UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232

June 14, 2017

Dear Reviewer:

In accordance with the National Environmental Policy Act (NEPA), we, the National Marine Fisheries Service (NMFS), are announcing the availability for review of a Draft Environmental Impact Statement (DEIS) analyzing the new *U.S. v. Oregon* management agreement for the Years 2018-2027.[1] The Federal Register notice announcing the public comment period and the DEIS are accessible at the NMFS West Coast Region's website:
http://www.westcoast.fisheries.noaa.gov/publications/nepa/nepa_documents.html.

The proposed action is for the Federal parties to sign the new management agreement, as negotiated by the parties to *U.S. v. Oregon*, and for NMFS and the U.S. Fish and Wildlife Service to issue an Incidental Take Statement exempting the take of listed species taken pursuant to the agreement. This new agreement would take effect after the current agreement expires at the end of 2017. The new agreement implements harvest policies and incorporates hatchery programs that the parties have agreed are needed to support harvest opportunities and the conservation of salmon or steelhead runs above Bonneville Dam.

Written comments should be submitted through mail, facsimile (fax), or email to:

Jeromy Jording, Fishery Biologist
National Marine Fisheries Service
West Coast Region
510 Desmond Dr. SE, Suite 103
Lacey, WA 98503-1263

Fax: 360-753-9463
Attn: Jeromy Jording
Subject: U.S. v. Oregon DEIS comment

Email: usvornepa@noaa.gov
Subject: U.S. v. Oregon DEIS comment

Comments must be received during the 45 day public comment period mentioned in the Federal Register notice. Please identify comments with the subject line "U.S. v. Oregon DEIS comment."

Sincerely,

Barry A. Thom
Regional Administrator

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[1] The full title of the DEIS is: Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service joining as a signatory to a new U.S v. Oregon Management Agreement for the Years 2018-2027.

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Title of Environmental Review:	Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service joining as a signatory to a new *U.S v. Oregon* Management Agreement for the Years 2018-2027.
Responsible Agency and Official:	Barry A. Thom, Regional Administrator National Marine Fisheries Service, West Coast Region West Coast Region, 7600 Sand Point Way NE, Building 1, Seattle, WA 98115-0070, (206) 526-6150
Contact:	Jeromy Jording Sustainable Fisheries Division National Marine Fisheries Service, West Coast Region 510 Desmond Dr. SE, Suite 103, Lacey, WA 98503-1263 jeromy.jording@noaa.gov, (360) 753-9576
Location of Proposed Activities:	Columbia River and Tributaries, located in Oregon and Washington
Cooperating Agencies:	U.S. Fish and Wildlife Service Bureau of Indian Affairs
Abstract:	The action considered in this draft environmental impact statement (DEIS) concerns how the National Marine Fisheries Service (NMFS) views implementing salmon and steelhead fishery policies contained in a proposed *U.S. v. Oregon* Management Agreement for the Columbia River Basin. Salmon and steelhead fishery management is complex, but in general, seeks to implement fisheries that are consistent with a variety of statutory and legal obligations related to resource conservation, economic and cultural benefits associated with resource use, and treaty Trust obligations. The framework management plan would be multiyear that specifies the conservation objectives. Each year, annual fishery plans are developed within the context of the framework plan to meet the year-specific circumstances related to the status of stocks affected by the fisheries. The federal action considered is Federal agency review and approval of the framework plan and implementation of annual fishery plans that would adhere to the framework and issuance of an Incidental Take Statement under the Endangered Species Act by NMFS and the U.S. Fish and Wildlife Service. However, there are different ways to balance these objectives and different strategies that can be used that may provide better solutions for meeting the obligations and objectives of the respective framework plan. The alternatives considered in this DEIS are programmatic in nature and are designed to provide an overview of fishery management policies that can be implemented as part of the annual planning process.
Public Comment:	Comments on this DEIS must be received no later than 45 days after the Federal Register Notice that the DEIS is available for public comment Please email comments to: usvornepa@noaa.gov or mail comments to the contact address above. More information is available at: http://www.westcoast.fisheries.noaa.gov/publications/nepa/nepa_documents.html

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EXECUTIVE SUMMARY

What is US v. Oregon?

United States v. Oregon (*US v Oregon*) is the on-going Federal court proceeding that enforces and implements the reserved fishing rights of the Nez Perce, Umatilla, Warm Springs, Yakama, and Shoshone-Bannock tribes. Fisheries in the Columbia River have been managed subject to provisions of *US v Oregon* under the continuing jurisdiction of the Federal court.

What is the Management Agreement?

The 2008-2017 *US v Oregon* Management Agreement provides the current framework for managing fisheries and hatchery programs in much of the Columbia River Basin. The current agreement expires on December 31, 2017; negotiations on a new management agreement are ongoing. The Columbia River treaty tribes, the states of Washington, Idaho and Oregon, and the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (FWS) and the Bureau of Indian Affairs (BIA) are signatories of the management agreement.

What are the objectives of the Management Agreement?

The management agreement accomplishes two primary objectives. First, it implements harvest policies that the parties have agreed should govern the amount of harvest. Second, the management agreement incorporates hatchery programs that provide harvest and that are important to the conservation of salmon or steelhead runs above Bonneville Dam.

What fisheries are included in the Agreement and in this document?

Treaty Indian fisheries and non-treaty fisheries are considered in the Management Agreement and in this Environmental Impact Statement (EIS). Treaty Indian fisheries are guaranteed by one or more treaties. These fisheries include both commercial as well as ceremonial and subsistence (C&S) fisheries. Non-treaty fisheries are those that do not have a treaty guaranteeing a fishing right. These include all state fisheries and certain Indian fisheries operated by tribes that are not party to *US v Oregon*. Non-treaty fisheries consist of both commercial and recreational fisheries.

What proposed Federal action does this EIS analyzes?

The Proposed Action is for the Federal parties to sign the management agreement, as negotiated by the parties to *US v Oregon*, and for NMFS and FWS (collectively, the "Services") to issue an Incidental Take Statement (ITS) under the Endangered Species Act (ESA) exempting take[1] of listed species taken pursuant to implementing the management agreement. A listed species is one that is identified either as endangered or threatened under the ESA.

What is the Purpose and Need?

The purpose and need for the Proposed Action is three-fold: (1) to meet the Federal government's tribal treaty rights and trust and fiduciary responsibilities; (2) to support fishing opportunities to the states of Oregon, Washington, and Idaho; and (3) to work collaboratively with co-managers to protect and conserve ESA-listed and non-listed species.

The Services have an obligation to administer the provisions of the ESA and to protect ESA-listed species. They also have a Federal trust responsibility to the treaty Indian tribes, as well as a duty to support the fishing rights reserved in their treaties as defined by the Federal courts. Thus, the Services seek to harmonize the effects of fishery programs with the provision for tribal harvest. Because of the Federal government's trust responsibility to the tribes, the Services are committed to considering the tribal co-managers' judgment and expertise regarding conservation of trust resources.

What is the purpose of this Environmental Impact Statement (EIS)?

The National Marine Fisheries Service has prepared this EIS under the National Environmental Policy Act (NEPA) to inform the decision to sign the new management agreement. The Fish and Wildlife Service and the Bureau of Indian Affairs, also signatories of the management agreement, are cooperating agencies on this EIS.

What is a harvest policy?

Harvest policies provide a framework designed to inform how to achieve the appropriate balance between harvest and conservation objectives. *Harvest* provides the benefits of catch including those related to treaty rights; *conservation* seeks to keep healthy stocks healthy and rebuild weak stocks so that all are sustained and can provide for the ongoing benefits of harvest. *Harvest management measures* are the

[1] While this term is defined in the glossary using the ESA definition, readers must understand that it includes fishing and hatchery use.

actions or tactics implemented to harvest consistent with the overarching policy selected. This EIS focuses on the harvest policy alternatives and their effects on the environment.

What options do harvest policy makers have in setting harvest policy?

Policies depend on the availability of specific kinds of information. For example, abundance based management requires the availability of preseason or inseason abundance estimates; an effort based policy does not. Policy choices for a fishery directed at a single stock near the spawning grounds may be different than a fishery directed at a mix of many stocks in the ocean or mainstem Columbia River. Harvest policies for healthy and abundant stocks may be different than for a depressed stock that needs rebuilding. Specific options are addressed under each alternative analyzed in this EIS.

What alternatives are analyzed in this EIS?

This EIS analyzes six alternatives for setting harvest policies:

Alternative 1—Extension of current agreement for the next 10 years consistent with the terms of the 2008–2017 agreement. The new agreement would use a blend of harvest policies, including a blend of abundance-based management, escapement-based management, and harvest rate management. The blend depends on the specific salmon or steelhead stock. This alternative recognize that the stocks have varying conservation requirements, with some providing abundant opportunity for harvest, and others requiring more protection from harvest encounters at this time.

Alternative 2—Abundance-based Management. This alternative establishes harvest levels based on the status of the fish stocks. It provides more protection when the abundance of a given stock is low and the conservation need greatest, and more harvest opportunity when abundance is high.

Alternative 3—Fixed Harvest Rate. This alternative uses a fixed harvest rate management framework that would apply a fixed harvest rate to each fishery regardless of abundance. Harvest rate refers to the ratio of fishery related mortality for a group of fish over its abundance in a defined period of time.

Alternative 4—Escapement-based Management. This alternative uses an escapement-based management framework. Escapement refers to the number of fish surviving (escaping from) a given fishery at the end of the fishing season and reaching a specified location where the fish can be enumerated. In cases where the projected run size is below the escapement goal, escapement goal harvest policies are sometimes coupled with a *de minimis* level of harvest opportunity to meet minimal needs for tribal fisheries and limited access to other harvestable stocks.

Alternative 5—Voluntary Fishery curtailment. Under this alternative, the sovereign parties voluntarily curtail harvest activities for an extended period of time. This alternative may include some very limited treaty fishing opportunity to meet base ceremonial needs of the tribes. The parties may adopt a voluntary extreme harvest curtailment policy when the continued viability of the stocks are at imminent risk. This alternative does not meet the purpose and need for the action insofar as it does not provide for meaningful tribal harvest as guaranteed by Treaty and it provides no opportunity for non-treaty harvest. This alternative provides the benchmark required by NEPA in that it represents the alternative with the lowest fishing harvest.

Alternative 6—No Action - Uncoordinated Harvest. Under this alternative, the existing agreement would expire without a new agreement. While it is uncertain what would transpire under this situation, NMFS anticipates that the state and tribal parties would implement harvest independently according to their own uncoordinated interpretations. Theoretically, state and or tribal parties may choose to curtail harvest entirely. Alternative 5 represents the analysis of that result. On the other hand, it is more likely that the parties' interpretation results in a level of harvest that would be very high, likely exceeding the highest historic harvest rates observed. Alternative 4 represents the analysis of that result. This alternative does not meet the purpose and need for the Proposed Action in that it does not meet the requirements of Federal parties to act in accord with other legal requirements such as the ESA or the Federal trust responsibility. This alternative provides another "no-action" alternative benchmark in that it represents the alternative of the Federal agencies doing nothing (not signing an agreement).

What environmental resources are analyzed in this EIS?

Resources that may be affected by the Proposed Action and that are analyzed in the EIS are fish, marine-derived nutrients, wildlife, economics, cultural resources, and environmental justice. These resources were identified during the public scoping period. This scoping period was initiated with a Notice of Intent to prepare a draft EIS (NOI) that was published in the Federal Register on July 1, 2016 (81 Fed. Reg. 43187). This NOI announced a 30-day public comment period (July 1, 2016 to August 1, 2016) to gather information on the scope of the issues and the range of alternatives to be analyzed in the EIS.

Why are other resources not analyzed in this EIS?

The Proposed Action would not change measures or strategies that are used to implement harvest policy. These include fishing gear, locations, and timing. These are established by the states and the Indian tribes; not by the Federal government. The proposed action is therefore limited in scope—it would not affect all environmental components of the Columbia River Basin. It does not include any form of construction or demolition to bridges, dams, hydroelectric facilities, or other related infrastructure. No effects are expected on the physical environment, habitat, ecosystem component species, or environmental resources such as air quality, water quality (other than marine-derived nutrients), or sedimentation. No effects are expected on river transportation, river navigation, or historical properties (Section 106 of the National Historic Preservation Act).

What fish stock are included in the analyses?

Fisheries target particular groups of fish, referred to as "stocks". Stocks targeted specifically for harvest are known as *Harvest Indicator Stocks*. Fisheries may also incidentally catch ESA-listed species, which are known as *Abundance Indicator Stocks*. Harvest Indicator Stock are the "Management Units" of the *US v Oregon* management agreement and most have subcomponents that include ESA-listed stock.

The following *Harvest Indicator Stocks* are analyzed in the EIS: Upriver spring Chinook salmon, Upriver summer Chinook salmon, Upriver Sockeye salmon, Upriver fall Chinook salmon, and Snake River B-run steelhead. The *Abundance Indicator Stocks (ESA-listed)* that are analyzed in the EIS are the Natural-Origin Upriver spring/summer Chinook salmon and natural-origin UCR spring Chinook salmon (part of the Upriver spring Chinook salmon *Harvest Indicator Stock*), Snake River sockeye salmon (part of the Upriver sockeye salmon *Harvest Indicator Stock*), natural-origin Snake River Fall Chinook salmon (part of the Upriver fall Chinook salmon *Harvest Indicator Stock*) and natural-origin B-run (part of the Snake River B-run steelhead *Harvest Indicator Stock*). The Upriver summer Chinook salmon *Harvest Indicator Stock* does not include any *Abundance Indicator Stock* components.

What are the results of the analyses? What are the environmental consequences of each alternative? Which alternative is better?

Table ES-1 presents a comparison of each alternative. The effects on each resource analyzed are described below.

<u>Salmonids</u>

Fisheries impact the environment by killing target species and thereby reducing fish abundance and spawning potential. Implementing a new *US v Oregon* management agreement will result in the removal of salmonids from the environment for commercial, recreational, or ceremonial and subsistence (C&S) consumption. Reducing fish abundance, and subsequent spawning population potential, can lead to impacts of population parameters. At levels of high fish removal an originally stable, mature and efficient ecosystem might be deprived of nutrient input that results in the ecosystem becoming immature and stressed. This happens in various ways. By targeting and reducing the abundance of high-value predators, fisheries modify the trophic chain and the flows of biomass (and energy) across the ecosystem as well as remove the nutrients from the system that are contained within the fish carcasses themselves.

Each harvest policy analyzed in this EIS results in a rate at which fish may be harvested. The direct inverse result of each harvest rate is a rate at which fish that are not harvested are able to escape past the fisheries and potentially return to the spawning grounds to spawn (e.g., if a harvest rate was 40%, then the subsequent escapement rate would be roughly 60% of any particular run size). Each alternative analyzed in this EIS only differs in the calculation of these two rates, however escapement estimates are presented in total numbers (e.g., if a harvest rate was 40% on a run size of 10,000, then 4,000 fish died from harvest (10,000 * 0.4 = 4,000), and the resulting escapement is 6,000 (10,000 - harvest of 4,000 = 6,000)). Therefore, the impacts of each alternative analyzed are the harvest rates and escapement totals. These will vary based on the alternative and the fluctuating projected fish run sizes. The sections that follow (4.1.1.1 through 4.1.1.5) describe the impacts of the alternatives on each indicator stock. Section 4.2 compares these impacts of each alternative relative to baseline conditions and the other alternatives for each indicator stock.

The effects of Alternative 1 and Alternative 2 on Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, and B-run steelhead would not impact the current baseline conditions. The effects of Alternative 3 on these same resources is practically the same as those of Alternative 1 and Alternative 2, but generally provides a slight positive impact to spawning escapement. Alternative 4 and Alternative 6 have the greatest effects (largest harvest) on all affected salmonid species, especially for Snake River Fall Chinook salmon. Snake River spring/summer Chinook salmon, Upper Columbia River Chinook salmon, Snake River sockeye salmon and Group B steelhead. Only for Upper Columbia River summer/fall Chinook salmon the effects of Alternative 4 or Alternative 6 are lower than for Alternatives 1, 2, and 3. This results in a high negative impact to spawning escapement for these two alternatives across all stocks. Alternative 5 has the lowest harvest impacts on all salmonid species because it involves no fishing, and therefore provides a positive impact to spawning escapement across all stocks.

Alternative 5, however, would likely result in escapement of larger numbers of hatchery-origin adults, leading to potential negative effects from elevated levels of hatchery-origin fish spawning. These negative effects result from the high levels of unharvested hatchery fish ending up on natural spawning grounds and competing with and reproductively interacting with natural-origin (wild) fish of the same species/run. None of the alternatives, not even Alternative 5, meet the escapement goal for Snake River Sockeye salmon because of the depleted nature of the stock.

ESA-Listed Non-Salmonids

There is a potential for incidental take of ESA-listed green sturgeon as bycatch in fisheries directed at white sturgeon. White sturgeon is discussed in the next section. The total past and expected annual take of green sturgeon associated with *US v Oregon* fisheries was very low (0 to 14 fish annually) and policies adopted in 2014 by the states further restrict the retention of white sturgeon. Therefore, the effect on green sturgeon would not change across any of the alternatives. The fisheries would have no discernable effect on bycatch of bull trout or eulachon during salmon or steelhead fisheries under any of the alternatives.

Other Non-Salmonids (non ESA-listed Fish Species)

The *US v Oregon* agreement has not and would not specify conservation specific needs for any white sturgeon, American shad, Pacific lamprey and walleye. Instead, fisheries for these species are mentioned in the agreement because very small levels of salmon or steelhead bycatch might occur in fisheries targeting these species. The direct effects of fishing on these species are independent of each alternative.

Water Quality and Quantity — Hatchery Effects and Marine-derived nutrients

Hatcheries can produce effluent (discharged water that has been used in the facility) with elevated temperature, as well as elevated levels of: ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand (BOD), pH, and solids; as well as levels of chemicals used for disease treatment and disinfection. Since none of the alternatives moving forward into the future would alter hatchery production, the negative impacts associated with hatchery effluent as it relates to water quality would be constant across all alternatives.

Anadromous species such as salmon and steelhead are important components of the freshwater ecosystem, particularly for their role in transporting nutrients upstream from the marine ecosystem. Under Alternatives 1, 2, 3, 4, and 6 there will be a decrease in nutrients transported upstream, although the difference between these alternatives is negligible. By comparison, Alternative 5 would lead to an immediate positive effect and improvement over time relative to the other alternatives as there would be more marine derived nutrients deposited throughout the Columbia River basin.

Wildlife

Seabirds, raptors, and other piscivorous birds prey on salmonids. Seabirds do not prey on adult salmon and no alternative examined were expected to impact seabirds. Raptors, corvids, and numerous species of gulls prey on returning adult salmonids, primarily post-spawn adults.

Alternative 1 and Alternative 2 would have no impact change relative to baseline levels of adults available as prey to these birds. Alternative 3 would have a slightly positive impact as its average harvest is lower than that of Alternatives 1 and 2, thereby providing a larger number of prey items available. Alternative 4 and Alternative 6, with the largest harvest, would have the most noticeable negative impact on these birds by removing the largest numbers of available prey items. Alternative 5 would offer the most adult salmonids as prey since they would not be harvested en route to the spawning grounds, thereby providing a positive impact. This alternative would maximize post-spawn adults as a food source.

Implementation of the Mitchell Act EIS Preferred Alternative, would not be expected to change the current availability of juvenile salmonid prey base for seabirds as hatchery production is not affected by the alternatives and the resulting adult returns would be well within annual variability of total salmon and steelhead returns, so would not have a discernable effect on the availability of adult salmon and steelhead prey.

Marine mammals, especially seals and sea lions, prey on the adult salmonids that are also target of the fisheries. Alternative 1 and Alternative 2 would have a negative effect on these marine mammals through reduction in adult fish available as prey via harvest removals, while Alternative 3 would have a slightly lower negative effect as it would have a lower average harvest. Alternative 4 and Alternative 6, with the largest harvest, would have the most noticeable negative effect on these marine mammals, as they remove the largest number of adults. Alternative 5 would offer the most adult salmonids as prey since they would not be harvested.

There is no discernable difference between the alternatives on the effect to Southern Resident Killer Whales (SRKW) as any salmonids returning to the Columbia River would have already passed through whale's ocean habitat. Furthermore, any increase in escapement of adult fish to terminal spawning areas does not translate into an increase in juvenile salmonids because the capacity limit of the current spawning habitat does not allow for increased juvenile production at higher escapement numbers.

Economics

The economic analysis focuses on analyzing effects related to commercial and recreational fishing activity directed on the five harvest indicator stocks. Under the existing conditions, there is a moderate positive effect on the value to tribal and non-tribal commercial fishers, non-tribal recreational fishers, employment, and personal income contribution to the regional and local economy. Harvest and primary processing of salmon caught in tribal and non-tribal commercial fisheries is estimated to generate $16.2 million in personal income and 419 Full-time Equivalent (FTE) jobs. Recreational fishing activities targeting salmon and steelhead would generate an estimated $27.9 million in personal income and 672 jobs.

Alternative 1 would continue to maintain this moderate positive effect. By comparison, because of the change in harvest levels based on different harvest policies, Alternative 2 would have a lower positive effect and Alternative 3 a low negative effect. Alternative 4 and Alternative 6, with more aggressive fishing policy would result in a high positive effect, while Alternative 5, with curtailed fishing, would yield a high negative economic effect.

Cultural resources

Ceremonial and Subsistence (C&S) harvest is a priority for Indian tribes and any deficit in the harvest is taken from tribal commercial harvest. Under Alternatives 1, 2, and 3, Indian tribes in the project area would be able to continue their C&S harvest without substantial changes to tribal cultural viability. However, the effects of Alternative 4 and Alternative 6 would be negative. Under these two alternatives, the minimum C&S harvest in years with low runs may not be sufficient to meet C&S needs in years with low runs, thereby either directly negatively affecting the tribal cultural viability, or, more likely, reducing the available commercial harvest. Alternative 5 would result in a high negative effect as the C&S harvest would be largely curtailed.

Are there any Environmental Justice effects?

Each alternative was evaluated to determine whether it resulted in a disproportionate adverse effect on environmental justice communities. The analysis found that Alternatives 4, 5, and 6 would result in a disproportionate adverse effect on cultural resources for Indian Tribes as it pertains to C&S fisheries. Alternatives 1, 2, and 3 would not have a disproportionate adverse effect on either cultural resources or economics for Indian Tribes. Alternative 4 and Alternative 6 would also result in a disproportionate adverse economic effect on Indian tribes. Note that Alternative 5, although it largely curtails fishing, equally negatively affects Indian tribes and non-tribes as it pertains to economics and is therefore not disproportionate.

What are the cumulative impacts of the alternatives?

Some of the alternatives would demonstrate positive effects on biological resources. For example, Alternative 5 (Voluntary Curtailed Fishing) would result in positive effects on the fish species, prey for birds, and marine-derived nutrients. However, when considered together with the negative effects of past, present, and foreseeable future activities in the project area, these positive effects are largely eroded. These non-harvest activities they may have largely negative biological effects (development, habitat destruction, hydropower, and climate change), or largely positive effects (habitat restoration), or a mix of positive and negative effects (hatcheries). Yet cumulatively, the negative effects would prevail.

By comparison, the adverse effects resulting from the past, present, and foreseeable future activities in the project area would be greater when combined with the effects of Alternatives 1, 2, and 3. The cumulative negative effects resulting from alternatives 4 and 6, with their high harvest rates, would be the greatest.

The adverse effects from other projects in the area result in less fish. Therefore, the cumulative effects of Alternatives 1, 2, 3, 4, and 6 on economics (commercial, recreational, and regional or local economic impacts), when combined with the effects of other actions, all decrease. As there is no economic impact of Alternative 5 on the fisheries, there is no effect based on cumulative impacts. The negative cumulative effects on cultural resources (C&S) increase proportionally to the cumulative decrease in fish stock that results from other actions in the project area. The cumulative disproportionate adverse effects on cultural resources (Alternatives 4, 5, and 6) as well as economics (Alternative 4 and Alternative 6) as it pertains to the Indian tribes does not change when effects of past, present, and reasonably foreseeable future actions are considered. These effects remain disproportionate.

What about hatcheries?

Yes, signing a new *US v Oregon* agreement that references levels of hatchery production supporting harvest requires the federal agencies to be informed of their effects to the environment. NMFS has completed an EIS on Columbia River Hatchery Operations (Final EIS to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs (NMFS 2014). The Mitchell Act EIS analyzed the impacts of Basin-wide, alternative hatchery policies and the resulting production. NMFS will use the Mitchell Act EIS, and the analysis contained therein, to inform the hatchery related effects on the harvest management alternatives.

The existing 2008-2017 *US v Oregon* agreement includes hatchery programs that produce fish. The agreement describes the number of fish to be released, life-history of release, release location, hatchery rearing facilities, entity(s) that manages the program(s), and the responsible funding entity(s). Some of these fish are subsequently harvested in the fisheries that fall under the Agreement's management framework. Therefore, the hatcheries are included in the Agreement both as a measure to formalize the production of hatchery fish for harvest above Bonneville Dam and to identify hatchery programs that are important to the conservation of salmon or steelhead runs above Bonneville Dam.

Hatcheries augment fisheries by increasing certain stock abundances, including both ESA-listed and non-listed stocks. Certain fisheries would be able to continue without hatchery production, because these fisheries target non-listed stocks of relatively healthy natural-origin fish. In the absence of hatcheries, these fisheries would operate at different levels based solely on the abundance of natural-origin fish. Therefore, while this EIS stands separate from the Mitchell Act EIS, it incorporates data, analyses, and conclusions from the Mitchell Act EIS as appropriate.

Which harvest framework or policy will the Management Agreement incorporate?

The final harvest framework will depend on a number of factors that include, but are not limited to, the public's input to this EIS, the ongoing negotiations between the parties to the *US v. Oregon*, and the consultations that are required under the Endangered Species Act (ESA). These consultations lead to the publishing of a Biological Opinion and an Incidental Take Statement. Upon the completion of the NEPA and ESA processes, the decision makers will select the most appropriate harvest framework.

What is the timeframe for a decision?

Under the NEPA process, the public has 45 days after publication in the Federal Register to comment on this Draft EIS. Thereafter, NMFS will review all of the comments, adjust the analyses and EIS if needed, and publish a Final EIS. NMFS will complete a "Record of Decision" (ROD) that captures the outcome of both the NEPA and ESA processes 30 days after publication of the ROD.

Table ES – 1. Summary of Alternatives

Alternative		Meets Purpose & Need	Effects Compared to Baseline								Environmental Justice	
			Harvest	Effects on ESU-listed salmonids		Water Quality	Raptors	Mammals	Economics	Cultural	Economics	Cultural
				US v Oregon Fishing Only	Cumulative Effect	Nutrients	Prey	Pinnipeds		C&S	Disproportionate Adverse Effect	
EIS Section	2.1	2.1	2.1	4.2	5.3.1	4.3	4.4.2	4.4.2	4.5	4.6	4.7.2	4.7.1
1	Extension	Yes	No Change	No Change	No Change	No Change	No Change	No Change	No Change	No Change	No	No
2	Abundance-Based	Yes	No Change	No Change	No Change	No Change	No Change	No Change	Slight Negative	No Change	No	No
3	Fixed Harvest Rate	Yes	Slight Decrease (1)	Slight Positive	No Change	No Change	Slight Positive	Slight Positive	Negative	No Change	No	No
4	Escapement-Based	Yes	High (Aggressive)	High Negative (2)	High Negative	No Change	Negative	Negative	High Positive	Negative	Yes	Yes
5	Voluntary Fishing Curtailment	No	No Harvest	Positive	Negative	Positive	Positive	Positive	High Negative	High Negative	No	Yes
6	No-action. Uncoordinated Harvest	No	High (Aggressive)	High Negative (2)	High Negative	No Change	Negative	Negative	High Positive	Negative	Yes	Yes

(1) No change for Sockeye salmon

(2) Except Upper Columbia River Summer/Fall Chinook salmon for which the fishing effort is lower than the baseline resulting in a positive effect compared to the baseline.

There are no meaningful differences across the alternatives for resources analyzed in the EIS but not presented in the table above: ESA-listed non-salmonids, other non-salmonids that are not ESA-listed, and Southern Resident Killer Whales (SRKW).

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ACRONYMS

BIA	Bureau of Indian Affairs
BPH	Bonneville Pool Hatchery
BOR	Bureau of Reclamation
BUB	Bonneville Upriver Bright
C&S	Ceremonial and Subsistence fisheries
CEQ	Council for Environmental Quality
CFR	Code of Federal Regulations
CRFMP	Columbia River Fish Management Plan
DAO	Departmental Administrative Order
DOC	Department of Commerce
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit (a term used by NMFS)
FR	Federal Register
FTE	Full-time Equivalent Job
HR	Harvest Rate
LCR	Lower Columbia River
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
ODFW	Oregon Department of Fish and Wildlife
PFMC	Pacific Fishery Management Council
PUB	Pool Upriver Bright
PUD	Public Utility District
RIS	Rock Island Dam
RM	River mile
ROD	Record of Decision
SAFE	Select Area Fisheries Evaluation Commercial Fisheries
SMU	Species Management Unit. A term used by ODFW
SRKW	Southern Resident Killer Whale
SR	Snake River

SST	Sea Surface Temperature
TAC	*U.S. v Oregon* Technical Advisory Committee
UCR	Upper Columbia River
URB	Upriver Bright
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
UWR	Upper Willamette River
WDFW	Washington Department of Fish and Wildlife

GLOSSARY OF KEY TERMS

- Abundance: Generally, the number of fish in a defined area or unit. It is also one of four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).
- Abundance Indicator Stock: See stock.
- Adipose fin: A small fleshy fin with no rays, located between the dorsal and caudal fins of salmon and steelhead. The adipose fin is often "clipped" on hatchery-origin fish so they can be differentiated from natural-origin fish.
- Anadromous: A term used to describe fish that hatch and rear in freshwater, migrate to the ocean to grow and mature, and return to freshwater to spawn.
- Analysis area: Within this Environmental Impact Statement (EIS), the analysis area is the geographic extent that is being evaluated for each resource. See also Project area.
- Bycatch: Species killed when fishing operations unintentionally catch and discard non-target species, potentially causing unobserved injury and mortality.
- Commercial harvest: The activity of catching fish for commercial profit.
- Conservation: Used generally in the EIS as the act or instance of conserving or keeping fish resources from change, loss, or injury, and leading to their protection and preservation. This contrasts with the definition under the United States Endangered Species Act (ESA), which refers to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.
- Critical habitat: A specific term and designation within the ESA, referring to habitat area essential to the conservation of a listed species, though the area need not actually be occupied by the species at the time it is designated.
- Distinct Population Segment (DPS): Under the ESA, the term "species" includes any subspecies of fish or wildlife or plants, and any "Distinct Population Segment" of any species or vertebrate fish or wildlife that interbreeds when mature. The ESA thus considers a DPS of vertebrates to be a "species." The ESA does not however establish how distinctness should be determined. Under NMFS policy for Pacific salmon, a population or group of populations will be considered a DPS if it represents an Evolutionarily Significant Unit (ESU) of the biological species. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing DPSs (DPS Policy:61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates.
- Diversity: Variation at the level of individual genes (polymorphism); provides a mechanism for populations to adapt to their ever-changing environment. It is also one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).
- Emigration: The downstream migration of salmon and steelhead toward the ocean.
- Endangered species: As defined in the ESA, any species that is in danger of extinction throughout all or a significant portion of its range.
- Escapement: Adult salmon and steelhead that survive fisheries and natural mortality, and return to spawn.
- Estuary: The area where fresh water of a river meets and mixes with the salt water of the ocean.
- Ex-vessel value: The price (income) that fishermen receive for the fish "at the dock."
- Evolutionarily Significant Unit (ESU): A concept NMFS uses to identify Distinct Population Segments of Pacific salmon (but not steelhead) under the ESA. An ESU is a population or group

of populations of Pacific salmon that 1) is substantially reproductively isolated from other populations, and 2) contributes substantially to the evolutionary legacy of the biological species. See also Distinct Population Segment (pertaining to steelhead).

- Fishery: Harvest under a specific jurisdiction in a specific geographical area during a specific period of time.
- Habitat: The physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal; the place where an organism naturally lives.
- Harvest Indicator Stock: See stock
- Harvest Rate: The ratio of fishery related mortality for a group of fish over its abundance in a defined period of time.
- Harvest Rate Limits: The total allowable harvest rate for a species or stock that may be taken during a period of time.
- Incidental fishing effects: Fish, marine birds, or mammals unintentionally captured during fisheries using any of a variety of gear types.
- Limiting Stock: One that constrains harvest during a season, by being the lowest in abundance and therefore restricting access to more abundant stocks and limiting total catch.
- Listed Species: Under the ESA, species may be listed as either endangered or threatened. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. “Endangered” means a species is in danger of extinction throughout all or a significant portion of its range. “Threatened” means a species is likely to become endangered within the foreseeable future. For the purposes of the ESA, Congress defined species to include subspecies, varieties, and, for vertebrates, distinct population segments.
- Native fish: Fish that are endemic to or limited to a specific region.
- Natural-origin: A term used to describe fish that are offspring of parents that spawned in the natural environment rather than the hatchery environment, unless specifically explained otherwise in the text. “Naturally spawning” and similar terms refer to fish spawning in the natural environment.
- Population: A group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group.
- Productivity: The rate at which a population is able to produce reproductive offspring. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).
- Recovery: Defined in the ESA as the process by which the decline of an endangered or threatened species is stopped or reversed, or threats to its survival neutralized so that its long-term survival in the wild can be ensured, and it can be removed from the list of threatened and endangered species.
- Recovery plan: Under the ESA, a formal plan from NMFS (for listed salmon and steelhead) outlining the goals and objectives, management actions, likely costs, and estimated timeline to recover the listed species.
- Recreational harvest: The activity of catching fish for non-commercial reasons (e.g., sport or recreation).
- Run: The migration of salmon or steelhead from the ocean to freshwater to spawn. Defined by the season they return as adults to the mouths of their home rivers.
- Run size: The number of adult salmon or steelhead (i.e., harvest plus escapement) returning to their natal areas.
- Salmonid: A fish of the taxonomic family Salmonidae, which includes salmon, steelhead, and trout.

- Section 7 consultation: Federal agency consultation with NMFS or USFWS (dependent on agency jurisdiction) on any actions that may affect listed species, as required under section 7 of the ESA.
- Stock: A group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place in a different season.
    - Abundance Indicator Stock: Stocks that provide detailed information about natural-origin populations. Abundance Indicator Stocks are equivalent to the ESA-listed "units" (DPS or ESU) affected by *US v Oregon* fisheries.
    - Harvest Indicator Stock: Stocks that are the target of fisheries. These may include one or more Abundance Indicator Stocks.
- Take: Under the ESA, the term "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."
- Threat: A human action or natural event that causes or contributes to limiting factors; threats may be caused by past, present, or future actions or events.
- Threatened species: As defined by Section 4 of the ESA, any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
- Tributary: A stream or river that flows into a larger stream or river.
- Viability: As used in this EIS, a measure of the status of listed salmon and steelhead that uses four criteria: abundance, productivity, spatial distribution, and diversity.
- Viable salmonid population (VSP): An independent population of salmon or steelhead that has a negligible risk of extinction over a 100-year timeframe (McElhany et al. 2000).
- Watershed: An area of land where all of the water that is under it or drains off of it goes into the same place, e.g. Rogue River watershed or Umpqua River watershed.

Section 1

1. PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1. Background

United States v. Oregon (*US v Oregon*) is the on-going Federal court proceeding first brought in 1968 to enforce the reserved fishing rights of the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation. In his 1969 decision, Judge Robert C. Belloni of the Federal District Court for the District of Oregon ruled that state regulatory power over Indian fishing is limited because treaties between the United States and the tribes in 1855 reserved the tribes' exclusive rights to fish in waters running through their reservations and at “all usual and accustomed places, in common with the citizens of the United States [or citizens of the territory].” Sohappy v. Smith, 302 F. Supp. 899 (D. Oregon 1969). The court further held that the state is limited in its power to regulate treaty Indian fisheries. Among other things, the court held that the state may only regulate when reasonable and necessary for conservation, provided: reasonable regulation of non-Indian activities is insufficient to meet the conservation purpose, the regulations are the least restrictive possible, the regulations do not discriminate against Indians, and voluntary tribal measures are not adequate.

In 1974, Judge George Boldt considered identical treaty language in United States v. Washington. Judge Boldt held that the "in common with the citizens of the United States [or citizens of the territory]" language reserved 50 percent of all the harvestable fish destined for the tribes' traditional fishing places. Later that same year, Judge Belloni reached the same holding, the Columbia River treaty tribes’ were entitled to 50 percent of the harvestable runs destined to reach the tribes’ usual and accustomed fishing grounds and stations.

Fisheries in the Columbia River have subsequently been managed subject to provisions of *US v Oregon* under the continuing jurisdiction of the Federal court. The Columbia River Fish Management Plan provided a framework for management from 1988 through 1998, although certain provisions were modified during that time to address concerns related to the increasing number of ESA-listed species. After 1998, fisheries were managed through a series of short term agreements, the duration of which ranged from several months to five years. The 2008-2017 *US v Oregon* Management Agreement, which provides the current framework for managing fisheries and hatchery programs in much of the Columbia River Basin, expires December 31, 2017; negotiations on a new management agreement are ongoing. The parties to *US v Oregon* (hereafter, the Parties) negotiating the agreement include: the States of Oregon, Washington, and Idaho; the Shoshone-Bannock Tribes, the Nez Perce Tribe, 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 Yakama Nation (collectively, the Columbia River Treaty Tribes); and the United States (as represented by the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Bureau of Indian Affairs (BIA)).

The Federal parties to the management agreement have specific responsibilities for aspects of the agreement related, for example, treaty trust responsibilities, a duty to support the fishing rights in the treaties, to certain production programs, and implementation of the Endangered Species Act (ESA). The NMFS and FWS have prepared this Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) to inform the decision to sign the new management agreement and issuance of an ITS under ESA. The BIA, also party to the agreement, is a cooperating agency on this EIS.

The existing agreement includes, and the new agreement would include, both a list of treaty Indian and non-treaty fisheries and a list of hatchery programs with stipulated production levels in the Columbia River Basin. The management agreement provides a framework to keep healthy stocks healthy and rebuild weak stocks, and fairly share the harvest of upper river runs between treaty Indian and non-treaty fisheries. While the agreement would include a hatchery production component, the hatchery operations aspect is not solely dependent on the *US v Oregon* agreement and may occur regardless of the outcome of the *US v Oregon* agreement. The harvest policies analyzed in this EIS are independent of site specific production levels of the hatcheries. Separate processes and actions occur outside the *US v Oregon* agreement that review and analyze the hatchery programs at site specific levels. However, a review of the impacts from a comprehensive level of the total hatchery production referenced in the agreement is necessary to evaluate the impacts of including all of the hatchery programs collectively in the agreement. NMFS has completed an EIS and issued a Record of Decision on Columbia River Hatchery Operations (Final EIS to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs (NMFS 2014); hereafter, the Mitchell Act EIS). Applicable information from the Mitchell Act EIS analyzed the impacts of Basin-wide, alternative hatchery policies and the resulting Basin-wide production. The Mitchell Act EIS analysis is therefore incorporated by reference herein. In the analysis that follows, we reference applicable sections of the MA EIS and summarize the relevant conclusions.

1.2. Description of the Proposed Action

The Proposed Action is for the Federal parties to sign the new management agreement, as negotiated by the parties to *US v Oregon*, and for NMFS and FWS to issue an Incidental Take Statement (ITS) exempting take[2] of listed species pursuant to the implementation of the management agreement. This new management agreement would take effect after the current management agreement expires at the end of 2017. The management agreement accomplishes two primary objectives. First, it memorializes the harvest policies that the parties have agreed should govern the amount of harvest. Second, the management agreement incorporates hatchery programs, developed individually at site specific locations that provide harvest and are important to the conservation of salmon or steelhead runs above Bonneville Dam.

1.3. Project and Analysis Areas

The project area is the geographic area where the Proposed Action would take place. It includes the Columbia River mainstem, the primary segment of the river as contrasted to tributary rivers that drain into it, from its mouth upstream to Wanapum Dam (river mile 415) and to the Idaho – Washington state boundary just upstream of Lower Granite Dam on the Snake River mainstem (Snake River river mile (RM) 107) (Figure 1-1). These mainstem Columbia and Snake River areas are where the Columbia River treaty tribes and other *US v Oregon* parties regulate fishing activities detailed in the *US v Oregon* Management Agreement in order to fairly share harvestable salmon and steelhead. Fishing activities, which are further detailed in Subsection 1.3.1, occur to varying degrees across the project area. These

[2] While this term is defined in the glossary using the ESA definition, readers must understand that it includes fishing and hatchery use.

activities are generally grouped by seasonal time frame, management jurisdiction and geography into separate "fisheries."

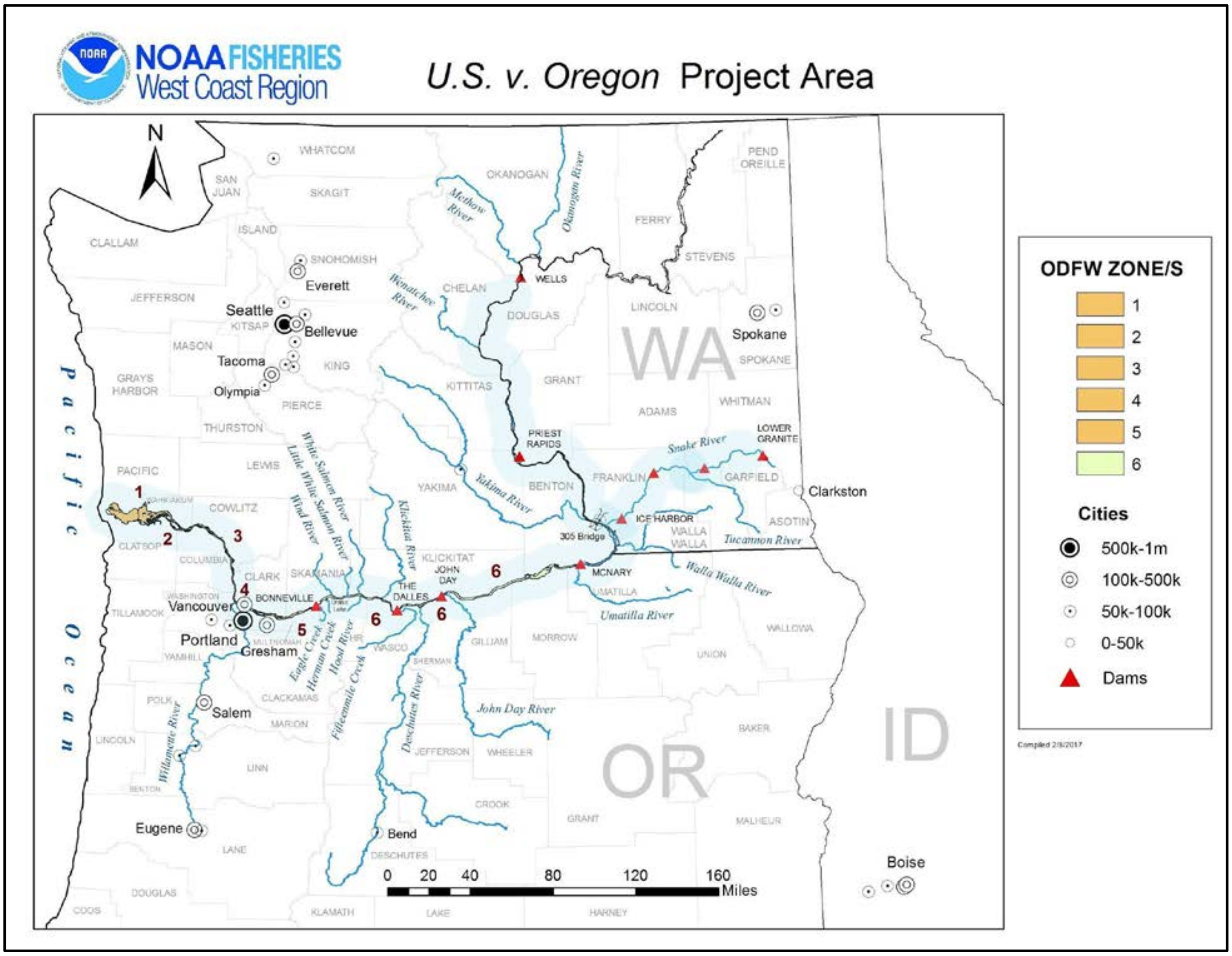

Figure 1-1. Project Area. (The states of Washington and Oregon have each adopted for statistical data-gathering, management of fisheries, and jurisdictional purposes, boundaries of areas where fisheries operate. Commercial fishery boundaries are referred to as "zones". Columbia River treaty tribes, and other *US v Oregon* parties have, in general, adopted the Oregon boundary terminology and therefore we present the Oregon Department of Fish and Wildlife (ODFW) commercial fishery management zones here for general reference, as these geographical boundaries and terminology are used throughout this analysis.)

The analysis area is the geographic extent that is being evaluated for potential impacts under a particular resource and alternative. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. The Mitchell Act EIS utilized a larger project area because many of the hatchery facilities that it analyzed exist outside the geographic areas where the fisheries specified in the *US v Oregon* management agreement occur. As described in Subsection 1.3.2, hatchery activities, including the release of hatchery fish, also take place outside areas where these fisheries occur. This EIS examines the area where these fisheries and their effects occur.

1.3.1. Fisheries

Treaty Indian fisheries and non-treaty fisheries are considered in this EIS. Non-treaty fisheries are those that do not have a treaty guaranteeing a fishing right. These include all state fisheries and certain Indian fisheries operated by tribes that are not party to *US v Oregon*. Non-treaty fisheries consist of both commercial and recreational fisheries. Treaty Indian fisheries are guaranteed by one or more treaties. These fisheries include both commercial as well as ceremonial and subsistence (C&S) fisheries.

Fisheries target particular groups of fish, referred to as "stocks". The *US v Oregon* agreement establishes harvest management policies for fisheries in the project area directed at Upriver salmon and steelhead stocks. Stocks targeted specifically for harvest are known as *Harvest Indicator Stocks*. Fisheries may also incidentally catch ESA-listed species, which are known as *Abundance Indicator Stocks*. Harvest Indicator Stocks and Abundance Indicator Stocks are described in more detail in Subsection 3.2.1.

Historically, fisheries governed by the harvest policies have been managed within a winter/spring, summer, and fall season time frame, each referred to as a management period. These management periods are approximate; some fisheries are longer in duration and occur during more than one management period (See Table 1-1).

Table 1-1. Fisheries occurring in the project area during more than one management period.

Jurisdiction	Fishery Description	Target species	Location
Non-Treaty	Mainstem Recreational steelhead	Summer and Winter steelhead	Mouth of Columbia (Buoy 10) upstream to Highway 395 Bridge near Pasco, WA
	Recreational fisheries in Select Areas	Select Area hatchery-origin Spring Chinook, Fall Chinook, and coho salmon	Off-channel areas near the mouth of the Columbia River (upstream of Buoy 10 area)
Treaty Indian	Ceremonial and Subsistence (C&S)	Salmon and steelhead	Project area

The winter/spring season extends from January 1 to June 15 (Table 1-2). During this management period fisheries in the mainstem Columbia River primarily target spring Chinook salmon stocks returning to the upper Columbia, the Willamette River, and lower Columbia River tributaries.

Table 1-2. Fisheries occurring in the project area during the winter/spring management period.

Fishery Management Period	Jurisdiction	Fishery Description	Target species	Location
Winter/Spring season (January 1 through June 15)	Non-Treaty	Commercial spring Chinook	Spring Chinook salmon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Commercial Fisheries in Select Areas	Select Area hatchery-origin Spring Chinook, Fall Chinook, and coho salmon	Off-channel areas near the mouth of the Columbia River (upstream of Buoy 10 area)
		Recreational spring Chinook – below BON	Spring Chinook salmon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Recreational spring Chinook – BON - HWY 395 Bridge	Spring Chinook salmon	Bonneville Dam upstream to Highway 395 Bridge near Pasco, WA
		Recreational spring Chinook – Snake River (WA waters Downstream of LGR)	Spring Chinook salmon	Mouth of the Snake River upstream to Lower Granite Dam
		Recreational spring Chinook – Ringold Area	Spring Chinook salmon	Highway 395 Bridge near Pasco, WA upstream to Priest Rapids Dam
		Wanapum tribal spring Chinook	Spring Chinook salmon	Mainstem Columbia River from Priest Rapids upstream to Wanapum Dam
	Treaty Indian	Ceremonial and Subsistence (C&S)	Spring Chinook salmon	Project area
		Winter Gillnet (Zone 6)	White Sturgeon	Bonneville Dam to McNary Dam
		Spring gillnet (Zone 6)	Spring Chinook salmon	Bonneville Dam to McNary Dam
		Platform and Hook&Line (Zone 6 + downstream of BON)	Spring Chinook salmon	Buoy 10 to McNary Dam
		Permit Gillnet	Spring Chinook salmon	Project area

		McNary - HWY 395 Bridge	Spring Chinook salmon	McNary Dam upstream to Highway 395 Bridge near Pasco, WA

The summer season extends from June 16 to July 31 (Table 1-3). During this management period, fisheries target primarily Upper Columbia River (UCR) summer Chinook salmon, which is not ESA-listed, and Upriver Columbia sockeye salmon, which contains ESA-listed Snake River salmon as a subcomponent. These stocks constrain the summer season fisheries. Summer season fisheries are constrained primarily by the available opportunity for UCR summer Chinook salmon which includes fish returning to the Okanogan and Wenatchee rivers, and by specific harvest limits for Snake River (SR) sockeye salmon.

Table 1-3. Fisheries occurring in the project area during the summer management period.

Fishery Management Period	**Jurisdiction**	**Fishery Description**	**Target species**	**Location**
Summer season (June 16 through July 31)	Non-Treaty	Recreational – mouth to McNary	Summer Chinook and sockeye salmon and summer steelhead	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Recreational – McNary to I-395	Summer Chinook and sockeye salmon and summer steelhead	McNary Dam upstream to Highway 395 Bridge near Pasco, WA
		Wanapum tribal summer Chinook	Summer Chinook salmon	Mainstem Columbia River from Priest Rapids upstream to Wanapum Dam
		Commercial salmon	Summer Chinook salmon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Select Area commercial	Select Area hatchery-origin Spring Chinook and Fall Chinook salmon	Off-channel areas near the mouth of the Columbia River (upstream of Buoy 10 area)
	Treaty Indian	Ceremonial and Subsistence (C&S)	Summer Chinook or sockeye salmon	Project area
		Commercial gillnet (Zone 6)	Summer Chinook and sockeye salmon	Bonneville Dam to McNary Dam
		Platform and Hook&Line (Zone 6 +	Summer Chinook and sockeye salmon	Buoy 10 to McNary Dam

		downstream of BON)		
		Permit Gillnet (Zone 6)	Summer Chinook salmon	Bonneville Dam to McNary Dam
		McNary - HWY 395 Bridge	Summer Chinook and sockeye salmon	McNary Dam upstream to Highway 395 Bridge near Pasco, WA

Fall season fisheries begin on August 1 and extend to the end of the calendar year (Table 1-4). During the fall management period fisheries target primarily harvestable hatchery and natural-origin fall Chinook and coho salmon, and steelhead. Fall season fisheries are constrained by specific ESA related harvest rate limits for listed SR fall Chinook salmon, and both A-run and B-run components of the listed UCR and SR steelhead DPSs (A-run and B-run steelhead are stock designations that refer to components of the summer run steelhead DPSs, that have particular life history characteristics).

Table 1-4.Fisheries occurring in the project area during the fall management period.

Fishery Management Period	**Jurisdiction**	**Fishery Description**	**Target species**	**Location**
Fall season August 1 through December 31	Non-Treaty	Commercial gillnet	fall Chinook and coho salmon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Commercial tangle net	coho salmon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Commercial seine	fall Chinook and coho salmon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
		Select Area commercial	Select Area hatchery-origin fall Chinook and coho salmon	Off-channel areas near the mouth of the Columbia River (upstream of Buoy 10 area)
		Recreational Buoy 10	fall Chinook and coho salmon	Mouth of the Columbia River (Buoy 10/Estuary area)
		Mainstem Recreational – below BON	fall Chinook, coho salmon, and summer steelhead	Upstream of Buoy 10 to Bonneville Dam

		Recreational – BON - HWY 395 Bridge	fall Chinook, coho salmon, and summer steelhead	Bonneville Dam upstream to Highway 395 Bridge near Pasco, WA
		Recreational Lower Snake River	fall Chinook salmon and summer steelhead	Mouth of the Snake River upstream to Lower Granite Dam
		Recreational steelhead (tributary dip-ins Klickitat, Deschutes, John Day)	fall Chinook, coho salmon, and summer steelhead	Klickitat River, WA Deshcutes River, OR John Day River, OR
	Treaty Indian	C&S fisheries	fall Chinook salmon or steelhead	Project area
		Commercial gillnet (Zone 6)	fall Chinook salmon	Bonneville Dam to McNary Dam
		Platform and Hook&Line (Zone 6 + downstream of BON)	fall Chinook salmon	Buoy 10 to McNary Dam
		Late Fall Commercial gill net	White Sturgeon	Bonneville Dam to McNary Dam
		Permit Gillnet	fall Chinook salmon	Project Area
		McNary - HWY 395 Bridge	fall Chinook and coho salmon	McNary Dam upstream to Highway 395 Bridge near Pasco, WA

1.3.1.1. Treaty Indian Fishery location and jurisdiction

Treaty Indian fisheries considered in the proposed new *US v Oregon* agreement would be managed subject to the regulation of the Columbia River Treaty Tribes. Each tribe regulates its fisheries using an array of management measures designed to achieve harvests that meets its needs, including voluntary management measures to reduce or eliminate harvest of stocks for conservation needs where the tribe deems it appropriate to do so. The fisheries are managed primarily by specifying the time and area for fishery openings, allowable gear types, and monitoring the fisheries to ensure that they achieve catch targets and stay within conservation constraints. Treaty Indian fisheries are generally managed allowing the retention of all fish caught (full retention), but under some circumstances the tribes may choose to implement species selective fisheries. Treaty Indian fisheries generally occur in the mainstem Columbia River between Bonneville Dam and McNary Dam, although some fishing does occur both above and below Bonneville Dam. Impacts associated with these fisheries are accounted for wherever they occur. Reservoirs of water behind each dam are designated separately (upstream of Bonneville Dam is

Bonneville Reservoir, Zone 6/61; upstream of The Dalles Dam is Lake Celilo, Zone 6/62; and, upstream of John Day Dam is Lake Umatilla, Zone 6/63). However, they are commonly known collectively as "Zone 6" (Figure 1-2).

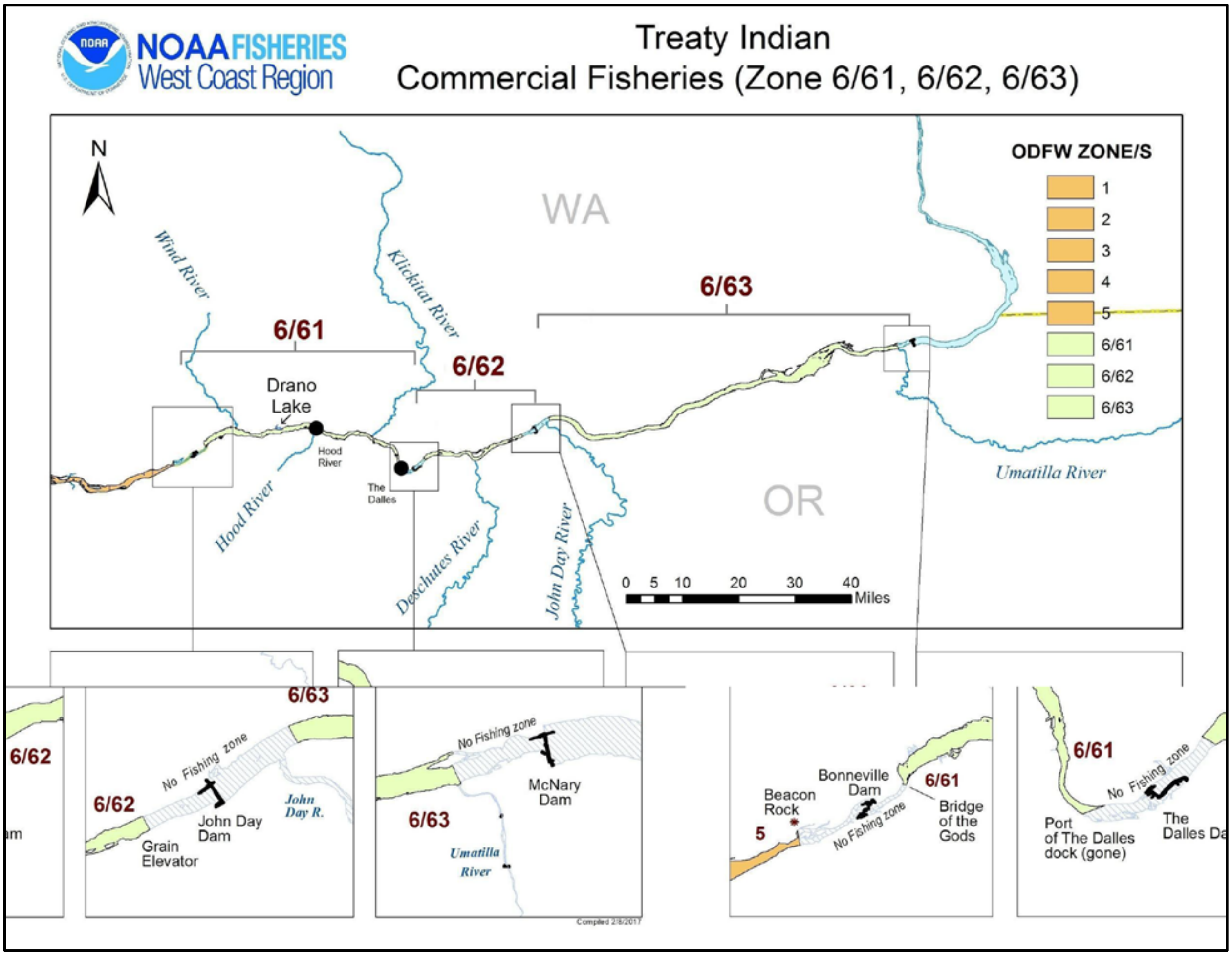

Figure 1.-2. Location of mainstem treaty Indian fisheries downstream of McNary Dam, collectively known as Zone 6.

Fisheries implemented in the reservoir upstream of McNary Dam, known as Lake Wallula, up to the mouth of the Snake River are managed under the same mainstem harvest limits as the rest of the mainstem.

The tribes also manage a set of tributary fisheries discussed in Subsection 1.3.1.2.5. These fisheries target spring Chinook, fall Chinook, and coho salmon, or steelhead depending on the status of the stocks returning to each tributary. These fisheries are discussed further in Subsection 1.3.1.2.5.

1.3.1.2. Non-Treaty Fishery location and jurisdiction

Non-treaty fisheries considered in a new *US v Oregon* agreement would be managed under the jurisdiction of the states of Oregon and Washington. Generally, these include mainstem Columbia River commercial and recreational salmonid fisheries between Buoy 10 at the mouth of the Columbia River and Bonneville Dam (commonly known as Zones 1-5, described in more detail below in Subsection 1.3.1.2.1), designated off channel Select Area Fishery Enhancement fisheries (SAFE fisheries, described in more detail below in Subsection 1.3.1.2.2), mainstem recreational fisheries between Bonneville Dam and McNary Dam (commonly known as Zone 6), recreational fisheries between McNary Dam and Highway 395 Bridge in Pasco, Washington, recreational and Wanapum tribal spring Chinook salmon fisheries from McNary Dam to Priest Rapids Dam, and recreational fisheries in the Snake River upstream to the Washington/Idaho state boundary. Catch also occurs in a set of "dip-in" fisheries. These dip-in fisheries are located at mouths and lower reaches of certain tributaries in Zone 6 where migrating fish may hold prior to continuing their upstream migration. The catch of upriver stocks in these dip-in fisheries are included in the catch accounting for upriver stocks. Dip-in fishing areas include Drano Lake at the mouth of the Little White Salmon River, the lower Wind River, the lower Deschutes River (upstream to Shearers Falls), and the John Day River Arm of John Day Reservoir.

1.3.1.3. Mainstem Non-Treaty Commercial Fisheries

Commercial fisheries below Bonneville Dam occur in the lower Columbia River in commercial catch Zones 1-5 (Figure 1-3). The majority of commercial harvest occurs in Zones 4 and 5 (Figure 1-3).

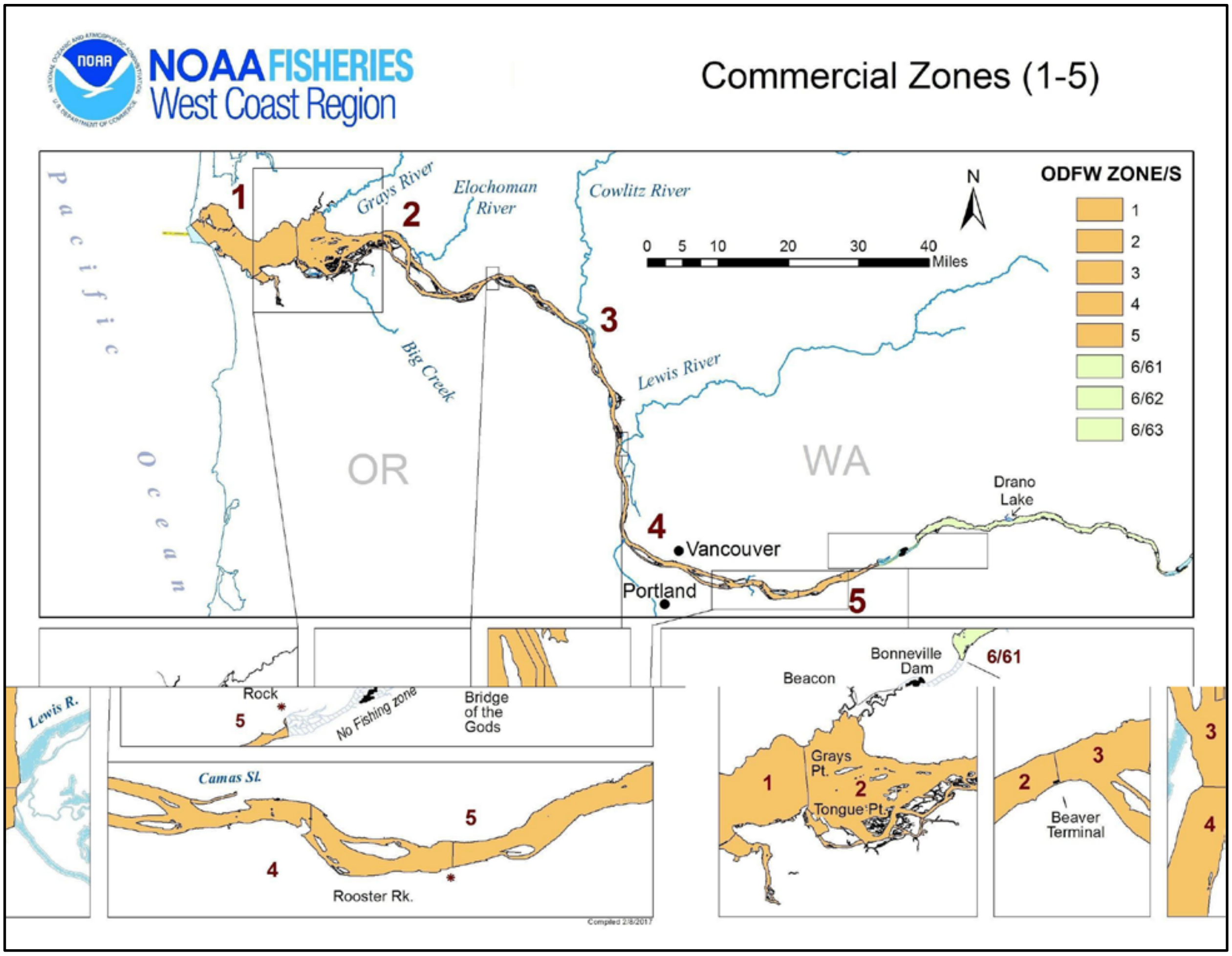

Figure 1-3. Commercial fishing zones downstream of Bonneville Dam.

