and spill levels.

	Estimated Smolt to Adult Survival (LGR to LGR)		
	Yearling Chinook	Steelhead	Breach/Spill Level
MO3	.042	.050	Yes/120%
MO4	.035	.031	No/125%
MO1	.021	.019	No/120%
MO2	.012	.012	No/110%
NAA	.018	.020	No/BiOp

Table 12. Predicted SARs with 20% surface passage efficiency using the CSS Life-Cycle Model.

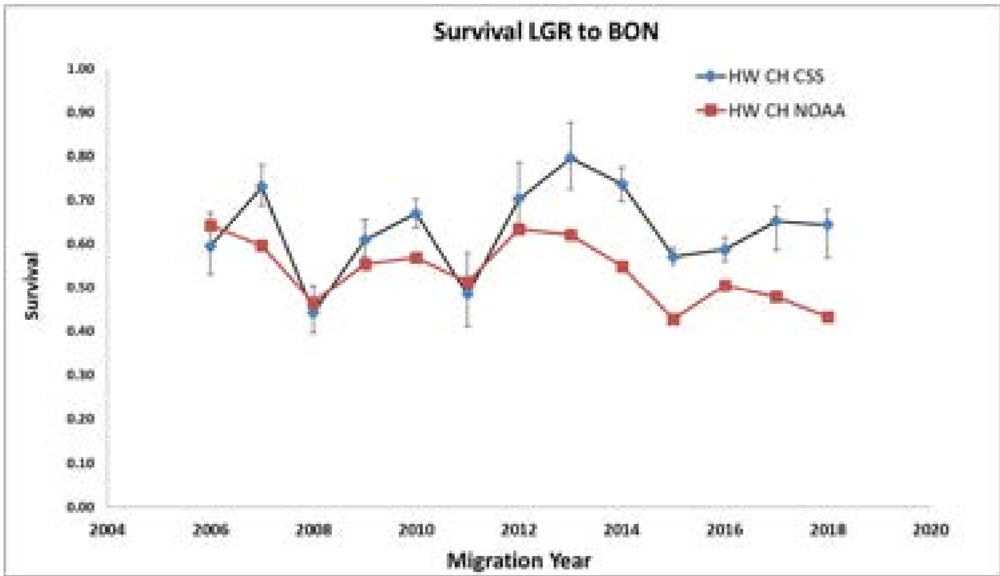
SARs for two of the Alternatives, MO3 and MO4, fell within the 2% to 6% range identified by the NPCC and multiple other authors.

3. Juvenile Salmon Reach Survival

Juvenile salmon and steelhead survival through the hydro system is also an important indicator of the mortality burden of the dams and their affected environment. Survival data have been collected from Lower Granite Dam on the Snake River through Bonneville Dam on the Columbia from 2001 to present. The information is annually reported by NOAA's Northwest Fish Science Center and the reports of the CSS, and available on the NPCC's website. From 2001 through 2013 reach survival improved, and then began a steady decline over the past five years.[57]

[56] *Id.* at 62.

[57] NPCC, High Level Indicators, Indicator 2a <https://app.nwcouncil.org/ext/hli/level1.php?q=hydrosystem >.



Current reach survivals do not correspond to SAR survival rates associated with the goals adopted by the Tribes, ISAB, CSS or the NPCC for rebuilding salmon populations. Analyses from the CSS showed that juvenile survival to below Bonneville Dam needs to be approximately 80% or greater in order to consistently meet the NPCC regional SAR goals. Reach survivals for upper Columbia or Snake River Basin spring Chinook or steelhead in the last 15 years have failed to meet this goal.

The reach survivals annually reported by NOAA are troubling. During their migration through the federal hydro system, juvenile spring Chinook, steelhead and sockeye experience levels of mortality roughly equal to or greater than the observed mortality from more than two decades ago and survived at a rate less than the long-term average:[58]

> Estimated survival for wild steelhead from Lower Granite to Bonneville Dam was 0.299 (0.211-0.387) in 2017, which was below the long-term average of 0.417.
>
> For wild yearling Chinook salmon in 2017, the estimated survival from Lower Granite to Bonneville Dam of 0.309 (0.221-0.397) was below the long-term average of 0.476 and was among the lowest of our time series.
>
> For pooled groups of wild and hatchery Snake River sockeye salmon, survival from Lower Granite to Bonneville Dam was 0.176 (0.097-0.320) in 2017. This estimate was

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[58] CSS 2017 Annual Report, *supra,* note 54. The reach survival observed in the CSS results differs somewhat from NOAA's reported information. As reported by NOAA, the tagged populations it assessed would encounter more powerhouses than the run-at-large group of tagged fish assessed in the CSS work. This difference may explain why the NOAA estimates are on average lower than the CSS estimates, since powerhouse encounters are known to cause delayed mortality in juvenile migrants that can be measured in reach survivals.

> the fourth lowest of our time series through this reach and was well below the 1996-2017 average of 0.392.

The recent CSS Analysis of CRSO Operation Alternatives estimates reach survival from Lower Granite Dam to the tailrace of Bonneville Dam under the CRSO DEIS scenarios (assuming 20% SPE for surface bypass routes).

	Estimated Reach Survival	
	Yearling Chinook	Steelhead
MO3	.682	.831
MO4	.634	.737
MO1	.582	.585
MO2	.531	.427
NAA	.576	.571

Table 14. Predicted juvenile survival (LGR-BON) with 20%, surface passage efficiency using the CSS cohort-specific model.

None of the CRSO Alternatives, analysis of which were constrained by the data sets provided by the Co-Lead Agencies and other information limits, meet the 85% reach survival metric. While reach survivals did not meet the reach survival goal, SARs for two of the CRSO Alternatives fell within the 2% to 6% range identified by the NPCC and multiple other authors – MO3 and MO4.[59]

The results from COMPASS, the other modeling system being used to analyze the CRSO Alternatives, describe different results. Analyzed with the COMPASS modeling system, there is no contrast in the predictions regardless of the CRSO Alternatives that include the current dam configurations. Only MO3 showed an increase in survival.[60]

The CSS and COMPASS modeling systems make different assumptions and apply empirical data differently, which may explain the differences in their predictions. The CSS life cycle results are based on actual (empirical) adult returns. The COMPASS modeling system is a deterministic model of individual juvenile survival parameters measured dam by dam and ultimately

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[59] *See supra,* discussion accompanying note 54-56. The 2017 CSS Annual Report, *supra* note 54, considered alternative spill and breach scenarios which differ slightly from those that are being considered in the CRSO DEIS. The results are similar in that higher spill levels and breach scenarios result in higher SARs (*see e.g. id.* at figure 2.10). As discussed above, the 2017 CSS Annual Report, at 62, found 2-4 fold increase in return abundance under the different spill and breach scenarios.

[60] Independent Scientific Advisory Board, Review of NOAA Fisheries' Interior Columbia Basin Life-Cycle Modeling (May 27, 2017). https://www.nwcouncil.org/sites/default/files/isab-2017-1-noaalifecyclemodelreview22sep.pdf The 2017 ISAB report commented that COMPASS did not appear to be sensitive to alternative spill operations. The ISAB could not discern from the information presented by the COMPASS authors why the analysis produced these results. Pp. 54-55.

calibrated to fit adult return data.[61] The COMPASS model also explains variability in survival with variability in arrival timing of juveniles, whereas the CSS model explains variability in survival with route of passage, which can be controlled with spill. The tribes have been critical of the COMPASS modeling systems over the years and further information will be submitted to the Co-Lead Agencies in this regard through the draft EIS process.

CONCLUSION

The Meyer Report forms the foundation to this report on the Columbia River Treaty Tribes' perspectives on the CRSO DEIS. The Tribes' perspectives are fundamentally informed by their place on the land and the foods provided by the Creator and the reciprocal commitments made by the Indian people to these foods. The foods are named explicitly in the Tribes' 1855 treaties with the United States. It is an expression of tribal law, sometimes called *Tamanwit.*

> There is so much to this word or this way, this *Tamanwit.* It's how we live. It's our lifestyle. There is so much that we as Indian people are governed by, through our traditions, our culture, our religion, and most of all, by this land that we live on. We know through our oral histories, our religion, and our traditions how time began. We know the order of the food, when this world was created, and when those foods were created for us. We know of a time when the animals and foods could speak. Each of those foods spoke a promise. They spoke a law – how they would take care of the Indian people and the time of year when they would come. All of those foods got themselves ready for us – our Indian people who lived by the land. It was the land that made our lifestyle. The foods first directed our life. Today, we all have these traditions and customs that recognize our food: our first kill, first fish, first digging, the first picking of berries. All of those things are dictated to us because it was shown and it directed our ancestors before us.
>
> The songs we sing with our religion are derived from how we live on this land. Our cultural way of life and the land cannot be separated. Even though we recognize that our life is short, it all goes back to that promise that was made when this land was created for us as Indian people, the promise that this land would take care of us from the day we are born until the day that we die.[62]

The DEIS must respect the Columbia River Treaty Tribes' culture, food, and ways of life. The draft purposes section recognizes this obligation. It contains three particularly relevant provisions that form the basis for the analyses contained in the document.

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[61] Sometimes called a mechanistic model. Regarding COMPASS, the ISAB observed that its statistical models are very complex with each having from 13 to 23 explanatory variables. And then asked, "Is collinearity or over-parameterization an issue?" *Id.*

[62] CTUIR, Comprehensive Plan, 2010 <https://ctuir.org/system/files/FinalCompPlan.pdf > (quoting Armand Minthorn, *As Days Go By,* 2006).

- Provide for fish and wildlife conservation, including protection of threatened, endangered, and sensitive species, and provide for equitable treatment with other project purposes
- Comply with environmental laws and regulations and all other applicable federal statutory and regulatory requirements
- Address Native American treaty rights and trust obligations for natural and cultural resources

Fish and wildlife conservation, compliance with environmental laws and addressing Tribes' treaty rights go hand in hand. This Tribal Perspective broadly describes what achieving these purposes means in terms of the federal treaty commitments to the Columbia River Treaty Tribes. For the tribes, these will be measured in terms of the treaty commitments made by the United States to the Columbia River Treaty Tribes in 1855. The salmon, steelhead, lamprey, sturgeon and other fish and wildlife populations that existed at the time of the 1855 treaty negotiations represent levels of species viability at which there would be no question about the need for ESA listings. Nor, at these levels, would there be questions about the discriminatory effects of mitigation programs on four tribes' cultures and economies that depend on salmon.

Of the alternatives presented to date in the CRSO DEIS, as measured by the CSS modeling systems, only two come close to meeting rebuilding requirements for Snake River yearling Chinook and steelhead that flow from the treaties and other laws. These are MO3 (breaching the Snake River dams) and MO4 (spill to 125% TDG levels). Using the NOAA modeling systems (COMPASS), only the Snake River dam breaching alternative (MO3) shows any substantial improvement over the status quo.

At this point, the CRSO DEIS analysis is limited and has not quantitatively addressed:

Other Stocks: The CSS and COMPASS systems have not addressed upper Columbia yearling Chinook and steelhead stocks that are particularly at risk as well as other salmon and steelhead stocks in the Basin that have been impacted by the federal and are also listed under the ESA. Whether the CRSO DEIS will quantify the biological requirement of these stocks remains unclear.

Mitigation: The CRSO DEIS mitigation analysis is still in beginning information-gathering phases. The Co-Lead Agencies have not presented any of their own mitigation proposals. What has been provided to date is a collection of mitigation ideas collected during CRSO DEIS scoping stages. The collection did not relate the mitigation measures to existing obligations such as consistency with the NPCC's Fish and Wildlife Program or ongoing contractual commitments. The extensive history and ongoing commitments to mitigation for the development and operation of the federal Columbia River System of dams are important to understanding current conditions and has not been present in the CRSO DEIS to date.

All four of the Columbia River Treaty Tribes are vitally interested in the analyses and outcomes related to the CRSO DEIS.[63] Three of the Columbia River Treaty Tribes are Cooperating Agencies in the process for development of the CRSO DEIS. With the assistance of CRITFC, their technical services organization, the tribes have attempted to engage the federal Co-Lead Agencies. We have been hampered in this effort by extraordinarily limited periods for review and comment, lack of a composite framework for the affected environment and analysis, significant factual errors in the draft text, and the absence of historical context, particularly with regard to federal mitigation obligations.

We look forward to continuing to assist the Co-Lead Agencies to assure that the tribes' treaty secured interests are protected. All the documents cited in this paper will be made available to the Co-Lead Agencies in electronic format.

[63] The Columbia River Treaty Tribes supported the 2019-2021 Flex Spill Agreement that established spill operations for the eight federal dams. Four additional examples serve to highlight the tribes' consistent concerns with the operations of the federal Columbia River system:

- In 1973, the Confederated Tribes of the Umatilla Indian Reservation and numerous individual tribal plaintiffs received a final judgment from Judge Robert Belloni in *Confederated Tribes v. Callaway* that limited federal power peaking operations and required reporting the status of the federal research studies. *Confederated Tribes v. Callaway,* Civ. No. 72-211 (Final Judgment, August 17, 1973)

- In 1979 and 1980, the Columbia River Treaty Tribes sought obtained numerous amendments to the draft Northwest Power Act that eventually became law. These amendments are found throughout the Act, but particularly in section 4(h) of the Act, 16 U.S.C. 839b (h), which among other things requires that the Council's Fish and Wildlife Program only include measures that are consistent with the tribes' rights.

- In 2003, CRITFC published an "Energy Vision for the Columbia River". https://www.critfc.org/wp-content/uploads/2012/11/tev.pdf. In 2013, CRITFC solicited Bonneville's comments on a draft update to the Tribal Energy Vision. The Energy Vision sought to reduce the burden of the region's energy needs on the ecosystem of the Columbia River.

- In 2017, with other tribes in the Basin, the tribes supported the publication of a research report on "The Value of Natural Capital in the Columbia River Basin". https://www.eartheconomics.org/crb Anticipating changes in the Columbia River Treaty, the authors analyzed the broad economic context of the Columbia River Basin's ecosystem values.

We request that each of these documents be included in the CRSO DEIS record and be carefully considered in the development of the co-lead agencies decisions.

EXHIBIT B
TRIBAL CIRCUMSTANCES AND IMPACTS OF THE LOWER SNAKE RIVER PROJECT ON THE NEZ PERCE, YAKAMA, UMATILLA, WARM SPRINGS AND SHOSHONE BANNOCK TRIBES
MEYER RESOURCES, INC.
APRIL 1999

Exhibit Coversheet Only. [Paginated separately.]

The attached document, Tribal Circumstances and Impacts [Report], is provided to the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy, Climate, and Grid Security for the Hearing Record, dated January 30, 2024 in response to a question from the Honorable Frank Pallone, Jr.

Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes

Developed for the:

Columbia River Inter-Tribal Fish Commission

Developed by:

Meyer Resources, Inc.

April 1999

6.0
Circumstances and Impacts on the People of the Yakama Indian Nation

This section provides information on past and related present circumstances of the fourteen tribal peoples who now form the Yakama Indian Nation (Table 2)[263]. Expected effects of Lower Snake project options will be discussed in the later project impacts section of this report.

6.1 Accustomed Tribal Areas and Seasonal Harvest Rounds of the Peoples of the Yakama Indian Nation

In pre-contact times the peoples now living together as the Yakama Indian Nation (YIN) ranged over 12 million acres[264], from the confluence of the Columbia and Methow Rivers southwesterly along the Columbia to the Cascade Range[265]. This territory included Mount Adams in the Cascades and the north side of the Snake River, downstream of the confluence of the Palouse[266]. From this territory, traveling parties of the peoples now described as the Yakama also fished, hunted and/or traded westward as far as the rivers flowing into Puget Sound, and eastward as far as the buffalo country. Above all, the Yakama were people of the land.

> In the beginning, our Creator spoke the word and the earth was created. He spoke the word again and all living things were put on earth. And then He said the word and we, the people, were created and planted here on this earth.
>
> We are like the plants on this earth. Our food was put here as plants to feed us; just like when we plant a garden. That is the way our earth was in the beginning.
>
> There were salmon, deer, elk, and all kinds of birds. It is as if our bodies are the very end of the earth, still growing while our ancestors are all buried in the ground.
>
> He named everything he created. He put water on this earth. He made it flow into the rivers and lakes to water this great garden and to quench the thirst of the people, the animals, plants, birds and fish.
>
> He took the feet of the people and made them walk on the earth. He created the horse; which is like a human being. He put the horse and the people together to help one another.

---

[263] Yakama is the present spelling utilized by the Yakama Indian Nation. In earlier written references, Yakima was the spelling most often used.

[264] Confederated Tribes and Bands of the Yakima Indian Nation, 1977. **The Land of The Yakimas**. Toppenish, p. 10.

[265] Selam, Leroy B., 1975. **The Yakima Indians: Study and Analysis of the Yakima Water Rights**. Masters Thesis. Oregon State University. Corvallis, p.23.

[266] Lane & Lane and D. Nash, 1981a. **Supra** at 21.

> All the land where we live and where our ancestors lived was created for the [Indian] people.[267]

> ...the Yakima today still live on the same land that has been a part of their traditional territory for thousands of years. Their roots are deeply sunk into the earth. Their sense of identity is clear. As a result, many of the Yakima's cherished traditions still live, imparting a sense of the wisdom that sustained the people in the past and enabled them to survive into the present.[268]

> The land don't belong to the Indian; the Indian belongs to the land.[269]

As did their neighbors, the Yakama peoples of the pre-contact era lived with the land - following seasonal rounds of fishing, hunting and gathering - in each usual and accustomed location at the appropriate time and season.

> The Yakima derived their subsistence primarily by fishing and by gathering wild plants, but they supplemented their supply by hunting. In order to obtain as much food as possible, they traveled to wherever plants or wildlife were most plentiful during a specific time of year. Although the camps they established at these sites were temporary, they had an air of permanence because people tended to return to the same areas year after year.[270]

A general sense of these seasonal rounds is provided in Table 15.

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[267]Excerpted from "The Way It Was: Anaku Iwacha, Yakima Indian Legends", in, Schuster, Helen H., 1990. **The Yakima**. New York: Chelsea House Publishers, p. 13.
[268]Schuster, Helen H., 1990. **Supra** at 19.
[269]Robert Jim, 1972, in, Schuster, Helen H., 1990. **Supra** at p. 21.
[270]Schuster, Helen H., 1990. **Supra** at 21.

Table 15

A General Profile of the Seasonal Rounds of the Yakama Peoples	
Time of Year	**Characteristics of the Period**
February	Snow begins to melt - and Yakamas begin to break winter camps in the Valley bottoms. Before leaving these camps they harvested the first plant food of the new year - a wild celery called khasija.
Late February & into March.	The Yakama arrived at fishing stations on the Columbia, Lower Snake and Yakima rivers, and their tributaries. These rivers teemed with early run salmon (nusukh), including chinook, silver, sockeye and chum. The Yakama also fished for steelhead, resident trout, sturgeon, suckers and lampreys.
Late April	Harvests from fishing sites declined, and the Yakama moved to root-digging grounds - where the women gathered more than 20 varieties of roots, and the men hunted for deer, and other wildlife such as elk, bear, wolves, foxes, mountain sheep and goats, and birds.
June	Families returned to fishing sites to harvest the second salmon run of the season.
July	Families moved to cooler higher elevations, where the men hunted and the women gathered wild plants.
August	Many Yakama families traveled south to the Klikitat territory to gather roots. They traded with other Indian groups and fished for trout. In mid-month, women and girls, guarded by an older man or a boy, went into the mountains to pick huckleberries.
Early Fall	Families began to return to the river valleys for the fall fish runs. Often, these fishing centers were also places for extensive trade between tribal groups. Families gathered and stored the supplies they would need for winter, and some men went into the mountains to hunt deer and elk.
Mid-November	Families returned to their winter camps in the valley bottoms, which were protected from severe winter weather. They repaired their homes for winter, made tools and needed clothing during this quiet time. They remained there until snow-melt, socializing, and living on the roots, berries, salmon, venison and other foods they had gathered in previous months. Sometimes, the men ventured out to do limited hunting during this winter period.

Source: Developed from, Schuster, Helen H., 1990. **The Yakima**. pp. 21-25.

Of the resources of the “land” which the Yakama depended on, water was first, salmon was second, and the other food sources were also required, each in its season.

> Since immemorial days we have had great prophets to guide our laws that had been established for us to follow and which we do so at the present knowing the living God still exists; first, the water; second, the salmon; third, the big game; fourth, the roots; and fifth, the berries. All of which we used each year to give thanks to our living God, which when first taken are new to us each year, in other words “communion” with our living God through the water and the food he provides us with each year.[271]

[271]Martin Hannigan, Chairman, Yakima Tribal Council, **Letter**, to K.R.L. Simmons, Yakima Tribal Attorney,

We were talking about the essence of the teaching as our Creator handed down to our people, which has been handed down through centuries or through generations. And I always sing that song before we eat and when I'm coming back from services. That's at the Longhouse with the Seven Drum religion. And this song does explain the three promises God made to mankind, not just to Indian people, to mankind: that the food would always be plentiful if it's carefully been kept, and used in care and respect for the food itself. The first food is salmon to us; that's our first food. And we recognize that, as such, without it our life would not have its full potential as far as our existence is concerned.... (T)he salmon goes and then comes back. The old ones give up their life for the new ones, just like the mother gives birth to young. That is what we're taught -- to show respect and have empathy for the salmon.[272]

Since the beginning of time -- since time immemorial the people of the YAKIMA NATION have been told the history of our ancestors and their ancestors before them by our tribal elders. History and legends are kept and handed from one generation to the next generation.

Ranking first is our Creator's most precious gifts of water, and land -- Mother Earth. These he gave us for our daily use, our sustenance, our survival. He blessed the waters and instructed our First Peoples to take care of the water because it is there for a reason. For without water nothing can survive. There would be no rivers, streams or creeks for our salmon, trout, eels; No trees (forests), plants, roots (edible and medicinal) berries. There would be no animal life - no life at all.

It has been this way since our Creator placed us in this part of the world and instructed our First Peoples in the care, and the gathering of all fish, game, fowl, roots and berries. Creator chose certain men and women of the First Peoples to be teachers and showed them what fishes, animals and fowls that were allowed to give up their lives to sustain ours; what plants, roots and berries we could use to keep our bodies healthy and strong. He taught our Old Ones which trees and grasses we could use for shelter, for processing and storage of our foods. Nothing is to be wasted, and so Creator taught us how to replenish all that He provided for our sustenance. Our Creator taught us how to survive on what he provided.

The Old Ones say the Creator told them to follow his path, a path of religion that would be in gratitude to Him for all that is provided for our sustenance and our life. Our religion begins all meals with His first blessing -- water, followed by Salmon, the deer/elk, first roots and berries. All meals conclude with water as we were instructed by the Creator.

Creator's second gift of life to the Yakima Indians is the Salmon. Salmon was placed in the Columbia and in its tributaries for us to harvest as the Creator said the salmon was to help nurture and sustain us. In return for the gift -- we are to care for the waters that sustain the salmon.[273]

Billings Montana. August 9, 1949.

[272]Tom Eli, at Toppenish, October 22, 1982. **Oral Testimony**, in, Meyer Resources, 1983. **Supra** at 39-40.

[273]Aguilar, Florence L., 1995. Yakama Indian Nation, Cultural Resources Program. **Memorandum** to Johnson Meninick. May 29.

Outside experts have reached similar conclusions with respect to the role of fishing in Yakama traditional life.

> Fishing was a major economic activity for the Yakima. Some early writers referred to salmon as the "main staple" and "chief food resource"; and as a single item it probably was.[274] [275]

6.2 Natural Capital and Annual Productive Yield of Original Yakama Lands and Resources

In economic terms, the lands and waters of the traditional territories of the Yakama peoples represented the "natural capital" upon which they depended. This natural capital produced the annual harvests of salmon and other fishes, the game, and the roots, berries and plants that allowed the peoples who are now called the Yakama to survive and prosper. As noted earlier, salmon was the key element of this annual produce.

Hewes estimated that the Yakima, Klikitat, Palus and Wanapum peoples would have consumed approximately 400 pounds of salmon per person per year in pre-contact times, based on caloric requirements[276]. Walker identified additional uses of salmon, for example, for fuel, and suggested a median consumption of salmon per capita of 583 pounds for Plateau tribes[277]. Swindell identified that tribes of the mid-Columbia caught salmon for trade as well as for their own consumption - with one respondent indicating that a family on the river would catch a third more additional salmon for trading purposes.

Allowing for Hewes' differentiation between consumption rates for up river and downriver tribes, adjusting to coincide with Walker's median estimate, and increasing harvest by a further 25 percent as a discounted adjustment for Swindell's trade observation, we estimate an annual per capita salmon catch for the peoples now known as the Yakama Indian Nation of approximately 800 pounds in pre-contact times. This also coincides with the upper range of Walker's average estimate for all Plateau tribes[278].

Schuster estimates that, prior to contact and ensuing epidemics, the population of Upper and Lower Yakima bands was approximately 7,000 persons[279]. Estimates of the population of Yakima bands at Treaty times (1855) vary from 2,000 persons (Schuster[280] and Selam[281]), to approximately 3,000 persons (McWhorter[282]), and to 3,500 persons (Fitch[283]).

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[274]Schuster, Helen H., 1975. **Yakima Indian Traditionalism: A Study in Continuity and Change**. Phd. Dissertation. University of Washington, Seattle, pp. 69-70.
[275]See also, Smith, Courtland L., 1979. **Salmon Fishers of the Columbia**. Corvallis: Oregon State University Press, pp. 6-7.
[276]Hewes, Gordon W., 1947. **Supra** at 237.
[277]Walker, Deward E., 1967. **Supra** at 19.
[278]Supra.
[279]Schuster, Helen H. **The Yakimas: A Critical Bibliography**. American Indian Bibliographical Series. Bloomington, Indiana: Indiana University Press, p. 22.
[280]Supra.
[281]Selam, Leroy B. **Supra** at 30.
[282]McWhorter, Lucullus V., 1913. **The Crime Against the Yakimas**. Yakima: Republic Print, p. 5.

Using the middle 1855 estimate of 3,000 persons, and our per capita annual harvest estimate of 800 pounds - we estimate that peoples of what is now the Yakama Indian Nation likely harvested approximately 5.6 million pounds of salmon annually prior to contact, and approximately 2.4 million pounds of salmon in the mid-1800's.

Lane, Lane and Nash estimated that Yakima fish consumption in pre-contact times amounted to approximately 40 percent of total food consumption, based on estimates from the nearby Umatilla peoples[284]. On this basis, we estimate total annual food consumption by Yakama bands at 14 million pounds in pre-contact times, and at 6 million pounds in 1855.

Finally, use of the US Bureau of the Census estimate that contemporary families on an economy budget spend one third of their income on food[285], would result in an estimate that Yakama bands gathered both food and non-food items from their usual and accustomed lands and waters equivalent to 36 million pounds of food in pre-contact times, and equivalent to 18 million pounds of food in 1855.

6.3 A Broader Perspective of the Living Circumstances of Yakama Peoples in Pre-Contact Times

Expert assessment suggests that the Yakama peoples were generally well off in pre-contact times.

> The rich environment of the Yakima homeland allowed prehistoric peoples to prosper there.[286]

> Throughout this vast primeval (Yakama) expanse the accumulated wealth of millions of years was deep buried or heaped upon the land. Other wealth swam in the seldom silent rivers, congested at the fisheries along the Columbia or winged low above the marshes.[287]

In these times, Yakama wellbeing extended across material and spiritual lifeways.

> The People's survival from year to year, generation to generation, was assured. **Their way of life was in rhythm with nature. Earth and life were sacred. The land taught material and spiritual values**.[288]

> The relationship of the Yakama to the earth, animals, and plants was far more than economic. It was a spiritual relationship that originated at the beginning of time. This axiom is at the heart of Yakama tradition, culture, and history, and without an appreciation of the

[283]Fitch, James B., 1974. **Economic Development in a Minority Enclave: The Case of the Yakima Indian Nation, Washington**. Phd. Dissertation. Stanford University, p. 75.
[284]Lane & Lane Associates and D. Nash, 1981b. **The White Salmon River Indian Fisheries and Condit Dam**. A Report to the US Bureau of Indian Affairs, Portland, p. 68.
[285]Recall Note 68.
[286]Schuster, Helen H., 1990. **Supra** at 16.
[287]Relander, Click, 1962. **Strangers on the Land**. Yakima, WA: Franklin Press, p. 5.
[288]Confederated Tribes and Bands of the Yakima Indian Nation, 1977. **Supra** at 3.

> significance of the earth and spiritual beliefs, there is little understanding of any aspect of Yakama history.[289]
>
> Although the Indians of the Columbia Plateau did not live a utopian life before white contact, their standard of living was relatively high due to diet, climate, housing, and availability of resources. Most tribes, even those from other language families, coexisted in relative peace, sharing food resources, geography, and ceremonies.... Yakama people "knew what to expect as causes of death. Predictability is of course, a staple of human existence."[290]
>
> It was as Wa-tum-nah said in his predictions, "We are a happy people - but it would not always remain so".[291]

As with other neighbor tribes, pre-contact Yakama peoples exhibited the physiological, safety, belongingness and love, and self-esteem characteristics required for a fully functional society, outlined by Maslow, and cited in Bachtold[292] (Figure 8).

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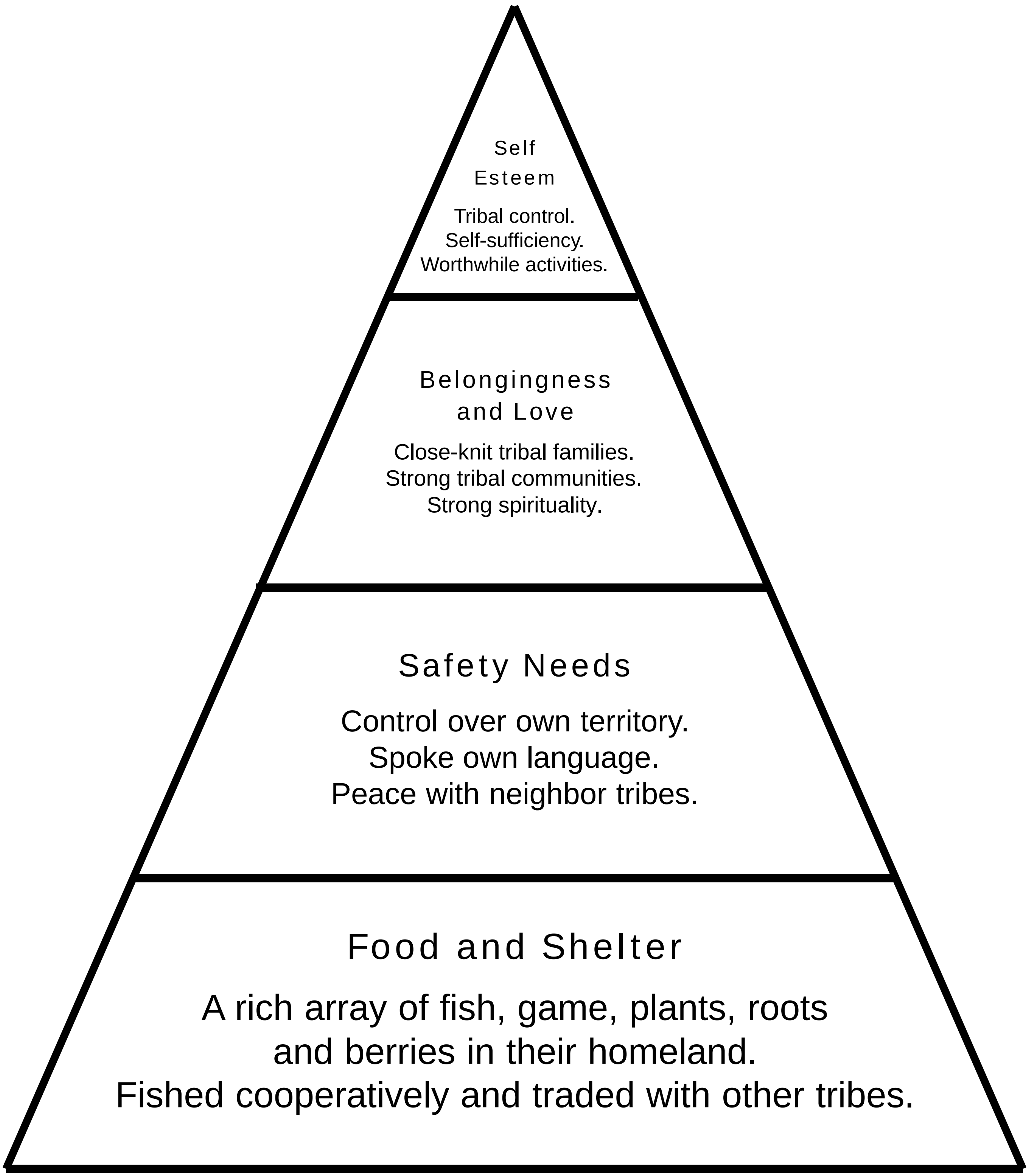
[289]Trafzer, Clifford E., 1997. **Supra** at 23-24.
[290]Supra at 71-72.
[291]Selam, Leroy B., 1975. **Supra** at 23-24.
[292]Bachtold, L.M., 1982. **Supra** at 19.

Figure 8
Yakama Circumstances & Capabilities in the early 1800's



6.4 Changes in Yakama Circumstances Following the Treaty of 1855

As with neighbor tribes, the coming of the white man resulted in great changes for the Yakama peoples.

> Life changed for us forever on the morning of October 17, 1805. On this date the Lewis and Clark Expedition arrived at the confluence of the Taptette (Yakima) and the Ench-wana (Columbia) Rivers....
>
> After Lewis and Clark came other explorers, fur trappers and traders. These strangers were welcomed as guests, and as tradition required, were extended our hand in friendship....
>
> America's growing population was moving west. They came along the trails through our Valley urged on by the discovery of gold and the desire for land.... Our people watched these events with growing concern....
>
> In 1850 Congress enacted the Donation Act which invited settlers to occupy the Pacific Northwest Lands. No longer was the white man a visitor. He began to live on our land, and he now wanted to divide it up and own it privately for himself. Our People could not conceive of buying and selling land, of owning a part of Nature for oneself. We stood in awe of Nature.
>
>> "My Mother is the earth, my Father the light, when I die, my body returns to my Mother and my spirit to my Father"...
>
> The Yakimas feared the rising, irresistible tide of people with ideas about private property that threatened to deprive them of their land. These strangers brought diseases to which the Indians had no resistance. Tribes in the Willamette and Grand Ronde Valleys and along the Columbia were wiped out in appalling numbers....
>
> Eager to clear the land for white settlement, the (federal) government began hurried preparations for the making of treaties which would establish federal title to the land. Governor Stevens began a series of negotiations with the Tribes along the coast of Washington Territory and then moved inland. In the summer of 1855 the Walla Walla Valley was the site selected for negotiations that would lead to a treaty with the inland Tribes of the Walla Wallas, Cayuse, Umatillas, Nez Perce and the Tribes and Bands of the Yakimas.[293]

These Treaty negotiations troubled tribal peoples. This is evident in the words of Yakima Chief Kamiakin.

---

[293]Confederated Tribes and Bands of the Yakima Indian Nation, 1977. **Supra** at 5-8.

We wish to be left alone in the lands of our forefathers, whose bones lie in the sand hills and along the trails, but a pale face stranger has come from a distant land and sent words to us that we must give up our country, as he wants it for the white man. Where can we go? There is no place left.

> Only a single mountain now separates us from the big salt water of the setting sun. Our fathers from the hunting grounds of the other world are looking down on us today. Let us not make them ashamed! My people, the Great Spirit has his eyes upon us. He will be angry if, like cowardly dogs, we give up our lands to the whites. Better to die like brave warriors on the battlefield, than live among our vanquishers, despised. Our young men and women would speedily become debauched by their fire water and we should perish as a race.[294]

At the same time, dialogue from Governor Stevens included substantial threats.

> In the summer of 1854, Governor Issac Stevens met with Ow-hi, leader of the Upper Yakimas. Governor Stevens told Ow-hi that he wanted to make a treaty with the Indians of Eastern Washington and Oregon concerning purchase of Indian lands. Ow-hi advanced the position of no sale lands. It was at this time that the threat of genocide was made by Governor Stevens. He asked that Ow-hi deliver a message to the leaders of the tribes indicating that a council be gathered and that if the tribes did not make a treaty, the white people would take the land, anyhow. He further stated that in addition to the land grab by the European descendants, the soldiers would come and "wipe them off the face of the earth...".[295]
>
> The Indians were called in council, including the Nez Perces, Yakimas, Cayuses, Palouses, and Walla Wallas. Several days were occupied in feasting and talking, but apparently making no progress in the aim of the meeting, finally the Governor getting out of patience, recapitulated all that had been said and offered, and concluded by saying:
>
> > "If you do not accept the terms offered and sign this paper (holding up the paper) you will walk in blood knee deep."[296]

Given this "incentive":

> All the chiefs signed, Kamiakin was the last, as he turned to take his seat, the priest punched me and whispered, "Look at Kamiakin, we will all be killed." He was in such a rage that he bit his lips that they bled profusely.[297]

The Yakima Treaty was subsequently ratified by the US Senate in 1859. The Yakima Treaty required that 14 different tribes and bands live together on 1.2 million acres, later referred to as the Yakima Reservation - approximately 10 percent of their original home territory[298]. As with

[294] Chief Kamiakin, 1854, in, Yakima Indian Nation, 1978. **1855 Yakima Treaty Chronicles**, p.4.
[295] Selam, Leroy B., 1974. **Supra** at 25-26.
[296] Pambrun, Andrew D., 1855. Interpreter at the Walla Walla Treaty Council, in, Yakima Indian Nation, 1978. **1855 Yakima Treaty Chronicles**. p. 17.
[297] Supra.
[298] Confederated Tribes and Bands of the Yakima Indian Nation, 1977. **Supra** at 10.

other “Stevens treaties”, ability to move from food source to food source, harvesting each resource in its appropriate time and place, was critical to the peoples who are now described as the Yakama - and they retained the right:

> **…to fish within the reservation and outside it “at all usual and accustomed places”, right to hunt, gather roots and berries, and pasture horses and cattle on “unclaimed land.. .**[299]

6.5 Allotment of Yakama Lands - To Tribal Members and to Whites

Non-Indian efforts to obtain Yakama land did not stop with the Treaty of 1855. The principal means for further alienation of Yakama land was the Dawes’ Severalty Act of 1887 (also known as the Allotment Act) - and as subsequently amended.

> ...the Allotment Act...ended common ownership of the entire Reserve and brought the members of the Tribe closer to the white man’s ideas of dividing the land and owning individual plots. The results of this Act were momentous. It led to non-Indian ownership of much of the most valuable flat land and made the Yakimas a minority on their own Reservation.
>
> The Allotment Act provided for the allotting of tracts of this tribally owned land to individual Indians. Reluctant at first, but forced by government pressure to divide up the Reservation, a majority of tribal members finally agreed to accept the new plan whereby individuals received tracts in various sizes up to 160 acres.
>
> ...This Act allowed allotments to be given along the Columbia and Wenatchee Rivers. Members could retain in this way their traditional fishing sites. Allotments were also made at good water or good grazing locations. This explains how a number of Yakimas made their homes on the ancient sites inhabited by their ancestors but not located within the boundaries of the Reservation.
>
> ...With the granting of allotments, the Indian owners were allowed to request and obtain fee patents removing the trust restrictions from their land. They were then free to dispose of the lands to any buyer they chose. Land sales became frequent to land hungry whites with the result that much of the valuable irrigated land went out of Indian ownership very quickly. Towns on the reservation, such as Toppenish and Wapato, were founded during this period through purchases of fee patent land from Indian owners and through special bills enacted by Congress.
>
> As many individual Indians were persuaded to sell their land, most of the flat fertile land in the northeastern part of the Reservation became rich ranches owned by whites. Today (1977) non-Indian ownership amounts to 253,280 acres, leaving 1,118,638 under Indian ownership – mostly mountain timberland and dry foothills good for stock grazing. Today (1977) 80% of the 27,000 people living within the boundaries of our Reservation are non-Indian.

[299]Yakima Indian Nation, 1978. **Supra** at 23.

The allotment Act undermined the treaty handed down by our ancestors.[300]

Non-Yakama reviewers have been similarly critical.

The beginnings of new times and changed days commenced with explorations, forerunner years to military occupation and land settlement. Wrongs imposed during this era by others stronger and powerful enough to do so have never been denied. Yet these intolerances have never been rectified through just compensation or by full use of an element upon which no monetary evaluation can be placed. ...

The earth did not know the strangers in the way it knew its children, the First People.

The strangers came.

They took more and more country, squeezing the First People with an ever tightening force. Whether they were explorers, missionaries, miners or land settlers they seemed determined to exterminate a culture older than the Pyramids. Modified in hundreds of ways this determination carried through the settlement and upbuilding years has never relaxed. Nor is it likely to ease as long as there is Indian-owned land, and while a multitude of friends keep their tongues silent.

Always the land seizures have been defended on the thin pretext of "progress". Yet here were people whose masses of population existed in contentment without knowledge of gold and silver currency. They took their wealth as it was offered, from the earth.[301]

The majority of Yakima Indians were reluctant to accept allotments. ...

The Yakima's fight against allotment of reservation land failed, however. To enforce its policy, the government informed all resisters that if they did not claim their allotments, the land would be opened to non-Indian homesteaders. Eventually most Yakima reluctantly accepted allotments.

As the Yakimas were assigned tracts and issued fee patents, non-Indians began to infiltrate their land. Many promoted fraudulent land deals, often with the assistance of bootleg whiskey. The Indians' rights were ignored, and Indian-white relations worsened....

As allotment continued, Yakima country soon became like a checkerboard, as non-Indians established holdings among the Indian-owned allotments....

By 1914, when allotment of the Yakima Reservation ended, 4,506 tribal members had received a total of 440,000 acres, leaving 780,000 acres still tribally owned. Today (1990), non-Indians own about 253,280 acres, more than half of the Indian land originally allotted.[302]

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[300]Yakima Indian Nation, 1977. **Supra** at 18-19.
[301]Relander, Click, 1962. **Supra** at 6.
[302]Schuster, Helen H., 1990. **Supra** at 81-83.

De-watering of Treaty lands also created difficulties for the Yakama peoples.

> With the opening of the reservation, many existing problems escalated. Large-scale irrigation projects were developed both on and bordering the reservation. Political and legal battles quickly raged over who had the rights to the irrigation water. The irrigation projects drew water to off-reservation lands, diminishing the supply that was needed for reservation irrigation and for the Indians' livestock.[303] [304]

Checkerboarding of tribal and non-tribal ownership within Reservation boundaries further exacerbates difficulties for tribal governments, by severely limiting Tribal jurisdiction over non-Indians living on-Reservation[305] [306].

In 1900, the federal government corrected an "error" associated with the original survey of the reservation, returning an additional 357,879 acres to the Reservation[307]. Present YIN Reservation acreages under control of Yakama peoples are identified in Table 16.

Table 16

Present Yakama Land Holdings Within the Yakama Reservation	
Type of Ownership	Acreage
Yakama in Trust	866,445
Yakama Individual Fee Ownership	260,000
Non-Indian	253,280
Total Reservation Acreage	1,379,725

Source: Schuster, Helen H., 1990. **Supra** at 83-84

6.6 Yakama Access to Usual and Accustomed Fishing, Hunting and Gathering

The 1855 Treaty guaranteed that the peoples of the Yakama Indian Nation (YIN) retained the right to fish, hunt and gather at usual and accustomed places within and outside their reservation boundaries. Given that their homeland was reduced to one-tenth of its former size by the Treaty, and that the peoples of the YIN traditionally harvested over a more extensive area, in cooperation with other tribes, this guarantee was essential to their material and cultural survival. But subsequent to the Treaty, the access of YIN peoples to usual and accustomed harvest places was progressively reduced. In part, this was due to the spread of white settlement over YIN traditional areas - as YIN rights to hunt and gather were conditioned in the Treaty by the availability of public lands. With respect to hunting and gathering, this adverse effect was

[303]Supra at 84.

[304]For a further discussion of shady practices with respect to diversion of Yakama water, see, for example: McWhorter, Lucullus, L., 1913. **Supra** at 5-14.

[305]For example: Brendale v. Yakima Indian Nation, 106 L.Ed 2d 343 (1989); and Duro v. Reina, 109 L.Ed. 2nd 693 (1990).

[306]"Checkerboarding" describes the random dispersal of Yakama (trust and fee) and non-Yakama land holdings within the reservation.

[307]Schuster, Helen H., 1990. **Supra** at 83-84.

partially mitigated by the Yakama retention of extensive upland areas within their 1855 Treaty Reservation boundaries - and, in fact, today, about one third of their Reservation is “closed” to non-Yakamas, and extensive traditional gathering and ceremonial activities are still undertaken by tribal members in this area.

Usual and accustomed fishing resources of the Yakama peoples have not fared well, due to attempts to preempt Tribal access to these resources in early years, and to the progressive transformation of the land and water upon which the salmon depend. On balance, these actions have had the effect of creating wealth for other interests, at Yakama expense.

> Irrigation dams prevented salmon from making their regular spawning runs, prompting more controversies involving fishing rights. In addition, small salmon, or fingerlings, were often caught in lateral irrigation canals. Unable to reach the rivers, they perished by the millions.... White fishermen on the Columbia added to the problem by using fish wheels. ...
>
> The Yakama’s right to fish at their traditional sites was also threatened. White homesteaders on lands adjoining the fisheries sometimes refused to allow the Indians to cross their lands in order to reach these stations. In 1905, the U.S. Supreme Court upheld the Indians’ right to use their ancient and accustomed fisheries in *U.S. v. Winans*, a case brought against a white settler whose homestead blocked Indian access to these sites. The Court also ruled that the treaties the Indians had made with the United States were to be interpreted in the way the Indians had understood them. It stated that “a treaty was not a grant of rights *to* Indians but a grant of rights *from* them”.
>
> However, non-Indian fishermen often ignored the ruling. Eight years later, U.S. Attorney Francis Garrecht was called to defend Yakima Nation fishing rights in *U.S. v. the State of Washington*, a case involving two principal Yakima chiefs, George Meninock and Jim Wallahee. Meninock presented the following speech as part of the tribal testimony:
>
>> God created this Indian country and it was like He spread out a big blanket. He put the Indians on it... Then God created the fish in this river and put deer in these mountains and made laws through which has come the increase of fish and game. ...For the women, God made roots and berries to gather, and the Indians grew and multiplied as a people. When we were created we were given our ground to live on, and from that time these were our rights. This is all true. We had the fish before the missionaries came. ...This was the food on which we lived.. ...My strength is from the fish; my blood is from the fish, from the roots and the berries. The fish and the game are the essence of my life. ...We never thought we would be troubled about these things, and I tell my people, and I believe it, it is not wrong for us to get this food. Whenever the seasons open, I raise my heart in thanks to the Creator for his bounty that this food has come.
>
> Through the years, the Yakama Indian Nation was fairly successful in defending its treaty rights in the federal courts, but the abuses against them continued. For instance, the Yakima’s traditional Indian fishing grounds at the Long Narrows and Great Cascades were flooded in 1938 when the government constructed Bonneville Dam on the Columbia River. Congress passed legislation promising that the salmon and steelhead that had been destroyed would be

> replaced by hatchery fish. However, this act was implemented by establishing almost all of the hatcheries downriver from Bonneville Dam, where only non-Indians fished, instead of upriver in the tribal fishing areas. Similar problems arose in 1941 when Grand Coulee Dam was built on the Columbia and blocked miles of spawning grounds.
>
> The late 19th and early 20th centuries brought the Yakima into conflict with both white settlers and government officials as the tribe tried to hold on to the land and resources that were legally theirs. These years were only a prelude to the battles the Yakima Nation would be forced to fight in the last decades of the 20th century.[308]

6.7 Changing the Production Function for Yakama Lands and Waters

6.7.1 Tribal Perspective Concerning Yakama Lands and Waters

The previous section identifies that the production function for the Columbia/Snake basin - defined as the manner in which residents of the area Basin combine lands and waters to create wealth - has changed over time; and in a manner that has increased the wealth of non-Indians in the region while reducing tribal peoples to poverty. Cheap electricity to support modern industries, millions of acres of irrigated agriculture, use of rivers and reservoirs as depositories for waste, and the demise of the salmon are particular features of this change. The Northwest Power Planning Council captured the essence of this wealth transfer in 1982.

> Three generations ago, when the Columbia River and its many tributaries ran free to the sea and the fish and wildlife flourished, the people of our region were presented an unmatched opportunity. To the credit of their vision, skill and courage, they harnessed this mighty river system into a seemingly boundless supply of low-cost electricity. Thanks to their visions of the time, we have all benefited immensely.
>
> But this achievement, like all great achievements, had a price. The development of the Columbia River System’s hydro-electric projects dramatically changed the natural fish and wildlife habitat, especially that of the prized Pacific salmon and steelhead. The fish runs were nearly destroyed. It falls to the next generation to rebuild these natural resources which thrived before we came.[309]

Tribal peoples did little sharing in the benefits described by NPPC - and it was the Yakama Indian Nation and other basin tribes who have paid much of the price referred to in the previous citation. Understandably, as the tribes watched the center of their lifeways being destroyed, they raised their concerns and objections.

> My name is Watson Totus, member of the Yakima Tribal Council. I am a direct descendent of the Columbia River tribes and chiefs who signed the Yakima Treaty of 1855.

---

[308] Supra at 84-87.

[309] Northwest Power Planning Council, 1982. **Letter to the People of the Pacific Northwest**, in, Draft Fish and Wildlife Program. Portland.

> I am protesting the construction of the Dalles Dam. It should never have been authorized by the United States Congress in 1950 and the 82nd Congress never should have appropriated $4,000,000 and let the contract for construction in 1952.
>
> I make this statement because the proposed dam violates the Yakima Treaty and threatens to abolish and destroy one of the most historical and scenic natural monuments in the United States. The dam would do irreparable damage to Celilo Falls fisheries, tribal traditions, and religion.
>
> My people fished at Celilo and many other tribal fishing places, both above and below the falls. Even yet, many Indians fish here to supplement their subsistence and livelihood. ...
>
> I teach my people that (1) water is blessed by God; (2) salmon is blessed by God, and it is the first food that we partake of in the "Washeat" church ceremonies on Sunday, fresh-root festivals and "first salmon-catch" festivals.
>
> I am now asking Congress to change its mind and not construct the Dalles Dam. It will make the spirits of my dead chief of long past rejoice and will build confidence in my present and future people that our treaties of 1855 are sacred and shall not be abrogated by Congress of the strongest and most religious country of the world, the United States of America.
>
> The spirits of my past chiefs cannot plead for justice. I can only pray, save Celilo Falls and all it represents. May the Great Spirit bless you all. I have spoken for my people.[310]

> As you come up the river, dam by dam by dam, every dam we look at and talk about has done some damage to the Indian culture and the Indian tradition, has taken away something every time a dam is built. And if you want to talk about Bonneville Dam then you go back to the very first dam, and it took away Cascade Rapids from the Indian people. It took away a big fishery. And as you come up, the Dalles Dam probably did the greatest damage of all, because it inundated the ancient fishing ground of Celilo and the rocks, and all of Spearfish and Tenino. The Dalles Dam also inundated an ancient burial ground....The John Day Dam inundated John Day Rapids and inundated Blalock Rapids all the way up to what is usually known as Patterson. And there was a great Indian fishing village in that area. Used to be a big rapids in that area. Naturally the dams were built on places that were shallowest, and those places were the places where Indians fished, in the rapids. McNary Dam, I don't know how much damage that did, but I suppose it did a lot of damage to spawning areas.... Priest Rapids has done a great deal of damage. It's ruined major spawning beds, and big, big fishing area, what we used to call Wannapum, Priest Rapids, Whitebluffs, all through that area.[311]

Evidence found throughout this manuscript suggest that many of the regions' residents, intent on creating wealth for themselves, had limited or no regard for the adverse impacts they were creating for the Yakama and other tribal peoples - terming such impacts the "price of

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[310]Watson Totus, 1952, in, a **Presentation on Behalf of the Yakima Tribe**, to the U.S. Senate Sub-Committee on Civil Functions of the Army, May 12. Printed Hearings, pp. 434-435.

[311]Rudy Saluskin, at Toppenish, October 22, 1982; in, Meyer Resources, 1983. **Supra** at 60-61.

progress"[312]. From the perspective of distributive economics, and recognizing that non-Indians reaped benefits while Indian peoples paid the "price", such a conclusion is not surprising.

In some cases, scientists and bureaucrats responsible for managing the salmon claimed "to know better" than tribal peoples.

> That's one thing you can't tell the biologist. They think they know more about it than the first people. Like last fall, they got the twelve hour season down there. They caught 70-some thousand fish. I looked at the television screen and saw that fish they were bringing out--pure black. That's fish that's been in the river a long time. When they first coming in from the ocean they got to be chrome, silver. They weren't that. I told them guys down at the meeting those fish were held back purposely. The way they do that is with electric fence impulse. You see some of that fish that gets down in there burnt. They got spots on them. The biologists didn't want to admit nothing. They said they come out of the ocean. No, they did not. They'd been in the river for a long time--I know.[313]
>
> I can tell you. The fish used to be really bright. ... When the Dalles Dam came in and then John Day Dam, they became very poor. Like he says, they fall apart.... The last fish I caught on the Yakima was up near what they call "Upper Dam", the last dam that began there. I was up there fishing and I caught a salmon. ...I gave it to the old man that lives there.... While he was sitting there talking, he said, "See out that window. It's changed since they put Dalles Dam in. I noticed the change in the creek." He says, "I've fished here a long time. And the fish at that time used to be able to jump and reach the top of the dam. But today they jump, they barely reach halfway up." So it has taken away. ...They have become weak, like he says. And I'm thinking about that, and it seems to have lost a great deal of their constitution, what keeps them solid.[314]
>
> The hatchery fish live in a tube, and when they're released, they don't know how to camouflage themselves. When they hit the stream they jump around at the surface, and kind of bundle up together - and the birds come and pick them off. They have trouble now acclimatizing to the river. We didn't ever agree to let them make dummies out of our fish.[315]

In other cases, biologists claimed "not to know enough" to save the salmon. The following quote, written some fifteen years ago, and referencing Indian certainty concerning the adverse effects of dams on salmon, is similar to some aspects of current debate.

> Indian people have been consistently conservative in risking fisheries for other water-related development. Indian people correctly predicted the deleterious effects that dams and their associated mitigative measures would have on the salmon and steelhead of the Columbia River. **While biologists studied and debated, Indians, living on the river, saw fish quality decline and sea gulls eating dead smolts out of dam spillways. More often than not, Indian concern and counsel was ignored**. (Our bolding)

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[312]Recall Notes 293 and 302.
[313]Dave SoHappy, at Toppenish, October 21, 1982; in, Meyer Resources, 1983. **Supra** at 69.
[314]Tom Eli, at Celilo, October 28, 1982; in, Meyer Resources, 1983. **Supra** at 67.
[315]Bill Yallup, at Toppenish, October 3, 1997. **Personal communication**.

> It would appear that Indian people, with their extensive knowledge of the salmon, its characteristics and requirements, can provide valuable information for ongoing decision-making on the river....(T)heir advice on safety margins needed by salmon during flow, fish passage and other river-related decisions, their ability to quickly observe whether programs are working or not, and their basic common sense concerning the salmon resources of the river could be invaluable to any upper river restorative effort.[316]

Other non-Indians and their agencies are reported to have simply not told the truth, and buried salmon killed by dams at night.

> On these ladders they're talking about, I was one of those boys that went around to the farmers over in Nickleson area and Horsehaven area. Talked to the farmers about this (in 1956-57): We should have, its like a river, a channel, like a canal, somewhere above or down where the fish would go up. Well, the farmers went along. They had a big list of people signing that petition to have the dam fixed up. Well the Corps of Engineers agreed to it. They said, "We'll do it." But when the dam went up there was no channel.[317]
>
> She's angry about when they took the Falls from the people that were here....She says, "What good would it do to speak up?"...Like the promises that they made to the Indians that we get free electricity from the dam. I think it was three months they got it. The next thing, the people were getting light bills and they were getting water bills.[318]
>
> I've got something to say to comment on the fishing. I know four people who were lucky to get jobs at the dams, and these are the things that they come back and tell me. I won't mention names, you know, because...I don't want to say my name, all right? These people work at the dams. They usually help clean the ladders out, fish ladders. And they hauled out tons of fish that were found under the steel grating that's under the fish ladders. A lot of them were dead or they were damaged pretty bad. These guys were working there and they had to clean the ladders out, you know, help. Well, they used to come home and they'd tell me about it. And they'd say they'd haul them out by the pick-up load. You know, these pick-ups they use at the dam. Cuz the guys that work there, they tell me, "Oh, we were cleaning fish ladders. And they took these fish out, and they dug holes, and they burned this fish. And then they buried them. To hide the evidence. And then they turn around and blame the Indians, that the Indians are catching all the fish.
>
> A lot of these things happened right when John Day Dam came up. They worked on the dam from '66, '67, '68. Then I think the last year they worked, since they quit hiring Indians out there, see. A long time ago they made a promise to the Indians that there would be ten percent Indians working on the dams. I don't think there's one Indian working on any dam now.[319]

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[316]Meyer Resources, 1983. **Supra** at 71-72.

[317]Warner Jim, at Celilo, October 28, 1982; in, Meyer Resources, 1983. **Supra** at 58.

[318]Warner Jim on behalf of an identified Yakama woman at Celilo, October 28, 1982: in, Meyer Resources, 1983. **Supra** at 58. The woman was afraid to identify herself because on the previous day a car had stopped on Hwy. 84 and a man had shot at her and her daughters as they fished on the Columbia River.

[319]Unidentified Yakama woman, at Celilo, October 28, 1982: in, Meyer Resources, 1983. **Supra** at 68-69. This is the same woman referred to in the previous citation.

Some officials compounded folly with attempts at intimidation and with arrogance. The following statement is from a non-tribal official, during a 1954 meeting with representatives of the Yakama Indian Nation.

> (I)t is noted...that the Yakima Tribe contend that the $23,000,000.00 represents only 85% of the total value of the Celilo fishery because of the alleged losses that occurred during the year 1947 to 1951, due to the construction of the Bonneville Dam. This office does not admit that there is any loss of the Columbia River fish due to the construction of Bonneville Dam. In fact, we categorically deny that there is a loss due to this reason. ...
>
> Mis-information sometimes attributed to the press, but for the most part disseminated by word of mouth, has created a false public opinion, especially among the Indians, that the fish runs at Bonneville have decreased in recent years due to the construction of Bonneville Dam. The actual fact is that the runs have increased since 1938 and the convincing figures which are briefly stated above must be admitted as facts and taken into account if the contention that there is a loss due to Bonneville Dam is considered objectively and with unbiased honesty.[320]

Whether because the "price was right", because biologists were unsure, because tribal knowledge was ignored, because of unintended or forgotten promises, or due to arrogance and disingenuous behavior - the number of salmon that survive in the Columbia/Snake system has steadily declined. For the Yakama people, the human toll resulting from these wealth transfers along the river has been substantial. Where such destructive action has been accompanied by intent or deceit, reaction by some Yakamas has been one of anger and despair.

> I don't know what we would call such a policy. Genocide? Yes, I think perhaps that is the word.[321]

6.7.2 Economic Perspective Concerning Yakama Production Functions

Fitch (1974), in his Phd. dissertation at Stanford University, provides an economist's perspective of Yakama circumstances during the late 19th and early 20th centuries.

> The picture which emerges during the period after the opening of the Reservation (to whites) is one of stagnation of Indian economic activity. Downward trends in farming and livestock are evident... . A series of legal battles over Indian fishing rights had not been successful in re-establishing viable salmon fishing on the Columbia River for the Yakimas during this period. Access continued to be a problem, and the fish wheels were not eliminated from the river until 1926.[322]

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[320] Othus, P.M., 1954. US Army Corps of Engineers. Statement to a Yakima Indian Tribal Committee during compensation discussions associated with construction of the Dalles Dam. **Meeting** Minutes. Portland, Oregon, April 22, 1954, pp. 18-20.

[321] Tom Eli, at Celilo, October 29, 1982; in, Meyer Resources, 1983. **Supra** at 62.

[322] Fitch, James B., 1974. **Economic Development in a Minority Enclave: The Case of the Yakima Indian Nation, Washington**. Phd. Dissertation. Stanford University, p. 93.

Summing up from a later (1974) perspective, and discussing Yakama adaptive efforts, Fitch continues:

> The historical analysis makes a number of points quite clear. First of all, a large portion of the impact of the various modern activities which have been introduced to the Reservation has come in the form of payments for the use or purchase of resources to the Yakimas--that is, land rentals, timber sales and so forth. While recent improvements in Indian employment are encouraging,...the employment status of the Yakima is still deplorable.
>
> ...While the entry of outside factors to the Reservation economy may have greatly increased the returns to the Yakimas' natural resources, this has acted to limit returns to their human resources or labor, and in the long run to depress human capital formation applicable to modern production. ...
>
> With the opening of the (Reservation) land market...there was a decrease in Indian production and an increase in land rentals. This response was probably reinforced...by discrimination against Indians in water project administration and in the government regulation of the use of individual Indian monies, tending to cause inadequate capital formation. Discrimination and a generally hostile reservation environment for Indians also contributed to stagnation in human capital formation. Given these unfavorable circumstances for participation in modern activities, together with renewed possibilities for fishing and the production of cattle, in the low-wage depression era the Yakimas returned to these two largely traditional activities. Note, however, that this switch was a joint result of (the lack of) economic incentives, the existence of traditional preferences and alternatives, and possibly discrimination--not due to any one of these factors alone.[323]

Meyer Resources (1983), writing eight years later, provides a more quantitative glimpse of Yakama circumstances.

> While the Yakimas are relatively better off than many tribes of the Columbia River, they cannot be considered wealthy by non-Indian standards. In 1975, per capita income was \$2,100, compared to \$5,827 in Yakima County and \$6,284 in Washington State. Unemployment among Indians (1978) was estimated at 30 percent, compared to a 10 percent rate in the county. In 1982, unemployment was estimated at 72 percent of the employable Tribal labor force.[324]

6.8 Lower Granite, Little Goose, Lower Monumental and Ice Harbor Dams

As identified previously, peoples who now form the Yakama Indian Nation had usual and accustomed fishing stations and villages throughout the mid-Columbia area. They fished Snake River salmon stocks along the Columbia river - and the impacts of the four Lower Snake dams being assessed under this project directly affect Yakama fisheries and Yakama peoples.

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[323]Supra at 153-154.
[324]Meyer Resources, 1983. **Supra** at 27-28.

The Palouse peoples had their principal village at the confluence of the Palouse and Snake Rivers - and their home territories and fishing areas also extended along the north bank of the Snake, from Nez Perce territory to its confluence with the Columbia[325]. The Palouse peoples were included in discussion at the Treaty with the Yakamas - and today descendants live on the Yakama and Umatilla Reservations[326]. In addition, they fished cooperatively with the Nez Perce at several upstream locations along the Lower Snake River (Section 3.1.3).

Consequently, in addition to the existence of usual and accustomed fishing areas along the Lower Snake River, and downstream on the Columbia River, an extensive array of villages, fishing sites, hunting and gathering areas, burial sites and other resources important to the culture and lifeways of the peoples of the Yakama Indian Nation are currently inundated by the reservoirs created by **Lower Monumental** and **Ice Harbor** dams. These Yakama areas and resources will most likely be found - but not exclusively - along the north bank of the original Lower Snake River.

It was earlier identified that the initial "allotment" legislation enabled Yakama peoples to receive title to some traditional sites that were off reservation[327]. Yakamas report that some of these sites were along the Lower Snake River, and have been affected by the dams.

> I no longer have any fishing sites, the Palouse peoples' fishing sites were destroyed by Ice Harbor Dam; the Corps of Engineers told us that we can fish below Ice Harbor dam, but I, nor the rest of the Palouse people utilize the fishing site... . I have not received full compensation for my loss, the loss of my birthplace, birth rights, and my rights to fishing; for I no longer enjoy my God's gift, the first food of my people, as well as the rest of the Columbia River Indian people.
>
> I want to know if my fishing site and my fishing right still exists. My fishing site is now below Ice Harbor dam, both sides of the Snake River. I have proof. I have in my possession a photo of a fisherman and his grandson.
>
> That area is my father's birthplace, and that now belongs to white people. I did not, nor my father, give any type of consent to let white people own that land. We did not receive any monetary compensation, nor did we receive any exchange of any land. So I want someone to do right by that crime committed to me and my Palouse people. Give me my food back. Give me my birthplace and birth right back.[328]
>
> My maternal grandmother was Palouse. She owned an allotment that is now inundated by Ice Harbor Dam. When it came time to build the dam, a Corps man named Ed Markley approached me and my brother to take money for this property. We refused. So he determined that other Indians had a 51% ownership and did a deal with them. I did not have access to a lawyer at the time to fight this injustice, but I have never agreed to sell my grandmother's allotment - and have never been compensated for it.[329]

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[325]Lane & Lane and D. Nash, 1981a. **Supra** at 9.
[326]Supra.
[327]At Note 300.
[328]Mary Chapman, at Toppenish, October 22, 1982; in, Meyer Resources, 1983. **Supra** at 57.
[329]Johnson Meninick, at Toppenish, July 22, 1998. **Personal communication**.

Finally, the Yakama, as with other study tribes, have suffered adverse impact - first as river managers risked Snake River salmon stocks in order to transform the river for power, navigation and irrigation purposes, and today as those same managers set far higher standards for predictive certainty before taking action to restore Treaty-protected fisheries[330].

6.9 Post-Contact Yakama Tribal Health

Trafzer (1997) concludes that in pre-contact times the peoples now known as the Yakama Indian Nation had a relatively good standard of living based on diet, climate, housing, an available resource base, and a satisfying and predictable rhythm of living[331]. During this period:

> Yakama (native) doctors were practitioners, holy people, pharmacists, shamans, and psychologists, and they recognized no division between mind and body.[332]

Selam (1975) notes that Yakamas living in the pre-contact period had a happy life - but that it was not to remain so[333].

From a health perspective, erosion of traditional lifeways followed fast after the coming of the whites.

> Indian doctors and Yakama people suffered several epidemics before the introduction of the reservation system, but they were largely powerless to prevent the waves of death that swept across the Columbia Plateau in the nineteenth century and those that struck the native population in the twentieth century.
>
> Smallpox was the first disease to strike Northwestern Indians. The first epidemic started in 1775, the result of sailors from trading vessels off the Northwest coast introducing it to native peoples. Another smallpox epidemic traveled up the Missouri River in 1873, but its effect upon the Plateau is unknown. In 1801, still another smallpox epidemic spread among the native people of the Northwest, reducing the original population to about one half by the time of Lewis and Clark’s expedition in 1805. In 1824-25, and in 1853, smallpox likely killed more Indians. In 1830, “fever and ague” broke out at Fort Vancouver, infecting native people for four years. The epidemic may well have been malaria, although it was linked to an outbreak of influenza, and the “mortality directly or indirectly attributable to this scourge...is 90%”. The malaria outbreak in 1830 reportedly did not spread much above The Dalles, and Plateau Indians probably died instead from influenza, although the number of deaths is not known. In 1844, scarlet fever and whooping cough spread across the Columbia Plateau, and scarlet fever struck again in 1846. In 1847, measles moved across the Plateau, taking the lives of many Indians and sparking the killings of Marcus and Narcissa Whitman and others at the Whitman Mission which, in turn, triggered the Cayuse Indian War of 1848. These epidemics and the new diseases that followed killed numerous Yakama and their neighbors. Diseases depopulated the native peoples and strained the social, cultural, and spiritual fabric

[330] Also recall discussion in Section 4.4.8.
[331] See Note 290.
[332] Trafzer, Clifford E., 1997. **Supra** at 40.
[333] At Note 291.

> of Yakama society whose *twati* could not undo the horrors of white diseases.[334]

By 1865, the ravages of these diseases had more than halved the 7,000 Yakama pre-contact population estimated by Schuster[335]. Table 17 arrays Yakama population estimates between 1865 and 1972 from Lane & Lane and Nash (1981b, p. 43). That publication should be referenced for original sources.

Table 17
Selected Population Estimates for Yakama Peoples, 1865 through 1972

Year	Population
1865	3,400
1892	2,700
1899	1,909
1910	2,679
1923	2,939
1928	3,000
1940	2,904
1950	3,598
1960	4,844
1972	7,480

Yakama ill health and death during this period did not stem from epidemics alone.

> For approximately thirty years, roughly from 1870 to 1900, native people living on the Yakama Reservation witnessed a radical cultural, social, and economic transformation of their native lands as white ranchers, farmers, politicians, bureaucrats, ministers, bankers, road builders, and a host of other whites invaded their country, altering nearly every aspect of traditional Indian life. The process accelerated in the twentieth century as hunting, root, berry, and grazing areas declined or were destroyed. Indians living on the reservation lost their native foods which were closely tied to their spiritual beliefs. They lost more than their economy, for they lost important threads of their social fabric. Indians living on the Yakama Reservation faced a social and cultural calamity by 1900, a communal depression that corresponded with a serious rise of infectious diseases, particularly tubercular infection. Between 1900 and 1940, the Yakama population suffered greatly from tuberculosis, pneumonia, and gastrointestinal disorders, bacterial infections that preyed on a Yakama host seriously injured by government Indian policies and the reservation system.[336]

It can be observed from this information that from the contact with the whites in the 1800's, through much of the 20th century, death - often from causes that the Yakamas could neither predict nor control - "stalked the Yakama". Trafzer suggests that principal causes of Yakama death during this period evolved - from an age dominated by "Pestilence and Famine" (contact through the early 20th Century) to an "Age of Receding Pandemics" featuring death from

[334]Trafzer, Clifford E., 1997. **Supra** at 41.
[335]At Note 279.
[336]Trafzer, Clifford E., 1997. **Supra** at 70.

bacterial infections (from early century to the 1920's - 30's)[337].

By the 1930's, Trafzer concludes that causes of Yakama death had evolved still further, entering an "Age of Man-Made and Degenerative Diseases" that continues to the present.

> During the late twentieth century, alcohol-related deaths, diabetes, murders, and suicides rose significantly as accidental deaths and pneumonia continued to plague Yakama people... . Barry Popkin has argued that part of this transition to man-made disease is a predictable product of nutrition related to "modernization". He is correct in terms of Yakama people who had lost nearly all of their traditional foods by the 1940's... .[338]

Trafzer notes that loss of traditional foods, while important, is not a sole cause of Yakama mortality.

> Resettlement of the Columbia Plateau by whites, the building of dams, and the destruction of the natural foods familiar to the Yakama brought about a change in lifestyle and housing. Whites farmed, ranched, and logged many regions of the Columbia Plateau, modifying the environment, which was detrimental to Indians. Rather than moving about for a good portion of the year, the Yakama became confined to the reservation... . The health of the Yakama people suffered from inadequate sanitation, absence of clean ground water, polluted rivers from insecticides, and complete lack of any means of treating sewage. The change of housing among the Yakama contributed to their ill health, and as a consequence, the people became ill and died.[339]

Too often, death of Yakama and other tribal members has been following by post-mortem abuse.

> Before the early twentieth century, the Yakama and their neighbors usually wrapped the body in tule mats and placed it in crevices of hills and mountains. They also buried their dead in designated cemeteries, where they interred a number of people from the same area, village, or family. These cemeteries were and are sacred places to Yakama who revere the remains of their loved ones - long past and recent past. They respect the dead of their own people as well as the dead of other nations, believing that it was and is sacrilege to disturb burials of any people. Many believe that the spirits of the dead cannot rest if their bones are taken out of the earth or generally disturbed by contractors, pot hunters, etc.[340]
>
> A white rancher who hated (Yakama Chief) Kamiakin had led a scientist to the grave and had helped the "scholar" cut off Kamiakin's head with a shovel. The scientist tore off Kamiakin's head, placed it in a gunny sack, and took it to his lab for analysis. When the family found that Kamiakin's remains had been disturbed, they cleaned the remaining bones and reburied them on lands belonging to a friendly white rancher in eastern Washington territory. Members of the family knew the location of the grave, and they returned periodically to pray for the spirit of the famous chief. Kamiakin's head has never been recovered, and the associated grave

[337]Supra at 2-3.
[338]Supra at 71.
[339]Supra at 75.
[340]Supra at 51.

> goods buried with him have not been repatriated. However, some members of the Indian and non-Indian communities continue to search for Kamiakin's head so that it can be repatriated and reburied in the heart of the Columbia Plateau. The desecration of this grave is just one example of many that have occurred in the Pacific Northwest.[341]
>
> When the United States began building power dams in the Pacific Northwest, construction crews ruined several burials in canyons along inland rivers, **including the Snake River**. Sometimes archaeologists working for the federal government raided Indian burials to preserve choice specimens for university collections before water from a new dam inundated the locations.
>
> **Mary Jim, a Palouse elder living today on the Yakama Reservation, still laments the theft of her grandfather from the family's cemetery on an island in the Snake River**. She remembers the night in the 1960's when an amphibious vehicle came up the Snake River and moved onto the island. While white men dug up the grave, Mary's cousin, Charlie Jim, paddled out to chase the whites away. "They took our grandpa," Mary reported years later, "they took him. They went across. And they took that grave. They dug a hole and we hollered at them. Charlie Jim went out to tell them to stop. We waved red flags at them, telling them to stop. Then the car went through the water and on the ground too. We didn't know how to chase them or where they went. And we reported this to the agency but they never helped us." Unfortunately, the Palouse were not able to prevent the "scholars" from stealing the canoe coffin that contained the remains of Mary and Charlie's grandfather.[342] (Our bolding)
>
> The Yakama and their neighbors have faced a continual onslaught by ghouls, construction crews, and government agencies that disregard and discredit the spiritual beliefs of the Northwest Indians in reference to their dead. Many Indians believe that when the graves of their ancestors are desecrated, the souls of the dead are also disturbed, unable to rest until they are placed back into the bosom of the earth.[343]

White disease killed thousands of Yakama and their neighbor tribes in the 1800's and early 20th century. Violated by disease and in other ways in life, some of these persons have been violated again in death - through actions perpetrated by some, and permitted by others. Not only can the souls of these "violated" not rest, but many of their descendants, living today, cannot rest either until desecration of Indian graves stops - and the violated dead are returned to rest in the earth.

Trafzer concludes that, from the late 1800's though the mid-1900's:

> The reservation system of the United States destroyed the native standard of living and introduced a host of viruses and bacilli to the Indians living on the Yakama Reservation. The result was poverty, ill health and death among Yakama people. Once the United States had destroyed much of Indian culture, they failed to enrich it in accordance with trust and treaty responsibilities by providing minimal health care for native people living on the Yakama

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[341]Supra at 57.
[342]Supra at 51-52.
[343]Supra at 57.

