Draft Columbia River System Operations Environmental Impact Statement

Appendix P
Tribal Perspectives

Note: The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The Agency has made every effort to ensure that the information in Appendix P: Tribal Perspectives is accessible. However, if readers have any issues accessing the information in this appendix, please contact the U.S. Army Corps of Engineers at (800) 290-5033 or info@crso.info so additional accommodations may be provided.

COEUR D'ALENE TRIBE

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April 30, 2019

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Pacific Northwest Region
Bureau of Reclamation
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RE: Supplement Information on Tribal Perspective for the CRSO EIS

Dear Administrator Mainzer, Brigadier General Helmlinger, Regional Director Gray:

This letter is sent on behalf of the Coeur d'Alene Tribe ("Tribe") as supplemental information to the Tribe's December 10, 2018 letter regarding the Tribe's perspective on the impacts of the Columbia River Systems Operations ("CRSO") to tribal resources. We appreciate the opportunity to provide additional detail on the impacts of the CRSO to the Coeur d'Alene Tribal community.

First, the Tribe must express its disappointment in the approach taken by your agencies in collecting this information. In previous NEPA processes, the action agencies have hired experts agreed upon by affected tribes to assess and document the impacts in a detailed manner. The attached report titled *Tribal Circumstances & Impacts from the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs, and Shoshone Bannock Tribes* ("Tribal Circumstances Report") was prepared by Meyer Resources, Inc. on behalf of the Columbia River Inter-Tribal Fish Commission with funding from the Army Corps of Engineers ("Corps") for the NEPA process for the Lower Snake River dams.

This report involved a significant amount of tribal coordination, was funded by the Corps, and was then utilized by the agencies as part of the NEPA process, including the environmental justice section. To date there have been no overtures by the action agencies to fund a tribal impact assessment within the CRSO NEPA process. As the tribes have been left to provide their own internal resources for an impact assessment, any information gathered will not meet acceptable milestones due to a lack of funding. We urge the action agencies to consider building an internal process that encompasses the tribes concerns regarding a thorough and well-funded impact assessment to properly assess impacts of CRSO to tribal communities.

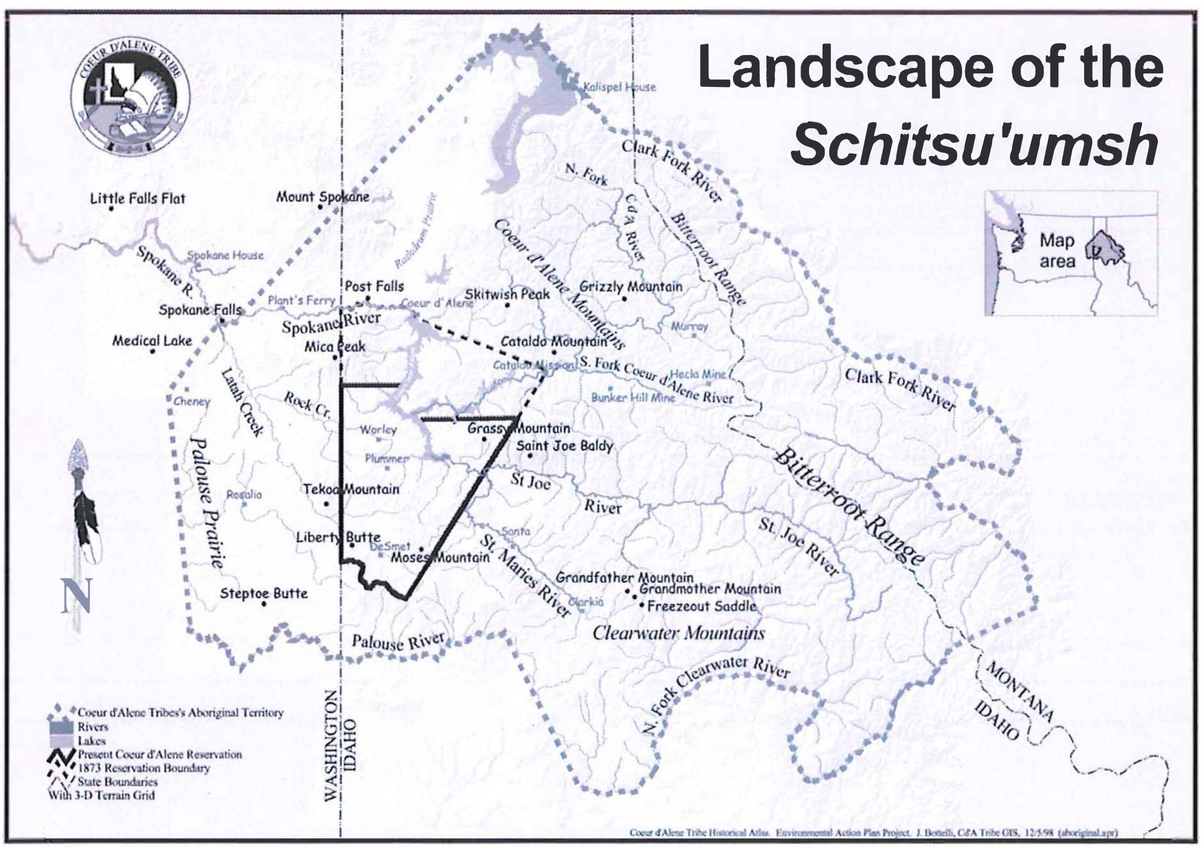
The Tribal Circumstances Report identifies impacts to tribal income/health, life-support resources, and economic base from the status quo operations of the Snake River dams (see summary in chart below).

Summary of Environmental Justice Effects for the Tribes from Lower Snake River Project Alternatives	
EJ Factors	Relative Effects on the Tribes
Alternative A1 (Status Quo)/ Alternative A2 (Status Quo + Transportation):	
Income Level/ Health.	• Tribal families are impoverished and unemployed at 3-4 times levels of Washington/Oregon/Idaho residents as a whole (Table 41). Winter-time tribal unemployment reaches as high as 80 percent. • Tribal members are dying at from 20 percent to 130 percent higher rates than non-Indian residents. • Recent analyses describe tribal health and health care access as "poor". • Implementation of A1 or A2 would have no discernible effect in remedying these cumulative adverse conditions.
Life-support Resources.	• Extensive information in this report places salmon at the center of the study tribes' cultural, spiritual and material world. Table 43 identifies that salmon guaranteed to the tribes by Treaty has almost entirely been lost. Tribal spokespersons and health experts cited throughout this report have identified the devastating effect these losses have had on tribal culture, health and material wellbeing. • Beaty, et.al (1999) identify lower Snake River dams have contributed substantially to destruction of these life-support resources • Selection of A1 or A2 would not significantly change these cumulative conditions-and the pain, suffering and premature deaths of tribal peoples would continue for decades.
Economic base.	• The cumulative effects of dam construction have transferred potential wealth produced in the river basin from the salmon on which the tribes depend to electricity production, irrigation of agriculture, water transport services and waste disposal, these latter primarily benefiting non-Indians. These transfers have been a significant contributor to gross poverty, income and health disparities between the tribes and non-Indian neighbors. • Selection of A1 or A2 would continue these conditions and disparities.
Inconsistent Standards.	• Historically, agencies asserted confidence that they could manage uncertainty concerning adverse impacts on salmon during construction of the dams that facilitated wealth transfers from the tribes to non-Indians. Some of the same agencies now claim to be risk adverse, when considering more substantial remedial action which would recover salmon and result in some measure of rebalancing of wealth to improve the circumstances of tribal peoples.

Many of these issues, including disproportionate impacts to the economic base, community health and loss of culture, are relevant to the Coeur d'Alene Tribe. These are impacts that must be considered in the NEPA process. To the extent possible, given all the constraints that are embedded in the CRSO NEPA process, we discuss the importance of salmon and impacts to Tribal health and resources below:

1. **Landscape of the Schitsu'umsh.**

The traditional aboriginal territory of the Schitsu'umsh, (Coeur d'Alene) depicted below, spans more than 5 million acres encompassing much of what is today known as the "Idaho Panhandle" as well as portions of eastern Washington and western Montana. Their overall territory extended north to Lake Pend Oreille and the Clark Fork River. On the south the territory extended into the drainages of the Palouse and North Fork of the Clearwater Rivers and the Clearwater Mountains. The eastern boundary extended across the Bitterroot Range into Montana. To the west, the territory was marked by a place called "Plante's Ferry" on the Spokane River, and then ran south from Spokane Falls to encompass the entire Hangman Creek drainage (also known as Latah Creek) and Steptoe Butte, near the present Rosalia, Washington. Importantly, the aboriginal landscape of the Tribe included many important rivers that reinforced the cultural connections of Tribal members to the anadromous fishery and fostered a considerable reliance on those resources.



Over time, changes to the Coeur d'Alene Reservation boundaries has influenced the patterns of land use affecting the Tribe. The area within each negotiated Reservation boundary was reserved for the Tribe's use and exclusive management. Prior to the changes brought about by allotment, the Tribe's land use had developed into a combination of agricultural and traditional subsistence activities on the Reservation. Large farms of 1,000 acres and more were successfully managed and notions of property ownership were handled within the Tribe's own organizational entities. In the year 1906, the Federal Government unilaterally violated the Coeur d'Alene Treaty of 1887, forcing Tribal members onto individual land allotments and opening the rest of the Reservation to settlement. This "subdivision" created a market for land parcels on the Reservation. Many allotments passed into non-Indian use and ownership within a short period of time. By 1934 when the Allotment era ended with passage of the Indian Reorganization Act, Tribal land ownership had declined to less than one fifth of their 334,471-acre Reservation.

2. Traditional Harvest and Fishing.

For the Schitsu'umsh people, traditional culture is seasonally-based. For generations, food-gathering activities and physical activity aligned with the seasons. In the spring, tribal families would travel to the outskirts of their territory to gather camas and bitterroot. In the summer, families traveled to higher elevation to gather berries, such as huckleberry and service berry. Fall was generally the time for hunting game such as deer and elk. Winter saw families return to the lowlands around Coeur d'Alene Lake to take advantage of milder weather. Fishing for trout, salmon, and whitefish took place throughout the year.

The Coeur d'Alene Tribe fishing territory extended from the North Fork of the Clearwater River on the southern margin to Lake Pend Oreille and the Clark Fork River on the north, the upper portion of the Spokane River to Spokane Falls, Hangman Creek and the headwaters of the Palouse River. The Coeur d'Alene routinely visited Kettle Falls during the fishing season and occasionally fished for salmon on the Snake and Lower Columbia at sites such as Celilo Falls. This practice continued until Celilo Falls was inundated by The Dalles Dam in 1957. The Celilo Falls site became especially important to the Coeur d'Alene after the Spokane River dams and Grand Coulee Dam blocked the runs into the upper basin, because it was one of few places left where they were able to obtain salmon for religious rituals. The construction of Dworshak Dam on the North Fork of the Clearwater River during the late 1960s – early 1970s signaled the complete extirpation of anadromous salmon and steelhead from the cultural territories of the Coeur d'Alene Tribe. Hence, the history of the dam building era marks a decades long progression during which the Coeur d'Alene Tribe was systematically removed from the anadromous resources that were available to their ancestors.

3. Loss of Fishing Areas Due to Dams.

All drainages relied upon by the Tribe for anadromous fish harvest have been adversely impacted by dam construction and operation. Chief Joseph and Grand Coulee dams block access for anadromous salmon and steelhead to significant amounts of habitat, totaling 711 miles for spring Chinook and 1,610 miles for summer steelhead for spawning, rearing and migration. Much of these habitats fall within the Coeur d'Alene Tribe's usual and accustomed fishing areas. In addition, construction of Dworshak Dam eliminated 54 miles of riverine habitat and blocked access to a much greater, but unquantified amount of habitat on the North Fork of the Clearwater

River, which accounted for sixty percent of the average annual count of steelhead which passed into Idaho via the Snake River.[1] The loss of these habitats to anadromous fisheries has had a significant and continuing impact on the Coeur d'Alene Tribe's cultural, economic and social well-being.

4. Historic Harvest and Consumption Rates.

Tribal members are estimated to have consumed about 124,000 salmon and steelhead annually (1.3 million to 2.3 million pounds). This included the shared fishery on the Spokane River where Indians caught about 1000 salmon a day at five weirs for a period of 30 days each year for a total harvest of 150,000 salmon. Estimates of fish consumption, including anadromous and resident fish, puts historic Tribal consumption per capita at between 300-1000 lbs per year.[2] Current fish consumption rates are a tiny fraction of historic levels due largely to the loss of fisheries from dam construction.

5. Loss of Salmon and Tribal Health.

As addressed above, the Tribal Circumstance Report documented impacts to tribal health that corresponds to impacts to salmon harvest.

Recent public health research has demonstrated that dominant culture-based approaches to community health that focus primarily on biophysical and socioeconomic indicators, such as disease incidence and poverty rates, ignore the broader determinants of Indigenous health. Impacts of historic trauma, including loss of language, land base and culture, contribute to what psychologist Dr. Eduardo Duran has termed a "soul wound." This wound exists at the community level, where generations of loss require an attention to collective grief that requires collective solutions to heal. The chronic psychological stresses associated with this collective trauma have been recognized as an established risk factor for cardiovascular disease. The failure of western public health interventions to change the trajectory of health disparities in Indigenous communities "reflects a non-engagement with the social/cultural drivers of health and the subsequent application of inappropriate intervention models."

Nationwide, disparities of American Indian/Alaska Native (AIAN) populations are well-documented, such as disproportional amounts of death attributed to cerebrovascular disease and diabetes when compared with the general population. AIAN mortality rates for these two diseases are 2.7 times that of the general population. High poverty rates contribute to these disparities. Though the AIAN population makes up approximately 1% of the U.S. population, it represents approximately 2% of recipients of the Supplemental Nutrition Assessment Program

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[1] *See* UCUT. 2019. Fish passage and reintroduction Phase 1 Report: Investigation upstream of Chief Joseph and Grand Coulee dams. Upper Columbia United Tribes, Spokane, WA and U.S. Army Corps of Engineers. 1974. Dworshak Dam and Reservoir, North Fork Clearwater River, Idaho, Draft Environmental Impact Statement. U.S. Army Engineer District, Walla Walla, WA (available at https://babel.hathitrust.org/cgi/pt?id=ien.35556030997696;view=1up;seq=181).

[2] *See* Scholz, A. (and 9 others). 1985. Compilation of information on salmon and steelhead total run size, catch and hydropower related losses in the Upper Columbia River basin, above Grand Coulee Dam. Upper Columbia United Tribes, Fisheries Technical Report No 2. Eastern Washington University, Cheney, WA and Ridolfi, Inc. 2016. Heritage fish consumption rates of the Coeur d'Alene Tribe. Prepared for the U.S. EPA, Contract EP-W-14-020. Both of these reports are attached to these comments.

(SNAP). In addition to poverty, cultural challenges are barriers to health. Less than 0.2% of health providers in the U.S. are AIAN (National Stakeholder Strategy for Achieving Healthy Equity, 2011). Lack of familiarity with the historical and societal issues that may impact AIAN communities' participation in prevention programs is a barrier for providers working in Indian Country. Additionally, community-level health assessments have typically neglected many of the aspects of well-being considered critical to Indigenous communities, particularly the interconnectedness of physiological health with cultural, environmental, and community connections. As a result, physical health indicators alone are insufficient in providing a full assessment of Indigenous community health.

Recent community-level health assessments on the Coeur d'Alene Reservation have attempted to broaden their approach by taking a multi-dimensional approach that includes physical environmental and community design. A 2013 Community Health Assessment completed by the Coeur d'Alene Tribe's Marimn Health (formerly Benewah Medical and Wellness Center) included attention to environmental safety and water quality, as well as access to healthy foods and physical activity. The assessment found significant disparities in rates of obesity, diabetes, and hypertension between the Native and non-Native population. According to the 2013 Uniform Data Service Data, Marimn's Native population included 2,325 Native Americans, or approximately 55% of its service population, yet this population accounted for 61.8% of clients with diabetes.[3]

At the regional level, University of Idaho researchers reported in a Body Mass Index study conducted in 2009 that AIAN children had the highest levels of being overweight and obesity in the state. Overall, 50% of all AIAN children evaluated in grades 1,3,5,7,9 and 11 were overweight or obese, compared to 30% of all Idaho children. The highest rates of obesity are among older males and children receiving free and reduced lunch (an estimate of Social Economic Status) and residing in northern Idaho regions. Access to health supports exacerbates health and wellness issues; at the state level, Idaho ranks 48th out of the 50 states in access to physicians.[4] In the 2018 Panhandle Health District Community Health Assessment, 22.6% of the Benewah County population was reported as having low food access.

Within the Marimn Health service area, a high proportion of Native clientele are burdened with chronic diseases issues, with obesity rates much greater than Benewah County (reported at 30% in 2018[5]), as well as higher rates of diabetes (11% for the Native Marimn population v. 9% for Benewah County).

Disease incidence in Marimn Health Native Population (source: Marimn Health)

	2015	% of Native patients	2016	% of Native patients	2017	% of Native patients
Native Client Population	2986		3207		3328	
Heart Disease	299	10%	303	9%	284	8%

[3] Benewah Medical and Wellness Center, Community Health Assessment, 2013.
[4] "Get Healthy Idaho 2018," Idaho Health and Welfare.
[5] Panhandle Health, Community Health Assessment, 2018.

Disease incidence in Marimn Health Native Population (source: Marimn Health)						
	2015	**% of Native patients**	**2016**	**% of Native patients**	**2017**	**% of Native patients**
Stroke	27	1%	27	1%	26	1%
Cancer	49	2%	46	1%	49	1%
Obesity	1189	40%	1242	39%	1258	38%
Diabetes	339	11%	365	11%	360	11%
Suicidal ideation*	3		16		31	

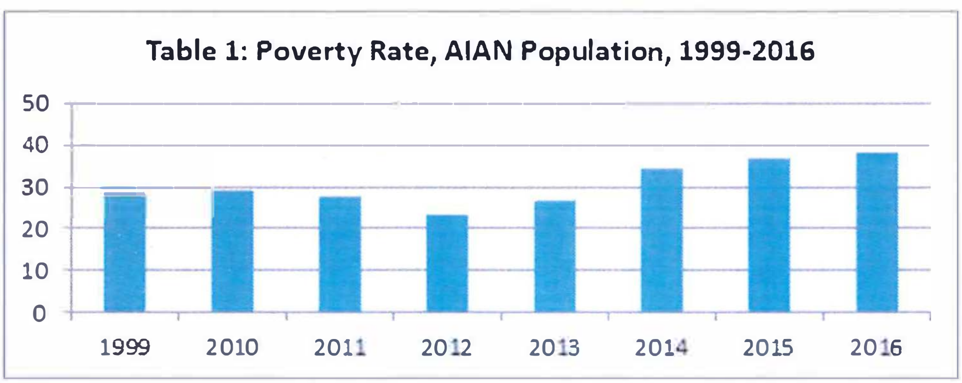
*improvements in coding practice may be related to the significant increase in diagnosis.

6. Loss of Salmon and Tribal Poverty Rates.

A major contributing factor to these health disparities are issues of poverty and joblessness. The Tribal Circumstances Report describes the intersection of dam construction and poverty:

> *"The cumulative effects of dam construction have transferred potential wealth produced in the river basin from the salmon on which the tribes depend to electricity production, irrigation of agriculture, water transport services and waste disposal, these latter primarily benefiting non-Indians. These transfers have been a significant contributor to gross poverty, income and health disparities between the tribes and non-Indian neighbors."*
> Tribal Circumstances Report at 21.

As of April 2018, the Benewah County unemployment rate was 5.8%, while state unemployment rate was 2.9% (Idaho Department of Labor, July 2018). Based on data from the American Community Survey, the 2016 poverty rate for the Coeur d'Alene Reservation was 18.7%, while the poverty rate for the American Indian population was a staggering 38% (Table 1).[6]



[6] *See* www.indicatorsidaho.org .

Furthermore, thirty-six percent of Native youth live in poverty, compared to 21 percent of their non-Native counterparts on the Reservation.[7] Mental health issues are persistent. Since 2015, four Tribal members died as a result of suicide, all under the age of 30 and two under the age of 17.

7. Wildlife Habitat Impacts

Currently there are more than sixty dams that were constructed in the Columbia River watershed system that inundated millions of acres of critical habitat important to the Tribal cultures that subsisted in these traditional areas. Subsequent to the inundation of wildlife habitat, operational impacts in the form of water level manipulation and wave action further diminished any available habitat left through magnified erosional processes.

Other impacts that grew from the construction of dams were habitat conversions to agricultural farms, namely center pivot irrigation as well as mining, logging, and increased open water habitat in favor of riverine systems and wetlands.

Secondary impacts while not easily quantified are no less important than quantifiable resource impacts. Without a dependent and once abundant resource (salmon) the shift to a commensurate wildlife resource for subsistence placed undue stresses on resident fish and wildlife populations causing cyclic population fluctuations to a marked degree. Historic migration routes of ungulate wildlife species were disrupted and subsequently affected population structures whether by seasonal starvation (blocked wintering areas) or increased disease vectors.

We appreciate this opportunity to provide additional information regarding the impacts of the CRSO to the Coeur d'Alene Tribe. We reiterate our request that the action agencies will provide resources necessary to better quantify these impacts in the NEPA process, including environmental justice and tribal impacts.

If you have any questions about this letter, please contact me at (208)686-1800.

Sincerely,

Caj Matheson
Director, Natural Resources

[7] Benewah Medical and Wellness Center Community Health Assessment, 2013.

Columbia River System Operations EIS
Tribal Cultural Resource Perspective Assessment

Tribal Perspectives, Traditional Places, and the Federal Columbia River System

CTCR Elder, Agatha Bart, at Harry Jim's inundated home site and fishing station, north bank of Snake River, 2007

Jon Meyer and Guy Moura, 2015
Revised Guy Moura and Crystal Miller 2018
History/Archaeology Program
Confederated Tribes of the Colville Reservation

February 28, 2019

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Introduction

Prior to presenting detailed information on tribal perspectives related to the effects of the Federal Columbia River Power System (FCRPS) on tribal culture and cultural resources, it is important to convey the totality of the impacts on tribal members. The focus of this assessment is on Grand Coulee Dam, but also applies to Chief Joseph Dam and all other dams in the Basin. Detrimental effects of dams may be the single most devastating factor in the loss of traditional lifeways among the affected tribes. Settlement patterns centered on the rivers' shores were disrupted as Indian towns (like Inchelium), individual homes, archaeological villages, and ancestral cemeteries were inundated. Salmon, the staple food and trade item for Columbia River tribes, were abruptly blocked from many areas, while in other areas, the annual runs were decimated. Gathering areas for traditional cultural plants have been compromised by the effects of irrigation, inundation, and agriculture. Traditional transportation routes across the Columbia and Snake Rivers became impassable without seasonal low water conducive to fording the rivers. Productive riparian habitat was drowned. Tribal members who successfully transitioned to a commercial agricultural-based economy lost their fields beneath the rising waters of reservoirs, as well as the family gardens used to augment the yearly food supply and supplement traditional hunting, gathering, and fishing. Religious, ceremonial, ritual, sacred, and burial sites were lost. Indian cemeteries were flooded.

Population displacement was compounded when many tribal members moved to dam construction sites and associated boom towns. Almost everything about life in boom towns was detrimental to traditional ways (Ortolano and Cushing 2000; Ray 1977). Native language was lost, a cash economy upset traditional social roles, and alcoholism and prostitution were prevalent in these non-native communities. Gone were many of the traditional familial and leadership roles. Increasing civil authority and abandonment of Indian villages undermined the influence of tribal elders and leadership families. Key cultural roles, like that of the Salmon Chief, which was once a powerful and prestigious position, were no longer needed where the salmon no longer ran.

On June 12, 2018, at the Environmental Impact Statement (EIS) Deputy-Level Regional Meeting in Spokane, Dr. Michael Marchand, Chairman of the Colville Business Council at the time, summarized the enormity of the dams' impacts. He stated that a once powerful and independent people, rich in heritage, culture, and the natural resources to sustain themselves, became a Fourth World Nation as the resources upon which they relied were destroyed.

Cultural Resources: Definition

For the purposes of the Columbia River System Operations (CRSO) EIS, the Confederated Tribes of the Colville Reservation (Tribes or CTCR) take a broad view of cultural resources.[1]

[1] CTCR's Cultural Resource Management Plan explains that "Cultural resources can be generally defined as sites, structures, landforms, objects and locations of importance to a culture or community for historic, educational, traditional, religious, ceremonial, scientific or other reasons. Given this broad definition, the number and kinds of cultural resources is indeed vast. Cultural resources extend from whole rivers and mountain ranges down to individual items. Overall, cultural resources reflect, nourish, and reinforce our communities." Confederated Tribes of the Colville Reservation, Cultural Resource Management Plan (March 6, 2006) at 5. *Available at https://static1.squarespace.com/static/56a24f7f841aba12ab7ecfa9/t/57bf56cdb3db2bdb891e63d1/1472157400402/Cultural+Resource+Management+Plan.pdf.*

These include, but are not limited to, cultural resources defined in applicable laws directed toward tangible resources. They also include cultural heritage that is not necessarily site-specific such as ritual, ceremony, language, traditional teachings, etc., and they include resources such as the land, water, air, and animals. These resources consist of individual artifacts, sites, natural resources, and ecosystems. A vast literature on effects to cultural resources exists.

Laws, Regulations, and Guidelines

What follows is a summary of definitions of 'cultural resources' as provided in various federal and state laws. Much of the language is taken directly from the laws or their implementing regulations.

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4231 et seq.)

NEPA expands the definition of cultural resources beyond objects and bounded properties. NEPA states the need to preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice. Under the Scoping clause (1508.25), project components cannot be reviewed independently as unconnected actions. This means irrigation projects, recreation, hydroelectric power generation, power transmission, off-channel storage, etc., are ancillary components of the primary undertaking that is the power system itself.

Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. 470aa-mm)

The term "archaeological resource" means any material remains of past human life or activities which are of archaeological interest, as determined under uniform regulations promulgated pursuant to this chapter. Such regulations containing such determination shall include, but not be limited to: pottery, basketry, bottles, weapons, weapon projectiles, tools, structures or portions of structures, pit houses, rock paintings, rock carvings, intaglios, graves, human skeletal materials, or any portion or piece of any of the foregoing items. No item shall be treated as an archaeological resource under these regulations unless such item is at least 100 years of age.

National Historic Preservation Act (NHPA) of 1966 (54 U.S.C. 300101 et seq.)

"Historic property" or "historic resource" means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register, including artifacts, records, and material remains related to such a property or resource.

Protection of Historic Properties (36 CFR 800.16)

Historic property means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization that meet the National Register criteria.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 U.S.C. 3001-3013)

These regulations apply to human remains, funerary objects, sacred objects, or objects of cultural patrimony.

Guidelines for Evaluating and Documenting Traditional Cultural Properties (National Register Bulletin 38)

A traditional cultural property (TCP) is a property eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that are rooted in that community's history, and are important in maintaining the continuing cultural identity of the community. In practice, CTCR TCPs include, but are not limited to: religious areas, resource gathering areas (plant, animal, fish, and mineral), places associated with stories and legends, archaeological and ethnographic sites, habitation sites, campsites, rock images, special use sites, trails, tribal allotments and homesteads, and locations named in Native languages.

American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. 1996)

Religious practices of the American Indian are an integral part of their culture, tradition, and heritage – such practices form the basis of Indian identity and value systems. Traditional American Indian religions, as an integral part of Indian life, are indispensable and irreplaceable. It shall be the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.

Indian Graves and Records (RCW 27.44)

Includes any glyptic or painted records, cairns, graves, and any associated archaeological material from any such cairn or grave.

Archaeological Sites and Resources (RCW 27.53)

All sites, objects, structures, artifacts, implements, and locations of prehistorical or archaeological interest, whether previously recorded or still unrecognized, including, but not limited to, those pertaining to prehistoric and historic American Indian or aboriginal burials, campsites, dwellings, and habitation sites, including rock shelters and caves, their artifacts and implements of culture such as projectile points, arrowheads, skeletal remains, grave goods, basketry, pestles, mauls and grinding stones, knives, scrapers, rock carvings and paintings, and other implements and artifacts of any material that are located in, on, or under the surface of any lands or waters owned by or under the possession, custody, or control of the state of Washington or any county, city, or political subdivision of the state are hereby declared to be archaeological resources. Any object that comprises the physical evidence of an indigenous and subsequent culture including material remains of past human life including monuments, symbols, tools, facilities, and technological by-products or any geographic locality, including but not limited to, submerged and submersible lands and the bed of the sea within the state's jurisdiction, that contains archaeological objects.

When added together, tangible cultural resources span the wide range from an isolated fire-cracked rock to entire ecosystems, such as those supporting anadromous fish runs.

Cultural Traditions

Language, ceremonies, rituals, traditional teachings, religion, legends, settlement and subsistence patterns, and many other intangible things are a product, and shape the beliefs, of a living community and the history of that community. They are essential to maintaining the continuing cultural identity of the tribes. The impacts of the loss or diminution of these cultural ways are identifiable and can be documented historically, quantitatively, and qualitatively. For example, in 1956, the Canadian government issued an extinction declaration for the Lakes (Sinixt) people that led to the erroneous and damaging concept that the Sinixt people no longer exist. This notion of Sinixt extinction has no basis in fact, as they moved to the southern reach of their territory (including the Colville Reservation) after the establishment of the Colville Reservation, bringing their traditions with them. The untiring efforts of Sinixt tribal members and the CTCR to assert, exercise, and uphold the traditional subsistence rights and rights to territory of the Sinixt people are clear evidence of the centrality of these practices to the maintenance of cultural continuity.

It is critical to keep in mind, however, that the cause of an impact can rarely be ascribed to a single action, event, entity, or moment, and also that impacts are cumulative. We understand there is difficulty documenting the causal relationship between the loss of language, ceremonies, legends, and other non-property-based aspects of culture to specific undertakings. We offer the following statement in support of the connection.

Sylvia Peasley (personal communication, 2012), a former member of the Colville Business Council, stated that “culture” is lost when the Indian language is lost and when spiritual ceremonies are no longer conducted. Sylvia grew up on Keller Butte, above the Sanpoil River, a tributary of the Columbia that passes through the Colville Reservation. Sylvia’s grandfather and great grandparents lived along the Sanpoil River by the town of Keller. She learned her traditional ways from her grandfather. Her family ritually practiced daily sweat baths. During the ceremonies, they spoke in their language, discussed family history, and told legends. Elders relayed details of the sweat bath ceremony through teaching and practice. As an adult, Sylvia moved to Keller. Knowing smelter contamination from industrial activities in Trail, B.C. pollutes the Columbia River; she is hesitant to continue the ways taught to her. She still sweats intermittently, but fears that by heating the rocks, vaporizing the water, and burning fir boughs, toxins will be released and she or her family will inhale or ingest them.

Many of her traditions are compromised. Indian people are aware of the contamination and they fear it. Salmon are not present on most of the Colville Reservation, including Keller, above Chief Joseph Dam and there are health alerts limiting the intake of resident fish in the Grand Coulee Dam reservoir. [Similar fears are connected with most dams; for example, tribal members fear the radioactivity in the water and sediment related to the operation of the Hanford Nuclear Facility.] Sylvia sees youth, elders, and other community members overcome with various health issues tied to the transformation of the river and all that the Columbia River encompasses in Indian culture and subsistence. The dams’ effect on tribal culture is far-reaching. Youth in Keller are losing their traditional ways, the tainted river and loss of salmon damaged the CTCR way of life. Parents do not have the same opportunities to pass down their customs and traditions. Few know all the words to the different ceremonies anymore. No one person still remembers the names of all the fish. No one person remembers all the different names used for some species of fish, as they are called by different names as they move through the stages of their life. Sylvia contends that when sweats are not conducted, the language is not spoken as often, legends are not told, family history is forgotten, ritual practices are lost, and the status and role of the elders are diminished.

However, more than just polluted waters caused such loss. Examples of comparable Columbia River losses relate to preventing the migration of salmon and lamprey runs, the destruction of the sturgeon fishery, inundation of the Indian towns, the move to a cash economy in the construction boomtowns, and the breaking up of families who moved to earn money. The examples provided by Sylvia Peasley are the experiences of one tribal member. Many more among the over nine thousand CTCR members have had (and continue to have) similar experiences.

Reservoirs of Concern

The Confederated Tribes of the Colville Reservation are comprised of twelve constituent tribes (Okanogan, Lakes, Colville, Sanpoil, Nespelem, Moses-Columbia, Methow, Chelan, Entiat, Wenatchi, Palus, and Chief Joseph Band of Nez Perce). Altogether, CTCR's traditional territory spans more than 37 million acres across Washington, Oregon, Idaho, and British Columbia (Figure 1).

No less than nineteen dams and their corresponding reservoirs affect traditional use areas of the CTCR constituent tribes:

McNary Dam – Lake Wallula (Palus)
Ice Harbor Dam – Lake Sacajawea (Palus)
Lower Monumental Dam – Lake Herbert G. West (Palus)
Little Goose Dam – Lake Bryan (Palus and Chief Joseph Band of Nez Perce)
Lower Granite Dam – Lower Granite Lake (Palus and Chief Joseph Band of Nez Perce)
Priest Rapids Dam – Priest Rapids Lake (Moses-Columbia)
Wanapum Dam – Lake Wanapum (Moses-Columbia)
Rock Island Dam – Rock Island Pool (Moses-Columbia and Wenatchi)
Rocky Reach Dam – Lake Entiat (Wenatchi, Entiat, Chelan, and Moses-Columbia)
Wells Dam – Lake Pateros (Chelan, Methow, Okanogan, and Moses-Columbia)
Chief Joseph Dam – Rufus Woods Lake (Okanogan, Moses-Columbia, Nespelem, and Sanpoil)
Grand Coulee Dam – Lake Roosevelt (Nespelem, Moses-Columbia, Sanpoil, Colville, and Lakes)
Keenleyside Dam – Arrow Lakes (Lakes)
Revelstoke Dam – Lake Revelstoke (Lakes)
Mica Dam – Kinbasket Lake (Lakes)
Waneta Dam - Waneta Reservoir (Lakes)
Seven Mile Dam – Seven Mile Reservoir (Lakes)
Boundary Dam – Boundary Reservoir (Lakes)
Hells Canyon Dam – Hells Canyon Reservoir (Chief Joseph Band of Nez Perce)
Enloe Dam – Similkameen River (Okanogan)

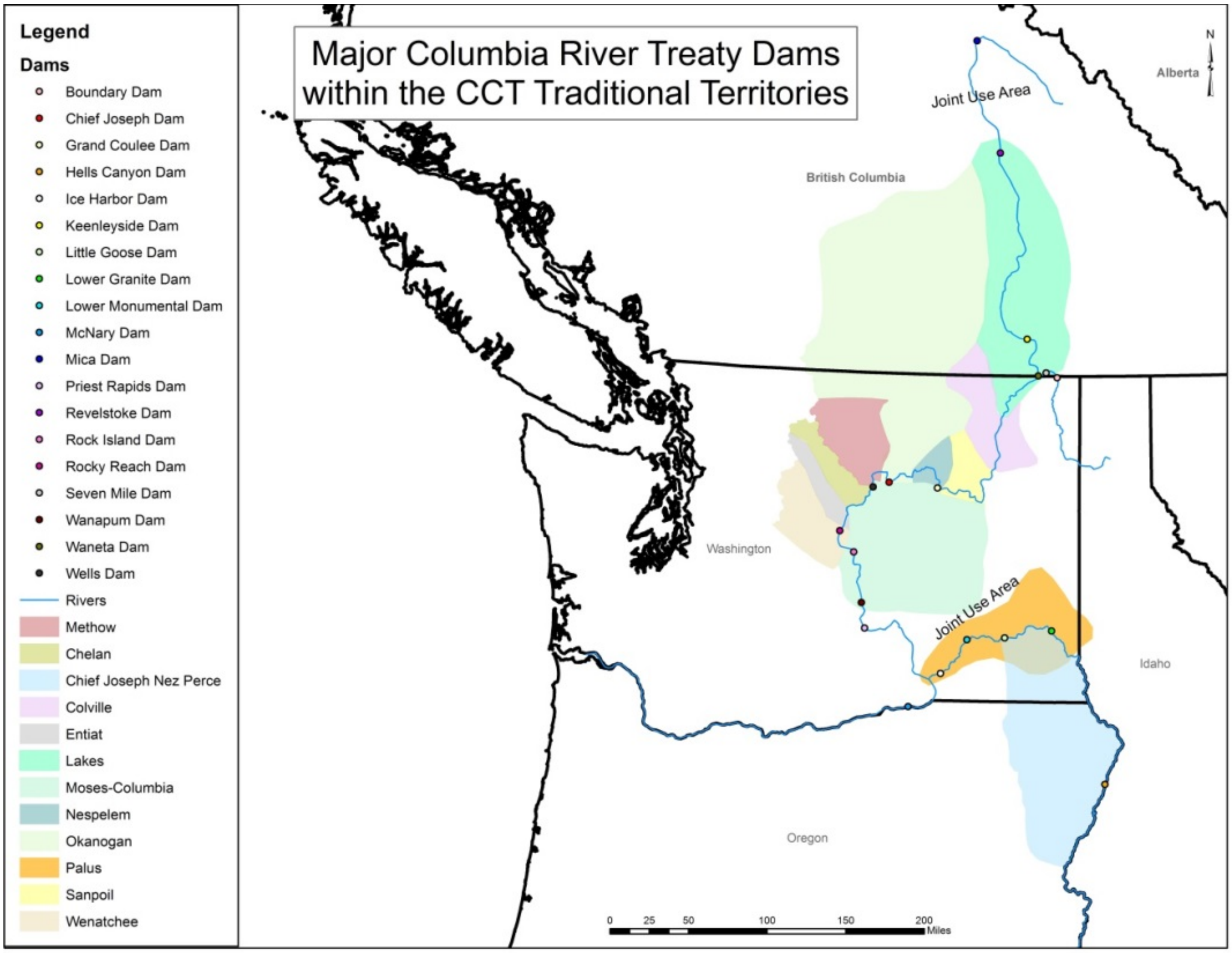

Figure 1: Major Columbia River Dams and Traditional Territories of the Confederated Tribes of the Colville Reservation

The existence, operation and management of these dams and their associated reservoirs have played a major role in some of the CTCR's most pressing contemporary cultural resource concerns, including:

- The destruction of the salmon fishery at Kettle Falls and traditional fishing locations on much of the Colville Reservation was directly caused by the construction of Grand Coulee Dam and Chief Joseph Dam and the continuing failure to include fish passage in the management of these dams. Tribal salmon fisheries below Chief Joseph Dam have been severely depleted by the construction, operation and management of nine dams on the mainstem Columbia below the Reservation. This devastation of the Tribes' ancestral fisheries caused (and continues to cause) irreparable harm to the culture, subsistence, religion, and economy of the 12 constituent tribes. While salmon are a focal point of any impacts discussion from the Tribes' perspective, the dams have also severely limited tribal access to lamprey, sturgeon, and other native fish species while creating an environment where non-native predator species are increasing in abundance and posing grave risks to these native fauna.

- Current CTCR fisheries, such as the summer/fall Chinook fishery on the Reservation at the tailrace of Chief Joseph Dam, are affected by CRS operations. The ability of tribal members to harvest salmon directly from the Columbia River in one of the few places it is still available to them is severely impacted by power, flood risk and other operations that result in high levels of spill from Chief Joseph Dam.

- The exposure of the ancestral remains of the Ancient One, also known as Kennewick Man, in 1996, caused by the operations of the McNary Dam and the fluctuating waters of Lake Wallula Reservoir. The exposure and recovery of his remains led to decades of legal battles pertaining to their repatriation to his descendants. CTCR considers the monitoring of known and likely ancestral cemetery locations impacted by reservoir operations to be of paramount importance;

- The crack in Wanapum Dam discovered in 2014 necessitated a substantial drawdown of the Wanapum Reservoir. Staff members of CTCR's History/Archaeology Program were tasked with monitoring ancestral cemeteries and gravesites that were either exposed or impacted by erosion due to the drawdown. A number of the Columbia River Treaty dams are aging structures that are not without flaws, and we expect that similar emergent situations will arise; and

- The excessive flow rates on the Columbia, Snake, and Palouse Rivers in May 2018 caused a marked increase in the inundation of, and erosive activity at, previously documented archaeological sites including villages, camps, rock image locations, rock feature sites, and other places of cultural and archaeological significance.

Resources Impacted

The Columbia River and its tributaries are central to the cultural traditions of the Confederated Tribes of the Colville Reservation. Each of the twelve constituent tribes of the Colville Reservation utilized the Columbia River, and their traditional territories had boundaries encompassing and lying adjacent to portions of the Columbia and Snake Rivers. To this day, only two federally recognized tribes retain reservation lands on the Columbia and Snake Rivers – the CTCR is one of those tribes. Tribes utilized riverine resources continually throughout the year (Ray 1933). Beyond subsistence, the Columbia River occupies a central role in CTCR culture, spirituality, and history. The Columbia River, or some aspect of the river, is central to the identity of each of the tribes of the Colville Reservation.

The Columbia and Okanogan Rivers border the current Colville Reservation for approximately 150 miles starting from a point around Malott on the Okanogan, past Chief Joseph Dam, and extending to an arbitrary line at the division of cadastral markers Township 34 North and Township 35 North. The boundaries of the Colville Reservation recognized the importance of fishing to tribes and were originally defined with the intent to include fisheries important to the tribes assigned to the Reservation (Hart 2002). The completion of the Grand Coulee Dam, and later the Chief Joseph Dam, inundated these fisheries and prevented salmon and other anadromous species from reaching much of the Colville Reservation lands, and the lands and waters of the former North Half of the reservation, rendered as public domain in 1898, to which CTCR members retain federally protected reserved hunting, fishing and gathering rights. The effects have been devastating. The subsistence fishing economy has been destroyed and many of the cultural traditions associated with it are now diminished. The subsistence harvesting economy – particularly the gathering of traditional cultural plant foods, medicines, and materials – has been dramatically impacted by the Columbia Basin-wide effects of irrigation projects, and the agricultural industry they sustain, which have dramatically altered entire ecological systems. Furthermore, the waters behind the dams inundated hundreds of culturally important sites such as villages, hunting and gathering areas, and ceremonial grounds. Today, the erosional effects of dam operations continue to damage cultural sites. Impacts to cultural resources also result from recreation and the federal taking of lands. Decisions regarding the management of the Columbia River System affect CTCR tribal members directly and constantly.

Legends pertaining to the Columbia River highlight the importance of the river to tribes. KwElkwElta'xEn, a Nespelem tribal member, told the story of the Origin of the Columbia River to James Teit (1917:65-66).

> *Coyote was travelling, and heard water dropping. He said, "I will go and beat it." He sat down near it, and cried, "Hox-hox-hox-hox!" in imitation of water dripping. He tried four times, but the noise never ceased. He became angry, arose, and kicked the place where the water dropped. The noise ceased. He thought he had beaten it, and laughed, saying, "I beat you. No more shall water drip thus and make a noise." Shortly after he had gone, the water began to drip as before. He became angry, and said, "Did I not say water shall not run and make a noise?" The water was coming after him, and increased in volume as it flowed. He kept on running; but still he heard the noise of water, and was much annoyed. Now he travelled along the edge of a plateau. There was no water there, nor trees. He looked down into the coulee, bet everywhere it was dry. It was warm, and he became very thirsty. He heard the noise of water, but saw none. Then he looked again down into the coulee, and saw a small creek flowing along the bottom. It seemed a long distance away. He went down, and drank his fill. And ascended again, but had not reached the top when he was thirsty, as before. He thought, "Where can I drink?" The water was following him. He went to the edge of a bench and looked down. A small river was now running below. He descended and drank. He wondered that much water was running where there had been none before. The more he drank, the sooner he became thirsty again. The fourth time he became thirsty he was only a little way from the water. He was angry, and turned back to drink. The water had now risen to a good-sized river, so that he had not far to go. He said, "What may be the matter? I am always thirsty now. There is no use of my going away. I will walk along the edge of the water." He did son; but as he was still thirsty, he said, "I will walk in the water." The water reached up to his knew. This did not satisfy him; and every time after drinking, he walked deeper, first up to the waist, then up to the arms. Then he said, "I will swim, so that my mouth will be close to the water, and I can drink all the time." Finally he had drunk so much that he lost consciousness. Thus the water got even with Coyote for kicking it; and thus from a few drops of water originated the Columbia River.*

Among other messages, this story reminds the listener to respect the Columbia River, suggesting that it is foolish to think that nature can be controlled.

The second story details the creation of Kettle Falls as told by Lakes Indian Eneas Seymour to Mrs. Goldie Putnam (Lakin 1976:V-VI):

> *I am Coyote, the Transformer, and have been sent by Great Mystery, the creator and arranger of the world. Great Mystery has said that all people should have an equal right in everything and that all should share alike. As long as the sun sets in the west this will be a land of peace. This is the commandment I gave to my people, and they have obeyed me.*
>
> *My people are the Skoyelpi and Snaitceskt Indians, who lived near the Kettle Falls on the Columbia River. I gave them that Falls to provide them with fish all their days. It was called Ilthkoyape, which means "falls of boiling baskets," but the name was shortened to Skoyelpi. The Falls was surrounded by potholes which resembled the boiling baskets in which my people cooked their food…*
>
> *Many generations ago my people were hungry and starving. They did not have a good place to catch their fish. One day while I was out walking I came upon a poor man and his three daughters. They were thin from hunger because they could not get salmon. I promised the old man I would make him a dam across the river to enable him to catch fish, if he would give me his youngest daughter as my wife. The old man agreed to this and I built him a fine falls where he could fish at low water. But when I went to claim the daughter the old man explained that it was customary to give away the eldest daughter first. So I took the oldest daughter and once again promised the man I would build him a medium dam so he could fish at medium water if I could have the youngest daughter. The old man explained again that the middle daughter must be married before the youngest, so I claimed his middle daughter and built him a fine falls where he could fish at medium water.*
>
> *Shortly after the father came to me and said he was in need of a high dam where he could fish at high water. He promised me his youngest daughter if I would build this. So I built him a third and highest dam where he could fish at high water. And then I claimed the long-awaited youngest daughter as my wife.*
>
> *And now, because I had built the Falls in three levels, my people could fish at low, medium and high water. I had become responsible for my people, and I saw that the fish must jump up the falls in one certain area where the water flowed over a deep depression. I appointed the old man as Salmon Chief, and he and his descendants were to rule over the Falls and see that all people shared in the fish caught there. All people must live there in peace, and no one should leave there unprovided. Indians and white men from hundreds of miles away have gathered during the salmon runs at my falls, and they have all lived in peace sharing together.*

The construction of the Grand Coulee Dam destroyed the Kettle Falls Fishery. The falls were submerged beneath the waters of Lake Roosevelt and the salmon were stopped at the base of the Grand Coulee Dam and, later, the Chief Joseph Dam. Now those who visit Kettle Falls will not be able to catch salmon and will leave "unprovided." Not only has the Kettle Falls economy been ruined, but the moral lessons embedded in the site have been debased.

The two legends above are among many told over the centuries by members of CTCR. They demonstrate that the Columbia River is not simply a tool for subsistence and travel, but an integral part of the cosmology of Columbia Plateau tribes.

Figure 2: Kettle Falls before inundation.

Figure 3: Kettle Falls today.

Within the Grand Coulee Project Area, from the Grand Coulee Dam upriver to the Canadian border, 408 traditional cultural properties had been identified up through 2017 (George 2008), and another 54 are being added in 2018. Hundreds of other TCPs have been recorded along the Columbia River system within the traditional territories of the Confederated Tribes of the Colville Reservation (e.g. Finley 2006, 2008; Finley, Wazaney and Moura 2008; Kennedy and Bouchard 1998; Mattina 1987; Ray 1932, 1933, and 1936; Shannon 2007; Shannon and Moura 2007a, 2007b, and 2010; Spier 1938; Turner, et al. 1979; Wazaney and Moura 2008).

Given the immense number of cultural sites that are affected under the current Columbia River System Operations (and which are being analyzed in the CRSO EIS), we will limit our discussion to traditional non-archaeological cultural resources under ten categories. These are vision quest sites, ceremonial locations, traditional sites, named places, legendary locations, fishing stations, mineral procurement areas, plant gathering areas, hunting areas, and burials. Descriptions of each of these categories are provided below. These descriptions should not be considered hard definitions, as many of these categories have overlapping elements, and an individual site can often be described under several categories. Additionally, these categories should not be considered all-inclusive. Some cultural sites important to CTCR may not fit any of the categories provided here.

Vision Quest Sites

Vision quests are used by tribal members to obtain a guardian spirit, power, or medicine. These sites are often marked by cairns (Figure 4), although many times they are also left unmarked (Cline 1938, Ray 1942). Integrity of setting is very important for vision quest sites. While vision quest sites usually sit great distances from the Columbia River or other rivers, these rivers often lie in the viewsheds of these sites. The appearance of the river or sounds coming from the river can affect the setting of a vision quest site. For example, the setting during the drawdown behind Grand Coulee Dam differs greatly from that during full pool. This affects the experience for the individual on a vision quest.

Ceremonial Locations

Ceremonial locations include, but are not limited to, prayer sites, sweathouses, traditional dance locations, vision questing sites and prehistoric sites identified as containing features such as rock rings, cairns, and certain types of talus pits are associated with ritual activity. Many of these places are located alongside rivers. In the case of the cairn formation representing a prayer site in Figure 55, access to the site is dependent on the reservoir level behind Grand Coulee Dam. During full pool, the site is mostly inundated and cannot be reached without traversing the water. Other ceremonial locations have been found to be completely inundated during full pool. Significant drafting of the reservoirs pursuant to Columbia River System Operations may also adversely affect such locations through erosion and other impacts.

Figure 4: Rock cairn on the Colville Reservation, looking south over the Columbia River

Figure 5: Cairn formation located adjacent to Columbia River.

Named Places

Figure 6: Location of *nsʔátqʷəɬp*.

Named places are locations that have been given a Native language name. Usually, these are locations found in the ethnographic record with names provided in the native language.

Named places are often important for identifying geographic or environmental features, resources, or stories associated with the place.

Reservoir effects have damaged many of these sites, either through erosion or inundation. In some cases, the dams have caused irreparable harm to named places by preventing a resource from being present at the site. For example, the site called *snc'əm'túst*n, translated as "sturgeon place," was an important fishing location for sturgeon (George 2008). Since the construction of the Grand Coulee Dam, however, sturgeon have been unable to return to this location. The ponderosa pines at another site, *nsʔátqʷəłp*, translated as "in pine groves," were traditionally used for canoe construction. During the drawdown period, this site can be revisited, but pine trees can no longer grow here. Examples such as these also demonstrate the negative indirect impacts that may occur when a site is damaged. Since sturgeon and ponderosa pine are no longer present at these sites, there is no incentive to return to these areas. Consequently, the transmission of teachings by older generations to younger ones does not occur here. Moreover, the native words to describe these places are not passed on to the younger generation. Both language and culture are lost.

Legendary Locations

Legendary locations are places associated with traditional legends or stories. Many of these places, such as the Owl Sisters' Site (Figure 7), sit along the Columbia River or one of its tributaries. While the legends persist, if associated places are eroded or inundated, the re-telling of the legend dwindles over time. Some of these sites, such as Kettle Falls, lie in or adjacent to these rivers and can be directly impacted by river management activities.

Fishing Stations

Fishing stations are places that were repeatedly revisited for fishing. Often fishing stations included rock and stick weirs, net locations, traps, and places with platforms for the use of hoop nets or spears. Many of the fishing stations used prior to the arrival of Europeans are now inundated. Contemporary fishing requires that desired fish are actually present in the rivers and streams. Obviously, the Chief Joseph and Grand Coulee dams prevent some of these fish from reaching traditional fishing areas and being harvested by CTCR members. Additionally, flow rates, spill (and associated turbidity, flow and dissolved gas), temperature, and fluctuating reservoir pool levels may have negative impacts on traditional fishing conducted today.

Mineral Procurement Areas

Mineral procurement areas include those areas where naturally occurring inorganic materials are obtained. Most commonly, these areas refer to locations where rocks or minerals used for stone tool production are found. However, these places also include sites that produce minerals, such as ochre, that may be used for ceremonial purposes or as pigments in paints.


Figure 7. Owl Sisters' Site along the Columbia River


Figure 8: Petrified wood found at Ginkgo Petrified Forest State Park (USGS 2013).

Mineral procurement areas are often found in quarries where the desired stone is extracted. At some sites, such as the Ginkgo Petrified Forest, the resource is easily accessible. Here, petrified wood is found on the ground surface next to the Columbia River (Figure 8). Some minerals, such as agate, chalcedony, jasper and other cryptocrystallines, are collected in nodules found among the gravels in the Columbia River and its tributaries (Beste 1996). Where the natural river channels are inundated, retrieval of these cobbles becomes infeasible.

Alternatives Analysis and Tribal Impacts

The Confederated Tribes of the Colville Reservation are in the unique position of representing tribes that have an interest in cultural resources in both the United States and Canada, and in several states on both the Columbia River and Snake River drainages. Under any proposed alternative for the Columbia River System Operations EIS, the management of these rivers will result in negative impacts to CTCR cultural resources. In all of the alternatives to be evaluated by the Columbia River System Operations EIS, especially the No Action Alternative, there is there is room for vast improvements to System operations, resource management, traditional non-archaeological cultural resource treatments, and the application of creative mitigation. Therefore, with regard to potential Columbia River System Operations effects, CTCR has no preferred alternative for the protection of cultural resources. Selection of any of the alternatives put forth within Iteration 2 of the Columbia River System Operations EIS will not lessen the continued diminishment and destruction of cultural resources of the Colville Reservation and other areas in the Tribes' traditional territory that are vitally important to the CTCR.

The tribal and family histories obtained from informants suggest that throughout the project area, tribal members continue to practice subsistence and ceremonial activities related to hunting, gathering, and fishing. Such places have traditional cultural value. Places, practices, stories and legends also serve as a means of perpetuating tribal tradition. As the ethnographic interviews emphasize, these activities cease only when access is prohibited, or in areas permanently altered by environmental change caused by farming, ranching, recreation, land tenure policies, inundation, or impoundment. CTCR considers all of the preceding impacts as direct or indirect effects of dams, especially those projects including in the CRS.

Parker and King, in ***Guidelines for Evaluating and Documenting Traditional Cultural Properties***: (1998:1), state that: "A traditional cultural property [...] can be defined generally as one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community." Even within the restricted guidance under the National Historic Preservation Act, such places are considered to be significant. Parker and King (1998:3) further explain that these guidelines are "meant to supplement, not substitute for, more specific guidelines, such as those used by…Indian tribes with respect to their own lands and programs." Additionally, the effects of ethnocentrism must be avoided: "It is vital to evaluate properties thought to have traditional cultural significance from the standpoint of those who may ascribe such significance to them, whatever one's own perception of them, based on one's own cultural values, may be" (Parker and King 1998:4). This is because, "The existence and significance of such locations often can be ascertained only through interviews with knowledgeable users of the area" (Parker and King 1998:2).

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DRAFT CRSO STATEMENT OF THE CSKT

<u>This Statement is DRAFT - and is submitted for internal review and essentially as a placeholder. The CSKT reserve the right to edit or withdraw the Statement in part or whole (photos and text boxes anticipated as placeholders for cultural/elder content).</u>

From time immemorial the aboriginal homeland of the Confederated Salish and Kootenai Tribes of the Flathead Reservation (CSKT) reached from what is now British Columbia, down through parts of what are now the states of Idaho, Montana and Wyoming, including the Greater Yellowstone Area (GYA). Like most tribal nations in Montana the Séliš, Ksanka and Ql̓ispé people hunted, fished and gathered in their traditional homelands.

No natural resource is more vital to the people than water – the importance of water is woven into all aspects of tribal lives. For thousands of years, the Bitterroot Salish, Kootenai and Upper Pend d'Oreille, thrived in the aboriginal homeland situated in what is now Montana, Idaho, British Columbia and Wyoming, subsisting off of healthy native fisheries, plants, and wildlife. The Confederated Salish and Kootenai Tribes still honor, depend on, and manage these waters and the natural resources that depend on it.

The CSKT have recognized Treaty rights and interests within and to waters and lands that coincide with hydropower facilities and reservoirs of the Federal Columbia River Power System ("FCRPS"). Specifically, the Kootenai River and the Flathead River systems include Libby Dam and Hungry Horse Dam, respectively, and associated reservoirs - Lake Koocanusa and Hungry Horse Reservoir - all of which are part of the CSKT's aboriginal lands and waters and subject to Treaty protections. All changes or mandates in hydropower operations, such as flow augmentation, will call for water that is stored behind, and that will flow through or over, Libby Dam or Hungry Horse Dam.

Both of these Montana river systems and associated reservoirs are home to sensitive fish and listed species including the Kootenai River white sturgeon *(Acipenser transmontanus),* bull trout *(Salvelinus confluentus),* burbot *(Lota lota)* and resident populations of the native westslope cutthroat trout. The Kootenai River white sturgeon is listed under the Endangered Species Act (ESA) as endangered. The bull trout, which inhabits both systems, is listed as threatened. Critical habitat designated by the U.S. Fish and Wildlife Service ("FWS") for the Columbia River population of bull trout is also potentially implicated by developments in the instant litigation. More broadly, the life-cycles and biological demands of the CSKT's resident fish are not in all respects the same as the salmon populations that are the focus of this litigation. These differences in fish life-cycles are an important component of the CSKT's claims.

Until 1871, the United States conducted its official relations with the sovereign tribal nations compromising the "domestic dependent nations" within its territories by treaty negotiated by the executive branch and ratified by Congress. CSKT Tribal chiefs signed the Hellgate Treaty on July 16, 1855 near present day Missoula, Montana. The Hellgate Treaty is a "Stevens Treaty", negotiated by Governor and Superintendent for Indian Affairs for the Washington Territory, Isaac I. Stevens. Governor Stevens was tasked with making peace with the tribal nations along the Oregon Trail. He negotiated a majority of the treaties with Indian Nations throughout the northwest, and those treaties contain similar language regarding hunting, fishing and gathering.

Under the Hellgate Treaty, the Tribes retained certain rights on ceded aboriginal territory, including, among other things, the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory. This includes the fishery and all natural resources in and appurtenant to significant reaches of the Upper Columbia watershed located within the present-day boundaries of the State of Montana, including the reservoirs operated as part of the FCRPS. The CSKT are a sovereign trustee for natural resources in, appurtenant to, and arising from waters included in the CRSO NEPA process. The CSKT seek to enforce their Treaty rights and protect their natural resource interests through their participation in the CRSO NEPA processes (and indeed, as defendant intervenors in the BiOp litigation.

By the terms of the Hellgate Treaty, the CSKT agreed to cede vast areas of their aboriginal territory to the United States, including certain waters that are included in this litigation. In return the United States promised to provide specified goods and services and guaranteed that the CSKT could continue their traditional way of life. To effectuate this guarantee, the CSKT retained exclusive possession of a delineated homeland (i.e. the Flathead Indian Reservation) and expressly reserved in perpetuity hunting, fishing, gathering and grazing rights in the ceded lands. *See* Treaty of Hellgate, Arts. II and III. The fishing rights were reserved by Article III language that provides in relevant part:

> The exclusive right of taking fish in all the streams running through or bordering said reservation is further secured to said Indians; as also the right of taking fish at all usual and accustomed places, in common with citizens of the Territory, and of erecting temporary buildings for curing; together with the privilege of hunting, gathering roots and

Water management is central to all life, and has had profound impacts on the culture, resources, and peoples of the Flathead Reservation. Under the Treaty of Hellgate the Tribes ceded over 20 million acres of land in return for a permanent homeland on the 1.3 million-acre Flathead Reservation.

In the century after the promises made in the Hellgate Treaty, the United States broke its word and diminished the tribal land holdings to less than one-fifth of the 1.3 million-acre Reservation that had been reserved under the Treaty. In 1904, over the Tribes' strenuous objection, Congress enacted a statute that opened much of the Reservation to non-Indian settlement and promised to use the proceeds from the sale of reservation lands to develop an irrigation project "for the benefit of said Indians." But, in fact, the United States constructed the Flathead Indian Irrigation Project to provide water to, almost exclusively, the non-Indian homesteaders. The operation of the Project (over 100 years, now) created what can only be described as an environmental catastrophe on the Reservation. Irrigation diversions of mountain streams dewaters streams and destroys native fisheries and fish habitat. The irrigation project's inefficiencies and polluted return flows have created severe water quality issues that threaten endangered species.

berries, and pasturing their horses and cattle upon open and unclaimed land.

Thus, for all Columbia River tributary streams located in the State of Montana the CSKT retain either an exclusive or shared right to manage and utilize the fishery. The CSKT have effectuated this right directly by Tribal members individually and continuously performing their traditional fishing activities since time immemorial throughout the CSKT aboriginal territory and by having developed significant CSKT governmental natural resource programs to manage and protect the sensitive fish species within the Flathead Reservation. The CSKT have effectuated this right indirectly by consulting and coordinating with state and federal fish management agencies about fish management and protection issues throughout the CSKT aboriginal territory. The Hellgate Treaty provides independent grounds for jurisdiction. The Treaty is the supreme law of the land which memorializes the CSKT's sovereign and Treaty interests in the fish species that inhabit the rivers, tributaries and reservoirs of the CSKT's reservation and aboriginal territories.

Placeholder culture/resources impacts

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Much of the CRSO NEPA process, and indeed BiOp litigation, focuses on salmon populations with needs that are not the same as the needs of resident fish in CSKT aboriginal territory. As a result, the life-cycles and biological demands for downriver salmon populations are not necessarily consistent with the life-cycles and biological demands of the Columbia River's headwater's/CSKT's resident fish. These differences are an important component of the CSKT's interests and rights and have guided the CSKT's participation in the BiOp litigation, the CRSO NEPA process, and other private and public actions.

The CSKT have developed federally-approved water quality standards for the Flathead Indian Reservation. The CSKT are continuously working to protect and improve the water quality in Reservation waters, including Flathead Lake, by various means, including: membership in the Flathead Basin Commission; negotiating with trans-boundary interests regarding coal development in the North Fork Flathead River; participating in FERC-relicensing workgroups; implementing Sẻliš Ksanka Qḷispẻ Hydroelectric Project (SKQ Dam, formerly Kerr Dam) environmental mitigation requirements; and operating of a certified Tribal water quality laboratory. The federal action agencies must consider the significant effects FCRPS operations will have on Tribal waters when proposing Hungry Horse Reservoir drawdowns to support flow augmentation for anadromous fish, because these flows will pass through the Flathead Indian Reservation and accordingly, by timing and volume, affect Tribal water quality.

Libby Dam, Hungry Horse Dam, and their associated reservoirs inflicted many other serious impacts on the culture, resources and economy of the CSKT. They caused the inundation of traditional use sites, cultural sites, and archaeological sites. Bank erosion continues to threaten and destroy these sites. The inundation also eliminated riparian ecosystems that produced traditional plant foods and medicines for CSKT tribal people. The U.S. Army Corps of Engineers and Bureau of Reclamation are aware of these impacts and have made progress in mitigating them, but there is much left to do and reservoir drawdowns will significantly impact the federal government's ability to protect and preserve these resources.

Placeholder culture/resources impacts

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The CSKT also have significant interests in energy resources impacted by hydropower generation. First, the CSKT own the SKQ Dam, a 180 megawatt hydroelectric facility located on the Flathead River that is operated pursuant to a license issued by the Federal Energy Regulatory Commission. Second, the CSKT operate Mission Valley Power ("MVP"), a federal electrical distribution utility, pursuant to a contract with the United States. The utility acquires most of its power from the Bonneville Power Administration ("BPA"). As a result, the CSKT and its members have an economic stake in hydropower decisions that may precipitate major rate increases for MVP's share of BPA power.

The CSKT maintains historic, present, and future interests in the resources included in the CRSO NEPA process. The CSKT work closely with other tribes in the Columbia River Basin to work towards shared, collective tribal needs and goals. Guided by historic and present-day cultural, natural resources, governmental, and economic interests, the CSKT continues to work on natural Columbia River Basin resources management and solutions that serve the CSKT's tribal members and all the basin's inhabitants. It is not possible to turn back the pasts management decisions that have degraded tribal and other resources. But thru improved decision-making and management the Columbia River Basin's waters can support lost uses that are important to many CSKT interests and uses.

Placeholder culture/resources impacts

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DRAFT Blueprint for Characterizing Tribal Cultural Landscapes (TCLs)
In the Area of Potential Effect (APE)
Of the Columbia River System Operations Environmental Impact Statement (CRSO-EIS)

Draft v. 4.26.2019

I. Background and Issue Statement

In 2016, the U.S. Army Corps of Engineers (USACE), Bonneville Power Administration (BPA), and U.S. Bureau of Reclamation (USBR) (collectively, the Coleads) announced the initiation of a 5-year process under NEPA for developing the CRSO-EIS, a document that would analyze the impacts of continued and modified operations of 14 federal dams in the Columbia River system, pursuant to federal judicial order.

Within a year, several scoping meetings with leaders of the 19 federally recognized tribes of the Columbia Basin had been hosted by the Coleads in Spokane, Boise, The Dalles, and Portland. In the same timeframe, several interagency working groups were formed to focus on the various affected resources and began meeting regularly. As expected, the degree of tribal involvement in the CRSO-EIS has varied between individual tribes. However, certain themes began to be expressed among the tribes who were members of the working groups, particularly the Cultural Resources group. One such theme centered around a concern regarding the narrowness of the "Traditional Cultural Properties (TCPs)" and "Sacred Sites" policies making it difficult to fully capture, describe, and analyze tribally important resources that would potentially be affected by CRSO-EIS alternatives, if limited only to those two policies.

Soon after this, in Fall 2018, a Presidential Memorandum was released providing for a revised understanding of NEPA process regarding the CRSO-EIS, with a Record of Decision (ROD) being signed in September 2020, one year sooner than originally scheduled. The Coleads announced they would be seeking tribal input and proposals on a "Tribal Perspectives" section to be authored by tribes, around the same time they announced the revised EIS schedule.

In light of (1) the accelerated schedule and (2) the need to identify and analyze impacts to tribally important resources beyond "TCPs" and "Sacred Sites", the issue is that a stepwise and documentable (but also protectable) system is needed to describe protocols for resource identification, prioritization and analysis in the CRSO-EIS APE. In this way, the protocols themselves may be followed both before and after the issuance of the ROD, and their outcomes and products may inform CRSO operations even if not written into the EIS.

II. Proposal Statement—the Blueprint

Project staff from the Confederated Tribes of Grand Ronde propose, as part of the Tribal Perspectives section of the CRSO-EIS, a blueprint for developing the protocols for resource identification and analysis of tribally important resources ("Blueprint"), as described above. Tribes would develop and write the protocols, Coleads and tribes would follow them, and the outcomes and products would be used only as determined/allowed by the contributing tribes.