1.3.1.3.1. Select Area Fisheries Evaluation (SAFE) Commercial Fisheries

SAFE fisheries occur in off-channel areas downstream of Zones 4 and 5 and target hatchery-reared and locally acclimated spring and fall Chinook and coho salmon. The SAFE area fisheries provide opportunity for expanded commercial and recreational fisheries directed at hatchery fish returning to their specific location.

SAFE areas are described as follows (see Figure 1-4):

- *Youngs Bay* is located in Oregon waters adjacent to the city of Astoria and inland of the Highway 101 Bridge. The fishing area extends from the Highway 101 Bridge upstream to Battle Creek Slough below the confluence of the Youngs and Klaskanine rivers.

- *Tongue Point Basin* is just east of the city of Astoria in Columbia River waters bounded by the Oregon shore and Mott and Lois islands. The fishing area includes the South Channel from the mouth of the John Day River upstream to its confluence with the Prairie Channel.
- *Blind Slough* is located near Brownsmead, Oregon and comprises the lower reaches of Gnat Creek. The fishing area also includes Knappa Slough from the mouth of Blind Slough to the east end of Minaker Island.
- *Deep River* is located on the Washington side in the waters of Grays Bay and Deep River.
- *Steamboat Slough* is located on the northern side of Price Island near the town of Skamokawa, Washington.

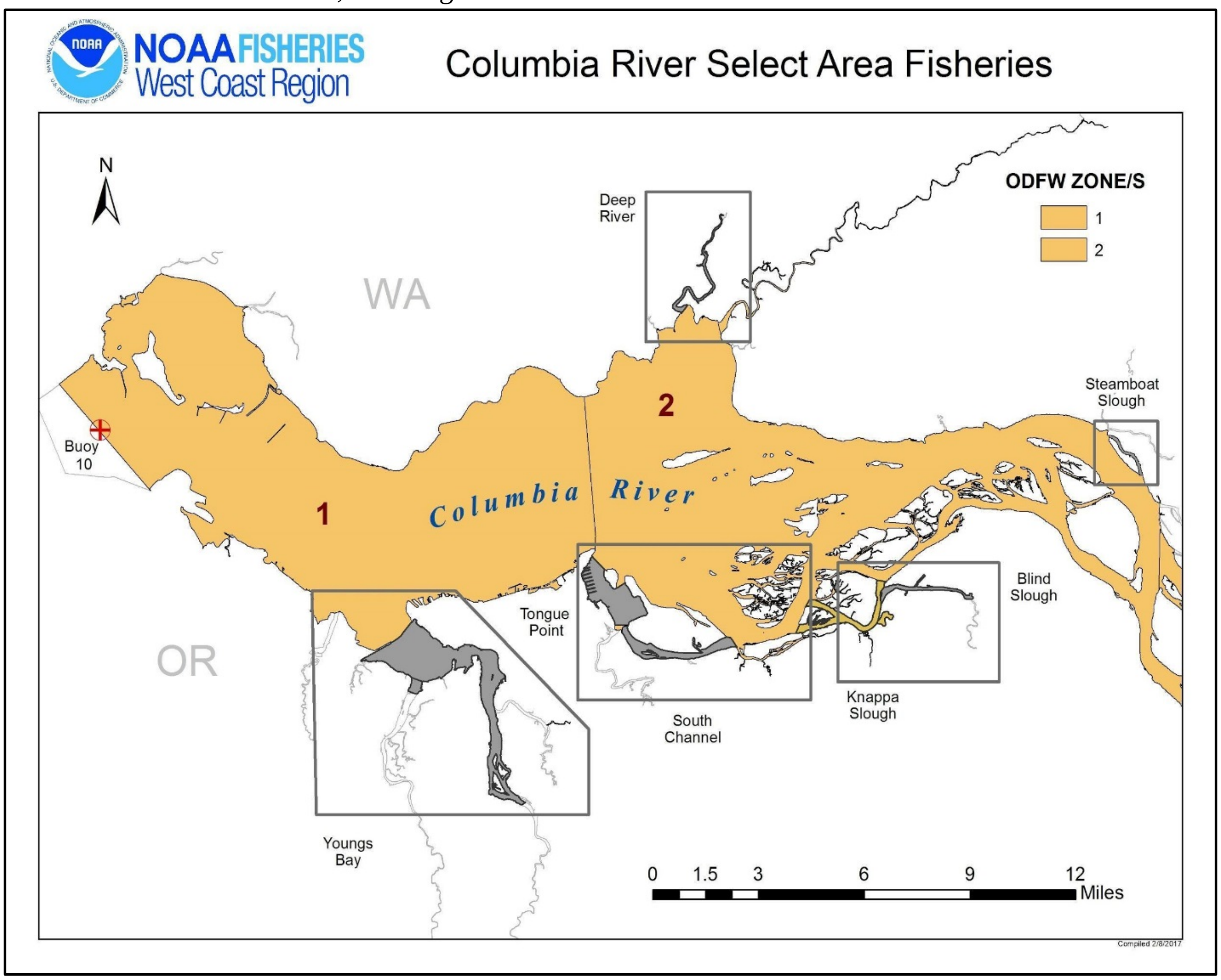

Figure 1-4. Location of SAFE fishery areas near the Columbia River mouth.

1.3.1.3.2. Columbia River Mainstem and Lower Snake River Recreational Non-treaty Fisheries

The states of Washington and Oregon individually set regulations concerning recreational fisheries in the mainstem Columbia River. These fisheries occur in the area from Buoy 10 upstream to Priest Rapids Dam, during the winter/spring, and fall management periods and upstream to Chief Joseph Dam in the summer management period. Fish targeted include hatchery spring Chinook, summer Chinook, fall Chinook, and hatchery coho salmon and hatchery steelhead. Sockeye salmon fishing may occur if run sizes permit.

1.3.1.3.3. Non-treaty Tribal Fisheries Included in Non-Treaty Catch

The Wanapum Tribe is a federally recognized tribe, but do not have treaty fishing rights, nor are they a party to *US v Oregon* or the new *US v Oregon* agreement. Catch from Wanapum fisheries are accounted for as part of the non-treaty fisheries under the *U.S. v. Oregon* Agreement. A Washington State statute (RCW 77.12.453; WAC 220-32-055) authorizes the Director of the Washington Department of Fish and Wildlife to issue permits for subsistence fishing to Wanapum tribal members. Seasons have been authorized annually to allow subsistence fishing for spring Chinook, sockeye, and fall Chinook salmon. The tribe is required to provide catch estimates, and Grant County Public Utility District (PUD) has historically acted as a liaison between the tribe and state fishery managers.

Additionally, the Colville Tribe is a federally recognized tribe that does not have treaty fishing rights and is not party to *US v Oregon* or the new *US v Oregon* agreement. The Colville Tribe fishes for spring Chinook, summer Chinook, sockeye salmon, and steelhead using a variety of gears in both mark selective and full retention fisheries. Their catch of UCR summer Chinook salmon are counted as part of the total allowed non-treaty UCR summer harvest under the *U.S. v. Oregon* Agreement.

1.3.1.3.4. Treaty Indian Tributary Fisheries

The *US v Oregon* agreement includes certain treaty Indian tributary fisheries (Table 1-5). Harvest policies and management frameworks for these fisheries that may be specific to that tributary population are not described in the agreement. These policies and management frameworks are instead developed cooperatively by the States and Indian tribal management entities with primary responsibility in each tributary. However, fish caught in these tributary fisheries are components of both the Harvest and Abundance Indicator stocks. For example spring Chinook salmon returning to the Klickitat River are part of the Upriver spring Chinook Harvest Indicator stock (see Subsection 4.1 for more). So, fish returning to the tributaries are part of the larger indicator stock aggregates. They are caught in mainstem fisheries, and subject to the stock specific harvest policies that constrain the mainstem fisheries. Salmon or steelhead caught during the operation of these tributary fisheries are included in calculations of total fishery abundance used in this EIS. But the additional catch on individual populations in tributary fisheries is managed for and accounted for separately as we describe above. For these reasons, the analysis does not include a detailed review of the effects of each alternative on the tributary fisheries.

Table 1-5. Treaty Indian tributary fisheries.

Jurisdiction	Fishery Description	Target species	Location
Treaty Indian	Little White Salmon/Drano Tributary	Spring Chinook, Fall Chinook, and coho salmon	Drano Lake, WA
	White Salmon River Tributary	Spring and Fall Chinook salmon	White Salmon River, WA
	Hood River Tributary	Spring Chinook salmon	Hood River, OR
	Klickitat River Tributary	Spring Chinook, Fall Chinook, and coho salmon	Klickitat River, WA
	Deschutes River Tributary	Spring and Fall Chinook salmon	Deschutes River, OR
	John Day River Tributary	Chinook	John Day River, OR
	Umatilla River Tributary	Spring Chinook, Fall Chinook, coho salmon, and steelhead	Umatilla River, OR
	Walla Walla River Tributary	Spring Chinook salmon	Walla Walla River, WA
	Yakima River Tributary	Spring, Summer, and Fall Chinook salmon	Yakima River, WA
	Icicle Creek Tributary	Spring Chinook salmon	Icicle Creek, WA

1.3.1.4. Fisheries with harvest policy set outside the agreement

Harvest policies for non-salmonid species and lower Columbia River stocks are not specified in the *US v Oregon* agreement and are discussed below.

1.3.1.4.1. Non-salmonid species

Harvest policies for non-salmonid species are not specified in the existing *US v Oregon* agreement, nor would they be in a new management agreement. These fisheries are managed independently by the states and tribes. However, these fisheries are referenced in the agreement because there is some potential for incidental take of ESA-listed salmonids in those non-salmonid fisheries. All salmon or steelhead caught in these fisheries as bycatch are included in harvest sharing and fishery management calculations. A list of these fisheries is provided at the end of this section in Table 1-6.

Table 1-6. Fisheries referenced in the agreement but not subject to the harvest policies contained in the agreement.

Jurisdiction	Fishery Description	Target species	Location
Non-Treaty	Recreational Walleye	Walleye	Mouth of Columbia (Buoy 10) upstream to Highway 395 Bridge near Pasco, WA
	Recreational sturgeon	White Sturgeon	Mouth of Columbia (Buoy 10) upstream to Highway 395 Bridge near Pasco, WA
	Commercial sturgeon	White Sturgeon	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
	Recreational Shad	American Shad	Mouth of Columbia (Buoy 10) upstream to Highway 395 Bridge near Pasco, WA
	Commercial shad gillnet	American Shad	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
	Commercial shad seine	American Shad	Mouth of Columbia (Buoy 10) upstream to Bonneville Dam
Treaty Indian	Zone 6	White Sturgeon, Walleye	Bonneville Dam to McNary Dam
	Shad Trap Fishery	American Shad	Bonneville Dam to McNary Dam
	Willamette River Lamprey	Lamprey	Willamette River Falls, OR

1.3.1.4.2. Lower Columbia River (LCR) Stocks

The *US v Oregon* agreement sets harvest policies and provides associated management frameworks for upriver salmon and steelhead stocks returning to areas above Bonneville Dam. The agreement does not set policies or provide management frameworks for the lower river stocks that return to areas and are harvested below Bonneville Dam. These include Lower Columbia River (LCR) Chinook, coho, chum salmon or steelhead, and Upper Willamette River spring Chinook or steelhead. Each of these lower river stocks are an ESA -listed species that is managed subject to the terms of applicable biological opinions and NEPA.

For example, LCR fall Chinook (a subcomponent of LCR Chinook) and LCR coho salmon are managed using frameworks that apply to all ocean and inriver fisheries below Bonneville Dam (NMFS 2012, 2015).

While the action considered in this EIS focuses on harvest policies used for the management of upriver stocks, and while the harvest of some of these upriver stocks occur in the lower Columbia River, they occur in the same geographical area as the harvest of the LCR stocks. This is from the mouth of the Columbia River up to Bonneville Dam. Fisheries in this area are more consistently constrained for harvesting LCR stocks but harvest policies for these stocks are not set in the *US v Oregon* agreement and therefore not analyzed in this EIS because they are separate actions and have been analyzed under separate NEPA and ESA authorizations. The impacts of catch of upriver stocks in these fisheries are included in this EIS.

1.3.2. Hatcheries

As mentioned in Subsection 1.1, Background, the existing 2008-2017 US v Oregon agreement incorporates hatchery programs that produce fish. The agreement describes the number of fish expected to be released, life-history of release, release location, hatchery rearing facilities, purpose of the program, entity(s) that manages the program(s), and the responsible funding entity(s).

As these fish are subsequently harvested in the fisheries that fall under the Agreement's management framework, the hatcheries are included in the Agreement both as a measure to formalize the parties' expectations for production of hatchery fish for harvest above Bonneville Dam and to identify hatchery programs that are important to the conservation of salmon or steelhead runs above Bonneville Dam.

The Final Environmental Impact Statement (FEIS) to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs (The Mitchell Act EIS; NMFS 2014), provides a detailed analysis of all of the hatchery programs in the Columbia River Basin, many of which are not included in the Agreement.

The Mitchell Act EIS was developed by NMFS to assess one major source of Federal support for hatchery operations, Mitchell Act grants, and to guide NMFS' policy with regard to distributing Mitchell Act hatchery funding throughout the Columbia River Basin. The Mitchell Act EIS process developed and analyzed six alternatives, including a preferred alternative, which offered a range of program operation objectives that focused on balancing:

- The biological and ecological risks of artificial production;
- The benefits of the conservation of ESA-listed salmon and steelhead; and
- The harvest benefits to Treaty and non-treaty fisheries in the Columbia River Basin and in ocean fisheries.

The hatcheries augment fisheries by increasing certain stock abundances, including both ESA-listed and non-listed stocks. Certain fisheries would be able to continue without hatchery production, because these fisheries target non-listed stocks of relatively healthy natural-origin fish. In the absence of hatcheries, these fisheries would operate at different levels based solely on the abundance of natural-origin fish.

NMFS finalized the EIS in September of 2014 and issued a Record of Decision (ROD), for the Mitchell Act EIS in January of 2017. (http://www.westcoast.fisheries.noaa.gov/hatcheries/mitchell_act/ma_programs.html).

While the purpose and need for the Mitchell Act EIS was different than for this action, the analysis of the effects of Columbia River basin hatchery production, including analysis of the relevant resources in this EIS, can substantially inform NMFS of the likely impacts of the hatchery production referenced in this management agreement. Thus, as described herein, the Mitchell Act EIS analysis of hatchery effects will be incorporated by reference into this DEIS.

1.4. Purpose of and Need for the Proposed Action

The purpose and need for the Proposed Action is three-fold: (1) to meet the Federal government's tribal treaty rights and trust and fiduciary responsibilities; (2) to support fishing opportunities to the states of Oregon, Washington, and Idaho; and (3) to work collaboratively with co-managers to protect and conserve ESA-listed and non-listed species.

The Services have an obligation to administer the provisions of the ESA and to protect ESA-listed species. They also have a Federal trust responsibility to the treaty Indian tribes, as well as a duty to support the fishing rights reserved in their treaties as defined by the Federal courts. Thus, the Services seek to harmonize the effects of fishery programs with the provision for tribal harvest. Because of the Federal government's trust responsibility to the tribes, the Services are committed to considering the tribal co-managers' judgment and expertise regarding conservation of trust resources.

1.5. Scoping: Notice of Intent

Public scoping was officially initiated with the Notice of Intent to prepare a draft EIS (NOI) which was published in the Federal Register on July 1, 2016 (81 Fed. Reg. 43187). This NOI announced a 30-day public comment period (July 1, 2016 to August 1, 2016) to gather information on the scope of the issues and the range of alternatives to be analyzed in the EIS.

1.5.1. Written Comments

Fifteen comment letters and emails were received during the public scoping period announced in the NOI, including four letters from governmental agencies, seven letters from non-governmental organizations and businesses, and four letters and emails from individual citizens. The letters all originated in Washington and Oregon, except for one from Idaho and one from Montana.

Issues raised in public comments responding to the NOI fell into four main categories:

- Concern for ESA-listed species and including recovery plans in the analysis
- Incorporation of hatchery and hydroelectric impacts in the analysis
- Ecosystem impacts such as marine derived nutrients and climate change
- Environmental justice, economics, and tribal rights

1.6. Other Applicable Laws, Plans, and Policies

This EIS is being prepared under NEPA. However, there are other laws, plans, and policies that are applicable to the Proposed Action. These are described below.

1.6.1. *US v Oregon*

In 1855, representatives of the United States government negotiated separate treaties with each of the Columbia River Treaty Tribes. During treaty negotiations, the tribes sought to retain the right to continue their fishing practices as a primary objective. Each treaty contained a substantially identical provision reserving to the tribes the right take "fish at all usual and accustomed places in common with citizens of the United States."

By the late 1800s, state officials sought to regulate tribal members fishing at their usual and accustomed fishing places. Litigation regarding the validity of state regulation occurred in both Federal and state courts throughout much of the early to mid-twentieth century. In 1969, a Federal district court ruled in *Sohappy v. Smith/United States v. Oregon* that the Columbia River Treaty Tribes had an absolute right to an equitable share of the upriver Columbia River fish runs and issued a declaratory judgement outlining the parameters of state regulation. Since that time, the United States District Court for the District of Oregon has retained continuing jurisdiction.

The Federal District Court, as upheld by the Ninth Circuit Court of Appeals, further defined the "equitable share" as the right to take up to 50 percent of the harvestable fish that are destined to pass through the tribes' usual and accustomed fishing grounds. The treaty right is subject to regulation by the states only to the extent necessary for conservation, using the least restrictive means and without discriminating against the Indians. *See Antoine v. Washington*, 420 U.S. 194, 207 (1975).

Over the years, the Federal District Court has urged the state and tribal parties to *US v Oregon* to make agreements on allocation and management of upriver salmon runs. The parties have reached several agreements to meet this goal. In reaching agreement, the parties have used the 50 percent treaty share as a measure of the Treaty right for a fair allocation of fish. This has served as a starting point for negotiating allocation agreements. The parties can agree, however, to deviations from the 50 percent division in order to accommodate complex management concerns in the Columbia River. See, for example, United States v. Oregon, 718 F.2d 299, 302 (9th Cir. 1983); United States v. Oregon, 913 F.2d 576, 585 (9th Cir. 1990).

In 1977, the parties developed a management plan which was approved by the court that set conservation goals for each fish species, established fishing regulations and provided for the establishment of future management techniques. In 1988, the Columbia River Fish Management Plan (CRFMP) was agreed to by the parties and adopted by District Court Order as a partial settlement of *US v Oregon*. The court noted that the CRFMP was a delicate, but effective structure for allocating and planning harvest activities. The purpose of the CRFMP, after 20 years of legal tests and negotiations, as defined upon adoption by the court in 1988 and agreed to by the Parties, was to:

> "provide a framework within which the Parties may exercise their sovereign powers in a coordinated and systematic manner in order to protect, rebuild, and enhance upper

> Columbia River fish runs while providing harvests for both treaty Indian and non-Indian fisheries.
>
> In order to achieve the goals of the CRFMP, the Parties intend to use habitat protection authorities, enhancement efforts, artificial production techniques, and harvest management to ensure that Columbia River fish runs continue to provide a broad range of benefits in perpetuity." (*US v Oregon* 2008)

Fisheries in the Columbia River Basin were managed subject to provisions of the CRFMP from 1988 through 1998. Following 1998, fisheries were managed subject to provisions of a series of short term agreements among the Parties, the durations of which ranged from several months, covering a single fishing season, to five years.

In a 1995 court settlement, the Parties agreed to discuss the possibility of amending the CRFMP and, in 1996, negotiated three-year (1996 through 1998) management agreements for upper Columbia fall Chinook and upper Columbia spring Chinook, summer Chinook, and sockeye salmon. These management agreements formed the basis for subsequent agreements, and included escapement goals, production measures and harvest allocations. Annual agreements were implemented for fall Chinook and coho salmon, and summer steelhead during the period 1999 to 2003. A 5-year agreement for harvest was reached for spring Chinook, summer Chinook, and sockeye salmon for the period 2001 through 2005.

In 2005, the Parties negotiated a 3-year (2005 through 2007) Interim Management Agreement (2005 Agreement). Unlike some previous agreements, the 2005 Agreement was a year-long agreement, applying to winter, spring, summer, and fall season fisheries. The 2005 Agreement and associated harvest provisions were the result of ongoing negotiations in *US v Oregon* and the evolution and development of fishery management in response to ESA-listings of Pacific salmon species. The 2005 Agreement expanded the use of abundance-based harvest schedules and served as the model for the current 2008 Agreement. Negotiations for these agreements have been under the continuous supervision of the Federal court with jurisdiction over *US v Oregon*.

Management provision of the current agreement, implemented in 2008, are, in most respects, similar to those in the 2005 Agreement, and further expanded the application of abundance-based harvest rate schedules to fall Chinook salmon and steelhead fisheries. The use of abundance-based harvest rate schedules allows harvest rates to rise and fall in response to overall stock status, which the fixed harvest rate that was previously used for managing these stocks does not.

1.6.2. Endangered Species Act (ESA)

Section 7(a)(2) of the ESA requires that Federal agencies ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat. In addition, Section 7(a)(3) of the ESA requires that Federal agencies consult with the Services on any action authorized, funded, or carried out by such agency that may affect a species listed under the ESA or their designated critical habitat. When a consultation results in a biological opinion that concludes that the action is likely to affect an ESA-listed species, but not cause jeopardy (i.e., appreciably reduce the likelihood of survival and recovery of ESA-listed species), the Services issue an incidental take statement that details the amount and extent of anticipated incidental take (e.g., death, injury, harm, or harassment) that will be caused by the Proposed Action and any additional terms or conditions that must be met. Incidental Take Statements provide an exemption from ESA Section 9 prohibitions on such take.

Columbia River fisheries likely to be implemented as a result of reaching a new management agreement would affect fish species that are listed under the ESA. The Parties recognize that the Services have an obligation to consult under Section 7 of the ESA on the fishery proposals that are to be contained in the new management agreement prior to signing. Therefore, NMFS, which is the lead agency responsible for administering the ESA as it relates to anadromous fish species (e.g., ESA-listed salmon, steelhead, green sturgeon, and eulachon) and marine mammals, and FWS, which is the lead agency responsible for administering the ESA as it relates to non-anadromous fish species, terrestrial species, birds, and plants, will use the information developed in this EIS to inform their consultations. The Services will be able to sign the new management agreement after completing their ESA analyses.

The Mitchell Act EIS, incorporated herein by reference, provides additional information on the Services' roles under the ESA (NMFS 2014) (Section 1.1.2).

1.6.2.1. Definition of "species" under the ESA

The ESA allows listing of distinct population segments (DPS) of vertebrates, as well as named species and subspecies. However, the Act provides no specific guidance for determining what constitutes a DPS, and the resulting ambiguity led to the use of a variety of approaches for considering vertebrate populations. To clarify the issue for Pacific salmon, NMFS published a policy describing how the agency would apply the definition of "species" in the ESA to anadromous salmonid species (56 Fed. Reg. 58612, November 20, 1991). NMFS' policy stipulated that a salmon population (or group of populations) would be considered "distinct" for purposes of the ESA if it represents an evolutionarily significant unit (ESU) of the biological species. An ESU is defined as a population that 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species (Waples 1991).

In 1996, the Services adopted a joint policy for recognizing DPS under the ESA (61 Fed. Reg. 4722, February 7, 1996). This policy recognized NMFS' use of ESU as consistent with the intent of the ESA; therefore, for Pacific salmon (i.e., Chinook, chum, coho, sockeye, and pink salmon), the term ESU remains in use. For other species, including steelhead, the term DPS is used, with the following two criteria: 1) the group must be discrete from other populations, i.e., markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors, and 2) it must be significant to its taxon. As a result of this policy, the reader will see both terms, ESU and DPS, used in this EIS, as appropriate.

1.6.3. Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361) as amended, establishes a national policy designated to protect and conserve wild marine mammals and their habitats. This policy was established so as not to diminish such species or populations beyond the point at which they cease to be a significant functioning element in the ecosystem, nor to diminish such species below their optimum sustainable population. All marine mammals are protected under the MMPA.

The MMPA prohibits, with certain exceptions, the take of marine mammals in United States waters and by United States citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. The term "take," as defined by the MMPA, means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA further defines harassment as "any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

NMFS is responsible for reviewing Federal actions for compliance with the MMPA. Fisheries can indirectly affect marine mammals by altering the availability of prey, such as salmon and steelhead.

1.6.4. Executive Order 12898

The objectives of Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-income Populations*, include developing Federal agency implementation strategies, identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process.

1.6.5. Secretarial Order 3206

Secretarial Order 3206 (*American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA*) issued by the Secretaries of the Departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the Departments when actions taken under the ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the Order. The Secretarial Order acknowledges the trust responsibility and treaty obligations of the United States toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the Order, the Services:

> will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation (Secretarial Order 3206).

In the event that the Services determine that conservation restrictions directed at a tribal activity are necessary to protect ESA-listed species, specifically where the activity could result in incidental take under the ESA, the Services shall provide the affected tribe(s) written notice, including an analysis and determination that (i) the restriction is reasonable and necessary for conservation of the species; (ii) the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities; (iii) the measure is the least restrictive alternative available to achieve the required conservation purpose; (iv) the restriction does not discriminate against Indian activities, either as stated or applied; and (v) voluntary tribal measures are not adequate to achieve the necessary conservation purpose.

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Section 5, Principle 1).
- Recognize that Indian lands are not subject to the same controls as Federal public lands (Section 5, Principle 2).
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Section 5, Principle 3).
- Be sensitive to Indian culture, religion, and spirituality (Section 5, Principle 4).

Additionally, the U.S. Department of Commerce has issued a Departmental Administrative Order (DAO) addressing Consultation and Coordination with Indian Tribal Governments (DAO 218-8, April 26, 2012; http://www.osec.doc.gov/opog/dmp/daos/dao218_8.html), which implements relevant Executive Orders, Presidential Memoranda, and Office of Management and Budget Guidance. The DAO describes actions to be "followed by all Department of Commerce operating units … and outlines the principles governing Departmental interactions with Indian tribal governments." The DAO affirms that the "Department works with Tribes on a government-to-government basis to address issues concerning … tribal trust resources, tribal treaty, and other rights."

1.6.6. The Federal Trust Responsibility

The United States government has a trust or special relationship with Indian tribes. The unique and distinctive political relationship between the United States and Indian Tribes is defined by statutes, executive orders, judicial decisions, and agreements, and differentiates tribes from other entities that deal with, or are affected by the Federal government. Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments,* states that the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes.

The relationship has been compared to one existing under common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources of the United States as the trust corpus (Newton et al. 2005). The trust responsibility has been interpreted to require Federal agencies to carry out their activities in a manner that is protective of Indian treaty rights. This policy is also reflected in the March 30, 1995, document, *Department of Commerce –American Indian and Alaska Native Policy* (U. S. Department of Commerce 1995).

1.6.7. Recovery Plans for Columbia River Salmon and Steelhead

Federal recovery plans have been developed for the following ESA-listed Columbia River salmon and steelhead species:

- Upper Columbia Spring Chinook salmon and Steelhead (72 Fed. Reg. 57303, October 9, 2007)
- Snake River Sockeye salmon (80 Fed. Reg. 3265, June 8, 2015)
- Snake River fall Chinook salmon (80 Fed. Reg. 67386, November 2, 2015, proposed plan)
- Snake River spring/summer Chinook salmon and Steelhead (81 Fed. Reg. 74770, October 27, 2016, proposed plan)
- Middle Columbia River steelhead (74 Fed. Reg. 50165, September 30, 2009)
- Upper Willamette River Chinook salmon and Steelhead (76 Fed. Reg. 52317, August 22, 2011)
- Lower Columbia River Lower Columbia River Chinook salmon, coho salmon, steelhead, and Columbia River chum salmon (78 Fed. Reg. 41911, July 12, 2013)

Broad partnerships of Federal, state, local, and tribal governments and community organizations collaborated in the development of these recovery plans. The comprehensive recovery plans include conservation goals and proposed habitat, hatchery, and harvest actions needed to achieve the conservation goals for each watershed within the geographic boundaries listed species.

1.7. Other Permits and Consultations

This action will require the following permits or consultations:

- Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

1.8. Related Documents Incorporated by Reference

This EIS should be reviewed in conjunction with the current *US v Oregon* Management Agreement for 2008 through 2017 and the associated Biological Opinion, which contain more detailed information and explanations of fishery programs affecting Columbia River resources. Links to online sources of information used in the DEIS are active at the time of publication; however, NMFS cannot guarantee that they will remain active over time.

Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs (NMFS 2014). The Mitchell Act EIS provides a comprehensive review and analysis of the effects of all Columbia River Basin hatchery programs throughout the basin. This document is publicly available via this link: http://www.westcoast.fisheries.noaa.gov/publications/nepa/3_state_nepa_documents.html

2008-2017 United States v. Oregon Management Agreement (*US v Oregon* 2008).This is the existing agreement; it provides a baseline for describing and analyzing the alternatives being analyzed in this EIS. This document is publicly available via this link: http://www.westcoast.fisheries.noaa.gov/fisheries/salmon_steelhead/united_states_v_oregon.html

Section 2

2. ALTERNATIVES

This chapter describes harvest policy alternatives that were analyzed in detail as well as alternatives that were considered but eliminated from detailed analysis.

At the outset it is useful to distinguish harvest policy from harvest management measures or strategies as they are used in this EIS. *Harvest policies* provide a framework designed to inform how to achieve the appropriate balance between harvest and conservation objectives. *Harvest* provides the benefits of catch including those related to treaty rights; *conservation* seeks to keep healthy stocks healthy and rebuild weak stocks so that all are sustained and can provide for the ongoing benefits of harvest. *Harvest management measures* are the actions or tactics implemented to harvest consistent with the overarching policy selected.

Harvest policies help set the appropriate level of catch consistent with conservation mandates of the *US v Oregon* case law and for ESA-listed species. Harvest management measures or strategies are the tools used to implement a policy. Once a harvest policy is set, there may be important allocation decisions about who will catch the fish. Where treaty Indian fisheries are involved, for example, the harvest has to be allocated in a way that assures that treaty rights are met. For treaty Indian and non-treaty fisheries there are often subsequent decisions about gear type, fishery location, and times. These include a broad array of measures and strategies used to implement a harvest policy. For example, the non-treaty catch is often allocated between recreational and commercial fishing interests. Commercial fisheries may use gillnets, purse seines, beach seines, traps or other gears. Recreational fisheries may operate from shore or boat and allow the retention of all fish or be selective in some way requiring the release of certain species or unmarked natural-origin fish. The tribes make their own decisions about commercial and C&S fisheries, the gear types to use in each, and when and where to open fisheries. The details of these allocation decisions and underlying harvest management measures and strategies provide an infinite array of choices. But they are all choices designed to describe how fisheries will be implemented consistent within boundaries the harvest policy sets for levels of allowable catch. This is fundamental to this analysis. These conservation boundaries, defined through a chosen harvest policy, provide the framework to determine effects to stocks of fish, which then allows us to analyze effects to the environment in general.

A harvest policy choice may lead to zero available harvest on certain stocks of fish, and therefore the infinite array of choices for underlying management measures and strategies to implement fisheries (e.g., commercial or recreational choices, gear type choices, fishery location choices, limiting effort to high or low participation levels, etc.) are entirely immaterial under circumstances where harvest is zero. Therefore, in this EIS we focus on the harvest policy alternatives and their effects on the environment.

The choice between policies depends on the circumstances for each fishery application. Some policies depend on the availability of specific kinds of information. For example, abundance based management requires the availability of pre-season or in season abundance estimates; an effort based policy does not. Policy choices for a fishery directed at a single stock near the spawning grounds may be different than a fishery directed at a mix of many stocks in the ocean or mainstem Columbia River. Harvest policies for healthy and abundant stocks may be different than for a depressed stock that needs rebuilding. The purpose of this EIS is to analyze various harvest policy alternatives that could provide a coordinated and systematic framework among the sovereign parties to the *US v Oregon* case, and to guide more specific harvest measures in the management agreement.

2.1. Alternatives Analyzed in Detail

As presented in Section 1.3.1 and detailed in Section 4.1, harvest policies are established for each Harvest Indicator Stock. Harvest Indicator Stocks are called “Management Units” in the *US v Oregon* management agreement and tend to be aggregates of fish runs larger than the ESA-listed “units” (ESU or DPS). Abundance Indicator Stocks are equivalent to the ESA-listed “units” (DPS or ESU) affected by implementing fisheries that adhere to harvest policies specified in the agreement. Harvest Indicator Stocks may include one or more Abundance Indicator Stocks. The numbers presented in the sections that follow are based on actual observed rates of fishing and should be viewed as approximations and examples of an approach. They are not recommendations for the specific biological criteria that should be used for implementing harvest policies and the related management frameworks. Nonetheless, they are used here to evaluate the relative effects of each alternative.

Where forecasts of fish abundance are necessary to implement an alternative, the Parties rely on the Technical Advisory Committee (TAC) established by the *US v Oregon* agreement, to develop, analyze, and review data pertinent to the harvest management framework (e.g., annual forecasts, abundance estimates, catch estimates, etc.). Members are required to be qualified fisheries scientists familiar with harvest management of Columbia River fish runs.

The *US v Oregon* agreement also establishes a regulatory coordination committee with a designee from each party to provide enforcement regulations. The Parties agree that the Columbia River Treaty Tribes bear primary responsibility for enforcing agreed-upon regulations applicable to Treaty fisheries subject to the agreement and that the States bear the similar responsibility for the non-treaty fisheries.

2.1.1. Alternative 1—Extension of current agreement

Under this alternative, the Federal parties would sign a new agreement, wherein the policy is to continue to manage fisheries in the Columbia River for the next 10 years consistent with the terms of the 2008–2017 agreement, and the NMFS and FWS would issue an ITS exempting take of listed species associated with implementing the terms of a new agreement pursuant to Section 7 of the ESA. As described in the previous section, the choice of harvest policies depend on the stock and fishery. Also, as described in Section 1.6.1 the harvest policies in the 2008-2017 agreement have been under consideration and refinement since 1988. We anticipate a new agreement would use a blend of harvest policies, including applications of abundance-based management, escapement-based management, and harvest rate management. While these management approaches are summarized in this section, Sections 2.1.2 through 2.1.4 and Section 4.1 provide additional background and examples.

This blend of harvest policies under this alternative applies to each harvest indicator stock as summarized below:

- Upriver Spring Chinook salmon – The natural-origin Upriver spring/summer Chinook and natural-origin UCR spring Chinook salmon abundance indicators are both part of the Upriver Spring Chinook salmon harvest indicator. Abundance-based management for Upriver Spring Chinook salmon ensures fisheries are restricted when fish returns are low, but offers greater harvest levels when abundance is high. Upriver Fall Chinook salmon and B-Run Steelhead are also managed under an abundance-based framework.

- Upriver summer Chinook salmon – As this harvest indicator stock has no ESA-listed subcomponents, separate forecasts for the component populations are not used. Within this context, therefore, an aggregate escapement goal is most appropriate for this stock. Coupled with the escapement goal is an abundance based framework for harvest sharing purposes.
- Upriver Sockeye salmon – The abundance indicator is Snake River Sockeye, an ESA-listed ESU. Snake River Sockeye salmon is a subcomponent of the Upriver Sockeye salmon harvest indicator. Regardless of any increases in Upriver Sockeye salmon, Snake River Sockeye salmon require a strong conservation focus. Therefore, a fixed harvest rate policy is more appropriate for this stock until the abundance levels for Snake River sockeye salmon increase.

These policies recognize that upriver stocks have varying conservation requirements, with some providing abundant opportunity for harvest, and others requiring more protection from harvest encounters at this time. The resulting fisheries are implemented using a complex set of harvest measures and near continuous pre-season, in-season, and postseason monitoring and analysis to ensure that the goals of this policy are being achieved.

2.1.2. Alternative 2—Abundance-based Management

Under this alternative, the Federal parties would sign a new agreement with the other parties, and salmonid fisheries in the Columbia River affecting upriver stocks would all be managed using abundance-based management frameworks, and the NMFS and FWS would issue an ITS exempting take of listed species associated with implementing the terms of a new agreement pursuant to Section 7 of the ESA. Abundance based management establishes harvest levels based on the status of the fish stock(s) affected by the fishery. The purpose is to provide more protection when the abundance of a given stock is low and the conservation need greatest, and more harvest opportunity when abundance is high. This is done by setting catch limit tiers, for example, allowing a high catch tier when stock abundance is high, and a mid-level catch tier when stock abundance is average, and a low catch limit tier when stock abundance is low. This model provides a management framework that recognizes the inherent year-to-year variability of salmonid stocks. Abundance based management plans provide the basis for managing many fisheries. For example, ocean fisheries for Chinook salmon off Alaska and Canada are managed year-to-year under the Pacific Salmon Treaty using measures of the overall abundance of Chinook salmon in each fishery. This type of policy tends not to be very aggressive towards a stock as it requires that a large number of fish return before allowing a large level of harvest to occur. In the current *US v Oregon* agreement, abundance-based frameworks are used to manage Upriver spring Chinook salmon, Upriver fall Chinook salmon, and B-run steelhead. Abundance-based management requires the availability of preseason forecasts and/or updated in-season run size information. Catch needs to be actively monitored in-season so that fisheries can be adjusted to meet the year-specific harvest rate target. This alternative would be responsive to inter-annual variations in the abundance of Columbia River salmonid stocks.

2.1.3. Alternative 3—Fixed Harvest Rate

Under this alternative, the Federal parties would sign a new agreement with the other parties, and salmonid fisheries in the Columbia River affecting upriver stocks would be managed under fixed harvest rate management frameworks that would apply a fixed harvest rate to each fishery regardless of abundance, and the NMFS and FWS would issue an ITS exempting take of listed species associated with implementing the terms of a new agreement pursuant to Section 7 of the ESA. Harvest rate refers to the ratio of fishery related mortality for a group of fish over its abundance in a defined period of time. For example, if a fixed harvest rate was set at 25 percent and a stock's estimated total run size in a given year consisted of 100,000 fish, then up to 25,000 could be harvested in that year. In the following year, if the stock's run size went to 200,000 fish then up to 50,000 could be harvested. Similarly, if the total run size fell to 50,000, then only 12,500 would be available.

Fixed harvest rate policies require the availability of preseason forecasts and/or updated in-season run size information. Catch needs to be actively monitored in-season so that fisheries can be adjusted to meet the fixed harvest rate target. This approach sometimes used for managing weak stocks by setting a low fixed harvest rate designed to protect the stock while providing access to more abundant co-mingled healthy stocks. Fixed harvest rate policies are also used sometimes to manage healthy stocks when there is a good understanding about the productivity of the stock and the rate of harvest that can be sustained over the long term. The allowable catch under a fixed harvest rate policy will vary from year-to-year with abundance, but tends to be more stable than under either the abundance-based or escapement-based harvest policy alternatives.

Under the current agreement, Upriver sockeye salmon is an example of a weak stock managed using what is in effect a fixed harvest rate of 8 percent.

2.1.4. Alternative 4—Escapement-based Management

Under this alternative, the Federal parties would sign a new agreement with the other parties, and salmonid fisheries in the Columbia River affecting upriver stocks would be managed under escapement-based management frameworks, and the NMFS and FWS would issue an ITS exempting take of listed species associated with implementing the terms of a new agreement pursuant to Section 7 of the ESA. Escapement refers to the number of fish surviving (escaping from) a given fishery at the end of the fishing season and reaching a specified location where the fish can be enumerated. In some applications, escapement goals are population specific and designed to provide a specific number of fish to the spawning ground. If fisheries are going to be actively managed for an escapement goal, it requires a population specific forecast and the ability to track the catch through the fisheries that affect the population. In other cases, escapement goals are stock specific where the stocks are an aggregate of two or more populations. Stock based management goals are often used when we don't have separate forecasts for the component populations and can track the stock, but not the populations, through the fisheries. B-run steelhead and upriver spring Chinook salmon are stocks in this context.

Escapement-based management is responsive to inter-annual variations in salmon abundance and allows fishery managers to set appropriate spawning goals for conservation. Escapement-based management can result in more year-to-year variability in harvest opportunity. The resulting harvest rates can be quite high when the run size is large relative to an escapement goal. Conversely, when the run size is low relative to an escapement goal, harvest opportunity can be very low or even reduced to zero. In cases where the projected run size is below the escapement goal, escapement goal harvest policies are sometimes coupled with a *de minimis* level of harvest opportunity to meet minimal needs for tribal fisheries and limited access to other harvestable stocks.

2.1.5. Alternative 5—Voluntary Fishery curtailment

Under this alternative, the Federal parties would sign a management agreement in which the sovereign parties voluntarily curtail harvest activities for an extended period of time, and the NMFS and FWS would issue an ITS exempting take of listed species associated with implementing the terms of a new agreement pursuant to Section 7 of the ESA. This alternative may include some very limited treaty fishing opportunity to meet base ceremonial needs of the tribes. The circumstances in which the parties may adopt a voluntary extreme harvest curtailment policy would likely be where they determine that in the context of other mortality factors acting on the stocks across their life-cycle (e.g. prior fishery interceptions; critically low emigration; extreme environmental impacts in ocean or spawning/rearing areas), that adding adult harvest mortality would further reduce escapement levels to the point that continued viability of upriver stocks is at imminent risk. This alternative expresses a conservation policy that even harvest actions with measures designed to target stocks with harvestable surplus must be curtailed to avoid unintentional encounters with critically weak stocks that may be interspersed with strong stocks. This voluntary extreme conservation harvest curtailment alternative does not meet the purpose and need for the action insofar as it does not provide for meaningful tribal harvest as guaranteed by Treaty and it provides no opportunity for non-treaty harvest.

NEPA requires that an EIS provide a benchmark that enables decision makers to compare the magnitude of environmental effects of the alternatives. This benchmark is often found in the “no action” alternative. For this EIS, “Alternative 5 – Voluntary Fishery curtailment” provides this benchmark in that it represents the alternative with the lowest fishing harvest, even though, in this case, it does not meet the purpose and need for the Proposed Action as described in Subsection 1.4.

2.1.6. Alternative 6—No Action—Uncoordinated Harvest

Under this alternative, the existing agreement would expire without the Services signing a new agreement with the other parties. The Services, in this case, would not issue an ITS. This could occur if the state and tribal parties failed to reach a new agreement to coordinate their harvest activities in which the Services could join. Alternatively, this alternative may be adopted if the state and tribal parties did reach an agreement, but the Services did not concur and were unable to sign. In either case, it is uncertain what would transpire. Under this alternative, it is anticipated that the state and tribal parties would implement harvest independently according to their own uncoordinated interpretation of the prior rulings of the District Court of Oregon in *US v Oregon* since 1969, and the interpretation of their own legal authorities and harvest objectives for their constituent harvest groups. The result could be uncoordinated harvest as the sovereign managers implement fisheries absent a broad underlying agreement.

As noted above, the Services may choose not to sign if the state and tribal parties do reach a management agreement but it does not meet the requirements of Federal parties to act in accord with other legal requirements such as the ESA or the Federal trust responsibility.

Under the most foreseeable circumstances under which the Federal parties would not sign a new management agreement, actual harvest is tremendously uncertain. Theoretically, state and or tribal parties may decide that in the absence of support of the Federal parties, they would choose to curtail harvest entirely. See Alternative 5 for the analysis of that result. It is more likely, however, that the parties could each choose to implement harvest activities as they interpret the District Court's rulings in *US v Oregon*, with the result that the level of harvest would be very high, constrained primarily by the fishing effort that could be deployed. In this latter case it is reasonable to expect that the harvest rate on each upriver stock would meet and likely exceed the highest historic harvest rates observed.

Our assumption under this alternative is that the state and tribal parties would revert to the escapement-based management policies that were once implemented in the past. For purposes of analysis of this no action-uncoordinated harvest alternative, and to contrast the likely result from the other alternatives, it is assumed that actual harvest rates would be similar to the annual highest harvest rates observed in Alternative 4. Every fish that exceeds a static number of fish set as the escapement goal will be considered harvestable. This approach does not associate harvest with annual run size variations that stocks may exhibit. For example, an escapement goal of 3,000 fish allows for a harvest of 97,000 fish on a run size of 100,000 or a harvest of 27,000 fish on a run size of 30,000. No additional fish escape fisheries when run sizes fluctuate; instead harvest is maximized on the most abundant stock aggregate.

NEPA requires a 'No Action Alternative' in the full range of analyzed alternatives even though, in this case, it does not meet the purpose and need for the Proposed Action as described in Section 1.4.

2.1.7. Alternatives Considered But Not Analyzed in Detail

The following additional alternatives were identified during scoping and were considered, but not analyzed in detail.

Fixed Effort Management Alternative

Under this alternative, the Services would sign a new agreement with the other parties, and salmonid fisheries in the Columbia River that affect upriver stocks would be managed under fixed effort management frameworks. Fixed effort management would establish a constant metric of effort for each fishery. This could be number of fishing days, number of angler days, fishing hours for a net fishery, etc. Fixed effort management is useful when there is no preseason forecast of abundance. A fixed effort fishery is relatively simple to implement requiring only that effort and catch be measured. This alternative would not be actively responsive to changes in abundance. For fisheries managed under the *US v Oregon* agreement, there are preseason forecasts for all of the stocks of interest. The fixed effort strategy is designed to catch a constant fraction of the return and is therefore an indirect way of achieving a fixed harvest rate. The effects are therefore likely to be very similar to the fixed harvest rate alternative. For these reasons, this alternative was not analyzed in further detail.

Section 3

3. Affected Environment

3.1. Introduction

The Proposed Action is to sign a management agreement that establishes harvest policies and defines management frameworks for fisheries in the Columbia River and issue an ITS pursuant to Section 7 of the ESA. The Proposed Action would not change measures or strategies that are used to implement harvest policy, as discussed in Section 2, all of which are established by the states and the Indian tribes. Harvest policies are designed to respond to changes in the status of fish stocks, which are influenced by environmental conditions including those that could be driven by climate change.

The Proposed Action is therefore limited in scope—it would not affect all environmental components of the Columbia River Basin. The Proposed Action would not include any form of construction or demolition to bridges, dams, hydroelectric facilities, or other related infrastructure. No effects are expected on the physical environment, habitat, ecosystem component species, or environmental resources such as air quality, water quality (other than marine-derived nutrients), or sedimentation. No effects are expected on river transportation, river navigation, or historical properties (Section 106 of the National Historic Preservation Act). The choice of signing the agreement setting harvest policies and adopting cumulative hatchery programs and issuing an ITS does not affect these resources. Implementing fishing regulations (e.g., boats with active fishing gear) may affect these resources, but as discussed in Section 2, and reiterated above, fishing strategies or harvest management measures are state and tribal decisions with no federal involvement.

In this Section, baseline conditions are described for resources that may be affected by the Proposed Action: fish, marine-derived nutrients, wildlife, economics, cultural resources, and environmental justice. These resources were identified during scoping, including the 15 comments received on the NOI.

As described in Section 1, Subsection 1.1 and Subsection 1.3.2, NMFS is utilizing the existing Mitchell Act EIS (NMFS 2014), and the analysis contained therein, to inform the hatchery related effects on the harvest management alternatives. As such, under each resource discussed in this Chapter, NMFS has included in this section, a summary of the hatchery effects, as analyzed in the Mitchell Act EIS to the resources contained in this draft EIS. These include: Fish, Water Quality, Wildlife, and Environmental Justice. This information, presented in this section, includes the expected baseline hatchery effects, relative to the reference period used in the Mitchell Act EIS, which was the Columbia River basin-wide hatchery production in the year 2010, which included the hatchery production levels established within the previous (2008-2017) *US v Oregon* management agreement.

3.2. Fish

This section describes baseline conditions for fish species that may be affected by the proposed action, either through harvest or because of a predator/prey relationship with species that would be harvested. Further information on fish in the Columbia River Basin is presented in Section 3.2 of the Mitchell Act EIS, which is incorporated herein by reference.

3.2.1. Salmonids

This section provides information on salmonid species (i.e., fish taxonomically classified in the family Salmonidae) affected by the Proposed Action.

Table 3-1 summarizes all ESA-listed salmonids in the project area.

Several ESA-listed salmonids are inadvertently affected by fisheries under *US v Oregon*, but they do not drive fishery management targeting upriver stocks, and are not addressed in the agreement (refer to Subsection 1.3.1.3.2, Lower Columbia River (LCR) Stocks).

Table 3-1. ESA-listed salmonid fish species located in the project area in the Columbia River Basin.

Species	ESA-listed DPS or ESU	ESA Status	Reference
Chinook salmon	Upper Columbia River spring-run ESU	Endangered	79 Fed. Reg. 20802, April 14, 2014
Chinook salmon	Snake River spring/summer-run ESU	Threatened	79 Fed. Reg. 20802, April 14, 2014
Chinook salmon	Snake River fall-run ESU	Threatened	79 Fed. Reg. 20802, April 14, 2014
Chinook salmon	Upper Willamette River ESU	Threatened	79 Fed. Reg. 20802, April 14, 2014
Chinook salmon	Lower Columbia River ESU	Threatened	79 Fed. Reg. 20802, April 14, 2014
Chum salmon	Columbia River ESU	Threatened	79 Fed. Reg. 20802, April 14, 2014
Coho salmon	Lower Columbia River natural ESU	Threatened	79 Fed. Reg. 20802, April 14, 2014
Sockeye salmon	Snake River ESU	Endangered	79 Fed. Reg. 20802, April 14, 2014
Steelhead	Lower Columbia River DPS	Threatened	79 Fed. Reg. 20802, April 14, 2014
Steelhead	Upper Willamette River DPS	Threatened	79 Fed. Reg. 20802, April 14, 2014
Steelhead	Mid-Columbia River DPS	Threatened	79 Fed. Reg. 20802, April 14, 2014
Steelhead	Upper Columbia River DPS	Threatened	79 Fed. Reg. 20802, April 14, 2014
Steelhead	Snake River Basin DPS	Threatened	79 Fed. Reg. 20802, April 14, 2014

Salmonids in the Columbia River Basin that would be affected by the Proposed Action include four species of Pacific salmon (*Oncorhynchus* sp.), and steelhead. These species are:

- Chinook salmon (*Oncorhynchus tshawytscha*)
- Sockeye salmon (*O. nerka*)
- Steelhead (*O. mykiss*)
- Coho salmon (*O. kisutch*)

As a group, salmonids are diverse in their biology, exhibiting a range of life history and reproductive strategies, which has given rise to a unique lexicon used in salmon management. Terms that are used in this EIS to describe each species include descriptors of the migratory patterns of salmonids and the reproductive types. There are two basic migratory patterns, or life history types, of salmonids: anadromous and nonanadromous. Anadromous fish hatch from eggs in freshwater, then migrate to the ocean, while undergoing the physiological process of smoltification, to grow and mature, and then return to freshwater as adults to spawn. Nonanadromous fish remain in freshwater throughout their life cycle. Pacific salmon (e.g., Chinook salmon, coho salmon, sockeye salmon, and steelhead) are largely anadromous, although there are nonanadromous forms (e.g., nonanadromous sockeye are called kokanee, and nonanadromous steelhead are called rainbow or redband trout). Reproductively, salmonids are either semelparous—reproducing once before dying, or iteroparous—capable of reproducing multiple times. Most Pacific salmon are semelparous; however, steelhead are iteroparous. Additional life history terms are applied to individual species, and will be introduced in that context.

In Subsection 1.6.2.1, we introduced the terms ESU and DPS, which comprise one or more populations as a "species" under the ESA. A population of fish is a group of the same biological species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season (McElhany et al. 2000). In fishery management, the term stock is commonly used to describe one or more populations that are managed collectively and are exposed to similar fishery pressure; in some cases, a stock may correspond to a single population. The ESA terms ESU and DPS comprise one or more populations, but may not be exactly identical to a stock, as the key feature of an ESU or DPS is reproductive isolation from other conspecific groups. Salmon fisheries affected by the Proposed Action generally manage for large stock groupings, as stocks, and their component populations, overlap temporally and spatially during their upstream migrations.

In Subsection 1.3.1, we introduced the concept that fisheries target particular groups of fish, referred to as "stocks". The *US v Oregon* agreement establishes harvest management policies for fisheries in the project area directed at upriver salmon and steelhead stocks. Here we will more thoroughly explain what *Harvest Indicator Stocks* and *Abundance Indicator Stocks* are so that baseline conditions for affected salmonid resources are described in the management units used by past *US v Oregon* management agreements. In order to compare the relative baseline effect of past harvest on the resources listed in this Chapter, we must also establish specific ***defined metrics*** to use as common currency. These *defined metrics* are used to provide a quantitative assessment of past harvest effects to establish the baseline for resources impacted by the proposed action. The modeled outputs for these *defined metrics* may change under the six alternatives for each of the *Harvest Indicator Stocks* and *Abundance Indicator Stocks* relative to baseline conditions. Changes will be presented later in Chapter 4 where we will detail how the defined metrics conceptually equally apply quantitative outcomes across each alternative. These defined metrics are listed in Table 3-2.

Table 3-2. Defined metrics for all alternatives.

Defined metrics for all alternatives:
Escapement for each of the Harvest Indicator Stocks at defined locations
Escapement for each of the Abundance Indicator Stocks at defined locations
Treaty harvest for Abundance and Harvest Indicator Stocks, by fishery or location
Non-treaty harvest for Abundance and Harvest Indicator Stocks, by fishery or location
Treaty HR for each Abundance Indicator Stock
Non-treaty HR for each Abundance Indicator Stock

Harvest Indicator Stocks are the "Management Units" of the *US v Oregon* Fisheries and tend to be aggregate of fish runs larger than the ESA-listed "units" (ESU or DPS). Each Harvest Indicator Stock is currently managed under a given harvest policy, such as abundance-based management, fixed harvest rate management, or fixed escapement goal management, or a combination of these. The current harvest policy type (under the 2008-2017 management agreement) for each Harvest Indicator Stock is shown in Table 3-3.

Table 3-3 Harvest Indicator Stocks and current harvest policy types.

Harvest Indicator Stocks	Current Harvest Policy Type
Upriver spring Chinook salmon	Abundance Based Management
UCR summer Chinook salmon	Mixed-Abundance Based Management /Escapement Goal
Upriver Sockeye salmon	Fixed harvest rate
Upriver fall Chinook salmon	Abundance Based Management
Snake River B-run steelhead	Abundance Based Management

Abundance Indicator Stocks are equivalent to the ESA-listed "units" (DPS or ESU) affected by *US v Oregon* fisheries. *Harvest Indicator Stocks* may include one or more *Abundance Indicator Stocks*. For example, natural-origin Upriver spring/summer Chinook salmon and natural-origin UCR spring Chinook salmon are part of the Upriver spring Chinook salmon *Harvest Indicator Stock*. Snake River sockeye salmon is part of the Upriver sockeye salmon *Harvest Indicator Stock*. Natural-origin Snake River Fall Chinook salmon is part of the Upriver fall Chinook salmon *Harvest Indicator Stock*, and natural-origin B-run is part of the Snake River B-run steelhead *Harvest Indicator Stock*. Table 3-4 lists the *Abundance Indicator Stocks* along with the location where escapement counts occur and the current harvest rate limits.

Table 3-4 Abundance Indicator Stocks and locations where escapement counts occur.

Abundance Indicator Stocks	**Location**	**Current HR Limits [1]**
Natural-origin Upriver spring/summer Chinook	Lower Granite Dam	5.5 - 17%
Natural-origin UCR spring Chinook	Priest Rapids Dam	5.5 - 17%
Snake River sockeye	Lower Granite Dam	6 - 8%
Natural-origin Snake River fall Chinook	Lower Granite Dam	21.5 - 45%
Natural-origin Group B-run steelhead	Lower Granite Dam	21.5 - 45%

[1] These harvest rate limits are imposed by the current Management Agreement and associated Biological Opinion (NMFS 2008). Observed harvest rates, meaning those recorded as actually happening, are reported in Section 3 relative to these limits. Harvest Rate limits are the total allowable amount of a species or stock that may be taken during a period of time.

The following baseline descriptions for *defined metrics* for the *Harvest Indicator Stocks* and *Abundance Indicator Stocks* include estimates of escapement past fisheries, the number of fish harvested, and harvest rates (proportion of the total "Stock" that was harvested or killed by fisheries).

Hatchery Effects to Salmon and Steelhead

As described in detail in Section *3.2.3.1*, *General Risks and Benefits of Hatchery programs to Salmon and Steelhead Species*, in the Mitchell Act EIS (NMFS 2014), hatchery salmon and steelhead programs can have beneficial effects to these species but also pose risks. Those beneficial effects include potential increases to abundance by increasing populations and helping maintain at-risk populations threatened by extirpation, to productivity by providing nutrients and improving spawning gravel conditions, and to spatial structure by expanding spatial distribution. Additionally, hatcheries can pose risks to natural-origin salmon and steelhead populations in the form of effects to abundance and productivity through competition, predation, disease and harvest. Interbreeding of hatchery and natural-origin fish can negatively affect genetic diversity and productivity, by interfering with the natural forces that strengthen the population genetics and by introducing maladaptive genetic changes. The presence of hatchery fish can lead to impacts to natural-origin populations from competition for resources such as food and spawning sites, and to predation by hatchery fish on natural-origin fish. Finally, hatchery facilities have impacts that result from the operation of weirs and other structures that can disrupt migrations, water intakes that risk entrainment and impingement, removal of water from the stream, discharge of effluent into streams, and impacts to river flows that interfere with migration and spawning.

3.2.1.1. Chinook Salmon

Chinook salmon are the largest of the Pacific salmon and are known by many names, most commonly king salmon or Chinook salmon. We use the name Chinook salmon in this EIS. Chinook salmon have an anadromous life history (although, nonanadromous males and landlocked populations do occur) and are semelparous. Age at maturity is highly variable among populations, but most Chinook salmon on the West Coast spawn at 3, 4, or 5 years of age. Chinook salmon are classified into two races: stream-type and ocean-type. These races have several ecological differences, but the most basic difference is how long the juveniles spend in the freshwater habitat prior to migrating to the ocean; stream-type outmigrate as yearlings, whereas ocean-type outmigrate much younger and may spend substantial time in the estuarine environment. In the Columbia River Basin, Chinook salmon occurring west of the Cascade Crest are ocean-type (Myers et al. 1998). Chinook salmon occurring east of the Cascade Crest include both stream-type and ocean-type races, with stream-type limited to the Snake River Basin (Myers et al. 1998).

Chinook salmon stocks are often described as seasonal "runs." In the Columbia River Basin, there are spring-run, summer-run, and fall-run Chinook salmon stocks. The run refers to the time of year they return to freshwater to start their spawning migration, but does not mean that all Chinook salmon of a seasonal run are closely related; for example, lower Columbia River fall Chinook salmon and Snake River fall Chinook salmon are not closely related, despite both being "fall-run" Chinook salmon. Some fall-run Chinook salmon below Bonneville Dam are called "tules" and are distinguished by their dark skin coloration and advanced state of maturation at the time of freshwater entry (Myers et al. 1998). Other Chinook salmon stocks that return to freshwater in an immature condition are called "brights," these include a late fall run of Chinook salmon from the Lewis and Sandy River, as well as Chinook salmon from higher in the Columbia River Basin that are termed upriver brights (Myers et al. 1998).

NMFS has identified eight Chinook salmon ESUs in the Columbia River Basin (Myers et al. 1998):

- Upper Columbia River spring-run—ESA-listed (See Table 3-1)
- Snake River spring/summer-run—ESA-listed (See Table 3-1)

- Middle Columbia River spring-run
- Upper Columbia River summer/fall-run
- Deschutes River summer/fall-run
- Snake River fall-run—ESA-listed (See Table 3-1)
- Upper Willamette River—ESA-listed (See Table 3-1)
- Lower Columbia River—ESA-listed (See Table 3-1)

Upper Willamette and LCR Chinook salmon are lower river stocks and not subject of the *US v Oregon* agreement (refer back to Subsection 1.3.1.3.2, Lower Columbia River (LCR) Stocks). All of the others are upriver stocks that are the subject of the *US v Oregon* agreement. The Upper Columbia River spring-run stock is the known limiting stock during winter/spring fisheries, which limits all catch during this season (Subsection 4.1.1 provides further details on the limiting stock concept).

Baseline conditions for the Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Upper Columbia River summer Chinook salmon, and Snake River fall Chinook salmon are presented in the following tables. These baseline conditions represent the observed minimum, maximum and average values for the river mouth runsize, total harvest rate, escapement past fisheries, and escapement to a counting point such as Rock Island Dam or Lower Granite Dam over the last 12 years (2005 to 2016). Total harvest rate is the ratio of fish taken in all *US v Oregon* fisheries divided by rivermouth runsize. The difference between escapement past fisheries and escapement to a specific counting point represent fish loses due to natural mortality or turnout to mainstem tributaries, and mortality associated with hydro operations, illegal fishing, and habitat degradation. The baseline summarizes information from 2005 to 2016. The current management framework was in place during that time.

Table 3-5. Baseline conditions for Upper Columbia River spring Chinook salmon.

	UCR spring Chinook River Mouth	**Total Harvest Rate**	**Esc. Past Fisheries**	**Rock Island Dam Run**
min.	1,374	9.2%	1,248	1,101
max.	5,032	13.4%	4,360	3,846
ave.	3,003	11.8%	2,650	2,338

Table 3-6. Baseline conditions for Snake River spring/summer Chinook salmon.