> Reservation.[344]

Bachtold, writing with respect to Northwest tribes, concurs:

> It appears that Native Americans, as a group, have been blocked on the hierarchy of needs at basic levels. Many are dealing with survival - trying to resolve physiological and safety needs. This condition often leaves belongingness and self-esteem needs essentially unmet. Movement through developmental stages has been perilous, beginning with birth itself, increasing with entry into school, and peaking in excessive stress for young adults, who should be entering the productive years of life and in control of their environment.
>
> Alleviation of poverty conditions are clearly indicated as essential, for as Pareek emphasized, “Poverty is causally related to behavior, producing a series of behavioral patterns relevant to the conditions of poverty. ...
>
> Gloster...identified economics as potentially the key to improvement for Native Americans. He further maintained it is essential that they control their land and water. On this point he is congruent with the psychological prerequisite for a healthy personality outlined in this section - if Indian people are to obtain a greater level of achievement and satisfaction in their lives, and regardless of respective goals, it will be essential that they achieve a greater level of control over their psychological, social and economic environment.[345]

6.10 Present Circumstances of the Yakama Indian Nation

Having reviewed the cumulative pattern of abuse and impoverishment through wealth transfers to non-Indians that the Yakama peoples were subject to, this section considers any recent changes in tribal opportunities and lifeways - and profiles present-day circumstances of the peoples of the Yakama Indian Nation.

6.10.1 Remaining Yakama Lands

Yakama tribal membership presently stands at 9,601 persons, a substantial recovery from earlier years of this century.[346]

Since losing approximately 90 percent of their homeland in the Treaty of 1855, the Yakama Indian Nation has been somewhat successful in holding onto the Treaty lands they retained. The ravages of the Dawes Act have facilitated the loss to the Yakama of a further almost 20 percent of lands within Reservation boundaries (253,280 acres) - but over 80 percent of Treaty lands are still in Yakama hands - 866,000 acres held in trust, and 260,000+ in fee simple ownership. The fact that significant portions of this land is forested, and that approximately one third of Reservation lands, in the western portion of the Reservation, are closed to non-Yakamas has

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[344] Supra at 153.
[345] Bachtold, L.M., 1982. **Supra** 31-33.
[346] Recall Table 17.

allowed the YIN to retain and expand benefits for its people.

Commercial timber harvest has been a particular strong point for the YIN (Table 18).

Table 18

Volume and Value of Timber Harvested Under Yakama Sales Program 1943 to 1992		
Year	Volume in MBM	Value ($1,000's)
1943-44	9,172	23.6
1950	29,906	361.7
1960	70,892	1,922.3
1970	116,271	4,406.7
1980	172,686	23,755.5
1990	93,523	19,749.9
1991	99,134	23,819.7
1992	93,688	28,513.3

Source: Yakima Indian Nation, 1993. **Yakama Indian Reservation Forest Management Plan: 1993-2002**. with, US Bureau of Indian Affairs, p. VII-3.

These forest activities employ approximately 137 Yakama Indians[347], generate important revenue for YIN infrastructure, and yield annual "dividend" payments that amounted to $1,753 per Yakama member in 1992[348]. The YIN has, for some years, been examining "adding value" earned from tribal timber harvest by establishing a timber processing facility - but such a facility has not been established to date.

Conversely, as we noted previously, much of the acreage the Yakamas have lost because of the Dawes Act is located in fertile valley areas of the Reservation - and YIN agriculture-based revenues have been substantially limited as a result. Meyer Resources (1983) reported that the Indian share of revenue from crops in the irrigated portion of the Reservation in 1981 was $2.7 million, out of total revenue of $79.5 million[349]. In 1990, the value of irrigated lands within the Reservation exceeded $200 million[350] - but we have no indication that the Yakama share of this revenue has increased substantially.

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[347]Yakama Indian Nation, 1993. **Yakima Indian Reservation Forest Management Plan: 1993 to 2002**. with US Bureau of Indian Affairs, p. VII-3.

[348]Supra at VII-5.

[349]Meyer Resources, 1983. **Supra** at 26-27.

[350]Yakama Indian Nation, 1996. **1996 OEDP Report**. Toppenish, p. 8.

A number of additional economic initiatives are in the planning stage[351], but timber, agriculture, rental income from lessees of tribal land and fishing continue to be the sustaining features of the Yakama economy.

6.10.2 What Remains of the Yakama Salmon?

Protection and renewal of salmon in the Yakima River basin has been one of the principal efforts of the Northwest Power Planning Council's Fish and Wildlife Program. In 1997, the four tribes of the Columbia River Inter-Tribal Fish Commission (CRITFC) initiated a "direct commercial sales" program for some Zone 6 catches. This program has approximately doubled revenue received by participating tribal fishermen - and expanded the opportunity available to tribal members for involvement in traditional fishing and processing activities. Despite these promising developments, Yakama catches of salmon for the 1993-1997 period averaged less than half of tribal harvests at Treaty times (Table 19).

Table 19

Estimated Commercial, Ceremonial and Subsistence Harvests of Salmon and Steelhead of the Yakama Indian Nation: 1993 to 1997

Year	Chinook	Steelhead	Sockeye	Coho	All Species
	1,000's of pounds				
1993	832.5	251.5	22.2	8.7	1,114.9
1994	696.7	174.5	2.7	22.5	896.2
1995	674.4	170.6	1.4	4.8	851.2
1996	1,181.3	173.5	4.3	4.4	1,363.5
1997	1,199.4	207.7	6.2	4.0	1,199.4
				Five Year Average	1,128.7

Source: Developed from data provided by the Yakama Indian Nation, Department of Fisheries.

6.10.3 A General Assessment of Present Yakama Material Circumstance

The material wellbeing of members of the Yakama Indian Nation, relative to citizens of Washington State as a whole, is illustrated in Table 20.

[351]Supra.

Table 20

Comparative Data Showing the Relative Material Circumstances of the Yakama Indian Nation		
Economic Indicator	Yakama Tribe	Washington
Families in Poverty (%)	42.8	10.9
Unemployment %: (US Census)	23.4	5.7
Unemployment %: (BIA)	73.0	
Per Capita Income ($'000)	5.7	14.9

Source: US Bureau of the Census, 1990 - Special Tribal Run. US Bureau of Indian Affairs, 1995 - Indian Population and Labor Force Estimates.

It can be observed that while timber and some fishing provide economic bright spots for YIN, as with neighbor tribes, the Yakama peoples' material prospects overall remain difficult.

6.10.4 Yakama Tribal Health

In 1992, the Center for Health Statistics of the Washington State Department of Health issued a report on People of Color in the state. They concluded:

> Currently, the health status of Native Americans is very poor, with high rates of mortality, infectious disease, and limitation of major activities due to chronic health problems.[352]

The same report identified that death rates for Native Americans were significantly higher through age 59 than for Washington residents as a whole[353].

These conclusions are generally supported by a 1993 analysis of American Indian health status in the State of Washington by the American Indian Health Care Association (AIHCA). The AIHCA study reported that, in Washington, the average Native American dying prior to age 65 loses 7.6 more years of life than his counterpart in the general Washington population - and that a Native American female dying prematurely (prior to age 65) loses 6.1 more years of life than her general population counterpart[354]. The study concludes:

> The health status of Washington's American Indians can be illustrated by birth characteristics, disease prevalence and mortality. The findings on all these factors form a picture of American Indian health that is, in many ways, alarmingly poor.[355]

Both the studies cited previously identify poverty as a causal factor with respect to the unsatisfactory level of health of Native Americans living in Washington State[356].

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[352]Washington State Department of Health, 1992. **People of Color**. Center for Health Statistics. Olympia, p. 51.
[353]Supra at 61-64.
[354]American Indian Health Care Association, 1993a. **Northwest Area American Indian Health Status and Policy Assessment Project: State of Washington Report**. Saint Paul, p. 47.
[355]Supra at x.
[356]Washington State Department of Health, 1992. **Supra** at 4; American Indian Health Care Association, 1993.

Data from the US Indian Health Service further confirms these findings. Based on data from 1989-91, the Native American age adjusted death rate in the Yakima Service Area[357] was 1.9 times the rate for other races[358]. Table 21 provides comparative data on the five leading causes of tribal death in the Yakima Service Area.

Table 21

Leading Causes of Tribal Death - Yakima Service Area: 1989-1991			
Cause of Death	Native American	All Other Races	Ratio of NA to Other Races
	deaths per 100,000 population		
Heart disease	215.0	141.6	1.5
Motor vehicle accidents	117.8	26.9	4.4
Malignant Neoplasms	102.8	129.6	0.8
Cirrhosis of the Liver	80.0	5.7	14.1
All Other Accidents	44.5	16.1	2.8

Source: US Indian Health Service, 1994b. **Supra** at 214.

Diabetes are also a significant cause of Yakama death, accounting for 4.5% of mortalities[359].

These types of statistical outcomes are consistent with the hypotheses advanced by both Trazfer[360] and Bachtold[361] - relating unsatisfactory levels of health to poverty and deprivation-related stresses. Discussion with Yakama health experts provides further insight regarding present health conditions on the Reservation - and with fish and fishing.

> A lot of Yakama people don't have access to salmon on a daily basis. So that, of course, affects their health. They've lost a source of the type of protein that is very beneficial. Fish makes a positive contribution to the diet. Even giving the people an opportunity to eat fish two or three times a week would be beneficial. There is a real strong link between the fats salmon provide and preventing heart disease - and at present, heart disease is a major problem here.
>
> What's been substituted for fish has the opposite effect on health. Hamburger and fried foods raise LDL's and cholesterol levels.
>
> Diabetes is a problem at Yakama. The type we have here is Type II diabetes. Its onset has a strong link to poor diet and lack of exercise, which can lead to weight gain, which in turn exacerbates onset of diabetes at an earlier age. Diabetes in turn is linked with kidney and heart disease. Type II diabetes has a genetic component. But genes do not dictate destiny. Good diet and exercise will put off the onset of diabetes considerably.

Supra at ix-x, 22-23, 54.

[357]The Yakima Service Unit serves Klickitat, Lewis, Skamania and Yakima counties.

[358]US Indian Health Service, 1994b. **Supra** at 136.

[359]Supra at 213.

[360]At Note 73.

[361]At Note 66.

> The lack of traditional foods and the lack of traditional preparation of foods seems to have impacted worse than everything. The roots grounds are gone. The fishing grounds that sustained them through the whole year are largely gone. Its more than food. Its also loss of income - and there is a real spiritual component. Its part of their culture - part of their living.[362]
>
> They don't consider what salmon really means to our people. When I was growing up, my whole life was centered around what we gathered - what we used. The fishing brought families close together - not only for the food, but also spiritually and for religion. That way the family was able to cure a lot of its own problems. Fishing is for the family as well as the food. When we lose the salmon, its not just one thing we've lost. You have to take everything into consideration.[363]
>
> My specialty is psycho-social nursing. From my perspective, everything is tied together. Nothing is separate. The health of the kids is impacted every day. We see kids come in who are grossly overweight, and they're laying the groundwork for the diabetes to come. The impact of the loss of the salmon, and the loss of the traditional grounds - the loss of the time with the elders to learn the ways and to feel as if they're part of this community, instead of feeling alienated not only from their neighbors and their families but also from the bigger community of humans - has a devastating effect on the kids. I have moms come in here eighteen years old who have been pregnant two or three times, who use substances and who don't teach their children the old ways because they don't know them. They don't feed their kids the old foods because they don't have any idea what they were. So the loss of the food and the salmon is monumental - and it is all tied together. Food is a really big part of the Yakama culture - as it is elsewhere. Anywhere you look in the world, food carries culture. So if you lose your foods, you lose part of your culture - and it has a devastating effect on the psyche. You also lose the social interaction. When we can fish, we can spend time together - you share all the things that impact your life - and you plan together for the next year. Salmon is more important that just food.
>
> In sum, there's a huge connection between salmon and tribal health. Restoring of salmon restores a way of life. It restores physical activity. It restores mental health. It improves nutrition and thus restores physical health. It restores a traditional food source, which as we know, isn't everything - but its a big deal. It allows families to share time together and build connections between family members. It passes on traditions that are being lost. If the salmon came back, these positive changes would start.[364]

Finally, health experts at YIN expressed concern regarding dumping and leaching of toxins into the waters of the Columbia/Snake system. A study by the Columbia River Inter-Tribal Fish Commission (1994) identifies that CRITFC tribes, because of the material and cultural importance of fishing to them, consume about nine times more fish than national norms used by

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[362]Monicka Franz, Yakama Tribal Nutritionist. Personal communication at Toppenish. August 13, 1998.
[363]Vivian George, Yakama Indian Nation. Personal communication at Toppenish, August 13, 1998.
[364]Chris Walsh, Psycho-Social Nursing Specialist. Yakama Indian Nation. Personal communication at Toppenish, August 13, 1998.

EPA to set health standards[365]. Subsequent work by Harris and Harper (1997) identifies that exposure levels for tribal members who target traditional foods is far higher[366]. This suggests that study tribes may face significant risk from deposition of toxins in Snake and Columbia waterways - particularly from consumption of resident fishes. Further analysis of potential toxin loadings of key fishes is being pursued by the tribes, in coordination with EPA. Results are expected during 1999.

6.10.5 Present Incidence of "Own Language" Speakers Among the Yakama

According to the 1990 Census, approximately 15 percent of Yakamas still speak their original language at home[367].

6.10.6 A Diagrammatic Profile of Yakama Present Circumstances

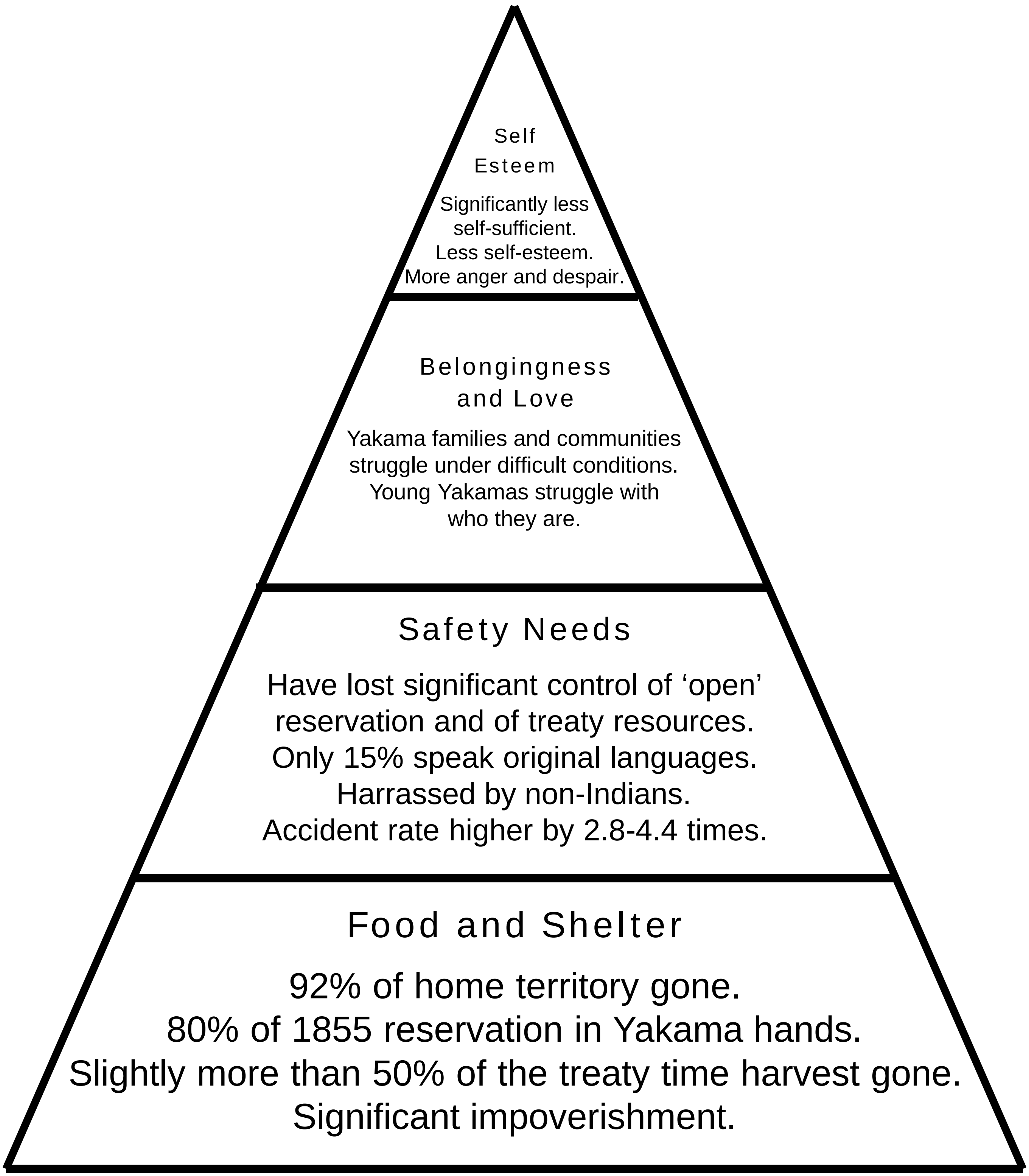
Finally, present circumstances of the peoples of the Yakama Indian Nation are represented in Figure 9 using a Maslow-like diagram.

[365] Columbia River Inter-Tribal Fish Commission, 1994. **A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin**. Technical Report 94-3.

[366] Harris, Stuart G. and Barbara L. Harper, 1997. "A Native American Exposure Scenario", in, **Risk Analysis**. Vol. 17, No. 6, pp. 789-795.

[367] US Bureau of the Census. 1990 CP-2-1A. **Supra** at 44.

Figure 9
Present Yakama Circumstances & Capabilities



7.0
Circumstances and Impacts on the Confederated Tribes of The Umatilla Indian Reservation

These sections provide information on the historic and related present circumstances of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Estimated impacts associated with Lower Snake River project alternatives will be discussed in a following section.

7.1 Accustomed Tribal Areas and Seasonal Rounds of the CTUIR

The peoples who presently form the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) originated from three tribes, the Walla Wallas, Cayuses and Umatilla - and a number of other bands[368]. Members of the Palouse peoples are included in these latter (Table 2).

Suphan (1974) has provided detail with respect to the traditional areas frequented by the peoples who are now the CTUIR. With respect to the **Umatillas**:

> The permanent camps or villages of the Umatilla Indians...were strung along both shores of the Columbia River from about the Gilliam-Morrow county line in Oregon upstream to the mouth of the Umatilla River; two other sites were along the lower course of the Umatilla. ...
>
> During the summer treks, the Umatilla crossed over the Blue Mountains into the Grande Ronde valley to numerous fishing, root-gathering, hunting and berrying areas. ...In none of these subsistence areas were the Umatilla the sole exploiters, Walla Walla, Cayuse and Nez Perce Indians visiting these same spots. ...
>
> Just east of the Grande Ronde Valley, the Umatilla exploited a spot on the Minan River, together with the Cayuse, Walla Walla and Nez Perce Indians, while they also journeyed into the Wallowa River Valley to subsistence spots about the present towns of Wallowa, Lostine, Enterprise, Joseph, and Wallowa Lake. These areas were also frequented by the neighboring Walla Walla, Cayuse and Nez Perce.
>
> Further southward, in what is now Baker County, the Umatilla and Cayuse fished and hunted on Eagle Creek and on Pine Creek two miles above Halfway with the Nez Perce. The only other spots in Baker County known to have been utilized by the Umatilla Indians were on Anthony Fork some 5-8 miles above the town of North Powder, and in Sumter Valley near Lockhart on the Powder River; both were shared with the Cayuse.
>
> To the west and south of the Grande Ronde Valley, the Umatilla people spread out into various fishing, hunting, and gathering spots on Snipe Creek just north of Albee, along

[368] Kappler, C.J. (ed.) 1972. **Indian Treaties: 1778-1883**. New York: Interland Publishing, p.694.

> Camas Creek at Ukiah and Lehman Springs, and to the heads of Winom, Cable, and Big creeks south of Lehman Springs. South of these areas, in what is now Grant County, the Umatilla occupied various spots along the forks of the John Day River from about Monument eastward.... Virtually every one of these sites was shared with the Cayuse, while those along the John Day, Silvies, and the Malheur River were also visited and exploited by the Warm Springs (Tenino), Columbia River Indians, and the Paiute. ...
>
> ...it may be concluded that the Umatilla Indians had their permanent winter quarters or villages along the Columbia from Alderdale, Washington, to the Umatilla River, and on the lower course of the Umatilla. Here too, were many accustomed fishing areas which extended farther eastward to the Oregon-Washington state line. In summer and fall, the Umatilla wandered in the Blue Mountains, Wallawa and Grande Ronde valleys, and along the John Day River to numerous subsistence areas for hunting, fishing, and gathering. It is impossible to say with what frequency any one spot was visited; undoubtedly those nearer the winter supply quarters were the more intensely and regularly used, simply because of convenience. Yet the distant sites along the heads of the Silvies and Malheur rivers were said by informants to be of paramount importance to the Umatilla not only because of their plentiful natural resources, but also because of the trading and social activities carried on there with other Indian groups.[369]

With respect to the **Cayuse**, Suphan reports:

> The Cayuse wintered in several local groups along the upper courses of the rivers lying between the Columbia River and the Blue Mountains in what is now Oregon and Washington.
>
> ...The Cayuse bands remained in these winter quarters until well into the spring, for salmon runs ascended the Umatilla and Walla Walla rivers and their tributaries, while roots and berries could be found close to these camp sites. Some families either then or later in the year, journeyed to the Columbia to fish at the mouth of the Umatilla River with the Umatilla Indians; some went as far as Celilo Falls to fish and trade. However, the Cayuse seem to have depended more heavily on the annual migrations of salmon into the headwaters of such streams as the Grande Ronde, Minam, and Wallowa rivers for their supplies of this staple than on the Columbia River fisheries. During the balance of the summer and in the fall, they were then found making their circuits through the mountains and valleys intercepting the fish as they arrived at various places. This, too, was the season for hunting, berrying, and root-digging....
>
> Summing up, the Cayuse Indians were subdivided into seven or eight named local groups, collectively designated by themselves as Waiilatpu. Wintering along the northern foothills of the Blue Mountains from Butter Creek on the west to about where Walla Walla, Washington now stands, they spread out during summer and fall through the Blue Mountains, into Grande Ronde and Wallowa valleys, and as far as the John Day, Silvies and Malheur rivers.[370]

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[369]Suphan, Robert J., **The Socio-Political Organization and Land Use Patterns of the Umatilla, Walla Walla and Cayuse Indians**. MA dissertation. Columbia University, pp. 128-134.

[370]Supra at 145-149.

Suphan also provides some information with respect to the **Walla Walla** Indians.

> The Walla Walla Indians, or Walula as they called themselves, spoke a Sahaptin dialect said to have been closely related to that of the Nez Perce.
>
> Permanent sites of the Walla Walla were few in number, located on the Columbia near the entrance of the Walla Walla River. ...
>
> Fishing sites considered to "belong" to the Walla Walla Indians were along the Columbia on the east bank from a point about where the Oregon-Washington state line intersects the river upstream to the Snake River junction; the only known point on the west bank in this region was directly across from the entrance of the Walla Walla River. On that river, fishing areas extended upstream about two miles. In keeping with general native practice, these were not exclusively used, however, for the Cayuse fished at least one, while the site at the Snake junction was fished by the **Palus** and Upper Columbia (Wanapum) as well. ...
>
> Inland, the Walla Walla moved up both forks of the Walla Walla River and over into the country about the forks of the Wenaha River; subsistence spots along both these streams were used in conjunction with the Cayuse. In the Grande Ronde Valley, they journeyed to sites about the present location of the towns of Hilgard and La Grande to which the Umatilla, Nez Perce, and Cayuse also resorted. On the Minam River, they exploited in a region about opposite Cove, Oregon. Further eastward, they ascended the Wallowa River to favored subsistence areas near where the towns of Minam, Wallowa, Lostine, Enterprise, and Joseph now stand, and at Wallowa Lake; the Umatilla, Cayuse and Nez Perce were present at all of these. As in the case of the Umatilla Indians, it is impossible to say with what frequency any one such spot was visited; informants alleged that each would be visited at least once yearly by some members of the Walla Wallas.[371]

Lane & Lane and Nash (1981a) also point out that the Walla Walla "occupied territory downstream from the Nez Perce on the south bank of the Snake River and perhaps on the north bank as well"; and that the **Palouse** territory was centered at the confluence of the Palouse and Snake Rivers, and that they "lived on the north bank of the Snake River below Nez Perce territory"[372].

As with neighbor tribes, salmon was the key resource for the tribal peoples now known as the Confederated Tribes of the Umatilla Indian Reservation.

> Salmon has played the key role for the people of the CTUIR since earliest remembered time. Every CTUIR leader and elder who speaks reminds us that the salmon is at the core of their material and cultural wellbeing.[373]

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[371] Supra at 135-144.

[372] At Note 98.

[373] Meyer Resources, 1995. **Assessment of the Effect on Trust Resources of the Confederated Tribes of the Umatilla Indian Reservation from Alternative System Operating Strategies (SOS) for Columbia/Snake River Flows**. A Report to the Confederated Tribes of the Umatilla Indian Reservation. Davis, CA, p. v.

> When God created Indians on the Earth, he gave us everything. Main thing was salmon and meat. And all the vegetables--the potatoes, celery--everything, you name it, that's what he gave to us. And that's what we were raised on.[374]
>
> It's just that salmon was part of the country, they're part of the environment. They belong here as much as the Indians belong here. And in that way they complement each other. They've become a part of us because its what we depend on to live... .[375]
>
> The first catch, you know, the first spring salmon? We still have a big feast. Like in Celilo they do yet. They always did so our Creator would preserve it, help the Indian people to have more salmon come up, and so they could get more fish to the Indians. Most of us people this way, we like fish. I know that's all I could eat; I can hardly eat meat anymore, but I can sure eat salmon. We're known this way as "salmon eaters" by the Montanas and the Dakotas; and they're meat eaters that way. That's what I hear. They tell me, "What do you like?" I say, "Salmon, of course. I'm from that way." So they call us "salmon eaters".[376]

7.2 Natural Capital and Annual Productive Yield of Original CTUIR Lands

The lands and waters of the CTUIR traditional territory provided the natural capital which allowed these tribal peoples to survive and prosper. These resources were responsible for the "annual production" of fish, game, roots, berries and edible plants upon which the CTUIR peoples depended. As noted, salmon was the key product of this tribal production function.

Hewes assumed that an average person living in the Columbia/Snake region in pre-contact times would have required 2,000 calories per day to survive[377], and on this basis, estimated that each Umatilla and Walla Walla person would have consumed 500 pounds of salmon annually - and that each Cayuse person would have consumed 365 pounds[378]. Hunn (1990) considers these estimates to be conservative[379]. Walker (1967) identified that the tribes also used salmon for other purposes, such as fuel, and adjusted Hewes' annual per capita consumption estimates upward by a median figure of 16.6 percent[380]. Finally, information from Swindell (1942) suggests that tribal families fishing in the mid-Columbia area would catch more than one-third more salmon for trade, after having taken care of their own needs[381].

With respect to the population size of peoples now members of CTUIR, we follow estimates by Verne Ray.

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[374]Mary Lawyer, on the Umatilla Reservation, October 13, 1982; in, Meyer Resources, 1983. **Supra** at 37.
[375]Antone Minthorn, on the Umatilla Reservation, October 13, 1982; in, Meyer Resources, 1983. **Supra** at 38.
[376]Carrie Sampson, on the Umatilla Reservation, October 13, 1982; in, Meyer Resources, 1983. **Supra** at 42.
[377]Note 110.
[378]Hewes, Gordon W., 1947. **Supra** at 227.
[379]Hunn, Eugene S., 1990. **Supra** at 148.
[380]Walker, Deward E., 1967. **Supra** at 19.
[381]Swindell, Edward G., 1942. **Supra** at 165.

> Dr. Verne F. Ray testified, without contradiction by the government’s expert witness, that the population of the three tribes in 1790 was approximately 5,000. He estimated that by 1850, the tribal populations had been reduced by epidemics to 2,300, as follows: 1,000 Walla Wallas, 800 Cayuse, and 500 Umatillas.[382]

Using Hewes estimates, adjusted by Walker - and, per Swindell, increasing harvest estimates for Umatillas and Walla Wallas by one third, and Cayuses by one-quarter, to allow for trade - we obtain the following estimated CTUIR harvests in pre-contact and at Treaty times (Table 22).

Table 22

Estimated Pre-Contact and Treaty Annual Salmon Harvests by Tribes of the CTUIR						
Tribe	Per Capita Harvest		Total Annual Tribal Harvest			
	Consumption	Consumption Plus Trade	Pre-Contact Period		About 1850	
			Population	Harvest (’000 lbs)	Population	Harvest (’000 lbs)
	pounds per year					
Walla Walla	583	775	2,200	1.7	1,000	0.8
Umatilla	583	775	1,100	0.9	500	0.4
Cayuse	426	532	1,700	0.9	800	0.4
Total CTUIR				3.5		1.6

Salmon was the principal, but not the only source of food, for the pre-contact peoples of the CTUIR.

> All of Indian groups of the Middle Columbia River depended on fish, and particularly upon anadromous fish for their sustenance. However, it is doubtful if any depended upon this source of food to a greater degree than did the Walla Walla and their close kin the Umatilla. Murdock has estimated that between 36 percent and 45 percent of the food of the Umatilla came from the fisheries. Murdock’s estimates are generally conservative. For the Walla Walla, if not for the Umatilla, we would suggest that their dependence on fishing may have been greater than that.[383]

Using these estimates, and assigning the top of the range percentage to Walla Walla (45%), a median range percentage to Umatilla (40%), and adjusting the Cayuse fish percentage proportionately downward (to 27%) - we estimate that salmon amounted to 37 percent of the diet for the three CTUIR tribes, taken together. On this basis, we estimate total annual food consumption by the CTUIR tribes to be equivalent to 9.5 million pounds in pre-contact times, and to 4.3 million pounds in 1850.

Finally, if we were to utilize the US Bureau of the Census’ present-day estimate that families on an economy budget spend one-third of their income on food[384] - we could infer that, at Treaty times, the CTUIR Tribes obtained food and non-food items from their usual and accustomed lands and waters equivalent to 12.9 million pounds of food each year - and more than twice that

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[382]Confederated Tribes of the Umatilla Indian Reservation, 1979. **Tribal History**. Mission, p.2.

[383]Lane & Lane and Nash, D., 1981c. **Indian Fishing and the Walla Walla River System**. A Report to the US Bureau of Indian Affairs. p. 52.

[384]Note 69.

in pre-contact times. These estimates are inferential. It may be that in historic times, the ratio of food to non-food items obtainable by the tribes was greater than that used here. At the same time, however, the Census estimates are for “budget” families - and by the lights of the day, the CTUIR people lived well.

> The Plateau region of the Umatilla, Cayuse, and Walla Walla may be fairly described as one of relative abundance. From a pure survival standpoint, none of these Indians were customarily threatened with starvation, yet the cyclical, rhythmical nature of their food quest determined by the annual runs of fish, the ripening of the roots and berries, and the life-habits of the game resulted in their existing in a semi-nomadic state for about eight months of the year, and meant that the problem of subsistence was always the dominant factor of their lives. Yet the problem was only one of securing sufficient supplies, provided only that they keep on the move.[385]

> The horse was the key to expansion of the Sahaptian culture. Mobility of the horse brought the people into contact with other Indian cultures in Montana, Canada, California, Nevada, and the Pacific Northwest. The region was rich with food, materials for shelter, water, fish, game, and food and medicinal herbs. The geographical setting placed the people in the prime situation of being the middlemen of the trade between the Great Plains and the rich Pacific Coast cultures. The people were in essence the wholesalers and retailers between the two cultures.[386]

7.3 A Broader Perspective of CTUIR Living Circumstances in Pre-Contact Times

As Suphan notes, in pre-contact times, survival for the CTUIR peoples required only that they move with the natural food resources they depended on. The 1996 Comprehensive Plan of CTUIR provides further detail.

> The numbers of salmon, lamprey, steelhead, sturgeon and other fish were infinite. The fisheries were the staple of all life on the Columbia Plateau. Eagles, Bears, Coyotes, Cougars and Indians were amongst those who relied on the Salmon. Elk, deer, antelope, and many other smaller mammals were abundant. The rivers and streams abounded with beaver and otters, seals and sea lions were known to venture up the Columbia River to the great fisheries at Celilo. Several kinds of grouse, quail, and multitudes of geese and ducks, as well as hawks, owls, badger, rabbits, and other wildlife shared the diverse wetland, steppe, desert and upland.

> Roots, nuts berries, mushrooms, medicine, food, and fiber plants were seasonally available during the year. The hillsides were covered with lush bunch grasses, the timbered mountains were healthy, natural wildfires and floods were part of the cycle, the river vegetation was lush, and the water was cool and clean. The conditions were pristine and wildlife was naturally abundant. Survival was not easy for Indian people but the tools and resources were

[385]Suphan. **Supra** at 75-76.
[386]Confederated Tribes of the Umatilla Indian Reservation, 1979. **Supra** at 7.

EXHIBIT C
COLUMBIA RIVER SYSTEM OPERATIONS FINAL ENVIRONMENTAL IMPACT STATEMENT, APPENDIX F
U.S. ARMY CORPS OF ENGINEERS
(2020)

Exhibit Coversheet Only. [Paginated separately.]

The attached document, Columbia River System Operations Final Environmental Impact Statement, is provided to the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy, Climate, and Grid Security for the Hearing Record, dated January 30, 2024 in response to a question from the Honorable Frank Pallone, Jr.

Columbia River System Operations
Final Environmental Impact Statement

Appendix F
Vegetation, Wetlands, and Wildlife

Region	Social Welfare Effects (2019 dollars)	Regional Economic Effects (2019 dollars)	Other Social Effects
Total	Negligible to minor adverse effects to reservoir visitation associated with boat ramp access (20,000 fewer visits, representing approximately 0.2 percent of total visitation) in a typical water year, with consumer surplus value losses of approximately $246,000 annually. The potential for decreases in fish abundance for several anadromous and resident fish species could adversely affect angler opportunities and visitation in all regions. Minor adverse effects to quality of hunting, wildlife viewing, swimming, and water sports associated with changing river conditions in river segments below reservoirs.	Expenditures associated with non-local recreational visits would decrease by $861,000 across the region (0.2 percent change from the No Action Alternative) in a typical water year associated with boat ramp access. Regional economic effects of this change in expenditures are likely to be minor (11 fewer jobs, and $434,000 less in labor income, and approximately $1.3 million less in sales). If anglers reduce trips to this region due to declines in fishing conditions and experiences, adverse impacts to regional economic conditions could occur.	Although changes in access to recreation sites would be minor under MO2, adverse effects to fish species may have adverse effects on angler opportunities under this alternative, which, in turn, could have adverse effects on the well-being of those recreationists who value these fish, communities who rely on angler spending, and area tribes.

CHAPTER 6 - MULTIPLE OBJECTIVE ALTERNATIVE 3

Anticipated changes in water surface elevations under MO3 would affect boat ramp accessibility and water-based visitation relative to the No Action Alternative at Lake Koocanusa (Libby Dam) and Hungry Horse Reservoir in Region A. The breaching of the four lower Snake River projects would have major adverse effects on current recreation in the short term at the four lower Snake River projects in Region C and Lake Wallula in Region D. In the longer-term, near-natural river conditions could return, which would draw visitors to the region to experience water- and land-based activities associated with the riverine environment. Changes in water levels at other reservoirs in the basin would not affect accessibility or visitation.

6.1 SUPPLEMENTAL DETAIL DESCRIBING QUANTIFIED SOCIAL WELFARE EFFECTS

The sections below present the changes in visitation and social welfare effects by region under MO3 relative to the No Action Alternative. As discussed above, this appendix focuses on providing additional details to support the quantitative analysis on water-based visitation that is described in Chapter 3. In addition, the lower Snake River recreational evaluation under MO3 is also provided in this section.

Table 6-1 presents the percentage change in the number of accessible days across boat ramps by month for the two reservoirs in Region A affected under MO3 relative to the No Action Alternative in a typical water year, as well as the associated change in water-based visitation. Table 6-2 and Table 6-3 present these results using the 25th percentile H&H results (high water year) and 75th percentile results (low water year). The social welfare effects associated with these changes in water-based visitation are presented in Table 6-5 along with effects in other regions. Note, the accessibility differences under high and low water years are similar to a typical water year (50th percentile), therefore just the social welfare effects in a typical water year are presented.

Table 6-1. Change in Boat Ramp Accessibility and Water-Based Visitation (Visits) under MO3 Relative to the No Action Alternative in a Typical Water Year (50th Percentile), by Month

Month	NAA Accessible Days	MO3 Accessible Days	Percentage Change in Accessible Days	Change in Water-Based Visitation (Visits)[1/]
Libby Dam and Lake Koocanusa				
Jan	248	248	0%	0
Feb	224	224	0%	0
Mar	248	238	-4%	(23)
Apr	206	184	-11%	(203)
May	248	248	0%	0
Jun	247	246	0%	(27)
Jul	279	279	0%	0
Aug	279	279	0%	0
Sep	270	270	0%	0
Oct	279	279	0%	0

Month	NAA Accessible Days	MO3 Accessible Days	Percentage Change in Accessible Days	Change in Water-Based Visitation (Visits)[1/]
Nov	270	264	-2%	(55)
Dec	251	248	-1%	(8)
Total	**3,049**	**3,007**	**-1%**	**(316)**
Hungry Horse Dam and Reservoir				
Jan	213	186	-13%	0
Feb	166	124	-25%	0
Mar	127	111	-13%	0
Apr	120	90	-25%	0
May	151	136	-10%	(13)
Jun	287	276	-4%	(15)
Jul	310	310	0%	0
Aug	310	310	0%	0
Sep	300	300	0%	0
Oct	310	210	-32%	0
Nov	294	200	-32%	0
Dec	276	186	-33%	0
Total	**2,864**	**2,439**	**-15%**	**(29)**
Basin-Wide Total	**5,913**	**5,446**	**-8%**	**(345)**

Note: The number of "accessible days" is a summation across boat across ramps within a month. Therefore, the number of accessible days reflects the number of days within a month and the number of boat ramps.
[1/] Change in water-based visitation calculated as the percentage change in accessible days multiplied by the NAA visitation presented in Table 3-5.

Table 6-2. Change in Boat Ramp Accessibility and Water-Based Visitation under MO3 Relative to the No Action Alternative in a High Water Year (25th Percentile), by Month

Month	NAA Accessible Days	MO3 Accessible Days	Percentage Change in Accessible Days	Change in Water-Based Visitation[1/]
Libby Dam and Lake Koocanusa				
Jan	248	248	0%	0
Feb	224	224	0%	0
Mar	248	248	0%	0
Apr	240	240	0%	0
May	248	248	0%	0
Jun	259	255	-2%	(109)
Jul	279	279	0%	0
Aug	279	279	0%	0
Sep	270	270	0%	0
Oct	279	279	0%	0
Nov	270	265	-2%	(46)
Dec	254	248	-2%	(16)

Month	NAA Accessible Days	MO3 Accessible Days	Percentage Change in Accessible Days	Change in Water-Based Visitation[1/]
Total	**3,098**	**3,083**	**0%**	**(171)**
Hungry Horse Dam and Reservoir				
Jan	289	243	-16%	0
Feb	183	168	-8%	0
Mar	186	158	-15%	0
Apr	180	120	-33%	0
May	220	197	-10%	(21)
Jun	300	300	0%	0
Jul	310	310	0%	0
Aug	310	310	0%	0
Sep	300	300	0%	0
Oct	310	293	-5%	0
Nov	300	270	-10%	0
Dec	310	279	-10%	0
Total	**3,198**	**2,948**	**-8%**	**(21)**
Basin-Wide Total	**6,296**	**6,031**	**-4%**	**(192)**

Note: The number of "accessible days" is a summation across boat across ramps within a month. Therefore, the number of accessible days reflects the number of days within a month and the number of boat ramps.

[1/] Change in water-based visitation calculated as the percentage change in accessible days multiplied by the NAA visitation presented in Table 3-7.

Table 6-3. Change in Boat Ramp Accessibility and Water-Based Visitation (Visits) under MO3 Relative to the No Action Alternative in a Low Water Year (75th Percentile), by Month

Month	NAA Accessible Days	MO3 Accessible Days	Percentage Change in Accessible Days	Change in Water-Based Visitation (Visits) [1/]
Libby Dam and Lake Koocanusa				
Jan	248	248	0%	0
Feb	156	161	3%	10
Mar	129	147	14%	41
Apr	90	105	17%	138
May	151	154	2%	74
Jun	230	230	0%	0
Jul	277	277	0%	0
Aug	279	279	0%	0
Sep	270	270	0%	0
Oct	279	279	0%	0
Nov	270	263	-3%	(65)
Dec	251	248	-1%	(8)
Total	**2,630**	**2,661**	**1%**	**191**

Month	NAA Accessible Days	MO3 Accessible Days	Percentage Change in Accessible Days	Change in Water-Based Visitation (Visits) [1/]
Hungry Horse Dam and Reservoir				
Jan	186	124	-33%	0
Feb	126	99	-21%	0
Mar	104	78	-25%	0
Apr	66	60	-9%	0
May	86	83	-3%	(3)
Jun	242	234	-3%	(11)
Jul	310	310	0%	0
Aug	310	310	0%	0
Sep	300	300	0%	0
Oct	310	190	-39%	0
Nov	262	172	-34%	0
Dec	204	136	-33%	0
Total	**2,506**	**2,096**	**-16%**	**(14)**
Basin-Wide Total	**5,136**	**4,757**	**-7%**	**177**

Note: The number of “accessible days” is a summation across boat across ramps within a month. Therefore, the number of accessible days reflects the number of days within a month and the number of boat ramps.
[1/] Change in water-based visitation calculated as the percentage change in accessible days multiplied by the NAA visitation presented in Table 3-8.

Breaching the dams at the four lower Snake River projects in Region C —Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, and Ice Harbor Dam—would return the lower Snake River to free-flowing conditions. This substantial change in reservoir and river conditions would affect existing developed and dispersed recreation areas and associated recreational activities. Water-based recreation activities would change from lake or flat-water activities to river-oriented recreation along the lower Snake River. Given the magnitude of these changes, the shift in usage patterns could take years to settle.

Fishing activities, as well as other recreation types, would be considerably reduced in the shorter-term during and immediately following breach, but could rebound in the long term as anadromous fish populations improve. The largest increases in the number of salmon and steelhead are projected under MO3. Therefore, fishing for these anadromous species could increase in the long term in Region C relative to the No Action Alternative. The value for trips could also increase due to increased abundance and diversity of wild fish.

Construction and demolition activities at these projects during the breaching activities would limit access during breaching. Most of the existing facilities were developed around the reservoirs. Pre-dam river stages under dam breaching would range from approximately 8 to 100 feet below current water surface elevations. Existing water-based recreation facilities, such as boat ramps, swimming beaches, and moorage facilities, were designed to operate within very specific ranges of water elevations (generally within 5 feet of full pool). If dam breaching were to occur, none of these facilities could continue to be used without modification or relocation because river stages would be substantially lower than would be anticipated under the No Action Alternative. Some facilities, such as marinas and moorage facilities, would likely be incompatible with river conditions under MO3.

Many lower Snake River recreation areas have upland facilities such as picnic shelters, concrete walks, and interpretive signs that are located near the existing reservoirs. Although the activities that occur at these facilities are not water-dependent, the proximity of water enhances the recreation experience. Some of these facilities, such as picnic tables, could be moved closer to the river. However, other more permanent facilities such as shade structures and parking areas may not be able to be relocated because of the need to allow natural riparian functions to develop along the newly exposed river shorelines. The fish viewing facilities at the four dams would no longer be functional under the new river conditions. Fish viewing opportunities could occur at outdoor interpretive displays. Some sites would simply cease to be used because the features that attracted people would be eliminated, while other sites would be abandoned because they would be so high above or far away from the river that access would be difficult and possibly dangerous.

Dispersed recreation use would likely be reduced in the short term, but would likely return after the breaching activities and in the long term as the river and shoreline stabilize and natural features form. The action of dam breaching itself may draw some curious visitors in the short term. Many of the recreational activities that presently occur at existing dispersed sites could occur at new dispersed sites.

Lake or flatwater-oriented recreation activities, including water skiing, sailing, motorboating (in fiberglass boats), fishing for some warm-water species, and sightseeing in tour boats that cruise between Portland and Lewiston, would no longer be possible if breaching were to occur. Some activities that occur on lakes, such as fishing, swimming, hiking, camping, and wildlife viewing, could still occur. Breaching the dams would also expand opportunities in the long-term for river recreation activities, such as drift boating, rafting, and kayaking that require, or are more favorable under, riverine conditions.

The four lower Snake River projects currently support 0.9 million annual water-based visits, 1.7 million land-based visits, with a total of 2.6 million annual visits overall (i.e., including water- and land-based visits; Table 3-1 and Table 3-3). This is converted to 2.7 million annual recreational visitor days using the methodology described in section 2.1.3 of this appendix. This visitation supports $8.6 million and $23.8 million in annual consumer surplus value (social welfare), for water-based and all visitation, respectively.

In the short term, major effects to social welfare would occur associated with the construction and breaching activities, with a large reduction in consumer surplus value of up to $23.8 million with major reductions in both land- and water-based visitors to the area (Table 6-5).

After the construction and breaching activities conclude, it is possible that some of the existing land-based visitation would return, with the potential for up to 1.7 million visitors (land-based visitors pre breach). However, the loss of water-based recreation on the lower Snake reservoirs would result in major adverse effects in the short-term post dam breach, a decrease in consumer surplus of $8.6 million (-36%), compared to $23.8 million under the No Action Alternative.

In the long term, both water-based and land-based river recreation would become re-established. The future physical condition of the river is uncertain, which would affect its suitability for supporting specific types of recreational activities (e.g., river rafting). In addition, it is uncertain how the environment might be managed to achieve other resource goals (e.g., fishing regulations and restrictions associated with the ESA-listed species, particularly Chinook salmon), and the effect these management decisions would have on recreation activities. To provide an estimate of the range of potential recreational use levels that may occur in the long-term under MO3 in the lower Snake River area, this section reviews existing data and past efforts to estimate these effects. The estimates developed suggest that a wide range of potential changes to river-based recreational visitation could occur following dam breach. Information sources for this estimate include the 2002 *Lower Snake River Juvenile Salmon Migration Feasibility Report and Environmental Impact Statement* (2002 EIS) and visitation estimates to other similar rivers in the region.

2002 Lower Snake River Juvenile Salmon Migration Feasibility Report / Environmental Impact Statement

For the 2002 Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Study (2002 EIS*)*, a contingent behavior survey was conducted to estimate how non-fishing recreation use would change if the four lower Snake River dams were breached. Using results from this survey, visitation after dam breach was estimated to be 1.5 million to 2.7 million annual recreational visitor days after full recovery of the natural river system, excluding fishing use. Estimates of fishing visitation specifically for the lower Snake River following dam breach were not estimated (Corps 2002a, p. I3-65 to I3-66).[20]

To provide an updated visitation level, the visitation was adjusted for changes in the target survey populations since the study was conducted. The following counties were used to assess the changes in population from 1998 to 2018. Rural Washington would include the following counties: Adams, Asotin, Benton, Columbia, Franklin, Garfield, Grant, Spokane, Walla, and Whitman. Rural Oregon would include the following counties: Union, Umatilla, and Wallowa. Rural Idaho would include the following counties: Adams, Idaho, Latah, Lewis, and Nez Perce. Based on population adjustments, the updated visitation would range from approximately 1.9 million to 3.4 million (Table 6-4).[21]

[20] The range reflects uncertainty about how to extrapolate the survey results, so two different methods were used (Corps 2002a, p. I3-61).

[21] This population adjustment was made based on personal communication with the study author (Loomis 2019) and is consistent with increased participation in non-fishing river activities (e.g., rafting) since the study was done (White et al. 2016).

The Corps had a number of concerns about the survey methods and results from the contingent behavior survey from the 2002 EIS (Corps 2002a, Section 3.2.9). In 2002, the Corps' was concerned that the "potential recreation benefits associated with dam breaching may be significantly overstated." (Corps 2002a, p. I3-74), and these concerns remain. First, the result was much higher than visitation estimates to other free-flowing river/unimpounded river stretches. Second, the results suggested that visitors from California would account for over 30 percent of the visits to a near natural lower Snake River, even though data for other free-flowing rivers/unimpounded river stretches suggested that would be unlikely. Other concerns pertained to representativeness (the target survey response rate was not met), and the associated potential for nonresponse and strategic bias.[22]

Given the Corps' concerns, Table 6-4 also presents adjusted visitation estimates from the 2002 EIS without California visitors. Without California, visitation estimates would range from approximately 1.2 million to 1.9 million, depending on whether the estimates were adjusted to current levels and the extrapolation method used. Visitation to the lower Snake River would be limited by the availability of infrastructure to access river recreational opportunities.

Table 6-4. Visitation Estimates for the Lower Snake River in the Long-Term, With and Without Adjusting for Population Growth (excludes recreational fishing), from 2002 EIS

2002 Contingent Behavior Study Region	Total Recreation Visitor Days Demanded, 2002 EIS	Percentage Change in Population (1998-2018)	Total Recreation Visitor Days Demanded, Population-Adjusted
Rural Washington, Estimate 1	406,372	132%	535,066
Rural Washington, Estimate 2	317,280		417,760
Rural Oregon, Estimate 1	3,914	111%	4,331
Rural Oregon, Estimate 2	10,382		11,487
Rural Idaho, Estimate 1	36,846	111%	40,804
Rural Idaho, Estimate 2	29,739		32,933
Rest of Washington, Estimate 1	426,746	130%	556,631
Rest of Washington, Estimate 2	545,190		711,125
Rest of Oregon, Estimate 1	311,071	125%	390,232
Rest of Oregon, Estimate 2	396,671		497,615
Rest of Idaho, Estimate 1	24,328	142%	34,663
Rest of Idaho, Estimate 2	109,127		155,487
Montana, Estimate 1	14,188	119%	16,889
Montana, Estimate 2	49,157		58,514
California, Estimate 1	299,162	120%	358,739
California, Estimate 2	1,268,226		1,520,788

[22] Nonresponse bias arises when respondents differ in meaningful ways from nonrespondents (e.g., respondents were more likely to report changes in visitation to the lower Snake River after dam removal than nonrespondents). Thus, bias would exist when extrapolating survey responses to the target population. Strategic bias can arise when respondents think they can shape future decisions based on their survey responses. For example, respondents who support dam breach (possibly for reasons beyond its impact to their recreation) might exaggerate the number of visits they would take post breaching (and vice versa for those opposed).

2002 Contingent Behavior Study Region	Total Recreation Visitor Days Demanded, 2002 EIS	Percentage Change in Population (1998-2018)	Total Recreation Visitor Days Demanded, Population-Adjusted
Total, Estimate 1	**1,522,627**	**-**	**1,937,354**
Total, Estimate 2	**2,725,772**		**3,405,709**
Total, Estimate 1 (without California)	**1,223,465**	**-**	**1,578,615**
Total, Estimate 2 (without California)	**1,457,546**	**-**	**1,884,921**

Sources: 2002 EIS estimates from Table 3.2-7 (Corps 2002a, p. I3-61). Estimates 1 and 2 reflect uncertainty about how to extrapolate the survey results, so two different methods were used (Corps 2002a, p. I3-61). County-level population data for 1998, the year of the contingent behavior survey, from State and County Intercensal Tables: 1990-2000 (U.S. Census Bureau 2016); county-level population data for 2018, most recent data available, from American FactFinder (U.S. Census Bureau 2019).

Visitation to Other Similar Rivers in the Region

The 2002 EIS evaluated a number of potential additional comparison sites, including areas along the Main Salmon River, Middle Fork of the Salmon River, and the Hells Canyon stretch of the Snake River. As stated in the 2002 EIS, "it appears that a near-natural lower Snake River would offer a very different type of recreation experience to the region's premier whitewater rivers, such as the Main Salmon River, the Middle Fork of the Salmon River, and the Hells Canyon stretch of the Snake River. In addition to whitewater, these rivers also offer a wilderness experience and spectacular scenery. In terms of accessibility, the range of activities offered, and scenery, a near-natural lower Snake River would appear to have more in common with the lower Deschutes River, the Grand Ronde River, or the lower Salmon River. It would, however, be much larger than these rivers, with about 10 times the flow of the lower Deschutes and Grand Ronde Rivers, and about 5 times the flow of the lower Salmon River. In addition, visitation data for these rivers is limited (Corps 2002b, p. 5.13-18)." The 2002 EIS concluded that "a near-natural lower Snake River would be a fairly unique recreation resource primarily because of its size, accessibility, and the available range of existing recreation facilities and activities" (Corps 2002b, p. 5.13-18).

Despite the limitations, an approach for estimating recreational visitation, primarily for fishing, to the lower Snake River after dam removal would be to consider estimates of current visitation to other rivers in the region. The Hanford Reach of the Columbia River and the North Fork of the Clearwater River have been identified by Corps personnel as reasonable sites to evaluate as potentially comparable to future dam breach conditions on the lower Snake River. The Hanford Reach, which is located below Priest Rapids Dam on the Columbia River in Washington, and the North Fork of the Clearwater, which is located above Dworshak Reservoir in Idaho, are somewhat similar to a near-natural lower Snake River in terms of size, accessibility, and proximity to local users.

For the Hanford Reach, WDFW has estimates of fishing effort for select anadromous species (about 30,000-55,000 trips per year)[23] and traffic count data for some boat launches in this reach, but no comprehensive estimates of use. The USFWS does not have visitation numbers for the Hanford Reach National Monument (Haas 2019), a significant recreation site in the reach. For the 2002 EIS, it was estimated that the Hanford Reach had 50,000 annual recreational fishing visits (Foster Wheeler Environmental and Harris, 2001). Since the Hanford Reach is approximately 50 miles long, this would be equivalent to approximately 1,000 annual fishing visits per mile.

Recreational visitation data are available from the BLM for sites they manage along the Clearwater River, but visitation data are not available for other sites. The partial visitation data totaled about 80,000 visits in 2018. This would be comparable to the 100,000 visits estimated for this area when the 2002 EIS was written (Foster Wheeler Environmental and Harris, 2001). Since the North Fork of the Clearwater is approximately 135 miles long, visitation per mile would be similar to the 1,000 visits per mile for the Hanford Reach.

Estimating Visitation in the Long-Term

As discussed above, the sources available for estimating recreational use levels and activities along the lower Snake River after dam removal under MO3 suggest a wide range of estimates of potential recreational visitation that may occur post dam breach.

Applying the results of the contingent behavior study conducted for the 2002 EIS would yield an estimate that would range from approximately 1.2 to 3.4 million annual visits (adjusted and unadjusted for population) under MO3 in the long-term, depending on whether or not California estimates are included. As described above, the Corps has expressed concerns that the 2002 EIS may have overstated recreation benefits from dam breach.

Because the contingent behavior survey in the 2002 EIS specifically focused on non-fishing visitation in the lower Snake River, it would underestimate that type of recreation. Recreational fishing visitation could be possible in the long-term although there is uncertainty around it being an allowable activity, given the current measures to regulate, protect, and support ESA-listed fish populations and habitat in the region. Applying the current estimates of visitation rates to the Hanford Reach or Clearwater River to the 140-mile lower Snake River without any other adjustments would yield an estimate of approximately 140,000 annual visits, primarily angler visitation, which would be anticipated in the lower Snake River in the long term.

Combining the proxy site estimate of 140,000, which primarily captures fishing visitation, with the visitation estimates from the general recreation survey (contingent behavior survey) from the 2002 EIS, long-term visitation in the lower Snake River could range from 1.3 to 3.5 million following dam breach for all types of recreational activities (water- and land-based activities). In comparison to the current water-based and land based visitation on the lower Snake River under the No Action Alternative of approximately 2.7 million recreational visitor days, the long-

[23] ODFW and WDFW (2018) and NMFS (2014).

term visitation estimates would suggest that visitation to the river reach (both water-based and land-based recreation) could range from 50 percent lower to 30 percent higher than under the No Action Alternative. As described above, visitation to the lower Snake River could be limited by and dependent upon visitors' ability to access the recreational opportunities.

As described in Section 3.5.3.6 of the EIS, MO3 would result in major beneficial effects on upstream migration of Snake River anadromous fish, including steelhead and salmon, in the long term. With increases in salmon and steelhead migration to the Snake River, there is the potential for increased fish abundance that draws additional recreational anglers to Region C and tributaries relative to the No Action Alternative. Salmon and steelhead migration under MO3 would likely support the salmon and steelhead recreational fishery in Region C, supporting continued and increased angler visitation in the long-term.

Region D – McNary, John Day, The Dalles, and Bonneville Dams

Breaching the dams at the four lower Snake River projects would release substantial amounts of sediment, almost all of which would be deposited in Lake Wallula behind McNary Dam within the first 2 to 7 years. Seven recreation sites in Lake Wallula—located along the east and south sides of the Columbia River below the mouth of the Snake River—could be affected by this sedimentation permanently. These sites include Hat Rock State Park, Hood Park, McNary Yacht Club, Sacajawea State Park, Walla Walla Yacht Club, Warehouse Beach, and McNary National Wildlife Refuge. Some boat launches and beaches may be buried in sediment, which would adversely affect visitation to those areas, while other areas may experience new vegetation and wetland conditions. In order to address these effects, local entities may need to remove sediment materials, extend boat launches, and/or modify the recreation sites to adapt to sediment and potentially new vegetation and wetland conditions, depending on the localized effect and desired recreation conditions.

The seven affected sites in Lake Wallula support 163,000 water-based visits during a typical water year (5.6 percent of total Region D visitation) (Table 3-2 and Table 3-3), which support $1.4 million in annual consumer surplus value (social welfare) (Table 6-5). This social welfare may be considerably reduced immediately after breaching of the dams and last for up to several years until any issues associated with the sediment and recreational access are addressed. Some types of visitation may increase, and some visitors may experience increased fishing success if the abundance of key recreational species (Snake River runs of spring-run Chinook and steelhead) increases in Region D. Further, after the breaching, visitors may adapt to the conditions by visiting recreation areas downstream or in other places not directly impacted by the sedimentation.

Summary

Table 6-5 presents the average annual changes in recreation days and associated social welfare effects in a typical water year by reservoir, CRSO region.

Table 6-5. Changes in Annual Social Welfare Effects of Recreation under MO3 Relative to the No Action Alternative in a Typical Water Year (2019 Dollars)

CRSO Region, Reservoir/River Reach	Changes in Recreational Visitor Days	Social Welfare Effects (Consumer Surplus)
Region A Total (Lake Koocanusa and Hungry Horse Reservoir)	**(<1,000)**	**($3,000)**
Lake Koocanusa	(<1,000)	($3,000)
Hungry Horse Reservoir	(0)	($0)
Region B Total (Lake Roosevelt)	**0**	**$0**
Region C Total in the Short-Term (Four Lower Snake River Reservoirs)[1/]	**(2.7 million)**	**($23,820,000)**
Region C Total in the Long-Term (Four Lower Snake River Reservoirs)	Uncertain - may range from reduction of 1.4 million to increase of 0.8 million recreational visitor days	not estimated
Region D Total (Lake Wallula) in the Short-Term[1/]	**(169,000)**	**($1,413,000)**
Region D Total (Lake Wallula) in the Long-Term	Uncertain; visitation would be return if sediment is removed and/or wetland and vegetation conditions are established and recreational access is re-established in Lake Wallula	

Notes: Changes in water levels at other reservoirs in the basin would not affect accessibility or visitation.
[1/] Social welfare effects presented for Regions C and D represent short-term effects. The long-term impacts to visitation is uncertain. Some adaptation is likely over time. To the extent that increases in anadromous fish populations draw additional fishing visits to the region, increases in social welfare and regional economic effects would increase in the long term.

6.2 SUPPLEMENTAL DETAIL DESCRIBING QUANTIFIED REGIONAL ECONOMIC EFFECTS

The tables below present the regional economic effects under MO3 relative to the No Action Alternative. Table 6-6 presents the average annual changes in expenditures associated with recreation in a typical water year by reservoir, CRSO region, and in total, as well as the percentage of expenditures associated with non-local visitors. Table 6-7 presents the regional economic effects associated with these changes in expenditures by CRSO region and in total. Regional effects associated with local, non-local, and total visitation are presented for completeness, but the focus of the regional economic effects evaluation was on non-local visitors since changes in their expenditures would result in impacts to the regional economy.

Short-term adverse effects of dam breach on current reservoir recreation facilities and visitation would be major, with water levels falling substantially below No Action Alternative conditions and limitations for recreational access during the breach and construction period. A wide range of businesses that serve visitors would be adversely affected in the short term when recreationists forego trips to the region. Some facilities, such as marinas and moorage facilities, that serve water-based visitors would likely be incompatible with river conditions under MO3, and employment at these businesses would likely be eliminated.

In the short-term during construction activities, a decrease of 2.3 million water- and land-based visitors in Region C could result in decreased visitor spending of $103 million (Table 6-6), a decrease of 83 percent compared to non-local visitor spending under the No Action Alternative. Reduced visitor spending would result in a decrease of approximately 1,230 jobs, $39 million in labor income, and $147 million in sales during this construction period.

After the construction and breaching period is over, access would be re-opened to some of the recreation areas, and it is likely that a portion of the land-based visitors, such as site-seers, hikers, and others, would visit the region after construction while the reservoirs transition to river conditions. A reduction in only the water-based visitors at the reservoirs (land-based visitation would remain), compared to No Action Alternative, would result in a decrease of 820,000 non-local visitors and $37.4 million in visitor spending in the region.[24] The decreased non-local water-based visitor spending would lead to decreases in 450 jobs and $14 million in labor income and $53 million in sales compared to the No Action Alternative.

Although the specific response of visitors to new river conditions is uncertain, the establishment of near-natural river conditions would result in changes to regional economic effects over time. In particular, new opportunities for land- and water-based river recreation in the lower Snake River (i.e., rafting, kayaking, etc.) and anadromous recreational fishing in Region C would occur. These increases in visitation in the long-term may offset visitation losses in Region C associated with reservoir or flatwater-oriented recreation activities, and recreational opportunities and associated regional economic benefits may even increase in the long term relative to the No Action Alternative. Again, river recreation in the long-term would be dependent on the development of recreational facilities and infrastructure to facilitate access by private and public investments. Tourism businesses, such as retail, rental businesses, and service providers, would likely have to adapt to the new type of visitor who may demand different types of activities, services, gear, and retail merchandise. With increased visitation and visitor spending in the long-term, there is the potential for an increase in jobs and income for outfitters, boating companies, and other tourism businesses relative to the No Action Alternative.

Reduced water quality due to increased sedimentation in Region D at water-based recreation sites in Lake Wallula may render sections of this area unusable to recreationists for a period of time following dam breach (approximately 2 to 7 years). Non-local visitor expenditures associated with water-based visitation at affected sites could decrease by up to $6.1 million under MO3 (Table 6-6). The specific site conditions may not preclude visitation entirely, which would render this estimate higher than would be likely. However, were it to occur, this change would represent a decrease of 2.6 percent of non-local visitor expenditures on recreation in Region D relative to the No Action Alternative. Regional economic effects of this change in

[24] Non-local water-based visitors are calculated as the average 2017-2018 visitation to the site multiplied by the percentage of visitation that is water based at the site and the percentage of non-local visitation at the site. The site-level results are then summed across sites. 820,000 non-local water-based visitors represent 36 percent of total non-local water- and land-based visitors. Thus, expenditures and associated regional economic effects would be 36 percent of the values reported for non-local visitors.

regional expenditures, should they occur, would be a reduction of 80 jobs, $3 million in labor income, and $10 million in sales when compared to the No Action Alternative. Effects would likely be most acute in the short term. Over time, Lake Wallula visitation would likely rebound to levels similar to the No Action Alternative and could increase if visitation from the lower Snake River is diverted to this area. As noted above, potential long term increases in anadromous fish populations could increase fishing activities in Region D, which may draw additional visitors.

As noted above in the social welfare analysis, potential long-term increases in anadromous fish populations could increase anadromous recreational fishing activities in Regions B and D, drawing additional visitors. Visitor expenditures associated with these increases in recreational fishing could also accrue, with benefits to tourism business, jobs, and income in the regions.

Table 6-6. Changes in Visitor Expenditures under MO3 Relative to the No Action Alternative in a Typical Water Year (2019 Dollars)

CRSO Region, Reservoir/River Reach	Local Visitor Expenditures	Non-Local Visitor Expenditures	Total Expenditures	Percentage Non-Local
Region A Total (Lake Koocanusa and Hungry Horse Reservoir)	**($1,000)**	**($15,000)**	**($16,000)**	**96%**
Lake Koocanusa	($1,000)	($14,000)	($15,000)	96%
Hungry Horse Reservoir	($0)	($1,000)	($1,000)	96%
Region B Total (Lake Roosevelt)	**$0**	**$0**	**$0**	**89%**
Region C Total (Four Lower Snake River Reservoirs) – Short-Term[1/]	**($13,282,000)**	**($102,965,000)**	**($116,248,000)**	**89%**
Region C Total (Four Lower Snake River Reservoirs) – Long-Term[1/]	The long-term impacts to visitation, visitor expenditures, and regional economic effects are uncertain. Post dam breach, river conditions and increases in anadromous fish populations would draw visitation to the region in the long-term, and the increased visitor expenditures and regional economic effects would partially or fully offset losses in the short-term, with the potential to increase in the long-term relative to the No Action Alternative.			
Region D Total (Lake Wallula)[1/]	**($1,511,000)**	**($6,091,000)**	**($7,603,000)**	**80%**

Notes: Changes in water levels at other reservoirs in the basin would not affect accessibility or visitation.
[1/] Changes in expenditures and regional economic effects presented for Regions C and D represent short-term effects associated with the reduction of all land- and water-based visitation at the four lower Snake River projects and some of the visitation at Lake Wallula.

Table 6-7. Changes in Regional Economic Effects of Recreation under MO3 Relative to the No Action Alternative in a Typical Water Year (2019 Dollars)

CRSO Region, Local/Non-Local	Local/Non-Local Visitation	Jobs	Labor Income	Sales
Region A				
Local	(14)	(0)	($0)	($1000)
Non-Local	(331)	(0)	($7,000)	($20,000)
Total	**(345)**	**(0)**	**($7,000)**	**($21,000)**
Region B				
Local	0	0	$0	$0
Non-Local	0	0	$0	$0
Total	**0**	**0**	**$0**	**$0**
Region C[1/]				
Short-Term Effects				
Local	(292,298)	(159)	($5,044,000)	($18,901,000)
Non-Local	(2,265,893)	(1,233)	($39,101,000)	($146,519,000)
Total	**(2,558,191)**	**(1,392)**	**($44,145,000)**	**($165,420,000)**
Long-Term Effects	The long-term impacts to visitation, visitor expenditures, and regional economic effects are uncertain. Near-natural river conditions and increases in anadromous fish populations would draw visitation to the region in the long-term, and the increased visitor expenditures and regional economic effects would partially or fully offset losses in the short-term, with the potential to increase in the long-term relative to the No Action Alternative.			
Region D[1/]				
Local	(32,393)	(19)	($826,000)	($2,575,000)
Non-Local	(130,558)	(77)	($3,329,000)	($10,377,000)
Total	**(162,951)**	**(96)**	**($4,155,000)**	**($12,951,000)**

Notes: The multiplier effect is larger for the entire Basin, so total regional economic effects are greater than the summation of effects across CRSO regions.

[1/] Changes in expenditures and regional economic effects presented for Regions C and D represent short-term effects associated with the reduction of all land- and water-based visitation at the four lower Snake River projects and some of the visitation at Lake Wallula.

6.3 SUMMARY OF EFFECTS

Consistent with the summary table provided in Section 3.11 of the EIS, Table 6-8 summarizes social welfare effects, regional economic effects, and social welfare effects associated with changes in recreation conditions under MO3. Detailed discussion of qualitative effects (i.e., quality of the recreation experience, fishing condition, other social effects) described in the table are provided in Section 3.11, of the EIS, Recreation.

Adverse effects of MO3 on recreational visitation at the four lower Snake River projects in Region C are anticipated to be major due to dam breach and construction activities. Some land-based visitation would return to the region following the construction activities once areas are opened to recreation. With about one-third of the current visitation associated with water-based activities, the loss of this visitation would be large and adverse. However, as the river returns to natural conditions, river-based recreation would increase over time, given recreational access and infrastructure is developed; the exact long-term beneficial impacts to visitation and social welfare are uncertain, although the losses in reservoir recreation would be offset by increases in river recreation visitors, and may eventually increase to levels and values greater than under the No Action Alternative.

Water quality effects are expected to be major at Lake Wallula in Region D in the short term due to temporary sedimentation effects associated with dam breach; water-based visitation would be adversely affected.

An increased quantity and quality of recreational fishing trips for key anadromous species in Regions B, C, and D could occur in the long-term, supporting continued and increased angler visitation. However, while Section 3.5 in the EIS, Aquatic Habitat, Aquatic Invertebrates, and Fish, describes increased abundance of these species under MO3, other factors may limit their long-term success (e.g., decreased hatchery operations on the lower Snake River).

Across the basin in the short-term, total recreational visitation and associated social welfare effects could decrease by up to 21 percent in the study area (approximately 2.7 million visits and $25.2 million across all locations).

Expenditures associated with the 2.4 million non-local recreational visits (an additional 0.3 million are local recreational visits) could decrease by up to $109 million across the basin in the short-term during the breaching and construction activities (representing 22 percent of non-local visitor expenditures on recreation across the basin under the No Action Alternative). The decrease of 2.4 million non-local visitors would result in decreases in 1,420 jobs, $59 million in labor income, and $189 million less in sales.[25] The largest effects would be anticipated at the four lower Snake River projects in Region C and Lake Wallula in Region D due to dam breach and associated sedimentation effects.

Changes in other social effects could be substantial, as communities that are economically dependent on visitation to these five projects could be adversely affected in the short term. Users of these projects could experience diminished physical, mental, and social health benefits associated with the reduced quantity or quality of recreational activities (staying home or diverting recreational use to less-preferred sites), particularly in the short term. River recreation in the lower Snake River and increased abundance of anadromous fish in Regions B, C, and D would bring social benefits to individuals, Tribes, and communities in the long-term. Restoration of riverine conditions and increases in anadromous fish species to the Snake River has been a long-term objective of area tribes, who would experience benefits to their ability to utilize the area recreationally and exercise treaty rights, in addition to other cultural and spiritual benefits.

[25] The multiplier effect is larger for the entire Basin, so total regional economic effects are greater than the summation of effects across CRSO regions.

Table 6-8. Changes in Economic Effects of Recreation Under Multiple Objective Alternative 3 Relative to the No Action Alternative

Region	Social Welfare Effects (2019 dollars)	Regional Economic Effects (2019 dollars)	Other Social Effects
Region A	A reduction of less than 350 water-based recreational visits (less than 1 percent of regional water-based visitation) would occur at Lake Koocanusa and Hungry Horse Reservoirs in a typical water year. In high-water-level years, water-based visitation would decrease by 0.4 percent at these two reservoirs and would increase by 0.4 percent in low-water-level years. Annual social welfare benefits would decrease by $3,000 in a typical water year associated with access to boat ramps. Potential for adverse effects for anglers at Hungry Horse Reservoir.	Expenditures associated with non-local recreational visits would decrease by $15,000 across the region (less than 0.1 percent change from the No Action Alternative). Regional economic effects of this change in expenditures would be negligible. If recreationists reduce recreation trips to this region due to declines in recreation experiences at Hungry Horse Reservoir, additional effects could occur.	Negligible change in well-being of water-based recreation visitors due to slight decrease in recreation days. Negligible difference in the well-being of recreationists that value recreational fishing and tribes.
Region B	No changes in reservoir visitation would occur associated with access to boat ramps. Increased effort or enjoyment of recreational fishing for anadromous fish could occur over time as populations increase. Changes in the quality of recreational experience are anticipated to be long term and beneficial.	No changes in visitor expenditures or regional effects associated with access to boat ramps. Increases in anadromous fish populations may draw additional fishing visits to the region, increasing regional economic expenditures and jobs and income in the long term.	Social benefits could accrue in Region B with the increased abundance of anadromous fish under MO3.
Region C	Overall, long-term beneficial (e.g., riverine-oriented recreation) and adverse (e.g., lake or flatwater-oriented recreation) effects are anticipated.	In the short-term, non-local visitor expenditures would decrease by $103 million during construction and breaching activities, resulting in major adverse effects to regional economic conditions (decrease in 1,230 jobs and $39 million in labor income). After the construction and breaching period is over, access would be re-opened to some of the recreation areas. A reduction in only the reservoir water-based visitors compared to No Action Alternative would result in a major decrease in non-local visitor expenditures of $37 million, with associated decreases in 450 jobs, $14 million in income, and $53 million in sales.	Major changes in other social effects would occur, which could be both beneficial and adverse. Communities that benefit economically from recreational visits could be adversely affected, particularly in the short term. However, restoration of riverine conditions and increases in anadromous fish species could benefit individuals, Tribes, and communities with river-based recreation ties and values, including recreational fishing and related economic opportunities.

Region	Social Welfare Effects (2019 dollars)	Regional Economic Effects (2019 dollars)	Other Social Effects
	Due to dam breaching and construction activities, there would be major short-term adverse effects to all water- and land-based reservoir visitation from construction closures in the short-term at the 4 lower Snake River projects. This could result in a decrease of 2.7 million annual recreational visitor days on average $24 million in social welfare in the short term. Some land-based visitation would return in the short term as access to lower Snake River areas is reopened. The reduction of only water-based reservoir recreation compared to No Action Alternative at the lower Snake River would result in a decrease of 0.9 million visitors and $8.6 million in social welfare. In the long-term, as riverine conditions return, river recreation would increase, with benefits to visitation and social welfare values. Access to the lower Snake River would be dependent on the development of new recreation facilities and water access points. Additional costs would be incurred to provide recreational infrastructure. The long-term river visitation estimates in the lower Snake River (land- and water-based) suggest that recreation values could range from 50 percent lower to 30 percent higher than under the No Action Alternative (1.3 million to 3.5 million visitor days). Anadromous fish migration would support recreational fisheries in Region C, supporting continued and increased angler visitation in the long-term.	Over time, river recreation would grow, along with the quality of the recreational experience. The newly-created river conditions would draw a different pattern of visitors to the region, with different types of visitor spending compared with reservoir visitors. Depending on the numbers and type of visitor, tourism economic activity may partially or fully offset the loss in economic activity associated with reservoir recreation, with the potential for greater economic activity in the region relative to the No Action Alternative. Increased anadromous fish migration under MO3 would likely support continued and increased angler visitation in the long-term in Region C. With increased angler visitation and visitor spending in Region C, there would be an increase in jobs and income for outfitters, boating companies, and other tourism businesses relative to the No Action Alternative.	The restoration of the Snake River has been a long-term objective of area tribes, who would experience benefits to their ability to utilize the area recreationally and exercise treaty rights, in addition to other cultural and spiritual benefits. Adverse effects to resident fish species would have adverse effects on fishing experiences in Region C, which, in turn, could have adverse effects on the well-being of those tribes in Region C who value the affected resident fish. Natural landscapes and the transition to a natural river state would likely provide social benefits to many people, as well as educational and scientific research opportunities associated with this unique area. Recreationists who recreational activities depend on reservoir conditions could experience reduced well-being associated with the reduced availability of reservoir recreation within Region C.