The Blueprint is based heavily upon the Bureau of Ocean Energy Management (BOEM) documents *A Guidance Document for Characterizing Tribal Cultural Landscapes*,[1] and *Characterizing Tribal Cultural Landscapes, Volumes I* and *II*.[2] All of the above documents were prepared under BOEM-NOAA Interagency Agreement M12PG00035 by the National Oceanic and Atmospheric Administration (NOAA) Office of National Marine Sanctuaries, the Makah Tribe, the Confederated Tribes of the Grand Ronde Community of Oregon, the Yurok Tribe, the National Marine Sanctuary Foundation, and the BOEM Pacific OCS Region, and were first published in 2015-2017.

III. Description of Blueprint Methodologies and Parameters

A. Concepts

1. Tribal Cultural Landscape (TCL): Any place in which a relationship, past or present, exists between a spatial area, resource, and an associated group of indigenous people whose cultural practices, beliefs, or identity connects them to that place. A tribal cultural landscape is determined by and known to a culturally related group of indigenous people with relationships to that place.[3]
2. TCLs are defined as significant by tribes and indigenous communities, rather than by exterior criteria. This is a fundamental difference between TCLs and Section 106 TCPs.[4]
3. Each tribe or indigenous group has a unique set of traditional knowledge and lifeways which are inextricably connected to places on the landscape. A group of tribes may all have connections to the same geographic area or overlapping geographic areas, and their connections may differ widely. Therefore, the same geography may carry a vast, wide array of associated tribal resources and knowledge.
4. Tribal cultures tend not to separate natural, cultural, historical, ethnographic, archaeological, ecological, spiritual, and subsistence resources from each other in terms of labels or categories. The same location or species may have multiple levels of TCL importance to a single tribe.
5. While TCL identification by a tribe does not by itself mandate any special action or consideration from government agencies or others, a government agency acting in good faith should at least attempt to adaptively incorporate such values into its relevant management practices and policies.
6. The tribe(s) identifying a TCL should determine the level of sensitivity of tribal information associated with the TCL or resource, and this determination should be

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[1] Ball, David, R. Clayburn, R. Cordero, B. Edwards, V. Grussing, J. Ledford, R. McConnell, R. Monette, R. Steelquist, E. Thorsgard, and J. Townsend. OCS Study BOEM 2015-047, November 30, 2015. Online at http://www.boem.gov/Pacific-Completed-Studies.
[2] Same authors as above. OCS Study BOEM 2017-001, December 31, 2017. Online at http://www.boem.gov/Pacific-Completed-Studies.
[3] Ball *et al.* (2015).
[4] *Id.*

respected by all partners. Often such information is not meant to be shared outside of the tribal group or subgroup. Where multiple tribes identify the same identical TCL or resource information, the most restrictive tribe's policies and practices should govern.

7. As much as possible, information about a tribe should come from that tribe.[5]
8. TCL and tribally important resource identification and/or analysis (a "TCL study") should be utilized as part of ongoing conversations and adaptive decision-making processes in the course of project planning, design, implementation, monitoring, and evaluation. They should not be treated as "check the box" steps to be completed and then forgotten.

B. Protocols[6]

The protocols listed here are intended only to enhance the government-to-government consultation process, not to replace it. Each tribe as a sovereign has the right to engage in consultation with the Coleads within or outside of this process.

1. Conceptualization
   - Tribe(s) identify appropriate geographic scope of study, with CRSO-EIS alternatives in mind
   - Tribe(s) determines types of information to be collected and analyzed
   - Tribe(s) determines formats for recording and processing
   - Tribe(s) may identify format for presentation, if applicable
   - Tribe(s) may identify desired use of information in CRSO processes
   - Conversation between Coleads and tribe(s) regarding capacity needs, organizational needs, and other needs as applicable, given the above
2. Data Acquisition—this can be an ongoing process
   - Tribe(s) determines data standards and attributes
   - Tribe(s) gathers and stores information according to tribal access policy
3. Geo-reference
   - Locating of boundaries, if applicable
   - Data layer development, including metadata
   - Data linkage and cleaning
   - Document verification
4. Synthesis
   - Analyze information on, and illuminate linkages between, the following:
     - Places
     - Activities
     - Traditional knowledge (TK)
     - Context
     - Cultural understanding
5. Presentation—this step is at sole discretion of each tribe, and may include:
   - Public presentations, in person or written, of non-sensitive data
   - Maps (redacted if necessary)

[5] *Id.*
[6] *See id.* for a thorough description of this process and the associated "Figure 1" attachment.

- GIS data layers (redacted if necessary)
- Field visits
- Written (redacted if necessary) and oral reports.

C. Participants and mode of participation

For purposes of this Blueprint, each of the 19 federally recognized tribes of the U.S. portion of the Columbia Basin is a potential participant. Participation is completely voluntary. Each tribe will determine whether, and to what extent, it will participate in a TCL study. A tribe may complete all of the protocols as described above, or it may wish only to participate in one or some of the protocols. A number of tribes may wish to group together for the purposes of the TCL study, but this would not have the effect of "outweighing" or excluding an individually participating tribe's TCL study.

IV. Outcomes and Products

While outcomes and products would differ from tribe to tribe, the Coleads would have the ability to consolidate and synthesize the non-sensitive information shared by all participating tribes. Such products may take the form of maps, GIS data layers, reports, presentations, or other information to be utilized adaptively in CRSO management.

While it is understood that final products would likely not be complete until after the issuance of the ROD for the CRSO-EIS, the reasoning is that the information gathered and shared through the TCL study process would be used to inform best practices and adaptive strategies for avoidance, minimization, and mitigation of impacts moving forward.

V. Treatment of Sensitive TCL Information

Any and all sensitive information a tribe chooses to share with the Coleads, and describes as sensitive, should be treated respectfully and as Confidential. This holds true whether or not the same information is publicly available elsewhere. Where possible, and when acceptable to the contributing tribe(s), the sensitive information should be redacted and/or made more general for the development of public products. Examples of this include large-scale circles on maps rather than points, and GIS data layers with sensitive fields removed from the attribute tables.

VI. Conclusion and Attachments

This Blueprint is offered as an alternative means for tribes to identify, gather, and use (and share with others as determined appropriate by the tribe) meaningful information on tribally important places and resources potentially impacted by CRSO-EIS alternatives.

Attachments: "Figure 1" Template for Indigenous Data Collection and Retention[7]
"Figure 2" Process for Application of TCL Approach[8]

[7] *Id.*
[8] *Id.*

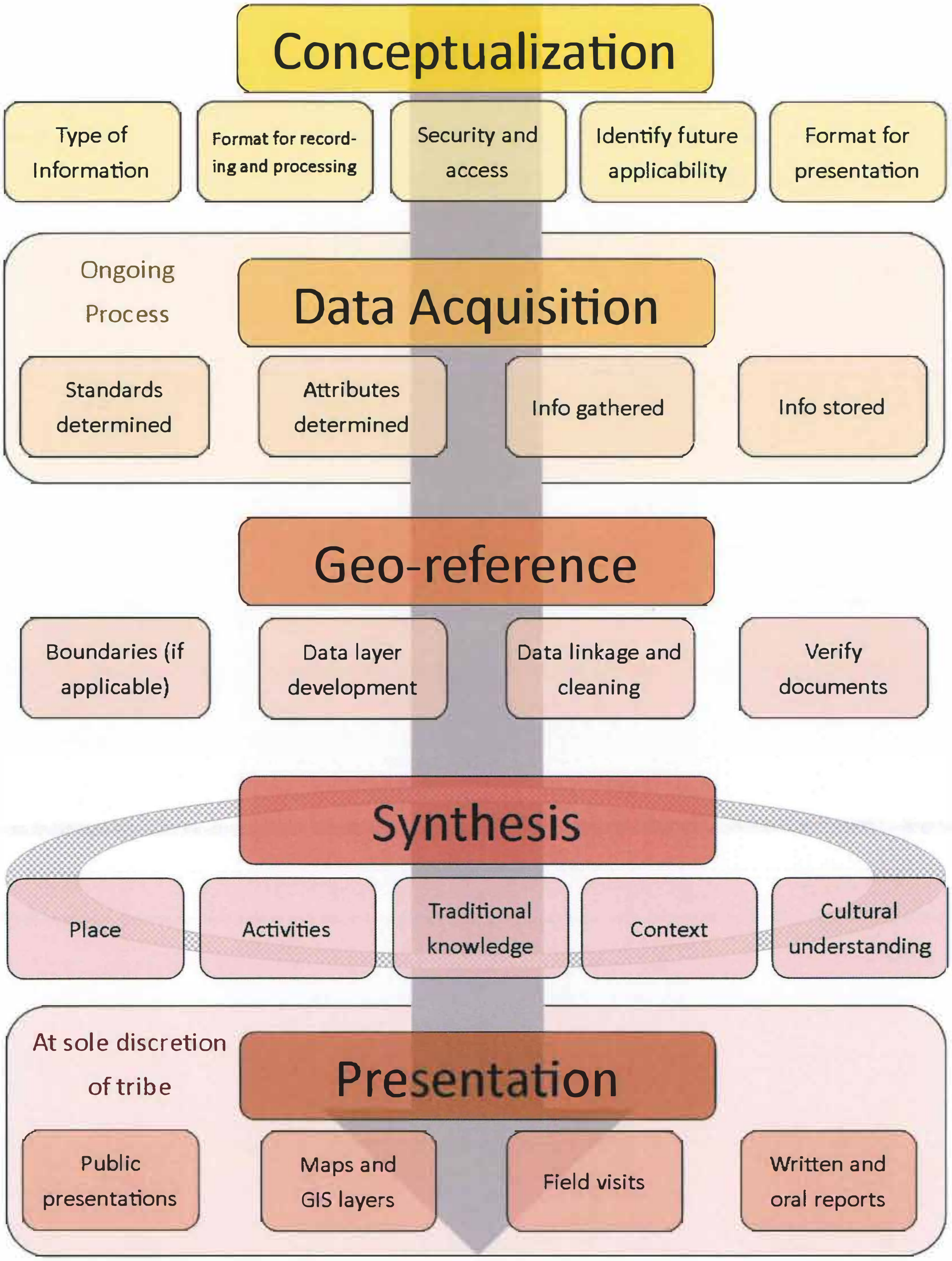

Figure 1. Template for Indigenous Data Collection and Retention. This process provides a method for tribes to collect and hold information that can be queried internally, with the ability to provide summary results to external parties.

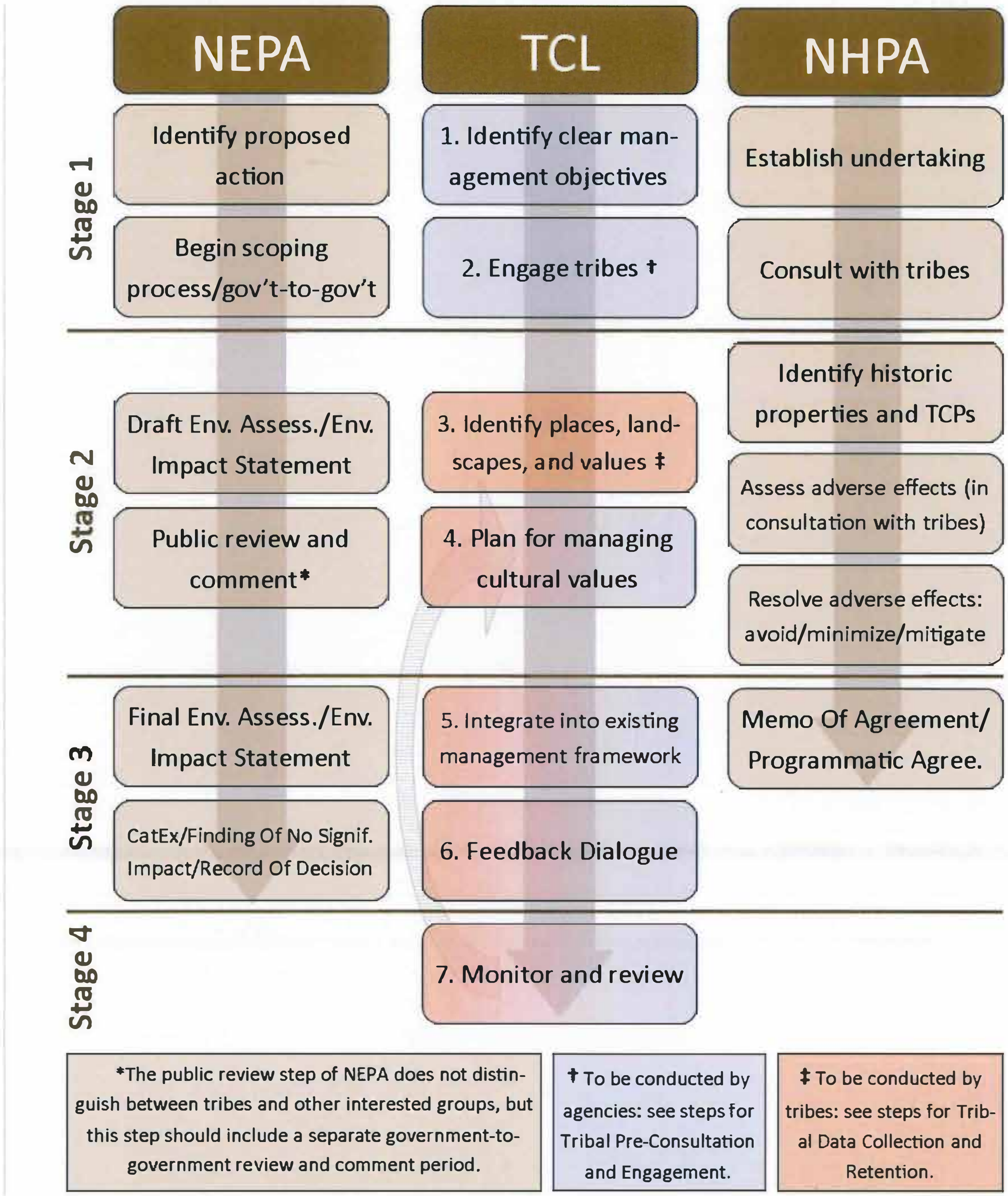

Figure 2. Process for application of TCL approach, showing how it can be feasibly implemented under existing federal policy and regulatory framework. The steps for conducting NEPA and NHPA Section 106 analyses are also included for comparison, to illustrate how the steps in the TCL approach align, and at what points they could be implemented.

KOOTENAI TRIBE OF IDAHO

PERSPECTIVES ON THE COLUMBIA RIVER SYSTEM OPERATIONS

Kootenai Elders and oral Historians say that much of their very early history, including Creation and the beginning of time, is so uniquely Kootenai and so sacred that it cannot be shared with outsiders. They have consented to provide the following information:

> "It's just like in your Bible. There is a Creator who made the world. You call the Creator God; He told us to call Him Nupika.
>
> The Creator-Spirit was in everything, and there were no people. Then He decided to make human beings. He made different people for different places. He made the Kootenai People for this place.
>
> When He was ready to put us on the earth, He told all the spirit-creatures they would have to move above, because the people were coming. Only their forms and their songs could stay behind, to help the people.
>
> And then, the same as with Moses in your Bible, He told us Kootenais our rules, our Commandments. Here is part of what He said:
>
> 'I am your Quilxka Nupika, your supreme being. I have no beginning and no end. I have made my Creation in my image – a circle – and you Kootenai people are within that circle along with everything else in my Creation.
>
> Remember that everything in my Creation is sacred, and is there for a purpose. Treat it well.
>
> > Take only what you need, and waste nothing.
> > Don't commit murder.
> > Respect and help one another.
> > Cherish your children and your old ones – They are your future and your past.
> > Your word must always be good. Never lie, never break a promise.
> > At all times, pull together – act with one heart, one mind.
>
> Then He told us the ceremonies and prayers we could use to get help when we need it. You have your angels and your saints, who help you. We Kootenai People have our Nupikas, who help us.
>
> Finally, Quilxka Nupika told us His most important commandment. He said:
>
> 'I have created you Kootenai People to look after this beautiful land, to honor and guard and celebrate my Creation here, in this place. As long as you do that, this land will meet all your needs. Everything necessary for you and your children to

live and be happy forever is here, as long as you keep this Covenant with me. Will you do that?'

And those first Kootenai People promised to keep the Covenant with the Creator, just the way the Jews did in the Old Testament. So He put us here, in our Kootenai Aboriginal Territory.

And that's how time began."

Century of Survival, A Brief History of the Kootenai Tribe of Idaho, By the Elders of the Kootenai Nation and the Members of the Tribe (2nd Ed. 2010).

The Ktunaxa (Kootenai) Nation consists of several modern communities in the United States and Canada. The Kootenai Tribe of Idaho (ʔaq̓anqmi) (KTOI) is located near Bonners Ferry, Idaho. The other bands are:

- yaqan nuʔkiy (Lower Kootenay Band), located near Creston, B.C.
- ʔaq̓am (St. Mary's Band) located near Cranbrook, B.C.
- ʔakink̓umǂasnuqǂiʔit (Tobacco Plains Band) located near Tobacco Plains, B.C.
- ʔakisq̓nuk (Columbia Lake Band) located near Windermere, B.C.
- k̓upawi¢q̓nuk (Ksanka Band) located in Elmo, Montana

The KTOI is governed by the Kootenai Tribal Council. The Ksanka Band is part of the Confederated Salish and Kootenai Tribes of the Flathead Reservation (CSKT) and is governed by CSKT Tribal Council. The four communities in British Columbia are governed by their individual Band Councils and the Ktunaxa Nation Council. The Ktunaxa Nation comes together as one to discuss and address issues affecting the Nation and the Territory under a Protocol signed in 2009.

Ktunaxa Territory consists of portions of Idaho, Montana, Washington, British Columbia and Alberta. The KTOI inhabited the area along the Kootenai River from above Kootenai Falls, Montana in the east, Priest Lake, Idaho in the west, Lake Pend Oreille, Idaho in the south and Kootenay Lake, British Columbia in the north.

The heart of Ktunaxa Territory is the Kootenai/y River and its tributaries. The Kootenai Subbasin Plan provides a useful overview (found at https://www.nwcouncil.org/sites/default/files/Assessment_01IntroOverview.pdf):

> The Kootenai River Subbasin is situated between 48° and 51° north latitude and 115° and 118° west longitude and includes within its boundaries parts of southeastern British Columbia, northern Idaho, and northwestern Montana. It measures 238 miles by 153 miles and has an area 16,180 sq miles. Nearly two-thirds of the Kootenai River's 485-mile-long channel and almost 70 percent of its watershed area, is located within the province of British Columbia. The Montana part of the subbasin makes up about 23 percent of the watershed, while the Idaho portion is about 6.5 percent (Knudson 1994). The primary focus of this assessment

is on that part of the subbasin that falls within the U.S.; those parts of the subbasin upstream and downstream in British Columbia are covered in less detail. ***

***

The headwaters of the Kootenai River, which is spelled Kootenay in Canada, originate in Kootenay National Park, B.C. The river flows south into the Rocky Mountain Trench, and then enters Koocanusa Reservoir (also known as Lake Koocanusa) created by Libby Dam and located near Libby, Montana. After leaving the reservoir, the Kootenai River flows west, passes through a gap between the Purcell and Cabinet Mountains and enters Idaho. From Bonners Ferry, it enters the Purcell Trench and flows northward through flat agricultural land (formerly a floodplain/wetland complex) toward the Idaho-Canada border. North of the border, it runs past the city of Creston, B.C. and into the south arm of Kootenay Lake. Kootenay Lake's west arm is the outlet, and from there, the Kootenai River flows south again to join the Columbia River at Castlegar, B.C. At its mouth, the Kootenai has an average annual discharge of 30,650 cfs (KRN 2003). The Continental Divide forms much of the eastern boundary of the subbasin, the Selkirk Mountains the western boundary, and the Cabinet Range the southern. The Purcell Mountains fill the center of the river's J-shaped course to where it joins Kootenay Lake.

In its first 70 miles (from the source to Canal Flats), five rivers—the Vermillion, Simpson, Cross, Palliser and White—empty into the Kootenai. Together those streams drain an area of approximately 2,080 square miles. At Canal Flats, the Kootenai enters the Rocky Mountain Trench, and from there to where it crosses the border into Montana, a distance of some 83 miles, it is joined by several more tributaries (Skookumchuck, Lussier, St. Mary, Elk, and Bull Rivers and Gold Creek). Collectively, they drain another 4,280 square miles. After entering Montana, the Tobacco River and numerous small tributaries flow into Koocanusa Reservoir. Between Libby Dam and the Montana-Idaho border, the major tributaries are the Fisher and Yaak Rivers. In Idaho, the major tributary is the Moyie River, which joins the Kootenai from the north between the Montana-Idaho border and Bonners Ferry, Idaho. The Goat River enters the river in Canada, near Creston, B.C.

Almost all of the major tributaries to the river—including the Elk, Bull, White, Lussier, and Vermillion Rivers—have a very high channel gradient, particularly in their headwaters. The highest headwater areas lie almost 10,000 vertical feet above the point at which the Kootenai River enters Kootenai Lake. Much of the mainstem, however, has a low gradient; from near Canal Flats to where the river enters Kootenay Lake, a distance of 300 miles, the river drops less than 1000 feet. Still, even there valley-bottom widths are generally under two miles and are characterized by tree-covered rolling hills with few grassland openings. Only in the Bonners Ferry-to-Creston area and the Tobacco Plains are there slightly wider floodplains.

> In terms of runoff volume, the Kootenai River is the second largest Columbia River tributary. In terms of watershed area (10.4 million acres), the subbasin ranks third in the Columbia (Knudson 1994).

Libby Dam became operational in 1974 and is part of the Columbia River System Operations. The Kootenay River is also impounded by Corra Linn Dam where the west arm of Kootenay Lake flows into the Kootenay River where it meets the Columbia River. Duncan Dam, also authorized by the Columbia River Treaty and spanning the Duncan River, also controls flows into Kootenay Lake.

Ktunaxa people also inhabited and used the Arrow Lakes, Priest Lake and Lake Pend Oreille for subsistence gathering and cultural activities. Ktunaxa participated in the Kettle Falls fishery, traveling from Ktunaxa Territory to the location annually to obtain salmon.

The construction, inundation and operation of the hydroelectric facilities had a profound impact on Ktunaxa resources and continues to do so. Nearly all the species Ktunaxa relied on for subsistence and cultural purposes are threatened, endangered or extirpated.

]

Thus, the ability of Ktunaxa people to practice their religion and culture is impeded by the Columbia River System Operations. Especially for the KTOI and Yaqan Nukiy, the main source of subsistence was fishing rather than hunting due to the location. The Kootenai/y River itself became part of KTOI identity and historically there were a number of camp locations along the River such as at Jennings, Montana.

The construction, inundation and continued operation of Libby Dam interrupted the lifeways of the River and its ecosystems, which had a cascading effect from the fish, to the riparian areas, and to the mountaintop ridges, including berries. This in turn had a cascading effect on KTOI culture.

For example, the Kootenai Sturgeon Nose Canoe was an integral part of KTOI identity and was unique to the Kootenai. The Kootenai would travel throughout the Kootenai Valley during the spring floods to different areas for different purposes, as well as between villages to visit other Ktunaxa. The CRSO eliminated the ability to do so and the Kootenai Sturgeon Nose Canoe was nearly lost.

One significant site along the River for the KTOI specifically and Ktunaxa generally is the Kootenai Falls located in present-day Montana. There have been attempts to dam the Falls, but Ktunaxa people from all communities gathered together to fight the attempts and won. CRSO operations have changed the Falls somewhat, but thankfully Ktunaxa People are still able to utilize Kootenai Falls as their modern church. Every June, the Ktunaxa Nation gather at Kootenai Falls for ceremony and social interaction.

Ktunaxa Territory generally and the Kootenai River Subbasin specifically is transboundary and impacted by Columbia River System Operations. The KTOI works diligently to mitigate the impacts of the CRSO operations through ecosystem restoration. The Tribe works in close coordination with its sister communities in the Ktunaxa Nation as well as the United States, Canada, British Columbia, Idaho and Montana governments, along with local governments, individuals and organizations to address those impacts and restore Ktunaxa resources.

Unfortunately, the CRSO EIS analysis focuses solely on resources in the United States. It is impossible to fully analyze impacts to Ktunaxa resources with this artificial limitation. Libby Dam operations affect both upstream resources in British Columbia, as well as downstream resources in Montana, Idaho and British Columbia. Columbia River System Operations are also closely coordinated with Columbia River Treaty operations, which have an impact on Ktunaxa resources on both sides of the international boundary. The alternatives analysis will not show those impacts unless the EIS is expanded to address all impacts to Ktunaxa resources.

Shoshone-Bannock Tribes
CRSO Tribal Perspectives Document

Summary/Abstract: *The Shoshone-Bannock Tribes (Tribes) of the Fort Hall Indian Reservation, located in Southeast Idaho, appreciate the co-lead agencies providing this opportunity to hear our perspective on the Columbia River System Operations (CRSO) and the Environmental Impact Statement (EIS) currently being developed for the Columbia River System (System). As a cooperating agency, federally recognized Tribe, and Fish Accord partner, the Tribes have a unique view of the issues surrounding anadromous fish management in the context of the operations of the System. Given the limiting factors affecting the recovery of anadromous fish throughout the System, the Tribes believe it is time to select an alternative that restores the systems and affected unoccupied lands to a natural condition. This includes the restoration of component resources to conditions which most closely represents the ecological features associated with a natural riverine ecosystem. Based on the range of feasible alternatives, the nearest alternative to this perspective would be for the co-lead agencies to select and implement Multiple Objective - 3 (MO3).*

The Tribes perspectives are based upon our reliance on the natural riverine ecosystem of the Columbia River Basin (Basin) for subsistence since time immemorial. This reliance was recognized and guaranteed through the Treaty reserved right to hunt on unoccupied lands of the United States. Our rights and interests are directly impacted by the operation, maintenance, and configuration of the System. To protect our rights and interests we are participating in the development of the EIS as a cooperating agency. Since our perspective can be broader than the boxes of National Environmental Policy Act (NEPA) allows for and our expanded definitions of Indian Trust Assets and Cultural Resources cannot be heard we feel that the Tribal Perspective section is a welcomed opportunity to express our values, concerns, and risks to the Tribes culture and Treaty reserved rights.

As is the fate of the Salmon, the continued existence of our culture is at risk of extinction because of the environmental inequities that have been forced upon our people. Over the last 200 years we have endured brutal atrocities against our people, the taking of our lands, the depletion of our food and medicinal resources, the political interests of the majority, and the legal conclusions that now govern how our culture can exist. The equitable distribution of environmental risk and benefits has not been afforded to the Shoshone and Bannock peoples, and as it has been done throughout history, we are forced to shoulder the burdens of conservation. Because what is at stake now is our Treaty reserved subsistence lifestyle.

Populations of salmon, including those in the Snake River subbasin, decreased substantially coincident with the construction of hydroelectric dams on the Lower Snake and Columbia rivers and other anthropogenic impacts across the landscape. Currently, salmon occupy 40% of their historic habitat in the Basin. Salmon in the Snake River subbasin have been completely eliminated above the Hells Canyon Complex and abundance in the Salmon River is estimated at 0.5% of its historical runs size. Snake River chinook and steelhead smolt to adult returns (SARs) are generally less than 1% — far below the necessary standard for population replacement or to meet the Northwest Power and Conservation Council goals of 2-6%. Reducing current annual Tribal member consumption to 1.2 pounds of salmon compared to historical use of about 700 *pounds per person. The loss of salmon threatens traditional cultural practices that are a vital part of our Tribal identity.*

I. Shoshone and Bannock Peoples' Culture of Stewardship

The Tribes' desired future condition for the System is that Tribal members will have the opportunity to harvest salmon using both traditional and contemporary methods on populations that are sustainable, resilient, and abundant. The lands and resources within the Basin are an important part of the Tribes' history, contemporary subsistence, and traditional cultural practices. The management direction taken by this environmental evaluation will have a significant impact on our people and our cultural resources. The resulting decisions must ensure future generations of Tribal members will have the same unique opportunities to enjoy the landscape, gather resources and continue traditional cultural practices.

Knowledge and stewardship of traditional fisheries is a privilege and a responsibility of the present generation to continue the unique heritage of the Shoshone and Bannock people. Continuation of traditional cultural practices in modern day requires the use of technical innovation combined with essentials of tradition. Persistent today is an instinct to return to the fisheries, resource patches, and lands to continue the heritage of the Shoshone and Bannock peoples. Tribal identity continues to be defined by practicing traditional cultural lifeways. Hunting and gathering in the same location as our ancestors and continuing to practice the same traditions is a powerful realization that these lifeways have been unchanged for millennia. Tribal identification is found by practicing traditional principles that mirror the images of our ancestors hunting anadromous fish and gathering and giving thanks for the blessings.

During the nineteenth century, increasing numbers of emigrant fur trappers, miners, ranchers, and non-Indian settlers occupied the lands within the Columbia River basin. These early contacts with the Shoshone and Bannock peoples identified settlements with large concentrations of our people noted throughout the Snake River drainages. "By the time Euro-Americans began to write about the Upper Snake Region in 1811, most of the Shoshone-Bannock populations in the area were fully equestrian peoples who traveled a wide territorial range." (Albers, 1998) Although the *Agai Deka* (Shoshone Salmon Eaters) were fully equestrian, the *Tuku Deka* (Sheepeater Shoshone) never adopted the horse and had permanent residence in Central Idaho until the late 1800's when conflict forced this last band to the reservation lifestyle. The fierce competition for resources by a growing population required the Shoshone and Bannock peoples to travel further for wildlife resources now absent from the Snake River subbasin; increasing the importance of anadromous fisheries for basic survival.

The Shoshone and Bannock peoples endured decades of conflict with encroaching settlers onto traditional gathering areas and witnessed the once sustainable resources disappearing from the landscape. At the height of the Civil War, troops led by General Connor massacred over 300 Shoshone people at the Bear River and a new era of forced removal began for our people. The federal government and territorial officials negotiated numerous treaties with Shoshone and Bannock peoples but never ratified. During the summer of 1863 treaties were proposed to Shoshone and Bannock peoples at Fort Bridger, Box Elder, and Soda Springs; all three were unratified. In 1864 a treaty was offered to Shoshone and Bannock peoples in the Boise Valley to force them to make way for settlement, the treaty was signed but, never ratified and our people were removed. In 1866, 1867 and 1868, the Bruneau, the Long Tom Creek, and Virginia City treaties were offered to Shoshone, Paiute and Bannock peoples and then the Virginia City; but none were ratified. Finally, on July 3, 1868 the Fort Bridger Treaty was negotiated and ratified by Congress in 1869, which reaffirmed the permanent home and reserved off-reservation rights.

In June 1867, an Executive Order established the Fort Hall Indian Reservation in Southeastern Idaho, as a collective place to consolidate the various bands of Shoshones and Bannocks, from their aboriginal lands, clearing the way for European-American settlements, such as ranchers and miners who desired rich resources present on aboriginal lands. Following the ratification of the Fort Bridger Treaty of 1868, an Executive Order in 1869 confirmed Fort Hall as the permanent home of the Tribes. The Tribes acted in good faith to protect our subsistence rights to harvest foods, medicine, and materials from our homelands, while promoting a safe, secure permanent homeland on the Fort Hall Reservation. Article IV of the Fort Bridger Treaty secured the off-reservation right to procure subsistence resources:

> *The Indians herein named agree, when the agency-house and other buildings shall be constructed on their reservations named, they will make said reservations their permanent home, and they will make no permanent settlement elsewhere; but they shall have the right to hunt on the unoccupied land of the United States so long as game may be found thereon, and so long as peace subsists among the whites and Indians on the borders of the hunting districts.*

In the Lemhi River Valley, the *Agai Deka* (Salmon Eater) Shoshone, Bannock and mixed *Tuku Deka* (Sheepeater) bands occupied a small reservation reserved near present day Salmon, Idaho through the Virginia City Treaty of 1868. By 1900, the Lemhi Bands of Shoshone, mixed bands of Bannock, and Sheepeater Shoshone were forcibly removed from the Lemhi Reservation to Fort Hall to join the Shoshone-Bannock Tribes. With the termination of the Lemhi Reservation our people were forced to travel long distances to procure anadromous fish resources from our homelands.

Cultural resources, as narrowly defined by most federal and state agencies, are "historic and archeological sites, historic structures and buildings". The Tribes expand this definition of cultural resources and include all elements of mind, spirit, and physical being; all are inextricably tied to the physical landscape. Examples include archaeological sites, historic sites, traditional cultural practices, spiritual beliefs, sacred landscapes, intellectual property, subsistence resources, language and oral tradition, place names and tribal cultural geography. The Tribes' definition of cultural resources is based in a holistic perspective that encompasses plants, water, animals and humans, as well as the relationships existing among them. Cultural resources located in the Basin and associated drainages are highly significant because they directly contribute to the Shoshone and Bannock peoples' unique cultural heritage. Simply stated, a cultural resource is any resource of cultural character. The Tribes policy for Cultural Resource states:

> *The Tribes retain, assert, and exercise our inherent and ongoing rights as a sovereign government, pertaining to cultural resources and cultural properties. Where federal laws are non-existent or inconsistent, the Tribes will continue to exercise our inherent*

> *rights and unwritten traditional practices, in regards to the management of cultural properties and natural resources.*
>
> *It is the Tribes' right and responsibility to interpret and perpetuate cultural and heritage resources for future generations of Tribal members and the Tribal community. The Tribes continue to practice our unique subsistence lifestyle that maintains Tribal traditions and ceremonies, improves health, and utilizes ancestral territories. In addition, the Tribes will continue to work diligently to ensure the protection, preservation, and enhancement of our rights for future generations.*

Archeological records indicate that the Shoshone and Bannock cultures are at least 10,000 years old in their aboriginal range, while our oral histories are centered around creation in our homelands. Research shows salmon is a significant primary resource along with terrestrial wildlife, resident fish, roots, berries and other botanical resources. A renowned ethnographer and linguist for the Tribes described our connection to anadromous fish in the mid-1900's by noting, "A culture existence is dependent on the continuity of interconnected knowledge, beliefs, conventional behavior and technical practices" (Lilljeblad 1972:79). The traditional cultural practices, including the use of riverine resources, are the foundation on which the Shoshone and Bannock peoples built sustainable communities across our homelands for millennia.

It is well established that the United States has a solemn trust obligation to the Tribes. Under this obligation, the United States has a trust responsibility to consider the best interests of the Tribes pursuant to federal law, including the Native American Graves Protection and Repatriation Act (NAGPRA) and other federal heritage laws. The Tribes policy for NAGRPA states:

> *The Shoshone and Bannock people continue to advocate for protection of the human remains of our ancestral people because we consider that to be a basic human right. Although we were forcibly removed to the Fort Hall Reservation, our innate connections with the off-reservation lands are strong and viable. It is not our wish to see the forcible removal of our people who have already left this world, and move them to the Fort Hall Reservation, but it is the Tribes desire to retain the ancestral links to the lands in which they lived. These Newenne people demonstrate the proof of our existence on our aboriginal lands, therefore we do not want them removed from these lands. It is the policy of the Tribes to repatriate the human remains of our people as close as reasonably possible to the original burial location or with the original discovery site.*
> *Recognizing the timely need to collaborate with federal land owners, museums and other curation facilities, it is the policy of the Shoshone-Bannock Tribes to develop agreements on repatriation, to ensure confidential protection of burial locations and original discovery location. It is the policy of the Shoshone-Bannock Tribes that any commercialization of any aspect of the NAGPRA process is expressly prohibited.*
> *It is the policy of the Shoshone-Bannock Tribes that all of our past people's human remains, and funerary items, associated and unassociated items, shall not be subject to destructive testing, handling or scientific research inquires by academia. Any photography, use of social media or video of such items by reporters, academics, federal agencies, and private individuals is expressly prohibited, unless a Tribally-designated representative is present with written approval from the Tribes.*

It is the intent of this perspectives section to include more than the basic archeological issues identified in the DEIS and discuss all aspects of the cultural resources present in the Basin. From the Tribes' perspective, the empirical data in ethnographic and archaeological records documenting Tribal occupancy, oral history regarding the importance of the riverine ecosystem, and the cultural aspects of procuring subsistence foods cannot be effectively separated. In essence the entire Basin is a connected cultural resource for our people, as well as many other tribes residing in the Basin. It is only when you view this complex system as a whole that you realize the cascading effect of management actions for every living being that relies on it. The construction, inundation, operations, and current configuration of the System have impacted cultural resources by contributing to the decline in anadromous fish abundance.

II. Tribal Subsistence in an Era of Depletion

Shoshone and Bannock peoples consumed approximately 700 pounds of salmon per person annually, prior to the development of the System. At present, only 1.2 pounds of salmon are consumed per tribal member annually. Using simple subtraction results in a deficit of ~699 pounds of salmon consumed per Tribal member annually when comparing traditional and current harvest estimates by the Tribes. As a people, we have gone from relying on anadromous fish runs that provided year-long subsistence resources for our communities to ingesting merely ceremonial amounts of salmon during a short window each fishing season. While abundantly cheap hydropower has benefitted the Basin, it has come at the expense of our community's health and well-being. While every reasonable person recognizes that we cannot return to pristine, pre-contact conditions, the Tribes will continue to advocate for our members because we are currently shouldering the burden of conservation in our homelands, and losing an important part of our culture along the way.

Throughout the 20th Century, anadromous fish runs began to diminish in both total abundance and in their range. Although commercial over-harvest was one of the earliest issues, the development of the contemporary System from 1927-1978 severely limited the ability of salmon, steelhead, and Pacific lamprey to access their historic range; in some instances this development completely blocked entire watersheds. The challenges associated with managing ever limited anadromous fish resources inevitably led to structural conflict across the Basin.

The Tribes were not immune to the challenges surrounding off-reservation treaty rights and the often limited access to anadromous fish resources in the Basin. Gerald Cleo Tinno, an enrolled member of the Tribes and permanent resident of the Fort Hall Indian Reservation, was charged by the State of Idaho for spearing a Chinook salmon on the Yankee Fork Salmon River on July 16, 1968. Both spear fishing and taking salmon at that particular time and location were violations of state fishing regulations. The runs of anadromous fish were low and the state had curtailed all fishing in an attempt to preserve the species.[1]

The record specifically shows that historically Indians took salmon by spear at the spawning beds; likewise, there is evidence that after the treaty signing Fort Hall Reservation Indians customarily hunted and fished in the region encompassing the Yankee Fork locale. Salmon and steelhead have always been a key resource for the Shoshone and Bannock peoples throughout

[1] State v. Tinno, 94 Idaho 759 (Supreme Court of Idaho, June 8, 1972)

our homeland. The Supreme Court of Idaho concluded that this area was within the meaning of the Treaty for fishing by Tribal members.

The Supreme Court of Idaho stated that the "special consideration which is to be accorded the Fort Bridger Treaty fishing right must focus on the historical reason for the treaty fishing right. The gathering of food from open lands and streams constituted both the means of economic subsistence and the foundation of a native culture. Reservation of the right to gather food in this fashion protected the Indians' right to maintain essential elements of their way of life, as a complement to the life defined by the permanent homes, allotted farm lands, compulsory education, technical assistance and pecuniary rewards offered in the treaty. Settlement of the west and the rise of industrial America have significantly circumscribed the opportunities of contemporary Indians to hunt and fish for subsistence and to maintain tribal traditions. But the mere passage of time has not eroded the rights guaranteed by a solemn treaty that both sides pledged on their honor to uphold. As part of its conservation program, the State must extend full recognition to these rights, and the purposes which underlie them."[2]

Article IV of the Fort Bridger Treaty extended the right to take salmon, although the reasonable and necessary conservation regulations enacted by the State of Idaho may apply in certain circumstances. It was becoming very clear that anadromous fish would no longer be found in the same abundance as were necessary to sustain our people with subsistence resources unless intensive management objectives were implemented by all parties. It became essential that the Tribes continue to actively support restoration, supplementation and cooperative efforts with interested parties so that those anadromous fish species continue to be 'found thereon' in harvestable abundance. While the Action Agencies utilize a generic definition of Indian Trust Resources, the Tribes view every salmon as a trust asset that should be collectively managed to sustain our Treaty reserved right to harvest those subsistence foods. The Tribes determined it was necessary to adopt reasonable regulations to protect the Treaty right to 'hunt' free of interference from outside entities. As such, the Tribes adopted ordinances to govern the conduct of hunting activities both on and off the reservation by our membership. The basic tenets of these ordinances are then refined into regulations and guidelines for the harvest of anadromous fish and are coordinated, as necessary, with appropriate co-managers to alleviate conflicts during annual management seasons.

The shift in focus by the Tribes to become an active co-manager of anadromous fish resources led to new policy that would guide future Tribal actions. The Tribes offered a policy statement that would stress the importance of initiating efforts to restore the Snake River and affected unoccupied lands to a natural condition. The Tribes Policy for Management of the Snake River Basin Resources states:

> *The Shoshone Bannock Tribes (Tribes) will pursue, promote, and where necessary, initiate efforts to restore the Snake River systems and affected unoccupied lands to a natural condition. This includes the restoration of component resources to conditions which most closely represents the ecological features associated with a natural riverine ecosystem. In addition, the Tribes will work to ensure the protection, preservation, and*

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[2] *Id.* See generally.

> *where appropriate-the enhancement of Rights reserved by the Tribes under the Fort Bridger Treaty of 1868 (Treaty) and any inherent aboriginal rights.*

The Tribes then followed the policy statement by committing significant resources to developing a comprehensive Fish and Wildlife Department to manage resources across our homelands; one arm of that Department is solely focused on managing anadromous fish species. Consistent with the Tribes' Snake River policy, the Tribes' Fish and Wildlife Department are guided by the following mission statement:

> *The mission of the Shoshone-Bannock Tribes Fish & Wildlife Department is to protect, restore, and enhance, fish and wildlife related resources in accordance with the Tribes' unique interests and vested rights in such resources and their habitats, including the inherent, aboriginal and treaty protected rights of Tribes members to fair process and the priority rights to harvest pursuant to the Fort Bridger Treaty of July 3, 1868 (15 Stat . 673).*

The Department uses the language from our Treaty, policy statements, and mission statement to implement a collective Tribal vision for management. The Tribes still have a significant interest in developing sustainable hunting and fishing opportunities in the Basin because without broad consensus on goals and mitigation measures, it is likely anadromous fisheries will remain below sustainable and harvestable quantities. A quintessential component of the Tribal perspective is blending our traditional ecological knowledge with the tenets of western science to develop projects that will holistically benefit numerous native species and provide sustainable opportunities for subsistence harvest of those resources.

Populations of salmon, including those in the Salmon River subbasin, decreased substantially coincident with the construction of hydroelectric dams on the Lower Snake and Columbia rivers and other anthropogenic impacts across the landscape. Anadromous fish populations have been reduced to the point that Chinook salmon are listed under the Endangered Species Act (ESA) as a threatened species; this listing occurred on April 22, 1992 (57 FR 14653). Prior to 1992, the Tribes implemented Chinook salmon fisheries throughout the Salmon River, but in 1992 the dynamics of these fisheries were drastically altered. The annual harvest guidelines changed on a yearly basis and were dependent upon escapement estimates. Once the ESA protections were established, the Tribes were forced to adapt their fishing practices to hatchery influenced areas, which resulted in a diminishment of fishing practices in traditional fishing areas. After the listing of Snake River Sockeye the Tribes were precluded from harvesting these fish in any meaningful manner. Our perspective at that time was that ESA listing would help these anadromous fish populations recover over the next few decades to sustainable, harvestable levels again. Unfortunately, populations remain roughly in the same condition as they were during the listing decisions almost thirty years ago.

Historically, the Shoshone and Bannock peoples harvested salmon and trout throughout the Basin for subsistence across an almost year-round timeline. Annual salmon and steelhead runs in what are now Oregon, Washington, Idaho and Nevada provided harvest opportunities throughout the year for our people. Anthropogenic impacts to the Basin severely constrained runs of anadromous fish over the next century, in particular System development and operations.

Current salmon abundance in the Upper Salmon River subbasin is estimated at about 0.5% of historical runs and the Hells Canyon Complex completely eliminated upstream migration into the Middle Snake Province in Idaho, Nevada, and Oregon. **Recent harvest opportunities for Tribal members have only provided 1.2 pounds of salmon per Tribal member compared to historical use of about 700 pounds per person annually.** The following excerpt demonstrates how this estimate is derived.

Shoshone-Bannock Reliance on Anadromous Fish Resources – taken from Walker 1993[3].

> *Several methods have been employed by scholars and scientists to estimate both the amount of fish traditionally available and the amounts traditionally harvested by the tribes of Idaho including the Shoshone-Bannock Tribes. It has been estimated by Rostlund, Hewes and Walker, the Shoshone and Bannock people's average annual fish harvest for the Salmon River region was 233,555 fish (range 36,500-604,166). This is based on several methods of estimating historical catch information and assumes 15 pounds per fish.*
>
> *One of the earliest and most enduring studies of fish populations and harvests in Native North America was completed by Erhard Rostlund in 1952 and published as "Freshwater Fish and Fishing in Native North America." Assuming Rostlund's method is correct, the home territory of the Tribes which includes 10 million square acres or about 15,625 square miles, the Tribal catch derived by Rostland would be 9,062,500 pounds. At an average weight of 15 pounds per fish, this equates to 604,166 total fish.*
>
> *A different method was used by Hewes in his 1947 "Aboriginal Use of Fishery Resources in Northwestern North America." By this method, a tribal population of 1,000 would consume 1,000 pounds per day or 365,000 pounds per year. The Shoshone and Bannock population of southern and central Idaho probably exceeded 5,000 which would produce an average annual catch of 1,825,000 pounds. By apportioning 1,500 of this 5,000 total Shoshone and Bannock peoples to central-Idaho (Salmon River region), the Hewes method would yield an average annual catch of 547,500 pounds, a figure close to the estimate made by Walker. At an average weight of 15 pounds per fish, this equates to 36,500 total fish.*
>
> *Another method used for estimating Shoshone and Bannock subsistence harvest, typical of central Idaho during the mid-19th century is the direct comparison of harvest of fish and game in Alaska. The Alaskan research indicates that contemporary hunting and gathering ranged as high as 1,498 pounds of fish and game per person per year with an estimated annual average throughout Alaska of 250 pounds (dressed weight). About 65% of the harvest was found to be fish with such species at salmon, halibut, herring, whitefish, cod, and artic char. Also resembling the Columbia system during the latter nineteenth century, ninety-five percent of the total fish harvest in Alaska is now taken by the commercial harvest.*

[3] Walker, D. E. 1993. Lemhi Shoshone-Bannock reliance on anadromous and other fish resources. Northwest Anthropological Research Notes Vol. 27, pp. 215–250.

> *Although we cannot compare specific Alaska communities with the Shoshone-Bannock, we can use the Alaskan survey data to help validate ranges of historic Shoshone-Bannock fish consumption. For example, 65% of the Alaskan high estimate is 973.7 pounds of fish per person per year, a figure within the range of estimates for tribal groups of the Columbia River system.*
>
> *Walker (1993) further improved fish consumption estimates for the Shoshone-Bannock. Walker used more empirical methods as a first step in estimating Shoshone-Bannock reliance on fish resources in the Salmon River country. Walker (1993) grouped the Shoshone-Bannock fishing sites into three broad types: fishing sites at natural falls, cascades, or rapids; those constructed as weirs, traps, and fish walls, and the simple fishing site commonly utilized without any such distinguishing features. The first two types are by far the most productive sites and are capable of daily harvests in the hundreds and even thousands of fish during certain peak days of the fish runs. Walker (1993) located about 50 such sites. The third type is not usually employed during peak days of the anadromous fish runs and is used in an opportunistic manner for both anadromous and resident species. Walker estimates Shoshone-Bannock harvest in the Lemhi/Salmon River region to be 200 fish per day, per weir, averaging 15 pounds each. This yields a potential average annual harvest of 900,000 pounds, or about 60,000 fish*

Several methods have been employed to estimate the amounts traditionally harvested by the Tribes in the Salmon River subbasin. Rostlund (1952), Hewes (1947), and Walker (1993) used different methods for estimating annual harvest, but the average annual salmon harvest for the Salmon River was 233,555 salmon (range 36,500 – 604,166). Assuming an average of 15 pounds per salmon, the annual average harvest in pounds of salmon was 3,503,325 (range 547,500 – 9,062,500). Hewes (1947) also apportioned 1,500 of the 5,000 total Shoshone and Bannock peoples to traditionally inhabit central Idaho (Salmon River subbasin) to hunt salmon. Using the annual average harvest in pounds of salmon (3,503,325) and dividing by the approximately 1,500 Tribal members traditionally in the Salmon River region, equates to 2,336 pounds of salmon consumed per tribal member annually. (Denny et al. 2010)

Current estimates (1981 – 2018) of average salmon harvested by the Tribes in the Salmon River are approximately 470 salmon annually (range 0 – 1,678). After applying an average of 15 pounds per salmon, the current annual average harvest in pounds of salmon is 7,050. Using the current annual harvest in pounds per salmon (7,050) and dividing by the current approximately 6,000 Tribal members, equates to an *average* of 1.2 pounds of salmon consumed per tribal member annually. On years of particularly low abundance, it is common for many Tribal members to consider themselves fortunate to procure enough fish for a single family meal or ceremony. To make up for some of this loss the Tribes conduct traditional trades for salmon with other Northwest tribes or receive surplus hatchery salmon from collection racks in Idaho, Oregon, and Washington. Without a doubt, the loss of this food source has had impacts on our community's health and well-being, with anadromous fish resources contributing healthy sources of protein for our people in an age of processed foods and rising rates of diabetes[4].

[4] Estimates for diabetes rates among Native American populations is generally twice as high as the national average (2018 CDC.gov Diabetes Quick Facts).

Regardless of the decision from this environmental evaluation, the Tribes remain focused on the sustainability of anadromous fish resources in the Basin. Over the past three years, abundance of Snake River Sockeye, Snake River Steelhead, and Snake River Chinook have all decreased to their lowest levels since they were listed under the ESA. This environmental evaluation is coming at a critical time for the Basin and could have long-reaching effects for these iconic anadromous fish species and the Tribal members who rely upon them. Our obligation as managers and stewards of these resources from time immemorial has shaped our perspective on the best manner to operate the System and ultimately, recover anadromous fish species to sustainable and harvestable levels.

III. Salmon and Ecosystems

The Tribes perspective on meaningful recovery includes the restoration of component resources to conditions that most closely represent the ecological characteristics and processes associated with a natural riverine ecosystem. We agree with Williams et al. (1999) who concluded "that management of the Columbia River and its salmonid populations has been based on the belief that natural ecological processes comprising a healthy salmonid ecosystem can, to a large degree, be replaced, circumvented, simplified, and controlled by humans while production is maintained or even enhanced." If one conclusion can be effectively drawn, it is that with the current system configuration we will be unable to meet our collective goals of species conservation and sustaining Tribal treaty rights. The Tribes endorse a more holistic perspective where humans work to restore the natural processes that support healthy ecosystems, healthy economies, and healthy cultures.

Based on our unique Traditional Ecological Knowledge gathered over generations as stewards of the Snake River, is a desire to move toward more normative river conditions. In the Basin an estimated 5-9 million anadromous fishes returned annually (Alldredge et al., Northwest Power and Conservation Council ISAB Report 2015).[5] Watersheds across the Basin were filled with an abundance we can scarcely comprehend in our current management paradigm. The anthropogenic impacts of industrialized development in the Basin have dramatically reduced anadromous fish abundance to near-extinction and as co-managers the Tribes are seeing a growing acceptance of the new levels of abundance.

Salmon and steelhead are crucial components of the landscape of the Basin. Abundant populations of anadromous salmonids (*Oncorhynchus* spp.) historically contributed large amounts of marine-derived nutrients (MDN) to aquatic and terrestrial ecosystems in the Pacific Northwest (PNW) of the United States of America (California, Oregon, Washington, and Idaho) (Kline et al. 1990; Larkin & Slaney 1997; Cederholm et al. 1999; Gresh et al. 2000; Bilby et al. 2003). Nitrogen, phosphorous, and carbon sequestered in the marine environment, where approximately 95% of the body mass of salmon accumulates, are subsequently delivered to inland watersheds via upstream migrations (Groot & Margolis 1991). These migrations represent a major nutrient and energy vector from the marine environment to freshwater and terrestrial ecosystems (Cederholm et al. 1999).

After returning to natal spawning habitat, salmon complete their life cycle and in turn deliver ecologically significant amounts of MDN to inland habitats (Gende et al. 2002; Thomas et al.

[5] Alldredge et al., Northwest Power and Conservation Council ISAB Report, 2015.

2003). Anadromous fishes deliver MDN to freshwater ecosystems through excretion, gametes, and their own nutrient-rich carcasses. Primary nutrient pathways from salmon carcasses to stream biota include: 1) uptake of inorganic nutrients (provided by excretion during spawning events) by primary producers; 2) uptake of mineralized inorganic nutrients by primary producers and subsequent food web transfer; 3) uptake of dissolved organic matter by microfauna in the streambed and subsequent food web transfer; and 4) direct consumption of eggs and carcass materials by secondary consumers and fishes (Cederholm et al. 1999; Kiernan et al. 2010). Energy and nutrients delivered to freshwater ecosystems also benefit a myriad of aquatic and terrestrial wildlife species and acts to sustain the ecological integrity and proper functioning condition of whole ecosystems. In the PNW, Cederholm et al. (1989) documented 22 species of mammals and birds that were observed or known to directly consume salmon carcasses. And Bilby et al. (1996) estimated that 18% of nutrients in riparian area vegetation along a salmon bearing stream were derived from salmon themselves.

Spawning salmon contribute an estimated 5 to 95% of the P and N loading in salmon-bearing watersheds (Gresh et al. 2000), and even small input of nutrients and C may be important to the maintenance of trophic productivity (Larkin & Slaney 1997). This process has been described as a positive feedback loop functioning to enhance freshwater productivity for future generations of anadromous and resident stream biota (Wipfli et al. 1998; Hicks et al. 2005). The presence and availability of marine-derived nutrients has been shown to increase the growth rate, lipid level, and condition factor of juvenile fishes (Bilby et al. 1996; Wipfli et al. 2004); and higher growth rates appear to increase freshwater and marine survival (Beckman et al. 1999; Bilton et al. 1982; Ward and Slaney 1988). It is now clear that spawning salmon serve numerous ecological functions and should be an important component of ecosystem recovery plans (Cederholm et al. 1999).

Following periods of intense commercial harvest, hydrosystem development, hatchery production, and habitat loss, significant declines in Pacific salmon abundance have occurred throughout the region (Lichatowich 1999). Returning anadromous adults in the Basin, once estimated at 5-9 million fish annually, now return at an average of less than 2-3 million fish per year (Alldredge et al. (ISAB) 2015). Healthy populations of salmon that once provided annual nutrient subsidies to otherwise nutrient-impoverished environments largely remain depressed or have been extirpated (Levy 1997). Currently, salmon occupy approximately 40% of their historic range (Nehlsen et al. 1991) and contribute just 6-7% of the MDN historically delivered to PNW rivers and streams (Gresh et al. 2000). Consequently, many forested streams of the region are now characterized as ultra-oligotrophic (Welsh et al. 1998), a condition of low nutrient concentrations suggested to result from a combination of parent geology and low numbers of returning anadromous fishes (Ambrose et al. 2004).

The upper Salmon River subbasin of central Idaho is an example of this process, where we have seen evidence that the paucity of returning anadromous fishes, coupled with low watershed scale nutrient inputs, act synergistically to limit freshwater productivity and associated habitat carrying capacities. Effectively, the loss of ecological functions associated with abundant salmon returns will constrain efforts to recover salmon and steelhead populations. Thomas et al. (2003) estimated that 25-50% of Idaho streams are nutrient-limited and Alldredge et al. (ISAB 2015) and Achord et al. (2003) found evidence of density-dependent mortality at population sizes well below historical levels, suggesting nutrient deficits as a limiting factor capable of reducing stream rearing carrying capacities. In a recent analysis, Scheuerell et al. (2005) examined phosphorous-transport dynamics by spring/summer Chinook salmon (*Oncoryhnchus tshawytscha*) in the Snake River subbasin and estimated that over the past 40 years less than 2% of historical marine-derived phosphorous is currently delivered to natal spawning and rearing streams.

Interestingly enough, these same central Idaho streams and lakes found in wilderness or roadless areas are reported by Idaho Department of Environmental Quality as presumed to be fully supporting all beneficial uses (IDEQ 2016). However, the 'new normal' abundance levels do not adequately support harvest, species conservation, or the ecosystems these populations of anadromous fish influenced over thousands of years. The simple truth is that we need returning adults to feed the next generation of anadromous fish and to support the ecological functions necessary for their survival.

IV. Salmon in a Changing Climate

Climate change impacts have the potential to affect the entire Basin and resources the Tribes stewarded from time immemorial. The change has the potential to impact both aquatic systems across the Basin and the generation of electricity from the System. Planning for these changes will require a focused shift in attention towards building resilience, supporting ecosystem services and habitat health, decreasing non-climate stressors, and improving watershed retentive capabilities to help buffer these climate changes. Climate change presents a threat to critical cultural resources, thereby also threatening the lifeways and wellbeing of the Tribes. This creates an urgent need to build climate resilience to protect and preserve these resources for future generations. The Tribes policy on Climate Change states:

> *Global temperatures very likely exceed anything observed in the last 1,400 years and current levels of carbon dioxide are at concentrations unseen in the last three million years. Projected changes in temperature, precipitation, hydrology, and ocean chemistry threaten not only the lands, resources, and economies of the Shoshone-Bannock Tribes (Tribes), but also tribal homelands, ceremonial sites, burial sites, tribal traditions, and cultural practices that have relied on native plants, fish, and animal species since time immemorial. Therefore, the Tribes recognizes that action must be taken to reduce greenhouse gas emissions, positive radiative forces, and observed warming. The Tribes also recognizes a need for additional information to assess and convey uncertainties, identify actions to implement, develop decision support tools and climate projections, maintain and enhance healthy and resilient ecosystems, conserve water, and understand how climate change will impact the health and wellbeing of the Tribes. Therefore the Tribes will make efforts to mitigate the effects of human caused climate change through planning, consultation, education, and enforcement of Treaty Rights.*

The Tribes, in cooperation with the Upper Snake River Tribes Foundation, received funding from the Bureau of Indian Affairs in 2016 to prepare a Climate Change Vulnerability Assessment and Adaptation Plan for the Snake River Basin. The Tribes used an interdisciplinary approach where technical staff worked collectively with outside consultants to assess climate vulnerability and identify adaptation actions for critical plant and animal species and their habitats. While the primary focus of the adaptation plan was to determine impacts to the Fort Hall Reservation, one of the assessment areas included the Salmon River subbasin to the importance of anadromous fish to the Tribes. This report included downscaled future climate projections for the project area and a description of the vulnerability assessment process and outcomes for species evaluated (Snake River Spring/Summer Chinook salmon).

The impacts of climate change will likely be severe throughout the Basin and that some of those impacts are occurring right now. Anadromous fish require relatively cold water habitats and favorable ocean conditions to thrive; unfortunately, future conditions are unlikely to support the ecosystem services that anadromous fishes depend upon without planning to mitigate the effects of reduced snowpack, elevated summer air temperatures, extreme precipitation events, and the overall effects of greenhouse gases to the biosphere. While a specious argument could be made that hydropower does not generate carbon dioxide, the more immediate concerns lie with the impacts from the facilities that create slack-water reservoirs and a loss of riverine ecosystem structure and function.

Across the entire project area, average annual temperatures are projected to increase under both future climate scenarios and for all time periods. Warmer ambient air temperatures are expected to have important impacts on water availability and seasonal stream flows in the Snake River subbasin. Even with precipitation patterns staying relatively consistent (though still highly variable from year to year), the warmer temperatures are likely to increase evaporation and evapotranspiration. Mountainous regions, like the Salmon River subbasin, are projected to have less overall soil moisture available and receive less precipitation in the form of snowpack.

A change in ambient air temperatures and a shift from snowpack based systems to warmer, rain based systems may have cascading effects throughout the Salmon River subbasin. Reductions in snowpack due to a greater proportion of winter precipitation falling as rain instead of snow, will shift peak streamflow earlier in the year, increase winter streamflow, and decrease base summer stream flows. In basins where winter precipitation historically falls largely as snow, year-to-year variability in winter monthly flows is relatively small because the precipitation accumulates as snow instead of making its way to streams. This creates a winter flow regime that is relatively stable year-to-year. For aquatic species adapted to a relatively stable winter flow regime, changes in flow regimes will affect migration and refugia for anadromous and resident fish at all life stages.

More alarming than a change in flow regimes for anadromous fishes is the projection that stream temperatures are projected to rise as air temperatures rise. This will result in summer temperatures reaching thresholds above which the aquatic environment ceases to provide suitable habitat for some species. During the Tribes' planning process we viewed modelling results showing river segments throughout the Salmon River subbasin and Snake River migratory corridor in which the August mean water temperature is projected to exceed 63.5°F by the 2040s. This temperature threshold was chosen for illustrative purposes as temperatures exceeding 63.5°F extremely harmful for many salmonid species like Chinook salmon, Snake River sockeye salmon, Steelhead, and Bull Trout. For example, in 2015, greater than 98% of adult Snake River sockeye salmon perished attempting to migrate through the System during extreme July temperatures and low flow conditions. The compounding effect of warmer stream temperatures, warmer reservoirs, and altered flow regimes would negatively affect many native salmonid populations beyond their innate adaptive capability.[6]

V. Managing for Sustainability

In a contemporary setting, the Tribes exercise their right to hunt for Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) under inherent rights and the Fort Bridger Treaty. Under the ESA Section 4(d) Rule (50 CFR 223) allows a tribal government to submit a Tribal Resource Management Plan (TRMP) with the intent of exempting the tribes' harvest of protected species from the ESA. The purpose and scope of the Tribes' TRMP is to provide the Tribes an exemption under the ESA to harvest listed Chinook salmon in the Salmon River and Grande Ronde/Imnaha subbasins, while the species is listed as threatened. This approach is a responsible way to manage listed stocks and provides opportunities to pursue anadromous fish across our cultural landscape. The severe limitation of these conservation frameworks often restricts a ceremonial take of several fish in wild watersheds due to the extremely low abundance of wild fish returning in the past three decades. From our perspective, we have done everything possible to preserve our presence through traditional fishing in our homelands; it is time to implement an action that will provide for meaningful harvest opportunities for our future generations.

The current management paradigm, now almost two decades old, is that minor modifications to hydropower facilities and improvements in natal habitat and hatchery management will provide a vehicle for populations to 'trend toward recovery'. The Tribes continue to believe that conservation work has resulted in significant benefits to ecological processes and that hatchery reform will pay dividends for any program in the Basin; however, those benefits are not significant enough to overcome impacts from highly modified mainstem river habitats. The Northwest Power and Conservation Council has set goals of 2-6% (4% average) smolt to adult returns (SAR) so populations are at replacement even in low-abundance years, while on higher productivity years we see population growth.

McElhany et al. (2000[7]) developed a science-based framework to better understand and recover salmon populations. Within that framework, viable salmonid populations (VSP's) are defined as having a negligible risk of extinction resulting from demographic variation, local environmental variation, and loss of genetic diversity for a period of 100 years. McElhany et al. (2000) identified four broad categories for VSP parameters: diversity, spatial structure, abundance, and productivity. These factors have been identified as a means to assess populations, establish de-listing goals, and provide guidelines for relating viability at the population level to larger ecologically significant unit's (McElhany et al. 2000).
Currently (2012 to 2018), 84% of natural origin spring/summer Chinook salmon populations are below abundance levels needed to sustain themselves (viable population threshold abundance criteria) (SBT *unpublished data*). During the same period, 50% of these Chinook populations where Tribal members harvest salmon are at imminent risk of extinction (critical population threshold) (SBT *unpublished data*). The Snake River spring/summer Chinook ESU remains

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[6] *See generally*, https://eprints.qut.edu.au/103728/1/Isaak_et_al-2010-Ecological_Applications.pdf
[7] 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.

likely to become endangered (NWFSC 2015[8]). In more recent years, adverse ocean conditions and System management acted synergistically to yield some of the lowest adult Chinook salmon returns to the upper Salmon River subbasin since these populations were listed under the ESA.

Snake River Chinook salmon and steelhead smolt to adult return rates (SARs) from Lower Granite Dam to Lower Granite Dam are generally less than 1% — far below the necessary standard for population replacement. According to the Comparative Survival Study modeling conducted by the Fish Passage Center (FPC 2018), major population declines of Snake River wild spring/summer Chinook salmon were associated with SARs less than 1%. Only with SARs greater than 2% were populations at or above replacement. The Tribes support actions that will help achieve the Northwest Power and Conservation Council's Fish and Wildlife Program goal of SARs in the 2% to 6% range (average 4%) for federally ESA-listed Snake and Columbia River salmon and steelhead populations.

The Lower Snake River Compensation Plan (LSRCP) was authorized in 1976 explicitly to mitigate for lost commercial and recreational harvest opportunities associated with the construction and completion of the four dams on the Lower Snake River (Corps of Engineers 1975[9]). LSRCP included a significant hatchery program aimed at compensating for the estimated loss of 48% of juveniles migrating through the system and set production goals at 11 hatcheries to offset that loss (ISRP 2002[10]). Throughout the program's history up to present, LSRCP programs have not met their compensation goals in most years despite decades of hatchery reform and expensive changes to System infrastructure to increase the viability of hatchery reared juveniles and decrease System related losses, respectively (Marshall 2010[11], Marshall 2012[12]). For example, the LSRCP hatchery in the Upper Salmon River (i.e. Sawtooth Fish Hatchery), which produces Chinook salmon available for tribal members to harvest, are now not meeting the production goals to provide salmon for future generations (IDFG 2018[13]). The failure of the LSRCP to meet its congressionally authorized goals parallels continued declines in wild anadromous fishes above the four Lower Snake River dams and demonstrates that the losses associated with the current configuration of the System may be too great, and its effects too strong, to adequately mitigate.

[8] Northwest Fisheries Science Center. 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

[9] Corps of Engineers. 2975. Special Report, Lower Snake River Fish and Wildlife Compensation Plan. Lower Snake river Washing and Idaho. U.S. Army Engineer District, Walla Walla, Washington. 96pp plus appendices.

[10] ISRP. 2002. Lower Snake River Compensation Plan — Final Proposal Review for the Columbia Plateau, Blue Mountain, and Mountain Snake Provinces, April 23, 2002. ISRP 2002-6.

[11] Marshall, S. L. 2010. A brief history of the Lower Snake River Compensation Plan Hatchery Program for spring and summer Chinook salmon. In: Lower Snake River Compensation Plan spring/summer Chinook program review, November 30-December 02, 2010. Boise, ID.

[12] Marshall, S. L. 2012. A brief history of the Lower Snake River Compensation Plan Hatchery Program for summer steelhead. In: Lower Snake River Compensation Plan Summer Steelhead Program Review, June 20-21, 2012. Clarkston, WA.

[13] IDFG. 2018. Sawtooth FH Operations and Maintenance 2018 Annual Report. https://www.fws.gov/lsnakecomplan/Reports/IDFGreports.html.