	Snake River spring/summer Chinook River Mouth	Total Harvest Rate	Esc. Past Fisheries	Lower Granite Run
min.	12,017	9.2%	10,913	8,360
max.	44,014	13.4%	38,115	29,199
ave.	26,269	11.8%	23,171	17,751

Table 3-7. Baseline conditions for Upper Columbia River summer Chinook salmon.

	UCR summer Chinook River Mouth	Total Harvest Rate	Esc. Past Fisheries	Priest Rapids Dam Run
min.	37,000	21.6%	29,000	30,644
max.	134,000	62.7%	50,000	80,288
ave.	74,417	52.5%	35,375	58,047

Table 3-8. Baseline conditions for Snake River fall Chinook salmon

	Snake River fall Chinook River Mouth	Total Harvest Rate	Esc. Past Fisheries	Average Loss to Granite	Expected Granite Run Size
min.	5,808	25.9%	4,305	1,077	3,228
max.	40,916	43.9%	22,960	5,744	17,216
ave.	19,804	41.0%	11,334	2,836	8,499

3.2.1.2. Coho salmon

Coho salmon are also commonly known as silver salmon; we use the name coho in this EIS. Coho are anadromous, with a fixed life history, and semelparous. Coho south of Alaska are three years old at maturity, spending half of that time in the freshwater environment prior to smolting (Weitkamp et al. 1995). Historically, coho salmon distribution likely extended to the upper Columbia River and the Snake River Basin (Weitkamp et al. 1995); however, at present, natural populations are limited to the lower Columbia River, from Hood River westward (Weitkamp et al. 1995).

Coho stocks exhibit early- or late- run timing. Early coho salmon spawn in the upper reaches of larger rivers in the lower Columbia River. Late coho salmon generally spawn in smaller rivers or the lower reaches of larger rivers. Late-run fish also undertake oceanic migrations to the north of the Columbia River, extending as far as northern British Columbia and southeast Alaska. As a result, late coho salmon are known as "Type N" coho. LCR coho, a lower river stock (refer to Subsection 1.3.1.3.2, Lower

Columbia River (LCR) Stocks), are the only ESA-listed ESU of coho in the Columbia Basin (Table 3-1). Coho found upstream of The Dalles Dam are not ESA-listed.

Although coho salmon in the upper Columbia River and its tributaries were extirpated, reintroduction programs conducted in the Clearwater, Wenatchee, Methow, and Yakima River Basins are resulting in coho returning to those rivers. Reintroduction programs are having some success. The number of adult coho salmon crossing Bonneville Dam in the last ten years (2007-2016) has averaged 119,674 (www.fpc.org fish passage query). In additional to the reintroduction programs, there are also coho salmon harvest programs, as identified in table B7 of the *US v Oregon* management agreement.

Harvest policy for the management of upriver coho has not been set in the prior *US v Oregon* agreements except to specify limitations to insure 50/50, treaty/non-treaty sharing of the catch. This is expected to continue under a new *US v Oregon* agreement as the success of reintroduction programs in the previously mentioned basins are evaluated and possibly expanded to other areas. Apart from the 50/50 sharing provisions, fisheries for upriver coho salmon are not actively managed, but are instead limited by the incidental catch of other species, particularly steelhead and fall Chinook salmon.

While the coho salmon hatchery production above Bonneville Dam does not affect a defined ESU or ESUs of coho salmon, it still has benefits to the rebuilding natural coho salmon populations (listed and unlisted) as well as benefits and risks to other salmon ESUs and steelhead DPSs. As described above, these programs can provide benefits to the abundance, productivity, and spatial structure of coho salmon, as well as providing benefits to other species of salmonids through marine derived nutrients from the adult carcasses, cleaning and transport of spawning gravels, and as a prey base for other salmonids. They also, however present risks to these other species in the form of ecological interactions, including competition for scarce resources and direct and/or indirect predation. Additionally, the hatchery facilities where these programs are reared and released pose risks associated with delaying or blocking migration of adult and juvenile fish, as well as risks from water withdrawal and effluent discharge. As explained in Subsection 1.3.2 and Subsection 3.1, above, NMFS is incorporating the analysis of effects from the Mitchell Act EIS to disclose the likely impacts from the hatchery programs referenced in the management agreement. This description of effects from the Mitchell Act EIS summarizes the past effects of ongoing hatchery operations, which are a part of the affected environment. The effects of continued hatchery production associated with a new *US v Oregon* management agreement are discussed in Section 4.

3.2.1.3. Sockeye salmon

Sockeye salmon are also called blueback and red salmon, we use the name sockeye salmon in this EIS. The Columbia River Basin is the southern extent of the species on the West Coast (Gustafson et al. 1997). Sockeye salmon have anadromous and nonanadromous life history types; this EIS will only discuss the anadromous form, as no nonanadromous sockeye salmon populations are affected by the Proposed Action. There are three anadromous forms of sockeye salmon: lake-type, river-type, and sea-type (Gustafson et al. 1997). Sockeye salmon in the Columbia River Basin are lake-type, they spawn in either inlet or outlet streams of lakes or in lakes themselves, juveniles rear in the lake for one to three years before smolting and migrating to the marine environment for 1 to 4 years, adults generally return to their natal lake system to spawn.

NMFS' status reviews for sockeye salmon (Waples et al 1991; Gustafson et al. 1997) identified the following extant ESUs sockeye salmon in the Columbia River Basin:

- Non-ESA-listed Sockeye salmon ESUs
    - *Okanogan River ESU*. Okanogan sockeye salmon are currently the most abundant sockeye salmon stock in the Columbia River Basin, estimated return in 2014 was 523,700 fish (http://wdfw.wa.gov/fishing/salmon/sockeye/columbia_river.html). Most Okanogan sockeye salmon rear in Osoyoos Lake, which spans the U.S./Canada border; production of Okanogan sockeye salmon occurs largely in British Columbia.
    - *Lake Wenatchee ESU*. For the 10-year period 2003 to 2012, Lake Wenatchee sockeye salmon returns averaged 27,000 fish, and estimated return in 2014 was 118,500 (http://wdfw.wa.gov/fishing/salmon/sockeye/columbia_river.html). These sockeye salmon spawn and rear in and above Lake Wenatchee, a natural lake on the Wenatchee River in Washington State.
- ESA-listed Sockeye salmon ESUs (See Table 3-1)
    - *Snake River ESU*. ESA-listed Endangered. These sockeye salmon utilize Redfish Lake in Idaho; the lake is in the Salmon River Subbasin of the Snake River. This ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River Basin, and also sockeye salmon from one artificial propagation program: Redfish Lake Captive Broodstock Program.

Baseline information for Upriver sockeye salmon and Snake River sockeye salmon is provided in tables 3-9 and 3-10. The baseline conditions represent the minimum, maximum and average values for the river mouth runsize, total harvest rate observed, escapement past fisheries, and escapement past fisheries from 2005 to 2016 when the current management framework was in place.

Table 3-9. Baseline conditions for upriver sockeye salmon.

	River Mouth Run Size	Total Harvest	Total Harvest Rate	Escapement Past Fisheries
min.	27,000	1,620	6.0%	25,380
max.	648,000	51,840	8%	596,160
ave.	277,833	22,120	8%	255,713

Table 3-10. Baseline conditions for Snake River sockeye salmon

	Snake River Sockeye Run Size	Total Harvest Rate	Esc. Past Fisheries	Lower Granite Run Size
min.	124	6.0%	117	97
max.	2,977	8.0%	2,738	2,286
ave.	1,276	7.7%	1,175	981

Some sockeye salmon reintroduction programs have been established in areas where the species has been extirpated. A reintroduction program began in 2007 to restore sockeye salmon to the Deschutes River in Oregon (ODFW News Release http://www.dfw.state.or.us/news/2012/September/092812d.asp), where sockeye salmon historically reared in Suttle Lake. In Washington, the Yakama Nation initiated a reintroduction program in 2009 for the Cle Elum River (a tributary to the Yakima River); sockeye salmon historically reared in Cle Elum Lake (http://wdfw.wa.gov/fishing/salmon/sockeye/columbia_river.html).

The sockeye salmon hatchery program contained in the agreement is a conservation program associated with the endangered, Snake River sockeye salmon ESU. This program is operated for the conservation of this species, which has incurred abundance and spatial structure benefits from the program. Additionally, and early in the development of the program, the hatchery program acted as protection from extinction, conserving valuable genetic diversity and artificially boosting the productivity of the captive population. As explained in Subsection 1.3.2 and Subsection 3.1, above, NMFS is incorporating the analysis of effects from the Mitchell Act EIS to disclose the likely impacts from the hatchery programs referenced in the agreement. This description of effects from the Mitchell Act EIS summarizes the past effects of ongoing hatchery operations, which are a part of the affected environment. The effects of continued hatchery production associated with a new *US v Oregon* management agreement are discussed in Section 4.

3.2.1.4. Steelhead

The name steelhead has a complex history; we use the name steelhead in this EIS to refer to anadromous populations of the biological species *Oncorhynchus mykiss*. Steelhead are anadromous, although individual fish may residualize and remain nonanadromous, and have the capacity for iteroparity. Iteroparous steelhead are predominately female (Busby et al. 1996); males tend to be semelparous. Juvenile steelhead can spend between one and seven years in fresh water prior to smolting, and then spend up to three years in the ocean before their first spawning migration (Busby et al. 1996). Most steelhead in the Columbia River Basin spend two years in freshwater and two years in the ocean; some populations east of the Cascade Crest have only one ocean year (Busby et al. 1996).

Steelhead have two reproductive ecotypes: ocean-maturing and stream-maturing (Busby et al. 1996). On the West Coast, these correspond to winter steelhead and summer steelhead, respectively. Ocean-maturing winter steelhead enter fresh water in a sexually mature condition and spawn shortly thereafter; stream-maturing summer steelhead enter fresh water in a sexually immature condition, and can spend several months in fresh water prior to spawning (Busby et al. 1996). Both of these ecotypes occur in the Columbia River Basin.

Steelhead, and their nonanadromous kin, have two major genetic groupings that are significant enough to be considered subspecies by some authors: coastal steelhead and rainbow trout (*O. m. irideus*), and inland steelhead and redband trout (*O. m. gairdneri*). Both subspecies occur in the Columbia River Basin. The coastal grouping occurs as far upstream as the Hood River in Oregon and the Wind River in Washington. The inland grouping occurs upstream of those rivers. Coastal steelhead can be winter or summer steelhead; inland steelhead are almost exclusively summer steelhead, i.e., stream-maturing (Busby et al. 1996).

Inland steelhead of the Columbia River Basin, especially in the Snake River, are commonly referred to as either A-run or B-run. These designations are based on the observation of a bimodal migration of adult steelhead at Bonneville Dam (Columbia River river kilometer (RKm) 235) and differences in age (1-

versus 2-ocean) and adult size observed among Snake River steelhead (Busby et al. 1996). A-run steelhead have generally spent one year in the ocean and are smaller than their B-run counterparts, which spend two years in the ocean. Under the *US v Oregon* agreement, B-run index steelhead are defined as any steelhead measuring at least 78 cm fork length and passing Bonneville Dam between July 1 and October 31. A-run steelhead are believed to occur throughout the steelhead-bearing streams of the Snake River Basin; additionally, inland Columbia River steelhead outside of the Snake River Basin are also considered A-run. B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon Rivers. (Busby et al. 1996).

NMFS has identified six DPSs for steelhead in the Columbia River Basin (Busby et al. 1996); all but one are ESA-listed:

- Non-ESA-listed steelhead DPSs
  - *Southwest Washington*. Not ESA-listed. Includes populations in the Columbia River below the Cowlitz River in Washington and below the Willamette River in Oregon.
- ESA-listed steelhead DPSs (See Table 3-1)
  - *Lower Columbia River*. ESA-listed threatened, includes naturally spawned steelhead originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls. This DPS includes steelhead from seven artificial propagation programs.
  - *Upper Willamette River*. ESA-listed threatened, includes naturally spawned anadromous winter-run steelhead originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River.
  - *Mid-Columbia River*. ESA-listed threatened, includes naturally spawned steelhead originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood Rivers (exclusive) to and including the Yakima River; excludes such fish originating from the Snake River Basin. This DPS does include steelhead from seven artificial propagation programs.
  - *Upper Columbia River*. ESA-listed threatened, includes naturally spawned steelhead originating below natural and manmade impassable barriers from the Columbia River and

its tributaries upstream of the Yakima River to the U.S.-Canada border. Also, steelhead from six artificial propagation programs.

- *Snake River Basin*. ESA-listed threatened, includes naturally spawned anadromous steelhead originating below natural and manmade impassable barriers from the Snake River basin, and also steelhead from six artificial propagation programs.

Baseline information for Snake River B-run steelhead and natural-origin B-run steelhead is provided in Table 3-11. The baseline conditions represent the minimum, maximum and average values for the river mouth runsize, total harvest rate observed, escapement past fisheries, and escapement to Lower Granite Dam. The baseline summarizes information from 2005 to 2016 when the current management framework was in place.

Table 3-11. Baseline conditions for natural-origin B-run steelhead

	B-run Steelhead Run Size	Total Harvest Rate	Escapement Past Fisheries	Expected Lower Granite Run
min.	2,420	19.2%	1,954	1,129
max.	19,951	27.8%	14,404	8,325
ave.	10,220	27.1%	7,450	4,306

Hatchery production of steelhead in the Snake River basin encompasses both harvest programs and conservation programs. As described above, conservation programs can benefit the natural populations of ESA-listed steelhead by increasing the abundance and spatial structure of the extant natural populations. The programs can also benefit the species by conserving much of the genetic diversity of the natural populations, by providing marine-derived nutrients, and by improving spawning gravel conditions. However, as also described above, both the conservation and the harvest programs can present risks to these natural populations, including: risks to population productivity and genetic diversity through interbreeding with wild fish at elevated levels; risks from direct and indirect competition and predation; and physical and ecological risks from the operation of the hatchery facilities where these steelhead programs are reared and released. As explained in Subsection 1.3.2 and Subsection 3.1, above, NMFS is incorporating the analysis of effects from the Mitchell Act EIS to disclose the likely impacts from the hatchery programs referenced in the Agreement. This description of effects summarizes the past effects of ongoing hatchery operations, which are a part of the affected environment. The effects of continued hatchery production associated with a new *US v Oregon* management agreement are discussed in Section

4.

3.2.2. Other ESA-Listed Fish Species

Other ESA-listed fish species that may be affected by the Proposed Action are listed in the table below.

Table 3-12. ESA-listed non-salmonid fish species that may be affected by the Proposed Action in the Columbia River Basin.

Species	ESA-listed DPS or ESU	ESA Status	Reference
Bull-trout	Columbia River DPS	Threatened	63 Fed. Reg. 31647, June 10, 1998
Green sturgeon	Southern DPS	Threatened	71 Fed. Reg. 17757, April 7, 2006
Eulachon	Southern DPS	Threatened	75 Fed. Reg. 13012, March 18, 2010

3.2.3. Other Non-Salmonids (non ESA-listed Fish Species)

Non-salmonid (non-ESA-listed Fish species) mentioned in the agreement are listed in Table 1.3.1.3-1 and include:

- White Sturgeon (*Acipenser transmontanus*)

White sturgeon are the largest North American sturgeon. They live in rivers from central California to southern Alaska and migrate among them via the Pacific Ocean. In the Columbia River they historically ranged from the ocean up into Idaho, Montana, and Canada. White sturgeon can live for over 100 years, can be 20 feet long, and can weigh over 1,500 pounds. Their skeleton is largely cartilage and they have thick skin and bony plates, called scutes, instead of scales. Sturgeon appeared in the fossil record 200 million years ago and have survived to the present relatively unchanged. Female sturgeon spawn at 20-25 years of age (males at about 12 years old), and can produce 300,000-4,000,000 eggs. Of these, less than 0.1% will survive the first year (Wydoski and Whitney 1979).

There are no historic estimates of white sturgeon abundance before the non-Native Americans began to settle in the Pacific Northwest and the Columbia River hydrosystem was developed. Historically, white sturgeon ranged freely up and down the Columbia and Snake Rivers (Bajkov 1951) and undertook extensive seasonal migrations among riverine habitats to take advantage of scattered and seasonally favorable resources.

Construction of dams on the Columbia and Snake Rivers from 1931 to 1968 segregated groups of white sturgeon into a series of functionally discrete populations (North et al. 1993). Development of the Columbia River Basin hydrosystem created impoundments (reservoirs) throughout the basin, restricting movements of white sturgeon and two of their principal food sources (eulachon and lamprey). Development has also degraded or destroyed white sturgeon spawning and rearing habitat. As a result, many impounded white sturgeon populations are not as productive as they were before non-Native American settlement of the region and development of the hydrosystem. In some upper Columbia River Basin reaches, isolated populations may face extirpation or extinction (Beamesderfer et al. 1995, North et al. 1993, Parsley and Beckman 1994, Parsley et al. 1993).

- American Shad (*Alosa sapidissima*)

American shad routinely average large numbers of returns to the Columbia River, and in some years the number counted at Bonneville Dam is as high as 4-5 million (5.3 million in 2004, and 4.2 million in 2005, for example). The U.S. Geological Survey has estimated as many 10 million to 20 million adult shad may enter the Columbia annually — 4,000 metric tons (adults average 2-3 pounds). Shad have migrated past Bonneville, The Dalles, John Day, McNary, and Priest Rapids dams on the Columbia and the four lower Snake River dams, according to the Survey.

Unlike salmon and steelhead, shad are not native to the Columbia. They were introduced to the Pacific Coast from the Atlantic coast, first planted 10,000 in the Sacramento River in 1871. Five years later shad were being captured in the Columbia River and in 1880 the shad invasion was confirmed by fish scientist David Starr Jordan, who sent a specimen to the Smithsonian Institution where it is preserved to this day.

Like salmon and steelhead, shad are anadromous. Biologically part of the herring family of fish, they spawn in the mainstem Columbia River primarily above Bonneville Dam between May and July and also in the Willamette River of Oregon. Shad go to the ocean as adults, returning to spawn when they are three to five years of age. The run peaks in June. Unlike salmon and steelhead, shad spawn in open water rather than laying eggs on gravel. Also unlike salmon, shad can make the round trip to the ocean several times and spawn additional generations.

Shad spawn prolifically, produce large numbers of smolts, and return as adults in such volume that they are fished both commercially and for sport. There is no daily limit on Columbia River shad in either Washington or Oregon. Shad are caught in the lower Snake River, but that is about as far inland as they go. The bulk of the annual run spawns downstream from McNary Dam.

- Pacific Lamprey (*Entosphenus tridentatus*)

Lampreys, jawless fishes of the family Petromyzontidae, are among the oldest existing vertebrates, having changed little since emerging about 530 million years ago (Dawkins 2004). The Pacific lamprey *Entosphenus tridentatus* (formerly *Lampetra tridentata*) is an anadromous species native to the north Pacific Rim (Scott and Crossman 1973) including the Columbia River Basin. Pacific lamprey are an important food source for marine mammal, avian, and fish predators, and may act as a predation buffer for Pacific salmon Oncorhynchus species juveniles. Moreover, they are a source of marine-derived nutrients in the upper tributaries of the Columbia and Snake rivers (Close et al. 1995). Pacific lamprey may also be a key indicator of ecological health of the Columbia River Basin. Importantly, Pacific lamprey serve a role in the culture of many Native American tribes (Close et al. 2002).

Despite their persistence through time, lamprey are now believed to be declining throughout much of their distribution (e.g., see Renaud 1997). Pacific lamprey along the west coast of North America have recently experienced declines and regional extirpations (Beamish and Northcote 1989; Kostow 2002; Moser and Close 2003). These declines parallel those of Pacific salmonids, perhaps because the two groups share widely sympatric distributions (Scott and Crossman 1973; Simpson and Wallace 1978; Moyle 2002) and similar anadromous life histories (McDowall 2001; Quinn and Myers 2004). Causes for the decline in the Columbia River Basin may include construction and operation of dams for hydropower, flood control, and irrigation, habitat degradation, poor water quality, proliferation of exotic species, and direct eradication actions.

Numerous management and research actions have been recommended to help restore Pacific lamprey in the Columbia River Basin (Nez Perce, Umatilla, Yakama, and Warm Springs Tribes 2008; Columbia Basin Fish and Wildlife Authority 2008). These actions include improving adult and juvenile passage at known and suspected obstacles, restoring degraded habitat and water quality, and implementing reintroduction methods.

- Walleye (*Sander vitreus*)

Walleye are an exotic species introduced into Lake Roosevelt in the upper Columbia River during the 1940s and 1950s. Walleye are not native to Washington fish, and exactly how they originally entered the state is unknown. The first verification of a walleye in Washington was in 1962, from Banks Lake in eastern Washington. Soon afterwards, populations began to show up in Lake Roosevelt (connected to Banks Lake through a huge pipe and pump). Since then they have spread from these original sites to the remainder of the mainstem Columbia River, from near the mouth to the Canadian border and throughout reservoirs in the Columbia River Basin.

Walleye continued to advance to other waters in the Columbia River Basin by using canals as frontier highways. They have established populations in Lake Billy Clapp, Moses Lake, Potholes Reservoir, Long Lake, Crescent Lake, Soda Lake and Scooteney Reservoir. They have thrived in reservoir environments and are a primary gamefish species. Young walleye are typically found in littoral (nearshore) areas associated with woody debris. Adults are most commonly found in pelagic (open water) areas during daylight hours and near the mouths of embayments and tributaries at night. where they come to feed (Peone et al. 1990).

Hatchery Effects to Other Fish Species

Hatchery salmon and steelhead may act to enhance, artificially, existing pathways of prey, predator, and competition between the hatchery-reared species and other species, including: bull trout, eulachon, shad, lamprey, and walleye.

Bull trout feed primarily on fish (referred to as piscivorous) as subadults and adults, they can be substantial predators of young salmon and steelhead. Eulachon are important in the food chain as a prey species of salmon and steelhead. Newly hatched and juvenile eulachon are food for a variety of larger marine fish species, including salmon and steelhead. Shad are a non-indigenous species of anadromous fish, in the Columbia River, that provide both a prey-base for some juvenile salmonids (Chinook salmon) but also may compete with salmon and steelhead for prey in the freshwater environment. Lamprey prey on a variety of fish and marine mammals (whales), including salmon, which are an important food source for lamprey. Walleye, a non-indigenous warm water fish is known to prey on seaward migrating salmon and steelhead juveniles.

3.3. Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients

As detailed in the Mitchell Act EIS (Subsection 3.6.3.1, *Water Quality Parameters*) and incorporated herein, by reference, hatchery facilities can have impacts to in-stream water quality, where they operate. Hatcheries can produce effluent (discharged water that has been used in the facility) with elevated temperature, as well as elevated levels of: ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand (BOD), pH, and solids; as well as levels of chemicals used for disease treatment and disinfection. Effluent from hatchery facilities rearing 20,000 lbs or more of fish, is regulated under the federal Clean Water Act (CWA), through National Pollutant Discharge Elimination System (NPDES) permits, and issued by the states or directly by the Environmental Protection Agency (EPA). Hatcheries that are in compliance with their NPDES permits (where required), and thus water quality standards, are considered not to cause or to contribute to a violation of water quality standards. However, the amount effluent being discharged into receiving waters from hatcheries do contribute to the total pollutant loads of those receiving waters and downstream waters. The baseline condition of water quality, with regard to the effects of hatchery production in the Columbia River basin, and including facilities that rear and release programs included in the proposed action, is consistent with current federal and state regulations.

Anadromous species such as salmon and steelhead are important components of the freshwater ecosystem, particularly for their role in transporting nutrients upstream from the marine ecosystem, and possibly as watershed engineers that structure streambed habitats and alter sediment composition during spawning.

Hatchery produced salmon and steelhead currently provide a significant number of the returning adults to the Columbia River basin, contributing substantially to the total contribution of marine-derived nutrients. This EIS incorporates by reference Subsection 3.5.6.5 of the Mitchell Act EIS (NMFS 2014) which provides a comprehensive discussion of the role of salmon and steelhead in transporting marine-derived nutrients.

3.4. Wildlife

Fisheries have the potential to affect wildlife through interactions from changes in the availability of fish as prey. Wildlife that are most likely to be affected by fishing activities are seabirds and marine mammals. Both of these groups are protected under Federal laws, such as the Migratory Bird Treaty Act (MBTA) and the Marine Mammal Protection Act (MMPA)

3.4.1. Seabirds, Raptors, and other Piscivorous Birds

Numerous seabird species, as well as raptors, are protected under the MBTA, including several that are present within the project area. These seabirds include Caspian terns, Double-crested cormorants, and several species of gulls. Guillemots, murres, and puffins also prey on juvenile salmon, primarily in the ocean. . These birds feed on out-migrating juvenile salmon.

Predation on juvenile salmon occurs in the Columbia River, as salmon smolts migrate downstream and into marine waters. Two man-made islands, East Sand Island and Rice Island were created using dredge spoils from the Columbia River. The islands have since become occupied by colonies of Caspian terns and double-crested cormorants. In 2010 and 2011, an estimated 19.2 million and 20.5 million (respectively) juvenile salmon were consumed by the double-crested cormorant colony on East Sand Island. These numbers are approximately equal to 18 percent of the entire Columbia River out-migrating salmon for those years (BRNW 2011). Caspian Terns nesting on East Sand Island and Rice Island also consume outmigrating salmonids: 8.1 million salmon smolts in 1997 and 12.4 million in 1998. The U.S. Army Corps of Engineers has implemented culling actions in 2015 and 2016 on double-crested cormorants in the Columbia River Estuary under MBTA depredation permit issued by the USFWS to reduce predation impacts on ESA-listed salmonids.

Raptors (bald eagles, turkey vultures, osprey), corvids (crows, ravens), and numerous species of gulls prey on returning adult salmonids, primarily post-spawn adults.

Hatchery produced salmon and steelhead make up the majority of the current, total Columbia River basin production. As such, avian species that rely on juvenile or adult salmon of steelhead, from the Columbia River are affected by the level of hatchery production of these species. Baseline conditions for Caspian terns and bald eagles result from the recent levels of hatchery production, within the Columbia River basin, as analyzed in the Mitchell Act EIS (NMFS 2014).

3.4.2. Marine Mammals

Fisheries in the lower Columbia River can occur in the presence of harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*). In compliance with the MMPA, NMFS publishes an annual list of fisheries that classifies fisheries by the level of mortality and serious injury of marine mammals that occurs incidental to each fishery. NMFS has determined that salmon troll fisheries and Columbia River net fisheries for salmon and eulachon have little to no known impact on marine mammals (82 Fed. Reg. 3655, January 12, 2017).

California sea lions have a substantial effect on salmon and steelhead migrating up the Columbia River, through predation below Bonneville Dam. After non-lethal methods to remove or discourage sea lion predation were unsuccessful, NMFS authorized, under MMPA Section 120, the states of Washington, Oregon and Idaho to lethally remove individually identifiable California Sea Lions in the vicinity of Bonneville Dam that are having a negative impact on the recovery of salmon and steelhead listed under the ESA.

The Southern Resident Killer Whale DPS (SRKW) is ESA-listed as endangered. SRKW pods have been sighted off of the West Coast as far south as Monterey, California (SRKW recovery plan, January 2008). These whales are known to prey upon salmon in the ocean; therefore, SRKW may be affected by the Proposed Action.

NMFS' recovery plan for SRKW (2008) singles out decline of Columbia River salmon as possibly the single greatest change in food availability for SRKW since the late 1800s. Returns during the 1990s averaged only 550,000 adult salmonids crossing Bonneville Dam, representing a decline of 90 percent or more from historical levels. With so many fish present back in the 1800s, salmonids returning to the Columbia River may have been an important part of the diet of SRKW. More recently returning adults crossing Bonneville Dam has increased, as the 10-year average (2007-2016) of all salmonids crossing Bonneville Dam is now 1.8 million.

As described in the Mitchell Act EIS, hatchery produced salmon and steelhead currently provide the majority of the total fish produced from the Columbia River basin. As such, the baseline condition of marine mammal species that rely on salmon or steelhead, from the Columbia River, are affected by the level of overall hatchery production of these species, including the programs referenced in the US v Oregon Agreement. Baseline conditions for SRKW, resulting, in part, from recent levels hatchery Chinook salmon production from the Columbia River basin are described in Section 3.5.3.1.1, of the Mitchell Act EIS, and incorporated herein by reference. Baseline conditions for marine mammals resulting from implementation of the Mitchell Act EIS preferred alternative would likely result in a small increase in overall Chinook salmon (NMFS 2014).

3.5. Economics

Economic issues addressed in this section include harvest effects related to management strategies, economic values of fish predicted to be caught in commercial tribal and non-tribal) fisheries, and the contribution of commercial and recreational fishing activity on local and regional economies in the Columbia River basin. Additional economic information related to tribal harvests is provided in Section

3.6, Cultural Resources - Ceremonial and Subsistence Harvest.

This economic analysis focuses on commercial and recreational fishing targeting five harvest indicator stocks that collectively account for more than 80 percent of the total catch of salmon and steelhead in the mainstem Columbia River. In addition to supporting tribal commercial and non-tribal recreational fisheries in the mainstem, these stocks also support ceremonial and subsistence tribal fishing.

This section describes baseline conditions for harvest and related economic values for affected commercial (tribal and non-tribal) and recreational fisheries on the mainstem Columbia River (including the mainstem Snake River), and the contribution of these fisheries to affected regional economies. For this economic analysis, indicators of economic conditions evaluated include direct and indirect employment, ex-vessel values for commercial fisheries, trip-related expenditures by recreational fishers, and regional economic impacts (jobs and personal income) associated with fishing-related activities.

The analysis area for economics includes the project area (Subsection 1.2, Description of Project Area) and areas outside the project area in which economic activity generated by fishing activities occurs. This analysis area consists of four subregions of the Columbia River Basin that are used to characterize effects on commercial harvest and recreational fishing effort:

- Lower Columbia River subregion, where catch assumed to contribute to economic activity in eight counties (Columbia, Clatsop, and Multnomah Counties in Oregon, and Pacific, Wahkiakum, Clark, Cowlitz, and Skamania in Washington) that border ODFW mainstem fishing zones 1 through 5 downstream of Bonneville Dam;
- Mid-Columbia River subregion, where catch assumed to contribute to economic activity in eight counties (Hood River, Wasco, Sherman, Gilliam, Morrow, and Crook Counties in Oregon, and Benton and Klickitat Counties in Washington) that border ODFW fishing zone 6 between Bonneville Dam and McNary Dam;
- Upper Columbia River subregion, where catch assumed to contribute to economic activity in four counties (Benton, Kittatas, Franklin and Grant Counties in Washington) that are upstream of McNary Dam; and
- Lower Snake River subregion, where catch assumed to contribute to economic activity in five counties (Walla Walla, Columbus, Garfield, Whitman, and Franklin Counties in Washington) that are upstream of the confluence with the mainstem Columbia River.

The counties that comprise these four subregions are identified in Figure 1-1.

Communities and ports in the Lower Columbia River subregion that are affected by the commercial, recreational, and tribal ceremonial and subsistence fisheries in the project area include the ports, cities, and communities of Portland, Oregon and Cathlamet, Longview and Vancouver, Washington. Rural communities in the other three subregions that are near to the mainstem are also affected by commercial (both treaty and non-treaty) and recreational fishing activities for salmon and steelhead activities.

It should be noted that values presented in this section are not rounded to aid the reader in finding corresponding numbers between tables and text. The use of unrounded numbers, however, should not be interpreted as suggestive of unusually high levels of precision in the estimates. All numbers presented represent a reasonable estimate of the underlying values. More detailed information on methods and analyses applied in analyzing the economic resource is presented in Appendix A, Economic Methods.

3.5.1. Affected Fisheries

This subsection provides a description of commercial and recreational harvests of fish produced by salmon and steelhead in the Columbia River basin including numbers of salmon and steelhead harvested and recreational effort. For historical context, harvest data from 2005 through 2016 are presented in Subsection 3.2.1, representing the period in which average conditions are developed for this analysis.

3.5.1.1. Commercial (Tribal and Non-tribal) Fisheries

The Columbia River mainstem salmon and steelhead fishery is currently divided into a non-tribal commercial fishery, which is located downstream of Bonneville Dam, and a tribal commercial fishery, which is located upstream of Bonneville Dam. The tribal commercial fishery is also called the Zone 6 fishery. The upstream boundary of the Zone 6 fishery is McNary Dam.

As described in Subsection 1.3.1, Fisheries, commercial fishing in the Columbia River Basin also occurs in terminal areas, such as SAFE areas and the lower Columbia River; however, as discussed in that same section the harvesting of lower Columbia River stocks in these areas is managed separately from the *US v Oregon* agreement and would not be affected by the harvest policies evaluated in this document. In addition to commercial salmon harvesters, processors provide Columbia River basin salmon supply products to a growing market for wild-caught fish.

For tribal and non-tribal commercial harvests in the Columbia River basin, more salmon are harvested from the lower and mid-Columbia River subregions than from the other two subregions. Within the lower

Columbia River subregion, the harvest is primarily from non-tribal commercial fisheries. Between 2002 and 2009, the annual harvest in the mainstem of the Lower Columbia River was 56,238 fish (NMFS 2014). Coho and Chinook salmon account for most of the non-tribal commercial fishing harvest because steelhead are not commercially harvested by non-tribal commercial fishers.

In the tribal commercial fisheries above Bonneville Dam (Zone 6), the harvest of Chinook salmon dominates the catch in the mainstem between Bonneville Dam and McNary Dam. The tribal commercial fisheries in the upper Columbia River and lower Snake River subregions are mostly Chinook salmon fisheries, although small numbers of steelhead are also caught in the Lower Snake River subregion.

As described in Subsection 3.1, average estimates of salmon and steelhead harvest between 2005 and 2016 were used to characterize baseline harvest conditions for this analysis. Indicator harvest stock-specific estimates for tribal and non-tribal fisheries are presented in the following tables. Minimum, maximum, and mean conditions are used to characterize the following status quo conditions.

Table 3-13 identifies average annual harvest conditions over 2005 and 2016 for Upriver Spring Chinook salmon, including average minimum values, average maximums, and average mean values of harvest, as measured by number of fish. As shown, all of the tribal commercial harvest is caught in the Zone 6, whereas all of the non-tribal commercial harvest is caught in Zones 1 through 5. Tribal harvest for ceremonial and subsistence needs averaged 10,340 spring Chinook salmon annually over the 12-year period (Table 3-13).

Table 3-13 Commercial harvest of Upriver Spring Chinook salmon under status quo conditions.

Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**C&S Fisheries**
min		173			173	6,191
max		23,472			23,472	10,548
AVERAGE		7,528			7,528	10,340
Non-Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**Above Z 6 NT Tribal**
min	1,448				1,448	4
max	7,743				7,743	21
AVERAGE	4,067				4,067	11

Table 3-14 identifies average annual harvest conditions between 2005 and 2016 for Upriver Summer Chinook salmon, including average minimum values, average maximums, and average mean values of harvest (number of fish). Similar to Upriver Spring Chinook salmon, all of the tribal commercial harvest is caught in Zone 6, whereas the non-tribal commercial harvest is caught in both Zones 1 through 5 and above Zone 6. Tribal harvest for ceremonial and subsistence needs averaged 1,952 fall Chinook salmon annually over the 12-year period.

Table 3-14 Commercial harvest of upriver Summer Chinook under status quo conditions.

Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**C&S Fisheries**
min		3,600			3,600	400
max		37,800			37,800	4,200
AVERAGE		17,569			17,569	1,952
Non-Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**Above Z 6 NT Tribal**
min	688				688	792
max	7,221				7,221	8,317
AVERAGE	3,356				3,356	3,866

Table 3-15 below identifies average annual harvest conditions between 2005 and 2016 for Upriver Fall Chinook salmon, including average minimum values, average maximums, and average mean values of harvest (number of fish). Similar to Upriver Spring Chinook salmon, all of the tribal commercial harvest is caught in the Zone 6, whereas all of the non-tribal commercial harvest is caught in Zones 1 through 5. Tribal harvest for ceremonial and subsistence needs averaged 8,078 Fall Chinook salmon annually over the 12-year period.

Table 3-15 Commercial harvest of upriver Fall Chinook under status quo conditions.

Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**C&S Fisheries**
min		42,849			42,849	1,848
max		393,700			393,700	16,980
AVERAGE		187,303			187,303	8,078
Non-Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**Above Z 6 NT Tribal**
min	3,657				3,657	
max	96,614				96,614	
AVERAGE	44,870				44,870	

Table 3-16 below identifies average annual harvest conditions between 2005 and 2016 for Upper Columbia River (UCR) sockeye salmon, including average minimum values, average maximums, and average mean values of harvest (number of fish). Similar to Upriver Spring Chinook salmon, all of the tribal commercial harvest is caught in Zone 6, whereas all of the non-tribal commercial harvest is caught in Zones 1-5. Tribal harvest for ceremonial and subsistence needs averaged 2,902 sockeye salmon annually over the 12-year period.

Table 3-17 below identifies average annual harvest conditions between 2005 and 2016 for Lower Snake River steelhead, including average minimum values, average maximums, and average mean values of harvest (number of fish). Similar to Upriver Spring and Summer Chinook salmon, all of the tribal commercial harvest is caught in Zone 6, whereas all of the non-tribal commercial harvest is caught in Zones 1-5. Tribal harvest for ceremonial and subsistence needs averaged 471 steelhead annually over the 12-year period.

Table 3-16. Commercial harvest of Upper Columbia River Sockeye salmon under status quo conditions.

Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**C&S Fisheries**
min		1,148			1,148	203
max		38,556			38,556	6,804
AVERAGE		16,440			16,440	2,901
Non-Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**Above Z 6 NT Tribal**
min	50				50	
max	1,194				1,194	
AVERAGE	512				512	

Table 3-17. Commercial harvest of Snake River Steelhead under status quo conditions.

Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**C&S Fisheries**
min		1,455			1,455	77
max		17,950			17,950	945
AVERAGE		8,945			8,945	471
Non-Tribal Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Total Commercial**	**Above Z 6 NT Tribal**
min	56				56	
max	458				458	

AVERAGE	235				235	

In terms of economic value, the average annual harvest value (known as the ex-vessel value, which is the price received for the product 'at the dock') of salmon caught in the non-tribal commercial fisheries in the Lower Columbia River subregion was $2,418,367 (Table 3-18). In the Mid-Columbia River, the harvest value of salmon and steelhead caught by tribal commercial fishers was $7,745,794, and the value to non-tribal fishers was $148,749. No harvest value is estimated for the upper Columbia River and Lower Snake River subregions because there was no commercial harvest of the harvest indicator stocks.

Table 3-18. Commercial harvest and ex-vessel value of harvest indicator species under status quo conditions, by Columbia River subregion and type of fishery.

Subregion/Type of Fishery	**Value**	**% of Total for All Subregions**
Lower Columbia River Subregion		
Non-Tribal		
Harvest (number of fish)	53,039	22.3
Ex-vessel harvest value	$2,418,367	31.2
Tribal		
Harvest (number of fish)	0	0
Ex-vessel harvest value	$0	0
Total		
Harvest (number of fish)	53,039	18.0
Ex-vessel harvest value	$2,418,367	23.4
Mid-Columbia River Subregion		
Non-Tribal		
Harvest (number of fish)	3,877	6.8
Ex-vessel harvest value	$148,749	5.8
Tribal		
Harvest (number of fish)	237,785	100.0
Ex-vessel harvest value	$7,745,794	100.0
Total		
Harvest (number of fish)	241,662	
Ex-vessel harvest value	$7,894,543	
ALL SUBREGIONS		
Non-Tribal		
Harvest (number of fish)	56,916	
Ex-vessel harvest value	$2,567,116	
Tribal		
Harvest (number of fish)	237,785	
Ex-vessel harvest value	$7,745,794	
Total		
Harvest (number of fish)	294,701	

Ex-vessel harvest value	$10,312,910	

Notes: All dollar values are expressed in 2015 dollars.
Source: Catch estimates provided by NMFS; all other estimates developed by TCW Economics.

The total ex-vessel value[3] of the commercial harvest of salmon and steelhead under the status quo conditions is $10,312,910, with tribal fisheries accounting for 75 percent ($7,745,794) of this value, and non-tribal fisheries accounting for 25 percent ($2,567,116) of the total harvest value.

3.5.1.2. Recreational Fisheries

The recreational fishery on the mainstem Columbia River below Bonneville Dam includes two main management areas; the mainstem Columbia River extending from Bonneville Dam downstream to the Point/Rocky Point line, and the Buoy 10 area extending from below the Tongue Point/Rocky Point line to Buoy 10, which marks the ocean/in-river boundary. According to information in the Mitchell Act FEIS (NMFS 2014), about 52 percent (161,397 fish) of the annual average recreational harvest between 2002 and 2009 of salmon and steelhead in the Columbia River basin (311,252 fish) occurred in the Lower Columbia River and tributaries. This percentage was previously reported to be 80 percent in the final EIS for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River basin (NMFS 2003), but more recent data show that the percentage has decreased. The recreational fisheries above Bonneville Dam, which account for the remainder of the harvest, are geographically widespread but socially important. Much of the recreational harvest in both the lower and upper Columbia River occurs in tributaries (NMFS 2003).

Based on historical information (NMFS 2003), the Cowlitz, Lewis, Kalama, and Elochoman Rivers in Washington and the Willamette, Sandy, and Santiam Rivers in Oregon account for approximately 45 percent of the Lower Columbia River basin salmon and steelhead harvest. Above Bonneville Dam, the Klickitat, White Salmon, and Little White Salmon tributaries in Washington, the Deschutes in Oregon, and other tributaries account for approximately 60 percent of the salmon and steelhead harvest (NMFS 2003). The Snake River and its main tributaries, the Clearwater and Salmon, account for 35 percent of the Upriver steelhead harvest from the Columbia River system (NMFS 2003).

Similar to status quo conditions for commercial harvest of salmon and steelhead, average estimates between 2005 and 2016 were used to characterize baseline harvest conditions. Indicator harvest stock-specific estimates are presented in the following tables for affected recreational fisheries. Minimum,

[3] The term ex-vessel value refers to the price (income) that fishermen receive for the fish "at the dock."

maximum, and mean conditions are used to characterize status quo conditions.

Table 3-19 identifies average annual catch conditions between 2005 and 2016 for upriver Spring Chinook salmon, including average minimum values, average maximums, and average mean values. As shown, most (78 percent) of the catch occurs in Zone 1 through 5.

Table 3-19 Recreational catch of Upriver Spring Chinook salmon under status quo conditions.

Recreational Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Non-treaty**	**Total Sport**
min.	3,877	714		321		4,912
max.	20,726	3,817		1,713		26,256
ave.	10,886	2,005		900		13,791

Table 3-20 identifies average annual catch conditions between 2005 and 2016 for Upriver Summer Chinook salmon, including average minimum values, average maximums, and average mean values. Of the total sport catch, about half is caught by non-treaty tribal fishers (this catch is not part of the tribal allocation) and half by non-tribal recreational fishers. Most (about 92 percent) of the catch by non-tribal recreational fishers is caught in Zones 1 through 5.

Table 3-20 Recreational catch of Upriver Summer Chinook salmon under status quo conditions.

Recreational Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Non-Treaty**	**Total Sport**
min.	752	103	36		820	1,711
max.	7,901	1,085	377		8,614	17,977
ave.	3,672	504	175		4,003	8,354

Table 3-21 identifies average annual catch conditions between the 2005 through 2016 for upriver fall Chinook salmon, including average minimum values, average maximums, and average mean values. As shown, most (about 82 percent) of the catch occurs in the Zone 1-5, and is only caught by non-tribal fishers.

Table 3-21 Recreational catch of Upriver Fall Chinook salmon under status quo conditions.

Recreational Fisheries	**Zone 1-5**	**Zone 6**	**Above Zone 6 thru I-395 Bridge**	**Lower Snake River**	**Non-treaty**	**Total Sport**
min	2,775	477	134			3,386
max	73,317	12,595	3,542			89,453
ave.	34,050	5,849	1,645			41,544

Table 3-22 identifies average catch conditions over the 2005 through 2016 for upriver spring Chinook salmon, including average minimum values, average maximums, and average mean values.

Table 3-22 Recreational catch of Upper Columbia River Sockeye salmon under status quo conditions.

Recreational Fisheries	Zone 1-5	Zone 6	Above Zone 6 thru I-395 Bridge	Lower Snake River	Non-treaty	Total Sport
min	220					220
max	5,286					5,286
ave.	2,266					2,266

Table 3-23 identifies average annual catch conditions between 2005 and 2016 for Snake River steelhead, including average minimum values, average maximums, and average mean values. As shown, most (about 89 percent) of the catch occurs in Zone 6 and is caught by non-treaty tribal fishers.

Table 3-23 Recreational catch of Snake River Steelhead under status quo conditions.

Recreational Fisheries	Zone 1-5	Zone 6	Above Zone 6 thru I-395 Bridge	Lower Snake River	Non-Treaty	Total Sport
min	161	1,333				1,494
max	1,327	10,992				12,319
ave.	680	5,631				6,310

Based on estimates of angler effort per fish caught (refer to Appendix A, Economic Methods), the total number of angler trips made to catch the five harvest indicator stocks in the mainstem of the Columbia River is estimated at 895,961 (Table 3-24). Similar to catch estimates, most of the angler trips occurred in the Lower and Mid-Columbia River Subregions. There is no recreational catch or angler trips in the Upper Columbia River Subregion. Trip-related expenditures are estimated to total $111,821,173, based on average expenditures per angler trip (refer to Appendix A, Economics Methods for details).

Table 3-24. Recreational salmon and steelhead catch, angler trips, and trip-related expenditures under status quo conditions, by Columbia River subregion.

Subregion	Value	% of Total for all Subregions
Lower Columbia River Subregion		
Catch	155,704	84.4
Trips	753,994	84.1
Trip-related expenditures	$98,390,721	88.0
Mid-Columbia River Subregion		
Catch	27,508	14.9
Trips	134,950	15.1
Trip-related expenditures	$12,779,061	11.4
Lower Snake River Subregion		
Catch	1,333	0.7
Trips	7,016	0.8
Trip-related expenditures	$651,391	0.6
ALL SUBREGIONS		
Catch	184,545	100.0
Trips	895,961	100.0
Trip-related expenditures	$111,821,173	100.0

Notes: All dollar values are expressed in 2015 dollars.
Source: Catch estimates provided by NMFS; all other estimates developed by TCW Economics.

3.5.1.3. Contribution of Affected Fisheries to Regional Economic Conditions

Commercial and recreational fisheries generate personal income and support jobs in regional and local economies throughout the Columbia River basin. Commercial landings of salmon and steelhead are frequently sold directly, or after processing, to persons or businesses located outside the region. This transfer of money supports payments to labor, which are then re-spent regionally (i.e., the multiplier effect). Similarly, non-local recreational anglers (i.e., anglers who live outside the local area) spend money on guide services, lodging, and other goods and services that generate income for local communities. Last, money spent on hatchery operations and management, which often comes from state or Federal sources located outside the local area, provides an additional infusion of income to local economies. Hatchery operations in the Columbia River basin also generate direct, indirect, and induced economic effects within the basin's four economic impact regions by providing employment opportunities and through local procurement of goods and services for hatchery operations. Hatchery-related spending affects regional economies where hatchery operations occur and where the businesses that provide materials and services are located. This spending also extends to communities where hatchery administration and management decisions take place (sometimes referred to as headquarter costs); refer to the Mitchell Act FEIS (NMFS 2014) (Subsection 4.3) for a discussion of hatchery-related economic effects.

Economic activity generated by commercial and recreational fishing is concentrated within certain sectors of the regional economy. In addition to the fish harvesting sector, commercial fisheries affect seafood product preparation and packing, including the canning and curing of seafood and preparation of fresh or frozen fish or seafood. Wholesaling, retailing and restaurant sectors may also be affected, although income and employment in those sectors is not included in the subregional and regional totals. Recreational fisheries contribute to local economies through the purchase of fishing-related goods and supplies, and by the retention of local services, such as outfitter and guiding services. Sectors particularly affected by recreational fishing activities include food services, eating and drinking establishments, lodging, recreation services, and fueling stations. Expenditures on fishing-related goods and services by fishermen contribute to both local and non-local businesses.

The commercial and recreational fisheries that target salmon and steelhead in the Columbia River Basin generate economic activity characterized by employment (jobs) and personal income. Commercial harvest and recreational fishing (trips) and associated employment and personal income are distributed among the four subregions constituting the analysis area (Table 3-25).

Commercial harvest of salmon and steelhead by tribal and non-tribal fishers in the Columbia River region under status quo conditions generated an estimated 419 jobs and $16.2 million in personal income. More than three-quarters of jobs and income from commercial harvests landed in the Mid-Columbia River Subregion with the remainder in the Lower Columbia River Subregion (Table 3-25). Recreational fishing activities targeting salmon and steelhead generate an estimated 672 jobs and $27.9 million in personal income in the Columbia River region (Table 3-25). More than two-thirds of jobs and income generated by recreational fishing occur in the Lower Columbia River Subregion, with most of the remainder occurring in the Mid-Columbia River Subregion and a small amount (1.4 percent of income and 2 percent of jobs) in the Lower Snake River Subregion (Table 3-25).

Table 3-25. Regional economic effects from harvest of indicator stocks of commercial and recreational salmon and steelhead under status quo conditions, by Columbia River Subregion

Subregion/Type of Fishery	Value (dollars or number of jobs)	% of All Region Total
Lower Columbia River Subregion		
Commercial (Tribal and Non-tribal) Fisheries		
Personal income	$3,799	23.4%
Jobs	86	20.6%
Recreational Fisheries		
Personal income	$19,602	70.2%
Jobs	446	66.3%
Mid-Columbia River Subregion		
Commercial (Tribal and Non-tribal) Fisheries		
Personal income	$12,400	76.6%
Jobs	332	79.4%
Recreational Fisheries		
Personal income	$7,951	28.5%
Jobs	213	31.7%
Lower Snake River Subregion		
Commercial (Tribal and Non-tribal) Fisheries		
Personal income	$0	0%
Jobs	0	0%
Recreational Fisheries		
Personal income	$387	1.4%
Jobs	13	2.0%
Total (all subregions)		
Commercial (Tribal and Non-tribal) Fisheries		
Personal income	$16,199	100%
Jobs	419	100%
Recreational Fisheries		
Personal income	$27,940	100%
Jobs	672	100%

Notes:
1. All dollar values are expressed in 2015 dollars. Jobs are expressed in full-time equivalents.
2. Estimates for commercial and recreational effects are not combined because the effects for commercial fisheries are measured at the harvesting/processing level, whereas the effects of recreational fisheries are measured at the retail level.

Source: Estimated by TCW Economics using coefficients from the IMPLAN input-output model, and based on harvest estimates provided by the NMFS (personal communication with Enrique Patiño, March 17, 2017.

3.6. Cultural Resources - Ceremonial and Subsistence (C&S) Fisheries

Salmon and steelhead play a significant role in the Ceremonial and Subsistence cultural practices among

Indian tribes in the project area. This important cultural resource may be affected by the alternatives analyzed in this EIS. Salmon and steelhead have always been and will continue to be a core symbol and foundation of tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy.

Salmon evoke sharing, gifts from nature, responsibility to the resource, and connection to the land and water. They represent the ability of Indian cultures to endure; they facilitate the transmission of tribal fishing culture to younger members, who are taught from an early age to fish and to understand their responsibility to the salmon and its habitat. The struggle to affirm and maintain the right to fish has made salmon an even more evocative symbol of tribal identity.

Salmon remain central in what is known as the first foods. The salmon was the first food to appear in early spring. First salmon ceremonies focus on thanking the fish for returning and assuring the entire community of a successful harvest. These ceremonies also draw attention to the responsibility Indian people have for providing a clean, welcoming, habitat for the returning fish. Family bands gathered along the Columbia River at their favorite or traditional fishing sites to catch and dry enough salmon to use for the year ahead.

The tribes strive to keep at least some subsistence fisheries open the entire year and regard subsistence fishing as an extremely important way for tribal people to provide food for themselves. Even during commercial fisheries, a certain portion of the catch is normally retained for subsistence use. While not all tribal members currently participate in fisheries, those who fish typically share fish with family and friends. Sharing and informal distribution of fish help to bind the community in a system of relationships and obligations. Tribal subsistence harvest can also be used for trade or barter among tribes.

This EIS incorporates by reference Subsection 3.4 of the Mitchell Act EIS, which details the importance of salmon to tribes, the ceremonial and subsistence harvests, and the role that salmon plays in the cultural viability of tribes in the area. It also details how hatchery-produced salmon and steelhead contribute to C&S harvest. As detailed in the Mitchell Act EIS, C&S harvests generally do not vary a great deal from year to year because fish are taken to meet the need. Subsistence fish are, in practice, the priority fish taken by a tribe. Tribes whose fisheries are depleted are helped by buying salmon from other tribes or receiving donations of fish. Tribes make an effort to keep salmon on hand or send out special boats for occasions that include: winter ceremonials, first salmon ceremony, naming ceremonies, and funerals.

Some of these occasions require the use of traditional foods, including salmon, for both Indian and non-Indian guests, hosts, and those who cook and serve.

3.7. Environmental Justice

The Environmental Justice analysis area includes counties and communities that may be affected by the alternatives analyzed in this EIS. The analysis area encompasses all Indian tribes that were identified in the Mitchell Act EIS. It also encompasses all counties and communities in the states of Washington, Oregon, and Idaho that are associated with the Columbia River watershed as defined in Subection 1.3. Coastal counties and communities identified in the Mitchell Act EIS outside of the project area are not included in the Environmental Justice analysis area.

3.7.1. Low Income and Minority Populations

Section 3.4.3 of the Mitchell Act EIS defined the low income and minority thresholds for counties. This EIS incorporates the same methodology as Section 3.4.3 of the Mitchell Act EIS for defining low income and minority thresholds for counties. An environmental justice county is one whose minority or low-income population was meaningfully greater than the state in which the county is located. Five population categories were considered: non-white, Native American, Hispanic, per capita income and poverty rate.

Tables 3-27 and 3-28 of the Mitchell Act EIS presented counties and communities in Washington and Oregon that exceeded the environmental justice thresholds for low income and/or minority populations. By incorporating by reference the analysis and the findings presented in those tables, 21 counties (Benton, Hood River, Jefferson, Marion, Morrow, Multnomah, Sherman, Umatilla, Wasco, Washington, and Whitman counties in Oregon and Benton, Chelan, Douglas, Franklin, Grant, Kittitas, Klickitat, Okanogan, Walla Walla and Yakima in Washington), are identified as Environmental Justice communities for this EIS.

3.7.2. American Indian Tribes

The Council for Environmental Quality (CEQ) guidance on Environmental Justice under NEPA (CEQ, 1997) requires that effects on Indian tribes also be analyzed. As the alternatives analyzed in this EIS may affect Indian tribes within the analysis area, they are included as Environmental Justice communities for this EIS. The tribes include those that are parties to the *U.S. v. Oregon* Agreement as discussed in Section 1.1 (the Shoshone-Bannock Tribes, the Nez Perce Tribe, 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 Yakama Nation (collectively, the Columbia River Treaty Tribes)) as well as the Confederated Tribes of the Colville Reservation, Cowlitz Indian Tribe, and the Confederated Tribes of the Grand Ronde.

Section 4

4. Environmental Consequences

4.1. Introduction

As described in Section 1, the Proposed Action is to issue an ITS under ESA section 7 and sign a 10-year management agreement that establishes harvest policies and defines management frameworks for *US v Oregon* fisheries in the Columbia River between January 1, 2018 and December 31, 2027. The six alternatives analyzed here are used to compare and contrast the effects on the resources that would result from the implementation of such harvest policies and management frameworks in the prosecution of *US v Oregon* fisheries between January 1, 2018 and December 31, 2027.

As described earlier in the document, in Chapters 1 and 3, NMFS is utilizing the existing analysis of hatchery effects from the Mitchell Act EIS (NMFS) to disclose the likely impacts of the hatchery production associated with a new *US v Oregon* management agreement. After careful review of the hatchery programs adopted in the proposed action and the hatchery programs analyzed in the Mitchell Act EIS, as detailed in Subsection 4.2.1, Salmonids, below, NMFS has incorporated the analysis of the Mitchell Act EIS preferred alternative to disclose the likely impacts, to the relevant resources, from the hatchery production included in the proposed action. Where the impacts may vary from those described in the Mitchell Act EIS preferred alternative, based on the comparative review detailed in Subsection 4.2.1, below, NMFS includes an assessment of the likely difference in impacts expected. These impacts are further detailed in the subsections that follow.

4.1.1. Description of Modeled Metrics for Harvest Indicator Stocks and Abundance Indicator Stocks

In order to compare the relative effect of each alternative on the resources listed in Section 3, we modeled the behavior of the previously described specific *defined metrics* for each alternative (see Subsection 3.2.1 for a description of the *defined metrics*). Modeled outputs for these *defined metrics* are used to provide a quantitative assessment of effects on the resources under the six alternatives.

Similar to how we presented baseline conditions, we present the modeled outputs for *defined metrics* for the Harvest Indicator Stocks and Abundance Indicator Stocks by providing estimates of escapement past fisheries, the number of fish harvested, harvest rate (proportion of the total "Stock" that was harvested or killed by fisheries) for each alternative, for each stock.

Recall from Subsection 3.2.1 the first two *defined metrics* measure the escapement of the Harvest and Abundance Indicator Stocks at defined locations. Fish returning to the Upper Columbia River are counted at Priest Rapids Dam and those returning to the Snake River are counted at Lower Granite Dam. This EIS models the expected abundance for a respective stock that would pass (escape) through fisheries in the *US v Oregon* agreement if that particular alternative was implemented. The expected escapement abundance outputs are modeled using recent historical minimum, average, and maximum run size information from 2005 to 2016. The harvest policies and management framework in the current management agreement have not changed since 2005.

The second set of the *defined metric*s measure catch in the Treaty commercial and C&S, and Non-treaty commercial and recreational fisheries. The expected catch is modeled based on observations from the 2005 through 2016 base years and reported showing the minimum, average, and maximum that would have occurred under each of the harvest policies analyzed.

The third set of *defined metrics* measure harvest rates in the Treaty and Non-Treaty fisheries. Harvest rates are calculated by dividing the catch and associated fishing mortality by the abundance. The expected harvest rates are modeled based on observations from the 2005 through 2016 base years and reported showing the minimum, average, and maximum that would have occurred under each of the harvest policies analyzed.

Implementing the previous *US v Oregon* agreement taught the parties that certain stocks were consistently limiting fisheries across the various seasons (season structure was described in Subsection 1.3.1). A limiting stock is one that constrains harvest during a season, by being the lowest in abundance relative to its management objective and therefore restricting access to more abundant stocks thus limiting total catch. The analysis in this EIS uses Harvest Indicator Stocks that are also the known limiting stocks, which allow for minimum and maximum catch estimates across each alternative. The modeled outputs for *defined metrics* for the Harvest Indicator Stocks and Abundance Indicator Stocks are presented in tables below.

We make the explicit assumption that the environmental conditions and status of the fish stocks for the next 10 years will be similar to those observed in the recent past. This includes effects associated with climate change (discussed in Subsection 5.2.1). By using this short contemporary time frame of historical information (2005-2016) we assume recent variations of run sizes and harvest effects related to climate change will follow similar patterns during the next decade. We note that this time frame includes a broad range of run size and environmental conditions, including 2015 which was characterized by extreme temperature and related mortalities during upstream migration. The minimums reported in the analysis of alternatives will more closely represent the outcomes if adverse conditions resulting from climate change are more frequent over the next ten years than they were since 2005.

US v Oregon fisheries have been managed under the current management framework since 2005. We can therefore use historical information to estimate numerical outputs for each of the *defined metrics* in our analysis. Our analysis is based on historical data made available by the *US v Oregon* TAC that is used to compare the relative differences in impacts to the resources among alternatives.

Some assumptions are necessary to compare the relative effects of different alternatives and minimize the complexity of the underlying analyses. Harvest policies and associated management frameworks are used to set catch levels. But the catch must also be allocated between the treaty and non-treaty fisheries, and subsequently the states and tribes then make decisions about how to allocate further into their respective fishing sectors. The allocation of catch may not affect biological outcomes, but does affect economic outcomes. Allocations between treaty and non-treaty fisheries are explicitly determined by the *US v Oregon* management agreement for certain stocks, but not for others. In the following analysis, we use the allocations specified in the agreement where they exist, and use historic patterns of allocations where it is not otherwise specified. The allocation between non-treaty commercial and recreational fisheries is determined by the states of Oregon and Washington outside of the *US v Oregon* management agreement. These allocation decisions have changed in the past and may well change in the future. However, for the purposes of comparing the effects of the different alternatives, we have made the assumption that future allocations will be the same as those observed in recent years. Likewise, allocations in tribal fisheries between ceremonial and subsistence (C&S), and commercial fisheries are made by the tribes based on year and fishery specific circumstances. We assume observations from the recent past encompass the range of outcomes likely to be observed during the course of the next agreement.

Results from the analysis are organized as follows. First, we show the results of the analysis for all alternatives for each of the Harvest Indicator and associated Abundance Indicator Stocks one by one. The *defined metrics* provide the basis for comparison of the relative effect of each alternative. This information is then used to examine the impacts of the alternatives on each subsequent resource identified in Section 3.

We assume that all fish allowed under the "harvest policy" criteria for each alternative are caught even though in some cases, such as fall season fisheries where there are multiple limiting stocks, certain fisheries cannot always catch all their available fish from one *Indicator Stock* due to limits on other *Indicator Stocks*. In Subsections 4.2 through 4.7 we will examine one resource at a time and compare the relative effects on that resource from each alternative.

Escapement Benchmarks

For each of the abundance indicator stocks, we use escapement related benchmarks to assess the conservation outcomes and impacts for each alternative. These are generally based on the population abundance recovery criteria that are summed at the ESU or DPS level and reported at the last upstream counting location - Lower Granite Dam on the Snake River and Rock Island Dam on the upper Columbia River. In most cases we further adjust the escapement benchmark at the last upstream counting station to account for subsequent mortality while migrating upstream from that final counting station and for the likelihood that fish arriving at the upstream counting station would distribute themselves unevenly to the individual tributaries. In most cases this adjustment factor is 25 percent, meaning that we assume that only 75 percent survive to their final spawning ground. The 25 percent value is used as a surrogate absent better, stock specific information. However, for Snake River sockeye salmon, we have direct estimates of the survival rate from Lower Granite Dam to the Stanley Basin (55.4 percent) and use that value to approximate an escapement benchmark at Lower Granite Dam.

These benchmarks should be viewed as approximations and examples of an approach and not recommendations for the specific criteria that should be used for implementing harvest policies and the related management frameworks. Nonetheless, they are used here to evaluate the relative effects of each alternative.