Region	Social Welfare Effects (2019 dollars)	Regional Economic Effects (2019 dollars)	Other Social Effects
Region D	Due to sedimentation effects associated with dam breach, 163,000 annual water-based visits could be lost at seven Lake Wallula recreation sites (5.6 percent of total Region D visitation) in the short term (2 to 7 years). Annual social welfare benefits would decrease by $1.4 million associated with this change. Some visitation could be replaced or improved through a transition to river-based recreation over time. Short-term adverse and long-term beneficial effects are anticipated. Increased effort or enjoyment of recreational fishing for anadromous fish could occur over time as populations increase.	Expenditures associated with non-local recreational visits would decrease by $6.1 million (2.6 percent), particularly in the short term (2 to 7 years). Regional economic effects of this change in expenditures would be minor (80 fewer jobs, $3 million less labor income, and $10 million less sales). Some adaptation is likely over time. Increases in anadromous fish populations may draw additional fishing visits to the region, with increases in regional economic expenditures and jobs and income in the long term.	In the short run, there could be decrease water-based recreation visitor days at Lake Wallula decreasing these recreationists well-being. Over the long term, depending upon modifications made at several Lake Wallula facilities, well-being of reservoir recreationist would improve. In addition, increased opportunity for recreational fishing for anadromous fish occur, bringing social benefits to communities and individuals.
Total	In Region A, a reduction of less than 1 percent in regional water-based visitation would occur at Lake Koocanusa and Hungry Horse Reservoirs in a typical water year. Negligible changes in water-based visitation in Region B and Region D. Overall in Region C, long-term beneficial (e.g., riverine-oriented recreation) and adverse (e.g., lake or flatwater-oriented recreation) effects are anticipated. A number of recreation areas on Lake Wallula would be adversely affected by sedimentation from breaching. Basin-wide visitation could decrease by up to 21 percent (approximately 2.7 million recreational visitor days and $25 million in annual social welfare benefits). The long-term river visitation estimates (land- and water-based) suggest that recreation values could range from 50 percent lower to 30 percent higher than under NAA (1.5 to 3.4 million visitor days). Increased catch rates and angler visitation could occur over time as anadromous fish populations increase in Regions B, C, and D.	Expenditures associated with non-local recreational visits could decrease by up to $109 million across the region (22 percent decrease compared to the No Action Alternative), in the short term, primarily associated with closures during dam breaching activities. Regional economic effects of this change in expenditures would be major, with 1,420 fewer jobs, $59 million less labor income, and $189 million less in sales. In the long-term, depending on the numbers and type of visitor, tourism economic activity may partially or fully offset the loss in economic activity associated with reservoir recreation, with the potential for greater economic activity in the region relative to the No Action Alternative. Increases in anadromous fish populations could draw additional fishing visits to the region in the long term with benefits to jobs, income, and tourism businesses. These changes may be major in small rural river communities, particularly those in Region C. .	Negligible changes in other social effects in Region A compared to the No Action Alternative. In Region C major changes in other social effects would occur, which would be adverse in the short term and beneficial in the long term at the four lower Snake River projects and Lake Wallula. Long-term increases in anadromous fish abundance in Regions B, C, and D would result in increased social benefits compared to the No Action Alternative.

EXHIBIT D
INITIAL ECONOMIC ASSESSMENT
COLUMBIA BASIN FUND
BRIAN MURPHY ET AL. (APRIL 2021)

Exhibit Coversheet Only. [Paginated separately.]

The attached document, Initial Economic Assessment, is provided to the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy, Climate, and Grid Security for the Hearing Record, dated January 30, 2024 in response to a question from the Honorable Frank Pallone, Jr.

Columbia Basin Fund

INITIAL ECONOMIC ASSESSMENT

April 2021

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Cover images by Ian Roberts and Orin Blomberg
Study funded by the Water Foundation

Executive Summary

On February 7, 2021, U.S. Representative Mike Simpson of Idaho announced the broad outlines of a proposed “Columbia Basin Fund,” which would invest $33.5 billion in infrastructure, economic development, and salmon recovery. This Fund represents a unique approach to addressing the future of the four dams on the Lower Snake River (LSR). This Assessment constitutes an initial consideration of the proposal from a purely economic perspective. It is not an exhaustive review, but instead an initial consideration of key questions:

- How can investments strengthen the regional economy in the LSR area and Pacific Northwest?
- How will different sectors and communities be impacted by proposed changes? How can investment funds be targeted to mitigate negative impacts?
- How will the expenditure of funds impact the regional economy? How will key sectors fare over the long-term?

SUMMARY OF THE PROPOSED INVESTMENT

Representative Simpson’s proposal for the Columbia Basin Fund includes more than 50 line-items for community investment but leaves many of the specifics of investment items up to local communities and industries. Building on the Fund framework, BERK has created an illustrative investment scenario with assumed phasing of the investment over time, high-level assumptions around the kind of expenditures, and assumptions around the geographic location of the investment. The majority of the expenditure would occur in Washington State, with nearly half (45%) of the non-energy expenditure being spent in the nine counties closest to the LSR dams. Funds would also be spent in Idaho, Oregon, and Montana.

Proposed Investment: Key Findings

1. Over $30 billion of the proposed investment (93% of the funds) would be allocated to supporting the region’s economic transition.
2. $2.2B (7%) will be invested in Tribal communities.
3. Approximately $20 billion, or just less than 60% of the total investment, would likely be spent during the 8-10 years before breach of the dams.
4. Just more than $21 billion (63%) of the investment would likely be spent on construction and infrastructure.
5. At least $7.9 billion, or 24% of the total investment, would likely be spent in the 9 counties closest to the LSR. Significant additional funding tied to energy replacement and habitat restoration may also be expended in the 9-county region.

ANTICIPATED ECONOMIC IMPACTS

Based on a possible breakdown of costs, we estimate that $21.1 billion would be expended on infrastructure and construction, including planning and engineering, labor, materials, and supplies. Assuming 75% of these contracts by value are awarded to businesses and organizations in the Pacific Northwest, investments during Phases 1 and 2 will support an estimated total average of more than 20,000 jobs each year across the Northwest over this period. Throughout the entire duration of the

Columbia Basin Fund program (between 2022 and 2046, across all four project phases), investments and operations will, on average, support a total employment impact of nearly 11,000 jobs per year in the Pacific Northwest. This is lower than the more than 20,000 jobs supported each year during Phases 1 and 2 because spending is anticipated to ramp down in Phases 3 and 4.

Economic Impact: Key Findings

6. $21.1B would likely be spent on infrastructure, stimulating jobs and spending in the region. The $12.3B spent on planning, design, and services would also benefit the economy, though benefits would be more geographically diffuse.
7. Phase 1 and 2 spending would support an annual average of more than 20,000 jobs across the Northwest. The investment would support an annual average of 11,000 jobs across the Northwest from 2021 to 2046.
8. Local and state net fiscal impacts would likely be positive via additional sales tax and other one-time revenues. Costs of providing services are unlikely to shift significantly.

LONG-TERM ECONOMIC OUTLOOK

Agriculture

Under the status quo, the LSR dams and reservoirs provide transportation and irrigation benefits to agricultural producers in the region. Breaching the LSR dams will eliminate the LSR barge transportation option for grain producers and affect the functionality of some irrigation infrastructure in the region. Previous studies have estimated the costs (in 2020 dollars) to mitigate impacts to grain producers at $403M to $1.4B and the costs to mitigate impacts to irrigators (and other water users) at $153M to $683M. The Fund addresses the impacts to transportation and irrigation through $3.5B for agricultural transportation, including road and rail infrastructure, grain storage, port improvements, expanded barging on the Lower Columbia, and a flexible fund that could directly subsidize grain shipping, as well as $750M for irrigation mitigation, including well and pump construction and improvement, and water conveyance infrastructure.

Agriculture Sector: Key Findings

9. The $3.5B for transportation mitigation is more than double the highest estimate of mitigation costs.
10. The $1.5B fund for grain producers exceeds previous estimates of increased shipping costs under a dam breach scenario, indicating producers will likely face lower shipping costs under the proposal.
11. The $750M for irrigation mitigation is 10% greater than the highest estimate of mitigation costs.

Energy

The four LSR dams generate a median of 795 annual average MWs. To mitigate the impacts of losing the LSR dams as a power source, the investment package focuses on new zero-emission generation capacity, energy storage, and upgrades to the regional transmission network. This portion of the investment offers the following benefits:

- Supports jobs in infrastructure and construction through the duration of the project.
- Exceeds estimated capital and operating and maintenance costs for energy replacement, reducing the likelihood that ratepayers will experience price hikes.

- Invests in improved grid stability, energy efficiency, and regional research and innovation.

While the investment will support new jobs in energy, the quality of employment opportunities is less certain. The investment in energy research in the package attempts to address this uncertainty.

Energy Sector: Key Findings

12. Energy investment is the largest component of the investment, with $16B for energy replacement, efficiency, and grid improvements and $1.25B for the Snake River Center for Advanced Energy Storage.

13. $10B would help mitigate impacts to ratepayers and potentially augment capacity beyond the current level.

14. Investment has the potential to promote regional employment, grid stability, innovation, research, and development.

Recreation and Tourism

Removing the dams will transform the LSR from a flatwater to a whitewater recreation area. Some existing tourism activities, including cruises, boating, and swimming, will cease; while others, including rafting, camping, and fishing, will face new possibilities. To assist the LSR in transforming into a whitewater recreation area, the Fund invests $125M for a national recreation area along the LSR, $125M for tourism promotion, a combined $175M to mitigate impacts to marinas, boat owners, and sport fishers, and, in the long term, the potential return of salmon and steelhead population would support additional sport fishing and other recreational activities.

Recreation and Tourism Sector: Key Findings

15. The industry would likely benefit from the investment of $425M for tourism, $7.3B for salmon and conservation, and $175M for regional economic development.

CONCLUSION

This initial assessment indicates that from a purely economic perspective, the proposed Columbia Basin Fund holds great promise for stimulating job creation, fully mitigating impacts to key regional industries, and investing in future regional growth.

- The expenditure of at least $7.9 billion in the 9-county region around the LSR will stimulate significant positive economic impacts, creating an estimated average of 11,000 jobs a year in the Northwest over 25 years and injecting substantial resources into the regional economy.
- Such significant investment can be used to strategically upgrade infrastructure and strengthen the regional economy, making it more broadly prosperous and resilient to future conditions. By addressing key areas of concern, the package should leave economic sectors of significance stronger than they are now, particularly in the areas of energy generation and tourism.

As soon as a final investment package is identified, further study will be needed to fully understand these risks, and further engagement with affected stakeholders will be needed to strategize how resources and policies can mitigate risks, minimize harms, and maximize long-term economic well-being and resiliency.

Contents

Introduction

On February 7, 2021, U.S. Representative Mike Simpson of Idaho announced the broad outlines of a proposed “Columbia Basin Fund,” which would invest $33.5 billion in infrastructure, economic development, and salmon recovery. Envisioned as part of a larger federal infrastructure package, the Columbia Basin Fund represents a unique approach to addressing the future of the four dams on the Lower Snake River (LSR) that have been the subject of intense study, debate, and litigation for decades. The proposal recognizes the various roles the dams play in the regional economy, and includes elements designed to support transformation of the economy through infrastructure investment and economic development, while breaching the dams to support the recovery of threatened salmon populations.

This Initial Economic Assessment, completed in the several weeks after the release of Representative Simpson’s announcement, constitutes an initial consideration of the proposal from a purely economic perspective. It is not an exhaustive review but instead an initial look to set the stage for more detailed consideration of key questions:

- How can investments strengthen the regional economy in the LSR area and broader Northwest to make it more resilient to future conditions?
- What sectors and communities will be negatively impacted by proposed changes? How can investment funds be targeted to mitigate these negative impacts?
- How will the expenditure of funds as proposed impact the regional economy? How will key sectors fare over the long-term?

Given the rapid nature of this assessment, it is subject to the following considerations:

- This work builds specifically on prior study of these issues, with limited original analysis.
- It focuses on tangible economic issues, not intangible non-use benefits or environmental or social impacts and outcomes, although we recognize the interconnections among these areas.
- We acknowledge the limits of what we can answer definitively and identify additional ways economic issues can be further examined in future studies.

CONSIDERATION OF THE STATUS QUO

While this assessment focuses on understanding the likely economic impacts of the proposed investment package, it is important to identify our basis of comparison, as continuation of the status quo entails significant ongoing investment and considerable economic uncertainty:

- **Operating, maintenance, and capital investments required.** Continuation of the status quo implies ongoing investment in operations and maintenance, as well as pending capital investments to update aging infrastructure. The federal government is currently responsible for maintaining navigability of the LSR, which it does through routine dredging and other measures. As more fully described in the Energy section, operations and maintenance of the four Lower Snake River dams (LSRD) costs an estimated $52 million annually. Planned capital investments to maintain the functioning of the dams range from $654 million to $1.6 billion from 2020–2040.

- **Economic challenges in key sectors.** As discussed later in this report, key industries in the 9-county region face challenges or have opportunities to increase in performance.
  - **Energy.** The inflation-adjusted price of wholesale electricity has trended upwards at the same time that rates for purchasing power on the Intercontinental Exchange have been decreasing. There is a risk that electricity generated by the existing dams may become less competitive with lower cost power from other sources in the future, eliminating some of the value of the dams.[1]
  - **Recreation and Tourism.** Compared to other areas, the region's tourism industry has room for growth and may benefit from reinvention. At the same time, fishing-based recreation and tourism is under threat from the declining fish populations that are a primary motivator for the proposed breaching of the dams.
- **Litigation risk.** The most significant challenge associated with the status quo is the economic uncertainty associated with the threat of litigation. After decades of studies, lawsuits, and rulings, it is unclear how the courts may eventually rule on the future of the dams. A judgment requiring significant changes to river operations to protect endangered salmon could have significant effects on irrigation, transportation, energy, and recreation benefits currently provided by the dams *without* of the mitigating investment proposed via the Columbia Basin Fund.

ORGANIZATION OF THIS REPORT

In this initial assessment, we focus primarily on a 9-county area surrounding the LSR, including Adams, Asotin, Benton, Columbia, Franklin, Garfield, Walla Walla, and Whitman counties in Washington and Nez Perce County in Idaho. The following sections make up the remainder of this document:

- **Summary of the Proposed Investment** presents summaries of the investment package by categorical benefit area, as well as an illustrative investment scenario.
- **Anticipated Economic Impacts** qualitatively describes the economic impact of the proposed expenditure of investment funds.
- **Long-term Economic Outlook** considers (again preliminarily and qualitatively) how the key economic sectors of agriculture, energy, and recreation and tourism may fare over the long-term.
- The **Conclusion** summarizes the document and identifies the recommended next steps. This includes a recap of **Key Findings**, which are noted throughout the report and summarized on page 30.

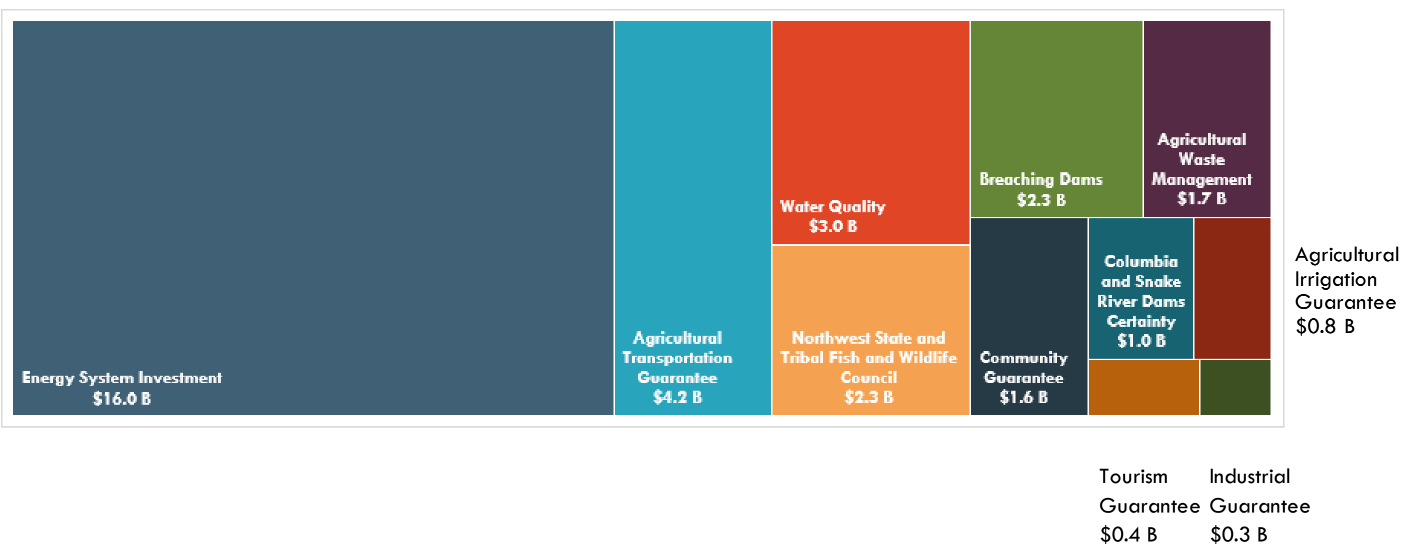
Appendix A contains a summary of key assumptions for each investment, and **Appendix B** describes the methodology used for the economic impact analysis. Sources for references throughout the document may be found on page R-1.

Summary of the Proposed Investment

The proposed Columbia Basin Fund would invest $33.5 billion in infrastructure and economic development largely, but not exclusively, in the area around the LSR. Representative Simpson's proposal for the Columbia Basin Fund includes more than 50 line-items for community investment (see **Appendix A**) but leaves many of the specific details up to local communities and industries. As shown in Exhibit 1, only 7% of these funds would be expended on breaching the four Lower Snake River dams (LSRD).

Exhibit 1. Expenditure by Proposed Investment Category

Investment Categories	Amount	Percent
Energy System Investment	$16.0 B	48%
Agricultural Transportation Guarantee	$4.2 B	13%
Water Quality	$3.0 B	9%
Northwest State and Tribal Fish and Wildlife Council	$2.3 B	7%
Breaching Dams	$2.3 B	7%
Agricultural Waste Management	$1.7 B	5%
Community Guarantee	$1.6 B	5%
Columbia and Snake River Dams Certainty	$1.0 B	3%
Agricultural Irrigation Guarantee	$0.8 B	2%
Tourism Guarantee	$0.4 B	1%
Industrial Guarantee	$0.3 B	1%
	$33.5 B	**100%**



Sources: The Northwest in Transition (Representative Simpson website: websiteslides2.4.pdf), 2021; BERK, 2021.

KEY FINDING

1. **Over $30 billion of the proposed investment (93% of the funds) would be allocated to supporting the region's economic transition through investment in the energy system, transportation infrastructure, fish and wildlife, water quality, and more. Approximately 7% of the proposed package would be expended on breaching the four Lower Snake River dams.**

Exhibit 2 summarizes the proposed investments by benefit areas, with some investments contributing to multiple different benefit areas as shown in Exhibit A-2. These benefit areas are distinct from the categories identified in Exhibit 1.

Exhibit 2. Contributions by Benefit Areas

***Certainty, Security, Viability* Categories**	**Amount**
Energy	$17.0 B
BPA	$16.0 B
States	$10.9 B
Salmon/Conservation	$7.3 B
Agriculture	$7.2 B
Transportation	$4.5 B
Communities	$2.8 B
Tribes	$2.2 B
Recreation	$0.4 B
Total not applicable as investments contribute to multiple categories.	

Sources: The Northwest in Transition (Representative Simpson website: websiteslides2.4.pdf), 2021; BERK, 2021

KEY FINDING

2. **$2.2 billion, or about 7% of the total proposed package, is designated for Tribal communities, including the $125 million LSR Cultural Resource Protection Fund and $2.1 billion for the Northwest State and Tribal Fish and Wildlife Council.**

Building on the Columbia Basin Fund framework, BERK has created an investment scenario with assumed phasing of the investment over time, high-level assumptions around the kind of expenditures that may be made, and assumptions around the geographic location of the investment. The purpose of this scenario is illustrative, and it is not intended to indicate how the funds actually will or should be expended because:

- As the investment moves forward, the total magnitude and composition of the investment package will surely evolve.
- The proposal allows regional control of much of the funding, with local interests determining when and how various investment categories would be expended to best meet regional priorities.

The illustrative investment scenario supplies the assumptions around the timing of the investment, the types of spending, and the geographic location of the investment that underpin the economic impact analysis described in the section titled Anticipated Economic Impacts. Our assumptions for each investment are shown in **Appendix A**.

1) *Investment Phases*

As investment will occur over several decades, we have identified several phases of focus. Because phases are defined by the primary focus of work, the number of years in each phase is different, as illustrated in Exhibit 3. Many activities, such as waterfront partnerships, university research on animal waste mitigation, and others, continue throughout the investment period and are not shown below.

Exhibit 3. Investment Phases

	Phase	Length	Example Activities	
2022–2029	Preparing & Implementing Key Investments	8 years	▪ Study and migration of rail and road infrastructure ▪ Energy capacity development and grid optimization ▪ Construction of the Snake River Center for Advanced Energy Storage ▪ Irrigation infrastructure ▪ Animal waste research and biodigester development ▪ Reconfiguring grain transportation and storage infrastructure	▪ Fish habitat restoration and salmon fisheries infrastructure investment ▪ National recreation area infrastructure ▪ Economic development investment – Tri-Cities, Lewiston-Clarkston ▪ Intermodal transportation hub – Tri-Cities ▪ Columbia River lock, dam maintenance
2030–2031	Transitioning	2 years	▪ Removing berms from four LSR dams and sediment from river	▪ Habitat restoration ▪ Continuing energy investment
2032–2035	Adapting	4 years	▪ Corridor restoration ▪ Cultural resource protection ▪ Lewiston-Clarkston waterfront redevelopment ▪ Continuing energy investment	▪ Marina relocation and compensation ▪ Sport fishing compensation ▪ Recreational boating compensation
2036–2046	Ongoing	11 years	▪ Tourism promotion ▪ Maintaining water quality and habitat restoration	

Source: BERK, 2021.

2) Nature of Expenditure

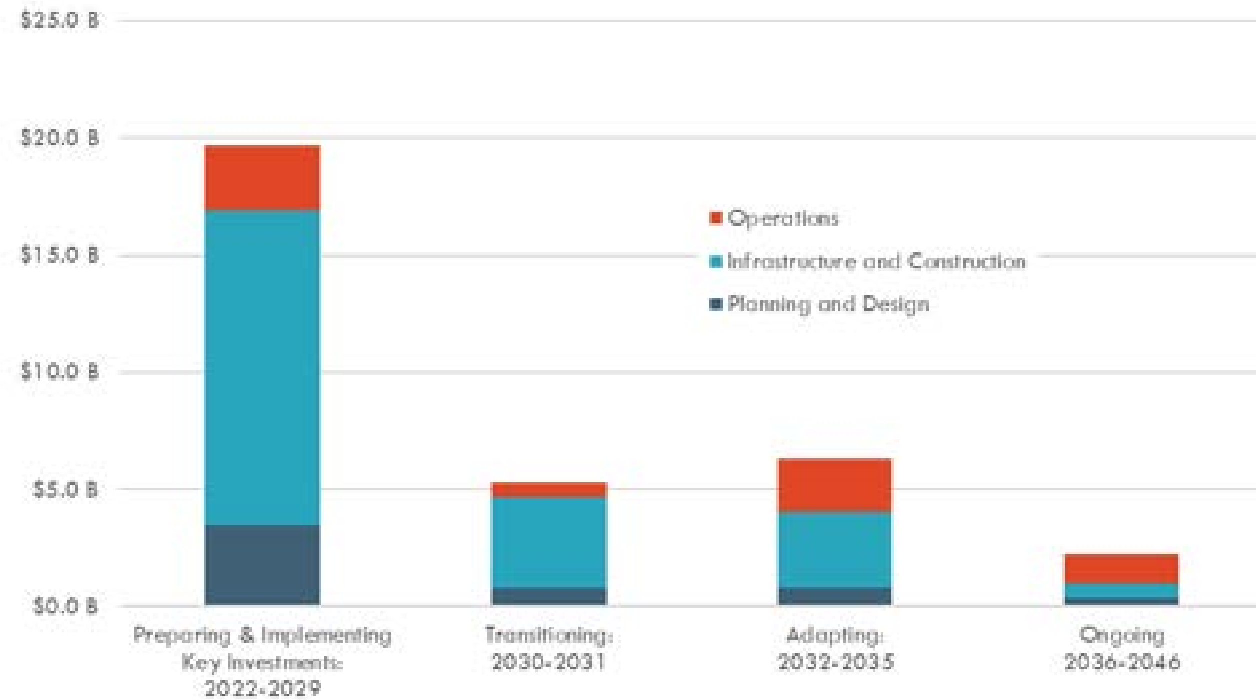
We made high-level assumptions around the nature of the expenditure for each investment according to the work anticipated in each phase. We categorized expenditures according to the three broad categories and illustrative activities shown in Exhibit 4. The Expenditure Type percentages shown in **Appendix A** are a weighted average of these phase-specific assumptions. Exhibit 5 summarizes anticipated spending over time and type, combining the ideas presented in Exhibit 3 and Exhibit 4.

Exhibit 4. Primary Activities by Phase

Planning and Design	Infrastructure and Construction	Operations
▪ Surveying ▪ Infrastructure and construction planning and design ▪ Energy generation, efficiency, and transmission resource planning ▪ Community and stakeholder engagement ▪ Engineering	▪ Berm removal ▪ Dredging ▪ Road construction and maintenance ▪ Irrigation/pipes ▪ Waterfront redevelopment ▪ Snake River Center for Advanced Energy Storage construction ▪ Fisheries improvements ▪ Energy generation and grid infrastructure construction ▪ Rail and barge system infrastructure construction ▪ Agricultural waste management infrastructure construction ▪ Grain storage expansion ▪ Pipe re-engineering construction ▪ Installation of fish protection infrastructure	▪ Workforce development ▪ Habitat restoration ▪ Cultural resource protection ▪ Water quality improvements ▪ Tourism promotion ▪ Compensation funds ▪ Technology partnerships ▪ Oversight, management, and administration ▪ Research and development for biodigesters and advanced energy storage

Source: BERK, 2021.

Exhibit 5. Illustrative Investment Scenario by Phase and Type of Expenditure



Expenditure Type	Preparing & Implementing Key Investments: 2022-2029	Transitioning: 2030-2031	Adapting: 2032-2035	Ongoing 2036-2046	Total	
Planning and Design	$3.5 B	$0.8 B	$0.8 B	$0.4 B	**$5.5 B**	**16%**
Infrastructure and Construction	$13.4 B	$3.8 B	$3.3 B	$0.6 B	**$21.1 B**	**63%**
Operations	$2.8 B	$0.6 B	$2.2 B	$1.3 B	**$6.9 B**	**21%**
Total	$19.7 B	$5.3 B	$6.3 B	$2.2 B	**$33.5 B**	**100%**
Average/Year	$2.5 B	$2.6 B	$1.6 B	$0.2 B		
	59%	**16%**	**19%**	**7%**	**100%**	

Source: BERK, 2021.

KEY FINDINGS

3. **Approximately $20 billion (59% in BERK's expenditure scenario) would be spent before the dams are breached to help the region prepare for this shift.**
4. **Slightly more than $21 billion (63% in BERK's expenditure scenario) is likely to be spent on infrastructure improvement and construction.**

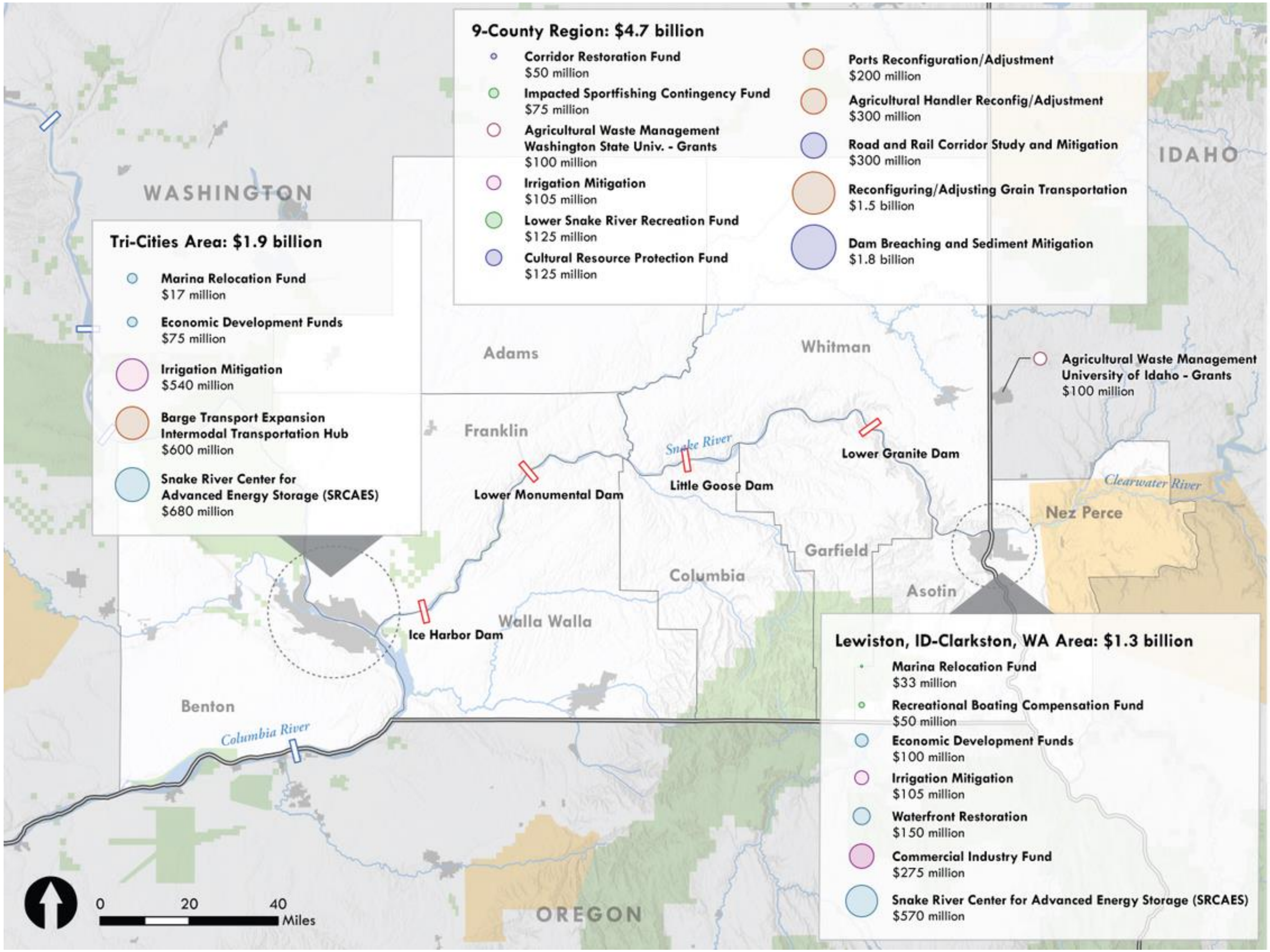
3) Geographic Focus of Investment

Finally, we assigned a geographic area of focus for each investment. Exhibit 6 shows investment across the nine counties most likely to be impacted, and Exhibit 7 shows investments across the Northwest. These maps illustrate the distribution of funding in the illustrative investment package by geography. The geographic designations indicated in the map do not necessarily mean all related expenditures would occur in this location, or that the full economic benefit of such expenditures would be found here, but rather that the majority of spending (and the infrastructure and construction in particular) would be concentrated in these locations. The anticipated regional economic impacts of the proposed investment are discussed in the next section.

KEY FINDING

5. **At least $7.9 billion, or 24% of the total investment, would likely be spent in the 9 counties closest to the LSR. This includes about $1.3 billion in funding for projects in Lewiston-Clarkston, $1.9 billion in the Tri-Cities, and $4.7 billion in the remainder of the 9-county region around the LSR. Beyond these investments directed at these named geographies, significant additional funding tied to energy replacement and habitat restoration may also be expended in the 9-county region.**

Exhibit 6. Distribution of Funding, Lower Snake River Area



LEGEND

- State Boundary
- County Boundary
- Federal Lands
- Tribal Lands
- Water

Major Dams: Snake and Columbia Rivers

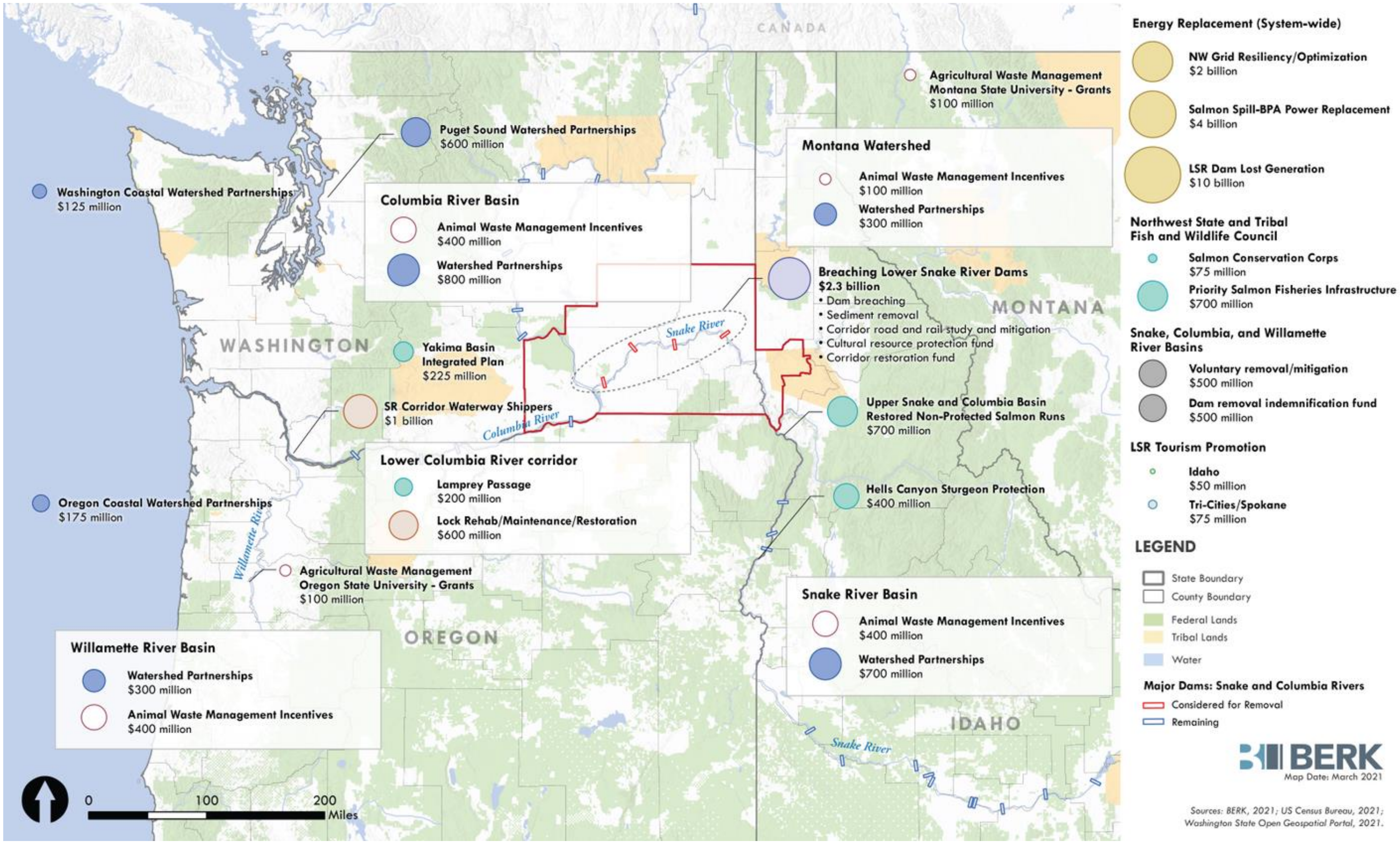
- Considered for Removal
- Remaining

BERK

Map Date: March 2021

Sources: BERK, 2021; US Census Bureau, 2021; Washington State Open Geospatial Portal, 2021.

Exhibit 7. Distribution of Funding, Northwest



Anticipated Economic Impacts

The direct expenditure of the investment package described on the preceding pages would lead to additional spending and a total economic effect greater than the initial spending. A full economic impact analysis could answer the following:

- How do the impacts of this investment affect different economic sectors, including industries receiving direct investments, as well as increased activity with indirect and induced effects from suppliers and household spending from wages received from supported labor?
- How many jobs would be created (both temporary and ongoing), in what sectors and locations, and what wages would be received from these positions?
- What share of these economic benefits would be captured within the local region versus "leaking" outside of the area?

For this initial assessment, we rely on the assumptions made in the BERK investment scenario described on the previous pages, specifically for the assumptions regarding spending across categories. A significant portion of the proposed investment package is allocated to infrastructure investment and construction. Based on a possible breakdown of costs, we estimate that about $21.1 billion would be expended on waterfront redevelopment, associated construction, habitat restoration, dam breaching, and other physical and infrastructure improvements as shown in Exhibit 5. This is a significant injection of one-time spending for the construction industry, including planning and engineering, labor, materials providers, suppliers, and others.

The effects across the economy will not be limited to this direct spending, however. Indirect effects related to suppliers and supporting businesses across the supply chain will also promote economic activity, and wages from supported jobs will stimulate spending throughout the economy.

Note that this activity may not all be directed to the 9-county region immediately surrounding the LSR. Many of the planning, design, and engineering firms typically involved in infrastructure and construction projects of this scale are based outside the region, in Boise, Portland, Seattle, Spokane, and urban areas across the country. The supply chain needed to support these activities may also extend outside the region, which can result in indirect benefits accumulating elsewhere. Examples would include fuel, building materials, and equipment. The final legislative package could use local sourcing requirements to address the "leakage" of benefits outside the nine counties most affected by breaching of the dams, and outside the Northwest overall. Efforts to build local and Tribal capacity and connections with supply chains could also help in retaining these benefits in the affected region.

ASSESSING POTENTIAL ECONOMIC IMPACTS

During the first investment phase from 2022 to 2029, an average of $2.5 billion will be spent each year on engineering, design, planning, implementation, and related services. For planning purposes, we assume 75% of these contracts by value are awarded to businesses and organizations located in the Northwest, with the remainder awarded to businesses located elsewhere in the U.S. These contracts will support direct employment and associated labor income for trades workers, administrative staff, and other employees at these firms. Additional revenues, employment, and labor income will be supported by upstream supply chain transactions in the region (indirect impacts), such as the purchase of materials by construction and engineering firms, and household expenditures on goods and services (e.g., groceries, entertainment) by workers employed in support of these projects (induced impacts). Together, these impacts combined are referred to as "total impacts."

Based on a preliminary assessment, **investments and operations during Phases 1 and 2 will support an estimated average of 9,250 direct jobs each year over this period, including members of the building trades and workers at heavy construction and civil engineering firms. When indirect and induced impacts are considered, Phase 1 and 2 investments will support a total of approximately 20,000 jobs each year across the Northwest.**[2] [3] This equates to an employment multiplier of 2.2, where one direct job is tied to an additional 1.2 jobs elsewhere in the economy. Most of these impacts will accrue in Washington state, with large jobs impacts in Idaho, Montana, and Oregon based on a projected geographic distribution of investments. This figure compares to an estimated jobs multiplier of 2.4 for aerospace and less than 2.0 for wholesale and retail activities.[2] To appreciate the magnitude of this total employment impact, in Washington state, this is roughly equal to

CONSIDERING FISCAL IMPACTS

While economic analysis considers employment impacts and spending in the regional economy, fiscal analysis focuses on the impacts to local, state, and national layers of government. Impacts may include tax revenues generated by spending in the region, as well as changes to the cost of providing public sector services. While a detailed fiscal analysis is not possible in this short study period, the following directional fiscal impacts would be associated with the proposed investment package.

- **Federal.** As noted in the Introduction and Energy sections, continuation of the status quo implies significant federal expenditures, including dredging to maintain navigable channels, ongoing maintenance and operations of the dams and surrounding recreational facilities, and capital investments to update aging dam infrastructure. While these costs would likely be less than the expenditure of federal dollars proposed in the investment package, status quo costs should be subtracted from the investment total to understand the net cost to the federal government.
- **State and Local.** It is not anticipated that the investment package would significantly change the cost of providing state and municipal services, although a more detailed analysis would be necessary to evaluate the net fiscal impact on individual jurisdictions. Changes in employment, residential population, visitation by out of area guests, and commercial goods transportation patterns would affect both tax revenues and service delivery costs. It would be important to include these incremental changes on top of the tax revenues that would be generated by the infrastructure investment planned in the region over the next 25 years.

the size of the commercial and industrial building construction industry, which directly employed an annual average of 23,000 workers in 2019.[4]

Throughout the entire duration of the Columbia Basin Fund program (between 2022 and 2046, across all four project phases), investments and operations will, on average, support a total employment impact of nearly 11,000 jobs per year in the Northwest. This is lower than the 20,000 jobs supported each year during Phase 1 and 2 because spending is anticipated to ramp down in Phases 3 and 4.

Appendix B contains a summary of the methodology used to derive these figures, which are based on a high-level, rapid assessment and are intended to provide a general understanding of the potential economic impacts of the proposal. A more rigorous and comprehensive analysis would include detailed estimates of direct and total jobs, income, and revenues broken out by industry and specific geography (e.g., by state, and for the nine counties in Washington and Idaho located in closest proximity to the LSR).

In addition to the above benefits associated with direct spending in the economy, the investment in new capital facilities, including the Snake River Center for Advanced Energy Storage and additional electricity generation capacity and efficiency, will support long-term employment opportunities in various communities. These impacts are further considered in the following section.

KEY FINDINGS

6. **The approximately $21.1 billion to be invested in infrastructure and physical improvements will have significant positive economic impacts, generating jobs and stimulating spending not only in the construction and professional services sectors, but also indirectly in support industries in the supply chain such as suppliers, surveyors, and planners, as well as in household services supporting local employees. The remaining $12.4 billion spent over time on planning and design, operations, and other services will have additional positive impacts on the regional economy, though this may be subject to relatively greater leakage. Policies and investment strategies can be put in place to retain as much of these benefits as possible in the nine counties most directly affected by breaching of the dams, as well as the broader Northwest region.**

7. **Spending during Phases 1 and 2 will support a total average of more than 20,000 jobs each year across the Northwest, primarily in Washington state but with additional jobs impacts in Idaho, Oregon, and Montana. These jobs impacts include workers directly employed in the building trades, at civil engineering and heavy construction firms, and various supporting organizations and services. Additional jobs will be supported by business supply chain transactions and household expenditures. Throughout the entire duration of the project (all four phases, including ramped down spending in Phases 3 and 4), an average of nearly 11,000 jobs will be supported directly and through multiplier effects each year**

8. **Local and state net fiscal impacts are likely to be positive given increased tax revenues associated with sales tax on construction and other one-time revenues. Shifts to the ongoing cost of providing services are not anticipated to be significant, with additional study warranted for jurisdictions likely to see significant changes in population, employment, visitation, or transportation patterns.**

Long-term Economic Outlook

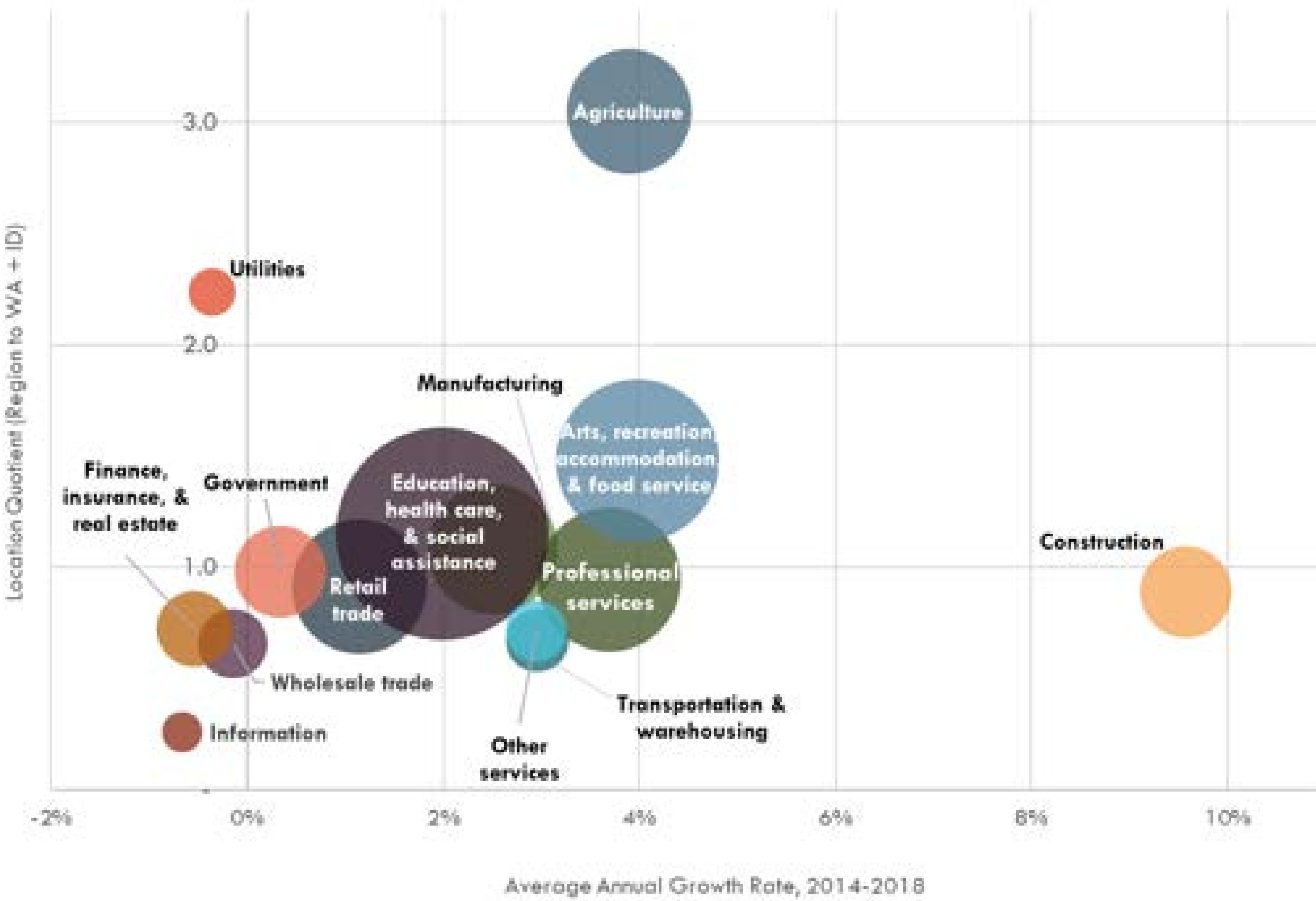
While the previous section discusses the economic impact of the expenditures contained in the proposed investment package, this section considers the future of key sectors of the regional economy that would be affected by the investment proposal, including agriculture, energy production, and recreation and tourism. Employment in these industries is highlighted in Exhibit 8, which shows size of the industry in terms of employment (size of the bubble), average annual employment change between 2014 and 2018 (along the horizontal axis), and the relative concentration of employment in the sector compared to the average for Washington and Idaho (vertical axis).[5] Industries above the 1.0 line are more highly concentrated in the region than in Washington and Idaho as a whole, while those below the line are less concentrated.

Exhibit 9 presents similar information for the region's gross domestic product by industry. Gross domestic product (GDP) is a measure of economic activity that indicates the value of goods and services produced within a specific geography within a year. While GDP is most frequently calculated on a national basis, the U.S. Bureau of Economic Analysis estimates GDP for U.S. counties. That data forms the basis of this chart.[6] Exhibit 9 indicates the value of goods and services produced within each sector (size of the bubble), the inflation-adjusted average annual growth rate in the value of goods and services produced in each industry between 2014 and 2018 (along the horizontal axis), and the relative concentration of the 9-county region's GDP in the industry, as compared to Washington and Idaho as a whole (along the vertical axis). Industries above the 1.0 line contribute to a larger portion of the region's GDP than they do to the combined GDP of Washington and Idaho.

- **Agriculture** is a strong regional industry, with a high concentration, modest contribution to GDP, large employment, and solid growth. While GDP from the agricultural industry declined by an average of 1% per year between 2014 and 2018, this is primarily due to the nature of the industry, as the value of goods produced in a year is determined largely by commodity prices. The period of 2014-2017 coincided with a drop in wheat prices (the predominant crop in the region). Wheat prices increased between 2017 and 2019 and GDP from agriculture in the 9-county region increased in inflation-adjusted terms each year in that more recent period.
- **Energy generation** (captured in the "Utilities" sector) is also more highly concentrated in the region than across Washington and Idaho as a whole in terms of both employment and GDP. Over the last five years, employment has been relatively modest, and the industry has seen a very slight job loss. The sector's importance should not be understated, however, as energy is a key input for other industries.
- **Recreation and tourism** employment is embedded in Accommodation & Food Service, Arts & Recreation, and other sectors. While the accommodation, food service, arts, and recreation sectors together make up a relatively large percentage of total regional jobs, the majority of these are in the food service sector and include jobs that serve locals as well as visitors. Compared to its share of regional employment, this sector makes up a relatively smaller portion of the region's GDP. As described below, the recreation and tourism industry makes important contributions to the region despite its small size.

In addition to these three key sectors, it is important to note that **construction** is a relatively large industry in the region; while it is slightly less concentrated here than in the Washington and Idaho economies as a whole, it grew by about 11% per year between 2015 and 2019 and employment in construction grew by an average of 10% per year between 2014 and 2018. This indicates there is increasing capacity regionally to absorb investment in infrastructure and construction.

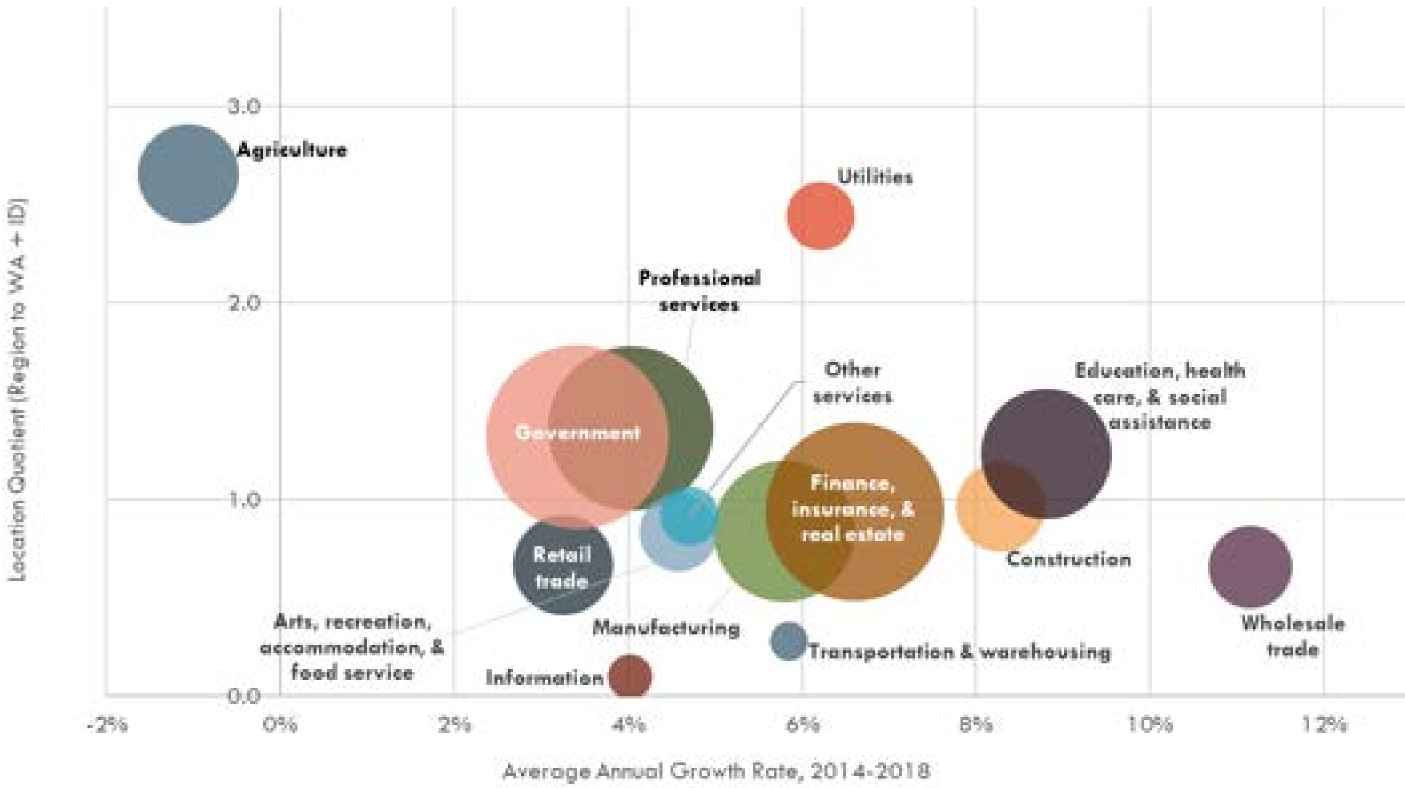
Exhibit 8. Employment by Sector in 9-County Region



Note: Size of bubble represents quantity of jobs in the sector. Horizontal axis represents the 5-year average annual growth rate for employment in the sector. Vertical axis represents the location quotient for employment in the sector, comparing the 9-county region to the states of Washington and Idaho combined. Excludes industries with fewer than 200 total employees across the region.

Sources: U.S. Census Bureau Longitudinal Employer-Household Dynamics (LEHD), 2018; BERK, 2021.

Exhibit 9. GDP by Sector in 9-County Region



Note: Size of bubble represents size of GDP by sector. Horizontal axis represents the 5-year average annual growth rate for GDP in the sector. Vertical axis represents the location quotient for GDP in the sector, comparing the 9-county region to the states of Washington and Idaho combined. Excludes industries with less than $25 million in average annual GDP across the region.

Sources: U.S. Census Bureau of Economic Analysis (BEA), 2018; BERK, 2021.

As we consider the future of the agriculture, energy, and tourism industries, the key questions are complex and nuanced:

- What are the likely long-term outcomes associated with the expenditure of the $21.1 billion in funds dedicated to infrastructure investment and economic development as well as with the breaching of the four LSRD?
- While this expenditure of outside resources will generate significant positive short-term economic gains for the region, will the core industries of agriculture, energy generation, and tourism be enhanced or diminished in the long-term?
- How can investment expenditures best be targeted to minimize economic disruptions, address anticipated challenges, and maximize returns for the region by strengthening the economy and making it more resilient to future changes?

Given the rapid nature of this initial assessment, our analysis here is preliminary and we recommend that additional study be given to these questions with the direct involvement of affected industries and communities. For now, we draw on preexisting studies and previous conversations to briefly describe the current state of each sector and summarize previously identified concerns and opportunities.

AGRICULTURE

Agriculture, and wheat farming in particular, is integral to the economies of Southeast Washington, Northwest Idaho, and Northeast Oregon. In the nine counties closest to the LSR, agriculture contributed an average of $1.4 billion to the area's GDP each year between 2015 and 2019, equal to 5.4% of the area's total GDP.[6] Sales of wheat alone were equal to 1.8% of the area's total GDP in the most recent year in which data was available (2017).[7] Between 2014 and 2018, agriculture accounted for an average annual equivalent of just under 18,000 jobs, representing 9% of total employment in the 9-county area.[8] Grain farming represents about 5% of total agricultural employment in the region, equal to an annual average full-time equivalent of at least 800 jobs.[9] As shown in Exhibit 8 and Exhibit 9, the agriculture industry is generally growing.

Anticipated Investment Outcomes

Grain Transportation

If the LSRD were breached without investment in grain transportation infrastructure, grain growers would face increased transportation costs and longer and less certain transportation times for their products to reach customers. Taken together, these impacts could have significant detrimental effects on the competitiveness of the grain industry in the region. Grain growers have indicated that the cost increases and logistical challenges could be large enough to lead grain growers to exit the industry, threatening the future of the industry in the region.[10]

This is due to two key conditions in the existing transport system:

- The **competitive environment between rail and barge shippers**. Under current conditions, rail and barge shippers have an incentive to compete on price and service (timeliness). Absent a barge system, rail companies have little incentive to compete on price and service, particularly in the absence of government intervention. In interviews as part of prior studies,[11] [12] grain producers have raised this as a major concern and expressed that shipping costs for grain products could increase by as much as 100%. This concern has been borne out in real-world conditions – during the temporary 2010-2011 closure of the LSRD locks to barging, shipping costs for grain producers increased by nearly 40%.[13]
- The **lack of sufficient rail and grain storage capacity** to make timely delivery of grain products via rail shipping possible. In 2019, more than 85 million bushels of grain (primarily wheat) were moved down the LSR by water. Transporting the same quantity via rail would require sufficient capacity to handle nearly 24,000 additional rail car loads (at 3,600 bushels per car) and additional storage capacity.[14] Responsiveness and timeliness are critical factors for grain producers in considering shipping modes, and the current barge configuration has the advantage of offering 3-day turn-around times from notification to delivery.[15] The existing rail system lacks the capacity to transport this additional cargo in the same timeframe. This is due to a combination of factors, including congestion on rail lines, lack of rail car storage space, lack of unit train loaders, and lack of grain storage facilities.[16] [17] [18]

Previous studies of the economic impacts of breaching the LSRD have identified a range of costs for the infrastructure investments that would mitigate the impacts of eliminating the LSR navigable waterway on agricultural producers. Exhibit 10 summarizes the range of costs identified in these studies. At the high end, the FCS Group study estimates $1.1 billion in total costs to mitigate transportation impacts in 2020 dollars,[19] though this does not include an estimate of increased shipping costs paid by grain producers. Using the highest-cost estimate from either study in each category results in a total high-end estimate of $1.4 billion in mitigation costs.

Exhibit 10. Range of Estimated Agricultural Transportation System Mitigation Costs (in 2020 dollars)

Category	ECONorthwest Study*	FCS Group/ PNWA Study**	Highest Estimate: Either Study
Road Repair (Soil Stabilization)	$214.4M - $575.6M	$96.8M – $387.4M	$575.6M
Road Maintenance and Improvements	$57.6M - $99.1M	$169.2M – $203.5M	$203.5M
Rail and Storage Infrastructure Expansion	$118.2M - $141.9M	$367.8M - $432.7M	$432.7M
Other Infrastructure	*Not estimated*	$49.0M – $73.6M	$73.6M
Increased Transportation Costs to Producers	$42.5M - $81.1M	*Not estimated*	$81.1M
Total	**$403.7M - $832.1M**	**$683.4M - $1.1B**	**$1.4B**

**Expressed in present value, using a 2.75% discount rate over a 30-year period. Original estimates were in 2018 dollars.*
*** Original estimates were in 2019 dollars.*

Sources: ECONorthwest, 2019; FCS Group, 2020; Kramer Consulting et al., 2020; BERK, 2021.

The proposed investment package presents a unique opportunity to expand the capacity of the grain shipping system in the region and to "make the agricultural industry whole" in the event of the breaching of the LSRD. It includes a total of **$3.5 billion**[a] in investments to build and improve road, rail, barge, port, and storage facilities and support transportation of grain, more than double the $1.4 billion highest-end estimate of costs. The package funding is greater than the identified need, even if the increased transportation costs to grain producers (the most uncertain element) exceed those identified in the ECONorthwest study by a large margin.

KEY FINDING

9. **The $3.5 billion in dedicated funding for agricultural transport mitigation and improvements is more than double the highest previously identified estimate of the investment needed to make agricultural producers whole.**

[a] There is an additional $1.0 billion in the package for a compensation fund for shipping companies currently operating on the LSR. While those funds are included in the $4.5 billion "Transportation" category in the Summary of the Proposed Investment, they are not included in the discussion in this section because they do not directly impact grain producers. In addition, the $3.5 billion in transportation investments cited here includes the $300 million for road and rail infrastructure study and mitigation, which is included in the Dam Breaching category rather than the Agricultural Transportation Guarantee category in Exhibit 1.

The package addresses the transport system issues through the following actions:

- **$300 million** to **study and mitigate the impacts of dam breaching on road and rail** infrastructure in the 9-county region as water levels fall post-breach.
- Providing funding to **expand rail and road capacity** in the area, including **$300 million** for agricultural handler reconfiguration/adjustment, allowing for upgrades to unit train loaders on the corridor.
- Funding to **expand grain storage and loading capacity** in the form of **$200 million** in port reconfiguration/adjustment funds for the ports of Lewiston, Clarkston, Wilma, Whitman, and other grain-collecting ports.
- Providing funding to **expand shipping on the Lower Columbia River** from the Tri-Cities, in the form of **$600 million** for the construction of an intermodal transportation hub and **$600 million** for lock rehabilitation and improvements for dams on the Lower Columbia River.
- Providing funding **to fully compensate grain farmers for the impacts of increased transportation costs**. This is in the form of a **$1.5 billion** grain transportation reconfiguration/adjustment fund to the states of Idaho and Washington. The funds could be applied across a range of investments and solutions, including, but not limited to:
  - Direct subsidies for growers facing increased shipping costs on rail and/or truck. If the funds are placed in trust, the States could provide farmers with an annuity that fully subsidizes transportation costs in perpetuity.
  - Investments in unit train loaders to increase the capacity and reliability of the rail transport system.
  - Expanding rail cooperatives (e.g., Washington Grain Train), which provide lower cost and more reliable rail transport for growers.
  - Additional investments in increasing barging capacity on the Lower Columbia River.

KEY FINDING

10. The $1.5B flexible transportation fund for grain producers exceeds all previous estimates of the increased shipping costs under a dam breach scenario, indicating producers will likely face lower shipping costs under the investment package.

In addition to being more than sufficiently large to meet the required transportation system mitigation investments identified to date, the package has the advantage of offering flexibility to affected producers. The $1.5 billion grain transportation reconfiguration/adjustment fund for the states of Washington and Idaho can be invested in a range of different solutions, providing funding where it will be most impactful and addressing the current constrictions from multiple angles.

Irrigation

There are an estimated 57,600 acres of irrigated agricultural land within 5 miles of the LSR that could potentially be affected by the loss of irrigation from the LSRD reservoirs, of which around 37,000 acres are currently irrigated from the Ice Harbor Reservoir.[20] More than half of this irrigated cropland is in orchards and vegetable fields.[21]

In addition to agricultural users, there are a small number of wells and municipal and industrial pump stations located near the LSR that are likely to be affected by the river drawdown. As of the 2002 EIS, these included 228 residential and irrigation wells and six municipal and industrial pump stations, including pump stations used for municipal water backup, golf course irrigation, and paper product production at the Clearwater Paper Mill.[22]

If the LSRD are breached, the existing reservoirs will recede and the groundwater table is likely to drop, at least in the short-term.[23] Previous studies have estimated the costs associated with improving well, pump, and water transportation infrastructure in the region to mitigate the loss of water associated with the dam breaches. Exhibit 11 summarizes the range of costs identified in these studies in 2020 dollars.

At the high end, the 1999 Drawdown Regional Economic Workgroup (DREW) Water Supply Analysis[24] and 2002 EIS study[25] estimated a total of $683.4 million (in 2020 dollars) to mitigate impacts to irrigated agricultural land, municipal and industrial pumps, and private wells by constructing a large central pumping station and water conveyance infrastructure to transport water to agricultural land, and modifying existing wells and pumps. However, the DREW Water Supply Analysis notes that the significantly higher cost shown in this infrastructure-cost estimate (versus the cost shown in an alternate calculation method based on change to land value) likely indicates that those costs are overestimated. The 2019 ECONorthwest study estimated a total cost of $153.2 to $191.5 million to replace 41 affected surface water diversions and 84 wells likely to be affected by the dam breaches.[26]

Exhibit 11. Range of Estimated Irrigation System and Water Supply Mitigation Costs (in 2020 dollars)

Category	ECONorthwest / Vulcan Study *	DREW / EIS **	Highest Estimate: Either Study
Agricultural Irrigation Mitigation	*Not disaggregated*	$227.6M - $494.1M †	
Municipal & Industrial Pump Improvements	*Not disaggregated*	$19.5M - $93.6M ††	
Private Well Improvements	*Not disaggregated*	$95.7M	
Total	**$153.2M - $191.5M**	**$247.1M - $683.4M**	**$683.4M**

** Original estimates were in 2018 dollars.*

*** Original estimates were in 1998 dollars.*

† The range of cost estimates for agricultural irrigation mitigation in the 2002 EIS and the 1999 DREW Water Supply Analysis is based on two cost estimate methods. 1) A method which estimated the potential change in assessed value of irrigated agricultural land if the dams were removed. This method resulted in the lower-end cost estimate. 2) A method which estimated the costs to modify pumps and other irrigation infrastructure. This method resulted in the higher-end cost estimate. The USACE chose to use the lower-end estimate, stating: "The pump modification costs are significantly higher than the estimate of the change in land value, therefore, it is reasonable to conclude that this option is not economically viable, and is an overstatement of the economic effects. The land value approach is therefore carried forward as the approach to measure the economic effects to pump irrigators at Ice Harbor reservoir."[27]

†† The range of cost estimates for municipal and industrial pump improvements is based on a range of construction cost estimates, the range was generated due to uncertainty around the cost of modifications at a papermill in Lewiston, ID.

Sources: ECONorthwest, 2019; U.S. Army Corps of Engineers, 2002; BERK, 2021.

The investment package dedicates **$750 million** to irrigation mitigation for the construction and improvement of wells, pumps, and water conveyance infrastructure. The dedicated funding exceeds the highest previously identified infrastructure cost estimate by 10%, indicating the investment package is at least appropriately sized to address impacts to irrigation and water supply associated with the dam breaches.

KEY FINDING

11. The $750 million investment in irrigation infrastructure exceeds the highest previously identified estimate of the investment needed to fully mitigate irrigation impacts from dam breach by 10%.

ENERGY

The four dams proposed to be removed in 2030 were placed in service between 1962 and 1975 as part of the Federal Columbia River Power System (FCRPS) and are currently being operated and maintained by the U.S. Army Corps of Engineers (USACE). The Bonneville Power Association (BPA) maintains the transmission system used to carry this power to utilities and hence consumers and is also responsible for marketing power across the Intercontinental Exchange.

Altogether these facilities provide a total nameplate capacity of 3,033 megawatts (MW) with an estimated 20-year average capacity factor of 32–34%, resulting in a median yearly generation of around 795 annual average MWs (aMW).[28] This includes additional dispatchable capacity that can be employed at short notice and for short periods in response to increased demand from customers. This ability to respond quickly to demand is a key advantage for this source of power, as it provides additional stability to the regional grid during peak-load periods, and opportunities for the export of power outside of the BPA service area to other regions.

Systemwide, these four dams contribute about 14% of the total capacity of the dams in the FCRPS and around 3% of the total generating capacity in the region.[29] It is important to note that continuation of the status quo carries its own uncertainties and costs:

- **A competitive market.** The ECONorthwest study notes that the inflation-adjusted price of wholesale electricity has trended upwards at the same time that rates for purchasing power on the Intercontinental Exchange have been decreasing, calling into question the economic competitiveness of the current generation model.[30]
- **Ongoing operations and maintenance (O&M) costs.** The expense to operate and maintain the dams on the LSR was estimated in a 2016 study jointly issued by the BPA, USACE, and Bureau of Reclamation at $52 million per year in 2018 dollars.[31] These costs are currently incurred by BPA and the USACE and borne by ratepayers.
- **Capital costs of maintain existing generating capacity with dams.** Anticipated capital investments needed to keep the dams operational range between $654 million and $1.6 billion from 2020–2040, with the high range including the replacement of 24 generating turbines at $46 million per unit.[32] [33] Over the longer term, it is expected that regional loads will increase by 1,800–4,400 aMW out to 2035, as projected by the Northwest Power and Conservation Council (NPCC).[34] Although there are concerns about peak capacity for winter and summer loads, the NPCC highlights that energy efficiency and demand-side management strategies could address most if not all of this increase in demand.
- **Requirements for clean power.** Under the 2019 *Clean Energy Transformation Act*, the State of Washington has committed to a goal of 100% clean energy (with offsets) by 2030 and 100% renewable or non-emitting electricity supplies by 2045.[35] [36] Any proposed changes to the grid must be evaluated against the ability to make progress towards this goal.

Proposed Investments

At $16 billion, investments in the energy system constitutes nearly half of the proposed investment package, as illustrated in Exhibit 1. Per **Appendix A**, this includes three related investments:

- $10 billion to replace the current energy production of the four dams.
- $4 billion to replace energy production on downstream Columbia River dams, where additional non-generating voluntary spill will be needed to aid salmon migration.
- $2 billion to optimize the Northwest transmission grid in response to where generation occurs.

In addition to these three core investments, $1.25 billion is dedicated to building and supporting the Snake River Center for Advanced Energy Storage with research and operations at the Pacific Northwest National Laboratory in the Tri-Cities and a new facility to be constructed and staffed in the Lewiston-Clarkston area.

KEY FINDING

12. The largest component of the investment package is devoted to energy, with $16 billion allocated to replacing capacity and strengthening the grid, as well as $1.25 billion to create the new Snake River Center for Advanced Energy Storage.

The primary purpose of these investments is to offset generation losses associated with breaching the four LSRD and changes to dam operations on the lower Columbia rivers. As described in the Columbia Basin Fund framework, these investments seem likely to result in:

- **New zero-emission generation capacity,** which would likely include significant wind and solar generation projects.
- **Energy storage,** likely in the form of batteries or pumped storage on the grid, to increase stability during peak demand and reduce the loss of load probability.
- **Upgrades to the regional transmission network** to allow for existing and future projects to be reliably connected to the regional system.

Final strategies to address the loss of capacity after breaching may also include other approaches not identified in early thinking about the investment package, potentially including:

- Purchasing additional clean power from other regions to address peak demand.
- Supporting increased efforts to coordinate with customers to reduce electricity demand.
- Changing pricing structures to encourage lower consumption.
- Investing in distribution systems to increase utilities' ability to integrate variable energy.

While these are not recognized directly in the package under review, they may have distinct economic effects that should be evaluated under a more complete study.

Anticipated Investment Outcomes

The proposed investments in energy generation, storage, and transmission will have multiple economic effects on the region:

- **Direct spending and one-time labor effects in the economy.** The expenditures identified in the investment package are expected to impact the economy as goods, services, and labor are purchased to meet the objectives outlined in the package. As noted previously, effects will move through the economy according to location, supply chain purchases, and employee wages needed to support these activities.
- **Long-term labor shifts.** The jobs associated with operating and maintaining the existing dams will no longer be needed if the dams are breached, but new employment associated with the new capacity for generation and storage will be necessary, and new jobs and opportunities for innovation will be created by siting the Snake River Center for Advanced Energy Storage in the Tri-Cities and Lewiston-Clarkston areas. The qualities of the jobs gained versus lost are not estimable as part of this assessment, but the potential for workers to transfer between lost and gained positions, the differences in wage rates, and other factors will be relevant for understanding the detailed effects of this package on jobs in the energy industry.
- **Wholesale and consumer electricity price impacts.** In previous studies, the costs of installing new zero-emission generating capacity were assumed to be incorporated into consumer electricity rates, resulting in a range of possible rate increases. The proposed investment package seeks to avoid these impacts by providing a significant external investment in new generation infrastructure, including $10 billion identified for replacing LSRD capacity and $4 billion to compensate for diminished generation on the Columbia River. While estimating full energy replacement costs is beyond the scope of this paper, the NWEC report and 2020 EIS provide a range of costs that can be compared to costs under the status quo and the proposed investment amount. As shown in Exhibit 12, the current costs plus an annualized amount for the $10 billion slated for LSRD generation replacement exceed estimated capital and O&M costs under nearly all scenarios.

  There are many variables to consider, and we recommend that this analysis be expanded in future work. The proposed $10 billion will help to mitigate impacts for ratepayers and other stakeholders from the costs of new capacity that would otherwise be capitalized into electricity rates. In fact, this investment may exceed the capital and operating costs associated with building new alternative energy capacity and could represent an opportunity not only to replace LSRD generation, but to augment it.

KEY FINDING

13. **The proposed $10 billion will help to mitigate the impacts to ratepayers associated with the capitalized costs of building replacement capacity. As this amount could exceed the costs associated with developing alternative energy capacity, this investment also represents a potential opportunity to augment capacity beyond simply replacing the lost generation from the four dams.**

- **Public goods resulting from new investment.** There are also other characteristics resulting from new investment that may have downstream effects in the economy: changes in greenhouse gas emissions, improvements in technology, changes in market costs for zero carbon power generation, and so forth. These are noted here, although a full assessment of these impacts may be difficult to calculate.
  - **Improved stability of the grid.** The $2 billion allocated for grid optimization is expected to enhance the overall function of the current grid. This may include adding storage systems (e.g., batteries, pumped storage), supporting transmission line improvements to connect with new projects, and smartening and hardening local electricity systems.
  - **Enhanced regional innovation, research, and development.** The total expenditure of $16 billion on expanding local generating capacity, efficiency, and storage, as well as funding the new Snake River Center for Advanced Energy Storage in partnership with the Pacific Northwest National Laboratory, will have other long-term effects on building capacity for developing zero-carbon power generation in the local economy. Building local capacity in constructing and integrating these facilities can help reduce costs and increase the local economic benefits derived from these projects, and this may even support development of local businesses devoted to energy production, storage solutions, and other energy-related goods and services.

KEY FINDING

14. The proposed investment has significant potential to produce additional public goods, including regional economic stimulus and employment; improved stability of the grid; and enhanced regional innovation, research, and development.

The proposed investment in the energy sector represents an opportunity for the Northwest to develop and apply new technologies, advance decarbonization, and harden and smarten the grid. Used wisely, this investment will benefit the region well beyond replacing the energy generation of the four dams. Strategies should be deployed to ensure that the investment is optimized to meet multiple goals, including:

- Energy reliability, including the availability of dispatchable capacity to meet short-term needs.
- Advancing decarbonization goals.
- Creating economic and employment opportunities for regional communities. Provisions may include efforts to increase permitting certainty for new energy projects and provisions to ensure a dedicated portion of benefits accrue to Tribal enterprises, regionally based business, or other communities of interest.

Exhibit 12. Energy Replacement: Capital and O&M Costs

A) Comparison to NWEC Study

Analytic Period	20	years*

Status Quo Costs		
Status Quo Annual Operating Costs	$52	million
Status Quo Total Capital Costs (low estimate)	$654	million
Status Quo Total Capital Costs (high estimate)	$1,600	million

Status Quo Costs - Annualized	**Annualized Capital Costs**	**O&M Annual**	**Total**
Low Capital Estimate	$33 M	$52 M	**$85 M**
High Capital Estimate	$80 M	$52 M	**$132 M**
Median of Low and High Estimates	$56 M	$52 M	**$108 M**

Proposed Investment in LRSD Generation Replacement		
Total Investment	$10	billion
Annualized Investment Amount	$500	million

Replacement Portfolios	**Annualize Capital Costs**	**Annual O&M**	**Total**	**Increase Over Status Quo (median capital costs)**	**Annualized Investment Amount Minus Increase**
NGA	$165 M	$255 M	**$421 M**	$313 M	**$187 M**
NGA Plus	$1,107 M	$84 M	**$1,191 M**	$1,083 M	**($583) M**
Balanced	$183 M	$212 M	**$396 M**	$288 M	**$212 M**
Balanced Plus	$400 M	$63 M	**$464 M**	$356 M	**$144 M**
All Gas	$335 M	$200 M	**$535 M**	$427 M	**$73 M**

B) Comparison to 2020 EIS

	Replacement Portfolios						
	Gas	**Demand Reduction**	**Solar**	**MT Wind**	**Gorge Wind**	**Solar and MT Wind**	**Battery**
Total Annual Increase (per 500 MW, including O&M and capital)	$22 M	$14 M	$27 M	$38 M	$47 M	$33 M	$98 M
Total Increase (500 MW x 7)	$155 M	$97 M	$190 M	$266 M	$328 M	$229 M	$683 M
Annualized Investment Amount Minus Increase	**$345 M**	**$403 M**	**$310 M**	**$234 M**	**$172 M**	**$271 M**	**($183) M**

* This analysis uses a 20-year investment period to align with NWEC's annualized costs.