VI. Economics of Energy - Why Restoring the Snake River Makes Fiscal Sense
One of the most contentious issues to face our region has been the mitigation measures associated with the Snake River facilities for listed stocks and the continued use of the facilities for hydropower and transportation. In 2002, the US Army Corps of Engineers performed a feasibility report that concluded the presence of these facilities outweighed alternatives in favor of removing the earthen portions of the dams; a practice commonly referred to as breaching.[14] Almost twenty years later it is time to revisit the issue in an objective manner and determine if the underlying assumptions associated with those facilities have shifted away from the status quo; the Tribes believe they have.

The following three perspectives from 2002 represent a spectrum of the discussion at that time, from how we value rivers and transport to the actual costs of maintaining them in place for the foreseeable future.

Loomis, John. "Quantifying recreation use values from removing dams and restoring free-flowing rivers: A contingent behavior travel cost demand model for the Lower Snake River." *Water Resources Research* 38.6 (2002): 2-1.

> *The river recreation use value estimates of $192–310 million are 6–10 times larger than current reservoir recreation benefits ($31.6 million). However, the annual hydro-power losses associated with dam removal are estimated to be $271million annually [USACOE, 1999]. Including the dam removal cost and foregone barge transportation, the costs rise to $360 million [USACOE, 1999]. River recreation would cover a large portion of these costs but not all of it. Owing to the need to recover the fish stocks, recreational, commercial, and tribal fishing benefits are limited as well. Thus in a traditional national economic development (NED) analysis that does not incorporate passive use values of recovering of threatened and endangered species, a strict benefit cost criterion would suggest it is economically efficient to allow the dams to remain.*

Whitelaw, E., & MacMullan, E. (2002). A Framework for Estimating the Costs and Benefits of Dam Removal: Sound cost–benefit analyses of removing dams account for subsidies and externalities, for both the short and long run, and place the estimated costs and benefits in the appropriate economic context. *BioScience*, *52*(8), 724-730.

> *In estimating the benefits from breaching the dams, the Corps excluded a number of relevant values, including tribe related benefits and the benefits that all of us gain from the existence of both the increased salmon runs and a free-flowing lower Snake River. First, the Corps' estimate of tribe related benefits included the number of acres of sacred and traditional sites that the tribes would regain access to, as well as the number of pounds of fish from treaty-protected subsistence and ceremonial fisheries, but it did not include the economic benefits that tribal members and other Northwesterners and*

[14] USACE Walla Walla District. 2002. Lower Snake Feasibility Report/Environmental Impact Statement Economic Appendix (I))

Americans would gain from these changes (USACE 1999b). In not doing so, it overlooked economic benefits to tribal members that constitute real increases in the value of national goods and services. As a result, the Corps underestimated how breaching the dams would benefit the tribes, and how that, in turn, would benefit all of us.

Babbitt, B. (2002). What goes up, may come down: Learning from our experiences with dam construction in the past can guide and improve dam removal in the future. *BioScience*, *52*(8), 656-658.

And lest there be any misunderstanding, my own stand on consensus-based dam removal is on the record. It became increasingly pronounced over the past half-decade as I graduated from one level to the next, embracing sledgehammer, jackhammer, wrecking ball, sky crane, and even C-4 plastic explosives to help dismantle dozens of obsolete structures, structures that had either outlived their function or outweighed their benefits with costs that society was no longer willing to pay. The change has come. The heyday of dams has come and gone. From my perspective, there is no turning back…. Dam removal, like dam construction, is not an end unto itself, only a means to an end. It is a means by which humans can live more responsible lives in harmony with creation, a means that requires the illumination of science, ensuring that we look clearly back, and down, before we can truly move forward on solid ground together.

While these differing perspectives dominated the conversation at the time, the underlying assumptions should be critically evaluated. In 2016, a group, Earth Economics[15], reviewed the 2002 Economic Appendix to the Lower Snake Feasibility report and concluded that circumstances have changed enough to warrant a new evaluation of these facilities.[16] This particular evaluation concluded that the "benefits created by the four dams are outweighed by the costs of keeping them." The basis for this conclusion included several aspects that were assumed to maintain a positive benefit over the 2002-2021 evaluation period, including: annual power production from the region, the cost and assumed benefit of mitigation programs aimed at recovering listed anadromous fishes, and, the maintenance of these facilities for transport programs.

The Tribes recognize the benefits that hydropower facilities have had in developing industries and providing electricity to customers in rural areas. However, these benefits were accrued at the expense of fisheries across the Basin, with impacts to Tribal communities who had relied on their presence for millennia. In 2019, the Basin is producing more electricity than we use and the growing renewable energy sector is changing the market at a rapid pace.[17] In the 2017 Pacific Northwest Loads and Resources Study (commonly referred to as the 2017 BPA White Book) the analysis shows significant surplus electricity generation through 2028. As noted in the

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[15] Earth Economics is a non-partisan, non-profit, science based group that develops value estimates for ecological services. General information may be found at their website: https://www.eartheconomics.org/ .

[16] (Mojica, J., Cousins, K., Briceno, T., 2016. National Economic Analysis of the Four Lower Snake River Dams: A Review of the 2002 Lower Snake Feasibility Report/Environmental Impact Statement. Economic Appendix (I). Earth Economics, Tacoma, WA.)

[17] See generally, *Power Shift*, Jim Norton, January 11, 2019. Available online at: https://columbiarediviva.org/power-shift/

BPA's evaluation of the issue, "This annual surplus has seasonal variability, spiking from April through June as Columbia River Basin flows increase through the spring, and dropping to net demand during low water from December to March. This variability has implications for specific hydro assets managed by BPA, which must curtail and/or sell surplus power some of the year while procuring power from regional markets other times of the year." It is critical to note that this projected surplus also coincides with the new contract period for large-scale customers of energy produced in the System.

While profits from the sale of electricity have remained static or declined over the past ten years, the regional appetite for renewable energy in the form of solar and wind has fundamentally changed the market. Carbon-free policies and decentralized sources of renewable energy have led to hundreds of new large and small scale sources of electricity in the Basin. Previously reliable customers of Columbia River power (e.g., California) may see an overall reduction in need for large-scale hydropower facilities as solar and wind generators assume space on the grid. During a 2018 NPCC meeting, BPA acknowledged that this changing market has led BPA to institute rates that are now significantly higher than the current market prices and that may have long term effects on overall profitability for the System; these sentiments are echoed in BPA's 2018 Strategic Plan.[18]

> *Bonneville is committed to remaining a cost-effective power supplier, but its cost advantage has eroded. A substantial challenge is low wholesale power prices caused by persistently low natural gas prices and ever-increasing renewable energy expansion during a time when electric loads remain flat. Supply is outpacing demand. Low wholesale power prices entice customers to consider other power suppliers while also reducing BPA's net secondary revenues, which BPA uses to help keep rates low.*
>
> *Bonneville also faces cost pressure from maintaining aging generation infrastructure, increasing costs to meet fish and wildlife obligations, the cost of the Residential Exchange Program settlement, and flat-to-declining firm power sales.*

In particular, the current mitigation program for fish and wildlife in the Basin is often described as one of the most expensive and rigorous conservation programs in the country. The Tribes remain proud of the countless hours each co-manager and action agency commits on an annual basis to ensure the survival of these species. The basis for these mitigation measures is to return to stasis on non-listed stocks and recover listed stocks to prevent extinction. The region has avoided extinction of listed stocks, but recovery has been an elusive goal for the fish and wildlife program. At the time of the current evaluation, the region is experiencing an annual return that puts virtually every wild stock in Idaho at critical levels and is inherently increasing the risk of near-term extinction for some of these stocks. A potentially dwindling pool of resources to mitigate impacts from the operations of the System has the Tribes concerned that future efforts may not include comprehensive, watershed level efforts to conserve and recover listed wild stocks in our homelands.[19] Based on the current program priorities, the listed stocks in our

[18] 2018 BPA Strategic Plan, Strategic Goal 3, page 34.

[19] From the 2018 BPA Strategic Plan, Page 41. *Fish and wildlife costs account for a sizable portion, about 25 percent, of BPA's direct power costs; combined with the financial impacts of spill, these costs account for about one-third of BPA's power rates. BPA and its partners have made great strides in improving fish survival, fish*

homelands in most need of conservation generally receive a small portion of the overall allocation from the current Fish and Wildlife Program.

The 'Lower Four' Snake River dams comprise a massive 140-mile corridor along the Snake River with each facility in desperate need of significant capital investments for turbine generators, channel dredging, spillway modifications, adult and juvenile fish passage modifications, cold-water ladder modifications for late run anadromous fish like Sockeye, etc. Unlike the new wave of decentralized renewable power sources becoming available across the basin, this entire facility requires constant structural and operational maintenance. Even though barging has reached an effective rate of zero in Idaho for most products, and Portland has shifted away from container shipping up the Columbia to Idaho, the facility still needs to be maintained for navigation whether it is used or not. Ironically, one of the most expensive barged 'products' through this corridor are juvenile salmonids that are currently a component of mitigation programs.

The maintenance expense for these facilities has reached over a billion dollars, although estimates vary so widely it is difficult to define exactly how expensive this renovation would actually cost. While the Lower Snake River facilities have known impacts to listed stocks and are no longer being used for barging traffic at any economically significant level, the conversation should now focus on the actual benefit of effectively divesting this asset from the System. The restoration of the Snake River would replace an expensive mitigation program, an unused navigation channel, and alleviate the need to replace turbines generating surplus power that cannot be effectively sold at a profit on the open market. An objective evaluation of these economic conditions would speak strongly in favor of divesting the Snake River component of the System and allow free-flowing river conditions to drive recovery processes for wild anadromous fish stocks in our homelands. The alternative is a direct reflection of the past twenty years: spill regimes that cost exorbitant amounts of money, stocks at perilously low abundance, and significant capital investments in facilities that have a net zero, or lower, rate of return for BPA.

VII. Restoring the Snake River

The Tribes have actively participated in the development of the CRSO Draft EIS and recognize the difficult task of balancing project configuration between anadromous fish needs and the desire to generate hydroelectric power. The co-lead agencies have identified objectives that would improve salmonid passage and survival throughout the project, as well as objectives to maximize power production at each of the facilities in the Basin. Although these objectives are not necessarily diametrically opposed, it is difficult to reconcile both of these concepts without favoring one issue over another; the same is true with the Tribal perspective.

During the development of the Fish Accords, the Tribes advocated for an approach that would place an emphasis on efforts to build system resiliency and efficacy in lieu of participating in

abundance and providing habitat restoration, and have used BPA's funding to leverage additional resources from others. But going forward, we must continue to be deliberate about controlling Fish and Wildlife Program costs, consistent with sound business principles and in the context of BPA's competitive position, while assuring that fish and wildlife receives equitable treatment with the other purposes of the system, as required by the Northwest Power Act.

litigation. The outcome of this environmental review for operations also has objectives for integrating adaptive management techniques and measures to mitigate the effects of power generation on mainstem Columbia River habitat attributes. The effect of any management scheme will depend on the consensus of co-managers and action agencies on those measures with the most potential to re-build an ecosystem impacted by a century of over-development.

Mitigation measures will be critical to resolve long-standing issues with the operational aspects of the system (i.e., spill, juvenile survival, adult passage, etc.). As with previous comments and position statements, the Tribes continue to advocate for a more comprehensive approach to resolve issues with ESA-listed populations in Idaho. The populations most at risk are those populations occupying the furthest extent of anadromy in the Basin and should be the highest priority for mitigation measures. While the Tribes recognize that there are significant issues in the mainstem reaches and associated tributaries throughout Oregon and Washington, the fact remains that the majority of listed anadromous fish species in the Basin occur in Idaho. Thankfully, central Idaho has large areas of high quality spawning and rearing habitat available to anadromous fishes. These habitats, such as the Middle Fork Salmon River, are intact and functioning in a manner that best exemplifies the ecological integrity of natural riverine ecosystems; except for the absence of abundant runs of anadromous fishes and marine derived nutrients.

The Tribes endorse the selection and implementation of Multiple Objective Alternative 3, which includes the removal of earthen embankments and adjacent structures within the lower four Snake River dams. Selecting this alternative would require additional work within the project on the ground and by action agency policy makers through coordination with affected stakeholders, Congress, Tribes, and the States. While the undertaking is undoubtedly the largest single action for the conservation of listed species in the Basin, it is also appropriate given the challenges we face collectively and the needs of our Tribe noted in the preceding discussion.

Through this evaluation, each agency, tribe, and State agency is offered an opportunity to develop a measure that fundamentally re-prioritizes our current paradigm into one that balances sustainable utilization of water resources for power generation and anadromous fish resources. In the next century we will face an unprecedented shift in how water resources are allocated at each project and how species reliant on those resources adapt to changing thermal regimes. By selecting an alternative to remove obsolete and unnecessary projects today, we will have an opportunity to support conditions suitable for anadromous fish species throughout the mainstem migratory corridor. It is unrealistic to assume that hydroelectric features constructed for climatic conditions during the mid-twentieth century will remain effective in the next. In fact, we are already seeing the limitations of current conditions for species like Snake River sockeye salmon. In addition, the nature of decentralized renewable energy projects in the Basin will provide new opportunities for communities to access sustainable energy resources from the market. Anadromous fish populations in the Snake River subbasin are experiencing average annual smolt to adult returns of less than one-half of one-percent (e.g. Snake River sockeye salmon averages 0.1-0.3%). There simply is no easy way to improve anadromous fish productivity and ecological health, maintain harvest and hydroelectric production, and support tribal lifeways without a change in how we view the system. Confrontation, particularly in the context of Basin litigation, is typically a debate over deeply ingrained views on the best way to manage our special riverine resource; those involved come to the table with a philosophy constructed over decades of litigious confrontation. There is no way to debate our way out of an inescapable truth facing the Basin, that the resources we all rely on are going to continue to change regardless of who prevails in a courtroom; it is up to each manager and action agency to adapt to that change.

Adaptation is the process of changing habits and perspectives to meet a new reality that challenges our ability to thrive in the environment we all call home. Adaptation is not an easy process; it is painfully slow and requires a fundamental shift in behavior. In a similar fashion, meeting the coming challenges will not be an easy task, but the Tribes remain optimistic that collectively we can make the necessary decisions about our environment. This begins with re-imagining how the System could operate more efficiently with new attributes, and by leaving antiquated solutions in the past. The current environmental evaluation is not going to be a 'silver bullet' solution for every issue facing anadromous fish, hydroelectric project operators, or stakeholders tied to the riverine ecosystem; but it is a start. Bold decisions are borne of necessity; wise decisions are made in context of both time and place, while the worst decisions are made by holding onto past solutions that did not deliver the promised results. The Tribes view the selection of an alternative to breach the lower four Snake River dams as a decision that meets the necessity of conserving wild fish and offers a new paradigm for our posterity.

Confederated Tribes of the Warm Springs Indian Reservation of Oregon

10 June 2019

Tribal Perspectives Report

Prepared by the Columbia River Treaty Tribes

Introduction and Purpose

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

B. Tribal Circumstances Framework

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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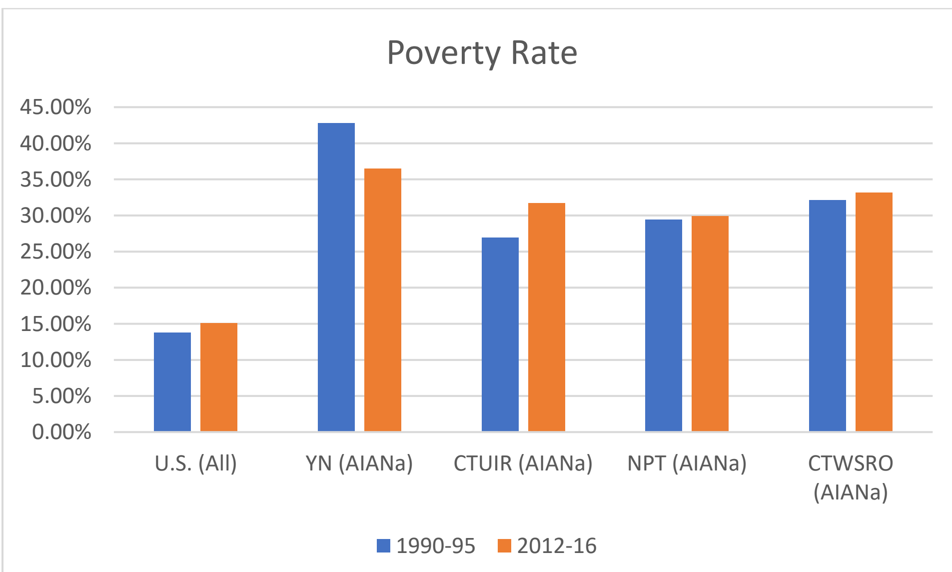
[10] Statement of Delbert Frank, Meyer Report, *supra* note 1 at 34.

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

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

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

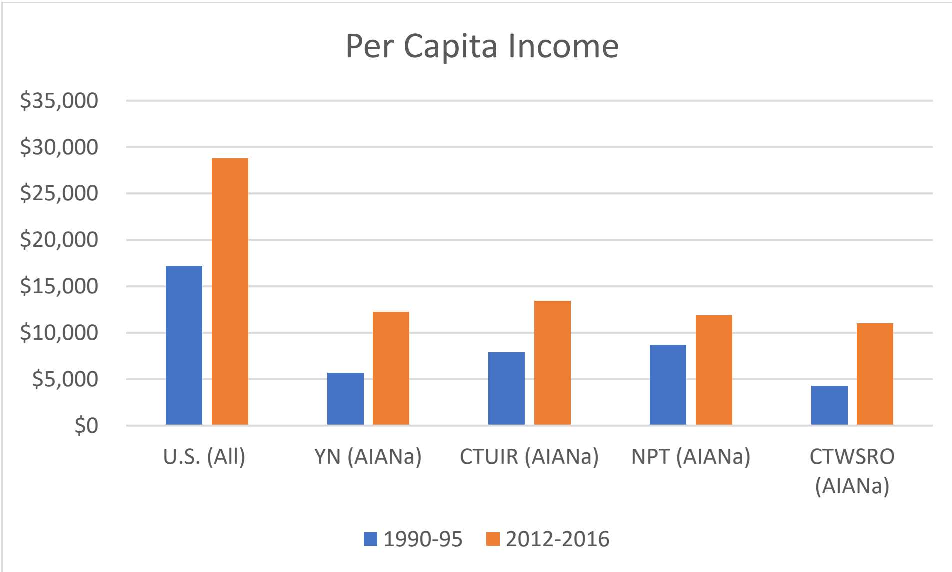
One of the ways this Tribal Perspectives Report updates the continuing relevance of those portions of the Meyer Report concerning tribal well-being is to compare the tribal poverty levels and income information from the Meyer Report with more current data. The data for this comparison were obtained from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



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

[13] *Id.* at 49.

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

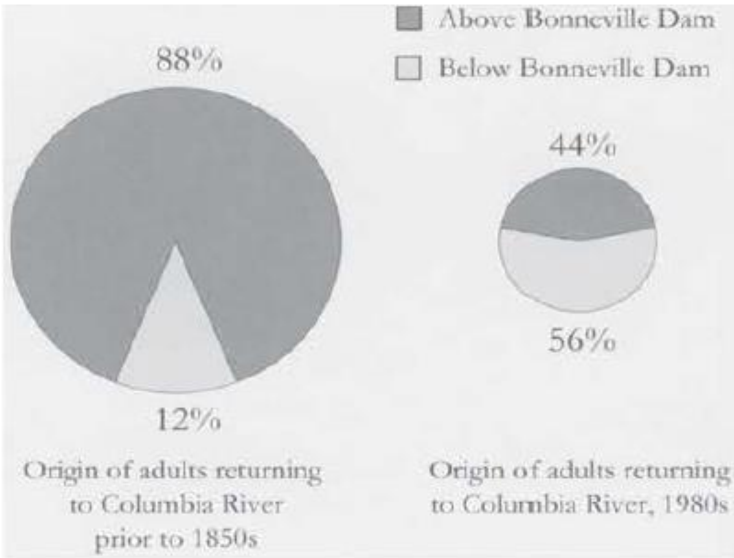


Figure 1: Changes in the distribution of salmon production in the Columbia River Basin (Northwest Power Planning Council, Columbia River Basin Fish and Wildlife Program, *Portland, Ore., 1987, app. E, table 6)*

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

E. Tribal Restoration Initiatives Published Since 1999

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

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[19] *Id.* at 221.

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

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

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

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

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

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

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

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

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

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

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

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

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

[25] *Id.*

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

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

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

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

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

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

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

[28] *Id.* at 52.

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

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

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

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

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

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

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

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

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

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

1. Columbia Basin Partnership (CBP) 2019 Provisional Goals

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

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

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

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

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

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

[35] *Id.* at 25.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1. Salmon Abundance

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

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

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

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

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

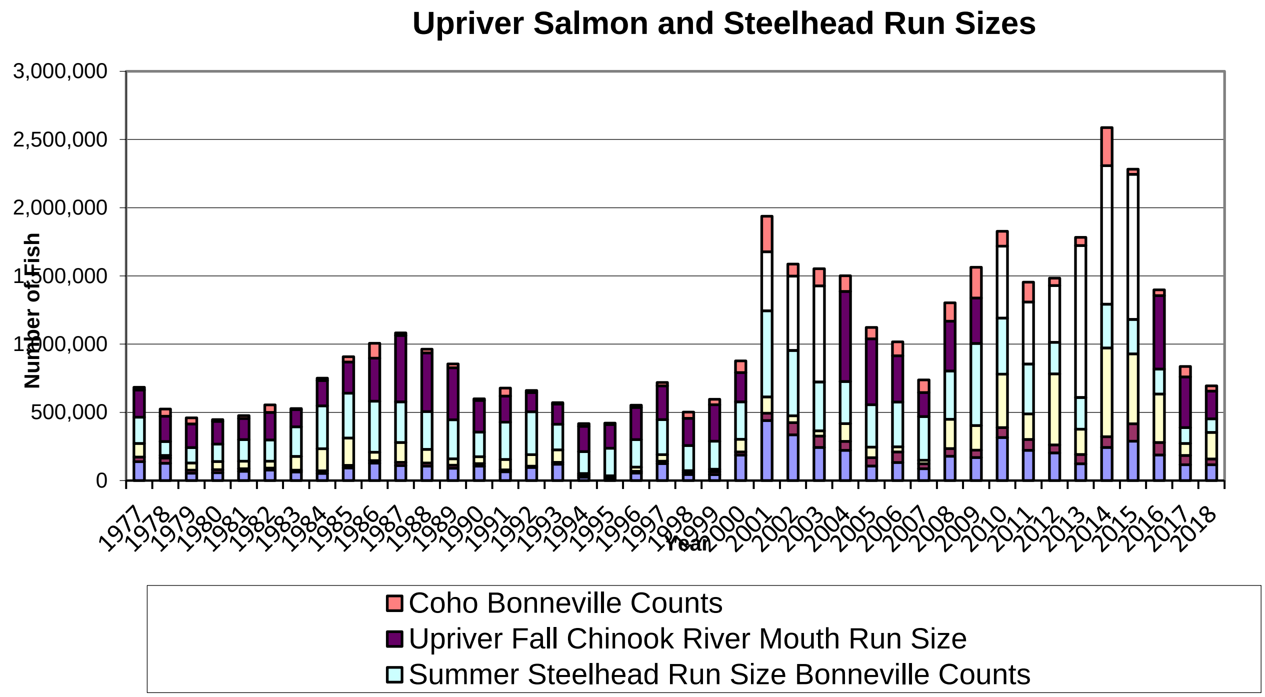
In the Mid-Columbia[44] region, current naturally spawning populations are roughly an order of magnitude less than the historic naturally spawning abundance levels.

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[55] *Id.* at 25.

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

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

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

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

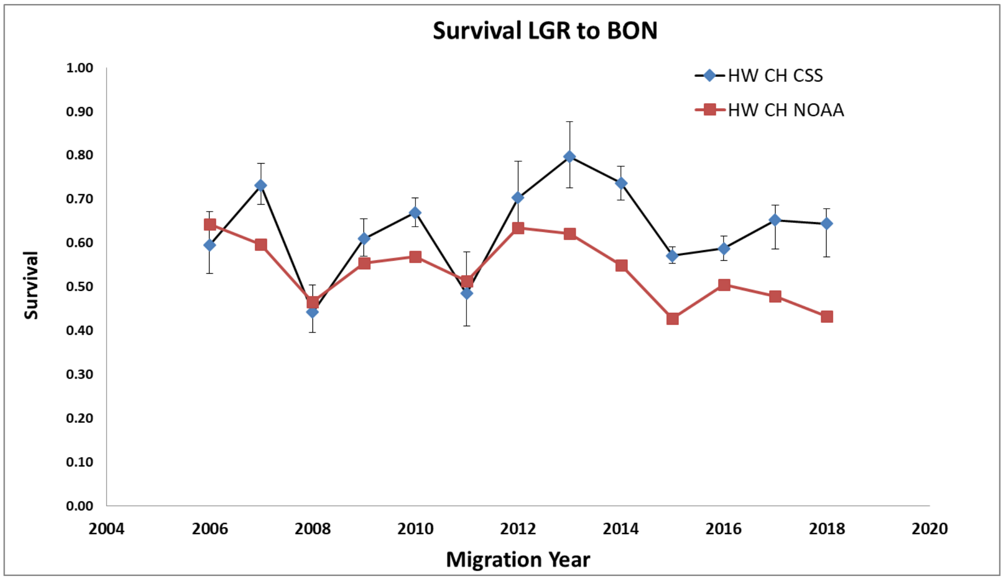
SARs for two of the Alternatives, MO3 and MO4, fell within the 2% to 6% range identified by the NPCC and multiple other authors.

3. Juvenile Salmon Reach Survival

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

[56] *Id.* at 62.

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

CONCLUSION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Spokane Tribe of Indians

P.O. Box 100 • Wellpinit, WA 99040 • (509) 458-6500 • Fax (509) 458-6575

June 3, 2019

Subject: Columbia River System Operation: Tribal Perspective

Brigadier General D. Peter Helmlinger,

The Spokane Tribe of Indians traces a deep and rich history that is tied to inland northwest waterways, especially the Spokane River. The lower stretch of the river is known today as the Spokane Arm of Lake Roosevelt, which stretches 30 miles from Little Falls Dam to its confluence with the Columbia River. Often called "People of the River", the Spokane people have considered the river that bears their name a sacred place that provided food and a place to call home.

Throughout history, the Spokane River has been a center of Spokane ancestral culture with a documented time depth of at least 8000 years. The locale contains dozens of significant and irreplaceable ancestral cultural sites, both sacred and profane. The importance of these sites lies not only in the artifacts themselves, but in the history contained within the objects (singly and collectively), features, pictographs, and landscapes. Moreover, hundreds, if not thousands of Spokane ancestors were laid to rest along this waterway and many of them remain here. Many of these sites have been recommended as eligible for listing on the National Register of Historic Places (NRHP), and two archaeological/traditional cultural place (TCP) districts containing a combined 33 sites are in the process of being recommended as eligible for NRHP listing.

The Spokane Tribe is inextricably tied to the Spokane River, resulting in a close association with this place that began thousands of years ago and continues into the present day. As a result, the Spokane Tribe considers the entire Spokane Arm a traditional cultural place.

Sincerely,

Carol Evans

Carol Evans, Chairwoman
Spokane Tribe Business Council

Draft Columbia River System Operations Environmental Impact Statement

Appendix Q
Cost Analysis

TABLE OF CONTENTS

List of Annexes

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ACRONYMS AND ABBREVIATIONS

CEFMS	Corps of Engineers Financial Management System
O&M	Operations and maintenance
NAA	No Action Alternative
MOs	Multiple objective alternatives
CRSO	Columbia River System Operations
CRFM	Columbia River Fish Mitigation
ESA	Endangered Species Act
ROD	Record of Decision
NREX	Non-routine Extraordinary Expense
NEPA	National Environmental Policy Act
MCACES	Micro-Computer Aided Cost Engineering System
MII	Second Generation (MCACES)
BOR	U.S. Bureau of Reclamation

CHAPTER 1 - INTRODUCTION

The purpose of the cost analysis is to provide an estimate of the total cost for implementing, operating and maintaining the system under each of the CRSO alternatives. The emphasis of the cost analysis is to understand the cost difference between alternative, particularly between the proposed CRSO action alternatives, including the multi-objective alternatives (MOs) and the Preferred Alternatives (PA) and the No Action Alternative (NAA). Implementation costs include the costs of constructing proposed structural measures under the action alternatives. All alternatives including the NAA have costs associated with operating and maintaining the Columbia River System, costs that may change relative to the structural and/or operational measures included under an action alternative. These on-going future costs include capital investments, routine and non-routine operations costs (including extraordinary maintenance (NREX), and mitigation costs including fish & wildlife mitigation costs. For the purpose of the cost analysis, these future costs are referred to as “system costs.” The cost analysis is focused on 14 federal multiple purpose dams (projects), reservoirs and navigation channels known as the Columbia River System (CRS).

The cost analysis presents annual-equivalent costs over the 50-year period of analysis in 2019 dollars. The federal water resources discount rate of 2.75% was used in the discounting process and to amortize the costs to annual-equivalent costs (Corps (2019), EGM 20-1, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2020). Construction of structural measures and associated operations is assumed to begin in 2021. For consistency across alternatives, construction of the structural measures under each action alternative is assumed to occur over a two-year period. However, given the uncertainty around the potential implementation timing for a complex alternative such as the dam breaching alternative (MO3), a sensitivity analysis was completed to determine the effect of construction timing on costs (described in Section 3.1.2).

There are multiple areas of uncertainty related to the development of the cost analysis. These include factors such as utilizing preliminary or planning level designs for structural measures; assessing capital costs and operations and maintenance cost estimates based on these designs; and the uncertainty related to assumptions that will affect cost estimates, such as implementation timing and period of construction. Due to a complex federal study approval and project appropriation process, the actual implementation timeframe for each alternative is uncertain. The effect of assuming a shorter timeframe is that it reduces the effect of discounting for costs that may not actually occur for several years, therefore increasing the annualized costs of structural measures associated with the alternatives. Given the unknowns surrounding implementation, there is no simple solution to reduce this uncertainty. However, further detailed evaluation would occur on planning, design, engineering, after the CRSO FEIS is completed.

The details of the methodology and results of the cost analysis are presented in this appendix. In addition, the methods to estimate the costs of the structural measures are described in Annex A. The approach to develop the costs for each of the additional mitigation measures as well as the cost estimate for each measure is provided in Annex B. Finally, Annex C of this appendix provides the methods and results of a regional economic analysis, which estimates the jobs and income supported by the CRS system costs under the No Action and action alternatives.

CHAPTER 2 - OVERVIEW OF APPROACH

USACE, Bonneville, and BOR technical specialists, including hydrology and hydraulics engineering, operations, cost engineering, budget, asset management, project-specific specialists, fish, navigation, and hydropower provided input to the cost analysis. An extensive effort was undertaken to obtain a comprehensive perspective of the costs to operate the CRS under the No Action Alternative and how these costs would change under the multiple objective alternatives.

This section provides a brief overview of the methodology to conduct the cost analysis. Table 2-1 provides a short description of the cost categories, organized by the four general categories described above: construction costs of structural measures; capital costs; operations and maintenance (O&M) costs; and mitigation costs. There is additional detail on the methodology employed to estimate costs for each category in Chapters 3, 4, and 5 of this appendix.

Table 2-1. Cost Components and Descriptions

Cost Category		Description	Source
Construction of Structural Measures	Structural Measure Costs of the Action Alternatives	Includes the construction costs (and contingency) of the structural measures associated with the alternatives, as well as supervision, administration, and engineering during construction, and real estate administration costs (Bonneville, Corps, and Reclamation).	USACE Cost Engineering Center of Expertise
Capital Costs	Capital Costs (Power Specific and Joint)	Includes Bonneville-funded large and small capital costs associated with additions, improvements and replacements for hydropower equipment as well as the Bonneville's funded portion of "joint" features that serve multiple purposes at the 14 federal projects. Includes USACE and BOR share of joint costs (often called joint tail) for large and small capital costs for the 14 federal dams in the Columbia River Basin.	Federal Columbia River Power System 2018 Strategic Asset Management Plan (SAMP); USACE District and Bureau of Reclamation resource and budget specialists
O&M Costs	Non-routine Extraordinary Maintenance (NREX) Costs (Power Specific and Joint)	Includes Bonneville's power specific and joint costs for non-routine extraordinary maintenance, such as costs for repair of a failed units. Includes the USACE and Bureau of Reclamation joint cost share (often called joint tail) for NREX costs for the 14 federal dams in the Columbia River Basin	Bonneville Resource Economic Planners; USACE District and Bureau of Reclamation resource and budget specialists
	Hydropower Routine O&M	The costs associated with the routine operations and maintenance of the hydropower portion of one of the 14 Columbia River Projects (Bonneville).	Corps of Engineers Financial Management System, queried by AMSCO code, Category Class Subclass (CCS) code, for past five fiscal years
	Navigation Routine O&M Costs	The costs that are typically associated with routine operations and maintenance of the	Corps of Engineers Financial Management System, queried

Cost Category		Description	Source
		locks that regularly occurs, such as lock maintenance (Corps).	by AMSCO code, CCS, for past five fiscal years
	Recreation Routine O&M	The costs associated with routine operations and maintenance recreation facilities at the 14 federal projects, including park ranger salaries (Corps and Reclamation).	Corps of Engineers Financial Management System, queried by AMSCO code, CCS, for past five fiscal years
	Fish and Wildlife Routine O&M	The costs associated with routine fish and wildlife activities, such as fish ladder maintenance, trapping and transport, and biologists' salaries at the 14 federal projects (Corps, Reclamation, and Bonneville).	Corps of Engineers Financial Management System, queried by AMSCO code, CCS, for past five fiscal years
	Cultural Resources Routine O&M	The costs associated with routine activities for cultural resource protection, such as the costs to preserve and maintain historic cultural sites or practices, and salaries for cultural resource and Native American specialists (Corps, Reclamation, and Bonneville)	Corps of Engineers, Bonneville, and BOR cultural resource specialists; Federal Columbia River Power System Fiscal Year 2018 Annual Report.
	Other Routine O&M	The Other O&M category includes routine costs, such as regular facilities upkeep, security equipment, salaries for guards, and general grounds maintenance (Corps, Reclamation, and Bonneville).	Corps of Engineers Financial Management System, queried by AMSCO code, CCS, for past five fiscal years
	Non-routine Navigation	The costs associated with maintaining the navigation portion of the dams and locks for navigation at the 4 Columbia and 4 Lower Snake River projects, including dredging activities required to maintain the federal deep draft and shallow draft navigation channel (mouth of the Columbia, Lower Columbia Deep Draft, Columbia Shallow, and Lower Snake River Shallow Draft) (Corps).	Corps operations technical specialists and asset managers

Cost Category		Description	Source
Mitigation Costs[1]	Bonneville Fish and Wildlife (F&W) Program[2]	Bonneville provides funding to multiple local, state, tribal, and federal entities as part of its F&W Program to implement off-site mitigation actions[3] listed in various Biological Opinions for ESA-listed species as well as off-site mitigation actions for non-listed species. The Bonneville F&W Program also supports efforts to protect, mitigate, and enhance fish and wildlife affected by the development and operation of the Federal Columbia River Power System (FCRPS), which includes the CRS under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act) (16 U.S.C. § 839b(h)(10)(A)). This category only includes non-capital expenses; Bonneville F&W program capital costs, such as hatchery construction, are analyzed as part of the Power and Transmission chapter.	Bonneville budget specialists
	Lower Snake River Compensation Plan (LSRCP)	Congress authorized the LSRCP as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four Lower Snake River dams. A major component of the authorized plan was the design and construction of fish hatcheries and satellite facilities. Bonneville directly funds USFWS for the annual operation and maintenance of these LSRCP facilities.[4]	Bonneville and Corps operations and budget specialists

[1] Please note that some of the fish and wildlife mitigation costs are included in the fish and wildlife routine O&M cost category, such as Dworshak and John Day hatchery production, and timber and elk management.
[2] This category only includes non-capital expenses; Bonneville F&W program capital costs, such as hatchery construction, are evaluated as part of the Power and Transmission analysis (see Power Revenue Requirement under Section 3.8.2.7).
[3] Over the last decade, the Co-lead Agencies have spent tens of millions of dollars to improve the quantity and quality of fish habitat in the estuary and tributaries as "off-site mitigation" for the residual adverse effects of system water management on migrating salmon and steelheads as well as resident fish. These actions typically address impacts to fish not caused by the Columbia River System, but are implemented to improve the overall conditions for fish to help address uncertainty related to any residual adverse effects of Columbia River System management on fish species.
[4] The only funding of the LSRCP assumed under the No Action Alternative is Bonneville's direct funding of the Program. The Corps' construction and implementation activities associated with the LSRCP are complete, and no additional funds are anticipated under this authorization.

Cost Category		Description	Source
	Columbia River Endangered Species Act (ESA) Mitigation	These funds are used to meet the BOR ESA requirements, including mitigation commitments in coordination and administration; hydrosystem management; hatcheries; research monitoring and evaluation; tributary habitat improvement projects; and predation management (Reclamation)	BOR Program Specialists
	Columbia River Fish Mitigation (CRFM)	These costs are part of the Corps Construction account for fish mitigation activities to meet the Corps obligations under the Biological Opinion (Corps).[5]	Corps Construction Account, obtained from Corps Northwestern Division Program Managers
	Costs of Additional Mitigation Measures under the CRSO alternatives	Mitigation measures were developed that would mitigate adverse impacts of the multiple objective alternatives. Construction or annual costs as well as any relevant O&M and non-routine costs were developed for the additional mitigation measures from input from Bonneville, Corps, and Reclamation specialists.	USACE cost engineers from the Cost Engineering Center of Expertise

The costs to operate the system are funded through multiple mechanisms including federal tax dollars appropriated to cover system costs, as well as revenue generated through the marketing and sale of hydropower. The Corps and Reclamation receive annual Congressional appropriations to fund system capital, and operations and maintenance activities. Bonneville funds the power-share of these costs to the Corps, Reclamation and USFWS. In addition, Bonneville is responsible for repaying the US Treasury for a share of the appropriations if it is determined that the costs are appropriately allocable to power. The cost team has made every effort to not double count the costs included in the cost analysis. For example, if the Corps receives both appropriations and Bonneville direct funding for a capital investment, each portion of those costs go into separate categories, the sum of which is the total spent on the investment.

2.1 NO ACTION ALTERNATIVE

The No Action Alternative (NAA) provides a baseline for understanding the costs associated with operating and maintaining the CRS. These costs include all the cost categories summarized in Table 2-1 above, except for structural measures construction costs. The NAA also provides a starting point for determining how costs will change as various structural or operational changes or both are made under action alternatives. Under the No Action Alternative it was assumed the CRS would continue to be operated in a similar manner to current operations, balancing operations for congressionally authorized purposes across the CRS. Under the No Action Alternative, co-lead agencies will continue to maintain system infrastructure, while making large capital investments in power-related improvements, additions, and replacements,

[5] Bonneville is required to repay the power-share of the CRFM appropriations, with interest.

as needed, to meet reliability standards, efficiency needs, environmental requirements, safety and security standards, and other requirements. In addition, non-routine and routine O&M costs would continue to meet system requirements; these include non-routine extraordinary maintenance (NREX) costs (both power and joint), and non-routine navigation costs, while routine O&M costs would occur for hydropower, cultural resources, navigation, recreation, fish and wildlife, and other routine costs.

The NAA was developed with extensive input from Bonneville, Reclamation, and the Corps to provide a comprehensive accounting of all costs to operate and maintain the CRS. A team from the three agencies met regularly to discuss cost data needs, review the costs, and verify and validate the cost analysis. Experts from the three agencies provided input on current, historic, and, if possible forecasted, large and small capital costs; non-routine extraordinary maintenance (NREX); routine operations and maintenance costs; mitigation costs including F&W costs and costs of mitigation measures specific to the CRSO alternatives; and others. These current, historic, and forecasted costs were used to estimate the total costs to operate and maintain the CRS.

2.2 CONSTRUCTION COSTS OF THE STRUCTURAL MEASURES

Cost estimates for each of the structural measures included in the action alternatives were developed by the cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District. Given the uncertainty associated with the planning level design for structural measures, a contingency of 50 percent was added to all construction estimates. Based on historic Corps cost engineering estimates, 30 percent of the construction and contingency cost was included to account for supervision, administration, and engineering during construction. The total project first costs for the structural measures are assumed to be implemented over the first two years after the signing of the Record of Decision (ROD), consistent with co-lead agency guidance.[6] The RODs are scheduled to be signed in 2020; construction is assumed to occur in 2021 and 2022.

The structural measures only include measures that are unique additions under an action alternative. For example, as described under the NAA, the co-lead agencies will continue to invest in power-related capital improvements, additions, replacements and fund O&M (including NREX), as needed (described in Capital and O&M costs). Based on a review of structural measures relative to these system costs it was determined that some structural measures are planned under NAA and all action alternatives, and therefore these costs are included under the system costs for capital and O&M only. For example, the fish turbines at John Day are currently planned to be constructed and the capital costs for their implementation are included in the Strategic Asset Management Plan. Therefore, this measure and associated cost is included as a capital cost under NAA and the multiple objective alternatives and not included under the structural measures to avoid double counting.

[6] Project first costs include construction costs, as well as contingency, supervision and administration, planning engineering and design, and engineering during construction. They do not include any annual O&M costs (including NREX) that may be necessary once the structural measures are constructed. See Annex A: Cost engineering for further details.

Additional details on the cost estimates for the structural measures under the multiple objective alternatives are provided in Section 3.19, Implementation and System Cost Analysis of the EIS and in Annex A, Costs of the Structural Measures.

2.3 CAPITAL AND OPERATIONS AND MAINTENANCE COSTS

Costs to operate the CRS were organized into two categories: 1) capital costs; and 2) routine and non-routine O&M costs. If possible, costs were categorized by project. The capital costs include power-specific and joint large and small capital costs. The O&M costs include routine costs to operate and maintain the projects, non-routine extraordinary maintenance (NREX) costs, and non-routine navigation maintenance, such as dredging and lock and dam costs.

Capital and O&M costs, including NREX costs, have been estimated for each action alternative based upon the specific structural and operational measures included. An estimate of capital and O&M costs were developed by operations and programs staff based upon their knowledge of similar structural measures, and costs associated with system operations. In general, the estimated changes are relatively small compared to the No Action Alternative, with the exception of MO3 for the lower Snake River projects.

2.4 MITIGATION COSTS

The federal agencies are required to protect, mitigate, and enhance fish and wildlife affected by the operation of the CRS projects. In addition, NEPA requires that mitigation measures be identified to avoid significant impacts of proposed alternatives. This section describes fish and wildlife mitigation activities, including the Endangered Species Act (ESA) compliance across the CRS, as well as additional mitigation measures that were identified for each action alternative to mitigate adverse impacts.

2.4.1 Fish and Wildlife

The Bonneville Fish and Wildlife (F&W) Program funds hundreds of projects each year to mitigate the impacts of the federal hydropower system on fish and wildlife. Bonneville began this program to fulfill mandates established by Congress in the Pacific Northwest Electric Power Planning and Conservation Act of 1980[7] to protect, mitigate, and enhance fish and wildlife affected by the development and operation of the FCRPS. Each year Bonneville funds projects with local, state, tribal, and federal entities to fulfill its Northwest Power Act fish and wildlife responsibilities and to implement offsite mitigation actions listed in various Biological Opinions for ESA-listed species, including direct funding of Corps and Reclamation fish and wildlife projects.

In addition to its F&W Program, Bonneville also directly funds the annual operations and maintenance of the Lower Snake River Compensation Plan (LSRCP) facilities. A major component of the authorized Plan was the design and construction of fish hatcheries and

[7] Section 4(h)(10)(A), 16 U.S.C. § 839b(h)(10)(A).

satellite facilities. Congress authorized the LSRCP as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four Lower Snake River dams. Current and anticipated future annual costs for Bonneville's F&W program and LSRCP, were developed by Bonneville F&W Program experts for the No Action and action alternatives

The Corps has recently completed construction and implementation activities associated with its LSRCP authorization, including habitat development and game bird production, throughout the lower Snake River basin. The Corps would continue to manage fish and wildlife resources through its O&M funding.

The Corps and Reclamation also provide funding for fish and wildlife conservation measures and activities under obligations to the Endangered Species Act. The Corps has a construction program for fish and wildlife mitigation activities, titled the Columbia River Fish Mitigation (CRFM). Reclamation's mitigation costs include ESA compliance measures for habitat improvement, hatcheries, and monitoring activities. The NAA cost estimates were provided by program specialists at the Corps and Reclamation, along with estimates of how costs would likely change under the action alternatives.

2.4.2 Additional Mitigation Measures for the CRSO Alternatives

Mitigation measures were developed that would mitigate adverse impacts related to the implementation of action alternatives (see Chapter 5 of the DEIS). The measures were identified during the resource evaluations and include reasonably foreseeable activities that could be undertaken to avoid, minimize or mitigate adverse impacts from occurring under the action alternatives. These activities may include protecting cultural resources, improving or mitigating fish and wildlife or water quality impacts under the breach scenario, among others.

The associated costs for these mitigation measures were estimated by the cost engineers at the Mandatory Cost Center for Expertise with input from the Corps, Reclamation, and Bonneville specialists. Bonneville is obligated to repay the power share of these costs. Additional details on the mitigation measures are provided in Annex B, Costs for Additional Mitigation Measures.

CHAPTER 3 - COSTS OF THE STRUCTURAL MEASURES

3.1 DATA COLLECTION AND METHODS FOR STRUCTURAL MEASURES

This section describes how the cost estimates of the structural measures were developed and summarizes these costs by alternative. The detailed cost estimates for each structural measure are provided in Annex A, Costs of the Structural Measures. This section also describes the approach and cost estimates for real estate administration costs associated with MO3.

3.1.1 No Action Alternative

Generally, the structural measures under the multi-objective alternatives would not occur under the No Action Alternative. As described previously, there is one structural measure that would be implemented under the NAA and all of the multi-objective alternatives, including the preferred alternative -- the fish passage turbines at the John Day project. This measure is currently included in the three-agency Strategic Asset Management Plan (SAMP). As a result, in order to avoid double counting it is not treated as a “new” structural measure, but rather associated construction and implementation costs for this measure are included in the capital costs under the No Action Alternative and all of the multi-objective alternatives (see Chapter 4). The implementation of this structural measure would occur over multiple years, consistent with assumptions in the SAMP.

3.1.2 Multiple Objective Alternatives

This section describes the approach to estimate the construction costs of the structural measures and the real estate administrative costs under MO3.

3.1.2.1 Construction Costs of the Structural Measures

Construction cost estimates for each of the structural measures were developed by the cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District. The construction costs were developed based on the Corps Micro-computer Aided Cost Estimating System (MCASES) Second Generation (MII) with the conceptual designs of the structural measures, and also using construction requirements and design from similar projects and studies (e.g., Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002a). Where designs were not available, an escalation factor was applied to the costs developed in the 2002 Lower Snake River Juvenile Salmon Migration Final Feasibility Report and EIS utilizing the Civil Works Construction Cost Index System (CWCCIS) tables for the type of construction anticipated. For a number of measures that were escalated from the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and EIS (2002), additional efforts were undertaken to validate the costs; cost estimates were developed with the MCACES MII based on the same scope as in the 2002 Report. These newly developed estimates were very similar to the escalated costs from the 2002 Report.

For the dam breaching measures, preliminary designs were used from the 2002 Lower Snake River Juvenile Salmon Migration Final Feasibility Report and EIS along with the MCACES MII system to provide the cost estimates. A contingency of 50 percent was added to all construction estimates based on preliminary designs, scope, and uncertainty surrounding the construction estimates and in consultation with Bonneville. A 50 percent contingency is typical for this level of scope and cost engineering estimate development. Thirty percent of the construction and contingency cost was included to account for supervision, administration, planning, engineering, design, and engineering during construction costs based on historic Corps cost engineering experience with these types of costs. All costs were developed at a 2019 price level. The costs for construction, contingency, supervision, administration, and engineering during construction in total are referred to as the “project first costs” or “first costs.” The cost estimates for the structural measures are provided in Annex A of this document.

The construction costs for the structural measures were assumed to be implemented over the first two years of the project (2021 and 2022), consistent with guidance provided by the co-lead agencies. Although some of these measures, especially the dam breaching measures, may take a number of years to implement or may not start for a number of years (pending further studies), it was necessary to provide a consistent time-frame for implementation in the evaluation to compare across the alternatives A sensitivity analysis was conducted on the timing of the construction in terms of its impact on annualized costs under MO3. A scenario was conducted to estimate the annual-equivalent cost if the construction costs for the lower Snake River dams, including demolition, supervision, administration, and engineering during construction, occurred over 10 years, as compared to the two-year construction implementation assumption. Because of the large system costs, delaying and spreading out costs for breaching the Lower Snake River dams would result in a change in annual-equivalent costs for the construction activity of $3.5 million (from $45.7 million with a two-year implementation to $42.1 million with a 10-year implementation schedule). This difference in cost ($3.5 million) represents approximately 8 percent of the construction costs of the structural measures and 0.4 percent of total annual-equivalent costs under MO3. The difference between a two-year and a ten-year implementation schedule does not warrant deviation from the two-year approach used throughout the evaluation.

Any needed operations and maintenance or capital costs associated with the structural measures under the multiple objective alternatives (or operational measures) are assessed as changes in capital and O&M costs in Chapters 4 and 5.

3.1.2.2 Real Estate Administrative Costs under MO3

Real estate administrative costs were captured as first costs under MO3. It is anticipated that the Corps would retain jurisdiction over the land holdings throughout the implementation period and biological evaluation process and that public control of a portion of public lands would be necessary to protect the environmental and natural benefits to salmon associated with dam breaching. Post dam breaching, the Corps may choose to transfer the lands to another federal or state agency.

Under the dam breaching measures of MO3, it could be necessary to negotiate agreements with affected parties and property owners and enter into relocation contracts for the alteration or replacement of affected structures. Under MO1, MO2, and MO4, there would be no additional real estate costs compared to the No Action Alternative and therefore no further evaluation was necessary.

Real estate administrative costs were developed for renegotiating contracts, leases, agreements, rights-of entry, etc. Given the uncertainty in the design and specifics of MO3 at this point, the real estate evaluation used the approach from the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002) and updated the data and costs as needed (Corps Walla Walla District Real Estate Division, 2019). Further detailed evaluation would occur on planning, design, engineering, real estate, costs, etc., in subsequent studies, if MO3 were chosen for implementation.

The Walla Walla District Real Estate Division reviewed the evaluation that was conducted under the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement, Appendix K (2002b). The Corps Real Estate experts updated the 2002 figures to reflect current numbers of contracts and agreements, where possible. Real estate administration costs for modifying a number of the contract components used the 2002 study costs and updated the costs to current price levels with the West All Urban Consumer Price Index (CPI) (U.S. Bureau of Labor Statistics, 2019). The present value of the real estate administration costs was estimated to be $1.8 million, and the annual-equivalent cost over the 50-year period was estimated to be $68,000.

3.1.3 Multiple Objective Alternative 1

Under MO1, there would be very little change in the capital costs compared to the No Action Alternative, a change of approximately 0.02 percent annually over the period of analysis (Table 3-1). The costs would change only slightly under MO1 associated with the upgraded spillway weirs, Lower Granite trap modifications, Lower Snake river ladder pumps, and the modifications to the turbine strainer systems to safely exclude lamprey when compared with the capital expenses that would continue to be required to operate the CRS under the No Action Alternative.

Table 3-1. Capital Cost Estimates for MO1 and Change from the No Action Alternative (2019$)

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
Bonneville	$18,733,000	$8,000	0.0%
The Dalles	$26,336,000	$8,000	0.0%
John Day	$24,297,000	$11,000	0.0%
Chief Joseph	$18,975,000	$0	0.0%
Grand Coulee	$70,757,000	$0	0.0%
Albeni Falls	$2,792,000	$0	0.0%
Libby	$7,137,000	$0	0.0%

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
Hungry Horse	$8,525,000	$0	0.0%
McNary	$29,559,000	$9,000	0.0%
Ice Harbor	$8,280,000	$5,000	0.1%
Lower Monumental	$8,633,000	$5,000	0.1%
Little Goose	$8,774,000	$2,000	0.0%
Lower Granite	$6,659,000	$9,000	0.1%
Dworshak	$5,691,000	$0	0.0%
Total	$245,148,000	**$57,000**	0.02%

3.2 STRUCTURAL MEASURE COST ESTIMATES

The costs estimated for structural measures by alternative are provided below.

3.2.1 No Action Alternative

The structural measures under the action alternatives would not occur under the No Action Alternative and therefore there are no cost estimates for new structural measures. Please note that the NAA includes activities to operate the system, including capital investments and operations and maintenance costs, which are described in Chapters 4 and 5, respectively.

3.2.2 Multi-Objective Alternative 1

The present value of the costs for the structural measures for MO1 are estimated to be $533 million, which includes construction and associated contingency costs, supervisions and administration costs, and planning and engineering during construction costs. When amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $19.7 million.

Almost half of the cost associated with structural measures would occur at the McNary project ($244 million in present value costs), where a number of structural measures would be constructed. These measures include construction of additional surface passage (modifications to the juvenile fish facility and to the floor elevation of the project; adding telescoping weirs); upgrading spillway weirs to adjustable spillway weirs; constructing lamprey passage structures; modifying the turbine cooling water strainer systems to exclude lamprey; modifying the turbine intake bypass screens to reduce impingement; and modifying existing fish ladders. The most costly measure at McNary is the additional surface passage ($152 million in present value costs).

The costs of the structural measures at Ice Harbor are second highest under MO1 after those at McNary, with a present value cost of $110 million. Many of the same measures would occur at Ice Harbor as planned at McNary. Although additional surface passage would be constructed at Ice Harbor, it is almost half as costly as McNary because many of the modifications to the fish facility at McNary would not be needed at Ice Harbor. New pumping systems would be installed for the fish ladders at Ice Harbor and Lower Monumental dams.

A number of weirs would be upgraded to adjustable spillway weirs under MO1, with a cost between $19 to $38 million per project (present value costs), including at Lower Granite, Lower Monumental, Ice Harbor, McNary, and John Day projects. Modifying the intake bypass screens that cause juvenile lamprey impingement and entanglement would be constructed at McNary, Little Goose, and Lower Granite, and would cost between $21 million and $50 million per project in costs (present value) at each project.[8]

3.2.3 Multi-Objective Alternative 2

The costs associated with the structural measures for MO2 are estimated to be $1.4 billion (present value), which includes construction and associated contingency costs, supervisions and administration cost, and planning and engineering during construction costs. When amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $52.3 million.

Much of the cost increase under MO2 compared to MO1 occurs at McNary ($854 million under MO2 versus $152 million under MO1 in project costs). Additional surface passage would be constructed at McNary including construction of a collection channel for surface passage, a dewatering facility, demolition of the fish facility, and repurposing water through replacing fish pumps. In addition under MO2, additional surface passage would be constructed at John Day, which also does not occur under MO1, with a project present value cost of $240 million.

Similar to MO1, MO2 includes updates to the adjustable spillway weirs at Lower Granite, Lower Monumental, Ice Harbor, McNary, and John Day projects; modifying the intake bypass screens that cause juvenile lamprey impingement and entanglement at Little Goose and Lower Granite (this would not occur at McNary as under MO1); modifying the turbine cooling water strainer systems to exclude lamprey at all of the Lower Snake River and Lower Columbia river projects; and modifying existing fish ladders at the Lower Snake River projects and The Dalles, Bonneville, and McNary projects.

3.2.4 Multi-Objective Alternative 3

The total cost of the structural measures for MO3 is estimated to be $1.2 billion (net present value), which includes construction and associated contingency costs, supervision and administration costs, and planning and engineering during construction costs. Of the $1.2 billion, $955 million (or approximately 80%) would costs associated with breaching the lower Snake River dams. When amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $45.7 million ($35.4 million for the costs for breaching the Lower Snake River dams). Breaching of the dams includes constructing water control structures such as cofferdams and levees at breach locations to direct and control flows, and removal of earthen and adjacent structures at the dams to facilitate reservoir drawdown.

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[8] The current intake bypass screens would likely be replaced when needed (and not necessarily within the first two years of the period of analysis).

Similar to MO1, MO3 includes constructing additional powerhouse surface passage at McNary Dam; updating to adjustable spillway weirs at McNary and John Day projects; modifying the turbine cooling water strainer systems to exclude lamprey at all of the Lower Columbia river projects; and modifying existing fish ladders at The Dalles, Bonneville, and McNary projects.

3.2.5 Multi-Objective Alternative 4

The total present value of the costs associated with the structural measures for MO4 are estimated to be $1.2 billion, which includes construction and associated contingency costs, supervision and administration costs, and planning and engineering during construction costs. When amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $44.4 million. The structural measures that differ from the other alternatives under MO4 include spillway weir notch inserts at the lower Snake River projects, McNary and John Day projects. MO4 would not include upgrading to adjustable spillway weirs at any of the projects.

Similar to MO1, MO4 includes modifying the intake bypass screens that cause juvenile lamprey impingement and entanglement at Little Goose, Lower Granite, and McNary projects; modifying the turbine cooling water strainer systems to exclude lamprey at all of the Lower Snake River and Lower Columbia river projects; and modifying existing fish ladders at the Lower Snake River projects and The Dalles, Bonneville, and McNary projects.

3.2.6 Preferred Alternative

The total present value of the structural measure costs for the preferred alternative are estimated to be $104.2 million, and when amortized over the 50-year period, the annual-equivalent cost is estimated to be approximately $3.9 million, considerably lower than the other MOs. Structural measures would be constructed at Bonneville, The Dalles, John Day, McNary, and the four lower Snake River projects. The projects that would incur the largest costs under the preferred alternative are at Bonneville for the Lamprey passage structures and the ladder serpentine weir; and at Lower Granite and Little Goose projects associated with the bypass screen modifications for Lamprey.

CHAPTER 4 - CAPITAL COSTS

4.1 DATA COLLECTION AND METHODS

This section describes the cost components included in the capital costs under the No Action Alternative and the methods to estimate the changes in capital costs under the action alternatives. Section 4.2 summarizes the capital costs for all of the alternatives.

4.1.1 No Action Alternative

Under the No Action Alternative, there are several items under the category of capital costs, including the Bonneville direct-funded power-specific and joint capital costs as well as the Corps and Reclamation joint capital costs. The large and small capital investments needed to maintain the projects were obtained from the SAMP. The 2018 SAMP forecasts capital requirements for assets based on their estimated economic end-of-life between the years 2019 to 2068. The large capital requirements include rehabilitation and replacement costs for hydropower equipment as well as the Bonneville funded portion of "joint" features that serve or mitigate for multiple purposes at the facilities. The SAMP outlines strategies for both the FCRPS Asset Management System and FCRPS hydro system assets. Asset management maturity is assessed and specific gaps are described with plans for improvement. For asset strategies, optimal levels of investment are identified based on the condition, criticality and risk of FCRPS assets. These results are intended to drive investment identification and, in combination with input from the 31 hydropower facilities, form the basis for the FCRPS System Asset Plan. The SAMP is developed by experts at the three Co-lead Agencies.

These capital costs were extended to the year 2070 by averaging the previous 5 years. The SAMP investments are adjusted for inflation every year; so they were deflated to 2019 dollars using the rates of inflation provided by Bonneville (2.08% annually for the SAMP costs).[9] Then the total present value for inflation adjusted capital costs was estimated based on the 2020 federal water resources discount rate of 2.75%, and then amortized over the 50-year period for an annual-equivalent value. For all projects, SAMP large and small capital costs are estimated to be $233 million annually.

The capital costs also include the Corps and Reclamation share of joint costs (often referred to as joint tail) for large and small capital costs for the 14 federal CRS projects. District and project experts relied on past years joint costs as a percentage of the SAMP to project future joint costs. Annual joint capital costs were estimated to be $12.0 million for large and small capital costs and $2.5 million for NREX for all projects.

[99] For the purposes of Bonneville cost recovery, the costs of capital assets are recovered over the useful life of the asset. The NREX costs are recovered in the year they are incurred.

4.1.2 Action Alternatives

The structural measures under the action alternatives were reviewed by Corps and Reclamation engineers, operations support, and budget experts to assess how the new infrastructure and structures under the alternatives would affect needed capital investments in the future (Corps Walla Walla District, 2019a; Corps Portland District, 2019a; Corps Seattle District, 2019a). In many cases, a structural measure would require replacement or major rehabilitation over the 50-year period[10] A one-time cost for these replacements or rehabilitations was assumed to occur in year 25. These costs were assessed by project, discounted to reflect the present value in in 2019$, and then amortized over the 50-year period to provide an annual-equivalent cost.

Under MO3, the capital costs reflected by the SAMP as well as the Corps and Reclamation joint capital cost for the four Lower Snake River projects would be assumed to no longer be incurred. With the selection of the MO3, Bonneville budgets and expenses and the associated cost shares associated with the four Lower Snake projects would no longer be budgeted or expended, starting at the beginning of the period in year 2021.

4.2 CAPITAL COST ESTIMATES

This section provides estimates of the capital costs under the No Action and multi-objective alternatives.

4.2.1 No Action Alternative

Table 4-1 summarizes the capital costs for the NAA, which include power-specific capital investments (from SAMP) and joint capital costs. Grand Coulee and McNary have the highest capital costs under the NAA, with an annual cost of $70.8 million and $29.6 million, respectively.

Table 4-1. Capital Cost Estimates for the No Action Alternative (2019$)

Project	Annual-equivalent Cost	Percent of Total Cost
Bonneville	$18,725,000	7.6%
The Dalles	$26,328,000	10.7%
John Day	$24,286,000	9.9%
Chief Joseph	$18,975,000	7.7%
Grand Coulee	$70,757,000	28.9%
Albeni Falls	$2,792,000	1.1%
Libby	$7,137,000	2.9%
Hungry Horse	$8,525,000	3.5%
McNary	$29,550,000	12.1%
Ice Harbor	$8,275,000	3.4%
Lower Monumental	$8,628,000	3.5%

[10] The non-routine costs associated with the rehabilitation or major repair of the structures were captured as capital costs, although sometimes activities are funded through NREX.

Project	Annual-equivalent Cost	Percent of Total Cost
Little Goose	$8,771,000	3.6%
Lower Granite	$6,651,000	2.7%
Dworshak	$5,691,000	2.3%
Total	**$245,091,000**	**100.0%**

4.2.2 Multiple Objective Alternative 2

Under MO2, there would be very little change in the capital costs compared to the No Action Alternative, an increase of approximately 0.02 percent annually over the period of analysis (Table 4-2). When compared to MO1, there are two structural measures under MO2 that would result in a slight change in costs under MO2. Additional powerhouse surface passage would occur at John Day under MO2 and not under MO1, and Lower Granite trap modifications would occur under MO1 but not under MO2. When these capital costs associated with these structural measures are annualized over the 50-year period of analysis, there is very little change in these costs compared to the No Action Alternative.

Table 4-2. Capital Cost Estimates for MO2 and Change from the No Action Alternative (2019$)

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
Bonneville	$18,733,000	$8,000	0.0%
The Dalles	$26,336,000	$8,000	0.0%
John Day	$24,298,000	$12,000	0.0%
Chief Joseph	$18,975,000	$0	0.0%
Grand Coulee	$70,757,000	$0	0.0%
Albeni Falls	$2,792,000	$0	0.0%
Libby	$7,137,000	$0	0.0%
Hungry Horse	$8,525,000	$0	0.0%
McNary	$29,559,000	$9,000	0.0%
Ice Harbor	$8,280,000	$5,000	0.1%
Lower Monumental	$8,633,000	$5,000	0.1%
Little Goose	$8,774,000	$2,000	0.0%
Lower Granite	$6,655,000	$4,000	0.1%
Dworshak	$5,691,000	$0	0.0%
Total	**$245,145,000**	**$53,000**	**0.02%**

4.2.3 Multiple Objective Alternative 3

Under MO3, the breaching of the four Lower Snake dams would result in large decreases in annual-equivalent costs compared to the No Action Alternative. A decrease of $32.3 million (-13.2%) in annual-equivalent capital costs would occur under MO3 (Table 4-3). All large and small capital investments incurred for power, fish, dredging, and other dam infrastructure would no longer be required at the four lower Snake River dams, an annual decrease between $6.6 and $8.7 million for each of these projects. However, at the other projects on the

Columbia River, there would be very little change in capital costs compared to the No Action Alternative.

Table 4-3. Capital Cost Estimates for MO3 and Change from the No Action Alternative (2019$)

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
Bonneville	$18,733,000	$8,000	0.0%
The Dalles	$26,336,000	$8,000	0.0%
John Day	$24,297,000	$11,000	0.0%
Chief Joseph	$18,975,000	$0	0.0%
Grand Coulee	$70,757,000	$0	0.0%
Albeni Falls	$2,792,000	$0	0.0%
Libby	$7,137,000	$0	0.0%
Hungry Horse	$8,525,000	$0	0.0%
McNary	$29,559,000	$9,000	0.0%
Ice Harbor	$0	-$8,275,000	-100.0%
Lower Monumental	$0	-$8,628,000	-100.0%
Little Goose	$0	-$8,771,000	-100.0%
Lower Granite	$0	-$6,651,000	-100.0%
Dworshak	$5,691,000	$0	0.0%
Total	**$212,802,000**	**-$32,289,000**	**-13.2%**

4.2.4 Multiple Objective Alternative 4

Under MO4, there would be a small change in the capital costs compared to the No Action Alternative, a change of approximately 0.02 percent annually over the period of analysis (Table 4-4). Under MO4 there would not be costs associated with the upgraded adjustable spillway weirs (as under MO1 and MO2), although there would be some costs associated with the spillway weir notch inserts at John Day, McNary, and the Lower Snake River projects. The changes in the anticipated capital costs under MO4 are negligible in comparison to the capital costs to operate the CRS under the No Action Alternative.

Table 4-4. Capital Cost Estimates for MO4 and Change from the No Action Alternative (2019$)

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
Bonneville	$18,733,000	$8,000	0.0%
The Dalles	$26,336,000	$8,000	0.0%
John Day	$24,296,000	$10,000	0.0%
Chief Joseph	$18,975,000	$0	0.0%
Grand Coulee	$70,757,000	$0	0.0%
Albeni Falls	$2,792,000	$0	0.0%
Libby	$7,137,000	$0	0.0%
Hungry Horse	$8,525,000	$0	0.0%

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
McNary	$29,554,000	$4,000	0.0%
Ice Harbor	$8,280,000	$5,000	0.1%
Lower Monumental	$8,636,000	$8,000	0.1%
Little Goose	$8,775,000	$4,000	0.0%
Lower Granite	$6,660,000	$9,000	0.1%
Dworshak	$5,691,000	$0	0.0%
Total	**$245,147,000**	**$56,000**	**0.02%**

4.2.5 Preferred Alternative

Under the Preferred Alternative, there would be a small change in the capital costs compared to the No Action Alternative, a change of approximately 0.02 percent annually over the period of analysis (Table 4-5). The There would be some very small changes in capital costs associated with the Lower Granite trap modification and the turbine strainer Lamprey exclusion over the period of analysis. The changes in the anticipated capital costs under the preferred alternative are negligible in comparison to the capital costs to operate the CRS under the No Action Alternative.