The escapement benchmark for natural-origin UCR spring Chinook salmon is 4,000 fish (3,000/0.75) measured at Rock Island Dam which approximates the aggregate abundance of natural-origin spawners necessary to meet recovery objectives. The aggregate abundance of natural-origin spawners necessary to meet recovery objectives for natural-origin Snake River spring/summer Chinook salmon is 34,000 (25,500/0.75). The escapement objective for UCR summer Chinook salmon used for evaluating the alternatives is 20,000 hatchery and natural-origin fish (which requires 29,000 fish at the mouth of the Columbia River). This is consistent with the escapement goal used in the current management agreement and is used directly without expansion. For Snake River Sockeye salmon we use 12,600 (7,000/0.554) fish to Lower Granite Dam. The escapement benchmark for Snake River fall Chinook salmon is 4,000 (3,000/0.75) natural-origin fish. Developing a similar benchmark for Snake River steelhead, and Snake River B-run steelhead in particular, is more problematic. Recovery level abundance criteria have been defined for some, but not all populations. As a consequence, we describe below the approach taken for this EIS.

There are 23 populations in the Snake River steelhead DPS. Twenty-two are located above Lower Granite Dam. The Tucannon population is the exception. We have abundance related recovery criteria for 11 of the 22 populations that sum to a total of 6,700. To approximate the recovery abundance of all 22 populations, we double the estimate to 13,400. The Snake River steelhead DPS includes both A-run and B-run fish. As described more thoroughly in Subsection 3.2.1.4, B-run steelhead are generally older, larger, and have later run timing. Some populations have a higher proportion of B-run fish, but none are entirely B-run. We are not aware of a peer reviewed scientifically reviewed abundance based related recovery criterion for B-run steelhead. We multiply 13,400 by 0.15, the average proportion of all natural-origin steelhead at Lower Granite Dam that are designated B-run as counted over the base period (2005 - 2016). The result is approximately 2,000. The abundance related benchmark used in the analysis is therefore 2,700 (2000/0.75).

The table format below is used in the sections that follow to provide the defined metrics for each abundance indicator stock.

A	B	C	D	E	F	G
	River Mouth	*Treaty Harvest*	*Non-Treaty Harvest*	*Total HR*	*Esc. Past Fisheries*	*Rock Island Dam Count*
min						
max						
ave						

- Column A. River Mouth: Shows the type of modelled run size at the river mouth. As described in Subsection 3.2, the actual river mouth run sizes from 2005 to 2016 were cataloged and three data points representing the minimum run size, maximum run size, and average run size were calculated. As explained in Subsection 4.1.1, we assume recent variations of run sizes and harvest effects related to climate change will follow similar patterns during the next decade.
- Column B. River Mouth: Presents the expected minimum, maximum, and average projected run sizes for the period 2018-2027 at the mouth of the Columbia River.
- Columns C. Treaty Harvest: Presents the calculated treaty fisheries total harvest number for the stock
- Column D. Non-Treaty Harvest: Presents the calculated non-treaty fisheries total harvest number for the stock
- Column E. Total Harvest Rate. This shows the total harvest rate (treaty plus non-treaty harvest combined) as a percentage of the run size
- Column F. Esc. Past Fisheries: The modeled number of fish that escape past the fisheries; i.e., the run size (Column B) minus the total harvest number (Column C plus Column D).
- Column G. Rock Island Dam County: this is the projected count of fish at the last upstream counting location (in this case Rock Island Dam on the Upper Columbia River).

There are two other important indicators used in the figures in the subsections in Subsection 4.2:

- Spawning Escapement Benchmark – As discussed above under Escapement Benchmark, the modeled count at the last counting station (Column G) is further adjusted to account for the loss of fish between the counting station and their spawning ground. This loss includes mortality upstream of the counting station as well as uneven distribution to the individual tributaries.
- Interdam Loss **-** This is calculated as the difference between Columns G and F, the difference in fish stocks between the mouth of the river and the last upstream counting station independent of fishing. The difference represents fish loses due to natural mortality or turnout to mainstem tributaries, and mortality associated with hydro operations, illegal fishing, and habitat degradation. The difference is based on estimates developed by the *US v Oregon* TAC. While this number provides an illustrative benchmark by which to evaluate the effects on the stock, it is not a specific proposal for the number of fish that suffer interdam loss.

Impacts of fishing

Fisheries impact the environment by killing target species and thereby reducing fish abundance and spawning potential. Fisheries may also kill fish species that they do not target. These fish, known as bycatch, are killed when fishing operations unintentionally catch and discard non-target fish, potentially causing unobserved injury and mortality. These non-target fish may include the harvest indicator units that are the subject of this EIS. As explained in Section 1 and Section 2, a new *US v Oregon* management agreement would track salmonid harvest across a wide number of fisheries, including bycatch of salmonids in non-salmonid directed fisheries.

Implementing a new *US v Oregon* management agreement will result in the removal of salmonids from the environment for commercial, recreational, or ceremonial and subsistence (C&S) consumption. In the following Subsections (4.1.1.1 through 4.1.1.5) we provide the modeled outputs, as just described above, to the harvest indicator stocks known as limiting stocks in the form of harvest rates (recall a harvest rate is the ratio of fishery related mortality for a group of fish over its abundance in a defined period of time). Reducing fish abundance, and subsequent spawning population potential, can lead to impacts of population parameters. At levels of high fish removal an originally stable, mature and efficient ecosystem might be deprived of nutrient input that results in the ecosystem becoming immature and stressed. This happens in various ways. By targeting and reducing the abundance of high-value predators, fisheries modify the trophic chain and the flows of biomass (and energy) across the ecosystem as well as remove the nutrients from the system that are contained within the fish carcasses themselves.

Each harvest policy analyzed in this EIS results in a rate at which fish may be harvested. The direct inverse result of each harvest rate is a rate at which fish that are not harvested are able to escape past the fisheries and potentially return to the spawning grounds to spawn (e.g., if a harvest rate was 40 percent, then the subsequent escapement rate would be roughly 60 percent of any particular run size). Each alternative analyzed in this EIS only differs in the calculation of these two rates, however escapement estimates are presented in total numbers (e.g., if a harvest rate was 40 percent on a run size of 10,000, then 4,000 fish died from harvest (10,000 * 0.4 = 4,000), and the resulting escapement is 6,000 (10,000 - harvest of 4,000 = 6,000)). Therefore, the impacts of each alternative analyzed are the harvest rates and escapement totals. These will vary based on the alternative and the fluctuating projected fish run sizes. The subsections that follow (4.1.1.1 through 4.1.1.5) describe the impacts of the alternatives on each indicator stock. Subsection 4.2 compares these impacts of each alternative relative to baseline conditions and the other alternatives for each indicator stock.

4.1.1.1. Upriver Spring Chinook Salmon

For management purposes, Upriver spring Chinook salmon are defined in the agreement as all adult spring and Snake River spring/summer Chinook salmon returning to areas upstream of Bonneville Dam between January 1 and June 15. This stock includes both hatchery and natural-origin fish. Under the current agreement, Upriver spring Chinook salmon are managed using an abundance based management framework that depends on the abundance of Upriver spring Chinook salmon, natural-origin Snake River spring/summer Chinook salmon, and natural-origin UCR spring Chinook salmon. Allowable harvest rates range from 5.5 percent to 17 percent (Table 4-1).

Table 4-1. Spring Management Period Harvest Rate Schedule

Harvest Rate Schedule for Chinook Salmon in Spring Management Period					
Total Upriver Spring and Snake River Summer Chinook Run Size	**Snake River Natural Spring/Summer Chinook Run Size[1]**	**Treaty Zone 6 Total Harvest Rate**	**Non-Treaty Natural Harvest Rate**	**Total Natural Harvest Rate[2]**	**Non-Treaty Natural Limited Harvest Rate[2]**
<27,000	<2,700	5.0%	<0.5%	<5.5%	0.5%
27,000	2,700	5.0%	0.5%	5.5%	0.5%
33,000	3,300	5.0%	1.0%	6.0%	0.5%
44,000	4,400	6.0%	1.0%	7.0%	0.5%
55,000	5,500	7.0%	1.5%	8.5%	1.0%
82,000	8,200	7.4%	1.6%	9.0%	1.5%
109,000	10,900	8.3%	1.7%	10.0%	
141,000	14,100	9.1%	1.9%	11.0%	
217,000	21,700	10.0%	2.0%	12.0%	
271,000	27,100	10.8%	2.2%	13.0%	
326,000	32,600	11.7%	2.3%	14.0%	
380,000	38,000	12.5%	2.5%	15.0%	
434,000	43,400	13.4%	2.6%	16.0%	
488,000	48,800	14.3%	2.7%	17.0%	

1. If the Snake River natural spring/summer forecast is less than 10 percent of the total upriver run size, the allowable mortality rate will be based on the Snake River natural spring/summer Chinook run size. In the event the total forecast is less than 27,000 or the Snake River natural spring/summer forecast is less than 2,700, Oregon and Washington would keep their mortality rate below 0.5 percent and attempt to keep actual mortalities as close to zero as possible while maintaining minimal fisheries targeting other harvestable runs.

2. If the Upper Columbia River natural spring Chinook forecast is less than 1,000, then the total allowable mortality for treaty and non-treaty fisheries combined would be restricted to 9 percent or less. Whenever Upper Columbia River natural fish restrict the total allowable mortality rate to 9 percent or less, than non-treaty fisheries would transfer 0.5 percent harvest rate to treaty fisheries. In no event would non-treaty fisheries go below 0.5 percent harvest rate.

Each of the alternatives for Upriver spring Chinook salmon presumes that the catch balance provisions of the agreement continue to apply. Catch balancing requires that the total fishery mortality (landed catch plus release mortality) for non-treaty fishery cannot exceed the allowed treaty total harvest. Non-treaty spring season fisheries are mark selective and treaty fisheries are full retention. Treaty fisheries utilize total harvest rate limits and non-treaty fisheries utilize natural-origin harvest rate limits and this would be expected to continue into the future under any of the alternatives. As a consequence, the following tables show the total catch of fish when comparing treaty or non-treaty total harvest is equal (catch sharing), but the catch of natural-origin fish in the non-treaty fisheries is less than treaty fisheries.

4.1.1.1.1. Alternative 1—Extension of Current Agreement

Under Alternative 1 fisheries would be managed using the abundance based management framework that allows harvest rates to range from 5.5 percent to 17 percent. For the purpose of comparing the relative effects of the alternatives we assume that extending the current *US v Oregon* agreement for the next ten years would result in harvest patterns similar to those of the last 12 years. Table 4-2 provides the minimum, maximum and average values for the *defined metrics* for Upriver spring Chinook salmon (a Harvest Indicator Stock). Table 4-3 and Table 4-4 provide *defined metrics* for natural-origin Snake River spring/summer Chinook salmon and natural-origin Upper Columbia River spring Chinook salmon under Alternative 1, respectively (Abundance Indicator Stocks). The values for the defined metrics in these three tables are based on the projected run sizes.

Under Alternative 1 (Extension), the harvest and escapement levels are unchanged from the baseline. Harvest fluctuates with the projected run size, meaning in years of low abundance harvest rates are lower than in years of high abundance. This results in escapement levels lower during years of low abundance, thereby reducing the adverse impact of removing fish from the spawning population during these years. Conversely, during years of high abundance, the greatest proportion of fish are harvested at the highest harvest rate. The resulting impact to the spawning population is negligible as the total number of fish escaping past the fisheries is still large.

Table 4-2. *Defined Metrics* for Upriver Spring Chinook salmon under Alternative 1.

	Total Treaty Catch	**Min. Expected C&S**	**Max Expected Comm.**	**Total Non-treaty Catch**	**Total Comm.**	**Total Z 1-5 Sport**	**Total Z 6 - I395 sport**	**Total Lower Snake Sport**	**Total NT Tribal**
min.	6,364	6,191	173	6,364	1,448	3,877	714	321	4
max.	34,020	10,548	23,472	34,020	7,743	20,726	3,817	1,713	21
ave.	17,868	10,340	7,528	17,868	4,067	10,886	2,005	900	11

Table 4-3. *Defined Metrics* for natural-origin Snake River Spring/summer Chinook salmon under Alternative 1.

	Snake River Spring/ summer Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Lower Granite Run
min.	12,017	942	161	9.2%	10,913	8,360
max.	44,014	5,037	862	13.4%	38,115	29,199
ave.	26,269	2,645	453	11.8%	23,171	17,751

Table 4-4. *Defined Metrics* for natural-origin UCR spring Chinook salmon under Alternative 1

	UCR Spring Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Rock Island Dam Count
min	1,374	108	18	9.2%	1,248	1,101
max	5,032	576	97	13.4%	4,360	3,846
ave	3,003	302	51	11.8%	2,650	2,338

4.1.1.1.2. Alternative 2—Abundance-based Management

Under Alternative 2 fisheries would be managed using an abundance based management framework. Although other abundance based frameworks could be devised that would be more or less restrictive, the analysis assumes that the current framework would apply thus allowing harvest rates to range from 5.5 percent to 17 percent. The relative merits of abundance based management as a harvest policy are discussed in Subsection 2.1.2. Because the frameworks under Alternative 1 and Alternative 2 are the same, the analytical results and impacts are also the same (Tables 4-5 through 4-6).

Table 4-5. *Defined Metrics* for Upriver spring Chinook salmon under Alternative 2.

	Total Treaty Catch	Min. Expected C&S	Max Expected Comm.	Total Non-treaty Catch	Total Comm.	Total Z 1-5 Sport	Total Z 6 - I395 sport	Total Lower Snake Sport	Total NT Tribal
min.	6,364	6,191	173	6,364	1,448	3,877	714	321	4
max.	34,020	10,548	23,472	34,020	7,743	20,726	3,817	1,713	21
ave.	17,868	10,340	7,528	17,868	4,067	10,886	2,005	900	11

Table 4-6 *Defined Metrics* for natural-origin Snake River spring/summer Chinook salmon under Alternative 2.

	Snake River spring/ summer Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Lower Granite Run
min.	12,017	942	161	9.2%	10,913	8,360
max.	44,014	5,037	862	13.4%	38,115	29,199
ave.	26,269	2,645	453	11.8%	23,171	17,751

Table 4-7. *Defined Metrics* for natural-origin UCR spring Chinook salmon under Alternative 2.

	UCR spring Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Rock Island Dam Count
min.	1,374	108	18	9.2%	1,248	1,101
max.	5,032	576	97	13.4%	4,360	3,846
ave.	3,003	302	51	11.8%	2,650	2,338

4.1.1.1.3. Alternative 3—Fixed Harvest Rate

Under Alternative 3 fisheries would be managed using a fixed harvest rate of 11.3 percent. This is the average of the rates observed from 2005 to 2016. Although other fixed harvest rate levels could be devised that would be more or less restrictive, the average represents a plausible alternative that is used for comparison to the other alternatives. The fixed rate sets a limit on the total harvest rate. The analysis assumes that catch is distributed between fisheries using the average proportions observed during the 2005 to 2016 base years. Table 4-8 shows the minimum, maximum and average values for the Defined Metrics for Upriver spring Chinook salmon under Alternative 3. Table 4-9 and Table 4-10 provide the minimum, maximum and average values for *Defined Metrics* for natural-origin Snake River spring/summer Chinook salmon and natural-origin Upper Columbia River spring Chinook salmon under Alternative 3, respectively. In Table 4-8 the average expected C&S catch is greater than the maximum because in the past twelve years the tribes have allocated a greater proportion of the catch to C&S relative to commercial catch in the middle of the observed runsize range. In other words, at the highest observed runsize, less catch was allocated to C&S than in years of runsizes around the middle of the historical range.

Under Alternative 3, the harvest and escapement levels are constant. Harvest rate impacts occur constantly at the same proportions regardless of any fluctuation in projected run size. Therefore, in years of low abundance harvest rates are the same as those in years of high abundance. This restricts the negative impacts associated with removing a greater number of fish from the spawning population during years of high abundance, thereby providing a slightly positive increase in the escapement past fisheries during large run sizes.

Table 4-8. *Defined Metrics* for Upriver spring Chinook salmon under Alternative 3.

	Total Treaty Catch	Min. Expected C&S	Max Expected Comm.	Total Non-treaty Catch	Total Comm.	Total Z 1-5 Sport	Total Z 6 - I395 sport	Total Lower Snake Sport	Total NT tribal
min	7,826	7,613	213	7,826	1,781	4,768	878	394	5
max	28,665	8,888	19,777	28,665	6,524	17,464	3,216	1,444	17
ave	17,108	10,335	6,773	17,108	3,894	10,423	1,919	862	10

Table 4-9. *Defined Metrics* for natural-origin Snake River spring/summer Chinook salmon under Alternative 3.

	Snake River spring/ summer Chinook River Mouth	Treaty Harvest	Non-Treaty Harvest	Total HR	Esc. Past Fisheries	Lower Granite Run
min	12,017	1,159	198	11.3%	10,660	8,166
max	44,014	4,244	727	11.3%	39,044	29,911
ave	26,269	2,533	434	11.3%	23,302	17,851

Table 4-10. *Defined Metrics* for natural-origin UCR spring Chinook salmon under Alternative 3.

	UCR spring Chinook River Mouth	Treaty Harvest	Non-Treaty Harvest	Total HR	Esc. Past Fisheries	Rock Island Dam Count
min	1,374	132	22	11.3%	1,219	1,075
max	5,032	485	81	11.3%	4,466	3,939
ave	3,003	290	49	11.3%	2,665	2,351

4.1.1.1.4. Alternative 4—Fixed Escapement Management

Under Alternative 4 fisheries would be managed using a fixed escapement goal policy based on the abundance of natural-origin UCR spring Chinook salmon. For this example, the escapement goal was set at 3,000 natural-origin UCR spring Chinook salmon past fisheries. The escapement goal approximates the aggregate abundance of natural-origin spawners necessary to meet recovery objectives for the UCR spring Chinook ESU. In this example, if the expected escapement is below the escapement goal, the allowable harvest during the spring management period would be zero and Alternative 5 would best represent the expected outcome. Often under similar circumstances, a fixed escapement goal is coupled with a *de minimis* level of harvest opportunity to meet the minimal needs for tribal fisheries and allow limited access to other harvestable stocks. In this Alternative, the fixed escapement policy was coupled with a *de minimis* harvest rate cap of 1 percent for non-treaty fisheries and 5 percent for treaty fisheries. The *de minimis* rates are drawn from the lowest rates allowed in the abundance based harvest framework described in Alternative 1.

Other fixed escapement goal management objectives could have been used to explore the effect of fixed escapement goal policies. The aggregate abundance of natural-origin spawners necessary to meet recovery objectives for natural-origin Snake River spring/summer Chinook salmon is 25,500. In either case, we would be using a weak stock as the basis for the harvest policy. Another approach would be to design a fixed harvest rate policy designed to maximize harvest opportunity. For example, setting an escapement goal based on the aggregate abundance of hatchery and natural-origin Upriver spring Chinook salmon would maximize harvest in the short term, but would do so at the expense of weaker stocks that would routinely be subject to higher harvest rates. The basis for choosing the conservative approach offers the highest likelihood of adhering to recovery plans.

Table 4-11 illustrates what the minimum, maximum and average could be for the *defined metrics* for Upriver spring Chinook salmon under Alternative 4. Table 4-12 and Table 4-13 provide the minimum, maximum and average values for *Defined Metrics* for natural-origin Snake River spring/summer Chinook salmon and natural-origin Upper Columbia River spring Chinook salmon under Alternative 4, respectively.

Analyzing this approach in more detail, harvest adhering to fixed escapement goals may be defined in various ways. They may be defined as a number of fish escaping fisheries or they may be defined as a number of fish reaching a certain location after fisheries occur such as an upstream dam or spawning area. Fixed escapement goals imply that each fish exceeding the goal may be harvested. Under situations where run sizes are less than the escapement goal, these alternatives provide for a minimal level of fishing. This is a common practice in salmon management especially to allow some minimal opportunity to meet either treaty needs or to access other more abundant stocks. The natural-origin escapement goal for upper Columbia spring Chinook salmon was set at 3,000 fish. The average escapement past fisheries since 2005 is approximately 2,700. Historic relationships between natural-origin and total harvest rates were utilized to calculate treaty total harvest rates and non-treaty natural-origin harvest rates that would both meet the catch balance requirement and escape 3,000 natural-origin upper Columbia fish past the fisheries. Using average post fishery loss rates an expected run size to Rock Island Dam (RIS) can be calculated. Post fishery loss includes a mix of natural and anthropogenic mortality such as passage loss through the hydrosystem.

Under Alternative 4 the impacts from harvest vary based on the run size, but the associated impacts towards modifying spawning population levels are constant. A fixed number of fish escape the fisheries. Harvest rates fluctuate as the projected run sizes fluctuate. In years of low abundance harvest rates are low, but in years of high abundance harvest rates are high. This is because all fish above the fixed escapement goal are deemed harvestable. During years of high abundance, negative impacts are maximized as all the fish above the escapement level are harvested. Thereby, compared to baseline conditions, Alternative 4 results in the lowest average level of escapement towards a total spawning population abundance.

Table 4-11. *Defined Metrics* for Upriver spring Chinook salmon under Alternative 4.

	Total Treaty Catch	Min. Expected C&S	Max Expected Comm.	Total Non-treaty Catch	Total Comm.	Total Z 1-5 Sport	Total Z 6 - I395 sport	Total Lower Snake Sport	Total NT tribal
min	4,300	4,183	117	4,300	979	2,620	482	217	3
max	102,811	31,877	70,934	102,811	23,399	62,637	11,534	5,178	62
ave	26,468	11,541	14,928	26,468	6,024	16,126	2,969	1,333	16

Table 4-12. *Defined Metrics* for natural-origin Snake River spring/summer Chinook salmon under Alternative 4.

	Snake River spring/summer Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Lower Granite Run
min.	12,017	637	109	6.2%	11,271	8,634
max.	44,014	15,221	2,606	40.5%	26,188	20,062
ave.	26,269	3,919	671	17.5%	21,679	16,608

Table 4-13. *Defined Metrics* for natural-origin UCR spring Chinook salmon under Alternative 4.

	UCR spring Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Rock Island Dam Count
min.	1,374	73	12	6.2%	1,289	1,137

max.	5,032	1,740	292	40.4%	3,000	2,646
ave.	3,003	448	75	17.4%	2,480	2,188

4.1.1.1.5. Alternative 5—Voluntary Fishing curtailment

Under Alternative 5, harvest rates were assumed to be zero thus providing a benchmark for comparison to the other alternatives. Table 4-14 shows the maximum escapement of Upriver spring Chinook that could occur absent all fishing. Table 4-15 and Table 4-16 show the maximum escapement of natural-origin Snake River spring/summer Chinook salmon and natural-origin Upper Columbia River spring Chinook salmon that could occur absent all fishing, respectively.

Under Alternative 5, the impacts associated with harvest are removed. This thereby provides the largest possible spawning population to the greatest extent possible each year.

Table 4-14. *Defined Metrics* for Upriver spring Chinook salmon under Alternative 5.

	Total Treaty Catch	Min. Expected C&S	Max Expected Comm.	Total Non-treaty Catch	Total Comm.	Total Z 1-5 Sport	Total Z 6 - I395 sport	Total Lower Snake Sport	Total NT tribal
min.	0	0	0	0	0	0	0	0	0
max.	0	0	0	0	0	0	0	0	0
ave.	0	0	0	0	0	0	0	0	0

Table 4-15. *Defined Metrics* for natural-origin Snake River spring/summer Chinook salmon under Alternative 5

	Snake River spring/ summer Chinook River Mouth	Treaty Harvest	Non-Treaty Harvest	Total HR	Esc. Past Fisheries	Lower Granite Run
min	12,017	0	0	0%	12,017	9,013
max	44,014	0	0	0%	44,014	33,011
ave	26,269	0	0	0%	26,269	19,702

Table 4-16. *Defined Metrics* for natural-origin UCR spring Chinook salmon under Alternative 5

	UCR spring Chinook River Mouth	Treaty Harvest	Non-treaty Harvest	Total HR	Esc. Past Fisheries	Rock Island Dam Count
min	1,374	0	0	0%	1,374	1,031
max	5,032	0	0	0%	5,032	3,774
ave	3,003	0	0	0%	3,003	2,252

4.1.1.1.6. Alternative 6—No-action—Uncoordinated Harvest

Under the No Action—Uncoordinated Harvest alternative the federal parties would not sign the new agreement leading to tremendous uncertainty. As described in Subsection 2.2.6, the state and tribal parties might choose to forego harvest, a potential outcome that is described in Alternative 5. On the other hand, the parties could also choose to act independently to implement fisheries resulting in uncoordinated harvest that, at the upper end, would be constrained by the capacity of the various fishing sectors to catch fish. Resulting harvest levels could greatly exceed those observed in recent years. It is of course difficult to predict the level of fishing that would occur under this alternative, but the outcome can be approximated by the results and impacts described under Alternative 4.

Therefore, Alternative 6 results in aggressive harvest rates that range from 6.2 percent minimum to 40.4 percent maximum, with an average of 17.4 percent as shown in tables 4-11 through 4-13. This compares to an average harvest rate under the baseline conditions of 11.8 percent (Table 3-5).

Under Alternative 6, as just described, the highest levels of impacts observed in Alternative 4 are expected to occur. This results in maximizing negative impacts associated with removing fish from a resulting spawning population to the greatest extent during years of high abundance, and thereby results in the lowest average level of escapement towards a total spawning population.

4.1.1.2. Upriver Summer Chinook Salmon

For management purposes, upper Columbia summer Chinook salmon are defined in the agreement as all Chinook salmon passing Bonneville Dam between June 16 and July 31. They are not listed under the ESA. Upper Columbia summer Chinook includes both hatchery and natural-origin fish. In recent years, the stock has been abundant providing significant harvest opportunity and therefore can be used to illustrate harvest policy alternatives that apply to healthy stocks.

Under the current agreement, summer Chinook salmon are managed using a mix of harvest policies

(Table 4-17). When the run size is less than 29,000, fisheries are managed using an abundance based harvest rate framework with harvest rates ranging from 7 percent to 17 percent. At higher run sizes, the stock is managed using a modified fixed escapement policy that allows for some of the otherwise harvestable fish to accrue to escapement to better inform management decisions in the future. As a consequence, at higher abundance, the expected escapements range from 29,000 to 41,500. If the fixed escapement policy without this feature, expected escapements would never exceed 29,000. Upriver summer Chinook are generally managed to achieve 50/50 sharing between treaty and non-treaty fisheries. Under the current framework a greater proportion of the catch is allocated to the treaty fishery at low run size.

Table 4-17. Summer Management Period Chinook Harvest Rate Schedule.

River Mouth Run Size	Max. Treaty Total Harvest Rate	Treaty Harvest	Max Non-treaty Total Harvest Rate	Non-treaty Harvest	Escapement Past Fisheries
5,000	5.0%	250	2.0%	<100	4,650
7,500	5.0%	375	2.7%	<200	6,925
10,000	5.0%	500	2.0%	<200	9,300
12,500	5.0%	625	1.6%	<200	11,675
15,000	5.0%	750	1.3%	<200	14,050
16,000	10.0%	1,600	5.0%	800	13,600
17,500	10.0%	1,750	5.0%	875	14,875
20,000	10.0%	2,000	5.0%	1,000	17,000
22,500	10.0%	2,250	5.0%	1,125	19,125
25,000	10.0%	2,500	5.0%	1,250	21,250
27,500	10.0%	2,750	5.0%	1,375	23,375
29,000	10.0%	2,900	5.0-6.0%	1,450-1,740	≥24,360
30,000	10.0%	3,000	5.0-6.0%	1,500-1,800	≥25,200
32,500	10.0%	3,250	7.0%	2,275	26,975
35,000	10.0%	3,500	7.0%	2,450	29,050
36,250	10.0%	3,625	10.0%	3,625	29,000
37,500	11.3%	4,250	11.3%	4,250	29,000
40,000	13.8%	5,500	13.8%	5,500	29,000
42,500	15.9%	6,750	15.9%	6,750	29,000
45,000	17.8%	8,000	17.8%	8,000	29,000
47,500	19.5%	9,250	19.5%	9,250	29,000
50,000	21.0%	10,500	21.0%	10,500	29,000
52,500	21.8%	11,438	21.8%	11,438	29,625
55,000	22.5%	12,375	22.5%	12,375	30,250
57,500	23.2%	13,313	23.2%	13,313	30,875
60,000	23.8%	14,250	23.8%	14,250	31,500

62,500	24.3%	15,188	24.3%	15,188	32,125
65,000	24.8%	16,125	24.8%	16,125	32,750
67,500	25.3%	17,063	25.3%	17,063	33,375
70,000	25.7%	18,000	25.7%	18,000	34,000
72,500	26.1%	18,938	26.1%	18,938	34,625
75,000	26.5%	19,875	26.5%	19,875	35,250
77,500	26.9%	20,813	26.9%	20,813	35,875
80,000	27.2%	21,750	27.2%	21,750	36,500
82,500	27.5%	22,688	27.5%	22,688	37,125
85,000	27.8%	23,625	27.8%	23,625	37,750
87,500	28.1%	24,563	28.1%	24,563	38,375
90,000	28.3%	25,500	28.3%	25,500	39,000
92,500	28.6%	26,438	28.6%	26,438	39,625
95,000	28.8%	27,375	28.8%	27,375	40,250
97,500	29.0%	28,313	29.0%	28,313	40,875
100,000	29.3%	29,250	29.3%	29,250	41,500

Each alternative presumes the status quo treaty/non-treaty allocation under the *US v Oregon* agreement where the harvestable number of Chinook salmon are shared 50/50 at any run above the escapement goal with the treaty fisheries receiving a larger share at very low run sizes. The allocation for non-treaty fisheries includes non-treaty sport and commercial impacts in the Pacific Fishery Management Council (PFMC) management area as well as Wanapum and Colville tribal fishery impacts in the upper Columbia. These to tribal groups are separate from the other treaty tribes and their harvest is considered as non-treaty catch. These alternatives do not specifically analyze impacts to natural-origin fish as the summer Chinook salmon hatchery and natural-origin proportions are not available from TAC.

4.1.1.2.1. Alternative 1—Extension of Current Agreement

Under Alternative 1, fisheries would be managed using the mixed harvest management framework described above. That would allow for harvest rates that range from 7 percent to nearly 60 percent. Table 4-18 provides the minimum, maximum and average values for the *defined metrics* for Upriver summer Chinook salmon.

Under Alternative 1 (Extension), the harvest and escapement levels are unchanged from the baseline. Harvest fluctuates with the projected run size, meaning in years of low abundance harvest rates are lower than in years of high abundance. This results in escapement levels lower during years of low abundance, thereby reducing the adverse impact of removing fish from the spawning population during these years. Conversely, during years of high abundance, the greatest proportion of fish are harvested at the highest harvest rate. The resulting impact to the spawning population is negligible as the total number of fish escaping past the fisheries is still large.

Table 4-18. *Defined Metrics* for Upriver summer Chinook salmon under Alternative 1

		Non-Treaty								Treaty				
	Run Size	Ocean	Non-treaty Commercial	Sport Z 1-5	Sport Z 6	Sport Mcn - PRD	Sport Above PRD	Non-treaty Tribal	Total Non-treaty	Treaty C&S	Treaty Commercial	Total Treaty	Total Harvest	Esc. Past Fisheries
min.	37,000	808	688	752	103	36	820	792	4,000	400	3,600	4,000	8,000	29,000
max.	134,000	8,485	7,221	7,901	1,085	377	8,614	8,317	42,000	4,200	37,800	42,000	84,000	50,000
ave.	74,417	3,944	3,356	3,672	504	175	4,003	3,866	19,521	1,952	17,569	19,521	39,042	35,375

4.1.1.2.2. Alternative 2—Abundance-based Management

Under Alternative 2 fisheries would be managed using a simple abundance management framework based on the abundance of Upriver summer Chinook salmon. In the example, the total harvest rate would range from 20 percent to 60 percent with the catch shared equally between treaty and non-treaty fisheries (10 percent to 30 percent for each) (Table 4-19). Table 4-20 provides the minimum, maximum and average values for the *defined metrics* for Upriver summer Chinook salmon. Because the frameworks under Alternative 1 and Alternative 2 are the same, the analytical results and impacts are also the same.

Table 4-19. Abundance-based harvest rate schedule for upriver summer Chinook salmon.

Run Size	Allowed Total Harvest	Allowed Treaty or Non-treaty Harvest	Allowed Treaty or Non-treaty Harvest Rate
37,000	7,400	3,700	10.0%
52,000	20,800	10,400	20.0%
58,000	23,200	11,600	20.0%
60,000	30,000	15,000	25.0%
61,000	30,500	15,250	25.0%
71,000	35,500	17,750	25.0%
75,000	40,500	20,250	27.0%
78,000	42,120	21,060	27.0%
83,000	44,820	22,410	27.0%
87,000	50,460	25,230	29.0%
97,000	56,260	28,130	29.0%
134,000	80,400	40,200	30.0%

Table 4-20. *Defined Metrics* for Upriver summer Chinook salmon under Alternative 2

		Non-Treaty								Treaty				
	Run Size	Ocean	Non-Treaty Commercial	Sport Z 1-5	Sport Z 6	Sport Mcn - PRD	Sport Above PRD	Non-Treaty Tribal	Total Non-Treaty	Treaty C&S	Treaty Commercial	Total Treaty	Total Harvest	Esc. Past Fisheries
min	37,000	748	636	696	96	33	759	733	3,700	370	3,330	3,700	7,400	29,600
max	134,000	8,122	6,911	7,562	1,039	361	8,244	7,961	40,200	4,020	36,180	40,200	80,400	53,600
ave	74,417	3,889	3,309	3,621	497	173	3,948	3,812	19,248	1,925	17,324	19,248	38,497	35,920

4.1.1.2.3. Alternative 3—Fixed Harvest Rate

Under Alternative 3 fisheries would be managed using a fixed harvest rate of 42 percent which is the recent year average. In this example, we presume that the catch would be shared equally between the treaty and non-treaty fisheries. Table 4-21 provides the minimum, maximum and average values for the *defined metrics* for Upriver summer Chinook salmon.

Under Alternative 3, the harvest and escapement levels are constant. Harvest rate impacts occur constantly at the same proportions regardless of any fluctuation in projected run size Therefore, in years of low abundance harvest rates are the same as those in years of high abundance. This restricts the negative impacts from removing a greater number of fish from the spawning population during years of high abundance, thereby providing a slightly positive increase in the escapement past fisheries during large run sizes.

4.1.1.2.4. Alternative 4—Fixed Escapement Management

Under Alternative 4 fisheries would be managed using a fixed escapement goal of 29,000, but does not include other features of the management framework described under Alternative 1. Table 4-22 provides the minimum, maximum and average values for the *defined metrics* for Upriver summer Chinook salmon.

Under Alternative 4 the impacts from harvest vary based on the run size, but the associated impacts towards modifying spawning population levels are constant with a fixed escapement level. A fixed number of fish escape the fisheries. Harvest rates fluctuate as the projected run sizes fluctuate. In years of low abundance harvest rates are low, but in years of high abundance harvest rates are high. This is because all fish above the fixed escapement goal are deemed harvestable. During years of high abundance, negative impacts are maximized as all the fish above the escapement level are harvested. Thereby, compared to baseline conditions, Alternative 4 results in the lowest average level of escapement towards a total spawning population abundance.

4.1.1.2.5. Alternative 5—Voluntary Fishing curtailment

Under Alternative 5, harvest rates were assumed to be zero thus providing a bench for comparison to the other alternatives. Table 4-23 shows the maximum escapement of Upriver summer Chinook salmon that could occur absent all fishing.

Under Alternative 5, the impacts associated with harvest are removed. This thereby provides the largest possible spawning population to the greatest extent possible each year.

Table 4-21. *Defined Metrics* for Upriver summer Chinook salmon under Alternative 3.

		Non-treaty								**Treaty**					
	Run Size	Ocean	Non-Treaty Comm.	Sport Z 1-5	Sport Z 6	Sport Mcn - PRD	Sport Above PRD	Non-Treaty Tribal	Total Non-Treaty	Treaty C&S	Treaty Comm.	Total Treaty	Total Harvest	Esc. Past Fisheries	Exp. Priest Rapids Dam counts
min	37,000	1,570	1,336	1,462	201	70	1,593	1,539	7,770	777	6,993	7,770	15,540	37,000	21,460
max	134,000	5,685	4,838	5,294	727	253	5,771	5,572	28,140	2,814	25,326	28,140	56,280	134,000	77,720
ave	74,417	3,157	2,687	2,940	404	140	3,205	3,095	15,628	1,563	14,065	15,628	31,255	74,417	43,162

Table 4-22. *Defined Metrics* for Upriver summer Chinook salmon under Alternative 4.

		Non-treaty								**Treaty**					
	Run Size	Ocean	Non-treaty Comm.	Sport Z 1-5	Sport Z 6	Sport Mcn - PRD	Sport Above PRD	Non-treaty Tribal	Total Non-treaty	Treaty C&S	Treaty Comm.	Total Treaty	Total Harvest	Total HR	Esc. Past Fisheries
min	37,000	808	688	752	103	36	820	792	4,000	400	3,600	4,000	8,000	21.6%	29,000
max	134,000	10,607	9,026	9,876	1,357	471	10,767	10,396	52,500	5,250	47,250	52,500	105,000	78.4%	29,000
ave	74,417	4,588	3,904	4,272	587	204	4,657	4,497	22,708	2,271	20,438	22,708	45,417	61.0%	29,000

Table 4-23. *Defined Metrics* for Upriver summer Chinook salmon under Alternative 5.

		Non-Treaty								**Treaty**				
	Run Size	Ocean	Non-Treaty Commercial	Sport Z 1-5	Sport Z 6	Sport Mcn - PRD	Sport Above PRD	Non-treaty Tribal	Total Non-treaty	Treaty C&S	Treaty Commercial	Total Treaty	Total Harvest	Esc. Past Fisheries
min	37,000	808	0	0	0	0	0	0	0	0	0	0	0	27,750
max	134,000	10,607	0	0	0	0	0	0	0	0	0	0	0	100,500
ave	74,417	4,588	0	0	0	0	0	0	0	0	0	0	0	55,813

4.1.1.2.6. Alternative 6—No-action—Uncoordinated harvest

Under the No Action—Uncoordinated Harvest alternative, the level of fishing can be approximated by the results and impacts described under Alternative 4 resulting in aggressive harvest rates, therefore Alternative 6 results range from 21.6 percent minimum to 78.4 percent maximum and an average of 61.0 percent as shown in table 4-22. This compares to an average Upriver summer Chinook salmon harvest rate under the baseline conditions of 52.5 percent (Table 3-7).

Under Alternative 6, as just described, the highest levels of impacts observed in Alternative 4 are expected to occur. This results in maximizing negative impacts associated with removing fish from a resulting spawning population to the greatest extent during years of high abundance, and thereby results in the lowest average level of escapement towards a total spawning population.

4.1.1.3. Upriver Sockeye Salmon

For management purposes, Upriver sockeye salmon include stocks returning to the Okanogan, Wenatchee, and Snake rivers. These are primarily natural-origin fish. In recent years at least, the Okanogan and Wenatchee stocks have been healthy with substantial surpluses available for harvest. Snake River sockeye salmon are listed under the ESA as endangered. Upriver sockeye salmon are managed using what is nominally an abundance based harvest rate schedule that allows for rates that range from 6 percent to 8 percent (1 percent for non-treaty fisheries and 5 to 7 percent for treaty Indian fisheries) (Table 4-24). Since the upriver run has exceeded 50,000 in all recent years, the current framework is effectively a fixed harvest rate framework that allows for a harvest rate of 8 percent. Under the current agreement, the harvest rates are limited by the status of Snake River sockeye and are not structured to provide greater access to the more abundance Okanogan and Wenatchee stocks.

Table 4-24. Upriver sockeye salmon harvest framework

Upriver Sockeye Run Size	Harvest Rate on Upriver Sockeye
<50,000	5%
50 to 75,000	7%
>75,000	7% with further discussion

4.1.1.3.1. Alternative 1—Extension of Current Agreement

Under Alternative 1 fisheries would be managed using the two step abundance based schedule described above. At run sizes less than 50,000 the total allowed harvest rate is 6 percent and at 50,000 and greater, the allowed total harvest rate is 8 percent. The non-treaty portion of the total harvest rate is limited to 1 percent at all run sizes. Tables 4-25 and 4-26 show the defined metrics for upriver and Snake River sockeye salmon, respectively.

Under Alternative 1 (Extension), the harvest and escapement levels are unchanged from the baseline. Harvest fluctuates with the projected run size, meaning in years of low abundance harvest rates are lower than in years of high abundance. This results in escapement levels lower during years of low abundance, thereby reducing the adverse impact of removing fish from the spawning population during these years. Conversely, during years of high abundance, the greatest proportion of fish are harvested at the highest harvest rate. The resulting impact to the spawning population is negligible as the total number of fish escaping past the fisheries is still large.

Table 4-25. *Defined Metrics* for upriver sockeye salmon under Alternative 1.

	River Mouth Run Size	Comm.	Sport	Total Non-treaty	Treaty C&S	Treaty Comm.	Total Treaty	Total Harvest	Escapement Past Fisheries
min	27,000	50	220	270	203	1,148	1,350	1,620	25,380
max	648,000	1,194	5,286	6,480	6,804	38,556	45,360	51,840	596,160
ave	277,833	512	2,266	2,778	2,901	16,440	19,342	22,120	255,713

Table 4-26. *Defined Metrics* for Snake River sockeye salmon under Alternative 1.

	Snake River Run Size	Total Harvest	Total HR	Escapement Past Fisheries	Lower Granite Run Size
min	124	7	6.0%	117	65
max	2,977	238	8.0%	2,738	1,517
ave	1,276	102	7.7%	1,175	651

4.1.1.3.2. Alternative 2—Abundance-based Management

Under Alternative 2, fisheries would be managed using an expanded abundance based harvest rate schedule that is tied more directly to conservation related abundance objectives. In this example, a river mouth run size of 13,750 for Snake River sockeye salmon approximates the aggregate abundance necessary to meet abundance related recovery objectives for the ESU. A run size of 13,750 accounts for upstream migration losses that occur between the river mouth and Stanley Basin, the endpoint of the migration corridor for Snake River sockeye salmon. Under this framework, harvest rates range from 6 percent to 11 percent depending on the abundance of Snake River sockeye salmon (Table 4-27). Tables 4-28 and 4-29 show the defined metrics for upriver and Snake River sockeye salmon for Alternative 2.

Under Alternative 2, the harvest and escapement levels are slightly changed from the baseline, but only at high abundances. Harvest fluctuates with the projected run size, meaning in years of low abundance harvest rates are lower than in years of high abundance. This results in escapement levels lower during years of low abundance, thereby reducing the adverse impact of removing fish from the spawning population during these years. Conversely, during years of high abundance, the greatest proportion of fish are harvested at the highest harvest rate. The resulting impact to the spawning population is negligible as the total number of fish escaping past the fisheries is still large.

Table 4-27. Abundance-based harvest rate schedule for upriver sockeye salmon.

River Mouth Run size All Sockeye Stocks	Minimum Snake River Run Size at CR Mouth	Non-Treaty Total Harvest Rate	Treaty Total Harvest Rate	Total Harvest Rate
<50,000	<1,000	1%	5.00%	6.00%
50,000	1,000	1%	7.00%	8.00%
75,000	2,500	1%	7.50%	8.50%
100,000	3,000	1%	8.00%	9.00%
125,000	4,000	1%	8.25%	9.25%
150,000	5,000	1%	8.50%	9.50%
175,000	6,000	1%	8.75%	9.75%
200,000	8,000	1%	9.00%	10.00%
225,000	10,000	1%	9.50%	10.50%
250,000	12,500	1%	10.00%	11.00%
>300,000	>13,750	>1%	>10.0	>11.0%

Table 4-28. *Defined Metrics* for upriver sockeye salmon under Alternative 2

	River Mouth Run Size	Comm.	Sport	Total Non-treaty	Treaty C&S	Treaty Comm.	Total Treaty	Total Harvest	Escapement Past Fisheries
min.	27,000	50	220	270	203	1,148	1,350	1,620	25,380
max.	648,000	2,388	10,572	12,960	10,692	60,588	71,280	84,240	563,760
ave.	277,833	611	2,707	3,318	4,071	23,071	27,143	30,461	247,372

Table 4-29. *Defined Metrics* for Snake River sockeye salmon under Alternative 2

	Snake River Run Size	Total Harvest	Total HR	Escapement Past Fisheries	Lower Granite Run Size
min.	124	7	6.0%	117	65
max.	2,977	387	13.0%	2,590	1,435
ave.	1,276	140	9.7%	1,136	629

4.1.1.3.3. Alternative 3—Fixed Harvest Rate

Under Alternative 3 fisheries would be managed using a fixed harvest rate of 8 percent. This is similar to Alternative 1 except the 8 percent total harvest rate would apply to all run sizes. This alternative would not be as conservative as Alternative 1 at the lowest run sizes. Tables 4-30 and 4-31 show the defined metrics for Upriver and Snake River sockeye salmon for Alternative 3.

Under Alternative 3, the harvest and escapement levels are constant. Harvest rate impacts occur constantly at the same proportions regardless of any fluctuation in projected run size. Therefore, in years of low abundance harvest rates are the same as those in years of high abundance. This restricts the negative impacts associated with removing a greater number of fish from the spawning population during years of high abundance, thereby providing a slightly positive increase in the escapement past fisheries during large run sizes.

Table 4-30. *Defined Metrics* for Columbia River sockeye salmon under Alternative 3.

	River Mouth Run Size	Comm.	Sport	Total Non-Treaty	Treaty C&S	Treaty Comm.	Total Treaty	Total Harvest	Escapement Past Fisheries
min.	27,000	50	220	270	284	1,607	1,890	2,160	24,840
max.	648,000	1,194	5,286	6,480	6,804	38,556	45,360	51,840	596,160
ave.	277,833	512	2,266	2,778	2,917	16,531	19,448	22,227	255,607

Table 4-31. *Defined Metrics* for Snake River sockeye salmon under Alternative 3.

	Snake River Run Size	Total Harvest	Total HR	Escapement Past Fisheries	Lower Granite Run Size
min.	124	10	8.0%	114	63
max.	2,977	238	8.0%	2,738	1,517
ave.	1,276	102	8.0%	1,174	650

4.1.1.3.4. Alternative 4—Fixed Escapement Management

Under Alternative 4 fisheries would be managed using a fixed escapement goal of 150,000 Upriver sockeye salmon past fisheries while still allowing for a 6 percent total harvest rate for runs less than the goal. In this example, the management framework is focused on the abundance of Upriver sockeye salmon and Snake River sockeye salmon are no longer the limiting stock. The 6 percent harvest rate provides for *de minimis* fisheries at low abundance. Otherwise, the harvest rate would be reduced to zero. The escapement objective of 150,000 approximates the aggregate abundance necessary meet escapement objectives for the Wenatchee and Okanogan stocks. Tables 4-32 and 4-33 show the defined metrics for upriver and Snake River sockeye salmon for Alternative 4.

Under Alternative 4 the impacts from harvest vary based on the run size, but the associated impacts towards modifying spawning population levels are constant with a fixed escapement level. A fixed number of fish escape the fisheries. Harvest rates fluctuate as the projected run sizes fluctuate. In years of low abundance harvest rates are low, but in years of high abundance harvest rates are high. This is because all fish above the fixed escapement goal are deemed harvestable. During years of high abundance, negative impacts are maximized as all the fish above the escapement level are harvested. Thereby, compared to baseline conditions, Alternative 4 results in the lowest average level of escapement towards a total spawning population abundance.

Table 4-32 *Defined Metrics* for upiver sockeye salmon under Alternative 4.

	River Mouth Run Size	Comm.	Sport	Total Non-treaty	Treaty C&S	Treaty Comm.	Total Treaty	Total Harvest	Escapement Past Fisheries
min.	27,000	50	220	270	203	1,148	1,350	1,620	25,380
max.	648,000	45,877	203,123	249,000	37,350	211,650	249,000	498,000	150,000
ave.	277,833	14,170	62,739	76,909	11,607	65,772	77,379	154,288	123,545

Table 4-33. *Defined Metrics* for Snake River sockeye salmon under Alternative 4.

	Snake River Run	Total Harvest	Total HR	Escapement Past	Lower Granite Run

	Size			Fisheries	Size
min.	124	7	6.0%	117	65
max.	2,977	2,288	76.9%	689	382
ave.	1,276	709	36.8%	567	314

4.1.1.3.5. Alternative 5—Voluntary Fishing curtailment

Under the Alternative 5, harvest rates on sockeye salmon were assumed to be zero thus providing a bench for comparison to the other alternatives. Tables 4-34 and 4-45 show the maximum escapement of Upriver sockeye salmon and Snake River sockeye salmon that could occur absent all fishing.

Under Alternative 5, the impacts associated with harvest are removed. This thereby provides the largest possible spawning population to the greatest extent possible each year.

Table 4-34. *Defined Metrics* for Upriver sockeye salmon under Alternative 5

	River Mouth Run Size	Commercial	Sport	Total Non-treaty	Treaty C&S	Treaty Commercial	Total Treaty	Total Harvest
min.	27,000	0	0	0	0	0	0	0
max.	648,000	0	0	0	0	0	0	0
ave.	277,833	0	0	0	0	0	0	0

Table 4-35. *Defined Metrics* for Snake River sockeye salmon under Alternative 5.

	Snake River Run Size	Total Harvest	Total HR	Escapement Past Fisheries	Lower Granite Run Size
min.	124	0%	0%	124	69
max.	2,977	0%	0%	2,977	1,649
ave.	1,276	0%	0%	1,276	707

4.1.1.3.6. Alternative 6—No-action—Uncoordinated harvest

Under the No Action—Uncoordinated Harvest alternative, the level of fishing can be approximated by the results and impacts described under Alternative 4, resulting in aggressive harvest rates that range from 6 percent minimum to 76.9 percent maximum and an average of 36.8 percent as shown in Tables 4-32. This compares to an average Upriver sockeye salmon harvest rate under the baseline conditions of 8 percent (Table 3-9).

Under Alternative 6, as just described, the highest levels of impacts observed in Alternative 4 are expected to occur. This results in maximizing adverse impacts associated with removing fish from a resulting spawning population to the greatest extent during years of high abundance, and thereby results in the lowest average level of escapement towards a total spawning population.

4.1.1.4. Upriver Fall Chinook Salmon

For management purposes, Upriver fall Chinook salmon are defined as any of the fall Chinook salmon stocks passing Bonneville from August 1-December 31. The stock includes both hatchery and natural-origin fish. Upriver fall Chinook salmon include a "tule" type which is an earlier maturing fall Chinook salmon which historically spawned in tributaries downstream of Celilo falls, and a "bright" stock of later maturing fish which historically spawned primarily in mainstem and tributary areas upstream of Celilo falls however bright fall Chinook salmon likely utilized areas downstream of Bonneville as well. The upriver stocks include an upriver bright (URB) fall Chinook salmon which includes all hatchery and natural bright stock fish originating upstream of McNary Dam and natural-origin fish originating in the Deschutes River. The URB stock includes the ESA listed Snake River fall Chinook ESU. The other upriver stocks include the pool upriver bright (PUB) stock, the Bonneville Pool Hatchery (BPH) stock, and the soon to be defunct Bonneville upriver bright (BUB) stock (the last return of adult BUBs will likely occur in 2017, with the possibility of a small amount of six year old fish returning in 2018). The PUB stock includes all hatchery and any natural-origin bright stock fish originating from tributaries other than the Deschutes between Bonneville and McNary Dams. Under the current agreement, Upriver fall Chinook salmon are managed using an abundance based harvest schedule that depends on the abundance of upriver fall Chinook salmon and natural-origin Snake River fall Chinook salmon. Allowable harvest rates range from 21.5 percent to 45 percent (Table 4-36).

Table 4-36. Fall management period Chinook salmon harvest rate schedule.

Expected URB River Mouth Run Size	Expected River Mouth Snake River Natural-origin Run Size[1]	Treaty Total Harvest Rate	Non-treaty Harvest Rate	Total Harvest Rate	Expected Escapement of Snake River Natural-origin Past Fisheries
< 60,000	< 1,000	20%	1.50%	21.5%	784
60,000	1,000	23%	4.00%	27.00%	730
120,000	2,000	23%	8.25%	31.25%	1,375
> 200,000	5,000	25%	8.25%	33.25%	3,338
	6,000	27%	11.00%	38.00%	3,720
	8,000	30%	15.00%	45.00%	4,400

1. If the Snake River natural fall Chinook salmon forecast is less than level corresponding to an aggregate URB run size, the allowable mortality rate will be based on the Snake River natural fall Chinook salmon run size.

4.1.1.4.1. Alternative 1—Extension of Current Agreement

Under Alternative 1 fisheries would be managed using the abundance based schedule described above. Tables 4-37 and 4-38 provide the minimum, maximum and average values for *defined metrics* for Upriver fall Chinook salmon and natural-origin Snake River fall Chinook salmon under Alternative 1. For reference, the abundance related recovery objective for natural-origin Snake River fall Chinook salmon is 3,500.

Under Alternative 1 (Extension), the harvest and escapement levels are unchanged from the baseline. Harvest fluctuates with the projected run size, meaning in years of low abundance harvest rates are lower than in years of high abundance. This results in escapement levels lower during years of low abundance, thereby reducing the adverse impact of removing fish from the spawning population during these years. Conversely, during years of high abundance, the greatest proportion of fish are harvested at the highest harvest rate. The resulting impact to the spawning population is negligible as the total number of fish escaping past the fisheries is still large.

Table 4-37. *Defined Metrics* for Upriver fall Chinook salmon under Alternative 1.

	Total SAFE	Total Comm.	Total Lower River Sport	Total Sport	Expect. Treaty C&S	Expect. Treaty Comm.	Total Treaty	Total Non-Treaty	Total Harvest	Esc. Past Fisheries
min.	180	3,657	2,775	3,265	1,848	42,849	44,697	6,923	51,620	109,431
max.	4,767	96,614	73,317	86,259	16,980	393,700	410,680	182,872	593,553	540,925
ave.	2,214	44,870	34,050	40,060	8,078	187,303	195,381	84,930	280,311	268,788

Table 4-38. *Defined Metrics* for natural-origin Snake River fall Chinook salmon under Alternative 1.

	Snake River Fall Chinook Run Size at the Mouth	HR (less due to MSF)	Harvest	Esc. Past Fisheries	Average Loss to Granite	Expected Granite Run Size
min.	5,808	25.9%	1,504	4,305	1,077	3,228
max.	40,916	43.9%	17,957	22,960	5,744	17,216
ave.	19,804	41.0%	8,470	11,334	2,836	8,499

4.1.1.4.2. Alternative 2—Abundance-based Management

Under Alternative 2 fisheries would be managed using an abundance based management framework. Although other abundance based frameworks could be devised that would be more or less restrictive, the analysis assumes that the current framework would apply thus allowing harvest rates to range from 21.5

percent to 45 percent. Because the frameworks under Alternative 1 and Alternative 2 are the same, the analytical results and impacts are also the same (Tables 4-39 and 4-40).

Table 4-39. *Defined Metrics* for Upriver fall Chinook salmon under Alternative 2.

	Total SAFE	Total Comm.	Total Lower River Sport	Total Sport	Expect. Treaty C&S	Expect. Treaty Comm.	Total Treaty	Total Non-treaty	Total Harvest	Esc. Past Fisheries
min.	180	3,657	2,775	3,265	1,848	42,849	44,697	6,923	51,620	109,431
max.	4,767	96,614	73,317	86,259	16,980	393,700	410,680	182,872	593,553	540,925
ave.	2,214	44,870	34,050	40,060	8,078	187,303	195,381	84,930	280,311	268,788

Table 4-40. *Defined Metrics* for natural-origin Snake River fall Chinook salmon under Alternative 2.

	Snake River Fall Chinook Run Size at the Mouth	HR	Harvest	Esc. Past Fisheries	Average Loss to Granite	Expected Granite Run Size
min.	5,808	25.9%	1,504	4,305	1,077	3,228
max.	40,916	43.9%	17,957	22,960	5,744	17,216
ave.	19,804	41.0%	8,470	11,334	2,836	8,499

4.1.1.4.3. Alternative 3—Fixed Harvest Rate

Under Alternative 3 fisheries would be managed using a fixed harvest rate of 40.9 percent for ESA-listed Snake River fall Chinook salmon. This is the average rate observed over the last twelve years. Tables 4-41 and 4-42 provide the minimum, maximum and average values for *defined metrics* for Upriver fall Chinook salmon and natural-origin Snake River fall Chinook salmon under Alternative 3.

Under Alternative 3, the harvest and escapement levels are constant. Harvest rate impacts occur constantly at the same proportions regardless of any fluctuation in projected run size. Therefore, in years of low abundance harvest rates are the same as those in years of high abundance. This restricts the negative impacts associated with removing a greater number of fish from the spawning population during years of high abundance, thereby providing a slightly positive increase in the escapement past fisheries during large run sizes.

Table 4-41. *Defined Metrics* for Upriver fall Chinook salmon under Alternative 3

	Total SAFE	Total Comm.	Total Lower River	Total Sport	Expect. Treaty C&S	Expect. Treaty Comm.	Total Treaty	Total Non-treaty	Total Harvest	Esc. Past Fisheries

			Sport							
min	587	11,887	9,020	10,613	2,330	54,027	56,357	22,499	78,856	82,194
max	4,132	83,732	63,541	74,758	16,414	380,577	396,991	158,489	555,480	578,997
ave	2,000	40,527	30,755	36,183	7,944	184,203	192,148	76,711	268,859	280,241

Table 4-42. *Defined Metrics* for natural-origin Snake River fall Chinook salmon under Alternative 3

	Snake River Fall Chinook Run Size at Mouth	HR	Harvest	Esc. Past Fisheries	Average Loss to Granite	Expected Granite Run Size
min	5,808	40.9%	2,375	3,434	859	2,575
max	40,916	40.9%	16,729	24,187	6,051	18,136
ave	19,804	40.9%	8,097	11,707	2,929	8,778

4.1.1.4.4. Alternative 4—Fixed Escapement Management

Under Alternative 4 fisheries would be managed using a fixed escapement goal of 3,000 natural-origin Snake River fall Chinook salmon to Lower Granite Dam. To account for the additional mortality that occurs during upstream migration, the escapement objective of 3,000 to Lower Granite Dam is expanded to 4,000. This expansion is an approximation of the interdam loss that occurs absent fishing based on estimates of conversion loss from the *US v Oregon* TAC and is an illustration of the approach rather than a specific proposal. At the highest Snake River fall Chinook salmon run sizes, harvest rates on the PUB and BUB stocks would severely limit expected escapement of these stocks. Where negative escapement past fisheries is shown, the model is in effect showing that harvest rates on the PUB and BUB stocks are excessive based on historic allocations and fishery patterns. Tables 4-43 and 4-44 provide the minimum, maximum and average values for *defined metrics* for Upriver fall Chinook and natural-origin Snake River fall Chinook salmon under Alternative 4.

Under Alternative 4 the impacts from harvest vary based on the run size, but the associated impacts towards modifying spawning population levels are constant with a fixed escapement level. A fixed number of fish escape the fisheries. Harvest rates fluctuate as the projected run sizes fluctuate. In years of low abundance harvest rates are low, but in years of high abundance harvest rates are high. This is because all fish above the fixed escapement goal are deemed harvestable. During years of high abundance, negative impacts are maximized as all the fish above the escapement level are harvested. Thereby, compared to baseline conditions, Alternative 4 results in the lowest average level of escapement towards a total spawning population abundance.

Table 4-43. *Defined Metrics* for Upriver fall Chinook salmon under Alternative 4.

	Total SAFE	Z-1-5 Comm.	B 10	Z 1-5 Sport	Total Lower River Sport	Z-6 Sport	McN-I 395 sport	Total Sport	Total Non-treaty	Expect. Treaty C&S	Expect. Treaty Comm.	Total Treaty	Total Harvest	Esc. Past Fisheries
min.	241	8,360	1,721	6,644	8,365	716	539	9,620	18,221	892	17,329	18,221	36,442	76,558
max.	4,817	166,782	34,342	132,547	166,889	14,285	10,752	191,926	363,525	17,799	345,726	363,525	727,050	68,950
ave.	2,065	71,514	14,725	56,834	71,559	6,125	4,610	82,295	155,874	7,632	148,242	155,874	311,747	73,525

Table 4-44. *Defined Metrics* for natural-origin Snake River fall Chinook salmon under Alternative 4.

	Natural-origin Snake River fall Chinook Run Size at the Mouth	HR	Harvest	Esc. Past Fisheries	Average Loss to Granite	Expected Granite Run Size
min.	5,808	31.1%	1,808	4,000	1,000	3,000
max.	40,916	90.2%	36,916	4,000	1,000	3,000
ave.	19,804	71.6%	15,804	4,000	1,000	3,000

4.1.1.4.5. Alternative 5—Voluntary Fishing curtailment

Under Alternative 5, harvest rates were assumed to be zero thus providing a bench for comparison to the other alternatives. Tables 4-45 and 4-46 show the maximum escapement of Upriver fall Chinook salmon and natural-origin Snake River fall Chinook salmon that would occur absent all fishing.

Under Alternative 5, the impacts associated with harvest are removed. This thereby provides the largest possible spawning population to the greatest extent possible each year.

Table 4-45. *Defined Metrics* for Upriver fall Chinook salmon under Alternative 5.

	Total SAFE	Total Comm.	Total Lower River Sport	Total Sport	Expected Treaty C&S	Expected Treaty Comm.	Total Treaty	Total Non-treaty	Total Harvest
min.	0	0	0	0	0	0	0	0	0
max.	0	0	0	0	0	0	0	0	0
ave.	0	0	0	0	0	0	0	0	0

Table 4-46. *Defined Metrics* for natural-origin Snake River fall Chinook salmon under Alternative 5.

	Snake River Fall Chinook Run Size at the Mouth	HR (less due to MSF)	Harvest	Esc. Past Fisheries	Average Loss to Granite	Expected Granite Run Size
min	5,808	0%	0	5,808	1,452	4,356
max	40,916	0%	0	40,916	10,229	30,687
ave	19,804	0%	0	19,804	4,951	14,853

4.1.1.4.6. Alternative 6—No-action—Uncoordinated harvest

Under the No Action—Uncoordinated Harvest alternative, the level of fishing can be approximated by the results and impacts described under Alternative 4, resulting in aggressive harvest rates that range from 31.1 percent minimum to 90.2 percent maximum and an average of 71.6 percent as shown in tables 4-43 and 4-44. This compares to an average Snake River fall Chinook salmon harvest rate under the baseline conditions of 41.0 percent (Table 3-8).

Under Alternative 6, as just described, the highest levels of impacts observed in Alternative 4 are expected to occur. This results in maximizing adverse impacts associated with removing fish from a resulting spawning population to the greatest extent during years of high abundance, and thereby results in the lowest average level of escapement towards a total spawning population.