Sources: NW Energy Coalition, 2018; U.S. Army Corps of Engineers, 2020; BERK, 2021.

RECREATION AND TOURISM

The LSR Basin has many recreation and tourism assets that enhance quality of life for local residents and attract out-of-area residents. While these enhanced quality of life benefits have intrinsic economic value, as noted earlier, the extent of these benefits is beyond the scope of this analysis. Out-of-area visitors who engage in recreation activities bring new money directly into the regional economy, which they spend in restaurants, grocery stores, gas stations, overnight lodging establishments, and on local tourism guides and attractions. Activities include fishing, hunting, birdwatching, boating, swimming, picnicking, hiking, camping, and a variety of other pastimes. Many of these current uses depend on flat water reservoirs and access facilitated by 58 facilities maintained by the U.S. Army Corps of Engineers.

While these are important economic stimulators for the region, it is important to consider the overall scale and health of the sector. The 2020 EIS notes that "regional economic effects associated with… expenditures on recreation in the Basin support 6,480 annual jobs, $265 million in labor income, and $843 million in sales across the recreation study area annually".[37] For context, the report cites the overall size of the regional economy, illustrating that the tourism in the Basin constitutes about 0.2% of total employment, labor income, and sales.

The 2019 ECONorthwest report provides a similar perspective on the Basin's tourism economy, noting that "broader increases in tourism throughout the state have not been captured by Clarkston and Lewiston" and that "significant opportunities for growth exist".[38]

Anticipated Investment Outcomes

The breaching of the dams would trigger a significant transformation of the regional recreation and tourism sectors. Flatwater recreation opportunities would be lost, including water skiing, flatwater fishing, picnicking in facilities established and maintained by the U.S. Army Corps of Engineers, and river boat cruises between Portland and Clarkston. As noted in the 2020 EIS, "With about one-third of the current visitation associated with water-based activities, the loss of this visitation would be large and adverse".[39]

The question is whether new recreation opportunities would offset these losses and whether the region could effectively reorient itself to these new opportunities. The 2020 EIS and the ECONorthwest report are both optimistic. While the ECONorthwest report anticipates substantial additional visitation and economic benefit with breaching of the dams, the EIS is more circumspect, noting that benefits would require substantial investment:

> [A]s the river returns to natural conditions, river-based recreation would increase over time, given that recreational access and infrastructure is developed; the exact long-term beneficial impacts to visitation and social welfare are uncertain, although the losses in reservoir recreation would be offset by increases in river recreation visitors, and may eventually increase to levels and values greater than under the No Action Alternative[40]

The EIS also notes that after adaption of the industry, "there is the potential for an increase in jobs and income for outfitters, boating companies, and other tourism businesses relative to the No Action Alternative".[41]

Our assessment is that a return to a free-flowing river would create significant recreation opportunities:

- **The return to a free-flowing river will create opportunities for rafting, canoeing, kayaking, and other boating.** Sources indicate that there are sections of a restored lower Snake River that could include class I and II rapids.[42] The net economic value of this shift from flatwater recreation to whitewater recreation includes many nuances, including total number of visits and spending per visit, and deserves additional study.

- **Growth of anadromous fish populations would support increases in recreational fishing.** Sport fishing is already a significant contributor to the regional economy, with the Idaho Department of Labor estimating that fishing brings in $8.6 million per month to Nez Perce and Clearwater counties. Closures of steelhead fishing in 2019 negatively impacted surrounding communities, with Idaho Fish and Game estimating that salmon and steelhead anglers spend approximately $350 per trip.[43] The potential economic contributions of fishing are a case study of extremes: while declines in anadromous fish populations would lead to a reduction or elimination of the industry, the return of healthy populations would be a regional economic boon.
- **The establishment of an additional 14,000 acres of recreation lands along the river would generate significant opportunities for hunting, birding, hiking, camping, and other active recreation.** As noted below, $125 million is set aside for recreation infrastructure development to facilitate such activities.

The proposed investment package includes significant investment designed to help private and public sector stakeholders capture the benefits of this potential evolution. The **$425 million Tourism Guarantee** includes:

- $125 million for development of a national recreation area with river access, campgrounds, boat launches, and other facilities managed by the Bureau of Land Management.
- $125 million in tourism promotion resources for Washington and Idaho to communicate the area's new attractions.
- A $75 million sport fishing contingency fund to offset potential temporary declines in fishing immediately following the breach due to dislodged sediment in the waters.
- $50 million for relocation or compensation of affected marinas.

$50 million to compensate owners of motorized boats designed for use on lakes.

Further, recreation and tourism related to fishing and wildlife would be supported by the $7.3 billion focused on salmon and conservation (Exhibit 2), as well as $150 million for Lewiston and Clarkston waterfront redevelopment, $175 million in locally-directed economic development funding for the Tri-Cities and Lewiston-Clarkston areas, and $275 million in a commercial industry fund to eliminate odors and improve water quality around a pulp mill in Lewiston.

KEY FINDING

15. **Regional tourism is a relatively small but important economic sector with significant opportunity for growth. It is reasonable to assume that the industry would benefit from the proposed investment of $425 million directly related to tourism, as well as the $7.3 billion for salmon and conservation, and $175 million for regional economic development. Together, these investments have the potential to energize and strengthen the regional tourism sector.**

Conclusion

The initial assessment above indicates that from a purely economic perspective, the proposed Columbia Basin Fund holds great promise.

- **The expenditure of at least $7.9 billion in the 9-county region (see Exhibit 13) will stimulate significant positive economic impacts, creating an estimated average of 11,000 jobs a year in the Northwest over the 25-year investment period and injecting substantial resources into the regional economy.**
- **Such significant investment can be used to strategically upgrade infrastructure and strengthen the regional economy, making it more broadly prosperous and resilient to future conditions.** By addressing key areas of concern, the package should leave economic sectors of significance stronger than they are now, particularly in the areas of energy generation and tourism.

These direct and long-term economic impacts are summarized by geographic area of interest in Exhibit 13. Particularly when compared with the economic costs and risks associated with continuation of the status quo, we recommend that the proposed investment package be considered a unique opportunity for largescale regionally directed investment in infrastructure and economic resiliency. The investment package has the potential to bring significant economic benefit to the residents, employers, and employees of the 9-county region and the broader Northwest.

It is important to acknowledge, however, that this transformation will cause economic disruption and loss to some user groups, communities, and other stakeholders. **As soon as a final legislative and investment package is identified and adopted, further study will be needed to fully understand these risks, and further engagement with affected stakeholders will be needed to strategize how resources and policies can mitigate risks, minimize harms, and maximize long-term economic well-being and resiliency.** We recommend that the next phase of analysis and discussion include:

- Conducting a more detailed economic and fiscal impact analysis to calculate indirect and induced impacts of the proposed investment by sector and sub-geography.
- A comprehensive assessment of the long-term economic outcomes in the agriculture, energy, and recreation and tourism sectors, as well as individual communities in the affected area.
- Engaging affected stakeholders directly in shaping this analysis, reviewing the results, and identifying effective investment strategies and supporting policies such as local sourcing requirements, permitting certainty for new energy projects, and other measures to ensure that the investment does as much as possible to create well-paying jobs and a more competitive and resilient regional economy.

SUMMARY OF KEY FINDINGS

Proposed Investment

1. Over $30 billion of the proposed investment (93% of the funds) would be allocated to supporting the region's economic transition through investment in the energy system, transportation infrastructure, fish and wildlife, water quality, and more. Approximately 7% of the proposed package would be expended on breaching the four Lower Snake River dams.
2. $2.2 billion, or about 7% of the total proposed package, is designated for Tribal communities, including the $125 million LSR Cultural Resource Protection Fund and $2.1 billion for the Northwest State and Tribal Fish and Wildlife Council.
3. Approximately $20 billion (59% in BERK's expenditure scenario) would be spent before the dams are breached to help the region prepare for this shift.
4. Slightly more than $21 billion (63% in BERK's expenditure scenario) is likely to be spent on infrastructure improvement and construction.
5. At least $7.9 billion, or 24% of the total investment, would likely be spent in the 9 counties closest to the LSR. This includes about $1.3 billion in funding for projects in Lewiston-Clarkston, $1.9 billion in the Tri-Cities, and $4.7 billion in the remainder of the 9-county region around the LSR. Beyond these investments directed at these named geographies, significant additional funding tied to energy replacement and habitat restoration may also be expended in the 9-county region.

Economic Impact

6. The approximately $21.1 billion to be invested in infrastructure and physical improvements will have significant positive economic impacts, generating jobs and stimulating spending not only in the construction and professional services sectors, but also indirectly in support industries in the supply chain such as suppliers, surveyors, and planners, as well as in household services supporting local employees. The remaining $12.4 billion spent over time on planning and design, operations, and other services will have additional positive impacts on the regional economy, though this may be subject to relatively greater leakage. Policies and investment strategies can be put in place to retain as much of these benefits as possible in the nine counties most directly affected by breaching of the dams, as well as the broader Northwest region.
7. Spending during Phases 1 and 2 will support a total average of more than 20,000 jobs each year across the Northwest, primarily in Washington state but with additional jobs impacts in Idaho, Oregon, and Montana. These jobs impacts include workers directly employed in the building trades, at civil engineering and heavy construction firms, and various supporting organizations and services. Additional jobs will be supported by business supply chain transactions and household expenditures. Throughout the entire duration of the project (all four phases, including ramped down spending in Phases 3 and 4), an average of nearly 11,000 jobs will be supported directly and through multiplier effects each year
8. Local and state net fiscal impacts are likely to be positive given increased tax revenues associated with sales tax on construction and other one-time revenues. Shifts to the ongoing cost of providing

services are not anticipated to be significant, with additional study warranted for jurisdictions likely to see significant changes in population, employment, visitation, or transportation patterns.

Agriculture Sector

9. The $3.5 billion in dedicated funding for agricultural transport mitigation and improvements is more than double the highest previously identified estimate of the investment needed to make agricultural producers whole.

10. The $1.5B flexible transportation fund for grain producers exceeds all previous estimates of the increased shipping costs under a dam breach scenario, indicating producers will likely face lower shipping costs under the investment package.

11. The $750 million investment in irrigation infrastructure exceeds the highest previously identified estimate of the investment needed to fully mitigate irrigation impacts from dam breach by 10%.

Energy Sector

12. The largest component of the investment package is devoted to energy, with $16 billion allocated to replacing capacity and strengthening the grid, as well as $1.25 billion to create the new Snake River Center for Advanced Energy Storage.

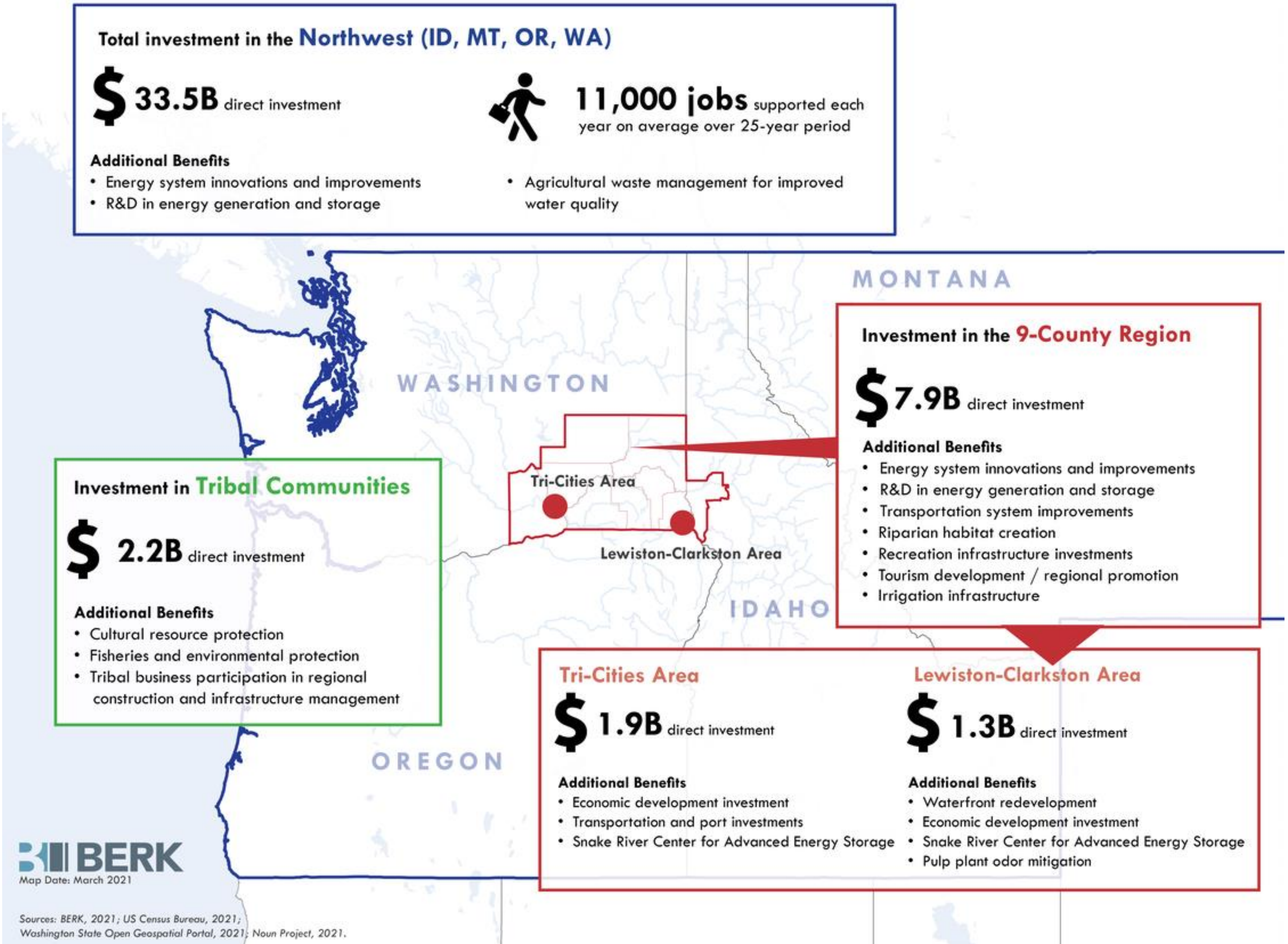
13. The proposed $10 billion will help to mitigate the impacts to ratepayers associated with the capitalized costs of building replacement capacity. As this amount could exceed the costs associated with developing alternative energy capacity, this investment also represents a potential opportunity to augment capacity beyond simply replacing the lost generation from the four dams.

14. The proposed investment has significant potential to produce additional public goods, including regional economic stimulus and employment; improved stability of the grid; and enhanced regional innovation, research, and development.

Recreation and Tourism

15. Regional tourism is a relatively small but important economic sector with significant opportunity for growth. It is reasonable to assume that the industry would benefit from the proposed investment of $425 million directly related to tourism, as well as the $7.3 billion for salmon and conservation, and $175 million for regional economic development. Together, these investments have the potential to energize and strengthen the regional tourism sector.

Exhibit 13. Distribution of Funding, Summary



Appendix A: Summary of Investments and Key Assumptions

The following two exhibits summarize key aspects of the proposed investment package and BERK's illustrative investment scenario that was used to determine likely direct expenditures by time, geography, and type of spend, as well as corresponding indirect and induced economic impacts.

Exhibit A-1. Summary of Data and Assumptions for each Proposed Investment.

Investments			Expenditure		Allocation by Phase				Expenditure Type			Expenditure Location (State)			
Category	Investment	Investment Location	Total	% of Total	Preparing & Implementing Key Investments: 2022-2029	Transitioning: 2030-2031	Adapting: 2032-2035	Ongoing 2036-2046	Planning and Design	Infrastructure and Construction	Operations	WA	ID	OR	MT
A.	**Breaching Dams**		**$2,275,000,000**	**7%**											
	1. Removing berms and sediments														
	a. Lower Granite	9-county region	$400,000,000		10%	80%	10%	0%	15%	73%	12%	100%	0%	0%	0%
	b. Little Goose	9-county region	$350,000,000		10%	80%	10%	0%	15%	73%	12%	100%	0%	0%	0%
	c. Lower Monumental	9-county region	$350,000,000		10%	80%	10%	0%	15%	73%	12%	100%	0%	0%	0%
	d. Ice Harbor	9-county region	$300,000,000		10%	80%	10%	0%	15%	73%	12%	100%	0%	0%	0%
	2. Sediment Mitigation Fund	9-county region	$400,000,000		0%	0%	100%	0%	15%	0%	85%	100%	0%	0%	0%
	3. Lower Snake River Corridor Restoration Fund	9-county region	$50,000,000		10%	10%	80%	0%	30%	0%	71%	90%	10%	0%	0%
	4. Lower Snake River Cultural Resource Protection Fund	9-county region	$125,000,000		10%	10%	80%	0%	30%	0%	71%	95%	5%	0%	0%
	5. LSR Corridor Road and Rail (WA) Study and Mitigation	9-county region	$300,000,000		80%	10%	10%	0%	15%	85%	0%	100%	0%	0%	0%
B.	**Energy System Investment**		**$16,000,000,000**	**48%**											
	6. LSR Dam Lost Generation	Washington, Idaho, Oregon, Montana	$10,000,000,000		65%	15%	15%	5%	20%	78%	2%	67%	3%	20%	10%
	7. Salmon Spill-BPA Power Replacement	Washington, Idaho, Oregon, Montana	$4,000,000,000		65%	15%	15%	5%	20%	78%	2%	50%	10%	30%	10%
	8. NW Grid Resiliency and Optimization	Washington, Idaho, Oregon, Montana	$2,000,000,000		65%	15%	15%	5%	20%	78%	2%	50%	10%	30%	10%
C.	**Columbia and Snake River Dams Certainty**		**$1,000,000,000**	**3%**											
	9. 35 Year Hydro License Extensions		$0		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	10. 35-Year Dam Litigation Moratorium		$0		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	11. Dam Mitigation and Indemnification Program: Incentives for voluntary removal/mitigation	Washington, Idaho, Oregon	$500,000,000		57%	14%	29%	0%	10%	85%	5%	40%	20%	40%	0%
	12. Dam Mitigation and Indemnification Program: Dam removal indemnification fund	Washington, Idaho, Oregon	$500,000,000		57%	14%	29%	0%	10%	85%	5%	40%	20%	40%	0%
D.	**Water Quality**		**$3,000,000,000**	**9%**											
	13. Watershed Partnerships														
	a. Snake River Basin	Idaho	$700,000,000		32%	8%	16%	44%	7%	0%	93%	0%	100%	0%	0%
	b. Willamette Basin	Oregon	$300,000,000		32%	8%	16%	44%	7%	0%	93%	0%	0%	100%	0%
	c. Columbia Basin	Washington	$800,000,000		32%	8%	16%	44%	7%	0%	93%	100%	0%	0%	0%
	d. Puget Sound Watershed	Washington	$600,000,000		32%	8%	16%	44%	7%	0%	93%	100%	0%	0%	0%
	e. Washington Coastal Watershed	Washington	$125,000,000		32%	8%	16%	44%	7%	0%	93%	100%	0%	0%	0%
	f. Oregon Coastal Watershed	Oregon	$175,000,000		32%	8%	16%	44%	7%	0%	93%	0%	0%	100%	0%
	g. Montana Watershed	Montana	$300,000,000		32%	8%	16%	44%	7%	0%	93%	0%	0%	0%	100%
E.	**Agricultural Waste Management**		**$1,700,000,000**	**5%**											
	14. University Grants														
	a. University of Idaho	Idaho	$100,000,000		57%	14%	29%	0%	0%	0%	100%	0%	100%	0%	0%
	b. Oregon State University	Oregon	$100,000,000		57%	14%	29%	0%	0%	0%	100%	0%	0%	100%	0%
	c. Washington State University	9-county region	$100,000,000		57%	14%	29%	0%	0%	0%	100%	100%	0%	0%	0%
	d. Montana State University	Montana	$100,000,000		57%	14%	29%	0%	0%	0%	100%	0%	0%	0%	100%
	15. Columbia, Snake and Willamette Basins Animal Waste Mgmt. Incentives														
	a. Columbia Basin, Washington	Washington	$400,000,000		57%	14%	29%	0%	26%	62%	12%	100%	0%	0%	0%
	b. Willamette Basin, Oregon	Oregon	$400,000,000		57%	14%	29%	0%	26%	62%	12%	0%	0%	100%	0%
	c. Snake River Basin, Idaho	Idaho	$400,000,000		57%	14%	29%	0%	26%	62%	12%	0%	100%	0%	0%
	d. Montana	Montana	$100,000,000		57%	14%	29%	0%	26%	62%	12%	0%	0%	0%	100%
F.	**Community Guarantee**		**$1,575,000,000**	**5%**											
	16. Lewiston-Clarkston Waterfront Restoration	Lewiston-Clarkston	$150,000,000		10%	10%	80%	0%	25%	75%	0%	50%	50%	0%	0%
	17. Snake River Center for Advanced Energy Storage											0%	0%	0%	0%
	a. Siting, Development, and Construction	Lewiston-Clarkston	$250,000,000		80%	20%	0%	0%	20%	80%	0%	20%	80%	0%	0%
	b. R&D and University Grants	Lewiston-Clarkston, Tri-Cities	$350,000,000		57%	14%	29%	0%	0%	0%	100%	84%	16%	0%	0%
	c. Tech Partnership Grants	Lewiston-Clarkston, Tri-Cities	$500,000,000		57%	14%	29%	0%	0%	0%	100%	84%	16%	0%	0%
	d. Infrastructure Development Fund	Lewiston-Clarkston	$150,000,000		57%	14%	29%	0%	15%	80%	5%	20%	80%	0%	0%
	18. Economic Development Funds											0%	0%	0%	0%
	a. Economic Development Funds: Tri Cities Area	Tri-Cities	$75,000,000		20%	25%	55%	0%	2%	67%	31%	100%	0%	0%	0%
	b. Economic Development Funds: Lewiston Clarkston Area	Lewiston-Clarkston	$100,000,000		20%	25%	55%	0%	2%	67%	31%	20%	80%	0%	0%
G.	**Tourism Guarantee**		**$425,000,000**	**1%**											
	19. Lower Snake River Recreation Fund BLM/State of WA	9-county region	$125,000,000		10%	60%	30%	0%	18%	79%	3%	100%	0%	0%	0%
	20. Lower Snake River Tourism Promotion State of Washington (Tri-Cities/Spokane Area)	Washington	$75,000,000		0%	0%	10%	90%	5%	0%	95%	100%	0%	0%	0%
	21. Lower Snake River Tourism Promotion State of Idaho (Lewiston-Clarkston Area)	Idaho	$50,000,000		0%	0%	10%	90%	5%	0%	95%	0%	100%	0%	0%
	22. Impacted Sportfishing Contingency Fund	9-county region	$75,000,000		0%	0%	100%	0%	2%	0%	98%	90%	10%	0%	0%
	23. Marina Relocation Fund	Lewiston-Clarkston, Tri-Cities	$50,000,000		10%	10%	80%	0%	20%	80%	0%	47%	53%	0%	0%
	24. Recreational Boating Compensation Fund Lewiston-Clarkston Area	Lewiston-Clarkston	$50,000,000		0%	0%	100%	0%	0%	0%	100%	20%	80%	0%	0%
H.	**Agricultural Irrigation Guarantee**		**$750,000,000**	**2%**											
	25. Lower Snake River Corridor Irrigation Mitigation	Lewiston-Clarkston, Tri-Cities, 9-county region	$750,000,000		80%	0%	20%	0%	12%	66%	22%	89%	11%	0%	0%
I.	**Agricultural Transportation Guarantee**		**$4,200,000,000**	**13%**											
	26. Reconfiguring/Adjusting Lower Snake River Corridor Grain Transportation	9-county region	$1,500,000,000		57%	14%	29%	0%	14%	64%	21%	90%	10%	0%	0%
	27. LSR Corridor Agricultural Handler Reconfiguration/Adjustment	9-county region	$300,000,000		80%	20%	0%	0%	20%	80%	0%	90%	10%	0%	0%
	28. LSR Corridor Ports Including Lewiston-Clarkston-Wilma Reconfiguration/Adjustment	9-county region	$200,000,000		80%	20%	0%	0%	20%	80%	0%	80%	20%	0%	0%
	29. Columbia River Transportation Guarantee											0%	0%	0%	0%
	a. Barge Transport Expansion- Tri-Cities/Mid-Columbia Basin Intermodal Transportation Hub	Tri-Cities	$600,000,000		100%	0%	0%	0%	20%	80%	0%	100%	0%	0%	0%
	b. SR Corridor Waterway Shippers (Bargers/Riverboats)Barging Reconfiguration/Economic Adjustm	Washington, Oregon	$1,000,000,000		100%	0%	0%	0%	2%	0%	98%	50%	0%	50%	0%
	c. Lower Columbia River Lock Rehab/Backlog Maintenance/Dredging/Maritime Restoration	Washington, Oregon	$600,000,000		57%	14%	29%	0%	10%	90%	0%	50%	0%	50%	0%
J.	**Industrial Guarantee**		**$275,000,000**	**1%**											
	30. Commercial Industry Fund: Lewiston-Clarkston Industrial Pipe Re-engineering and Odor Abatement	Lewiston-Clarkston	$275,000,000		100%	0%	0%	0%	64%	36%	0%	20%	80%	0%	0%
K.	**Northwest Power Council Energy Role Expanded**		**$0**	**0%**											
	31. No associated expenditure.		$0												
L.	**Northwest State and Tribal Fish and Wildlife Council**		**$2,300,000,000**	**7%**											
	32. Block Grant States (BPA-funded, so not included in cost of package)	Washington, Idaho, Oregon, Montana	*$3,075,000,000*									25%	25%	25%	25%
	33. Block Grant Tribes (BPA-funded, so not included in cost of package)	Washington, Idaho, Oregon, Montana	*$5,375,000,000*									25%	25%	25%	25%
	34. Joint Fish Council Funding for Operations (BPA-funded, so not included in cost of package)	Washington, Idaho, Oregon, Montana	*$6,550,000,000*									25%	25%	25%	25%
	35. Priority Salmon Fisheries Infrastructure Backlog	Washington, Idaho, Oregon, Montana	$700,000,000		57%	14%	29%	0%	15%	85%	0%	35%	35%	20%	10%
	36. Upper Snake and Columbia Basin Restored Non-Protected Salmon Runs (NoESA Protections)	Washington, Idaho	$700,000,000		80%	20%	0%	0%	15%	85%	0%	50%	50%	0%	0%
	37. Salmon Conservation Corps	Washington, Idaho, Oregon, Montana	$75,000,000		57%	14%	29%	0%	15%	85%	0%	35%	35%	20%	10%
	38. Hells Canyon Sturgeon Protection	Idaho	$400,000,000		57%	14%	29%	0%	15%	85%	0%	0%	100%	0%	0%
	39. Yakima Basin Integrated Plan	Washington	$225,000,000		57%	14%	29%	0%	15%	85%	0%	100%	0%	0%	0%
	40. Lamprey Passage	Washington, Oregon	$200,000,000		57%	14%	29%	0%	15%	85%	0%	50%	0%	50%	0%
Total Investment Package (does not include items 31-33)			**$33,500,000,000**	**100%**											

Sources: The Northwest in Transition (Representative Simpson website: websiteslides2.4.pdf), 2021; BERK, 2021.

Exhibit A-2. Summary of Investment by Benefit Area.

Category	Investment	Salmon / Conservation	Tribes	States	Communities	Recreation	Transportation	Agriculture	Energy	BPA
A.	**Breaching Dams**									
	1. Removing berms and sediments									
	a. Lower Granite									
	b. Little Goose									
	c. Lower Monumental									
	d. Ice Harbor									
	2. Sediment Mitigation Fund	✓								
	3. Lower Snake River Corridor Restoration Fund									
	4. Lower Snake River Cultural Resource Protection Fund		✓							
	5. LSR Corridor Road and Rail (WA) Study and Mitigation						✓			
B.	**Energy System Investment**									
	6. LSR Dam Lost Generation								✓	✓
	7. Salmon Spill-BPA Power Replacement								✓	✓
	8. NW Grid Resiliency and Optimization			✓					✓	✓
C.	**Columbia and Snake River Dams Certainty**									
	9. 35 Year Hydro License Extensions									
	10. 35-Year Dam Litigation Moratorium									
	11. Dam Mitigation and Indemnification Program: Incentives for voluntary removal/mitigation			✓					✓	
	12. Dam Mitigation and Indemnification Program: Dam removal indemnification fund			✓					✓	
D.	**Water Quality**									
	13. Watershed Partnerships									
	a. Snake River Basin	✓		✓				✓		
	b. Willamette Basin	✓		✓				✓		
	c. Columbia Basin	✓		✓				✓		
	d. Puget Sound Watershed	✓		✓				✓		
	e. Washington Coastal Watershed	✓		✓				✓		
	f. Oregon Coastal Watershed	✓		✓				✓		
	g. Montana Watershed	✓		✓				✓		
E.	**Agricultural Waste Management**									
	14. University Grants									
	a. University of Idaho	✓		✓				✓		
	b. Oregon State University	✓		✓				✓		
	c. Washington State University	✓		✓				✓		
	d. Montana State University	✓		✓				✓		
	15. Columbia, Snake and Willamette Basins Animal Waste Mgmt. Incentives									
	a. Columbia Basin, Washington	✓		✓				✓		
	b. Willamette Basin, Oregon	✓		✓				✓		
	c. Snake River Basin, Idaho	✓		✓				✓		
	d. Montana									
F.	**Community Guarantee**									
	16. Lewiston-Clarkston Waterfront Restoration				✓					
	17. Snake River Center for Advanced Energy Storage (SRCAES)									
	a. Siting, Development, and Construction			✓	✓					
	b. R&D and University Grants			✓	✓					
	c. Tech Partnership Grants			✓	✓					
	d. Infrastructure Development Fund			✓	✓					
	18. Economic Development Funds									
	a. Economic Development Funds: Tri Cities Area				✓					
	b. Economic Development Funds: Lewiston Clarkston Area				✓					
G.	**Tourism Guarantee**									
	19. Lower Snake River Recreation Fund BLM/State of WA					✓				
	20. Lower Snake River Tourism Promotion State of Washington (Tri-Cities/Spokane Area)				✓	✓				
	21. Lower Snake River Tourism Promotion State of Idaho (Lewiston-Clarkston Area)				✓	✓				
	22. Impacted Sportfishing Contingency Fund					✓				
	23. Marina Relocation Fund					✓				
	24. Recreational Boating Compensation Fund Lewiston-Clarkston Area					✓				
H.	**Agricultural Irrigation Guarantee**									
	25. Lower Snake River Corridor Irrigation Mitigation							✓		
I.	**Agricultural Transportation Guarantee**									
	26. Reconfiguring/Adjusting Lower Snake River Corridor Grain Transportation						✓	✓		
	27. LSR Corridor Agricultural Handler Reconfiguration/Adjustment						✓	✓		
	28. LSR Corridor Ports Including Lewiston-Clarkston-Wilma Reconfiguration/Adjustment				✓		✓			
	29. Columbia River Transportation Guarantee									
	a. Barge Transport Expansion- Tri-Cities/Mid-Columbia Basin Intermodal Transportation Hub				✓		✓			
	b. SR Corridor Waterway Shippers (Bargers/Riverboats)Barging Reconfiguration/Economic Adjustm						✓			
	c. Lower Columbia River Lock Rehab/Backlog Maintenance/Dredging/Maritime Restoration						✓			
J.	**Industrial Guarantee**									
	30. Commercial Industry Fund: Lewiston-Clarkston Industrial Pipe Re-engineering and Odor Abatement				✓					
K.	**Northwest Power Council Energy Role Expanded**									
	31. No associated expenditure.									
L.	**Northwest State and Tribal Fish and Wildlife Council**									
	32. Block Grant States (BPA-funded, so not included in cost of package)									
	33. Block Grant Tribes (BPA-funded, so not included in cost of package)									
	34. Joint Fish Council Funding for Operations (BPA-funded, so not included in cost of package)									
	35. Priority Salmon Fisheries Infrastructure Backlog	✓	✓	✓						
	36. Upper Snake and Columbia Basin Restored Non-Protected Salmon Runs (NoESA Protections)	✓	✓	✓						
	37. Salmon Conservation Corps	✓	✓	✓						
	38. Hells Canyon Sturgeon Protection	✓	✓	✓						
	39. Yakima Basin Integrated Plan	✓								
	40. Lamprey Passage	✓	✓	✓						

Sources: The Northwest in Transition (Representative Simpson website: websiteslides2.4.pdf), 2021; BERK, 2021.

Appendix B. Methodology for Economic Impact Analysis

Economic impacts are measured in jobs, income, and business revenues, or "output." These impacts include the following:

- **Direct impacts**. Employment, income, and output tied directly to the activity being modeled, or what is also referred to as "final demand." All subsequent impacts are traced to direct activities, in this case, the infusion of funds and spending from federal sources into the Northwest for infrastructure construction, dam breaching, and related activities.
- **Indirect impacts**. Additional jobs, income, and output supported through upstream, business-to-business transactions. E.g., the purchase of materials and other inputs necessary for completion of a Columbia Basin Fund project by an engineering firm.
- **Induced impacts**. Additional impacts supported by the spending of income earned by direct and indirect workers on household goods and services. E.g., purchases of groceries, entertainment, dining out, household appliances, and retail purchases.

We first assumed that 75% of contracts by value will be awarded to businesses and organizations in the Northwest, with the remainder going to recipients in other parts of the country and world. We then computed average contract spending per year for each phase, state, and expenditure type (infrastructure and construction, planning and design, and operations).

To model the economic impacts of this spending, we employed an input-output modeling approach. There is no readily constructed economic impact model that is specific to the Northwest as a whole. Thus, to estimate impacts, we used existing multipliers for Washington state and national multipliers with adjustments for the remaining three states. Industry employment multipliers for Washington state came from the Washington State Input-Output (I-O) Model, published by the Washington State Office of Financial Management.[44] U.S. national industry economic multipliers are published by the Economic Policy Institute (EPI), based on U.S. Bureau of Economic Analysis input-output tables and employment and wage data from the U.S. Bureau of Labor Statistics.[45]

Estimated program spending retained in the Northwest and occurring in Washington state was redistributed by sectors delineated in the Washington State I-O Model. For example, project spending on "infrastructure and construction" was allocated in the model to "Highway, Street and Bridge Construction" (I-O sector 9), which includes heavy construction. Multipliers were then applied to arrive at direct and total employment impacts.

For remaining spending (in the other three states), we used national multipliers published by EPI to estimate direct and total jobs impacts. A 50% reduction in indirect and induced impacts was then applied to these preliminary estimates to account for potential leakage (e.g., the household purchase of goods and services from outside the Northwest), whereby spillover impacts would accrue to these other regions. Washington state and remaining state impacts were then summed to arrive at a regional total impact estimate.

A MORE RIGOROUS AND DETAILED APPROACH TO ESTIMATE IMPACTS

The above analysis is suitable for a high-level, rapid assessment of impacts. However, the scale of this program should lead to a much more detailed and rigorous approach as part of its implementation. Such an analysis would involve development of an economic impact model specific to the Northwest, as well as state and sub-regional breakouts to allow policymakers to assess the potential economic impacts at smaller geographies, including for the counties in Washington and Idaho directly impacted by the investment package, dam breaching, and related work.

Elements of this more rigorous approach would include:

- Creating a national-level input-output model, using input-output tables, labor income, and personal consumption expenditures published by the U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics.
- Using location quotients and other instruments to refine the model down to the 4-state Northwest region, so as to capture the unique dynamics of the regional economy and leakage effects from spending outside the region.
- Estimating final demand for the Northwest region, including federal, state, and local government purchases, exports, investment, and household spending.
- Further disaggregating the model down to subregional groupings, including the counties in proximity to the Lower Snake River most directly affected by the investment package and dam breaching program.
- Integrating the Washington State Input-Output Model so as to capture multipliers generated from this state-level custom-developed analytic tool for Washington state activities.
- Refining estimates of spending by region, direct employment, and associated income.

References

[1] ECONorthwest, 2019. *Lower Snake River Dams: Economic Tradeoffs of Removal.* https://static1.squarespace.com/static/597fb96acd39c34098e8d423/t/5d41bbf522405f0001c67068/1564589261882/LSRD_Economic_Tradeoffs_Report.pdf.

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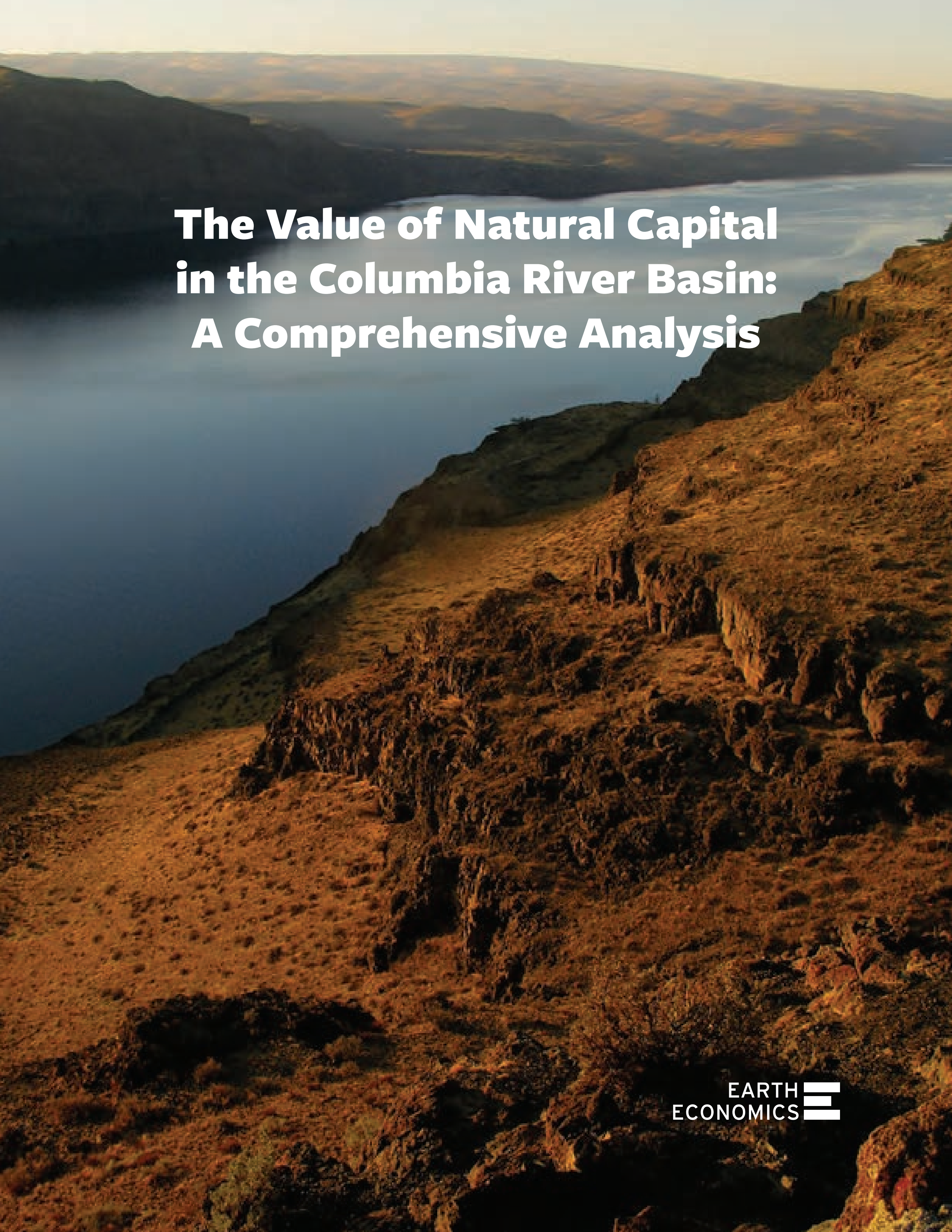
EXHIBIT E
THE VALUE OF NATURAL CAPITAL IN THE COLUMBIA RIVER BASIN: A COMPREHENSIVE ANALYSIS
EARTH ECONOMICS
LOLA FLORES ET AL. (2017)

Exhibit Coversheet Only. [Paginated separately.]

The attached document, The Value of Natural Capital in the Columbia River Basin: A Comprehensive Analysis, is provided to the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy, Climate, and Grid Security for the Hearing Record, dated January 30, 2024 in response to a question from the Honorable Frank Pallone, Jr.



The Value of Natural Capital in the Columbia River Basin: A Comprehensive Analysis

EARTH ECONOMICS

Partners

Earth Economics

Report Version 1.5

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Errata: This report has been corrected to address copyediting errors which may confuse the reader. A summary of these corrections may be found on page 155.

Cover Photo: Columbia Plateau, Source: Brian Gruber

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Acronyms and Abbreviations

3Ea-80	Modernized Columbia River Treaty scenario, official 80-year modified flow
AA	Action Agencies
AF	Acre-feet
aMW	Average Megawatt
AOP	Assured Operating Plan
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BTM	Benefit Transfer Methodology
CBO	Congressional Budget Office
cfs	Cubic feet per second
CIS	CRITFC Information System
CO_2	Carbon Dioxide
COMPASS	Comprehensive Passive Model
CRB	Columbia River Basin
CREST	Columbia River Estuary Study Taskforce
CRITFC	Columbia River Inter-Tribal Fish Commission
CRT	Columbia River Treaty
CSS	Comparative Survival Study
DFO	Department of Fisheries and Oceans
EbF	Ecosystem-based Functions
EE	Earth Economics
EMS	Energy Management System
ES	Ecosystem Services
ESA	Endangered Species Act
ESV	Ecosystem Services Valuation
EVT	Ecosystem Valuation Toolkit
FCRPS	Federal Columbia River Power System
FCRPS BiOp	Federal Columbia River Power System Biological Opinion
FEMA	Federal Emergency Management Agency
FLISR	Fault location, isolation, and service restoration
FWCP	Fish and Wildlife Compensation Program
GIS	Geographical Information System

GWH	Gigawatt hour
HVAC	Heating, Ventilating and Air Conditioning
Kcfs	Thousands of cubic feet per second
kWh	Kilowatt-Hour
LCA	Life Cycle Assessment
LCI	Land Cover Institute
MEA	Millennium Ecosystem Assessment
MW	Megawatt
MWh	Megawatt-hour
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
O&M	Operation and Maintenance
OMB	Office of Management and Budget
PEB	Permanent Engineering Board
PNCA	Pacific Northwest Coordination Agreement
RCC-80	Reservoir Current Conditions-80 years
SEDAC	Socioeconomic Data and Applications Center
UCUT	Upper Columbia United Tribes
USACE	U.S. Army Corp of Engineers
USBR	U.S. Bureau of Reclamation
USD	U.S. Dollars
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WRC	U.S. Water Resource Council
WRDA	Water Resources Development Act
WTP	Willingness-to-Pay
WY	Water Year

Executive Summary

The Columbia River Basin (CRB) is globally recognized for its abundant watersheds and rivers that founded unique natural assets and capital including immense forests and other native vegetation, the largest salmon runs in the world and diverse and abundant wildlife. These assets have supported native peoples for millennia. Although these resources still have substantial existence value, they have been seriously degraded by development of built capital such as dams. When assets, whether built or natural, are not managed sustainably, economic loss occurs through resource degradation. In the CRB, past and current economic practices have developed and operated built capital assets while undervaluing, or entirely disregarding, natural capital assets. Yet, natural capital assets provide the region with essential goods and services such as sustainable food, jobs, recreation, clean water, and carbon sequestration, among many others.

THIS REPORT ILLUSTRATES AND DOCUMENTS THE IMMENSE ECONOMIC VALUE OF THE COLUMBIA RIVER BASIN'S NATURAL ASSETS AND PROVIDES CLEAR EVIDENCE OF THE INCREASED VALUE THAT CAN BE GAINED BY ADDRESSING ECOSYSTEM-BASED FUNCTION IN A MODERNIZED CRB RIVER MANAGEMENT REGIME. Thus, this report substantiates that changes in extant river management can enhance sustainable natural capital wealth for present and future generations.

The following economic analysis provides robust present and future assessments of the CRB's economic value by comparing two modeled river management scenarios: current conditions (RCC-80), and conditions under a modernized Columbia River Treaty ecosystem-based function (3Ea). The RCC-80 scenario identifies the value of present CRB river operations. **THE 3EA SCENARIO FOCUSES ON THE POTENTIAL FUTURE VALUE OF THE CRB IF RIVER OPERATIONS WERE TO BE MODIFIED TO ADOPT AN ECOSYSTEM-BASED FUNCTION PARADIGM FOR MANAGEMENT DECISIONS.**

The 3Ea scenario would augment spring and early summer river flows with reservoir storage, thereby also stabilizing reservoirs, providing for restoration of fish populations to historical areas, and increasing the sustainable, regional economic value of the basin. This is evident despite reductions in the present built capital value from hydroelectricity generation. Although hydrogeneration would be reduced by $69 million (from its present annual value of almost $3 billion), the **3EA SCENARIO WOULD INCREASE THE TOTAL CRB ECONOMIC VALUE BY APPROXIMATELY $1.5 BILLION ANNUALLY.**[a]

Furthermore, reduced hydrogeneration appears to be the only benefit that declines under the 3Ea scenario, and this loss is mitigated by numerous other enhanced benefits. For example, non-tribal commercial fishery value would increase by $7

a The values presented here are rounded to the nearest million, and could be slightly different than the values presented in the report tables below.

million per year. General recreation is expected to experience a slight increase of $39,000, while angling value would increase by $46 million. The 3Ea scenario, which provides additional valuation of increased spring and early summer water flow, would value at $389 million, and nutrient enhancement could reach an estimated value of $31 million. The flood risk management, agriculture and navigation values for both RCC-80 and 3Ea remained the same.

With the existence value increasing by $1 billion, the 3Ea scenario represents the largest annual asset increase in the analysis. Thus, enhanced regional benefits from the ecosystem scenario could produce positive and sustainable values for the regional economy and environment. This value is very conservative and would likely be substantially increased. For example, numerous other populations of fish and wildlife benefits, not quantified in this analysis, would benefit from a modernized river management scenario. **IF THE COLUMBIA RIVER BASIN WERE TO SEE EVEN A 10 PERCENT INCREASE IN ECOSYSTEM-BASED FUNCTION, IT COULD ADD $19 BILLION TO THE TOTAL NATURAL CAPITAL VALUE.**

The CRB's profound cultural value is expressed qualitatively in this report. The cultural value description focused on the relationships with the landscape and rivers and the socio-economic losses that tribes and others continue to suffer due to regional actions that largely promote non-tribal economic values. Loss of natural, sustainable capital (i.e. salmon and other tribal first foods) has impoverished tribal people, causing higher rates of death, disease, and poverty than among non-native communities. Monetary valuation of these impacts and cultural and spiritual losses are difficult to quantify, but are much underappreciated.

The analyses in this report highlight the extensive value that the CRB currently provides and show the potential to increase sustainable economic values of non-tribal commercial fisheries, recreation, existence, nutrient enhancement, and ecosystem services by modifying management regimes to engage in restoration activities and enhance conservation policies.

As Columbia River Treaty assessments continue and U.S. domestic decision-making processes ensue, it is essential that sustainable natural capital value be given serious consideration in actions that affect river management. Considering the findings in this report, an informed course of action should carefully examine pathways to promote sustainable ecosystem function and increased ecosystem health. The economic values provided in this report support and advocate for the inclusion of ecosystem-based function into the Treaty and other regional processes, and they should help guide restoration and conservation efforts throughout the basin.

Key Points

1. **The Columbia River Basin holds immense natural capital value.**
2. **3Ea would modernize the Columbia River Treaty in a way that recognizes the Basin's natural capital value.**
3. **A 10 percent increase in ecosystem-based function would add $19 billion to the Basin's natural capital value.**

Report Overview

This report evaluates and compares different resources, including ecosystem services, non-tribal commercial fisheries, existence values, hydropower, recreation, navigation, and agriculture under two scenarios (RCC-80 and 3Ea). Furthermore, nutrient enhancement and increased water flow are also valued for 3Ea. In addition to the basin's monetary value, this report also presents a cultural analysis to demonstrate the CRB's integral connections to tribal culture. The report is outlined as follows:

CHAPTER 1: INTRODUCTION. This chapter introduces the goal of this report and the study area, briefly describing the natural characteristics of the Columbia River Basin. The report focuses on defining basin-wide natural capital, particularly as it relates to tribal socio-economics including tribal first foods. The chapter also outlines a brief history of the Columbia River Basin, highlighting some of the major threats to ecological health. Finally, the chapter describes current river management under the Columbia River Treaty.

CHAPTER 2: ECOSYSTEM FUNCTIONS OF THE COLUMBIA RIVER BASIN. Chapter 2 defines three key concepts that appear throughout the report: ecosystem-based function, ecosystem services, and natural capital. This chapter also presents the value of ecosystem services provided by different land and water cover types present throughout the Columbia River Basin, including a description of the methods used to assess this value.

CHAPTER 3: THE CURRENT VALUE OF THE COLUMBIA RIVER BASIN. This chapter presents our analysis of the CRB's resources under the first scenario, current conditions (RCC-80). The analysis values non-tribal commercial fisheries, existence, hydropower, flood risk, recreation, navigation and agriculture currently present in the basin.

CHAPTER 4: THE MODERNIZED VALUE OF THE COLUMBIA RIVER BASIN. Chapter 4 calculates the potential increase in natural capital value under a modernized management regime scenario (3Ea). We assess the benefits provided under a modernized scenario for non-tribal commercial fisheries, existence, hydropower, recreation, nutrient enhancement, and ecosystem services. Total economic values for each of the resources listed above are presented at the end of this chapter.

CHAPTER 5: THE CULTURAL VALUE OF THE COLUMBIA RIVER BASIN. Because tribes and other residents value the Columbia River Basin for far more than monetary value alone, this chapter analyzes the cultural value of the basin. The chapter focuses on qualitatively describing cultural and spiritual components, including links to first foods, tribal fishing, and tribal resources.

CHAPTER 6: DAM OPERATIONS AND MAINTENANCE COSTS. This chapter summarizes some of the costs associated with hydropower generation and flood risk management.

CHAPTER 7: CONCLUSION. Chapter 7 discusses the results of our analyses within the context of the Treaty. This chapter also includes recommended next steps and further research to promote the inclusion of ecosystem-based function into decision making and secure the benefits of modernized river management under an inclusive, updated treaty.

Chapter One

Introduction

"Evidence says we've been here for 10,000 plus years. Our elders say we've been here since time immemorial."

– Quanah Matheson – Coeur d'Alene Tribe, Cultural Director[1]

"The tribal vision for the future of the Columbia River Basin respects and reflects upon the tribal memories of the past. It simultaneously looks ahead, with a vision filled with images of Indian and non-Indian use and enjoyment of clean air and water, healthy lands, fish, wildlife, plants and other resources. The tribal vision calls for recognition and appreciation of the spiritual values of these, not merely to extract and exploit them for monetary or other economic value they may hold, but to restore and sustain them to bless the human spirit."

– The Tribal Vision for The Future of the CRB & How to Achieve it. Pg. 10.[2]

The Columbia River is North America's fourth-longest river, a vital component of both the regional economy and the environment. It is also foundational to tribal culture and traditions as a source of vital first foods. However, dams and other developments are degrading the river's ecosystem, causing fish populations to decline. There are ongoing discussions between sovereign nations and other stakeholders regarding how to address these challenges in an updated Columbia River Treaty. In Chapter 1, we introduce the main goal of this report, followed by an introduction to the history of resources throughout the basin and a brief description of the socioeconomic, geographic, and climatic characteristics of the study area. Finally, this chapter describes the major threats that contribute to declining fish populations and introduces the Columbia River Treaty and the modifications currently being discussed by sovereign nations and other stakeholders. Throughout the report, our focus will be on Native American tribal relationships to the Columbia River and the resources, including essential first foods that it provides.

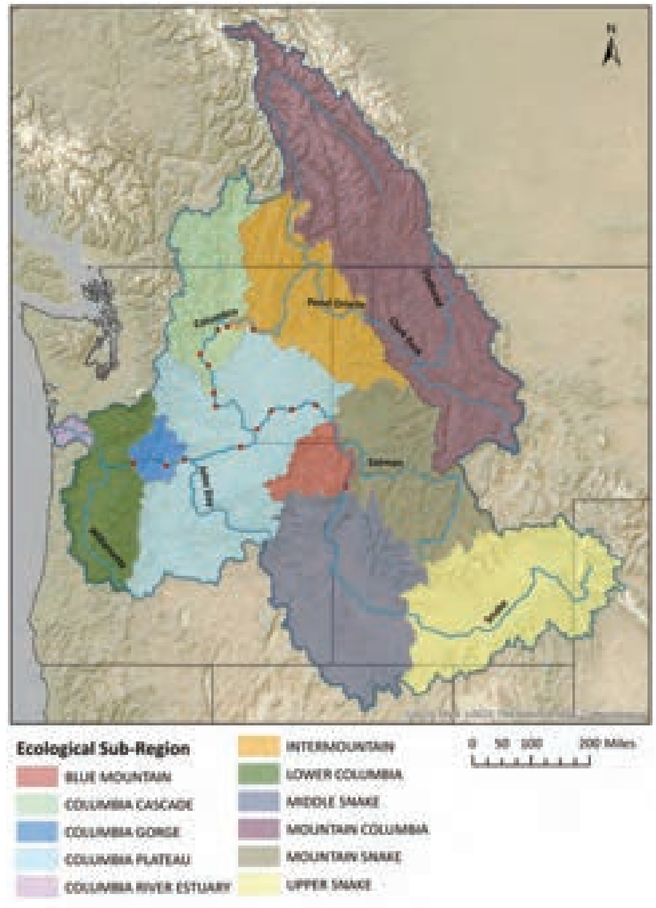


Figure 1. Sub-Regions of the Columbia River

Goal of this Report

The primary goal of this report is to identify, understand, and value ecosystem-based functions (EbF) within the Columbia River Basin (CRB) under the Columbia River Treaty (CRT) and to explain how valuing EbF relates to tribal socio-economics. This report compares two potential post-2024 scenarios- current condition (RCC-80) and a modernized scenario (3Ea) in which ecosystem-based functions are integrated into river operations decision making.[b] This report explores the relationship between natural and built capital, highlighting the benefits produced from natural capital that are currently ignored or undervalued.

Site Overview

The Columbia River, at 1,243 miles long, spans a vast basin of 258,000 square miles. With headwaters in British Columbia, the river and its tributaries flow through seven U.S. states, with headwaters in British Columbia. Although it is much smaller than the U.S. portion, the British Columbia area of the basin has the largest river management potential due to the existence of three large reservoir storage areas and a stable snowpack. Because it covers such a large area, the basin encompasses several unique climates, including arid semi-desert zones, lush temperate areas, and cold continental mountainous climates. Figure 1 maps the watershed's eleven ecological sub-regions and Table 1 describes their features.

b Both scenarios originated from the CIS model. More detail of this model can be found in the methodology section in Chapter 2.

Table 1. Important Characteristics of the Major Sub-regions of the Columbia River[c]

SUB-REGION	STATE/MAJOR CITIES	MAJOR RESERVOIRS	MAJOR TRIBUTARIES
Blue Mountain	Lewiston, ID; La Grande, OR	Wallowa Lake Reservoir	Grande Ronde River, Snake River, Imnaha River
Columbia Cascade	Kelowna, BC; Vernon, BC; Penticton, BC; Wenatchee, WA	Lake Chelan, Wanapum Reservoir, Lake Entiat	Methow River, Okanogan River, Entiat River
Columbia Gorge	The Dalles, OR	Lake Bonneville, Lake Celilo	Klickitat River
Columbia Plateau	Spokane, WA; Yakima, WA; Bend, OR; Kennewick-Pasco-Richland, WA	Lake Umatilla, Lake Wallula, Banks Lake	Yakima River, John Day River, Deschutes River, Snake River, Palouse River, Umatilla River, John Day River
Columbia River Estuary	Longview, WA	None	Grays River
Intermountain	Spokane, WA; Coeur d'Alene, WA	Franklin D. Roosevelt Lake, Lake Pend Orielle, Coeur D'Alene Lake	Saint Joe River, Sanpoil River, Hangman Creek, Kettle River, Spokane River, Little Spokane River, Clark Fork River and Coeur d'Alene River
Lower Columbia	Portland, OR; Salem, OR; Eugene, OR; Albany, OR; Corvallis, OR; Longview, WA.	Riffe Lake, Swift Reservoir	Willamette River, Clackamas River, Tualatin River, Cowlitz River
Middle Snake	Boise, ID; Nampa, ID	Brownlee Reservoir, Lake Owyhee, Cascade Reservoir	Snake River, Malheur River, Owyhee River, Payette River
Mountain Columbia	Missoula, MT	Lake Koocanusa, Hungry Horse Reservoir, Flathead Lake	Blackfoot River, Clark Fork, Flathead River, Kootenai/y River
Mountain Snake	Lewiston, ID	Dworshak Reservoir	Snake River, Salmon River, Clearwater River
Upper Snake	Idaho Falls, ID; Pocatello, ID; Twin Falls, ID	American Falls Reservoir, Palisades Reservoir, Jackson Lake	Henrys Fork, Snake River

c Cities: USGS, 2014. Small-scale Dataset – Cities and Towns of the United States 201403 Shapefile; Rivers: USGS, 2015. National Hydrology Dataset, High Resolution GDB; Reservoirs: Lehner, B., C. Reidy Liermann, C. Revenga, C. Vorosmarty, B. Fekete, P. Crouzet, P. Doll, M. Endejan, K. Frenken, J. Magome, C. Nilsson, J.C. Robertson, R. Rodel, N. Sindorf, and D. Wisser. 2011. Global Reservoir and Dam Database, Version 1 (GRanDv1): Reservoirs, Revision 01. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC).http://dx.doi.org/10.7927/H4HH6H08.

Brief History of Natural Resources in the Columbia River Basin

Since time immemorial, Native American communities in the basin have centered their lifestyles on the resources provided by their native land and river systems. A variety of fish are highlighted in this report, including burbot, lamprey, and salmon. These fish and other first foods are important, sustainable, natural capital. Within the Columbia River Basin, they nourish native people and hold immense cultural value. Sharing resources such as fish, game, roots, or berries at ceremonies has been central to tribal cultural values for hundreds of years. Although all resources gathered from the Columbia River and its watershed are of great importance, particular attention is given to salmon, as they are an "indicator species".Salmon productivity is tied to the health of multiple ecosystems, including estuaries, coastal areas, the open ocean, and rivers. [3] Improvement through restoration in one of the types of salmon habitat improves habitat for all other species within that habitat. In addition, the consumption of salmon via natural predators fertilizes riparian soils, increasing forest productivity and the system-wide provision of ecosystem function.

Pre-European settlement, the Columbia River and its tributaries produced abundant salmon runs with an average year producing runs of up to 16 million.[4] The Columbia and Snake River systems, formed to their current geologic state by massive ice-agefloods about 14,500 years ago, have long fostered thousands of miles of habitat for fish populations.

Although human settlement in the Columbia River Basin can be documented back about 14,500 years[5], European "discovery" of the river's mouth didn't happen until the mid-18th century. European, Canadian and American governments subsequently spent decades exploring and disputing claims to the region. When white settlers first arrived in the basin, they were in awe of the massive salmon runs. As late as the mid-1850's, salmon runs were likely not greatly affected by the anthropogenic demand for salmon.[6] Though white entrepreneurs salted, packaged, and sold salmon purchased from tribes, the environmental impacts were not yet apparent.

In the latter part of the 19th century, however, the introduction of a salmon canning industry took advantage of these immense salmon runs. By the end of the century, it was clear that commercial fishing was depleting the once abundant chinook salmon runs. To help offset the high demand for canned salmon, canneries began processing other salmon runs, including sockeye, steelhead, coho, and chum. Between 1891

Celilo Falls fishery, Source: CRITFC

and 1895, canneries packaged approximately 23 million pounds of salmon annually. Although salmon canneries are no longer major contributors to salmon run depletion, other mechanisms such as permanent hydrological alterations due to dam development continue to negatively impact fish populations and fisheries.

By the 1930s, the vision for development of the Columbia River and tributaries became clear: establish large public works projects that would provide substantial volumes of controlled reservoir storage and altered flow regimes for the benefit of hydroelectric power, navigation, flood control, and irrigation. Where possible, but as an afterthought, these projects attempted to allow for fish passage. These alterations to the river would substantially change the natural capital and ecosystem-based function of the basin (concepts defined in Chapter 2). The 20th century became an era of dam building, navigation, and agricultural projects by federal and local agencies as well as private entities. These projects relied on incomplete analyses that failed to include ecological and economic tradeoffs, ultimately ignoring the value of natural capital. During the 20th century, attitudes toward the environment shifted as education and research addressed the nature of people's relationship with the environment more holistically.[7] Methodological developments within economics now allow economists to account for the changing perceptions and values embraced in the modern day, which were largely ignored in earlier times.

Over the course of the 20th century, fish runs experienced severe population declines. Fish species native to the Columbia River Basin such as salmon, sturgeon, bull trout, eulachon and steelhead were listed under the Endangered Species Act (ESA), in addition to the dozens of salmon runs extirpated from the basin.[8] The decline in fish populations can be attributed to many different sources, but the construction of dams along the mainstem Columbia River is at the center of this analysis.

First Foods

First foods are the traditional foods provided by a functional ecosystem. Tribes have harvested first foods for thousands of years, and they continue to rely on them today as a primary source of sustenance for their families. These foods define the nourishment, trade, and health of tribal members as well as the land and water.

First foods are culturally, socially, and spiritually significant. Because of their wide-reaching significance, they are recognized and honored through trading and ceremonies that express gratitude and respect for the nourishment they provide. These foods are honored with ceremony and prayer,

CRITFC researchers sampling salmon smolt populations in the Hanford Reach, Source: CRITFC

D.R. Michel with large Chinook Salmon from the FV Dream Catcher, Source: Keith Kutchins

following the first foods order—first water, followed by fish, game, roots, and berries. Water comes first in this order as the sustainer of other first foods. Without water, there would be no fish. Berries and roots need water to grow. Game such as elk and deer also need water to survive.

First foods directly affect the resilience and longevity of the Columbia River tribes, and tribal ancestors have always protected and cared for first foods. In that way, they are also a gift from the past.

The gathering of first foods has declined substantially since pre-contact times. Prior to European contact, tribes would harvest tens of millions of pounds of first foods. Tribal first food harvests are now ten times lower.[9] Access to many fishing, hunting, and gathering areas has been lost. Immense areas of the Basin have been blocked to upstream and downstream migrations and access. More than 33,000 acres of land once used to hunt game and gather roots and berries have been flooded. Where tribes once used to fish, fish have now disappeared.

Within this hunting and gathering culture, the well-being of the land and water determine the well-being and prosperity of tribal people and their culture. As threats to Columbia River ecosystems have emerged, so too have tribal culture and health been impacted.[d]

Threats to Columbia River Ecosystems

This section briefly explains some of the threats to the ecosystems in the Columbia River Basin, specifically noting threats to salmonids, which are directly affected by the management of hydropower dams throughout the river. The Columbia River Basin contains a myriad of ecosystems that house thousands of animal and plant species. The threats to these species are numerous. Several major threats to these species are known as the "four H's": habitat (degradation and total loss of), hydropower (dams as barriers and reservoir flooding), harvest (overharvesting) and hatcheries (fish competition). There are also other factors worth noting, such as climate change, increased floodplain development, and riparian degradation. This section will describe some of the threats listed above to demonstrate the complexity of conserving ecosystems and restoring fish runs throughout the basin.

HYDROPOWER AND LOSS OF HABITAT: Hydropower dams along the Columbia River have degraded habitats that are crucial to anadromous fish and other species. The key dam-related factors that degrade ecosystems are: altered thermal regimes, excessive nutrients, anoxic and hypoxic conditions, altered flows, inundated habitats, slowed water velocity, increased water temperatures, slowed upstream and downstream fish migration, and creation of habitat for predatory fish species. Dam construction and other types of development such as mining, agriculture and forest practices have severely altered stream hydrology and geomorphology, thus greatly impacting habitat for salmon and other riverine species. Each dam blocks sediment from traveling downstream, starving the riverbed of needed gravel and cobble that provide salmon spawning habitat. Additional habitat stressors, such as dam management-induced water velocity alterations, are discussed in the burbot and lamprey case studies in Chapter 5's Tribal Fishing section. Over time, the reductions in the quality and quantity of habitat have decreased salmon populations, and thus their harvest.[10] For example, the Nez Perce Tribe's current salmon harvest is only 160,000 pounds, compared with salmon harvests of 2.8 million pounds in pre-contact times.[11]

d More information on first foods and how it relates to health can be found in Chapter 5- The Cultural Value of the CRB.

WATER QUALITY, TEMPERATURE AND DEPTH: Each CRT dam immediately affects upstream and downstream water quantity and quality.[12] Especially during drought years, water levels are much lower, further limiting salmon's ability to move up and downstream. During drought years, dam operators refill reservoirs from winter power drafts, reducing spring and early summer flows causing temperatures to increase more quickly. Elevated river temperature was cited as the primary cause of low adult sockeye salmon passage and high mortality during the 2015 drought.[13] Water quality is also threatened by land uses such as livestock grazing, timber harvest, agriculture, rural residences, roads, mining, and recreation. These activities have an effect on water quality due to increased water temperature and sediment, excessive nutrients, channel alterations, and increased pollution.[14]

DAMS AS BARRIERS: Dams are barriers to fish in multiple ways. First, they impede the downstream migration of juvenile fish to the ocean where they will spend their adult lives. For example, juvenile survival rates through the system have been as low as 7 to 15 percent in low water years. They also impede or hinder adult salmon, lamprey, and sturgeon from swimming upstream to spawning areas. Adults may fallback over dams one or more times, depriving them of vital energy needed for spawning. Dams can act as temperature solar collectors, causing direct or indirect fish mortality. Some dams and reservoirs block passage to some of the most historically productive spawning areas. This is the case for the Hells Canyon Complex, where this dam system alone inundates 95 miles of historical fall chinook habitat.[15] Efforts have been made to facilitate passage around some dams. Fish ladders and other mechanisms have been constructed at many facilities, such as Bonneville Dam on the Columbia River. The Army Corps of Engineers' original budget for the Bonneville Dam fish ladders was $640,000 in 1937, although the mechanism eventually cost the agency nearly $7 million after additions were made to the original plan, small bill for multiple benefits.[16]

HARVEST: Due to their patterns of ocean distribution and the timing of their spawning run up the Columbia River, salmon are subject to incidental harvest by both ocean and in-river fisheries. Coastal fisheries in California, Oregon, Washington, British Columbia, and Southeast Alaska annually report recoveries of tagged fish from the Columbia River. The timing of returns of many fish coincide, and the harvest of a particular runs of fish isn't easy to distinguish, therefore incidental by-catch, and overfishing are problems.[17]

PREDATION: Ecosystem alterations attributable to hydropower dams created bottlenecks and modification of river and estuarine habitat, such as creation of bird colonies on dredged habitat, have increased the of salmon and steelhead predation. The abundance of certain predators has

Grand Coulee Dam 2013, Source: Brian Gruber

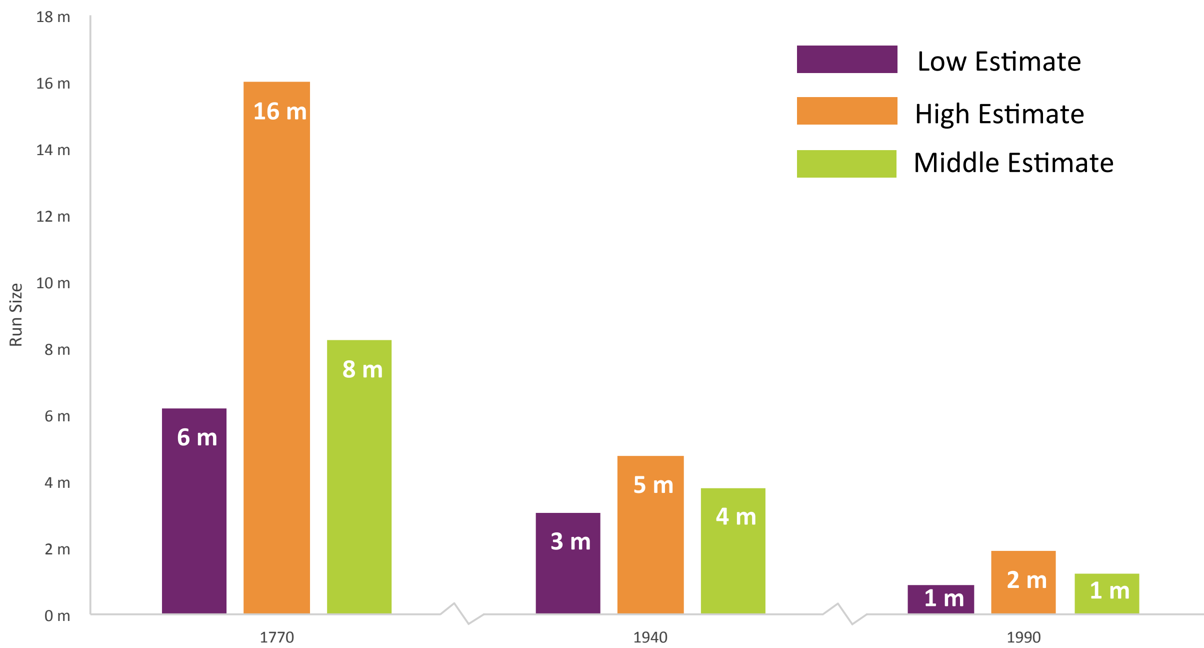


Figure 2. Salmon Entering the Columbia River

increased exponentially, particularly in localized areas. Some notable predators are birds, marine mammals and native, and non-native fish.[18]

HATCHERIES: Salmon produced in hatcheries can pose a threat to wild salmon by competing for available food and habitat and by reducing the genetic fitness of wild fish. A recent NOAA study suggests that some hatcheries in the CRB must undergo operational changes to reduce the risks mentioned above.[19] These changes include halting the use of hatchery brood stock that originates outside the CRB to reduce genetic risk to native fish; reducing hatchery production in the same place; increasing hatchery production where stray hatchery fish are not a threat to recovery of protected salmon and steelhead; additional research and monitoring to better track and understand the effects of hatchery fish on wild salmon and steelhead populations.[20] However, hatchery fish can be an important restoration tool to restore and promote fish productivity in areas of degraded habitat from built capital such as dams (which is most of the CRB). Hatchery fish also provide important tribal and non-tribal harvest opportunities.

CLIMATE CHANGE: The health of aquatic resources within the Columbia River Basin is dependent on the maintenance of historical temperature and hydrological conditions. Future climate change in the Pacific Northwest is predicted to cause increased water temperatures and major alterations in the seasonality and volume predictability of river flow. As winter air temperatures rise, precipitation patterns shift away from snowfall and towards winter rainfall, reducing the size of spring freshets, reducing summer flows and reducing quality of riverine and riparian habitat.[21] Climate change compounds the environmental and built capital management challenges ensuing from basin population growth such as excessive floodplain development, riparian vegetation degradation, increased hydropower and agriculture and municipal water demand, and water pollution.

FLOODPLAIN DEVELOPMENT: Development along riverine systems has significant economic benefits, which are tied to the development of infrastructure such as cities, ports, industrial uses, navigation, the fertility of riparian lands, access for irrigation, recreation and other opportunities. However, all of these benefits come at a cost to the river and the community of plants and animals linked to riverine and riparian habitats. Levee construction disrupts the hydro period (seasonal pattern of water levels) of riparian vegetation, altering the type and density of vegetation that will grow in riparian areas.[22] Development of riparian areas for grazing also reduces vegetation coverage, further leading to increased erosion rates, less shade (leading to increased water temperatures), limited input of woody debris (reducing the complexity and quality of riverine habitats), and infiltration and proliferation of invasive species into riparian areas.[23] Constructing large areas of impermeable pavement and other development only compounds the challenges of restoring floodplains. Runoff from paved areas cannot infiltrate into groundwater, but carries with it the pollutants (i.e. nutrients, petrochemicals and other synthetic compounds) associated with urban development, negatively impacting habitat and water quality.[24]

RIPARIAN VEGETATION DEGRADATION: Riparian vegetation plays a vital role in supporting riverine habitat. Habitat stressors such as increased air temperatures, urban runoff, and bank erosion can all be mitigated through adequate riparian vegetation levels.[25] Degradation of riparian vegetation via hydrological disruption and floodplain development reduces riparian effectiveness in regulating to regulate the health of aquatic environments. Given the complexity of riverine health, riparian vegetation loss cannot be successfully addressed without considering major stressors, such as floodplain development and climate change.

Columbia River Salmon

The Columbia River Basin is home to four types of salmon: sockeye, chinook, coho, and chum, as well as steelhead, an anadromous rainbow trout. Salmon hatch and rear in freshwater rivers and streams, migrate to the Pacific Ocean as juveniles, and return to the Columbia River to spawn—mostly in the same tributary where they hatched.[26] Since the first dams were constructed in the late 1930s, salmon runs have sharply declined.[27] Although this reduction can be attributed in part to urban development in Columbia River Basin floodplains and historical overharvesting, dam construction has also directly and significantly contributed to much of this population reduction.[28] Figure 2 presents a snapshot of salmon run declines since the 1770s.[29]

Understanding the benefits provided by the Columbia River Basin's built infrastructure (hydropower generation, irrigation, navigation, and flood control) is important, but understanding the economic value of the basin's natural functions is equally as important for making sound management decisions. How the dams are managed under their authorized purposes can have significant economic effects, many of them negative. Currently, dams included within the Columbia River Treaty are managed for hydroelectric production and flood control. Although natural capital value and ecosystem-based function are equally significant, current dam management practices do not maximize these benefits or even give them equal prioritization in management decisions. As the 1964 Treaty is updated, holistic management guidelines should be incorporated into a modernized treaty.