Table 4-5. Capital Cost Estimates for the Preferred Alternative and Change from the No Action Alternative (2019$)

Project	Annual-equivalent Cost	Change in Annual-equivalent Cost from No Action Alternative	Percent Change from No Action Alternative
Bonneville	$18,733,000	$8,000	0.0%
The Dalles	$26,336,000	$8,000	0.0%
John Day	$24,294,000	$8,000	0.0%
Chief Joseph	$18,975,000	$0	0.0%
Grand Coulee	$70,757,000	$0	0.0%
Albeni Falls	$2,792,000	$0	0.0%
Libby	$7,137,000	$0	0.0%
Hungry Horse	$8,525,000	$0	0.0%
McNary	$29,556,000	$6,000	0.0%
Ice Harbor	$8,278,000	$3,000	0.0%
Lower Monumental	$8,630,000	$2,000	0.0%
Little Goose	$8,774,000	$3,000	0.0%
Lower Granite	$6,658,000	$7,000	0.1%
Dworshak	$5,691,000	$0	0.0%
Total	**$245,136,000**	**$45,000**	**0.02%**

CHAPTER 5 - OPERATIONS AND MAINTENANCE COSTS

5.1 DATA COLLECTION AND METHODS

The data collection and methods for estimating O&M costs for the NAA and action alternatives are summarized in this section. The O&M cost estimates are provided in Section 5.2.

5.1.1 No Action Alternative

The O&M costs include routine O&M, non-routine extraordinary expenses, and non-routine navigation-related maintenance expenses.

5.1.1.1 Routine O&M

The routine O&M costs for the 12 Corps Federal Columbia River Basin Projects were obtained from the Corps of Engineers Financial Management System (CFEMS). CFEMS is the Corps of Engineer's financial database system and contains detailed costs for all of the Corps projects. The CEFMS is accessed through the Enterprise Data Warehouse. Routine O&M costs were obtained for the past 5 years (2013-2017) organized by business lines/categories: hydropower, fish and wildlife, cultural resources, navigation (dredging expenditures are covered under non-routine costs), recreation, and other operations and maintenance. The O&M costs include both the appropriated and power share of the costs. The Corps Walla Walla, Portland, and Seattle District and Northwestern Division project managers, operations personnel, as well as cost and budget experts from the Corps, Bonneville, and Reclamation provided input and review of the estimated O&M costs to ensure the represented current and anticipated future O&M needs under NAA.

The Corps Civil Works category class subclass code (CCS) for Corps business lines and projects were queried in CEFMS to obtain the routine O&M costs for each project. Relevant CCS codes are as follows: fish and wildlife – 394; hydropower (routine) – 381; navigation – 300; recreation – 300; and other – 396. Routine O&M costs include appropriated and joint costs. The O&M costs were reviewed in detail operations experts at the Corps Districts to ensure the estimated O&M costs were reasonable, as well as to ensure that costs were not double-counted among the categories.

The "other routine O&M" category includes costs associated with regular activities such as facilities upkeep, security equipment, salaries for security guards, general grounds maintenance, and office upgrades and maintenance. Hydropower O&M costs include routine costs associated with generating power at the respective projects, such as turbine upkeep, tailrace maintenance, and support salaries. Routine fish and wildlife O&M costs include hatchery operations, trap and transport activities for fish, and biologist salaries. Navigation costs include costs such as routine lock maintenance; however, the non-routine navigation costs, such as dredging, are described in Section 5.1.1.3 of this appendix. Recreation costs include O&M of recreation areas provided by the Corps as well as park ranger salaries.

Routine O&M costs for cultural resource were obtained from Bonneville, Corps, and Reclamation cultural resource specialists and are consistent with the Federal Columbia River Power System Fiscal Year 2018 Annual Report (Bonneville, Reclamation, and Corps 2019a). These costs include activities to preserve and maintain historic cultural sites or practices, as well as salaries and operations for cultural resource specialists. Based upon this annual report, O&M costs for cultural resources are assumed to be $10 million annually over the period of analysis for all projects.

Routine O&M costs for Hungry Horse and Grand Coulee projects were obtained from the BOR from 2013 to 2018 for the water users and appropriated accounts. The costs were reviewed with the BOR budget experts, and the costs for 2018 were selected as representative of current and future annual routine O&M costs and activities under the NAA at the two projects. The costs were inflated to 2019 dollars with the CWCCIS for the dam category.

Routine O&M costs for all projects (including all business line expenses) were estimated to be $353 million annually. More details regarding routine O&M by alternative and projects are provided in Section 5.2 below.

5.1.1.2 Non-routine Extraordinary Expenses

Bonneville operations experts provided the NREX cost estimated by project for 2020 to 2065. NREX costs include specific hydropower related items such as repair of failed units. Large and small capital (see Chapter 4) and non-routine navigation costs (see section 5.1.1.3) were provided separately. The Bonneville NREX costs were extended to the year 2070 by averaging the previous 5 years. The NREX investments included 2 percent inflation added every year; therefore, the NREX costs were deflated to 2019 dollars using the rates of inflation provided by Bonneville. Bonneville NREX costs were estimated to be $38.3 million, annually.

The Corps and Reclamation provided estimates of their share of joint NREX costs. The joint cost assumptions were based on historic estimates of these costs as a percentage of the SAMP costs, which were then projected of the 50-year period. The joint NREX costs were estimated to be $2.5 million for all projects.

5.1.1.3 Navigation

The non-routine navigation costs, including costs for dredging activities, were obtained from operations experts at the Corps Walla Walla and Portland Districts. For the Corps Walla Walla District, non-routine navigation and dredging costs were estimated based upon historic and current CEFMS data and projected over a 50-year period of analysis based on existing conditions and future anticipated needs (Corps Walla Walla District, 2019a). The bulk of dredging activities under the NAA would occur at Lower Granite; dredging costs for Walla Walla District projects were estimated to cost $3.04 million annually over the 50-year period.

The Portland District provided dredging quantities and costs for five locations between 2011 and 2018: the mouth of the Columbia River; the Columbia and lower Willamette River; the

Portland and Vancouver Anchorages; Vancouver to The Dalles; and The Dalles Lock and Dam (Corps Portland District, 2019b). These costs were inflated to 2019 price levels and averaged to provide an annual estimate of the anticipated dredging requirements in the Portland District under the NAA. The total cost of the dredging activities within the Portland District were estimated to be $67.1 million annually over the 50-year period.

The Technical Operations Branch at the Portland District also provided cost estimates to maintain the locks for the three Portland projects. All locks have had recent major rehabilitation. The District specialists estimated the non-routine costs that would likely need to occur over the next 10 to 30 years. Since recent rehabilitation has recently occurred, it was assumed that the non-routine lock costs would occur at year 20; these costs were then discounted to2019 dollars and amortized over the 50-year period of analysis (Corps Portland District, 2019c). The annualized navigation non-routine costs (not including dredging) were estimated to be $14 million for all projects in the lower Columbia and lower Snake River under the NAA.

5.1.2 Multiple Objective Alternatives

For the multi-objective alternatives, the Corps District operations, engineering, and budgeting personnel reviewed each of the structural and operational measures to evaluate how these measures would affect or change the estimates of O&M activities and costs under the multiple objective alternatives. For the multi-objective alternatives, the District personnel expressed each cost as a change from the current O&M activities and costs. Additional details on this approach are provided in this section.

5.1.2.1 Routine O&M

The structural and operational measures under the multiple objectives alternatives were evaluated by all of the Corps districts and Reclamation engineers, operations support, and budget experts to assess how the new infrastructure and structures and operations under the alternatives would increase or decrease the current routine O&M activities and costs (Corps Walla Walla District, 2019a; Corps Portland District, 2019b; Corps Seattle District, 2019b). These costs were assessed by project, structural or operational measure, and by alternative, discounted to reflect 2019 dollars and then amortized over the 50-year period of analysis to provide an annual-equivalent cost.

For the four lower Snake River projects that would be breached under MO3, multiple interviews and communications with Bonneville experts and Walla Walla District operations and budget experts were conducted to assess the levels of Corps operations and maintenance support and costs that would be needed after the breaching of the four lower Snake River dams (Corps Walla Walla District, 2019c). Each of the business line routine operations and maintenance activities were evaluated for these projects. The following assumptions were used in the cost analysis for the changes in the operations and maintenance costs under MO3. The O&M activities and associated costs for recreation, cultural resources, navigation, hydropower, and fish and wildlife would not be required or wouldn’t be funded under current authorities. Other operations and maintenance activities in the lower Snake River area would be considerably reduced compared to the NAA, but would include maintenance of Clarkston and Lewiston Levees, law enforcement, and engineering/safety inspections. Additional costs would be incurred as MO3-specific mitigation costs (for example, for public safety, transportation and navigation, and cultural resources, etc.) (see Sections 6.1.2 and 6.2.4 and Annex B for additional details on mitigation measures).

5.1.2.2 Non-routine Extraordinary Maintenance

Under MO3, the NREX as well as the Corps and Reclamation NREX cost shares for the four lower Snake River projects would be assumed to no longer be incurred. With the selection of MO3, NREX budgets and expenses and the associated cost shares associated with the four lower Snake projects would no longer be budgeted or expended, starting at the beginning of the period of analysis in year 2021. The estimates of NREX would not change under MO1, MO2, MO4, and the preferred alternative.

5.1.2.3 Navigation

All changes in the need for dredging or navigation-related activities were considered relative to the current estimates under the NAA. There would be no anticipated changes in non-routine non-dredging-related navigation costs under MO1, MO2, MO4, and the preferred alternative. There would be additional dredging needed under MO3, MO4, and the preferred alternative.

All non-routine navigation and dredging costs associated with the four Lower Snake Locks and Dams would no longer be incurred under MO3. Annual navigation costs of approximately $10 million, including $3 million in dredging costs, would no longer be authorized at the 4 lower Snake River projects under MO3.

5.2 OPERATIONS AND MAINTENANCE COST ESTIMATES

5.2.1 No Action Alternative

Table 5-1 summarizes the annual-equivalent O&M costs for each of the projects, which includes routine O&M costs, navigation non-routine costs, and NREX. Grand Coulee and Bonneville represent the projects with the highest O&M costs, with $117 million and $39.6 million, respectively. Note that the Portland District dredging is provided as a separate line item as it is not readily categorized into project-specific expenses. Of the O&M costs categories, routine O&M is the highest annualized cost, accounting for $353 million, while NREX accounts for $40.9 million, and non-routine navigation costs (including dredging) account for $84.1 million.

Table 5-1. No Action Alternative Annual Operations and Maintenance Costs by Project

Dam	Routine O&M Costs	NREX	Non-routine Navigation Costs	Total Annual-equivalent O&M Cost (2019$)	Percent of Total
Bonneville	$33,344,000	$4,596,000	$1,656,000	$39,596,000	8.3%
The Dalles	$25,479,000	$3,005,000	$439,000	$28,923,000	6.0%
John Day	$33,837,000	$3,001,000	$805,000	$37,643,000	7.9%
Chief Joseph	$27,509,000	$4,892,000	-	$32,401,000	6.8%
Grand Coulee	$104,049,000	$12,921,000	-	$116,970,000	24.5%
Albeni Falls	$9,705,000	$273,000	-	$9,978,000	2.1%
Libby	$12,213,000	$994,000	-	$13,207,000	2.8%
Hungry Horse	$6,369,000	$855,000	-	$7,224,000	1.5%
McNary	$27,449,000	$2,914,000	$3,698,000	$34,061,000	7.1%
Ice Harbor	$14,945,000	$1,308,000	$1,941,000	$18,194,000	3.8%
Lower Monumental	$12,281,000	$1,620,000	$1,663,000	$15,564,000	3.3%
Little Goose	$11,670,000	$1,103,000	$2,276,000	$15,049,000	3.1%
Lower Granite	$19,560,000	$2,558,000	$4,585,000	$26,703,000	5.6%
Dworshak	$14,902,000	$827,000	-	$15,729,000	3.3%
Portland Dredging	-	-	$67,072,000	$67,072,000	14.0%
TOTAL	$353,312,000	$40,867,000	$84,135,000	$478,314,000	100.0%

5.2.2 Multiple Objective Alternative 1

MO1 includes structural and operational measures that would lead to a very small change in the overall cost of operating and maintaining the CRS. Although annual costs would increase and decrease depending on the measure, total O&M costs across all projects would decrease slightly under MO1 when compared to the NAA, resulting in annual-equivalent O&M cost decrease of -$16,000 or -0.003 percent. Table 5-2 presents the O&M costs associated with MO1.

Increased O&M costs would occur from some of the structural measures as well as additional fish transport associated with the operational measure. During spring juvenile fish passage spill operations juvenile fish transportation would begin earlier in the spring. . Some small increases in O&M costs compared to the NAA would occur due to additional staffing levels for fish transportation at Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, Dworshak, John Day, The Dalles, and Bonneville. In addition, small increases in O&M would occur from some of the structural measures: adjustable spillway weirs at John Day, Ice Harbor, Lower Granite, Lower Monumental, and McNary dams; Lower Granite trap modifications; Lower Snake Ladder pumps at Ice Harbor and Lower Monumental; turbine strainer modifications to exclude lamprey at the Lower Snake River projects, McNary, Bonneville, The Dalles, and John Day projects; and turbine bypass screen modifications at McNary, Lower Granite, and Little Goose.

Under MO1, the juvenile fish facilities at Ice Harbor and McNary would no longer be needed due to the construction of additional fish surface passage. Reductions in costs compared to the NAA would occur from reduced levels of staffing for the juvenile fish facility at Ice Harbor and McNary. NREX and navigation costs would not be anticipated to change under MO1.

Table 5-2. Operations and Maintenance Costs for MO1 and Change from the No Action Alternative

Dam/Project/Project	Annual-equivalent Cost (2019$)	Change in Annual-equivalent Costs from No Action	Percent Change in Annual-equivalent Costs
Bonneville	$39,695,000	$100,000	0.3%
The Dalles	$29,023,000	$99,000	0.3%
John Day	$37,748,000	$104,000	0.3%
Chief Joseph	$32,401,000	$0	0.0%
Grand Coulee	$116,970,000	$0	0.0%
Albeni Falls	$9,978,000	$0	0.0%
Libby	$13,207,000	$0	0.0%
Hungry Horse	$7,224,000	$0	0.0%
McNary	$33,525,000	-$535,000	-1.6%
Ice Harbor	$18,023,000	-$171,000	-0.9%
Lower Monumental	$15,661,000	$97,000	0.6%
Little Goose	$15,141,000	$92,000	0.6%
Lower Granite	$26,823,000	$120,000	0.4%
Dworshak	$15,807,000	$79,000	0.5%
Portland Dredging	$67,072,000	$0	0.0%
TOTAL	$478,298,000	-$16,000	-0.003%

5.2.3 Multiple Objective Alternative 2

MO2 includes structural and operational measures that would affect the cost of operating and maintaining the CRS. Total O&M costs across all projects would result in a decrease in annual-equivalent O&M costs of $1.5 million or -0.3 percent when compared to the NAA. Table 5-3 presents the O&M costs associated with MO2.

Decreased O&M costs would occur at McNary, Ice Harbor, and John Day projects. Under MO2, with the additional fish surface passage at Ice Harbor, the juvenile fish facility would no longer be required. There would not be the need for fish transportation (i.e., trap and transport) at McNary, reducing O&M activities compared to the NAA. In addition, MO2 would cease installation of fish screens at Ice Harbor, McNary, and John Day projects, which would require fewer resources for routine O&M activities at these projects. NREX and navigation costs would not be anticipated to change under MO2.

Table 5-3. Operations and Maintenance Costs for MO2 and Change from the No Action Alternative

Dam/Project	Annual-equivalent Cost (2019$)	Change in Annual-equivalent Costs from No Action	Percent Change in Annual-equivalent Costs
Bonneville	$39,625,000	$30,000	0.1%
The Dalles	$28,953,000	$29,000	0.1%
John Day	$37,332,000	-$312,000	-0.8%
Chief Joseph	$32,401,000	$0	0.0%
Grand Coulee	$116,970,000	$0	0.0%

Dam/Project	Annual-equivalent Cost (2019$)	Change in Annual-equivalent Costs from No Action	Percent Change in Annual-equivalent Costs
Albeni Falls	$9,978,000	$0	0.0%
Libby	$13,207,000	$0	0.0%
Hungry Horse	$7,224,000	$0	0.0%
McNary	$33,194,000	-$866,000	-2.5%
Ice Harbor	$17,817,000	-$377,000	-2.1%
Lower Monumental	$15,575,000	$11,000	0.1%
Little Goose	$15,044,000	-$5,000	0.0%
Lower Granite	$26,702,000	-$1,000	0.0%
Dworshak	$15,728,000	$0	0.0%
Portland Dredging	$67,072,000	$0	0.0%
TOTAL	$476,822,000	-$1,492,000	-0.3%

5.2.4 Multiple Objective Alternative 3

MO3 includes structural and operational measures including breaching of the four lower Snake River projects, that would affect the cost of operating and maintaining the CRS. Changes in costs across all projects would result in a decrease in annual-equivalent O&M costs of -$78.9 million or -16.5 percent. Table 5-4 presents the O&M costs associated with MO3.

The largest change in O&M costs would occur as reductions in costs, or cost savings compared to the NAA at Ice Harbor, Little Goose, Lower Granite, and Lower Monumental projects. Most of the O&M costs would no longer be required with the breaching of the four Lower Snake River dams, including routine O&M costs to support navigation, recreation, hydropower, cultural resources, and fish and wildlife. Other O&M would be considerably reduced compared to No Action (Corps Walla Walla District, 2019c). However, mitigation costs to address the adverse effects to fish, cultural resources, and other resources during the breaching activity and transitional period would be anticipated to occur and are captured in the costs as described in Section 6.1.2 and 6.2.4 and Annex B. The NREX costs and non-routine dredging and lock and dam costs at the Lower Snake River projects would also no longer be incurred under MO3.

Bonneville, The Dalles, John Day, and Dworshak projects would experience a decrease in routine O&M costs from the elimination of the fish trap and transport program under MO3. There would be decreased O&M costs at McNary relative to the No Action Alternative from the elimination of fish screens and considerable reduction in staffing levels from the elimination of the juvenile fish facility. Additional dredging costs at McNary would be needed to maintain the federal navigation channel, which are further described under Mitigation Costs, Section 6.2.4. There are no anticipated changes in dredging required in the Portland District (at the projects, at the mouth of the Columbia, or in the Columbia and Lower Willamette River).

Table 5-4. Operations and Maintenance Costs for MO3 and Change from the No Action Alternative

Dam /Project	Annual-equivalent Cost (2019$)	Change in Annual Costs from No Action	Percent Change in Annual Costs
Bonneville	$38,949,000	-$646,000	-1.6%
The Dalles	$28,278,000	-$646,000	-2.2%
John Day	$36,950,000	-$694,000	-1.8%
Chief Joseph	$32,401,000	$0	0.0%
Grand Coulee	$116,970,000	$0	0.0%
Albeni Falls	$9,978,000	$0	0.0%
Libby	$13,207,000	$0	0.0%
Hungry Horse	$7,224,000	$0	0.0%
McNary	$32,365,000	-$1,695,000	-5.0%
Ice Harbor	$62,000	-$18,132,000	-99.7%
Lower Monumental	$62,000	-$15,502,000	-99.6%
Little Goose	$62,000	-$14,987,000	-99.6%
Lower Granite	$687,000	-$26,016,000	-97.4%
Dworshak	$15,061,000	-$667,000	-4.2%
Portland Dredging	$67,072,000	$0	0.0%
TOTAL	**$399,328,000**	**-$78,986,000**	**-16.5%**

5.2.5 Multiple Objective Alternative 4

MO4 includes structural and operational measures that would affect the cost of operating and maintaining the CRS. Changes in O&M activities across all projects would result in an increase in annual-equivalent O&M costs of $274,000 or 0.1 percent. Table 5-5 presents the O&M costs associated with MO4.

Similar to MO1, the juvenile fish facilities at Ice Harbor and McNary would no longer be required with the construction of additional fish surface passage under MO4. Reductions in costs compared to the NAA would occur from reduced levels of staffing for the juvenile fish facility at Ice Harbor and McNary. O&M activities for fish trap and transportation would shift in terms of the locations to more fish transportation activities required at Lower Monumental, Little Goose, ad Lower Granite, and fewer fish transportation requirements at McNary, Ice Harbor, Dworshak, John Day, The Dalles, and Bonneville.

Increased costs compared to the NAA would occur from a number of the structural and operational measures under MO4, including additional fish transport needs under MO4 at Lower Granite, Little Goose, and Lower Monumental projects; increased cavitation repair from operating the turbines within and above 1% peak efficiency in juvenile fish passage season; and additional O&M activities associated with the lower Snake Ladder pumps, intake bypass screens, and spillway weir notch gate inserts.

The NREX costs would not change under MO4 compared to NAA. There would be some additional dredging needed associated with the 125 Gas Cap spill operation, although these activities and costs are captured under Mitigation Costs, Section 6.2.5. Aside from small increase in dredging at John Day (captured under mitigation), there are no additional anticipated changes in dredging required in the Portland District (at the projects, at the mouth of the Columbia, or in the Columbia and Lower Willamette River).[11]

Table 5-5. Operations and Maintenance Costs for MO4 and Change from the No Action Alternative

Dam/Project	Annual-equivalent Cost (2019$)	Change in Annual-equivalent Costs from No Action	Percent Change in Annual-equivalent Costs
Bonneville	$39,639,000	$44,000	0.1%
The Dalles	$28,867,000	-$57,000	-0.2%
John Day	$37,689,000	$45,000	0.1%
Chief Joseph	$32,401,000	$0	0.0%
Grand Coulee	$116,970,000	$0	0.0%
Albeni Falls	$9,978,000	$0	0.0%
Libby	$13,207,000	$0	0.0%
Hungry Horse	$7,224,000	$0	0.0%
McNary	$33,501,000	-$559,000	-1.6%
Ice Harbor	$18,177,000	-$17,000	-0.1%
Lower Monumental	$15,791,000	$227,000	1.5%
Little Goose	$15,274,000	$225,000	1.5%
Lower Granite	$27,070,000	$367,000	1.4%
Dworshak	$15,728,000	$0	0.0%
Portland Dredging	$67,072,000	$0	0.0%
TOTAL	**$478,588,000**	**$274,000**	**0.1%**

5.2.6 Preferred Alternative

The preferred alternative includes structural and operational measures that would affect the cost of operating and maintaining the CRS. Changes in O&M costs for all projects would result in a slight decrease in annual-equivalent O&M costs of $729,000 or -0.15 percent. Table 5-6 presents the O&M costs associated with the preferred alternative.

Small increases O&M costs would occur at Bonneville, The Dalles, Lower Monumental, Little Goose, Lower Granite, and Dworshak associated with the earlier start time for fish transportation (all Portland and Walla Walla District projects), and the turbine bypass screen Lamprey exclusions and trap modifications at Lower Granite.

Under the preferred alternative, there would be decreases in O&M costs at McNary, Ice Harbor, and John Day projects compared to the NAA with the potential to cease installation of fish

[11] Private and/or and municipal dredging of ports would likely be needed under MO4, which is described in the Navigation section .

screens to increase efficiency of new hydropower turbines. As a result, there would be reduced routine O&M costs from fewer staffing requirements at these projects compared to the NAA.

Table 5-6. Operations and Maintenance Costs for the Preferred Alternative and Change from the No Action Alternative

Dam/Project/Project	Annual-equivalent Cost (2019$)	Change in Annual-equivalent Costs from No Action	Percent Change in Annual-equivalent Costs
Bonneville	$39,700,000	$105,000	0.3%
The Dalles	$29,023,000	$99,000	0.3%
John Day	$37,402,000	-$242,000	-0.6%
Chief Joseph	$32,401,000	$0	0.0%
Grand Coulee	$116,970,000	$0	0.0%
Albeni Falls	$9,978,000	$0	0.0%
Libby	$13,207,000	$0	0.0%
Hungry Horse	$7,224,000	$0	0.0%
McNary	$33,313,000	-$747,000	-2.2%
Ice Harbor	$17,806,000	-$388,000	-2.1%
Lower Monumental	$15,669,000	$105,000	0.7%
Little Goose	$15,167,000	$118,000	0.8%
Lower Granite	$26,845,000	$142,000	0.5%
Dworshak	$15,807,000	$79,000	0.5%
Portland Dredging	$67,072,000	$0	0.0%
TOTAL	$477,585,000	-$729,000	-0.15%

CHAPTER 6 - MITIGATION COSTS

Mitigation includes fish and wildlife-related expenses required to mitigate the operation of the Federal Columbia River Power System (FCRPS), as well as separate, ESA-related mitigation requirements. Additional mitigation measures have also been proposed under each of the a alternatives to mitigate adverse impacts of the alternatives; these measures include fish and wildlife-related measures as well as other measures, such as, protecting fish, cultural resources, and others. This section describes these mitigation measures and costs.

6.1 DATA COLLECTION AND METHODS

6.1.1 Fish and Wildlife Costs

Bonneville's F&W Program funds hundreds of projects each year to mitigate the impacts of the federal hydropower system on fish and wildlife. Bonneville began this program to fulfill mandates established by Congress in the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act), 16 USC § 839b(h)(10)(A), to protect, mitigate, and enhance fish and wildlife affected by the development and operation of the FCRPS. Each year Bonneville funds projects with many local, state, tribal, and federal entities to fulfill its Northwest Power Act fish and wildlife responsibilities and to implement offsite mitigation actions listed in various Biological Opinions for ESA-listed species. Offsite protection and mitigation actions typically address impacts to fish and wildlife not caused directly by the CRS, but they are actions that can improve the overall conditions for fish to help address uncertainty related to any residual adverse effects of CRS management. For example, F&W Program funding improves habitat in the mainstem as well as tributaries and the estuary, builds hatcheries and boosts hatchery fish production, evaluates the success of these efforts, and improves scientific knowledge through research. This work is implemented through annual contracts, many of which are associated with multi-year agreements like the Columbia River Basin Fish Accords, the Accord extensions, or wildlife settlements. The Bonneville F&W Program also includes capital projects, such as hatchery construction projects, but those costs are analyzed as part of the Power and Transmission chapter.

Funding decisions for the Bonneville F&W Program are not being made as a part of the CRSO EIS process. However, a range of potential F&W Program costs are included to inform the broader cost analysis for each alternative in the EIS. To make the most of available funds, investments in fish and wildlife mitigation would be prioritized based on biological and cost effectiveness and their connection to mitigating for impacts to the FCRPS. Future budget adjustments would be made in consultation with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements.

Congress authorized the Lower Snake River Compensation Plan (LSRCP) as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four Lower Snake River dams. A major component of the authorized plan was the design and construction of fish hatcheries and satellite facilities. Bonneville also directly funds the annual operations and maintenance of the Lower Snake River

Compensation Plan (LSRCP) facilities; this program is administered through the USFWS. The LSRCP hatcheries and satellite facilities produce and release more than 19 million salmon, steelhead and resident rainbow trout as part of the program's mitigation responsibility. The 25 LSRCP hatcheries and satellite facilities are operated by Idaho Fish and Game (IDFG), Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), USFWS, the Nez Perce Tribe (NPT), Confederated Tribes of the Umatilla River (CTUIR), and Shoshone-Bannock Tribes (SBT). Current and anticipated future annual costs for both Bonneville's F&W program and LSRCP were obtained from experts at Bonneville; any potential changes in funding and anticipated costs under the multiple objective alternatives were estimated by Bonneville. Costs for the F&W Program and LSRCP were obtained for 2016 (BP16 Rate Case) and inflated to reflect costs/funding in 2019 dollars.

The Corps has recently completed construction and implementation activities associated with its LSRCP authorization, including habitat development and game bird production, throughout the lower Snake River basin. The Corps would continue to manage fish and wildlife resources through its O&M funding. No costs were included for the LSRCP program under the No Action Alternative or under the action alternatives.

The Corps and Reclamation also provide funding for fish and wildlife conservation measures and activities under obligations including the Endangered Species Act. The Corps Columbia River Fish Mitigation (CRFM) Program includes construction-focused conservation and fish and wildlife mitigation measures. In recent years, funding for this program has decreased and is anticipated to continue decreasing in the near team, and will no longer be required in approximately 10 years (Corps Northwestern Division, 2019). Any structural measures that would occur under the action alternatives were removed from these estimates to avoid double counting. Funding under the CRFM included the Four-year plan (FY21-FY24) estimates as well as one additional project that was not included in plan estimates, debris management at McNary and the four lower Snake River projects. The debris management project was assumed to be implemented over ten years. The Four-year plan estimates and the debris management projects were discounted to reflect a present value of the CRFM Program in 2020. When amortized over 50 years, the CRFM program was estimated to cost approximately $2.0 million annually (50% associated with the Lower Snake River projects). Bonneville is obligated to repay the power share of these costs.

Reclamation has a fish and wildlife program to meet its ESA obligations at its two projects, Grand Coulee and Hungry Horse. The program funds activities such as improving tributary habitat, avian predation management, and it also includes funding for ESA consultation and litigation support. Program experts at BOR estimated that annual costs to meet these obligations under the NAA would be approximately $14.3 million. This estimate excludes measures and activities for the Upper Snake Flow Augmentation Biological Opinion, which is outside of the scope of this EIS.

In addition to the fish and wildlife mitigation costs described in this section, there are also fish and wildlife costs that are, in part, directly funded by Bonneville to the Corps and Reclamation for mitigation activities, such as hatchery operations, fish stocking, elk habitat maintenance, and others. In addition, Bonneville directly funds the power share of O&M costs for Corps operated fish passage facilities. These costs were captured under the fish and wildlife routine O&M costs (Sections 5.1.1.1 and 5.1.2.1).

The Preferred Alternative is being coordinated for consultation with the USFWS and NMFS. Chapter 7 of the EIS, Preferred Alternative, describes the specific measures added for ESA compliance. A number of the ESA measures would be implemented through existing funding mechanisms, for example, through the Bonneville F&W Program or the CRFM program, while others would require additional appropriations or funding sources. Therefore, it is expected that there would be some small additional annual costs for ESA compliance measures. Note, that these costs are not included in the mitigation costs summarized in Table 6-1. This is because a number of the measures would likely be implemented under existing programs and funding sources. Additionally, some of the specific measures and implementation plans are still being established through consultation with USFWS and NMFS. Although the focus of the consultation is on the Preferred Alternative, it is expected that the ESA-compliance measures would be similar across the action alternatives (i.e. the Preferred Alternative and the MOs).

6.1.2 Costs for Additional Mitigation Measures

Additional mitigation measures for the action alternatives are activities that have been identified during the resource evaluation process that include reasonably foreseeable activities undertaken to avoid, minimize, or mitigate impacts from occurring under the action alternatives. These activities may include protecting cultural resources, planting and re-vegetating areas, and extending boat and ferry ramps. MO3 has a number of additional mitigation measures to help to offset certain adverse impacts from breaching the four lower Snake River projects. Chapter 5 in the main body of the EIS provides additional details on the mitigation measures. In addition, Annex B, Costs for Additional Mitigation Measures, provides additional details on how the costs were developed and an estimate of the costs for each measure.

Resource specialists along with agency policy and technical leads developed mitigation measures based upon likely effects under each alternative. Similar to the process for developing action alternative cost estimates, the mitigation measure costs were developed utilizing cost engineering as well as related historic, current or estimated future costs, depending upon the proposed measure. Structural mitigation measures were estimated by the cost engineers at the Mandatory Cost Center for Expertise, while on-going system annual system costs were developed with input from programs, operations and cost engineering. Similar to action alternative cost estimates, capital and O&M costs for routine and non-routing activities were estimated for mitigation measures, if applicable.

Bonneville F&W Program experts reviewed the fish and wildlife mitigation measures to identify specific measures that would be funded under Bonneville's F&W Program, and to ensure double-counting between cost categories did not occur. These measures include wetland, riparian, and tributary habitat improvements; planting vegetation and cottonwoods; and creating back channel habitat. Because these specific measures are currently being implemented or would be prioritized for funding under Bonneville's F&W Program, the mitigation measures are recognized under the appropriate MO, but costs are captured in the Bonneville F&W Program costs.

6.2 MITIGATION COST ESTIMATES

This section presents the mitigation costs under the alternatives. Additional details on the costs of the additional mitigation measures are provided in Annex B. Table 6-1 summarizes the Bonneville F&W Program costs, LSRCP costs, the CRFM costs, the BOR ESA-related costs, and the MO-specific mitigation costs.

Table 6-1. Annual Mitigation Costs under the No Action Alternative and the Action Alternatives

	Fish and Wildlife Mitigation						Total Mitigation Costs (Low F&W Program Cost)	Total Mitigation Costs (High F&W Program Cost)
Alternative	Bonneville's F&W Program[a] (Low Estimate)	Bonneville's F&W Program[a] (High Estimate)	LSRCP	BOR ESA Funding Obligations	CRFM	Additional Mitigation Costs[b]		
NAA	$282,000,000	$282,000,000	$34,000,000	$14,300,000	$2,000,000	NA	$332,300,000	$332,300,000
MO1	$282,000,000	$282,000,000	$34,000,000	$14,300,000	$2,000,000	$1,200,000	$333,500,000	$333,500,000
MO2	$282,000,000	$335,000,000	$34,000,000	$14,300,000	$2,000,000	$1,700,000	$334,000,000	$387,000,000
MO3	$177,000,000	$282,000,000	$0	$14,300,000	$900,000	$45,700,000	$237,900,000	$342,900,000
MO4	$177,000,000	$282,000,000	$34,000,000	$14,300,000	$2,000,000	$6,200,000	$233,500,000	$338,500,000
Preferred Alternative	$235,000,000	$282,000,000	$34,000,000	$14,300,000	$2,000,000	$5,200,000	$287,900,000	$334,900,000

[a]The F&W Program also includes capital projects, such as hatchery construction projects; those costs are analyzed as part of the Power and Transmission chapter of the Draft EIS (Section 3.8).
[b] Note that the additional mitigation measures include some fish and wildlife-related measures that would not be implemented or funded through the F&W Program, LSRCP, CRFM, or the BOR ESA measures. Please see Annex B for additional details.

6.2.1 No Action Alternative

The NAA would include approximately $316 million in annual funding for Bonneville's F&W Program and LSRCP.[12] BOR ESA funding obligations are estimated to be $14.3 million annually under the NAA and would not change under the multiple objective alternatives. The CRFM Program would cost approximately $2.0 million in annual-equivalent costs under the NAA. There are no additional mitigation costs under the NAA.

6.2.2 Multiple Objective Alternative 1

System operations under MO1 is similar to the NAA; therefore, fish and wildlife mitigation costs associated with existing co-lead agency programs, are estimated to be the same as those estimated under the NAA. MO1 would result in additional mitigation measures of $1.2 million

[12] In 2016, the Bonneville Fish and Wildlife Program budget was $267,000,000, and the LSRCP budget was $32,303,000. When these budgets are adjusted to represent 2019 dollars, they become $281,536,000 and $34,062,000, respectively. It should be noted that in fiscal year 2020, Bonneville adjusted the F&W Program budget to $249 million and the LSRCP budget to $30.5 million (BP-18 Rate Case).

annually, which would occur at Grand Coulee, Hungry Horse, Libby, and the Lower Snake River projects. Additional fish and wildlife mitigation measures ($520,000 annually) under MO1 are currently being implemented and/or would be prioritized for funding under Bonneville's F&W Program (these costs are captured under the F&W Program costs in Table 6-1).

6.2.3 Multiple Objective Alternative 2

Under MO2, power generation would increase, and juvenile fish passage spill would be reduced. If the changes to system operations under MO2 impact fish as anticipated, there may be an increased need for off-site mitigation funded through Bonneville's F&W Program (Bonneville 2019), with the potential for increases in funding for Bonneville's F&W Program. As a result, Bonneville's F&W Program costs were provided as a range under MO2: from $282 million to $335 million (an increase of $53 million annually compared to the NAA). Future budget adjustments will be made with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. Under MO2, Bonneville would continue funding O&M of the LSRCP, estimated at $34 million annually (Bonneville, 2019). CRFM and BOR ESA funding would also remain the same as estimated under the NAA.

MO2 would result in additional mitigation measures, which would occur at Grand Coulee, Libby, Hungry Horse, and Dworshak, with an annual cost of $1.5 million. Additional fish and wildlife mitigation measures ($520,000 annually) proposed under MO2 are currently being implemented and/or would be prioritized for funding under Bonneville's F&W Program (these costs are captured under the F&W Program costs in Table 6-1).

6.2.4 Multiple Objective Alternative 3

Upon the breaching of the LSR dams, Bonneville would no longer have an obligation to fund USFWS for O&M of the LSRCP facilities, estimated at $34 million, because Bonneville's funding authority is directly tied to the operation of the LSR dams. However, the co-lead agencies recognize that there would be transitional needs that would be addressed by Bonneville and other funding sources. Additionally, the Bonneville F&W Program funding for offsite mitigation projects in the Snake River Basin would be reviewed and potentially adjusted. Any changes of this nature would be implemented over time as the effectiveness of dam breaching is observed and would be done in consultation with fish and wildlife managers, regulatory agencies, and the Northwest Power and Conservation Council. Consistent with this, offsite mitigation projects for the other CRS dams would be reviewed and could be adjusted as operations change over time. As a result, Bonneville's F&W Program costs were provided as a range under MO3: from $282 million annually (the same estimate of Bonneville's F&W Program cost as under the NAA) to $177 million annually (a decrease of $105 million annually compared to the NAA). By analyzing a range of costs, Bonneville reflects the year-to-year fluctuations related to managing its F&W Program and also acknowledges the uncertainty around both the magnitude of biological benefits and the potential impacts on funding, including the timing of funding decisions.

Future budget adjustments would be made in consultation with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. Proposed project modifications would be coordinated with project sponsors and regional stakeholders to determine appropriate funding levels. Future budget adjustments will be made with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. BOR ESA funding obligations are estimated to be $14.3 million annually under the NAA and would not change under MO3. The CRFM Program annual funding is estimated to be reduced by about half of the current funding of $1.5 million under MO3.

Additional mitigation measures under MO3 are anticipated to cost $45.7 million annually, most of which would occur to mitigate the adverse effects of the breach at McNary and the lower Snake River projects. The additional mitigation measures include: planting and restoration activities ($7.4 million annually); actions to protect and enhance fish habitat ($5.0 million annually); navigation and transportation ($30 million annually); public safety ($1.6 million annually); and protecting cultural resources ($1.5 million annually). Additional fish and wildlife mitigation measures ($520,000 annually) proposed under MO3 are currently being implemented and/or would be prioritized for funding under Bonneville's F&W Program (these costs are captured under the F&W Program costs in Table 6-1).

6.2.5 Multiple Objective Alternative 4

Operational changes at the Lower Columbia and Lower Snake dams that benefit fish under MO4 would decrease power generation.[13] Bonneville included a range of potential F&W Program costs to acknowledge the possibility that MO4 could provide biological benefits to fish and wildlife and that this could, in turn, reduce the need for some offsite mitigation funded by the Bonneville F&W Program. By analyzing a range of costs, Bonneville reflects the year-to-year fluctuations related to managing its F&W program and also acknowledges the uncertainty around both the magnitude of biological benefits and the potential impacts on funding, including the timing of funding decisions. Therefore, Bonneville's F&W Program costs were provided as a range under MO4: from $282 million annually (the same estimate as provided for the NAA) to $177 million annually (a decrease of $105 million annually compared to the NAA). Future budget adjustments would be made in consultation with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. Bonneville would continue to fund O&M of the LSRCP, estimated at $34 million annually. CRFM and BOR ESA funding would remain the same as estimated under the NAA.

[13]Please see the Power and Transmission Technical Appendix for additional details.

Additional measures to mitigate the adverse effects of MO4 were estimated to be $6.2 million annually at Albeni Falls, Hungry Horse, Grand Coulee, Lower Monumental, Little Goose, Lower Granite, McNary, and John Day. Included are measures to protect water quality, fish habitat, cultural resources, and to navigation and transportation. One additional fish and wildlife mitigation measure ($250,000 annually) proposed under MO4 is currently being implemented and/or would be prioritized for funding under Bonneville's F&W Program (this cost is captured under the F&W Program costs in Table 6-1).

6.2.6 Preferred Alternative

Under the preferred alternative, Bonneville included a range of potential F&W Program costs to acknowledge the possibility that the preferred alternative could provide biological benefits to anadromous fish species (see Chapter 7 of the EIS) and that this could, in turn, reduce the need for some offsite mitigation funded through the Bonneville F&W Program. By analyzing a range of costs, Bonneville reflects the year-to-year fluctuations related to managing its program and also acknowledges the uncertainty around both the magnitude of biological benefits and the potential impacts on funding, including the timing of funding decisions. Bonneville's F&W Program costs were provided as a range under the preferred alternative: from $282 million annually (the same estimate as provided for the NAA) to $235 million annually (a decrease of $47 million annually compared to the NAA or 17 percent). Proposed project modifications would be coordinated with project sponsors and regional stakeholders to determine appropriate funding levels. [14] Bonneville would continue to fund the operations and maintenance of the LSRCP, estimated at $34 million annually. CRFM and Reclamation ESA funding would remain the same as estimated under the NAA.

Additional measures to mitigate the adverse effects of preferred alternative were estimated to be $2.6 million in annual costs at Grand Coulee, Libby, Lower Monumental, Lower Granite, Ice Harbor, and McNary. These measures include measures to protect water quality, fish habitat, cultural resources, and to maintain navigation and transportation. One additional fish and wildlife mitigation measure ($270,000 annually) proposed under MO4 is currently being implemented and/or would be prioritized for funding under Bonneville's F&W Program (this cost is captured under the F&W Program costs in Table 6-1).

[14] In 2016, Bonneville's F&W Program budget was $267,000,000, and the LSRCP budget was $32,303,000. When these budgets are adjusted to represent 2019 dollars, they become $281,536,000 and $34,062,000, respectively, which are the budgets used under the No Action Alternative. Bonneville's fiscal year 2020 decisions to adjust the F&W Program budget to $249 million and the LSRCP budget to $30.5 million (BP-18 Rate Case) are consistent with the range of costs analyzed for the Preferred Alternative.

CHAPTER 7 - SUMMARY OF ALL COSTS

This chapter presents a summary of the annual-equivalent costs for all alternatives, including the change and percent change from the No Action Alternative. Table 7-1 summarizes the annual-equivalent costs by alternatives; Table 7-2 summarizes the changes in annual-equivalent costs compared to the No Action Alternative; and Table 7-3 summarizes the percent change in annual-equivalent costs compared to the No Action Alternative.

As shown in Table 6-1, the estimated total cost for operating and maintaining the CRS under the NAA is approximately $1.06 billion annually. As described in Chapters 4, 5, and 6, the NAA costs include capital, O&M and mitigation costs. Mitigation costs include Bonneville's F&W Program and the LSRCP; the Corps CRFM costs; Reclamation ESA-related costs as well as additional measures to mitigate adverse effects under the action alternative (includes fish and wildlife, water quality, cultural resources, public safety, and others). Across these general cost categories under the No Action Alternative, capital costs accounts for 23 percent of total annual system costs, O&M 45 percent of total annual system costs, and mitigation 31 percent of total annual system costs.

MO1 represents a relatively small increase in annual-equivalent costs when compared to the NAA. Under MO1 there would be an estimated increase of $21 million annually, or 2.0 percent compared to NAA. This cost increase is driven primarily by construction of structural measures. Present value of the structural measure costs for MO1 are estimated to be $533 million. When amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $20 million (or 95 percent of the annual cost increase). Almost half of this cost would occur at the McNary project ($253.8 million in first costs for all structural measures at McNary), where a number of fish-related measures would be constructed, followed by similar fish-related measures at the Ice Harbor project ($114.2 million in first costs). There would be slight changes to capital and O&M costs from the structural measures and operational changes under MO1, while fish and wildlife mitigation costs are expected to be similar to NAA (i.e. Bonneville F&W Program, LSRCP, CRFM, and the BOR ESA-related mitigation would continue). MO1 would also include additional mitigation measures as described in Section 6.2 and Annex B.

As shown in Table 7-1, MO2 is estimated to cost between $53 to $106 million more annually than the No Action Alternative (5.0 to 10.0 percent increase). Under MO2, power generation would increase and juvenile fish passage spill would be reduced. MO2 cost increases are driven by construction costs of structural measures estimated to be $1.4 billion (present values of the cost of the structural measures). Much of the increase in costs for the structural measures under MO2 compared to MO1 occurs at McNary (powerhouse surface passage first cost under MO2 is $889 million versus $158 million under MO1), where additional surface passage would include construction of a collection channel and dewatering facility. There would be related increases in capital and O&M costs from the structural measures and operational changes under MO2. If the operational measures under MO2 have a negative effect on fish, there could be an increased need for off-site mitigation funded through the Bonneville F&W Program (Bonneville 2019). Potential increases to the Bonneville F&W Program are estimated to range from the same as No Action up to $53 million above the NAA budget of $281 million. Future budget adjustments would be made with the region through Bonneville's budget-making processes and other appropriate forums, consistent with existing agreements. LSRCP, CRFM, and Reclamation ESA-related mitigation would remain the same as under the No Action Alternative. Some additional MO2 mitigation actions are proposed as described in Section 6.2.2 and Annex B of the Cost Analysis appendix.

Under MO3, total costs are anticipated to decrease between $159 and $54 million annually, or between 15.1 to 5.1 percent decline compared to the No Action Alternative (Table 7-2 and Table 7-3). The present value of the construction of the structural measures for MO3 are estimated to be $1.2 billion. Of the $1.2 billion, $994 million (or 77%) are costs associated with breaching the Lower Snake River dams. When amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $46 million ($35 million for the costs for breaching the Lower Snake River dams).

As described in Section 3.1.2, a sensitivity analysis was conducted on the timing of the construction of the structural measures in terms of its impact on annualized costs under MO3, comparing the cost of completing MO3 over a 10 year timeframe, versus the two-year implementation assumption. Delaying and spreading out costs for breaching the Lower Snake River dams would represent a difference in annualized costs of $3.5 million, which represents approximately 8 percent of the construction costs of the structural measures and 0.4 percent of total annual-equivalent costs under MO3. Therefore, the difference between a two-year and a ten-year implementation schedule does not warrant deviation from the two-year approach used throughout the study.

MO3 would result in a large decrease in capital costs (-$32 million or -13%) and O&M costs (-$79 million or -16.5%) across all projects compared to the No Action Alternative, with the largest decrease at the Lower Snake River projects (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) (Table 7-2). Upon the breaching of the LSR dams, Bonneville would no longer have an obligation to fund USFWS for the operations and maintenance of the LSRCP facilities, estimated at $34 million. Bonneville's funding authority is directly tied to the operation of the LSR dams. However, the co-lead agencies recognize that there would be transitional needs that would be addressed. Additionally, the Bonneville F&W Program funding for offsite mitigation projects in the Snake River Basin would be reviewed and potentially adjusted. Any changes of this nature would be implemented over time as the effectiveness of dam breaching is observed and would be done in consultation with fish and wildlife managers, regulatory agencies, and the Northwest Power and Conservation Council. Consistent with this, offsite mitigation projects for the other CRS dams would be reviewed and could be adjusted as operations change over time. As a result, Bonneville's F&W Program costs are estimated as a range: from the same as under the No Action Alternative to a 37 percent decrease, or a decrease of $105 million annually when competed to the No Action Alternative. Proposed project modifications would be coordinated with project sponsors and regional stakeholders to determine appropriate funding levels. Future budget adjustments would be made with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. The CRFM costs would also decrease under MO3 by $1.0 million annually, while the Reclamation's ESA-related costs would remain the same as under the No Action Alternative ($14.3 million per year).

Additional mitigation costs to offset the adverse impacts of MO3 are estimated to be $45.7 million annually. The largest mitigation costs would occur at the Lower Snake River projects, including measures for vegetation, wildlife, wetlands, and floodplains; water quality; cultural resources; anadromous fish; resident fish; public safety; navigation and transportation, and other mitigation measures. Details on the additional mitigation measures are described in Section 6.2.2 and Annex B.

Estimated MO4 costs range from a decrease in annual costs of $55 million to an increase in annual costs of $50 million, or a -5.2% decrease to 4.7% increase compared to the No Action Alternative (Table 7-2 and Table 7-3). MO4 includes $1.2 billion (present value) for the construction of structural measures, or $44 million annually. MO4 includes powerhouse surface passage measures as well as spillway weir notch inserts at all Lower Snake River, McNary and John Day projects (which are not included under the other MOs) along with several other fish-related measures similar to those included under MO1. There would be slight changes to capital and operating and maintenance costs from the structural measures and operational changes under MO4. Bonneville included a range of potential F&W Program costs to acknowledge the possibility that MO4 could provide biological benefits to fish and wildlife and that this could, in turn, reduce the need for some offsite mitigation funded by the Bonneville F&W Program. As a result, offsite mitigation projects in the Bonneville F&W Program would be reviewed and could be adjusted as operations change over time. As a result, Bonneville's F&W Program costs are estimated to range: from no change from No Action Alternative to a decrease of approximately 37 percent, or approximately $105 million, annually. Proposed project modifications would be coordinated with project sponsors and regional stakeholders to determine appropriate funding levels. Future budget adjustments would be made with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. The LSRCP, CRFM, F&W O&M, and the Reclamation ESA-related mitigation would remain the same as under the No Action Alternative. MO4 would include additional mitigation measures, estimated to cost approximately $6.2 million, annually (see Section 6.2.2 and Annex B for additional details).

The Preferred Alternative is estimated to cost from $6 million more annually (+0.6%) to $41 million less than the No Action Alternative (-3.9%) (Table 7-2 and Table 7-3). Present value of the structural measure costs for the Preferred Alternative are estimated to be $104 million, and when amortized over the 50-year period of analysis, the annual-equivalent cost is approximately $4.0 million. Most of the costs of the structural measures would occur at Bonneville project for the Lamprey passage structures and the ladder serpentine weir and at Lower Granite and Little Goose projects associated with the bypass screen modifications for Lamprey. Additionally, there could be slight decreases in capital and O&M costs under the Preferred Alternative driven by ceasing installation of fish screens at Ice Harbor, McNary and John Day. The timing for ceasing the installation of these screens would be coordinated with the Corps and NMFS. However, the changes in capital and O&M costs compared to the No Action Alternative would be minimal.

As previously discussed, funding decisions for the Bonneville F&W Program are not being made as a part of the CRSO EIS process. However, a range of potential F&W Program costs are included to inform the broader cost analysis for each alternative in the EIS. Future budget adjustments would be made in consultation with the region through Bonneville's budget-making processes and other appropriate forums and consistent with existing agreements. In the case of the Preferred Alternative, Bonneville included a range of potential Fish and Wildlife Program costs to acknowledge the possibility that the Preferred Alternative could provide biological benefits to anadromous fish species (see Chapter 7 of the EIS, Preferred Alternative) and that this could, in turn, reduce the need for some offsite mitigation funded through the Bonneville F&W Program. By analyzing a range of costs, Bonneville reflects the year-to-year fluctuations related to managing its program and also acknowledges the uncertainty around both the magnitude of biological benefits and the potential impacts on funding, including the timing of funding decisions. In 2016, Bonneville's F&W Program budget was $267,000,000, and the LSRCP budget was $32,303,000. When these budgets are adjusted to represent 2019 dollars, they become $281,536,000 and $34,062,000, respectively, which are the budgets used under the No Action Alternative. For the Preferred Alternative, Bonneville would continue funding the operations and maintenance of the LSRCP facilities, consistent with the No Action Alternative. Bonneville's F&W Program costs under the Preferred Alternative are estimated to range from no change from the No Action Alternative to a decrease of approximately 17 percent, or approximately $47 million, annually. Bonneville's fiscal year 2020 decisions to adjust the F&W Program budget to $249 million and the LSRCP budget to $30.5 million (BP-18 Rate Case) are consistent with the range of costs analyzed for the Preferred Alternative.

Under the Preferred Alternative, the CRFM, F&W O&M, and the Reclamation ESA-related mitigation would remain the same as under the No Action Alternative. The Preferred Alternative would include additional mitigation measures, estimated to cost approximately $2.6 million, annually (see Section 6.2.2 and Annex B for additional details).

Table 7-1. Annual-equivalent Costs for the Alternatives ($2019)

Alternative	Construction Costs of Structural Measures (present value)	Construction Costs of Structural Measures (annual)	Capital Costs (annual)	O&M Costs (annual)	Mitigation (Low F&W Costs) (annual)	Mitigation (High F&W Costs) (annual)	Total Annual-Equivalent Costs (Low)	Total Annual-Equivalent Costs (High)
No Action Alternative		NA	$245,000,000	$478,000,000	$332,000,000	$332,000,000	$1,055,000,000	$1,055,000,000
MO1	$533,000,000	$20,000,000	$245,000,000	$478,000,000	$333,000,000	$333,000,000	$1,076,000,000	$1,076,000,000
MO2	$1,412,000,000	$52,000,000	$245,000,000	$477,000,000	$334,000,000	$387,000,000	$1,108,000,000	$1,161,000,000
MO3	$1,235,000,000	$46,000,000	$213,000,000	$399,000,000	$238,000,000	$343,000,000	$896,000,000	$1,001,000,000
MO4	$1,200,000,000	$44,000,000	$245,000,000	$478,000,000	$233,000,000	$338,000,000	$1,000,000,000	$1,105,000,000
Preferred Alternative	$104,000,000	$4,000,000	$245,000,000	$478,000,000	$288,000,000	$335,000,000	$1,015,000,000	$1,062,000,000

Table 7-2. Change in Annual-equivalent Costs from the No Action Alternative for the Alternatives ($2019)

Alternative	Construction Costs of Structural Measures (annual)	Change in Capital Costs (annual)	Change in O&M Costs (annual)	Change in Annual Mitigation (Low F&W Costs)	Change in Annual Mitigation (High F&W Costs)	Change in Annual-Equivalent Costs (Low F&W costs)	Change in Annual-Equivalent Costs (High F&W costs)
MO1	$20,000,000	$0	$0	$1,000,000	$1,000,000	$21,000,000	$21,000,000
MO2	$52,000,000	$0	-$1,000,000	$2,000,000	$55,000,000	$53,000,000	$106,000,000
MO3	$46,000,000	-$32,000,000	-$79,000,000	-$94,000,000	$11,000,000	-$159,000,000	-$54,000,000
MO4	$44,000,000	$0	$0	-$99,000,000	$6,000,000	-$55,000,000	$50,000,000
Preferred Alternative	$4,000,000	$0	$0	-$44,000,000	$3,000,000	-$40,000,000	$7,000,000

Table 7-3. Percent Change in Annual-equivalent Costs from the No Action Alternative for the Alternatives ($2019)

Alternative	Construction Costs of Structural Measures (annual)	Percent Change in Capital Costs (annual)	Percent Change in O&M Costs (annual)	Percent Change in Annual Mitigation (Low F&W Costs)	Percent Change in Annual Mitigation (High F&W Costs)	Percent Change in Annual-Equivalent Costs (Low F&W costs)	Percent Change in Annual- Equivalent Costs (High F&W costs)
MO1	NA	0.0%	0.0%	0.3%	0.3%	2.0%	2.0%
MO2	NA	0.0%	-0.2%	0.6%	16.6%	5.0%	10.0%
MO3	NA	-13.1%	-16.5%	-28.3%	3.3%	-15.1%	-5.1%
MO4	NA	0.0%	0.0%	-29.8%	1.8%	-5.2%	4.7%
Preferred Alternative	NA	0.0%	0.0%	-13.3%	0.9%	-3.8%	0.7%

CHAPTER 8 - REFERENCES

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ANNEX A: COSTS OF THE STRUCTURAL MEASURES

Approach to Develop Costs for Structural Measures

Cost estimates for each of the structural measures were developed by the cost engineers at the USACE Mandatory Cost Center of Expertise at the Walla Walla District. The construction costs were developed based on the USACE Micro-computer Aided Cost Estimating System (MCASES) Second Generation (MII) with the conceptual designs of the structural measures, and also using construction requirements and design from similar projects and assessing previous estimates from the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002). Where designs were not available, an escalation factor was applied to the costs developed in the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002) utilizing the Civil Works Construction Cost Index System (CWCCIS) tables for the type of construction anticipated. When possible, the items that were escalated from the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002) were validated by developing an additional cost estimate in 2019 based on the same scope (as described in the 2002 Report). The newly developed estimates were within similar ranges to the escalated cost values from the 2002 Report.

The construction costs for the dam breaching measures used preliminary designs from the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement along with the MCACES MII system to provide the cost estimates. A contingency of 50 percent was added to all construction estimates based on preliminary designs and uncertainty surrounding the construction estimates and in consultation with BPA. An additional 30 percent was added to the construction cost to account for supervision, administration, and engineering during construction costs based on historic Corps cost engineering experience with these types of costs. All costs were developed at a 2019 price level.

The structural measures were all assumed to occur over two years; the costs for these two years (assumed to be divided evenly) were discounted to present value and amortized over the 50-year period of analysis to present an annual-equivalent cost. The federal water resources discount rate of 2.75 was used in the discounting to provide average annualized costs for the structural measures (Corps, EGM 20-1, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2020). Additional details on the approach to develop the costs of the structural measures are presented in this section.

Additional Powerhouse Surface Passage

Location and Features included:

- Applied at Ice Harbor in M01, MO2, and MO4; at McNary in MO1, MO3, and MO4
    - Includes demolition of six concrete bulkheads at each of the projects, which would be replaced with telescoping weirs

    - Existing collection channel and dewatering systems for juvenile fish facility operations would be demolished within the sluices
    - McNary would require additional modification with the lowering of the sluiceway floor
    - Downwell geometry would be modified at each project with the addition of flow control and increased radiuses of curvature
    - Tailrace flow entry would include the construction of a transition chute and flow deflector for each of the two projects.

- Additional surface passage at McNary in MO2 paired with an operational measure (alter juvenile fish transportation program) requires the collection and transportation of all juveniles entering the McNary additional surface passage. Assumes flow capacity of 8000 cfs and the capability of collecting and transporting fish.

Key features:

- <u>Surface Passage/Collection Channel - $75 million</u>
- The complete removal of existing fish collection channel.
- Demolition and reshaping historic ice/trash channel floor.
- Demolition of 6 concrete bulkheads to be replaced by telescoping weirs.
- Construction of bulkhead for north ice trash chute for use in emergency release

- <u>Dewatering Facility - $247 million</u>
- Demolition and reconstruction of south powerhouse downwell
- Construction of overhead transportation flume
- Construction of overhead vertical screen dewatering facility with capability to dewater 8,000 cfs at 0.4 feet per second thru screen velocity criteria

- <u>Juvenile Fish Facility - $86 M</u>
- Water surfaces too low for existing facility operation
- Demo Juvenile fish facility site except for Lab building, fish lift system to keep lab building operational (hopper)
- Rebuild separator, sampling, raceways.

- <u>Repurpose Water (replace fish pumps) - $48 M</u>
- Construction of conveyance to supplement/replace adult fish pumps
- Incorporates turbine to reduce amount of energy entering system
- Bypass flow could reenter tailrace via adult fish pump intakes

- Additional surface passage at John Day for MO2 and MO4 would include a floating steel structure attached to the powerhouse face designed to mimic the hydraulics of an ice/trash chute with the capacity of 8kcfs and conveyance of the flow through the powerhouse would be made possible by modifying a skeleton unit.

- Additional surface passage at Lower Granite, Little Goose, and Lower Monumental in MO4 would include a floating steel structure attached to the powerhouse face designed to mimic the hydraulics of an ice/trash chute with the capacity of 4kcfs
    - Conveyance of the flow through the powerhouse would be made possible by modifying non-overflow sections of the powerhouse
    - tailrace flow entry would include the construction of a transition chute and flow deflector for each project
- Scope similar to past project costs developed from the McNary configuration and operations plan (COP). The cost estimate was developed utilizing the cost estimates from the McNary COP study conducted in 2009. The costs were updated to reflect current pricing levels and scaled accordingly for Ice Harbor.

Upgrade to Adjustable Spillway Weirs

- Applied at Lower Granite, Lower Monumental, and Ice Harbor for MO1 and MO2
- Applied at McNary and John Day projects for MO1, MO2, and MO3
- Includes upgrading the existing spillway weirs that are not adjustable to adjustable spillway weirs at McNary, Lower Granite, Lower Monumental, Ice Harbor, and John Day projects
- Two dams, McNary and John Day, would receive two weirs each, while Lower Granite, Lower Monumental, and Ice Harbor would each receive a single weir
- Scope replicates adjustable spillway weirs found at Little Goose. Cost estimate based on historical prices from similar projects constructed in 2016. The 2016 estimate was updated to reflect current pricing levels and scaled accordingly for each of the applicable projects.

Lower Granite Trap Modifications

- Applied at Lower Granite in MO1 and MO4
- Replace the existing trap gate with a drop gate actuated by a dedicated hoist.
- The new gate will feature a gap on the bottom to allow lamprey passage.
- Used a similar scope to a past design/build project at Ice Harbor and scaled to the current application. Prices were updated to 2019 price levels.

Modify Bonneville Ladder Serpentine Weir

- Applied at Bonneville project in MO1, MO3, and PA
- Include modifying the upper serpentine flow control fish ladder sections at Bonneville project and converting them to a vertical slot style fishway
- the existing baffles at the project's Bradford Island and Washington Shore fish ladders would be replaced with baffles that have vertical slot orifices for fish passage
- Scope similar to past project within John Day ladder. The 2009 cost for the ladder at John Day was $3.2 million, which was reduced by half to meet the appropriate scope of Bonneville serpentine weir and updated to 2019 price level.

Lower Snake Ladder Pumps

- Applied at Lower Monumental and Ice Harbor in MO1, MO2, and MO4
- Installing new pumping and pipe systems for the fish ladders at Lower Monumental and Ice Harbor projects
- Pumps and pipes would pull water from elevations deep in the reservoir to provide cooling water to fish ladders and at fish ladder exits to potentially reduce thermal barriers to fish passage for adult salmon migrating upstream.
- Scope uses recent similar projects at Lower Granite and Little Goose that were constructed in 2015. The 2015 costs were escalated to current price levels.

Spillway Weir Notch Inserts

- Applied at all Lower Snake projects, McNary and John Day for MO4
- Provide a notch gate to be installed in one spillway weir at each dam to create a smaller opening in the weir and enable reduced spill.
- Assumes a steel structure allowing for 2kcfs flow with a 12 foot wide opening.
- Used a scope similar to the adjustable spillway weir that was installed at Little Goose. The 2016 cost estimate was reduced in scale for each of the applicable project and updated to reflect current pricing levels.

Lamprey Passage Structures

- Applied at John Day, The Dalles, and Bonneville in MO1, MO2, MO3, MO4, and PA.

- Modifying existing fish ladders at John Day, Bonneville, and The Dalles projects with additional structures to make upstream passage easier for Lamprey
- The structures may be an aluminum slot or tunnel that Lamprey would use to travel an alternate, but parallel route along the existing fish ladder
- The lamprey structure would use an independent water source and employ flow velocities that attract lamprey to the alternative route.
- These structures would be constructed as follows:
    - at Bonneville project, additional Lamprey passage structures would be installed in two locations -- on the Bradford Island ladder (south ladder) and at the Washington Shore fish ladder (north ladder)
    - at John Day project, an Lamprey passage structure would be constructed on the south fish ladder and the existing Lamprey passage structure on the north ladder would be extended from the tailrace deck to the forebay.
    - At The Dalles project, a diffuser grating plating would be added to the diffuser on the north ladder
- Used a scope similar to past project effort at Bonneville. Costs based on historical pricing from the 2018 project. The 2018 costs were escalated to current levels and modified to align with the appropriate scope for each project.

Turbine Strainer Lamprey Exclusion

- Applied at all Lower Columbia projects for all multi objective alternatives and PA
- Applied at all Lower Snake projects for MO1, MO2, MO4, and PA
- Installation of exclusion structure to prevent juvenile lamprey and all other fish from being entrained into the turbine unit cooling water source at the Bonneville, the Dalles, and John Day projects
- These structures provide a hood over the existing intake grating and allow sweeping flows to move fish past the opening, making entrainment unlikely.
- Used a scope for a similar project at Ice Harbor for cooling water lamprey exclusion cover. This estimate was scaled appropriately to each of the projects. Pricing levels were also updated to FY2019 levels.

Bypass Screen Modifications for Lamprey

- Applied at McNary for all multi objective alternatives

- Applied and Lower Granite and Little Goose for MO1, MO2, MO4, and PA
- Includes replacing existing fish screens used to divert fish into the collection channel of the juvenile bypass system
- Includes replacing existing extended length bar screens with submerged traveling screens to reduce juvenile lamprey entanglement
- Pricing was based on Corps Walla Walla District fish screen replacement budgetary data in FY2014. Pricing was escalated to FY2019 and scaled to the appropriate level for this project.

Lamprey Passage Ladder Modifications

- Applied at all Lower Columbia projects for all Mos and PA
- Applied at all Lower Snake projects for MO1, MO2, MO4, and PA
- Includes modifying existing fish ladders at the Lower Snake and Lower Columbia River projects
- Install ramps to salmon orifices at Bonneville dam; install concrete or aluminum ramps in the fish ladder to make salmon orifices elevated above the fish ladder floor more accessible to lamprey; a ramp would enable adult lamprey to more easily and directly access the salmon passage openings by removing right angles at the approach.
- Install diffuser grating plating at Bonneville (south and Cascade Island ladders), The Dalles (north ladder), and Lower Monumental (north and south ladders); install a solid stainless steel plate over the floor diffuser grating within the existing fish ladder
- Install additional refuge boxes at Bonneville Dam; construct metal refuge boxes on the floor of the fish ladder to provide a protected resting environment for lamprey migrating upstream; additional refuge boxes would be installed in the Washington shore and Bradford Island fish ladders.
- Install a wetted wall in the fish ladder at Bonneville Dam; install a metal wall in the serpentine section of the Washington shore fish ladder at Bonneville (similar to that already installed in the Bradford Island ladder)
- Install entrance weir caps at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Round edges at fish ladder entrance weirs to eliminate 90 degree surfaces which hinder lamprey from entering fish ladders on the lower Snake projects and at McNary.
- Used a scope similar to past project effort at Ice Harbor in 2017. The 2017 costs were escalated to current levels and modified to align with the scope for each project.

Breach Lower Snake River Embankments

- Applied at all Lower Snake projects for MO3
- Includes removal of the earthen embankments, abutments, and structures at each dam as needed to provide a 140-mile stretch of river without impoundment
- To control sediment inputs and maintain safe conditions at downstream dams, breaching would be accomplished in phases, starting with Lower Granite and Little Goose dams, followed by Lower Monumental and Ice Harbor dams
- Includes installing water control structures such as cofferdams and levees at breach locations to direct and control flows near the powerhouse, spillways, and navigation locks to facilitate safe drawdown of the reservoirs and provide fish passage
- A cost estimate was developed based on the scope and quantities listed in both the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002). Where information was limited, the costs were escalated from the Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement.