4.1.1.5. Snake River Steelhead

Upriver steelhead returning to areas above Bonneville Dam have a complex life history and protracted run timing that introduces considerable complexity into the harvest management process. Although steelhead are present in the system throughout the year, most migrate through the areas above Bonneville Dam during the fall management period. For that reason and to reduce the complexity of the analysis of harvest policy alternatives, the analysis here focuses on steelhead management during the fall season.

Under the current agreement, B-run steelhead are used as an indicator stock. B-run steelhead are defined as those that pass above Bonneville dam between July 1 and October 31 and are at least 78 cm in length. B-run steelhead return primarily to areas in the Snake River. B-run steelhead are used as an indicator because they can be visually identified based on their length, are general subject to higher harvest rates because of their size, and were, for the most part, depressed relative to other stocks in the basin. Harvest rate limits for B-run steelhead therefore provide protection for the smaller A-run components of the run. Under the current agreement, fisheries are managed during the fall season using an abundance based harvest rate schedule that depends on the abundance of natural-origin B-run steelhead. Allowable harvest rates on natural-origin fish range from 15 percent to 22 percent (Table 4-47).

Table 4-47. Fall Management Period Steelhead Harvest Rate Schedule.

Forecast Bonneville Total B Steelhead Run Size	River Mouth URB Run Size	Treaty Total B Harvest Rate	Non-treaty Natural-origin B Harvest Rate	Total Harvest Rate
< 20,000	Any	13%	2.0%	15.0%
20,000	Any	15%	2.0%	17.0%
35,000	>200,000	20%	2.0%	22.0%
B-Run Steelhead are defined as steelhead measuring ≥78 cm				

4.1.1.5.1. Alternative 1—Extension of Current Agreement

Under Alternative 1 fisheries would be managed using the abundance based harvest rate schedule described above that limits the harvest of natural-origin B-run steelhead to 15 percent to 22 percent. Tables 4-48 and 4-49 show the defined metrics for B-run (hatchery and natural-origin combined) and natural-origin B-run steelhead, respectively.

Under Alternative 1 (Extension), the harvest and escapement levels are unchanged from the baseline. Harvest fluctuates with the projected run size, meaning in years of low abundance harvest rates are lower than in years of high abundance. This results in escapement levels lower during years of low abundance, thereby reducing the adverse impact of removing fish from the spawning population during these years. Conversely, during years of high abundance, the greatest proportion of fish are harvested at the highest harvest rate. The resulting impact to the spawning population is negligible as the total number of fish escaping past the fisheries is still large.

4.1.1.5.2. Alternative 2—Abundance-based Management

Under Alternative 2 fisheries would be managed using the same abundance-based harvest rate schedule as Alternative 1. Because the frameworks under Alternative 1 and Alternative 2 are the same, the analytical results and impacts are also the same (Tables 4-50 and 4-51).

4.1.1.5.3. Alternative 3—Fixed Harvest Rate

This alternative uses a fixed total B-run harvest rate for the tribal fishery and a fixed 2 percent natural-origin B harvest rate for the non-treaty fishery.

Under Alternative 3, the harvest and escapement levels are constant. Harvest rate impacts occur constantly at the same proportions regardless of any fluctuation in projected run size. Therefore, in years of low abundance harvest rates are the same as those in years of high abundance (Tables 4-52 and 4-53). This restricts the negative impacts associated with removing a greater number of fish from the spawning population during years of high abundance, thereby providing a slightly positive increase in the escapement past fisheries during large run sizes.

4.1.1.5.4. Alternative 4—Fixed Escapement Management

This alternative uses an escapement goal of 4,700 natural-origin B-run steelhead at Lower Granite which is based on the 10 year average run size. This was expanded to an equivalent run size at Bonneville Dam of 8,200 using TACs run reconstruction methodology. For run sizes under 8,200 natural-origin B-run steelhead, our analysis assumes *de minimis* fisheries of 7% for treaty fisheries and 0.7% for non-Indian fisheries.

Under Alternative 4 the impacts from harvest vary based on the run size, but the associated impacts towards modifying spawning population levels are constant with a fixed escapement level. A fixed number of fish escape the fisheries. Harvest rates fluctuate as the projected run sizes fluctuate. In years of low abundance harvest rates are low, but in years of high abundance harvest rates are high. This is because all fish above the fixed escapement goal are deemed harvestable. During years of high abundance, negative impacts are maximized as all the fish above the escapement level are harvested. Thereby, compared to baseline conditions, Alternative 4 results in the lowest average level of escapement towards a total spawning population abundance.

Table 4-48. *Defined Metrics* for B-run steelhead under Alternative 1.

	Run Size	Z 1-5 Comm.	Z 1-5 Sport	Treaty C & S	Treaty Comm.	Total Treaty	Z 6- i395 Sport	Total Sport	Total NT	Total Catch	Escapement Past Fisheries	Expected Granite Run
min.	11,780	56	161	77	1,455	1,531	1,333	1,494	1,550	3,081	8,699	8,118
max.	94,476	458	1,327	945	17,950	18,895	10,992	12,319	12,777	31,672	62,804	58,609
ave.	48,575	235	680	471	8,945	9,416	5,631	6,310	6,545	15,961	32,614	30,436

Table 4-49. *Defined Metrics* for natural-origin B-run steelhead under Alternative 1.

	Run Size	Total Treaty	Treaty HR	Total NT	NT HR	Total Catch	Total HR	Escapement Past Fisheries	Expected Granite Run
min	2,420	417	17.2%	48	2.0%	466	19.2%	1,954	1,129
max	19,951	5,148	25.8%	399	2.0%	5,547	27.8%	14,404	8,325
ave	10,220	2,565	25.1%	204	2.0%	2,770	27.1%	7,450	4,306

Table 4-50. *Defined Metrics* for B-run steelhead under Alternative 2.

	Run Size	Z 1-5 Comm.	Z 1-5 Sport	Treaty C & S	Treaty Comm.	Total Treaty	Z 6- i395 Sport	Total Sport	Total NT	Total Catch	Escapement Past Fisheries	Expected Granite Run
min.	11,780	56	161	77	1,455	1,531	1,333	1,494	1,550	3,081	8,699	8,118
max.	94,476	458	1,327	945	17,950	18,895	10,992	12,319	12,777	31,672	62,804	58,609
ave.	48,575	235	680	471	8,945	9,416	5,631	6,310	6,545	15,961	32,614	30,436

Table 4-51. *Defined Metrics* for natural-origin B-run steelhead under Alternative 2.

	Run Size	Total Treaty	Treaty HR	Total NT	NT HR	Total Catch	Total HR	Escapement Past Fisheries	Expected Granite Run
min.	2,420	417	17.2%	48	2.0%	466	19.2%	1,954	1,129
max.	19,951	5,148	25.8%	399	2.0%	5,547	27.8%	14,404	8,325
ave.	10,220	2,565	25.1%	204	2.0%	2,770	27.1%	7,450	4,306

Table 4-52. *Defined Metrics* for B-run steelhead under Alternative 3.

	Run Size	Z 1-5 Commercial	Z 1-5 Sport	Treaty C & S	Treaty Commercial	Total Treaty	Z 6- i395 Sport	Total Sport	Total NT	Total Catch	Escapement Past Fisheries	Expected Granite Run
min.	11,780	56	161	106	2,014	2,120	1,333	1,494	1,550	3,670	8,110	7,568
max.	94,476	458	1,327	850	16,155	17,006	10,992	12,319	12,777	29,782	64,693	60,373
ave.	48,575	235	680	437	8,306	8,743	5,631	6,310	6,545	15,288	33,286	31,063

Table 4-53. *Defined Metrics* for natural-origin B-run steelhead under Alternative 3.

	Run Size	Total Treaty	Treaty HR	Total NT	NT HR	Total Catch	Total HR	Escapement Past Fisheries	Expected Granite Run
min	2,420	578	23.9%	48	2.0%	626	25.9%	1,794	1,037
max	19,951	4,633	23.2%	399	2.0%	5,032	25.2%	14,919	8,623
ave	10,220	2,382	23.3%	204	2.0%	2,587	25.3%	7,633	4,412

Table 4-54. *Defined Metrics* for B-run steelhead under Alternative 4.

	Run Size	Z 1-5 Commercial	Z 1-5 Sport	Treaty C & S	Treaty Commercial	Total Treaty	Z 6- i395 Sport	Total Sport	Total NT	Total Catch	Escapement Past Fisheries	Expected Granite Run
min.	11,780	19	56	34	648	682	467	523	542	1,225	10,555	9,850
max.	94,476	1,122	3,250	2,170	41,234	43,404	26,929	30,179	31,301	74,706	19,770	18,450
ave.	48,575	348	1,008	580	11,018	11,598	8,355	9,364	9,712	21,310	27,265	25,444

Table 4-55. *Defined Metrics* for natural-origin B-run steelhead under Alternative 4.

	Run Size	Total Treaty	Treaty HR	Total NT	NT HR	Total Catch	Total HR	Escapement Past Fisheries	Expected Granite Run
min.	2,420	169	7.0%	17	0.7%	186	7.7%	2,233	1,291
max.	19,951	10,774	54.0%	978	4.9%	11,751	58.9%	8,200	4,740
ave.	10,220	2,879	28.2%	303	3.0%	3,182	31.1%	7,038	4,068

4.1.1.5.5. Alternative 5—Voluntary Fishing curtailment

Under Alternative 5, harvest rates on B-run steelhead were assumed to be zero thus providing a benchmark for comparison to the other alternatives. Tables 4-56 and 4-57 show the maximum escapement of B-run and natural-origin B-run steelhead that could occur absent all fishing.

Under Alternative 5, the impacts associated with harvest are removed. This thereby provides the largest possible spawning population to the greatest extent possible each year.

Table 4-56. *Defined Metrics* for B-run steelhead under Alternative 5.

	Run Size	Z 1-5 Comm.	Z 1-5 Sport	Treaty C & S	Treaty Comm.	Total Treaty	Z 6- i395 Sport	Total Sport	Total NT	Total Catch
min.	11,780	0	0	0	0	0	0	0	0	0
max.	94,476	0	0	0	0	0	0	0	0	0
ave.	48,575	0	0	0	0	0	0	0	0	0

Table 4-57. *Defined Metrics* for natural-origin Group-B steelhead under Alternative 5.

	Run Size	Total Treaty	Treaty HR	Total NT	NT HR	Total Catch	Total HR	Average Loss to Granite	Expected Granite Run
min.	2,420	0	0%	0	0%	0	0	605	1,815
max.	19,951	0	0%	0	0%	0	0	4,988	14,960
mve.	10,220	0	0%	0	0%	0	0	2,555	7,665

4.1.1.5.6. Alternative 6—No-action—Uncoordinated harvest

Under the No Action—Uncoordinated Harvest alternative, the level of fishing can be approximated by the results and impacts described under Alternative 4, resulting in aggressive harvest rates that range from 7.7 percent minimum to 58.9 percent maximum and an average of 31.1 percent as shown in tables 4-54 through 4-55. This compares to an average B-run steelhead harvest rate under the baseline conditions of 27.1 percent (Table 3-11).

Under Alternative 6, as just described, the highest levels of impacts observed in Alternative 4 are expected to occur. This results in maximizing adverse impacts associated with removing fish from a resulting spawning population to the greatest extent during years of high abundance, and thereby results in the lowest average level of escapement towards a total spawning population.

4.2. Fish

4.2.1. Salmonids

Salmonids in the Columbia River Basin that would be affected by the Proposed Action include five species of Pacific salmon (*Oncorhynchus* sp.), including steelhead. Recall that each alternative analyzed in this EIS uses the rate at which fish may be harvested to assess the impact of each alternative. These rates provide the levels at which fish abundance is reduced, and subsequent spawning population potential is conversely impacted. These species impacted are:

- Chinook salmon (*Oncorhynchus tshawytscha*)
  - Upper Columbia River spring-run - ESA-listed

For Upper Columbia River spring Chinook salmon the average harvest rate and average escapement past fisheries are the same for Alternative 1 and Alternative 2 (Table 4-58, Subsection 4.1.1.1.1 and Subsection 4.1.1.1.2). The average harvest rate of Alternative 3 is the lowest of all alternatives that provide fishing opportunity, but not by much (Table 4-58, Subsection 4.1.1.1.3). The average escapement past fisheries of Alternative 3 is the highest of all alternatives that provide fishing opportunity, but not by much. Therefore impacts to the spawning escapement level are a slight positive under Alternative 3. Alternative 4 and Alternative 6 have the highest harvest rates and the lowest average escapements past fisheries of all the alternatives (Table 4-58, Subsection 4.1.1.1.4 and Subsection 4.1.1.1.6). This results in a high negative impact to spawning escapement for these two alternatives. Alternative 5 has the lowest overall average harvest rate (0 percent) and the highest average escapement past fisheries of all alternatives because Alternative 5 does not provide any fishing opportunity but provides a positive impact to spawning escapement.

Table 4-58. Comparison of alternatives modeled outputs for Upper Columbia River spring Chinook salmon.

	Total HR			Esc. Past Fisheries			Rock Island Dam Run		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Alternative 1	9.2%	13.4%	11.8%	1,248	4,360	2,650	1,101	3,846	2,338
Alternative 2	9.2%	13.4%	11.8%	1,248	4,360	2,650	1,101	3,846	2,338
Alternative 3	11.3%	11.3%	11.3%	1,219	4,466	2,665	1,075	3,939	2,351
Alternative 4/6	6.2%	40.4%	17.4%	1,289	3,000	2,480	1,137	2,646	2,188
Alternative 5	0.0%	0.0%	0.0%	1,374	5,032	3,003	1,031	3,774	2,252

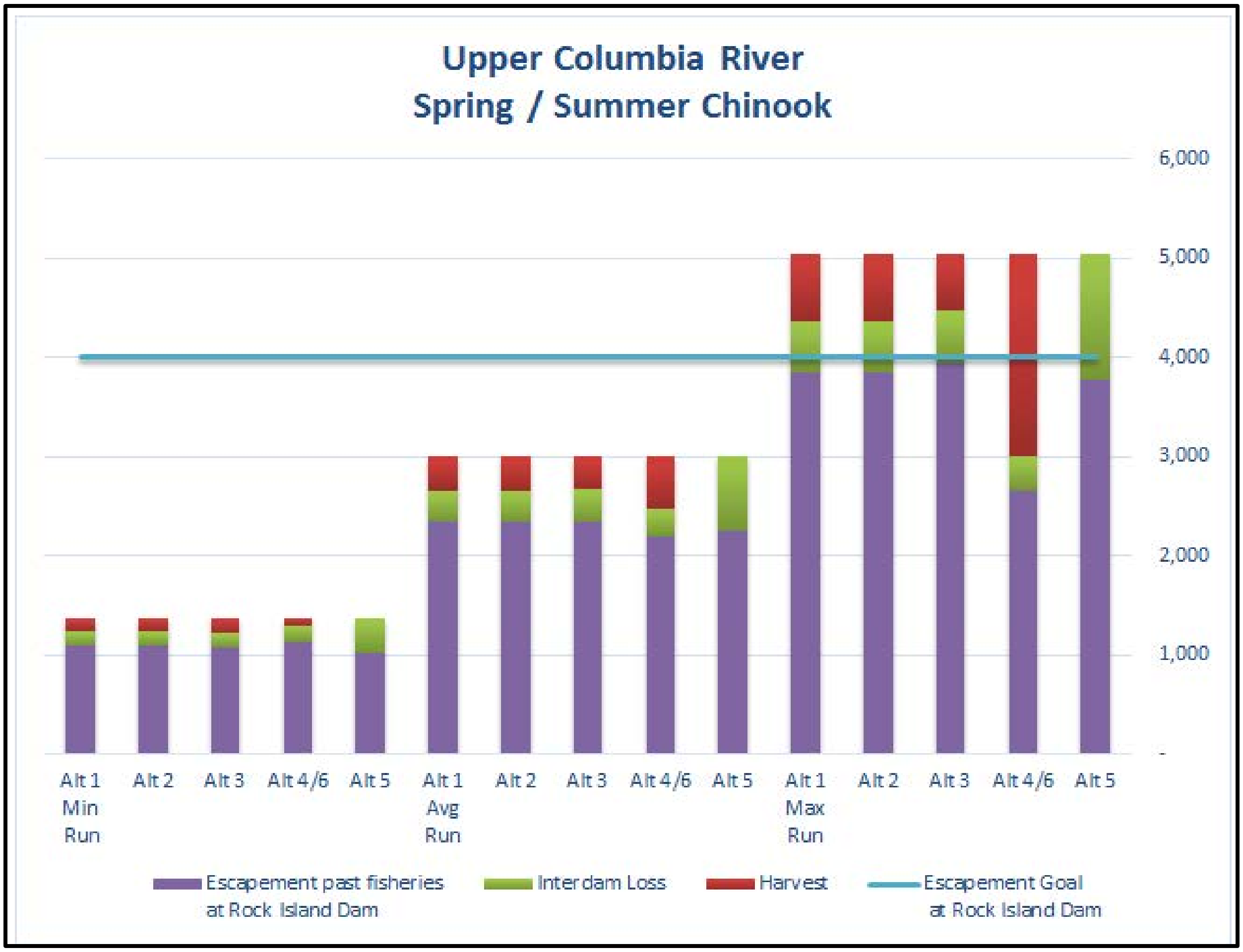

Figure 4-1. Comparison of alternatives modeled outputs for Upper Columbia River spring Chinook salmon at minimum, average, and maximum run sizes expected

Figure 4-1 illustrates the minimum, maximum and average defined metrics values for Upper Columbia River spring/summer Chinook salmon, along with its escapement goal at Rock Island Dam. The escapement goals were defined in Subsection 4.1.1. The aggregate abundance of natural-origin spawners necessary to meet recovery objectives for natural-origin Snake River spring/summer Chinook salmon is 3,000 at Rock Island Dam. And with an average survival rate of 75 percent, the escapement past fisheries goal is 4,000. At a maximum observed rivermouth runsize used for modeling, Alternative 3 is the one that comes closest to reaching the recovery target abundance of 3000 to Rock Island Dam. All alternatives, except Alternative 5 show some level of harvest.

- Snake River spring/summer-run - ESA-listed

For Snake River spring/summer Chinook salmon the average harvest rate and average escapement past fisheries are the same for Alternative 1 and Alternative 2 (Table 4-59, Subsection 4.1.1.2.1 and Subsection 4.1.1.2.2). The average harvest rate of Alternative 3 is the lowest of all alternatives that provide fishing opportunity, but not by much (Table 4-59, Subsection 4.1.1.2.3). The average escapement past fisheries of Alternative 3 is the highest of all alternatives that provide fishing opportunity, but not by much. Therefore impacts to the spawning escapement level are a slight positive under Alternative 3. Alternative 4 and Alternative 6 have the highest harvest rates and the lowest average escapements past fisheries of all the alternatives (Table 4-59, Subsection 4.1.1.2.4 and Subsection 4.1.1.2.6). This results in a high negative impact to spawning escapement for these two alternatives. Alternative 5 has the lowest overall average harvest rate (0 percent) and the highest average escapement past fisheries of all alternatives because Alternative 5 does not provide any fishing opportunity but provides a positive impact to spawning escapement.

Table 4-59. Comparison of alternatives modeled outputs for Snake River spring/summer-run Chinook salmon

	Total HR			**Esc. Past Fisheries**			**Lower Granite Run**		
	Min	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**
Alternative 1	9.2%	13.4%	11.8%	10,913	38,115	23,171	8,360	29,199	17,751
Alternative 2	9.2%	13.4%	11.8%	10,913	38,115	23,171	8,360	29,199	17,751
Alternative 3	11.3%	11.3%	11.3%	10,660	39,044	23,302	8,166	29,911	17,851
Alternative 4/6	6.2%	40.5%	17.5%	11,271	26,188	21,679	8,634	20,062	16,608

Alternative 5	0%	0%	0%	12,017	44,014	26,269	9,013	33,011	19,702

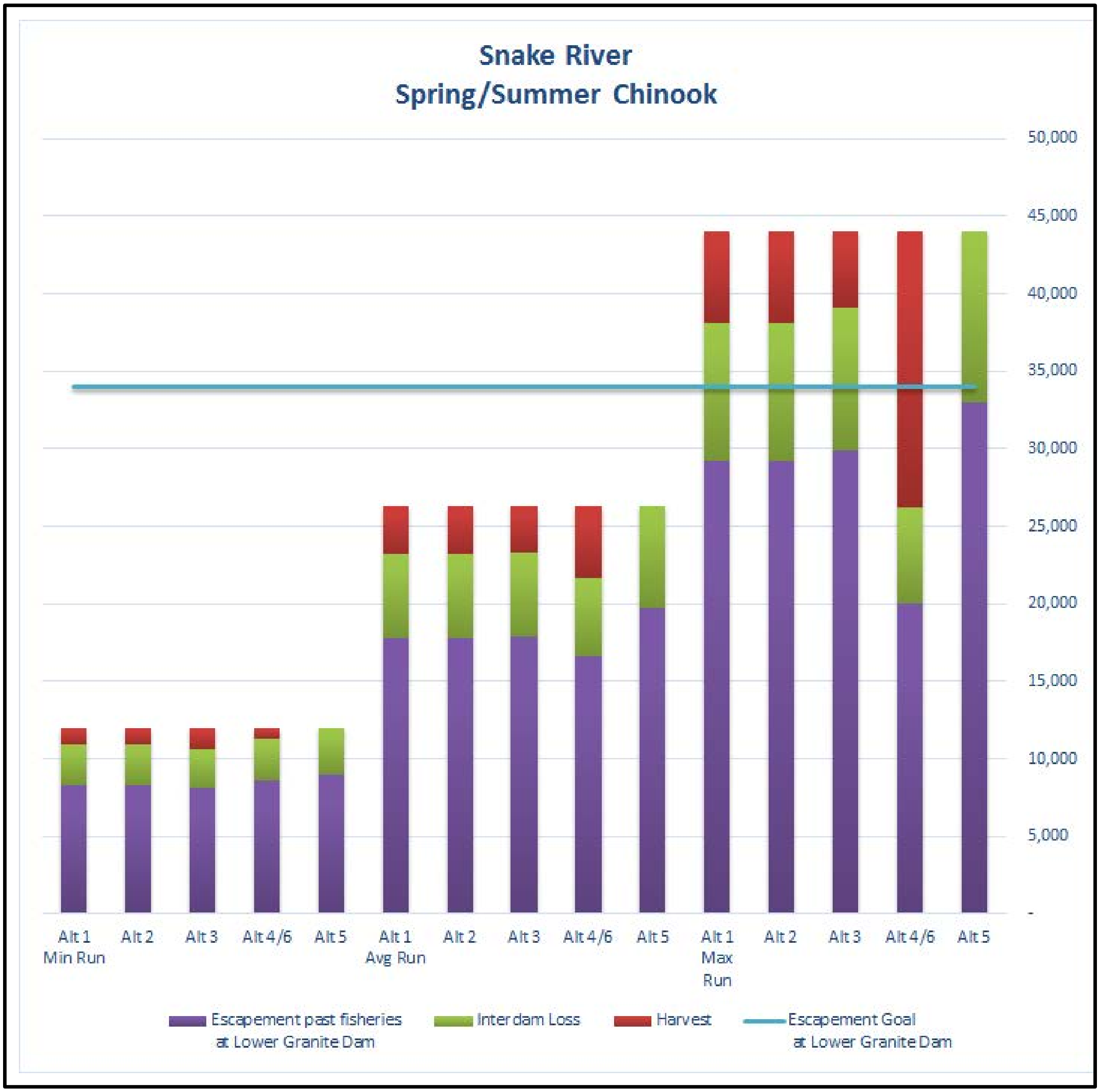

Figure 4-2. Comparison of alternatives modeled outputs for Snake River spring/summer-run Chinook salmon at minimum, average, and maximum run sizes expected

Figure 4-2 illustrates the minimum, maximum and average defined metrics values for Snake River spring/summer Chinook salmon, along with its current escapement goal. The aggregate abundance of natural-origin spawners necessary to meet recovery objectives for natural-origin Snake River spring/summer Chinook salmon is 25,500 at Lower Granite. And with an average survival rate of 75 percent, the rivermouth goal is 34,000. All alternatives, except Alternative 5 show some level of harvest. None of the modeled output for all alternatives meet the escapement goal. Escapement past fisheries is consistently higher for Alternative 5 than for the other four alternatives. Modeled outputs for escapement past fisheries under Alternative 4 and Alternative 6 are consistently lower than for all other alternatives.

- Middle Columbia River spring- run

Effects to Middle Columbia River spring-run Chinook salmon are assumed to be the same as those represented by Snake River spring/summer-run Chinook salmon effects as fisheries are limited by the number of Snake River spring/summer-run Chinook salmon that can be caught and are closed once that is achieved. This means impacts to Middle Columbia River spring-run Chinook salmon will always be less than those to Snake River spring/summer-run Chinook salmon as fisheries are never constrained for this stock due to it being healthier than the Snake River stock. The Middle Columbia River spring-run Chinook salmon migrate at the same time as the Snake River stock, and therefore we expect impacts to this ESU to vary proportionally to harvest impacts of Snake River spring/summer-run Chinook salmon.

- Upper Columbia River summer run

Upper Columbia River summer Chinook salmon is not an ESA-listed ESU. It is both a Harvest Indicator and, because it is a single ESU, an Abundance Indicator Stock. The average harvest rate for this stock is the lowest for Alternative 3, aside Alternative 5 that involves no fishing (Table 4-60, Subsection 4.1.1.2.3 and Subsection 4.1.1.2.5). Therefore impacts to the spawning escapement level are a slight positive under Alternative 3 but a positive impact under Alternative 5. The average harvest rate is almost the same for Alternative 1 and Alternative 2 (Table 4-60, Subsection 4.1.1.2.1 and Subsection 4.1.1.2.2). The highest average harvest rate is for Alternative 4 and Alternative 6 (Table 4-60, Subsection 4.1.1.2.4 and Subsection 4.1.1.2.6). This results in a high negative impact to spawning escapement for these two alternatives. The average escapement past fisheries is almost the same for Alternative 1 and Alternative 2. The highest average escapement past fisheries, apart from Alternative 5, is for Alternative 3 (Table 4-60).

Table 4-60. Comparison of alternatives modeled outputs for Upper Columbia River summer Chinook salmon

	Total HR			Esc. Past Fisheries		
	Min	Max	Ave	Min	Max	Ave
Alternative 1	21.6%	62.7%	52.5%	29,000	50,000	35,375
Alternative 2	20.0%	60.0%	51.7%	29,600	53,600	35,920
Alternative 3	42.0%	42.0%	42.0%	21,460	77,720	43,162
Alternative 4/6	21.6%	78.4%	61.0%	29,000	29,000	29,000
Alternative 5	0%	0%	0%	37,000	134,000	74,417

- Deschutes River summer/fall- run

Effects to Deschutes River summer/fall-run Chinook salmon are assumed to be the same as those represented by Upper Columbia River summer Chinook salmon. Fisheries are limited by the number of Upper Columbia River summer Chinook salmon that can be caught and are closed once that is achieved. This means impacts to Deschutes River summer/fall-run Chinook salmon will always be less than those to Upper Columbia River summer Chinook salmon as fisheries are never constrained for this stock. The Deschutes River summer/fall-run Chinook salmon migrate at the same time as the Upper Columbia River summer Chinook salmon stock, and therefore we expect impacts to this ESU to vary proportionally to harvest impacts of Upper Columbia River summer Chinook salmon stock..

- Snake River fall- run - ESA-listed

For Snake River fall Chinook salmon the average harvest rate and average escapement past fisheries are the same for Alternative 1 and Alternative 2 (Table 4-61, Subsection 4.1.1.4.1 and Subsection 4.1.1.4.2). The average harvest rate of Alternative 3 is the lowest of all alternatives that provide fishing opportunity, but not by much (Table 4-61). The average escapement past fisheries of Alternative 3 is the highest of all alternatives that provide fishing opportunity, but not by much (Table 4-61, Subsection 4.1.1.4.3). Therefore impacts to the spawning escapement level are a slight positive under Alternative 3. Alternative 4 and Alternative 6 have the highest harvest rates and the lowest average escapements past fisheries of all the alternatives (Table 4-61, Subsection 4.1.1.4.4 and Subsection 4.1.1.4.6). This results in a high negative impact to spawning escapement for these two alternatives. Alternative 5 has the lowest overall average harvest rate (0 percent) and the highest average escapement past fisheries of all alternatives because Alternative 5 does not provide any fishing opportunity but provides a positive impact to spawning escapement.

Table 4-61. Comparison of alternatives modeled outputs for Snake River fall Chinook salmon

	Total HR			Esc. Past Fisheries			Lower Granite Run		
	Min	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**
Alternative 1	25.9%	43.9%	41.0%	4,305	22,960	11,334	3,228	17,216	8,499
Alternative 2	25.9%	43.9%	41.0%	4,305	22,960	11,334	3,228	17,216	8,499
Alternative 3	40.9%	40.9%	40.9%	3,434	24,187	11,707	2,575	18,136	8,778
Alternative 4/6	31.1%	90.2%	71.6%	4,000	4,000	4,000	3,000	3,000	3,000
Alternative 5	0.0%	0.0%	0.0%	5,808	40,916	19,804	4,356	30,687	14,853

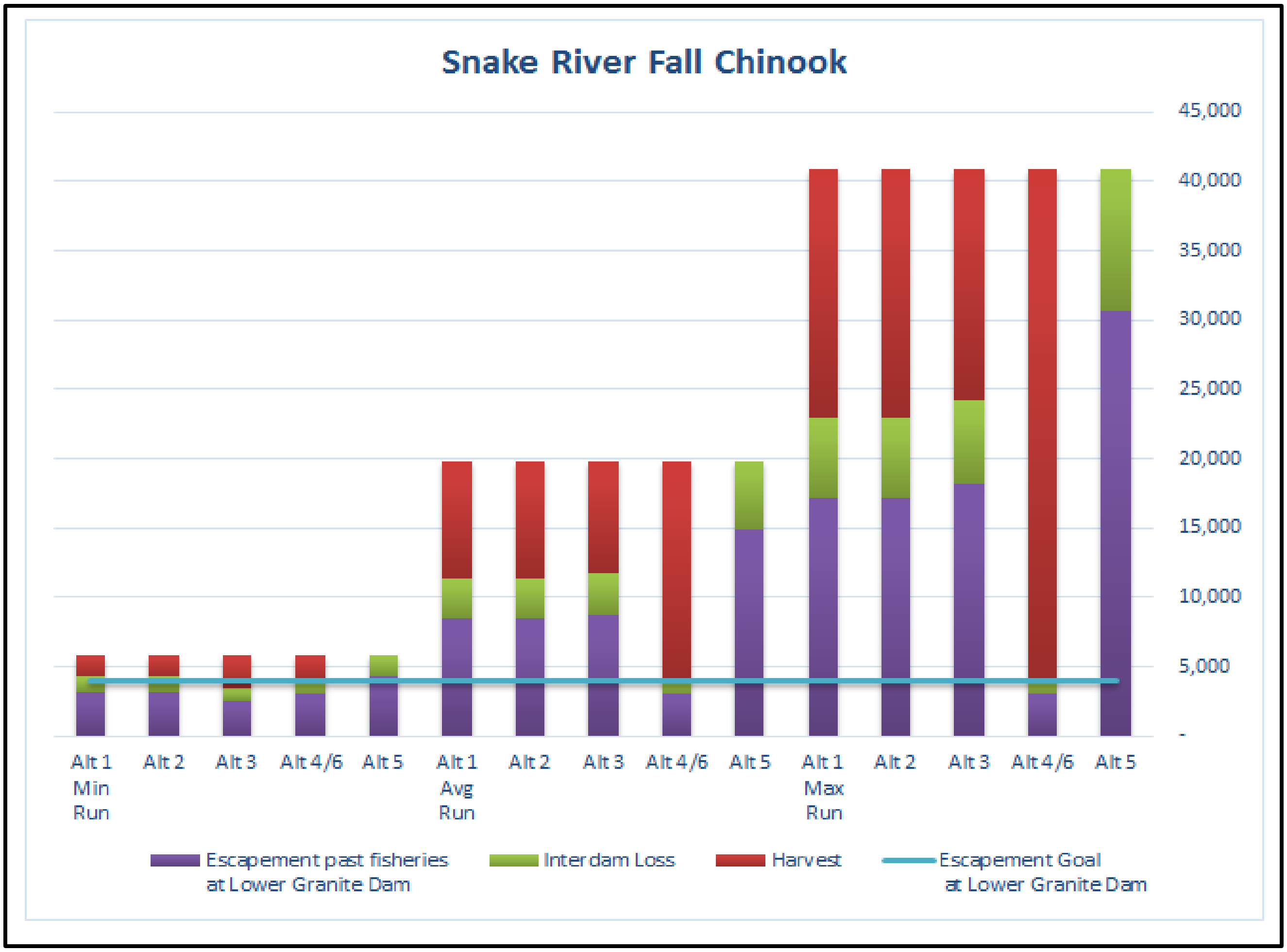

Figure 4-3. Comparison of alternatives modeled outputs for Snake River fall Chinook salmon at minimum, average, and maximum run sizes expected

Figure 4-3 illustrates the minimum, maximum and average defined metrics values for Snake River fall Chinook salmon. There is a small difference for the minimum, average and maximum harvest and escapement values between Alternatives 1 through 3. Alternative 4 and Alternative 6 offer the highest harvest opportunity, but also provides for the lowest escapement. The differences in escapement numbers between Alternative 1 and Alternative 3 are small for minimum, average and maximum values. Escapement for Alternative 2 is somewhat lower than for Alternative 1 and Alternative 3. Alternative 5 offers the most escapement and zero harvest. For a minimum observed river mouth runsize, the single alternative modeled output which meets the escapement goal at Lower Granite of 4,000 is Alternative 5. For the average observed river mouth runsize, the modeled output for all alternatives meet the escapement goal, except Alternative 4 and Alternative 6. For the minimum observed river mouth runsize, all of the alternatives modeled outputs meet the escapement goal of 4,000, except Alternative 4 and Alternative 6. For the average observed river mouth runsize, the modeled output for Alternative 5 meets the escapement goal, but all other alternatives also almost meet the escapement goal. For the maximum observed river mouth runsize, all of the alternatives modeled outputs meet the escapement goal.

- Coho salmon (*O. kisutch*)

Harvest policy for the management of Upriver coho salmon has not been set in the prior *US v Oregon* agreements except to specify limitations to insure 50/50, treaty/non-treaty sharing of the catch. This is expected to continue under a new *US v Oregon* agreement as the success of reintroduction programs in basins upstream of The Dalles Dam are evaluated and possibly expanded to other areas. Reintroduction of coho salmon into areas upstream of The Dalles Dam is still underway at this point in time. It is currently unknown the level upriver areas could support in terms of coho salmon abundance and escapement. Upriver coho salmon fall fisheries are therefore yet to be developed, but instead are currently only limited by the harvest policies that are set for steelhead and fall Chinook salmon. Fisheries targeting these two species operate during the fall and simply retain coho salmon as bycatch, but there is no harvest policy in the *US v Oregon* agreement specific for a conservation requirement for coho salmon upstream of Bonneville Dam. Therefore with no harvest policy for the management of Upriver coho salmon there will be no limits to fisheries based on coho salmon. Harvest impacts to coho salmon will vary proportionally with B-run steelhead harvest impacts, meaning if there is a large abundance of B-run steelhead then higher numbers of coho salmon will be caught as bycatch in fisheries targeting B-run steelhead. If B-run steelhead are low in abundance then lower harvest impacts to coho salmon will occur as fisheries targeting salmonids will be curtailed due to B-run steelhead low abundances. For these reasons, the analysis does not include detailed review of the effects of each alternative on coho salmon interception.

- Sockeye salmon (*O. nerka*)
    - Okanogan River ESU.
    - Lake Wenatchee ESU.
    - Snake River ESU

For Snake River sockeye salmon, the average harvest rate for alternatives providing fishing opportunity is lowest for Alternative 1 (Table 4-62, Subsection 4.1.1.3.1). The average harvest rate of Alternative 3 is the second lowest of all alternatives that provide fishing opportunity, but not different than Alternative 1 (Table 4-62, Subsection 4.1.1.3.3). The average escapement past fisheries of Alternative 1 and Alternative 3 are the highest of all alternatives that provide fishing opportunity (Table 4-62, Subsection 4.1.1.3.1 and

Subsection 4.1.1.3.3). Therefore impacts to the spawning escapement level are a slight positive under these Alternatives. Alternative 2 has no change in impact relative to the baseline. Alternative 4 and Alternative 6 have the highest harvest rates and the lowest average escapements past fisheries of all the alternatives (Table 4-62, Subsection 4.1.1.3.4 and Subsection 4.1.1.3.6). This results in a high negative impact to spawning escapement for these two alternatives. Alternative 5 has the lowest overall average harvest rate (0 percent) and the highest average escapement past fisheries of all alternatives because Alternative 5 does not provide any fishing opportunity but provides a positive impact to spawning escapement.

Table 4-62. Comparison of alternatives modeled outputs for Snake River sockeye salmon

	Total HR Snake River ESU			**Esc. Past Fisheries**			**Lower Granite Run**		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Alternative 1	6.0%	8.0%	7.7%	117	2,734	1,175	65	1,517	651
Alternative 2	6.0%	13.0%	9.7%	117	2,590	1,136	65	1,435	629
Alternative 3	8.0%	8.0%	8.0%	114	2,738	1,174	63	1,517	650
Alternative 4/6	6.0%	76.9%	36.8%	117	689	567	65	382	314
Alternative 5	0%	0%	0%	124	2,977	1,276	69	1,649	707

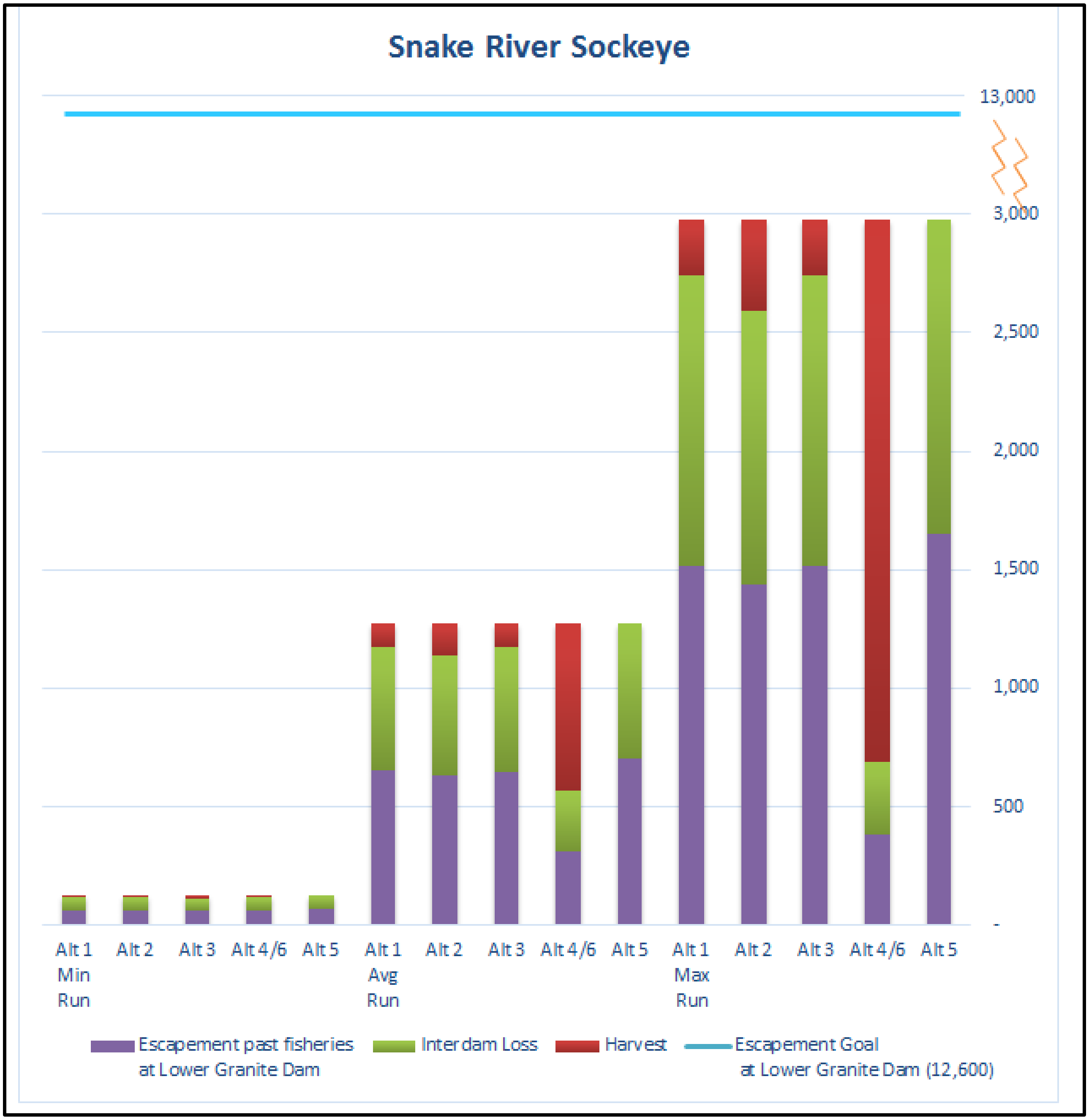

Figure 4-4. Comparison of alternatives modeled outputs for Snake River sockeye salmon at minimum, average, and maximum run sizes expected

Figure 4-4 illustrates the minimum, maximum and average defined metrics values for Snake River sockeye salmon. For the minimum values, there is practically no difference between alternatives, except that Alternative 5 has zero harvest. For the average values and maximum values, Alternative 4 and

Alternative 6 offer the highest harvest opportunity, but also provide for the lowest escapements. The differences in escapement numbers between Alternative 1 and Alternative 3 are small for minimum, average and maximum values. Escapement for Alternative 2 is somewhat lower than for Alternative 1 and Alternative 3. Alternative 5 offers the most escapement and zero harvest. None of the alternatives modeled outputs meet the escapement goal.

- Steelhead (*O. mykiss*)

Steelhead limits are constrained by Snake River Basin B-run steelhead, by being the lowest in abundance and therefore restricting access to more abundant stocks and limiting total catch. Fisheries are therefore limited by the number of Snake River Basin B-run Steelhead that can be caught and fisheries are closed once that is achieved. This means impacts to every other steelhead stock will always be less than those to Snake River Basin B-run Steelhead as fisheries are never constrained for any other steelhead stock due to them being healthier than the B-run stock. Other steelhead migrate at the same time as the Snake River Basin B-run Steelhead stock, and therefore we expect impacts to other DPSs to vary proportionally to harvest impacts of Snake River Basin B-run Steelhead. But the harvest impacts to the other DPSs are lower, likely much lower, as these other DPSs are greater in abundance, than those to Snake River Basin B-run steelhead, and effects were not modeled or analyzed in this EIS.

We expect harvest and resulting escapement levels, and therefore impacts, to these DPSs to vary proportionally to catch of B-run fish.

  - Southwest Washington DPS.
  - Lower Columbia River DPS.
  - Upper Willamette River DPS.
  - Mid-Columbia River DPS.
  - Upper Columbia River DPS.
  - Snake River Basin DPS.

For Snake River Basin B-run steelhead the average harvest rate and average escapement past fisheries are the same for Alternative 1 and Alternative 2 (Table 4-63, Subsection 4.1.1.5.1 and Subsection 4.1.1.5.2). The average harvest rate of Alternative 3 is the lowest of all alternatives that provide fishing opportunity, but not by much (Table 4-63, Subsection 4.1.1.5.3). The average escapement past fisheries of Alternative 3 is the highest of all alternatives that provide fishing opportunity, but not by much (Table 4-63, Subsection 4.1.1.5.3). Therefore impacts to the spawning escapement level are a slight positive under

Alternative 3. Alternative 4 and Alternative 6 have the highest harvest rates and the lowest average escapements past fisheries of all the alternatives (Table 4-63, Subsection 4.1.1.5.4 and Subsection 4.1.1.5.6). This results in a high negative impact to spawning escapement for these two alternatives. Alternative 5 has the lowest overall average harvest rate (0 percent) and the highest average escapement past fisheries of all alternatives because Alternative 5 does not provide any fishing opportunity but provides a positive impact to spawning escapement.

Table 4-63. Comparison of alternatives modeled outputs for B-run Snake River steelhead.

	Total HR B-run			**Esc. Past Fisheries**			**Lower Granite Run**		
	Min	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**
Alternative 1	19.2%	27.8%	27.1%	1,954	4,404	7,450	1,129	8,325	4,306
Alternative 2	19.2%	27.8%	27.1%	1,954	14,404	7,450	1,129	8,325	4,306
Alternative 3	25.9%	25.2%	25.3%	1,794	14,919	7,633	1,037	8,623	4,412
Alternative 4/6	7.7%	58.9%	31.1%	2,233	8,200	7,038	1,291	4,740	4,068
Alternative 5	0%	0%	0%	2,420	19,951	10,220	1,815	14,960	7,665

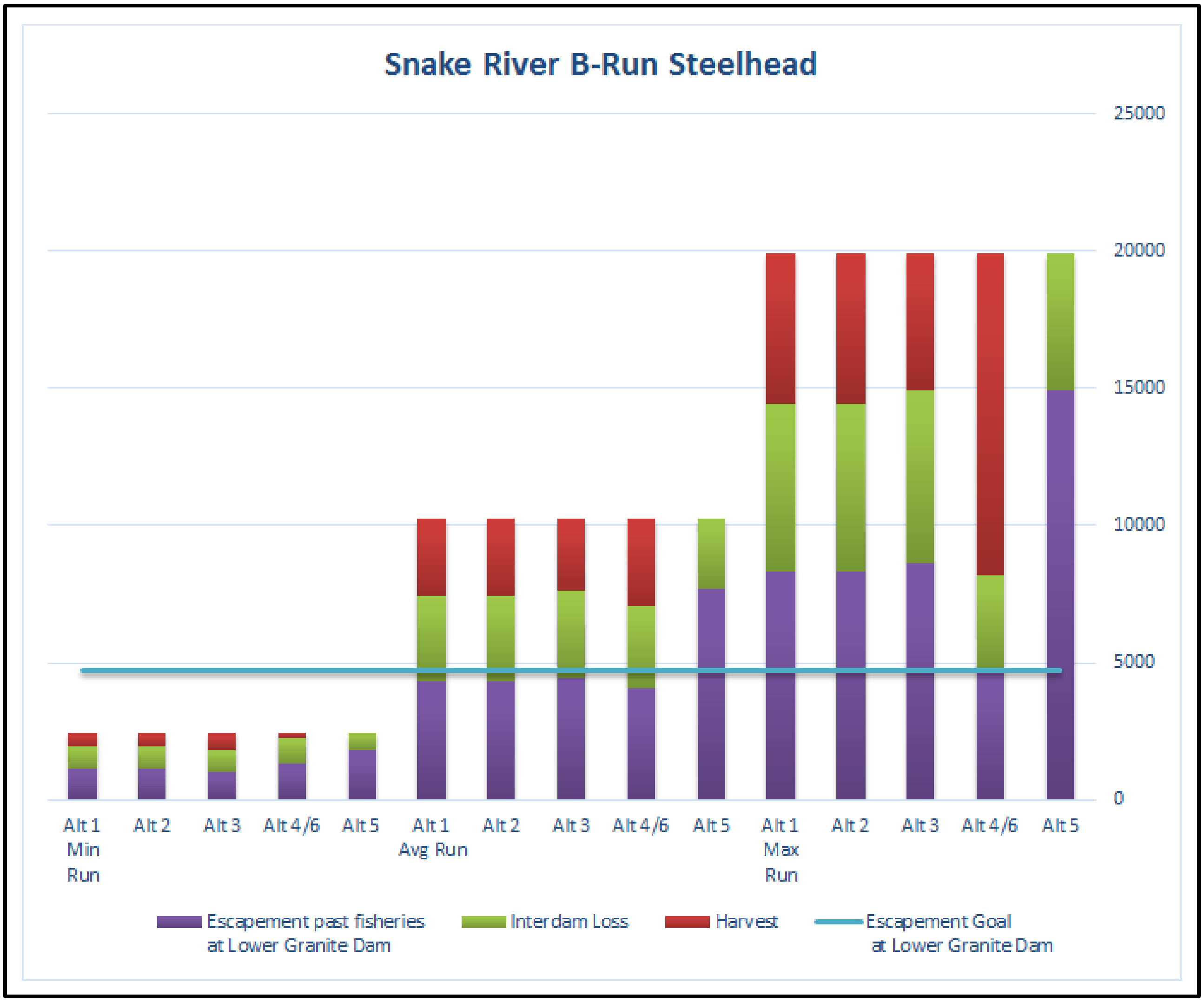

Figure 4-5. Comparison of alternatives modeled outputs for Snake River Basin B-run steelhead at minimum, average, and maximum run sizes expected

Figure 4-5 illustrates the minimum, maximum and average defined metrics values for Snake River Basin B-run steelhead. For the minimum values, there is practically no difference between alternatives, except that Alternative 5 has zero harvest. For the average values and maximum values, Alternative 4 and Alternative 6 offer the highest harvest opportunity, but also provide for the lowest escapements. The differences in escapement numbers between Alternative 1 and Alternative 3 are small for minimum, average and maximum values. Escapement for Alternative 2 is somewhat lower than for Alternative 1 and Alternative 3. Alternative 5 offers the most escapement and zero harvest. For the minimum observed river mouth runsize, none of the alternatives modeled outputs meet the escapement goal of 4,700. For the average observed river mouth runsize, the modeled output for Alternative 5 meets the escapement goal, but all other alternatives also almost meet the escapement goal. For the maximum observed river mouth runsize, all of the alternatives modeled outputs meet the escapement goal.

In summary, Alternative 1 and Alternative 2 on Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, and B-run steelhead would not impact the current baseline conditions. The effects of Alternative 3 on these same resources is practically the same as those of Alternative 1 and Alternative 2, but generally provides a slight positive impact to spawning escapement. Alternative 4 and Alternative 6 have the greatest effects (largest harvest) on all affected salmonid species, especially for Snake River Fall Chinook salmon, Snake River spring/summer Chinook salmon, Upper Columbia River Chinook salmon, Snake River sockeye salmon and B-run steelhead. Only for Upper Columbia River summer/fall Chinook salmon the effects of Alternative 4 or 6 are lower than for Alternatives 1, 2, and 3. This results in a high negative impact to spawning escapement for these two alternatives across all stocks. Alternative 5 has the lowest harvest impacts on all salmonid species because it involves no fishing, and therefore provides a positive impact to spawning escapement across all stocks. None of the alternatives, including Alternative 5, meet the escapement goal for Snake River Sockeye salmon.

Hatchery Effects to Salmonid Populations

The operation of salmon and steelhead hatcheries in the Columbia River Basin, including the hatchery programs contained in a new *US v Oregon* management agreement, results in impacts to ESA-listed and non-listed salmon and steelhead. As discussed earlier in this DEIS, the impacts of Columbia River hatcheries were disclosed in the Mitchell Act EIS. For this reason, NMFS is incorporating Section 4 of the Mitchell Act EIS into our impacts analysis here.

As described in detail in Subsection *3.2.3.1, General Risks and Benefits of Hatchery programs to Salmon and Steelhead Species*, in the Mitchell Act EIS and Appendix B of this EIS, hatchery salmon and steelhead programs can have beneficial effects to these species but also pose risks. Those beneficial effects include potential increases to abundance by increasing populations and helping maintain at-risk populations threatened by extirpation, benefits to productivity by providing nutrients and improving spawning gravel conditions, and to spatial structure by expanding spatial distribution. Additionally, hatcheries pose risks to natural-origin salmon and steelhead populations in the form of effects to abundance and productivity through competition, predation, disease and harvest. Interbreeding of hatchery and natural-origin fish can negatively affect genetic diversity and productivity, by interfering with the natural forces that strengthen the population genetics and by introducing maladaptive genetic changes. The presence of hatchery fish can lead to impacts to natural-origin populations from competition for resources such as food and spawning sites, and to predation by hatchery fish on natural-origin fish. Finally, hatchery facilities have impacts that result from the operation of weirs and other structures that can disrupt migrations, water intakes that risk entrainment and impingement, removal of water from the stream, discharge of effluent into streams, and impacts to river flows that interfere with migration and spawning.

Each of the alternatives in this action will continue to result in impacts from hatchery operations. As discussed in Subsection 1.3.2, above, hatchery production is incorporated into a new *US v Oregon* management agreement. Although individual programs are technically independent of harvest goals and would be expected to continue under any of the alternatives, continued impacts from the collective hatchery production in the Columbia River basin adopted cumulatively in a new *US v Oregon* management agreement is considered part of the impacts discussed here.

In addition to disclosing hatchery impacts generally at a basin-wide level, the Mitchell Act EIS disclosed impacts at the ESU/DPS-level as well as for each hatchery program, species by species, for each of its six hatchery alternatives, which can be viewed in the Mitchell Act EIS appendices (NMFS 2014) (Appendices C-F).

NMFS has reviewed the Mitchell Act EIS and determined that it contains an analysis of 113 of the 115 programs incorporated into a new *US v Oregon* management agreement, and therefore the impacts disclosed in the Mitchell Act EIS comprise a significant portion of the impacts of the current action. However, two programs in the new *US v Oregon* management agreement were not analyzed in the Mitchell Act EIS, and 42 of the programs that were analyzed there have either increased or decreased in size, resulting in potential changes to the impacts of individual programs. To update the analysis for this EIS, NMFS has reviewed the changes program-by-program and assessed how the impacts could differ from those reported in the Mitchell Act EIS. This review and its conclusions are found in Appendix B of this document.

Overall, the comparison of total programs, species by species, reveals that the production incorporated into a new *US v Oregon* management agreement falls within the range of total hatchery production analyzed in the Mitchell Act EIS, with the exception of sockeye salmon programs, which doubles the total production analyzed in the Mitchell Act EIS, and coho salmon programs, which are proposed to be 2 percent greater than the upper limit of programs analyzed in the Mitchell Act EIS.

Table 4-64 Comparison of Hatchery Program Production Referenced in the proposed *US v Oregon* Management Agreement Compared to the Hatchery Production Analyzed in the Mitchell Act EIS (NMFS 2014)

Hatchery Species	Total Proposed *US v Oregon* Releases	Mitchell Act EIS Releases (same programs, range across alternatives)	Percent of *US v Oregon* Production Analyzed in Mitchell Act EIS
spring Chinook salmon	19,236,461	14,741,000 to 20,936,000	77% - 109%
summer Chinook salmon	5,996,569	5,465,000 to 7,517,000	91% - 125%
fall Chinook salmon	42,176,000	4,359,000 to 42,680,000	10% - 101%
sockeye salmon	1,000,000	500,000	50%
steelhead	6,783,300	6,085,000 to 8,167,000	90% - 120%
coho salmon	8,550,000	2,508,000 to 8,400,000	29%-98%
Total	**83,742,330**	**33,658,000 to 88,200,000**	**40% - 105%**
	Proposed # *US v Oregon* Programs	**MA EIS Analyzed # Programs**	**% of *US v Oregon* programs analyzed in Mitchell Act**
spring Chinook salmon	39	39	100%
summer Chinook salmon	14	13	92%

fall Chinook salmon	16	15	93%
sockeye salmon	1	1	100%
steelhead	32	32	100%
coho salmon	13	12	92%
Total	**115**	**112**	**97%**

At the species level, the production referenced in a new *US v Oregon* management agreement will result in the same overall impacts to both listed and unlisted salmonids. The 2 percent increase in coho salmon does not significantly alter the effects of coho salmon production generally in the basin, and the increase in sockeye salmon production represents a single program which is proposed to double its capacity. For all other salmonid species, the production levels fall within the range of overall impacts analyzed in the Mitchell Act EIS. However, the program changes may result in changes to how each program impacts salmonid populations. For detailed program-by-program changes and assessment of impacts, please refer to Appendix B.

Chinook Salmon

As detailed in Table 4-64 above, the hatchery production levels of Chinook salmon, referenced in a new *US v Oregon* management agreement, are well represented in the Mitchell Act EIS analysis. Therefore, NMFS is incorporating by reference the likely effects of the Mitchell Act EIS Preferred Alternative, in consideration of any program changes, as described above and in Appendix B, to the Chinook salmon ESUs impacted by new *US v Oregon* management agreement harvest actions.

- Upper Columbia River spring-run

Under the Mitchell Act EIS preferred alternative, and considering any differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects that: hatchery effects to productivity and abundance of this ESU would likely decrease overall, due to the reduction in total spring Chinook salmon hatchery production; hatchery effects to population genetic diversity would likely decrease, slightly; and hatchery risk of competition and predation from hatchery fish to this ESU would likely remain consistent with baseline conditions, due to the overall hatchery salmon and steelhead production in the Upper

Columbia River area.

- Snake River Spring/Summer-run Chinook Salmon ESU

Under the Mitchell Act EIS preferred alternative, and considering any differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects that: hatchery effects on productivity of this ESU would likely increase, slightly, overall; while hatchery effects to abundance would likely be increased slightly, overall, given the potential use of more natural-origin fish in the hatchery broodstocks; hatchery effects to population genetic diversity would likely increase, slightly, overall; hatchery risk of competition and predation, from hatchery fish, to this ESU, would increase, slightly, due to likely increases in overall hatchery spring/summer Chinook and coho salmon production in the Snake River Basin.

- Upper Columbia River Summer Chinook Salmon ESU

Under the Mitchell Act EIS preferred alternative, and considering the differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects that: hatchery effects to population productivity and abundance would likely decrease, overall; hatchery risks to population genetic diversity would likely be decreased; and hatchery risk of competition and predation, from hatchery fish, to this ESU would likely remain consistent with baseline conditions, due to the overall hatchery salmon and steelhead production in the Upper Columbia River area.

- Snake River Fall-run Chinook Salmon ESU

Under the Mitchell Act EIS preferred alternative, and considering the differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects that: hatchery effects to the productivity of this ESU would likely remain constant while abundance would likely be reduced slightly, given the potential use of more natural-origin fish in the hatchery broodstock; hatchery risks to population genetic diversity would also, likely remain constant; hatchery risk of competition and predation from hatchery fish to this ESU would likely increase, slightly, due to likely increases in overall hatchery spring/summer Chinook and coho salmon production in the Snake River Basin.

Coho Salmon (above Bonneville Dam)

As detailed above in Table 4-64, the hatchery production level of coho salmon, overall, referenced in a new *US v Oregon* management agreement, is slightly higher than the production level analyzed in the Mitchell Act EIS analysis. Therefore, NMFS is incorporating by reference the likely effects of the

Mitchell Act EIS Preferred Alternative, in consideration of any program changes, as described above and in Appendix B, to the coho salmon populations impacted by a new *US v Oregon* management agreement.

Under the Mitchell Act EIS preferred alternative, and considering the differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects: the hatchery effects to coho salmon abundance from the programs would be higher; the hatchery effects to coho salmon productivity would likely remain constant; hatchery risks to coho salmon population genetic diversity would increase, slightly; and hatchery risks of competition and predation from hatchery fish to these coho salmon populations would likely remain consistent with baseline conditions.

Sockeye Salmon

As detailed above in Table 4-64, the hatchery production level of sockeye salmon, referenced in a new *US v Oregon* management agreement, is higher than the production level analyzed in the Mitchell Act EIS analysis. Therefore, NMFS is incorporating by reference the likely effects of the Mitchell Act EIS Preferred Alternative, in consideration of any program changes, as described above and in Appendix B, to the sockeye salmon ESUs impacted by a new *US v Oregon* management agreement.

- Snake River Sockeye Salmon ESU

Under the Mitchell Act EIS preferred alternative, and considering the differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects: the abundance benefits from the program would likely be higher, relative to the program analyzed in the Mitchell Act EIS preferred alternative; the benefits to productivity would likely be lower, relative to the program analyzed in the Mitchell Act EIS preferred alternative; the risks to population genetic diversity may increase, relative to the program analyzed in the Mitchell Act EIS alternative; and hatchery risks of competition and predation from hatchery fish to this ESU would likely increase, slightly, due to likely increases in overall hatchery spring/summer Chinook and coho salmon production in the Snake River Basin.

Steelhead

As detailed above, the hatchery production levels of steelhead, referenced in a new *US v Oregon* management agreement, are well represented in the Mitchell Act EIS analysis. Therefore, NMFS is summarizing here and incorporating by reference the likely effects of the Mitchell Act EIS Preferred Alternative, and in consideration of any program changes, as described above and in Appendix B to the steelhead DPSs impacted by a new *US v Oregon* management agreement.

- Snake River Steelhead DPS

Under the Mitchell Act EIS preferred alternative, and considering the differences in release number from the proposed programs (Appendix B, Table 2), NMFS expects that: hatchery effects to the productivity of this DPS would likely decrease, with an overall decrease in hatchery steelhead production; hatchery effects to the abundance of this DPS would also, likely, decrease; hatchery effects to population genetic diversity would likely for this population. Risk of competition and predation, from hatchery fish, to this DPS would likely decrease, slightly, due to decreases in overall hatchery steelhead in the Snake River Basin.

4.2.2. ESA-Listed Fish Species (non-salmonids)

There is potential for incidental take of non-salmonid ESA-listed green sturgeon (*Acipenser medirostris*, Threatened, 71 Fed. Reg. 17757) in fisheries directed at white sturgeon. However, in 2008 NMFS determined the total expected annual take of Southern DPS green sturgeon associated with prospective *US v Oregon* non-treaty commercial white sturgeon fisheries was estimated annually to be 14 fish and zero in treaty Indian fisheries (NMFS 2008). Between 2008 and 2013, salmon fisheries largely replaced white sturgeon seasons, further limiting the possibility of green sturgeon incidental take. Effective 2014, policies adopted by the Washington Fish and Wildlife Commission and Oregon Fish and Wildlife Commission prohibited the retention of white sturgeon in all non-Indian fisheries downstream of Bonneville Dam (JSR 2016), thereby reducing the likelihood of green sturgeon incidental take to near zero. Therefore there is no discernable effect on green sturgeon from any of the alternatives.

In 2008 the USFWS determined encounters with bull trout (*salvelinus confluentus*) were expected to be extremely limited in fisheries subject to a *US v Oregon* agreement (USFWS 2008). USFWS determined bull trout may only rarely or intermittently be present in mainstem locations. In general, bull trout are too small to be taken in gear types known to be used by treaty and non-treaty commercial fisheries. Recreational fisheries in the mainstem Columbia and Snake Rivers are not allowed to keep bull trout and all bull trout incidentally hooked in recreational fisheries must be released immediately. Therefore there is no discernable effect on bull trout from any of the alternatives.

Neither harvest policy nor salmon harvest strategies used in prospective *US v Oregon* fisheries are expected to incidentally take ESA-listed Pacific Eulachon (*thaleichthys pacificus*, Threatened, 79 Fed.