For example, salmon populations within the Snake River have declined since the installation of four federal dams on the lower Snake River decreased juvenile passage survival and since the privately owned three-dam Hells Canyon Complex eliminated passage to historical spawning grounds and led to irrigation water removals upstream of the Hells Canyon Complex. A variety of methods have been tested to ameliorate the impact of dams upon salmon, but populations continue to experience serious decline, at times to extirpation. Hatchery production was employed but it was not a panacea. For example, the high proportion of salmon runs composed by hatchery salmon is threatening the survival of wild salmon species, leading to a reduction in genetic diversity of salmon stocks.[30] Some smaller dams have been removed with successful results for salmon, such as Condit Dam on the White Salmon River. Removal of dams on the lower Snake River would allow for recovery of 140 miles of chinook spawning habitat and increased access to 5,300 miles of spawning and rearing habitat.[31] In addition, the costs of dam removal have been shown to be approximately two-thirds lower than initial estimates, making removal a more tractable option than initially thought.[32]

CRITFC researchers sampling salmon smolt populations in the Hanford Reach, Source: CRITFC

The 1964 Columbia River Treaty

The Columbia River Treaty is an evergreen[e] agreement between Canada and the United States that required the construction of three dams in British Columbia – Keenleyside, Duncan and Mica - and governs their operation.[33] The Treaty was implemented in 1964 to provide for coordinated flood

e The coordinated flood control provisions under the Columbia River Treaty change after 60 years (2024) while the obligation to return the Canadian Entitlement continues unless one of the parties terminates the Treaty with 10 years' notice.

control and optimized power production; it also allowed the U.S. to construct Libby Dam in Montana to support flood control in both countries. U.S. President Eisenhower designated the Administrator of the Bonneville Power Administration and the Division Engineer, North Pacific Division, Corps of Engineers, Department of the Army as the U.S. Entity responsible for the implement of the Treaty for the United States; Canadian Prime Minister Diefenbaker designated B.C. Hydro as the Canadian Entity.

The Permanent Engineering Board (PEB) was established by the Treaty and oversees and monitors the Treaty's implementation by the U.S. and Canadian Entities. The three dams that Canada was required to build under the Treaty were to be capable of holding 15.5 million acre-feet of water for flood protection. Canada built Mica Dam larger than required by the Treaty; as it a result it can store an additional 5 million acre-feet of water, known as non-Treaty water. The United States exercised its option to build Libby Dam, which can store up to 5 million acre-feet of water.[34] The U.S. and Canada prepare an annual Assured Operating Plan (AOP) to guide the storage and release of water from the three Canadian reservoirs. The AOP is completed six years in advance of each operating year.[35] The AOP defines the level of the Canadian Entitlement[f] from downstream power benefits generated for that year.

The Treaty design ensures that both countries benefit from this agreement, either through reduced flood risk or through hydropower generation. For flood control coordination, Canada was paid half of the estimated value of U.S. flood damages avoided by storing water in Canada.[36] Canada received three payments, totaling $64.4 million, as each Canadian project was completed and began storing water (approximately $493 million in 2015 dollars[g]).

Canada sold its share of the downstream power benefits for $254 million to a consortium of U.S. utilities for a period of 30 years. Since 2003, the Canadian Entitlement has been delivered daily to the Province of British Columbia at the U.S. - B.C. border for Canada's use or resale. The Treaty also resulted in the development of the U.S. Pacific Northwest Coordination Agreement (PNCA), which helps optimize the operation of Pacific Northwest projects to take advantage of water flow control from Canada. Under the PNCA, most Pacific Northwest hydropower projects operate as though they were owned by one utility, taking advantage of the regional diversity in stream flows and power loads, as well as the ability to optimize all reservoir storage operations to one power load.

John Day Dam, Source: CRITFC

Ecosystem-Based Function and the Existing Columbia River Treaty

In 1993, the Canadian and U.S. Entities opted to develop Supplemental Operating Agreements that consider aspects of river management beyond hydropower and flood protection. Supplemental Operating Agreements permit the Entities to include fisheries and other non-power objectives that provide mutual benefits, such as meeting Endangered Species Act (ESA) requirements. These other ecosystem-based considerations suggest actions such as flow augmentation agreements.[37]

Despite the provisions under Supplemental Operating Agreements, ecosystem-based function is still not a among the Treaty's objectives. U.S. regulations for meeting ESA requirements do not address the long-term implications of dam management regimes. Even with decades of U.S. environmental policy, including the ESA and Clean Water Act, dams continue to bar migrating fish and altered hydrologic and geomorphologic conditions continue to degrade habitat for salmon and other species.

The Treaty Update

Multiple sovereigns and user groups within the Columbia River Basin are impacted by the current Treaty conditions. These include the following:

- **TRIBES:** The economic, social, cultural, spiritual, and

f The three Treaty dams are operated to optimize the downstream power benefits generated in the U.S. by U.S. hydropower projects, not to maximize benefits in Canada. The Canadian Entitlement is the method by which the United States reimburses Canada for these operations.

g Adjusting $64.4 million for inflation between 1964 to 2015 environmental status of tribes is directly affected by the Columbia River dam operations. The tribes call for ecosystem-based function to be part of treaty decision-making and planning.

- **LOCAL ANGLERS, BIRDERS, WILDLIFE SURVEYORS:** Public stakeholders who use waters for environmental and recreational benefits will be affected by changes in the Columbia River. Changes in ecosystem quality or quantity will affect the quantity of fish available for recreation, and habitat restoration will be important for all residents (ex: the Columbia River Gorge National Scenic Area).
- **COLUMBIA BASIN RESIDENTS RECEIVING HYDROPOWER ELECTRICITY:** Accommodating ESA requirements and a changing climate includes changing water levels on areas of the Columbia River, which will influence how hydropower is delivered. Residents that depend on their electricity from Columbia River hydropower may see variable electricity rates due to changes in water flow, rainfall, and flood conditions.
- **FARMERS:** River water available for irrigated agriculture may fluctuate if ESA requirements or climate change result in less water. Reservoir levels will be dramatically affected during drought years, especially with climate change. Farmers' water use is linked to the water needs of their crops.
- **THE U.S. GOVERNMENT:** The federal government is responsible for managing the Columbia River dams for flood control and economic benefits, in addition to the safety of water containment in the United States. The U.S. President and Senate retain constitutional authority over international treaties, and thus have a significant role in decisions concerning the Treaty. The U.S. Army Corps of Engineers and the Bonneville Power Administration are the primary federal agencies involved in developing the Regional Recommendation for reshaping the treaty. The U.S Negotiating Team, headed by the U.S. Lead Negotiator

Mt. Hood sunset behind Columbia River, Source: CRITFC

Jill Smail, will be guided by the Department of State's negotiating position as developed through the Circular 175 process. This team will represent the needs and focus of the American government in this treaty, including the interests of various federal agencies such as the Environmental Protection Agency and Fish and Wildlife; Columbia Basin tribes; the States of Washington, Oregon, Idaho and Montana; multiple stakeholders; and the U.S. voters.

- **BC HYDRO AND THE CANADIAN ENTITY:** These entities are responsible for implementing the CRT in British Columbia and receive the annual return of the Canadian Entitlement. BC Hydro controls reservoir levels of three Treaty dams and will seek to benefit the interest of the hydropower consumers in BC.
- **THE COLUMBIA RIVER BASIN FEDERAL CAUCUS:** Comprised of ten land, energy, and environmental federal agencies, the Caucus is responsible for the promotion and recovery of native fish and wildlife in the Columbia River. They will be influenced by the need to protect wildlife and habitat under the Endangered Species Act and to adapt to conditions resulting from a changed climate. They will be motivated to uphold their cultural values against any scarcity of native salmon, with interests to improve salmon return rate and habitat quality.
- **U.S. ARMY CORPS OF ENGINEERS (USACE):** The USACE's main responsibility is for flood control and navigation. The USACE, the Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (BPA), collectively referred to as the Action Agencies (AAs), have consulted with NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) on the effects of operating the 14 Federal hydropower projects in the Federal Columbia River Power System (FCRPS) on fish species listed as endangered or threatened under the Endangered Species Act (ESA). These consultations resulted in biological opinions (BiOps) from NOAA Fisheries and USFWS that identify FCRPS operations that are implemented by the AAs to avoid jeopardizing the survival and recovery of ESA listed fish species. These protections are implemented to the letter of the law while maintaining the priorities of the Treaty.
- **BONNEVILLE POWER ADMINISTRATION (BPA):** BPA markets and transmits electricity for private use from 31 federal dams and one nuclear power facility.[38] BPA provides one-third of the Northwest's electric power and is also responsible for the country's largest fish and wildlife mitigation program.[39] It will seek to operate at profit-maximizing levels, though these may be affected if restrictions are made to their operations and reservoir water elevations. Currently, these elements are designed for maximum revenue generation through hydropower sales, although there are some restrictions for flood control. There are some flow and operational requirements under NOAA and USFWS's Biological Opinion for ESA species and court orders issued under Oregon. v. U.S. litigation and the NWF v. NMFS 2014 litigation over Federal Columbia River Power System Biological Opinion (FCRPS BiOp) under the Endangered Species Act (ESA) and National Environmental Policy Act (NEPA). NMFS has currently started working on a new BiOp with full NEPA review due out sometime between 2018 and 2021. BPA decisions will be influenced by their hydropower customers.

In 2011, the U.S. Entity and the Tribes developed a Sovereign Participation Process for collaboration and consultation between four Northwest States (Washington, Oregon, Idaho, and Montana), 15 tribal governments, and the Northwest federal caucus. As part of this process, the U.S. Entity was committed to consult directly with tribal interests through the federal government's tribal trust responsibility.[h] Additionally, BPA and USACE agreed with each state and federally recognized tribes on the review to ensure that the U.S. Entity hears state and tribal concerns are brought to the U.S. Entity for consideration. Through this process, the Regional Recommendation was developed and submitted to the State Department for review in December of 2013.

h This references the Presidential Executive Order of 2000 called "Consultation and Coordination with Indian Tribal Governments."

Chapter Two

Ecosystem-Based Function of the Columbia River Basin

"At the center of tribal cultures lay a deeply ingrained ethic of reciprocity between people, and between people and the land".

– Salish Pend d'Oreille Culture Committee[40]

In this section, we introduce core concepts for understanding ecosystem-based function and natural and built capital valuation. First, we address ecosystem-based function, then natural capital, ecosystem services, and built capital, including a description of how these elements provide value to human communities and the economic systems that sustain them. We conclude the chapter with our methodology and a valuation of the ecosystem services in the Columbia River Basin.

Ecosystem-based function, natural capital, and ecosystem services are three related, yet distinct, concepts for describing nature's value. Ecosystem-based function, a concept embraced by the Columbia River Basin Tribes, describes nature's value as inherent and independent of any human assessment. Rather, humans are an integral part of the ecosystem as opposed to users or benefactors of the ecosystem. The concept recognizes that nature has a voice and a value simply by virtue of existing, and that this value does not depend on any human estimation of what nature provides. Natural capital and ecosystem services, on the other hand, are economic concepts that specifically apply to natural products and processes that produce a benefit for humans and that can be valued monetarily. In this report, the term ecosystem services applies to all natural benefits that are assigned a monetary value.

Finally, built capital is defined as natural capital transformed by human actions. Construction and operation of dams, cities, agricultural systems, navigation dredging, and locks are all examples of built capital that have diminished the historical natural capital that has sustained the tribes over thousands of years.

The following sections explain these concepts in further detail.

Ecosystem-Based Function

Since time immemorial, the rivers of the Columbia Basin have been the lifeblood of the Columbia Basin tribes. For these tribes, the ecosystem-based function (EbF) of the Columbia River watershed is its ability to provide, protect, and nurture subsistence and cultural resources, traditions, values, and landscapes throughout its length and breadth. Clean, abundant water is a core part of this concept. This resource must be sufficient to sustain life, healthy fish, wildlife, and plant populations that are vital to tribal traditions and way of life. A restored, resilient, and healthy watershed will demonstrate EbF through:

- Increased spring and early summer flows resulting in a more natural hydrograph;
- Higher and more stable headwater reservoir levels;
- Restored and improved fish passage to current and historical habitats;
- Higher river spring flows during dry years;
- Lower late summer water temperature;
- Reconnected floodplains throughout the river, including a reconnected lower river estuary ecosystem
- Enhanced Columbia River plume and near shore ocean through higher spring and early summer flows and lessened duration of hypoxia; and,
- An adaptive and flexible suite of river operations responsive to a great variety of changing environmental conditions, such as climate change and population demand.

Improved EbF in the Columbia Basin Watershed is expected to result in:

- Increased recognition, protection, and preservation of cultural/sacred sites, activities, and tribal First Foods, including water, salmon, other fish, wildlife, berries, roots, and other native medicinal plants;
- Restored and resilient tributary, mainstem and estuarine floodplains and riparian areas
- An estuary and mainstem river with an enhanced food web and increased juvenile and adult fish survival;
- Increased juvenile and adult salmon in-river survival;
- Decreased mainstem travel time for migrating juvenile salmon;
- Increased resident fish productivity that provides stable, resilient populations;
- Increased wildlife productivity that provides stable, resilient populations; and,
- Salmon and other juvenile and adult fish passage to historical habitats in the Upper Columbia and Snake River basins, and into other currently blocked parts of the Columbia River Basin.

Columbia River, Grand Coulee Area, Source: Brian Gruber

EbF encompasses both of the economic terms in this report: natural capital and ecosystem services (ES). Figure 3 illustrates the spatial relationship between these three core concepts using the value of restored fish passage as an example. The black arrows describe the flow: natural capital is the source of EbF, while EbF and functions flow into each other; ecosystem services and benefits flow out because they are a product of EbF. Quantification of ES is the only concept that lies outside of EbF. In Figure 3, the ES food (in the form of salmon) is subject to degradation from external forces, which will thus impact its monetary value. Degraded ecosystems will not be as productive as healthy ones.

Again, the primary distinction between EbF and ES is that ES are monetarily valued. These dollar values provide an economic argument for ecosystems that can be leveraged in decision-making processes. In the following, we outline the core economic concepts of natural capital and ecosystem services.

Natural Capital

In economics, there are five types of capital which determine our quality of life: natural, built[41], financial, human, and social capital. Together, these five building blocks create the conditions for a healthy, sustainable economy. Natural capital, however, is the foundation for all other types of capital. It consists of any "minerals, energy, plants, animals, ecosystems, [climatic processes, nutrient cycles, and other natural structures and systems] found on Earth that provide a flow of natural goods and services".[42] Natural capital thus plays a particularly important economic role, yet its value is frequently overlooked.

Natural capital performs natural functions that provide goods and services that humans need to survive. For example, natural capital assets within a watershed (e.g. forests, wetlands, and rivers) perform critical natural functions such as intercepting rainfall and filtering water. This natural storage and filtration process supports a clean water supply, which is crucial to human survival and a healthy ecosystem. Benefits such as these that people receive from nature are known as ecosystem goods and services. The tribal concept of EbF encompasses all three of these economic concepts (functions, goods and services, and benefits). In economic thought, however, ecosystem services solely refer to natural goods and services that provide benefits to humans and can be monetarily valued. In summary, natural capital provides what we need to survive. Without healthy natural capital, many of the services (benefits) that we freely receive could not exist. Once lost, if possible, these services must be replaced with costly built capital solutions, which are often less resilient and shorter-lived.[43] Thus, not every service can be replaced, like clean air, clean water, fish and wildlife or culturally significant sites. Sometimes when natural capital is lost, its value is also lost to present and future generations.

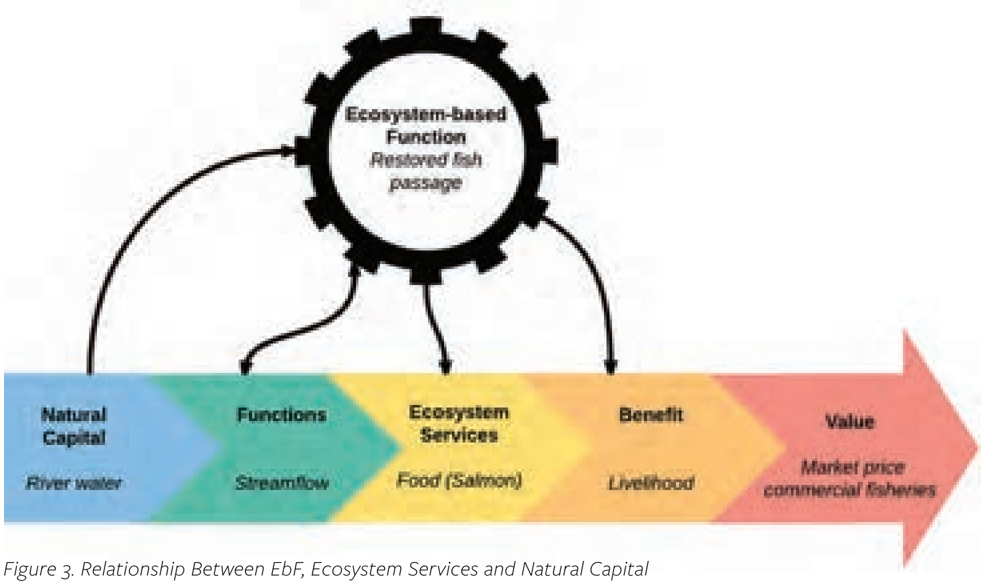


Figure 3. Relationship Between EbF, Ecosystem Services and Natural Capital

Ecosystem Services

Ecosystem services are essential to human survival. Breathable air, drinkable water, nourishing food, and stable atmospheric conditions are prime examples of ecosystem services. Their benefits are similar to other economic benefits typically valued in the economy, such as skilled workers, buildings, and infrastructure. When ecosystem services are lost, economic impacts can be measured in terms of job loss, infrastructure costs, restoration costs, or property loss in the event of storm damage.

Over the last 15 years, considerable progress has been made in systematically linking functioning ecosystems with human well-being. The work of De Groot et al. (2002),[44] the Millennium Ecosystem Assessment (MEA)[45] and The Economics of Ecosystems and Biodiversity (TEEB)[46] marked key advancements in this task. These studies laid the groundwork for a conceptual framework for valuing natural capital and ecosystem goods and services.

Figure 4. Types of Ecosystem Services

Earth Economics' approach to valuation is adapted from the MEA's ecosystem service descriptions. The adapted framework clearly articulates and values the vast array of critical services and benefits that natural capital provides. Under this framework, the four categories of ecosystem goods and services (see Figure 4), which are now commonly used in the field of ecological economics, are as follows:

- **PROVISIONING GOODS AND SERVICES** provide physical materials and energy for sovereign nations and stakeholders that varies according to the ecosystems in which they are found. Forests produce lumber, while agricultural lands supply food and rivers provide drinking water.
- **REGULATING SERVICES** are benefits obtained from the natural control of ecosystem processes. Intact ecosystems keep disease organisms in check, maintain water quality, control soil erosion or accumulation, and regulate climate.
- **SUPPORTING SERVICES** include primary productivity (natural plant growth) and nutrient cycling (nitrogen, phosphorus, and carbon cycles). These services are the basis of the vast majority of food webs and life on the planet.
- **INFORMATION SERVICES** are functions that allow humans to interact meaningfully with nature. These services include providing spiritually significant species and natural areas, natural places for recreation, and opportunities for scientific research and education.

Table 2. 21 Ecosystem Services

GOOD/SERVICE	ECONOMIC BENEFIT TO PEOPLE
PROVISIONING SERVICES	
Food	Producing crops, fish, game, and fruits
Medicinal Resources	Providing traditional medicines, pharmaceuticals, and assay organisms
Ornamental Resources	Providing resources for clothing, jewelry, handicrafts, worship, and decoration
Energy and Raw Materials	Providing fuel, fiber, fertilizer, minerals, and energy
Water Storage	The quantity of water held by a water body (surface or ground water) and its capacity to reliably supply water for multiple purposes
REGULATING SERVICES	
Air Quality	Providing clean, breathable air
Biological Control	Providing pest and disease control
Climate Stability	Supporting a stable climate at global and local levels through carbon sequestration and other processes
Disaster Risk Reduction	Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts
Pollination and Seed Dispersal	Pollination of wild and domestic plant species
Soil Formation	Creating soils for agricultural and ecosystems integrity; maintenance of soil fertility, sediment transport for fish spawning areas.
Soil Quality	Improving soil quality by decomposing human and animal waste and removing pollutants
Soil Retention	Retaining arable land, slope stability, and coastal integrity
Water Quality	Improving water quality by decomposing human and animal waste and removing pollutants
Water Capture, Conveyance, and Supply	Providing natural irrigation, drainage, groundwater recharge, river flows, drinking water supply, and water for industrial use
Navigation	Maintaining water depth that meets draft requirements for recreational and commercial vessels
SUPPORTING SERVICES	
Habitat and Nursery	Maintaining genetic and biological diversity, the basis for most other ecosystem functions; promoting growth of commercially harvested species
INFORMATION SERVICES	
Aesthetic Information	Enjoying and appreciating the presence, scenery, sounds, and smells of nature
Cultural Value	Using nature as motifs in art, film, folklore, books, cultural symbols, architecture, media, and for religious and spiritual purposes
Recreation and Tourism	Experiencing the natural world and enjoying outdoor activities
Science and Education	Using natural systems for education and scientific research

Ecosystem Services Valuation

Understanding and accounting for the value of natural capital assets and the ecosystem services they provide can reveal the economic benefits of investing in natural capital. Natural systems have only recently begun to be viewed as economic assets that provide economically valuable goods and services. Yet when these valuable goods and services are lost, people are more susceptible to disasters such as flooding, and they face costly expenditures to replace lost services, like water quality. When the ecosystem services that nature previously provided for free are damaged or lost, they must be replaced by costly, taxpayer-funded built structures. Developing a watershed, for instance, can inhibit or even destroy natural flood risk management, which in turn requires replacing natural protective services with pipes or other infrastructure. In some cases, lost ecosystem goods and services are irreplaceable.

Many ecosystem goods, like food, water, and timber, are already valued and sold in markets. Some ecosystem services, however, are not amenable to markets and have not traditionally been valued. Recreation and climate stability are prime examples of ecosystem services that provide vast value and yet go largely unvalued within traditional accounting. To illustrate, if a stream becomes polluted with toxic chemicals, thus eliminating the public's ability to swim and fish in that stream, this loss can result in significant economic damages to local economies through job losses and reduced spending on fishing equipment, recreation gear, hotels, and restaurants.

Conversely, when investments are made to protect and support ecosystem services, local economies are more stable and less prone to the sudden need for burdensome expenditures on disaster mitigation. For example, during Superstorm Sandy, New York City's Catskills Watershed provided naturally filtered, clean, gravity-fed water with virtually no interruption in service. Previous efforts to protect and restore the watershed helped to minimize disruption. In contrast, New Jersey's damaged pumps, filtration plants, and contaminated intakes left much of New Jersey without potable water for weeks after the storm and with a $2.6 billion tab for water infrastructure repair.[47,48,49] In addition to the economic value associated with these avoided costs, natural capital such as healthy watersheds provides a myriad of other services, including water supply, carbon sequestration, water filtration, and biodiversity. All ecosystem services provide additive economic value locally, regionally, and globally.

Today, there are recognized economic methods to value natural capital and many non-market ecosystem services. When valued in dollars, these services can be incorporated into a number of economic tools, including benefit-cost analysis, accounting, environmental impact statements, asset management plans, conservation prioritization, and return on investment calculations. Inclusion of these values ultimately strengthens decision-making. When natural capital assets and ecosystem services are not considered in economic analysis, they are effectively valued at zero, which can lead to inefficient capital investments, higher incurred costs, poor asset management, and losses related to cultures, such as tribes that rely on these assets.[50,i]

In summary, natural capital provides what we need to survive. Without healthy natural capital, many of the services that we freely receive could not exist. Once lost, these services must be replaced with costly built capital solutions, which are often less resilient and shorter-lived. When we lose natural capital, we also lose the economic and cultural goods and services it provides.

Success Stories: Ecosystem Services Valuation

Ecosystem services valuation (ESV) is a cutting-edge tool that allows analysts to assess the economics value of natural capital. Though ESV has yet to be required for ecosystem conservation, there are nevertheless many success stories that illustrate the value of this type of analysis. For instance, Earth Economics influenced a systemic change in 2013 that affected all 50 U.S. states when FEMA adopted EE's natural capital values for all hurricane and flood disaster mitigation for homeowners, businesses, and government agencies. This policy change improved disaster assistance, helped build community resilience, saved taxpayer money, ensured greater equity, and contributed to conservation efforts.

Earth Economics provided benefit-cost analysis training to 40 applicants for the $1 billion Natural Disaster Resilience Competition offered by the Department of Housing and Urban Development in 2015-16. We valued ecosystems, health, and community cohesion for four of thirteen winners, with awards totaling $475 million of the $1 billion. We provide compelling evidence for investment in natural systems.

Finally, our four-year collaboration with the Eugene Water & Electric Board (EWEB) and the McKenzie Watershed Council has produced measurable conservation results. EE provided

i The same is true when built assets are not considered in economic analysis or asset management. See for example Grubisic, M., Nusinovic, M., Roje, G., 2009. Towards efficient public sector asset management. Financial Theory and Practice 33, 329-362. Available at: http://www.fintp.hr/en/archive/towards-efficient-public-sector-asset-management_283/

the economic justification for greater watershed restoration investment, reducing built capital expenditures: water treatment, levees, and artificial storage. The work increased Eugene's water quality, lowered maintenance costs, and helped stabilize the water supply.

Natural Capital Valuation of the Columbia River Basin

To value the ecosystem services within the CRB, we first determined the extent of natural capital in the study area. Using Geographic Information System (GIS) software, we identified the spatial extent of land and water cover types within the basin. We did not use a historical baseline for natural capital, but rather a snapshot of what is currently present in the basin to best demonstrate the increase in value of the modernized scenario. Next, the benefit transfer method (BTM) was used to determine dollar-per-acre values for ecosystem services. Last, the landcover types and ecosystem service values were combined to estimate the total value of economic benefits provided by the Columbia River Basin. These results were then used to calculate an asset value for the CRB. The following sections provide further detail on these methods and results

Methodology

CRITFC Information System (CIS) Model

Both scenarios, RCC-80 and 3Ea, were created using the CIS model, which is the Columbia River Inter-Tribal Fish Commission (CRITFC) database modeling platform for the Columbia River System. The model foundation is based upon the Bonneville Power Administration (BPA) HYDSIM Columbia River hydro regulation model code, inputs and outputs. The CIS model contains a number of databases, software, queries, and a graphical user interface contained in Microsoft Access. Model outputs are based upon a 14 period time series, generally representing monthly periods, but with April and August split into two periods. Inputs such as volume forecasting, 70- and 80-year historical volumes, flood risk management and power criteria for CIS were obtained from the Corps of Engineers and the BPA. The primary difference between HYDSIM and CIS is that HYDSIM requires manipulation of numerous Excel spreadsheets by hand whereas CIS creates libraries of scenarios in Excel files that are manipulated in the access-based platform. CIS also contains a valuable graphical user interface that quickly constructs table and graphic outputs. In addition, for ecosystem scenarios, CIS has ecosystem rule curves for the largest system reservoirs that drive reservoir operations and

Meacham Creek habitat restoration project. Work done by the Conf. Tribes of the Umatilla Indian Reservation, Source: CRITFC resulting river flows. Various river operational scenarios can be modeled resulting in several metric outputs including, but not limited to, reservoir elevations, flows, power generation, flood risk, dam spill, Federal Columbia River Power System Biological Opinion requirements and water particle travel time (a key variable relating to juvenile salmon survival).

The objective function of this model is simulation and comparative analysis of different river operational scenarios with and without climate change. The goal is to create robust output data to assist tribes in decision making regarding future river operations that adapt to climate change.

CIS output data includes historical quintiles and individual water year system and individual project 14 period generation, regulated outflows, ending reservoir elevations, spill per hydro-electric project and other metrics such as meeting BiOp requirements and water particle travel time which is a major component in computing salmon survival. The model is used for comparing current and alterative river operational scenarios including EbF scenarios. Through the CRT processes, CRITFC collaborates with U.S. federal agencies and the Canadian entity in performing modeling studies for the future of the Columbia River Treaty.

Current Condition (RCC-80) Scenario and Modernized Scenario (3Ea)

Two scenarios were selected to compare the economic benefits between the current conditions (RCC-80) and a modernized management scenario (3Ea) that promotes sustainable natural capital through increased ecosystem function and services. For this reason, RCC-80 values benefits provided in a business-as-usual situation, and 3Ea values the increase of benefits under modified river management. Figure 5 illustrates the differences in values in this report between the two scenarios.

Both scenarios represent hypothetical Columbia River Treaty post-2024 situations. However, post-2024 changes to flood risk management required by the Treaty are not reflected in either scenario. The RCC-80 represents a scenario where ecosystem-based function is limited to Biological Opinion operations. For that reason, RCC-80 still has a natural capital value, but it is lower than the value produced under the 3Ea scenario, where increased ecosystem-based functions would be implemented. The same is true for the CRT. Although there is value under the CRT, this value is lower than what the 3Ea scenario would supply.

The modernized 3Ea scenario would increase both EbF and the value of ecosystem services. The 3Ea scenario will also shift built capital, emphasizing the need for green and resilient infrastructure, and creating a Columbia River Basin that can adapt to climate change by restoring spring and early summer flows and reconnecting flood plains. Lastly, 3Ea would increase social and cultural benefits throughout the basin by conserving landscapes, enabling wildlife to thrive and increasing salmon runs and resident fish populations.

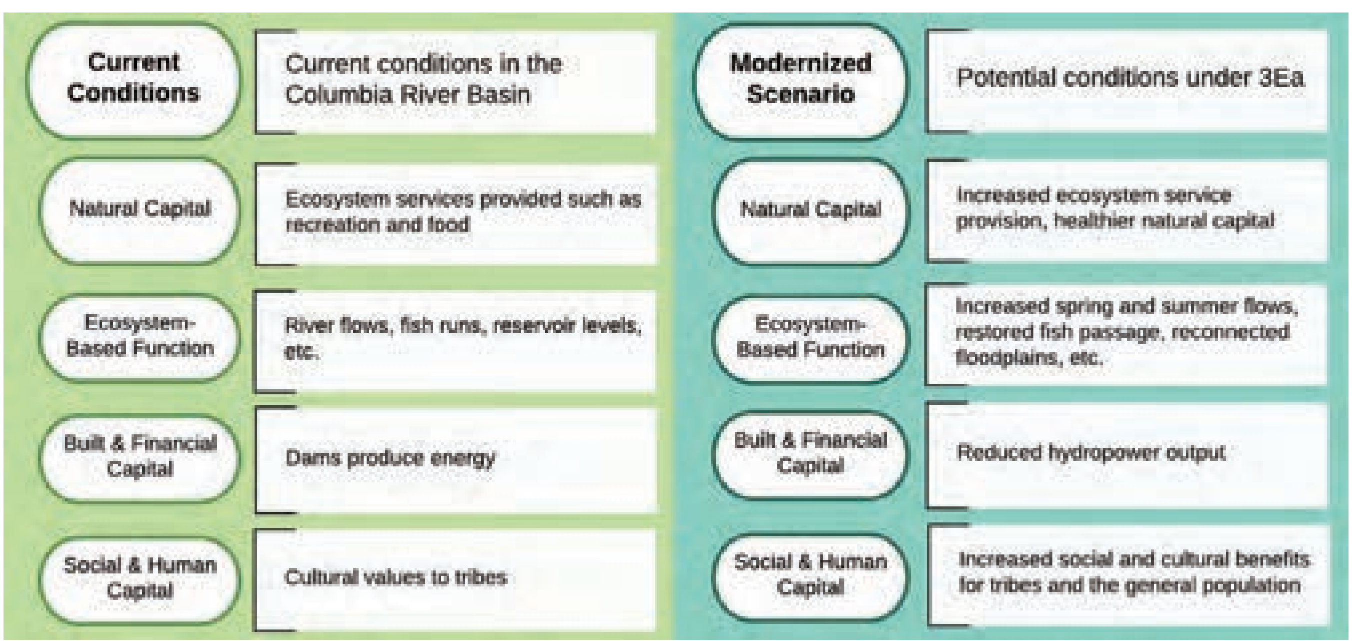


Figure 5. Types of Capital Present in the CRB, Current Conditions and Modernized Scenarios

Major Differences in a Modernized Scenario

The 3Ea scenario describes a Columbia River Treaty in which EbF are included in decision making. Listed below are some of the major changes that would come from this enhanced decision-making, Table 3 also describes some of the differences between the two scenarios:

- A partially restored spring and early summer peaking hydrograph to improve resident and anadromous fish survival and wildlife habitat and help restore tribal First Foods, with a special focus on ensuring flows in low runoff years to allow for hydrologic conditions that promote ecosystem function
- Increased late summer and early fall flows to improve immigration, habitat, and water quality for resident and anadromous fish;
- Stable reservoir elevations to improve resident fish production and better protect tribal cultural resources;
- Increased spring and early summer spill to increase anadromous fish survival;
- Reestablished floodplain habitat to allow for groundwater recharge and restoration of important habitat for riparian dependent wildlife species;
- Structural modifications to immediately restore fish passage and improve water management and to handle anticipated climate change impacts now and in the future.

Deschutes River mouth, Source: CRITFC

Land Cover Analysis

Land cover acreage for the Columbia River Basin was derived from the USGS Land Cover Institute (LCI) spatial data using GIS software.[52] Acreage was calculated for every land cover category in the LCI data, including cultivated, forest, grassland, shrub-steppe, dammed reservoir, lake, river, and wetland land covers.

The GIS data was modified in several ways to enable a more detailed description of the natural capital of the study area. "Spatial attributes" were constructed to describe unique locations of ecosystems within the landscape. In this analysis, we considered four spatial attributes that affect ecosystem service values: proximity to agricultural areas and the location

Table 3. Expected Differences Between RCC-80 and 3Ea[51]

	RCC-80 (CURRENT CONDITION)	3EA (EBF)
FLOOD RISK	USACE Flood Control Operating Plan	USACE Flood Control Operating Plan
HYDROPOWER	Winter reservoir storage drafted to meet loads	Reduced winter generation- increased spring/ early summer generation
ECOSYSTEM FLOWS	Reduced winter reservoir storage reduces spring-early summer peak flows	Reservoir storage enhances peak spring-early summer freshet down through estuary
RESERVOIR OPERATION	Heavy reservoir drafting destabilizes reservoir environment	Reduced reservoir drafting stabilizes reservoir environment
FISH SPILL	Spring and summer spill	Slightly longer spring spill period
FCRPS BIOP	Misses spring flow targets in most years	Meets spring flow targets in most years
SUPPLEMENTAL AGREEMENTS	Trout and whitefish flows	Can alter trout and whitefish flows in some years

of land covers within riparian, urban, or climate zones. Table 4 describes how each spatial attribute was derived and the datasets involved in calculating the boundaries of each spatial attribute. For example, classifying a certain acre of forest as "riparian" allows us to choose ecosystem service values unique to riparian forests, or categorizing a grassland under dry and arid climates enables the application of different values than temperate grasslands. In addition, a landcover type could have one or more spatial attributes associated with it. For example, riparian wetlands adjacent to agricultural areas provide much higher values in terms of waste treatment from agricultural runoff than wetlands further removed from agricultural areas. Identifying the spatial attributes of landcover data allows the application of more granular study values and increases accuracy as each attribute provides information that narrows the scope of values and mitigates uncertainty. Valuations tend to be more accurate when the spatial distribution of values is taken into account.[53] Appendix B describes some limitations of this spatial attribute analysis.

Water-Based Analysis (Per Acre-Foot)

Increased flows that are beneficial to ecosystem function provide economic value. To estimate the increase in economic value, data from the CIS model is converted from cubic feet per second (cfs) to acre-feet. Assuming a constant rate of release between periods, the cfs is converted to acre-feet per day and then multiplied by the total number of days in the study period. This calculation yields the total acre-feet of water released over given a period. The net change in water volume over the critical period (March 1 through September 31) is calculated by subtracting the volume under the 3Ea scenario from the volume under RCC-80 for the driest, medium, and wettest water years.

Benefit Transfer Method

The benefit transfer method (BTM) is broadly defined as "…the use of existing data or information in settings other than for what it was originally collected."[54] Within the field of ecological economics, this method is a validated, well-established approach for indirectly estimating the value of ecological goods or services. BTM can generate reasonable ecosystem services estimates quickly and at a fraction of the cost of conducting local, primary studies, which may require more than $50,000 per service/land cover combination. Frequently, BTM is the most practical option available for producing reasonable estimates in an ecosystem services valuation.[55]

The BTM process involves taking ecosystem service values from comparable ecosystems as found in peer-reviewed journals and transferring them to a study site, in this case, the Columbia River Basin.[56] The BTM process is similar to a home appraisal, in which the value and features of comparable, neighboring homes (two bedrooms, a garage, one acre, recently remodeled) are used to estimate the value of another home. As with home appraisals, BTM results include a degree of uncertainty, yet the process quickly generates reasonable values appropriate for policy and project analysis.

The first step in the process is to identify primary studies with comparable climate and land cover classifications (wetland, forest, grassland, etc.) as those within the study area. Earth Economics maintains the Ecosystem Valuation Toolkit (EVT), a comprehensive repository of published, peer-reviewed primary valuation studies.[j] Studies under consideration were assessed based on their correspondence to the CRB. Any primary studies deemed to have incompatible assumptions, ecosystem services, or land cover types were excluded. Individual primary study values were adjusted and standardized for units of measure, inflation, and land cover classification to ensure an "apples-to-apples" comparison. Frequently, primary studies offer a range of values that reflect the uncertainty or variability within the research area. As such, high and low dollars per acre values in 2014 USD are included for each value provided in this report. Appendix F lists all primary studies used for value transfer estimates.

Winter in the Columbia River Gorge, Source: CRITFC

j Earth Economics Ecosystem Valuation Toolkit (EVT). More information available at www.esvaluation.org.

Table 4. Spatial Attributes and Data Sources

ATTRIBUTE	DESCRIPTION	METHODOLOGY	DATA SOURCE
Climate	Different weather patterns like precipitation, humidity, or temperature can result in different conditions under which ecosystem services are produced, e.g. water supply in arid climates may be more valuable than in temperate climates.	The Köppen-Geiger climate classification is based on average temperature and precipitation. In the CRB, three main climates exist: • dry and arid (B climate): 70% or more of annual precipitation falls in the summer half of the year and average annual precipitation less than 20 times the average annual temperature plus 280, or 70% or more of annual precipitation falls in the winter half of the year and average annual precipitation less than 20 times the average annual temperature, or neither half of the year has 70% or more of annual precipitation and average annual precipitation is less than 20 times the average annual temperature plus 140 • temperate (C climate): temperature of warmest month greater than or equal to 100C and temperature of coldest month less than 180C but greater than -30C • continental (D climate): temperature of warmest month greater than or equal to 100C and temperature of coldest month -30C or lower	Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorologische Zeitschrift 19: 135-141.
Agriculture	Areas within or adjacent to nearby farms which benefit cultivated lands or reduce the impacts of agriculture, e.g. native vegetation near farms can be home to wild pollinators that help increase crop yields.	The USDA tracks cultivated lands nationwide and produces the yearly Cropland Data Layer (CDL). All cropland in the CRB was identified using the 2015 CDL.	USDA National Agricultural Statistics Service Cropland Data Layer. 2015. Published crop-specific data layer [Online]. Accessed 06/15/16. USDA-NASS, Washington, DC. Agriculture and Agri-Food Canada – Land Use 2010 [Online]. Accessed 06/15/16. Agri-Geomatics Service of Agriculture and Agri-Food Canada.

ATTRIBUTE	DESCRIPTION	METHODOLOGY	DATA SOURCE
Riparian	Areas alongside streams and rivers where ecosystem services tend to be produced or demanded in greater quantities due to higher ecological productivity, e.g. some kinds of wildlife viewing or water-based recreational activity.	The National Hydrology Dataset, which provides data on all U.S. rivers, streams, and waterbodies, was combined with Canadian National Hydro Network data. This network is then buffered by 50 feet to approximate the riparian zone.	USGS National Hydrology Dataset. 2015. Accessed 08/10/16.USGS-NHD, Washington, D.C. GeoGratis, National Hydro Network. 2015. Accessed 08/10/16. Natural Resources Canada, Ottawa, CA.
Urban	Areas where the value of some ecosystem survival tends to be higher due to the proximity of dense populations, e.g. urban parks have greater positive impact on nearby property values.	U.S. Census data (Urban Growth Areas for Washington and Oregon and Urban Areas for remaining states) and Canadian Census Metropolitan Areas were used to map urban areas.	U.S. Census Bureau Urban Growth Areas. 2010. Accessed 06/15/16. U.S. Census Bureau, Washington, D.C. U.S. Census Bureau Urban Areas. 2015. Accessed 06/15/16. U.S. Census Bureau, Washington, D.C. Statistics Canada Boundary Files. 2011.Accessed 06/15/16.

Asset Valuation

The asset value of built capital can be calculated as the net present value of its expected future benefits. Provided the natural capital of the CRB is not degraded or depleted, the annual flow of ecosystem services will continue into the future. As such, analogous to built capital, we can calculate the asset value of natural capital in the CRB.

The asset value calculated in this report is based on a snapshot of the current land cover, consumer preferences, population base, and productive capacities. It provides a measure of the expected benefits flowing from the study area's natural capital over time. The net present value formula is used in order to compare benefits that are produced at various points in time. In order for this to be accomplished, a discount rate must be used.

Discounting allows for sums of money occurring in different time periods to be compared by expressing the values in present terms. In other words, discounting shows how much future sums of money are worth today. Discounting is designed to take two major factors into account:

1. Time preference. People tend to prefer consumption now over consumption in the future, meaning a dollar today is worth more than a dollar received in the future.
2. Opportunity cost of investment. Investment in capital today provides a positive return in the future.

However, experts disagree on the appropriate discount rate for natural capital benefits. Public and private agencies vary widely in their standards for discount rates. The Office of Management and Budget (OMB) recommends a seven percent rate for average investments, while the Congressional Budget Office (CBO) recommends a two percent rate for long-term investments. The choice of discount rate is critical, however, as it heavily influences the outcome of the present values of benefits which occur over a long period of time. This report uses two discount rates to analyze the asset value of the CRB: a standard seven percent discount rate, and a lower two percent discount rate. Lower discount rates better demonstrate the value of long-term assets, as benefits hundreds of years into the future are discounted at a smaller rate.

Present values can be calculated over different timeframes depending on the purpose of the analysis and the nature of the project. In the case of natural capital valuations, ecosystems, if kept healthy, show long-term stability and productivity. We chose a 100-year timeframe to reflect this fact; which is longer than many built-capital projects are valued for. Still, if kept healthy, the CRB would provide benefits for much longer than 100 years.

Table 5. Ecosystem Services Valued in this Analysis

	CULTIVATED	FORESTS	GRASSLANDS	SHRUBLANDS	DAMNED RESERVOIRS	LAKES	RIVERS	WETLANDS
Aesthetic Information		X	X					X
Air Quality		X	X	X				
Biological Control	X	X	X	X				
Climate Stability	X	X	X	X				X
Disaster Risk Reduction		X	X	X				X
Food	X	X	X					
Habitat		X					X	X
Pollination and Seed Dispersal		X		X				
Recreation and Tourism		X	X		X		X	X
Soil Formation	X	X	X	X				
Soil Retention	X	X	X	X				X
Water Capture, Conveyance, and Supply		X	X					X
Water Quality		X	X			X		X
Water Storage		X		X		X	X	X

Note: An 'x' marks an ecosystem service/land cover combination that was valued in this analysis.
See Appendix G for the dollar-per-acre-per-year results for each combination of land cover and ecosystem service.

Ecosystem Services Identified

For this analysis, 14 ecosystem services were valued over eight land cover types. We were able to value at least one ecosystem service on each land cover type. Table 5 shows the ecosystem services that were valued on each land cover. The greatest limitation to this analysis is a lack of valuation studies representing all of the ecosystem services provided in the CRB. Many ecosystem services that clearly have economic value provided by a land cover type could not be assigned value due to a lack of applicable values available in the literature. In particular, reservoirs, lakes, and rivers could not be assigned many ecosystem service values due to data gaps, yet these ecosystems provide clear benefits. For example, many reservoirs provide people with water supply and flood protection, two key ecosystem services that could not be assigned value for this land cover type.

The Value of Ecosystem Services

In total, the CRB provides annual ecosystem service benefits of $189.9 billion. The highest total benefits accrue from forests at $149 billion, followed by rivers at $11 billion. Given that forests represent over 56 million acres, or 18 percent of the basin's total area, the high forest value was foreseeable. Rivers, on the other hand, cover only 658 thousand acres (0.2 percent of the basin), and yet had markedly high per-acre ecosystem service values.

However, caution should be taken when comparing ecosystem service values between categories, as the difference in value may be due to data gaps rather than ecosystems' true value. Not every ecosystem service could be valued in this analysis due to a lack of available data in the literature. Furthermore, these values represent underestimates of the watershed's value, as many ecosystem services could not be valued at this time. However, these underestimates still give value to services provided by ecosystems that are currently valued at zero in the market system, therefore these underestimates are vital given they provide needed economic arguments to guide decision-making.

Table 6. Annual Ecosystem Services Valuation Results

LAND COVER TYPE	DRY	TEMPERATURE	CONTINENTAL	AGRICULTURAL	RIPARIAN	URBAN	ACRES	PER-UNIT ESV (USD/ACRE/YEAR)	TOTAL ESV (USD/YEAR)
Cultivated	X						6,496,768	$395	$2,566,223,496
Cultivated		X					6,837,363	$475	$3,247,747,227
Cultivated			X				2,373,152	$225	$533,959,247
Forest	X						406,166	$663	$269,287,966
Forest	X			X			3,448	$663	$2,285,830
Forest	X				X		521	$704	$366,825
Forest	X					X	32	$2,066	$66,460
Forest	X			X	X		4	$704	$2,596
Forest	X			X		X	0	$2,066	$0
Forest	X				X	X	8	$2,107	$16,612
Forest	X			X	X	X	0	$2,107	$0
Forest		X					12,940,699	$2,221	$28,741,291,994
Forest		X		X			5,599	$2,222	$12,440,980
Forest		X			X		41,417	$2,481	$102,754,659
Forest		X				X	41,820	$4,686	$195,968,422
Forest		X		X	X		2	$2,355	$5,448
Forest		X		X		X	5	$4,686	$22,976
Forest		X			X	X	375	$4,819	$1,805,572
Forest		X		X	X	X	0	$4,819	$0
Forest			X				42,574,821	$2,787	$118,661,987,637
Forest			X	X			590,445	$1,475	$870,989,758
Forest			X		X		100,706	$2,787	$280,680,399
Forest			X			X	23,925	$1,346	$32,206,061
Forest			X	X	X		6,459	$2,787	$18,002,904

LAND COVER TYPE	DRY	TEMPERATURE	CONTINENTAL	AGRICULTURAL	RIPARIAN	URBAN	ACRES	PER-UNIT ESV (USD/ACRE/YEAR)	TOTAL ESV (USD/YEAR)
Forest			X	X		X	4,879	$1,346	$6,567,701
Forest			X		X	X	305	$2,658	$809,725
Forest			X	X	X	X	30	$2,658	$79,213
Grassland	X						2,768,587	$117	$323,924,717
Grassland	X			X			373,141	$117	$43,657,532
Grassland	X				X		7,766	$117	$908,661
Grassland	X					X	4,578	$117	$535,655
Grassland	X			X	X		259	$117	$30,310
Grassland	X			X		X	307	$117	$35,902
Grassland	X				X	X	47	$117	$5,454
Grassland	X			X	X	X	0	$117	$38
Grassland		X					2,751,628	$284	$781,462,458
Grassland		X		X			512,737	$282	$144,591,730
Grassland		X			X		8,413	$28,062	$236,085,604
Grassland		X				X	29,830	$3,219	$96,021,617
Grassland		X		X	X		290	$28,062	$8,135,258
Grassland		X		X		X	1,173	$3,219	$3,775,259
Grassland		X			X	X	176	$30,609	$5,394,402
Grassland		X		X	X	X	2	$30,609	$75,360
Grassland			X				4,982,755	$618	$3,079,342,385
Grassland			X	X			326,924	$618	$202,038,935
Grassland			X		X		19,798	$618	$12,235,406
Grassland			X			X	23,491	$584	$13,718,709
Grassland			X	X	X		1,483	$618	$916,650
Grassland			X	X		X	11,291	$584	$6,594,017
Grassland			X		X	X	238	$603	$143,320
Grassland			X	X	X	X	37	$603	$22,493
Shrubland	X						21,463,551	$26	$558,052,321
Shrubland	X			X			826,529	$26	$21,489,743
Shrubland	X				X		45,770	$646	$29,567,184

LAND COVER TYPE	DRY	TEMPERATURE	CONTINENTAL	AGRICULTURAL	RIPARIAN	URBAN	ACRES	PER-UNIT ESV (USD/ACRE/YEAR)	TOTAL ESV (USD/YEAR)
Shrubland	X					X	36,459	$26	$947,923
Shrubland	X			X	X		465	$646	$300,217
Shrubland	X			X		X	647	$26	$16,816
Shrubland	X				X	X	407	$646	$262,865
Shrubland	X			X	X	X	12	$646	$7,856
Shrubland		X					19,548,075	$89	$1,739,778,675
Shrubland		X		X			635,820	$89	$56,587,963
Shrubland		X			X		50,888	$89	$4,529,050
Shrubland		X				X	129,364	$89	$11,513,390
Shrubland		X		X	X		274	$89	$24,364
Shrubland		X		X		X	907	$89	$80,699
Shrubland		X			X	X	1,675	$89	$149,035
Shrubland		X		X	X	X	2	$89	$167
Shrubland			X				30,128,010	$30	$903,840,311
Shrubland			X	X			650,558	$498	$323,977,644
Shrubland			X		X		86,965	$30	$2,608,937
Shrubland			X			X	62,620	$30	$1,878,606
Shrubland			X	X	X		5,165	$498	$2,572,286
Shrubland			X	X		X	6,964	$498	$3,467,984
Shrubland			X		X	X	1,148	$30	$34,425
Shrubland			X	X	X	X	94	$498	$46,724
Reservoir	X						156,078	$785	$122,521,168
Reservoir		X					149,217	$0	$0
Reservoir			X				800,944	$0	$0
Lake	X						222,005	$0	$0
Lake		X					282,507	$1,073	$303,130,201
Lake			X				744,782	$2	$1,489,563
River	X						102,406	$23,277	$2,383,693,226
River		X					343,690	$36,763	$12,635,071,838
River			X				212,458	$23,271	$4,944,110,812

LAND COVER TYPE	DRY	TEMPERATURE	CONTINENTAL	AGRICULTURAL	RIPARIAN	URBAN	ACRES	PER-UNIT ESV (USD/ACRE/YEAR)	TOTAL ESV (USD/YEAR)
Wetland	X						5,528	$21,123	$116,758,266
Wetland	X			X			472	$17,624	$8,321,346
Wetland	X				X		491	$21,123	$10,364,972
Wetland	X					X	0	$21,123	$0
Wetland	X			X	X		11	$17,624	$187,431
Wetland	X			X		X	0	$17,624	$0
Wetland	X				X	X	0	$21,123	$0
Wetland	X			X	X	X	0	$17,624	$0
Wetland		X					103,058	$50,500	$5,204,453,535
Wetland		X		X			2,942	$22,445	$66,022,804
Wetland		X			X		6,995	$56,718	$396,729,112
Wetland		X				X	23,887	$62,054	$1,482,265,913
Wetland		X		X	X		31	$28,663	$896,043
Wetland		X		X		X	71	$33,999	$2,415,884
Wetland		X			X	X	1,404	$68,272	$95,848,837
Wetland		X		X	X	X	0	$40,217	$4,142
Wetland			X				30,283	$43,976	$1,331,735,103
Wetland			X	X			14,544	$114,741	$1,668,740,432
Wetland			X		X		837	$23,851	$19,974,700
Wetland			X			X	2,810	$27,409	$77,026,104
Wetland			X	X	X		225	$102,737	$23,146,603
Wetland			X	X		X	1,271	$114,741	$145,839,563
Wetland			X		X	X	61	$9,393	$576,070
Wetland			X	X	X	X	6	$102,737	$649,164
TOTAL							**161,082,853**		**$189,963,081,928**

In addition to the annual flow of ecosystem service benefits, we calculated a general asset value for the CRB's natural capital. If treated as an asset, the CRB's ecosystem services amount to $2.7 trillion over 100 years using a seven percent discount rate, or as high as eight trillion using a two percent discount rate.

Table 7. Net Present Value of CRB Natural Capital Over 100 Years

DISCOUNT RATE	HIGH (USD)
2%	8,187,095,703,552
7%	2,710,630,841,480

Given that this valuation does not include all ecosystem services across all land cover types; these values should be considered underestimates. Yet, even these conservative estimates demonstrate the sizeable value of the CRB's natural capital. These high values indicate that investments in natural capital can provide vast long-term benefits if these assets are conserved or enhanced. Moreover, investment in natural capital can yield a tremendous return on investment due to both the low cost of investment (relative to building new assets) and because it supports a suite of ecosystem services and benefits, not just a single benefit.

Chapter Three

The Current Value of the Columbia River Basin

"In the way of our elders who came before us, we worship, dance, drum, sing and continue to gather foods, treading along some of the same paths they did to find food for our families and tap into our rich heritage."

– Confederated Tribes of the Umatilla Indian Reservation[57]

This chapter identifies the value of fisheries, existence of species, hydropower, flood risk management, recreation, navigation, and water supply for agricultural uses under current conditions. This scenario, Reservoir Current Conditions-80 years (RCC-80), models post-2024 dam management based on hydrological data from 1929 to 2008, and assumes that the dams will continue to be managed primarily for hydropower generation and flood control.

Spawning salmon, Columbia River, Source: Unknown

Non-Tribal Commercial Fisheries

Commercial fishing has been a source of significant economic value in the Pacific Northwest since the late 1800s.[58] Today, the Columbia River Basin supports multiple commercial fisheries throughout the Pacific, including local tribal and non-tribal commercial fisheries from Oregon to Alaska.[59] Within the basin, there are five species of salmon, but chinook, coho, and sockeye dominate commercial harvests. Steelhead and sturgeon are also caught in great numbers by tribal fisheries, and several thousands of pounds of shad and smelt are harvested each year in non-tribal fisheries.[60] Columbia River coho and chinook travel as far north as southeast Alaska and south along the Oregon Coast, supporting commercial fisheries there, as well as in British Columbia and Washington. Recent declines in salmon runs have cut commercial harvests to a fraction of their historic levels,[61] with related losses to commercial fishing jobs and income.

For Columbia River Tribes, salmon have always been a vital cultural resource for subsistence, ceremonial, and economic purposes. The Treaty tribes (Warm Springs, Nez Perce, Umatilla, and Yakima) have exclusive commercial fishing rights in 147 miles of the Columbia between the Bonneville and McNary dams; treaty fisheries bring in 50 percent of all harvestable adults in the river.[62] Non-tribal commercial fisheries are restricted to the 145 miles of river below Bonneville Dam.

In this section, we evaluate the economic value of non-tribal commercial fisheries. We do not quantify the economic value of tribal commercial, ceremonial, or subsistence fisheries, as these are invaluable to the tribes.

Economic Value of Commercial Fisheries

Methodology

To assess the current state of commercial fisheries within the Columbia River Basin, as well as coastal fisheries that rely on the Columbia River, we valued non-tribal commercial fisheries landings in: the Columbia River Basin and areas off the Washington, Oregon, British Columbia, and southeastern Alaska coasts. We collected data on salmon landings and ex-vessel prices from the National Marine Fisheries Service, Pacific Fishery Management Council, the government of British Columbia, Oregon Department of Fish and Wildlife, and the Alaska Department of Fish and Game. For regions outside the Columbia River Basin, we reduced landings based on estimates of the proportion of fisheries which can be attributed to habitat in the Columbia River. For example, an estimated 28 percent of chinook landings are from the Columbia River, so we only valued 28 percent of chinook landings in Southeast Alaska.[63] Table 8 shows the percent of commercial salmon catch attributed to Columbia River salmon stocks.

Table 8. Percentage of Salmon Catch Attributable to the Columbia River Basin

AREA	CHINOOK	COHO
Southeast Alaska	28%	0%
British Columbia	7%	<1%
Oregon Coast	16%	11%
Washington Coast	32%	1%
Washington Puget Sound	1%	0%

Source: National Marine Fisheries Service[64]

We based current conditions on the average landings over five years (2011 to 2015) for each of the zones identified in Table 8. To value landings, we used the average ex-vessel price per pound for each species over the same years.[65] We used the ex-vessel price per pound[k] because these data are readily

k Ex-vessel price per pound is the price paid to fishermen for their catch. It does not exclude the costs fishermen incur in producing the landed catch.

available and better reflect the net economic value of the resource. Ex-vessel value is the closest product to fish catch.[66] Other prices, such as first wholesale value or retail prices, can include markups for profit and labor. Assessing the impacts of commercial fisheries throughout the value chain is beyond the scope of this report.

Gillnet drying on a rack, Source: CRITFC

The Value of Commercial Fishing Under Current Conditions

Table 9 reports the annual landings and value of non-tribal commercial fisheries in the Columbia River Basin, and coastal fisheries of CRB salmon. Within the basin, non-tribal fisheries catch on average 2.4 million pounds in landings each year, producing $5.4 million in ex-vessel value. Outside of the basin, Columbia River salmon stocks support more than 1.5 million pounds of landed salmon, and an ex-vessel value of about $6.7 million for non-tribal fisheries. The total value of non-tribal commercial fisheries under the RCC-80 scenario is over $12 million.

Existence Value

Many Columbia River fish species, including salmon, are threatened or endangered.[67] There is significant evidence that people are willing to pay to protect rare, threatened, and endangered species[68] In economic terms, this concern is known as "existence value", or the value that people place on knowing that certain ecosystems or species exist, even if they will never see or use those ecosystems or species.[69] Recovering salmon populations in the basin would economically benefit the regional population.

Table 9. Non-Tribal Commercial Fishery Harvests Attributable to the Columbia River Basin, Summary of Salmon Landings

AREA & SPECIES	LANDED POUNDS (WHOLE)	LANDED VALUE
IN-BASIN		
Chinook	1,722,664	$4,343,686
Coho	654,725	$1,046,296
Pink	90	$144
Shad	11,346	$18,131
Sockeye	1,038	$1,659
Total In-Basin	2,389,864	$5,409,916
ALASKA AND BRITISH COLUMBIA		
Chinook	1,177,348	$5,392,618
COASTAL WASHINGTON AND OREGON		
Chinook	406,492	$1,326,975
Coho	2,726	$ 3,635
Total Out-of-Basin (AK, BC, WA, OR)	1,586,566	$6,723,228
GRAND TOTAL	**3,976,430**	**$12,133,144**

In 2009, Richardson and Loomis conducted a meta-analysis on existence value for various species from around the United States, including several cases of Pacific Northwest anadromous salmon populations. We chose this study because the complexity of the Columbia River Basin would be better matched by a meta-analysis of many studies. We used this study and function transfer methodology to estimate the economic benefits of existence value for Columbia River salmon. Function transfer uses economic models estimated in an original study with site-specific data (see Appendix I for the model used here).

The model shows that for current conditions, willingness-to-pay for salmon is about $13 per household per year. Using US Census data,[70] we determined that there are about 2.8 million households within the Columbia River Basin. Thus, the total existence value for households under current conditions is estimated at $37.3 million annually.

Hydropower

In 2014, the US electric power industry generated nearly $400 billion in revenue.[71] On average, hydropower accounts for about half of all electricity produced in the Pacific Northwest, excluding Canada.[72] Electricity produced within the basin powers cities up and down the Western US and Canada, from Vancouver to Los Angeles. Clearly, the benefits provided by the Columbia River Basin extend far beyond its ecological boundaries.

The US Bureau of Reclamation (USBR), the Army Corps of Engineers (USACE), and the Bonneville Power Administration (BPA) collaborate to generate and market hydropower through the Federal Columbia River Power System (FCRPS).[l] Annually, the 31 FCRPS dams provide 75,000 GWh (gigawatt-hour) of power.[73] There are also non-federal dams in the Columbia River Basin that contribute 43 GWh of power to the grid. Four major and seven smaller hydroelectric dams in the Canadian portion of the Columbia River Basin generate 22,000 GWh, about half of BC Hydro's total generation.[74]

Typically, the system can produce high amounts of baseload power and usually meet on demand power needs, meaning that hydropower can cover both the base demand requirements for power and much of the sudden increases in demand up to maximum capacity. In coordination with other generating resources, the system generates surplus power on a monthly basis, especially in high water years.

Chief Joseph Dam, Source: Brian Gruber

Hydropower generation is dependent on several factors, including: water supply within the basin, the regional power demand, irrigation demands, ecological requirements, system and transmission limitations and the climate (i.e. temperature). Year after year these factors can vary greatly, resulting in large fluctuations in the amount of hydroelectric power supplied by dams. For example, drought years can limit hydroelectric power generation, forcing the region to rely on other resources to either meet demand or to reduce environmental, agricultural or other water uses. Of course, in high water years, hydropower can be equal to or greater than regional demand, bumping other generating sources offline or resulting in spill levels (described below) that may cause ecological problems.[m]

Current Power Generation

The current conditions scenario (RCC-80) assumes that the Columbia River hydropower system will continue to be operated with the main objectives of hydropower and flood control. That means that priority is given to meeting power demands and managing reservoir storage levels to minimize flood risk to the best of their ability. Agencies are legally required to comply with fish and wildlife law and regulations, these often are not sufficient and dams are not adequately managed to promote and sustain and dam management does address ecosystem-based function as defined by the tribes. Thus, to a certain extent, more could be accomplished to fully realize this. The current condition scenario mimics the business-as-usual river management.

l Other uses of the FCRPS include flood control, irrigation, navigation and recreation.

m Because of the Public Utility Regulatory Policies Act, utilities are required to market any power produced by non-utility producers, even when there is no demand for said power. On rare occasions, BPA will pay non-utility producers to forego the production of power.

Methodology

Using CRITFC's Information System (CIS) modeling software, scenarios were developed using hydrologic and system operational data from 1929 to 2008. For each water year, data was provided for 14 periods throughout the year. System operational data was measured monthly, with the exception of April and August. These months were split into two periods each because there are often major changes in power operations instream flow during these months. The 80 water years are grouped into five water year quintiles based on hydrologic flow: quintile 1 included the driest 20 percent of water years, and quintile 5 included the wettest 20 percent. With this data, both system-wide and project-specific information was provided by individual water year, water month, and quintile. Furthermore, the data also represented total hydroelectric power generation, system surplus, spot pricing of surplus and deficit power, estimated dollar value of surplus and deficit power, and three types of spill at the dams. Although this approach is robust, one caveat to the RCC-80 scenario is that it does not incorporate climate change.[n]

Spill

Not all water that moves through a hydropower project is used for power generation. Occasionally, water is 'spilled', or released from a reservoir through a dam which bypasses the generating turbines. In addition, water may move through fishways and navigation locks and these sources do not generate electrical power. There are three reasons that water may be spilled from a dam. In the spring and summer, voluntary fish spill is released to assist juvenile salmon migrating to the Pacific Ocean. Second, forced spill can occur when there is more water entering the reservoir than can be run through the turbines (i.e. river flows exceed turbine capacity- which may be due to dysfunctional power generation facilities.) The last type, over-generation spill, occurs when demand for regional power is lagging.

The Value of Hydropower Under Current Conditions

The Pacific Northwest relies on power generated by the Columbia River power system, the majority of which comes from hydroelectric dams.

Figure 8, Figure 9, and Figure 10 show the hydroelectric demand and estimated generation based on hydrologic flow in the driest, medium, and wettest water years, respectively. Values are presented in average megawatts, or the electricity produced by continually generating one megawatt for one year. Power generated above the demand line is considered surplus and can be sold on the open market, helping to keep energy costs low for Pacific Northwest ratepayers.

In all water years, hydroelectric production is greatest in May due to peak natural runoff driven by snowmelt. In most years,

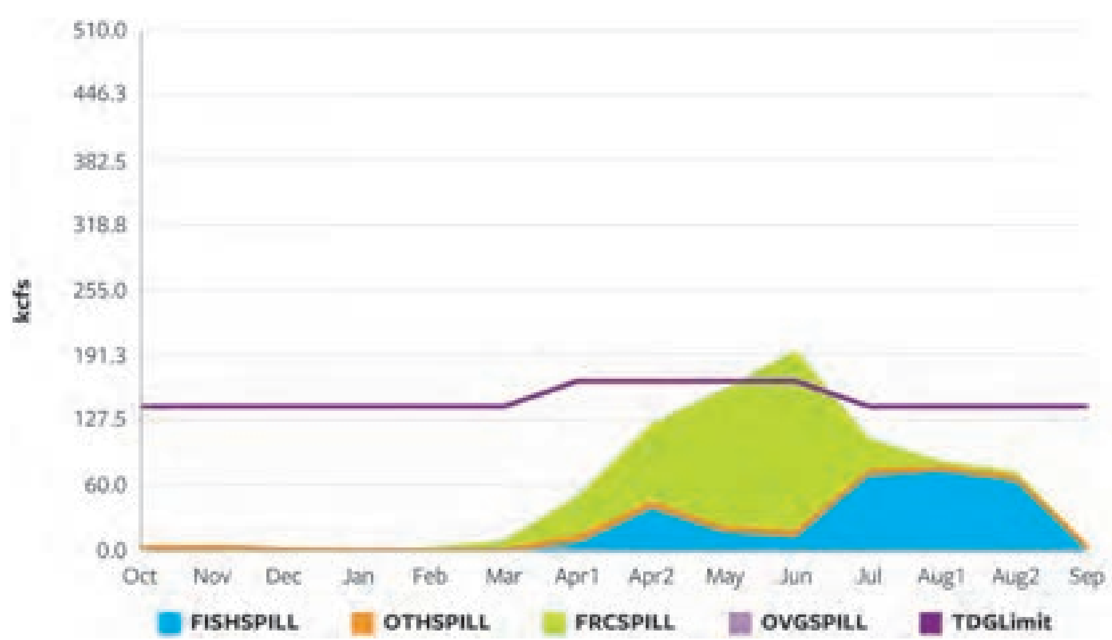


Figure 6. Different RCC-80 Spill Categories at The Dalles Dam for the Highest Flow Years

n The data for basin climate change hydrology is currently being developed and updated through the River Management Joint Operating Committee. Given the need to complete this analysis, climate change hydrology could not be included in any of the modeling efforts.

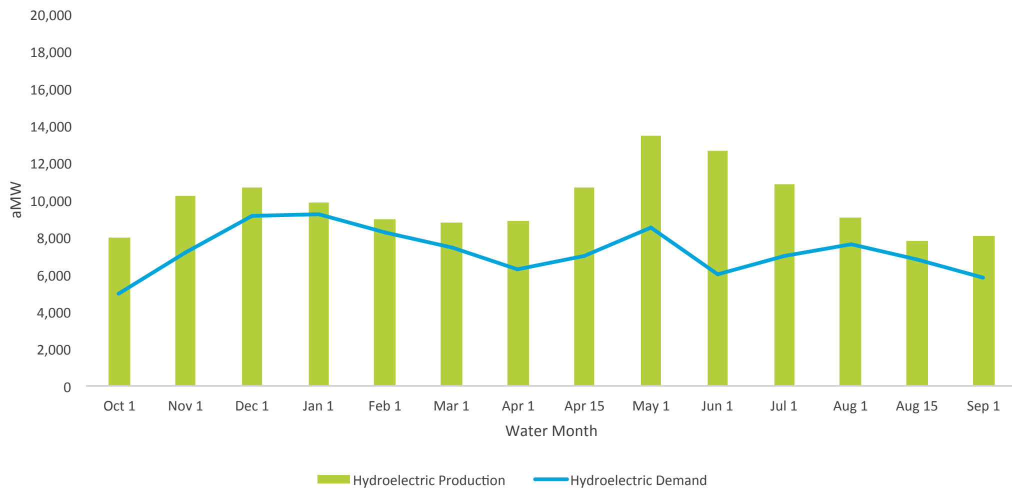


Figure 7. Columbia River Basin Hydroelectric Production—Q1

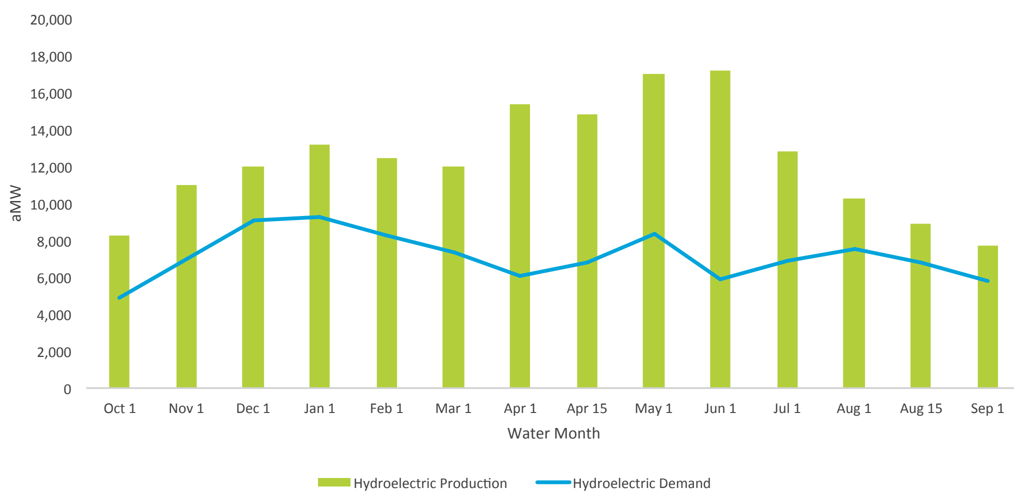


Figure 8. Columbia River Basin Hydroelectric Production—Q3

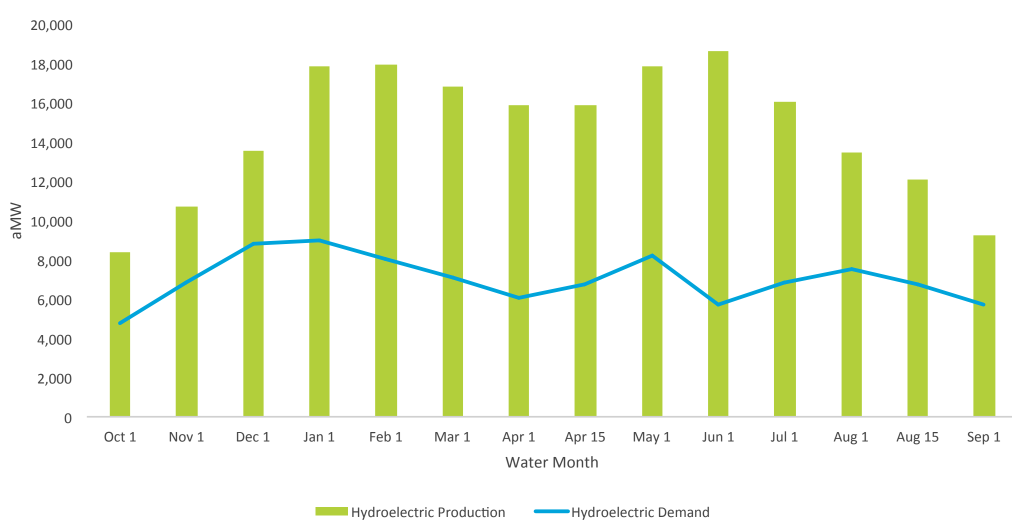


Figure 9. Columbia River Basin Hydroelectric Production—Q5

the initial controlled flow[o] has occurred by mid-April so that flood control storage requirements can be met. As can be seen by the graphs, hydroelectric demand is being met in all water years, including under the driest conditions. In high water years, the system sees major power surpluses that increase revenue flow, assuming the power generated can be marketed.

Revenues were estimated by using PNW East prices (MID-Columbia Prices) observed for each of the 14 water periods under each water year. Although prices vary by day and even by hour, these prices are assumed to be reflective of the economic value of hydropower. Revenues from hydroelectric power generation are estimated to be $3.1 billion in the driest years, $3.4 billion in medium years, and $3.7 billion in the wettest years. In the current conditions scenario, CIS models estimate demand is met in all months and all water years, leaving surplus power that can be sold on the open market.

Table 10. Value of Hydropower under Current Conditions

HYDROPOWER VALUES	CURRENT CONDITIONS
Driest Water Years	$3,066,514,176
Medium Water Years	$3,388,935,087
Wettest Water Years	$3,664,655,116
WEIGHTED AVERAGE	**$3,373,356,570**

Power-Generating Alternative Resources

The Columbia River Basin is a powerhouse for electricity production. A large portion of this production comes from hydropower, with natural gas, wind, nuclear, and coal making up the majority of the remaining production. The region's power generation and demand is not static, however. While historically shortfalls have occurred, according to the Northwest Power and Conservation Council, there is enough power generated in the CRB to meet expected loads until about 2026 due to reduced southwestern US needs through other sources and energy conservation gains in the CRB. Post 2026 the Council analysis indicates that additional power sources would not be needed unless demand exceeded the median forecast. In addition, the Council reports that shifts in Northwest energy demand from winter to summer as a result of climate change will necessitate changes in power generation timing and distribution.[p] As the population continues to grow and power demands increase, the region faces two choices, which are not mutually exclusive. To meet the needs of an increasing population, the Pacific Northwest must increase power-generating capacity to keep up with demand, or per-capita power must decrease through conservation efforts. BC Hydro is continuing to develop the Peace River Project, which will provide 1,100 megawatts of capacity and about 5,100 gigawatt hours of electricity each year, enough to power about 450,000 homes per year in BC.[75] Additionally, the Northwest Power and Conservation Council's 7th Power Plan identified around 5,100 aMW's of technically achievable conservation potential by the end of the 20-year forecast period (2035).[76]

Meeting Demand through Increased Generating Capacity

All power-generating resources have pros and cons. Coal is inexpensive, but carries high environmental costs. Hydropower does not directly contribute to carbon emissions, but decomposing matter held behind reservoirs produce significant GHG emissions[q], particularly methane. Additionally, hydropower adversely affects the natural hydrograph, and therefore the ecosystem, including impeding salmon production and migration. Wind has low environmental implications, but is inconsistent hour-over-hour, even as it is consistent year-over-year.

Life cycle assessments (LCA) can help to compare the

Grand Coulee Dam , Source: CRITFC

o According to the USACE Flood Control Operating Plan, the initial controlled flow (ICF) occurs when the runoff forecasts indicate that flood control storage is adequate in system reservoirs to avoid flooding.

p Northwest Power and Conservation Council. 2015. 7th Power Plan. Climate Change Appendix; October 6, 2015 J. Fazio, Senior Systems Analyst- Briefing and Discussion to Council Members of Climate Change 7th Power Plan Climate Change Appendix.

q Washington State University (WSU) researchers say the world's reservoirs are an underappreciated source of greenhouse gases, producing the equivalent of roughly 1 gigaton of carbon dioxide a year. Reservoirs are a particularly important source of methane, a greenhouse gas that is 34 times more potent than carbon dioxide: https://news.wsu.edu/2016/09/28/reservoirs-play-substantial-role-global-warming/

environmental impact of various power-generating resources by providing a more complete view of environmental impacts over the course of a resource's life. LCA is a comprehensive assessment that includes extraction of resources, production, operations, and decommissioning.

Table 11 lists some of the pros and cons of traditional and alternative energy sources with their associated life cycle emissions, expressed as grams of CO_2 equivalent per kilowatt hour of electricity produced. These values are not specific to the Columbia River Basin resources.