Lower Snake Infrastructure Drawdown

- Applied at all Lower Snake projects for MO3
- Includes modifying existing equipment and dam infrastructure to adjust to drawdown conditions so that both spillways and powerhouse outlets may be used to evacuate the reservoir at various elevations
- Existing equipment and dam would not be used for hydropower generation, but would instead be used as outlets for drawdown below spillway elevations
- Costs were escalated from Lower Snake River Juvenile Salmon Migration Final Feasibility Report and Environmental Impact Statement (2002) cost estimate to 2019 price levels.

Improved Fish Passage Turbines[15]

This structural measure is include under the NAA, all of the multiple objective alternatives, and the preferred alternative. These costs for this measure are included in the capital costs estimates, as provided in the Strategic Asset Management Plan (2018).

[15] Note that this structural measure is being implemented under the No Action Alternative, and is also included under all of the MO alternatives.

Cost Estimates of the Structural Measures

No Action Alternative

The structural measures under the multi-objective alternatives are separate from the ongoing structural measures occurring under the NAA and therefore there are no cost estimates for structural measures under the NAA.

Summary of Structural Costs for Multi-Objective Alternatives

Table A-1 summarizes the costs for the structural measures for all of the multi-objective alternatives.

1498 **Table A-1. Cost Estimates for the Structural Measures under the Multi-objective Alternatives (2019$)**

MO1	MO2	MO3	MO4	Preferred Alternative	Description	Location	Construction Cost (A)	Contingency Cost (B)	Supervision and Administration, Engineering During Construction Cost (C)	Total Project First Cost (A+B+C)	Present Value of First Cost	Annual-equivalent Costs (Amortized over 50 years)
	X		X		Additional Powerhouse Surface Passage	John Day	$128,087,000	$64,043,000	$57,639,000	$249,769,000	$239,831,322	$8,883,573
	X					McNary	$455,911,000	$227,956,000	$205,160,000	$889,027,000	$853,654,897	$31,620,162
X		X	X			McNary	$81,065,000	$40,532,000	$36,479,000	$158,076,000	$151,786,382	$5,622,307
X	X		X			Ice Harbor	$43,988,000	$21,994,000	$19,795,000	$85,777,000	$82,363,857	$3,050,833
			X			Lower Monumental	$82,605,000	$41,302,000	$37,172,000	$161,080,000	$154,670,553	$5,729,139
			X			Little Goose	$84,750,000	$42,375,000	$38,138,000	$165,263,000	$158,687,249	$5,877,922
			X			Lower Granite	$86,895,000	$43,448,000	$39,103,000	$169,446,000	$162,703,947	$6,026,704
X	X				Upgrade to Adjustable Spillway Weirs	Lower Granite	$10,160,000	$5,080,000	$4,572,000	$19,811,000	$19,023,083	$704,632
X	X					Lower Monumental	$10,160,000	$5,080,000	$4,572,000	$19,811,000	$19,023,083	$704,632
X	X					Ice Harbor	$10,160,000	$5,080,000	$4,572,000	$19,811,000	$19,023,083	$704,632
X	X	X				McNary	$20,319,000	$10,160,000	$9,144,000	$39,623,000	$38,046,168	$1,409,265
X	X	X				John Day	$20,319,000	$10,160,000	$9,144,000	$39,623,000	$38,046,168	$1,409,265
X			X	X	Lower Granite Trap Modification	Lower Granite	$215,000	$107,000	$97,000	$418,000	$401,668	$14,878
X		X		X	Modify Bonneville Ladder Serpentine Weir	Bonneville	$6,504,000	$3,252,000	$2,927,000	$12,683,000	$12,177,975	$451,083
X	X		X		Lower Snake Ladder Pumps	Lower Monumental	$3,080,000	$1,540,000	$1,386,000	$6,006,000	$5,766,587	$213,600
X	X		X			Ice Harbor	$3,080,000	$1,540,000	$1,386,000	$6,006,000	$5,766,587	$213,600
			X		Spillway Weir Notch Inserts	Lower Granite	$8,549,000	$4,274,000	$3,847,000	$16,671,000	$16,007,259	$592,924
			X			Little Goose	$8,549,000	$4,274,000	$3,847,000	$16,671,000	$16,007,259	$592,924
			X			Lower Monumental	$8,549,000	$4,274,000	$3,847,000	$16,671,000	$16,007,259	$592,924
			X			Ice Harbor	$8,549,000	$4,274,000	$3,847,000	$16,671,000	$16,007,259	$592,924
			X			McNary	$8,549,000	$4,274,000	$3,847,000	$16,671,000	$16,007,259	$592,924
			X			John Day	$8,549,000	$4,274,000	$3,847,000	$16,671,000	$16,007,259	$592,924

MO1	MO2	MO3	MO4	Preferred Alternative	Description	Location	Construction Cost (A)	Contingency Cost (B)	Supervision and Administration, Engineering During Construction Cost (C)	Total Project First Cost (A+B+C)	Present Value of First Cost	Annual-equivalent Costs (Amortized over 50 years)
X	X	X	X	X	Lamprey Passage Structures	Bonneville	$4,117,000	$2,058,000	$1,853,000	$8,028,000	$7,708,461	$285,529
X	X	X	X	X		The Dalles	$2,058,000	$1,029,000	$926,000	$4,014,000	$3,854,231	$142,764
X	X	X	X	X		John Day	$4,117,000	$2,058,000	$1,853,000	$8,028,000	$7,708,461	$285,529
X	X		X	X	Turbine Strainer Lamprey Exclusion	Lower Granite	$527,000	$264,000	$237,000	$1,028,000	$987,573	$36,581
X	X		X	X		Lower Monumental	$527,000	$264,000	$237,000	$1,028,000	$987,573	$36,581
X	X		X	X		Little Goose	$527,000	$264,000	$237,000	$1,028,000	$987,573	$36,581
X	X		X	X		Ice Harbor	$527,000	$264,000	$237,000	$1,028,000	$987,573	$36,581
X	X	X	X	X		McNary	$1,194,000	$597,000	$537,000	$2,328,000	$2,235,396	$82,801
X	X	X	X	X		John Day	$1,360,000	$680,000	$612,000	$2,653,000	$2,547,351	$94,356
X	X	X	X	X		Bonneville	$1,694,000	$847,000	$762,000	$3,303,000	$3,171,264	$117,467
X	X	X	X	X		The Dalles	$1,860,000	$930,000	$837,000	$3,628,000	$3,483,219	$129,022
X	X	X	X		Bypass Screen Modifications for Lamprey	McNary	$26,754,000	$13,377,000	$12,039,000	$52,170,000	$50,094,557	$1,855,548
X	X		X	X		Little Goose	$11,466,000	$5,733,000	$5,160,000	$22,359,000	$21,469,096	$795,235
X	X		X	X		Lower Granite	$11,466,000	$5,733,000	$5,160,000	$22,359,000	$21,469,096	$795,235
X	X	X	X	X	Lamprey Passage Ladder Modifications	Bonneville	$1,671,000	$835,000	$752,000	$3,258,000	$3,128,384	$115,878
X	X	X	X	X		The Dalles	$1,671,000	$835,000	$752,000	$3,258,000	$3,128,384	$115,878
X	X	X	X	X		McNary	$804,000	$402,000	$362,000	$1,569,000	$1,506,318	$55,795
X	X		X	X		Ice Harbor	$804,000	$402,000	$362,000	$1,569,000	$1,506,318	$55,795
X	X		X	X		Lower Monumental	$1,570,000	$785,000	$706,000	$3,061,000	$2,938,952	$108,861
X	X		X	X		Little Goose	$486,000	$243,000	$219,000	$947,000	$909,420	$33,686
X	X		X	X		Lower Granite	$486,000	$243,000	$219,000	$947,000	$909,420	$33,686
		X			Breach Snake Embankments	Lower Granite	$52,405,000	$26,202,000	$23,582,000	$102,190,000	$98,123,789	$3,634,595
		X				Little Goose	$108,359,000	$54,180,000	$48,762,000	$211,301,000	$202,893,788	$7,515,372
		X				Lower Monumental	$112,566,000	$56,283,000	$50,655,000	$219,503,000	$210,769,305	$7,807,089
		X				Ice Harbor	$176,584,000	$88,292,000	$79,463,000	$344,338,000	$330,637,675	$12,247,124

MO1	MO2	MO3	MO4	Preferred Alternative	Description	Location	Construction Cost (A)	Contingency Cost (B)	Supervision and Administration, Engineering During Construction Cost (C)	Total Project First Cost (A+B+C)	Present Value of First Cost	Annual-equivalent Costs (Amortized over 50 years)
		X			Lower Snake Infrastructure Drawdown	Lower Granite	$15,406,000	$7,703,000	$6,932,000	$30,041,000	$28,845,539	$1,068,465
		X				Little Goose	$14,900,000	$7,450,000	$6,705,000	$29,054,000	$27,898,213	$1,033,375
		X				Lower Monumental	$14,888,000	$7,444,000	$6,700,000	$29,032,000	$27,876,925	$1,032,587
		X				Ice Harbor	$14,888,000	$7,444,000	$6,700,000	$29,032,000	$27,876,925	$1,032,587
X	X	X	X	X	Improved Fish Passage Turbines	John Day	Included under the capital costs for the NAA and all of the MOs					

Note that the cost estimates include items that were escalated from the Lower Snake River Feasibility Report and EIS (2002). To validate these escalated costs, several cost estimates were developed in 2019 based on the same scope as in the 2002 Report. These newly developed estimates were within similar ranges to the escalated cost values from the 2002 Report.

ANNEX B: COST OF ADDITIONAL MITIGATION MEASURES

As described in Chapter 6, mitigation includes the fish and wildlife mitigation as well as additional mitigation measures associated with mitigating the adverse effects under the MOs. The costs of the additional mitigation measures are provided for each MO in this Annex; the last column in the tables note if the measure is being implemented or would be prioritized for implementation under the Bonneville Fish and Wildlife (F&W) Program. The costs of the additional mitigation measures that are currently being implemented or would be prioritized for funding under the Bonneville F&W Program (as part of the fish and wildlife mitigation costs) are included in Bonneville's F&W Program costs and not as additional mitigation to avoid double counting (see Table 6-1 in Section 6.2).

The mitigation measures were estimated as on-going annual costs or as construction costs by the cost engineers. The Corps, Reclamation, and Bonneville provided input on mitigation measures and associated costs. Similar to the estimates developed for the structural measures under the MO alternatives, the mitigation construction cost estimates were developed utilizing planning level designs (when available), available documents, or best professional judgment based upon historic operations and/or knowledge of system costs. Cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District estimated the costs using MCACES MII software and proposed design. A contingency of 50 percent was added to all construction estimates based on preliminary designs and uncertainty surrounding the construction estimates and in consultation with Bonneville. Thirty percent of the construction and contingency cost was included to account for supervision, administration, and engineering during construction costs to represent project first costs based on historic Corps cost engineering experience with these types of costs.

The project first costs were assumed to occur over two years (for MO3, measures that would occur post breach were assumed to occur in years 3 and 4, consistent with the alternative implementation guidance), discounted to present value, and amortized over the 50-year period of analysis. For applicable structural mitigation measures, Corps project, operations, and engineers estimated the changes in O&M and capital investments and/or non-routine costs, if relevant, that would occur with these structural mitigation measures. These additional costs were discounted to reflect 2019 dollars and amortized over the 50-year period of analysis and aggregated with the annual-equivalent of the project first costs to estimate the annual-equivalent costs (provided in the last column in Tables B-1 to B-5).

Table B-1. Mitigation Costs for Multiple Objective 1

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Water Quality	Region C: Moderate adverse effects from water temperatures can create increased algal growth due to high August water temperatures in the Lower Snake River Projects. This can be a public safety issue for water recreation.	Region C: On the Lower Snake River Increased harmful algal bloom monitoring at recreational areas; if algal blooms produce toxins, post public advisories at recreational areas with to protect the public	Cost estimates were provided by water quality specialists in the Corps Portland District, and were based on current monitoring costs.	NA	$200,000
Vegetation, Wildlife, Wetlands, and Floodplains	In Region A & B exposure of mudflats and barren lands during the spring months could result in minor effects to native habitats by establishment of non-native, invasive plant species.	In Region A, update and implement Invasive Plant Management Plan for the shoreline at Libby. Region B will have habitat for fish mitigation	The estimate of 24 acres was based on information from fish and wildlife GIS mapping. The Corps Natural Resource Specialist estimated that in-water invasive plant treatments average about $1,000 per acre.	NA	$24,000
Vegetation, Wildlife, Wetlands, and Floodplains	In Region A, Conversion of wetland to upland habitat in May through summer (off-channel habitat). Effects on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Effects are minor and would occur seasonally.	In Region A, on Kootenai River downstream of Libby: Plant native wetland and riparian vegetation up to ~100 acres along river.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding.	$3.5 million	$142,000 (covered under F&W Program)

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Anadromous Fish	Regions C and D: Moderate adverse effect from increased spill levels, which create turbulence and eddies below the dams resulting in delays to adult passage.	Temporary extension of performance standard spill levels in coordination with the Regional Forum	NA	NA	No cost-
Resident Fish - ESA Kootenai River White Sturgeon	Region A: The current flow regime at Libby has made establishment of riparian vegetation difficult to sustain young stands of cottonwoods - major contributors to foodweb for Sturgeon, which results in moderate localized effects. While this MO would not exacerbated these effects in the No Action, it is an ongoing problem.	Plant 1-2 gallon cottonwoods near Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding.	$3.1 million	$130,000 (covered under F&W Program)
Resident Fish - Burbot, Kokanee, and Redband Rainbow Trout	In Region B changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. (a) Determine where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. (b) Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	Information was used from previous cost estimates. The cost estimate assumes approximately one foot of gravel would be needed for 100 acres, approximately 160,000 cubic yards, at $35 per cubic yard.	$10.9 million	$388,000

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Resident Fish – ESA Bull Trout	Region A: Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation. Negligible to Moderate adverse effect.	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Sullivan and Wheeler Creeks, possibly more) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize effects of reservoir fluctuation where the tributaries enter the reservoir.	Estimate assumes 15 sites, with 3 acres per site. Based on recent costs from the Skokomish River GI in Seattle, an approximate per acre cost for major in-stream restoration is $12k per acre. Additional cost for berm construction is based on 9,200 yards of material, with a major berm at each site and the unit cost of $45 per yard.	$6.76 million	$250,000 (covered under F&W Program)
Navigation & Transportation	Region B: Inchelium-Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members. This would be a moderate adverse effect that results in public safety and environmental justice concerns.	Extend the ramp at the Inchelium-Gifford Ferry on Lake Roosevelt so that it's available at lower water elevations.	Cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District estimated the costs using MCACES MII software and proposed design. Assumes the use of 2 drilled shafts, heavy steel structure, and aluminum decking 50 feet long	$2.4 million	$95,000
Cultural Resources	Region A and B: Major adverse effects from increase in number of acre-days that archaeological resources would be exposed.	Region A and B: Use the Cultural Resource Program funding for activities such as resource monitoring (pedestrian and drone use), reservoir and river bank stabilization, data recovery, public education awareness, protective signage, and other mitigation to address impacts to TCPs.	Costs were estimated by Cultural Resource specialists from the three agencies, based on operational changes under MO1.	NA	$500,000

Note: Some of the mitigation measures would require annual operations and maintenance activities and/or non-routine major repair or rehabilitation once over the 50-years; the present value of these costs were added to the project first costs and amortized to provide the annual-equivalent cost.

Table B-2. Mitigation Costs for Multiple Objective 2

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Water Quality	Region A: At Hungry Horse the drawdown in summer impacts primary and secondary biological productivity that result from reservoir drawdowns and higher flushing rates.	Initiate a nutrient supplementation program at Hungry Horse.	Estimates from the current nutrient supplementation program at Dworshak were used, including $20,000 in monitoring.	NA	$220,000
Recreation	Region C: Changes in water levels would make the Dworshak State Park (Freeman Creek) boat ramp inaccessible for 30 days in the month of April, the start of turkey hunting season and early bass fishing season. Because of the steep terrain and limited road access at Dworshak, this boat ramp is heavily used by recreators, especially hunters and fishermen, outside of the traditional recreation season. The alternative results in minor impacts to recreation.	Extend the boat ramp at Dworshak State Park (Freeman Creek) to make it accessible in April, when it is used by hunters and fishermen.	Costs were estimated based on previous estimates for Robie Creek Boat Ramp extensions project produced by the cost engineers at the Corps Walla Walla District Mandatory Cost Center for Expertise. Assumes 220 feet ramp extension at 14% slope for 30 foot water surface elevation drop and $1,000 per linear foot.	$429,000	$19,000

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Vegetation, Wildlife, Wetlands, & Floodplains	In Region A, Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Impacts are minor and would occur seasonally.	In Region A, on Kootenai River downstream of Libby: Plant native wetland and riparian vegetation up to ~100 acres along river.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with the Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding.	$3.5 million	$142,000 (covered under F&W Program)
Vegetation, Wildlife, Wetlands & Floodplains	In Region A & B exposure of mudflats and barren lands during the spring months could result in minor effects to native habitats by establishment of non-native, invasive plant species.	In Region A, update and implement Invasive Plant Management Plan for the shoreline at Libby. Region B will have habitat for fish mitigation (see below)	The estimate of 24 acres were based on information from fish and wildlife GIS mapping. Corps specialists estimated that in-water invasive plant treatments average about $1,000 per acre.	NA	$24,000

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Resident Fish - ESA Kootenai River White Sturgeon	Region A: The current flow regime at Libby has made establishment of riparian vegetation difficult to sustain young stands of cottonwoods - major contributors to food web for Sturgeon, which results in moderate localized effects. While this MO would not exacerbated these impact in the No Action, it is an ongoing problem.	Plant 1-2 gallon cottonwoods near Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding.	$3.1 million	$130,000 (covered under F&W Program)
Resident Fish – ESA Bull Trout	Region A: Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation. Negligible to Moderate adverse impact.	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Sullivan and Wheeler Creeks, possibly more) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir.	Estimate assumes 15 sites, with 3 acres per site. Based on recent costs from the Skokomish River GI in Seattle, an approximate per acre cost for major in-stream restoration is $12,000 per acre. Additional cost for berm construction is based on 9,200 yards of material, with a major berm at each site and the unit cost of $45 per yard.	$6.76 million	$250,000 (covered under F&W Program)

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Resident Fish - Burbot, Kokanee, and Redband Rainbow Trout	In Region B changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. (a) Determine where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. (b) Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	Information was used from previous cost estimates. Cost estimate assumes approximately one foot of gravel would be needed for 100 acres, approximately 160,000 cubic yards, at $35 per cubic yard.	$10.9 million	$388,000
Navigation & Transportation	Region B: Inchelium-Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members. This would be a moderate adverse effect that results in public safety and environmental justice concerns.	Extend the ramp at the Inchelium-Gifford Ferry on Lake Roosevelt so that it's available at lower water elevations.	Cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District estimated the costs using MCACES MII software and proposed design. Assumes the use of 2 drilled shafts, heavy steel structure, and aluminum decking 50 feet long.	$2.4 million	$95,000
Cultural Resources	Region A, B, and C: Major adverse effects from increase in number of acre-days that archaeological resources would be exposed.	Region A, B, and C: Use Cultural Resource Program funding for activities such as resource monitoring (pedestrian and drone use), reservoir and river bank stabilization, data recovery, public education awareness, protective signage, and other mitigation to address impacts to TCPs.	Costs were estimated by Cultural Resource specialists from the three agencies, based on operational changes under MO2.	NA	$1.0 million

Note: Some of the mitigation measures would require annual operations and maintenance activities and/or non-routine major repair or rehabilitation once over the 50-years; the present value of these costs were added to the project first costs and amortized to provide the annual-equivalent cost.

Table B-3. Mitigation Costs for Multiple Objective 3

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Vegetation, Wildlife, Wetlands, &Floodplains	Region A: Operations at Libby Dam impact wetland vegetation along the Kootenai River and could cause conversion of wetland habitat to upland habitat. This could cause impact to wildlife. Adverse, moderate impacts would occur seasonally.	In Region A, on Kootenai River downstream of Libby: Plant native wetland and riparian vegetation up to ~100 acres along river.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding. O&M costs were assumed to be $250 per acre.	$3.5 million	$142,000 (covered under F&W Program)

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Vegetation, Wildlife, Wetlands, a& Floodplains	Region C: Lowering of the water table associated with breaching could have a major adverse effect by conversion of plant communities to non-native, invasive plant communities.	Develop and implement a planting plan to restore arid, native plant communities on approximately 13,000 acres of arid lands along the lower Snake River.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. The cost estimate assumed unit prices based on previous project MCACES MII for plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit prices assumed were: hydroseed ($90 per acre, for 10lbs per acre at $9 pound); and shrubbery ($25 per planting, 80 stems per acre at $2,000 per acre). Annual O&M costs were assumed to be $250 per acre.	$53.0 million	$5.0 million

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Vegetation, Wildlife, Wetlands, a& Floodplains	Region C: Breaching the lower Snake River dams would expose approximately 13,000 acres of shoreline, creating major negative effects to wetland and riparian plant communities.	Develop and implement a planting plan for approximately 1500 acres of wetland and riparian species along the exposed shorelines.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Per acre costs were obtained from previous project cost estimates of plant prices from Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla wildlife biologists. The cost estimate assumed cottonwoods at 400 stems per acre (1-2 gallon) interspersed with willow, with half willow and half cottonwood. Unit costs were $17,674 per acre for cottonwoods and willows and $90 per acre for the seed mix. O&M costs were assumed to be $250 per acre.	$52.0 million	$2.1 million
Vegetation, Wildlife, Wetlands, a& Floodplains	Region C: Breaching the lower Snake River dams would result in sediment deposition, causing major adverse impacts for wetlands downstream of Ice Harbor dam.	Develop and implement a restoration plan for approximately 155 acres of wetlands downstream of Ice Harbor. The plan may include excavation of sediments deposited after breaching.	Unit prices were from previous project MCACES MII estimates for plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs were 400 stems per acre for willow whip at a per acre cost of $15,348 and $90 per acre for seed mix. Fish and Wildlife teams used GIS mapping to establish acreage needed for planting.	$4.7 million	$196,000

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Vegetation, Wildlife, Wetlands, a& Floodplains	Region A: Exposure of mudflats and barren lands could result in establishment of non-native, invasive plant species, a moderate, adverse effect.	Update and implement the existing Invasive Plant Management Plan at Libby to prevent establishment of invasive plant species	The estimate of 24 acres were based on information from fish and wildlife GIS mapping. The Corps Natural Resource Specialist at Albeni Dam estimated that in-water invasive plant treatments average about $1,000 per acre.	NA	$24,000
Anadromous Fish	Regions D: Moderate adverse effect from increased spill levels, which create turbulence and eddies below the dams resulting in delays to adult passage.	Temporary extension of performance standard spill levels in coordination with the Regional Forum	NA	NA	No Cost
Anadromous Fish	Region C: Breaching the lower Snake River dams would have major short-term adverse effects. Breaching would create lethal river conditions (turbidity and suspended sediment, low dissolved oxygen) which would cause major effects to Snake River anadromous fish populations in the short-term.	Construct a trap-and-haul facility at McNary and conduct at least two years of trap-and-haul operations for Snake River fish (Chinook salmon, Sockeye, Steelhead) to allow removal and transport of these fish from the lower Snake River prior to breaching.	Cost estimate was based on the Cost Appendix from the Lower Snake River Feasibility Report and EIS (2002) for the. Temporary Fish Handling Facilities for Ice Harbor ($19.6 million), updated FY19 costs was $36.6 million	$36.6 million	$1.6 million

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Anadromous Fish	Region C: Breaching the lower Snake River dams would create major adverse short-term effects from high levels of turbidity/suspended sediment from Lower Granite Dam to Ice Harbor Dam during fall fish migration. This could result in mortality of 20-40% of the populations. Very low dissolved oxygen levels caused by dam breaching would result in fish mortality in the lower Snake River, with considerable impacts to year class of fall migrating fish.	Raise additional hatchery fish to help to address two lost year classes of anadromous fish, prior to the initiation of each phase of breaching (2 phases) of the lower Snake River dams.	Produce up to 21 million salmon, steelhead, and resident rainbow trout at existing facilities, and work with facility operators to determine how best to support required production levels. This action would require new authority since Bonneville's authority for LSRCP is tied to the operation of the dams.	$78.1 million	$2.8 million
Anadromous Fish	In Region D, concentrations of total dissolved gas (TDG) could increase as a result of spill measures implemented as part of MO3. This could delay adult migration or cause health effects to fish.	Real time monitoring of fish. If it is observed that conditions in the tailrace are impeding upstream passage of adult salmon and steelhead or actionable TDG impacts to fish are observed, the co-lead agencies would implement performance standard spill operations until the situation is remedied.	NA	NA	No costs

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Resident Fish – White Sturgeon	Region C: Breaching the lower Snake River dams would create major adverse short-term effects from high levels of turbidity/suspended and very low dissolved oxygen levels in the river. This could result in mortality for sturgeon and the forage fish they feed on. Although sturgeon are not ESA-listed, they are important to regional tribes and sport fishers.	On the Snake River, trap –and-haul White Sturgeon from impacted areas prior to dam breaching. Relocate trapped sturgeon to locations in Hells Canyon on the Snake River, and downstream of McNary project on the Columbia River.	Used current costs of the trap and haul program. Assumes an operational cost of $105,000 per week for two week duration; 10 and boat crews consisting of 3 individuals per boat	NA	$28,000 ($784,000 in year 1)
Resident Fish - ESA Kootenai River White Sturgeon	Region A: The current flow regime at Libby has made establishment of riparian vegetation difficult to sustain young stands of cottonwoods - major contributors to food web for Sturgeon, which results in moderate localized effects. While this MO would not exacerbated these impact in the No Action, it is an ongoing problem.	Plant 1-2 gallon cottonwoods near Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwoods, and 10 pounds per acre at $9 per pound for grass seeding.	$3.1 million	$130,000 (covered under F&W Program)

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Resident Fish – ESA Bull Trout	Region A: Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation. Negligible to Moderate adverse impact.	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Sullivan and Wheeler Creeks, possibly more) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir.	Estimate assumes 15 sites, with 3 acres per site. Based on recent costs from the Skokomish River GI in Seattle, an approximate per acre cost for major in-stream restoration is $12,000 per acre, $36,000 per site with 15 sites. Additional cost for berm construction is based on 9,200 yards of material, with a major berm at each site and a unit cost of $45 per yard.	$6.76 million	$250,000 (covered under F&W Program)
Resident Fish - Burbot, Kokanee, and Redband Rainbow Trout	In Region B changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. (a) Determine where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. (b) Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	Information was used from previous cost estimates. Estimate uses approximately one foot of gravel would be needed for 100 acres, approximately 160,000 cubic yards, at $35 per cubic yard.	$10.9 million	$388,000

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Resident and Anadromous Fish	Region C: Breaching the lower Snake River Dams would result in major short-term adverse effects from reservoir drawdown. These conditions could make the Tucannon River (a tributary of the Snake River) delta inaccessible to Bull Trout, salmon and steelhead, inhibiting their access to spawning habitat.	In Region C: Modify the Tucannon River channel at the delta to allow Bull Trout, salmon, and steelhead passage after Snake River water elevations decrease from breaching.	Corps experts assumed 1 river mile of instream restoration would be required, including 1 week of work pre-breaching to clear the streambed. Stream restoration pricing is based on the most recent large scale in-stream restoration project in the region, Skokomish River Ecosystem Restoration.	$7.6 million	$270,000
Navigation & Transportation	Region B: Inchelium-Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members. This would be a moderate adverse effect that results in public safety and environmental justice concerns.	Extend the ramp at the Inchelium-Gifford Ferry on Lake Roosevelt so that it's available at lower water elevations.	Assumes the use of 2 drilled shafts, heavy steel structure, and aluminum decking 50 feet long .Cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District estimated the costs using MCACES MII software and proposed design.	$2.4 million	$95,000
Navigation/Transportation	Region C: Breaching the lower Snake River Dams would result in higher water velocities, increasing scour around bridge piers and creating a major adverse effect to transportation and public safety.	Armor piers of up to 25 bridges to protect from erosion caused by higher velocity flows in the river after breaching.	This estimate was based on the 2002 LSR Final Feasibility Report and EIS estimates of bridge pier and abutment protection costs for Ice Harbor, Lower Monumental, Lower Granite, and Little Goose. Costs were updated to FY19 price levels.	$203 million	$7.2 million

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Navigation & Transportation	More than 80 miles of railroad and highway embankments would need to be armored to protect from erosion.	Breaching the LSR dams will result in higher water velocities in the river, increasing erosion and higher flows through drainage structures/culverts.	This estimate was based on the 2002 LSR Final Feasibility Report and EIS estimates of the railroad and roadway damage repair costs for Ice Harbor, Lower Monumental, Lower Granite, and Little Goose. Costs were updated to FY19 price levels.	$472 million	$16.8 million
Navigation & Transportation	In Region D, breaching of the lower Snake River dams would cause sediment to deposit in the federal navigation channel in the lower Snake River near the confluence with the Columbia River in the upper part of McNary Reservoir.	At the confluence of the lower Snake River in Region D the Corps would dredge the Federal navigation channel post breaching and until the river equilibrium is achieved, as needed, to maintain the federal channel.	Sediment and hydraulic engineers at the Corps Walla Walla District estimated the amount of sediment that would be required to be removed from the lower Snake River approximately at the confluence with the Columbia River. Unit dredging costs were estimated based on a mid-point between lower Snake River and lower Columbia River costs.	$108.7 million (short-term dredging cost)	$6.1 million
Public Safety	Region C: Breaching the lower Snake River dams would create high water velocities that could increase scour conditions that would damage existing gas pipelines that cross the lower Snake River near Lyons Ferry. This would cause a major adverse effect to utilities and could contribute an interruption in service or public safety issues.	After breaching the lower Snake River dams, the gas lines would need to be modified to withstand the velocities due to breach.	This estimate was based on the 2002 LSR Final Feasibility Report and EIS estimates of replacing gas lines. Costs were updated to FY19 price levels.	$46 million	$1.6 million

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual-Equivalent Costs
Cultural Resources	Region A and B: Major adverse effects from increase in number of acre-days that archaeological resources would be exposed.	Region A and B: use Cultural Resources Program funding for activities such as resource monitoring (pedestrian and drone use), reservoir and river bank stabilization, data recovery, public education awareness, protective signage, and other mitigation to address impacts to TCPs.	Costs were estimated by Cultural Resource specialists from the three agencies, based on operational changes under MO3 at non-lower Snake River reservoirs.	NA	$500,000
Cultural Resources	Region C: Drawdown of the reservoirs on the lower Snake River caused by dam breaching would result in the exposure of over 350 known cultural resources.	Develop a new Programmatic Agreement under the existing FCRPS Cultural Resource Program for cultural resources exposed in the four reservoir areas.	Costs were estimated by Cultural Resource specialists from the three agencies, based on structural changes under MO3. Includes cultural resource protection in the short-term during and following breaching activities; and annual maintenance costs for cultural resources for 10 years as management of the LSR lands transitions.:.	$20 million (short-term protection measures at LSR)	$1.0 million

Note: Some of the mitigation measures would require annual operations and maintenance activities and/or non-routine major repair or rehabilitation once over the 50-years; the present value of these costs were added to the project first costs and amortized to provide the annual-equivalent cost.
The cost estimates include items that were escalated from the Lower Snake River Feasibility Report and EIS (2002). To validate these escalated costs, several cost estimates were developed in 2019 based on the same scope *as in the 2002 Report. These newly developed estimates were within similar ranges to the escalated cost values from the 2002 Report.

Table B-4. Mitigation Costs for Multiple Objective 4

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual Costs
Water Quality	Region A: Lower lake levels at Albeni Falls could make near shore areas more difficult to access due to greater macrophyte and periphyon growth (e.g. Eurasian water milfoil). This is estimated to be a negligible to minor effect.	Implement and expand the existing Invasive Aquatic Plant Removal program at Albeni Falls	The estimate of 1,200 acres was based on information from fish and wildlife GIS mapping. The Corps specialists at Albeni Dam estimated that in-water invasive plant treatments average about $1,000 per acre, annually.	NA	$1.2 million
Water Quality	In Region A, at Hungry Horse the drawdown in summer impacts primary and secondary biological productivity that result from reservoir drawdowns and higher flushing rates.	In Region A, initiate a nutrient supplementation program at Hungry Horse	Estimates from the current nutrient supplementation program at Dworshak were used, including $20,000 in monitoring.	NA	$220,000
Resident Fish – ESA Bull Trout	Region A: Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation. Negligible to Moderate adverse impact.	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Sullivan and Wheeler Creeks, possibly more) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir.	Estimate assumes 15 sites, with 3 acres per site. Based on recent costs from the Skokomish River GI in Seattle, an approximate per acre cost for major in-stream restoration is $12,000 per acre. $36,000 per site. Additional cost for berm construction is based on 9,200 yards of material, with a major berm at each site and the unit cost of $45 per yard.	$6.76 million	$250,000 (covered under F&W Program)

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual Costs
Resident Fish - Burbot, Kokanee, and Redband Rainbow Trout	In Region B changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. (a) Determine where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. (b) Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	Information was used from previous cost estimates. Estimate uses approximately one foot of gravel would be needed for 100 acres, approximately 160,000 cubic yards, at $35 per cubic yard.	$10.9 million	$388,000
Navigation & Transportation	Region B: Inchelium-Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members. This would be a moderate adverse effect that results in public safety and environmental justice concerns.	Extend the ramp at the Inchelium-Gifford Ferry on Lake Roosevelt so that it's available at lower water elevations.	Assumes the use of 2 drilled shafts, heavy steel structure, and aluminum decking 50 feet long .Cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District estimated the costs using MCACES MII software and proposed design.	$2.4 million	$95,000
Navigation & Transportation	In Region C & D, high spill volumes and lower tail water increase scour, creating sediments and filling of the navigation channel. This is a moderate adverse impact to navigation.	Monitoring of scour and infill at John Day, McNary, Ice Harbor, Lower Monumental, and Lower Granite projects and increase dredging maintenance, as needed to maintain navigation channel. This is predicted to be needed every 4-7 years.	Sediment and hydraulic engineers at the Corps Walla Walla District estimated the localized dredging required with the 125 TDG spill operation at Lower Monumental, John Day, Lower Granite, McNary, and Ice Harbor. Unit dredging and placement costs were estimated based on a mid-point between lower Snake River and lower Columbia River costs.	NA	$1.0 million

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual Costs
Navigation & Transportation	Regions C and D: High spill, combined with tailrace conditions could result in infrastructure damage and more frequent O&M of navigation channel at project.	Regular monitoring of tailrace conditions will be conducted. If discovery of negative impacts, install coffer cells at Lower Monumental, Lower Granite, McNary, and John Day to dissipate energy from higher spill levels.	Based on similar levels of effort and information in the Corps Walla Walla District; Assumes 4 cells per project at $2 million per cell and two projects would be affected.	$31.2 million	$1.2 million
Anadromous Fish	Regions C and D: Moderate adverse effect from increased spill levels, which create turbulence and eddies below the dams resulting in delays to adult passage.	Temporary extension of performance standard spill levels in coordination with the Regional Forum	NA	NA	No cost
Anadromous Fish	Region C: Water in the Little Goose raceway is expected to have high TDG due to higher spill levels. This could have major adverse effects to transported fish.	Modify the Little Goose Raceway infrastructure to de-gas the water in the raceway during collection for transport. This would allow the fish to be transported in water with lower TDG than that in the river.	Used MCACES MII software to develop a parametric cost estimate based on scope provided by PDT.	$1.9 million	$68,000
Cultural Resources	Region A, B, C: Major adverse effects from increase in number of acre-days that archaeological resources would be exposed.	Region A, B and C: use Cultural Resources Program funding for activities such as resource monitoring (pedestrian and drone use), reservoir and river bank stabilization, data recovery, public education awareness, protective signage, and other mitigation to address impacts to TCPs.	Costs were estimated by Cultural Resource specialists from the three agencies, based on operational changes under MO4.	NA	$2,000,000

Note: Some of the mitigation measures would require annual operations and maintenance activities and/or non-routine major repair or rehabilitation once over the 50-years; the present value of these costs were added to the project first costs and amortized to provide the annual-equivalent cost.

Table B-5. Mitigation Costs for the Preferred Alternative

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual Costs
Vegetation, Wildlife, Wetlands, and Floodplains	In Region A, Conversion of wetland to upland habitat in May through summer (off-channel habitat). Effects on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Effects are minor and would occur seasonally.	In Region A, on Kootenai River downstream of Libby: Plant native wetland and riparian vegetation up to ~100 acres along river.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding.	$3.5 million	$142,000 (covered under F&W Program)
Resident Fish - ESA Kootenai River White Sturgeon	Region A: The current flow regime at Libby has made establishment of riparian vegetation difficult to sustain young stands of cottonwoods - major contributors to foodweb for Sturgeon, which results in moderate localized effects. While this MO would not exacerbated these effects in the No Action, it is an ongoing problem.	Plant 1-2 gallon cottonwoods near Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region.	Fish and Wildlife teams used GIS mapping to establish acreage needed for planting. Previous estimates were obtained from MCACES MII of plant prices from the Inland Avian Predation Management Plan at Crescent Island San Francisco, and verified with Corps Walla Walla District wildlife biologists. Unit costs assumed: $40 per plant for cottonwood; $30.70 per willow; 10 pounds per acre at $9 per pound for grass seeding.	$3.1 million	$130,000 (covered under F&W Program)

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual Costs
Resident Fish - Burbot, Kokanee, and Redband Rainbow Trout	In Region B changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. (a) Determine where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. (b) Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	Information was used from previous cost estimates. Estimate uses approximately one foot of gravel would be needed for 100 acres, approximately 160,000 cubic years, at $35 per cubic yard.	$10.9 million	$388,000
Navigation & Transportation	Region B: Inchelium-Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members. This would be a moderate adverse effect that results in public safety and environmental justice concerns.	Extend the ramp at the Inchelium-Gifford Ferry on Lake Roosevelt so that it's available at lower water elevations.	Assumes the use of 2 drilled shafts, heavy steel structure, and aluminum decking 50 feet long .Cost engineers at the Corps Mandatory Cost Center of Expertise at the Walla Walla District estimated the costs using MCACES MII software and proposed design.	$2.4 million	$95,000

Resource	Impact	Potential Mitigation Action	Approach to Develop Costs	Project First Costs (Construction)	Annual Costs
Navigation & Transportation	Regions C and D: High spill, combined with tailrace conditions could result in infrastructure damage and more frequent O&M of navigation channel at project.	Regular monitoring of tailrace conditions will be conducted. If discovery of negative impacts, install coffer cells at Lower Monumental, Lower Granite, McNary, and John Day to dissipate energy from higher spill levels.	Based on similar levels of effort and information provided by the Corps Walla Walla District; assumes 4 cells per project at $2 million per cell and 2 projects would be affected.	$31.2 million	$1.2 million
Navigation & Transportation	In Region C & D, high spill volumes and lower tail water increase scour, creating sediments and filling of the navigation channel. This is a moderate adverse impact to navigation.	Monitoring of scour and infill at John Day, McNary, Ice Harbor, Lower Monumental, and Lower Granite projects and increase dredging maintenance, as needed to maintain navigation channel. This is predicted to be needed every 4-7 years.	Sediment and hydraulic engineers at the Corps Walla Walla District estimated the localized dredging required with the 125 TDG spill operation at Lower Monumental, Lower Granite, McNary, and Ice Harbor. Unit dredging and placement costs were estimated based on a mid-point between lower Snake River and lower Columbia River costs.	NA	$900,000
Anadromous Fish	Regions C and D: Moderate adverse effect from increased spill levels, which create turbulence and eddies below the dams resulting in delays to adult passage.	Temporary extension of performance standard spill levels in coordination with the Regional Forum	NA	NA	No cost-

Note: Some of the mitigation measures would require annual operations and maintenance activities and/or non-routine major repair or rehabilitation once over the 50-years; the present value of these costs were added to the project first costs and amortized to provide the annual-equivalent cost.

ANNEX C: REGIONAL ECONOMIC EFFECTS

Regional economic effects are measures of economic activity (jobs, labor income, and sales) that are supported by CRS expenditures. This section evaluates the regional economic effects of changes in expenditures associated with implementing, operating and maintaining the CRS across alternatives. Under the No Action Alternative, regional economic effects are evaluated by estimating the economic activity resulting from changes to annual spending on CRS operations and implementation. For each action alternative, regional economic effects are evaluated by estimating the economic activity resulting from anticipated system expenditures that are described in the Implementation and System Costs section of the EIS (Section 3.19) and in this appendix.

METHODOLOGY

Effects of changes in CRS expenditures on regional economic activity are estimated in terms of jobs, labor income, and sales by tracing expenditures by sector through the economy using the input-output model, IMPLAN.[16] IMPLAN is a widely used industry-standard input-output data and software system that is used by many federal and state agencies to estimate regional economic effects. The underlying data for IMPLAN is derived from multiple federal sources, including the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the U.S. Census Bureau.

Annual-equivalent expenditures from the cost analysis (Section 3.19, Implementation and System Costs) were used as inputs into the regional economic analysis. [17] CRS expenditures were categorized by industry sectors based on Corps' Regional ECONomic System (RECONS) spending profiles. RECONS provides specific expenditure or spending profiles for Corps work activities, using IMPLAN industry sectors. For some of the Corps work activities, RECONS uses the cost factors from Micro-Computer Aided Cost Estimating System (MCACES), which incorporates hundreds of construction project cost estimates, along with additional data and information from Corps "business line" experts (Corps 2019). In addition, based on the Corps budget line item data, RECONS also rolls up the work activities by business line to provide spending profile by business line (i.e., recreation, flood risk management, navigation, hydropower) and appropriation accounts (i.e., construction, operations and maintenance, and investigations). For example, the RECONS spending profile associated with the work activity of operations and maintenance of locks and dams includes (Corps 2019):

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[16] For more information on the IMPLAN® system, visit http://www.implan.com/.

[17] Including the annual-equivalent expenditures as the input to the regional economic analysis has the effects of averaging or smoothing out the effect over the 50-year period. In actuality, the timing of the costs associated with the action alternatives would include considerable jobs and income in the first years of the project during construction of the structural measures and the additional mitigation measures, while in general ongoing jobs and income associated with capital, O&M, and fish and wildlife expenditures would relatively steady across the 50-year period (with the exception of the lower Snake River projects under MO3).

- 86 percent of expenditures are spent on the industry: repair and maintenance of industrial machinery and equipment;
- 9 percent is spent on USACE construction management and planning;
- 4 percent is spent on USACE overhead costs; and
- 1 percent is spent on environmental compliance activities undertaken by the USACE and contractors.

Each of these expenditure categories is associated with one of 536 IMPLAN industry sectors.[18] In this manner, the expenditures were identified with RECONS spending profiles to assist in estimating how the government expenditures would be allocated to both government sectors and industries in IMPLAN. Table C-1 provides a summary of how CRS costs from the No Action Alternative and each action alternative were assigned to specific RECONS spending profiles to estimate the regional economic effects.

Table C-1. Distribution of Cost Expenditures by RECONS Spending Profiles

Costs Analysis Spending Category	Spending Subcategory	RECONS Spending Profile(s)
Construction Costs of Structural Measures	Structural Measures & MO3 Real Estate	• Hydropower Construction for the Civil Works Budget • Construction or Major Rehabilitation—Other Water Resources Infrastructure • Lock Construction of Onsite Features • Construction of Fish Facilities at Dams • Federal Government, Non-Military[1]
Capital Costs	Large Capital Costs	• Hydropower Construction for Civil Works Budget
Operations and Maintenance	Non-routine Extraordinary Maintenance (NREX) Costs	• Hydropower Construction for Civil Works Budget
	Navigation and Dredging Non-Routine O&M Costs	• Navigation Construction for Civil Works Budget
	Routine O&M Costs, including Recreation, Fish and Wildlife, Navigation, Cultural Resource, and Other	• Environment Operations and Maintenance for Civil Works Budget (fish and wildlife)[2] • Recreation Operations and Maintenance for Civil Works Budget (recreation)[2] • Navigation Operations and Maintenance for Civil Works Budget (navigation)[2] • Hydropower Operations and Maintenance for Civil Works Budget (other)[2]

[18] Some of the spending profiles were developed using IMPLAN's previous sectoring scheme, which had 440 industry sectors. In these cases, the sector numbers were updated to correspond to the relevant 536 sector scheme for purposes of this analysis.

Costs Analysis Spending Category	Spending Subcategory	RECONS Spending Profile(s)
Mitigation	Mitigation costs other than Fish & Wildlife Program Costs	• Environment Construction for Civil Works Budget • Hydropower Construction for Civil Works Budget • Construction or Major Rehabilitation of Utilities and Power Structures[3] • Navigation Construction for Civil Works Budget
	Fish & Wildlife Program	• Construction Activities for Ecosystem and Habitat Restoration or Improvements[4] • Ecosystem and Habitat Restoration or Improvements, Non-Construction Activities[4] • Construction of Fish Facilities at Dams[4]

[1] Modeling utilizes Federal Government (Non-Military spending) as a single sector. This sector was applied to legal/real estate fees.
[2] Routine O&M costs were mapped to the appropriate activity type for all dams other than Grand Coulee and Hungry Horse. Grand Coulee and Hungry Horse O&M costs are modeled using the average spending profile for all O&M activities (environment, hydropower, recreation, and navigation).
[3] Construction or Major Rehabilitation of Utilities and Power Structures is a single sector that was applied to gas line repairs under MO3 mitigation costs.
[4] Fish and Wildlife costs were assigned the average of the three spending profiles here.
Sources: U.S. Army Corps of Engineers Institute for Water Resources, RECONS 2.0 Methods Manual, Appendix A, April 2019.

The IMPLAN model estimates economic impacts for four metrics: employment, labor income, value added, and output.

- **Employment** reflects a mix of full-time and part-time job-years[19] that result from additional employment demand created by a project.
- **Labor Income** captures all employment income received as part of the project-related employment demand, including wages, benefits, and proprietor income.
- **Value Added** reflects the total value of all output or production minus the costs of intermediate outputs (value added is analogous to gross domestic product); Value Added includes payroll taxes, sales taxes, excise taxes, and property taxes.
- **Output** reflects the total value of all output or production, including the costs of intermediate and final outputs.

For each of these metrics, IMPLAN categorizes the impacts into direct, indirect, and induced effects:

- **Direct effects** are the production changes or expenditures that directly result from an activity or policy. In this analysis, the direct effects are equal to the expenditures on

[19] IMPLAN defines a "job" as a full-time job lasting 12 months, which is equivalent to two jobs lasting six months each. A job can be either full-time or part time. We convert the IMPLAN job-year results to full-time equivalents (FTEs) using sector-specific conversion factors developed by IMPLAN.

structural measures, capital costs, operation and maintenance, and mitigation costs (including fish and wildlife), which we assign to appropriate economic sectors.

- **Indirect effects are** "ripple" impacts that result from changes in the output of industries that supply goods and services to industries that are directly affected.
- **Induced effects** are changes in household consumption arising from changes in employment and associated income that result from direct and indirect effects.

STUDY AREA

The potential areas of impact associated with changes to the CRS and regional economic impacts includes counties in which expenditures are most likely to occur, and where associated direct, indirect, and induced effects will take place. There were 139 counties identified where these expenditures may occur, resulting in a study area that included counties across eight states: Washington (39 counties), Oregon (36 counties), Idaho (44 counties), Montana (16 counties), Nevada (2 counties), Wyoming (1 county), and California (1 county). Although a relatively broad study area was used for the evaluation, in general the jobs and income would be supported in the locations where the spending occurs.

SUMMARY OF REGIONAL ECONOMIC EFFECTS OF ALTERNATIVES

The tables below present the regional economic effects of spending on the CRSO system of the action alternatives, both total and relative to the No Action Alternative.

Table C-2 presents the regional economic effects associated expenditures under each alternative. Table C-3 presents the regional economic effects associated with changes in expenditures from the No Action Alternative. Table C-4 presents the changes as a percent relative to the No Action Alternative.

As shown, MO1 and M02 are anticipated to result in increased CRS expenditures and regional economic effects compared to the No Action Alternative. Under MO1, CRS spending and regional economic effects would increase by approximately 2 percent, while the regional economic effects under MO2 would increase by between 3 and 10 percent relative to the No Action Alternative. In contrast, MO3 would generally result in a decrease in CRS spending and regional economic effects, while MO4 and the Preferred Alternative would result in decreased CRS spending and regional economic effects under low fish and wildlife scenarios, and increased CRS spending and regional economic effects under high fish and wildlife scenarios.

Under MO3, CRS expenditures would decrease relative to the No Action Alternative, with decreases in employment ranging from approximately 961 to 2,822 (-7 to -21 percent) compared to the No Action Alternative. Under MO4, CRS expenditures would vary depending on the low and high fish and wildlife cost scenario, with employment ranging from a decrease of 1,423 (-10 percent) to an increase of approximately 438 (3 percent change) relative to the No

Action Alternative. Under the Preferred Alternative, CRS expenditures would result in a decrease in 777 jobs (6 percent) to an increase of 56 jobs (0.4 percent) relative to the No Action Alternative, depending on the low and high fish and wildlife cost scenario.

Table C-2. Regional Economic Effects of Average Annual CRS Expenditures under the Action Alternatives (2019 dollars)

Alternative		Employment	Labor Income	Value Added	Output
NAA		13,763	$843 million	$1,175 million	$1,840 million
MO1		13,970	$857 million	$1,195 million	$1,874 million
MO2	Low F&W	14,237	$874 million	$1,222 million	$1,923 million
	High F&W	15,176	$924 million	$1,288 million	$2,022 million
MO3	Low F&W	10,941	$685 million	$967 million	$1,539 million
	High F&W	12,802	$785 million	$1,097 million	$1,736 million
MO4	Low F&W	12,340	$767 million	$1,082 million	$1,732 million
	High F&W	14,201	$866 million	$1,213 million	$1,930 million
Preferred Alternative	Low F&W	12,986	$803 million	$1,122 million	$1,761 million
	High F&W	13,819	$847 million	$1,180 million	$1,849 million

Table C-3. Regional Economic Effects of Average Annual CRS Expenditures under the Action Alternatives, Compared to the No Action Alternative (2019 dollars)

Alternative		Employment	Labor Income	Value Added	Output
MO1		207	$13.1 million	$19.8 million	$34.5 million
MO2	Low F&W	474	$30.5 million	$47.2 million	$83.0 million
	High F&W	1,413	$80.6 million	$113.1 million	$182.5 million
MO3	Low F&W	(2,822)	($158.0 million)	($208.2 million)	($300.5 million)
	High F&W	(961)	($58.8 million)	($77.6 million)	($103.4 million)
MO4	Low F&W	(1,423)	($76.4 million)	($92.9 million)	($106.7 million)
	High F&W	438	$22.8 million	$37.7 million	$90.4 million
Preferred Alternative	Low F&W	(777)	($40.9 million)	($53.2 million)	($78.7 million)
	High F&W	56	$3.5 million	$5.2 million	$9.5 million

Table C-4. Regional Economic Effects of Average Annual CRS Expenditures under the Action Alternatives, Compared to the No Action Alternative, percent change (2019 dollars)

Alternative		Employment	Labor Income	Value Added	Output
MO1		2%	2%	2%	2%
MO2	Low F&W	3%	4%	4%	5%
	High F&W	10%	10%	10%	10%
MO3	Low F&W	-21%	-19%	-18%	-16%
	High F&W	-7%	-7%	-7%	-6%
MO4	Low F&W	-10%	-9%	-8%	-6%
	High F&W	3%	3%	3%	5%
Preferred Alternative	Low F&W	-6%	-5%	-5%	-4%
	High F&W	0%	0%	0%	1%

Draft Columbia River System Operations Environmental Impact Statement

Appendix R,
Monitoring and Adaptive Management
Part 1, Framework

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CHAPTER 1 - INTRODUCTION

The Columbia River System Operations (CRSO) Environmental Impact Statement (EIS) is prepared on operation, maintenance, and configuration of the 14 Federal Columbia River System (CRS) projects throughout the Columbia River Basin: Libby, Hungry Horse, Albeni Falls, Grand Coulee, Chief Joseph, Dworshak, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville. The EIS documents the analysis of the CRS alternatives (referred to in this EIS as No Action Alternative and Multiple Objective Alternatives 1 through 4 and the preferred alternative). The result of the analysis is an agency preferred alternative and its associated mitigation for environmental impacts. To ensure these actions and mitigation measures meet their environmental goals, the Federal agencies must implement a Monitoring and Adaptive Management Plan (MAMP). This framework identifies the goals of the operation, mitigation and habitat enhancement measures, describes the approach for developing an effectiveness monitoring program, and provides the starting point for establishing ecological parameters that may require adaptive management. The MAMP will guide decisions for refining, revising, or adapting operation measures and mitigation efforts and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect project success. The three co-lead agencies, U.S. Army Corps of Engineers (Corps), Bonneville Power Administration (Bonneville), and the Bureau of Reclamation (Reclamation), will be responsible for implementing the MAMP.

Successful adaptive management requires two basic tools: the ability to alter the ecosystem to recreate a desired condition, and the ability to determine whether those manipulations have produced, or are producing, the desired condition (Keddy 2000). The second tool is achieved through systematic monitoring of outcomes. The monitoring plan focuses on key indicators of project performance to address the question of whether operations, mitigation sites, and associated management measures are achieving stated objectives.

Adaptive management to be implemented by the CRSO EIS would employ a suite of management measures that attempt to address a complex set of objectives. These management measures are linked to their predicted ecological outcomes through a series of assumptions. While these assumptions are based on the best current scientific understanding, they involve scientific uncertainties inherent in the ecosystem. Monitoring and adaptive management provides a mechanism for testing assumptions and further reducing these uncertainties. As the scientific record develops, relationships, conceptual models, management measures and ultimately operation designs can be refined for use in future actions or to improve existing conditions.

1.1 PROJECT REQUIREMENT

The following legal requirements for monitoring and adaptive management actions apply to civil works projects:

- Section 906(d) of the Water Resources Development Act (WRDA) of 1986 Mitigation Plans as Part of Project Proposals

- Section 2036 of WRDA 2007 Mitigation
- Section 2039 of WRDA 2007 Ecosystem Restoration
- Section 1040 of WRDA 2014 Fish and Wildlife Mitigation
- Sections 1161 and 1162 of WRDA 2016 Completion of Ecosystem Restoration Projects, and Fish and Wildlife Mitigation, respectively.

The 2007 guidance states that a plan for monitoring ecological success must be included in the decision document, must include the rationale for monitoring, and must identify key project-specific parameters and how they relate to achieving the desired outcomes for making a decision about the next phase of the project. The guidance states that the monitoring and adaptive management costs will be included in the project cost estimate. The monitoring plan should also identify the criteria for success and when adaptive management is needed.

The structures and operations of the 14 CRS Federal projects have some undesired consequences for fish and wildlife and their habitats in the river system. The Federal agencies have proposed mitigation measures as well as some operational and structural changes as part of the agency-preferred alternative. Mitigation measures are required to avoid and minimize impacts to Endangered Species Act (ESA) listed species, cultural resources, recreation, water quality, and Clean Water Act resources. Other proposed measures have a goal of reducing impacts of the structures or operations of the dams, improving fish passage and survival, and managing predators of the ESA-listed fish species.

1.2 PURPOSE

The purpose of this framework is to establish the required components and approach of the monitoring and adaptive management plan. The plan itself shall provide all the components needed to demonstrate operational measures, cultural, and ecological success of the mitigation and management measures of the CRSO project. This success is determined by monitoring metrics that are specifically tied to project objectives, and setting performance targets. In addition, the plan identifies what adaptive management is proposed if the performance targets are not met. This framework provides the basis for the monitoring and adaptive management methodology and implementation, which will be refined in collaboration with the other Federal and non-Federal agencies, cooperating agencies, and tribes, as well as other stakeholders who may take responsibility for monitoring ecological variables in the CRSO EIS study area.

1.3 IMPLEMENTATION GUIDANCE

For each statutory requirement for mitigation, monitoring, or adaptive management, the USACE provides an implementation guidance document. Implementation guidance for Section 2036(a) of WRDA 2007 covers the requirements for mitigation for impacts to fish and wildlife resources, details of the mitigation plan, and the requirements for monitoring mitigation results with a contingency plan. In its Implementation Guidance for Section 2039 of the Water

Resources Development Act of 2007 (WRDA), the Corps defines monitoring as "the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits" (USACE 2009). In this context, the Corps uses "adaptive management" to denote "contingency planning"- in other words, determining the need for, and implementing, mid-course corrections to actions. Thus, the Corps recognizes that even the most strategically planned actions can yield unexpected results. Comprehensive monitoring of a site documents and diagnoses these results especially in the early, formative stages, providing information useful for taking corrective action. In this way, it reduces the risk of failure and enables effective, responsive management of actions.

Implementation Guidance for Section 2039 of WRDA 2007 states that a plan for monitoring ecological success must be included in a project's decision document, must include the rationale for monitoring, and must identify key project-specific parameters and how they relate to achieving the desired outcomes for making a decision about the next phase of the project. The monitoring plan should also identify the criteria for success and when adaptive management is needed. Section 1161 of WRDA 2016 amends Section 2039 of WRDA 2007 to describe specific information required to be included in MAMPs. Additionally, the implementation guidance for Section 1162 of WRDA 2016 and Section 1040 of WRDA 2014 provides clarifications of requirements for compensatory mitigation and add clarifying language to definitions of terms in the laws.

CHAPTER 2 - MONITORING FRAMEWORK SUMMARY

The CRSO project is complex and must meet a wide variety of authorities and purposes of the projects in the system. The agencies responsible for the projects must ensure that the system minimizes impacts to fish and wildlife and their habitats, cultural resources, utilities, and the human environment. Additionally, compensatory mitigation is required for impacts to fish and wildlife and their habitats. Improving the ecological productivity through changes in operations and structures has many opportunities and constraints while meeting the many purposes of the projects within the CRS. The proposed measures under consideration in the agency-preferred alternative in the CRSO EIS as well as the mitigation measures require monitoring to determine whether goals are being met. This can require contingency measures, often called adaptive management, to improve performance. Through monitoring, one assesses and finds ways to improve the effectiveness of a project in meeting its goal.

Monitoring and adaptive management theories, frameworks, and processes have been in use for over a century, but only substantially described in literature in the past 30 years. One of the most notable resources is the Conservation Measures Partnership's *Open Standards for the Practice of Conservation* (CMP 2004). The process of adaptive management is practiced as iterative and is represented as circular as in the generalized format below (Figure 2-1).

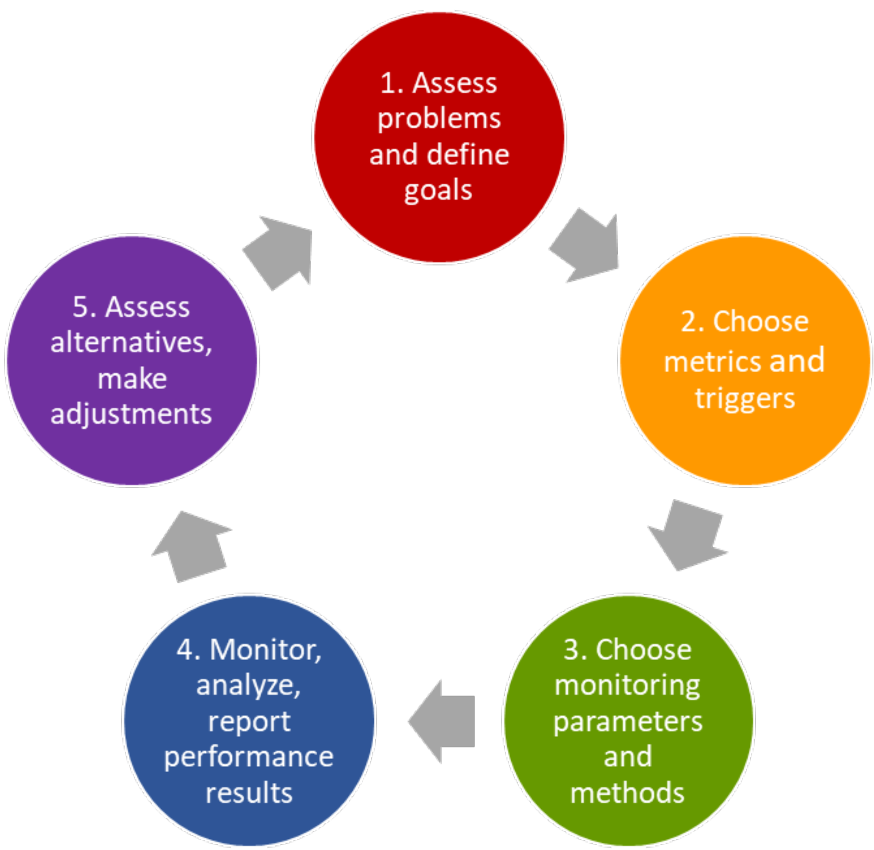

Figure 2-1. Standardized adaptive management process adapted from NRC 2004 and Thom et al. 2007.

In the practice of monitoring and adaptive management, several monitoring principles have been established as standard to any monitoring efforts:

1) The project objectives would be used to build performance criteria and implement a monitoring program that evaluates attributes directly related to these criteria and the objective they assess.
2) Restoration actions would test hypotheses or answer specific questions about ecosystem functions and processes and human intervention. Monitoring provides the data to test the hypotheses.
3) Monitoring would determine whether goals are being met.
4) Monitoring would be considered part of the information feedback system called adaptive management that leads to increased knowledge and reduces uncertainty in decision-making and in the outcomes of restoration.
5) Monitoring would be a long-term effort.
6) Monitoring would be interdisciplinary.
7) Monitoring would occur at multiple scales in time and space and selected indicators would be defined by objectives and be scaled appropriately.

Comprehensive monitoring for adaptive management generally falls into three broad categories:

1) **Implementation monitoring** also known as compliance monitoring, evaluates whether or not planned tasks have been carried out as intended. In other words, implementation monitoring is designed to answer the questions, “Did we do what we said we would do? Did we follow all applicable standards and guidelines when we did it?”
2) **Effectiveness monitoring** evaluates whether or not actions are achieving their stated objectives. Effectiveness monitoring is designed to answer the question, “Did the completed actions achieve the intended outcomes? To what degree did we meet our site-specific objectives?"
3) **Validation monitoring** tests the assumptions linking objective and program goals. It is designed to answer the question, “Are these objectives the right ones to achieve program goals, or are our underlying assumptions wrong?”

All three types of monitoring are critical to the success of the CRSO project. The monitoring framework presented in this document focuses primarily on effectiveness monitoring as it is the fundamental monitoring responsibility to measure success of the implemented project. Validation monitoring is necessary for programmatic adaptation and learning, but is presented as secondary in this framework to reflect its prioritization level. The completion of implementation monitoring is assumed to be part of project construction best practices. Thus, guidance for implementation monitoring is outside the scope of this document.

CHAPTER 3 - OVERVIEW OF EFFECTIVENESS MONITORING

The primary purpose of effectiveness monitoring is to track the progress of the project relative to its intended goals and objectives. Monitoring results will allow the natural resources managers and stakeholders to assess whether the management measures applied at the CRS projects are providing the target ecological performance conditions, maintaining performance, or on a positive or negative trajectory relative to historical conditions and management goals.

Effectiveness monitoring is the primary focus of this document. By evaluating performance criteria for each measure, effectiveness monitoring tests whether actions are achieving their stated ecological objectives. Measuring and tracking these criteria provides feedback to determine whether any adjustments to the action are necessary to improve its probability or degree of success. If properly planned and maintained, this feedback leads to increased knowledge reducing uncertainty in the outcomes of the operation, and allowing sequential improvement of management actions in meeting objectives from site to project scales. This feedback is the basis of an adaptive management framework.

3.1 APPROACH AND GOALS

The MAMP must focus on the parameters that will serve as key indicators of project performance to address the question of whether management measures are achieving stated targets. The Corps recognizes that even the most strategically planned management actions can yield unexpected results. Monitoring physical and biological parameters documents and diagnoses these results especially in the early, formative stages, providing information useful for taking corrective action. In this way, it reduces the risk of failure and enables effective, responsive management of corrective actions.

The goals of effectiveness monitoring for CRS operations are to achieve the following:

1) Assess the effectiveness of efforts in achieving defined objectives
2) Determine where corrective action is needed to improve the effectiveness of operations, and inform decisions about how to take such corrective action; and
3) Reduce risks and uncertainties associated with future operations by increasing understanding of the relationships between operations and the ecosystem processes, structures, and functions for the Columbia Basin.

The CRSO project strategies identify management measures used to implement the processes, which in turn generate a series of structural and functional responses specific to the system. These responses constitute a set of predicted ecological and other ecosystem goods and services outcomes that indicate the performance of the measure. Performance of the measure is documented through an evaluation of monitoring results as measured against these predicted outcomes. Thus, these outcomes effectively serve as strategy-specific objectives. To achieve the monitoring goals stated above, effectiveness monitoring of the CRSO project must answer the question, “Do management measures as implemented achieve the target conditions as stated in the project's goals and objectives of the management measures and mitigation plan?"

3.2 DEFINITION OF ECOLOGICAL SUCCESS

Some of the management measures employed will be continuous or seasonal implementation of operational measures, some will be structural updates or modifications, and other measures will be a single event or action as mitigation for impacts. There may be no endpoint for certain measures, whereas others will meet a target and not need further treatment. The co-lead agencies can work with the other stakeholders to determine at what point a measure should be deemed successful and continue as is in an optimized configuration or can be ended without further effort. Development of the MAMP will require a definition of success for each parameter; a general definition might be something like "the point at which the restored area can be described as self-sustaining in its restored condition." It is important to recognize the need for resilience in ecosystems. Johnson (1999) emphasizes the value of adaptive management not for maintaining one optimal condition, but to develop optimal management capacity. Maintaining ecological resilience allows the system to respond to stressors and allows resource managers flexibility in reactions when conditions change (Johnson 1999). Managing a large complex system should not target a single optimized state; it should rather aim for a range of conditions in which the ecosystem has the resilience for sustainability.

3.3 TYPES OF MONITORING

The measures applied for CRSO project will affect a variety of physical and biological parameters. Some of the types of ecological monitoring that will be described in detail in the MAMP include the following:

- Water quality
- Fish population numbers
- Juvenile fish health
- Plant growth rates, survivorship, and total ground coverage
- Establishment of Invasive plant species in restored areas
- Protection of Cultural Resources
- Protection of Infrastructure (i.e. dam structure, bridges, roads)
- Ensure public access to recreational sites

This document is intended to support comprehensive decision-making for the implementation phase of the CRSO project, including engineering and design of the measures. It will be used to develop individual site-specific monitoring plans for the proposed measures providing a framework to assess the effectiveness of actions by measuring the response of specific indicators.

3.4 OVERVIEW OF MEASURES AND PARAMETERS TO MONITOR

The CRSO EIS preferred alternative includes measures that have a purpose of improving various ecological aspects of the system such as improving fish passage adult and juvenile salmon. For impacts that cannot be directly addressed by one of the structural or operational measures, the co-lead agencies have proposed mitigation measures. These mitigation measures address impacts to fish; vegetation, wetlands, and wildlife; water quality; navigation and transportation; and cultural resources. For each type of impact, the MAMP will have a list of parameters that have specific indicators to measure to determine whether the measure is achieving the goals.