Reg. 20802). Therefore there is no discernable effect on Pacific Eulachon from any of the alternatives.

Under implementation of the Mitchell Act EIS Preferred Alternative, levels of hatchery produced salmon and steelhead smolts do not change substantially. This would not change the impacts to bull trout as either a prey base (hatchery juveniles) or through potential competition (returning hatchery adults). Nor would the impacts to eulachon, through predation from hatchery salmon and steelhead change.

4.2.3. Other Non-Salmonids (non ESA-listed Fish Species)

Harvest policies are not set in the *US v Oregon* agreement for fisheries directed at the following species:

- White Sturgeon (*Acipenser transmontanus*)
- American Shad (*Alosa sapidissima*)
- Pacific Lamprey (*Entosphenus tridentatus*)
- Walleye (*Sander vitreus*)

The *US v Oregon* agreement does not specify conservation specific needs for any of these fish. Instead, these species are mentioned in the agreement as very small levels of salmon or steelhead bycatch might occur during fisheries targeting these species. The parties to the *US v Oregon* management agreement track any salmon or steelhead bycatch, regardless of the low level, to ensure they remain static and accounted for in allocation and fishery management calculations. The level of effort for these fisheries have remained relatively unchanged and we expect this level of effect to continue. Therefore we expect no discernable effect on these species under any of the alternatives relative to baseline, but they are included in this DEIS as a new *US v Oregon* management agreement references fisheries targeting these species so that bycatch of salmonid resources are accounted for. We account for impacts to from salmonid bycatch in the salmonid resource Subsections.

Implementation of the Mitchell Act EIS Prefered Alternative would not substantially alter the total production of salmon and steelhead throughout the Columbia River Basin. As such, we would not expect a discernible difference in effects to other species of fish, from the hatchery programs included in a new *US v Oregon* management agreement.

4.3. Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients

In reviewing the differences in production levels between the agreement-referenced programs and those analyzed in the Mitchell Act EIS, NMFS considered the increases in production, for some programs, and the decreases in production, for some programs, represented by the programs in a new *US v Oregon* agreement, relative to the programs, as analyzed, in the Mitchell Act EIS. The small scale of these changes, in numbers of fish, and the relationship of that change to the total production at the facilities used makes it difficult to estimate the likely change in facility effects (as described in Subsection 3.3) to water quality from these production differences. Additionally, considering that the facilities operating in the Columbia River basin, including the facilities associated with the production in a new *US v Oregon* agreement, operate under existing federal Clean Water Act (CWA), National Pollution Discharge Elimination System (NPDES) permits (when required), NMFS concludes that the differences in the hatchery program releases, included in the *US v Oregon* Agreement, relative to the programs analyzed in the Mitchell Act EIS, are not likely to have substantively different effects to the water quality where they operate.

As discussed in Subsection 3.3, anadromous species such as salmon and steelhead are important components of the freshwater ecosystem, particularly for their role in transporting nutrients upstream from the marine ecosystem. There is no difference in hatchery production under any of the alternatives. Therefore, the level of marine derived nutrients deposited from hatchery production is constant and stable across every alternative.

Under Alternatives 1, 2, 3, 4, and 6 there will be a decrease in nutrients transported upstream in comparison to Alternative 5 because fish carcasses will be removed through harvest. Harvest would reduce nutrients to aquatic organisms, including listed salmon and steelhead, and limit stream engineering from spawning adult salmon. Table 4-65 shows the total harvest and indicates the level of reduced fish carcasses that would be distributed in the ecosystem. Alternative 5 would lead to an immediate positive effect and improvement over time relative to the other alternatives as there would be more marine derived nutrients deposited throughout the Columbia River Basin.

Table 4-65. Total treaty and non-treaty harvests of all salmon and steelhead species by minimum, maximum, and average run size abundances expected over the next 10 years.

	Treaty Total Harvest (all species)			**Non-Treaty Total Harvest (all species)**			**Total**
	Min	Max	Avg	Min	Max	Avg	Avg
Alternative 1 Extension	57,972	550,955	261,528	19,137	278,149	131,142	392,670
Alternative 2 Abundance	57,672	575,075	269,056	18,818	288,947	131,909	400,965
Alternative 3 Fixed Harvest	75,963	516,162	254,213	39,915	234,551	119,908	374,121
Alternative 4 / 6 Fixed Escapement / Uncoordinated Harvest	55,906	1,080,590	417,420	49,700	999,239	384,890	802,310
Alternative 5 Fishing curtailment	0	0	0	0	0	0	

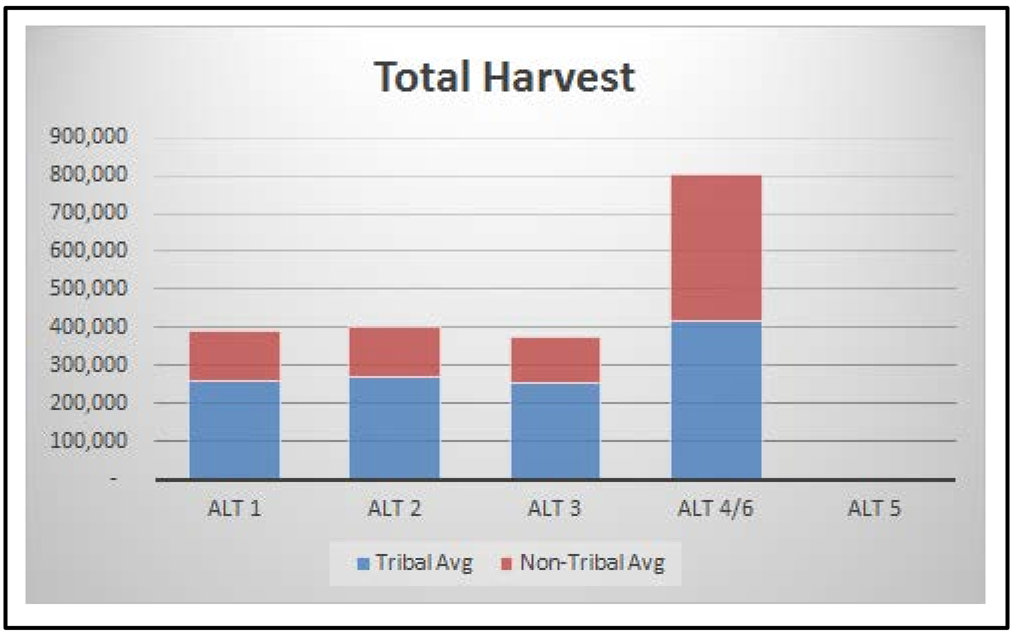

Figure 4-6. Total Treaty and Non-Treaty harvests of all salmon and steelhead species by average run size abundances expected over the next 10 years.

Alternative 3 results in the highest average escapement past fisheries, as it results in the lowest harvest total (Table 4-65), but relative to Alternative 1 and Alternative 2, it is a low difference (6 percent), and since the majority of fish harvested are hatchery fish, and hatchery fish normally return to traps and hatcheries, the reduction in available carcasses would not equal the number of fish harvested. Alternative 4 and Alternative 6 result in the lowest number of carcasses distributed compared to the other alternatives, as both result in the highest average harvest total (Table 4-65). Alternative 5 would have the maximum stream bed modification effect due to it resulting in the largest number of escaping adults, while the other alternative would show negligible differences between each other given the slight differences in escapement.

4.4. Wildlife

As discussed in Subsection 3.4 fisheries have the potential to affect wildlife through interactions between wildlife and fishing gear and through changes in the availability of fish as prey. Wildlife that are most likely to be affected by fishing activities are seabirds and marine mammals. Analyses conducted for wildlife were based on the use of literature representing the best available science and other studies.

4.4.1. Seabirds, Raptors, and Other Piscivorous Birds

Seabirds prey on juvenile salmon as they migrate down the Columbia River, primarily in the estuary (downstream of Bonneville Dam), and in the tailraces of some dams. Seabirds that prey on juvenile salmon include Caspian terns, Double-crested cormorants, and several species of gulls. Guillemots, murres, and puffins also prey on juvenile salmon, primarily in the ocean. However, they are considered to be a minor source of predation. Seabirds do not prey on adult salmon at any time during upstream migration.

None of the harvest alternatives examined in this DEIS are expected to directly affect seabirds by reducing their prey base, which do not include adult salmon. It is possible the harvest alternatives (Alternatives 1 through 6) could indirectly affect seabirds by reducing a potential food supply (by reducing the potential spawning population size). Seabirds are known to feed on juvenile salmon in the Columbia River estuary. However, the majority of the juvenile salmon eaten by seabirds originate from hatcheries downstream of Bonneville Dam. Since the alternatives do not affect the hatchery program release sizes, their production of juvenile salmon is not expected to be reduced. As such, this food source for seabirds would be maintained. However, the capacity limit of the current spawning habitat does not allow for increased juvenile production at higher escapement numbers. Therefore, an increase in escapement of adult fish to terminal spawning areas does not translate into an increase in juvenile salmonids. All alternatives would have a similar positive effect when salmonid abundance is sufficient to meet escapement goals, which is to produce juveniles at the maximum level of current habitat capacity.

Raptors (bald eagles, turkey vultures, osprey), corvids (crows, ravens), and numerous species of gulls prey on returning adult salmonids, primarily post-spawn adults. Since Pacific salmon die after spawning, post-spawn adults provide an important food source for these birds in the late summer, fall, and early winter. In general, adult salmon are not susceptible to bird predation until they are either actively spawning or are in a post-spawn condition.

Alternative 1 and Alternative 2 would have no impact change relative to baseline levels of adults available as prey to these birds. Alternative 3 would have a slightly positive impact as its average harvest is lower than that of Alternative 1 and Alternative 2, thereby providing a larger number of prey items available. Alternative 4 and Alternative 6, with the largest harvest, would have the most noticeable negative impact on these birds by removing the largest numbers of available prey items. Alternative 5 would offer the most adult salmonids as prey since they would not be harvested en route to the spawning grounds, thereby providing a positive impact. This alternative would maximize post-spawn adults as a food source.

Implementation of the Mitchell Act EIS Preferred Alternative, would not be expected to change the current availability of juvenile salmonid prey base for seabirds and the resulting adult returns would be well within annual variability of total salmon and steelhead returns, so would not have a discernable effect on the availability of adult salmon and steelhead prey.

4.4.2. Marine Mammals

Subsection 3.4.2 indicates fisheries occur in areas known to be inhabited by seals and sea lions and these mammals prey on adult salmonids that are also target of the fisheries. Alternative 1 and Alternative 2 would have no impact change relative to baseline levels of adults available as prey for marine mammals while Alternative 3 would have a slightly positive impact as its average harvest is lower than that of Alternative 1 and Alternative 2. Alternative 4 and Alternative 6, with the largest harvest, would have the most noticeable negative effect on these marine mammals, as they remove the largest number of adults available as prey. Alternative 5 would offer the most adult salmonids as prey since they would not be harvested resulting in a positive impact.

Alternatives examined in this analysis represent options for controlling harvest inside the Columbia River. Any anadromous fish taken or not taken through fisheries inside the Columbia River would not be available to Southern Resident Killer Whales (SRKW) given they would have already passed through their respective ocean habitat. However, the capacity limit of the current spawning habitat does not allow for increased juvenile production at higher escapement numbers. Therefore, an increase in escapement of adult fish to terminal spawning areas does not translate into an increase in juvenile salmonids that would eventually serve as adult prey for the SRKW. There is no discernable difference between the alternatives on the effect to SRKW.

Implementation of the Mitchell Act EIS Preferred Alternative would likely increase the number of adult Columbia River Basin Chinook salmon in the ocean. This increase, however, would likely be within the range of annual natural variability and would be difficult to distinguish from other sources of variability. Therefore, the implementation of the Mitchell Act Preferred Alternative would not be expected to add a substantial benefit for the population abundance of the SRKW.

4.5. Economics

This economic analysis evaluates harvest-related effects from implementing harvest policy alternatives in the project area, relative to existing conditions as described in Subsection 3.5, Economics. This analysis focuses on analyzing effects related to commercial and recreational fishing activity directed on the five harvest indicator stocks identified in Subsection 3.5: Upriver Spring Chinook salmon, Upriver Summer Chinook salmon, Upriver Fall Chinook salmon, Upper Columbia River Sockeye salmon, and Snake River Basin steelhead. The analysis identifies the effects of the harvest policy alternatives on the number of fish harvested in affected commercial fisheries in the Columbia River mainstem, catch and effort associated with affected recreational fisheries in the Columbia River mainstem, and changes in different metrics of economic value, including the ex-vessel value of commercial landings and estimates of trip-related expenditures by recreational anglers.

Potential changes in the direct and indirect contribution of the harvest policy alternatives to employment and personal income in the four economic impact subregions of the Columbia River basin are estimated. The numbers of jobs estimated in this analysis below are expressed as full-time equivalent (FTE) jobs. However, most jobs in the commercial fishing industry are part-time positions due to the seasonality of commercial salmon fishing in Puget Sound. Many persons engaged in commercial salmon fishing also participate in other fisheries and/or have other occupations. This situation should be considered in interpreting the employment effects presented for estimated job changes associated with commercial fisheries (and to a lesser extent, jobs associated with businesses that support recreational fishing activity).

In summary, considering all potential economic effects from the harvest policy alternatives for the *US v Oregon* Project Area, under existing conditions (Subsection 3.5, Economics), the value to tribal and non-tribal commercial fishers and to non-tribal recreational fishers, and the employment and personal income contribution to the regional and local economy overall, has a moderate positive effect in the economic analysis area. This is because of the contribution to income and jobs that are primarily associated with tribal commercial and non-tribal recreational fisheries. The harvest policy alternatives also affect salmon and steelhead for ceremonial and subsistence fishing, as discussed in Subsection 4.6, Cultural Resources—C&S Harvest.

Table 4-66. Comparative summary of economic effects under the alternatives.

Status Quo Conditions	**Alternative 1 (Extension)**	**Alternative 2 (Abundance-based)**	**Alternative 3 (Fixed Rate)**	**Alternative 4 / 6 (Escapement-based / Uncoordinated fishing)**	**Alternative 5 (Fishing curtailment)**
Moderate positive	Moderate positive	Low positive	Low negative	High positive	High negative

It should be noted that the information presented in this section is organized first by harvest policy alternative and then generally follows the organization in Subsection 3.5, Economics (commercial fisheries, recreational fisheries, and contributions to regional economic activity). As indicated in Subsection 3.5, Economics, values in the following subsections are not rounded to aid the reader in finding corresponding numbers between tables and text. The use of unrounded numbers, however, should not be interpreted as suggestive of unusually high levels of precision in the estimates. All numbers presented represent a reasonable estimate of the underlying values. Information on methods and analyses used in this analysis is presented in Appendix A, Economic Methods.

4.5.1. Alternative 1 – Extension of Current Agreement

Under Alternative 1, the harvest policy would support the same level of harvest as under the status quo condition, the same number of salmon and steelhead would be harvested in commercial and recreational fisheries as described in Subsection 3.5, Economics.

4.5.1.1. Commercial Fisheries

Upriver Spring Chinook Salmon

Under Alternative 1, the commercial harvest of Upriver Spring Chinook salmon (11,606 fish) would be the same as under the status quo condition, with tribal fisheries accounting for about 65 percent (7,528 fish) of the harvest and non-tribal fisheries about 35 percent (4,078 fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Spring Chinook salmon ($848,193) also would be the same as under status quo conditions, with tribal fisheries accounting for about 65 percent ($493,029) of total ex-vessel value and non-tribal fisheries for about 42 percent ($355,164) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-7.

Upriver Summer Chinook Salmon

Under Alternative 1, the commercial harvest of Upriver Summer Chinook salmon (24,791 fish) would be the same as under the status quo condition, with tribal fisheries accounting for about 71 percent (17,569 fish) and non-tribal fisheries about 29 percent (7,222 fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Summer Chinook salmon ($854,787) also would be the same as under status quo conditions, with tribal fisheries accounting for about 66 percent ($565,958) of total ex-vessel value and non-tribal fisheries for about 34 percent ($288,829) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-8.

Upriver Fall Chinook Salmon

Under Alternative 1, the commercial harvest of Upriver Fall Chinook salmon (232,173 fish) would be the same as under the status quo condition, with tribal fisheries accounting for about 81 percent (187,303 fish) of the harvest and non-tribal fisheries about 19 percent (44,870 fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Fall Chinook salmon ($8,373,007) also would be the same as under status quo conditions, with tribal fisheries accounting for about 77 percent ($6,457,182) of total ex-vessel value and non-tribal fisheries for about 23 percent ($1,915,825) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix

A, Table A-9.

UCR Sockeye Salmon

Under Alternative 1, the commercial harvest of UCR sockeye salmon (16,952 fish) would be the same as under the status quo condition, with tribal fisheries accounting for about 97 percent (16,440 fish) of the harvest and non-tribal fisheries about 3 percent (512 fish) of the harvest. Ex-vessel values associated with the total harvest of UCR sockeye ($110,569) also would be the same as under status quo conditions, with tribal fisheries accounting for about 97 percent ($106,825) of total ex-vessel value and non-tribal fisheries for about 3 percent ($3,744) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-10.

B-run Snake River Steelhead

Under Alternative 1, the commercial harvest of B-run Snake River steelhead (9,180 fish) would be the same as under the status quo condition, with tribal fisheries accounting for about 97 percent (8,945 fish) of the harvest and non-tribal fisheries about 3 percent (235 fish) of the harvest. Ex-vessel values associated with the total harvest of B-run Snake River steelhead ($126,353) also would be the same as under status quo conditions, with tribal fisheries accounting for about 97 percent ($493,029) of total ex-vessel value and non-tribal fisheries for about 3 percent ($3,554) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-11.

Summary

Under Alternative 1, the total commercial harvest across all harvest indicator units would be the same as under the status quo conditions (294,701 fish), including the harvest of 237,785 fish in tribal fisheries and 56,916 fish in non-tribal fisheries. The total ex-vessel value of the commercial harvest would be $10,312,910, including $7,745,794 in tribal fisheries and $2,567,116 in non-tribal fisheries.

4.5.1.2. Recreational Fisheries

Under Alternative 1, recreational catch and effort targeting the five harvest indicator stocks (71,366 fish and 342,318 angler trips) would be the same as under the status quo condition. Trip-related expenditures associated with the total recreational effort targeting the five harvest indicator stocks ($45,465,572) also would be the same as under status quo conditions. The Lower Columbia River subregion accounts for about 72 percent of the recreational catch, about 70 percent of angler effort, and about 79 percent of trip-related expenditures. Details of recreational catch, estimated angler trips and trip-related angler expenditures by sub-region and alternative are provided in Appendix A, Table A-12.

4.5.1.3. Contribution to Regional Economic Activity

Under Alternative 1, the contribution of commercial and recreational fisheries to regional economic activity would be identical to status quo conditions. Table A-13 in Appendix A presents the personal income and jobs by alternatives and sub-region for commercial and recreational fisheries.

Commercial Fisheries: Harvest and primary processing of salmon caught in tribal and non-tribal commercial fisheries is estimated to generate $16.2 million in personal income and 419 Full-time Equivalent (FTE) jobs. More than two-thirds of this activity would occur in the Mid-Columbia River subregion.

Recreational Fisheries: Recreational fishing activities targeting salmon and steelhead generate an estimated $27.9 million in personal income and 672 jobs in the Columbia River region. More than two-thirds of the jobs and income would occur in the Lower Columbia River subregion, with most of the remainder in the Mid-Columbia River subregion.

4.5.2. Alternative 2—Abundance-based Management Alternative

Under Alternative 2, the same level of commercial harvest and recreational catch and effort as under the status quo condition and Alternative 1.

4.5.2.1. Commercial Fisheries

Upriver Spring Chinook Salmon

Under Alternative 2, the commercial harvest of Upriver Spring Chinook salmon (11,606 fish) would be the same as under the status quo condition and Alternative 1, with tribal fisheries accounting for about 65 percent (7,528 fish) of the harvest and non-tribal fisheries about 35 percent (4,078 fish) of the harvest . Ex-vessel values associated with the total harvest of Upriver Spring Chinook salmon ($848,193) also would be the same as under status quo conditions, with tribal fisheries accounting for about 65 percent ($493,029) of total ex-vessel value and non-tribal fisheries for about 42 percent ($355,164) of the value.

Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-7.

Upriver Summer Chinook Salmon

Under Alternative 2, the commercial harvest of Upriver Summer Chinook salmon (24,791 fish) would be the same as under the status quo condition and Alternative 1, with tribal fisheries accounting for about 71 percent (17,569 fish) of the harvest and non-tribal fisheries about 29 percent (7,222 fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Summer Chinook salmon ($854,787) also would be the same as under status quo conditions, with tribal fisheries accounting for about 66 percent ($565,958) of total ex-vessel value and non-tribal fisheries for about 34 percent ($288,829) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-8.

Upriver Fall Chinook Salmon

Under Alternative 2, the commercial harvest of Upriver Fall Chinook salmon (232,173 fish) would be the same as under the status quo condition and Alternative 1, with tribal fisheries accounting for about 81 percent (187,303 fish) of the harvest and non-tribal fisheries about 19 percent (44,870 fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Fall Chinook salmon ($8,373,007) also would be the same as under status quo conditions, with tribal fisheries accounting for about 77 percent ($6,457,182) of total ex-vessel value and non-tribal fisheries for about 23 percent ($1,915,825) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-9.

UCR Sockeye Salmon

Under Alternative 2, the commercial harvest of UCR sockeye salmon (23,683 fish) would increase by 6,631 fish relative to the status quo condition and Alternative 1, with tribal fisheries accounting for more than 98 percent (6,631 fish) of the harvest increase and non-tribal fisheries about 2 percent (99 fish) of the increase. Ex-vessel values associated with the harvest of UCR sockeye salmon ($154,386) also would increase relative to status quo conditions, with tribal fisheries accounting for about 97 percent ($149,916) of total ex-vessel value and non-tribal fisheries for about 3 percent ($4,471) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in

Appendix A, Table A-10.

B-run Snake River Steelhead

Under Alternative 2, the commercial harvest of B-run Snake River steelhead (9,180 fish) would be the same as under the status quo condition, with tribal fisheries accounting for about 97 percent (8,945 fish) of the harvest and non-tribal fisheries about 3 percent (235 fish) of the total harvest. Ex-vessel values associated with the total harvest of Snake River steelhead ($126,353) also would be the same as under status quo conditions, with tribal fisheries accounting for about 97 percent ($122,799) of total ex-vessel value and non-tribal fisheries for about 3 percent ($3,554) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-11.

Summary

As compared to status quo conditions, the total commercial harvest across all harvest indicator units under Alternative 2 would be slightly higher (6,384 fish), with all of the harvest increase occurring in tribal fisheries. Sockeye salmon accounts for all of the increase, offset by a reduction of 245 fish of Upriver Spring Chinook salmon stocks. The overall ex-vessel value also would increase (by $31,869), with the value of the reduced harvest of Summer Chinook salmon stocks slightly offsetting the value of the increased tribal harvest of sockeye salmon.

4.5.2.2. Recreational Fisheries

Under Alternative 2, recreational catch and effort targeting the five harvest indicator stocks (71,366 fish and 342,318 angler trips) would be the same as under the status quo condition. Trip-related expenditures associated with the total recreational effort targeting the five harvest indicator stocks ($45,465,572) also would be the same as under status quo conditions. The Lower Columbia River subregion accounts for about 72 percent of the recreational catch, about 70 percent of angler effort, and about 79 percent of trip-related expenditures. Details of recreational catch, estimated angler trips and trip-related angler expenditures by sub-region and alternative are provided in Appendix A, Table A-12.

4.5.2.3. Contribution to Regional Economic Activity

Under Alternative 2, the contribution of commercial and recreational fisheries to regional economic activity would be identical to status quo conditions. Table A-13 in Appendix A presents the personal income and jobs by alternatives and sub-region for commercial and recreational fisheries.

Commercial Fisheries: Harvest and primary processing of salmon caught in tribal and non-tribal commercial fisheries is estimated to generate $16.2 million in personal income and 419 FTE jobs. More than two-thirds of this activity would occur in the Mid-Columbia River subregion.

Recreational Fisheries: Recreational fishing activities targeting salmon and steelhead generate an estimated $27.9 million in personal income and 672 jobs in the Columbia River region. More than two-thirds of the jobs and income would occur in the Lower Columbia River subregion, with most of the remainder in the Mid-Columbia River subregion.

4.5.3. Alternative 3 – Fixed Harvest Rate

Under Alternative 3, the total commercial harvest would decline by 13,864 salmon and steelhead relative to the status quo condition. The only harvest indicator stock in which there would be an increase in fish harvested relative to status quo conditions would be UCR sockeye salmon.

4.5.3.1. Commercial Fisheries

Upriver Spring Chinook Salmon

Under Alternative 3, the commercial harvest of Upriver Spring Chinook salmon (10,677 fish) would decrease relative to status quo condition, with a decrease of 755 fish in the tribal harvest and a decrease of 174 fish of the non-tribal harvest. Ex-vessel values of Upriver Spring Chinook salmon also would decrease relative to status quo condition, with a decrease of $49,478 in the tribal harvest of Upriver Spring Chinook salmon and a decrease of $15,146 in the non-tribal harvest value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-7.

Upriver Summer Chinook Salmon

Under Alternative 3, the commercial harvest of Upriver Summer Chinook salmon (19,846 fish) would decline relative to status quo condition, with a decrease of about 3,504 fish in the tribal harvest of Upriver Summer Chinook salmon and a decrease of 1,441 fish) in the non-tribal harvest. Ex-vessel values of Upriver Summer Chinook salmon also would decrease relative to status quo condition, with a decrease of

$112,878 in the tribal harvest of Upriver Summer Chinook salmon and a decrease of $57,618 in the non-tribal harvest value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-8.

Upriver Fall Chinook Salmon

Under Alternative 3, the commercial harvest of Upriver Fall Chinook salmon (224,731 fish) would decline relative to status quo condition, with a decrease of 3,100 fish in the tribal harvest of Upriver Fall Chinook salmon and a decrease of 4,342 fish in the non-tribal harvest. Ex-vessel values of upriver Fall Chinook salmon also would decrease relative to status quo condition, with a decrease of $106,855 in the tribal harvest of Upriver Fall Chinook salmon and a decrease of $185,412 in the non-tribal harvest value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-9.

UCR Sockeye Salmon

Under Alternative 3, the commercial harvest of UCR sockeye salmon (17,043 fish) would increase relative to status quo condition, with a small increase of 91 fish in the tribal harvest and no change in the non-tribal harvest. Ex-vessel values of UCR sockeye salmon also would slightly increase relative to status quo condition, with an increase of $592 in the tribal harvest of UCR sockeye salmon and no change in the ex-vessel value of the non-tribal harvest. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-10.

B-run Snake River Steelhead

Under Alternative 3, the commercial harvest of B-run Snake River steelhead (8,541 fish) would decline relative to status quo condition, with a decrease of 639 fish in the tribal harvest of Snake River steelhead. Ex-vessel values of Snake River steelhead also would decrease relative to status quo condition, with a decrease of $8,769 in the tribal harvest value of Snake River steelhead. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-11.

Summary

As compared to status quo conditions, the total commercial harvest across all harvest indicator units under Alternative 3 would be lower (by 13,864 fish), with about 57 percent (7,907 fish) of the harvest decrease occurring in tribal fisheries and 43 percent (5,957 fish) occurring in non-tribal fisheries. Most of the overall decrease in harvest would occur in the Upriver Summer and Fall Chinook salmon fisheries. The overall ex-vessel value would decrease by $535,563.

4.5.3.2. Recreational Fisheries

Under Alternative 3, recreational catch and effort targeting the five harvest indicator stocks (65,132 fish and 312,986 angler trips) would represent a decline (6,234 fish and 29,332) angler trips relative to the status quo condition. Total trip-related expenditures associated with the recreational effort targeting the five harvest indicator stocks ($441,119,593) would decrease by $4,345,979 relative to status quo conditions. The Lower Columbia River subregion would account for about a 72 percent of decrease in recreational catch, about 70 percent of decrease in angler effort, and about 75 percent of the decrease in total trip-related expenditures. Details of recreational catch, estimated angler trips and trip-related angler expenditures by sub-region and alternative are provided in Appendix A, Table A-12.

4.5.3.3. Contribution to Regional Economic Activity

Under Alternative 3, impacts are slightly more negative than under status quo conditions, Alternative 1 and Alternative 2. Overall economic impacts under Alternative 3 are the second lowest among the five alternatives, being more positive than only Alternative 5. Table A-13 in Appendix A presents the personal income and jobs by alternatives and sub-region for commercial and recreational fisheries.

Commercial Fisheries: Overall impacts from tribal and non-tribal commercial fisheries would be $841 thousand income and 21 FTE jobs lower than under Existing Conditions and Alternative 1. The decrease in commercial fishing activity is split between the Lower Columbia (-$359,000 income and -8 jobs) and Mid-Columbia subregions (-$482,000 income and -13 jobs).

Recreational Fisheries: Under Alternative 3, impacts from recreational fishing would be $2.4 million income and 57 FTE jobs lower than under Existing conditions and Alternative 1. The reduction in recreational fishing impacts would mainly occur in the Lower Columbia (-$1.7 million income and -38 jobs) and Mid-Columbia subregions (-$700,000 income and -19 jobs). A decrease of $16,000 income and 1 FTE job is also projected for Lower Snake River subregion.

4.5.4. Alternative 4 – Escapement-based Management

Under Alternative 4, the commercial harvest of salmon and steelhead would increase relative to the status quo condition. The only harvest indicator stock that would be harvested less than under status quo conditions would be Upriver Fall Chinook salmon.

4.5.4.1. Commercial Fisheries

Upriver Spring Chinook Salmon

Under Alternative 4, the commercial harvest of Upriver Spring Chinook salmon (20,968 fish) would be much greater than under the status quo condition, with tribal fisheries accounting for about 81 percent (7,400 fish) of the harvest, and non-tribal fisheries about 19 percent (1,962 fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Spring Chinook salmon ($1,503,704) also would increase relative to status quo conditions, with tribal fisheries accounting for about 65 percent ($977,652) of total ex-vessel value and non-tribal fisheries for about 35 percent ($526,052) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-7.

Upriver Summer Chinook Salmon

Under Alternative 4, the commercial harvest of Upriver Summer Chinook salmon (28,838 fish) would be much greater than under the status quo condition, with tribal fisheries accounting for about 71 percent (20,438 fish) of the harvest and non-tribal fisheries about 29 percent (8,401fish) of the harvest. Ex-vessel values associated with the total harvest of Upriver Summer Chinook salmon ($994,344) also would increase relative to status quo conditions, with tribal fisheries accounting for about 66 percent ($658,372) of total ex-vessel value and non-tribal fisheries for about 34 percent ($335,972) of the value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-8.

Upriver Fall Chinook Salmon

Under Alternative 4, the commercial harvest of Upriver Fall Chinook salmon (219,756 fish) would be lower than under the status quo condition, with tribal fisheries accounting for about 67 percent (148,242 fish) and non-tribal fisheries about 33 percent (71,514 fish) of the total harvest. The number of fish harvested by non-tribal fishers represents an increase of 26,644 fish, whereas the number of fish caught by tribal fishers represents a decrease of 39,061 fish. Ex-vessel values associated with the total harvest of Upriver Fall Chinook salmon ($8,164,049) also would be lower than under status quo conditions, with the value of tribal fisheries decreasing by $1,346,609) of the ex-vessel value of non-tribal fisheries increasing by 1,137,651. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-9.

UCR Sockeye Salmon

Under Alternative 4, the commercial harvest of UCR sockeye salmon (79,942 fish) would be much greater than under the status quo condition, with tribal fisheries accounting for about 65 percent (65,772 fish) and non-tribal fisheries about 35 percent (14,170 fish) of the total harvest. Ex-vessel values associated with the total harvest of UCR sockeye ($530,993) also would be much higher than under status quo conditions, with tribal fisheries accounting for about 65 percent ($320,553) and non-tribal fisheries for about 42 percent ($99,871) of the total value of UCR sockeye salmon. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-10.

B-run Snake River Steelhead

Under Alternative 4, the commercial harvest of B-run Snake River steelhead (11,366 fish) would increase relative to the status quo condition, with tribal fisheries accounting for almost all (11,018 fish) of the fish caught. Ex-vessel values associated with the total harvest of Snake River steelhead ($156,521) would resent an increase of about 24 percent relative to status quo conditions, with tribal fisheries nearly all of the increase in ex-vessel value. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-11.

Summary

As compared to status quo conditions, the total commercial harvest across all harvest indicator units under Alternative 4 would be substantially higher (by 66,169 fish), with 34 percent (22,612 fish) of the harvest increase occurring in tribal fisheries and 66 percent (43,557 fish) occurring in non-tribal fisheries. Sockeye salmon accounts most of the harvest increase, followed by harvest increases in Upriver Spring Chinook salmon and Summer Chinook salmon; decreases in the harvest of Upriver Fall Chinook salmon would offset the increases in the harvest of other harvest indicator stocks. The total ex-vessel value of the commercial harvest would increase by $1,036,709.

4.5.4.2. Recreational Fisheries

Under Alternative 4, recreational catch and effort targeting the five harvest indicator stocks (183,211 fish and 895,961 angler trips) would increase substantially (by 111,845 fish and 553,643 angler trips) relative to the status quo condition. Total trip-related expenditures associated with the recreational effort targeting the five harvest indicator stocks ($111,821,173) would increase by $6,635,600 relative to status quo conditions. The Lower Columbia River subregion would account for more than 90 percent of the increase in recreational catch, angler effort, and total trip-related expenditures. Details of recreational catch, estimated angler trips and trip-related angler expenditures by sub-region and alternative are provided in Appendix A, Table A-12.

4.5.4.3. Contribution to Regional Economic Activity

Under Alternative 4, overall economic impacts are the most positive among the five Alternatives. Table A-13 in Appendix A presents the personal income and jobs by alternatives and sub-region for commercial and recreational fisheries.

Commercial Fisheries: Overall impacts from tribal and non-tribal commercial fisheries would be $1.6 million income and 34 FTE jobs greater than under Existing Conditions and Alternative 1. Increases would occur in the Lower Columbia subregion (+$2.3 million income and +51 jobs) and Lower Snake River subregion (+$186 thousand income and +6 jobs), while the Mid-Columbia subregion would see a decrease of $622 thousand income and 17 jobs.

Recreational Fisheries: Under Alternative 4, overall impacts from recreational fishing would be $45.2 million income and 1,042 FTE jobs greater than under Existing conditions and Alternative 1. More than 90 percent of the increase in recreational fishing impacts would occur in the Lower Columbia subregion (+$41.9 million income and +954 jobs). Increases would also occur in the Mid-Columbia (+$3.1 million income and +82 jobs) and Lower Snake River subregions (+186 thousand and +6 jobs).

4.5.5. Alternative 5 - Fishing curtailment

Under Alternative 5, commercial and recreational fisheries targeting the harvest indicator stocks and other Columbia River stocks would be terminated.

4.5.5.1. Commercial Fisheries

Upriver Spring Chinook Salmon

Under Alternative 5, no commercial harvest of Upriver Spring Chinook salmon would occur, resulting in the elimination of 7,528 fish harvested in tribal fisheries and 4,078 fish in non-tribal fisheries. Ex-vessel values associated with the total harvest of Upriver Spring Chinook salmon also would be lost, with the value to tribal fisheries being reduced by $493,029 and the value to non-tribal fisheries being reduced by $355,164. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-7.

Upriver Summer Chinook Salmon

Under Alternative 5, no commercial harvest of Upriver Summer Chinook salmon would occur, resulting in the elimination of 17,569 fish harvested in tribal fisheries and 44,870 fish in non-tribal fisheries. Ex-vessel values associated with the total harvest of Upriver Summer Chinook salmon also would be lost, with the value to tribal fisheries being reduced by $565,928 and the value to non-tribal fisheries being reduced by $288,829. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-8.

Upriver Fall Chinook Salmon

Under Alternative 5, no commercial harvest of Upriver Fall Chinook salmon would occur, resulting in the elimination of 187,303 fish harvested in tribal fisheries and 4,078 fish in non-tribal fisheries. Ex-vessel values associated with the total harvest of Upriver Fall Chinook salmon would also be lost, with the value to tribal fisheries being reduced by $6,457,182 and the value to non-tribal fisheries being reduced by $1,915,825. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-9.

UCR Sockeye Salmon

Under Alternative 5, no commercial harvest of UCR sockeye salmon would occur, resulting in the elimination of 16,440 fish harvested in tribal fisheries and 512 in non-tribal fisheries. Ex-vessel values associated with the total harvest of UCR sockeye salmon would be lost, with the value to tribal fisheries being reduced by $ $106,825 and the value to non-tribal fisheries being reduced by $3,744. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-10.

Snake River Steelhead

Under Alternative 5, no commercial harvest of Snake River steelhead would occur, resulting in the elimination of 8,945 fish harvested in tribal fisheries and 235 fish in non-tribal fisheries (Table 4.5.1.1-5). Ex-vessel values associated with the total harvest of Snake River steelhead also would be lost, with the value to tribal fisheries being reduced by $122,799 and the value to non-tribal fisheries being reduced by $3,554. Details of ex-vessel value and harvest number of fish by sub-region, alternative, and type of fishery are provided in Appendix A, Table A-11.

Summary

Under Alternative 5, there would be no commercial fisheries targeting the harvest indicator stocks and other stocks that are commercially harvested. The economic effects would be the total loss of commercial harvest and ex-vessel value under existing conditions as described in Subsection 3.5, Economics.

4.5.5.2. Recreational Fisheries

Under Alternative 5, all recreational catch and effort targeting the five harvest indicator stocks and other Columbia River stocks would be eliminated, resulting in a loss of 111,845 fish caught, 342,318 angler trips, and $45,465,572 in trip-related angler expenditures. Details of recreational catch, estimated angler trips and trip-related angler expenditures by sub-region and alternative are provided in Appendix A, Table A-12.

4.5.5.3. Contribution to Regional Economic Activity

Under Alternative 5, overall economic impacts are the most negative among the five harvest policy alternatives. A complete loss of the commercial and recreational fishing income and employment estimated under status quo conditions would be expected to occur under this alternative. Table A-13 in Appendix A presents the personal income and jobs by alternatives and sub-region for commercial and recreational fisheries.

Commercial Fisheries: Overall impacts from tribal and non-tribal commercial fisheries would be $16.2 million income and 419 FTE jobs lower than under status quo conditions and Alternative 1 and Alternative 2. Elimination of all commercial fishing activity directed at harvest indicator stocks in all subregions where it occurs under status quo conditions would be expected under this alternative.

Recreational Fisheries: Under Alternative 5, overall impacts from recreational fishing would be $27.9 million income and 672 FTE jobs lower than under Existing conditions and Alternative 1. Elimination of all recreational fishing activity targeting harvest indicator stocks in all subregions under status quo conditions would be expected.

4.5.6. Alternative 6—No-action—Uncoordinated Harvest

Under Alternative 6, overall impacts would be assumed to be those observed under Alternative 4 at the highest harvest level.

4.6. Cultural Resources—Ceremonial & Subsistence (C&S) Fisheries

As described in Subsection 3.6, C&S Harvest is based on need and is considered a priority in that it typically occurs before fish are taken for commercial purposes. An increase in the C&S needs at a particular time, or a decrease in runs that lead to a reduction in fish available for harvest, may further reduce the fish available for commercial tribal harvests.

Table 4-67 and Figure 4-7 present a summary of the estimated availability for C&S based on the harvest modeling results as explained in Subsection 4.1. The values in the table and chart that follows are used to compare the relative numerical and proportional differences among alternatives, and they should not be considered precise predictions of actual harvests in the future.

Table 4-67. C&S harvest of all salmon and steelhead species by minimum, maximum, and average run size abundances expected over the next 10 years.

	Minimum	% change from Alt 1	Maximum	% change from Alt 1	Average	% change from Alt 1
Alternative 1 Extension	8,718	100%	39,477	100%	23,742	100%
Alternative 2 Abundance	8,688	0%	43,185	9%	24,885	5%
Alternative 3 Fixed Harvest	11,109	27%	35,770	-9%	23,196	-2%
Alternative 4 / 6 Fixed Escapement / Uncoordinated	6,704	-23%	102,814	163%	37,563	58%
Alternative 5 Fishey Curtailment	0*	-100%	0*	-100%	0*	-100%

* This alternative may include some very limited treaty fishing opportunity to meet base ceremonial needs of the tribes. However, the amounts cannot be quantified and depend on the specific needs as discussed in Subection 3.6.

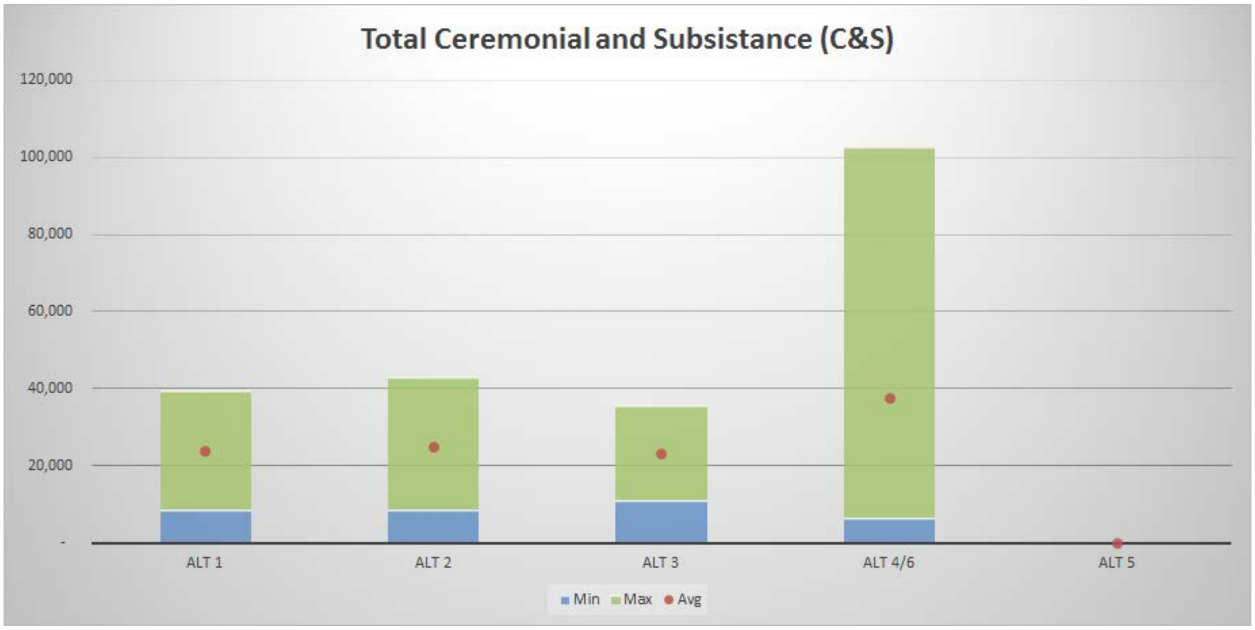

Figure 4-7. Total C&S harvest of all salmon and steelhead species by minimum, maximum, and average run size abundances expected over the next 10 years.

* See footnote to Table 4-77 above regarding ceremonial harvest.

Under Alternative 1, Extension, Alternative 2, Abundance, and Alternative 3, Fixed Harvest, Native

American tribes in the project area would be able to continue their C&S harvest without substantial changes to tribal cultural viability. The differences between the minimum and maximum harvest for each alternative is based on the modelled run sizes as described in Subsection 4.1. In years with low runs, any deficit in C&S harvest needs will likely be taken from the commercial harvest as the C&S harvest is the priority. This decision is made by the tribes as needed.

Under Alternative 4, Fixed Escapement, and Alternative 6, Uncoordinated Harvest, the modelled C&S harvest presents a wider range as compared to Alternative 1. The minimum C&S harvest, in years with low runs, may be as low as 6,704 fish, or 23 percent less than Alternative 1, while the maximum C&S harvest may be more than double (163 percent) that of Alternative 1 in years with high runs. C&S harvest levels under Alternative 4 or Alternative 6 may not be sufficient to meet C&S needs in years with low runs, thereby either directly negatively affecting the tribal cultural viability, or, more likely, reducing the available commercial harvest. The effects of Alternative 4 and Alternative 6 on cultural resources would therefore be medium negative.

Under Alternative 5, Voluntary Fishery Curtailment, there would be some very limited treaty fishing opportunity to meet base ceremonial needs of the tribes. However, C&S harvest would be largely curtailed. While salmon and steelhead could be purchased or obtained from other sources, the fundamental role that salmon play in the lives of Indian tribes would be affected. This Alternative, therefore, results in a high negative effect on cultural resources.

Implementation of the Mitchell Act EIS Preferred Alternative would not be expected to alter the amount of fish available for Columbia River tribal C&S harvest.

4.7. Environmental Justice

Executive Order (E.O.) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, states that “each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” Further, the environmental justice analysis also determine whether such populations or communities have been sufficiently involved in the decision-making process.

Environmental justice is not an impact category standing alone. First, it must be determined if impacts in other impacts categories are adverse under any alternative, and, if so, whether such impacts may be felt disproportionately by environmental justice populations. Effects of the alternatives on fish, marine-derived nutrients, and wildlife would not impact environmental justice populations. However, the effects of alternatives on both Economics and Cultural Resources may impact environmental justice populations. These populations are the Indian tribes and those living in the 28 counties and 2 communities described in Subsection 3.7.

4.7.1. Cultural Resources - Ceremonial & Subsistence (C&S)

Alternative 1 (Extension), Alternative 2 (Abundance), and Alternative 3 (Fixed Harvest) do not have an adverse effect on cultural resources among Indian tribes (Section 4.6). However, Alternative 4 (Fixed Escapement), Alternative 5 (Fishing Curtailment), and Alternative 6 (Uncoordinated) result in a negative effect. Given the significance of salmon and steelhead to Indian tribes, and given that this significance is not paralleled among other populations that may be affected by the C&S harvest, these negative effects would be disproportionate. This disproportionate effect cannot be quantified as no metric can be attributed to the importance of this cultural resource to Indian tribes and because the importance of the C&S harvest among non-Indian tribes is essentially zero.

Environmental Justice Determination: Alternatives 4, 5 and 6 would result in a disproportionate adverse Cultural Resources effect on Indian tribes as it pertains to C&S fisheries.

4.7.2. Economics

Indian Tribes

Indian tribes are defined as an Environmental Justice population for this EIS in Section 3.5. The change in tribal and non-tribal commercial harvest by harvest indicator stock, presented in Subsection 4.5.1.2 to 4.5.1.2, was analyzed to determine whether any of the alternatives would result in a disproportionate adverse effect on the tribes. Table 4-68 presents these findings based on the number of fish. The corresponding economic values for the commercial harvest are proportional to the number of fish and can be found in Subsections 4.5.1.2 to 4.5.1.2.

As shown in Table 4-68, Alternative 4 and Alternative 6 would result in a 198 percent increase in tribal commercial harvest for Upper Spring Chinook salmon compared to a corresponding non-tribal commercial increase of 48 percent. Similarly, Alternative 2 would result in a 40 percent increase in tribal commercial harvest for UCR Sockeye salmon, compared to no increase for the non-tribal commercial harvest. Both examples are positive disproportionate effects on an Environmental Justice population.

Table 4.7.2-1 Change in Tribal vs Non-Tribal Commercial Harvest by Harvest Indicator Stock and Alternative.

Change from Existing Conditions		**Fish**	**%**	**Fish**	**%**	**Fish**	**%**	**Fish**	**%**	**Fish**	**%**
	Tribal / Non-tribal	**Alternative 1**		**Alternative 2**		**Alternative 3**		**Alternative 4 / 6**		**Alternative 5**	
Upper Spring Chinook	T	0	0	0	0	-755	-10	14,928	198	-7,528	-100
	NT	0	0	0	0	-174	-4	1,962	48	-4,078	-100
Upriver Summer Chinook	T	0	0	-245	-1	-3,504	-20	2,869	16	-17,569	-100
	NT	0	0	0	0	-1,441	-20	1,179	16	-7,222	-100
Upriver Fall Chinook	T	0	0	0	0	-3,100	-2	-39,061	-21	-187,303	-100
	NT	0	0	0	0	-4,342	-10	26,644	59	-44,870	-100
UCR Sockeye	T	0	0	6,631	40	91	0.5	49,332	300	-16,440	-100
	NT	0	0	0	0	0	0	13,658	2,667	-512	-100
Snake River Steelhead	T	0	0	0	0	-639	-7	2,073	23	-8,945	-100
	NT	0	0	0	0	0	0	113	48	-235	-100

Alternative 4 and Alternative 6 would result in a larger non-tribal commercial increase for both UCR Sockeye salmon and Snake River Steelhead when compared to the tribal increase. However, given that the fact that the corresponding tribal harvest numbers are significantly higher under existing conditions and under Alternative 1, the change in non-tribal harvest would not be a disproportionate adverse effect. For example, non-tribal commercial harvest for Snake River Steelhead would increase from 235 fish under existing conditions and Alternative 1 by 48 percent to 113 fish under Alternatives 4 or 6. The corresponding non-tribal harvest would increase by 23 percent from 8,945 fish to 11,018 fish.

Tribal commercial harvest (and associated revenue) of Upriver Fall Chinook salmon would decrease by 21 percent under Alternative 4 and Alternative 6, while the non-tribal commercial harvest would increase disproportionately by 59 percent.

Alternative 5 does not represents a disproportionate economic effect on Indian tribes because tribes and non-tribes are equally affected.

Environmental Justice Determination: Alternatives 4 and 6 result in a disproportionate adverse economic effect on Indian tribes as it pertains to Upriver Fall Chinook salmon**.** However, given that Upriver Fall Chinook salmon represents the largest percentage (64 percent) of all harvest indicator stocks under Alternatives 4 and 6, this EIS analysis concludes that the disproportionate effect of Upriver Fall Chinook salmon represents that of Alternative 4 and Alternative 6 as a whole.

Counties

The economic impacts of the Proposed Action are presented by sub-region within the study area as described in Subsection 4.5. It is not possible to determine the specific economic impact on each county for the following reasons:

1) The economic model applies the overall harvest management framework to each sub-region in order to determine the harvest opportunities. Further dividing the sub-region forecast to each county would result in a proportional distribution among the counties in that region.

2) Fish captured in one geographic area may be landed in a different geographic area.

Therefore, while the study area does include Environmental Justice counties as presented in Subsection 3.7, the analysis cannot determine whether the economic effects of any alternative result in a disproportionate effect on any of these Environmental Justice counties.

4.7.3. Public Participation

CEQ's EJ Guidance require that agencies develop appropriate public participation strategies and assure meaningful community representation in the process. In addition, "Agencies should seek tribal representation in the process in a manner that is consistent with the government-to-government relationship between the United States and tribal governments, the Federal government's trust responsibility to federally-recognized tribes, and any treaty rights." (CEQ, 1997).

Throughout the DEIS process, NMFS has attempted to ensure that the requirements of E.O. 12898 regarding environmental justice are implemented, including the conduct of appropriate tribal consultation activities. As part of the public scoping process for this EIS, NMFS directly notified tribal entities on the Proposed Action. NMFS sent a letter to Columbia River, Puget Sound/Strait of Juan de Fuca, and Washington's coastal tribes asking them to participate in an EIS scoping meeting. Additionally, on May 31, 2016 NMFS sent a joint letter, with USFWS, to invite the U.S. Bureau of Indian Affairs (BIA) to participate as a cooperating agency on the EIS. As a result the BIA, as a party to *US v Oregon* as described in Subsection 1.1, is a cooperating agency for this EIS. NMFS also solicited advice and information from *US v Oregon* parties by incorporating the help of current *US v Oregon* TAC chair, Columbia River Inter-Tribal Fish Commission employee Stuart Ellis, in developing the model outputs used in this EIS.

Notices were published in the Federal Register and picked up by regional electronic newsletters. Emails were also sent to individuals who NMFS was previously aware that are interested in salmon fishery issues (e.g., non-tribal commercial, recreational, or tribal fishers). All groups notified during scoping are included on the EIS distribution list and received direct information about commenting on the draft EIS. In this way, a diverse population, located over a broad geographic area, was identified and reached during the scoping process, was also notified during the review period for the draft EIS, and will be notified when the final EIS is published.

Section 5

5. CUMULATIVE IMPACTS

5.1. Introduction

Against these baseline conditions, Section 4, Environmental Consequences, presents the incremental impacts of harvest policy alternatives for a proposed new *US v Oregon* agreement. The direct and indirect effects of each alternative on each resource's baseline conditions are presented in Section 3, Affected Environment, incorporating the past effects of harvest, hatcheries, hydropower, and habitat.

Section 5, Cumulative Effects, now further considers the cumulative effects of each alternative in the context of past actions, present action, and reasonably foreseeable future actions and conditions.

The cumulative effects analysis is important for review of this Proposed Action because it informs future fishery management affected by a new *US v Oregon* agreement. Provided below are known future actions reasonably likely to occur within the analysis area. Expected future actions include proposed developments, and planned habitat restoration activities. Climate change is an effect of past, present and future actions that may have a cumulative effect on resources in the analysis area.

Subsection 5.2, Future Foreseeable Actions, summarizes the anticipated effects from foreseeable future actions that may influence the Columbia and Snake Rivers, including Climate Change. Subsection 5.3, Effects From Future Actions, discusses all expected future actions within the action area including effects from Climate Change, and focuses on the effects of each alternative in the context of future climate change when combined with future actions.

Figure 5-1 shows the cumulative effects on salmonids through their complex and far-reaching life cycle. They are subject to multiple, diverse, and far-reaching effects in both freshwater and open ocean environments. It is important to keep in mind that the Columbia River harvests take place near the end of each salmonid species' life cycle. Some of the fish foregone in one fishery will be lost to other fisheries or dam mortality, while the remainder will contribute to escapement.

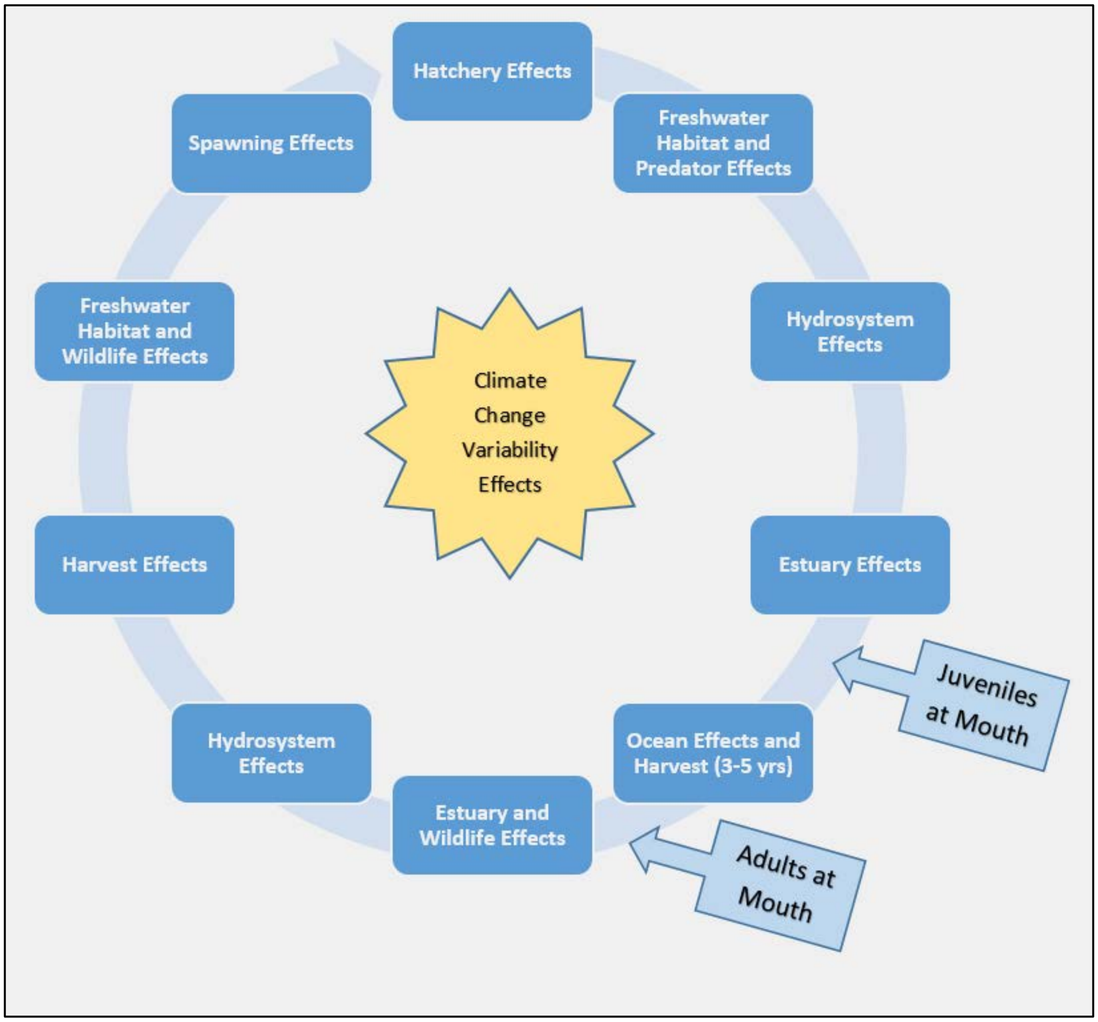

Figure 5-1. Life cycle cumulative effects diagram.

The cumulative impacts analysis area is the same as the project and analysis areas described in Subsection 1.3. The temporal scope of the cumulative effects analysis is 10 years, coinciding with the duration of the proposed *US v. Oregon* management agreement.

The existing baseline conditions, as described in the resource subsections in Section 3, include influences from historical and current conditions. Human uses and development have had substantial influences on the area. Human presence in the project area dates back more than 10,000 years when the Columbia River was the dominant contributor of food, water, and transportation for humans. Presently, the primary influencing factors on the Columbia and Snake Rivers are the dams that provide electrical power, flood control, and navigational opportunities, as well as supporting agricultural needs, while simultaneously resulting in long-term environmental impacts on aquatic life. Associated development and human uses have also impacted the Columbia River ecosystem. These factors include port improvements, dredging, fishing, urban pollution, and channelization. Despite these extensive uses, however, the basin is considered a diverse, highly productive ecosystem that will continue to provide both important biological functions and economic services. Human uses and associated development, as stressors to the existing ecosystem, are expected to continue under future actions as described below.

5.2. Future Foreseeable Actions

Future effects of climate change are discussed, as are the effects of development and proposed or ongoing projects, and habitat restoration and protection of salmon and steelhead efforts. Each of the above topics is described in terms of effects on the project area and proposed alternatives.

5.2.1. Climate Change

One factor affecting all species managed under a new *US v Oregon* agreement, and aquatic habitat at large is climate change. The U.S. Global Change Research Program (USGCRP)[4], mandated by Congress in the Global Change Research Act of 1990, reports average warming of about 1.3ºF from 1895 to 2011 and projects an increase in average annual temperature of 3.3ºF to 9.7ºF by 2070 to 2099 (CCSP, 2014). Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007). According to the Independent Scientific Advisory Board (ISAB)[5], these effects pose the following impacts into the future:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, these watersheds will see their runoff diminished earlier in the season,

[4] http://www.globalchange.gov

[5] The Independent Scientific Advisory Board (ISAB) serves the National Marine Fisheries Service (NOAA Fisheries), Columbia River Indian Tribes, and Northwest Power and Conservation Council by providing independent scientific advice and recommendations regarding scientific issues that relate to the respective agencies' fish and wildlife programs. https://www.nwcouncil.org/fw/isab/

resulting in lower stream-flows in the June through September period. River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.

- Water temperatures are expected to rise, especially during the summer months when lower stream-flows co-occur with warmer air temperatures.

These changes will not be spatially homogeneous across the entire Pacific Northwest. Low-lying areas are likely to be more affected. Climate change may have long-term effects that include, but are not limited to, depletion of important cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007). This is likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

Climate Change and Pacific Northwest Salmon

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Mote et al. (2003); Crozier et al. (2008a); Martins et al. (2012); Wainwright and Weitkamp (2013)). The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore and ocean environments.

The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- direct effects of increased water temperatures of fish physiology
- temperature-induced changes to stream flow patterns
- alterations to freshwater, estuarine, and marine food webs
- changes in estuarine and ocean productivity

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat specific, such as stream flow variation in freshwater, sea level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011). This occurred in 2015 on Upriver Sockeye in the Columbia River when over 475,000 sockeye entered the River but only two percent of sockeye counted at Bonneville Dam survived to their spawning grounds. Most died in the Columbia River beginning in June when the water warmed to above 68 degrees, the temperature at which salmon begin to die. It got up to 73 degrees in July due to elevated temperatures associated with lower snow pack from the previous winter and drought conditions exacerbate due to increased occurrences of warm weather patterns.

These impacts are likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

Temperature Effects

Like most fishes, salmon are poikilotherms (cold-blooded animals), therefore increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by Whitney et al. (2016)). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes including: increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce survival (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016). As examples of this, high mortality rates for adult sockeye salmon in the Columbia River have recently been attributed to higher water temperatures and likewise in the Fraser River, as increasing temperatures during adult upstream migration are expected to result in increased mortality of sockeye salmon adults by 9 to 16 percent by century’s end (Martins et al. 2011). Juvenile parr-to-smolt survival of Snake River Chinook salmon are predicted to decrease by 31 to 47 percent due to increased summer temperatures (Crozier et al. 2008b).

By contrast, increased temperatures at ranges well below thermal optima (i.e., when the water is cold) can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008a; Martins et al. 2012). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are also others where it is detrimental (Martins et al. 2012; Whitney et al. 2016).

These impacts are likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

Freshwater Effects

As described previously, climate change is predicted to increase the intensity of storms, reduce winter snow pack at low and middle elevations, and increase snowpack at high elevations in northern areas. Middle and lower elevation streams will have larger fall/winter flood events and lower late summer flows, while higher elevations may have higher minimum flows. How these changes will affect freshwater ecosystems largely depends on their specific characteristics and location, which vary at fine spatial scales (Crozier et al. 2008b; Martins et al. 2012). For example, within a relatively small geographic area (Salmon River Basin, Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while others were determined by flow (Crozier and Zabel 2006). Certain salmon populations inhabiting regions that are already near or exceeding thermal maxima will be most affected by further increases in temperature and perhaps the rate of the increases while the effects of altered flow are less clear and likely to be basin-specific (Crozier et al. 2008b; Beechie et al. 2013). However, river flow is already becoming more variable in many rivers, and is believed to negatively affect anadromous fish survival more than other environmental parameters (Ward et al. 2015). It is likely this increasingly variable flow is detrimental to multiple salmon and steelhead populations, and likely multiple other freshwater fish species in the Columbia River Basin as well.