Table 11. Pros and Cons of Common Energy Sources[r]

ENERGY SOURCE	PROS AND CONS	ESTIMATED LIFE CYCLE EMISSIONS[77]
Coal	**PROS** • Inexpensive • Infrastructure is already in place • Stable large-scale electricity generation **CONS** • Emits high levels of CO_2 • High environmental impacts from coal mining and transportation • Not a renewable resource • Technologies to reduce CO_2 at coal plants are expensive	950-1250 $_{g}CO_{2}eq/kWh_{e}$
Natural Gas	**PROS** • Carbon dioxide, carbon monoxide, and nitrogen are about half that of coal • Gas plants are less expensive than coal plants **CONS** • Environmental impacts from gas exploration • Not a renewable resource • More expensive than other fossil fuels	440-780 $_{g}CO_{2}eq/kWh_{e}$
Nuclear	**PROS** • Cost-effective alternative to fossil fuels • High energy output • High degree of flexibility **CONS** • Excavation of uranium is extremely harmful to the environment • High clean-up cost • High-risk waste produced	2.8-24 $_{g}CO_{2}eq/kWh_{e}$
Hydroelectric Power	**PROS** • Good for base load • Flexible/demand matching • Abundant resource in the Pacific Northwest **CONS** • Adversely affects fish spawning, rearing and passage • Reservoirs in particular are a source of methane emissions from decomposing matter • Traps sediment and nutrients behind dams • Susceptive to droughts • Changes hydrograph and thermograph • High land and water usage • Expensive to build, repair, and decommission	1-34 $_{g}CO_{2}eq/kWh_{e}$

r Source for LCA emissions: Weisser, D., 2007. A guide to life-cycle greenhouse gas (GHG) emissions from electric supply technologies.

ENERGY SOURCE	PROS AND CONS	ESTIMATED LIFE CYCLE EMISSIONS[77]
Biomass	**PROS** • Fuel tends to be inexpensive **CONS** • Waste collection can be difficult • Generates greenhouse gases	35-99 $_{g}CO_2eq/kWh_e$
Wind	**PROS** • Low impact on the environment • Produces no bi-products • Abundant and sustainable • Economic development opportunity **CONS** • Wind production can be intermittent, requires other types of on demand power to be ready • Some turbines can be a threat to birds and bats • Aesthetic impact • High land usage • Significant investment and maintenance costs	8-30 $_{g}CO_2eq/kWh_e$
Solar (photovoltaic)	**PROS** • Low operating and maintenance costs • Safe, renewable, clean power • Economic development opportunity • Abundant and sustainable **CONS** • High initial cost per kw/h • Intermittent • High land usage per kw/h	43-73 $_{g}CO_2eq/kWh_e$

In recent years, the potential for wind and solar power generation in the Columbia River Basin has been realized. Wind now accounts for about 7.6 percent of the region's power, having grown steadily since its introduction to the region circa 2000.[s] Looking forward, solar photovoltaic generation is expected to increase market share as costs per kilowatt hour continue to decrease.[78] Grid energy storage may eventually help to smooth the delivery of these more intermittent power sources.[79] However, grid energy storage will also carry its own lifecycle costs.

Many of the governments within the Columbia River Basin are adopting their own standards for renewable energy, several of which exclude the use of hydropower to meet these standards. For instance, Washington passed Initiative 937 in 2006, requiring utilities to use eligible renewable resources for at least 15 percent of their loads by 2020. Although these standards are a positive push towards clean renewable energy, they still present a large task for utilities to balance loads from sometimes erratic generating sources. As the shift towards renewables continues, hydropower will be important in this balancing act.

Meeting Demand through Conservation

Meeting regional demand through conservation simply means using less energy to provide the same level of services. One example of conservation would be changing from incandescent to LED light bulbs, which use less energy. Conservation is being promoted throughout the Northwest, not just within the Columbia River Basin. Box 1 below highlights the Northwest Power and Conservation Council's (NPCC) findings on where conservation can be improved by sector.

s The region is defined as those states contributing at least a portion of their electrical generation directly to BPA's grid (Idaho, Montana, Nevada, Oregon, Washington, and Wyoming).

The Grid

The BPA-operated power transmission lines reach Washington, Oregon, Idaho, western Montana, northern California, northern Utah, and western Wyoming.[80] Given the scope of this network, coordination between electrical power users and suppliers is a complex process. Investments within six categories can improve the efficiency and reliability of BPA power delivery (Table 12), leading to reduced environmental impacts from power generation and increased economic stability of businesses on the grid.[81] The expected benefit-cost ratio for implementation of smart grid technology is 1.8, indicating the feasibility of smart grid investments.[82]

RESIDENTIAL SECTOR: 2,300 aMW through improvements in water heating efficiency, lighting efficiency, and heating, ventilating, and air-conditioning (HVAC) efficiency.

COMMERCIAL SECTOR: 1,900 aMW through improvements in lighting systems, ventilation, server rooms, and other 'plug loads'.

INDUSTRIAL SECTOR: 580 aMW through effective management practices could increase savings from eqipment and system optimization measures.

AGRICULTURAL SECTOR: 130 aMW through irrigation system efficiency improvements, improved water management practices and more efficient dairy milk processing.

UTILITIES: 200 aMW through improved efficiency in distribution systems.

Adapted from the NPCC 7th Conservation and Electric Power Plan

Box 1. Potential Conservation Actions as Outlined by the Northwest Power and Conservation Council

Table 12. Grid Improvement Options

INVESTMENT CATEGORY	TECHNOLOGIES	IMPLEMENTATION OUTCOMES
Transmission & Distribution (T&D) Optimization	Smart Voltage Reduction	Increased efficiency of electricity delivery
Grid Reliability	Fault location, isolation, and service restoration (FLISR)	Reduced duration of grid outages
Dynamic & Responsive Demand (DR)	Energy management system (EMS) controlling HVAC load based on price signals	Reduced electricity use during times of peak demand
End Use Energy Efficiency (EE)	Smart thermostats automatically optimizing customer HVAC energy consumption	Reduced electricity demand
Grid Storage Integration & Control	Customer-sited, utility controlled, Li-Ion battery	Charging during low demand allows for reduction in power use during peak demand
Utility Operational Efficiency	Automated Advanced Metering Infrastructure (AMI) meter reading & billing software	Reduced operation and maintenance costs

Climate Change Impacts on Hydropower

Changes in Basin climatology/hydrology combined with PNW population growth will likely force substantial modifications to hydropower demand, production and grid transfer. The NWPCC projects additional regional generation resources would be required post 2026 should loads exceed medium forecasts due to climate change (Figure 10).

In any case, warming winters and warming summers with lower stream flow are expected to change historical regional energy load demands from winter to summer, as less power is needed in winter and air conditioning, which consumes more energy (Figures 11 and 12).

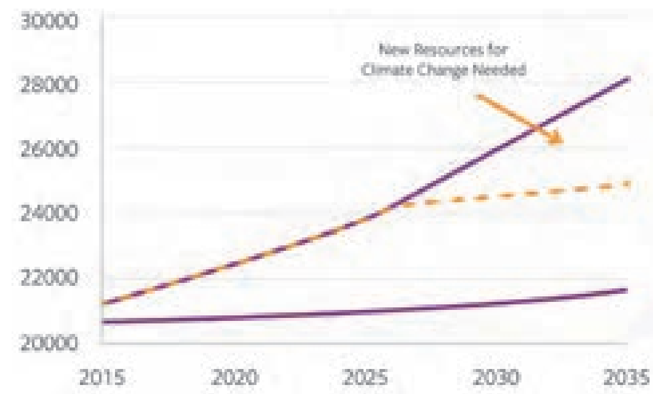


Figure 10. Projection When Additional Energy Resources May be Needed to Meet PNW Loads Under Climate Change Projections (NWPCC 2015)

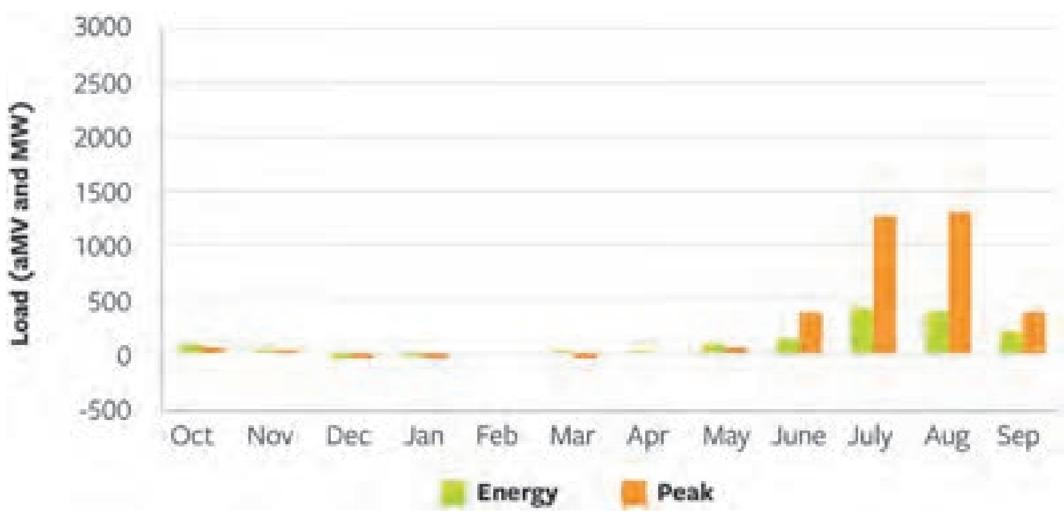


Figure 11. Projected Changes in 2026 Average and Peak Loads (NWPCC 2015)

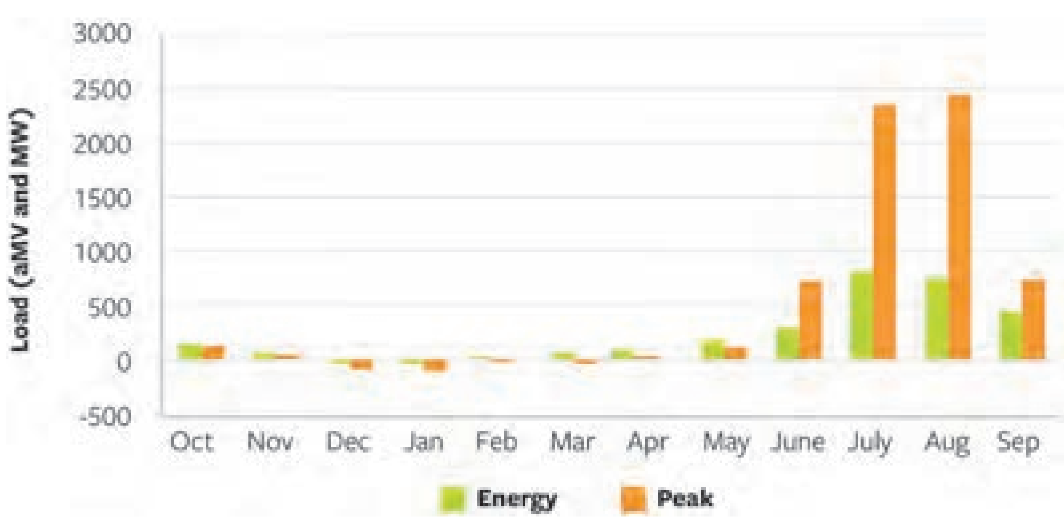


Figure 12. Projected Changes in 2035 Average and Peak Loads (NWPCC 2015)

Table 13. Recommended Actions to Address Energy Loads and Ecosystem Values Affected by Drought and Climate Change

DISTRIBUTED GENERATION—REDUCTION OF TRANSMISSION LOSSES
Strategically placed generation—smaller generation plants such as combustion turbines close to load centers
Peak Power True cost-pricing-increase power rates to reflect ecosystem costs
Efficiency Improvements—building conservation, lighting and heating efficiencies
Energy consumption timing—incentives to use energy during non-peak periods
Renewable development and integration—solar, wind, conservation
Fuel switching—increase natural gas capacity for selective peak use
Encourage public awareness and utility advances on energy consumption, price mechanisms, and energy efficiency

From Foley, T. and R. Lothrop. 2003. Tribal Energy Vision. Columbia River Inter-Tribal Fish Commission. Portland, OR. Available at CRITFC.org

Table 14. Major Flood Storage Dams in the CRB

	OPERATOR	INSTALLED CAPACITY (MW)	AVAILABLE FLOOD CONTROL STORAGE (ACRE-FEET)
Keenleyside Dam	BV Hydro	185	7,100,00
Mica Dam	BC Hydro	1805	7,000,000
Grand Coulee Dam	USBR	6,809	5,185,000
Libby Dam	USACE	600	4,979,500
Hungry Horse Dam	USBR	428	2,980,000
Dworshak Dam	USACE	400	2,015,800
Duncan Dam	BC Hydro	N/A	1,400,000
Brownlee Dam	Idaho Power	585.4	1,000,000
Revelstoke	BC Hydro	2480	1,000,000
All Other Dams			22,339,700
TOTAL CRB STORAGE			55,000,000

Hydropower generation is a valuable asset that has helped fuel the economic development of the Pacific Northwest. Its value will be affected by climate change and dynamic energy market forces that include conservation, renewables, and transmission grid modifications. Hydropower and associated builtv development would not have been possible without the natural capital that underlies all of the built capital used to produce hydropower. The total annual value of hydropower in the CRB under the current conditions scenario is $3.4 billion.

Flood Risk Management

As previously mentioned, the original Columbia River Treaty sought to maximize flood control and hydropower benefits, through water management via construction and operation of large upper basin storage dams. In doing so U.S. and British Columbia agencies permanently flooded a number of areas in the upper Columbia River Basin and in the impoundments above the dams along the Columbia River and its tributaries.

Today, the basin has approximately 55 million acre-feet of storage, with Kinbasket Reservoir behind Mica Dam as the largest storage with 12 area at million acre-feet.[83]

Table 14 describes the largest storage projects in the basin and their flood control storage capacity authorized by the CRT. According to the USACE, about 8.95 million acre feet in assured flood storage is available from Canadian reservoirs (USACE Post 2024 White Paper, 2011).

As a result of managing these impoundments for flood risk and hydropower, major flooding events have essentially been eliminated on the Columbia River itself, although it can remain a challenge in some along connecting upstream tributaries.[84] In this section, the major flood risk management dams and the uncertainty of future flooding and opportunities within the Columbia River Basin that could mitigate flood risk are described.

Flood Risk Management in the Columbia River Basin

Since the series of dams were built as a result of the 1964 Columbia River Treaty, serious flooding on the mainstem of the Columbia has become rare. However, some outside areas are still permanently flooded by Treaty dams, for example the 4,000 acres of tribal land from the Spokane reservation.[85]

The extensive Columbia River dam system can store nearly a third of all the water that flows through the Columbia in an average year.[86] Current drafting of large storage reservoirs such as Kimbasket and Arrow Lakes for basin winter hydropower provides storage space for flood risk during most years. Despite the river's power and volume, its system of dams and reservoirs moderates major flood events and limits damages. Flood control planning by USACE is based on forecasted flows at The Dalles and overall reservoir storage, where the objective is to keep flows below 600 kcfs whenever possible.[87] In reality, peak flows as the Dalles have seldom exceeded 450 kcfs in recent years. Flood control rule curves are created and implemented so that depending on forecasted runoff, enough reservoir storage is available to impound runoff to avoid major flood events. With regulation, the last time peak stream flows at The Dalles were above 600 kcfs was June of 1972.

Throughout the broader basin, however, extensive flood events have occurred, especially within the last two decades. In 1996, the Willamette Valley experienced extensive flooding resulting in millions of dollars in damage and disaster declarations by 18 counties.[88] Each year since, at least one or two communities along the Columbia River and its tributaries experience extensive rain that causes flooding.

Lake Roosevelt, Source: Brian Gruber

Figure 13. Tri-Cities 100-yr Floodplain

The need for a flood risk management review was identified during the Sovereign Participation Process as a domestic matter to be undertaken in 2014. The Columbia Basin tribes are concerned that the default change to current operations of "on call" to "called upon" and "effective use" after 2024 will adversely affect their efforts to enhance ecosystem-based function because it may: 1) require larger and more frequent drawdowns at Grand Coulee Dam and other U.S. reservoirs in order to provide the minimal flood risk protection presently offered through "Assured Flood Storage" from Canada; 2) adversely impact resident fish, cultural resources, navigation, recreation, riverbank stability and public safety through dramatic changes in reservoir operations; 3) limit system capability to provide necessary spring and summer flows for salmon; and 4) cause serious adverse consequences for the Basin's economy and increased uncertainty and risk related to major flood events in the face of climate change.

The tribes continue to pursue initiation of this review and associated congressional appropriations and if necessary, cost share waivers for a region-wide public process to assess potential changes to the current level of flood risk protection in the Columbia Basin. Such a process should have been initiated in 2016, or as soon as possible thereafter, but must be completed before 2024, when Treaty flood risk provisions are changed. The process should be broadly open to input from the public and stakeholders so that it addresses all options to manage both medium and high flow events.

Current Flood Risk

The greatest flood risks to CRB communities occur in two main areas: where the Columbia River meets major tributaries and at "choke points". In floodplain science, choke points reference narrow stretches of a stream or river, sometimes with sharp bends, where water is funneled.[89] The Snake and Willamette Rivers join the Columbia downstream of the Grand Coulee Dam, the closest substantial flood storage dam. The dams below Grand Coulee are essentially "run of river" projects, incapable of storing flood waters. Although the John Day Dam has some flood control capacity, it does little to reduce flood risk relative to Grand Coulee's capacity.

Several of the most recent flood events, however, occurred when heavy rainfall overwhelmed stormwater infrastructure before the water reached any major river. Rapid stormwater runoff can cause greater damage to CRB communities than flooding directly related to instream flows because current upstream reservoir storage infrastructure is designed to prevent major flood events before they occur. Yet, regions throughout the CRB still experience flood damages, even to the extent that requires a disaster declaration.

Local floodplain managers must rely on floodplain maps to pinpoint risk. However, FEMA's 100-yr and 500-yr maps project flood risks from major rivers, and thus do not accurately reflect urban flood risk from heavy rainfall events. Figure 13 shows that 100-yr maps do not reach far beyond the Columbia River, and thus do not reflect non-riverine flood risk.

CRB communities also face flooding risk from choke points, another event related to heavy rainfall. This feature can often cause a "bottleneck," especially during heavy rainfall or if the river is blocked by debris, resulting in elevated water levels directly upstream and potential flood. Floodplain managers attribute the 1996 Willamette River flood to the combination of heavy rainfall on upland snow combined with the choke point created by excessive Willamette River flows. This combination eventually backed up Columbia River flows. Downtown Portland was nearly flooded after the river crept over the harbor wall along the waterfront. The possibility of other choke points along the middle Columbia River is an increasing threat as the basin experiences larger, more frequent storms.

Climate Change in the Basin

Recent studies forecast warmer, wetter climatic conditions throughout the basin that will result in more intense winter precipitation falling more frequently as rain rather than snow, increasing river flow during winter and early spring months.[90] The same study projected that by 2080, the 100-yr floodplain will increase by 10 to 70 percent in many portions of the Columbia River's tributaries. These conditions call for protection of property and life by securing existing levee system and restoration of floodplains by moving built capital away from flood prone areas and restoring riparian areas. These climate change-induced hydrological changes will make flood management on the Columbia more challenging, particularly near the choke points described above.[91]

The largest cities in the CRB are located where major tributaries meet the Columbia River. Similar to the conditions of the 1996 Willamette River flood, the cities of Hood River, The Dalles, the Tri-Cities, and Portland are all located at confluences that could create choke points under large storm conditions. These cities are also at risk due to limited flood storage along specific stretches of the Columbia River. Although the upper basin has extensive storage, upstream storage is not able to provide flood protection from extensive runoff within the middle Columbia and Snake River. Few dams downstream of Grand Coulee Dam provide any appreciable flood storage. Only one dam in the middle Columbia provides relatively limited flood protection: John Day Dam. Other dams may slow water flow, but are not designed to store floodwater.

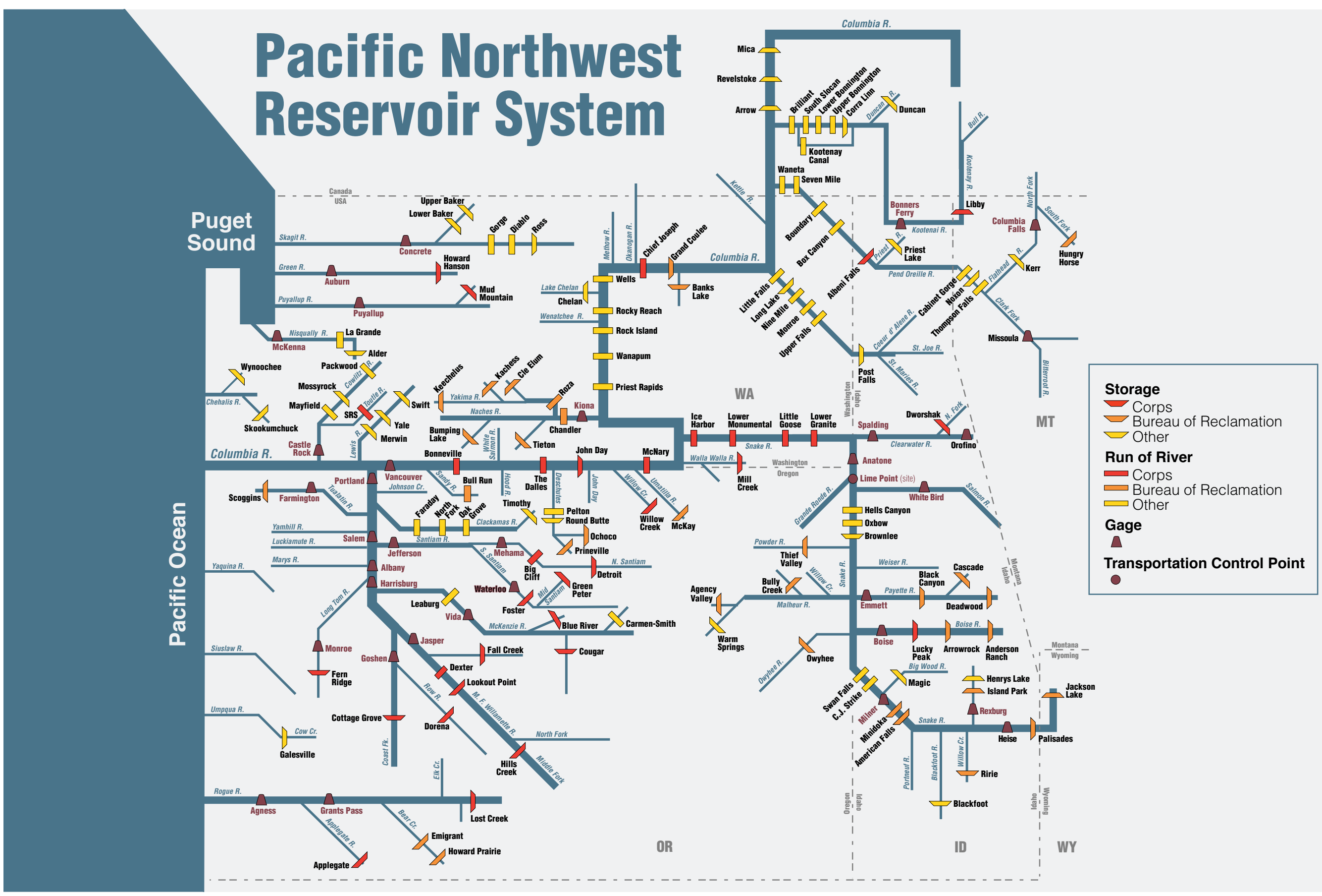


Figure 14. Dams of the Columbia River

Lake Rufus Woods at Bridgeport State Park, Source: Brian Gruber

Recreation

Whether fly fishing on the South Fork of the Snake River or wakeboarding on Lake Roosevelt, Columbia River Basin residents desire high quality outdoor recreation opportunities. Many of these recreation opportunities are greatly impacted by the operation of the Columbia River reservoir system. Degraded salmon habitat affects the quantity and quality of fish available for catch, and boating recreation often becomes inaccessible when reservoir levels drop.

This section evaluates the current economic value of recreation on the CRB's reservoirs and rivers. Additional analysis is presented on Lake Roosevelt and Dworshak Reservoir to estimate the effect on the economic value of recreation with the integration of ecosystem-based functions into the Columbia River Treaty (Chapter 4). Although the economic values presented here do not represent spending effects within the economy, outdoor recreation is still one of the largest job providers and generators of sustainable economic development in both urban and rural areas.[92]

Economic Value of Recreation

The Columbia River and its tributaries offer a wide variety of recreational opportunities, including fishing, kayaking, swimming, boating, wakeboarding, windsurfing/kiteboarding, etc. Some of these activities occur on the free-flowing stretches of river or along lakes, while others are made possible by the reservoirs behind dams.

These recreational activities satisfy consumers. Consumer satisfaction can increase or decrease depending on the quality of the recreational experience. For example, if a family arrives at Lake Roosevelt for a day of swimming and picnicking only to find that the lake level has dropped 20 feet from the level at their previous visit, then their experience (or satisfaction) may be negatively impacted. One way to measure consumer satisfaction is through the willingness-to-pay (WTP) for recreational experiences.

Previous studies have found that WTP increases when reservoir levels increase.[93] On the other hand, when reservoir levels decrease, participants lose access to recreation opportunities and their experiences suffer. For instance, the aesthetic impact of a "bathtub ring" around the reservoir (water marks on reservoir landscape caused by changing reservoir levels) discourages recreational fishing.[94] Additional studies have found there are preferred outflows for angling and other recreation occurring below the dams.[95]

Methodology

For the non-angling recreation analysis, visitation data was collected from federal and state recreation providers. Visitation data was then geocoded[t] and divided into the eleven basin sub-regions (see Chapter 1). Visitation captured by federal and state agencies in the U.S. and British Columbia is by no means a complete representation of recreation in the Columbia River Basin. Recreation also occurs on local and private lands and waters, tribal lands, and federal or state lands where visitation is not actively monitored or cannot be accurately estimated.

This analysis uses the benefit transfer method to measure the net WTP, a measure commonly used by the Army Corps of Engineers, the Bureau of Reclamation, and other federal agencies in economic analysis.[96] Recreational values were derived from a recreation value database developed by Dr. Randall Rosenberger, Professor of Environmental Economics at the Oregon State University.[97] Although dam management may increase or decrease an individual's WTP based on the quality of recreational experience, those potential effects are not modeled here. Values may thus be considered underestimates.

For the angling analysis, data was compiled from the Washington Department of Fish and Wildlife, the Pacific Fisheries Marine Council, the Pacific States Marine Fisheries Commission, and the Pacific Salmon Commission. Estimates are provided for increased fish runs and catch in the Columbia River Basin as well as for out-of-basin catch. Values for the angling analysis were derived from Olsen, et al 1991.[98]

Value of Non-Angler Recreation

The CRB provides numerous opportunities for wide-ranging forms of recreation. Each region offers distinct recreational opportunities, and thus, unique economic values. The following sections outline recreational opportunities, visitation, and economic values for the key recreational areas within the CRB. Values are derived from the Recreational Use Values Database.[99]

The high recreation visitation numbers presented below reflect the quality of recreational experiences within the Columbia River Basin. Without proper management of these lands and waters, economic value will likely diminish and visitation and consumer satisfaction will decline.

As was mentioned in the methodology, this is an incomplete representation of recreation in the Columbia River Basin. Limited participation data means that estimates should be considered extremely conservative. A full list of recreation sites used in this analysis is available in Appendix C.

Blue Mountain

The small Blue Mountain sub-region in Northeast Oregon lies within the Snake River Basin. Visitors come to numerous recreation areas, including the Wallowa Lake State Recreation Area, Hells Gate Recreation Area, and Iwetemlaykin State Heritage Area, the ancestral homeland of the Nez Perce Tribe.

Activities in the Blue Mountain area include boating, fishing, hunting, skiing, hiking, wildlife viewing, and swimming. About 1.1 million recreational participants visit the Blue Mountain sub-region annually, and the economic benefit of this recreation is estimated at $60 million.

National Forest lands in the Blue Mountain sub-region are a large provider of outdoor recreation, inspiring roughly 289,000 recreation trips annually that are estimated to be worth $22 million.

Additional recreation occurs on the Wild and Scenic Snake and Grand Ronde Rivers in the Wallowa-Whitman National Forest. An estimated 56,000 users recreate on the Snake River stretch annually,[100] engaging in commercial powerboat use and commercial or private floating. The Hells Canyon Creek Recreation Site also accommodates 5,000 drive in visitors not captured in the previous records. The economic value of the recreation in this area is estimated to be $5.3 million annually.

Columbia Cascade

Stretching from Central Washington into Canada, the Columbia Cascade is home to many of Washington's state parks, including Lake Chelan, Lake Wenatchee, and Pearrygin Lake. These state parks host over two million recreation participants annually, with a total economic value of $107 million.

The sub-region also receives visitors to Lake Chelan National Recreation Area, although this area is less visited than many of the area's state parks. Lake Chelan National Recreation Area welcomes 32,000 visitors annually, at an economic value of $2.4 million.

The Mt. Baker-Snoqualmie and Okanagan national forests both lie partially within the Columbia Cascade sub-region. Using acreage allocations, an estimated one million recreation participants visit these lands annually, providing an economic value of $83 million.

North of the border in Canada, BC Parks receive 1.7 million visitors annually. Most of their facilities see a high level of

t A set of geographical coordinates corresponding to a location.

day use activities, and about 225,000 overnight campers. The economic value of this recreation is $91 million.

Columbia Gorge

The Columbia Gorge sub-region is another small area on the Washington-Oregon border, home to some of the best windsurfing/kiteboarding in the world. Nearly 4.5 million recreation participants visit the sub-region annually to participate in windsurfing, kiteboarding, hiking, mountain biking, skiing/snowboarding, swimming, boating, and camping. The annual economic value of this recreation is estimated at $148 million.

Four national forests also provide recreational opportunities in the Columbia Gorge: The Columbia River Gorge, Gifford Pinchot, Mt. Hood, and Okanogan-Wenatchee National Forests. Together, the estimated recreation provided is over two million forest visits, at an economic value of $161 million.

Columbia Plateau

The large Columbia Plateau sub-region is located in the heart of the Columbia River Basin. At the very center lies the confluence of the Snake, Yakima, and Columbia Rivers. This gem hosts over 9.3 million recreation participants every year on BLM lands that receive 136,000 visitors, Oregon Parks with over 5 million visitors, Washington State Parks with 2.6 million visitors, and 1.5 million visitors to USACE lakes. These lands provide a recreational value of $500 million annually.

National forest lands are abundant in the Columbia Plateau sub-region, with over five million acres of National Forest Service lands. These lands host three million forest service visits annually and provide an economic value of $233 million.

The total recreation use value of this sub-region is estimated to be $733 million annually.

Columbia River Estuary

Many of the recreation sites in the Columbia River Estuary sub-region, from the mouth of the Columbia River to Portland, are U.S. historical sites. Recreation sites such as Fort Stevens State Park and Fort Columbia State Park receive about 1.5 million visitors annually. The economic value associated with this visitation is $52 million.

Intermountain

The Intermountain region holds large federal project areas and recreational lands including Lake Rufus Woods and Lake Roosevelt, as well as BLM recreational management areas. Lake Roosevelt National Park receives over 1.17 million visitors annually, Lake Rufus Woods receives 267,000, and Albeni Falls receives 277,000 per year. The economic value of recreation on federal lands in this basin is estimated to be $129 million.

In the Canadian portion of the Intermountain region, about 500,000 recreational participants frequent BC Parks. Syringa, Kettle River, Gladstone, and Christina Lake parks are among the most visited in this area. The economic value of this recreation is approximately $27 million.

The Intermountain region also receives about one million national forest visits each year. The estimated value of this recreation is $78 million.

Additionally, there are nine Idaho State Parks and eight Washington state parks in this region. These parks, including Coeur d'Alene Parkway, Priest Lake, Riverside and the Spokane Centennial Trail account for nearly six million visitors and $313 million in recreation-related economic value.

Lower Columbia

The Lower Columbia is one of the largest providers of recreation in the entire Columbia River Basin. Oregon Parks and Recreation

Meacham Creek habitat restoration project. Work done by the Conf. Tribes of the Umatilla Indian Reservation, Source: CRITFC lands, Washington State Parks, and the U.S. Army Corps of Engineers all provide recreational opportunities. Windsurfing on the Columbia River is a popular activity in this sub-region.

Oregon Parks and Recreation operates 38 parks in the sub-region with nine million annual visitors; Washington State Parks operates ten parks with over one million annual visitors; and the Army Corps operates 12 recreation areas with four million reported annual visitors. Altogether, over 14 million recreational participants visit these recreational lands, providing $540 million in annual economic benefits.

The Lower Columbia also has 3.5 million acres of national forests that receive an estimated five million visitors annually. Forest Service recreation values estimate that this recreation is worth approximately $385 million.

Middle Snake

The Middle Snake, with the Malheur River, Owyhee River, and the Payette River, receives 4.3 million recreation visitors annually. The most popular recreation site in the Middle Snake Sub-region is Lucky Peak Lake, the reservoir formed by Lucky Peak Dam. The Army Corps and Idaho State Parks both operate recreation facilities on the lake. The Middle Snake is also home to popular Idaho state parks such as Ponderosa and Eagle Island. Visitors to these parks provide an annual economic value of $230 million.

Additionally, 1.6 million visits to Forest Service lands occur annually in the Middle Snake. National forests with the greatest visitation are the Boise National Forest, the Humboldt-Toiyabe National Forest, and the Shoshone National Forest. National forest recreation contributes to $126 million in recreational benefits in the Middle Snake.

Mountain Columbia

The Mountain Columbia sub-region contains 37 British Columbia Provincial and Canada Federal parks with an annual visitation of 1.4 million. Montana State Parks also have a heavy presence in this sub-region with 26 parks and 1.3 million visitors. Libby Dam also sees a large influx of recreational participants, with 191,000 visiting annually. This visitation provides an economic value of $156 million.

The Mountain Columbia also receives a large amount of visitation to national forest lands, largely to Lolo National Forest and Flathead National Forest. A total of four million national forest visits occur in the basin annually, providing a recreational benefit of $303 million.

Most notably, Glacier National Park, which lies partially in the Columbia River Basin, is among one of the most visited national parks in the nation. Because Glacier National Park is only partially within the basin, total visitation has been split in half. Assuming 1.4 million participants are assigned to the Columbia River Basin, the economic value from Glacier NP is $102 million.

Mountain Snake

The Mountain Snake sub-region's most notable recreation opportunity is at Dworshak Lake where the Army Corps and Idaho Parks operate recreation facilities. Together, they provide 300,000 recreational visits per year. Recreation also occurs at Idaho State Parks Winchester Lake and Land of the Yankee Fork. The economic value associated with this level of visitation is estimated to be $30 million.

Additionally, the Mountain Snake receives 1.3 million national forest visits, mainly to the Payette and Sawtooth National Forests. The economic value of these recreational forest visits is estimated to be $102 million.

Upper Snake

From the headwaters of the Snake down to just East of Glens Ferry, Idaho, the Upper Snake sub-region is home to nine Idaho state parks. Most notably, Grand Teton is at the headwaters of the Snake and Yellowstone National Park is partially within the sub-region, with the remaining portion outside the Columbia River Basin. Over 3.1 million recreational visitors are recorded at Grand Teton National Park every year. Visitation to Yellowstone is approximately 3.5 million visitors annually, half of which are assigned to the Columbia River Basin as some of this recreation occurs outside of the CRB on the other side of the continental divide. Cumulatively, the economic value of this visitation is $367 million assuming visitation of 4.9 million.

State parks such as Mesa Falls, Henrys Lake, and City of Rocks are popular Idaho state parks that receive a decent number of recreational visitors. Idaho state parks account for nearly one million recreational visitors. The economic value of this visitation is estimated to be $52 million.

Finally, national forest lands in the basin provide an additional 3.6 million visits. Many of these visits occur in the Caribou-Targhee and Bridger-Teton National Forests. National forest visits account for $275 million in recreational benefits.

The Value of Recreation Under Current Conditions

Summing across the Columbia River sub-regions, the area provides at least 8.2 million recreation days within public parks

Table 15. Annual Non-Angling Recreation Days and Recreational Use Value by Sub-region

BLUE MOUNTAIN	
Recreational Days	1,492,189
Economic Value	$88,532,330
COLUMBIA CASCADE	
Recreational Days	4,816,392
Economic Value	$283,227,183
COLUMBIA GORGE	
Recreational Days	6,511,623
Economic Value	$309,637,236
COLUMBIA PLATEAU	
Recreational Days	12,400,034
Economic Value	$733,227,811
COLUMBIA RIVER ESTUARY	
Recreational Days	1,541,838
Economic Value	$51,728,648
INTERMOUNTAIN	
Recreational Days	9,113,210
Economic Value	$547,170,385
LOWER COLUMBIA	
Recreational Days	19,176,644
Economic Value	$923,991,174
MIDDLE SNAKE	
Recreational Days	5,966,505
Economic Value	$357,115,358
MOUNTAIN COLUMBIA	
Recreational Days	8,234,955
Economic Value	$562,174,659
MOUNTAIN SNAKE	
Recreational Days	1,880,220
Economic Value	$131,749,473
UPPER SNAKE	
Recreational Days	9,464,498
Economic Value	$694,904,337
COLUMBIA RIVER BASIN	
Recreational Days	80,598,106
Economic Value	$4,683,458,594

and recreation areas, as listed in Appendix C. These recreation days equate to a total economic value of $4.7 billion annually. This value is the net economic value, or consumer surplus, and does not take expenditures into account.

The table to the right provides the values associated with recreation in each sub-region.

Salmon and Steelhead Angling

The Columbia River and its tributaries provide opportunities for world-class salmon, steelhead, trout sturgeon, bass, and other fishing. Though equally important, this section only captures recreational use benefits from salmon and steelhead fishing. Other fishing is captured in the general recreation analysis.

Although salmon and steelhead runs are severely depleted from their once abundant state, hundreds of thousands of fishing days still occur on these rivers. Columbia Basin Salmon and Steelhead stocks also contribute significantly to Pacific coast, Puget Sound, British Columbia, and Southeast Alaska ocean recreational fisheries. These fishing days attract tourists from around the world and have a large economic value.

Total fishing days were estimated using harvest counts from the Washington Department of Fish and Wildlife, Pacific Fishery Management Council, Pacific States Marine Fisheries Commission, and the Pacific Salmon Commission. Per-day economic values are shown in Table 16.

Using values from Table 16, the economic value of salmon and steelhead angling in the Columbia River Basin is $134.5 million annually. For ocean stocks originating from the Columbia River, the economic value is estimated to be $6.4 million. In total, the economic value of Columbia River salmon and steelhead angling is estimated to be $140.9 million, as illustrated in Table 17.

Table 16. Salmon and Steelhead Values per Angler Day and Trips per Catch

SPECIES	LOCATION	PER-DAY VALUE (2016 USD)	DAYS/ CATCH
Chinook	In-river	$91.28	4.81
Coho	In-river	$91.28	4.17
Steelhead	In-river	$85.84	5.26
Chinook	Ocean	$95.01	1.14*
Coho	Ocean	$95.01	1.05*

Source: Olsen, Richards & Scott; 1990
*Weighted average *Sockeye data not available

Table 17. Economic Value of Salmon and Steelhead Angling

ECONOMIC IMPACT REGION/AREA/SPECIES	RECREATION CATCH	ECONOMIC VALUE
COLUMBIA RIVER SYSTEM		
Chinook	116,590	$51,948,853
Coho	57,541	$21,979,192
Steelhead	133,497	$60,572,823
TOTAL COLUMBIA RIVER	**307,628**	**$134,500,868**
OCEAN FISHING—COLUMBIA RIVER BASIN STOCKS		
Chinook Salmon	28,253	$2,355,192
Coho Salmon	44,793	$4,079,371
TOTAL OCEAN	**73,046**	**$6,434,565**
TOTAL	**380,674**	**$140,935,433**

Total Current Value of Recreation

Degradation of the lands that support outdoor recreation risks significantly diminishing the economic value of these areas. Additionally, tourism is a major industry throughout the Basin, with significant land area and parks that bring tens of billions of dollars in consumer expenditures and support hundreds of thousands of jobs.[101] Preserving these lands is an economic priority as much as anything else. The total value of recreation in the CRB under current condition scenario is $4.7 billion for general recreation, plus $140.9 million for salmon and steelhead angling.

Navigation

Navigation is another important capital built resource of the Columbia River. Since time immemorial, indigenous peoples have used the river for navigation and transportation. The introduction of passenger steamboats in the 1800s made river navigation one of the few methods of transportation in the development of the Pacific Northwest (railroad and horse drawn transport were common as well). Today, the Columbia's waters are primarily used for commercial barge transportation and recreation. There are also a few ferryboat crossings along the river that transport commuters more efficiently and over shorter distances than by road. Yet, river management and declining water levels may pose difficulties to navigation. In some cases, navigation has completely halted due to extremely low water levels, lock maintenance, and sediment accumulation. When navigation halts, economic and social losses occur.[102]

This section demonstrates the value of navigation for commercial transportation of goods and some of the costs associated with infrastructure maintenance and operations.

Dredging and Lock Operation and Maintenance

The USACE is responsible for maintaining adequate depth levels for commercial ship navigation. This is accomplished primarily by dredging material from the river navigation channel and port facilities. Over the past 15 years, USACE has dredged almost 63 million cubic yards of material and spent nearly $178 million on dredging vessel operations in the Columbia River.[103] After adjusting for inflation, the dredging costs in the Columbia have increased by nearly $0.15 per cubic yard every year since 2001 (when costs were at $1.90 per cubic yard). Tributaries such as the Snake River also undergo dredging; recent USACE reports indicate that approximately 480,000 cubic yards must be dredged annually to meet navigation obligations.[104] Assuming similar dredging costs for the Snake River and the Columbia, the annual financial cost of dredging this volume is $2.2 million dollars. These high financial costs are accompanied by significant environmental costs as well. Recent research indicates that dredging removes coarse gravel habitat, reduces fish diversity, increases salmon smolt predation by Caspian Terns, increases river bank erosion rates, and reduces the productivity of sub-aquatic vegetation.[105, 106] Dredging deeper navigation channels and port facilities has the secondary impact of allowing larger vessels to enter and navigate the river causing other environmental damage such as wave erosion and introduction of pollutants and invasive species through ballast and other vessel discharges.

Locks along the Columbia River need to allow the passage of commercial barges, which requires diverting upwards of 500,000 cubic feet of water from the power generating stations within dams along the Columbia.[107] Annually, lock usage diverts nearly 38 billion cubic feet from the Columbia from flowing through dam turbines and spillways.[108] Prior studies have established relationships between water flow through dams and electricity generation.[109] Approximately 51,000 megawatt hours were lost due to the diverted water. Applying wholesale electricity market rates to the volume of lost electricity elicited annual losses of approximately $1.3 million.[110] Currently, use of the locks is paid for by the USACE thus, ultimately is a subsidy by U.S. taxpayers.[111] In addition to the lost revenue from energy, there are also significant operation and maintenance costs. In 2016, the total operation and maintenance budget for these lock systems was approximately $47.9 million).[112,113]

Methodology

In order to calculate the value for navigation, total financial return to the water must be measured. The most practical means for valuing waterborne commerce is through the alternate cost of railroad transportation, or the next best option.[114] The total freight volume, as determined from USACE data[115], was multiplied by an average trip length of 42 miles on the Columbia River system to find the total amount of "ton-miles" of freight effort required to move goods along the Columbia.[116] We then multiplied the total freight effort by revenue per ton-mile for three shipping options (barge, truck, and rail) in order to compare the total cost of shipping freight.[117]

The Value of Navigation Under Current Conditions

The Columbia River provides a convenient path for transporting goods. Historical records indicate that total annual shipments ranged between 45 and 62 million tons from 1995 to 2015.[118] In 2015, approximately 62 million tons of goods worth over $16 billion were shipped down the river.[119,u] This shipping method saves money relative to other methods. Assuming an average trip length of 42 miles, approximately 2.6 billion ton-miles (one ton of goods traveling one mile) of freight work is required.[120] Barge transport along a river is the cheapest form of freight, with annual savings relative to truck transport at approximately $316 million.[121] These savings are smaller compared with rail transport, which reaches only $13.2 million annually. Given that infrastructure is already set up to handle shipments along the Columbia, these savings may be an underestimate of the true cost of switching transportation methods. The savings implicit in

Keller Ferry, Lake Roosevelt, 2011, Source: Brian Gruber

u Valuation of commodities is based upon price data gathered from IndexMundi, USGS, Energy Information administration, and several other agencies that collect data on less frequently traded commodities.

river transport rely upon the use of locks for traversing dams. Given the costs associated with their use, and the substantial savings of using barge freight, fees for use of locks are a clear revenue generating opportunity. The total value of navigation in the CRB under current condition scenario is $13.2 million, the estimated savings from barge use (relative to rail.

Agriculture—Irrigation

With a high level of regional agricultural production, irrigation is the largest non-hydropower water use in the Columbia River Basin.[122] Between 1981 and 2011, an average of 10.1 million acre-feet per year was devoted to agricultural purposes.[123]

There are approximately 14 million acres of agricultural lands in the Columbia River Basin, both irrigated and non-irrigated. The majority of agricultural lands are non-irrigated (9 million acres), but the Columbia River and tributaries supply water to five million acres of irrigated land. Large and small scale irrigation projects increase the economic value of these typically arid lands. The figure to the right depicts irrigated and non-irrigated agricultural lands within the basin and the boundaries of two massive irrigation projects, the Columbia Basin Project and the Minidoka Project.

Most of the agricultural lands in the Columbia River Basin receive abundant sunshine, but a limited amount of annual rainfall, most of which does not fall during the growing season.[124] Irrigation projects like the Columbia Basin Project, which irrigates 671,000 acres of farmland, help farmers grow crops in arid Eastern Washington.[125] More substantially, the Minidoka Project irrigates more than one million acres of land in the Snake River sub-region.

The 2016 Columbia River Basin Long-Term Water Supply and Demand Forecast reported that between 1981 and 2011, an average of 10.1 million acre-feet of surface water was used for crop production in the Columbia River Basin. Some of this water, about 30 percent, is returned to the river through field runoff

Figure 15. Irrigated and Non-Irrigated Agriculture in the CRB

Table 18. Total Value of Irrigated and Non-Irrigated Croplands

	CROPLAND ACRES		USDA CROPLAND VALUE PER ACRE			
STATE	**Irrigated**	**Non-Irrigated**	**Irrigated**	**Non-Irrigated**	**Difference**	**Economic Value of Water Supply**
Idaho	2,715,004	2,284,997	$5,000	$1,420	$3,580	$9,719,714,320
Montana	150,991	168,872	$2,980	$820	$2,160	$326,140,560
Nevada	875	914	$2,670	$770	$1,900	$1,662,500
Oregon	689,823	2,051,594	$4,650	$2,020	$2,630	$1,814,234,490
Utah	1,390	3,678	$5,350	$1,170	$4,180	$5,810,200
Washington	1,334,598	4,708,974	$8,250	$1,330	$6,920	$9,235,418,160
Wyoming	21,283	20,681	$5,000	$1,420	$3,580	$76,193,140
COLUMBIA RIVER BASIN	**4,913,964**	**9,239,710**				**$21,179,173,370**

and ground seepage, though it can be laden with agricultural chemicals and is much warmer than in free flowing streams.[126] Additional water is returned to the hydrologic cycle through evaporation and transpiration from plants.

Looking forward, higher concentrations of carbon dioxide in the atmosphere will allow crops to grow more efficiently. Therefore, agricultural water demand is estimated to decrease by .5 million acre-feet by 2035 assuming a historical crop mix.[123]

Economic Value of Agricultural Water Supply in the Columbia River Basin

Methodology

This analysis uses the U.S. Water Resource Council's land value method to determine the value of irrigation water.[127] The WRC's method employs a simple comparison of selling prices of irrigated lands with prices of non-irrigated, but otherwise similar lands.[128]

The following steps were taken to determine the economic value of irrigation in the Columbia River Basin:

1. Using GIS data from the United States Department of Agriculture (USDA), we calculated the total irrigated acres within the Columbia River Basin. These acreages were then separated by state. We determined the difference in prices between irrigated and non-irrigated land on a per-acre basis. Due to data and scope limitations, USDA National Agriculture Statistics Service Land Values were used for each state.[v]
2. We multiplied the difference in land values by the total irrigated acreages within the basin for each state to get a total value of irrigation water within the basin for each state.
3. The statewide total irrigation values were summed to yield the total value of irrigation water.

Values were converted to an annual equivalent value using a discount rate and planning period assumption. Results assume a 100-year planning period and are presented at the WRDA 2017 discount rate of 2.875 percent.[129]

Economic Value of Agricultural Lands and Water Supply

The Columbia River Basin's 14 million acres of farmland value is estimated to be over $42 billion. Table 18 presents the per-acre difference of land values associated with irrigated and non-irrigated farmland. The difference in land value of irrigated and non-irrigated land is calculated to be $21 billion

Annualized over 100 years at a 2.875 percent discount rate, the annual economic value of water supply in the Columbia River Basin is estimated to be $647 million. Because these estimates are based on state average cropland values, values should be considered rough estimates.

Table 19. Annual Value of Agricultural Water Supply in the Columbia River Basin

Net Present Value	$21,179,173,370
Discount Rate	2.875%
Periods (years)	100
ANNUAL VALUE	**$646,907,701**

Total Economic Value of Current Conditions Scenario

Table 20 summarizes the total economic value of the CRB under the current conditions scenario. This table is organized in alphabetical order for clarity, and all values are presented in thousands. The total assessed value of the Columbia River Basin under RCC-80 equals to $199 billion.

Table 20. Total Economic Value of the CRB under Current Conditions (number in thousands)

RESOURCE	CURRENT CONDITIONS
Agriculture - Irrigation	$646,908
Ecosystem Services	$189,963,082
Existence Value	$37,289
Hydropower	$3,373,357
Navigation	$13,248
Non-Tribal Commercial Fishery	$12,133
Recreation - General Recreation	$4,683,459
Recreation - Angling	$140,935
TOTAL ASSESSED VALUE	**$198,870,410**

v Land values in Wyoming were not available due to data limitations; therefore, Idaho land values were used to generate an approximate estimate for the value of non-irrigated land in Wyoming.

Chapter Four

The Modernized Value of the Columbia River Basin

“As we make decisions that affect this land, we must consider the consequences those decisions have, at least for the next seven generations.”

– Francis Auld – Confederated Salish and Kootenai Tribe Cultural Preservation Officer[130]

As Chapter 3 clearly demonstrated, the Columbia River Basin holds immense value. Yet under a modernized management regime, this value may increase even further. Chapter 4 assesses the potential value of natural capital under a modernized Columbia River Treaty. The modernized scenario, also known as 3Ea, prescribes higher retention of river water in the late fall and winter via storage at upstream reservoirs. The stored water will be released in the spring and early summer, augmenting the natural freshet from basin snow melt. These operations will help reestablish the historical shape of the river hydrograph, particularly in low and medium runoff years. By restoring the historical hydrograph shape, ecosystem functions will also be enhanced and restored. Fish habitat will increase, migration conditions throughout the mainstem and estuaries will improve, and the Columbia River plume into the near ocean environment will also improve. In addition, the modernized scenario will reduce drafting of basin reservoirs, allowing more stable and improved ecosystem function in the reservoir environment and increasing ecosystem service value.

Scenario 3Ea evaluates how changes in river managment from the current conditions (RCC-80) would impact non-tribal commercial fisheries, existence value, hydropower generation, and recreation. The primary difference between RCC-80 and the 3Ea scenario is the rebalancing of value between built capital and natural capital. In effect, the river wealth in historical tribal first foods that was lost to management and operation of built capital for flood risk and hydropower would be at least partially restored, enhancing tribal wealth and sustainable natural capital. The methodologies for evaluating these resources are the same as those outlined in each respective section in Chapter 3. The economic values for flood risk, agriculture, and navigation remain consistent under both scenarios, therefore the value does not change. However, this chapter does provide qualitative descriptions of ecosystem improvements due to 3Ea. In addition, this chapter includes additional valuation for nutrient enhancement and increased flow, given that a modernized management regime would enhance these benefits. Increased salmon and steelhead productivity would also enhance the economic value under scenario 3Ea. Lastly, we conclude with an analysis valuing a 10 percent increase in EbF.

Sturgeon and carp caught in a gillnet, Source: CRITFC

Modernized Non-Tribal Commercial Fisheries

In the Upper Columbia Basin, much of the habitat historically used by anadromous fish has been blocked, inundated, or degraded by dams. However, sites still exist that could support anadromous fish production, and the reservoirs behind the dams may provide juvenile rearing habitat. In the Modernized Columbia River Treaty scenario, we consider fish runs that could be restored to historical Columbia Basin habitats above Chief Joseph Dam in the U.S. and Canada. Earth Economics consulted with fisheries experts to estimate a working hypothesis on potential anadromous fish runs for reintroduction in the Upper Columbia Basin.[131] This paper constructs a range of potential run sizes that could be possible with the reintroduction proposal described in “Fish Passage and Reintroduction into the U.S. & Canadian Upper Columbia Basin, A Joint Paper of the Columbia Basin Tribes and First Nations”, January 9, 2015.

Several assumptions were made to estimate a range in potential run sizes from reintroduction. First, we assume historical habitats in the Upper Columbia Basin would be accessible to anadromous fish and that run sizes could be comparable to historic levels, or even increase because of the additional rearing capacity of reservoirs. For chinook, it was assumed introduction into the Upper Basin would add up to 310,000 chinook annually; for sockeye, up to 600,000 in annual runs; for coho, run sizes could approach 30,000; and for steelhead, run sizes would reach 20,000.[132]

Next, we estimated reductions in fish production due to loss of smelts passing through dam facilities. Finally, runs were multiplied by harvest rate percentages to estimate the potential non-tribal commercial harvest rate attributable to reintroduction of anadromous fish in the Upper Columbia Basin. At the time of writing, coho harvest estimates were not available.

The maximum potential harvests for each species over all these run sizes is about 1.6 million in landed pounds. In effect, the introduction of additional fish above Chief Joseph Dam would increase non-tribal commercial fisheries in the CRB by $7 million.

Table 21. Forecast of Additional Non-Tribal Commercial Fishery Harvests Attributable to the Columbia River Basin, Summary of Salmon Landings

AREA & SPECIES	LANDED POUNDS (WHOLE)	LANDED VALUE
IN-BASIN		
Chinook	15,532	39,164
Sockeye	113,959	187,383
Total In-Basin	129,491	226,547
ALASKA AND BRITISH COLUMBIA		
Chinook	1,322,270	5,928,090
COASTAL WASHINGTON AND OREGON		
Chinook	192,516	854,497
Total Out-Of-Basin (AK, BC, WA, OR)	1,514,786	6,782,587
GRAND TOTAL	**1,644,277**	**7,009,134**

Modernized Existence Value

Our methods for determining existence value under the modernized scenario were the same as those outlined in Chapter 3 for the current conditions scenario. In this case, the model valued increased salmon runs due to reintroduction above Chief Joseph Dam. For more detail, see "Fish Passage and Reintroduction into the U.S. & Canadian Upper Columbia Basin, A Joint Paper of the Columbia Basin Tribes and First Nations", January 9, 2015. Introduction of salmon above Chief Joseph Dam could add up to 960,000 chinook, sockeye, coho, and steelhead to historic annual run sizes. This level is a 26 percent increase compared to historic runs, which were around 3.7 million total for the four species. According to the CSS and COMPASS models, fish abundance below Chief Joseph Dam will increase as well. On average, salmon populations will increase by about 25 percent.

As described in the current conditions chapter on existence value, we utilized the function transfer method to value this ecosystem service. See Appendix I for detailed information on the model and parameters used.

In total, salmon populations could increase by up to 51 percent, based on the information above. Applying the model described in Chapter 3, these salmon runs yield a willingness-to-pay estimate of $404 per household per year for the increase in population size. Given that the total number of households within the Columbia River Basin is about 2.8 million, the annual existence value benefit of increased salmon runs would be $1.1 billion.

Modernized Hydropower

This section addresses the impact to hydroelectric power production under the 3Ea modernized scenario. To assess the difference in benefits provided by the Columbia River Power System hydroelectric generation, data was calculated from the CRITFC Information System (CIS), a model that calculates hydropower generation for 14 water periods throughout the year. This data was used to estimate the value of hydropower generation under both RCC-80 and 3Ea.

Hydropower plays a large part in ensuring the region's power needs are met. In dry water years, hydropower generation drops and the Pacific Northwest must rely on other generating resources or occasionally import power from outside the region. In the wettest water years, generation is high and can be sold to out-of-region customers, such as California. Because hydropower generation varies from year to year based on streamflow conditions, impacts were assessed for dry, wet, and average water years.

Figure 16 through Figure 18 illustrate hydropower production and estimated system demand for hydropower. A comparison of the 14 water periods in the three water years reveals that demand is met in medium and wet water years. In the driest water years, power will likely need to be purchased from outside the region.

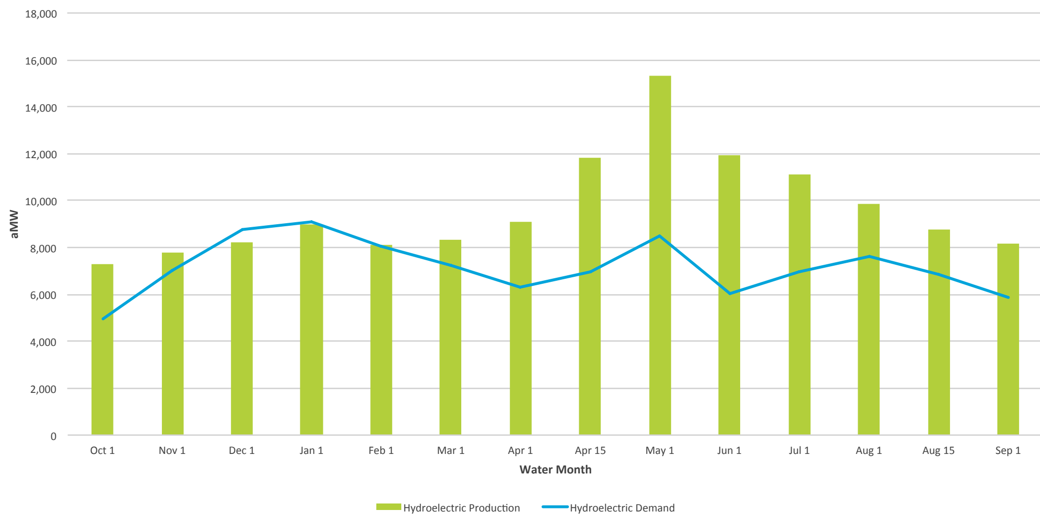


Figure 16. Hydroelectric Production—Driest Water Years under 3Ea

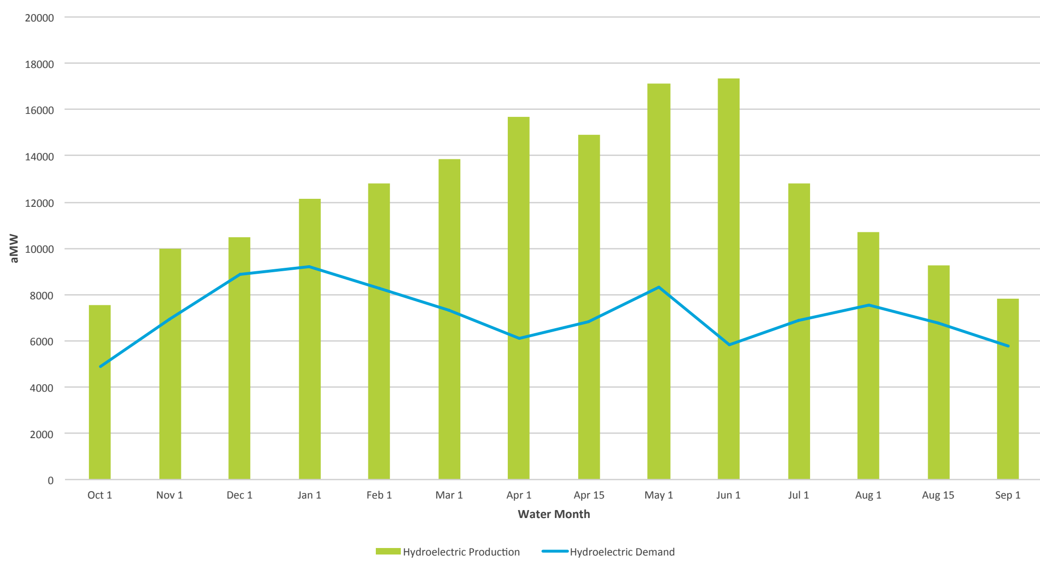


Figure 17. Hydroelectric Production—Median Water Years under 3Ea

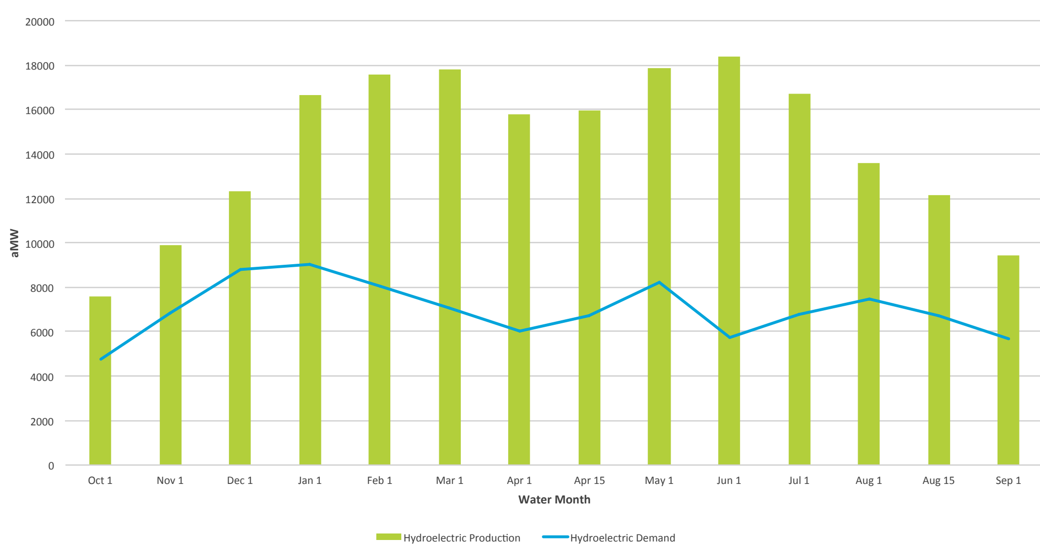


Figure 18. Hydroelectric Production—Wettest Water Years under 3Ea

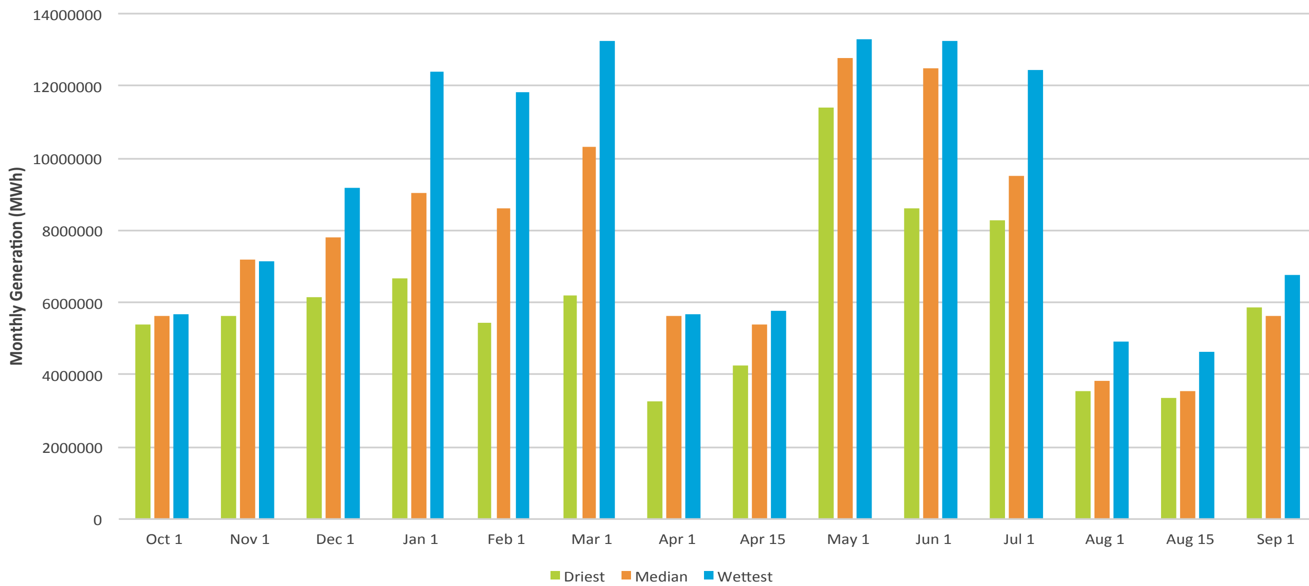


Figure 19. Hydroelectric Power Generation by Water Month and Water Year Quintile

We also estimated the dollar value of hydropower generated within the Columbia River Basin for both RCC-80 (see Chapter 3) and 3Ea. To identify values, wholesale prices were applied to hydropower generated within the given period. Although prices change hour by hour, with peak prices differing from non-peak, monthly average wholesale trading prices at the Mid-Columbia were used to obtain an estimate of total value.

The total value of hydropower in the Columbia River Basin is estimated at $2.95 billion in dry years, $3.33 billion in medium water years, and $3.63 billion in the wettest water years. December and January in the driest water years will likely see a power generation deficit, and the Pacific Northwest may be required to purchase power from out of market. Out-of-market pricing is based off of Southern California trading prices. This deficit may also be filled with other power-generating resources within the basin, but these effects were not analyzed.

Additionally, the net change in hydropower generation was calculated by subtracting the power generation levels under current conditions from the total generation under 3Ea (Table 22).

As can be seen in Table 22, there will be a loss of roughly $69 million in hydropower value under scenario 3Ea. This value loss will be most significant in low water years. Low water years also impact EbF, as resident and anadromous fish species receive large benefits from additional water in crucial migratory months.

Modernized Flood Risk Management

Under a modernized scenario, ecosystem integration supports flood adaptation under projected climate change conditions in that key reservoirs could remain fuller and promote partial restoration of the spring freshet while still providing adequate flood control. Tribes are seeking ecosystem integration in a manner that would not increase high peak flows in the highest water years, thus avoiding increased flood risk. That said, tribes and others in the region seek to reduce conservative drafting of storage reservoirs, especially premature drafting, in order to release storage

Table 22. Net Change of Power Generation in Both Scenarios

HYDROPOWER VALUE	CURRENT CONDITIONS	EbF (3Ea)	DIFFERENCE
Driest Water Years	$3,066,514,176	$2,952,631,383	-$133,882,793
Medium Water Years	$3,388,935,087	$3,327,217,445	-$61, 717,642
Wettest Water Years	$3,664,655,116	$3,633,159,148	-$31,495,968
WEIGHTED AVERAGE	**$3,373,356,570**	**$3,304,324,828**	**-$69,031,742**

and shift river management for ecosystem function values. To accomplish this, tribes and others in the basin seek flood risk management by improved runoff forecasting, structural improvements to floodplain structures that protect important built infrastructure, and reestablishment of floodplain habitat in areas that frequently flood or have less valuable built capital.

Under scenario 3Ea, flood risk management systems will continue to safely accommodate altered water release regimes, as described below. However, to lessen localized flooding and choke points while also gaining further benefits from 3Ea, an increased focus on natural infrastructure is needed. Reconnecting floodplains, restoring riparian zones, and incorporating green stormwater solutions can provide a range of habitat and community benefits in addition to flood risk reduction. As infrastructure ages and local communities work to mitigate the stresses of climate change, natural infrastructure can provide a valuable alternative. These flood risk management solutions are more resilient to shocks and future effects of climate change.

Due to major development in floodplains, extensive built infrastructure has been used to manage flood risk in the Columbia River Basin. Allowing for ecosystem-based function to play a larger role in river management means integrating built and natural capital into flood risk management through natural infrastructure solutions. This section looks first at the proposed flows and the current management capacity of the Lower Columbia Flood Risk Management. Then examples of natural infrastructure are discussed to highlight the importance of natural infrastructure solutions to maximizing benefits of scenario 3Ea.

Overview of Flood Risk

Flood risk is greatest in the wettest water years. USACE flood risk management planning is based on projected flows at The Dalles, where the objective is to keep flows below 600 kcfs whenever possible; such high flows are known to cause serious flood damages[133] As can be seen in Figure 22, unregulated peak flows at The Dalles can exceed 600 kcfs in the wettest water years.

Flood control rule curves are designed so that reservoir storage is available before major flood events and these are dependent upon runoff forecasts. Under scenario 3Ea, water that is held back in the winter would be released in the spring and early summer to partially restore the spring freshet, improving resident and anadromous fish survival. These alterations to streamflow would occur in dry and average water years, but current management procedures would remain constant in the wettest years to accommodate increased flood risk. Although daily flood risk is not analyzed under the 3Ea scenario, monthly streamflow in the driest and medium water years are well below the 450 kcfs threshold for flood damages. For the 14 water periods, neither the current condition or modernized scenarios had monthly flows over 600 kcfs. While there is little difference in the flood control curves and peak flows between 3Ea and RCC-80 for the 14 period outputs for the 80-year water record, there may be differences in flood risk based upon assessment of three- or five-day flood risk. These differences were not analyzed for this report.

Natural Infrastructure in the CRB

The following examples illustrate implemented or planned natural infrastructure projects that provide a suite of ecosystem service benefits while also addressing flood risk. Natural infrastructure is a viable, cost-effective opportunity to improve ecological function and ecosystem services benefits to surrounding populations. Projects such as those discussed below will help maximize the benefits of a modernized treaty.

Columbia River Estuary

In 2014, the Columbia River Estuary Study Taskforce (CREST) completed the Fee-Simon wetland enhancement and levee setback project at the Wildlife Center of the North Coast on a tributary of the Youngs River. Partners for this multi-benefit restoration project included Bonneville Power Administration, the Lower Columbia Estuary Partnership, the Oregon Watershed Enhancement Board, and the U.S. Fish and Wildlife Service.[134] A levee was removed and a setback levee was built to protect adjacent landowners. The reconnected floodplain land consisted of approximately 16 acres of former agricultural land and 33 acres of forested wetland previously disconnected from the hydrology of the river.[135]

This natural infrastructure approach to flood control provides a variety of ecological function improvements. Converting 16 acres of agricultural land to emergent wetland enhances ecosystem service benefits including improved aquatic habitat, increased water filtration potential, and increased storm attenuation. In addition, reconnecting isolated forested wetlands improves their health and function. Although these increases in ecosystem health can be difficult to monetarily value, the results are indeed valuable, including benefits from improved riparian productivity to increased soil nutrients.

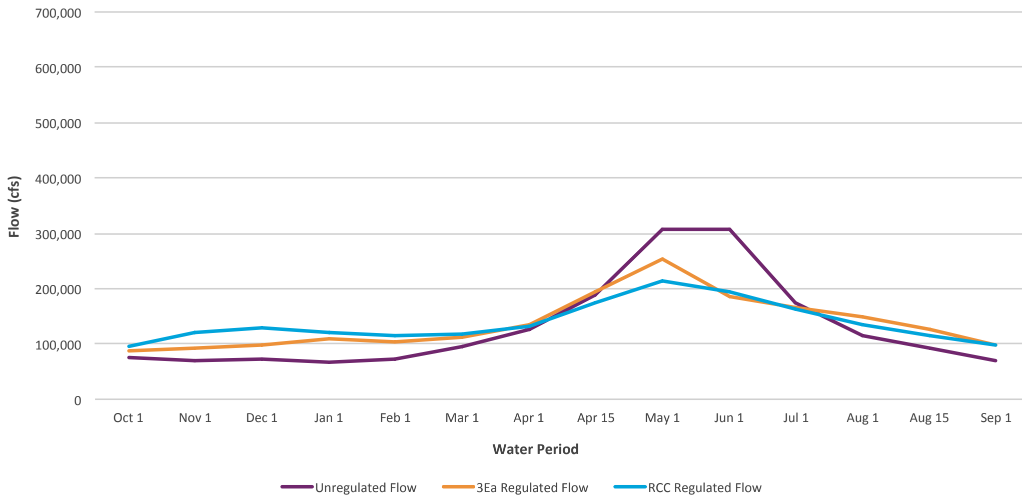


Figure 20. Flow at The Dalles—Driest Water Years

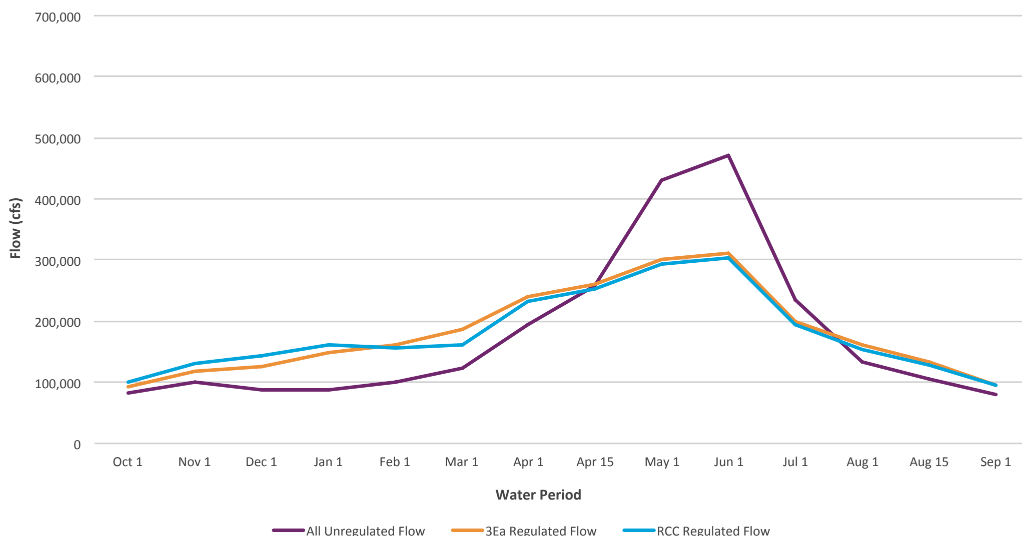


Figure 21. Flow at The Dalles—Median Water Years

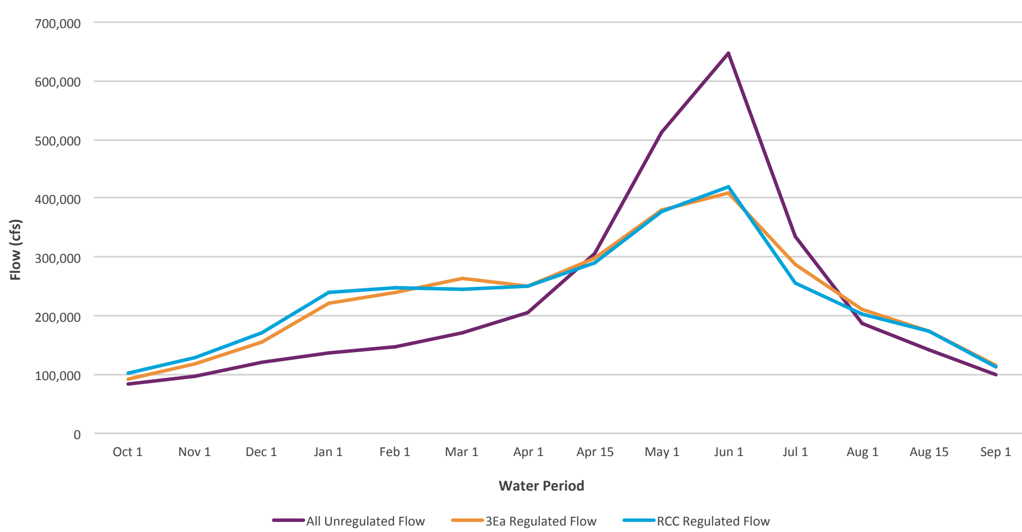


Figure 22. Flow at The Dalles—Wettest Water Years

This project is one example of opportunities in the Columbia River Estuary to improve habitat function and increase floodplain connectivity while maintaining flood protection for land owners. A continued focus on green infrastructure solutions for flood protection and restoration in the lower estuary can safely protect low-lying agricultural land while restoring vital wetland and instream habitat areas. Projects to improve floodplain habitat will catalyze further enhancement of the estuary and build off of other modernized treaty adjustments for ecological function.