Some examples of parameters that provide indication of whether measures are effective include those shown in Table 3.1 along with some generalized success criteria. This is not a comprehensive or complete list; each of these categories would be described and developed in detail in the final MAMP.

Table 3-1. Examples of parameters, the indicators to monitor, and some generalized success criteria to be developed in detail in the CRSO MAMP.

Parameter	Indicator to Monitor	Success Criteria
Water Quality	Total Dissolved Gas Water Temperature	Meets conditions that allow for fish survivorship
Fish Resources	Presence or absence of gas bubble trauma	Meets conditions that allow for fish survivorship
	Smolt-to-adult return rates for anadromous fish populations	Numbers of smolts and adults sustain or improve population densities
	Measure tributary passage and backwater habitats	Smolts and adults are capable of reaching headwaters without sediment obstruction caused by dams
Wetland/Riparian Ecosystems	Measure density and condition of wetland/riparian ecosystem Measure Plantings survivorship, composition, and density	Native Riparian and Wetland habitats occur along the Snake and Columbia River in current or better condition.
Cultural Resources	Erosion at Cultural Resource sites	Cultural Resources are present and protected within current or better condition.
Recreation	Number of days/trips used by public	Number of recreational opportunities remains the same as current conditions or in a better condition than current state.
Infrastructure (i.e. dam structure, bridges, roads, etc).	Assess current condition of infrastructure within project area	Number and condition of infrastucture does not degrade.

3.5 UNCERTAINTIES

Several types of uncertainties exist in the practice of the CRS operations. These uncertainties are derived from the following:

- **The response of the system to operations.** These arise from assumptions made in the conceptual model and can introduce risk of failure or delay meeting objectives.
- **Cumulative effects.** Multiple corrective actions can interact in unpredictable ways with synergistic or countervailing results.
- **External factors and constraints.** Factors outside the control of the operations can affect performance. These may include uncertain future change such as accelerated climate change, or practical constraints such as human modifications to watersheds or protection of private property.

In the MAMP developed for CRSO EIS, uncertainties can be addressed at three scales: (1) the individual measure scale (2) the scale over which individual measures may interact across individual projects (e.g. Grand Coulee and Chief Joe), and (3) the collection of the CRS projects or program scale. Effectiveness monitoring reduces risk associated with uncertainties at the site scale through contingency planning. At the program scale, information from effectiveness monitoring is used for programmatic improvement.

At the site scale, effectiveness monitoring reduces uncertainties associated with the response of the system to operations and structural management measures. Monitoring answers effectiveness questions by systematically tracking indicators over time and comparing results to a predicted response. If an indicator does not develop as predicted, a contingency plan presents options and instructions for corrective action.

Although effectiveness monitoring is performed at the site scale, the information it generates can be used to inform decisions and make improvement at the system scale. Monitoring tests assumptions and reduces uncertainties over time. In addition to improving the new measures applied as a result of the current EIS, refinements can make the next generation of operational and structural measures more effective after uncertainties have been reduced through measurement and analysis.

The large spatial scale and long timeframe that characterize the monitoring of CRSO EIS measures are also critical to programmatic improvement. Information from effectiveness monitoring across all CRS projects can reduce uncertainties about cumulative effects to track progress toward CRSO EIS program-scale objectives. The same information, collected over a long period as part of a broader assessment of overall success, can be used to track and understand the response of the system to external factors such as climate change and land use patterns. Co-lead agencies is can use this information to adjust the objectives, design, and implementation of the next generation of operations as well as adapt program objectives to changing conditions.

Some examples of areas of uncertainty in the CRSO EIS include the following:

- Risk and rate of herbivory of vegetation planted for mitigation
- Fish mortality from other factors outside the CRS
- Contamination of sediments
- Soil conditions (i.e. erosion, compaction) in the surrounding landscape
- Planting success of mitigation actions
- Colonization by invasive species
- Stochastic events (i.e. flood, fire, vandalism)
- Human development in the watershed and service area of the CRS projects
- Severe weather events
- Discoveries of cultural resources
- Erosion of cultural resources
- Contaminated groundwater
- Colonization by animals (i.e. gulls, beaver, pelicans)

3.6 CONTINGENCY PLANNING

The MAMP purpose is to address two factors that affect results of measure implementation: the first is the ability of the applied measures to achieve desired results, and second is to address unforeseen changes in site conditions or other components of the project and mitigation actions (e.g. riparian plantings). The MAMP would guide decisions for refining or revising activities and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect the project success. The co-lead agencies will use the information generated by the MAMP in consultation with Federal and State resource agencies to guide decisions on operations or structural changes to a project that may be needed to ensure that the project meets its success criteria.

Contingency plans are presented as management responses to unfavorable monitoring results. These responses consist of information that must be considered to explain the unfavorable results, and potential corrective actions to help reverse them and move the system toward success. More specific adaptive management responses will be developed for each indicator in the final MAMP. Target conditions may need to be reassessed if measures and follow-on contingency measures fail to meet targets after a designated monitoring period.

CHAPTER 4 - IMPLEMENTATION

Monitoring includes the systematic collection and analysis of data that provides information necessary to determine if the project is meeting its performance standards, and to determine when ecological success has been achieved or whether adaptive management measures are necessary to ensure that the project will attain project benefits.

When plans for implementation of the final preferred alternative of the EIS and the associated mitigation actions advance from current level of design to final design and construction, the co-lead agencies will develop a detailed MAMP to include each of the sites where measures will occur. Monitoring plans developed for individual sites are anticipated to vary according to site-scale conditions and requirements.

4.1 DATA COLLECTION METHODS AND SOURCES

Sampling methods and protocols selected for the MAMP must use methods that have been proven to have scientific validity to ensure stakeholder acceptance of results. Ideally, the MAMP procedures would use the sampling equipment and procedures that are already installed and functioning at each project where fish sampling occurs. Monitoring of other types of resources should make efficient use of systems already in place for data gathering to the extent possible.

How long the monitoring occurs depends on the information that is needed. The duration of sample collection should be conducted throughout the season of each subject's presence. Nearly all fish, plants, and wildlife have seasonal changes to their locations, behaviors, and habitat usage. The timing and frequency of sampling and data collection should be appropriate for adequate sample sizes to detect the effect being measured. For example, frequency for checking a planting plot could occur once or twice per year, whereas mammal usage of habitats may need to occur weekly to monthly during their specific season of interest.

The long-term duration of sampling will depend on how rapidly a resource is expected to show evidence of recovery, or indicate a trajectory toward recovery. For example, plants in a re-vegetated area may only need to be monitored for their first 3 to 5 years to determine whether restoration was successful; however, anadromous salmon smolt-to-adult returns may need 10 to 15 years to determine whether improvements are occurring.

4.2 INDICATORS AND METRICS (PERFORMANCE CRITERIA)

Performance criteria, often called "metrics", are the standards set for assessing the restored system where treatment was applied. The standards must be observable and measurable and linked to the goals of the actions. Ecological systems can often have a wide variety of measurable parameters; however, some aspects have great uncertainty and observations will have too large of variance to be meaningful in decision-making. Selection of parameters should focus on efficiency such that effort is spent on the key parameters that are most important for decision-making and are most likely to reveal whether the measures are achieving the targets.

Parameters form the basis of selecting indicators (described below) and establishing the specificity of metrics.

Metrics are developed beginning with the parameter of interest and then setting goals within reasonable expectations based on best available science. For example, after a planting plan has been executed, the monitoring team would start with a parameter like vegetative ground coverage. Based on other restoration areas that have been determine successful, the team would set metrics to achieve, for example, 50% coverage by year 2, 80% by year 5, and perhaps 100% by year 7. This uses a measurable indicator (coverage) and states the time and space for this ecological feature to be reasonably expected to occur.

Ecosystem interactions addressed in the EIS are a direct or indirect result of the structures and operations of the CRS. These interactions have measurable indicators for how the structures and operations affect ecosystem components. These interactions and responses are captured in monitoring by two levels of indicators depending on whether the reaction is direct or indirect:

- **Primary indicators** are measurable responses that are directly related (i.e. through a single causal relationship). For example, reducing erosion on cultural resources is a goal for the CRSO. Cultural resources degradation is a direct result of increased erosion, and is monitored as a primary indicator. Another example is managing water temperatures to reduce stress on fish. Water temperature is directly measurable and is an anticipated result of specific management measures.
- **Secondary indicators** are responses that occur from a single or a combination of management measures. Compared to primary indicators, they are less directly related to the operational or structural measure. For example, colonization by native vegetation is a response that relies on two restored processes: erosion and accretion of sediments, and exchange of aquatic organisms. These two processes operate most fully where the appropriate hydrologic regime is present.

Both levels of indicators must be monitored to evaluate whether they follow a predicted response. This response is developed from the best scientific understanding of the system's evolution following implementation of the CRSO EIS preferred alternative. Metrics for each indicator are selected to provide enough information to track an indicator through its predicted response, as well as to explain why an indicator is (or is not) developing as predicted. For example, site-scale topography measurements would track cultural resources integrity over time. If the cultural resources erode, then measurements of local sediment accretion and erosion may help provide an explanation.

When the MAMP is developed in detail, the co-lead agencies will collaborate with the scientific community to develop the list of primary and secondary indicators that should be monitored to determine whether the selected alternative and all mitigation measures are meeting their targets.

4.3 TARGETS AND TRIGGERS (DECISION CRITERIA)

The performance criteria need time, space, abundance, or other targets at which point the action can be considered a success. Success determination typically occurs when an indicator meets its target. The target is often defined as the point at which the restored area can be described as self-sustaining in its restored condition; however, a robust definition including the concept of resilience should be considered, as described in Johnson (1999). Decision criteria will be established within the MAMP and should be based on best available science.

Decision criteria are also set for triggers for further treatment if the management measure appears to be falling below a pre-determined point. To establish triggers, scientists determine how far below a target a parameter must fall, or the slope of a declining trajectory, before an action agency should take corrective actions and apply the agreed upon adaptive management measures. These are pre-negotiated commitments of what and when actions should be taken based on monitoring results, and the triggers provide greater certainty and accountability for agencies to enact the adaptive management measures (Nie and Schultz 2012).

Triggers are accompanied by the range of options for management measures to apply when an aspect of the action is not meeting its target. Further, these triggers signal the end of one cycle of the adaptive management process and the start at step one to reassess the problems and determine whether the goals should be re-defined (Figure 1).

4.4 ADAPTIVE MANAGEMENT RESPONSES

Through monitoring and data analysis, the co-lead agencies will learn whether specific mitigation measures are achieving the stated goals. For each instance in which the results show an indicator is falling below the target conditions to the level of triggering a follow-up action, there will be a decision point for which actions to take, and when and where to apply the management measures. These adaptive management responses can be thought of as tools in a toolbox. Coordination and collaboration will occur in advance responses to triggers can be timely and agreed upon without substantial consultation among stakeholders. The co-lead agencies should draw from best available science, which can be expected to change over time as new information becomes available and more research is conducted on species and habitats of concern. This stage of applying an adaptive management response to triggers moves the process to the restart of the steps of the adaptive management cycle in which goals are reassessed and problems reexamined.

CHAPTER 5 - MANAGEMENT ACTIONS

An adaptive management plan addresses unforeseen changes in site conditions or other components of the project. The MAMP will continue until the co-lead agencies determine that the success criteria have been met.

The adaptive management plan would stipulate the general procedures for identifying implementing, and funding remedial measures in the event of unexpected contingencies (fires, floods, drought, etc.). These remedial measures would be coordinated with the co-lead agencies and CRS stakeholders.

CHAPTER 6 - REGIONAL COLLABORATION

The monitoring plan will be developed in collaboration with other Federal and State agencies and entities that can provide scientific input to plan development and implementation. The co-lead agencies is propose to coordinate with USFWS, NMFS, and other Federal and State agencies and tribes in accordance with applicable laws to inform and signal appropriate adaptations to meet targets or to changing circumstances.

Communication and collaboration should be fostered and maintained with Federal, State and local agencies, as well as tribal governments, non-profit organizations, and community groups. This can occur as a continuation of cooperation of co-lead agencies and CRS stakeholders developed during the CRSO EIS. The MAMP will utilized existing regional forums, as appropriate. In addition to information sharing, this collaboration may include cooperative planning efforts, shared construction, shared operations and maintenance, or shared monitoring activities.

6.1 REPORTING

To support management of the CRSO project, raw monitoring data and basic field reports should be supplied to the party conducting data analysis as soon as possible following data collection. Raw monitoring data must be processed and converted into actionable information. This involves quality control, statistical analysis, and summary and presentation in regular reports. These reports should emphasize full reporting and synthesis of results into coherent narrative and graphical presentations. They should be provided in a timely manner to the co-lead agencies.

Results should also be shared less formally through participating in regional conferences and major science symposia. These events can serve as two-way conduits for system knowledge between the co-lead agencies and the broader scientific community. Ultimately, the co-lead agencies should ensure that results from monitoring and adaptive management actions are integrated with broader regional management initiatives.

The co-lead agencies propose to use the best available scientific information to identify and carry out actions that are expected to provide immediate and long-term benefits to listed fish and wildlife, while continuing to operate for other authorized purposes set forth by Congress.

The following example information the co-lead agencies may propose to report annually:

- Configuration or operational changes at the dams;
- Water quality at each projects
- Operations for juvenile fish (e.g., the placement of screens, the start and end of spill operations);
- Transport operations (start and end of transport operations, number of fish transported); operations for adult fish

- Predation management actions
- Kelt reconditioning actions
- Results from monitoring operations, such as
    - Adult fish counts
    - Pinniped numbers and predation estimates at Bonneville Dam
    - Juvenile fish in-river system survival estimates and
    - Adult fish upstream conversion estimates
- Tributary habitat improvements.
- Estuary habitat improvements
    - Acres of estuary floodplain improved, and
    - Miles of estuary riparian area improved

6.2 COORDINATING WITH AGENCIES AND STAKEHOLDERS

The co-lead agencies propose to continue to use an adaptive management framework to manage system operations and guide implementation of the additional non-operational measures. The co-lead agencies propose to continue to work collaboratively with regional sovereign parties to adaptively manage the implementation of system operations related to fish through various policy and technical teams, collectively referred to as the Regional Forum and to implement year-round system operations related to fish and adaptively manage operations, as necessary.

6.3 SCIENCE REVIEW

When appropriate, CRSO project should seek peer-review of the synthesized monitoring results. In general, peer review is a critical element of any science-based program. It helps to ensure use of best available science, can validate or provide alternative interpretations of monitoring results, and can make methods and conclusions defensible. The co-lead agencies should incorporate product-specific peer-review for reports, decision-support tools, and other products generated from monitoring results.

CHAPTER 7 - REFERENCES

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Appendix R,
Mitigation, Monitoring and Adaptive Management
Part 2, Process for Adaptive Implementation of the Flexible Spill Operational Component of the Columbia River System Operations EIS

Table of Contents

CHAPTER 1 - INTRODUCTION

The purpose of this document is to provide a framework for an adaptive management implementation plan to improve downstream passage of ESA-listed juvenile salmonids through the four Lower Snake River and four Lower Columbia River projects to reduce or minimize impacts to these species from bypassing these dams that is included as part of the preferred alternative in the Columbia River System Operations Environmental Impact Statement (CRSO EIS). The co-lead agencies anticipate working collaboratively with regional sovereigns to develop a more detailed adaptive management plan after the CRSO EIS Records of Decision are signed.

Adaptive Management is a structured decision making process that allows decision makers focus attention on what, why, and how actions will be taken (Williams et al, 2009). It is described by the National Research Council (2004) as follows:

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

The adaptive management process is a collaborative process among stakeholders. Adaptive Management promotes collaboration, flexible decision-making through deliberately designing and implementing management actions to test hypotheses and maximize learning about critical uncertainties to better inform management decisions (Williams and Brown 2012). A simplified model of the adaptive management process is shown in Figure 1.

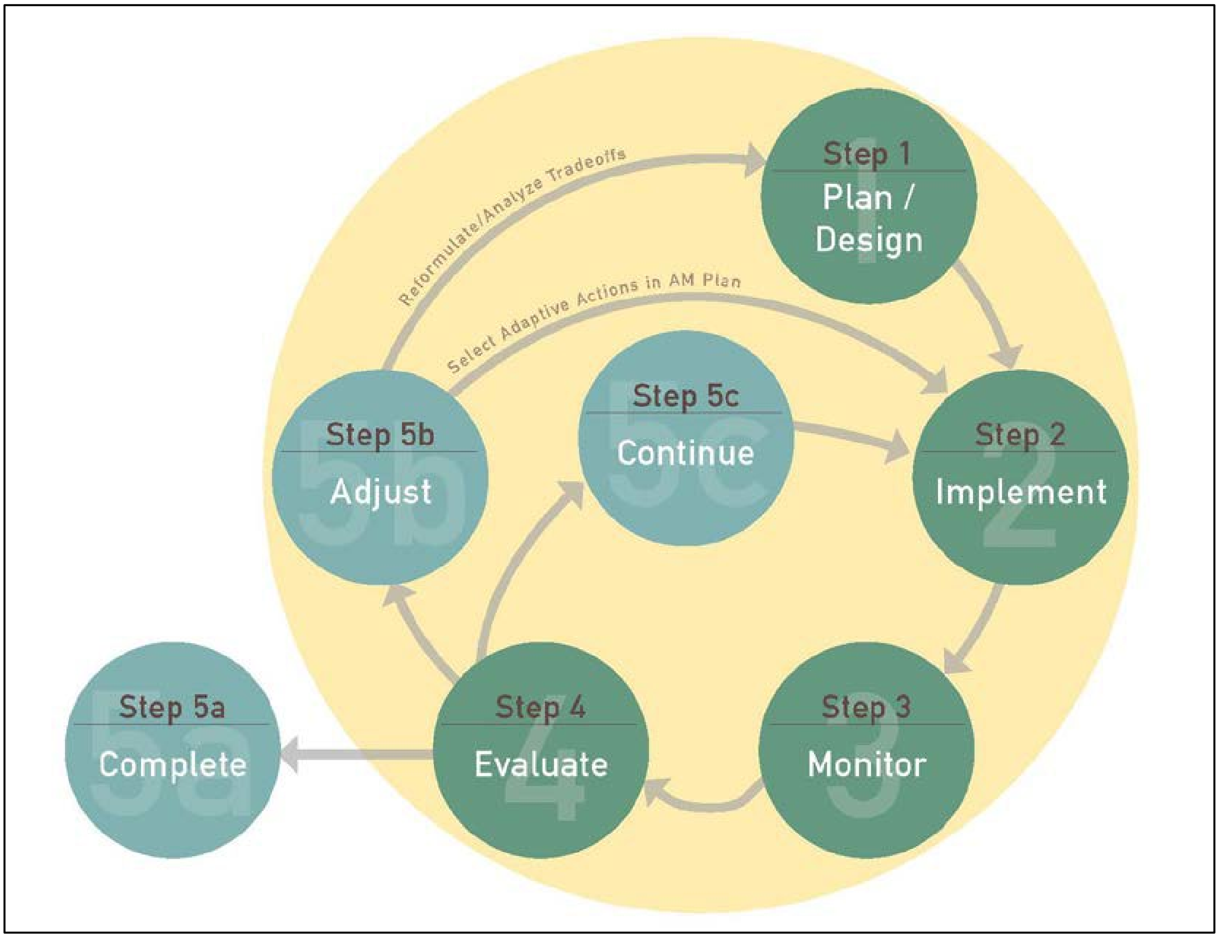

Figure 1-1. A simplified conceptual model of the adaptive management process.

The uncertainties associated with spill on the Lower Columbia River and Lower Snake River are ideal to be address through the adaptive management process. (Gregory, 2006) describes the five conditions where adaptive management are most suitable.

- Management is required in spite of uncertainty
- Clear and measureable objectives for decision making
- Opportunity to apply learning to management
- Monitoring can be used to better understand the system
- Sustained commitment by stakeholders

All five of these conditions are met for spill on the Lower Columbia River and Lower Snake River with regard to downstream passage of juvenile salmonids. This adaptive implementation and monitoring framework defines the elements of a flexible spill operation, determines monitoring questions, scopes the review and evaluation of the effects of the spill operation, and adjusts management towards desired conditions and away from undesirable conditions. The stakeholder participation and collaboration process that occurred during the 2019 and 2020 flex spill planning process was significantly aided by the efforts of the collaborative workgroup of diverse sovereign stakeholders.

CHAPTER 2 - 2019-2021 SPILL OPERATIONS AGREEMENT

To build off the success and momentum achieved through the *2019-2021 Spill Operations Agreement* (Agreement), the Action Agencies (U.S. Army Corps of Engineers, Bonneville Power Administration, and Bureau of Reclamation) plan to formally continue the efforts of Flexible Spill Working Group (FSWG). This group would be complementary with the existing Regional Forum. The specific phases and activities of the adaptive implementation framework are outlined herein. The intent is that this adaptive implementation framework will be utilized over a multi-year timeframe. Evaluating the effectiveness of these operations will require multiple years of data given the lifecycle of salmon and the potential changes in regional energy markets.

A flex spill operation is envisioned to incorporate a range of spring spill levels up to a 125% TDG spill cap during designated hours each day consistent with the concepts tested as part of the Agreement. The intent of that operation would be to meet shared “performance targets” for fish, power generation/transmission, and other implementation and operational considerations developed through collaboration with regional stakeholders. While flex spill is focused on spring operations, it is anticipated that some reduction of summer spill will be required to offset the power system impacts due to higher spring spill.

Spill levels implemented would be adapted or modified based on the framework in this document to account for unanticipated outcomes that affect the ability of the Action Agencies to maintain their individual federal mandates. Those modifications could include, but are not limited to, implementation of spill levels that are within the range of alternatives analyzed in the EIS. The primary goals of this framework are to align with and to complement existing Regional Forum processes to:

- Continue the participation of federal, state and tribal resource managers and the collaborative learning that occurred during the development of flexible spill operations in 2019 and 2020;
- Encourage and support the continuation of the collaborative FSWG efforts throughout implementation;
- Ensure the implementation of CRS spill operations is responsive to dynamic conditions experienced during implementation of this novel operation, new scientific information, and regional input;
- Demonstrate compliance with management direction specified in the FEIS/ROD;
- Coordinate with NOAA Fisheries and/or U.S. Fish and Wildlife Service to ensure consistency with the consultations associated with the CRSO EIS;
- Conduct a transparent adaptive implementation process that keeps stakeholders informed of and involved in annual operation decisions on timing, design, and monitoring;

- Ensure integrated engagement of interdisciplinary team members, project personnel (e.g. dam operators, power schedulers), scientists, federal agency policy leads;
- Focus on shared priorities and work to resolve concerns and solve problems related to implementation of flexible spill operations;
- Conduct monitoring activities, interpret and share results, adapt implementation practices to improve results and better meet project objectives; and,
- Evaluate the value of flex spill for fish and power over a range of environmental and economic conditions.

CHAPTER 3 - BACKGROUND – IMPLEMENTATION AND GOVERNANCE

3.1 LESSONS LEARNED FROM THE 2019-2021 SPILL OPERATION AGREEMENT

Through implementation of the 2019 flexible spill operation, the FSWG was able to pilot many of the adaptive implementation concepts detailed in this framework. There was a pre-season review of the specific directions given to project operators through the 2019 Fish Operations Plan (FOP) by members of the Regional Implementation Oversight Group (RIOG). In limited instances, specifications in the FOP clarified and refined points in the Agreement. When spill operations commenced in April of 2019, the Technical Management Team (TMT) monitored, and in some cases modified, operations in real-time to account for unanticipated challenges with implementation. Examples of these in-season changes included spill at John Day Dam producing TDG levels that reduced the spill at the next downstream project (The Dalles Dam) below performance standard levels, and adult salmon passage impacts at Little Goose Dam. In instances where members of the TMT were not able to resolve the issue to the satisfaction of all parties, the FSWG met and advised on outcomes for the Corps to implement without requiring further dispute resolution.

After the 2019 spring spill operation concluded, the FSWG met again to discuss whether or not the three pillars of the Agreement were satisfied under the first and only year of flex spill operation, and to finalize the details of the 2020 operation based on the lessons learned from 2019.[1] All Parties agreed that actual results were within the modeled pre-season predictions for both powerhouse encounter rates[2] as well as power system generation. The Corps was able to successfully implement the operational requirements of the 2019 operation.

3.2 BASE OPERATION FOR INITIAL IMPLEMENTATION

In order to start and then adapt from a common reference point, a base operation for the first year of implementation of the flexible spill operation component of the preferred alternative from the CRSO EIS needs to be defined. Prior to the change in EIS schedule, the Agreement was intended to last three years. To be consistent with this intent and to define a base operation that can be adaptively managed in the future, the Action Agencies are planning to continue the 2020 Spring and Summer spill operations in 2021. Lessons learned from the 2020 operation could be used to refine the 2021 operation where warranted. These operations will also form the basis for any additional analysis of impacts and can serve as the basis for deriving future performance targets for power and fish. This approach will give the FSWG time to develop scenarios and conduct additional analysis around potential future operations prior to the 2022 spill season.

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[1] Additional sovereign fish managers were participants in the discussions during summer 2019 and it is anticipated that the FSWG that participates in coordination of the flexible spill operation component of the selected alternative may include these entities in addition to the Parties to the Agreement. While participation in the FSWG is limited to sovereigns, the forum is intended to be open to any Columbia River System sovereign that expresses a desire to participate.

2 Powerhouse encounter rates based on PITPH metric.

Table 3-1. Planned 2020 spring spill operation, applying estimated 125% mean total dissolved gas (TDG) spill caps and performance standard spill operations at six projects ("125 flex"), applying estimated 120% mean TDG spill caps and performance standard spill ("120 flex") at John Day Dam (JDA), and 24 hour performance standard spill (40%) at The Dalles Dam (TDA).

Location	Estimated mean 125% Total Dissolved Gas Spill Cap (16 hours), with alternative operation at JDA and TDA.	Performance Standard Spill (8 hours).
Lower Granite (125 flex)	72 kcfs	20 kcfs
Little Goose (125 flex)	79 kcfs	30%
Lower Monumental (125 flex)	98 kcfs	30 kcfs
Ice Harbor (125 flex)	119 kcfs	30%
McNary (125 flex)	265 kcfs	48%
John Day (120 flex)	146 kcfs	32%
The Dalles (Performance Standard)	40%	40%
Bonneville (125 flex with 150 kcfs spill constraint)	150 kcfs	100 kcfs

Table 3-2. Planned summer spill operations for 2020.

Location	Initial Summer Spill Operation: Volume/Percent of Total Flow Routed to Spillway (June 21/16 – August 14)	Late Summer Transition Spill Operation: Volume/Percent of Total Flow Routed to Spillway (August 15 – August 31)
Lower Granite	18 kcfs	RSW or 7 kcfs
Little Goose	30%	ASW or 7 kcfs
Lower Monumental	17 kcfs	RSW or 7 kcfs
Ice Harbor	30%	RSW or 8.5 kcfs
McNary	57%	20 kcfs
John Day	35%	20 kcfs
The Dalles	40%	30%
Bonneville	95 kcfs	55 kcfs - includes 5k corner collector

CHAPTER 4 - OBJECTIVES, PRINCIPLES, AND PERFORMANCE TARGETS

The flex spill operation is designed to continue to meet the three pillar principles of power, fish benefits, and feasible operation of the Columbia River system with performance targets assumed to result in neutral power revenue as compared to 2018 Court Ordered spill operations and continued power reliability, increased biological benefits to migratory salmon and steelhead, and safe operation of the 8 federal dams. These principles are all compatible with and directly support the overall objectives of the EIS, specifically:

4.1 THE FLEX SPILL FISH PRINCIPLE:

Provide fish benefits, with the understanding that (i) in 2019, overall juvenile fish benefits associated with dam and reservoir passage through the lower Snake and Columbia rivers during the spring fish passage season must be at least equal to 2018 spring fish passage spill operations ordered by the Court, and (ii) in 2020 and 2021, these fish benefits are improved further (as estimated through indices of improved smolt-to-adult returns, e.g., PITPH, reservoir reach survival, fish travel time);is directly related to Objectives 1, and 2 of the CRSO EIS:

- Improve ESA-listed anadromous salmonid juvenile fish rearing, passage, and survival;
- Improve ESA-listed anadromous salmonid adult fish migration

4.2 THE FLEX SPILL POWER PRINCIPLE:

Provide federal power system benefits as determined by Bonneville, with the understanding that Bonneville must, at a minimum, be no worse financially compared to the 2018 spring fish passage spill operations ordered by the Court; is directly related to Objective 5 of the CRSO EIS:

- Provide an adequate, efficient, economical and reliable power supply that supports the integrated CR Power System

4.3 AND THE FLEX SPILL IMPLEMENTATION PRINCIPLE:

- Provide operational feasibility for the Corps implementation that will allow the Corps to make appropriate modifications to planned spring fish passage spill operations is directly related to meeting the authorized project purposes consistent with the Purpose and Need statement
- Allows the CRS to be operated for the authorized purposes of the system, including flood risk management, navigation, irrigation, hydropower, fish and wildlife conservation, and recreation

Also, given the longer term nature of these operations and acknowledging the uncertainties over how fish will respond to these operations, the Action Agencies are planning to add a fourth principle to the flex spill decision framework:

4.4 PRINCIPLE 4: EVALUATE THE EFFECTIVENESS OF THE SPILL OPERATION BY:

- Evaluate the extent to which further increases in spill lead to improved adult returns by reducing latent mortality
- Monitoring other interim metrics to evaluate progress and avoid unintended consequences
- Evaluating the impacts to power revenues and rates

For Principle 4 to be achieved, the operation will need to be accompanied by a robust study design that can provide statistically meaningful results within a reasonable management timeframe. The analysis of future scenarios and the adaptive implementation of future operations will need to consider and achieve all four principles to provide an optimized outcome that supports improved SARs for fish, affordable and reliable power, feasible implementation, and the ability to discern if the operation is having a measurable benefit.

Over time, the adaptive implementation framework will incorporate new information and aid in optimizing Columbia River System operations to meet all four principles. While power related performance targets will be initially measured as relative to the 2018 spill operation, the results of the 2020 operations will help future operations. Likewise, because it will be an adaptively implemented operation that, to-date, has only been modeled to predict outcomes, the biological metrics evaluated in 2020 will also likely provide a basis for defining biological performance targets during future spill operations.

Power, fish, and operation metrics will be evaluated to ensure that spill operations are meeting the four principles and that operations are not resulting in negative impacts. The last decade of monitoring the effects of operations under the current configuration of the projects (since approximately 2010) will provide a reference point for evaluation. Power performance metrics will focus on revenue targets and reliability.

Biological performance metrics will be managed for annual targets (e.g., survival, travel time and gas bubble trauma (GBT)) of migrating salmonids through the Columbia River System, and modeled powerhouse encounter rates (PITPH[3]). Where information specific to bull trout is available, it will be incorporated into assessments of both biological performance as well as monitoring for unintended consequences (e.g. adult passage through fish ladders). Where bull trout specific data is not available, surrogate species (i.e. steelhead or Chinook salmon) may be considered if appropriate.

While many factors that influence adult returns are generally outside of the direct influence of the federal agencies, this operation is explicitly designed to test and monitor the magnitude of the effect of passage through the CRS by using long-term performance targets (e.g., smolt-to-

[3] The calculated probability, based on Passive Integrated Transponder (PIT) tag detections, that a juvenile fish will pass through up to 8 powerhouse routes or associated bypass systems on its outmigration, given operations and water flows.

adult return (SARs) ratios measured by the return of adult salmon in the years to follow the initiation of this operation). Many different factors may contribute to uncertainty during implementation, including annual flow levels that will define how much water can be spilled; the natural variability of TDG; and ocean conditions experienced after juvenile fish have left the CRS. Additional biological monitoring of salmonids, non-salmonid fish, and water quality will be conducted to identify and resolve unintended consequences.

An operational feasibility assessment will be developed, monitored, and managed by the Corps and is anticipated to include dam safety/erosion and navigation. These indicators will be informed by past spill operations including the 2018 injunction spill and the first year of flexible spill operations in 2019.

4.5 POWER SYSTEM PERFORMANCE TARGETS

- Bonneville revenue target (neutral or positive compared to 2018 baseline)
  - Annual power sales
  - Rate impacts (Tier 1 System Firm Critical output)
  - Annual Fish and Wildlife Program budgets
- Power and Transmission reliability
  - Regional Loss of Load Probability

4.6 DRAFT BIOLOGICAL PERFORMANCE TARGETS TO BE REFINED DURING STUDY DESIGN DEVELOPMENT

- Salmonid Targets
  - In-river survival
    - (placeholder for actual metrics - TBD)
      - Snake River spring Chinook (2009-2018 averages)
        - Lower Granite **-** Bonneville: 53%
        - Lower Granite-McNary: 76%
        - McNary-Bonneville: 70%
      - Snake River Steelhead (2009-2018 averages)
        - Lower Granite – Bonneville: 57%
        - Lower Granite - McNary: 73%
        - McNary - Bonneville: 78%
  - Travel time
    - Juvenile downstream travel time (placeholder for actual metric - TBD)
    - Adult upstream migration time (placeholder for actual metric - TBD)

- Powerhouse Encounter Rates (PITPH)
    - Snake River Yearling Chinook: Avg. of 1.4
        - (should not exceed 2.0 on any year of the flexible spill operation)
    - Snake River Steelhead: Avg. of 1.3
        - (should not exceed 2.0 on any year of the flexible spill operation)
- Smolt to Adult Return Ratios (SARs)
    - (placeholder for actual metric - TBD)
    - Adult conversion rates

- **Non-salmonids** (monitor and evaluate for unintended consequences)
- **Water Quality** (monitor and evaluate)

4.7 OPERATIONAL PERFORMANCE TARGETS (TBD)

- Dam safety/erosion
- Navigation

If, as actual experience implementing the base operation develops each year, and if changes to the base operation were found to be required to meet any of the objectives and performance targets listed above, potential options for modification could include: changes to spill levels at individual dams; changes in dates to either start, stop, or reduce spill; daily duration of spill cap operations; or other reservoir related changes. The process to determine the necessity that would drive these types of alterations and the efficacy of those changes would be the focus of the adaptive implementation framework stepwise process detailed in this appendix.

CHAPTER 5 - DECISION MAKING, ACTION AGENCY AUTHORITY, AND THE REGIONAL FORUM

The RIOG was established following the 2008 Biological Opinion to provide a high-level policy forum for discussion and coordination of CRS management. The overall purpose of the group remains to inform the federal, state and tribal agencies that are actively engaged in salmon recovery efforts regarding implementation issues from each sovereign's perspective. The Technical Management Team (TMT) is the interagency technical group responsible for making recommendations on dam and reservoir operations for implementation of the CRS BiOps. It is anticipated that both the RIOG and TMT will continue under the current CRS BiOps.

The RIOG is a forum for interagency coordination and does not supplant existing federal, state or tribal decision making authorities. All decisions under the authority of the federal government continue to be made by the appropriate federal agency with the statutory authority to make such decisions. As it applies to the flexible spill operations contemplated in this framework, the federal Action Agencies retain final decision making authority related to operations of the dams while taking into account the perspectives of members of the FSWG.

Technical teams, such as TMT, make a reasonable effort to resolve proposals within the team, and allow issues to be fully developed. When policy guidance is needed or if there is a dispute at technical teams, the issues are brought to the RIOG through the RIOG Chair. If a team is unable to reach resolution, the members will frame the issue using the RIOG Policy Issues template.

In the context of flex spill, in 2020 the Parties to the Agreement agreed to implement a modified understanding, consistent with the terms of the Agreement and as noted through this adaptive implementation framework, existing Regional Forums (e.g. TMT) will evaluate the need for in-season operational changes. However, if any party that is a signatory to the Agreement objects to an in-season adaptive management operational change coordinated at the adaptive management forums that impacts implementation of the Agreement and that objection requires elevation, elevation of that objection will first be brought to the FSWG by the party objecting for an opportunity to resolve the objection before elevation to RIOG.

The FSWG shall, at a minimum, include a representative from each signatory to the Agreement. If carried forward for implementation beyond the terms of the Agreement, other regional sovereigns would also be invited to participate in efforts to resolve an objection. If the FSWG cannot resolve the issue without objection, the issue shall be elevated to RIOG for resolution. Given that this framework will be applied after the expiration of the Agreement, the FSWG would be open to any interested CRS sovereign that requests to be included.

CHAPTER 6 - ADAPTIVE IMPLEMENTATION FRAMEWORK

This framework is based on existing adaptive management models that have been used by other federal agencies. The specifics of this particular framework have been adapted to the existing Regional Forum processes that have been utilized in the CRS over the past decade but also include some revisions in order to acknowledge the effectiveness of recent collaborative processes that led to the Flex Spill Agreement. Through this framework, the Action Agencies are committing to a transparent and scientifically robust adaptive management process that incorporates knowledge to date, as well as new information as it becomes available.

The FSWG role in implementation of the flexible spill operation component of the selected alternative is outlined for each step of the process below. Opportunities for input are confined by the sideboards of the selected alternative, as outlined in Record of Decision (ROD), and consistent with the Endangered Species Act consultations associated with the CRSO EIS. Further, the Action Agencies retain the authority to make final decisions related to actual project operations planned and completed consistent with the FEIS/ROD. However, if at any time a FSWG member has a specific question or concern related to any aspect of flex spill implementation, the appropriate Action Agency will respond to that input to the extent practicable and will provide feedback on how the member's concerns were addressed.

The adaptive implementation steps will cover pre-season operations planning; post-implementation review; annual monitoring, evaluation, and new science integration; and annual management review with the Action Agency policy team.

Flexible spill operations that will occur after the FEIS/ROD will take several years to pass through all the phases of implementation. Therefore, at any given time there will be several brood year cohorts of salmon and steelhead that have passed through different steps of implementation and monitoring. Evaluating the effects of flex spill on these fish will require both annual and longer term evaluations as described in the steps below.

Initially consult the FEIS/ROD for direction on operational priorities and formally develop a study design to determine the effectiveness of the selected spill operation.

(Prior to year 1 Implementation)

The alternative selected for implementation in the FEIS/ROD reflects comprehensive public participation and collaborative efforts conducted between 2016 and 2020. The public had opportunities to influence all elements of these documents.

In coordination with sovereign parties with interests in CRS spill operations, the FSWG will design a long-term study plan to assess the impacts of high spill on latent mortality on Columbia and Snake River salmon and steelhead. The study will need to address the following criteria:

- Statistically meaningful results
- Within a reasonable timeframe
- While providing safe fish passage

This initial step would not be an annual exercise, but a one-time effort that would be managed under the provisions in this appendix. Products of this process are envisioned to include clearly defined targets with stakeholder buy-in. Clearly defined expectations for the duration of the study/monitoring program, off-ramps if unintended affects are observed that preclude continuation of initial operation, and alternate operations should the initial effort become untenable.

FSWG Opportunities:

- Become knowledgeable with the implementation parameters of the FEIS/ROD to develop an understanding of these limits and requirements and enhance ability to more meaningfully participate in implementation and adaptive management;
- Participate in the development of spill operation monitoring strategy and ISAB review;
- Operational implementation needs outside of the FEIS/ROD would need to be addressed under separate planning efforts.

Step 1) Complete annual erosion/dam safety surveys of mainstem fish passage projects. (Annually – typically late summer to late fall)

Step 2) Conduct a pre-season study design and monitoring workshop with FSWG, implementation, and science teams. (Annually – typically January or February)

Step 3) Assess any proposed study design changes within the CRS mainstem fish passage project area. (Annually – post off season workshop sponsored by Action Agencies)

Step 4) Action Agencies prepare Fish Operations Plan (FOP) and implementation instructions, including applicable study design features, project specific guidance, and monitoring requirements. (Annually – Action Agencies complete by early to mid-March)

Step 5) Provide opportunity to comment on updated operational plans and schedule to regional sovereign parties through RIOG. (Annually – Complete by mid to late-March)

Step 6) Action Agencies implement the spill operation including administration and dispute resolution through the Regional Forum processes. (Annually – April through August)

Step 7) Complete annual monitoring as specified in the scientifically developed study plans. (Annually – April through August concurrent with spill operation)

Step 8) Conduct formal post-season review. (Annually-- after monitoring results are available)

Step 9) Complete management review by the Action Agency leadership team (Executives and/or Deputies). (Annually)

Step 10) Publish annual report of implementation activities, stakeholder participation, and management review findings. (Annually)

Comprehensive Review – conducted every 3-5 years to review long term efficacy and assess accuracy of initial assumptions.

CHAPTER 7 - SUMMARY

This adaptive management and monitoring framework is intended to set up the initial steps in the development of a strategy to develop, implement, and monitor spill operations through coordination with sovereign parties with the goal of assessing the magnitude of latent mortality associated with juvenile salmonid passage through the CRS projects on the lower Snake and lower Columbia Rivers. The intent is, without ceding the decision making authorities of each Action Agency, to develop a transparent, collaborative process where regional experts will work with the Action Agencies to develop and monitor an operation that yields scientifically robust information to inform the efficacy of the CRSO EIS preferred alternative and proposed action from the consultations associated with the EIS. By following this adaptive implementation and monitoring framework, the Action Agencies will be able to collaborate with the regional experts, while maintaining the ability to adapt to new information and respond to unanticipated outcomes or challenges that may arise as a result of testing the magnitude of latent mortality.

CHAPTER 8 - REFERENCES

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Appendix R, Mitigation, Monitoring and Adaptive Management
Part 3, Mitigation Process

CHAPTER 1 - INTRODUCTION

Mitigation was only developed for adverse impacts; if an action resulted in negligible effects or the effect was beneficial, then no additional mitigation was proposed. For resources with minor effects, the co-lead agencies generally practice avoidance where practical through operations and implement BMPs, but did not propose taking additional mitigation actions. For purposes of meeting compliance with different federal laws, regulations, and EOs, the co-lead agencies have proposed mitigation measures, where appropriate, even if effects are minor, such as for wetland impacts. Conversely, if a proposed operational or structural measure would result in a moderate or major impact to any resource, then a range of mitigation measures were developed to address the impacted resource or resources. To differentiate among minor, moderate, and major effects as described in Section 3.1, the effect descriptors were used to evaluate the intensity of the impact in relation to significance (see 40 C.F.R. § 1508.27). The rationale for why an effect is considered to fall under one of the preceding intensity descriptors is included in each resource section and summarized in Chapter 3.

The full suite of proposed mitigation measures were assessed based on five criteria developed by the co-leads with cooperating agencies input, which helped to identify the likelihood that a measure would be adopted by the co-lead agencies:

Category type: in-kind and in-place mitigation measures were preferred over out-of-kind or out-of-place measures.

Effectiveness: a qualitative assessment of the mitigation measure's effectiveness in reducing the impact from the alternative.

Scale: a qualitative assessment of the spatial (i.e., site-specific or regional) and temporal scale (i.e., short-term or long-term, seasonal or annual, or temporary or permanent) of the mitigation measure relative to the severity and duration of the impact.

Feasibility: a qualitative assessment of the feasibility of implementing a measure based on technical and economic factors. For example, a mitigation measure may not be feasible if there are other technical actions that would effectively reduce the severity or duration of impact. Similarly, if the expense of implementing a measure would be unreasonable, then the measure would not be feasible.

Jurisdiction: an assessment of the co-lead agencies' jurisdiction or authority to implement the measures

CHAPTER 2 - MITIGATION SELECTION PROCESS

The co-lead agencies developed mitigation measures using actions suggested during the public scoping period and by technical teams. These preliminary mitigation measures were further refined, compared, and then vetted through a robust selection process. The process started with the co-lead agencies, using input from cooperating agencies on the technical teams, as they considered potential mitigation measures. In April 2019, the technical leads were provided with instructions to prepare for the June 2019 mitigation workshop, including guidelines for the first task. This first task was to review the list of potential mitigation measures to assess and add or delete measures with justification. The technical leads worked with their teams as appropriate based on expertise. This list of possible mitigation measures was a compilation of brainstormed input from multiple sources including scoping comments and workshops. Refer to Annex A for Mitigation Toolbox Instructions and April Mitigation Toolbox.

In May 2019, the next step in the mitigation process was to populate an Impact Summary spreadsheet. The technical leads were provided the template Impact Summary spreadsheet and instructions for how to populate it in preparation for the June 2019 mitigation workshop. Refer to Annex B for Strategy for Mitigation Workshop Preparation instructions, Fish Team - Strategy for Mitigation Workshop Preparation instructions, and Template Impact Summary spreadsheet.

Prior to the June 2019 mitigation workshop, the technical teams worked on identifying which mitigation measures from the June Mitigation Toolbox, with rationale, could be applied to offset known effects to their resource of expertise. The June Mitigation Toolbox includes the potential mitigation measures resulting from the refinement of the completed April Mitigation Toolbox task. The refinement was a step by step process of filtering for duplications, technical feasibility, definition of mitigation as defined in §1508.20, and completed mitigation measures. Refer to Annex C for June Mitigation Toolbox.

In June 2019, the technical leads attended the mitigation workshop in Portland, OR. The purpose of the workshop was to review the effects to resources from each of the 4 multiple objective alternatives (MO1-4) and assign appropriate mitigation measures to address those effects. The outcomes of this effort were the completed Impact Summary spreadsheets (refer to Annex D).

The potential mitigation measure identified in the Impact Summary spreadsheets were further screened using the decision framework (described above) to identify if mitigation was warranted based on the adverse effects of implementing a measure in the MOs, and an evaluation of the severity of the impact on a resource. The areas of analysis were divided into four regions (regions A, B, C, D), which correspond to the regions identified in Chapter 3, to assess regional and localized impacts. During the last round of the selection process, those screened mitigation measures were matched to adverse effects based on their ability to reduce specific effects, based upon a refined, and more comprehensive effects analysis. At this stage, the mitigation measures were further developed, refined, and screened, which resulted in the proposed mitigation as shown in Section 5.3. Annex E presents the proposed mitigation measures for each MO from the outcome of the mitigation workshop and further screened as more information and analysis become available.

Draft Columbia River System Operations Environmental Impact Statement

Appendix R, Mitigation, Monitoring and Adaptive Management Part 3, Mitigation Process

Annex A
Mitigation Toolbox Instruction April 2019
April Mitigation Toolbox

CHAPTER 1 - MITIGATION TOOLBOX INSTRUCTION APRIL 2019

1.1 CRSO MITIGATION EFFORT OVERVIEW

Background: In preparation for consideration of potential mitigation needs associated with each of the 4 action alternatives (MO1-4), a list of possible mitigation measures is being compiled and will be referred to as the "mitigation toolbox" for use during the June 2019 Mitigation Workshop. The attached list is a compilation of brainstormed input from multiple sources including scoping comments and workshops. Final selection of the mitigation measures within the Draft EIS will be determined by the co-lead agencies.

Tech Team Task 1: Review the attached list of potential mitigation measures with appropriate team members to assess and add or delete measures with justification. The Tech Lead will provide a single, compiled mitigation toolbox spreadsheet to Hannah Hadley by COB April 22nd.

Tech Team Task 2: Identify which measures, with rationale, could be applied to offset known impacts to their resource of expertise. This prep work is intended to increase the efficiency of group discussion during the Mitigation Workshop.

Mitigation Workshop Product: The purpose of this workshop is to evaluate the impacts to resources from each of the 4 action alternatives (MO1-4) and assign appropriate mitigation measures to offset those impacts. Workshop attendance will be limited to Technical Leads.

1.2 TECH TEAM TASK 1 INSTRUCTIONS

Toolbox Input Duration: April 8 – 22, 2019

Tech Lead Role: Disseminate the draft mitigation toolbox to technical team members of your choice, which may be the entire team or subset inclusive of Cooperating Agency team members, as appropriate based upon expertise. The Tech Lead will provide a single, compiled mitigation toolbox spreadsheet to Hannah Hadley by COB April 22nd. Hannah will disseminate all Tech Teams' spreadsheets to the NEPA Team for compilation and further refinement with Policy and ESA Teams prior to Task 2.

Task 1 Instructions: Review the draft list of potential mitigation measures. For measures the technical team advises to be removed from consideration, use strikeout in the measure cell and provide rationale for removal (e.g. previously studied and determined not feasible/effective, etc). For new measures to be added, please briefly note which anticipated resource impact the measure is intended to offset. Purpose of brief note on impact to be offset is to both aid next-step refinement of the mitigation toolbox and to aid Task 2. Tech Leads: please guide your teams to focus on developing the list of potential measures and not yet on assigning the proposed mitigation measures to impact types/locations, which is Task 2.

1.3 TECH TEAM TASK 2 INSTRUCTIONS

Pre-Mitigation Workshop Brainstorm Duration: May 22 – June 21, 2019

Tech Lead Role: Disseminate the final mitigation toolbox to technical team members of your choice, which may be the entire team or subset inclusive of Cooperating Agency team members, as appropriate based upon expertise. The Tech Lead will bring compiled team notes to the Mitigation Workshop.

Task 2 Instructions: Determine which measures from the final mitigation toolbox are recommended in specified locations to offset impacts to your respective resource of expertise (e.g. anadromous fish, water supply, etc). Indicate what the anticipated impacts are and provide details of the mitigation measure such as location, duration, and structural or operational implementation details. Goal is for each technical team to provide the information Tech Leads will need to bring to the Mitigation Workshop.

These Task 2 Instructions are preliminary to guide planning of next steps. Refined instructions will be provided with the final mitigation measure toolbox.

1.4 APRIL MITIGATION TOOLBOX

1.4.1 Water Quality

Draft Mitigation Measure: **if delete, please use strike through**	**Reason to add or delete?**	**Citations**	**Notes**
Implement a more flexible water management strategy during low flow years to preserve water in storage projects for release during summer to cool downstream water temperatures	–	–	–
Operate run-of-river projects that stratify (e.g., LSR projects) to pass cooler water from deeper in the forebay to cool downstream temperatures during warm/low flow conditions.	–	–	–
Minimize reservoir drawdown throughout the basin	–	–	–
Decreasing/stopping spill (stop voluntary spill)	–	–	–
Implement TDG reduction measures at GCD (flip lip, other)	–	–	–
Additional flow deflectors for TDG	–	–	–
Improve (lower) water temperatures (in summer) through additional selective withdrawal at storage projects that stratify	–	–	–
Change seasonal/monthly turbine operations/priorities to change temperature mixing for cooling	–	–	–
Install Submerged outlets below spillbay flow deflectors to reduce TDG	–	–	–
Reconfigure stilling basins (project specific) to higher elevation/less depth for plunging flows to limit TDG	–	–	–

1.4.2 Fish

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Alter spill (change timing, duration, frequency)	–	–	–
–	Spill outside fish passage season	–	–	–
–	Optimize dam flows for White Sturgeon spawning and early life stage survival	–	–	–
–	Reduce load following limited to +/- 5% on the big 10	–	–	Operations for peaking at Lower Snake and Lower Columbia plus CHJ and GCL.
–	Ops for temp	–	–	–
–	Change turbine operations to change temperature	–	–	–
–	Change FRM to make more water available to fish (relax rule curves ; go towards normative hydrograph)	–	–	–
–	Dry year strategy where we have additional reservoir draft in dry years and load management strategies in dry years	–	–	–
–	Modify flow by reducing irrigation to increase flow (reallocation)	–	–	–
–	Mimic natural hydrograph (ops) (including in the estuary)	–	–	–
–	Fish ladders/passage (add or improve)	–	–	Bull trout at Albeni Falls. No Action. Implemented through another program
–	Maintain less than 1 degree celsius differential (fish ladders)	–	–	–
–	cooling water pumped through fish ladder as an attractent	–	–	–
–	Intake fish screens	–	–	–
–	Spill Increase to maximize SPE (shouldn't change hydrograph) to improve juvenile fish passage	–	–	–
–	Stop all Spillway spill to improve adult fish passage	–	–	year-round
–	Selective spillway bay use (which gates lift)	–	–	–
–	re-design spillway to mimic normal step-pool/waterfall elevations. Look at stepped spillway (MSH SRS?)	–	–	–
–	Reintroduction - passage at dams	–	–	Duplicate of Fish ladders/passage (add or improve)

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Environmental flow (intentional overbank)	–	–	Both in fish and wetlands
–	Albeni Falls stop Flexible Winter Power Ops for resident fish	–	–	–
–	Albeni Falls expand FWPO for chum	–	–	–
–	Outlet exclusion	–	–	–
–	Selective outlet withdrawal for D/s temp	–	–	–
–	Max transport no spill	–	–	–
–	Balance optimize transport for all salmon/steelhead	–	–	–
–	No transport of juvenile fish	–	–	–
–	Re-design bypass to allow for microtopography and macroinvertebrate populations. Look at more of an oxbow type design.	–	–	–
–	Cease using juvenile bypass facilities	–	–	–
–	Re-design nav locks to allow for microtopography and macroinvertebrate populations, riffles and pools or to allow them to remain open during low boat traffic times (i.e. remove the navigational lock sill). #3 = breach?	–	–	–
–	Allow for periodic flow through locks to maximize flow rates	–	–	–
–	Additional flow deflectors for TDG	–	–	–
–	Close spillway weir(s) and other high-TDG routes (corner collector at BON, sluiceway at BON, TDA).	–	–	–
–	Managing for stable reservoir elevation (promote wetlands and grow riparian vegetation on shorelines)	–	–	Both in fish and wetlands
–	maximize storage of cold water at DWA, LIB and CJO	–	–	–
–	minimize pool level variability	–	–	–
–	Decrease the draft rates	–	–	–
–	Partial breach combined with Bypass channel to mimic natural river (including resting pools)	–	–	–
–	Reduce the amount of water level fluctuations in dam tailraces due to load following (for sturgeon this would be directed to early life stage development time)	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Implement "slow-roll" procedures for all turbine start-ups to reduce fish mortality	–	–	–
–	Increase spillways	–	–	–
–	Pull one turbine from each dam (effectively, increase spill)	–	–	–
–	At columbia falls, increase minimum flow in high water years to 5000 cfs and adjust linearly down to 3,200 cfs in the driest water years to benefit bull trout and other native fish species	–	–	–
–	[At hungry Horse] maintain lowered winter flows in years following high spring runoff to aid in the establishment of riparian vegetation with positive benefits to both aquatic and terrestrial communities.	–	–	Needs more development. Impact analysis for Bull Trout FMO?
–	Add biomimicry heat exchangers to tops of fish ladders	–	–	–
–	Use "Woosh!" - this is a technology, doesn't specify in what situation	–	–	Assume for reintroduction Coulee & DWA
–	Add bubble curtains to dams to aid fish entering ladders and exclude predators - excluding predators = predation management theme below	–	–	–
–	Increase liklihood of refill at storage projects that provide downstream water temperature mangement	–	–	–
–	Increase shoreline vegetation for habitat and shading	–	–	Managing reservoir elevation (promote wetlands and grow riparian vegetation on shorelines)
–	Increase use of spillway Weirs at projects	–	–	this is a technical analysis, but more spillway weirs would increase eddies and reduce spill volume through higher TDG production
–	Relax storage reservation diagram at 6 FRM projects	–	–	–
–	Deeper (existing) storage reservation diagrams to reduce FRM	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Investigate development of guide\ curves to avoid situations where heavy spill has to occur in the spring to meet FRM requirements. Concept would be to have a guide curve that is forecast based (to only be used in high water supply situations) to allow for earlier draft than the current SRDs.	–	–	–
–	Increase discharge capability at Libby Dam for sturgeon flow with addition of 6th turbine	–	–	–
–	Implement TDG reduction measures at GCD (flip lip, other)	–	–	Already studied
–	Reduce impoundments, stream restoration to reduce impacts to stream channels	–	–	–
–	Create riffle pool complex within the reservoirs.	–	–	–
–	Increase hatchery production for steelhead	–	–	–
–	Add/increase spawning gravel	–	–	–
–	Add pheromones/"scents" to suitable spawning tributaries	–	–	–
–	Eliminate mainstem harvest	–	–	–
–	Allow only terminal harvest	–	–	–
–	Eliminate gill nets and allow harvest at fish ladders via trap	–	–	–
–	Reduce harvest of Listed Fish	–	–	–
–	Stop Harvest of listed fish	–	–	–
–	Develop additional shallow water rearing habitat (e.g., for fall chinook in the lower snake river)	–	–	–
–	Build an alternate channel around the dams	–	–	–
Adult Salmon and Steelhead	–	–	–	–
–	Spill proportional to juvenile numbers. Minimizes TDG and spill effects on adult passage	–	–	–
–	Stop spill in August; Minimizes TDG and spill effects on adult passage	–	–	–
–	Change seasonal/monthly turbine operations/priorities to change temperature mixing for cooling	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Modify existing adult trap configurations and use to reduce handling stress	–	–	–
–	Reduce passage of non-native species through selective modification of ladders (e.g., American shad)	–	–	–
–	Alter Transport to decrease straying of adult migrants	–	–	–
–	Maintain estuary water levels that promote fish passage - unclear; passage into rearing tributaries below BON?	–	–	–
–	Modify DWA spillway to reduce TDG levels during spill	–	–	–
–	Restore passage to North Fork Clear Water River (aka passage at Dworshak)	–	–	–
–	Truncate DWA Drawdown	–	–	–
–	Improve adult ladder passage through modification of adult trap and adult trap bypass loop (potential for structural and operational changes)	–	–	–
Juvenile Salmon and Steelhead	–	–	–	–
–	Reduce fish handling at Little Goose JFF	–	–	–
–	Reduce flow augmentation (CSS)	–	–	–
–	Build Juvenile Bypass Structure Upgrade Phase 2 to improve fish handling for Smolt Monitoring Program and transportation program	–	–	–
–	Develop additional shallow water habitat throughout the length of the reservoir; reduce available holding habitat for fish predators in conjunction (e.g., convert rip rap areas to shallow water habitat)	–	–	–
–	Reduce fish handling at Lower Monumental JFF	–	–	–
–	Develop additional shallow water rearing habitat at McNary Pool	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Progressive Spill: to better mimic the natural hydrograph: percent spill increases as inflow increases (ie Snake River- 20% spill up to 40 kcfs inflow rising to 50% spill at 100 kcfs inflow…)	–	–	–
–	Install Submerged outlets below spillbay flow deflectors to reduce TDG	–	–	–
–	Reconfigure stilling basins (project specific) to higher elevation/less depth for plunging flows to limit TDG	–	–	–
–	Install deterents to fish entrance of draft tubes when not in operation	–	–	–
–	Pull Screens where turbine survival is high	–	–	–
–	Reduce fish handling at bypass locations	–	–	–
–	Improve (survival, reliability, operational ease, etc) JBS facilities at locations where JBS's will likely continue to be operated (for SMP, due to low turbine survival, transport program objectives, etc)	–	–	–
–	Alter Transport to focus on when there is demonstrable benefit to smolt survival	–	–	Mitigation
–	Establish an annual four-month "normal pool" period on Lake Pend Oreille (Memorial Day to October 1) and a higher winter lake level	–	–	–
–	Restore mainstem habitat through increased habitat complexity (rapid, riffle, run, pool), shallow water rearing habitat connectivity, temperature reduction, riparian function restoration, restore ecosystem processes	–	–	–
–	Reconnect mainstem and offchannel habitats	–	–	–
–	Maintain water levels that promote fish passage and access to habitat	–	–	–
–	Develop adult trap and haul facility at Ice Harbor to improve research/monitoring & truck/haul capabilities (e.g., for emergency sockeye truck & haul in hot water years)	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Resident Fish (Bull Trout, Sturgeon, Kokanee)	–	–	–	–
–	Increase Access to fish habitat and the tributaries	–	–	–
–	Minimize reservoir fluctuations	–	–	–
–	Manage reservoir levels to protect spawning areas	–	–	–
–	Improve natural and “normative” flows to improve salmon life stages	–	–	–
–	Install deterents to reduce fish entering draft tubes when not in operation	–	–	–
–	Activate fish lifts to move Sturgeon - where feasible (BON)	–	–	–
–	Catch and transport adult sturgeon (BON)	–	–	–
–	Increase Selective Withdrawal Gate temperature management flexibility (enable capability to provide a normative river thermograph)	–	–	–
–	Limit use of spillway to avoid bull trout entrainment at Libby	–	–	–
–	Minimize drawdown of storage reservoirs for resident fish lifestage production	–	–	–
–	Mitigate for White Sturgeon population losses due to dam impacts	–	–	–
–	Use White Sturgeon conservation aquaculture to mitigate for population losses due to the hydrosystem	–	–	–
–	Use screening technology to preclude White Sturgeon from entering draft tubes	–	–	–
–	Decrease White Sturgeon habitat fragmentation through dam passage improvements and/or dam removal	–	–	–
–	Improve White Sturgeon populations in the impounded river sections by improving flow conditions	–	–	–
–	Provision of volitional passage for White Sturgeon if reasonable and feasible means are developed	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Reduce the amount of water level fluctuations in dam tailraces due to load following (for sturgeon this would be directed to early life stage development time)	–	–	–
Piscivore Control	–	–	–	–
–	Draw Down John Day	–	–	–
–	continue to use spray deterrents and antideterrant measures	–	–	–
–	Minimize predation	–	–	–
–	expand wire arrays	–	–	–
–	Minimize predation on adult White Sturgeon by pinnipeds	–	–	–
–	Minimize predation of early life stages of White Sturgeon	–	–	–
–	Maintain high water flows with minimal river islands/decrease island habitat (island use by pinnipeds)	–	–	–
–	Increase harvest of invasive fish	–	–	–
–	Install deterents to minize predatory fish holding near intakes (e.g., around trash racks) and exits	–	–	–
–	Reduce predatory fish habitat through reduction of off chanel habitat, non-natural structures (e.g., removal/modification of large riprap structurs, pile dikes, in-water structures, etc), flow/velocities changes (reduce spawning, recruitment, etc)	–	–	–
–	Install wire array to dissuade piscivorous waterbirds at McNary	–	–	–
–	Remove non-native species and piscine predators passing through/residing in Juvenile Bypass Structure - predation management	–	–	–
–	Manage water levels/flows to reduce spawning habitat and recruitment success of non-native fish species at locations such as Yakima & Walla Walla River delta's	–	–	–
–	Manage avian nesting habitat to reduce predation losses to avian predators - predation management	–	–	–

types of species	Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
–	Conduct predatory fish removal throughout each of the reservoirs with emphasis on hotspots - predation management	–	–	–
–	Reduce predatory fish through reductions in spawning, rearing, foraging abilities - predation management	–	–	–
–	A bounty system for small mouth bass and walleyed pike would be effective (similar to Northern Pike Minnow program) - excluding predators	–	–	–
Lamprey	–	–	–	–
–	Reduce hydrosystem effects on distribution and escapement of adult lamprey spawning	–	–	–
–	Modify project operations to allow larval lamprey (ammocoetes) in shallow water rearing areas to safely move to deeper water as water surface elevation drops.	–	–	–
–	Modify spill operations to improve passage and survival of juvenile lamprey (through all routes) during pulses of outmigration (freshets).	–	–	–

1.4.3 Vegetation, Wetlands, and Wildlife

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Acquisition/deacquisition of Corps managed lands to ameliorate changes in wildlife habitat and recreational useage (coordinate HMUs with USFWS)	–	–	–
Environmental flow (intentional overbank)	–	–	in both fish and wetlands
Managing for stable reservoir elevation (promote wetlands and grow riparian vegetation on shorelines)	–	–	in both fish and wetlands

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Increase shoreline vegetation for habitat and shading	–	–	in both fish and wetlands
Prevention measures must be identified, assessed and implemented to stop the invasion and spread of zebra and quagga mussels, and invasive aquatic plants such as Eurasian mi/foil, hydrilla, and flowering rush. These measures should include, but are not limited to, education and public outreach efforts to promote awareness of the potential impacts and costs of a successful invasion, and the potential solution provided by required inspection, detection, and decontamination of boats previously moored in infested waters and then transported on our roadways in the region	–	–	–

1.4.4 Power and Transmission

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Decreasing/stopping spill (stop voluntary spill)	–	–	–
add RSWs or TSWs to reduce need for other spill	–	–	Evaluation: water temperature considerations
Increase capacity	–	–	redundant to adding turbines, improving turbine efficiency, raise head at projects (all already on list here)
More flexibility on seasonal, daily hourly flow	–	–	–
reduce restrictions on seasonal pool elevations	–	–	LSN-MOP, JDA-MIP
expand range of operating pools, esp at LCOL and LSN	–	–	Maybe at JDA? Probably not anywhere else. do not surcharge due to dam safety

Draft Mitigation Measure: if delete, please use strike through	**Reason to add or delete?**	**Citations**	**Notes**
fewer restrictions on ramping rates	–	–	Beneficial to generation if allowed to ramp down much faster than rates. Some restrictions for bank sloughing need to stay - earthen embankment projects (don't ramp @ rate to slough)
Store more in spring, optimize hydrograph to the annual energy cycle (store more in the spring)	–	–	subject to FRM
Rehabilitate turbines	–	–	Economically feasible units are already going to be rehabed. Waiting for $/limited in # at a time (year)
Index test all units to optimize current turbine operations	–	–	–
Use all turbine bays (ie. add turbines)	–	–	Economically feasible units are already going to be rehabed. Waiting for $/limited in # at a time (year)
Additional turbines at Dworshak, Libby, for resident fish, TDG abatement/management	–	–	Economically feasible units are already going to be rehabed. Waiting for $/limited in # at a time (year)
spill could be better managed to take advantage of power production during periods of time when insufficient numbers of smolts are migrating – both at the beginning and tail end of the runs; spill program is based on fish abundance rather than hard dates	–	–	–
Integrate renewable energy on breached structures	–	–	–

Draft Mitigation Measure: **if delete, please use strike through**	**Reason to add or delete?**	**Citations**	**Notes**
Reliability (keep loss-of-load within Council's standards) - could include keeping relability despite other actions that might reduce reliability such as removing dams or constraining operations -- could include keeping relability despite climate change	–	–	–
Develop alternative energy sources (non-hydropower)	–	–	–
Install low head high efficiency turbines in earthen fill sections of existing dams (or hydro-combine)	–	–	–
Increase probability of refill	–	–	–

1.4.5 Air Quality and Greenhouse Gases

Draft Mitigation Measure: **if delete, please use strike through**	**Reason to add or delete?**	**Citations**	**Notes**
The EPA supports incorporating mitigation strategies to minimize fugitive dust and toxic emissions, as well as emission controls for particulate matter (PM) and ozone precursors for construction-related activity. We recommend that best management practices, all applicable requirements under local or State rules, and the following additional measures be incorporated into the EIS, a Construction Emissions Mitigation Plan, and ultimately the Record of Decision. See EPA's Clean Construction USA website for additional information [http://www.epa.gov/cleandlesel/sector-programs/construct-overvlew.htm].	–	–	–

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Identify all commitments to reduce construction emissions and incorporate these reductions into the air quality analysis to reflect additional air quality improvements that would result from adopting specific air quality measures. Prepare an inventory of all equipment prior to construction, and identify the suitability of add-on emission controls for each piece of equipment before groundbreaking. (Suitability of control devices is based on: whether there is reduced normal availability of the construction equipment due to increased downtime and/or power output, whether there may be significant damage caused to the construction equipment engine, or whether there may be a significant risk to nearby workers or the public.) ? Meet EPA diesel fuel requirement for off-road and on-highway (i.e., 15 ppm), and where appropriate use alternative fuels such as natural gas and electric. ? Develop construction traffic and parking management plan that minimizes traffic interference and maintains traffic flow. ? Identify sensitive receptors in the project area, such as children, elderly, and infirm, and specify the means by which you will minimize impacts to these populations. For example, locate construction equipment and staging zones away from sensitive receptors and fresh air intakes to buildings and air conditioners.	–	–	–

1.4.6 Flood Risk Management

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Relax storage reservation diagram at 6 FRM projects	–	–	–
Optimize FRM – best FR projection for impact on storage reservoir	–	–	–
Guide curve for Hungry Horse to relax draft rate in high water conditions	–	–	–
Allow floodplain expansion	–	–	–
Modify levees	–	–	–
Remove levees*	–	–	–
Minimize trapped storage by drafting storage projects earlier so we have option to use the space for spring capture. Include creating a decision-point for modifying the draft rate (potential example is 1 or 2 standard deviations above/below the forecast)	–	–	–

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
In dry water year, operate to local flood control requirements only rather than system requirements (Note: include refill timing and Initial Controlled Flow (ICF))	–	–	–
Develop a definition of “system flood” that is based on the volume forecast (Note: a refill trigger already exists)	–	–	–
In a dry water year, establish a decision-making process for allowance of transitioning refill timing from system ICF approach versus local approach	–	–	–
Initiate refill based on flood risk decisions/assumptions on local hydrology versus system criteria	–	–	–
Blending local and system operations	–	–	–
In dry water year, establish a decision making process for reducing system flood control space requirement during spring draft (Note: local versus system trigger)	–	–	–
during transitions (draft/refill), situationally identify opportunities for movement of flood control space within the system	–	–	–
develop rules to limit flood control space shift between projects in high water years	–	–	–
use banded operation of specific target elevation and allowance for a range of +/- 2 ft of SRD target elevation	–	–	–
change channel capacity by intentional scouring flows by changing discharge during refill	–	–	–
minimize April drafting of Libby for purpose of reducing backwater effect at Bonners Ferry control point	–	–	–
Allow floodplain expansion	–	–	–

1.4.7 Navigation and Transportation

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Change spill patterns to facilitate nav	–	–	–
Limit dredging	–	–	–
Dredging	–	–	–

1.4.8 Recreation

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
No extreme high/low flows for rafting	–	–	–
More parks and boat ramps (Mitigation or w/ scope?)	–	–	–
Establish an annual four-month "normal pool" period on Lake Pend Oreille (Memorial Day to October 1)	–	–	–
Conserve/improve reservoir sport fisheries	–	–	–
Establish a higher winter lake level (i.e. Lake Pend Oreille)	–	–	–

1.4.9 Water Supply

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Increase storage	–	–	for irrigation
Keep reservoirs higher (lowers pumping costs)	–	–	–
More flow during irrigation season so states will permit more withdrawals	–	–	–
Change storage rule curves	–	–	–
Increase refill probability	–	–	–
Reduce flows for fish for irrigation (reduce fish flows to benefit irrigation)	–	–	–
Increase pump strength and capacity for irrigation	–	–	–
Augment downstream flow with release of upper basin project storage	–	–	–
Current operations require that USBR provide M&I and Odessa subarea water through draft of Banks during juvenile migration then refill be restricted to period outside of juvenile anadromous fish migration season. This caused complicated operations and coordination this is not necessary.	–	–	Does not change the colume of water delivered, bur does change the timing of pumping
Increase diversion to the CBP to serve an additional 220,000 acres of land (estimated increase in withdrawals of about 660,000 acre-feet of water)	–	–	Will be refined by USBR
Improve water delivery efficiency	–	–	–
Employ conservation measures	–	–	assuming water conservation measures?