Stream ecosystems will likely change in response to climate change in ways that are difficult to predict (Lynch et al. 2016). Changes in stream temperature and flow regimes will likely lead to shifts in the distributions of native species and provide “invasion opportunities” for exotic species. This will result in novel species interactions including predator-prey dynamics, where juvenile native species may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile native species will fare as part of “hybrid food webs,” which are constructed from natives, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

Estuarine Effects

In estuarine environments, the two big concerns associated with climate change are rates of sea level rise and temperature warming (Wainwright and Weitkamp 2013; Limburg et al. 2016). Estuaries will be affected directly by sea-level rise: as sea level rises, terrestrial habitats will be flooded and tidal wetlands will be submerged (Kirwan et al. 2010; Wainwright and Weitkamp 2013; Limburg et al. 2016). The net effect on wetland habitats depends on whether rates of sea-level rise are sufficiently slow that the rates of marsh plant growth and sedimentation can compensate (Kirwan et al. 2010).

Due to subsidence, sea level rise will affect some areas more than others, with the largest effects expected for the lowlands, like southern Vancouver Island and central Washington coastal areas (Verdonck 2006; Lemmen et al. 2016). The widespread presence of dikes in Pacific Northwest estuaries will restrict upward estuary expansion as sea levels rise, likely resulting in a near-term loss of wetland habitats for salmon (Wainwright and Weitkamp 2013). Sea level rise will also result in greater intrusion of marine water into estuaries, resulting in an overall increase in salinity, which will also contribute to changes in estuarine floral and faunal communities (Kennedy 1990). While not all anadromous fish species are generally highly reliant on estuaries for rearing, extended estuarine use may be important in some populations (Jones et al. 2014), especially if stream habitats are degraded and become less productive.

These impacts are likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

Marine Impacts

In marine waters, increasing temperatures are associated with observed and predicted poleward range expansions of fish and invertebrates in both the Atlantic and Pacific oceans (Lucey and Nye 2010; Asch 2015; Cheung et al. 2015). Rapid poleward species shifts in distribution in response to anomalously warm ocean temperatures have been well documented in recent years, confirming this expectation at short time scales. Range extensions were documented in many species from southern California to Alaska during unusually warm water associated with “The Blob” in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Niño events (Pearcy 2002; Fisher et al. 2015).

Exotic species benefit from these extreme conditions to increase their distributions. Green crab (*Carcinus maenas*) recruitment increased in Washington and Oregon waters during winters with warm surface waters, including 2014 (Yamada et al. 2015). Similarly, Humboldt squid (*Dosidicus gigas*) dramatically expanded their range during warm years of 2004-2009 (Litz et al. 2011). The frequency of extreme conditions, such as those associated with El Niño events or “blobs” are predicted to increase in the future (Di Lorenzo and Mantua 2016). This is likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

As with changes to stream ecosystems, expected changes to marine ecosystems due to increased temperature, altered productivity, or acidification, will have large ecological implications through mismatches of co-evolved species and unpredictable trophic effects (Cheung et al. 2015; Rehage and Blanchard 2016). These effects will certainly occur, but predicting the composition or outcomes of future trophic interactions is not possible with the tools available at this time.

Pacific Northwest anadromous fish inhabit as many as three marine ecosystems during their ocean residence period: the Salish Sea, the California Current, and the Gulf of Alaska (Brodeur et al. 1992; Weitkamp and Neely 2002; Morris et al. 2007). The response of these ecosystems to climate change is expected to differ, although there is considerable uncertainty in all predictions. It is also unclear whether overall marine survival of anadromous fish in a given year depends on conditions experienced in one versus multiple marine ecosystems. Several are important to Columbia River Basin species, including the California Current and Gulf of Alaska.

Wind-driven upwelling is responsible for the extremely high productivity in the California Current ecosystem (Bograd et al. 2009; Peterson et al. 2014). Minor changes to the timing, intensity, or duration of upwelling, or the depth of water column stratification, can have dramatic effects on the productivity of the ecosystem (Black et al. 2014; Peterson et al. 2014). Current projections for changes to upwelling are mixed: some climate models show upwelling unchanged, but others predict that upwelling will be delayed in spring, and more intense during summer (Rykaczewski et al. 2015). Should the timing and intensity of upwelling change in the future, it may result in a mismatch between the onset of spring ecosystem productivity and the timing of salmon entering the ocean, and a shift towards food webs with a strong sub-tropical component (Bakun et al. 2015).

Columbia River anadromous fish also use coastal areas of British Columbia and Alaska, and mid-ocean marine habitats in the Gulf of Alaska, although their fine-scale distribution and marine ecology during this period are poorly understood (Morris et al. 2007; Pearcy and McKinnell 2007). Increases in temperature in Alaskan marine waters have generally been associated with increases in productivity and salmon survival (Mantua et al. 1997; Martins et al. 2012), thought to result from temperatures that have been below thermal optima (Gargett 1997). Warm ocean temperatures in the Gulf of Alaska are also associated with intensified downwelling and increased coastal stratification, which may result in increased food availability to juvenile salmon along the coast (Hollowed et al. 2009; Martins et al. 2012). Predicted increases in freshwater discharge in British Columbia and Alaska may influence coastal current patterns (Foreman et al. 2014), but the effects on coastal ecosystems are poorly understood.

In addition to becoming warmer, the world's oceans are becoming more acidic as increased atmospheric CO2 is absorbed by water. The North Pacific is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells and relatively little direct influence on finfish (see reviews by Haigh et al. (2015); Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon will likely be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates (Haigh et al. 2015; Mathis et al. 2015).

Uncertainty in Climate Predictions

There is considerable uncertainty in the predicted effects of climate change on the globe as a whole, and on Pacific Northwest in particular and there is also the question of indirect effects of climate change and whether human "climate refugees" will move into the range of salmon and steelhead, increasing stresses on their respective habitats (Dalton et al. 2013; Poesch et al. 2016).

Many of the effects of climate change (e.g., increased temperature, altered flow, coastal productivity, etc.) will have direct impacts on the food webs that species examined in this analysis rely on in freshwater, estuarine, and marine habitats to grow and survive. Such ecological effects are extremely difficult to predict even in fairly simple systems, and minor differences in life history characteristics among stocks of salmon may lead to large differences in their response (e.g., Crozier et al. (2008b); Martins et al. (2011); Martins et al. (2012). This means it is likely that there will be "winners and losers" meaning some salmon populations may enjoy different degrees or levels of benefit from climate change while others will suffer varying levels of harm.

Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends both on characteristics of each individual population and on the level and rate of change. They should be able to adapt to some changes, but others are beyond their adaptive capacity (Crozier et al. 2008a; Waples et al. 2009). With their complex life cycles, it is also unclear how conditions experienced in one life stage are carried over to subsequent life stages, including changes to the timing of migration between habitats. Systems already stressed due to human disturbance are less resilient to predicted changes than those that are less stressed, leading to additional uncertainty in predictions (Bottom et al. 2011; Naiman et al. 2012; Whitney et al. 2016).

Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty.

Climate Change and Marine Mammals

The effects of climate change on marine species including the SRKW is not definitively known, however, it is likely that any changes in weather and ocean conditions affecting salmon populations would have consequences for fish-eating SRKW (NMFS 2008). Warming water and air temperature trends are ongoing and are expected to disrupt annual precipitation cycles, alter prevailing patterns of wind and ocean currents, and raise sea levels (Glick 2005; Snover et al. 2005). Together with increased acidification of ocean waters, these changes are expected to have substantial effects on marine productivity and food webs, including populations of salmon and other killer whale prey (NMFS 2008). Climate change could result in changes to migration patterns, alteration of ecological community composition and structure as species relocate from areas they currently use in response to changes in oceanic conditions, changes in species abundance, increased susceptibility to disease and contaminants, alterations to prey composition and availability, and altered reproductive timing (MacLeod et al. 2005; Robinson et al. 2005; McMahon and Hays 2006). Such changes could affect reproductive success and survival, and therefore would have consequences for the survival and recovery of SRKW (Robinson et al. 2005; Learmonth et al. 2006; Cotte´ and Guinet 2007). Naturally occurring climatic patterns, such as the Pacific Decadal Oscillation and El Niño and La Niña events, cause major changes to marine productivity and may also influence SRKW prey abundance (Mantua et al. 1997; Francis and Hengeveld 1998; Beamish et al. 1999; Hare et al. 1999; Benson and Trites 2002; Dalton et al. 2013). Prey species such as salmon are most likely to be affected through changes in food availability and oceanic survival (Benson and Trites 2002), with biological productivity increasing during cooler periods and decreasing during warmer periods (Hare et al. 1999; NMFS 2008). This is likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

In conclusion, the current literature supports previous concerns that natural climatic variability can amplify and exacerbate long-term climate change impacts. Recent estimates of rates of climate change are similar to those previously published. Anthropogenic climate change will likely to varying degrees affect all west coast fish species, especially when interacting factors are incorporated (e.g., existing threats to populations, water diversion, accelerated mobilization of contaminants, hypoxia, and invasive species). However, through historic selective processes native fish species have adapted their behavior and physiology to inhabit available habitat ranging from southern California up to the Alaskan western coastline. This process by which animals native to the Pacific Northwest are adapted to natural cycles of variation in freshwater and marine environments required a certain degree of plasticity, and may show resilience to future environmental conditions that mimic this natural variation. While climate change effects will certainly result in changes, it is unlikely that specifics are possible to predict. Alternate life history types, such as those associated with extended lake or estuarine rearing, provide an important component of the species diversity with which to guard against an uncertain future. However, the life history types that will be successful in the future is neither static nor predictable, therefore maintaining or promoting existing diversity that is specifically found in the natural populations of Pacific anadromous fish is essential for continued existence of populations into the future (Schindler et al. 2010; Bottom et al. 2011).

5.2.2. Development Projects

Development that has occurred within the Columbia River Basin over the past decade has affected the abundance, distribution, and health of hatchery-origin and natural-origin salmon and steelhead, other fish, economics, wildlife populations, and water quantity and quality. Provided below is a bulleted list of these development trends taken from ISAB (2007a, b) and the Lower Columbia River Estuary Partnership (2005), followed by some of the larger planned projects within the Columbia River Basin. These trends cannot be quantified in full detail because some of the development projects are in the early stages of permitting and planning, while others are closer to implementation decisions demonstrated by completion of records of decision (RODs) or draft EISs. However, this analysis assumes that all of the projects described in this chapter would be implemented during the 10-year period of the Proposed Action to provide a review of the highest-impact potential scenario.

- New, Non-*US v Oregon* management agreement hatchery production in the Columbia River Basin
- Human populations are increasing primarily in urban metropolitan areas, with smaller increases in rural areas. This increase is expected to continue until at least 2030.
- Freshwater withdrawals for domestic, industrial, commercial, and public uses are increasing, whereas withdrawals for irrigation purposes are decreasing due to the conversion of agricultural lands to residential areas.
- Forests are being converted for development, which is resulting in forest fragmentation.
- Mining in the Columbia River Basin is focused on sand and gravel with the removal occurring along or within rivers.
- Electrical demand continues to increase by approximately 1 percent per year.
- Globalization of trade has contributed to the loss of trade in some areas (e.g., the Mexico strawberry market) and to the increase in trade in other areas (e.g., increased Columbia River Basin wine production due to Australian droughts).
- An increase in ship traffic is likely to occur because of Columbia River channel-deepening projects.
- New port infrastructure projects continue to result in loss of aquatic habitat.
- Hazardous materials transport and airborne pollution have been increasing in the Columbia River Basin.
- Dam operations will continue at various levels to impound water, inundate habitat, and hamper passage conditions both upstream and downstream.

5.2.3. Habitat Restoration and Protection of Salmonids

Throughout the Columbia River Basin, habitat restoration efforts are supported by Federal, state, and local agencies; tribes; environmental organizations; and communities. Projects supported by these entities focus on improving general habitat and ecosystem function or species-specific conservation objectives that, in some cases, are identified through ESA recovery plans. The larger, more region-wide, restoration and conservation efforts, either underway or planned throughout the Columbia River Basin, are presented below. These actions have helped restore habitat, improve fish passage, and reduce pollution. While these efforts are reasonably likely to occur, funding levels may vary on an annual basis. These include:

- Bonneville Power Aadministration (BPA), Bureau of Reclamation (BOR), and USACE

- National Oceanic and Atmospheric Administration (NOAA) – Community-based Restoration Program (CRP).
- NMFS – Pacific Coastal Salmon Recovery Fund (PCSRF), Columbia and Snake Rivers.
- Northwest Power Planning and Conservation Council – Fish and Wildlife Program, Columbia and Snake Rivers.
- State of Idaho – ESA Section 6 Cooperative Agreement.
- State of Oregon – Oregon Plan for Salmon and Watersheds.
- State of Washington – Governor's Salmon Recovery Office.
- Miscellaneous Funding Sources – Regional and Local Habitat Restoration and Conservation Support.
- USACE – Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, Oregon.

5.3. Effects from Future Actions

Here we discuss effects of all expected future actions within the action area focusing on the additional effects of each alternative in the context of future climate change when combined with future actions.

5.3.1. Fish

Subsection 3.2, Fish, describes how past and present conditions have influenced fish populations in the analysis area. These conditions represent effects from many years of development, as well as habitat restoration, hydropower operations, existing hatchery production. The expected impacts of the alternatives on fish populations are described in Subsection 4.2, Fish. Section 4 also presents the likely impacts from the hatchery production associated with this agreement, ongoing fisheries in the basin and, most likely, climate changes. The Proposed Action itself occurs across the Columbia River Basin, and includes both harvest and hatchery impacts as part of the Proposed Action. Moreover, the affected environment already includes the full impact of hydropower effects across the basin. Therefore a great deal of the discussion that would ordinarily be found in cumulative impacts has taken place in Section 4. However, Section 4 does not take into account future foreseeable actions, especially in the context of future climate change. Future Foreseeable Actions are described in Subsection 5.2. This section considers impacts that may occur as a result of any one of the alternatives being implemented at the same time as other anticipated future actions and presents information in the context of future climate change.

5.3.1.1. Salmonids

According to ISAB (2007a), the effects of future climate change on salmonids would vary among species and with life history stages, but they potentially may affect virtually every species and life history stage of salmonids in the Columbia River Basin. Rising temperatures will increase disease and/or mortality in several iconic salmon species, especially for spring/summer Chinook salmon and sockeye salmon in the interior Columbia and Snake River Basins (Mote et al. 2014). This is because increases in water temperature are known to increase stress on these salmonid species thereby reducing their immune response and dually also provide positive conditions for pathogen incubation that is known to be harmful to these salmonid species. All alternatives, except Alternative 5, remove fish abundance from the spawning population, which reduces genetic diversity, by simply killing possibly sexually mature adult contributors to the general spawning populations. Harvest impacts might cumulatively add to the climate change impacts associated with increased disease/decrease immune responses as the diversity that may have been present is simply reduced by lowering the size of the spawning populations via harvest removals. This added impact would be greatest in Alternative 4 and Alternative 6, the same as baseline conditions and as Alternative 1 and Alternative 2, slightly less in Alternative 3, and none at all in Alternative 5.

As described in Subsection 4.2.1, Alternative 1 and Alternative 2 would not result in changes from the current baseline conditions of the Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, and B-run steelhead. The effects of Alternative 3 on these same resources is slightly positive relative to baseline conditions, as it increases the average level of spawning escapements. Alternative 4 and Alternative 6 have the greatest negative effects (largest harvest) on all affected salmonid species, especially for Snake River Fall Chinook salmon, Snake River spring/summer Chinook salmon, Upper Columbia River Chinook salmon, Snake River sockeye salmon and B-run steelhead. Only for Upper Columbia River summer/fall Chinook salmon the effects of Alternative 4 or Alternative 6 are lower than for Alternatives 1, 2, and 3. These negative impacts to spawning escapements would subject lower numbers of spawning adults to conditions where greater abundances for a spawning population might mitigate high rates of elevated mortality due to climate change impacts described above. Thereby Alternative 4 and Alternative 6 may cumulatively add to the future climate change impacts by subjecting lower spawning populations to higher levels of elevated mortality and diminishing future returns

Alternative 5 has a positive harvest effects on all salmonid species because it involves no fishing. Alternative 5, while having a positive harvest effects on all salmonid species, because it involves no fishing, would however, likely result in escapement of larger numbers of hatchery-origin adults, leading to potential negative effects from elevated levels of hatchery-origin fish spawning. These effects, discussed in Section 4, relate to the effects of high levels of unharvested hatchery fish ending up on natural spawning grounds and competing with and reproductively interacting with natural-origin fish of the same species/run.

Cumulatively, when combined with all past, present and future actions in the Columbia River Basin, the harvest and hatcheries will have a greater effect on genetic impacts from hatchery-origin interbreeding with natural-origin fish, and mortality of natural-origin fish associated with competition, predation, and disease impacts from hatchery-origin fish as those summarized above and in Section 4. As described in Subsection 3.2.1, Salmonids, unique patterns of genetic diversity can be lost in natural-origin populations when they interbreed with hatchery-origin fish. Competition, predations, and disease transmission occurs during interaction among members of the same species or different species utilizing a limited resource (e.g., food or space). These interactions typically results in winners and losers. Impacts between hatchery-origin and natural-origin fish result from direct interactions, in which hatchery-origin fish interfere with access to limited resources, predate (eat), or transmit disease to natural-origin fish. These interactions occur between juveniles during outmigration, including the mainstem and estuary areas of the Columbia River Basin, and between adults during spawning when the adults are competing for space and resources.

All alternatives that include some level of fishing (Alternatives 1, 2, 3, 4, and 6) would generally reduce genetic, competition, and disease impacts from the interaction of hatchery-origin fish with natural-origin salmon and steelhead populations because the fishing removes adult hatchery-origin fish from the river basin. There are no additional cumulative impacts on juvenile salmonids (primarily predation and disease) as a result of any of the alternatives, because the harvest alternatives will not alter or affect the level of hatchery production, and therefore the hatchery-related impacts to salmonids under each alternative are the same impacts discussed already in Section 4. All risks, however, may exacerbate the effects of climate change on natural-origin salmon and steelhead populations. For example, if hatchery production disrupts unique patterns of genetic diversity in a natural-origin salmon or steelhead population, that population may be less able to adapt to the changing environmental conditions anticipated because of future climate change (Subsection 5.3.1, Climate Change).

Specifically Alternative 5 would accumulate negative hatchery related impacts at the highest rate as there would be no fishing to remove adult hatchery-origin fish. These fish would be able to return to the spawning grounds and hatcheries and given the ratio of hatchery to non-hatchery spawners under Alternative 5, the genetic diversity will be diminished. Under this alternative, competition effects would be at the highest level, as would transmission potential of disease, while impacts from juvenile predation would likely remain similar to the other alternatives since there is no effect to the release sizes under any alternative.

Changing environmental conditions are also likely to occur as a result of future development, changes in hydropower operations, hatchery production and habitat restoration in the Columbia River Basin. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the project area, a new *US v Oregon* agreement, as a result of harvest and hatchery actions, all alternatives contribute meaningfully to cumulative effects and the result will continue to cumulatively negatively impact salmonids.

5.3.1.2. ESA-Listed Fish Species (non-salmonids)

The cumulative effects on ESA-Listed Fish Species (non-salmonids) from their bycatch during salmon and steelhead directed fisheries may be greater than those described in Subsection 4.2.2, ESA-Listed Fish Species (non-salmonids), but no discernable changes across any of the alternatives are expected. Changing environmental conditions are also likely to occur as a result of future development, changes in hydropower operations, hatchery production and habitat restoration in the Columbia River Basin. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the project area, a new *US v Oregon* management agreement resulting in fisheries and hatcheries would make a minor additive contribution to cumulative negative effects on ESA-Listed Fish Species (non-salmonids).

5.3.1.3. Other Non-Salmonids (non ESA-listed Fish Species)

The cumulative effects on non-salmonids from their bycatch during salmon and steelhead directed fisheries may be greater than those described in Subsection 4.2.3, Non-salmonids. Changing environmental conditions are also likely to occur as a result of future development, changes in hydropower operations, hatchery production and habitat restoration in the Columbia River Basin. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the project area, a new *US v Oregon* management agreement resulting in fisheries and continued hatcheries would make a minor additive contribution to cumulative adverse effects on Non-salmonids. No discernable changes across any of the alternatives are expected, especially when considering the increased potential negative effects from elevated levels of hatchery-origin fish spawning are taken into account.

5.3.2. Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients

The effects of the alternatives on water quality from hatchery operations are described in Subsection 4.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients. Future actions are described in Subsection 5.2, Future Foreseeable Actions. This section considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This section only discusses future impacts that have not already been described and evaluated in Subsection 4.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients. Climate change is expected to affect water quality in general by altering water temperatures and changing seasonal river flows, the cumulative effects on water quality may be greater than those summarized above and described in Subsection 4.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients, for all alternatives. Since none of the alternatives moving forward into the future would alter hatchery production, the negative impacts associated with hatchery effluent as it relates to water quality would add to the cumulative negative impacts.

Subsection 3.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients, describes how past and present conditions have influenced the level of marine derived nutrients in the Columbia River Basin, including conditions resulting from past development and ongoing restoration actions. Climate change effects on present marine derived nutrients are likely represented in these current conditions as well. The effects of the alternatives on levels of marine derived nutrients from harvest and hatchery operations are described in Subsection 4.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients. Future actions are described in Subsection 5.2, Future Foreseeable Actions. This section considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This section only discusses future impacts that have not already been described and evaluated in Subsection 4.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients. Climate change is expected to affect marine derived nutrients by altering water temperatures and changing seasonal river flows, affecting the ability and distribution of returning adult anadromous fish to deposit as carcasses and deliver marine derived nutrients in similar patterns.

As a result, cumulative effects may lead to less marine derived nutrients than is considered in Subsection 4.3, Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients. The potential benefits of restoration actions within the basin are difficult to quantify. It is unlikely that substantial benefits would be realized in the action area in the future, although minor improvements would likely occur over time from local restoration efforts. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the project area, a new *US v Oregon* agreement resulting in fisheries and continued hatcheries would make a minor additive negative contribution to the cumulative negative effects on Water Quality and Quantity—Hatchery Effects & Marine-Derived Nutrients under each of the alternatives except under Alternative 5, which eliminates the negative harvest impact.

While the effects of the voluntary fishing curtailment in Alternative 5 will be positive on marine derived nutrients, and the effects from the hatchery production will be positive in all alternatives, these are unlikely to mitigate for the net negative cumulative effects from the impacts of past, present, and reasonably foreseeable future actions in the project area.

5.3.3. Wildlife

Subsection 3.4, Wildlife, describes how past and present conditions have influenced wildlife populations in the Columbia River Basin. These conditions represent effects from many years of basin-wide development, as well as habitat restoration, and, most likely, climate changes. The effects of the alternatives on wildlife populations are described in Subsection 4.4, Wildlife. Future actions are described in Subsection 5.2, Future Foreseeable Actions. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses future effects that have not already been described and evaluated in Subsection 4.4, Wildlife.

As described in Subsection 5.3.1, Fish, salmonids, climate change and development in the Columbia River Basin is likely to reduce the abundance and productivity of natural-origin salmon and steelhead populations. Reduction in adult fish abundance would likely have an additional low negative impact on wildlife by reducing available prey. Overall, the total number of salmon and steelhead available as prey to wildlife may be lower than that considered in Subsection 4.4, Wildlife, for all alternatives if climate change effects are more pronounced than anticipated. Reduced abundance of salmon and steelhead would also decrease the number of salmon and steelhead carcasses available to wildlife for scavenging and for nutrient contribution to the freshwater system. The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on salmon and steelhead abundances. Therefore, it is difficult to estimate future trends in available prey bases for wildlife and available nutrient contributions to the freshwater system. Again, however, localized microclimate fish habitat improvements may be realized from these restoration actions. This potential benefit would be experienced in the future by wildlife that reside in the same localized ecosystems.

However, when aggregated with the impacts of past, present, and reasonably foreseeable future actions in the project area, a new *US v Oregon* agreement resulting in fisheries would make a minor additive contribution to cumulative negative impacts of reducing prey availability, via harvest removal, on wildlife under each of the alternatives except under Alternative 5. Given Alternative 5 results in no prey being removed, by itself when also aggregating Alternative 5 with the impacts of past, present, and reasonably foreseeable future actions in the project area it wouldn't likely mitigate for changing development and climate change effects therefore results in a likely non discernible cumulative effect.

5.3.3.1. Seabirds, Raptors, and other Piscivorous Birds

Subsection 3.4.1, Seabirds, Raptors, and other Piscivorous Birds, describes how past and present conditions have influenced these resources in the Columbia River Basin. These conditions represent effects from many years of basin-wide development, as well as habitat restoration, and, most likely, climate change impacts. The effects of the alternatives on birds are described in Subsection 4.4.1, Seabirds, Raptors, and other Piscivorous Birds. Overall Seabirds will continue to be affected by other development in the Columbia River Basin, but no additional impacts will be added by a new *US v Oregon* management agreement.

For Raptors and other piscivorous birds Alternative 1 and Alternative 2 impacts from adult prey reductions were unchanged relative to baseline conditions, slightly positive in Alternative 3, negative in Alternative 4 and Alternative 6, and positive in Alternative 5. The cumulative effects to these birds would be similar to those described to other wildlife in Subsection 5.3.3, Wildlife.

5.3.3.2. Marine Mammals

Subsection 3.4.2, Marine Mammals, describes how past and present conditions have influenced marine mammals in the Columbia River Basin. These conditions represent effects from many years of basin-wide development, as well as habitat restoration, and, most likely, climate change impacts. The effects of the alternatives on marine mammals are described in Subsection 4.4.2, Marine Mammals. For Alternative 1 and Alternative 2 impacts from prey reductions were unchanged relative to baseline conditions, slightly positive in Alternative 3, negative in Alternative 4 and Alternative 6, and positive in Alternative 5, while for SRKW there were no discernable impacts across the alternatives. Future actions are described in Subsection 5.2, Future Foreseeable Actions. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses future effects that have not already been described and evaluated in Subsection 4.4.2, Marine Mammals.

As described in Subsection 5.4, Wildlife, fish, salmonids, climate change and development in the Columbia River Basin is likely to reduce the abundance and productivity of natural-origin salmon and steelhead populations. Future actions in the project area will have a negative but unquantifiable effect on marine mammals, likely low because of Marine Mammal Protection Act restoration activities and ESA protections. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the project area, a new *US v Oregon* agreement resulting in fisheries would make a minor additive contribution to cumulative negative effects on marine mammals and SRKW under each of the alternatives except under Alternative 5, which results in a positive harvest impact to marine mammals since this alternative results in zero fishing and therefore zero prey removal via harvest.

By itself when also aggregating Alternative 5 with the impacts of past, present, and reasonably foreseeable future actions in the project area the effects of reduced harvest would not likely mitigate for changing development and climate change effects therefore resulting in a likely non discernible cumulative effect on marine mammals.

Under Alternative 5 the cumulative effect would still be non-discernible for SRKW, as adult fish would have passed through areas already where they might be preyed upon. In addition, higher numbers of adults escaping to the terminal spawning grounds would not increase juvenile production unless habitat improvements offset changing development and climate change effects enough to equate to increase future adult abundance.

5.3.4. Economics

Subsection 3.5, Economics, characterizes how past and present conditions have affected economic conditions related to commercial and recreational fishing activity targeting salmon and steelhead in the analysis area. These conditions reflect the effects of many years of land development, as well as effects from habitat restoration, hydropower operations, hatchery production and, most likely, climate changes on fisheries in the Columbia River Basin. The expected direct and indirect effects of the *US v Oregon* agreement alternatives on fishery-related economic conditions are described in Subsection 4.5, Economics. Future Foreseeable Actions that likely will affect these conditions are described in Subsection 5.2, Future Foreseeable Actions.

This section considers impacts that may occur as a result of any one of the alternatives being implemented at the same time as other anticipated future actions, and presents findings in the context of future climate change. This section only discusses future impacts that have not already been described and evaluated in Subsection 4.5, Economics.

5.3.4.1. Commercial Fisheries

As described in Subsection 5.2, future climate change and other changes in environmental conditions can be expected to affect salmonids and other species important to commercial (and recreational) fisheries in the Columbia River Basin. While the effects would be expected to vary among species, virtually every species of salmonids in the Columbia River Basin likely will be affected, as identified in Subsection 5.3.1, Fish. Rising water and air temperatures are a major concern for salmon species, especially spring/summer Chinook salmon and sockeye salmon in the interior Columbia and Snake River Basins. The effects of Alternative 1 and Alternative 2 on the harvest of Upper Columbia River spring Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, and B-run steelhead would be similar to current baseline conditions, but Alternatives 3, 4, and 6 have the greatest effects (negative for Alternative 3 and positive for Alternative 4 and Alternative 6) on the harvest of harvest indicator stocks.

Although unquantifiable, future climate change and development actions may reduce the number of salmon and steelhead available for harvest over time. This, in turn, would reduce the total ex-vessel value obtained by commercial fishers relative to conditions considered in Subsection 4.5.1.1, Commercial Fisheries, for all alternatives. As a result, the cumulative effects on economic values to commercial fishers may differ from those described in Subsection 4.5.1.1, Commercial Fisheries, for all alternatives except Alternative 5. If the abundance of salmon and steelhead decreases as a result of future climate change, combined with development in the Columbia River Basin, economic values derived from commercial fisheries may be lower than those identified in Subsection 4.5.1.1, Commercial Fisheries, for all alternatives except for Alternative 5, unless ex-vessel prices increase as a result of reduced supply. This would result in greater economic impacts than described in Subsection 4.5.1.1, Commercial Fisheries, on commercial fisheries under Alternative 3 and reduced benefits under Alternative 4 and Alternative 6.

5.3.4.2. Recreational Fisheries

As described in Subsection 5.2, future climate change and other changes in environmental conditions as a result of future development, changes in hydropower operations, hatchery production and habitat restoration, can be expected to affect salmonids and other species that contribute to recreational fisheries in the Columbia River Basin. Rising air and water temperatures are a particular concern for salmonid species, which are important to the recreational fisheries in the Columbia River Basin. Overall, environmental changes are likely to reduce the future abundance, catch, and level of effort directed on most, if not all, salmonid fish species in the Columbia River Basin, as compared to the direct and indirect effects on recreational fishing effort and associated economic effects described in Subsection 4.5.1.2, Recreational Fisheries, for all alternatives except Alternative 5.

Future climate change, combined with development in the basin, may affect the net benefit (benefits minus costs) that recreational anglers receive from participating in salmon and steelhead fishing. If fewer fish are available for harvest, and more restrictions are in place (e.g., reduced bag limits and fishing seasons), fewer recreational fishers may be willing to pay for the opportunity to fish. As a result, cumulative effects on economic values to recreational fishers could lead to lower future values (trip-related expenditures) than those identified in Subsection 4.5.1.2, Recreational Fisheries, for all alternatives except for Alternative 5. To some unpredictable extent, restoration actions within the basin would be expected to benefit salmonids in the Columbia River Basin. Overall, it is unknown whether restoration actions would fully, or even partially, mitigate for the impacts of climate change or development on the abundance of fish species that provide recreational fishing opportunities

5.3.4.3. Regional and Local Economic Impacts

The assessment of regional and local economic effects of the alternatives described in Subsection 4.5.1.3, Contribution to Regional Economic Activity, relies on changes in personal income and jobs as key indicators of the direction and magnitude of potential effects on regional economic activity. Commercial and recreational fisheries generate personal income and jobs in regional economies through the export of products and services to outside economies. Commercial catch of salmon and steelhead harvested in the Columbia River Basin is frequently sold directly, or after processing, to individuals or businesses located outside the regional economy. Similarly, non-local recreational anglers (i.e., anglers who do not live in a local area) spend money on guide services, lodging, and other goods and services that generate household income and employment in many sectors of the regional economy. This regional transfer of money supports payments to labor, and those payments are then re-spent regionally, resulting in a multiplier effect.

Future climate change and development-related impacts may reduce the abundance of salmon and steelhead available for catch, which would reduce the total number of salmon and steelhead exported to outside economies relative to conditions considered in Subsection 4.5.1.3, Contribution to Regional Economic Activity, for all alternatives except for Alternative 5. As a result, the cumulative effects on generating regional and local economic impacts may be lower than those identified in Subsection 4.5.1.3, Contribution to Regional Economic Activity, for all alternatives except for Alternative 5. Although it is unpredictable what effects restoration actions within the basin will have on salmonid resources, these actions would be expected to at least partially mitigate for the impacts of climate change or development on fish available for harvest in commercial or recreational fisheries, and therefore, also on regional and local economies.

5.3.5. Cultural Resources

A portion of tribal fish harvests is used to meet Ceremonial & Subsistence (C&S) needs as discussed in Subsection 3.6. The anticipated effects of each alternative on C&S harvest are described in Subsection 4.6. This section considers the effects that may occur as a result of implementing any one of the alternatives together with other foreseeable actions and the effects of climate change.

While the current and future habitat restoration activities offer mitigation, their benefits are difficult to predict in light of negative effects from concurrent development and climate changes. At the same time, the protection of ESA-listed salmonid stocks will continue. Coupled with the negative effect from development projects and habitat changes, there will likely be continuing cumulative adverse effects on cultural resources. These adverse effects are a continued reduction in the number of salmon and steelhead available for the tribe's C&S harvest that may result in a deterioration in cultural practices and the erosion of salmon and steelhead as a core symbol of tribal identity, health, individual identity, culture, spirituality, religion, emotional well-being, and economy.

However, as C&S harvests are given priority over commercial harvests, the adverse effect on C&S harvests is anticipated to be low when commercial harvests exist. Under Alternatives 1, 2, 3, 4, and 6, commercial harvests would continue. The size of the C&S harvest would therefore be driven primarily by the harvest framework in each alternative and not by other concurrent development changes or climate change. Each of these five alternatives will contribute a meaningful effect to the overall cumulative adverse effect on cultural resources.

Under Alternative 5, there would be no commercial harvest and minimal C&S harvest. Therefore, Alternative 5 contributes a higher effect on the overall cumulative adverse effect on C&S cultural resources than the other alternatives.

5.3.6. Environmental Justice

The expected effects of the alternatives on environmental justice communities, described in Subsection 4.7, found that Alternatives 4, 5, and 6 would result in a disproportionate adverse effect on Cultural Resources for Indian tribes as it pertains to C&S fisheries. Alternative 4 and Alternative 6 would also result in a disproportionate adverse economic effect on Indian tribes as it pertains to Upriver Fall Chinook salmon. Future actions are described in Subsection 5.2. This section considers the cumulative effects that may occur as a result of implementing any one of the alternatives together with other foreseeable actions.

5.3.6.1. Cultural Resources—C&S

Given the significance of C&S harvests on the cultural practices and traditions among Indian tribes, the effect on Indian tribes as an Environmental Justice community would be adverse and disproportionate whenever C&S harvests are negatively affected. The C&S harvest would be negatively affected under Alternatives 4, 5, and 6 as a result in a decrease in the number of fish available to the tribes. The C&S harvest is driven primarily by the harvest framework in each alternative and not by other concurrent development changes or climate change. Therefore, Alternatives 4, 5, and 6 result in a cumulative disproportionate adverse cultural resources effect in that the Indian tribes are the only population group that is affected by the loss of cultural resources pertaining to salmon and steelhead.

5.3.6.2. Economics

As described in Subsection 4.7.2, Alternative 4 and Alternative 6 results in a disproportionate adverse economic effect on Indian tribes resulting from a decrease in tribal commercial harvest of and revenue from Upriver Fall Chinook salmon by 21 percent under both alternatives compared to an increase in non-tribal commercial harvest by 59 percent. The economic impact on the tribes is driven primarily by the selected harvest. It may be affected by, but it is not driven by, other development or restoration activities. Alternative 4 and Alternative 6 would result in a cumulative disproportionate adverse economic effect on the tribes.

Section 6

6. LISTS

6.1. List of Preparers

The following individuals in NOAA's National Marine Fisheries Service were responsible for the preparation of this EIS:

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6.2. List of Agencies, Organizations, and Persons Contacted

The following agencies and persons were contacted in the course of preparing this EIS

- Columbia River Intertribal Fish Commission,
  - Mr. Stewart Ellis, current *US v Oregon* Technical Advisory Committee Chair, Portland, Oregon
- U.S. Fish and Wildlife Service, (Cooperating Agency)
  - Dr. Howard Schaller, Portland, Oregon
  - Mr. Mark Bagdovitz, Portland, Oregon
- U.S. Bureau of Indian Affairs, (Cooperating Agency)
  - Randy Peone, Portland, Oregon

6.3. Distribution List for DEIS

- **Federal and State Agencies**
  - U.S. Environmental Protection Agency, Region 10
  - U.S. Fish and Wildlife Service
  - U.S. Bureau of Indian Affairs
  - U.S. Bureau of Reclamation
  - U.S. Army Corps of Engineers
  - U.S. Geological Survey
  - U.S. Department of Justice
  - U.S. Department of the Interior
  - Bonneville Power Administration
  - Oregon Department of Fish and Wildlife
  - Washington Department of Fish and Wildlife
  - Idaho Department of Fish and Game
- **Elected Officials**
  - Governor's Offices in Idaho, Montana, Oregon, and Washington
- **Tribes**
  - Burns Paiute Tribe
  - Coeur d'Alene Tribe

    - Confederated Tribes of the Colville Reservation
    - Confederated Tribes of the Warm Springs Reservation of Oregon
    - Hoh Tribe
    - Kalispel Tribe
    - Kootenai Tribe of Idaho
    - Makah Indian Tribe
    - Nez Perce Tribe
    - Quileute Tribe
    - Quinault Indian Nation
    - Confederated Salish and Kootenai Tribes
    - Cowlitz Indian Tribe
    - Shoshone-Bannock Tribes
    - Spokane Tribe of Indians
    - Confederated Tribes of the Umatilla Reservation
    - Yakama Nation
    - Wanapum Indian Tribe
- **Councils and Commissions**
    - Columbia River Inter-Tribal Fish Commission
- **Organizations and Associations**
    - Stoel Rives, LLP
    - Northwest RiverPartners
    - The Conservation Angler
    - Hatchery Scientific Review Group
    - DJW Associates
    - Wild Fish Conservancy
    - Defenders of Wildlife,
    - Native Fish Society
    - Salmon for All
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Section 7

7. REFERENCES

Asch, R. G. 2015. Climate change and decadal shifts in the phenology of larval fishes in the California Current ecosystem. PNAS. 112(30): E4065–E4074.

Bajkov, A.D. 1951. Migration of white sturgeon (Acipenser transmontanus) in the Columbia River. Oregon Fish Commission Research Brief 3:8-21.

Bakun, A., B. A. Black, S. J. Bograd, M. García-Reyes, A. J. Miller, R. R. Rykaczewski, and W. J. Sydeman. 2015. Anticipated effects of climate change on coastal upwelling ecosystems. Current Climate Change Reports. 1(2): 85-93.

Beamesderfer, R. C. P., T. A. Rien, and A. A. Nigro. 1995. Differences in the dynamics and potential production of impounded and unimpounded white sturgeon populations in the lower Columbia River. Transactions of the American Fisheries Society. 124:857-872.

Beamish, R. J. and T. G. Northcote. 1989. Extinction of a population of anadromous parasitic lamprey, Lampetra tridentata, upstream of an impassable dam. Canadian Journal of Fisheries and Aquatic Sciences 46:420-425.

Beamish, R. J., D. J. Noakes, G. A. McFarlane, L. Klyashtorin, V. V. Ivanov, and V. Kurashov. 1999. The regime concept and natural trends in the production of Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences. 56: 516-526.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, J. Kimball, J. Stanford, G. Pess, P. Roni, P. Kiffney, and N. Mantua. 2013. Restoring Salmon Habitat for a Changing Climate. River Research and Applications. 29(8): 939-960.

Benson, A. J., and A. W. Trites. 2002. Ecological effects of regime shifts in the Bering Sea and eastern North Pacific Ocean. Fish and Fisheries. 3(2): 95-113.

Black, B. A., W. J. Sydeman, D. C. Frank, D. Griffin, D. W. Stahle, M. García-Reyes, R. R. Rykaczewski, S. J. Bograd, and W. T. Peterson. 2014. Six centuries of variability and extremes in a coupled marine-terrestrial ecosystem. Science. 345(6203): 1498-1502.

Blunden, J., and E. D.S. Arndt. 2016. State of the Climate 2015. Bulletin of the American Meteorological Society. 97(8): S1–S275.

Bograd, S. J., I. Schroeder, N. Sarkar, X. Qiu, W. J. Sydeman, and F. B. Schwing. 2009. Phenology of coastal upwelling in the California Current. Geophysical Research Letters. 36(1).

Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophysical Research Letters. 42(9): 3414–3420.

Bottom, D. L., K. K. Jones, C. A. Simenstad, C. L. Smith, and R. Cooper. 2011. Pathways to resilience. Oregon Sea Grant. 367p. Pathways to resilience: sustaining salmon ecosystems in a changing world (Vol. 11, No. 1). Oregon Sea Grant.

Brodeur, R. D., R. C. Francis, and W. G. Pearcy. 1992. Food consumption of juvenile coho (Oncorhynchus kisutch) and Chinook salmon (O. tshawytscha) on the continental shelf off Washington and Oregon. Canadian Journal of Fisheries and Aquatic Sciences. 49: 1670-1685.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-27. 275 p.

Cheung, W. W. L., R. D. Brodeur, T. A. Okey, and D. Pauly. 2015. Projecting future changes in distributions of pelagic fish species of Northeast Pacific shelf seas. Progress in Oceanography. 130: 19-31.

Close, D. A., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (Lampetra tridentata) in the Columbia River Basin. Technical Report to Bonneville Power Administration DOE/BP-39067-1.

Close, D. A, M. S. Fitzpatrick, and H. W. Li. 2002. The ecological and cultural importance of a species at risk of extinction, Pacific Lamprey. Fisheries 27:19-25.

Climate Change Science Program. 2014. U.S. Global Change Research Program. Northwest Report. http://nca2014.globalchange.gov/report/regions/northwest.

Climate Impacts Group. 2004. Overview of Climate Change Impacts in the U.S. Pacific Northwest. July 29, 2004. Climate Impacts Group, University of Washington, Seattle, Washington. 13p.

Columbia Basin Fish and Wildlife Authority. 2008. Recommendations for amendments to the Northwest Power and Conservation Council 2000 Columbia Basin Fish and Wildlife Program.

Council for Environmental Quality (CEQ). 1997, Environmental Justice Guidance under the National Environmental Policy Act.

Cotte´, C. d., and C. Guinet. 2007. Historical whaling records reveal major regional retreat of Antarctic sea ice. Deep Sea Research Part I: Oceanographic Research Papers. 54(2): 243–252.

Crozier, L., and R. W. Zabel. 2006. Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon. Journal of Animal Ecology. 75(5): 1100-1109.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008a. Potential responses to climate change in organisms with complex life histories: Evolution and plasticity in Pacific salmon.

Crozier, L. G., R. W. Zabel, and A. F. Hamlet. 2008b. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biology. 14(2): 236–249.

Dalton, M., P. W. Mote, and A. K. S. [Eds.]. 2013. Climate Change in the Northwest, Implications for Our Landscapes, Waters, and Communities. Washington, DC: Island Press. 271p.

Dawkins, R. 2004. The ancestor's tale: a pilgrimage to the dawn of evolution. Houghton Mifflin Company, New York, New York.

Di Lorenzo, E., and N. Mantua. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. Nature Climate Change.

Fisher, J. L., W. T. Peterson, and R. R. Rykaczewski. 2015. The impact of El Niño events on the pelagic food chain in the northern California Current. Global Change Biology. 21(12): 4401–4414.

Foreman, M. G. G., W. Callendar, D. Masson, J. Morrison, and I. Fine. 2014. A model simulation of future oceanic conditions along the British Columbia continental shelf. Part II: results and analyses. Atmosphere-Ocean. 52(1): 20-38.

Francis, D., and H. Hengeveld. 1998. Extreme Weather and Climate Change. 34p.

Gargett, A. E. 1997. The optimal stability `window': a mechanism underlying decadal fluctuations in North Pacific salmon stocks? Fisheries Oceanography. 6(2): 109-117.

Glick, P. 2005. Fish Out of Water: A Guide to Global Warming and Pacific Northwest Rivers. March 2005. National Wildlife Federation.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (Thaleichthys pacificus) in Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-105, 360 p.

Gustafson, R. G., T. C. Wainwright, G. A. Winans, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1997. Status Review of Sockeye Salmon from Washington and Oregon. NOAA Technical Memorandum NMFS-NWFSC-33. 300 p.

Haigh, R., D. Ianson, C. A. Holt, H. E. Neate, and A. M. Edwards. 2015. Effects of ocean acidification on temperate coastal marine ecosystems and fisheries in the Northeast Pacific. PLOS One. 10(2): e0117533.

Hare, S. R., N. J. Mantua, and R. C. Francis. 1999. Inverse production regimes: Alaska and west coast Pacific salmon. Fisheries. 24(1): 6-14.

Hollowed, A. B., N. A. Bond, T. K. Wilderbuer, W. T. Stockhausen, Z. T. A'mar, R. J. Beamish, J. E. Overland, and M. J. Schirripa. 2009. A framework for modelling fish and shellfish responses to future climate change. ICES Journal of Marine Science. 66: 1584–1594.

IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland. 169p.

ISAB. 2007. Climate change impacts on Columbia River Basin Fish and Wildlife. May 11, 2007. Report ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon. 146p

Johnson, O. W., W. S. Grant, R. G. Kope, K. Neely, F. W. Waknitz, and R. S. Waples. 1997. Status Review of Chum Salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-32. 298 p.

Jones, K. K., T. J. Cornwell, D. L. Bottom, L. A. Campbell, and S. Stein. 2014. The contribution of estuary-resident life histories to the return of adult Oncorhynchus kisutch. Journal of Fish Biology. 85: 52-80.

Kennedy, V. S. 1990. Anticipated effects of climate change on estuarine and coastal fisheries. Fisheries. 15(6): 16-24.

Kirwan, M. L., G. R. Guntenspergen, A. D'Alpaos, J. T. Morris, S. M. Mudd, and S. Temmerman. 2010. Limits on the adaptability of coastal marshes to rising sea level. Geophysical Research Letters. 37(23).

Kostow, K. 2002. Oregon lampreys: Natural history status and problem analysis. Oregon Department of Fish and Wildlife. Salem, OR

Learmonth, J. A., C. D. MacLeod, M. B. Santos, G. J. Pierce, H. Q. P. Crick, and R. A. Robinson. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology. 44: 431-464.

Lemmen, D. S., F. J. Warren, T. S. James, and C. S. L. M. Clarke. 2016. Canada's Marine Coasts in a Changing Climate; Government of Canada, Ottawa, Ontario. 280p.

Limburg, K., R. Brown, R. Johnson, B. Pine, R. Rulifson, D. Secor, K. Timchak, B. Walther, and K. Wilson. 2016. Round-the-Coast: snapshots of estuarine climate change effects. Fisheries. 41(7): 392-394.

Litz, M. N. C., A. J. Phillips, R. D. Brodeur, and R. L. Emmett. 2011. Seasonal occurrences of Humboldt Squid (Dosidicus Gigas) in the northern California current system. CalCOFI Rep. 52: 97-108.

Lucey, S. M., and J. A. Nye. 2010. Shifting species assemblages in the Northeast US continental shelf large marine ecosystem. Marine Ecology Progress Series. 415: 23-33.

Lynch, A. J., B. J. E. Myers, C. Chu, L. A. Eby, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, J. Lyons, C. P. Paukert, and J. E. Whitney. 2016. Climate Change Effects on North American Inland Fish Populations and Assemblages. Fisheries. 41(7): 346-361.

MacLeod, C. D., S. M. Bannon, G. J. Pierce, C. Schweder, J. A. Learmonth, J. S. Herman, and R. J. Reid. 2005. Climate change and the cetacean community of north-west Scotland. Biological Conservation. 124(4): 477–483.

Mantua, N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the american Meteorological Society. 78(6): 1069-1079.

Martins, E. G., S. G. Hinch, S. J. Cooke, and D. A. Patterson. 2012. Climate effects on growth, phenology, and survival of sockeye salmon (Oncorhynchus nerka): a synthesis of the current state of knowledge and future research directions. Reviews in Fish Biology and Fisheries. 22(4): 887-914.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, K. M. Miller, M. F. LaPointe, K. K. English, and A. P. Farrell. 2011. Effects of river temperature and climate warming on stock-specific survival of adult migrating Fraser River sockeye salmon (Oncorhynchus nerka). Global Change Biology. 17(1): 99-114.

Mathis, J. T., S. R. Cooley, N. Lucey, S. Colt, J. Ekstrom, T. Hurst, C. Hauri, W. Evans, J. N. Cross, and R. A. Feely. 2015. Ocean acidification risk assessment for Alaska's fishery sector. Progress in Oceanography. 136: 71-91.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

McDowall, R. M. 2001. Anadromy and homing: two life-history traits with adaptive synergies in salmonid fishes? Fish and Fisheries 2:78-85.

McMahon, C. R., and G. C. Hays. 2006. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology. 12(7): 1330–1338.

Moser, M. L. and D. A. Close. 2003. Assessing Pacific lamprey status in the Columbia River Basin. Northwest Science 77:116-125.

Morris, J. F. T., M. Trudel, J. Fisher, S. A. Hinton, E. A. Fergusson, J. A. Orsi, and J. Edward V. Farley. 2007. Stock-specific migrations of juvenile coho salmon derived from coded-wire tag recoveries on the continental shelf of western North America. In C. B. Grimes (Ed.). American Fisheries Society Symposium. 57: 81.

Morrison, W. E., M. W. Nelson, R. B. Griffis, and J. A. Hare. 2016. Methodology for assessing the vulnerability of marine and anadromous fish stocks in a changing climate. Fisheries. 41(7): 407-409.

Mote, P. W., and Eric P. Salathé Jr. 2010. Future climate in the Pacific Northwest. Climatic Change. 102(1-2): 29-50.

Mote, P. W., E. A. Parson, A. F. Hamlet, W. S. Keeton, D. Lettenmaier, N. Mantua, E. L. Miles, D. W. Peterson, D. L. Peterson, R. Slaughter, and A. K. Snover. 2003. Preparing for climatic change: the water, salmon, and forests of the Pacific Northwest. Climatic change. 61(1-2): 45-88.

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley, CA. Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D.M. Van Doornik, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-73, 311 p.

Naiman, R. J., J. R. Alldredge, D. A. Beauchamp, P. A. Bisson, J. Congleton, C. J. Henny, N. Huntly, R. Lamberson, C. Levings, E. N. Merrill, W. G. Pearcy, B. E. Rieman, G. T. Ruggerone, D. Scarnecchia, P. E. Smouse, and C. C. Wood. 2012. Developing a broader scientific foundation for river restoration: Columbia River food webs PNAS. 109(52): 21201–21207.

National Marine Fisheries Service (NMFS). 2014. Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs. 2120 p.

NMFS. 2008. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Seattle, Washington. 251p.

Nez Perce, Umatilla, Yakama, and Warm Springs Tribes. 2008. Tribal Pacific lamprey restoration plan for the Columbia River Basin. Formal Draft July 17, 2008.

North, J.A., R.C. Beamesderfer, and T.A. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia River reservoirs. Northwest Science 67:105-111.

Oregon Department of Fish and Wildlife (ODFW). 2005. 2005 Oregon Native Fish Status Report, Volume I: Species Management Unit Summaries. ODFW, Salem, OR. 164 p. (Accessed online on December 6, 2016 at: http://www.dfw.state.or.us/fish/ONFSR/docs/volume-1-final.pdf).

Pacific Fishery Management Council (PFMC). 2014. Pacific Coast Salmon Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as Revised through Amendment 18. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, OR. 90 p.

Parsley, M.J., and L.G. Beckman. 1994. White Sturgeon spawning and rearing habitat in the Lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Parsley, M.J., L.G. Beckman, and G.T. McCabe, Jr. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society 122:217-227.

PCIC. 2016. Plan 2 Adapt website, available at https://www.pacificclimate.org/analysis-tools/plan2adapt.

Pearcy, W. G. 2002. Marine nekton off Oregon and the 1997–98 El Niño. Progress in Oceanography. 54(1): 399-403.

Pearcy, W. G., and S. M. McKinnell. 2007. The ocean ecology of salmon in the Northeast Pacific Ocean - An abridged history. American Fisheries Society Symposium. 57: 7-30.

Peone, T.L., AT. Scholz, J.R. Griffith, S. Graves, and M.G. Thatcher, Jr. 1990. Lake Roosevelt fisheries monitoring program. Annual report. Bonneville Power Administration, Portland, Oregon.

Peterson, W. T., J. L. Fisher, J. O. Peterson, C. A. Morgan, B. J. Burke, and K. L. Fresh. 2014. Applied fisheries oceanography: Ecosystem indicators of ocean conditions inform fisheries management in the California current. Oceanography. 27(4): 80-89.

Poesch, M. S., L. Chavarie, C. Chu, S. N. Pandit, and W. Tonn. 2016. Climate change impacts on freshwater fishes: a Canadian perspective. Fisheries. 41(1): 385-391.

Quinn, T. P., and K. W. Myers. 2004. Anadromy and the marine migrations of Pacific salmon and trout: Rounsefell revisited. Reviews in Fish Biology and Fisheries 14: 421–442.

Rehage, J. S., and J. R. Blanchard. 2016. What can we expect from climate change for species invasions? Fisheries. 41(7): 405-407.

Renaud, C. B. 1997. Conservation status of northern hemisphere lampreys (Petromyzontidae). Journal of Applied Ichthyology 13:143-148.

Robinson, R. A., J. A. Learmonth, A. M. Hutson, C. D. Macleod, T. H. Sparks, D. I. Leech, G. J. Pierce, M. M. Rehfisch, and H. Q. P. Crick. 2005. Climate Change and Migratory Species. August 2005. BTO Research Report 414. 306p.

Rykaczewski, R. R., J. P. Dunne, W. J. Sydeman, M. García-Reyes, B. A. Black, and S. J. Bograd. 2015. Poleward displacement of coastal upwelling-favorable winds in the ocean's eastern boundary currents through the 21st century. Geophysical Research Letters. 42(15): 6424–6431.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Canadian Government Publishing Centre, Ottawa, Canada.

Scheuerell, M. D., and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography. 14(6): 448-457.

Schindler, D. E., R. Hilborn, B. Chasco, C. P. Boatright, T. P. Quinn, L. A. Rogers, and M. S. Webster. 2010. Population diversity and the portfolio effect in an exploited species. Nature. 465(7298): 609-612.

Schnorbus, M., A. Werner, and K. Bennett. 2014. Impacts of climate change in three hydrologic regimes in British Columbia, Canada. Hydrological Processes. 28(3): 1170–1189.

Simpson, J. and R. Wallace. 1978. Fishes of Idaho. University of Idaho Press, Moscow, ID.

Snover, A. K., P. W. Mote, L. W. Binder, A. F. Hamlet, and N. J. Mantua. 2005. Uncertain Future: Climate Change and its Effects on Puget Sound. October 2005. A report for the Puget Sound Action Team by the Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle). 37p.

Sykes, G. E., C. J. Johnson, and J. M. Shrimpton. 2009. Temperature and flow effects on migration timing of Chinook salmon smolts. Transactions of the American Fisheries Society. 138(6): 1252–1265.

Verdonck, D. 2006. Contemporary vertical crustal deformation in Cascadia. Tectonophysics. 417(3): 221-230.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. Northwest Science. 87(3): 219-242.

Waples, R. S., O. W. Johnson, and R. P. Jones, Jr. 1991. Status review for Snake River sockeye salmon. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-195, 23 p.

Waples, R. S., T. Beechie, and G. R. Pess. 2009. Evolutionary history, habitat disturbance regimes, and anthropogenic changes: What do these mean for resilience of Pacific Salmon populations? Ecology and Society. 14(1).

Ward, E. J., J. H. Anderson, T. J. Beechie, G. R. Pess, and M. J. Ford. 2015. Increasing hydrologic variability threatens depleted anadromous fish populations. Global Change Biology.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-Nwfsc-24. 266 P.

Weitkamp, L., and K. Neely. 2002. Coho salmon (Oncorhynchus kisutch) ocean migration patterns: insight from marine coded-wire tag recoveries. Canadian Bulletin of Fisheries and Aquatic Sciences. 59(7): 1100–1115.

Whitney, J. E., R. Al-Chokhachy, D. B. Bunnell, C. A. Caldwell, S. J. Cooke, E. J. Eliason, M. Rogers, A. J. Lynch, and C. P. Paukert. 2016. Physiological basis of climate change impacts on North American inland fishes. Fisheries. 41(7): 332-345.

Wydoski, R., and R.R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press. 220 pages.

Yamada, S. B., W. T. Peterson, and P. M. Kosro. 2015. Biological and physical ocean indicators predict the success of an invasive crab, Carcinus maenas, in the northern California Current. Marine Ecology Progress Series. 537: 175-189.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology. 20(1): 190-200.

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APPENDIX A

US v. OREGON AGREEMENT EIS

Economics Methods Appendix

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Appendix – Economics Impact Methods

1.0 Introduction

This appendix describes the methods and data used to conduct the analysis of economic effects described in Subsection 4.5. The analysis of economic impacts considers predicted harvest-related effects in affected commercial and recreational fisheries in the mainstem Columbia River, as affected by the *US v Oregon* Agreement.

An excel workbook with linked worksheets, referred to as the Columbia River Economic Impact Model, was developed by TCW Economics to assess harvest-related economic effects of the *US v Oregon* EIS alternatives. Data and values in the worksheets are organized by economic subregions. The analytical purpose of these regions is to present the economic impacts (i.e., generation of jobs and personal income) of fishing activity that occurs in the mainstem fisheries. For purposes of the analysis, four subregions of the Columbia River Basin are used to characterize effects on commercial harvest and recreational fishing effort:

- Lower Columbia River subregion, where catch assumed to contribute to economic activity in eight counties (Columbia, Clatsop, and Multnomah Counties in Oregon, and Pacific, Wahkiakum, Clark, Cowlitz, and Skamania in Washington) that border ODFW mainstem fishing zones 1 through 5 downstream of Bonneville Dam;
- Mid-Columbia River subregion, where catch assumed to contribute to economic activity in eight counties (Hood River, Wasco, Sherman, Gilliam, Morrow, and Crook Counties in Oregon, and Benton and Klickitat Counties in Washington) that border ODFW fishing zone 6 between Bonneville Dam and McNary Dam;
- Upper Columbia River subregion, where catch assumed to contribute to economic activity in four counties (Benton, Kittatas, Franklin and Grant Counties in Washington) that are upstream of McNary Dam; and
- Lower Snake River subregion, where catch assumed to contribute to economic activity in five counties (Walla Walla, Columbus, Garfield, Whitman, and Franklin Counties in Washington) that are upstream of the confluence with the mainstem Columbia River.

The counties that comprise these four subregions are identified in Figure A-1.

Commercial (tribal and non-tribal) and recreational fishing activity in affected fisheries in the mainstem

Columbia River were assigned to the economic subregion where the fishing activity was presumed to occur. The correspondence between fishing areas and economic subregions in the Columbia River Basin are described above.

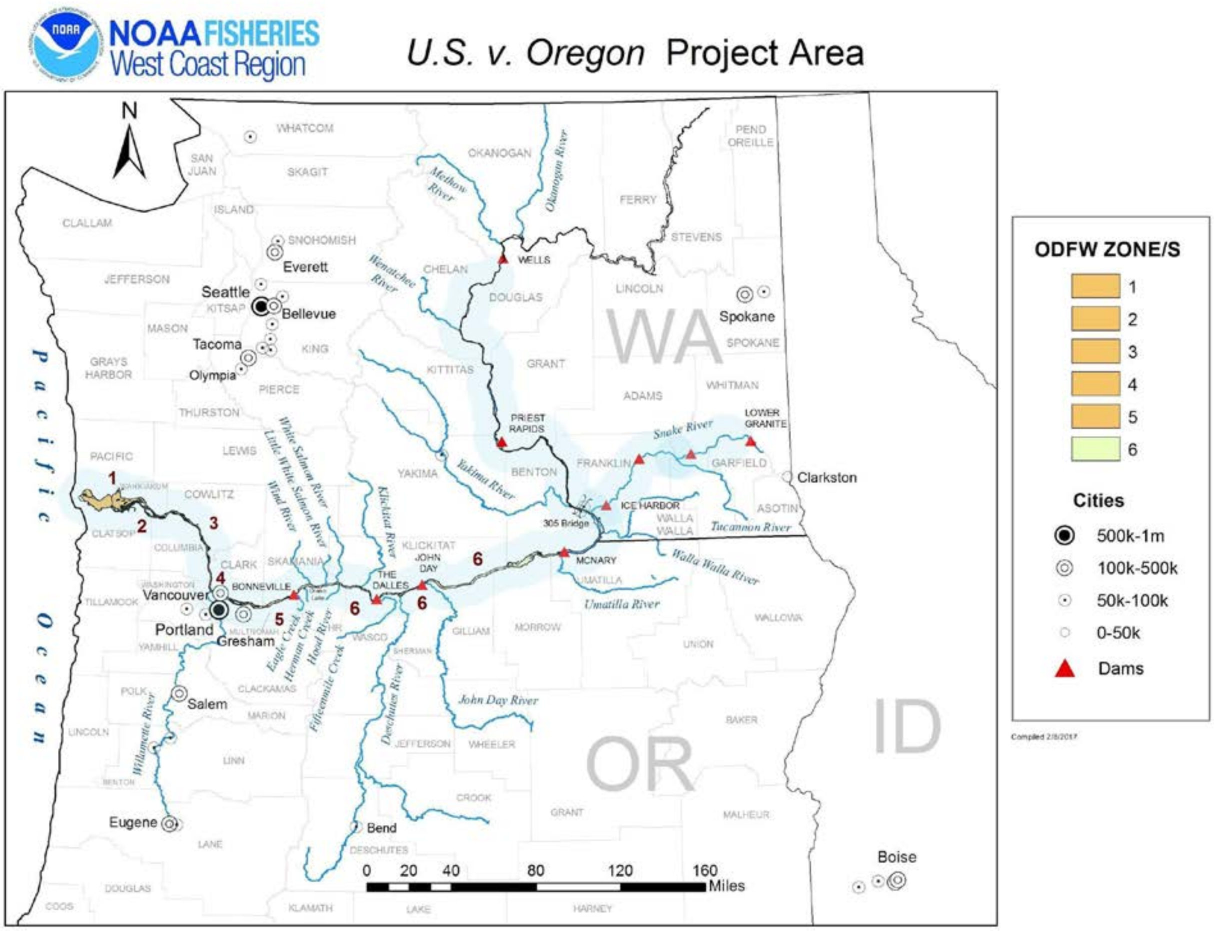

Figure A-1. Economic Analysis Area.