Portland, Oregon Metro Region

The proposed setback of the Steigerwald Lake National Wildlife Refuge levee system represents an important opportunity to improve ecological function while also increasing flood protection. Located outside of Washougal, WA, the wildlife refuge is a tract of prime floodplain land that has been isolated from the Columbia River, causing altered vegetation communities, reduced nutrient exchanges, and limited aquatic habitat availability.[136] A flood control and habitat project is currently in the design phase for the site. This project would breach the levee that isolates the refuge from the Columbia River, regrade historic channels to promote floodplain reconnection, build a setback levee, restore natural stream migration across the floodplain, and plant native vegetation.[136]

Potential benefits of the Steigerwald Lake National Wildlife Refuge project will span a range of ecological and economic improvements. Reconnecting over 1,000 acres of the refuge with the Columbia River is a valuable habitat improvement opportunity that would increase the acreage of unrestricted floodplain habitat between the Columbia/Willamette confluence and Bonneville Dam by 16 percent.[137] This increase will provide habitat for a variety of wildlife, particularly waterfowl. Additionally, the increased in-stream tributary habitat will benefit migrating salmon and support lamprey. Other ecosystem service benefits of the project include increased recreation and education opportunities and improved wetland filtration functions. The levee setback project also provides direct economic benefits, lessening operating costs for the Port of Washougal, eliminating the need for dredging Gibson's Creek, and decreasing flood risk. The new setback levee would rezone the port and portions of the surrounding community out of the 100-year floodplain, thereby reducing flood insurance costs.[138]

Steigerwald Lake National Wildlife Refuge is situated along the eastern edge of the Portland Metro Area. Expanding floodplain accessibility here will lessen the pressure on choke points further downstream, where built infrastructure continues to constrain the river. Lower Columbia floodplain expansion projects such as this provide an important habitat link and compound upstream improvements expected under the 3Ea modernized scenario. Importantly, this natural infrastructure approach not only improves habitat, but also provides valuable flood risk reduction and maintenance cost benefits.

Middle Columbia

South of Yakima, WA, a multi-stage effort to decrease flooding on the Yakima River involved removing several levees. These legacy flood risk reduction levees were built to protect property in the floodplain, but have contributed to flooding issues in the nearby towns of Wapato and Toppenish. Additionally, due to its large size and location, the floodplain behind these levees held a high potential for habitat benefits for Yakima River migrating salmon.[139] In planning for future flood risk reduction, multiple partners, including the WA Department of Transportation and Department of Ecology, collaborated to develop an integrated approach to risk reduction that utilizes both natural and built infrastructure to better accommodate river flows.

The Donald Wapato Levee Removal project was conducted in multiple phases. Before the project began, re-engineering a stretch of highway near the site eliminated the need for protection from roadway flooding.[140] The first stage of the project involved acquiring floodplain land currently isolated behind the levees. Once the properties were cleared, levee removal and restoration of natural habitat allowed for a natural river flow, significantly spreading floodwaters across the reconnected floodplain.[140] As opposed to leaving relic flood infrastructure in place, project partners saw the potential benefits of floodplain reconnection and habitat improvement. The removal of levees along this stretch of the river provides in-stream and floodplain habitat benefits in an area previously disconnected from river hydrology and now no longer requiring protection. While removal of floodplain assets may not be feasible for all communities, current infrastructure throughout the CRB can be reassessed as surrounding conditions change, evaluating the necessity and cost-effectiveness of infrastructure upkeep.

Boise, Idaho

Cities and towns throughout the basin are currently wrestling with localized flooding and outdated stormwater management systems. These systems were often not designed to effectively cope with additional stresses such as unexpected population growth and climate change. An integrated plan for the Boise River lays out several natural infrastructure solutions that will help mitigate localized flooding. In addition to floodplain restoration and riparian improvements along the river, urban solutions such as permeable pavement, bio-swales, and increased tree canopy cover are also highlighted as flood risk reduction measures.[141] While not traditionally thought of for habitat restoration purposes, these types of natural infrastructure projects do provide valuable ecosystem service benefits and fit into the larger picture of improved ecosystem function.

The City of Boise has collaborated with the Ada County Highway District through The Partners for Clean Water to enhance natural infrastructure in Boise's urban streets. Green alleys and parking lots help the city manage localized flooding by intercepting runoff before it enters and backs up the city's stormwater system.[142] Increased tree canopy cover and bioswales also help filter polluted stormwater before it reaches the Boise River. These projects provide ecosystem service benefits in addition to flood reduction and water quality including, but not limited to, improvements in air quality, aesthetics, carbon sequestration, and habitat.

While improving floodplains and riparian areas in the CRB will remain key to increased ecological function, additional urban natural infrastructure solutions are also important to maintaining healthy ecosystems. The shift towards natural urban infrastructure can help support watershed and basin-wide improvement efforts, as seen in the enhancement plan for the Boise River.

Modernized Recreation

One of the largest and most unique public benefits of the Columbia River Basin is its recreation opportunities. Currently, recreation in the Columbia River Basin is worth nearly $5 billion. Modifications to reservoir operations will impact the quality of recreation in the basin and change the recreation days demanded.

Modernized General Recreation

A 3Ea scenario may impact recreation through shifting reservoir levels. One of the biggest recreation reservoirs in the Columbia River Basin is Lake Roosevelt, which provides over $100 million in recreational benefits annually. This section examines the potential impacts of 3Ea for the economic value of recreation at Lake Roosevelt.

Lake Roosevelt National Recreation Area

Lake Roosevelt NRA is one of the most popular recreation sites in the Columbia River Basin. The recreation area receives well over one million visitors annually. Visitation to the reservoir created by Grand Coulee Dam can be sensitive to management operations.

As one might assume, visitation is lowest in the winter months and highest in the summer months.[143] As spring approaches, visitation increases at a fairly constant rate from February through April. In May, there is typically no increase in visitation, sometimes even a decrease, when compared with April's visitation. This coincides with the periods when water levels are lowest as pools are drafted for flood control. Refill typically begins in May, and by the end of June, the reservoir reaches near full pool. Peak water levels coincide with a sharp increase in visitation. In the summer months, the lake offers world class opportunities for boating, fishing, swimming, camping, and picnicking.

Reservoir Elevation Impacts on Visitation

The National Parks Service Visitor Use Statistics program has been collecting park ranger comments on the number of visits to Lake Roosevelt NRA since November 2004. In these comments, boat launches out of water were seen to be an issue in 39 out of the 118 months of reporting. Comments by park rangers indicate that boat launches out of water heavily influence park visitation. These comments occurred most frequently in May (11 times) and June (10 times), but also occurred in June for several years. Data collected by park rangers in Lake Roosevelt during low water levels indicate fewer visitations and therefore less recreation dollars during those events.
Under scenario 3Ea, drafting will continue to occur from October to April, then begin to refill May through June. To emphasize EbF, however, the February through April drafting will be about 10 feet less in the driest water years, when there is less flood risk. Drafting schedules for medium and wettest water years will nearly follow current form.

Though many factors can influence recreational participation (water quality, weather, economic climate), changing reservoir levels are known to significantly influence recreational participation.[94] With 3Ea, Grand Coulee operations will continue to be similar in median and high water years and therefore it is assumed that there will be no significant change in recreational visitor days. In the lowest water years, however, reservoir

Chief Joseph Dam, Source: Unknown

management will be slightly different. Regression analysis was used to estimate the effects of reservoir management under RCC-80 and 3Ea.

Economic Value of Lake Roosevelt Recreation under 3Ea

To estimate the effects that 3Ea might have on recreational participation at Lake Roosevelt, monthly visitation data was collected from 1979 to 2015. This visitation data was then regressed against average monthly reservoir levels. As was discussed earlier, many factors influence visitation, but were not found significant in these models. This insignificance is likely a factor of the crudeness of using monthly averages as opposed to daily data.

Using only summer season monthly visitation (May through September) and water elevation data, the regression did have significant predictive power with an R^2 of 0.96. The regression analysis was then used to estimate visitation under both RCC-80 and 3Ea for the driest water years.

Recreational benefits provided by Lake Roosevelt greatly depend on reservoir levels at near full pool for optimum recreation. Even though reservoir levels are at optimal recreation levels in both scenarios, the regression analysis does suggest a small increase in visitation is associated with these higher levels.

As seen in Table 22, total monthly visitation in summer increases in scenario 3Ea. The regression also showed a decrease in monthly visitation in September, when reservoir levels under 3Ea are actually lower than observed in RCC-80. This overall increase in visitation of 518 recreation participants has an economic value of $39,000.[144]

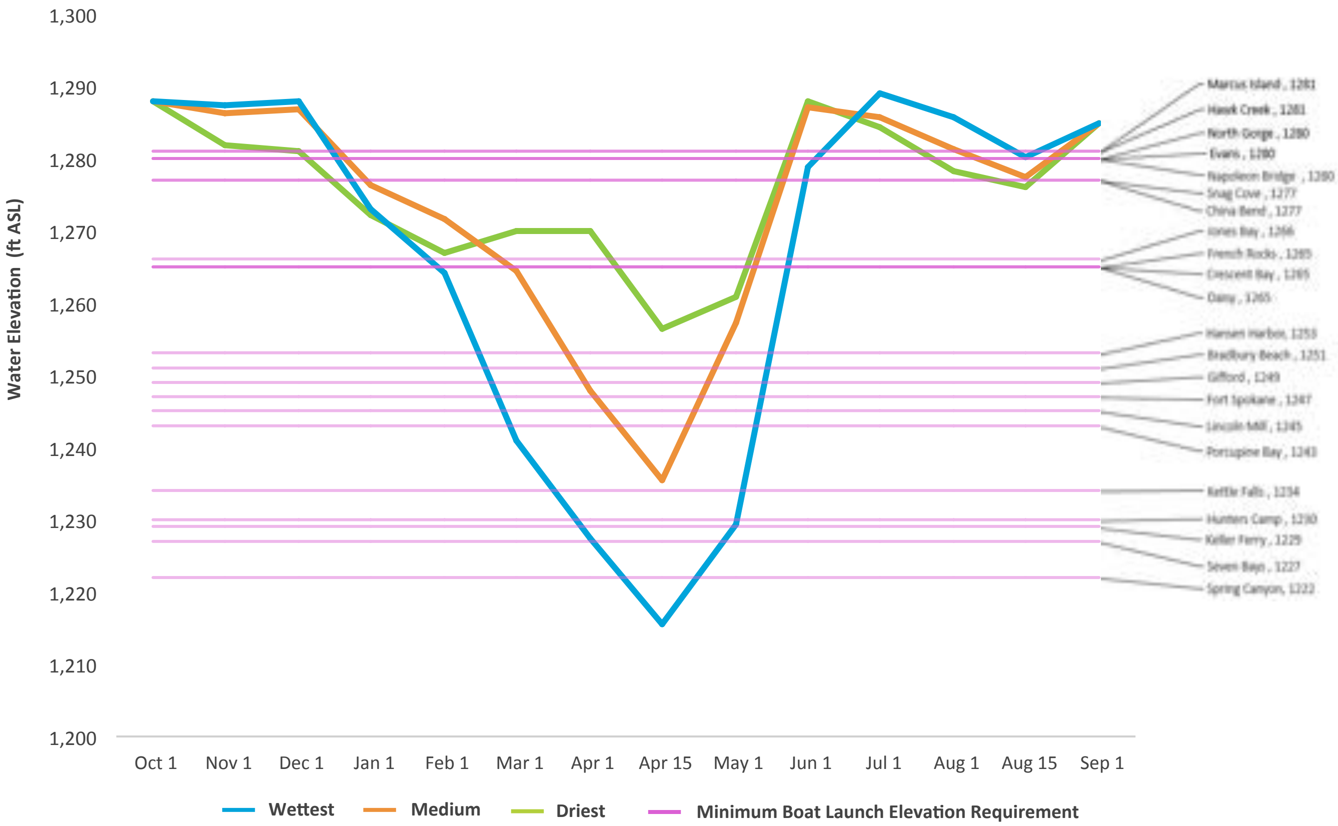


Figure 23. Water Elevation and Minimum Boat Launch Requirements at Lake Roosevelt

The regression analysis does have high predictive power, but these results are still within the margin of error. Nonetheless, it is clear that water levels associated with the 3Ea scenario will not significantly impact recreational opportunities over the RCC-80 scenario. This model does not, however, capture how improvements in EbF may increase the quality of recreational experiences. With improved ecological factors, such as water quality, recreational experiences will be heightened and in turn increase demand for recreation at sites like Lake Roosevelt.

Modernized Angling

Because much of the basin's ecosystem value has been impaired by built capital projects and management, anadromous and resident fish populations are a fraction of their historical numbers. Dams have isolated vast areas of habitat—currently, sturgeon, bull trout, and eulachon, as well as 13 species of salmon, are listed under the Endangered Species Act. The once-abundant Pacific lamprey and burbot populations have also collapsed. The 3Ea scenario addresses these losses through actions to restore habitat quality, function, and diversity and improve migration conditions for anadromous fish and reservoir and river conditions for resident fish.

Comparative Differences in Salmon Survival: Two Scenarios

Estimates for salmon and steelhead survival under the RCC-80 and 3Ea scenarios were acquired from the 2013 Columbia River Treaty Sovereign Review Process. In that process, a scenario similar to 3Ea was developed and compared to a scenario similar to the RCC-80 scenario with respect to salmon and steelhead in-river survival and smolt-to-adult estimates. Two regional fish survival models, NOAA's COMPASS and the Columbia River Estuary Study Taskforce

Table 23. Average Monthly Visitation under RCC-80 and 3Ea—Lowest Water Years

MONTH	1-MAY	1-JUNE	1-JUL	1-AUG	15-AUG	1-SEP
Low Water Year—RCC80	90,916	189,873	309,078	155,915	155,804	135,869
Low Water Year—3Ea	91,142	189,980	309,150	156,088	155,953	135,660

(CREST) were focused on the two most heavily impacted endangered salmon groups in the basin – Upper Columbia Spring chinook and Upper Columbia steelhead. In-river survival and smolt-to-adult survival estimates showed a 3Ea scenario would generate in-river improvement of 8.9 to 10 percent for steelhead, a 2.8 to 6.7 percent gain for Upper Columbia spring chinook over RCC-80 (see Table 24).

Because the river segments for survival estimates differ across models, a direct comparison of smolt-to-adult improvements cannot be made. However, across the full reach from Wells to Bonneville, steelhead in-river survival estimates from both models are similar. Thus, while there is no steelhead COMPASS smolt-to-adult estimate for the Wells-Bonneville reach, it can be assumed to be similar to CSS estimates at a 126 percent improvement for 3Ea (Table 24). For spring chinook, a range of smolt-to-adult estimates from both models yielded a conservative estimate of increased adult returns from the 3Ea scenario of 6.7 to 12.5 percent over RCC-80 (Table 24).

Table 24. Estimated Percent Increases in In-River and Smolt-to-Adult Survival from the Modernized Scenario Over the Current Condition

3EA % IMPROVEMENT FROM RCC-80	COMPASS	CSS
Upper Col Steelhead In-River Survival	8.9 %	10%
Upper Col Spring Chinook In-River Survival	2.8%	16.2%
Upper Col Steelhead Smolt-Adult Return (Wells-Priest Rapids)	14.6%	NA
Upper Col Spring Chinook Smolt-Adult Return (Wells-Priest Rapids)	6.7%	NA
Upper Col Steelhead Smolt-Adult Return (Rock Island-Bonneville)	NA	126%
Upper Col Spring Chinook Smolt- Adult Return (Rock Island-Bonneville)	NA	12.5%

The estimates reported in Table 24 were used to estimate growth in recreational catch and economic value within the Columbia River Basin, although growth rates were not calculated for recreational fishing on the ocean. Given the greater salmon and steelhead abundance, in-river recreational catch is estimated to increase by 102,000 fish under the 3Ea scenario. This estimate is conservative, as we did not model effects on the abundance of other salmon and steelhead stocks throughout the basin. However, these stocks are also likely to increase under a 3Ea scenario.

We also estimated the value of reintroducing salmon runs above Chief Joseph and Grand Coulee dam, along with the installation of passage infrastructure that would allow the fish to complete their lifecycle. These actions can be expected to increase recreational catch by 19,000 salmon and steelhead. reports the recreational catch and resulting economic value in the Columbia River Basin and open ocean commercial fishing areas that are expected to result from a 3Ea scenario and reintroducing salmon above Chief Joseph and Grand Coulee. A full breakdown of this table can be found in Appendix D.

Table 25 reports the recreational catch and resulting economic value in the Columbia River Basin and open ocean commercial fishing areas that are expected to result from a 3Ea scenario and reintroducing salmon above Chief Joseph and Grand Coulee. A full breakdown of this table can be found in Appendix D.

Under RCC-80, the recreational catch is estimated at 381,000 salmon and steelhead, resulting in $141 million in recreational value. Emphasizing the importance of ecosystem function in the Columbia River Treaty and restoring anadromous fish populations will increase the recreational catch from 381,000 to 498,000, and improve annual recreational value from $141 million to $187.4 million. The total annual value of general recreation in the Columbia River Basin under the 3Ea scenario is approximately $4.7 billion, with recreational fishing adding $187 million to that total. The 3Ea scenario increases recreational value by $46.5 million over RCC-80.

Modernized Navigation

This report does not value navigation changes under the 3Ea scenario, though increasing seasonal flows in late summer under 3Ea and throughout the river during low runoff years would improve opportunities for commercial transport and support much-needed ferry services. 3Ea increases in late August-September flows for adult salmon and steelhead migrations would also benefit lower river navigation needs. The following section describes issues with the Gifford-Inchelium Ferry, and how these could be solved under the 3Ea scenario.

Table 25. Modernized Columbia River Treaty Recreational Values

ECONOMIC IMPACT REGION/AREA/SPECIES	RECREATIONAL CATCH 3Ea	ECONOMIC VALUE 3Ea
COLUMBIA RIVER SYSTEM		
Chinook	137,023	$61,928,073
Coho	57,541	$21,979,192
Steelhead	214,373	$97,269,511
TOTAL COLUMBIA RIVER	**408,938**	**$180,981,728**
OCEAN FISHING—COLUMBIA RIVER BASIN STOCKS		
Chinook Salmon	36,148	$2,355,194
Coho Salmon	53,029	$4,079,371
TOTAL OCEAN	**89,178**	**$6,434,565**
	498,116	**$187,416,293**

Gifford-Inchelium Ferry

The Gifford-Inchelium Ferry provides a vital transportation route between the communities of Gifford and Inchelium,[145] but the ferry has closed in 10 of the past 25 years when water levels in Roosevelt Lake sank below 1,232 feet above sea level.[146] In those years, ferry services was disrupted an average of 30 days,[146] increasing 13,600 commutes between Gifford and Inchelium by 65 miles each way.[w,147] A river management plan that is more sensitive to the needs of local communities could reduce such hardships. The 3Ea scenario would support hydropower generation, flood protection, and navigation, while also increasing critical habitat throughout the basin.

Modernized Agriculture—Irrigation

Agricultural activities were not valued under 3Ea. Estimates under the current conditions scenario are assumed (see Table 20).

Modernized Increased Flow Value

Increased flows are associated with the 3Ea scenario are added to the ecosystem service value in a hypothetical 10 percent increase in EbF.

Before significant human impacts on the Columbia, spring thaws between late April and July would produce streamflows at The Dalles well above 450 kcfs. Known as the *spring freshet*, it was critical to helping juvenile salmon migrate safely downstream. Development within the Columbia River Basin has altered these flows. In an average water year, regulated flows during the spring freshet now only reach about 300 kcfs at The Dalles. A modernized Columbia River Treaty would increase instream flows during the spring freshet.

Based on CIS modeling, we assumed river flow to be constant at 292 kcfs from May 1st to May 31st, although hourly or daily streamflow would clearly vary. To calculate the total flow increase, model data was converted from cubic feet per second (cfs) to acre feet per day,[x] and then multiplied by the number of days in the study period to estimate the total acre feet of water released in a period. The net change in water volume over the critical period (March 1 through September 30) was calculated by subtracting 3Ea volumes from RCC-80 volumes for the driest, average, and wettest water years (Table 26).

The Columbia River Basin has an active water market for water leases and permanent water acquisitions for irrigation, hydropower, municipal use and ecological purposes. These data can be obtained from the Columbia Basin Water Transaction Program.[148] The benefits of increased in-stream flows are calculated by multiplying the per acre-foot water

w Per Analysis in Google Maps

x Footnote: One cubic foot of water per second released at a constant rate for 24 hours is equivalent to approximately 1.98 acre feet.

Table 26. Total Increase in Acre Feet at The Dalles for Period March 1–September 30

WATER YEAR	TOTAL AF RCC-80	TOTAL AF 3Ea80	AF INCREASE	ECONOMIC BENEFIT ($115.32/AF)
Driest Water Year	64,595,391	67,745,126	3,149,735	$363,227,414
Med Water Year	86,608,212	90,305,784	3,697,572	$426,404,015
Wettest Water Year	113,322,637	116,585,825	3,263,188	$376,310,790
ALL WATER YEARS	**88,175,157**	**91,545,311**	**3,370,153**	**$388,646,056**

value (adjusted to 2016 USD) by the increases in water volume under 3Ea. Growth of in-stream flow is calculated at The Dalles for historical purposes. These calculations are seen in Table 26.

Modernized Nutrient Enhancement Value

Prior to river modifications, salmon delivered large quantities of marine-derived nutrients to the upper reaches of the Columbia River Basin, contributing to in-stream, riparian, and other terrestrial ecosystems.[y] Under a modernized Columbia River Treaty, migrating salmon could again move nutrients to the Upper Columbia, by allowing fish passage above the Chief Joseph and Grand Coulee Dams. Annually, 1.5 to 5.2 million pounds of salmon are expected to journey above these two dams.[149]

The Shoshone Bannock Tribe's nutrient enhancement program improves ecosystem health by adding nutrients along tributaries of the upper Salmon River. The nutrient enhancement program demonstrates a willingness-to-pay for improved ecosystem health through salmon-derived nutrient inputs. Nutrients were valued based on both the quantity of nutrients and fieldwork costs. Because the average total annual weight of salmon expected to return above Chief Joseph and Grand Coulee Dams is 3.4 million pounds, the annual value of salmon-derived nutrients would be $30.8 million.

Lake Roosevelt, Source: Brian Gruber

y Salmon River Basin Nutrient Enhancement: Contract Year 2015-2016 RM&E Annual Progress Report, Project Number: 2008-904-00

Total Economic Value of Modernized Scenario

The benefits under current conditions and 3Ea scenarios are shown in Table 27, along with the net change under 3Ea. The total value of benefits under 3Ea increase by $1.5 billion dollars per year. If we assume the 3Ea scenario to increase EbF throughout the basin, the benefits derived from EbF would increase accordingly. Thus, including EbF in decision-making could be expected to increase benefits as well. Table 27 demonstrates the total increased value of benefits under 3Ea, with and without a hypothetical 10 percent increase in EbF.

Table 27. Total Economic Value of the CRB under Modernized Scenario (numbers in thousands)

RESOURCE	CURRENT CONDITIONS	EBF (3EA)	NET CHANGE UNDER EBF (3EA)
Agriculture (Irrigation)	$646,908	$646,908	$0
Ecosystem Services	$189,963,082	$190,351,728	$388,646
Existence Value	$37,289	$1,131,200	$1,093,911
Hydropower	$3,373,357	$3,304,325	-$69,032
Navigation	$13,248	$13,248	$0
Non-Tribal Commercial Fishery	$12,133	$19,142	$7,009
Nutrient Enhancement	$0	$30,847	$30,847
Recreation - General Recreation	$4,683,459	$4,683,498	$39
Recreation - Angling	$140,935	$187,416	$46,481
TOTAL ASSESSED VALUE	**$198,870,410**	**$200,368,311**	**$1,497,902**
10% EBF INCREASE	**$0**	**$19,035,173**	**$19,035,173**
TOTAL ASSESSED VALUE WITH EBF INCREASE	**$198,870,410**	**$219,403,484**	**$20,533,074**

Chapter Five

The Cultural Value of the Columbia River Basin

"Every time I go out in the woods I feel that something is and so I learn something every time I go out, I come back and my life is enriched, you know I took it to heart."

– Salish-Pend d'Oreille Culture Committee[40]

Up to this point, this focus of this report has been on assessing the monetary value of ecosystem services in the CRB. However, the data and information presented above does not convey the intangible benefits people receive from the basin's resources. These intangible benefits are especially valuable to the CRB tribes and cannot be measured in monetary terms. The negotiation of the original 1964 Columbia River Treaty did not involve or even consider the tribal nations or the potential and actual cultural losses associated with implementation of the CRT.

This section aims to identify and document the basin's cultural value in non-monetary terms, in order to contribute to inclusion of ecosystem-based function in the Treaty. In this chapter, we demonstrate the breadth of the CRB's immense cultural value. Due to limited available data, this cultural review accounts for a very small percentage of the cultural richness of this land. Nonetheless this chapter identifies aspects of nature's gifts and contributes to this important conversation, which is oftentimes overlooked.

Recognizing Cultural Value

Ecosystem service frameworks, such as the Millennium Ecosystem Assessment or EPA's Final Goods and Service classification,[150] interpret cultural values in a variety of ways. Some consider spiritual and religious experiences, while others espouse a broader definition that includes recreation, aesthetic beauty, education, and scientific research. In this report, cultural values encompass the perspectives and value systems of PNW tribal communities. Within this context, the natural environment is closely tied to individual, community, and societal identities.

Nature provides ancestral experiences shared across generations and offers settings for communal interactions that shape cultural relationships. Cultural heritage is usually defined as the legacy of biophysical features, physical artifacts, and intangible attributes of a group or society that are inherited from past generations, maintained in the present, and bestowed for the benefit of future generations.[151] Over millennia, the environment has been shaped by constant interactions between humans and nature. The globe is inscribed with not only natural features, but also the legacies of past and current societies, technologies, and cultures.

For many communities and people, certain landscapes and species are strongly associated with cultural identities and place attachments. In some cases, the relationships between ecosystems and religion center on material concerns, such as staking claim to land contested by immigrants, invading states, or development agencies. Nonmarket economic valuation techniques have, in few cases, been successfully applied to cultural heritage objects. However, cultural values such as regional identity or sense of place remain elusive, and even impossible, to value monetarily. Therefore, for the remainder of this report, cultural values will encompass non-monetary goods and services reserved primarily to tribal communities under the themes discussed here.

Cultural Assessment

Decision makers and land managers need a way to assess ecosystem service tradeoffs, both in the biophysical and cultural context. The ecosystem service frameworks mentioned above do little to address the diversity of cultural ecosystem values. Few attempts have been made to develop a framework to assess cultural values in tandem with biophysical ecosystem services, especially as they inform land and water-use decisions.

Likewise, efforts to measure cultural values face methodological difficulties and problems of scale. Nancy Turner, a top ethnobotanist and Indigenous Peoples researcher known for her extensive work on the problems of measuring cultural values, describes how cultural values are embedded into other ecosystem services and, in most cases, cannot be separated.[152] For example, salmon ceremonies require a healthy riparian habitat to provide food, access to riversides, and the historical value of nature of the activity itself. Turner argues that these elements are both inseparable and also extremely difficult to value. Measuring cultural services at large scales and across wide regions is also problematic.[153] Culturally valuable natural areas often exist in small-scale landscapes, home to few communities. Measuring cultural value across broad landscapes risks grouping diverse cultural entities and communities when each site should, in fact, carry unique cultural importance.

To address the aforementioned limitations, the Puget Sound Institute (PSI) and Stanford University created a method to qualitatively measure cultural value for Hood Canal tribes. The goal was to understand how community culture is influenced by land-use decisions and how well-being is improved with access to nearby aquatic resources off the Hood Canal. PSI developed a process for selecting cultural value indicators relevant to natural resource management in Hood Canal.[154] The purpose of this work was to monitor the state of Hood Canal communities and to inform integrated watershed strategies.

The method created by PSI and Stanford (referred to as the "PSI approach" in the remainder of this report) was adopted for this report to demonstrate the importance of cultural values to Columbia River tribes. This method is well-suited to reveal the array of cultural benefits received by tribes in ways that are otherwise ignored in decision making. The PSI approach establishes a comprehensive list of benefits summarized across multiple individuals to illustrate the full suite of cultural values not represented by monetary valuation. In reviewing existing methods, we found this technique to be the most appropriate for the context of this analysis. Other approaches, including in-person interviews and workshops, were not feasible for this analysis. In the following, we describe the PSI approach and its adoption into this report.

The PSI Approach

The original PSI approach was developed in close correspondence with cultural resource specialists, a well-respected member of the Hood Canal tribal community and curator of tribal documentation. The goal of the project was to understand how culture and well-being were influenced by access to river resources like salmon. The PSI approach involved two steps. The first was to interview individual tribal members concerning their day-to-day interactions with a variety of natural resources, and the second step used a data analytics approach to transcribing and coding the interviews. The coded responses fell into six primary categories: psychological, physical, cultural, social, economic, and governance.

Columbia River Basin Cultural Value Approach

For this report, we aimed to demonstrate the array of cultural value that the Columbia River Basin provides to the region's tribes. We applied an adapted version of the PSI approach for this analysis because the method effectively communicates the full array of cultural value that often goes unrecognized and unrepresented in decision-making. Any changes to the methodological approach were made to accommodate differences between the cultural analysis, and the PSI approach for the Quinault tribe. The following paragraphs detail our approach and any changes to the PSI approach.

Due to the timing and scope of this report, we were not able to conduct individual interviews as in the PSI approach. Instead, our analysis relied on media, narrative, and literary documentation to assess well-being indicators, including online video transcriptions, published stories, and documented poetry. Tribal stories, lessons, and poetry are sometimes the only documented sources that show how indigenous peoples throughout the world value natural resources[155], and text analytic techniques are well-recognized in multiple fields of study as an effective data collection tool.[155;156] Tribal member interviews are recommended for future analysis of the CRB cultural values.

The data collected for the CRB cultural analysis consisted of 45 videos, poems, and stories, most of which provided multiple pages of content. Appendix H provides a list of these sources for each tribe. All data was collected from public online sources or directly from the tribes themselves, and the documentation represents 13 of the 15 CRB tribes as well as multiple perspectives and generations within each tribal group. Given the lack of data from the Canadian First Nations they are not included in this cultural analysis. However, many tribes lie across the international border of U.S and Canada, such as the Okanagan and Kootenai Tribes, therefore we could assume that the cultural analysis for first nations would be similar.

Narrative Coding

The narrative coding for the CRB cultural analysis was consistent with the PSI approach. Each of the sources listed in Appendix H were converted or transcribed to narrative. The narrative was coded into the four categories described in Table 28. For example, the following sentence is narrative transcribed from a video about sustainable fishing from the Colville tribes (#16 in Appendix H): "*For us, it's about sustainability- the selective harvest program presents a piece of our traditional thinking and knowledge to better manage our natural resources that being the salmon.*" This sentence was labeled, or coded, as the well-being indicator "traditional practices," which fit under the "Cultural" category.

Classification of Human Well-Being Indicators

The PSI approach created a classification of well-being indicators broken down into six categories. A modified classification was adopted for CRB cultural analysis. The scope of the CRB cultural analysis was over a large area and defines cultural value broadly, and therefore adoption of the PSI classification required aggregation of unique cultural attributes (traditional fish catching methods) into broader categories (traditional practices). Table 28 shows the modified classification used for this analysis, which includes four categories of discussion topics: cultural, governance, economic, and social.

Table 28. CRB Cultural Analysis Classification of Well-being Indicators

CULTURAL	GOVERNANCE	ECONOMIC	SOCIAL
Spiritual Beliefs	Stewardship	Income	Communal Events
Identity	Fairness and Equity	Sustenance	Future Generations
Preferred Lifestyle	Trust	Trade and Giving	Nostalgia
Traditional Practices			Pride
Traditional Values			

Results of the Columbia River Basin Cultural Value Text Analysis

The results in Figure 24 shows the frequency with which each well-being indicator was referenced in the collected documentation. The most frequently referenced indicators were "traditional practices," "stewardship activities," "sustenance," and "nostalgic" memories. The frequency of these references does not suggest that some indicators are valued more than others, but should rather be recognized as a clear indicator of the immense cultural value that tribes and their ancestors place in CRB natural resources.

Furthermore, these results do not reflect the value system across all 15 CRB tribes, but rather provide insight on cultural values from perspectives captured in media. Further research is needed to assess the socioeconomic and cultural values of a broader cross-section of all 15 CRB tribes. Nevertheless, these results are indicative of how tribal members use and value the Columbia River in multiple ways.

In summary, this method effectively communicates the full array of cultural value that often goes unrecognized and unrepresented in decision-making. The data and information presented in Chapters 2, 3, and 4 do not describe or

Figure 24. Results of Cultural Assessment

account for the intangible benefits people receive from the basin's resources. Figure 24 summarizes the cultural values represented in existing tribal literature, allowing cultural value to be considered with monetary analysis when negotiating the modernized Columbia River Treaty.

As discussed above, cultural value is unique and exists in small-scale landscapes, home to few communities. Measuring cultural value across broad landscapes is difficult as it may miss the diversity of culture specific to tribes, regions, or even species. We therefore focus on examples of unique cultural value in the following sections, highlighting first foods, fishing, and tribal resources.

First Foods

"The prairies were full of bitterroots, which we welcome each spring with prayer as the first of our important plant foods."

– *Salish-Pend d'Oreille Culture Committee*[40]

First foods are the traditional foods provided by a functional ecosystem that the Tribes have harvested for thousands of years, and that they continue to rely on today as a primary source of sustenance for their families. These foods define nourishment, trade, health of tribal members as well as the land and water and, by extension, the resilience and longevity of the Tribe. First foods have always been protected and cared for by tribal ancestors and, in that way, they are also a gift from the past. They are recognized under tribal law, a management structure that calls attention to ecological processes that are ignored or greatly devalued outside of tribal culture.

Focusing on first foods *order* as a management structure was introduced by Eric Quaempts, Director of the Fisheries Department for the Confederated Tribes of the Umatilla Indian Reservation, a biologist and enrolled Yakama tribal member. Quaempts translated this elegant, centuries-old system into a management tool that guides and prioritizes DNR projects.[158] First foods are ordered by the way they are served in a tribal meal—water, fish (salmon, lamprey), game (elk, deer, moose), roots (celery, camas, bitterroot) and berries (huckleberry, chokecherry). This order follows the belief and recognition that these foods promised to take care of Indian people.

The Umatilla Tribe's Natural Resources Department also embeds first foods into their programs, including water in the Water Resources program, fish in the Fisheries Program,

Lake Pateros, Columbia River, FV Dream Catcher and crew, Source: Keith Kutchins

Ceremonial salmon cooking, Source: Keith Kutchins

big game in the Wildlife Program, and roots and berries in the Range and Forestry programs. Small tribal communities across Oregon are following suit, including first foods into a decision-making framework to ensure the existing of this sustaining good.[158]

The loss of first foods is directly linked to the health of Native peoples. Research has shown that loss of traditional food sources has put Native American people at risk of diet-related illnesses such as heart disease, hypertension, strokes, and more.[159] In particular, harvested fish are accumulating higher amounts of methylmercury as a result of fossil fuel emission (coal and oil fired power plants in particular) deposition into water.[160] Given the effects of bioaccumulation, salmon and other marketable fish have much higher levels of methylmercury than their surrounding environment. As Native Americans consume much more fish than the general population, they are exposed to heightened levels of methylmercury. These heightened methylmercury levels place Native Americans at a high risk of neurodevelopmental disorders, cardiovascular disease, autoimmune disorders, and infertility.[160] If methylmercury levels continue to increase, the value from salmon provision will be eroded as the health costs of methylmercury consumption increase.

American Indians are 2.2 times more likely to have type II diabetes than Caucasians.[161] Native tribes had to give up these healthy, nutrient-rich foods which are typically high in protein, iron, zinc, Omega 3 fatty acids and other minerals, and lower in saturated fats and sugar.[162] In addition, the exercise associated with gathering these first foods had physical benefits. As many traditional gathering grounds have been lost, the loss of this benefit has surely been another factor impacting the health of tribes as well.

First foods are significant in several ways—culturally, socially, and spiritually. As a result, they are recognized and honored through trading and ceremonies that express gratitude and respect for the nourishment they provide. These foods are honored with ceremony and prayer, following the first foods order—first water, followed by fish, game, roots, and berries. Within this hunting and gathering culture, the well-being of the land and water determine the well-being and prosperity of tribal people and culture.

Tribal Resources

"We to hunt for a purpose, you know for survival, you know my grandparents and that's how they survived."

– *Salish-Pend d'Oreille Culture Committee*[40]

Tribal members find a spiritual connection with other types of outdoor activities such as camping, hiking, and swimming. Whether defined as recreation or subsistence, these practices all rely on quality recreation lands and waters.

Tribal members have access to reservation and trust lands, as well as public lands for hunting, fishing, and gathering practices. Additionally, some tribes allow for permit-use hunting and fishing from non-tribal members, while others do not allow for non-tribal members to access reservation lands for hunting and fishing purposes. Wildlife properties acquired through BPA mitigation funding are required to provide reasonable access to non-tribal members if the tribes are actively using the land for recreation purposes.[163]

Through interviews with several tribes' department of natural resources, providing quality lands and waters for recreation and cultural purposes is a top priority.[164] In one case, the Cowlitz Indian Tribe has partnered with the USFS to have a special forest products program. This partnership allows tribal members to gather traditionally significant plants and maintain spiritual practices.

Tribal Fishing

"As guardians of our ancestral lands it is our duty to conserve the balance of nature."

– *Unknown Kalispel Tribal Member*[165]

The harvest of traditional resources is integral to tribal culture in the CRB. In particular, fish are a staple of many tribes' diets, one of the traditional first foods that are honored at tribal ceremonies. They appear in many tribal legends and play a significant role in tribal economies.[166]

Salmon is just as important as their nutritional value and cultural uses. Fishing trips shape many people's appreciation for nature. The Yakama, Umatilla, Warm Springs, and Nez Perce exercise commercial fishing in the Columbia River and are authorized to catch half of the harvestable fish in Zone 6. Tribal fisheries mainly occur in Zone 6 of the Columbia River, a 147-mile stretch of river between Bonneville and McNary dams. These rights were secured through lengthy legal battles between tribes and states regarding interpretation of historical treaties agreements regarding fish catch distribution.[167] Tribes often prioritize ceremonial and subsistence fisheries, only opening up commercial fisheries once the needs of these first two are met.[168]

Tribal commercial fisheries have caught 3 million pounds of salmon on average for the past 5 years, translating to $7 million in ex-vessel value annually. Yet, the value of this fishing activity and the fish itself is far beyond this value. Two species serve as excellent examples of the cultural value that transcends monetary values: burbot and Pacific lamprey. Both these species have been adversely affected by the Columbia River dams, and changes in dam management would be required to ensure their future abundance and survival. In addition to the two-species described in detail below, the Columbia River provides habitat for sturgeon, trout, minnows, suckers, cod, stickleback, and sculpin.[169]

Burbot and Pacific Lamprey

The burbot and Pacific lamprey are of great cultural importance to tribes within the Columbia River Basin. Previously abundant, both of these species have experienced significant population declines in their native habitats due to watershed development and dam operations.[171] However, both species are found in different regions of the Columbia River Basin and have unique challenges to overcome to ensure their continued survival and place within tribal culture.

Burbot

Historically, the abundant burbot runs provided a seasonal staple food source for Native Americans and early European settlers.[170] This great abundance continued throughout the 1960s, and burbot fishing was largely unregulated. However, construction of the Libby Dam in 1972, poses a threat to the burbot via high water discharge rates during spawning and increased water temperature due to summer storage of water above the Libby Dam in the Koocanusa reservoir.[171]

After completion of the dam, the burbot population declined rapidly, leading to a fishing closure in Idaho in 1992. Shortly after this closure, British Columbia closed burbot fisheries on Kootenay Lake and Kootenay River in 1997.[172] By the early 2000s, scientists estimated that the burbot population had declined to about 50 fish, indicating the species was very close to extirpation from the Kootenai River.

This steep decline is linked to summer reservoir storage and power generation practices during the winter. Libby Dam is operated with a focus on power generation and is also a large storage reservoir, leading to high levels of discharge during times of peak demand. However, high discharge events disrupt the burbot's spawning movements (December to February). Altered management practices could alleviate this disruption. Limiting flow from the Libby Dam to under 300 cubic meters per second during spawning season would enable the burbot to move upstream far more easily.[173] However, river flow data indicates that over 36 years, the average flow below the Libby Dam ranged from 254 to 481 cubic meters per second during burbot migration.[174] In addition to the rapid rate of flow, the water flowing through the dam is up to 5°C warmer than historical baselines.[175] Restoration of historical burbot runs would require reduction of winter outflows as well as reduction of river water temperature to under 5°C during spawning season.[176] Management options for reduction of river water temperature include the following: Installation of riparian vegetation for river shading, reduction of summer water storage in the Koocanusa reservoir, and reduction of effluent temperatures from industrial wastewater streams.[177,178]

Pacific Lamprey

The Pacific lamprey is an ancient, culturally important species of fish. Fossil records indicate that Pacific lamprey evolved 450 million years ago, making it the oldest fish species within the Columbia River system.[179] Columbia Basin tribal members describe the lamprey as a spiritually significant, historically abundant, easily caught food source that sustained Columbia Basin tribes for thousands of years.[180] Their historical habitat reached to the headwaters of the Columbia River, providing a widespread, reliable food source for riverine predators. Currently, these fish are only found in the middle and lower Columbia River in drastically reduced numbers relative to their historical abundance within the region. For example, returns of lamprey to the Bonneville Dam reached a low of 23,000 in 2010, as compared with the 400,000 returning in the 1960s.[181]

This decline is due to a variety of complex, challenging threats to lamprey habitat, including low water flow, dam passage, floodplain degradation, low water quality (via elevated temperature, chemicals and sedimentation), predation, and climate change.[182] It appears high—and low—head dams are the largest cause of decline due to inadequate adult passage and evidence that juvenile lampreys suffer serious impingement on turbine screens. Two other causes of lamprey habitat damages are watershed urbanization and agricultural runoff.[183] Given that multiple factors threaten habitat, restoring the Pacific lamprey population requires multiple restoration strategies, which can include channel reconstruction, floodplain reconnection, levee removal, riparian revegetation, dam passage improvements and upstream translocation.[184] Currently, two restoration efforts (Pacific Lamprey Research and Restoration and Pacific Lamprey Passage Design) are receiving about $1.2 million of funding annually.[185]

Chapter Six

Dam Operations and Maintenance Costs

"Before the Coulee Dam went in there were salmon, my elders used to say the salmon were so thick you could walk across the river on their backs."

– Unknown Colville Tribe Member[186]

Lake Rufus Woods, Columbia River, Source: Brian Gruber

The Columbia River reservoir and hydroelectric system generates revenues, but it is also expensive to run and maintain. Some examples of costs include resource intensive turbines (requiring large amounts of copper), navigational lock and spillway maintenance, substantial agriculture water-pumping facilities and non-routine extraordinary maintenance (unplanned and emergency maintenance). With an aging dam fleet,[z] general routine and non-routine extraordinary maintenance costs are rising, leading to an increase in overall capital and operating expenses. Additionally, because of the major adverse impacts to the environment, fish and wildlife mitigation and hydrosystem operational compliance requirements result in additional spending obligations that contribute to both federal and non-federal budgets.

The Columbia River hydro system is composed of many parts, but the largest contributors are part of the Federal Columbia River Power System (FCRPS). The FCRPS is a collaboration between the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the Bureau of Reclamation. Together, these agencies collaboratively manage the dams for purposes such as power, flood control, navigation, water supply, and recreation.

Although there are large financial costs from hydroelectric power production, providing for flood risk management and general dam operations also accrues costs, although much of these are covered by hydropower revenues. Other beneficiaries help cover portions of operations and maintenance costs. For instance, dams that provide flood control are partially paid for by taxpayers as a public service provided by the dam. U.S. taxpayers fund the USACE for annual operations and maintenance costs for dams and dredging for navigation. This section provides a big picture assessment of federal and nonfederal operations and maintenance (O&M) expenditures in the Columbia River hydroelectric power system.

z A fleet refers to the large group of hydropower structures working together to produce power for the system. Bonneville, Grand Coulee and Rock Island dams were constructed nearly 80 years ago. In general, the average life of a dam is estimated to be 100 years.

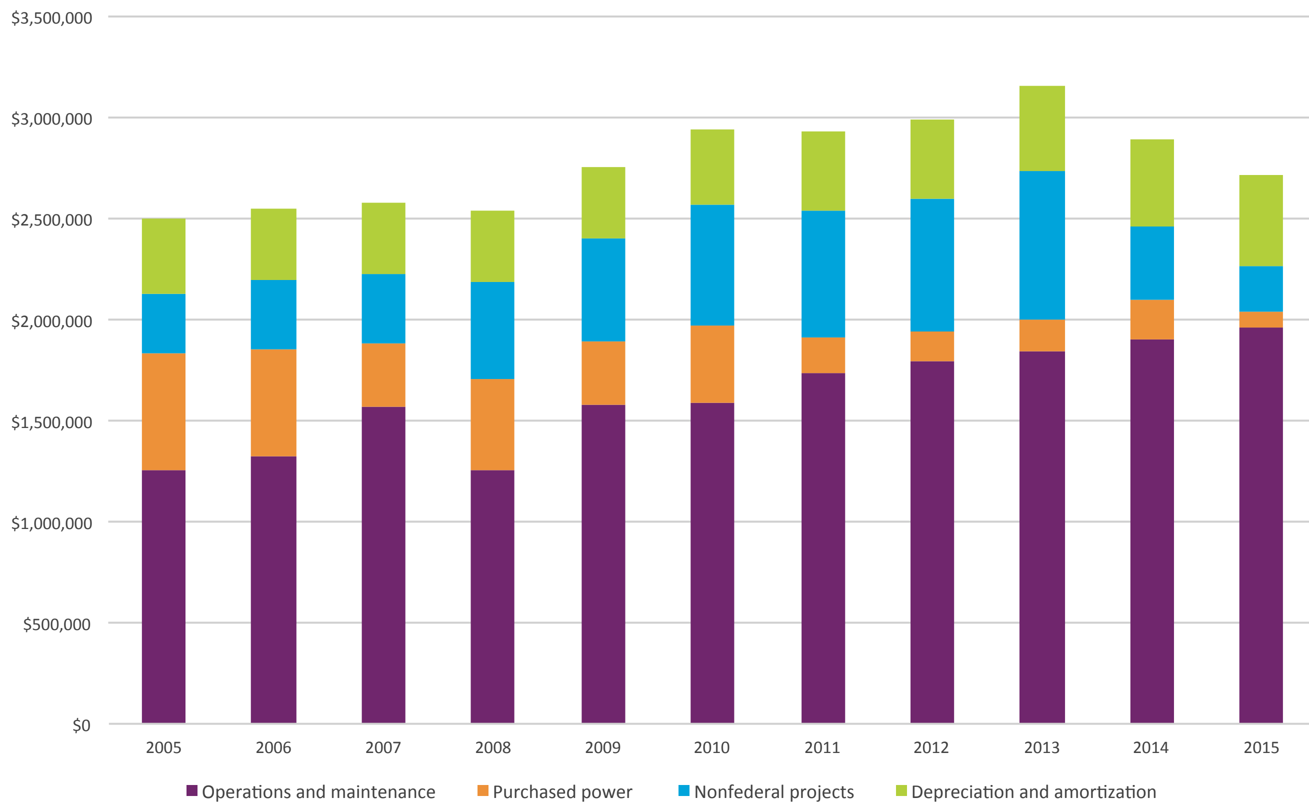


Figure 25. BPA Total Operating Expenses

Bonneville Power Administration

The Bonneville Power Administration (BPA) is responsible for purchasing, transmitting, and marketing power for the Federal Columbia River Power System (FCRPS). With this responsibility, BPA is also responsible for all power related costs of the 31 USBR and USACE owned FCRPS dams which are covered by the revenues collected from power sales.[187] Because the FCRPS dams are multipurpose, fish and wildlife mitigation costs are assigned through a cost allocation process defined in the Northwest Power Act.[188]

In 2015, BPA had total operating revenues of $3.4 billion, and total operating expenses of $2.7 billion.[189] From 2005 to 2015, BPA's total operating expenses remained fairly consistent. During this same period, however, BPA's operations and maintenance expenses have increased 56 percent from $1.26 billion in 2005 to $1.96 billion in 2015. These increases are due to the non-routine extraordinary maintenance and additional spending required to meet regulatory and biological opinion (BiOp) requirements.[aa] With these regulatory and BiOp requirements, a significant portion of BPA's overall operating for budget for power services is from mitigation efforts to offset dam and river management impacts to fish and wildlife.

Bonneville Power Administrations' Fish and Wildlife Program

The FCRPS dams are multipurpose structures, providing hydroelectric power, flood control, navigation, water supply, and recreation benefits. Under the Northwest Power Act, BPA is obligated to protect, mitigate, and enhance the dam impacts on fish and wildlife. BPA is only responsible for the 31 FCRPS dams' hydropower related costs, which account for approximately 78 percent of expenses and are paid for by ratepayers. Non-power purposes (navigation, flood control, etc.) make up for the remainder of the costs and are paid for by federal agencies, which are in turn paid for by taxpayers.

Since 1978, BPA has recorded a total of $15.3 billion in fish and wildlife costs.[190] These costs have increased in the past years as dams have been heavily scrutinized for the impacts they have on the natural environment and federal laws and regulations including the Northwest Power Act, the Endangered Species

aa Bull trout, sturgeon, eulachon, and 13 species of Columbia River Basin salmon and steelhead are listed for protection under the Endangered Species Act. Biological Opinions provide science based guidance to protect and rebuild fish and wildlife populations that are impacted by dam operations within the Basin.

Act and the Clean Water Act. Between 1986 and 1995, BPA's Fish and Wildlife costs averaged $188 million, from 1996 to 2005 costs averaged $561 million, and from 2006 to 2015 BPA's Fish and Wildlife costs averaged $750 million.

In 2015, BPA noted that fish and wildlife costs accounted for approximately 33.3 percent of its' overall operating budget for power services. This estimate includes what are termed foregone power revenue and power purchases. Foregone revenue and power purchases are BPA's way of recording the economic losses incurred from dam operations that reduce hydropower generation but greatly benefit fish passage, such as the dam spill. Though extremely beneficial for fish populations that have been severely degraded, the tribes believe that recording foregone revenue and power purchases as a fish and wildlife expenditures, are a cost of doing business and this cost misrepresents the size of the fish and wildlife mitigation program. Between 1978 and 2015, BPA has attributed a total of $7.7 billion to foregone power costs and power purchases, half of the total recorded expenditures of the fish and wildlife program. Losses to EbF caused by power production and other non-natural uses of the CRB are a cost to EbF. The value, revenue and benefits, of a natural CRB are diminished by these uses.

The Federal Columbia River Power Systems' Aging Fleet

As of 2015, the average age of the 31 FCRPS dams was 55 years. With an aging fleet, non-routine maintenance and large capital improvement costs are increasing. These expenses are required to meet increasing demand and maintain a high level of reliability.

In the past five years, the fleets' hydroAMP ratings (reliability scores for infrastructure; 1 being poor, 10 being good) have declined significantly from 7.8 to 7.3, and about 25 percent of equipment has exceeded its designed life.[191] The decreases in the average hydroAMP rating point toward underinvestment in capital improvement projects, which increases the likelihood of non-routine extraordinary maintenance and unit failure. In 2016, 17 percent of all BPA's operating and maintenance expenditures came from non-routine extraordinary maintenance.

Natural capital works in a similar way and the Columbia River Basin is a degraded system; without investment natural capital, we will continue to see mitigation expenditures increase.

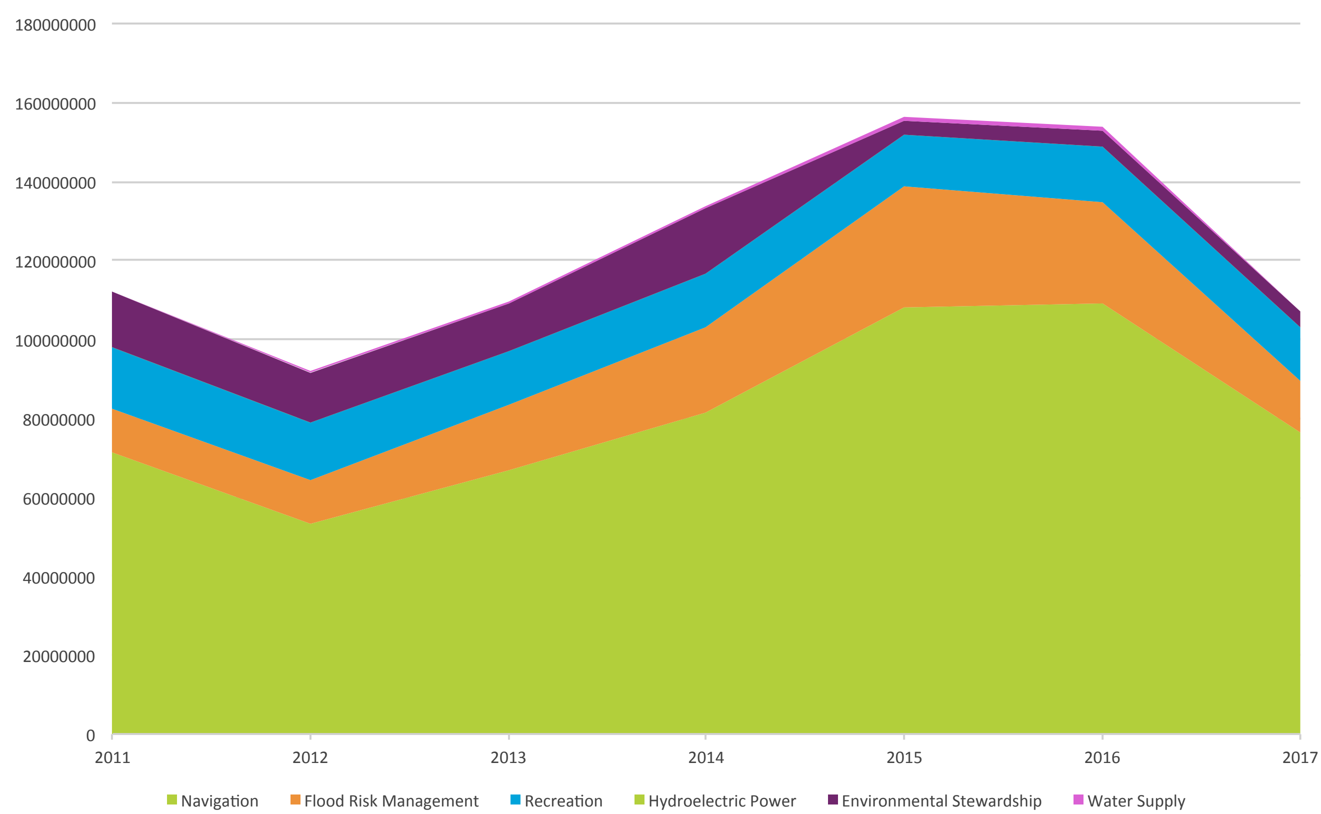


Figure 26. USACE Columbia Basin Operations and Maintenance Costs

Fishing platform across from The Dalles Dam, Source: CRITFC

The Basin needs serious investment to continue providing economic goods and services and as was illustrated in Chapter 4, investment in natural capital makes economic sense.

United States Army Corps of Engineers

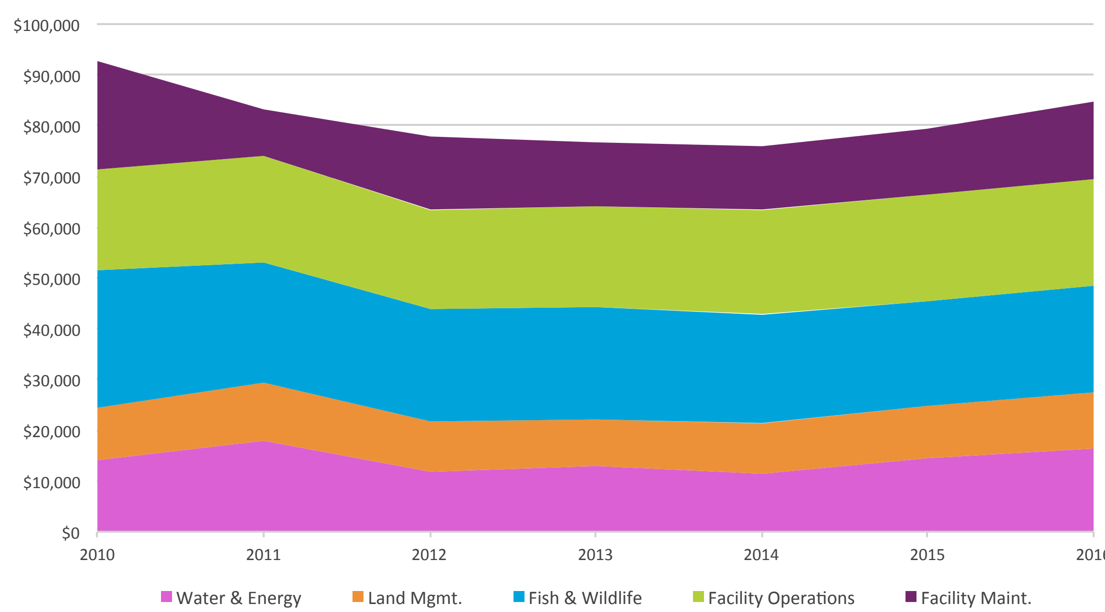
The United States Army Corps of Engineers owns 21 dams in the Columbia River Basin, fourteen of which have the authorized purpose of navigation. Mainstem Columbia and Snake River dams provide navigational channels for the transport of goods as far inland as Lewiston. As multipurpose dams, these projects also provide other benefits such as flood risk management, irrigation, hydroelectric power generation, water supply, and recreation.

A large portion of the costs incurred by USACE are from navigation activities. Between 2011 and 2017, the average budget for operations and maintenance of the locks for navigational purposes was $80 million per year, paid by U.S. taxpayers. U.S. taxpayers, also fund USACE annual operations and maintenance costs, amounting to tens of millions per year and other dam and associated infrastructure projects authorized by the Water Resource Development Act. As was discussed in the Navigation section, barges using the inland waterway do not pay do not pay the full cost of benefits received from using the inland waterway. Unlike hydropower, navigation expenses are directly funded by the federal government and not paid for through power sales. Although the dams do produce hydroelectric power, BPA covers any costs associated with the production of power, but not otherdam expenditures such as spillway maintenance, navigation locks, or fish passage facilities.

United States Bureau of Reclamation

The United States Bureau of Reclamation (USBR) operates and maintains nearly 40 dams in the Columbia River Basin, 10 of which are part of the FCRPS. Most significantly, the USBR operates and maintains Grand Coulee Dam, the largest power producer in the Columbia River Basin and one of the largest in the world. USBR dams provide hydroelectric power, flood control, navigation, irrigation, municipal and industrial water supply, and recreation.

Figure 27. Bureau of Reclamation Columbia Basin Operations and Maintenance Costs



The USBR spends approximately $70 million per year on operations and maintenance. The largest expenditures arise in the Fish and Wildlife department, misrepresented as explained above. Each year, the USBR spends $20 to $30 million to mitigate impacts to fish and wildlife.

Current BiOps will continue to require significant funding and are expected to continue for decades. BiOps require the Bureau to offset, or at a minimum reduce, adverse impacts to fish and wildlife. These actions include facility modifications, operational changes, and habitat rehabilitation. Some of these mitigation actions include hydrosystem improvements, hatchery improvements, avian predation reduction, and habitat improvement. These costs are co-funded by BPA through a cost-allocation process.

The Bureau's aging hydro infrastructure is also of concern, as unexpected maintenance costs will take up a larger part of the ledger in the coming years. Although the power portion of O&M costs are funded by BPA, cost allocations for other authorized purposes will see increases as well.

A breakdown of O&M costs can be seen in Figure 28, which have remained fairly consistent year over year.

Fishing platform across from The Dalles Dam, Source: CRITFC

BC Hydro Fish and Wildlife Compensation Program

BC Hydro's facilities in the Canadian portion of the Columbia River Basin include four major hydroelectric dams, two water storage dams that don't generate power and 7 smaller hydroelectric dams. The Columbia Region of BC Hydro has a total capacity of 5,946.4 MW, which is about half of BC Hydro's total capacity. BC Hydro operates both in and out of the Columbia River Basin. For the fiscal year ending March 31, 2015, total operating expenses both in and out of Basin were $4.5 billion.

To compensate for the impacts that dams have on their surrounding environment, BC Hydro established the Fish and Wildlife Compensation Program (FWCP). The Columbia Region FWCP's goal is to conserve and enhance fish and wildlife in the Columbia region of British Columbia. The Program operates as a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada (DFO), First Nations, and local communities, organizations and groups.

Approximately $5 million is spent annually on Fish and Wildlife compensation that primarily goes towards fish and wildlife enhancement projects. Administration and communications costs make up about 6 percent and 3 percent of the total operating budget, respectively.

Non-Federal Agencies

Of the more than 150 hydroelectric projects in the Columbia River Basin, only 31 are managed under the FCRPS. Whether owned by federal or non-federal agencies, these projects have high operating costs associated with them. Non-federal projects include Idaho Power's Hells Canyon Complex, Grant County PUD's Priest and Wanapum Dams, various irrigation districts, and many others.

Table 29. Annual Fund Category Spending Years 2013 to 2015

FUND CATEGORY	2013	2014	2015
Administration	$331,550	$301,909	$247,256
Wildlife	$1,949,370	$2,260,377	$2,372,244
Communications	$114,645	$140,360	$130,120
Fish	$2,430,090	$2,390,162	$2,513,195
TOTAL	**$4,825,655**	**$5,192,808**	**$5,262,815**

Grand Coulee Dam, Source: Keith Kutchins

Just as with federal agencies, these operators are required to comply with federal, state, regional, and local compliance standards and laws. Individually, these costs seem small in comparison to the large federal projects, but cumulatively they add up to a significant amount. Several examples of non-federal O&M costs are provided below. This list can help give context to the scale of large costs associated with operating projects within the basin.

- From 2013 to 2014, Douglas County saw total operating expenses increase from 1.4 million to $30.3 million. The majority of these expenses were a result of meeting FERC fish and wildlife mitigation measures associated with the Wells dam.
- At Idaho Powers' 17 hydroelectric facilities, Idacorp (Idaho Power) incurred $22 million of environmental expenditures and another $16 million in capital expenditures. These expenditures are associated with license compliance and relicensing efforts at hydroelectric facilities.
- Pend Oreille PUD' largest source of power comes from the Box Canyon Project. Due to debt service associated with a turbine upgrade project, the cost of producing power from this project has increased significantly over the last decade.
- Avista's 2016 capital budget of $392 million includes $22 million in environmental related costs. 40 percent of the power Avista transmits to end users is from hydro.

Continuing to Fund the Columbia River Basin Power System

With aging dams and stricter environmental considerations, hydrosystem costs are expected to rise in the Columbia River Basin in the coming years. The Northwest enjoys some of the least expensive electricity due to the extensive hydro driven generating resources supported by the natural capital within the Columbia River Basin. Investing in this natural capital makes sense from a financial, social, and environmental sense.

Although currently one-third of BPA's power budget is spent on fish and wildlife mitigation (or 22 percent when not including foregone revenue), the Columbia River Basin is still in need of major natural capital investments to restore ecosystem function and sustain natural capital. A consideration to incorporate a natural capital surcharge onto utility bills purchasing power produced within the Columbia River Basin could be consider to realize these investments. Though this analysis does not assess the economic ramifications of increased utility bills from a natural capital surcharge (e.g. the possibility of companies relocating), a case can be made that without the natural capital of the Columbia Basin the region wouldn't have inexpensive power. Investing in our natural capital assets can ensure that we manage these resources sustainably to continue to provide the same level of service well into the future.

The cost and value estimates in this chapter are quite conservative and only provide an incomplete, recent past and present snapshot. Because of the aging dam system, many new and expensive structural and operational improvements are in urgent need of implementation and completion. These include but are not limited to new turbines and generators, dam tailrace improvements and maintenance from erosion, and new spillways (i.e. Grand Coulee Dam). This assessment did not consider these expensive needs nor how they would be financed.

Chapter Seven

Conclusion

"The Earth is part of my body… I belong to the land out of which I came…The earth is my mother…"

– Too-Hool-Hool-Zute, Historical Nez Perce Leader[192]

Columbia Gorge, Source: CRITFC

The Columbia River Basin, with its close ties to tribal culture and its rich environmental resources, is a natural capital asset not only worth preserving, but also enhancing. Sustainable natural capital and ecosystem-based functions and services have been severely degraded in a relatively short period by the non-tribal development and operation of built capital, such as dams and associated infrastructure. Consideration of ecosystem-based functions and services from an economic perspective reveals previously unrecognized aspects of the CRB's value that should be incorporated in decision making and planning for a modernized river management regime under a renewed Columbia River Treaty. In this section, we summarize the report findings and recommend areas for further research. Finally, we identify a number of viable funding mechanisms that could be used to secure the benefits of modernized river management under an updated treaty.

Findings

The CRB is immensely beneficial to communities, and its benefits would only increase under a modernized treaty scenario. However, threats to the basin's ecological balance, including climate change and population growth, endanger these sustainable, nature-based benefits and compromise the livelihoods and quality of life of its residents. Given these severe challenges, enhancing and even maintaining the numerous benefits provided by this natural system demands changes in river management.

This report forecasts the value[ab] that would result from modifications to the current management regime. Resources were identified and valued under two scenarios, RCC-80 and 3Ea. The results clearly indicate that scenario 3Ea, which enhances and integrates ecosystem function into

ab Values are rounded to the nearest million, more exact estimates can be found in Table 27.

river operations, would significantly increase the value of natural capital throughout the basin. The 3Ea scenario would augment non-tribal commercial fisheries, increasing their value by about $7 million annually due to increased fish populations, particularly in the Upper Basin. Recreation, particularly angling, would also increase by about $46 million per year with higher fish populations. This difference would be especially notable during low-water years.

Because the proposed 3Ea scenario would improve the overall health of the CRB, there are additional areas of benefit. The CRB's ecosystem services value would increase by $389 million annually under the 3Ea scenario. A valuation of higher reservoir water levels accounts for this increase. Extending the reach of fish along the river would also improve the release of nitrogen and phosphorus from salmon carcasses in upstream areas. Increased nutrient levels would then benefit riparian areas throughout the system, adding almost $31 million in yearly benefits.

Lastly, the existence value of additional fish in the river would contribute approximately $1 billion. Under 3Ea, improved river

Umatilla Board of Trustees Member N. Kathryn "Kat" Brigham, ca. 1970s. Kat was one of the founding Commissioners of CRITFC back in 1977., Source: CRITFC

operations would increase salmon and steelhead abundance by at least 6.7 percent for spring chinook and 126 percent for steelhead. Reintroduction to areas currently blocked by Chief Joseph and Grand Coulee Dams has the potential to further increase salmon runs by 400 to 800 thousand salmon and steelhead. The modernized scenario will substantially contribute to delisting and recovery of ESA-listed salmon, steelhead, sturgeon, and other imperiled species such as lamprey and bull trout. Thus, the total economic gain assessed under 3Ea would reach about $1.5 billion annually.

The valuation of ecosystem services in this report is very conservative. For example, other than two stocks of salmon and steelhead, no additional value was placed on anadromous fish stocks that would benefit from increased spring and early summer flows, nor was any value benefit assessed on resident fish in reservoirs from more stable 3Ea operations. If quantified, these benefits could be substantial. For example, assuming a ten percent increase in EbF[ac] under 3Ea would add roughly an additional$19 billion in annual benefits.

The Columbia River Treaty is one of the most important regional international agreements. The inclusion of EbF and ecosystem services into the Treaty is essential to sustain the CRB's benefits. Substantial effort will need to be applied to create a healthy, sustainable, and functioning CRB. The ecosystem (3Ea) scenario illustrates positive potential changes in river management that can result in positive outcomes for the basin's ecological systems and provide sustainable economic prosperity throughout the region and future generations.

Further Research Needed

Though this report demonstrates clear value in the region, further analysis could greatly complement these results. In this section, we present select areas for further study that would address key areas of interest for tribes and other regional stakeholders. The funding mechanisms section that follows is intended to highlight viable funding opportunities for the CRB.

Enhanced Analyses

ECONOMIC CONTRIBUTION OF PORTS: Transportation of goods along the Columbia River is of vital economic importance for agricultural exporters and any business which

ac 10 percent is an arbitrary percentage and not based on any referenceable citation. This is simply an example of how benefits could increase if widespread ecosystem improvements were to occur under 3Ea.

relies heavily on large-scale container shipments. If ports close down or decrease their activity, the regional economy would suffer, with industries reliant upon agriculture or shipping experiencing the most significant economic consequences. Describing these economic relationships would require a full-fledged economic impact study of the impacts of increased shipping costs on regional economies.

ADDITIONAL SALMON FISHERY ANALYSIS: A more detailed salmon fishery analysis would require input from an ecological modeling team with the ability to model environmental changes and policy options over time. Ecopath with Ecosim is one such model that can facilitate this type of analysis. Additional fish survival and productivity analyses could be conducted using regional state-of-the-art models such as NOAA's COMPASS model and the CRB fishery agencies and tribes' Comparative Survival Study model should also be pursued.

Prior analyses conducted by EE (which were informed by teams of ecological modelers) have coupled biophysical fish modeling with economic models to elicit region-wide economic impact analyses of the economic benefits associated with fisheries. Expanding the scope to include recreational fisheries would require collection of fishing visitation and recreational expenditure data.

Fishers checking their nets on the Columbia River, Source: CRITFC

BUILT CAPITAL REPLACEMENT COSTS: A more detailed analysis of built capital replacement costs would require in-depth, comparative research into engineering-level documentation of capital costs. These kinds of documents are time-consuming to use, but they may offer a more precise estimate of the replacement intervals required to keep dams in operation. In addition, the analysis of future costs should be informed by the projected needs of Columbia River Basin residents. Given market and capacity diversification and changes in regional energy demands, including those driven by climate change (i.e. winter demand shifting to summer demand)[193], electricity generation needs change significantly. The level of investment in hydropower should reflect the direction (up or down) of the change in demand.

IRRIGATION WATER ANALYSIS: Water for irrigation is essential to the CRB's agricultural economy. Climate change and the treaty modernization may affect agricultural practices across the basin as the availability and timing of water supply changes. Water availability for both instream and agricultural use could increase under some climate change and treaty modernization scenarios. Increased instream flows may provide mutual benefits for farmers if more water comes over the border or if modernized operations provide more instream flows at certain times of year, as under 3Ea. Increased water conservation and efficiency could also affect agricultural water use and the water supply available for instream use in the basin.

FUTURE FLOOD RISK ESTIMATION: Future flood risk projections will have to incorporate the hydrological changes (reduced snowpack, increased winter rainfall, and extremely low summer flows) associated with climate change. Hydrographic changes may increase winter flood risk depending on the distribution of snow and rain in the winter season. Extensive research on potential floodplain restoration projects, in concert with information created by the CRITFC and UCUT should be pursued along with the economic valuation assessed. An interdisciplinary team of hydrologists, climate scientists, and ecological economists would be required to rigorously assess future flood risks and mitigation options.

RIPARIAN VEGETATION ANALYSIS: The quality and quantity of riparian vegetation can affect riverine water quality. Excess sediment or nutrient concentrations, for example, can degrade water quality. Increasing the width of riparian buffers reduces the amount of sediment and nutrients that may pass into a river. The social cost of additional pollutant input can be used to find the avoided social costs due to the presence of riparian buffers. Earth Economics has performed this type of analysis for water utilities in the past. It is an intense process both in terms of data and computational requirements.

CLIMATE CHANGE ANALYSIS: The best available scientific information from global circulation models shows a warming climate will substantially alter the Columbia River Basin's hydrology and increase air and stream temperatures. By the end of this century, snow-rain transient areas over most of the U.S. portion of the basin will likely become rain-dominated areas. In Canada, much of the snow-dominated area will remain, although glaciers will likely be seriously compromised.

Climate and hydrological model projections indicate that total precipitation volume will not change, but will be more concentrated in the winter period, which could increase flooding events. The reduction of snowpack and summer precipitation will likely increase the frequency and magnitude of summer low flows and drought conditions. Warming conditions will likely increase both winter and summer air and water temperatures and increase drought frequency throughout the Columbia Basin.

Warmer winters and warmer, drier summers will stress native aquatic species in direct and indirect ways, such as increased fish mortality and competition with invasive species that are expected to thrive in warmer conditions. Climatic conditions will also change power loads with shifts from winter to summer load demands and flood risk management operations for upstream storage reservoirs.

Adaptive measures and planning for EbF should be rigorously pursued. Such measures could include restoring natural or normative hydrograph volumes, timing and shaping via modifications of basin reservoir storage capacity, implementing structural measures at the dams to provide selective release of cool water to downstream rivers, increasing fish passage success at existing dams via dam spill and other measures, restoring fish passage to cooler areas in the basin, and rehabilitating floodplain habitats to provide thermal refuge for migrating fish populations.

Updated climate change assessments that will likely affect temperature and hydrology by the 2040's and certainly by the 2080's are under development through the U.S. River Management Joint Operating Committee. Integrating these model projections with ecosystem, power, and flood risk scenarios will provide information for further economic assessments.

Viable Future Funding Mechanisms

Any flood protection gained from Columbia River dams is predicated upon water being stored behind the dams and flooding previously usable and habitable land. Upstream residents suffer flooding losses and should be compensated.

Rock Creek mouth, Source: CRITFC

Tribal members, in particular the Spokane tribe, have lost portions of their land over time. Considering both the high value of flood prevention and the negative impacts on tribes, it is reasonable to fund riparian and riverine restoration efforts through taxation of downstream beneficiaries of flood risk protection. In particular, taxation of those that gain the most (floodplain residents) would be most appropriate.