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Extend irrigation systems that currently rely on the slackwater pools of the LSRDs to pump directly from the channel of the undammed Snake River.	–	–	–
Buy water from farmers and industry for fish	–	–	–
Improve irrigation practices	–	–	–
Aquifer recharge	–	–	–

1.4.10 Cultural Resources

Draft Mitigation Measure: if delete, please use strike through	Reason to add or delete?	Citations	Notes
Operate reservoirs so as to minimize fluctuation in elevation	–	–	–
Operate reservoirs so as to maintain full pool elevation as much as possible	–	–	–
fish passage on the Columbia Rier at Grand Coulee and Chief Joseph	–	–	–
Fish passage on the Snake River at Hells Canyon Complex	–	–	–
Replace lost roads if Lower Snake Kams are Removed	–	–	–

Draft Columbia River System Operations
Environmental Impact Statement

Appendix R, Mitigation, Monitoring and Adaptive Management
Part 3, Mitigation Process

Annex B
Strategy for Mitigation Workshop Preparation Instructions
Fish Team - Strategy for Mitigation Workshop Preparation Instructions
Template Impact Summary Spreadsheet

CHAPTER 1 - STRATEGY FOR MITIGATION WORKSHOP PREPARATION INSTRUCTIONS MAY 2019

Strategy for Mitigation Workshop Preparation

May 17, 2019

- May 17: Introduce template Impacts Summary Table with instructions.
- May 20 – June 14: Tech Leads work with their teams to populate the Impacts Summary Table.
- June 14: Impacts Summary Table fully completed. POC: Hannah Hadley

1.1 OVERVIEW OF IMPACTS SUMMARY TABLE

Use the Impacts Summary Table to summarize effects and discuss potential mitigation with your technical team. During the Mitigation Workshop (June 24-27, 2019 in Portland, OR), all Technical Leads will review the proposed mitigation for impacts to each resource by alternative.

Use the Mitigation Toolbox to select potential mitigation measures to offset impacts. If no mitigation measure exists in the Mitigation Toolbox to address the impact, propose a new measure.

Please reference the Mitigation Development Process diagram on page 2 of these instructions.

1.2 "SUMMARY OF NEGATIVE IMPACT(S) COMPARED TO NO ACTION ALTERNATIVE"

Provide a very brief summary of the impact(s). Please reference the Water Quality MO1 tab as an example to guide your team.

1.3 "CAUSE OF IMPACT (INDICATE THE MEASURE OR GROUP OF MEASURES FROM THIS ALTERNATIVE)"

Please use the abbreviated name of the alternatives' measures to identify impacting measure.

Analysis may have provided information as to which measure or group of measures resulted in the negative impact. Identification of the impacting measure will facilitate assignment of an effective mitigation measure.

1.4 "INDICATOR/METRIC USED TO DESCRIBE IMPACT"

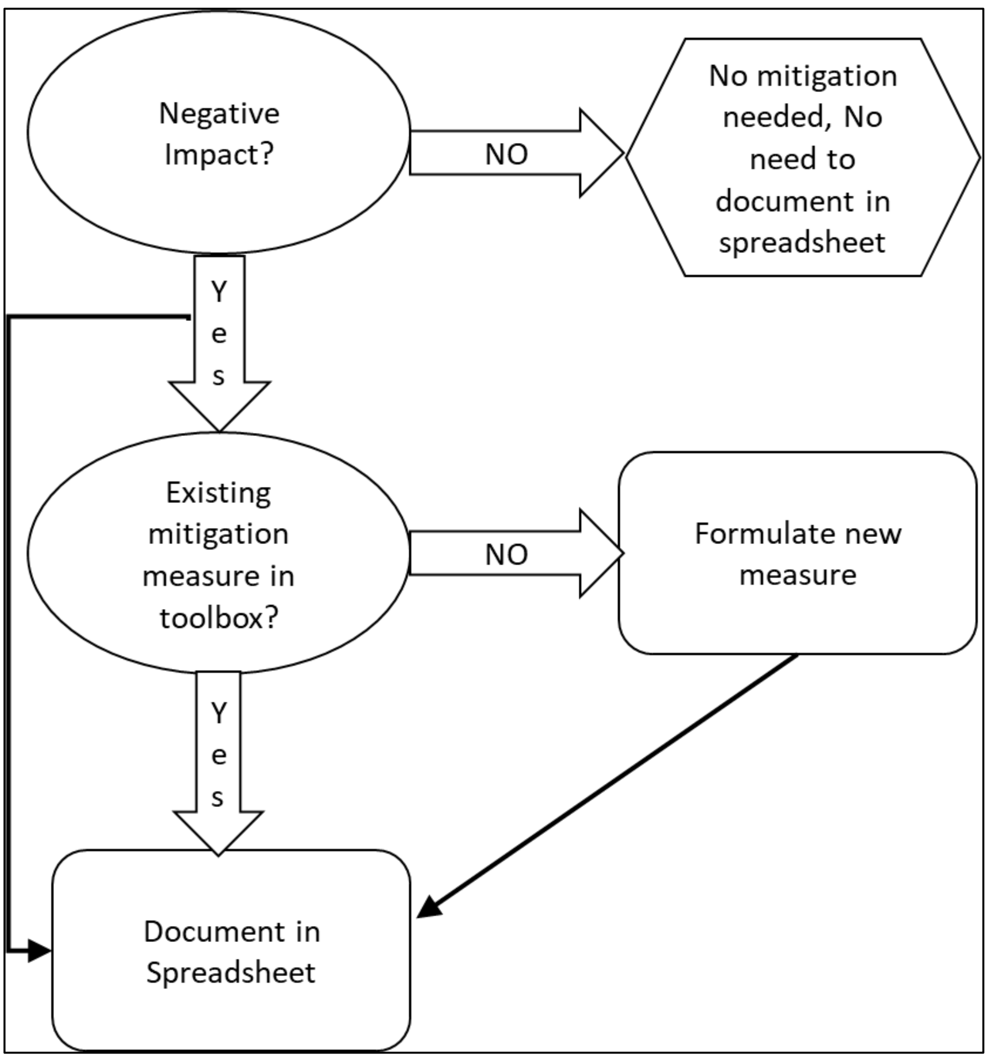
The indicator/metric provides the type of impact. For example, temperature, TDG, water surface elevation, fish travel time, etc. In some instances, the specific measure or group of measures from the alternative may not be identifiable as the source of the impact(s). Identifying the indicator/metric assists assignment of effective mitigation measures.

1.5 "PROPOSED MITIGATION MEASURE TO OFFSET IMPACT(S)"

Mitigation needs to be related to the effect (e.g. high water temperature effect mitigated by action to reduce water temperature in the area of effect). Mitigation should also be known to be effective and implementable (e.g. technically, environmentally, and economically feasible). Use the Mitigation Toolbox to select potential mitigation measures to offset impacts. If no mitigation measure exists in the Mitigation Toolbox to address the impact, propose a new measure.

If your team cannot identify a potential mitigation measure, it is appropriate to leave the cell blank.

NOTE: Task is to identify locations for and/or types of proposed mitigation. The task is NOT to develop the details of mitigation such as quantity or scale. These details would be a future exercise.



CHAPTER 2 - FISH TEAM - STRATEGY FOR MITIGATION WORKSHOP PREPARATION INSTRUCTIONS MAY 2019

FISH TEAM: Strategy for Mitigation Workshop Preparation, May 17, 2019

- May 17: Introduce template Impacts Summary Table with instructions to Technical Leads.
- May 29 (1-2pm PST): NEPA Team presents the concept of the Impacts Summary Table and assignment of mitigation to the whole Resident Fish Team.
- May 31 (10-11am PST): NEPA Team presents the concept of the Impacts Summary Table and assignment of mitigation to the whole Anadromous Fish Team.
- May 31 (12-3pm PST): Solicit input from the Clark Fork Fish Team to assign potential mitigation measures for impacts. Sue Camp and Pam Druliner will lead the discussion and Triangle will facilitate.
- June 6 (9-12pm PST): NEPA Team and Fish Tech Leads prepopulate potential mitigation measures into the Impacts Summary Table to expedite upcoming subteam effort.
- June 11 (9-12pm PST): Solicit input from the Lower Columbia Anadromous and Resident Teams plus Middle Columbia Resident Team to assign potential mitigation measures for impacts. Tina Teed will lead discussion and Triangle will facilitate.
- June 11 (1-4pm PST): Solicit input from the Lamprey Team to assign potential mitigation measures for impacts. Tina Teed will lead discussion and Triangle will facilitate.
- June 12 (1-4pm PST): Solicit input from the Upper Columbia River Anadromous and Resident Teams to assign potential mitigation measures for impacts. Tina Teed will lead discussion and Triangle will facilitate.
- June 17 (9-12pm PST): Solicit input from the Snake River Anadromous and Resident Fish Teams to assign potential mitigation measures for impacts. Hannah Hadley and Cindy Boen will lead discussion and Triangle will facilitate.
- June 17 (1-4pm PST): Solicit input from the Kootenai and Pend Oreille Resident Fish Teams to assign potential mitigation measures for impacts. Hannah Hadley and Cindy Boen will lead discussion and Triangle will facilitate.

2.1 OVERVIEW OF IMPACTS SUMMARY TABLE

The Impacts Summary Table presents the effects from analysis and will be used to identify potential mitigation from your technical team. During the Mitigation Workshop (June 24-27, 2019 in Portland, OR), all Technical Leads will review the proposed mitigation for impacts to each resource by alternative.

Use the Mitigation Toolbox to select potential mitigation measures to offset impacts. If no mitigation measure exists in the Mitigation Toolbox to address the impact, propose a new measure.

Please reference the Mitigation Development Process diagram on page 3 of these instructions. The Water Quality MO1 tab is provided as an example to guide your team.

CHAPTER 3 - INSTRUCTIONS FOR IMPACTS SUMMARY TABLE COLUMNS

3.1 "CAUSE OF IMPACT (INDICATE THE MEASURE OR GROUP OF MEASURES FROM THIS ALTERNATIVE)"

Please use the abbreviated name of the alternatives' measures to identify impacting measure.

Analysis may have provided information as to which measure or group of measures resulted in the negative impact. Identification of the impacting measure will facilitate assignment of an effective mitigation measure.

3.2 "INDICATOR/METRIC USED TO DESCRIBE IMPACT"

The indicator/metric provides the type of impact. For example, temperature, TDG, water surface elevation, fish travel time, etc. In some instances, the specific measure or group of measures from the alternative may not be identifiable as the source of the impact(s). Identifying the indicator/metric assists assignment of effective mitigation measures.

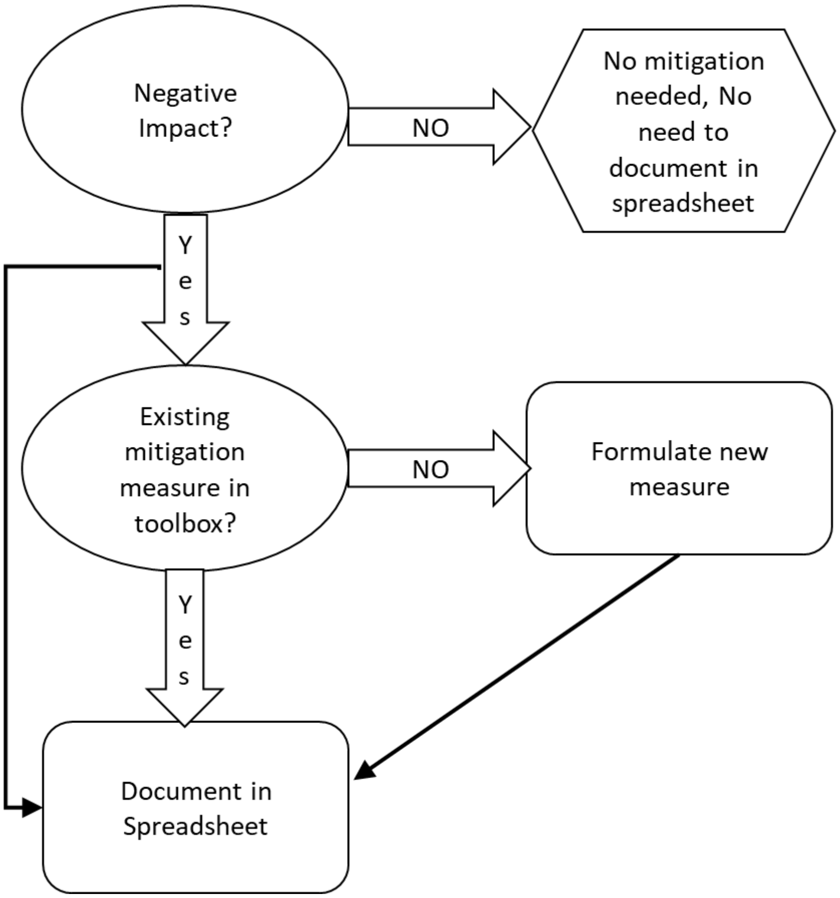
3.3 "PROPOSED MITIGATION MEASURE TO OFFSET IMPACT(S)"

Mitigation needs to be related to the effect (e.g. high water temperature effect mitigated by action to reduce water temperature in the area of effect). Mitigation should also be known to be effective and implementable (e.g. technically, environmentally, and economically feasible).

Use the Mitigation Toolbox to select potential mitigation measures to offset impacts. If no mitigation measure exists in the Mitigation Toolbox to address the impact, propose a new measure.

If your team cannot identify a potential mitigation measure, it is appropriate to leave the cell blank.

NOTE: Task is to identify locations for and/or types of proposed mitigation. The task is NOT to develop the details of mitigation such as quantity or scale. These details would be a future exercise.


Negative Impact?
NO
No mitigation needed, No need to document in spreadsheet
Yes
Existing mitigation measure in toolbox?
NO
Formulate new measure
Yes
Document in Spreadsheet

Template Impact Summary Spreadsheet

team name		–	–	–
Location	**Summary of Negative Impact(s) Compared To No Action Alternative**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Proposed Mitigation Measure to offset impact**
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–
–	–	–	–	–
–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–
–	–	–	–	–
–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–
–	–	–	–	–
–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–
–	–	–	–	–
–	–	–	–	–

Draft Columbia River System Operations Environmental Impact Statement

Appendix R, Mitigation, Monitoring and Adaptive Management Part 3, Mitigation Process

Annex C June Mitigation Toolbox

CHAPTER 4 - JUNE MITIGATION TOOLBOX

4.1 JUNE MITIGATION TOOLBOX - 2019

4.1.1 Water Quality

Draft Mitigation Measure	Reason to addition	Citations	Notes
move spill from Coulee to Chief Joe to manage TDG in the system	add	–	already do some of this, but should identify in report as a continued mitigation measure
system reserves shifts	–	–	
Bank stabilization	Lower reservoir elevation Increased reservoir refill rate	–	Increased risk and occurrence of landslides resulting in increased turbidity and impacts to local infrastructure.
Begin higher levels of juvenile fish passage spill later, when significant numbers of fish are in the river (e.g. start April 15, April 30 or start per fish count but only if also accompanied by 2-4 days' notice). Either no spill in the first part of April or spill to "performance standard" starting April 3/10.	This measure would: a) help to alleviate reductions in power generation; b) reduce TDG in early April and not "pre-gas" the river before significant numbers of juveniles show up	–	Power would need 2 days' notice before fish spill starts (longer if it is right after a weekend) because power is marketed 1-3 days in advance. --mitigation measure also added to power
Change seasonal/monthly turbine operations/priorities to change temperature mixing for cooling	add	–	additional studies would need to occur to determine feasibility
Compensate other large, mainstem dam operators (non-CRS) to operate their dams in a way that is beneficial for fish passing through CRS. For example, releasing cooler water during warm periods when they may not need to for their own environmental compliance, but has the opportunity to offset elevated mainstem temperatures in CRS areas that would benefit fish migration (juvenles or adults). Elevated flows is another option (pay them to store more/less water for downstream fish/water quality benefit).	–	–	Actions of other nonfederal operators is outside the scope of the EIS. Regulations of dams are the responsibility of FERC and EPA.
Decreasing/stopping spill (stop voluntary spill)	add	–	continue to explore idea of benefits to this operational strategy; July may be a more beneficial month to try this; look at MO2 results to inform discussion
Finanical/Monitoring	Financial support for native plantings and restoration of natural shorelines to help capture nutrients in stormwater runoff	–	–
Flow diversion structures, increased channel and habitat complexity to divert flows around in-channel slag deposits	Increased water velocities in contaminated reaches Decreased storage will change depositional zones to transitional/transport zones. Contaminants will spread further downstream.	–	Sediment transport of slag-bound metals
Implement a more flexible water management strategy during low flow years to preserve water in storage projects for release during summer to cool downstream water temperatures	add	–	Dworshak only viable project; we do this already, but could still discuss in mitigation section of report.

Draft Mitigation Measure	Reason to addition	Citations	Notes
Implement TDG reduction measures at other structural measures	Add, to reduce TDG generation from Grand Coulee Dam spill. Add. High priority for CTCR due to TDG-caused fish & aquatic life mortality downstream of GCD. An "extend and cover" modification would be superior to "flip lips" in reducing TDG per USBR analysis.	Frizell, K. H., & Cohen, E. (2000) Structural Alternatives for TDG Abatement at Grand Coulee Dam Feasibility Design Report. U.S. Bureau of Reclamation.	Analysis and report by USBR concluded the "extend and cover" structural alternative at GCD best lowers TDG and was the second least expensive alternative studied, ranking highest overall of three alternatives studies
Improve (lower) water temperatures (in summer) through additional selective withdrawal at storage projects that stratify	GCL temperature paper: USBR, 2008. Thermal Regime of the Columbia River at Lake Roosevelt. U.S Department of Interior, Bureau of Reclamation, Pacific Northwest Regional Office. Boise, Idaho	Eric R. to provide citation	Hungry Horse, Dworshsak & Libby already have SWS; Coulee not feasible.
Infrastructure improvements and repair	Lower reservoir elevation Increased reservoir refill rate	–	Increased risk and occurrence of landslides resulting in increased turbidity and impacts to local infrastructure.
Install Submerged outlets below spillbay flow deflectors to reduce TDG	add	–	not likely feasible to utilize lower level from technical perspective (Coulee); could be studied further
Minimize reservoir drawdown throughout the basin	–	–	It would be useful to add what environmental impact this measure will mitigate.
Operate run-of-river projects that stratify (e.g., LSR projects) to pass cooler water from deeper in the forebay to cool downstream temperatures during warm/low flow conditions.	add	–	(similar to row 5) continue to explore idea of benefits to this operational strategy; July may be a more beneficial month to try this; look at MO2 results to inform discussion
Summer and Fall water temps in the Columbia and Snake rivers commonly exceed mandated temps for salmonid survival. In the 1960's and 1970's these excessive temps were limited to a few days a year, now its months straight. The JD resevoir has no cold water refugia so does the McNary to Priest Rapids reach. Cold water wells must be used in conjunction with natural bays and embayments to create new CWR in this areas to allow returning adults successful passage during periods of excessive temperatures.	EPA Report https://www.epa.gov/columbiariver/columbia-river-cold-water-refuges. NOAA PP https://www.epa.gov/sites/production/files/2017-07/documents/columbia-river-cold-water-refuges-epa-presentation-sept2016.pdf	–	–
Tributary and upland restoration	Lower reservoir elevation Increased reservoir refill rate	–	Increased risk and occurrence of landslides and erosion leading to increased turbidity

4.1.2 Fish

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Additional turbines at Dworshak, Libby, for resident fish, TDG abatement/management	–	–	Moved from Power tab. Economically feasible units are already going to be rehabed. Waiting for $/limited in # at a time (year) Maximizing the efficiency of existing turbines and output from existing dam projects can result in increased carbon-free hydropower output.
–	Alter spill (change timing, duration, frequency)	–	OR provided citation: United States. The Endangered Species Act As Amended by Public Law 97-304 (the Endangered Species Act Amendments of 1982). Washington: U.S. G.P.O., 1983. Print. 2014 Columbia River Basin Fish and Wildlife Program https://www.nwcouncil.org/reports/2014-columbia-river-basin-fish-and-wildlife-program	*Alter for benefit of juvenile passage and survival? *We are doing this now, tweaking spill regimes in order to achieve better results. The PIT array at Granite may help in aiding spill programs in the Lower Snake. *Any ESA jeopardy analysis of the proposed action must comply with legal requirements.OR *Oregon remains open to consideration of flexibility in spill strategies so long as any alternative moved forward is robust enough to avoid jeopardy under the ESA and achieve regional recovery goals of 4-6% SARs of ESA-listed salmonids.
–	Balance optimize transport for all salmon/steelhead	–	–	Transportation strategy may be developed to optimize benefits based on water year and temperature.
Juvenile Salmon and Steelhead	Install Submerged outlets below spillbay flow deflectors to reduce TDG	–	–	Many of these seem to be latent mortality effects. Will the Spillway PIT tag arry lead us to management decisions regarding these?
–	Allow transport in only the lower 25% of water years and only in circumstances of reduced flows and limited spill.	–	–	Generally, transport has negative adult return results, except in years/periods of low flow when smolt survival through the CRS outweighs the negative impacts associated with adult straying upon return. Consider revising mitigation measure to allow transport in only the lower 25% of water years and only in circumstances of reduced flows and limited spill.
–	Reduce harvest of Listed Fish through continued development and implementation of selective harvest gears such as purse seines and pound nets or Reduce harvest of Listed Fish	–	–	Harvest regulation is outside the authority of the action agencies, but could be done by others.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Juvenile Salmon and Steelhead	Restore mainstem habitat through increased habitat complexity (rapid, riffle, run, pool), shallow water rearing habitat connectivity, temperature reduction, riparian function restoration, restore ecosystem processes.	–	–	–
–	Apply spill configurations that maximize smolt passage in spill, minimize eddy development to minimize predation opportunity on smolts and mimimize negative impacts to adult migration (confusion) and minimize TDG.	(2) During periods of reduced spill, maximizes benefits of spill for juvenile survival and minimizes potential negative impacts to adults.	–	–
–	Spill Increase to maximize SPE (shouldn't change hydrograph) to improve juvenile fish passage	–	–	Maybe some measure of the data we get from the PIT array at Granite might inform us for improved efficiency post BiOp? Assuming adaptive management will continue? So a lot of these measures could be considered post BiOp.
Adult Salmon and Steelhead	Spill proportional to juvenile numbers. Minimizes TDG and spill effects on adult passage.	–	–	How do we get numbers? JFF?
Adult Salmon and Steelhead	Stop spill in August; Minimizes TDG and spill effects on adult passage	–	–	Does pulling through turbines help cooling?
Piscine Predator Control	*Manage water levels/flows to reduce spawning habitat and recruitment success of non-native fish species at locations such as Yakima & Walla Walla River delta's *Manipulate reservoir elevations (and/or use culverts, etc.) to reduce or eliminate spawning habitat of non-native game fishes (example: Walleye spawning areas near the mouth of the Yakima River).	Not enough detail to evaluate. Although this measure may be beneficial at a localized scale or at certain locations for native fish, it may also introduce difficulties with operations such as MOP and MIP and therefore carry with it important resource trade offs. Oregon recommends this mitigation action be explored further from the perspective of scope, location, time, potential trade offs, etc. before moving it forward or deleting it at this time.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
resident fish	[At hungry Horse] maintain lowered winter flows in years following high spring runoff to aid in the establishment of riparian vegetation with positive benefits to both aquatic and terrestrial communities. [Add'l comment: this is already a CRSO measure in MO4, double this up as both operation and mitigation?]	Not enough detail to evaluate.	Merz (unpub data), Casey (2006), Braatne and Jamieson (2001), Auble and Scott (1998)	*Oregon needs more detail about this mitigation action prior to making a technical recommendation. Needs more development. Impact analysis for Bull Trout FMO? *This measure may be more helpful to wildlife. Consider moving it to the Wetland, Vegetation, Wildlife tab. Maybe consider at other dams as well *This measure is included for Libby Dam under MO4 and the same benefits would occur along the Flathead. Use citations, rationale, imact analysis etc. from that effort.
Piscine Predator Control	A bounty system for small mouth bass and walleyed would be effective (similar to Northern Pike Minnow program) - excluding predators	KEEP but not within USACE authority to implement.	–	*Outside authority of action agencies to implement, but could potentially be implemented by others *Did not see this when I added the metric above. I'd consider this critical. *Oregon needs more detail about this mitigation action prior to making a technical recommendation. *Make sure to consider Northern Pike too
–	Activate fish lifts to move Sturgeon - where feasible (BON)	Not enough detail to evaluate. Although Oregon supports the concept of increasing passibility at projects (both upstream and downstream) of sturgeon. The fish lifts are just one mechanism which may help achieve that outcome. It is Oregon's understanding that sturgeon may use fish ladders, spillways, and locks as means to pass the projects depending on size and passage direction. See referenced document	J. Parsley, M & Wright, Corey & van der Leeuw, Bjorn & E. Kofoot, E & Peery, Christopher & L. Moser, M. (2007). White sturgeon (Acipenser transmontanus) passage at the Dalles Dam, Columbia River, USA. Journal of Applied Ichthyology. 23. 627 - 635. 10.1111/j.1439-0426.2007.00869.x.	*Oregon needs more detail about this mitigation action prior to making a technical recommendation. *What about other facilities (CJO, GCD, Dalles, McNary, John Day, Snake River)? Methods to use the navigation channels for sturgeon movement?
–	Add biomimicry heat exchangers to tops of fish ladders	Need more detail to evaluate.	–	–
Adult Salmon and Steelhead	Add deflectors to DWR spillway to reduce TDG (impacts to incubating and rearing SR fall Chinook salmon)	–	–	–
–	Add flex spill operation both 120% and 125%	We are currently using the Flex 120% operations so makes sense to add as an option. 125% also since there was agreement to evaluate and if 120% is not getting us where we need to 125% could be used.	2018 BiOp and Flex spill agreement	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Lamprey	Add pheromones/"scents" to suitable spawning tributaries	Presumably this is for lamprey, only lamprey or other species too?	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Sturgeon	Add recommendations from the Sturgeon plan.	The plan's recommendation should be added to the CRSO mitigation tool box.	Contact CRITFC	–
–	Add/increase spawning gravel	Neutral; keep	–	*We considered this back in the late 80's when there were just a few fall chinook in the snake spawning between the Grande Rhone and Lewiston. Thought was to bring up a barge to the two key spawning areas defined and drop gravel every few years. I thought it had merit. Now however we have lots of fall shinook spawning. We drop dredge material, why not proper sized gravel. The hells canyon complex was what eliminated sediment transport into the Snake-poor above the Salmon confluence for instance. *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *may be important for native mainstem spawners (e.g. mountain whitefish)
Fish/Salmon, Steelhead, & Lamprey	Address conditions in the Yakima Delta portion of the McNary Pool The confluence of the Yakima with the Columbia is located in the McNary Pool and managed by the Corp of Engineers. The Mid-Columbia Fisheries Enhancement Group, WDFW, the Yakama Nation and other partners are actively working to design and implement modifications to the causeway that would restore more natural flow patterns. Backwater conditions behind the causeway to Bateman Island create highly artificial conditions that benefit non-native predators (bass, walleye and catfish) while harming migrating salmon, steelhead and lamprey.	–	–	–
–	Albeni Falls expand FWPO for chum	–	–	Needs refinement of activity and limit impacts to local resident fish
–	Albeni Falls stop Flexible Winter Power Ops for resident fish	Not enough detail to evaluate.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
general	All locations with fish bypass: JBS screen systems; Total overhaul, rebuilding and upgrading where needed	–	–	–
general	All locations with TSW or RSW: Install gates with electric winches to allow easy opening and closing so they can be used for fish passage during the non-spill season	–	–	–
–	All projects from 2018 Lower River tribes fish Accords should be incorporated in the Mitigation Tool package	This is on going and future proposed work that was not included in the base case and needs to be considered future CRSO mitigation	2018 Lower Tribal Fish Accords	Mitigation specific to the impacts of the actions will be considered. If mitigation components are identified, they can be evalauted and used.
Piscivore Control	Allow removal of invasive fish incidentally caught during dam angling	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Adult Salmon and Steelhead	Alter Transport to decrease straying of adult migrants	A good suggestion: Proposals have been devloped by NWFSC.	–	–
Juvenile Salmon and Steelhead	Alter Transport to focus on when there is demonstrable benefit to smolt survival	–	–	–
–	At Columbia falls, increase minimum flow in high water years to 5000 cfs and adjust linearly down to 3,200 cfs in the driest water years to benefit bull trout and other native fish species	–	–	–
ADD: Resident Fish, bull trout, westslope cutthroat trout, KR white sturgeon, burbot	At Libby, maintain lower winter flows in years following high spring runoff to aid in the establishment of riparian vegetation.	MO4 would implement this measure with much more detail, but this more generic approach would provide beneficial mitigation for the other MO alternatives.	Merz (unpub data), Casey (2006), Braatne and Jamieson (2001), Auble and Scott (1998)	The more frequently we can meet these conditions, the greater the likelihood of cottonwood regeneration and associated ecosystem benefits.
–	At the current Dam angling program to remove Northern Pike Minnow, remove other juvenile salmon predator fish such as walleye, small and large mouth bass, catfish, etc…..	Currently these species are returned to river. This would increase the effectivness of this program and remove additional predation fish species from hot spots and areas where the general public does not have access to help reduce these populations.	https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-scientific-advisory-board/non-native-species-impacts-on-native-salmonids-in-the-columbia-river-basin-including-recommendations-for-evaluating-the-use-of-non-native-fish-species-in-resid	*Outside authority of action agencies to implement, but could potentially be implemented by others
–	Balance optimize transport for all salmon/steelhead	–	–	–
–	Ban harvest for 1-2 years	Harvest regulation is outside the scope of the action agencies, but could be done by others	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
–	Breach scenario	–	–	A general note that breaching is modeled to remove O2 from the snake for a few weeks. This action, while it may improve smolt migration could have a serious impact on native species

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Breach the Bateman Island causeway, near the mouth of the Yakima River, Richland Washington	This site impact juvenile outmigration, creates piscivorous predators feeding and spawning habitat, impacts returning adult salmonid migration, NOAA needs to mandate this action	http://midcolumbiafisheries.org/restoration/fish-passage/yakima-delta-assessment/ http://midcolumbiafisheries.org/wp-content/uploads/2016/06/Executive-Summary.pdf	–
Juvenile Salmon and Steelhead	Build Juvenile Bypass Structure Upgrade Phase 2 to improve fish handling for Smolt Monitoring Program and transportation program	Not enough detail to evaluate.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Adult Salmon and Steelhead	Buy out harvesters to allow more adults to reach the spawning grounds.	Outside the authority of action agencies, but could be done by others.	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
–	Catch and transport adult sturgeon (BON)	Oregon would be supportive of catch and transport of sub-adult white sturgeon from Bonneville Pool to other Zone 6 locations within the context of CRITFC's sturgeon Master Plan, but not adults and not to other locations and not from below Bonneville dam.	–	*What about other facilities (CJO, GCD, Dalles, McNary, John Day, Snake River)? Methods to use the navigation channels for sturgeon movement? *Oregon needs more detail about this mitigation action prior to making a technical recommendation.
general	Cease Transport Operations if TIR ratios are consistently less than 1	–	–	–
–	Change FRM to make more water available to fish (relax rule curves ; go towards normative hydrograph)	*Add targeted evaluation of FRM based on CRT-13 Tribes Ecosystem Function recommendations. *Oregon strongly supports further development of operational and/or structural mitigation actions to optimize flow augmentation particularly of cold water for cold water fish	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *May not be feasible in high water years due to the potential increase in flood risk
Adult Salmon and Steelhead	Change seasonal/monthly turbine operations/priorities to change temperature mixing for cooling	*KEEP. However, measure has limited application *Oregon strongly supports further development of operational and/or structural mitigation actions to optimize water temperatures for cold water fish	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to irrigators.
–	Change turbine operations to change temperature	Oregon strongly supports further development of operational and/or structural mitigation actions to optimize water temperatures for cold water fish	–	* If altering turbine flows can reduce temperatures during migration season (upstream and downstream), then it should be considered. * Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Piscine Predator Control	Conduct predatory fish removal throughout each of the reservoirs with emphasis on hotspots - predation management	KEEP w/State support. Projects include: TDA	–	*Outside authority of action agencies to implement, but could potentially be implemented by others *Add measures like derbies/bounties on non native fish, and a good PR campaign on why to keep, recipes. *Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Adult Salmon and Steelhead	Continue to reconnect the estuarine floodplain (BON to mouth) to restore rearing habitat and increase flux of prey to the mainstem (support condition of outmigrants before ocean entry)	–	–	–
Predation	Continued disaussion activities (both active and passive) on avian colonies in the Potholes Reservoir	Very high avian predation rate from CATE colonies seen on UCR steelhead	Inland Avain Plan	–
general	Convert Bypass channels to surface passage routes where possible (JDA, MCN, and Snake River projects)	–	–	–
–	cooling water pumped through fish ladder as an attractant	Investigate other projects using results from Lower Granite Dam as the pilot project? Keep this measure but clarify intent.	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *It has provided benefits in the Snake.
–	Decrease the draft rates	Oregon strongly supports further development of operational and/or structural mitigation actions to optimize flow augmentation particularly of cold water for cold water fish	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
Sturgeon	Decrease White Sturgeon habitat fragmentation through dam passage improvements and/or dam removal	Keep	–	–
Predation	Deployment of green laser device to dissuade piscivorous waterbirds from facilities, loafing or nesting habitat	–	TERN Management Plan	–
Adult Salmon and Steelhead	Design, Construct, and Operate cooling water structures or showers at ladder exits to reduce temps to below 1 degree C differential in the ladders	–	–	–
–	Develop 3-to-5 year implementation plans for tributary habitat actions that identify specific actions expected to be implemented, rationale for action, and expected benefits.	Offsite mitigation for impacts of hydrosystem to abundance, productivity, and survival.	–	See 2019 CRS BiOp, Term and Condition #5

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Juvenile Salmon and Steelhead	Develop additional shallow water habitat throughout the length of the reservoir; reduce available holding habitat for fish predators in conjunction (e.g., convert rip rap areas to shallow water habitat)	Keep. KEEP. Affirmative. This action could include "softening the shorelines", i.e., keep the structual features, but soften them with soil wrapped walls, dredge material placement, etc. to naturalize the shoreline.	–	Similar to previous comments. Why not habitat above the Salmon too? Hard to do but it's known that Hell's canyon complex is stopping sediment transport
–	Develop additional shallow water rearing habitat (e.g., for fall chinook in the lower snake river)	Keep. KEEP to the extent possible.	–	Similar to bringing in spawning gravel in the snake from leweiston upstream.
Juvenile Salmon and Steelhead	Develop additional shallow water rearing habitat at McNary Pool	Keep.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Juvenile Salmon and Steelhead	Develop adult trap and haul facility at Ice Harbor to improve research/monitoring & truck/haul capabilities (e.g., for emergency sockeye truck & haul in hot water years)	Keep	–	–
general	Develop method to extract deeper colder water for longer periods during late spring, summer and early fall at Grand Coulee (extended intakes?); and fill Banks Lake with warmer surface waters (variable intake) to help mitigate for climate change impacts.	–	–	–
–	developing a downstream passage route for non-spillway or turbine passage for resident fish at certain facilities (Libby, HH, Dworshak, others) to reduce entrainment mortality	Increase entrainment survival downstream of high head dams, possible increases to support downstream populations.	–	–
Piscivore Control	Dissuade Terns on Blalock Islands	–	–	–
salmon and steelhead	Draw down Snake River reservoirs to spillway crest during juvenile salmon out migration period.	Improve conditions for outmigrating juvenile salmon and steelhead.	Previous FCRPS EIS	This action has been discussed and analyzed in previous processes.
–	Dry year strategy where we have additional reservoir draft in dry years and load management strategies in dry years	*Keep. *Develop different operational strategies based on flow year. Enable adaptive management to respond to flow year. *Oregon strongly supports further development of flexible mitigation actions that can be applied in dry/warm water years.	–	*A hedge against climate change/drought years. *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
–	Effective debris management to keep debris off of trashracks where it can impact smolts, auto release on boat barriers, shape debris booms to RSW	moved from WQ	–	Debris is a recurring issue with the safe and effective passage of fish through the Juvenile Bypass Systems and some adult laddders.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Flows/Chum/Lower River/Estuary	Eliminate lower Columbia chum flow operations to benefit other fish. Lake Roosevelt experiences a drawdown in August and September to assist lower river Chum Salmon migration. However, there has been little consideration or mitigation for the effects these flows have on fish populations of Lake Roosevelt. A review of the current chum operations and other similar single species operations must be reviewed within the alternatives.	–	–	–
–	Environmental flow (intentional overbank)	*Neutral. *Oregon strongly supports further development of operational and/or structural mitigation actions to return the hydrograph to a more normative (pre-hydrosystem) pattern. *See Ecosystem Function description from Columbia River Treat discussions.	–	Both in fish and wetlands. Re-engaging flood plans is shown to be beneficial. Depends on where. I've heard from our calls that it may be doable on the Upper Columbia?
Juvenile Salmon and Steelhead	Establish an annual four-month "normal pool" period on Lake Pend Oreille (Memorial Day to October 1) and a higher winter lake level	–	–	–
–	Evaluate optimal operations by flow level balancing good egress and reduced PITph in the spring for juveniles, with retention of water needed to reduce late spring, summer, and early fall temperatures for adults.	–	–	Moved from water supply

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Evaluate potential for improving tributary habitat productivity in populations in the Middle Fork Salmon River spring Chinook MPG. Habitat in the Middle Fork Salmon spring Chinook MPG is generally of high quality due to the preponderance of wilderness areas and other federal lands, and there appears to be relatively low potential for improving habitat productivity in most populations in this MPG. However, as noted in the ESA recovery plan (NMFS 2017), further exploration of ways to improve habitat is warranted. The potential of the following actions to improve freshwater productivity in the populations in this MPG should be evaluated: (1) continued efforts to address localized impacts of past land uses; (2) reintroduction of beaver in populations with significant marsh habitat; (3) nutrient supplementation; (4) management of non-native brook trout improve the function of spawning and rearing habitat and provide population benefits. Based on the results of this evaluation, the Action Agencies should develop implementation plans as appropriate.	Offsite mitigation for impacts of hydrosystem to abundance, productivity, and survival.	–	See 2019 CRS BiOp, Conservation Recommendation #18
–	Evaluate/construct entrainment reduction or downstream passage routes for facilities	Maintain survival of greater than 90% for all downstream routes. Use surogate species to estimate impacts in absence of BT data	Examine effects of entrainment on Lake Koocanusa Core Area Populations (USFWS 2015, Recov Plan D-111).	–
–	Existing BPA Fish and Wildlife program project implementation measures that are listed in PICSES and CBFISH should be incorporated into the mitigation toolkit. Most of these projects are intended to implement the Northwest Power Act's mitigation mandates. Most of the projects have at least a 10-year history. Few, if any, will sunset during the timeframe of this EIS. Many will, however, continue to add mitigation consequences to the mitigation actions that havve already occurred.	–	The Norwest Power and Conservation Council Website.	–
–	Expand tributary habitat projects to resident fish species (bull trout) waters	–	–	See all tributary suggestions by NOAA and expand to include areas of bull trout and the upper basin.
Invasives/Monitoring	Financial support for invasive species monitoring and mitigation programs	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
predation	Fish collector in or near GCD forebay, equipped with exclusionary netting - remove non-native predators	Increased water outflow Decreased water residence time	–	Capture and removal of Northern Pike and other non-native predators as they disperse downstream
–	Fish ladders/passage (add or improve)	Keep	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. This mitigating action should be considered at all project locations where it has the potential improve upstream or downstream passage of adults or resident species across a broad set of operations (low spill to high spill). Bull trout at Albeni Falls. No Action. Implemented through another program *Bull trout passage at Albeni Falls is critically important. Consider passage at other facilities that currently do not have passage (e.g. Dworshak, HHD, Libby, GCD, Chief Joe). Confirm passage efficiencies at other dams for bull trout. Need to improve to allow passage of species other than salmon (e.g., bull trout, sturgeon, lamprey, and westslope cutthroat trout).
–	Fish ladders/passage (add or improve). Fish passage in the "blocked areas" of the Columbia and Snake Rivers to achieve additional production in currently inaccessible historical habitats.	Potential to produce UCR summer/fall Chinook smolts in currently inaccessible habitats that may partially offset increased juvenile mortality in the lower Columbia dams and reservoirs as a result of reduced or suspended spill and reduced flow in late July and August. Keep.	–	Bull trout at Albeni Falls. No Action. Implemented through another program
–	Forecast and program O&M needs to address aging infrastructure.	ADD Aging infrastructure is an issue at all facilties. Need to further develop a strategy and plan to identify major rehabs and funding.	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Fully implement Tern Management Plan at ESI in the estuary.	Currently only managing to an acre plan and have not achieved population targets in plan. This program has failed to meet the predation reduction objectives set out in the management plan. No additional actions are planned but additional actions are needed. In past studies it was shown that river flows has an effect on predation rates and by altering the base case flows this could increase or decrease tern predation and thus should be included in the CRSO.	DCCO management Plan	–
–	Fully implement The Double Crested Cormorant Plan at ESI in the estuary and look to partner and expand to Megler-Astoria Bridge.	Currently the plan has not achieved the population numbers as outlined in the management plan. The COE used erronous data to cite that population goals were achieved but current population's estimates have the DCCO numbers back to near pre managment levels. The COE needs to continue to utilize population controls measures and look at partnering with others in estuary to help effectively manage cormorants. At the very least work with Astoria-Megler Bridge to reduce nesting.	–	–
Piscivore Control	Fund dissuasion efforts of Pinnpeds haul out sites and increase hazing intensity in the spring and fall at Bonneville Dam	–	–	–
Piscivore Control	Further reduce predation on juvenile salmonids from Caspian terns at ESI using a variety of methods (lethal and/or non-lethal means), which could include habitat modifications or colony reduction. Habitat modifications at ESI could reduce available habitat to less than 1.0 acres, translating into a reduction in colony size over time which is assumed to reduce predation rates (change is not immediate); colony reduction would reduce the number of terns breeding and foraging in the CRE.	–	–	–
Passage/Structural	Gentler slopes in fish ladder access to increase survival and passage rates	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Predation piniped	Give sea lions human appetite suppressants to reduce their consumption of fish below Bonneville without lethal effect on sea lions.	Reduce predation on juvenile and adult fish below Bonneville dam.	https://www.smithsonianmag.com/smart-news/human-diet-drugs-may-be-secret-stopping-mosquitoes-180971459/	–
Piscivore Control	Haze, dissuade, and facilitate removal of pinnipeds at TDA and BON	–	–	–
–	If flows prove to influence mainstem temperatures, draft storage reservoirs (like Libby) deeper in lower flow years as a response to climate change.	–	–	–
white sturgeon	Implement "slow-roll" procedures for all turbine start-ups to reduce fish mortality, particularly for those projects with white sturgeon	Because this technique/procedure has been demonstrated to reduce mortality from blade strike on sturgeon, particularly on adult fish, a critical segment of all sturgeon populations.	https://www.nwcouncil.org/sites/default/files/ColumbiaBasinWhiteSturgeonPlanningFramework2013Dec_0.pdf	This is a concern at Dworshak Dam, others?
–	Implement 2018/2019/2020 flex spill as a mitigation action to allow adult salmon and steelhead to pass Little Goose Dam in the spill to gas cap alternatives.	–	–	–
Hatcheries	Implement an aggressive program of stocking the river with steelhead/salmon.	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others *Unclear what the effects of the action would be, but all alternatives improve steelhead and salmon. No action would maintain current mitigation activities.
Flows/Lower River/Estuary	Implement higher spring and summer flows to lessen duration of hypoxia in the Columbia River plume and nearshore ocean.	–	–	–
Piscivore Control	Implement NOAA ITS and conservation recommendations	–	–	–
Resident Fish (Bull Trout, Sturgeon, Kokanee)	Implement 'off-site', within subbasin actions that address resident fish losses attributable to hydrosystem operations in circumstances where mitigation cannot be adequately or sustainably acheived within the immediate affected environment.	In some circumstances, 'off-site' mitigation results in more effective and sustainable outcomes.	–	–
Juvenile Salmon and Steelhead	Improve (survival, reliability, operational ease, etc) JBS facilities at locations where JBS's will likely continue to be operated (for SMP, due to low turbine survival, transport program objectives, etc)	KEEP 1) CLARIFCATION: "JBS facilities" to include "JBS systems, such as screens"; 2) Prioritize improvements at JBS facilities where the JBS's will be operated.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Adult Salmon and Steelhead	Improve adult ladder passage through modification of adult trap and adult trap bypass loop (potential for structural and operational changes)	Oregon would likely recommend retaining this mitigation action when and where it would be beneficial. More detail on the where and why of implementation would help clarify potential action efficacy.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
–	Improve hydraulic conditions in fishways, e.g., reduce velocities and radius corners, to benefit adult LR	ADD Measure has been implemented and shown to be a benefit.	–	–
resident fish	Improve natural and "normative" flows to improve life stages for native resident fish	Keep	–	This should be for all native species (i.e. sturgeon, bull trout, cutthroat, redband, whitefish, etc.)
–	Improve tributary channels to provide safe fish passage through drawdown zone	Increased duration of drawdown Lower reservoir elevations	–	Migration to and from tributaries and Lake Roosevelt is physically inhibited by channels within drawdown zone Increased predation of juveniles/adults as they migrate to/from tributaries through drawdown zone
Sturgeon	Improve White Sturgeon populations in the impounded river sections by improving flow and Spawning conditions	Oregon strongly supports further development of operational and/or structural mitigation actions to return the hydrograph to a more normative (pre-hydrosystem) pattern.	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
general	Improved monitoring capabilities, so we know how these changes are truly affecting fish i.e. the new spill levels and changes, hydrograph changes. Improved monitoring could improve the accuracy of inriver survival estimates (mitigate reduced accuracey of estimates due to higher spill levels, etc.) and better assess the latent mortality hypothesis for juveniles (basis for the Flex Spill operation). Invest in more spillway PIT detectors at LGR, MCN and BON and the Ice & Trash Sluiceway at TDA. Invest in setting up the PIT barge system below Bonneville and in optimization of the new PIT trawl design.	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	In most all cases, significant time and large-scale efforts at tributary habitat restoration are required to yield substantial benefits. The Action Agencies should consider the effects of a long-term tributary habitat improvement implementation strategy designed to more fully address limiting factors for particular populations over a time period that reasonably considers limitations on annual implementation capacity and other factors. Life-cycle modeling results for spring Chinook salmon in the Grande Ronde and Catherine Creek populations, for example, demonstrate that long-term, strategic implementation of habitat improvement actions can have marked effects (see Pess and Jordan et al., in press). The Action Agencies should ensure that their NEPA analysis includes consideration of long-term, strategic implementation of habitat improvement actions.	Offsite mitigation for impacts of hydrosystem to abundance, productivity, and survival.	–	See 2019 CRS BiOp, Conservation Recommendation #14
–	Increase Access to fish habitat and the tributaries	*Oregon assumes this mitigation action envisions remediation of existing artificial fish passage impediments? If so, Oregon is supportive of retaining this mitigation action. *Modify operations or construct habitat projects to flush out tributary mouths in Kootenai River, Lake Roosevelt, Upper Lake Pend Oreille/Clark Fork River, and other known areas where aggradation may be occurring.	–	–
–	Increase artificial production capacity	Increased water outflow Decreased water residence time	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Piscivore Control	Increase dam angling at all 8 CRS projects	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
–	Increase discharge capability at Libby Dam for sturgeon flow with addition of 6th turbine	Keep	–	
Piscine Predator Control	Increase harvest of invasive fish	Not enough detail to evaluate. The action agencies do not have authority to regulate harvest, but his could be done by others.	–	*Outside authority of action agencies to implement, but could potentially be implemented by others

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Increase hatchery production for steelhead	–	–	only if this measure is intended to ensure all mitigation targets are met (which they aren't now). Increasing hatchery production should be tied to a specific mitigation obligation. Unclear what the effects of the action would be. No action would maintain current mitigation activities.
–	Increase likelihood of refill at storage projects that provide downstream water temperature management	Oregon strongly supports further development of operational and/or structural mitigation actions to optimize flow augmentation particularly of cold water for cold water fish	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
–	Increase liklihood of refill at storage projects that provide downstream flow mangement	Storage reservoirs that provide increased flow for juvenile and/or adult migration also need to be priority to refill for resident fish, cultural resources and subsequent year flow/temperature modulation	–	–
–	Increase Sea Lion hazing of both stellars and California outside of current management time frame.	This is being considered in the current 2018 BiOp so should be included in the CRSO	2018 BiOp	The NPCC and all regional co-managers worked together to help facilitate an amendment to the MMPA to legally allow this mitigation action. The Action Agencies should immediately adopt this mitigation action as a measure in each of the Alternative currently under consideration.
–	Increase Selective Withdrawal Gate temperature management flexibility (enable capability to provide a normative river thermograph)	Oregon strongly supports further development of operational and/or structural mitigation actions to optimize water temperatures for cold water fish	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
–	Increase shoreline vegetation for habitat and shading	KEEP if feasible	–	*Managing reservoir elevation (promote wetlands and grow riparian vegetation on shorelines) *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. Managing reservoir elevation (promote wetlands and grow riparian vegetation on shorelines) *Managing reservoir elevation (promote wetlands and grow riparian vegetation on shorelines). Consider development or expansion of existing cottonwood galleries.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Increase spillways	CLARIFICATION / KEEP: Good idea if bays are reconfigured to aid fish passage	–	–
–	Increase the turbidity of water in the mainstem Columbia River at key locations by introducing biologically inert dyes or small colloidal sediments to the water column (spillways). Increasing turbidity would reduce predation rates and make turbidity levels closer to the pre-dam condition.	–	Slide 27 - https://www.westcoast.fisheries.noaa.gov/publications/col_basin_partnership/jun_7_wrkshp/6.7.2016_hydro_1_-_cbp_workshop_ritchie_graves.pdf	Dams generally increase water clarity by reducing the amount of fine sediment et. In the water column.
–	Increase use of spillway Weirs at projects -	–	–	–
–	Draft GCL and maybe upstream storage projects slightly deeper by April 10 or completely eliminate the April 10 requirement. Potentially lower the April 30 elevation as well.	This measure would a) help to alleviate reductions in power generation b) reduce April flows thereby permitting a higher percentage of spill within the TDG parameters which would lead to lower PITPH and would help fish	–	–
Juvenile Salmon and Steelhead	Install deterents to fish entrance of draft tubes when not in operation	Keep. A lot of efforts at this have been tried and failed… is this new ideas, or old (failed) ideas again? If former, need specificity, if latter, remove.	–	–
Piscene Predator Control	Install deterrents to minimize predatory fish holding near intakes (e.g., around trash racks) and exits	–	–	–
general	Install exclusion screens at DWR during turbine testing to avoid steelhead mortality	–	–	–
general	Install fish friendlier units (e.g. IHR unit 2,3) with modified draft tubes at all dams	–	–	–
Adult Salmon and Steelhead	Install North Jetty at LGO. Remove Peninsula at LGO to break up the hydraulic fence at high spill	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
juvenile salmon	Install surface collection/weirs along the dam face of all powerhouses to provide directed fish passage into a gentle graded channel (like the Bonneville PH2 Corner Collector) that delivers fish beyond tailrace boat restricted zones. This could improve collection of surface oriented fish while removing passage concerns associated with tailrace eddies or unstable flow vectors associated with dam operations.	Oregon supports reducing powerhouse passage rates by providing alternative passage routes that avoid turbine and bypass routes though the powerhouse structure. Developing surface collection channels along the face of the powerhouses that direct emigrants to a gentle sloping bypass channel (like Bonneville 2 Corner Collector) could aide in improving juvenile survival for more surface oriented fish while covering more area than an orifice cut in the concrete of a powerhouse.	***In part, for emphasis***: Johnson, G. E., S. M. Anglea, N. S. Adams, and T. O. Wik. 2005a. Evaluation of a prototype surface flow bypass for juvenile salmon and steelhead at the powerhouse of Lower Granite Dam, Snake River, Washington, 1996–2000. North American Journal of Fisheries Management 25:138–151.; Evans, S.D., N.S. Adams, D.W. Rondorg, J.M. Plumb and B.D. Ebberts. 2008. Performance of a prototype surface collector for juvenile salmonids at Bonneville Dam's first powerhouse on the Columbia River Oregon. River Research and Applications 24: 960–974 DOI: 1002/rra.1113; Gary E. Johnson, Fenton Khan, John R. Skalski & Bernard A. Klatte. 2013. Sluiceway Operations to Pass Juvenile Salmonids at The Dalles Dam, Columbia River, USA, North American Journal of Fisheries Management, 33:5, 1000-1012, DOI: 10.1080/02755947.2013.822441	This will not eliminate the need for powerhouse bypass operations, because deeper oriented emigrants will continue to require fish mitigation for passing powerhouse. This addition should be equipped with PIT detection capabilities and potentially include collection capabilities for Smolt Monitoring Program operations. All must be equipped with a channel similar to Bonneville 2 Corner Collector that delivers fish downstream of the tailrace, especially where tailrace conditions are considered to be a concern for delay.
Avian Predator Control	Install wire array to dissuade piscivorous waterbirds at McNary	KEEP. If avian wires don't exist at McN, then install.	–	–
Avian Predator Control	Install wire array to dissuade piscivorous waterbirds such as McNary and improve wire arrays at other locations where avain predators are problematic.	–	–	–
–	Intake fish screens	–	–	Need to improve to reduce impingment and entrainment by species other than salmon (e.g., Pacific lamprey macrothalmia).
Invasives	Invasive aquatic vegetation control	Lower reservoir elevation Increased duration of drawdown	–	Increased predation due to reservoir conditions benefiting predators resulting from increased predator/prey proximity during drawdown, and increased area and biomass of inundated vegetation upon refill
Adult Salmon and Steelhead	John Day: Replace or totally rebuild south fish ladder auxiliary supply system,	–	–	–
Avian Predator Control	Lethal control of persistant avian predators at key hot spots(e.g. egg oiling and adult removal) example location TDA.	Currently Walla Walla District employs lethal control at their projects but PDX projects do not. This would make current hazing programs more effective.	https://plan.critfc.org/ Evans, A., Q. Payton, B. Cramer, K. Collis, N. Hostetter, and D. Roby. 2019. System-wide effects of avian predation on the survival of Upper Columbia River steelhead: Implications for predator management. Draft Report submitted to Grant County Public Utility District No. 2 and the Priest Rapids Coordinating Committee.	–
Piscivore Control	Lethal removal of gulls at all projects	–	–	–
predation	Lethally take avian predators at CRS projects	ADD Lethal control is authorized at NWW projects but not NWP projects. Lethal control has been effective at NWW projects.	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
resident fish	Limit use of spillway to avoid bull trout entrainment at Libby	Not enough detail to evaluate.	–	*Oregon needs more detail about this mitigation action prior to making a technical recommendation. *Study entrainment reduction methods, including this method. Also, developing a downstream passage route?
Steelhead	Look at adding modified Surface Spill bays (long verticle slots) similar to those at Rock Is. These could be used outside the spill season to aid overshots and kelts but use less water.	This would allow for protection of overshots and kelts but use less water and be more effient with water usage.	–	–
Chinook - adult	lower flows in the John Day tailrace to promote fall chinook spawning	to increase fall chinook populations in this section of the river which was a major spawning location for fall chinook.	https://plan.critfc.org/	–
Adult Salmon and Steelhead	Maintain estuary water levels that promote fish passage - unclear; passage into rearing tributaries below BON?	KEEP. Consider for Chum access to spawning channels.	–	–
Predation	Maintain high water flows with minimal river islands/decrease island habitat (island use by pinnipeds) and island use birds	–	–	This might be helpful upstream of BON, but not for pinnepeds since they are downstream of BON. which islands are being used by pinnipeds or how project operations can decrease island habitat.
–	Maintain less than 1 degree Celsius differential (fish ladders)	Keep	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *This may be critically important in summer months for migrating sockeye.
Juvenile Salmon and Steelhead	Maintain water levels that promote fish passage and access to habitat	KEEP. Affirmative - off-set loss of shallow water habitat in the estuary	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Avian Predator Control	Manage avian nesting habitat to reduce predation losses to avian predators - predation management	CLARIFICATION: "Manage avian nesting habitat" on USACE property means altering the habitat or processes surrounding those habitats to preclude nesting by avian colonies known to predate on juvenile salmon (e.g., cormorants, terns, gulls, etc.)	–	–
Avian Predator Control	Manage avian nesting habitat to reduce predation losses to avian predators - predation management at the inland cites as identified in the inland avian management plan	Currently the Inland management plan dealt with limited species and locations, additional locations such as Blalocks Terns and Miller Rocks gulls are continued locations of problem predation.	Inland Avain Plan	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Manage flows at Libby to improve passage at downstream tributaries	–	–	Determine if altered flows or flows during certain timing might provide better flushing of aggrading sediments at downstream tributary mouths.
–	Manage reservoir levels (keep high) to minimize available nesting habitat on Blalock Island complex	High avian predation rate from this colony seen on steelhead smolt	–	–
–	Manage reservoir levels to protect spawning areas	–	–	–
–	Managing for stable reservoir elevation (promote wetlands and grow riparian vegetation on shorelines)	Not enough detail to evaluate. Although this measure may be beneficial at a localized scale or at certain locations for fish, it may also introduce difficulties with operations such as MOP and MIP and therefore carry with it important resource trade offs. Oregon recommends this mitigation action be explored further from the perspective of scope, location, time, potential trade offs, etc. before moving it forward or deleting it at this time.	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *A stable reservoir elevation is a crically important mitigative measure for a multitude of fish and wildlife species.
avain predator	maximize flow and reservoir elevation to prevent nesting of piscivorous birds in all reservoirs, particularly JD	Unmanaged Caspian terns, gulls, and other piscivorous water birds need to be controlled via river flows to prevent nesting and population increases.	https://plan.critfc.org/ Evans, A., Q. Payton, B. Cramer, K. Collis, N. Hostetter, and D. Roby. 2019. System-wide effects of avian predation on the survival of Upper Columbia River steelhead: Implications for predator management. Draft Report submitted to Grant County Public Utility District No. 2 and the Priest Rapids Coordinating Committee.	–
–	maximize storage of cold water at DWA, LIB and CJO	*Keep. *Oregon strongly supports further development of operational and/or structural mitigation actions to optimize flow augmentation particularly of cold water for cold water fish	–	*If Climate predictions become realized we will need all the cold water we can get. Even with MO3! This is probably a Key recover component. *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
Adult Salmon and Steelhead	McNary: Replace or rebuild auxiliary water system	–	–	–
–	Mimic natural hydrograph (ops) (including in the estuary)	*See Ecosystem Function description from Columbia River Treat discussions *Oregon strongly supports further development of operational and/or structural mitigation actions to return the hydrograph to a more normative (pre-hydrosystem) pattern.	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. * A more normative hydrograph will provide the outmigration conditions necessary to optimize smolt survival

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	minimize pool level variability	Not enough detail to evaluate. Although this measure may be beneficial at a localized scale or at certain locations for fish, it may also introduce difficulties with operations such as MOP and MIP and therefore carry with it important resource trade offs. Oregon recommends this mitigation action be explored further from the perspective of scope, location, time, potential trade offs, etc. before moving it forward or deleting it at this time.	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
Predation	Minimize predation	–	–	Support northern pike, walleye, and lake trout removal projects across basin.
Predatio	Minimize predation of early life stages of White Sturgeon	–	–	–
Predation	Minimize predation on adult White Sturgeon by pinnipeds	Keep	–	–
–	Minimize reservoir fluctuations		–	–
Adult Salmon and Steelhead	Modify DWA spillway to reduce TDG levels during spill	Keep	–	–
Adult Salmon and Steelhead	Modify existing adult trap configurations and use to reduce handling stress	Keep	–	This may be important to bull trout handling at some facilities as well.
–	Modify flow by reducing irrigation to increase flow (reallocation)	Several MO alternatives appear to include Water Supply operations that cannot be currently delivered due to lack of infrastructure and demand. This measure could be meant to identify that water savings and return it to the river for the purpose of modeling benefits to fish. This measure could also be used to support the Columbia RIver Transaction Program, funded by BPA to purchase water rights from willing irrigators and provide additional flow for fish. Keep this measure but clarify its purpose.	–	Reducing water withdrawals will benefit fish, but will also benefit hydropower by keeping water in the river, thereby offsetting some of the power lost to spill. For example, water taken out at the Columbia Basin Project (Grand Coulee) for water supply does not go through 11 hydropower projects, including 6 Federal projects. Keeping this water in the river improves fish survival and helps the power system.
–	Promote streamflow restoration through improved operational efficiencies (irrigation and municipal) and voluntary water transactions.	Oregon strongly supports further development of flexible mitigation actions that can be applied in dry/warm water years	Columbia Basin Water Transactions Program https://www.nfwf.org/cbwtp/Pages/home.aspx	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences
Adult Salmon and Steelhead	Modify LGR trap to reduce impacts to non-target fish; improve the BON AFF system so fish don't dewater	–	–	–
Lamprey	Modify or remove ESBS so they do not impact lamprey	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Lamprey	Modify project operations to allow larval lamprey (ammocoetes) in shallow water rearing areas to safely move to deeper water as water surface elevation drops.	KEEP. Reasonable measure to allow LR to move as wse is reduced.	–	–
Lamprey	Modify spill operations to improve passage and survival of juvenile lamprey (through all routes) during pulses of outmigration (freshets).	CLARIFICATION: Assume this means project operations. Keep. Measure has been discussed but not yet implemented.	–	–
juvenile salmon	No transport of juvenile fish	Not enough detail to evaluate.	–	*Oregon needs more detail about this mitigation action prior to making a technical recommendation. *We believe that if the juvenile salmon remain in the river, we can optimize spill during the migration season, and maximize the benefits of whatever spill regime is established.
–	Non-native predator control	Increased water outflow Decreased water residence time Reduction in storage	–	Removal of pike and other non-native predators for the benefit of native species and prevention of downstream distribution. Increased predation due to decreased storage by increasing proximity of predators and prey and reducing shallow water habitat for juvenile fish.
–	Nutrient enhancement in tributaries upstream of Dworshak Reservoir to mitigate for the effects that annual drawdown is having on shoreline productivity in the reservoir.	–	–	–
Adult Salmon and Steelhead	Open Corner Collector March 1 to improve kelt survival at Bonneville Dam	–	–	–
Salmon and steelhead	Operate John Day reservoir at Minimum Operating Pool (MOP)	Opportunity for improved juvenile out migration, improved habitat for wildlife, potential to reduce predation, etc.	Previous FCRPS EIS	Not enough time to research specifics but this action has been discussed and analyzed in previous processes.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Ops for temp	Keep. How different is this from NAA? Delete? Maintain Dworshak operations for mitigating temperatures during fish migration.	–	*In particular Dworshak Reservoir can be used to keep the Snake from irreversible warming in August and Early Sept. Which is somewhat considered, may even be needed for MO3 operations. If we are solely looking at fish benefits, and not power production, which is this metric, then we need to operate for favorable temperatures. In the past we have experienced adult steelhead thermal block in the snake in late August and Early September. We now also have a sockeye program with a summer timing in the snake. Water temperatures in the Snake is likely a critical component of recovery. *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *Managing cold water will continue to be an important consideration for hydropower operations.
sturgeon	Optimize dam flows for White Sturgeon spawning and early life stage survival	To create spawning habitat (ie flow, stable hydrograph, and temps) to create conditions that will benefit sturgeon production in tailrace reaches for all reaches that have populations of white sturgeon. M&E: Investigate sturgeon flows in lower river to encourage spawning	https://www.nwcouncil.org/sites/default/files/ColumbiaBasinWhiteSturgeonPlanningFramework2013Dec_0.pdf	*Assuming this is meant for dams other than Libby. More research on this topic is needed, but flows for white sturgeon are critical to spawning and rearing. *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
–	Outlet exclusion	Not enough detail to evaluate.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Lamprey	Passage structures for lamprey at all facilities across range	–	–	–
–	Prior to the spring migration, dredge and deepen river mouths if existing deltas create shallow predator feeding stations (i.e. Klickitat, Hood River, Umatilla, etc)	River operations have eliminated flushing flows that would remove this deltas. These pinch points expose outmigrating smolts to predation by avian and piscivorous predators. Mitigation actions are necessary to maximize smolt survival in a permanently altered habitat.	https://plan.critfc.org/	–
Adult Salmon and Steelhead	Provide money and support to harvest managers to develop improved harvest monitoring and reporting systems	–	–	*Outside the authority of action agencies to implement, but could potentially be implemented by others