The economic analysis focuses on commercial and recreational fishing targeting five harvest indicator stocks that collectively are believed to account for more than 80 percent of the total catch of salmon and steelhead in the mainstem Columbia River: Upriver Spring Chinook salmon, Upriver Summer/Fall Chinook salmon, Upriver Fall Chinook salmon, Upper Columbia River Sockeye salmon, and Snake River steelhead. In addition to supporting tribal commercial and non-tribal recreational fisheries in the mainstem, these stocks also support ceremonial and subsistence tribal fishing.

As explained in Section 2 of the EIS, the estimates of the number of fish harvested in commercial and recreational fisheries were estimated by the Fishery Analysis Team based on historical catch records between 2005 and 2016, and modified to meet the objectives of the different harvest policy alternatives. This 12-year period (2005-2016) represents the term of the current management framework. The historical harvest and effort information was used to estimate numerical outputs for each of the harvest indicator stocks in the analysis of the alternatives. In Subsection 4.1.1 we describe the incorporation of expected climate change effects into the analysis. The minimum, maximum and average harvest of the different harvest indicator stocks are based on implementation of the different alternatives.

2.0 Catch and Effort Estimates

The Fishery Analysis Team estimated harvest for the five harvest indicator stocks (Upriver Spring Chinook, Upriver Summer/Fall Chinook salmon, Upriver Fall Chinook salmon, Upper Columbia River Sockeye salmon, and Snake River steelhead) and were presented to the economic analysis team for evaluation. The estimated number of fish (both natural-origin and hatchery fish) caught in tribal, non-tribal commercial, and recreational fisheries was estimated for different areas of the mainstem Columbia River, including ODFW fishing zones 1 through 5, ODFW fishing zone 6, upstream of McNary Dam on the mainstem Columbia River, and in the Lower Snake River upstream of the confluence with the mainstem Columbia River. The catch estimates in each of these catch areas were then assigned to one of the four different economic subregions previously identified based on the county (and region) corresponding to the location of the fisheries. (Note that none of the catch was assigned to the Upper Columbia River subregion because there was no commercial harvest of the harvest indicator stock.)

2.1 Commercial Fisheries

Estimates of total tribal and non-tribal commercial catch provided by the Fishery Analysis Team were converted to economic values using different price factors. For estimating the ex-vessel value of commercial fisheries, the number of fish caught was first converted to pounds. The pounds-per-fish factors by species and region used in the conversion are presented in Table A-1. The data sources for these conversion factors include the following:

- Commercial weights (round weight per fish) for Columbia River regions: Calculated based on landings and weight data from fish receiving tickets reported by the Oregon Department of Fish and Wildlife, Columbia River Fishing Landing Reports, 2003-2009, available at http://www.dfw.state.or.us/fish/OSCRP/CRM/Comm_fishery_updates.asp (accessed on December 7, 2011). Calculated weights for each species, including spring, summer, and fall Chinook salmon, were averaged over the 2003-2009 period, weighted by the number of fish landed each year in Oregon. (Note that data were not available for 2002.)

Once commercial catch was converted to pounds, per pound ex-vessel prices for each species were applied to the estimates of tribal and non-tribal commercial landings to estimate the total regional ex-vessel value of commercial salmon landings in each subregion. The value-per-fish factors used to convert estimated landings to total ex-vessel values are shown in Table A-2. The data sources for these value factors include the following:

- Ex-vessel price per pound for Columbia River regions for Chinook salmon were calculated based on price and harvest data for Oregon and Washington from PFMC 2016 Salmon SAFE Report, Tables IV-8 and IV-9. Prices represent average ex-vessel prices of Columbia River coho salmon and spring and fall Chinook salmon, weighted by pounds of fish landed, over the 2014-2016 period.
- Ex-vessel price per pound for Columbia River regions for sockeye salmon and steelhead were calculated based on aggregated landings and ex-vessel revenue data from PacFIN. Prices represent average of ex-vessel prices for Columbia River sockeye salmon and steelhead over the 2014-2016 period.

Table A-1. Average pounds per commercially-landed fish.

	Tribal			**Non-Tribal**		
REGION	**Chinook**	**Steelhead**	**Sockeye**	**Chinook**	**Steelhead**	**Sockeye**
Columbia River Basin						
Lower Snake River		na	na		na	na
Spring	na			na		
Summer	na			na		

Fall	na			na		
Upper Columbia River		na	na		na	na
Spring	na			na		
Summer	na			na		
Fall	na			na		
Mid-Columbia River		10.6	3.5		na	na
Spring	14.2			na		
Summer	17.1			na		
Fall	18.3			na		
Lower Columbia River		na	na		10.6	3.5
Spring	na			14.1		
Summer	na			18.8		
Fall	na			19.1		

Notes:
na = not applicable

Sources:
Chinook salmon prices are weighted averages of 2014-2016 ex-vessel revenue per landed lb from PFMC's Review of 2016 Ocean Salmon Fisheries, Table 9.
Sockeye salmon and Steelhead prices are weighted averages of 2014-2016 ex-vessel revenue per landed lb from PacFIN annual vessel summaries for 2014-2016.

1 Table A-2. Ex-vessel price per pound (2016 dollars).

	Tribal			Non-tribal		
REGION	**Chinook**	**Steelhead**	**Sockeye**	**Chinook**	**Steelhead**	**Sockeye**
Columbia River Basin						
Lower Snake River		na	na		na	na
Spring	na			na		
Summer	na			na		
Fall	na			na		
Upper Columbia River		na	na		na	na
Spring	na			na		
Summer	na			na		
Fall	na			na		
Mid-Columbia River		$1.30	$1.86		na	na
Spring	$4.61			na		
Summer	$1.88			na		
Fall	$1.88			na		
Lower Columbia River		na	na		$1.43	$2.09
Spring	na			$6.18		

Summer	na			$2.24		
Fall	na			$2.24		

Notes:
na = not applicable
Sources:
Chinook salmon prices are weighted averages of 2014-2016 ex-vessel revenue per landed lb from PFMC's Review of 2016 Ocean Salmon Fisheries, Table 9.
Sockeye salmon and Steelhead prices are weighted averages of 2014-2016 ex-vessel revenue per landed lb from PacFIN annual vessel summaries for 2014-2016.

2.2 Recreational Fisheries

Table A-3 shows the angler-trip conversion factors used to convert catch to angler trips for each species and subregion. The data sources for these conversion factors include the following:

- Sport catch per trip for Columbia River region: compiled from 2002-2009 angler trips and catch data from Catch Record Card data provided by WDFW. (Note that sport-catch-per-trip factors were developed for individual species but that the same factors were used for species across all four Columbia River Basin economic impact regions. As a result, while trip estimates for the entire basin may be reasonably reliable, sport trips may be overestimated in some regions and underestimated in others.)

- Table A-3. Average catch per recreational fishing trip, by species and region.

Region	Coho Salmon	Chinook Salmon	Steelhead
Columbia River Basin			
Lower Snake River	0.24		0.19
Spring Chinook		0.19	
Summer Chinook		0.19	
Fall Chinook		0.23	
Upper Columbia River	0.24		0.19
Spring Chinook		0.19	
Summer Chinook		0.19	
Fall Chinook		0.23	
Mid-Columbia River			
Spring Chinook	0.24	0.19	0.19
Summer Chinook		0.19	
Fall Chinook		0.23	
Mid-Columbia River			
Spring Chinook	0.24	0.19	0.19
Summer Chinook		0.19	

Fall Chinook		0.23	

Notes:
na = not applicable
Sources:
Sport catch per trip for Columbia River. Compiled from 2002-2009 angler trips and catch data from Sport Catch Record data (Table 2) provided by WDFW (Dixon pers. comm.).

Once catch was converted to sport angler trips, per trip expenditure factors for each species and region were applied to the estimated number of sport trips to estimate the total trip-related expenditures in each region. The per trip expenditure factors, which are shown in Table A-4 in 2016 dollars, were developed based on the following data sources.

- Columbia River: Oregon Angler Survey and Economic Study, The Research Group 1991. Estimates were price-updated to 2016 using USDC BEA GDP implicit price deflator.

Table A-4. Average expenditures per sport trip (2016 dollars).

REGION	**Coho**	**Chinook**	**Steelhead**
Columbia River Basin Regions			
Lower Snake River	$92.84	$92.84	$92.84
Upper Columbia River	$92.84	$92.84	$92.84
Mid-Columbia River	$92.84	$92.84	$92.84
Lower Columbia River	$92.84	$92.84	$92.84

Sources:
Columbia River: Oregon Angler Survey and Economic Study, The Research Group 1991. Price updated to 2016 using USDC BEA GDP implicit price deflator

3.0 Contribution to Regional and Local Economic Impacts

Harvest-related regional economic impacts are generated by three fishery components: 1) economic activity from tribal commercial harvests, 2) economic activity from non-tribal commercial harvests, and 3) economic activity generated by sport fishing. Estimates of regional economic impacts from these activities are expressed in terms of personal income and jobs generated in each of the four subregions in the Columbia River Basin.

3.1 Personal Income

To estimate total (direct, indirect, and induced) personal income generated by estimated commercial and recreational catch under each alternative, personal income impact factors for each species and region were applied to the converted catch (i.e., ex-vessel revenue from commercial landings and numbers of sport trips). Table A-5 shows the regional personal income impact factors (in 2016 dollars) used to convert landings revenue and angler trips for each user group, species, and region to personal income impacts. The sources for the regional income impact factors include the following:

- Source for tribal and nontribal commercial real economic impact (REI) factors: Average of State-level income impact coefficients for Oregon and Washington Columbia River commercial salmon harvests estimated by IO-Pac (See: PFMC 2016 Salmon Review computational file <Tables CH IV Econ Sup.xlsx> tab 'CR_COM_IOPAC').
- Source for sport REI factors: 2016 WA state-level income impact factors for Buoy 10 recreational salmon fishery from PFMC 2016 Salmon Review computational file "Tables CH IV Econ Sup.slsx, tab 'B10_II_IOPAC'". Assumed that private boat income impact factors from Buoy 10 fishery were representative of average contribution from inriver sport trips.

It should be noted that regional income is measured as personal income accruing to households. It measures the contribution to personal income under current (or changed) conditions. Because dynamic changes in the economy over time are not considered in this analysis, results of the assessment are not considered valid for measuring effects on the economy over the long term from changes in fish abundance or policy.

Table A-5. Personal income factors, per ex-vessel dollar of commercially landed salmon and per sport trip (2016 dollars)

	Tribal				Non-tribal		Recreational
REGION	**Coho**	**Chinook**	**Steelhead**	**Sockeye**	**Coho**	**Chinook**	
Columbia River Basin							
Lower Snake River	**na**	**$1.57**	**$1.57**	**$1.57**	**na**	**$1.57**	**$81.62**
Upper Columbia River	**na**	**$1.57**	**$1.57**	**$1.57**	**na**	**$1.57**	**$81.62**
Mid-Columbia River	**na**	**$1.57**	**$1.57**	**$1.57**	**na**	**$1.57**	**$81.62**
Lower Columbia River	**na**	**$1.57**	**$1.57**	**$1.57**	**na**	**$1.57**	**$81.62**

Notes:
na = not applicable

Sources:
Source for tribal and nontribal commercial REI factors: Average of State-level income impact coefficients for Oregon and Washington Columbia River commercial salmon harvests estimated by IO-Pac (See: PFMC 2016 Salmon Review computational file <Tables CH IV Econ Sup.xlsx> tab 'CR_COM_IOPAC')
Source for sport REI factors: 2016 WA state-level income impact factors for Buoy 10 recreational salmon fishery in PFMC 2016 Salmon Review computational file "Tables CH IV Econ Sup.slsx, tab 'B10_II_IOPAC'". Assumed Private boat factors were representative of average income impact factors from inriver sport trips.

3.2 Jobs

Jobs (full- and part-time; direct, indirect, and induced) generated by the commercial and recreational catch in each region under each alternative were estimated by applying an earnings-per-job factor (Table A-6) to the estimated total personal income generated by catch in each subregion described above. The earnings-per-job factors for each region were calculated by using personal income totals for each region that were then divided by the earnings-per-jobs factors to estimate total jobs in each region under each alternative.

Table A-6. Average earnings per Job (2016 dollars).

Columbia River Basin Regions	
Lower Snake River	$29,222
Upper Columbia River	$33,613
Mid-Columbia River	$37,304
Lower Columbia River	$43,979

Notes:
Factors adjusted to $2016 using USDC BEA GDP implicit price deflator

Sources:
Bureau of Economic Analysis. April 2009. Table CA05N Personal Income by Major Source and Earnings by NAICS Industry; and Table CA25N Total Full-Time and Part-Time Employment by NAICS Industry.

Table A-7. Commercial Harvest and Ex-Vessel Value of Landings by Columbia River Basin Subregion under the Project Alternatives: **Upriver Spring Chinook Salmon**

Subregion/ Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt 6 – Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition
Lower Columbia River Subregion											
Tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Non-tribal											
Harvest (number of fish)	4,067	4,067	0	4,067	0	3,894	-173	6,024	1,957	0	-4,067
Ex-vessel harvest value	$354,199	$354,199	$0	$354,199	$0	$339,107	-15,093	$524,641	$170,441	$0	-$354,199
Total											
Harvest (number of fish)	4,067	4,067	0	4,067	0	3,894	-173	6,024	1,957	0	-4,067
Ex-vessel harvest value	$354,199	$354,199	$0	$354,199	$0	$339,107	-$15,093	$524,641	$170,441	$0	-$354,199

Mid-Columbia River Subregion											
Tribal											
Harvest (number of fish)	7,528	7,528	0	7,528	0	6,773	-755	14,928	7,400	0	-7,528
Ex-vessel harvest value	$493,029	$493,029	$0	$493,029	$0	$443,551	-$49,478	$977,652	$484,622	$0	-$493,029
Non-tribal											
Harvest (number of fish)	11	11	0	11	0	10	-1	16	5	0	-11
Ex-vessel harvest value	$965	$965	$0	$965	$0	$912	-$53	$1,411	$446	$0	-$965
Total											
Harvest (number of fish)	7,539	7,539	0	7,539	0	6,783	-756	14,944	7,405	0	-7,539
Ex-vessel harvest value	$493,994	$493,994	0	$493,994	0	$444,463	-$49,531	$979,062	$485,068	$0	-$493,994
TOTAL – ALL SUBREGIONS											
Tribal											
Harvest (number of fish)	7,528	7,528	0	7,528	0	6,773	-755	14,928	7,400	0	-7,528
Ex-vessel harvest value	$493,029	$493,029	$0	$493,029	$0	$443,551	-$49,478	$977,652	$484,622	$0	-$493,029
Non-tribal											

Harvest (number of fish)	4078	4078	0	4078	0	3,904	(174)	6,040	1,962	0	-4078
Ex-vessel harvest value	$355,164	$355,164	$0	$355,164	$0	$340,018	-$15,146	$526,052	$170,887	$0	-$355,164
Total											
Harvest (number of fish)	11,606	11,606	0	11,606	0	10,677	-929	20,968	9,362	0	-11,606
Ex-vessel harvest value	$848,193	$848,193	$0	$848,193	$0	$783,569	-$64,624	$1,503,704	$655,509	$0	-$848,193

Notes: All dollar values are reported in 2015 dollars.
Source: Ex-vessel values derived based on estimates of harvest provided by NMFS and by simulating the Columbia River economic impact spreadsheet model developed by TCW Economics.

Table A-8. Commercial Harvest and Ex-Vessel Value of Landings by Columbia River Basin Subregion under the Project Alternatives: **Upriver Summer Chinook Salmon**

Subregion / Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt 6 – Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition
Lower Columbia River Subregion											
Tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Non-tribal											
Harvest (number of fish)	3356	3356	0	3309	0	2687	-669	3904	548	0	-3356
Ex-vessel harvest value	$141,045	$141,045	$0	$139,076	$0	$112,914	-$28,131	$164,075	$23,031	$0	-$141,045
Total											
Harvest (number of fish)	3,356	3,356	0	3,309	0	2,687	-669	3,904	548	0	-3,356
Ex-vessel harvest value	$141,045	$141,045	$0	$139,076	$0	$112,914	-$28,131	$164,075	$23,031	$0	-$141,045

Mid-Columbia River Subregion											
Tribal											
Harvest (number of fish)	17,569	17,569	0	17,324	-245	14,065	-3,504	20,438	2,869	0	-17,569
Ex-vessel harvest value	$565,958	$565,958	$0	$558,058	-$7,900	$453,080	-$112,878	$658,372	$92,414	$0	-$565,958
Non-tribal											
Harvest (number of fish)	3,866	3,866	0	3,811	0	3,094	-771	4,496	630	0	-3,866
Ex-vessel harvest value	$147,784	$147,784	$0	$145,705	$0	$118,297	-$29,488	$171,897	$24,113	$0	-$147,784
Total											
Harvest (number of fish)	21,435	21,435	0	21,135	17,324	17,159	13,293	24,934	21,068	0	-21,435
Ex-vessel harvest value	$713,742	$713,742	$0	$703,763	-$7,900	$571,377	-$142,365	$830,268	$116,526	$0	-$713,742
Harvest (number of fish)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ex-vessel harvest value	0	0	0	0	0	0	0	0	0	0	0
TOTAL – ALL SUBREGIONS											
Tribal											
Harvest (number of	17569	17569	0	17324	-245	14065	-3504	20438	2869	0	-17569

fish)											
Ex-vessel harvest value	$565,958	$565,958	$0	$558,058	-$7,900	$453,080	-$112,878	$658,372	$92,414	$0	-$565,958
Non-tribal											
Harvest (number of fish)	7222	7222	0	7121	0	5781	-1441	8401	1179	0	-7222
Ex-vessel harvest value	$288,829	$288,829	$0	$284,781	$0	$231,210	-$57,618	$335,972	$47,143	$0	-$288,829
Total											
Harvest (number of fish)	24,791	24,791	0	24,444	-245	19,846	-4,945	28,838	4,048	0	-24,791
Ex-vessel harvest value	$854,787	$854,787	$0	$842,839	-$7,900	$684,291	-$170,496	$994,344	$139,557	$0	-$854,787

Notes: All dollar values are reported in 2015 dollars.
Source: Ex-vessel values derived based on estimates of harvest provided by NMFS and by simulating the Columbia River economic impact spreadsheet model developed by TCW Economics.

Table A9. Commercial Harvest and Ex-Vessel Value of Landings by Columbia River Basin Subregion under the Project Alternatives: **Upriver Fall Chinook Salmon**

Subregion/ Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt 6 – Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition
Lower Columbia River Subregion											
Tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Non-tribal											
Harvest (number of fish)	44,870	44,870	0	44,870	0	40,527	-4342	71,514	26,644	0	-44870
Ex-vessel harvest value	$1,915,825	$1,915,825	$0	$1,915,825	$0	$1,730,413	-$185,412	$3,053,476	$1,137,651	$0	-$1,915,825
Total											
Harvest (number of fish)	44,870	44,870	0	44,870	0	40,527	-4342	71,514	26,644	0	-44870
Ex-vessel harvest value	$1,915,825	$1,915,825	$0	$1,915,825	$0	$1,730,413	-$185,412	$3,053,476	$1,137,651	$0	-$1,915,825

Mid-Columbia River Subregion											
Tribal											
Harvest (number of fish)	187,303	187,303	0	187,303	0	184,203	-3,100	148,242	-39,061	0	-187,303
Ex-vessel harvest value	$6,457,182	$6,457,182	$0	$6,457,182	$0	$6,350,328	-$106,855	$5,110,573	-$1,346,609	$0	-$6,457,182
Non-tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total											
Harvest (number of fish)	187,303	187,303	0	187,303	0	184,203	-3,100	148,242	-39,061	0	-187,303
Ex-vessel harvest value	$6,457,182	$6,457,182	$0	$6,457,182	$0	$6,350,328	-$106,855	$5,110,573	-$1,346,609	$0	-$6,457,182
TOTAL – ALL SUBREGIONS											
Tribal											
Harvest (number of fish)	187303	187303	0	187303	0	184,203	(3,100)	148242	-39061	0	-187303
Ex-vessel harvest value	$6,457,182	$6,457,182	$0	$6,457,182	$0	$6,350,328	-$106,855	$5,110,573	-$1,346,609	$0	-$6,457,182
Non-Tribal											

Harvest (number of fish)	44,870	44,870	0	44,870	0	40,527	-4342	71,514	26,644	0	-44870
Ex-vessel harvest value	$1,915,825	$1,915,825	$0	$1,915,825	$0	$1,730,413	-$185,412	$3,053,476	$1,137,651	$0	-$1,915,825
Total											
Harvest (number of fish)	232,173	232,173	0	232,173	0	224,731	-7,442	219,756	-12,417	0	-232,173
Ex-vessel harvest value	$8,373,007	$8,373,007	$0	$8,373,007	$0	$8,080,741	-$292,266	$8,164,049	-$208,958	$0	-$8,373,007

Notes: All dollar values are reported in 2015 dollars.

Source: Ex-vessel values derived based on estimates of harvest provided by NMFS and by simulating the Columbia River economic impact spreadsheet model developed by TCW Economics.

Table A-10. Commercial Harvest and Ex-Vessel Value of Landings by Columbia River Basin Subregion under the Project Alternatives: **UCR Sockeye Salmon**

Subregion/ Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt 6 – Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition
Lower Columbia River Subregion											
Tribal											
Harvest (number of fish)	0	0	-	0	-	0	-	0	-	0	-
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Non-tribal											
Harvest (number of fish)	512	512	0	611	99	512	0	14170	13658	0	-512
Ex-vessel harvest value	$3,744	$3,744	$0	$4,471	$0	$3,743	-$1	$103,614	$99,871	$0	-$3,744
Total											
Harvest (number of fish)	512	512	0	611	99	512	0	14170	13658	0	-512
Ex-vessel harvest value	$3,744	$3,744	$0	$4,471	$0	$3,743	-$1	$103,614	$99,871	$0	-$3,744

Mid-Columbia River Subregion											
Tribal											
Harvest (number of fish)	16440	16440	0	23071	6631	16531	91	65772	49332	0	-16440
Ex-vessel harvest value	$106,825	$106,825	$0	$149,916	$43,091	$107,417	$592	$427,379	$320,553	$0	-$106,825
Non-tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	0	0	0	0	0	0	0	0	0	0	0
Total											
Harvest (number of fish)	16440	16440	0	23071	6631	16531	91	65772	49332	0	-16440
Ex-vessel harvest value	$106,825	$106,825	$0	$149,916	$43,091	$107,417	$592	$427,379	$320,553	$0	-$106,825
TOTAL – ALL SUBREGIONS											
Tribal											
Harvest (number of fish)	16,440	16,440	0	23,071	6,631	16,531	91	65,772	49,332	0	-16,440
Ex-vessel harvest value	$106,825	$106,825	$0	$149,916	$43,091	$107,417	$592	$427,379	$320,553	$0	-$106,825
Non-tribal											

Harvest (number of fish)	512	512	0	611	99	512	0	14,170	13,658	0	-512
Ex-vessel harvest value	$3,744	$3,744	$0	$4,471	$727	$3,743	-$1	$103,614	$99,871	$0	-$3,744
Total											
Harvest (number of fish)	16,952	16,952	0	23,683	6,730	17,043	91	79,942	62,990	0	-61,310
Ex-vessel harvest value	$110,569	$110,569	$0	$154,386	$43,818	$111,160	$591	$530,993	$420,424	$0	-$110,569

Notes: All dollar values are reported in 2015 dollars.

Source: Ex-vessel values derived based on estimates of harvest provided by NMFS and by simulating the Columbia River economic impact spreadsheet model developed by TCW Economics.

Table A-11. Commercial Harvest and Ex-Vessel Value of Landings by Columbia River Basin Subregion under the Project Alternatives: **SR Steelhead**

Subregion/ Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt 6 – Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition
Lower Columbia River Subregion											
Tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Non-Tribal											
Harvest (number of fish)	235	235	0	235	0	235	0	348	113	0	-235
Ex-vessel harvest value	$3,554	$3,554	$0	$3,554	$0	$3,554	$0	$5,274	$1,720	$0	-$3,554
Total											
Harvest (number of fish)	235	235	0	235	0	235	0	348	113	0	-235
Ex-vessel harvest value	$3,554	$3,554	$0	$3,554	$0	$3,554	$0	$5,274	$1,720	$0	-$3,554
Mid-Columbia River Subregion											
Tribal											

Harvest (number of fish)	8945	8945	0	8945	0	8306	-639	11018	2073	0	-8945
Ex-vessel harvest value	$122,799	$122,799	$0	$122,799	$0	$114,031	-$8,769	$151,257	$28,457	$0	-$122,799
Non-tribal											
Harvest (number of fish)	0	0	0	0	0	0	0	0	0	0	0
Ex-vessel harvest value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total											
Harvest (number of fish)	8,945	8,945	0	8,945	0	8,306	-639	11,018	2,073	0	-8,945
Ex-vessel harvest value	$122,799	$122,799	$0	$122,799	$0	$114,031	-$8,769	$151,257	$28,457	$0	-$122,799
TOTAL – ALL SUBREGIONS											
Tribal											
Harvest (number of fish)	8,945	8,945	0	8,945	0	8,306	-639	11,018	2,073	0	-8,945
Ex-vessel harvest value	$122,799	$122,799	$0	$122,799	$0	$114,031	-$8,769	$151,257	$28,457	$0	-$122,799
Non-tribal											
Harvest (number of fish)	235	235	0	235	0	235	0	348	113	0	-235
Ex-vessel harvest value	$3,554	$3,554	$0	$3,554	$0	$3,554	$0	$5,274	$1,720	$0	-$3,554
Total											

Harvest (number of fish)	9,180	9,180	0	9,180	0	8,541	-639	11,366	2,186	0	-9,180
Ex-vessel harvest value	$126,353	$126,353	$0	$126,353	$0	$117,585	-$8,769	$156,531	$30,177	$0	-$126,353

Notes: All dollar values are reported in 2015 dollars.
Source: Ex-vessel values derived based on estimates of harvest provided by NMFS and by simulating the Columbia River economic impact spreadsheet model developed by TCW Economics.

Table A-12. Impacts of the project alternatives on catch, angler trips and trip-related angler expenditures associated with recreation fishing for all harvest indicator stocks, by Columbia River subregion.

Subregion/ Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt. 6 – Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition	Number	Change from Status Quo Condition
Lower Columbia River Subregion											
Catch	51,554	51,554	0	59,209	0	47,064	-4,490	155,704	104,150	0	-51554
Estimated angler trips	240,167	240,167	0	280,456	40,289	219,551	(20,616)	753,994	513,827	0	(240,167)
Trip-related angler expenditures	$35,708,509	$35,708,509	$0	$39,448,870	$3,740,361	$32,464,451	-$3,244,058	$98,390,721	$62,682,211	$0	-$35,708,509
Mid-Columbia-River Subregion											
Catch	19,812	19,812	0	19,748	0	18,068	-1,744	27,507	7,695	0	-19812
Estimated angler trips	97,414	97,414	0	97,076	(338)	88,899	(8,514)	134,950	37,537	0	(97,414)
Trip-related angler expenditures	$9,317,305	$9,317,305	$0	$9,285,932	-$31,372	$8,234,110	-$1,083,195	$12,779,061	$3,461,756	$0	-$9,317,305
Lower Snake River Subregion											
Catch	900	900	0	900	0	862	-38	1333	433	0	-900
Estimated angler trips	4,737	4,737	0	4,737	0	4,535	(202)	7,016	2,280	0	(4,737)
Trip-related angler	$439,758	$439,758	$0	$439,758	$0	$421,033	-$18,725	$651,391	$211,633	$0	-$439,758

expenditures											
TOTAL (all subregions)											
Catch	71,366	71,366	0	78,957	0	65,132	-6,234	183,211	111,845	0	-71,366
Estimated angler trips	342,318	342,318	-	382,269	39,951	312,986	(29,332)	895,961	553,643	-	(342,318)
Trip-related angler expenditures	$45,465,572	$45,465,572	$0	$49,174,560	$3,708,988	$41,119,593	-$4,345,979	$111,821,173	$66,355,600	$0	-$45,465,572

Notes: All dollar values are reported in 2016 dollars.

Source: Derived based on harvest estimates provided by NMFS and by simulating the Columbia River basin economic impact spreadsheet model developed by TCW Economics.

Table A-13. - Contribution of commercial and recreational salmon and steelhead fishing for harvest indicator stocks to personal income and jobs in the Columbia River basin, by subregion.

Subregion/ Type of Fishery	Status Quo	Alt. 1- Extension		Alt. 2 – Abundance-based		Alt. 3 – Fixed Rate		Alt. 4 / Alt. 6– Escapement-based / Uncoordinated fishing		Alt. 5 – Fishing curtailment	
	Number	Number	Change from Existing Conditions	Number	Change from Existing Conditions	Number	Change from Existing Conditions	Number	Change from Existing Conditions	Number	Change from Existing Conditions
Lower Columbia River Subregion											
Commercial Fisheries											
Personal Income ($,000)	$3,799	$3,799	-	$3,797	-$2	$3,439	-$359	$6,049	+$2,250	$0	-$3,799
Jobs	86	86	-	86	0	78	-8	138	+51	0	-86
Recreational Fisheries											
Personal Income ($,000)	$19,602	$19,602	-	$22,891	+$3,288	$17,920	-$1,683	$61,541	+$41,939	$0	-$19,602
Jobs	446	446	-	520	+75	407	-38	1,399	+954	0	-446
Mid-Columbia River Subregion											
Commercial Fisheries											
Personal Income ($,000)	$12,400	$12,400	-	$12,452	+$52	$11,918	-$482	$11,778	-$622	$0	-$12,400
Jobs	332	332	-	334	+1	319	-13	316	-17	0	-332
Recreational Fisheries											
Personal Income ($,000)	$7,951	$7,951	-	$7,923	-$28	$7,256	-$695	$11,015	+$3,064	$0	-$7,951
Jobs	213	213	-	212	-1	195	-19	295	+82	0	-213

Lower Snake River Subregion											
Commercial Fisheries											
Personal Income ($,000)	$0	$0	-	$0	-	$0	-	$0	-	$0	-
Jobs	0	0	-	0	-	0	-	0	-	0	-
Recreational Fisheries											
Personal Income ($,000)	$387	$387	-	$387	-	$370	-$16	$573	+$186	$0	-$387
Jobs	13	13	-	13	-	13	-1	20	+6	0	-13
Total (all Columbia River subregions)											
Commercial Fisheries											
Personal Income ($,000)	$16,199	$16,199	-	$16,249	+$50	$15,358	-$841	$17,827	+$1,628	$0	-$16,199
Jobs	419	4190	-	420	+1	398	-21	453	+34	0	-419
Recreational Fisheries											
Personal Income ($,000)	$27,940	$27,940	-	$31,201	+$3,261	$25,546	-$2,394	$73,128	+$45,188	$0	-$27,940
Jobs	672	672	-	746	+74	615	-57	1,714	+1,042	0	-672

Notes: All dollar values are reported in 2015 dollars.

Source: Derived based on estimates of sport fishing effort provided by NMFS and by simulating the Puget Sound economic impact spreadsheet model developed by TCW Economics.

Source: Derived by TCW Economics using estimates of commercial salmon harvest (Table 4.5-2) provided by NMFS and sport fishing trips (Table 4.5-3) estimated by TCW Economics based on catch estimates provided by NMFS, and simulation of the economic impact model.

4.0 References

Minnesota IMPLAN Group, Inc. 2008. IMPLAN Professional model software (version 2.0.1025) and 2007 IMPLAN data file for Washington. Stillwater, MN.

APPENDIX B

US v. OREGON AGREEMENT EIS

Economics Methods Appendix

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June 2017

U.S. v Oregon Management Agreement Hatchery Production Review

Comparison of the programs, as analyzed in the Mitchell Act EIS.

This review has determined that the Mitchell Act EIS contains an analysis of 113 of the 115[6] programs referenced in the agreement and that, for the majority of these programs, the production levels that are referenced in the agreement tables (B1-B7), are contained at or within the individual hatchery program production levels analyzed in the Mitchell Act EIS, and therefore will result in substantially similar impacts to the environment, particularly to threatened or endangered salmon and steelhead. Additionally, the overall production level in the agreement, by species and run-timing, is also well represented in the Mitchell Act EIS analysis. Table 1 shows the overall hatchery production level and program number, referenced in the agreement compared to the levels analyzed in the Mitchell Act EIS.

Table 1. Comparison of Hatchery Program Production Referenced in the *US v Oregon* Management Agreement Compared to the Hatchery Production Analyzed in the Mitchell Act EIS (NMFS 2014)

Hatchery Species	**Total Proposed *US v Oregon* Releases**	**Mitchell Act EIS Releases (range across alternatives)**	**Percent of *US v Oregon* Production Analyzed in Mitchell Act EIS**
Spring Chinook salmon	19,236,461	14,741,000 to 20,936,000	77% - 109%
Summer Chinook salmon	5,996,569	5,465,000 to 7,517,000	91% - 125%
Fall Chinook salmon	42,176,000	4,359,000 to 42,680,000	10% - 101%
Sockeye salmon	1,000,000	500,000	50%
Steelhead	6,783,300	6,085,000 to 8,167,000	90% - 120%
coho salmon	8,550,000	2,508,000 to 8,400,000	29%-98%

[6] This total (115) considers programs that release juvenile salmon or steelhead, as referenced in Tables B1-B7 of the agreement; the Snake River Fall Chinook salmon program (agreement Table B4) is counted as one program, as analyzed in the MA EIS.

Total	**83,742,330**	**33,658,000 to 88,200,000**	**40% - 105%**

	Proposed # *US v Oregon* programs	**MA EIS Analyzed # Programs**	**% of *US v Oregon* programs analyzed in Mitchell Act**
Spring Chinook salmon	39	39	100%
Summer Chinook salmon	14	13	92%
Fall Chinook salmon	16	15	93%
Sockeye salmon	1	1	100%
Steelhead	32	32	100%
coho salmon	13	12	92%
Total	**115**	**112**	**97%**

Even though for most species, production levels, and program numbers identified in Table 1, the MA EIS analysis provides a thorough analysis the effects of the production levels referenced in the agreement, there are several individual programs where the program production size in the agreement is different than either, the specific level or range of production analyzed in the Mitchell Act EIS. Of the 115 hatchery programs that are referenced in the *US v Oregon* Management Agreement tables, 2 programs are newly added, and therefore were not considered in the MA EIS analysis, and 42 of the programs have production levels, individually, that are either less than or greater than levels analyzed in the Mitchell Act EIS, and by species the overall changes in the *US v Oregon* proposal for hatchery releases is small.

Types of Hatchery Program Referenced in the *US v Oregon* Agreement

The Production tables (B1-B7) of the agreement contain hatchery programs organized by species and run-timing. Each of the tables identified the individual hatchery program release, location, hatchery facilities related to the program, and identify a primary program purpose. These purposes are: Supplementation, Fishery, or Supplementation/Fishery.

As described in the Mitchell Act EIS, *Section 2.3.2, Purpose of Hatchery Programs*, the NMFS categorized hatchery programs, by purpose, in three categories: Conservation, Harvest, or Both. These describe, generally, the purpose of the individual programs, relative to the intent for the returning adult salmon or steelhead. An artificial production program that produces fish primarily or exclusively for conservation rather than for harvest is a conservation program, while harvest programs produce fish exclusively for harvest augmentation. The third category are programs which are managed to generate both a harvest benefit and a benefit to the local natural-origin population of salmon or steelhead; these are categorized as “both” in the Mitchell Act EIS.

The U.S. v. Oregon management agreement uses different terminology to describe these same program goals. Therefore, for the purposes of this review, NMFS has classified programs identified as “Supplementation” in the agreement as “Conservation”. For programs classified as “Fishery” in the agreement, NMFS has identified them as “Harvest”. For programs classified as “Supplementation/Fishery” in the agreement, NMFS has identified them as “Both”. This aligns the program’s purpose, as described in the agreement tables, with the categories used in the Mitchell Act EIS analysis.

Comparison of Agreement-referenced programs and the Same Programs in the Mitchell Act EIS

Of the programs within the *US v Oregon* Agreement which have production levels that vary from the level (larger or smaller) analyzed in the Mitchell Act EIS (44), 48% (21) of them are conservation programs. Additionally, 11 of the programs (25%) are in the “both” category and have a conservation objective as part of their intended benefit, as well as harvest. Lastly, there are 12 programs (27%) that have harvest as the objective for the program.

Of the 21 conservation programs identified above: 1 program is new, and 1 program has changed release location; 10 programs propose to release fewer hatchery fish and 11 programs (including the new and changed release location programs) propose to release more hatchery fish than the same programs, as analyzed, in the Mitchell Act EIS. Of the 11 programs identified in the both category, above, 3 programs propose to release fewer hatchery fish and 8 propose to release more hatchery fish than the same programs, as analyzed, in the Mitchell Act EIS. The 12 harvest programs, identified above, all were analyzed in the Mitchell Act EIS. Of these, 5 propose to release fewer hatchery fish and 7 hatchery programs propose to release more hatchery fish than the same programs, as analyzed, in the Mitchell Act

EIS.

Review of the Effects of Hatchery programs on Populations of Salmon and Steelhead

As described in detail in Section *3.2.3.1, General Risks and Benefits of Hatchery programs to Salmon and Steelhead Species*, in the Mitchell Act EIS, hatchery salmon and steelhead programs can have beneficial effects to these species but also pose risks.

Effects to population Viability

McElhany et al. (2000) developed the viable salmonid population (VSP) concept as a means to evaluate the conservation status of Pacific salmon and steelhead. A key part of this approach was the identification of four measurable indicators of population health that should be considered in performing conservation status assessments. These indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins).

Hatchery programs can provide benefits to some of these VSP indicators under certain circumstances, but can pose risks to VSP as well.

Effects on Abundance and Productivity

As described in detail in *Section 3.2.3.1.1.1*, of the Mitchell Act EIS, a primary benefit conferred by hatchery programs is an increase in the total abundance of a salmon population that returns to spawn naturally. Freshwater, habitat-related factors limiting the survival and productivity of a natural-origin population can be circumvented by spawning, incubating, rearing, and releasing fish from the population in a hatchery facility. In the situation where the hatchery stock is the same genetic population as the natural-origin population, the hatchery may also act as a protection for the population against catastrophic environmental conditions (e.g., Grande Ronde spring Chinook captive broodstock and Snake River sockeye hatchery programs). Productivity may also be increased if hatchery-origin fish improve conditions of spawning gravel or add nutrients to the system.

Hatchery programs may also pose risks to abundance and productivity because they can lead to additional mortality of natural-origin fish through competition, predation, disease, and fisheries. They may also unfavorably alter the genetic character of the natural-origin population (discussed below), or restrict the distribution of a population across its habitat. Abundance and productivity would be the most directly affected by any increased mortality on natural-origin fish. Substantial increases in mortality would be readily observable as a reduction in the abundance of natural-origin fish. Increased mortality would also result in a less efficient reproductive conversion of spawning adults to surviving offspring, which would be detectable as a reduction in productivity. A reduction in productivity would be measured as the ratio of surviving offspring (adults) per parents.

Effects on Genetic Diversity

Salmon and steelhead often differ genetically from population to population because of their strong tendency to return to spawn in their home stream. This behavior allows the forces of natural selection, mutation, and random genetic drift to operate in relative isolation in different streams or subbasins, resulting in genetic differences. In many instances, these differences are adaptive, allowing a local population to have a greater ability to survive and persist in that environment than would another population (Taylor 1991; McElhany et al. 2000).

While hatchery programs can help to conserve salmon and steelhead popu1ations, particularly those at very low abundance and in danger of extirpation (e.g., Snake River sockeye salmon captive brood program, Tucannon River spring Chinook salmon captive brood program, and the White River [Wenatchee] spring Chinook salmon captive brood program), hatchery programs can also pose genetic risks to salmon and steelhead populations. Populations of fish, adapted to the hatchery environment, that interbreed with natural-origin populations can result in substantial genetic changes (a diversity indicator) that are maladaptive for natural-origin fish in the natural environment. In addition to affecting population diversity, such changes would likely adversely impact the reproductive efficiency of natural-origin populations, lowering productivity. These effects would be most pronounced when highly domesticated and/or non-native hatchery-origin fish from isolated hatchery programs interbreed with natural-origin fish at excessive levels. However, even optimally managed, integrated hatchery programs using native fish can be expected to result in some risks to genetic diversity.

Effects on Spatial Structure

Hatchery programs can benefit the spatial structure of salmon and steelhead populations. The potential for a hatchery program to increase total adult returns to a particular river basin (see Effects on Abundance and Productivity, above) can expand the spatial distribution of spawning by forcing fish to inhabit less competitive reaches of the basin. Programs that spatially distribute juvenile releases throughout a particular river basin can increase the distribution of the returning hatchery-origin adults. Additionally, hatchery programs can be used to expand the area of a basin that is used for natural spawning, i.e., by transporting or passing hatchery-origin adults above a dam or other impassable barrier.

Hatchery programs can also pose risks to spatial structure through a number of actions. These include the operation of weirs that can impede upstream migration of returning adults or the construction of migration barriers to prevent the entry of spawners into portions of the watershed to ensure that the hatchery facility's water supply is less prone to carrying disease.

Other Effects from Hatchery Programs

Ecological Effects

Although competition and predation are identified as individual risks, they are related to each other and, as a consequence, are frequently lumped together and described in the scientific literature as "ecological" effects. Competition is an interaction among members of the same species or different species utilizing a limited resource (e.g., food or space). Competition typically results in winners and losers. Competition between hatchery-origin and natural-origin fish may result from direct interactions, in which hatchery-origin fish interfere with access to limited resources by natural-origin fish, or indirect interactions, as when utilization of a limited resource by hatchery-origin fish reduces the amount available for natural-origin fish (Species Interaction Work Group [SIWG] 1984). Specific types of competition include competition for food, for territory among stream-rearing juveniles, for mates, and for spawning sites.

For adult salmon and steelhead, effects from competition between hatchery-origin and natural-origin fish are assumed greatest in the spawning areas where competition for mates and spawning habitat occurs (U.S. Fish and Wildlife Service [USFWS] 1994). Hatchery-origin females compete with natural-origin females for spawning sites, and hatchery-origin males compete with natural-origin males for female mates. Although there is evidence that natural-origin fish have a competitive advantage over hatchery-origin fish in these situations (Fleming and Gross 1993; Berejikian et al. 1997) where spawning area is limited and abundances are high relative to available space, competition would likely be high. This circumstance could also result in superimposition (overlaying) of redds.

Juvenile hatchery-origin fish released into the natural environment may compete with natural-origin fish for resources as they migrate downstream. Steelhead, coho salmon, and spring Chinook salmon typically will migrate downstream rapidly once they make a complete physiological transition to the smolt life history stage. Therefore, the hatchery programs posing the least risk from competition are those that consistently produce full-term, rapidly migrating smolts that use river corridors as a “highway” to the ocean with minimal foraging and competition with natural-origin fish along the way. This ideal is difficult to achieve. Not all individuals in a population undergo the smolt transformation at the same time. Evidence suggests that smoltification timing can vary by 45 or more days within a single population (Quinn 2005). Most hatchery programs, however, release fish over a shorter period (e.g., 2 weeks). Such releases will include fish that have not yet smolted, as well as fish for which the peak smolt condition has passed. Juveniles released too early or too late with respect to smoltification are likely to migrate slowly, if at all. Because of their prolonged period in freshwater, such fish have a much greater opportunity to compete with natural-origin fish for food and space. Competition heightens if hatchery-origin fish are more numerous and are of equal or greater size. Although non-migratory, hatchery-origin juveniles (residuals) may eventually die, there will be a period when there may be significant competition with natural-origin fish.

Migrant juvenile chum salmon and fall Chinook salmon spend an extended period in the estuarine environment feeding and growing before they move into marine waters (Quinn 2005). Hatchery programs that release sub-yearling juveniles thus are more likely to create a competitive environment for natural-origin fall Chinook salmon and chum salmon. This situation may be particularly acute in the Columbia River, where the estuary has suffered a major loss of shallow water rearing habitat in the past century (Bottom et al. 2005). These habitat losses are likely to have reduced the capacity of these areas to support juvenile salmon, therefore exacerbating competition between hatchery-origin and natural-origin fish for the remaining habitat.

Competition may also occur within stream habitats when young, pre-migratory fish are released, regardless of the species involved. Release of large numbers of fry or pre-smolts in a small area has great potential for competitive effects because interactions can occur for long periods, up to 3 years in the case of steelhead. The potential effect of competition on the behavior, and hence survival, of natural-origin fish depends on the degree of spatial and temporal overlap, relative sizes, and relative abundance of the two groups (Steward and Bjornn 1990). Effects would also depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

In addition to the freshwater and estuarine environments, competition between hatchery-origin and natural-origin fish may extend into the marine environment. Evidence exists for density-dependent ocean survival affecting pink and chum salmon hatchery programs in Alaska, Russia, and Japan (Pearcy 1992). However, it is unclear whether density-dependent survival is a factor for coho salmon, steelhead, and Chinook salmon.

Hatchery Facility Effects

Potential risks to natural populations of salmon and steelhead from the operation of hatchery facilities include: hatchery facility failure (power or water loss leading to catastrophic fish losses); hatchery facility water intake effects (stream dewatering and fish entrainment); hatchery passage effects (blocking upstream or downstream fish passage); and hatchery facility effluent discharge effects (deterioration of downstream water quality).

Risk of hatchery facility failure is of particular concern when facilities rear species listed under ESA. Factors such as water supply flow reductions or failure, flooding, and poor facility conditions may cause hatchery facility failure or the catastrophic loss of fish under propagation.

Hatchery Facility Water Intake Effects. Water withdrawals for hatcheries within spawning and rearing areas can diminish streamflow, impeding migration and affecting the spawning behavior of salmon and steelhead. In addition, that portion of a hatchery facility’s water supply that comes from a water source containing natural-origin fish must have an intake structure with adequate screening such that injury and mortality, whether from impingement or permanent removal, is very low or avoided altogether.

Hatchery facilities can have many types of in-stream structures, depending on the location and type of facility. Most commonly, hatchery in-stream structures are for water supply intakes. These structures, typically are used to increase the available water volume for the facility by either utilizing a small dam to back water up and increase depth and pressure for non-pump facility intakes, or increase the depth for pump facility intakes. These facilities typically require a structure across the entire width of the stream or a portion of the stream depending on the site-specific requirements. These structures can affect access to usable habitat above the hatchery facility. These structures can also affect the downstream migration of fish in the stream, water volumes and flow are significantly affected by the structure or if the structure did not consider downstream migration in the original design.

Effluent discharges can change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra 1991). Little information and data exist to show how a hatchery facility's effluent affects salmon and steelhead and other stream dwelling organisms. Generally, the level of impact depends on the amount of discharge and the flow volume of the receiving stream. Any effects probably occur at the immediate point of discharge, because the effluent would dilute rapidly as it moves downstream. The Clean Water Act (CWA) requires hatcheries (i.e., aquatic animal production facilities) with annual production greater than 20,000 pounds to obtain a National Pollutant Discharge Elimination System (NPDES) permit to discharge effluent to surface waters. Currently the states of Washington and Oregon implement NPDES permit systems. The U.S. Environmental Protection Agency (EPA) currently administers hatchery effluent permitting for the state of Idaho (Section 1.7.8, Clean Water Act). These permits are intended to protect aquatic life and public health and to ensure that every facility treats its wastewater. The effects from the releases are analyzed prior to the issuance of the permit, and site-specific discharge limits are set. Additionally, monitoring and reporting requirements for the permits are subject to enforcement actions (EPA 2006).

Potential Differences in Effect-level of the U.S. v OR Agreement-Referenced Hatchery Production

After a thorough review, NMFS has identified the following additional effects to salmon and steelhead to disclose, beyond those discussed in the Mitchell Act EIS, which would be likely to result from the hatchery production programs referenced in the agreement tables B1-B7. A brief overview of those impacts is below, but for detailed program-specific disclosures of impacts please refer to the details in Table 2.

Conservation Programs

For conservation programs where the production level has been decreased, relative to the programs in the Mitchell Act EIS (10 programs), the potential changes in impact to affected natural populations of salmon and steelhead would be: reductions to the abundance benefit of the conservation programs; higher benefits to the population's productivity; reduced risks to population genetic diversity; and a likely lower benefit to the population's special structure.

For conservation programs where the production level has been increased, relative to the programs in the Mitchell Act EIS (11 programs), the potential changes in impact to affected natural populations of salmon and steelhead would be: increases to the abundance benefit of the conservation programs; lower benefits to the population's productivity; increased risks to population genetic diversity; and a likely greater benefit to the population's special structure.

Programs Identified as having "Both" purposes

For programs identified as having both conservation and harvest goals, and where the production level has been decreased, relative to the programs in the Mitchell Act EIS (3 programs), the potential changes in impact to affected natural populations of salmon and steelhead would be: lower benefits to population abundance; higher benefits to population productivity; lower risks to population genetic diversity; and lower benefit to population special structure.

For conservation programs where the production level has been increased, relative to the programs in the Mitchell Act EIS (8 programs), the potential changes in impact to affected natural populations of salmon and steelhead would be: higher benefits to population abundance; higher risks to population productivity; higher risks to population genetic diversity; and higher benefit to population special structure.

Harvest Programs

For programs identified as having harvest-only goals, and where the production level has been decreased, relative to the programs in the Mitchell Act EIS (5 programs), the potential changes in impact to affected natural populations of salmon and steelhead would be: lower risks to population abundance; lower risks to the population's productivity; lower risks to population genetic diversity; and lower risks to population special structure.

For programs identified as having harvest-only goals, and where the production level has been increased, relative to the programs in the Mitchell Act EIS (7 program), the potential changes in impact to affected natural populations of salmon and steelhead would be: higher risks to population abundance; higher risks to population productivity; higher risks to population genetic diversity; and higher risks to population special structure.

All programs with different production levels

For these programs, regardless of the goal of the program, the operation of hatchery facilities presents potential risks to salmon and steelhead populations residing in the streams where the facilities are located. For these programs, regardless of the goal of the program, the operation of hatchery facilities presents potential risks to salmon and steelhead populations residing in the streams where the facilities are located. In reviewing the differences in production levels between the agreement-referenced programs and those analyzed in the Mitchell Act EIS, NMFS considered the increases in production, for some programs, and the decreases in production, for some programs, represented by the programs in the *US v Oregon* agreement, relative to the programs, as analyzed, in the Mitchell Act EIS. The small scale of these changes, in numbers of fish, and the relationship of that change to the total production at the facilities used makes it difficult to estimate the likely change in facility effects to water quality from these production differences. Additionally, considering that the facilities operating in the Columbia River basin, including the facilities associated with the production in the *US v Oregon* agreement, operate under existing federal Clean Water Act (CWA), National Pollution Discharge Elimination System (NPDES) permits (when required), NMFS concludes that the differences in the hatchery program releases, included in the *US v Oregon* Agreement, relative to the programs analyzed in the Mitchell Act EIS, are not likely to have substantively different effects to the water quality where they operate.

For these programs, regardless of the goal of the program, the release of hatchery fish into the waters where natural salmon and steelhead populations reside presents risks from ecological effects. As described above, these ecological risks can negatively impact these population through competition for space and resources and through direct and indirect predation. Here NMFS assessment utilizes a more direct relationship between the size of the program and the potential for impact through ecological interaction, with increases in production resulting in higher potential ecological risks and lower production resulting in lower ecological risks, relative to the analysis in the Mitchell Act EIS, see Table 2.

References:

Berejikian, B. A., E. P. Tezek, S. L. Schroder, C. M. Knudson, and J. J. Hard. 1997. Reproductive behavioral interactions between spawning and wild and captivity reared coho salmon (*Oncorhynchus kisutch*). International Council for the Exploration of the Sea Journal of Marine Science. Volume 54, pages 1,040 to 1,049.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Bapista, D. A. Jay, K. K. Jones, E. Casillas, and M. H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-68, 246 pages.

Fleming, I. A. and M. R. Gross. 1993. Breeding success of hatchery and wild coho salmon (*Oncorhynchus kisutch*) in competition. Ecological Applications. Volume 3(2), pages 230 to 245.

Kendra, W. 1991. Quality of salmonid hatchery effluents during a summer low-flow season. Transactions of the American Fisheries Society. Volume 120, pages 43 to 51.

McElhaney, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-42, 156 pages.

National Marine Fisheries Service (NMFS). 2014. Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs. 2120 p.

Pearcy, W. G. 1992. Ocean ecology of north Pacific salmonids. Washington Sea Grant Program. University of Washington Press, Seattle, WA. 179 pages.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle, WA. 363 pages.

Species Interaction Work Group (SIWG). 1984. Evaluation of potential interaction effects in the planning and selection of salmonid enhancement projects. J. Rensel, chairman, and K. Fresh editor. Report prepared for the Enhancement Planning Team for Implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. WDFW. Olympia, WA. 80 pages.

Steward, C. R. and T. C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish: a synthesis of published literature. In Miller, W.H., editor. Analysis of salmon and steelhead supplementation. Report to Bonneville Power Administration (BPA), Portland, OR. Project No. 88-100. 126 pages

Taylor, E. B. 1991. Behavioral interaction and habitat use in juvenile Chinook, Oncorhynchus tshawytscha, and coho, O. kisutch, salmon. Animal Behavior. Volume 42, pages 729 to 744.

U.S. Environmental Protection Agency (EPA). 2006. Compliance Guide for the Concentrated Aquatic Animal Production Point Source Category. Engineering and Analysis Division Office of Science and Technology. EPA-821-B-05-001. 292 pages. Available at http://water.epa.gov/scitech/wastetech/guide/aquaculture/upload/2006_05_03_guide_aquaculture_guidance_full-final.pdf.

U.S. Fish and Wildlife Service (USFWS). 1994. Biological assessment for operation of USFWS operated or funded hatcheries in the Columbia River basin in 1995-1998. Submitted to NMFS under cover

letter dated August 2, 1994, from William F. Shake, Acting Regional Director to Brian Brown, NMFS.

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Table 2. Program-specific Review of Potential Differences in Impact Level, Relative to the same Program Analyzed in the Mitchell Act EIS (alternate shading for ESU/DPS affected).

Species/Run	**Program Location** (MA EIS subbasin)	**Proposed Hatchery Program release site** (*US v Oregon* Production Tables B1-B7)	**Program Type**	**Affected Salmon/ Steelhead ESU/DPS**	**ESA Listing Status of Potentially affected Pop**	**Hatchery Program Production Referenced in *US v Oregon* Production Tables B1-B7**	**Program Size or Range Analyzed in the Mitchell Act EIS**	**Difference in *US v Oregon* Hatchery program size[1]**	**Potential Impacts of *US v Oregon* Production to Natural Salmon and Steelhead Populations, Relative to the program size analyzed in the MA EIS)**					
									Effects to Salmon and Steelhead population (VSP)				**Ecological Effects - Target population and other salmonids**	**Facility Effects**
									Abundance	Productivity	Diversity	Spatial Structure		
Spring Chinook (Agreement Table B1)	Methow	Twisp River Acc. Site	Conservation	UCR Spring Chinook	Endangered	29,123	77,000-101,000	-71%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Wenatchee	Chiwawa R. Acc. Site	Conservation	UCR Spring Chinook	Endangered	144,026	249,000-672,000	-96%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Wenatchee	Nason Creek	Conservation	UCR Spring Chinook	Endangered	223,670	250,000	-11%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Clearwater	Meadow Creek (Selway)	Conservation	Snake River spring/Summer Chinook	Not listed in Clearwater River	400,000	430,000	-7%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Clearwater	Clear Cr.	Harvest	Snake River spring/Summer Chinook	Not listed in Clearwater River	635,000	701,000	-9%	lower risk	lower risk	lower risk	lower risk	lower risk	no difference
	Salmon	On Station (Rapid River)	Harvest	Snake River spring/Summer Chinook	Threatened	2,500,000	2,600,000	15%	higher risk	higher risk	higher risk	higher risk	higher risk	no difference

Spring Chinook (Agreement Table B1) Cont.	Salmon	Little Salmon River	Harvest	Snake River spring/Summer Chinook	Threatened	150,000	included in above							
	Snake	Hells Canyon –Snake R.	Harvest	Snake River spring/Summer Chinook	Threatened	350,000	included in above							
	Clearwater	Clearwater River/NPTH	Both	Snake River spring/Summer Chinook	Not listed in Clearwater River	200,000	125,000	60%	higher benefit	higher risk	higher risk	higher benefit	higher risk	no difference
	Clearwater	On Station (Dworshak)	Harvest	Snake River spring/Summer Chinook	Not listed in Clearwater River	1,050,000	1,000,000	5%	no difference	no difference	no difference	no difference	higher risk	no difference
	Deschutes	On Station (Round Butte)	Harvest	Mid-C Spring Chinook	Not listed	380,000	240,000	58%	higher risk	higher risk	higher risk	higher risk	higher risk	higher risk
	Hood	Hood River (Round Butte/Parkdale)	Both	LCR Chinook	Threatened	250,000	75,000-85,000	194%	higher benefit	higher risk	higher risk	higher benefit	higher risk	no difference
Summer Chinook (Agreement Table B2)	UCR mainstem	Chelan River	Harvest	UCR Summer/Fall Chinook	Not listed	400,000	600,000	-4%	no difference	no difference	no difference	no difference	Lower risk	no difference
	UCR mainstem	Chelan River	Harvest	UCR Summer/Fall Chinook	Not listed	176,000	included in above							
	Wenatchee	Dryden Ponds	Both	UCR Summer/Fall Chinook	Not listed	500,000	863,000	-42%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference

Summer Chinook (Agreement Table B2) Cont.	Methow	Carlton Rearing Pond	Both	UCR Summer/Fall Chinook	Not listed	200,000	400,000	-50%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Okanogan	Okanogan/ Similkameen Rivers	Both	UCR Summer/Fall Chinook	Not listed	166,569	576,000-1,450,000	-89%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	UCR mainstem	Wells or other locations	Research	UCR Summer/Fall Chinook	Not listed	200,000	399,000	-50%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Yakima	Yakima Basin (Prosser/Marion Drain)	Both	UCR Summer/Fall Chinook	Not listed	1,000,000	500,000	100%	higher benefit	higher risk	higher risk	higher benefit	higher risk	no difference
	Salmon	Johnson Creek	Conservation	Snake River spring/Summer Chinook	Threatened	150,000	100,000	50%	higher benefit	lower benefit	higher risk	higher benefit	higher risk	no difference
	Salmon	Curtis Cr/Cabin Cr	Conservation	Snake River spring/Summer Chinook	Threatened	300,000 (eyed eggs)	New Program[2]		benefit	benefit	risk	benefit	risk	N/A
Sockeye (Agreement Table B3)	Salmon	Stanley Basin	Conservation	Snake River Sockeye	Endangered	1,000,000	500,000	100%	higher benefit	lower benefit	higher risk	higher	higher risk	no difference
	Umatilla River	Umatilla	Both	Reintroduction	Not listed	600,000	included in below	39%	higher benefit	higher risk	higher risk	higher benefit	higher risk	no difference

Fall Chinook (Agreement Table B5)	Umatilla River (Pendleton Acclimation Site)	Umatilla	Both	Reintroduction	Not listed	780,000	999,000-1,080,000								
	Umatilla River	Umatilla	Both	Reintroduction	Not listed	120,000	included in above								
Steelhead (Agreement Table B6)	Twisp River Various locations	Methow	Conservation	UCR Steelhead	Threatened	48,000	50,000	-4%	no difference	no difference	no difference	no difference	lower risk	no difference
	Cottonwood Pond, Grande Ronde River	Grande Ronde	Harvest	Snake River Steelhead	Threatened	225,000	160,000-200,000	13%	higher risk	high risk	higher risk	higher risk	higher risk	no difference
Steelhead (Agreement Table B6) Cont.	Lower South Fork Clearwater – Red House Hole	Clearwater	Harvest	Snake River Steelhead	Threatened	400,000	1,050,000	-41%	lower risk	lower risk	lower risk	lower risk	lower risk	no difference
	Lower South Fork Clearwater – Red House Hole	Clearwater	Harvest	Snake River Steelhead	Threatened	220,000	Included in above							
	Lower SF Clearwater	Clearwater	Both	Snake River Steelhead	Threatened	290,000	1,050,000	-41%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference

	Meadow Cr., SF Clearwater	Clearwater	Conservation	Snake River Steelhead	Threatened	210,000	included in above							
	Newsome Ck SF Clearwater	Clearwater	Conservation	Snake River Steelhead	Threatened	123,000	included in above							
	Lolo Creek, MF Clearwater	Clearwater	Conservation	Snake River Steelhead	Threatened	200,000	60,000	233%	higher benefit	lower benefit	higher risk	higher benefit	higher risk	no difference
	East Fork Salmon	Salmon	Both	Snake River Steelhead	Threatened	<=200,000	135,000-171,000	17%	higher benefit	higher risk	higher risk	higher benefit	higher risk	no difference
Steelhead (Agreement Table B6) Cont.	Upper Salmon Tribs.	Salmon	Conservation	Snake River Steelhead	Threatened	1,000,000	1,200,000	-17%	lower benefit	higher benefit	lower risk	lower benefit	lower risk	no difference
	Yankee Fork	Salmon	Both	Snake River Steelhead	Threatened	440,000	118,000-363,000K	21%	higher benefit	higher risk	higher risk	higher benefit	higher risk	higher risk
	Touchet River	Walla Walla	Harvest	Mid-C Steelhead	Threatened	100,000	84,000	19%	higher risk	higher risk	higher risk	higher risk	higher risk	no difference
	Icicle Creek (at the NFH)	Wenatchee	Conservation	Reintroduction	Not listed	500,000	included in below							
Coho (Agreement Table B7)	Nason Creek	Wenatchee	Conservation	Reintroduction	Not listed	400,000	808,000-1,000,000							
	Beaver Creek	Wenatchee	Conservation	Reintroduction	Not listed	100,000	included in above	80%	higher benefit	lower benefit	higher risk	higher benefit	higher risk	no difference
	Methow Tributaries	Methow	Conservation	Reintroduction	Not listed	800,000	included in above							

	Clear Cr., Lapwai Cr., Nez Perce Tribal Hatchery	Clearwater	Conservation	Reintroduction	Not listed	550,000	830,000	27%	higher benefit	lower benefit	higher risk	higher benefit	higher risk	no difference
	Clear Creek	Clearwater	Conservation	Reintroduction	Not listed	500,000	included in above total							
	Grande Ronde/ Lostine River	Grande Ronde	Conservation	Reintroduction	Not listed	500,000	New Release Location [3]		benefit	benefit	risk	benefit	risk	N/A

[1] The difference in hatchery program size is based on agreement production size relative to the Mitchell Act EIS analyzed specific size or the high end of the production range, represented.

[2] The Curtis Creek/Cabin Creek program is an eyed-egg, egg box program to supplement natural, juvenile summer Chinook salmon production.

[3] The coho salmon released into the Lostine River, for reintroduction purposes, were formerly released into the Umatilla River.