Another option for funding riparian restoration would be through navigation fees. Shipping and navigation interests gain financially from continued dredging of the river. Given that dredging and ship passage both cause ecological degradation, it would also be reasonable to apply a riparian restoration fee to ships using locks and navigation features.

Columbia River power generation is financially valuable to the BPA and all of its customers. However, the dams that provide this power also have negative impacts on riverine habitat and fish stock survival. Given the existence of these social costs, it is within reason to apply a river restoration fee on top of energy prices so that funding for restoration can be provided directly by those that gain from dam-based water management. According to the U.S. Department of Energy, all major hydropower-producing dams on the main stem of the Columbia River (dams of interest) create approximately $19 million in revenue per day, or nearly $7 billion each year.[194] A tax could be an important source of additional annual funding for restoration endeavors.

The value of natural capital in the Columbia River Basin is truly extraordinary, and as this report demonstrates, this value can be further elevated with an updated management regime that accounts for EbF. Dated management practices, degraded built infrastructure, climate change, and other threats jeopardize the amount of benefits currently produced. Yet, under a modernized management scenario such as 3Ea, EbF could be included in decision making to sustain and augment this region's value. As seen in chapter 4, 3Ea would increase the value of benefits produced by almost $1 billion in yearly benefits, and that added value merits consideration. Not only does a modernized scenario augment the total value of the CRB, it also supports ecosystems to be more ecologically and economically productive.

Appendix A

Glossary

3Ea80: Modernized Columbia River Treaty scenario, official 80-year modified flow.

Average Megawatt (aMw): the electricity produced by continually generating one megawatt for one year (8,760 megawatt hours).

Base Load Requirement: The minimum level of electricity demand over 24 hours.

Benefit Transfer: Economic valuation approach in which estimates obtained in one context are used to estimate values in a different context. This approach is widely used because of its ease and low cost, but is risky because values are context-specific and must be used carefully.

Biodiversity: The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within and among species and diversity within and among ecosystems. Biodiversity itself is not an ecosystem service, but provides the major foundation for all ecosystem services.

Bonneville Power Administration: The Federal power marketing agency under the Department of Energy responsible for marketing wholesale electric power from 30 Federal dams and one non-Federal nuclear plant throughout Washington, Oregon, Idaho, and western Montana and portions of California, Nevada, Utah, and Wyoming. BPA also sells and exchanges power with utilities in Canada and California.

Built Capital: Refers to the productive infrastructure of technologies, machines, tools, and transport that humans design, build, and use for productive purposes. Coupled with our learned skills and capabilities, our built techno-infrastructure is what directly allows raw materials to be turned into intermediate products and eventually finished products.

Capital Value/Asset Value (of an ecosystem): The present value of the stream of future benefits that an ecosystem will generate under a particular management regime. Present values are typically obtained by discounting future benefits and costs; the appropriate rates of discount are often set arbitrarily.

Cultural Services: Ecosystem services that provide humans with meaningful interaction with nature. These services include the role of natural beauty in attracting humans to live, work and recreate, and the value of nature for science and education.

Discount Rate: The rate at which people value consumption or income now, compared with consumption or income later. This may be due to uncertainty, productivity, or pure time preference for the present. “Intertemporal discounting” is the process of systematically weighing future costs and benefits as less valuable than present ones.

Drafting: Lowering the reservoir elevation for several different purposes such as dam repairs, flood control, increase flows downstream for improving conditions for fish migration, lowering river temperatures, irrigations, as well as industrial and municipal water supplies. Outflow is greater than inflow at the time but the water will eventually be replaced.

Ecosystem-based Function: Concept from Columbia River Basin Tribes, used to explain the innate value of nature, regardless of any human use for these benefits.

Ecosystem Services: Benefits people derive from nature, free of charge.

Elasticity of marginal utility: The change in utility, or consumer satisfaction, gained or lost by people from consumption.

Externalities: A side effect or consequence of an industrial or commercial activity that affects other parties without this being reflected in the cost of the goods or services involved.

Forebay: Artificial pool of water in front of a larger body of water.

Gigawatt Hour (GWh): A unit of energy representing one billion watt hours.

Natural Capital: Refers to the earth’s stock of organic and inorganic materials and energies, both renewable and nonrenewable, as well as the planetary inventory of living biological systems (ecosystems) that when taken as one whole system provides the total biophysical context for the human economy. Nature provides the inputs of natural resources, energy, and ecosystem function to human economic processes of production. Nature by itself produces many things that are useful and necessary to human well-being.

Net Present Value: Net Present value is the amount that, at some discount rate, will produce the future benefits less costs after a defined length of time.

Operations and Maintenance Services: Operation and maintenance on gray infrastructure, usually undertaken by utilities or USACE.

Operations and Maintenance, Repair: Same as above, including repair, usually undertaken by utilities or USACE.

Participant Day: A singular visit to a recreational land or a one-time engagement by one individual in a recreational activity.

RCC-80: Reservoir Current Conditions-80 years models dam management using 80 years of historic hydrologic data from 1929 to 2008.

Pre-contact time: Pre-European contact in the Columbia River Basin.

River Basin: The area of land that is drained by a river and its tributaries. This includes all streams and creeks that flow downhill into the river.

Spill: Sending water over a spillway rather than through the turbines to generate power.

Spring Freshet: Increased natural stream flow due to the thawing of snow and ice melt. The spring freshet can help migrating smelt travel downstream.

Stakeholder: An actor having a stake or interest in a physical resource, ecosystem service, institution, or social system, or someone who is or may be affected by a public policy.

Sustainability: A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Value: The contribution of an action or object to user-specified goals, objectives, or conditions. Value can be measured in a number of ways (see Valuation).

Valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making), usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on).

Watershed: The area of land where all of the water that is under it or drains off of it goes into the same place. A good example of a watershed is a river valley that drains into the ocean.

Water Resource Council: Establishes guidelines used by USACE for economic and social analysis.

Appendix B

Commercial Fisheries Valuation Data

Washington state data were used for landings in Puget Sound, coastal Washington, and within the Columbia River. Oregon data was used for coastal Oregon landings only. The other data areas were only used in those areas. All prices are inflated to 2015 USD using consumer price indices.

Columbia River

Table 30. Landings and Ex-Vessel Value in the Columbia River Basin

	YEAR	CHINOOK	CHUM	COHO	PINK	SHAD	SOCKEYE
LANDINGS	2015	1,823,756	-	218,974	12	2,440	1,565
	2014	2,185,707	-	1,942,281	8	15,369	991
	2013	1,844,726	-	385,714	67	12,598	590
	2012	1,196,081	465	130,423	-	2,210	1,687
	2011	1,563,052	1,063	596,233	363	24,112	359
EX-VESSEL VALUE	2015	$4,598,588	$-	$349,936	$19	$3,899	$2,501
	2014	$5,511,245	$-	$3,103,899	$13	$24,561	$1,584
	2013	$4,651,464	$-	$616,398	$107	$20,132	$943
	2012	$3,015,910	$393	$208,425	$-	$3,532	$2,696
	2011	$3,941,225	$899	$952,821	$580	$38,533	$574

Source: Oregon Department of Fish and Wildlife[195]

Washington State

Table 31. Dollar Per Pound Ex-vessel Values for Salmon Species in Washington State

YEAR	SALMON, CHINOOK	SALMON, CHUM	SALMON, COHO	SALMON, PINK	SALMON, SOCKEYE
2011	2.60	1.24	1.72	0.51	1.85
2012	2.71	0.74	1.87	0.53	1.91
2013	2.71	0.62	1.90	0.41	1.45
2014	2.29	0.81	1.25	1.23	1.50
2015	2.61	0.58	1.54	0.24	1.62

Source: National Marine Fisheries Service[196]

Table 32. Washington Salmon Landings and Ex-Vessel Value Outside the Columbia River Basin

	YEAR	CHINOOK	COHO
LANDINGS	2015	767,191	22,172
	2014	536,866	118,942
	2013	556,048	46,637
	2012	556,048	25,229
	2011	373,131	23,569
EX-VESSEL VALUE	2015	$2,002,369	$34,145
	2014	$1,230,654	$148,826
	2013	$1,504,668	$88,719
	2012	$1,509,192	$47,125
	2011	$971,162	$40,482

Source: Pacific Fishery Management Council (2017)[197]

Oregon State

Table 33. Dollar Per Pound Ex-vessel Values for Salmon Species in Oregon

YEAR	SALMON, CHINOOK	SALMON, COHO
2011	3.29	1.74
2012	3.87	1.68
2013	3.76	1.86
2014	3.80	1.19
2015	3.94	1.53

Source: National Marine Fisheries Service[198]

Table 34. Coastal Oregon Landings and Ex-Vessel Value

	YEAR	CHINOOK	COHO
LANDINGS	2011	479,803	3,862
	2012	749,345	4,354
	2013	1,499,269	3,014
	2014	2,999,535	78,379
	2015	1,396,351	12,791
EX-VESSEL VALUE	2011	$1,577,435	$6,715
	2012	$2,899,942	$7,324
	2013	$5,643,230	$5,611
	2014	$11,409,643	$93,364
	2015	$5,501,623	$19,570

Source: Oregon Department of Fish and Wildlife[198]

Southeast Alaska

Table 35. Dollar Per Pound Ex-vessel Values for Salmon Species in Southeast Alaska

YEAR	CHINOOK	COHO
2015	3.81	0.78
2014	4.27	1.35
2013	6.82	1.19
2012	4.56	1.52
2011	4.19	1.34

Source: Alaska Department of Fish and Game[200]

Table 36. Total Landings and Ex-Vessel Value of Chinook Catch in Southeast Alaska

YEAR	LANDINGS	EX-VESSEL VALUE
2011	4,612,000	$19,344,573
2012	3,629,000	$16,542,828
2013	2,601,000	$17,724,313
2014	5,092,000	$21,765,766
2015	3,085,000	$11,751,000

Source: Alaska Department of Fish and Game[201]

British Columbia

Table 37. Total Landings and Ex-Vessel Value of Chinook Catch in British Columbia

YEAR	LANDINGS	EX-VESSEL VALUE
2013	2,425,082	$9,113,247
2014	5,291,088	$18,342,418
2015	3,306,930	$17,496,986

Source: B.C. Seafood Industry Year in Review (2015)[202]

Appendix C

Recreational Parks Used in this Study

BC Parks

Akamina- Kishinena Park, Allison Lake Park, Arrow Lakes Park, Blanket Creek Park, Boundary Creek Park, Bromley Rock Park, Bugaboo Park, Cascade Recreation Area, Cathedral Park, Champion Lakes Park, Christie Memorial Park, Christina Lake Park, Cody Caves Park, Conkle Lake Park, Drewry Point Park, Dry Gulch Park, Elk Lakes Park, Ellison Park, Fintry Park, Gladstone Park, Grohman Narrows Park, Height Of The Rockies Park, Inkaneep Park, James Chabot Park, Jewel Lake Park, Jimsmith Lake Park, Johnstone Creek Park, Kalamalka Lake Park, Kekuli Bay Park, Kettle River Recreation Area, Kickininee Park, Kikomun Creek Park, Kokanee Creek Park, Kokanee Glacier Park, Kootenay Lake Park, Lockhart Beach Park, Martha Creek Park, Mcdonald Creek Park, Mount Assiniboine Park, Mount Fernie Park, Moyie Lake Park, Myra-Bellevue Park, Nancy Greene Park, Norbury Lake Park, Okanagan Lake Park, Okanagan Mountain Park, Otter Lake Park, Pilot Bay Park, Premier Lake Park, Purcell Wilderness Conservancy Park (East), Purcell Wilderness Conservancy Park (West), Rosebery Park, Ryan Park, Skaha Bluffs Park, St. Mary'S Alpine Park, Stagleap Park, Stemwinder Park, Summit Lake Park, Sun-Oka Beach Park, Swì"Iwì"S (Formerly Haynes Pt), Sxìœê·É™Xìœ Ê·Nitkê· (Formerly Okanagan Falls), Syringa Park, Top Of The World Park, Valhalla Park, Vaseux Lake Park, Wasa Lake Park, Whiteswan Lake Park, Yahk Park.

Bureau of Land Management

Boundary Dam, Coffeepot Lake, Crab Creek, Fishtrap Lake, Govan, Hog Canyon Lake, Juniper Dunes Recreation Area, Juniper Dunes Wilderness, Odessa Craters, Pacific Lake, Rock Creek, Rocky Ford, Telford, Twin Lakes.

Idaho State Parks & Recreation

Bruneau Dunes, Castle Rocks, City Of Rocks, Coeur D' Alene Parkway, Dworshak, Eagle Island, Farragut, Harriman - Railroad Ranch, Hells Gate, Henrys Lake, Heyburn, Lake Cascade, Land Of The Yankee Fork, Lucky Peak - Discovery Park Unit, Lucky Peak - Sandy Point Unit, Lucky Peak - Spring Shores Unit, Massacre Rocks, Mesa Falls, Old Mission, Ponderosa, Priest Lake - Dickensheet Unit, Priest Lake - Indian Creek Unit, Priest Lake - Lionhead Unit, Round Lake, Thousand Springs - Billingley Creek Unit, Thousand Springs - Box Canyon Unit, Thousand Springs - Malad Gorge Unity, Thousand Springs - Niagara Springs Unit, Thousand Springs - Ritter Island Unit, Three Island Crossing, Trail Of The Coeur D'Alenes, Walcott, Winchester Lake.

Montana State Parks

Anaconda Smoke Stack, Beavertail Hill, Council Grove, Fish Creek, Flathead Lake, Flathead Lake - Big Arm, Flathead Lake - Finley Point, Flathead Lake - North Shore, Flathead Lake - Wayfarers, Flathead Lake - West Shore, Flathead Lake - Wild Horse Island, Flathead Lake - Yellow Bay, Fort Owen, Frenchtown Pond, Lake Mary Ronan, Lewis & Clark Caverns, Lone Pine, Lost Creek, Painted Rocks, Pictograph Cave, Placid Lake, Salmon Lake, Tcl/Logan - Logan, Tcl/Logan- Thompson Chain Of Lakes, Thompson Falls, Travelers' Rest, Whitefish Lake/Les Mason, Whitefish Lake/Les Mason - Les Mason, Whitefish Lake/Les Mason -Whitefish Lake.

National Park Service

Glacier, Grand Teton, Lake Chelan, Lake Roosevelt, Nez Perce National Historic Park, Yellowstone.

Oregon Parks and Recreation Department

Alderwood State Wayside, Bald Peak State Scenic Viewpoint, Banks-Vernonia State Trail, Bates State Park, Battle Mountain Forest St Scenic Corridr, Benson State Recreation Area, Bradley State Scenic Viewpoint, Bridal Veil Falls State Scenic Viewpoint, Cascadia State Park, Catherine Creek State Park, Champoeg State Heritage Area/Visitor Cnt, Cline Falls State Scenic Viewpoint, Clyde Holliday State Recreation Site, Cottonwood Canyon State Park, Crown Point State Scenic Corridor, Dabney State Recreation Area, Dalton Point State Recreation Site, Deschutes River State Recreation Area, Detroit Lake State Recreation Area, Dexter State Recreation Site, Elijah Bristow State Park, Ellmaker State Wayside, Emigrant Springs State Heritage Area, Fall Creek State Rec Area (Winberry), Farewell Bend State Recreation Area, Fort Stevens Historic Area, Fort Stevens State Park, Fort Yamhill State Heritage Area, Guy W Talbot State Park, Hat Rock State Park, Hilgard Junction State Recreation Area, Historic Columbia River Hwy State Trl, Holman State Wayside, Iwetemlaykin State Heritage Area, J. S. Burres, Jasper Point State Park, Jasper State Recreation Site, Koberg Beach State Recreation Site, Lake Owyhee State Park, Lapine State Park, Lewis And Clark State Recreation Site, Ll Stub Stewart State Park, Lowell State Recreation Site, Luckiamute Landing State Natural Area, Mary S Young State Recreation Area, Maud Williamson State Recreation Site, Mayer State Park, Milo Mciver State Park, Minam State Recreation Area, Molalla River State Park, North Santiam State Recreation Area, Ochoco

State Scenic Viewpoint, Ontario State Recreation Site, Peter Skene Ogden State Scenic Viewpoint, Pilot Butte State Scenic Viewpoint, Portland Women`S Forum State Scenic View, Prineville Reservoir State Park, Red Bridge State Wayside, Rooster Rock State Park, Saddle Mountain State Natural Area, Sarah Helmick State Recreation Site, Seneca Fouts Memorial State Natural Area, Silver Falls State Park, Silver Falls-North Falls, Smith Rock State Park, Starvation Creek State Park, Sumpter Valley Dredge State Heritage, The Cove Palisades State Park, Tryon Creek Mu Admin, Tryon Creek State Natural Area, Tumalo State Park, Ukiah-Dale Forest State Scenic Corridor, Unity Lake State Recreation Site , Viento State Park, Wallowa Lake Highway Forest State Scenic, Wallowa Lake State Recreation Area, Warm Springs State Recreation Site, Washburne State Wayside, White River Falls State Park, Willamette Greenway Properties, Willamette Greenway-Yamhill Co-Champoeg, Willamette Mission State Park.

United States Army Corps of Engineers

Albeni Falls Dam, Blue River Lake Or, Chief Joseph Dam, Cottage Grove Lake Or, Cougar Lake Or, Detroit Lake, Dorena Lake Or, Fall Creek Lake Or, Fern Ridge Lake Or, Green Peter Lake, Ice Harbor Lock And Dam, Libby Dam, Little Goose Lock And Dam, Lookout Point Lake Or, Lucky Peak Lake, Mcnary Lock And Dam, Bonneville Lock And Dam-Lake Bonneville, Dexter Lake, Dworshak Dam And Reservoir, Foster Lake, Hills Creek Lake, Lake Umatilla, Lower Granite Lock And Dam, Lower Monumental Lock And Dam, Willow Creek Lake, The Dalles Lock And Dam - Lake Celilo.

United States Forest Service

Beaverhead-Deerlodge National Forest, Bitterroot National Forest, Boise National Forest, Bridger-Teton National Forest, Caribou-Targhee National Forest, Columbia River Gorge National Scenic Area, Colville National Forest, Deschutes National Forest, Flathead National Forest, Fremont-Winema National Forests, Gallatin National Forest, Gifford Pinchot National Forest, Helena National Forest, Humboldt-Toiyabe National Forest, Idaho Panhandle National Forests, Kootenai National Forest, Lewis And Clark National Forest, Lolo National Forest, Malheur National Forest, Mt. Baker-Snoqualmie National Forest, Mt. Hood National Forest, Nez Perce-Clearwater National Forest, Ochoco National Forest, Okanogan-Wenatchee National Forest, Payette National Forest, Salmon-Challis National Forest, Sawtooth National Forest, Shoshone National Forest, Siuslaw National Forest, Umatilla National Forest, Umpqua National Forest, Wallowa-Whitman National Forest, Willamette National Forest.

Washington State Parks and Recreation Commission

Alta Lake, Banks Lake, Battle Ground Lake, Beacon Rock, Bridgeport, Brooks Memorial, Brooks Memorial (Elc), Camp Delany (Elc), Camp William T. Wooten (Elc), Columbia Hills, Columbia Plateau Trail, Columbia Plateau Trail S, Conconully, Crawford, Crown Point, Curlew Lake, Daroga, Doug'S Beach, Dry Falls (Ic), Fields Spring, Fort Columbia, Fort Columbia (Vh), Fort Simcoe, Ginkgo Petrified Forest, Ginkgo Petrified Forest (Ic), Goldendale Observatory, Ike Kinswa, Iron Horse Palouse - Adams, Iron Horse Palouse - Whitman, Jackson House, Lake Chelan, Lake Easton, Lake Wenatchee, Lewis & Clark, Lewis & Clark Trail, Lewis And Clark (Elc), Lewis And Clark (Ic), Lincoln Rock, Maryhill, Matilda N. Jackson, Mount Spokane, Olmstead Place, Palouse Falls, Paradise Point, Pearrygin Lake, Peshastin Pinnacles, Potholes, Puffer Butte (Elc), Reed Island, Riverside, Sacajawea, Sacajawea (Ic), Seaquest, Spokane House, Spokane River Centennial Trail, Spring Creek Hatchery, Squilchuck, St. Helens Visitor Center (Ic), Steamboat Rock (Banks Lake), Steptoe Butte, Steptoe Memorial, Sun Lakes Resort, Sun Lakes-Dry Falls, Twenty-Five Mile Creek, Wanapum Dam, Wanapum Dam - Grant (Kittitas Already Accounted For), Wenatchee Confluence, Wo-He-Lo, Yakima Sportsman.

Appendix D

Angling Analysis Data

Table 38. Current and Enhanced Value of Recreational Catch in the CRB

	COLUMBIA RIVER RECREATIONAL CATCH			ECONOMIC VALUE		
ECONOMIC IMPACT REGION/AREA/SPECIES	**RC-CC**	**3Ea**	**NET CHANGE**	**RC-CC**	**3Ea**	**NET CHANGE**
LOWER COLUMBIA RIVER						
Chinook	78,865	80,238	1,788	$34,806,112	$35,412,179	$606,067
Coho	41,621	41,621	-	$15,898,214	$15,898,214	$0
Steelhead	40,188	90,824	50,636	$18,234,631	$92,520,659	$23,581,703
TOTAL	**160,674**	**212,683**	**52,424**	**$68,938,956**	**$92,520,956**	**$23,581,703**
MID COLUMBIA RIVER						
Chinook	17,889	18,201	406	$7,762,524	$7,897,690	$135,166
Coho	15,920	15,920	0	$6,080,978	$6,080,978	$0
Steelhead	23,243	52,528	29,286	$10,546,144	$24,834,218	$13,288,104
TOTAL	**57,052**	**86,649**	**29,691**	**$24,389,616**	**$37,812,886**	**$12,423,270**
UPPER COLUMBIA RIVER						
Chinook	11,768	11,973	143	$5,487,873	$5,583,432	$95,559
Coho	-	-	-	$0	$0	$0
Steelhead	1,741	1,995	254	$789,944	$905,276	$115,332
TOTAL	**13,509**	**13,968**	**397**	**$6,277,817**	**$6,488,708**	**$210,890**
LOWER SNAKE RIVER						
Chinook	8,067	8,067	-	$3,892,344	$3,892,344	$0
Coho	-	-	-	$0	$0	$0
Steelhead	68,326	68,326	-	$31,002,134	$31,002,134	$0
TOTAL	**76,393**	**76,393**	**-**	**$34,894,478**	**$34,894,478**	$0
UPPER COLUMBIA RIVER—ABOVE CHIEF JOSEPH						
Chinook	-	18,544	18,544	$0	$8,948,380	$8,948,380
Coho	-	-	-	$0	$0	$0
Steelhead	-	700	-	$0	$317,617	$317,617
TOTAL	**-**	**-**	**19,244**	**$0**	**$9,264,997**	**$9,264,997**
COLUMBIA RIVER SYSTEM						
CHINOOK	**116,590**	**137,023**	**20,881**	**$51,948,853**	**$61,733,025**	**$9,784,172**
COHO	**57,541**	**57,541**	**-**	**$21,979,192**	**$21,979,192**	**$0**
STEELHEAD	**133,497**	**214,373**	**80,876**	**$60,572,823**	**$97,2269,511**	**$36,969,688**
TOTAL	**307,628**	**408,938**	**101,757**	**$134,500,868**	**$180,981,728**	**$46,480,860**

Table 39. Economic Impact of Columbia River Origin Recreational Catch

	COLUMBIA RIVER BASIN STOCKS	ECONOMIC VALUE
ECONOMIC IMPACT	**RCC-CC**	**RCC-CC**
CALIFORNIA COAST		
Chinook Salmon	-	$0
Coho Salmon	154	$18,150
TOTAL	**385**	$18,150
OREGON COAST		
Chinook Salmon	-	$0
Coho Salmon	14,938	$1,738,251
TOTAL	**14,938**	**$1,738,251**
WASHINGTON COAST		
Chinook Salmon	11,975	$936,521
Coho Salmon	29,538	$2,310,226
TOTAL	**41,512**	**$3,246,747**
PUGET SOUND/STRAIGHT OF SAN JUAN DE FUCA		
Chinook Salmon	1,986	$300,826
Coho Salmon	-	$0
TOTAL	**1,986**	**$300,826**
BRITISH COLUMBIA		
Chinook Salmon	1,060	$82,901
Coho Salmon	162	$12,743
TOTAL	**1,223**	**$95,645**
SOUTHEAST ALASKA		
Chinook Salmon	13,233	$1,034,926
Coho Salmon	-	$0
TOTAL	13,233	**$1,034,926**
CHINOOK SALMON	**28,253**	**$2,355,194**
COHO SALMON	**44,793**	**$4,079,371**
TOTAL	**73,046**	**$6,434,565**

Appendix E

Data Limitations

Climate Change Data

This report does not include climate change in the analyses given that at the time of the completion of this work climate change was data was still being developed. However, most of the analyses can be easily updated once the data is available.

ESV

Valuation exercises have limitations that must be noted, although these limitations should not detract from the core finding that ecosystems produce a significant economic value to society. A benefit transfer analysis estimates the economic value of a given ecosystem (e.g., wetlands) from prior studies of that ecosystem type. Like any economic analysis, this methodology has strengths and weaknesses. Some arguments against benefit transfer include:

1. Every ecosystem is unique; per-acre values derived from another location may be irrelevant to the ecosystems being studied.
2. Even within a single ecosystem, the value per acre depends on the size of the ecosystem; in most cases, as the size decreases, the per-acre value is expected to increase and vice versa. (In technical terms, the marginal cost per acre is generally expected to increase as the quantity supplied decreases; a single average value is not the same as a range of marginal values).
3. To value all, or a large proportion, of the ecosystems in a large geographic area is questionable in terms of the standard definition of exchange value. We cannot conceive of a transaction in which all or most of a large area's ecosystems would be bought and sold. This emphasizes the point that the value estimates for large areas (as opposed to the unit values per acre) are more comparable to national income account aggregates and not exchange values.[203] These aggregates (i.e. GDP) routinely impute values to public goods for which no conceivable market transaction is possible. The value of ecosystem services of large geographic areas is comparable to these kinds of aggregates (see below).

Proponents of the above arguments recommend an alternative valuation methodology that amounts to limiting valuation to a single ecosystem in a single location. This method only uses data developed expressly for the unique ecosystem being studied, with no attempt to extrapolate from other ecosystems in other locations. The size and landscape complexity of most ecosystems makes this approach to valuation extremely difficult and costly. Responses to the above critiques can be summarized as follows (See Costanza et al. (1997)[204] and Howarth and Farber (2002)[205] for a more detailed discussion):

1. While every wetland, forest or other ecosystem is unique in some way, ecosystems of a given type, by their definition, have many things in common. The use of average values in ecosystem valuation is no more or less justified than their use in other macroeconomic contexts; for instance, the development of economic statistics such as Gross Domestic or Gross State Product.
2. As employed here, the prior studies upon which we based our calculations encompass a wide variety of time periods, geographic areas, investigators and analytic methods. Many of them provide a range of estimated values rather than single-point estimates. The present study preserves this variance; no studies were removed from the database because their estimated values were deemed to be "too high" or "too low." Also, only limited sensitivity analyses were performed. This approach is similar to determining an asking price for a piece of land based on the prices of comparable parcels ("comps"): Even though the property being sold is unique, realtors and lenders feel justified in following this procedure to the extent of publicizing a single asking price rather than a price range.
3. The objection to the absence of even an imaginary exchange transaction was made in response to the study by Costanza et al. (1997)[206] of the value of all of the world's ecosystems. Leaving that debate aside, one can conceive of an exchange transaction in which, for example, all of, or a large portion of a watershed was sold for development, so that the basic technical requirement of an economic value reflecting the exchange value could be satisfied. Even this is not necessary if one recognizes the different purpose of valuation at this scale, a purpose that is more analogous to national income accounting than to estimating exchange values.[207]

We have displayed our study results in a way that allows one to appreciate the range of values and their distribution. It is clear from inspection of the tables that the final estimates are not precise. However, they are much better estimates than the alternative of assuming that ecosystem services have zero value, or, alternatively, of assuming they have infinite value. Pragmatically, in estimating the value of ecosystem services, it seems better to be approximately right than precisely wrong.

General Limitations

- **Static Analysis.** This analysis is a static, partial equilibrium framework that ignores interdependencies and dynamics, though new dynamic models are being developed. The effect of this omission on valuations is difficult to assess.
- **Increases in Scarcity.** The valuations probably underestimate shifts in the relevant demand curves as the sources of ecosystem services become more limited. The values of many ecological services rapidly increase as they become increasingly scarce.[208] If ecosystem services are scarcer than assumed, their value has been underestimated in this study. Such reductions in supply appear likely as land conversion and development proceed. Climate change may also adversely affect the ecosystems, although the precise impacts are difficult to predict.

Benefit Transfer/Database Limitations

- **Incomplete coverage.** That not all ecosystems have been valued or studied well is perhaps the most serious issue, because it results in a significant underestimate of the value of ecosystem services. More complete coverage would almost certainly increase the values shown in this report, since no known valuation studies have reported estimated values of zero or less for an ecosystem service. Table 5 illustrates which ecosystem services were identified in the Columbia River Basin for each land cover type, and which of those were valued.
- **Selection Bias.** Bias can be introduced in choosing the valuation studies, as in any appraisal methodology. The use of ranges partially mitigates this problem.

Primary Study Limitations

- **Price Distortions.** Distortions in the current prices used to estimate ecosystem service values are carried through the analysis. These prices do not reflect environmental externalities and are therefore again likely to be underestimates of true values.
- **Non-linear/Threshold Effects.** The valuations assume smooth and/or linear responses to changes in ecosystem quantity with no thresholds or discontinuities. Assuming (as seems likely) that such gaps or jumps in the demand curve would move demand to higher levels than a smooth curve, the presence of thresholds or discontinuities would likely produce higher values for affected services.[209] Further, if a critical threshold is passed, valuation may leave the normal sphere of marginal change and larger-scale social and ethical considerations dominate, as with an endangered species listing.
- **Sustainable Use Levels.** The value estimates are not necessarily based on sustainable use levels. Limiting use to sustainable levels would imply higher values for ecosystem services as the effective supply of such services is reduced. If the above problems and limitations were addressed, the result would most likely be a narrower range of values and significantly higher values overall. At this point, however, it is impossible to determine more precisely how much the low and high values would change.

GIS Limitations

- **GIS Data.** Since this valuation approach involves using benefit transfer methods to assign values to land cover types based, in some cases, on the context of their surroundings, one of the most important issues with GIS quality assurance is reliability of the land cover maps used in the benefits transfer, both in terms of categorical precision and accuracy.
- **Ecosystem Health.** There is the potential that ecosystems identified in the GIS analysis are fully functioning to the point where they are delivering higher values than those assumed in the original primary studies, which would result in an underestimate of current value. On the other hand, if ecosystems are less healthy than those in primary studies, this valuation will overestimate current value.

- **Spatial Effects.** This Ecosystem Services Valuation assumes spatial homogeneity of services within ecosystems, i.e. that every acre of forest produces the same ecosystem services. This is clearly not the case. Whether this would increase or decrease valuations depends on the spatial patterns and services involved. Solving this difficulty requires spatial dynamic analysis. More elaborate system dynamic studies of ecosystem services have shown that including interdependencies and dynamics leads to significantly higher values,[210] as changes in ecosystem service levels cascade throughout the economy.

Appendix F

Studies Used for Benefit Transfer

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Appendix G

Dollar-Per-Acre ESV Results by Ecosystem Service and Land Cover

Please email info@eartheconomics.org for more information on the dollar-per-acre ESV results (Appendix G).

Appendix H

Documentation
Sources of Cultural
Tribal Narrative

#	TITLE	TYPE	TRIBE	LINK
1	Couer d'Alene Tribe	Website	Couer d'Alene	http://www.cdatribe-nsn.gov/cultural/Overview.aspx
2	Couer d'Alene tribe trying to preserve language	Video	Couer d'Alene	https://www.youtube.com/watch?v=XUuh24EG5HM
3	Why the Traditional Arts Matter	Video	Couer d'Alene	https://www.youtube.com/watch?v=UjdqpPJJJw4
4	Kalispel	Website	Kalispel	http://www.kalispeltribe.com/
5	Kalispel- Water	Video	Kalispel	https://www.youtube.com/watch?v=6n59nDtnpDA
6	Kalispel- Wetlands	Video	Kalispel	https://www.youtube.com/watch?v=Y_Y5sNh_D90
7	Kalispel- Invasive	Video	Kalispel	https://www.youtube.com/watch?v=CoBUmIetRzk
8	Kalispel- People	Video	Kalispel	https://www.youtube.com/watch?v=YmCAi-hk9Yk
9	Spokane Tribe of Indians	Website	Spokane	http://www.spokanetribe.com/
10	Kootenai Tribe of Idaho	Website	Kootenai	http://www.kootenai.org/
11	Interview with Francis Auld, Salish Kootenai	Video	Kootenai	https://www.youtube.com/watch?v=4RIdSs3avdY
12	The Confederated Tribes of the Colville Reservation	Website	Colville Tribes	http://www.colvilletribes.com/
13	Coyote: Stories Along the Columbia	Video	Colville Tribes	http://www.colvilletribes.com/stories_along_the_columbia__1_2_.php
14	Coyote: Stories Along the Columbia Part 2	Video	Colville Tribes	http://www.colvilletribes.com/stories_along_the_columbia__2_2_.php
15	Fish and Wildlife: Friendliest Catch	Video	Colville Tribes	http://www.colvilletribes.com/friendliest_catch.php
16	Fish and Wildlife: Sustainable Fishing for the Future	Video	Colville Tribes	http://www.colvilletribes.com/sustainable_fishing_for_the_future.php
17	Grand Coulee Dam: Price We Paid	Video	Colville Tribes	http://www.colvilletribes.com/the_price_we_paid__1_2_.php
18	Grand Coulee Dam: Price We Paid Part 2	Video	Colville Tribes	http://www.colvilletribes.com/the_price_we_paid__2_2_.php
19	Building Grand Coulee Dam: A Tribal Perspective Part 2	Video	Colville Tribes	http://www.colvilletribes.com/building_gcd___a_tribal_perspective__2_3_.php

#	TITLE	TYPE	TRIBE	LINK
20	Building Grand Coulee Dam: A Tribal Perspective Part 3	Video	Colville Tribes	http://www.colvilletribes.com/building_gcd___a_tribal_perspective__3_3_.php
21	The Dam's Tribal Impacts Part 1	Video	Colville Tribes	http://www.colvilletribes.com/the_dam_s_tribal_impacts__1_.php
22	The Dam's Tribal Impacts Part 2	Video	Colville Tribes	http://www.colvilletribes.com/the_dam_s_tribal_impacts__2_4_.php
23	The Dam's Tribal Impacts Part 3	Video	Colville Tribes	http://www.colvilletribes.com/the_dam_s_tribal_impacts__3_4_.php
24	The Dam's Tribal Impacts Part 4	Video	Colville Tribes	http://www.colvilletribes.com/the_dam_s_tribal_impacts__4_40.php
25	The Kettle Falls Fishery	Video	Colville Tribes	http://www.colvilletribes.com/the_kettle_falls_fishery__1_2_.php
26	The Kettle Falls Fishery Part 2	Video	Colville Tribes	http://www.colvilletribes.com/the_kettle_falls_fishery__2_2_.php
27	The Complete Seymour	Book/ Interviews	Colville Tribes	http://www.colvilletribes.com/mattina.php
28	Nez Perce Tribe	Website	Nez Perce Tribe	http://www.nezperce.org/
29	Umatilla Indian Reservation: History & Culture	Website	Umatilla Tribes	http://ctuir.org/history-culture
30	Importance of Buffalo	Video	Umatilla Tribes	https://www.youtube.com/watch?v=PgydxFplABM
31	Resume Bison Hunting Traditions	Video	Umatilla Tribes	https://www.youtube.com/watch?v=DtTUOZSvlIo
32	The Confederated Tribes of the Warm Springs Reservation of Oregon	Website	Warm Springs Tribes	https://warmsprings-nsn.gov/
33	Plateau Peoples' Web Portal	Videos	Plateau Tribes	http://plateauportal.wsulibs.wsu.edu/
34	The Confederated Tribes and Bands of the Yakama Nation	Website	Yakima Nation	http://www.yakamanation-nsn.gov/
35	Warbonnet Ceremony	Video	Yakima Nation	http://plateauportal.wsulibs.wsu.edu/digital-heritage/warbonnet-ceremony
36	Traditional Dip Net Fishing	Video	Yakima Nation	https://www.youtube.com/watch?v=oy8HhnCEcEo
37	Burns Paiute Tribe	Website	Burns Paiute	http://www.burnspaiute-nsn.gov/

#	TITLE	TYPE	TRIBE	LINK
38	Burns Paiute Legends	Website	Burns Paiute	http://www.burnspaiute-nsn.gov/index.php?option=com_content&view=category&id=35&Itemid=59
39	Fred Townsend, Burns Paiute member, 78	Video	Burns Paiute	https://www.youtube.com/watch?v=qTi8uP5F3S8
40	Shoshone Paiute Tribe of the Duck Valley Indian Reservation	Website	Shoshone Paiute	http://shopaitribes.org/spt-15/
41	Culture	Videos	Shoshone Paiute	http://www.shopaitribes.org/culture/
42	Shoshone-Bannock Tribes	Website	Shoshone-Bannock Tribes	http://www.shoshonebannocktribes.com/
43	Upper Snake River Tribes Ceremonial Salmon Fishery Videos, Events and Photos	Website	USRT Member Tribes	http://www.uppersnakerivertribes.org
44	Cowlitz Indian Tribe	Website	Cowlitz	https://www.cowlitz.org/
45	Confederated Salish and Kootenai Tribes of the Flathead Nation	Website	Salish & Kootenai Tribes	http://www.csktribes.org/
46	Salish-Pend d'Oreille Culture Committee	Website	Salish-Pend d'Oreille (Kalispel)	http://www.salishaudio.org/

Appendix I

Existence Value Model and Detailed Methodology

Following Richardson and Loomis (2009), we estimate willingness-to-pay for existence value using the double log model. The following table lists the significant variables in the model, their coefficients, the parameters used in this study, and the results of the model. For methodological variables, such as "Mail", we took the sample mean as shown in Richardson and Loomis (2009) as the parameter. Under current conditions, we took the change size variable as zero, since salmon have been in decline and no additional restoration would come about. Under the future scenario, the addition of salmon above Chief Joseph dam would increase runs of chinook, sockeye, coho, and steelhead by as much as 26 percent, and populations in the lower river could increase by as much as 25 percent, for a total increase of about 51 percent. This parameter is used in the future scenario.

Table 40. Existence Value Detailed Methodology

VARIABLE	COEFFICIENT	DEFINITION	FUTURE SCENARIO PARAMETERS	COEFFICIENT X FUTURE SCENARIO PARAMETERS	CURRENT SCENARIO PARAMETERS	COEFFICIENT X FUTURE SCENARIO PARAMETERS
Constant	-153.231		1	-153.2310	1	-153.2310
ln change size	0.87	Natural log of the percent change in species population size	3.932	3.4207	0.000	0.0000
Visitor	1.256	Dummy variable	0.231	0.2901	0.231	0.2901
Fish	1.02	Dummy variable	1	1.0200	1	1.0200
Marine	0.772	Dummy variable	0	0.0000	0	0.0000
Bird	0.826	Dummy variable	0	0.0000	0	0.0000
ln response rate	-0.603	Natural log of the survey response rate	3.894	-2.3481	3.894	-2.3481
Conjoint	2.767	Dummy variable	0.075	0.2075	0.075	0.2075
Mail	-0.903	Dummy variable	0.851	-0.7685	0.851	-0.7685
Charismatic	1.024	Dummy variable	0	0.0000	0	0.0000
Study year	0.078	Year of value estimate	2016	157.2480	2016	157.2480
ln WTP				5.84		2.42
WTP (2006 USD/ household)				343.37		11.22
WTP (2015 USD/ household)				403.69		13.19

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Errata:

This report was corrected to address copyediting errors which may confuse the reader.

These include:

Page 20: The Kootenai/y River has been moved to Major Tributaries for Mountain Columbia.

Pages 26-27: The section "The 1964 Columbia River Treaty" has been edited for clarity.

Page 28: Since this document was originally published, the U.S. State Department named Jill Smail as U.S. Lead Negotiator, replacing Brian Doherty.

Page 51: The text "willingness-to-pay for salmon is about $11 per household" has been changed to "willingness-to-pay for salmon is about $13 per household per year" to adjust for inflation since the original study. Also, a rounding error in the estimate of the total existence value has been corrected to read "$37.3 million annually."

Page 54: The weighted average at the bottom of Table 10 was incorrectly printed as $4,373,356,570. The correct value is $3,373,356,570, as printed in this edition.

Page 70: The total acreage of agricultural land in the CRB has been corrected to 14 million acres, as has the total acreage of irrigated agricultural land (9 million acres).

Page 71: The value for irrigation in Table 19 has been corrected to $646,907,701.

Page 76: The weighted average at the bottom of Table 22 has been corrected to $3,373,356,570. Also, the Current Conditions value for Wettest Water Years has been corrected to $3,664,655,116.

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EXHIBIT F
QUANTIFYING RECREATION USE VALUES FROM REMOVING DAMS AND RESTORING FREE-FLOWING RIVERS: A CONTINGENT BEHAVIOR TRAVEL COST DEMAND MODEL FOR THE LOWER SNAKE RIVER
JOHN LOOMIS
WATER RESOURCES RESEARCH 38:6 (JUNE 2002)

Exhibit Coversheet Only. [Paginated separately.]

The attached document, Quantifying Recreation Use Values From Removing Dams and Restoring Free-Flowing Rivers: a Contingent Behavior Travel Cost Demand Model for the Lower Snake River, is provided to the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy, Climate, and Grid Security for the Hearing Record, dated January 30, 2024 in response to a question from the Honorable Frank Pallone, Jr.

WATER RESOURCES RESEARCH, VOL. 38, NO. 6, 1066, 10.1029/2000WR000136, 2002

Quantifying recreation use values from removing dams and restoring free-flowing rivers: A contingent behavior travel cost demand model for the Lower Snake River

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[1] A travel cost demand model that uses intended trips if dams are removed and the river restored is presented as a tool for evaluating the potential recreation benefits in this counterfactual but increasingly policy relevant analysis of dam removal. The model is applied to the Lower Snake River in Washington using data from mail surveys of households in the Pacific Northwest region. Five years after dam removal, about 1.5 million visitor days are estimated, with this number growing to 2.5 million annually during years 20–100. Using the travel cost method model estimate of the value of river recreation, if the four dams are removed and the 225 km river is restored, the annualized benefits at a 6.875% discount rate would be $310 million. This gain in river recreation exceeds the loss of reservoir recreation but is about $60 million less than the total costs of the dam removal alternative. The analysis suggests this extension of the standard travel cost method may be suitable for evaluating the gain in river recreation associated with restoration of river systems from dam removal or associated with dam relicensing conditions. *INDEX TERMS:* 6314 Policy Sciences: Demand estimation; 6304 Policy Sciences: Benefit-cost analysis; 6329 Policy Sciences: Project evaluation; *KEYWORDS:* contingent visitation behavior, river recreation, travel cost method

1. Introduction

[2] The United States is in the midst of a reevaluation of many of its dams owing to anadromous fish concerns. Smaller, older dams such as the Edwards Dam in Maine are being removed to improve migration of anadromous fish. The National Park Service in its Environmental Impact Statement (EIS) and the Clinton Administration in its budget requests have recommended the removal of the Elwha and Glines dams on the Olympic Peninsula [*National Park Service*, 1996]. The Federal Energy Regulatory Commission (FERC) has more than 400 dams that are either in the process of relicensing or will be up for relicensing by 2010. Dam removal is an option for some of these older, less productive dams. The four dams on the Lower Snake River from the confluence of the Columbia and Snake Rivers to Lewiston, Idaho, are also under review for possible removal as one alternative in a recently released EIS by the *U.S. Army Corps of Engineers* [1999]. National Marine Fisheries Service (NMFS) requested that the U.S. Army Corps of Engineers (USACOE) evaluate removal of the four Lower Snake River dams as part of NMFS recovery planning effort. Dam removal has both direct costs to remove the dams as well as large opportunity costs in terms of foregone hydropower and barging. Several groups of fisheries biologists have evaluated the likely gains from dam removal allowing for quicker migration of smolts downstream to the ocean. While there is some debate regarding the net effect of dam removal versus improved barging, dam removal is considered by federal and state agency biologists to have nearly twice the probability of recovering Chinook salmon as operational improvements to the four dams [*Marmorek et al.*, 1998].

[3] However, being biologically effective is not the same as being economically effective. If dam removal would result in quicker recovery of the Chinook salmon runs in the Snake River, one question may be whether the added direct and opportunity cost of dam removal would warrant the greater eventual recovery. The USACOE is required by the U.S. Water Resources Council Principles and Guidelines to conduct a benefit-cost analysis of the national costs and benefits of each alternative, including dam removal. As part of this benefit-cost analysis the nonmarket recreation values must be addressed. The travel cost method (TCM) is recommended by the *U.S. Water Resources Council* [1983] as one method to quantify these recreation values. TCM has been applied to measure the change in water-related recreation benefits for decades [*Loomis and Walsh*, 1997], including recent applications in *Water Resources Research* by *Huszar et al.* [1999] and *Eiswerth et al.* [2000] as well as *Cameron et al.* [1996] and *Ward et al.* [1997] in other journals.

[4] Estimating the loss in existing reservoir recreation can rely upon conventional travel cost method demand models [*Loomis and Walsh*, 1997]. However, there are times when analysts are required to evaluate water resource changes outside the current range of management. In real policy analyses performed by *Eiswerth et al.* [2000] and *Cameron et al.* [1996] these authors were required to evaluate potentially very large changes in lake water levels that were outside the range of anything that had been experienced. In this study, we were asked to evaluate recreation benefits of nonexisting natural river conditions that would result from dam removal. Obviously, since this is a counterfactual situation to what currently exists in the Lower Snake River, one cannot survey existing river users (as there are none) to directly apply the standard TCM to estimate the value of river recreation with dam removal. The need to evaluate counterfactual policy alternatives or policy alternatives beyond the range of what is currently experienced is becoming a frequent challenge in FERC relicensing studies as well. Therefore an approach known as "contingent behavior" (CB) has been recently developed by economists to address just such policy analyses. This stated preference approach involves (1) describing the new recreation conditions, e.g., water level drawdown, water quality improvements, etc; (2) surveying

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households and asking if they would visit and, if so, how many times per year; and (3) asking their expected travel cost and travel time to the water resource they would visit. From this information a travel cost model using intended number of trips as the dependent variable and round trip travel cost and time as independent variables is estimated. From this model, prospective use and benefits can be calculated to aid in policy decisions.

[5] In some cases, one scenario being evaluated is an existing one in which the analyst can record existing visitation and travel costs. This revealed preference data can be pooled with the stated preference contingent behavior data and a single TCM demand equation can be estimated from the combined data [*Englin and Cameron*, 1996; *Cameron et al.*, 1996; *Eiswerth et al.*, 2000; *Whitehead et al.*, 2000]. This pooled approach allows for augmenting the natural variation in travel costs with scenario-induced variations in travel cost to improve the precision of the estimated coefficient on the critical travel cost variable [*Englin and Cameron*, 1996] and/or augmenting the natural variation in environmental quality with scenario induced variations in quality to allow for estimation of a coefficient on environmental quality [*Cameron et al.*, 1996; *Eiswerth et al.*, 2000].

[6] The purpose of this paper is to describe the basic structure of a contingent behavior TCM estimated using only intended trips. This model is applied to estimating the river recreation benefits from removing the four Lower Snake River dams. This will illustrate a methodology that may very well be applicable to evaluation of relicensing of hundreds of dams regulated by FERC as well as dam removal.

2. Contingent Recreation Behavior Model for River Recreation

[7] The basic contingent behavior travel cost model estimated is

$$\text{Intended Numbers of Trips}_i = f(\text{TripCost, TravTime, Income, RecTimeBud, SubstituteCost, Demographics}), \quad (1)$$

where Intended Number of Trips$_i$ is the number of trips that the respondent indicates they would take if the dams were removed and the free-flowing river restored as described in Figure 1. This is the number of trips contingent upon the description, hence the name contingent behavior. TripCost is the reported round trip cost of the respondent to the Lower Snake River. TravTime is travel time from the respondent's home to the Lower Snake River. Income is respondent's household income. RecTimeBud is the recreation time budget measured as the number of days available for recreation. This variable is tested to see if the time constraint or time budget influences the number of trips (see *Bockstael et al.* [1987] and *McKean et al.* [1995] for the theoretical consistency with disequilibrium labor markets). SubstituteCost is for those respondents that currently visit other rivers and is the typical travel cost to those other rivers. Demographics includes boat ownership (OwnBoat), number of river recreation activities they would participate in at the river (RivNumAct), age (Age), etc.

[8] Travel time is included to account for the fact that greater travel time reduces trips in addition to out of pocket travel cost [*Cesario*, 1976]. The incorporation of travel time as a separate variable is consistent with the view that workers cannot adjust work hours but usually work a 40 hour week [*Larson*, 1993; *Shaw and Feather*, 1999].

[9] Our definition of the substitute price variable is not completely consistent with demand theory. In principle, we should have the prices (i.e., travel costs) to specific substitute rivers. However, this would result in a large number of travel cost variables that are likely correlated with each other and to the own price variable, resulting in extensive multicolinearity. This can be especially problematic in maximum likelihood models such as the negative binomial as the model may fail to converge in the face of such high multicolinearity.

[10] Since the number of trips to be taken is a nonnegative integer, (e.g., 0, 1, 2, 3, etc.), a count data model is an appropriate statistical model to estimate the contingent behavior TCM demand equation [*Creel and Loomis*, 1990; *McKean*, 1998; *Eisworth et al.*, 2000]. The count data model assigns probable outcomes only to these nonnegative integers and does not assign any probability to fractional trips, like 1.25 or 2.75, as an ordinary least squares (OLS) regression model would. This makes the count data model a more efficient statistical estimator of the demand function. There are two commonly used count data models, the Poission and the negative binomial. The Poisson probability law is [*Creel and Loomis*, 1990]

$$\Pr(T) = \left[\exp(-\lambda)\lambda^T\right]/T!, \quad (2)$$

Where $\Pr(T)$ is the probability an individual takes T trips per year, λ is both the mean and the variance of trips and T is annual recreation trips. Thus the Poisson model requires the variance of the dependent variable be equal to the mean. The negative binomial is a generalization of the Poisson model and does not require the variance to be equal to the mean. In particular, the negative binomial probability law is

$$\Pr(T) = \frac{\Gamma(T + 1/\alpha)}{\Gamma(T+1)\ \Gamma(1/\alpha)}(\alpha\lambda)^T(1+\alpha\lambda)^{-(T+1/\alpha)}, \quad (3)$$

where Γ is the gamma function and α is called the overdispersion parameter. The mean of trips is still λ, but now the variance is no longer equal to the mean but rather equal to $\lambda + \alpha\lambda^2$. Thus the negative binomial model estimates both λ and α. If the mean truly is equal to the variance, then $\alpha = 0$, and the negative binomial model collapses into the Poisson model. Since a plot of our data indicates the mean-variance equality of the Poission model is probably violated, we will estimate the more general negative binomial model and test to see if the α is significantly different from zero. *Creel and Loomis* [1990] provide the likelihood function for the negative binomial model as

$$\ln L = s' \ln[\Gamma(T + s/\alpha)] - s' \ln[\Gamma(T + s)] - N\{\ln[\Gamma(1/\alpha)] + \ln(\alpha)s'T + T'X\beta - (T + s/\alpha)'\ln[(s + \alpha\lambda)]\}, \quad (4)$$

where s is an N $\times$ 1 sum vector.

[11] The negative binomial count data TCM is the same approach used by *McKean* [1998] to estimate the economic value of current reservoir recreation at the existing Lower Snake River dams. Thus there is consistency in statistical models used for the nonmarket reservoir recreation benefits being lost and the river recreation being gained by dam removal.

[12] While reliance on intended number of trips rather than actual trips is a potential concern with use of the contingent behavior approach, some authors believe that the method is likely to be more reliable than contingent valuation [*Ward*, 1987]. In particular, it is argued that visitors will have less incentive to misreport the number of trips they might take than some monetary measure such as willingness to pay. In a simple contingent

Before we ask you whether you would visit the Lower Snake River if the dams were removed, we want to describe what the resulting free-flowing river would be like. Also see the map insert.

What Would the River Look Like?
Dam Sites: The earthen part of the four dams would be removed and the river would flow around the remaining concrete dam structure.
River Canyon: The 140 mile river canyon would be unchanged and is over 1,000 feet deep in places.
River Depths: Minimum river depths would be 4-6 feet during spring, summer and fall.
Islands: Prior to the dams, there were about 70 small islands. These islands will reappear with natural river levels. The islands would provide wildlife habitat as well as potential camping and lunch spots.
Vegetation: Would be re-established along the river and on re-emerging islands over a 5-10 year transition period.

What Would Recreation Access be Like?
Land Ownership: Federal, State and County ownership and management would continue. Generally there are no fees for most activities, except camping at developed campgrounds.

Roads to the river: 30 river segments would be accessible by car. There are several sections of paved road that parallel the river and provide access. (See map insert).
Several 10-20 mile segments of the river would remain unroaded and accessible only by boating or hiking.
Bridges across the river: Two existing paved roads across the middle of the river and existing road access at either end of the river would remain. (See map insert).
Trails: Old roadbeds and railroad beds in the canyon would re-emerge. Large portions of these would be suitable for hiking, mountain biking and horseback riding along the shoreline.
Boat ramps: 14 of the existing 27 boat ramps would be extended down to the river.

What Recreation Activities Would be Possible?
River Based:
River fishing, rafting, canoeing, kayaking, tubing, drift boats and jet boating would be possible.

Flows: During the high flow months of April to June, the entire 140 miles of river could be floated in boats such as rafts or canoes in about 7 days. During July and August, portions of the river could be floated on a typical weekend.

Rapids: Prior to the dams, the river had 63 named rapids. These were relatively small rapids.
Most of these rapids would return with dam removal.

Land Based:
Currently there are seven campgrounds, offering over 400 individual campsites located in the river canyon. The majority of these campgrounds have running water, flush toilets, tables, shade trees, and electrical hook-ups for RV' s. These campgrounds and facilities would remain in place, however, they would be a few hundred feet further to the new river level.
There are also hotels and lodging available in nearby towns of Pasco and Lewiston. (See map insert)

Figure 1. The key contingent behavior information presented to the respondents in the final mail survey.

behavior survey of visitors to a lake, a test-retest survey found that responses were reliable [*Loomis*, 1993]. Further, comparison of stated number of trips to actual number of trips for the same lake level indicated validity of the stated trip response [*Loomis*, 1993].

3. Sampling Strategy

[13] Efficient sampling requires concentrating sampling effort in the geographic region where a majority of the potential visitors may come from. This is a challenge with dam removal since natural river conditions do not exist. One factor in deciding how broad a geographic area to concentrate on was two surveys of current users of the Lower Snake River reservoirs. Using the zip codes of visitors contacted at boat ramps, we found that half the water-dependent recreation came from seven cities in the area (tricities of Kennewick, Richland, and Pasco along with Clarkston, Lewiston, Pullman, and Walla Walla). Spokane and Yakima were the next largest contributors of visitation. However, the opportunity provided by a restored 225 km free-flowing river with no recreation permit rationing is a potentially significant enough recreation resource that we also sampled households in other areas of the Pacific Northwest and California.

[14] In the sample design our goal was to provide 90% confidence that our sample estimated trips per person would be within 10% of the population mean for river based activities. To implement the standard formula for determining this sample size required an estimate of the variance of the population. To obtain an estimate of the variance, we relied upon *Callaway et al.*'s [1995] system operation review (SOR) TCM data for Lower Granite

Reservoir. In particular, the mean was 7.27 trips, and the standard deviation was 7.07. Thus the variance estimate was 49.96, and the 10% allowable error on trips equals 0.727. We also factored in survey nonresponse when developing our estimates of sample size. We then applied this estimate at the individual activity level and scaled up by the types of river recreation activities we were sampling for. This process implied a sample size of 8600 surveys assuming a 50% response rate of deliverable surveys. Given higher than average nondeliverables associated with rural addresses, we recommended this sample size be increased to 9000 with an additional 1000 supplemental user surveys. The 10,000 total surveys are allocated as follows: (1) 6000 to the 18 counties within 150 miles of the Lower Snake River based on population (these 18 counties included the seven cities where half the reservoir visitors are coming from), (2) 3000 to the rest of Idaho, Oregon, and Washington and all of California and Montana, and (3) 1000 to users intercepted at the Lower Snake River.

4. Description of Likely Effects with Natural River

[15] On the basis of discussions with USACOE staff as well as information in a wide variety of documents we sketched a description of the likely effects of natural river conditions. Figure 1 presents what the key contingent behavior information presented to the respondents was in the final mail survey. (The map referred to in Figure 1 is available from the author).

5. Focus Groups and Pretesting

[16] To check for understandability and internal validity of the survey, portions of the survey were made into one-page worksheets that were distributed at six focus groups. Individuals were then asked to review the description of what the river would be like with dam removal. They were asked to point out any words that were not clear. They were asked to identify any additional information that they felt was needed before they could make an informed decision about whether to visit the restored Lower Snake River. The responses on the written worksheets were supplemented by discussions with each focus group. After each focus group, changes were made to materials for the following focus group. Focus groups were conducted during the month of January 1998 in the cities of Seattle, Kennewick, Boise, Spokane, Lewiston, and San Jose.

[17] The revised survey was printed as a booklet with color cover and color recreation map insert. The pretest involved mailing this booklet to a random sample of households in each sample strata and then phoning them to discuss the survey and obtain their answers. Individuals were then asked to mail their booklets back. A total of 45 surveys were completed over the months of February and March. Individual interviews conducted over the phone provided several useful insights for revising the survey. This was followed by 11 face-to-face pretests conducted in person in Spokane, Washington. In addition, 100 surveys were priority mailed to Snake River recreation users to solicit their feedback. A total of 36 out of the 100 surveys were returned completed by the cutoff date for survey printing, with an additional five being returned undeliverable. A complete copy of the 8 page survey instrument is available from the author.

6. Mailing Procedures and Response Rate

[18] The 10,000 surveys were sent out in fall of 1998. The survey package was sent first class and included a personalized cover letter, stamped return envelope, and the survey with recreation map insert. A reminder postcard was sent to all households. The second mailing was sent out four weeks later with a new more emphatic cover letter that attempted to address any concerns individuals might have for not returning the survey and stressing the importance of completing the survey. A replacement survey was included. A third mailing was sent by U.S. Post office priority mail with a cover letter stressing the importance of the survey and urging them to complete it.

[19] Three mailings of the survey resulted in 3822 surveys being returned by respondents and another 1111 undeliverable surveys being sent back by the Post Office. There were also 98 survey packages returned indicating the respondent was deceased or had moved out of our sampling area. Given the net deliverable and eligible surveys a response rate of 43.5% was obtained. One of our visitor demand estimates specifically accounts for the sample nonresponse in each stratum when generalizing the survey sample estimates to the population.

[20] In the analysis below the sample is utilized as follows. To calculate the general river visitation rate, the 2515 respondents that indicated they were not anglers were used (the angler analysis is not reported here as the use and total benefits was driven by the limited allocation of salmon and steelhead for recreational fishing rather than the contingent behavior model). For the contingent behavior TCM analysis, only those respondents indicating they would definitely or probably visit the river if the dams were breached were asked their number of trips. The fraction of visitors definitely and probably visiting varied from a high of 26% in rural Washington counties surrounding the lower Snake River to about 10% in Boise, Idaho, area, Montana, and California. Given these percentages of respondents that were supposed to answer the contingent number of trips question, those that did, and then those that also completely answered all of the other questions used as independent variables (N = 574), the intersection results in 470 completed surveys for the TCM contingent behavior portion of this analysis. About 10% of the households checking that they would definitely or probably visit reported zero annual trips, indicating they would not visit each and every year. These zero trips are retained in our contingent behavior TCM model.

7. Results

7.1. Contingent Behavior Travel Cost Method Demand Model

[21] Table 1 presents the negative binomial count data model for nonfishing visits to the free-flowing Lower Snake River described in the survey. The reported trip cost per person (TRIPCOST) is negative and significant at the 0.02 level. Travel time (TRAVTIME) is also negative and statistically significant at 0.01 level. The total days available for recreation variable (RECTIMEBUD) is positive and statistically significant at the 0.01 level. INCOME is negative and significant at the 0.08 level. RIVNUMACT, or the number of river recreation activities the respondent would participate in, has a positive and statistically significant ($P < 0.01$) effect on the number of trips the individual would take. Those that own a boat (OWNBOAT) also would take more trips and is significant at the 0.016 level. The overdispersion parameter is statistically significant at $P < 0.01$, indicating the negative binomial model is preferred to the Poisson model. Overall, the contingent behavior travel cost method estimated using intended trips as the dependent variable performed similarly in terms of statistical significance and

Table 1. Contingent Behavior Travel Cost Demand Equation for Free Flowing Lower Snake River[a]

Variable	Coefficient	Standard Error	Probability
C	0.81323	0.1395	0.000
TRIPCOST[b]	−0.00249	0.0011	0.022
TRAVTIME[c]	−0.16957	0.0325	0.000
RECTIMEBUD[d]	0.00123	0.0004	0.004
INCOME[e]	−0.00219	0.0012	0.081
RIVNUMACT[f]	0.11245	0.0211	0.000
OWNBOAT[g]	0.2008	0.0835	0.016
Overdispersion Parameter α	−1.0999	0.1307	0.000

[a] Dependent variable is intended river trips. Standard error of regression is 2.92. Log likelihood is −896.79. Restricted log likelihood is −1138.12. Likelihood ratio (LR) statistic (7 degrees of freedom) is 482.66. Probability (LR stat) is 0.000. LR index (pseudo R^2) is 0.212. Sample size is 470.

[b] TRIPCOST is reported round trip travel costs per person.

[c] TRAVTIME is travel time.

[d] RECTIMEBUD is respondent's number of days available for recreation each year.

[e] INCOME is household income.

[f] RIVNUMACT is the number of river-based recreation activities the respondent would participate in while visiting the Lower Snake River.

[g] OWNBOAT is whether the respondent owned a boat (= 1) or not (= 0).

explanatory power to published travel cost models estimated with actual trips.

[22] The TCM model is robust with respect to checks for potential multidestination trips, potential outliers, and inclusion of a substitute variable. In particular, the respondents reported cost of traveling to their substitute river was not statistically significant ($t = -0.166$), and its coefficient was so extremely small (−0.0000078) that it had little effect on the demand function. This is partly due to cost of traveling to other river sites having a negative sign, possibly indicating other rivers have a complementary relationship with the Lower Snake River, rather than a positive sign, indicating a substitute relationship. A dummy variable for whether the household visited other rivers was also tested but also had a positive sign. This may indicate that this variable acted more like a measure of avidity toward river recreation than a measure of substitutes. To the extent that a theoretically correct and effective measure of the price of substitutes is omitted, our benefit estimates are somewhat overestimated.

[23] Using the TCM travel cost coefficient estimated in Table 1, the net willingness to pay (WTP), or average consumer surplus per trip, can be calculated. Since the negative binomial model is equivalent to a semilog functional form, the average consumer surplus per trip is $1/\beta_{\mathrm{TripCost}}$. Using this formula, the consumer surplus is \$401 per individual trip. Given the survey estimate of 2.51 days per trip, the average value per day would be \$160.

7.2. Estimating Restored River Recreation Participation Rate

[24] To expand per visitor day benefits to total annual recreation benefits, we calculate two likely estimates of the number of river recreationists that would visit. The first estimate uses only the number of respondents giving definitely yes answers in order to calculate the probability (or percentage) of that region's respective population visiting the Lower Snake River. The use of definitely yes responses is consistent with a criterion validity study of *Champ et al.* [1997], which showed a close match between actual behavior and intended behavior of the persons that were definitely sure of their answers. The second visitor use estimate consists of households that indicated they definitely or probably would visit but assumes that survey nonrespondents would not visit. Thus each of the two estimates balances a conservative element with an optimistic one. The first estimate being conservative by only using the number of respondents definitely certain they would visit but then applying that fraction to all households in the sample strata (assuming survey nonrespondent households will visit in the same proportion as survey respondent households).

7.3. Calculating Visitor Days Demanded

[25] Since the rural counties surrounding the Lower Snake River were sampled at a higher rate than the remainder of the states in the Pacific Northwest and they are located closer to the Snake River, it is appropriate to apply the percentage visitation rate to their respective populations. Further, California's population is so large and its response rate was lower than the Pacific Northwest, it was decided to split this geographic area out separately. To conserve space, Table 2 illustrates the process of estimating river recreation demand only for the second visitation rate approach. Table 2 uses definitely and probably yes visitors (to be consistent with the sample for the TCM) but assumes zero visitation rate for that proportion of the sample strata's households not returning the survey. As can be seen in Table 2, 25.9, 19.7, and 22.5% of local/rural Washington, Oregon, and Idaho counties adjacent to or nearby the Lower Snake River would definitely or probably visit the free-flowing Lower Snake River for river recreation. Ten to nineteen percent of those living in the more distant urban areas of the Pacific Northwest would definitely or probably visit the free-flowing Lower Snake River. Only about 10% of California residents would definitely or probably visit the free-flowing Lower Snake River. Visitors from the counties surrounding the river would take two to five visits per year, while those living in the remainder of the Pacific Northwest and California about one trip per year. To be conservative and account for survey nonresponse

Table 2. River Recreation Days Demanded Adjusted for Sample Response Rate

Sample Strata	Percent Visiting	Estimated Number of Interested Households	Estimated Number of Visitors	Number of Trips Per Visitor	Estimated Total Trips	Total Visitor Days Demanded
Rural Washington	25.9	152,222	39,425	3.41	134,441	317,280
Rural Oregon	19.7	13,437	2,647	2.12	5,612	10,382
Rural Idaho	22.5	17,527	3,944	5.13	20,231	29,739
Rest of Washington	15.4	833,419	128,347	1.34	171,984	545,190
Rest of Oregon	18.8	518,289	97,438	1.18	114,977	396,671
Rest of Idaho	9.5	199,428	18,946	1.2	22,735	109,127
Montana	8.3	156,266	12,970	1	12,970	49,157
California	9.8	2,374,598	232,711	0.93	216,421	1,268,226
Total		4,265,185	536,427		699,370	2,725,772

Table 3. Recreation Suitability Recovery Factors, Capacity Constraints, and Visitor Use Estimates With Dam Breaching

River Recreation Activity	Percent of Use	Suitability Factors: Year 1	Year 5	Year 10	Years 20–100
Jet boating, jet skiing	3.8%	20%	50%	70%	100%
Raft/kayak/canoe	12.3%	30%	40%	80%	100%
Swimming	12.1%	20%	40%	100%	100%
Picnic/primitive camping	28.0%	80%	100%	100%	100%
Developed camping	15.6%	60%	90%	100%	100%
Hike and mountain bike	24.2%	80%	100%	100%	100%
Hunting	4.0%	50%	80%	100%	100%
Total	100.0%				

Use Estimate 2 Activity	Visitor Demanded	Visitor Days Realized Each Time Period: Year 1 Use	Year 5 Use	Year 10 Use	Years 20–100 Use
Jet boating, jet skiing	103,579	20,716	51,790	72,506	103,579
Raft/kayak/canoe	335,270	100,581	134,108	268,216	335,270
Swimming	329,818	65,964	131,927	329,818	329,818
Picnic/primitive camping	763,216	167,400[a]	167,400[a]	558,000[a]	558,000[a]
Developed camping	425,220	219,294[a]	219,294[a]	425,220	425,220
Hike and mountain bike	659,637	527,709	659,637	659,637	659,637
Hunting	109,031	54,515	87,225	109,031	109,031
Total	2,725,772	1,156,179	1,451,381	2,422,428	2,520,556
Annual Recreation Value (millions)[b]		$185.0	$232.2	$387.6	$403.3

[a] Visitation capacity is constrained.
[b] Present value at 6.875% is $4,516.5 million, and average annual equivalent value (AAEV) at 6.875% is $310.5 million.

rate, we assume the proportion of households not returning the survey would not visit. Therefore we multiply the visitation rate times the estimated number of interested households (which is the percentage of households in that geographic area returning the survey times the number of households in that geographic area). This resulting number of visitors is then multiplied by the number of trips per household and days per trip to yield the estimate 2 of 2.75 million visitor days demanded annually shown in Table 2.

[26] Unlike current conditions, the contingent behavior surveys predict that a large percentage of total river recreation with a free-flowing Lower Snake River would originate in distant areas such as Portland, Seattle, and California. The two use estimates indicate that 20–45% of the total days would be from California, depending on the sample expansion assumptions. This percentage of days is consistent with the fact that California represents 60–70% of the population of the sampling area. This change in distribution of the origin of visitors with the free-flowing river is also consistent with the pattern found in McKean's TCM analysis of actual visitation to free-flowing rivers in central Idaho, where 21% of the river visitors come from 1609 km or more away, with 12% coming from 2414 km or farther [*McKean*, 1999]. This pattern is consistent with the lack of availability of substitute free-flowing rivers and the 225 km free-flowing length of the lower Snake River with the dams breached. Besides the limited number of major rivers in the western United States, many existing rivers, such as the Rogue, Salmon, or Colorado, have use limits, and permits are rationed by lottery. By contrast, reservoir visitors do not have to travel great distances as there are numerous reservoirs in the local area, including Lake Wallula downstream from Ice Harbor Dam very near the tricities area, Dworshak Reservoir near Lewiston, Idaho, and three large lakes near Spokane, Washington.

[27] Note that our estimates of free-flowing river visitation in Table 3 and the resulting benefit estimates does not net out the reduced number of trips that would be taken to other free-flowing rivers in the region. In particular, about 21% of survey respondents indicated they would take fewer trips to other rivers in the region, but the survey did not provide an estimate of the number of these reduced trips. The reader should keep this potential for over estimation of benefits in mind. Given the difficulty of respondents answering the substitute trip contingent behavior question, it would have been better, in retrospect, to adopt *Smith*'s [1993] general equilibrium approach for incorporating substitutes. That approach involves asking visitors to report the total number of trips to all other substitute sites and using that variable as a proxy for all other substitute site prices.

7.4. Translating Visitor Demand into Visitor Use Days Accommodated

[28] Not all of the 2.75 million visitor days demanded in Table 2 can be accommodated immediately after dam breaching. The upper half of Table 3 shows the time path to recreation resource recovery after the dams have been breached. This was developed by the USACOE recreation planners to assess how long it would take for the river channel and riverbanks to stabilize and become fully suitable for the seven recreation activities. As shown below, it is only after 20 years that the river is believed to be 100% restored and suitable for these activities. The bottom half of Table 3 applies these suitability factors to estimated demand and then constrains the visitor use to available facilities and river shore carrying capacity in each time period. Note that developed camping is initially constrained by existing facilities but is not constrained after year 10 as the USACOE would expand the developed campgrounds after the river banks stabilize allowing for construction at the end of the first decade. However, there are not sufficient river beaches and shoreline capacity to accommodate all the primitive camping and picnicking demands.

[29] The bottom of Table 3 also illustrates the calculation of present value (PV) and average annual equivalent value (AAEV) of recreation benefits over the 100 year time period of analysis at the USACOE discount rate of 6.875%. The annual benefits grow

Table 4. Annualized (AAEV) Value of Recreation Benefits over 100 years Millions of 1998 dollars at 6.875% (U.S. Army Corp of Engineers Rate)

	Alternative[a]			
	1	2	3	4
Reservoir recreation	$31.6	$31.6	$31.6	
River recreation				
Use estimate 1				$192.7
Use estimate 2				$310.7

[a] Dams remain in place in alternatives 1–3; dam removal is alternative 4.

from $185 million to $403 million over the 20 year time period, with an annualized value of $310 million per year.

8. Application of Survey Results to EIS Alternatives

[30] There are four different alternatives evaluated in the EIS. However, from the standpoint of general/nonfishing recreation, these alternatives can be grouped into two main categories: (1) alternatives in which the dams remain and (2) natural river drawdown, i.e., dam breaching (alternative 4). Group 1 includes existing system (alternative 1), existing system with maximum salmon transport (alternative 2), and major system improvements for salmon such as surface bypass collectors (alternative 3).

8.1. Overall Recreation Benefit Comparison

[31] Table 4 displays the average annual equivalent value of the recreation benefits of each of the EIS alternatives. The benefit estimate using use estimate 2 is $310 million annually. Use estimate 1, which only uses the definitely yes visitors, has an annualized value of $192 million. Use estimate 2 yields river recreation benefits 10 times the existing reservoir recreation benefits of $31.6 million estimated using a standard TCM model by *McKean* [1998].

8.2. Comparison to the Cost Estimates

[32] The removal of the four dams on the Lower Snake River and restoration of the river to a free-flowing condition appears to have substantial recreation use values to residents of the Pacific Northwest and California. The river recreation use value estimates of $192–310 million are 6–10 times larger than current reservoir recreation benefits ($31.6 million). However, the annual hydropower losses associated with dam removal are estimated to be $271 million annually [*USACOE*, 1999]. Including the dam removal cost and foregone barge transportation, the costs rise to $360 million [*USACOE*, 1999]. River recreation would cover a large portion of these costs but not all of it. Owing to the need to recover the fish stocks, recreational, commercial, and tribal fishing benefits are limited as well. Thus in a traditional national economic development (NED) analysis that does not incorporate passive use values of recovering of threatened and endangered species, a strict benefit cost criterion would suggest it is economically efficient to allow the dams to remain.

9. Conclusion

[33] This paper demonstrated how the contingent behavior method could be applied to estimate the recreation benefits associated with restoring free-flowing rivers. The contingent behavior travel cost method estimated using intended trips performed similarly in terms of statistical significance and explanatory power to published travel cost models estimated with actual trips. This contingent behavior based travel cost methodology should be useful in the future as more and more dams are reevaluated because of Federal Energy Regulatory Commission relicensing and fisheries concerns. Future research needs to better address the incorporation of the effect of substitute recreation into these models along the lines suggested by *Smith* [1993].

[34] The removal of the four dams on the Lower Snake River and restoration of the river to a free-flowing condition appears to have substantial recreation use values to residents of the Pacific Northwest and California. The recreation use value estimates range from $193 to $311 million annually. These estimates of restored river recreation benefit estimates are 6–10 times larger than current reservoir recreation benefits ($31.6 million). On the cost side the annual hydropower barge transportation foregone plus the dam removal are $360 million [*USACOE*, 1999]. Because of the need to rebuild the stocks of native salmon and steelhead to achieve recovery under the Endangered Species Act the recreational angling and commercial fishing benefits are a fraction of the river recreation. Not unexpectedly, the economic benefits from recovery of threatened and endangered fish stocks probably does not lie in the direct use values gained. Rather, passive use values gained from increased populations of endangered salmon may play a potentially important role in the overall economic efficiency benefits of dam removal. A complete benefit-cost analysis should account for these benefits as well. Since the U.S. Army Corps of Engineers interpretation of U.S. Water Resources Council Principles and Guidelines of 1983 currently precludes incorporation of passive use values, the Principles and Guidelines should be updated to reflect passive use values like other agency economic guidelines.

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