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Steelhead	Provide spill in Fall and Spring to protect overshot adults and downstream migrating kelts. (McNary study is evaluating this for overshoots)	This is currently being planned for McNary. Past McNary work has shown that adults will used the RSW spill routes when they are opened. It is newest 2018 BiOp and should be added to the CRSO.	2018 BiOp	–
Adult Salmon and Steelhead	Provide surface spill outside of fish passage season for adult overshoot and kelt steelhead at all 8 dams	Keep	–	–
Juvenile Salmon and Steelhead	Pull Screens where turbine survival is high	Keep.	–	–
–	Purchase/improve supplemental spawning habitat outside area impacted by drawdown	Increased duration of drawdown Change in timing of drawdown with regard to spawning.	–	Dewatering of native species' eggs/redds
Lamprey	Quit messing with ladder entrances. LPS are the biggest benefit for lamprey	–	–	–
Juvenile Salmon and Steelhead	Reconfigure stilling basins (project specific) to higher elevation/less depth for plunging flows to limit TDG	Technically unlikely, potentially harmful to juveniles, and not as cost effective as improved flip lips	–	*Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Juvenile Salmon and Steelhead	Reconnect mainstem and offchannel habitats	KEEP and CLARIFY. Reconnect and restore mainstem and off-channel habitats to off-set reduced inundation (and access to) shallow water habitats resulting from (anticipated - TBD) preferred alternative. In kind, in place mitigation. Develop mainstem habiat projects that provide rearing and holding habitat for juvenile and adult migrating fish. In kind, in place mitigation. Develop mainstem habiat projects that provide rearing and holding habitat for juvenile and adult migrating fish.	–	Reconnection of side channel and floodplain habitats through land acquisitions and habitat improvement projects
–	re-design spillway to mimic normal step-pool/waterfall elevations. Look at stepped spillway (MSH SRS?)	Not enough detail to evaluate.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
–	Reduce and/or characterize water quality at the outflows from irrigation waters	Unknown levels of discharge both flows and contaminants from irrigation waters into Columbia, Snake and other waters likely impact spawning, rearing, and foraging success of salmonids and other resident species.	–	–
Juvenile Salmon and Steelhead	Reduce fish handling at bypass locations	–	–	–
Juvenile Salmon and Steelhead	Reduce fish handling at Little Goose JFF	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Juvenile Salmon and Steelhead	Reduce fish handling at Lower Monumental JFF	–	–	–
Lamprey	Reduce hydrosystem effects by modifying structure and operations as needed to increase upstream passage efficiency for adults of all four species of lamprey to achieve increased escapement, better distribution, and increased spawning success. Identify and remediate any locations where weirs cul-de-sac or other structural deficiencies are accumulating delayed adults.	Keep	• Pacific Lamprey (Entosphenus tridentatus) -- Anadromous • Western River Lamprey (Lampetra ayresii) -- Anadromous • Western Brook Lamprey, (L. richardsoni) -- Resident • Pacific Brook Lamprey, (L. pacifica) –Resident	–
–	Reduce impoundments, stream restoration to reduce impacts to stream channels	Keep	–	–
–	Reduce load following limited to +/- 5% on the big 10	Keep	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. *Operations for peaking at Lower Snake and Lower Columbia plus CHJ and GCL. may only be necessary during the smolt migration season.
–	Reduce or eliminate areas of hard armoring/levees	Identify areas where levee setbacks could occur, or replace hard amoring (riprap) with "soft" or natural armoring to increase refugia for resident fish and improve migration habitat.	–	*If not on Corps or BOR owned land, then this action would be outside authority of action agencies to implement, but could potentially be implemented by others
Adult Salmon and Steelhead	Reduce passage of non-native species through selective modification of ladders (e.g., American shad, shrimp)	KEEP. Good idea. Reframe as an investigation (research)? Can dams be modified to reduce shad populations in Columbia?	–	American shad are non-native species that likely consumes a large biomass of productivity in the Columbia Basin that could be utilized by endemic species and should be reduced in abundance. However, short-stopping their adult migration through ladder modifications may result in large numbers of shad occupying the ladders and negatively impacting adult salmonid passage. Consider other strategies to effectively reduce shad abundance.
Piscene Predator Control	Reduce predatory fish habitat through reduction of non-natural structures (e.g., removal/modification of large riprap structurs, pile dikes, in-water structures, etc), flow/velocities changes (reduce spawning, recruitment, etc)	CLARIFICATION: Omit reference to off-channel habitats. These areas do not necessarily invite predators. See comment above regarding "softening shorelines".	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Piscene Predator Control	Reduce predatory fish through reductions in spawning, rearing, foraging abilities - predation management	KEEP but CLARIFICATION: USACE led habitat management could only occur on USACE managed lands or authorities.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
–	Reduce the amount of water level fluctuations in dam tailraces-(for sturgeon this would be directed to early life stage development time)	Keep	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
–	Relax storage reservation diagram at 6 FRM projects	–	–	*Needs explanation on what this is *Has the potential to increase flood risk downstream and likely only feasible during normal to low water years. *Oregon needs more detail about this mitigation action prior to making a technical recommendation.
general	Remove JBS screens in the event that fish friendlier units demonstrate high survival rates	–	–	–
Piscivore Control	Remove Miller Rocks nesting habitat via blasting, rock removal, or other means to reduce habitat availability for bird colonies in TDA pool.	–	–	–
Piscene Predator Control	Remove non-native species and piscine predators passing through/residing in Juvenile Bypass Structure - predation management	KEEP but do not believe this is within USACEs authority. Could coordinate with States.	–	*Surprised we are not doing this already. *Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Adult salmon and steelhead	Remove or reconfigure AFF at Bonneville	ADD AFF delays fish passage and potentially increases mortality.	–	–
Adult Salmon and Steelhead	Remove Shad from adult fishways to reduce stress on summer migrating adults.	–	–	–
–	Remove the double crested cormorant colonies that currently nest on the Troutdale BPA towers. There are hundreds of birds nesting and roosting on the towers, consuming smolts at a much higher rate than birds in the estuary due to lack of prey diversity.	Unneccesary loss of listed smolts , protection of a known salmonid predator, destruction of historically registered structures, a no-brainer to remove this colony.	DDC 2015 EIS	BPA Power Division knows about the problem, but lack the proper motivation from BPA administration
Avian Predator Control	restore barren deltas to forested deltas to maximize safe smolt passage	–	Cite work by Bill Sharp, YKFP, Yakama Nation	these deltas are death traps with shallow water and access by avian predators
–	Restore mainstem habitat through increased habitat complexity (rapid, riffle, run, pool), shallow water rearing habitat connectivity, temperature reduction, riparian function restoration, restore ecosystem processes	–	–	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Restore/enhance thermal refugia at mainstem confluences	–	–	develop projects and prioritization for improving LWD recruitment, habitat complexity, nutrient enhancement, and refugia in mainstem rivers downstream of projects
–	Restore/enhance thermal refugia at mainstem confluences in the lower Columbia River	–	–	thermal refugia are import for the survival of upstream migrating adult salmon and steelhead. We expect that these locations will become even more important given expected temperature increases due to climate change
–	Selective outlet withdrawal for D/s temp	–	–	Keep. This should be tested and implemented at all possible CSRO projects to combat climate change in-river.
–	Selective spillway bay use (which gates lift)	–	–	*Recommend managing adaptively thru existing operational forums. *Oregon supports further development of spill patterns which minimize unintended adverse consequences to fish.
General?	Slow down speeds of the ships on the Columbia River to reduce the size of waves that wash fingerlings up on beaches where they become stranded along the river.	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others *Not clear what species this action would be aimed at. Need more information/documentation that this is an issue.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Snake River Spring time spillway crest drawdown	Should dramatically improve Snake River Chinook, steelhead,and sockeye SAR's through reduced travel time, reduced predation, reduced energy expendature, and reduction of powerhouse direct and delayed mortality. During mid-summer through winter would allow for barge transportation and full power production during time of year when hydropower is more important and valuable to region. Would also assist with seditment management in the Snake and Clearwater rivers confluence area.	COE sediment management plan for the Lewiston/Clarkston area. COE drawdown report. Any Snake River Breach report since would likely provide most of the biological benefits of breaching the 4 LSR dams while still allowing for most of the economic and reservoir recreation benefits of current configuration and operations. Congelton reports from 1990's showed that in-river Snake River juveniles arrive at Bonnevile Dam in a depleted energy condition.	Reduced travel time throught increase water velocity by dramtically reducing cross sectional area of each reservoir to allow smolts to arrive at esturary during more normative timeframe. Predation reduction would occur with dramatically increased spring turbity levels, disruption of piscivorous fish spawning and reduction of their suitable habitat and therefore populations, and reduced juvenile travel times. Juvenile evergy expendature would be reduced by them being able to naturally drift downstream with the increased velocities instead of having to actively swim through slower reservoir velocities. Powerhouse direct and delayed mortality would be reduced through reduced powerhouse encounter probabilities as well as less strikes and pressure changes for those juveniles that do enter a powerhouse. At spillway crest could potentially open locks as a primary alternative juvenile passage route, and possibly roughen the bottom of the lock so it could serve as an adult passage route during drawdown. COE Engineers would need to determine if best to operate high head turbines at lower head, speed-no-load, or shut off. Could consider replacing 2-4 of high head turbines with those designed for drawdown operation since generally only can operate fewer high head turbine summer through winter.
–	Spill Increase to maximize SPE (shouldn't change hydrograph) to improve juvenile fish passage	Keep	–	This sounds like it may be synonymous with the measure in MO4 originally proposed by the Nez Purse to minimize Power House encounters project by project. If so, Oregon supports further development of this mitigation action.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Spill outside fish passage season	May be advisable to address kelt and overshoot downstream passage needs	–	*Need more discussion/clarification on how, where, and when to achieve desired outcomes. Operations for peaking at Lower Snake and Lower Columbia plus CHJ and GCL. *Spill should be considered for downstream passage of steelhead kelts and bull trout adults outside the timeframe for smolt migration. Downstream movement of adult bull trout may be an important issue on the Lower Snake River. There is a need to identify how to facilitiate adult passage during the "non-spill" season.
–	Stop all Spillway spill to improve adult fish passage	–	–	* In general, spill should not be reduced during the outmigration season unless it is clear that spill is causing a delay in adult passage for salmon, steelhead, and bull trout, and that the delay may result in pre-spawn mortality of salmon or delays in forage/migratory movements of bull trout. *Oregon believes implementation of this mitigation action would result in severe reduction in juvenile salmonid survival and a severe decrease in life cycle survival as measured in SARs.
–	Support artificial propagation programs that provide harvest, and conservation efforts for salmon and steelhead	Artificial propagation is necessary to partially offset CRSO impacts to harvest, conservation and Tribal cultural/subsistence.	–	Unclear what the effects of the action would be. No action would maintain current mitigation activities.
Piscene Predator Management	Support non-native fish derbies	NEW	–	*Outside authority of action agencies to implement, but could potentially be implemented by others *Fish tagging w/reward. Other rewards. Harvest proportionally larger fish. Low cost.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	The effectiveness of tributary habitat improvement actions can be enhanced when actions are implemented consistent with best available science and within a within a strategic framework that places near-term actions within a long-term strategic objective and plan. The Action Agencies should work through the Tributary Habitat Program Steering Committee to help maximize the effectiveness of tributary habitat improvement actions in terms of their benefits to targeted populations and to ensure implementation of the program in a manner consistent with long-term recovery goals. Efforts should include (a) ensuring that actions are prioritized, sequenced, and implemented actions consistent with approaches recommended in best available science on watershed restoration (see, e.g., Beechie et al. 2008, 2010; Hillman et al. 2016) and (b) working with NMFS, through the tributary habitat steering committee and the Columbia Basin RM&E steering committee, to improve alignment between tributary habitat improvement actions prioritized for implementation and NMFS focal populations (Cooney, in press).	Offsite mitigation for impacts of hydrosystem to abundance, productivity, and survival.	–	*See 2019 CRS BiOp, Conservation Recommendation #13 *The action alternatives have minimal to no impact on tributaries, and therefor are not anticipated to have mitigation. Fish impacts will first look at inplace inkind mitigation opertunities.
–	The Northwest Power and Conservation Council's Fish and Wildlife Program is in its 47th year. It follows the Northwest Power Act, 16 USC 839b (h). The Program mititagation measures must be included in the EIS, which is otherwise flawed for failing to take the Program into account at this relevent stage of the Action Agencies decision making process. 16 USC 839b (h)(11)(A).	–	The Norwest Power and Conservation Council Website.	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Lamprey	The Tribal Pacific Lamprey Restoration Plan sets forth near term and long term plans for mitigating the effects of the Corps dams on Pacific Lamprey. All of the mitigation measures in this plan should be addressed in the mitigation section of the EIS. Detailed implementation schedules have been developed by the Corps/Tribal Lamprey Technical Team and the individual actions within this plan should be listed in the mitigation measures	–	https://www.critfc.org/fish-and-watersheds/columbia-river-fish-species/lamprey/lamprey-plan/	–
–	To mitigate for high levels of kokanee entrainment at Dworshak Dam, emphasis should be put on maintaining the nutrient restoration program that occurs in the reservoir. This program has proven successful in maintaining higher numbers of kokanee in the reservoir and shortening the amount of time it takes the kokanee population to rebound from significant entrainment events. To shorten the amount of time it takes kokanee to rebound from a significant entrainment event, supplementation should also be a mitigation measure to be considered.	–	Wilson, S. M., and M. P. Corsi. 2016. Dworshak Reservoir nutrient restoration research, 2007-2015. IDFG report #16-22, Boise, ID.	Due to flood risk management at Dworshak Reservoir there are years when entrainment to kokanee can be significant (>80% of the entire population). Not only does this influence kokanee abundance in the reservoir for multiple years but it also influences smallmouth bass (and likely Bull Trout) growth and abundance, and stream productivity where kokanee spawn.
–	To mitigate for the effects that annual drawdown is having on shoreline productivity and survival of littoral species, emphasis should be put on maitaining the nutrient restoration program. In addition, investigations could occur to evaluate if there are aeas where shoreline habitat could be modified to provide population level effects for certain fish species.	–	–	Annaul water level fluctuations at Dworshak typically reach 80 feet. This annual drawdown has significantly reduced shoreline productivity and survival of critters (fish/crayfish/insects) that are more shoreline oriented.
UCR spring chinook; UCE steelhead; mid-C steelhead; SR Sp Chinook; SR steelhead.	Transport juvenile salmonids from McNary Dam in spring.	*Of collected UCR Spring Chinook and UCR Steelhead 20% more would retun as adults if transported rather than bypassed. *For those Columiba River summer outmigrants collected 11-17%, more could be expected to return as adults if transported.	*Marsh et al. 2011 *Axel 2009	–

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
Juvenile Salmon and Steelhead	Tributary habitat protection/enhancement to promote increased juvenile salmonid	There will always be some level of motality and adverse impacts to juvenile and adult migrants as a function of the CRSO. Increasing juvenile production increases as a result of habitat mitigation measures will partially offset the 'unavoidable" impacts of the CRSO	–	–
–	Tributary restoration to improve habitat and channel complexity	Increased duration of drawdown Lower reservoir elevations	–	Migration to and from tributaries and Lake Roosevelt is physically inhibited by channels within drawdown zone Increased predation of juveniles/adults as they migrate to/from tributaries through drawdown zone
Adult Salmon and Steelhead	Update and maintain fish ladders, pumps, and turbines to reduce outages and impacts	–	–	–
–	Upstream fish passage for adult salmon	Increased water outflow Decreased water residence time Extension of drawdown period. Delay of refill.	–	Entrainment/removal of mitigation fish which has already been documented to have not mitigated for the loss of anadromous species (NPCC 2000). Reduction of in-reservoir primary and secondary productivity which translate to reduced forage base for the mitigation fishery. Anadromous fishes accumulate the majority of their biomass in the ocean, reducing the importance of in-reservoir production.
Piscivore Control	Use findings from upcoming Avian Predation Synthesis Report to develop a conceptual management plan for warranted actions that would further reduce the size of piscivorous waterbird colonies at human created or influenced sites in the Columbia basin for the purpose of reducing predation rates.	–	–	–
Piscivore Control	Use green lasers or other dissuasion methods to discourage avian predators from roosting, foraging or loafing at hydro project infrastructure, resulting in reduction of predation on juvenile salmonids.	–	–	–
–	Use screening technology to preclude White Sturgeon from entering draft tubes	Not enough detail to evaluate.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.

Fish Type	Draft Mitigation Measure	Reason to addition	Citations	Notes
–	Use seasonal crews to conduct hazing/lethal control during spring outmigration at all hatchery release points, major trib mouth (Umatilla, Walla Walla, Yakima, etc), timed to maximize successful passage of hatchery, natural releases	Each spring, millions of smolts are consumed by avian predators throughout the basin. The predation near hatchery release points, river mouths, diversion dams, etc. is needless, wasteful, and can be mitigated.	https://plan.critfc.org/	The managed river has created these locations over time and therefore need to be properly mitigated for to maximize the regions investment in salmon recovery.
Passage/Structural	Use slot passageways (alternative to fish ladders)	–	–	–
Sturgeon	Use White Sturgeon conservation aquaculture to mitigate for population losses due to the hydrosystem	Oregon would be supportive of white sturgeon supplementation within the context of CRITFC's sturgeon Master Plan, but not otherwise.	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.
Piscivore Control	Where possible, use dredge spoils to connect avian island habitat to mainland making them unsuitable for nesting	–	–	–
Piscivore Control	Work with regional stakeholders to dissuade avian predators (terns and cormorants) from nesting on non-Federal structures (bridges, navigation towers, transmission towers, etc.).	–	–	–
Piscivore Control	Work with regional stakeholders to identify property ownership of Miller Rocks in TDA pool and implement warranted actions to reduce habitat availability for avian predators (gulls and terns).	–	–	–
–	Stop Harvest of listed fish	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.	*Outside authority of action agencies to implement, but could potentially be implemented by others *There is no direct harvest of listed fish other than tribal harvest through treaty right.
–	Allow only terminal harvest	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.	Outside authority of action agencies to implement, but could potentially be implemented by others
–	Eliminate gill nets and allow harvest at fish ladders via trap	–	–	Outside authority of action agencies to implement, but could potentially be implemented by others
–	Eliminate mainstem harvest	–	Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.	*Outside authority of action agencies to implement, but could potentially be implemented by others *Implementation of this wholesale action would result in unintended consequences to listed-salmonids
–	Wy-Kan-Ush-Mi Wa-Kish-Wit is the Columbia River Treaty Tribes Spirit of the Salmon Plan. It contains numerous measures intended to mitigate the effects of the federal dams on anadromous fish.	–	https://www.critfc.org/fish-and-watersheds/fish-and-habitat-restoration/the-plan-wy-kan-ush-mi-wa-kish-wit/	–

4.1.3 Vegetation, Wetlands, and Wildlife

Draft Mitigation Measure	Reason to addition	Citations	Notes
Acquisition/deacquisition of Corps managed lands to ameliorate changes in wildlife habitat and recreational useage (coordinate HMUs with USFWS)	Add: The Corps needs to maintain activities at HMU's as part of operations. Additional Acquition of additional lands may be necessary to offset additional impact to riparian habitat (i.e. fill or conversion of habitat) if selected alternative has additional impacts. This additional acquition may be necessary through the Fish and Wildlife Coordination Act.	Lower Snake River Comp Plan.	Lower Snake River HMU's were created to offset the initial impact of building the dams in accordance with the Fish and Wildlife Coordination Act.
Maintain lowered winter flows at Libby and Hungry Horse Dams in years following high spring runoff to aid in the establishment of riparian vegetation.	MO4 would implement this measure with much more detail, but this more generic approach would provide beneficial mitigation for the other alternatives.	Merz (unpub data), Casey (2006), Braatne and Jamieson (2001), Auble and Scott (1998)	The more frequently you can meet these conditions, the more benefit from this mitigation measure. Irregular, periodic establishment of woody riparian vegetation will provide measurable benefits to the aquatic and terrestrial ecosystem. Similar benefits would result if this measure were incorporated in other dams with significant acreage of altered floodplain downstream of the hydropower project.
Buy up land in estuary for restoration to tidal wetlands	–	–	–
Continue to reconnect the estuarine floodplain (BON to mouth) to restore rearing habitat and increase flux of prey to the mainstem (support condition of outmigrants before ocean entry)	Added by L Krasnow (4/19/19) - see also measures for "Juvenile salmon and steelhead" in Fish tab	–	–
Create AIS field survey and removal season crews to Initiate annual removals of known and new occurences of invasive aquatic plants on within and on Federal property.	Invasive species and their associated impacts will be a permanent concern for the basin, increased monitoring will help with early dection and rapid response to eradicate and/or control. Similar to the need the reason for row 2, the problem is increasing and stable involvement by action agencies.	https://plan.critfc.org/2013/spirit-of-the-salmon-plan/technical-recommendations/invasive-species/ https://www.nwcouncil.org/fish-and-wildlife/topics/invasive-species https://www.westernais.org/monitoring	Well documented issues and concerns, need overall increase and participation by the action agencies on AIS Proposed under new tab "Aquatic Invasive Species"
Elk Foraging areas in storage dams	Add. Maintaining elk habitat by creating deer browse areas replaces lands lost by the storage dam projects. Dworshak does have lands dedicated to providing elk browse.	Management of the corps' forested lands surrounding the project has involved providing mitigation for some of the impacts under the Fish and Wildlife coordination Act (Public Law 85-624) and Department of the Army Engineer Regulations (ER 1105-2-129, ER 1120-2-400, and ER 1165-2-104).	–
Environmental flow (intentional overbank)	Add: This measure would restore relic floodplains by allowing them to flood, thereby restoring riparian areas and allowing cottonwood dispersal. It would regain connectivity. Could be used to mitigate for any cottonwood impacts. It may conflict with FRM. Used in the Williamette Valley to get high flow events to overbank. Hungry Horse, looking for bankful flows for the cottonwoods and gravel sorting. *Oregon strongly supports further development of operational and/or structural mitigation actions to return the hydrograph to a more normative (pre-hydrosystem) pattern.	Hoag 2001, Hoag and Landis 1999.	in both fish and wetlands *may be appropriate to restore riparian habitat, in particular cottonwood/willow; emulate natural hydrograph *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish.
Estuary Habitat Improvements: Prohibit development within the estuary	–	–	*Outside the authority of action agencies to implement, but could potentially be implemented by others
Estuary Habitat Improvements:Reconnected floodplains throughout the river including a reconnected lower river estuary ecosystem	–	–	–
Habitat restoration.	Add. Habitat restoration for areas that were previous wetlands or other habitat types that are now managed for human use (i.e. they are currently in agricultural use).	–	–

Draft Mitigation Measure	Reason to addition	Citations	Notes
If drying out wetlands: creation or restoration of wetlands (wetland mitigation banks?)	Add. Can we create wetland mitigation banks along the Snake and Columbia River to serve multi-use projects? Can we restore wetland benefits for areas that are no longer wetlands (i.e. relic wetlands).	–	–
Increase shoreline vegetation for habitat and shading	Add: Add in areas where it may enhance the riparian buffer. It may not be appropriate in some sections of the project area (i.e. sagebrush areas).	–	in both fish and wetlands *Need more discussion/clarification on how, where, and when to achieve desired outcomes w/o other unintended consequences to fish. Managing reservoir elevation (promote wetlands and grow riparian vegetation on shorelines)
Minimize recreational events during nesting and breeding periods or near sensitive nesting sites	Jet boat races and other highly disrupting activities during nesting season.	–	*Outside the authority of action agencies to implement, but could potentially be implemented by others
Naturalize hydrograph / manage for environmental flows to promote survival and regeneration of riparian habitat downstream from dams	ADD: Managing flow regime in a way that mimics a natural river hydrograph can restore and revitalize riparian habitat and provide the best overall benefit and mitigation for environmental processes and wildlife in a dammed river system	Rood et al. 2005. Managing river flows to restore floodplain forests. Frontiers in Ecology and the Environment 3(4):193-201.	–
Prevention measures must be identified, assessed and implemented to stop the invasion and spread of zebra and quagga mussels, and invasive aquatic plants such as Eurasian mi/foil, hydrilla, and flowering rush. These measures should include, but are not limited to, education and public outreach efforts to promote awareness of the potential impacts and costs of a successful invasion, and the potential solution provided by required inspection, detection, and decontamination of boats previously moored in infested waters and then transported on our roadways in the region	Delete the zebra/quagga mussel component of this measure. This is more likely BMP's not mitigation. Add removal of flowing rush, reed canary grass, and other invasive aquatic plants as mitigation. This would be considered habitat enhancement as removing these invasive species can create an ecological lift in the environment by encouraging native vegetation, native animals, pollenators, etc. Areas where invasive species are being removed would likely need to be replanted with native species.	Federal Noxious Weed Act of 1974 (Public Law 93-629), the Carlson-Foley Act of 1968 (PL 90-583), and Executive Order 13112 (Invasive Species, 1999). Engineering Regulation 1130-2-540.	Invasive species have the potential to seriously disrupt the Columbia Basin ecosystem and critical infrastructure.
Provide funding for private landowners to do riparian fencing/improvement projects (Grants?)	–	–	*Outside the authority of action agencies to implement, but could potentially be implemented by others
Recreate the river pulse for cottonwoods.	Add. This would recreate the pulse necessary for cottonwood recruitment (spring freshet). This would only be needed in areas where it would be appropriate (areas that can sustain cottonwood habitat).	–	–
Reduce or eliminate avian predation control projects on native migratory birds	–	–	–
Trib Habitat Improvements	Focus mitigation on the Salmon and Clearwater basins, Idaho contains some of the best habitat in the Columbia River basin yet much of that habitat is not fully seeded.	–	–
Tributary restoration efforts?	Add. The tributaries provide wildlife habitats for animals and plants that utilize the mainstem of the Columbia and Snake River (i.e. beaver, otter, eagles, heron, osprey). More riparian habitat benefits can be provided on the tributaries.	–	–
Waterfowl habitat enhancement	Add. Waterfowl may be affected by loss of nesting habitat, loss of foraging areas due to water quality changes (i.e. temperature, turbidity). This mitigation measure would include creation of nesting habitat and foraging areas for waterfowl.	–	–
Winter Elk mitigation: This mitigation measure would provide enhancement of elk habitat to increase breeding success of elk populations as well as mitigation measures to prevent ice sheets from creating barriers to elk migration	Add. Elk migration in the storage projects can be treacherous during winter months because of the ice. .	Dworshak EIS	Changes in the reservoir levels as a result of project operation will resulting the ice covering being weakened along the shoreline. This will also cause problems for any animals venturing onto the ice since the dropping water levels and weakened ice will increase the chance of fall through.

4.1.4 Power and Transmission

Draft Mitigation Measure	Reason to addition	Citations	Notes
add RSWs or TSWs to reduce need for other spill	This measure would help offset loss in power generation but only if accompanied by a decrease in spill.	–	From a power perspective, this is only worth spending money on if there is an assurance that overall spill will be reduced because of the addition of the spillway weir.
expand range of operating pools, esp at LCOL and LSN	This measure would help offset loss in flexibility as well as offset increased costs for power.	–	*May be applicable at JDA only? Probably not anywhere else. do not surcharge due to dam safety *Operations measure may serve as mitigation for MOs that don't contain this measure. *Reducing restrictions on pool levels during certain seasons increases flexibility, thereby increasing the ability of FCRPS to integrate more non-hydro renewable energy.
fewer restrictions on ramping rates	This measure would help offset loss in flexibility as well as offset increased costs for power.	–	*Beneficial to generation if allowed to ramp down much faster than current rates. Some restrictions for bank sloughing need to stay - earthen embankment projects (don't ramp @ rate to slough) *This measure may serve as mitigation for MOs that don't already contain this measure. *Increasing ramp rates would allow BPA to better monetize the flexibility of federal hydropower by responding more quickly to changes in market conditions. Resources that can quickly ramp output up or down are increasingly valuable to integrate the output of more variable resources, such as wind and solar.
reduce restrictions on seasonal pool elevations	This measure would help offset loss in flexibility as well as offset increased costs for power.	–	*LSN-MOP, JDA-MIP *Operations measure may serve as mitigation for MOs that don't contain this measure. *Reducing restrictions on pool levels during certain seasons increases flexibility, thereby increasing the ability of FCRPS to integrate more non-hydro renewable energy.
Store more in spring, optimize hydrograph to the annual energy cycle (store more in the spring)	This measure would help offset loss in power generation as well as offset increased costs for power.	–	*subject to FRM *This measure may serve as mitigation for MOs that don't already contain this measure. *Power needs are different seasonally and are changing over time. For example, there is likely to be a growing need for increased summer generating capacity due to climate change. There is also likely to be less demand from California to import Northwest hydropower from excess spring runoff due to the abundance of solar power output at that time of year. Climate change is likely to influence changes in both demand and generation capacity into the future.
Add or modify resources (thermal, renewable, demand response, etc)	This measure would help to alleviate regional transmission congestion if added/modified in a location nearer loads.	–	This is outside of scope of the action agencies, but could be done by others.
Add price for carbon to all fossil-fuel generation to increase the value of hydropower	This measure would help offset loss in power rates.	–	This is outside of scope of the action agencies, but could be done by others.
Add transmission facillites (transmission lines, voltage reactor, RAS, etc)	This measure would help to alleviate transmission congestion and potential reliability issues.	–	This is in scope. We would not be able to determine where to determine impacts, site locations, but would include parametric costs.
Adjust (increase) minimum generation at Lower Columbia projects	This measure would help with transmission operations and reliability.	–	–
Adopt flex spill operation in the preferred alternative. Would need to choose what levels of spill are the upper and lower levels of spill	This measure would help offset loss in power generation, flexibility and reliability and would offset impact to power rates compared to spill that it at higher levels all the time.	–	–
Allow for flexibile draft target for Libby below 2420 ft at the end of December.	This measure would help offset loss in power flexibility.	–	This could be a compromise between the MO1/MO4 and the MO2/MO3 levels.

Draft Mitigation Measure	Reason to addition	Citations	Notes
allow spill curtailments to increase water available for generation to meet load during events with unusually high demand such as during summer heat-waves. (This would not replace much of the lost energy from new operations, but would help with reliability and reduce the need for replacement resources.) This could be only during emergencies or during driest X% of years or when flow is below y kcfs	This measure would help offset loss in power generation and reliability.	–	Note that this would be an operation separate from (or in addition to) flex spill. Flex spill would only be in the spring, and the bigger problem is in the summer. This measure is a more narrow version of the broader measure (currently in row 2 of the spreadsheet) "Decreasing/stopping spill (stop voluntary spill)"
average spill in 12-hour, 24-hour or shorter blocks. For example, in flex spill spring, average spill during the flex blocks and during the full-spill blocks. In the summer, average over 24-hours.	This measure would help offset loss in flexibility.	–	Adds flexibility to meet peak demands for power which is important for meeting load and for integrating other renewable energy sources in light of climate change.
Begin higher levels of juvenile fish passage spill later, when significant numbers of fish are in the river (e.g. start April 15, April 30 or start per fish count but only if also accompanied by 2-4 days' notice). Either no spill in the first part of April or spill to "performance standard" starting April 3/10.	This measure would a) help to alleviate reductions in power generation b) reduce TDG in early April and not "pre-gas" the river before significant numbers of juveniles show up.	–	Power would need 2 days' notice before fish spill starts (longer if it is right after a weekend) because power is marketed 1-3 days in advance. --mitigation measure also added to water quality for TDG impact
build LMS100 reciprocating plants instead of single-cycle and combined-cycle plants	This measure would help offset loss in flexibility.	–	LMS100 units are more expensive but also more flexible than the single-cycle gas plants
Change draft and refill timing in certain years, based on a prescribed trigger, to be earlier in response to climate change.	This may or may not help power generation. Would probably help FRM and fish	–	Not sure if this will be helpful (mitigation) or detrimental to power. drafting sooner moves water into winter, good for power. Touching full earlier is good for power in some years (head gain), but not in years where there is a risk of running out of water in August. May need to be done with adaptive management measures.
Decreasing/stopping spill (stop voluntary spill)	This measure would help offset loss in overall generation and in certain months helps reliability.	–	*This measure may serve as mitigation for MOs that don't already contain this measure. *Reductions in voluntary spill are helpful in the context balancing competeing needs from water. Giving federal agencies the flexibility to reduce spill during certain hours can enable BPA to maximize the value of its power sales in wholesale markets.
Delay the start of when turbines on the fish passage projects must operate within 1% (or within and above 1%) of their peak efficiency range until April 3/10 or even later when significant number of juvenile fish are in the river	This measure would help to alleviate reductions in power generation and power flexibility	–	–
demand response for increased flexibility	This measure would help offset loss in flexibility and perhaps reliability.	–	demand response is an option in the zero-carbon portfolios of potential replacement power to meet reliability needs. However, additional demand response may be applied in other circumstances to increase flexibility for hydropower generation.
Develop alternative energy sources (non-hydropower)	–	–	Utilities across the region have been developing new sources of non-hydro renewable output (mainly from wind, but increasingly solar, projects) in recent years in addition to continuing to develop cost-effective energy efficiency resources. This is occurring both to meet new electric demand, but also to supplant other existing supply resources (namely fossil fuel-powered generators). To the extent that any of these draft alternatives result in a reduction in output of hydropower from the federal system, additional regional investments in energy efficiency and non-hydro renewables could likely replace the output.
Develop dedicated funding sources for energy efficiency and demand response	Add-New Mitigation Measure	–	The federal hydropower system provides a significant amount of carbon-free flexibility that can help to integrate increasing volumes of wind and solar output at least cost. If that flexibility is diminished for any reason, developing dedicated funding sources for targeted energy efficiency and/or demand response investments can help to lessen the adverse impacts. Efficiency can reduce overall peak demand, while demand response can increase the flexibility of electric demand in instances where cost-effective flexibility in the available supply has been exhausted.

Draft Mitigation Measure	Reason to addition	Citations	Notes
Develop new renewable winter capacity resources (e.g., off-shore wind or wave)	Add-New Mitigation Measure	–	The federal hydro system contributes to the region's climate change goals in a variety of ways. First, the system provides a significant amount of carbon-free energy to meet the region's electric needs. Second, its flexibility helps to integrate solar and wind output. But third, it is capable of providing a significant amount of carbon-free winter capacity to meet the region's electric demand during sustained winter peaks. Carbon-free winter capacity is currently difficult to replace. One measure to mitigate any loss of winter capacity from the federal hydro system would be to develop new types of renewable resources with output profiles that peak in the winter, such as off-shore wind or off-shore wave energy. These types of generators could take advantage of strong winter storms to deliver additional winter capacity to the region.
Draft GCL and maybe upstream storage projects slightly deeper by April 10 or completely eliminate the April 10 requirement. Potentially lower the April 30 elevation as well.	This measure would a) help to alleviate reductions in power generation b) reduce April flows thereby permitting a higher percentage of spill within the TDG parameters which would lead to lower PITPH and would help fish	–	--mitigation measure also added to water quality tab as it helps with TDG management and to fish tab as it reduces PITPH
Draft GCL deeper at end of August to keep August flows higher	This measure would help offset loss in reliability. It would, however, reduce total power generation, if there is spill in August	–	Increases August flow (high value to power and may help adult fish migration). Could be particularly usefil in MO4 if the MCN flow augmentation measure I implemented because of that measure's large impact on reliability.
End fish spill spill earlier in drier years to increase power generation (may also help fish). May use more often and potentially start earlier as climate change leads to longer periods of low flows	This measure would help offset loss in power generation.	–	The value of this mitigation action to power is dependent on whether or not there is spill for juvenile fish passage in August.
explore other sources of funding for structural measures and fish mitigation measures	This measure would help offset impacts to power rates	–	Not sure this is feasible.
If the build-out of water supply is in the preferred alternative, modify the measure to be phased in as the water demand is phased in, rather than assuming it will all be used right away.	–	–	Two particular concerns: 1. if mitigation is required for the water withdrawals, the mitigation shouldn't be required until the water withdrawals really begin. 2. for any planning modeling in the region, it would certainly be more accurate to model the expected irrigation withdrawals, not the future irrigation withdrawals.
Implement 2018/2019/2020 flex spill as a mitigation action to reduce cost of spill to gas caps on hydropower generation	Reduce cost of spill to gas caps on hydropower generation in some alternatives	2019 NOAA BiOp	–
Implement some of the measures not selected for the PA in limited circumstances where/when the impacts to power are higher	This measure would help offset loss in power generation and flexibility.	–	presume we would refine this further during the mitigation workshops
Increase coordination across utilities in the Northwest and the west (e.g., grid regionalization)	Add-New Mitigation Measure	–	Increasing coordination (e.g., such as through expanded regional markets such as the Energy Imbalance Market) between utilities in the Northwest and in adjacent regions in the west can help mitigate the loss of any energy or capacity resulting from the draft alternatives being considered. For example, participation in the EIM could allow BPA to increase its revenues from the sale of hydropower to help offset any costs associated with loss in output from the draft alternatives. Alternatively, participation in EIM, or in other regional markets, could create new opportunities for the Northwest to replace carbon-free energy with imports from out-of-region.
Increase performance of PGs	This measure would help offset loss in power flexibility.	–	can be used more for reshaping power to load.
Increase probability of refill	This measure would help offset loss in summer power generation, but perhaps at the expense of winter power generation.	–	This measure may serve as mitigation for MOs that don't already contain this measure. Primary beneficiary might be anadromous fish and recreation, not power

Draft Mitigation Measure	Reason to addition	Citations	Notes
Increase transfer capabilities of regional transmission interties	Add-New Mitigation Measure	–	Increasing the transfer capability across regional transmission interties (e.g., at the California-Oregon Border) could enable the Northwest to import more carbon-free renewable power from other regions to mitigate against the loss of any energy or capacity resulting from the draft alternatives being considered.
Increasing investments in energy efficiency programs (potentially focus on low income communities).	This measure would help offset effects of MOs on cost of power to end users.	–	Could also be an Environmental Justice Mitigation measure. However, the load forecast assumed in these studies already includes all the cost-effective energy efficiency that the NW Power and Conservation Council has identified in the region.
Install low head high efficiency turbines in earthen fill sections of existing dams (or hydro-combine)	This measure would help offset loss in power generation.	–	*This can only be done for MO3. This will likely not be cost-effective and counter to the effort to have a free-flowing river. *Maximizing the efficiency of existing turbines and output from existing dam projects can result in increased carbon-free hydropower output
Look at adding modified Surface Spill bays (long verticle slots) similar to those at Rock Is. These could be used outside the spill season to aid overshots and kelts but use less water.	This would allow for protection of overshots and kelts but use less water and be more effient with water usage.	–	–
Look for more opportunities with Non-Treaty Storage water from Canada	This measure would help offset loss in reliability.	–	don't know if this is in scope for the CRSO EIS, and of course it depends on negotiations with Canada
Modify the measure that protets against rain-induced flooding. Allow Grand Coulee to be slightly higher when there is no low-elevation snow, but draft Grand Coulee more if low-elevation is falling. Presumably this would involve some sort of adaptive management	This measure would help offset loss in power generation and flexibility.	–	If low elevation snow is falling, it is often so cold that streamflows decrease, so this is coincidentally a perfect time to be drafting Grand Coulee deeper.
More flexibility on seasonal, daily hourly flow	*This measure would help offset loss in flexibility and power generation as well as offset increased costs for power. *Could be applied if it does not impact other operational purposes/requirements. We have a measure like this at Libby already.	–	*Operations measure may serve as mitigation for MOs that don't contain this measure. *Increasing this type of flexibility increases general operational flexiblity. This type of flexibility is expected to be increasingly valuable in future years as more variable output non-hydro renewable generation is added in the Northwest.
Participate in an energy market	This measure would help to alleviate regional transmission congestion.	–	this would offset effects to power
Reduce fraction of capital costs of MOs that get integrated into revenue requirement.	This measure would help offset effects of MOs on cost of power to end users. Most relevant to MO3.	–	Unsure if feasible; passes on costs to taxpayers.
Rehabilitate turbines	–	–	Economically feasible units are already going to be rehabed. Waiting for $/limited in # at a time (year) Maintaining optimal operation of the turbines can result in increased hydropower output.
Shut off spill in part or all of the summer on the Snake and possibly the lower Columbia to increase power production. (It could be implemented all summer, only July and Aug, or only during heat waves)	This measure would help offset loss in power generation.	–	Also a fish mitigation measure as it reduces temp in the Snake River
spill could be better managed to take advantage of power production during periods of time when insufficient numbers of smolts are migrating – both at the beginning and tail end of the runs; spill program is based on fish abundance rather than hard dates	This measure would help offset loss in power generation as well as offset increased costs for power.	–	*This measure may serve as mitigation for MOs that don't already contain this measure. *Looking at opportunities to apply this type of flexibility across the entirety of spill season--based on a scientific assessment of actual fish needs--could increase hydropower output and allow BPA to better monetize the value of the flexibility of federal hydro system.
Use all turbine bays (ie. add turbines)	–	–	Economically feasible units are already going to be rehabed. Waiting for $/limited in # at a time (year) Maximizing the efficiency of existing turbines and output from existing dam projects can result in increased carbon-free hydropower output.

4.1.5 Air Quality and Greenhouse Gases

Draft Mitigation Measure:	Reason to addition	Citations	Notes
The EPA supports incorporating mitigation strategies to minimize fugitive dust and toxic emissions, as well as emission controls for particulate matter (PM) and ozone precursors for construction-related activity. We recommend that best management practices, all applicable requirements under local or State rules, and the following additional measures be incorporated into the EIS, a Construction Emissions Mitigation Plan, and ultimately the Record of Decision. See EPA's Clean Construction USA website for additional information [http://www.epa.gov/cleandlesel/sector-programs/construct-overvlew.htm].	–	–	This is for BMPs for air quality.
All the mitigation measures that increase power generation have the possible, perhaps even likely effect of reducing CO2 emissions by reducing the use of fossil-fuel power generation in the PNW	–	–	–
Watershed nutrient reduction and erosion management aimed at preventing reservoir eutrophication may mitigate greenhouse gas emission, especially CH4 and NO2 release	–	–	–

4.1.6 Flood Risk Management

Draft Mitigation Measure	Reason to addition	Citations	Notes
Avoidance/mitigation of potential FRM impacts during system operations	–	–	Suggest consulting with water management for better language on operation strategies aimed at avoiding/mitigating FRM
Minimize trapped storage by drafting storage projects earlier so we have option to use the space for spring capture. Include creating a decision-point for modifying the draft rate (potential example is 1 or 2 standard deviations above/below the forecast)	Would need more detail as to which project this applies to. If the project regularly has trapped storage under a specific operation applying something like this suggestion would be appropriate.	–	We need to provide for a spring freshet; drafting water earlier doesn't help outmigration and then when spring flows do come they are not allowed to flow to the provide the spring flows needed instead they are used for refill. NOTE: Do any projects have trapped storage under new measures?
Modify levees	Assume this means modifying levee or raise levee height to decrease flood risk. Levee modification could be a mitigation measure for very specific location based increases in flood risk. However, it is dependent on many factors which make it difficult to apply as a mitigation measure on a CRSO basin wide scale.	–	Keeping, if there are FRM impacts at specfic locations, this may be mitigation.
Nonstructural measures	–	–	–
Purchase water rights to increase instream flows	–	–	–

4.1.7 Navigation and Transportation

Draft Mitigation Measure	Reason to addition	Citations	Notes
Build new highways to transport goods from Lewiston	–	–	This is outside of scope of the action agencies, but could be done by others. Note: Agencies do not mitigate for economic losses.
Build new railroad infrastructure to transport goods from Lewiston (might require more rail lines from Lewiston plus rail yards in Lewiston and in Portland/Vancouver harbor region)	–	–	*could be a challenge acquiring the land for new rail facilities in Portland/Vancouver area. Cost expected to be very high *This is outside of scope of the action agencies, but could be done by others. Note: Agencies do not mitigate for economic losses.
Change spill patterns to avoid or minimize navigation impacts	Added clarifying language	–	
Consider infrastructure improvements to ensure safety and minimized impacts along routes where increased traffic (rail or truck) may occur, especially if crossing through EJ communities. I.e., develop appropriate alternative routes to mitigate for increased wait times for local traffic.	–	–	This is outside of scope of the action agencies, but could be done by others. Note: Agencies do not mitigate for economic losses.
create an aquaduct/channel parallel to the river for barge traffic	–	–	–
Dredging to maintain authorized nav channel depth	–	–	–
Increase maintenance activities to address added wear on nav locks	–	–	–
Stabilize roadways that could be impacted by dam breach or draw down of LSR	Maintain usability of roadway	–	This is an assumption for MO3, however need to double check
Subsidize farmers in Idaho, eastern WA, eastern OR+ for the added transportation cost for shipping grain via rail or truck.	–	–	This is outside of scope of the action agencies, but could be done by others. Note: Agencies do not mitigate for economic losses.

4.1.8 Recreation

Draft Mitigation Measure	Reason to addition	Citations	Notes
Adjust operations to accommodate recreation	If substantial impacts to recreation conditions are identified could adjust operational plans	–	

Draft Mitigation Measure	Reason to addition	Citations	Notes
Conserve/improve reservoir sport fisheries	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Establish a higher winter lake level (i.e. Lake Pend Oreille)	This appears to be a measure, not mitigation for a measure? However, if evaluated for mitigation it could impact FR.	–	–
Establish an annual four-month "normal pool" period on Lake Pend Oreille (Memorial Day to October 1)	This appears to be a measure, not mitigation for a measure? However, if evaluated for mitigation it would impact FR. I don't believe there are	–	–
Establish decontamination (invasive species) stations including wash stations at all boat launches	Reduce or eliminate spread of invasive species	–	existing programs are ongoing
Extend boat ramps in Lake Roosevelt	Ramps during spring draw down are OOS and restricts access for those working with fisheries, subsistence fishermem, enforcement officers can't get on water to patrol for protection of cultural sites.	–	–
Extension of pre-existing or addition of new boat ramps	Lower reservoir elevation Increased duration of drawdown	–	Inoperable boat ramps inhibit access temporally and geographically) to the mitigation fishery and prevent fisheries research and monitoring from being conducted. Additionally, inoperable boat ramps reduce recreators of all kinds, resulting in economic loss to the region and prevention of tribal members from obtaining access to the focal feature of their usual and accustomed range.
Lengthen boat ramps	If access to reservoirs and/or rivers occurs due to change in water levels, boat ramps could be lengthened	–	–
Replace and/or relocate impacted recreation resources (parks, boat ramps, public facilities, etc.)	Mitigation measure will address direct impacts to rec resources	–	–

11 ### 4.1.9 Water Supply

Draft Mitigation Measure	Reason to addition	Citations	Notes
Develop potential mitigation and solution options in the context of a nonstationary system, rather than continuing to treat streamflow (and climate) as stationary, and our water supply as probabilistic.	Add, new mitigation action	–	–
Employ conservation measures	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Extend irrigation systems that currently rely on the slackwater pools of the LSRDs to pump directly from the channel of the undammed Snake River.	–	–	This is being explored in the socioeconomic analysis of the MO3
Given important advances on the horizon in water supply, weather and climate forecasting, including improved accuracy in amount (e.g., distribution over the water year); longer lead time (e.g., as early as Oct 1, the beginning of the water year), it will be imperative that the forecast information integrates with operations and mitigate measures.	Add, new mitigation action	–	Not sure if this is mitigation. What is the impact?
Improve irrigation practices	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Improve water delivery efficiency	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Increase pump strength and capacity for irrigation	–	–	Evaluating some of this in socioeconomic analysis
Increase storage	–	–	–
Higher and more stable headwater reservoir levels	–	–	–
Make irrigation practices more efficient, so that less water is lost through evaporation	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Modification of John W Keys III pump generators to be able to operate below 1240 feet	Add	–	–
Modification of pumps where access may be changed (MO3 - LSD and MO4 - John Day)	Add	–	–
Address Lewiston/Clarkston area pumps that might be affected by the disappearance of reservoirs and monitored for twenty years or more. If water levels drop and some pumps go dry, mitigation money could extend these wells.	–	–	Where data is available, the possible impacts to wells in this area (within 1 mile of the river/reservoir) will be evaluated. Extending wells using a mitigation fund will not be evaluated. J. Johnson BOR 7May19

Draft Mitigation Measure	Reason to addition	Citations	Notes
Reduce and/or characterize water quality at the outflows from irrigation waters	Unknown levels of discharge both flows and contaminants from irrigation waters into Columbia, Snake and other waters likely impact spawning, rearing, and foraging success of salmonids and other resident species.	–	–

4.1.10 Cultural Resources

Draft Mitigation Measure:	Reason to addition	Citations	Notes
Add physical barriers/protections for cultural sites.	–	–	
Continue to use the FCRPS cultural resource program to identify impacts to cultural resources	–	–	The FCRPS cultural resources program is currently being used as mitigation to cultural resources and it will continue to address impacts with all the alternative proposed.
Data recovery of archaeological sites	–	–	Data recovery is a mitigation for impacts to cultural resources.
Develop Tribal In-lieu fishing locations below CJD to facilitate greater Tribal access and fish-harvest success.	Discharge, stages (tailrace elevation) and spill all can have a negative effect on ability of anglers to access existing fishing sites and fishing success. Improving fish access and locations for fishing can partially offset cultural impacts associated with reduced havest associated with CRSO that affect fish prodcution (i.e. adult abundance) and reduced efficacy of fish efforts.	–	–
Disposal of excess federal land with sensitive sites to tribal governments.	–	–	–
Land or site 'banking': purchase of private/county/state land with at-risk, sensitive, or highly valued/visible cultural properties to bring into either federal or tribal ownership/management. Similar to current wetland mitigation processes used.	–	–	–
Native flora and fauna restoration within the study area	–	–	Restoration of flora and fauna would only be an appropriate mitigation for cultural resources if the intention was to facillitate traditional tribal use of said restored flora and fauna. There would possibly be ancillary benefits, such as to veg/wildlife mitigation projects
Offsite mitigation of all sorts	–	–	Off site mitigation, such as museum exhibits, language programs, and education, are good mitigations for cultural resources, as long as they tie to cultural resource impacts.
Operate reservoirs so as to maintain full pool elevation as much as possible	This might be good for some sites but bad for others. Show me the data. Also, again, would we overrule the flow regime established in the alternative?	Pool elevation is dictated by the need for power supply, as such it would not be possible to use pool elevation as a cultural resource mitigation.	Keeping pool elevation at full pool would help mitigate the impacts to cultural resources. It would help with erosion, exposure of sites from looters and recreationalists, and wave action on lower elevation sites. However, pool elevation is dictated by the need for power supply, as such it may not be possible to use pool elevation as a cultural resource mitigation.
Operate reservoirs so as to minimize fluctuation in elevation	Isn't this what the alternatives do, change the fluctuations? How could this be a mitigation? Could we overrule the alternative?	–	Minimizing pool elevation fluctuation would help mitigate the impacts to cultural resources. It would help with erosion, exposure of sites from looters and recreationalists, and wave action on additioanl sites. However, pool elevation is dictated by the need for power supply, as such it may not be possible to use pool elevation as a cultural resource mitigation.
Replace lost roads if Lower Snake Dams are Removed	What are you mitigating here? Loss of access for tribal members on the roads that currently go over the dam? Do we really want people to have more access to the newly exposed archaeological sites?	–	This could be a mitigation to cultural resource impacts because it would allow access to TCP and sacred sites that are hard or impossible to get to currently, making it easier for tribes to use the sites.
Shoreline stabilization	–	–	Stabilization of the shore would also stabilze the cultural resource sites along the shore. It would be important to not impact the sites during stabilization.

Draft Mitigation Measure:	Reason to addition	Citations	Notes
Stabilization of cultural resoure sites	–	–	Stabilization of cultural resource site would address direct impacts to the sites.
Support artificial propagation programs that provide harvest, and conservation efforts for salmon and steelhead	Artificial propagation is necessary to partially offset CRSO impacts to harvest, conservation and Tribal cultural/subsistence.	–	Unclear what the effects of the action would be. No action would maintain current mitigation activities. This is also in Fish
Creative mitigation measures to address tribal interests and concerns	–	–	Creative mitigation measures, such as language studies, education, and museum exhibits, could be used as mitigation to impacts to cultural resources as long as they tie to the impacts of cultural resources and not impacts to other fields of study, such as ESA, fish, or water quality, as these impacts will need to be mitigated by those areas.

4.1.11 Socio-Economics

Draft Mitigation Measure	Reason to addition	Citations	Notes
Cost-share recovery efforts with fisherman.	–	–	*Outside authority of action agencies to implement, but could potentially be implemented by others
Financial support for efforts to replace aging septic systems with upland community systems or sewer	–	–	–
Include meaningful mitigation to protect and improve the physical and spiritual health of the Tribe and its members (CTCR) diabetes prevention and other health protection improvements; language preservation, creation of employment opportunities; educational opportunities	–	–	–
Reclamation Fund Each federal hydropower facility annually generates revenue for the Reclamation Fund according to the Congressional Research Service. Each of the agencies participating in this EIS should identify the funding contribution to or receipt of funds from the Reclamation Fund, A mechanism to tap these funds could be developed and explored for the development of a system-wide and project specific mitigation fund. Because there already are funds for wildlife and habitat mitigation, a regional mitigation fund could be used to compensate counties for loss of tax revenue, infrastructure development, citizen participation, research, or other projects.	–	–	Came from scoping comment
Utilize the Reclamation Fund. The fourteen (14) federal dams contribute an annual percentage of hydropower revenue to the Reclamation Fund. A portion of that fund could be used as a system-wide and facility-specific mitigation fund for counties and private landowners, education, infrastructure improvements and other actions.	–	–	–

4.1.12 Mitigation – Screened Out

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
FISH	–	–	–	–
~~Add bubble curtains to dams to aid fish entering ladders and exclude predators - excluding predators = predation management theme below~~	REJECT. Measure would deter salmon, similar to predators. Any studies suggesting this would work for salmon/steelhead and exclude predators?	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.	–
~~Allow for periodic flow through locks to maximize flow rates~~	Not feasible structurally……. Remove. structurally unfeasible unless under spillway crest alternative which has been removed from consideration.	–	This could lower TGD. Surface passage instead? Or Flow deflectors?	–
Consider differential mitigation effects of various levels of effort and combinations of focus populations and identify the option that most effectively addresses mitigation needs in a manner that also contributed to long-term recovery goals.	There does not appear to be a mitigation suggestion; this is a comment.	–	Offsite mitigation for impacts of hydrosystem to abundance, productivity, and survival.	–
~~Cease using juvenile bypass facilities~~	Not a beneficial fish mitigation action. Even with spill, other non-turbine passage routes are necessary for non-spill passed fish to avoid powerhouse passage routes. Delete. REJECT. More fish will go through turbines which are generally lower survival routes.	–	For MO3, there will be no bypass facilities on the Lower Snake. Have we considered restoring McNary transport under breach? Our modeling says that food will be gone from the lack of oxygen in the snake during spring migrations the first year after breach (two seasons straight at this time) and then may have to build up. Should we consider transport post breach?	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Evaluate shallow water ponds cut off from maintstem by rip-rap, highways and railroads that create warm water habitats.	Evaluation is not mitigation as defined under NEPA. Evaluation, itself, does not offset an effect.	–	These shallow water lake type habitat types could either be re-connected for rearing habitat for native fish species Or should they be closed off so they are not provided rearing habitat for non-native species. This may be an opportunity to provide bass habitat disconnected from the main Columbia channel and perform bass eradication from shallow water areas that are connected to the main channel.	–
~~Close spillway weir(s) and other high-TDG routes (corner collector at BON, sluiceway at BON, TDA).~~	This routes provide some of the best SBE and have higher survival routes. As we understand, these are important structures to facilitate improved passage and survival of juvenile emigrants. Remove. REJECT. This would significantly lower fish passage survival. These routes more juvenile passage effective per TDG production than deep spill gates.	–	Oregon believes implementation of this mitigation action would result in severe reduction in juvenile salmonid survival and a severe decrease in life cycle survival as measured in SARs.	–
~~continue to use spray deterrents and antideterrant measures~~	*REJECT. Captured in NAA *Oregon supports avian predation deterrents but also understands these are continuing actions under the NAA so therefore not new mitigation.	–	–	–
~~Create riffle pool complex within the reservoirs.~~	Remove. Remove. Would require drawdown to create riffles. Would not allow barging and not as effective as springtime spillway crest drawdown or breaching.	–	Do habitat work in tribs instead.	–
~~Deeper (existing) storage reservation diagrams to reduce FRM~~	Drafting to reduce FRM is not a beneficial fish mitigation measure. Not a benefit to fish.	–	If this mitigation measure is for deeper drafts to reduce flood risk, how is that a mitigation measure for fish?	–
~~Eliminate gill nets and allow harvest at fish ladders via trap~~	Implementation of this wholesale action would result in unintended consequences to listed-salmonids	–	Oregon needs more detail about this mitigation action prior to making a technical recommendation.	–
~~Pull one turbine from each dam (effectively, increase spill)~~	Measure not needed. Just do not operate and during high flow times need more turbines to help reduce high TDG. Uncontrolled spill already at times results in TDG > 130% and GBT. Have we tried a deepwater passage route at the Columbia River dams? Possibly add as a conceptual investigation?	–	–	–
~~Pull one turbine from each dam (effectively, increase spill)~~	Delete, decreasing power flexibility and reliability capacity will not help fish.	–	–	–
~~Re-design bypass to allow for microtopography and macroinvertebrate populations. Look at more of an oxbow type design.~~	Not feasible……. Delete. Delete. Developing mainstem habitat features that support healthy macroinvertebrate populations would likely create more natural environments and support fish productivity; however, it is not clear what this measure is.	–	Talked about for years, even in the 80's when I worked for IDFG. Build a natural stream channel around granite etc. with a gate, then water it up during outmigration. We are far beyond this now with improvements to fish passage. Now if you are talking about some sort of natural channel in the bypass system, same thing just get the fish through the bypass as quick as we can.	–
~~Re-design nav locks to allow for microtopography and macroinvertebrate populations, riffles and pools or to allow them to remain open during low boat traffic times (i.e. remove the navigational lock sill). #3 = breach?~~	Not feasible……. Remove Structurally unfeasible unless under spillway crest alternative which has been removed from consideration	–	Just does not seem like a good idea. Obviously I have not been citing literature but I don't see the benefit. Instead of breach? May work but I think it would damage the infrastructure over time.	–
Limit fisherman from foreign countries coming too close to the coastline - limits anywhere between 3 to 50 miles of our territorial coastline for catching salmon. Recommend 50 miles.	could be some confusion about fishing in US Waters, foreign counties may not be allowed to fish that close to shore already. (double check)	–	–	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Make fishing licenses transferrable	Doesn't seem this would offset an impact to fish and thus would not be a mitigation measure.	–	–	–
Native Redband Trout and kokanee are significant to the cultures and economies surrounding Lake Roosevelt. There are a breadth of detrimental impacts operations inflict upon these species. Current operations impede access to spawning habitats and entrain juveniles of these species as they exhibit migratory behavior. Both of these factors have profoundly impacted the status of these species populations as reflected in the recent Washington Department of Fish and Wildlife fishing regulation change to release all unclipped Redband Trout. During crucial times of the year, the mouths of tributaries are routinely exposed within the drawdown zone. This presents a hazardous migration corridor both in terms of channel morphology and the absence of cover. The drawdown also exposes the redds of shore spawning species, rendering the embryos unviable. Current reservoir operations also result in entrainment of hatchery-reared sport fish (Rainbow Trout and kokanee), the Tribe's partial mitigation for the loss of anadromous species, and may account for 30% of the mortality of these species.13 [13Baldwin,C.and M.Polacek. 2002. Evaluation of Limiting Factors for Stocked Kokanee and Rainbow Trout in Lake Roosevelt,Washington,1999.] This considerably diminishes the level of mitigation. Reservoir operations are also responsible for the creation of habitats that support both native and non-native piscivorous fish species. The bounty of Northern Pike Minnow in the lower River targets a culturally important First-Food of tribes. Simultaneously, management of non-native predators in other regions receive comparably little financial support, despite the risk they pose to native resident species and downstream ESA-listed populations. Alternatives considered in the EIS need to evaluate piscivorous fish populations and their current management priorities. Alternatives presented in the EIS need to address these impacts imposed upon resident species. It should also be noted that Redband Trout offer the opportunity to assist in the recovery of the ESA-listed Upper Columbia River Evolutionarily Significant Unit of steelhead by improving genetic diversity. These fish are already, ??considered a mitigating factor by many of the BRT [biological review team] members in rating extinction risk,- for the UCR steelhead ESU.14 [14M.J.Ford(ed.). 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Region. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-113, 281p.] This is emphasized by the Independent Scientific Advisory Board's determination that, "the loss of either the anadromous or resident life history form [of O. mykiss]- would put the [population's] long-term viability at risk."15 [15Independent Scientific Advisory Board. 2005. Viability of ESU's Containing Multiple Types of Populations. ISAB2005-2. April 8, 2005. Available at: http://www.nwcouncil.org/fw/isab/isab2005-2/] Given this perspective, preservation of Redband Trout should become a primary consideration when developing the EIS. Such considerations could include the implementation of a conservation hatchery program for Redband Trout in our Region to ensure their long-term viability in addition to providing passage for these fish at Chief Joseph and Grand Coulee Dams.	Does not appear to identify a mitigation action. There does not appear to be a mitigation suggestion; this is a comment.	–	–	–
Transportation should be de-emphasized as a fish mitigation measure in favor of increased spill operations and an improved in-river migration environment	Delete. This is a comment about mitigation; not a mitigation measure	–	One of the MO alternatives is analyzing this idea.	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Studies show that dam breaching by itself would not recover the fish. Continuing aggressive fish mitigation efforts should continue to help fish get safely past the dams, and maintain effective habitat and hatchery programs.	Delete. This is a comment about mitigation; not a mitigation measure	–	–	–
Continued PIT tag work (on the Columbia Plateau) for M&E regarding avian predation rates	Monitoring and evaluating (M&E) is not mitigation as defined under NEPA. M&E does not offset an effect.	–	filter mitigation through NEPA definition of mitigation as defined in §1508.20, includes avoid, minimize, rectify, reduce, and compensate. For example, research, monitoring, and evaluation would not be included because they are not mitigation as defined by CEQ Regulations	–
Develop PR campaign to kill, keep, consume non-native fish species	Outreach efforts is not mitigation as defined under NEPA. Outreach efforts does not offset an effect.	–	Bass, Walleye etc. Outreach low cost buy-in from dam proponents.	–
Ensure that an RM&E program is in place to test and validate the hypotheses of the program in terms of mitigation benefits and to guide adaptive management of implementation.	Monitoring and evaluating (M&E) is not mitigation as defined under NEPA. M&E does not offset an effect.	–	–	–
Include adequate Monitoring and Evaluation to evaluate the impacts of all proposed actions.	Monitoring and evaluating (M&E) is not mitigation as defined under NEPA. M&E does not offset an effect.	January 14, 2011, Memorandum for Heads of Federal Departments and Agencies, From Nancy Sutley describing the Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact	"Monitoring is fundamental for ensuring the implementation and effectiveness of mitigation commitments, meeting legal and permitting requirements, and identifying trends and possible means for improvement."	–
Reduce flow augmentation (CSS)	*Delete. How is this a mitigation measure that benefits fish? Seems Counterproductive *Delete, Oregon strongly supports further development of operational and/or structural mitigation actions to return the hydrograph to a more normative (pre-hydrosystem) pattern. Implementation of this mitigation measure would likely have the opposite outcome. Ultimately and if the action agencies choose not to delete this mitigation action, Oregon questions why this measure appears to be associated with CCS?	–	–	–
Build an alternate channel around the dams	*Remove. The attraction flow would presumably be low relative to existing dam passage routes… if relatively high flow in new channel, it may be similar to dam breach concept. Relative effectiveness of building a new channel (v. more spill, bypass, breach) is questionable. *Remove - duplicate. *Is this the same a measures in the MO3 LSR Breach Alternative? Not enough detail to evaluate.	–	*Oregon needs more detail about this mitigation action prior to making a technical recommendation. *Building a channel around the dams will likely compromise the integrity of the structure.	–
Draw Down John Day	Delete. Captured in alternatives	–	–	–
Install PIT tag arrays at each Lower Snake dam and McNary	Monitoring and evaluating (M&E) is not mitigation as defined under NEPA. M&E does not offset an effect. ; however could be discussed as adaptive management	–	Yes, not a mitigation metric but something that can identify mitigation measures. Rather than adopting many spillway measures, use our data to move forward mitigation measures, like spill stilling basins, etc.	–
Investigate development of guide\ curves to avoid situations where heavy spill has to occur in the spring to meet FRM requirements. Concept would be to have a guide curve that is forecast based (to only be used in high water supply situations) to allow for earlier draft than the current SRDs.	Evaluation or investigation is not mitigation as defined under NEPA. Evaluation or investigation does not offset an effect.	–	*How is this a mitigation measure benefiting fish? *Oregon needs more detail about this mitigation action prior to making a technical recommendation.	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Ongoing fish tissue monitoring to update fish consumption advisory	Monitoring is not mitigation as defined under NEPA. Monitoring does not offset an effect.	–	Increased mercury methylation and bioaccumulation (see Willacker 2016, Reservoirs and Water Management Influence Fish Mercury Concentrations in the Western United States and Canada)	Lower reservoir elevation Increased duration of drawdown Increased sediment exposure during the spring and summer growing season
Study feasibility of recommended measures before implementing	Evaluation or investigation is not mitigation as defined under NEPA. Evaluation or investigation does not offset an effect.	–	ADD measure to study any NEW measures to determine feasibility of implementing and estimate effectiveness of treatment	–
Support productivity studies in BN, TD, & JD reservoirs for white sturgeon	Evaluation or investigation is not mitigation as defined under NEPA. Evaluation or investigation does not offset an effect.	https://www.nwcouncil.org/sites/default/files/ColumbiaBasinWhiteSturgeonPlanningFramework2013Dec_0.pdf	The reservoirs must be evaluated to determine production and mitigation measures to improve production for resident native fishes, particularly white sturgeon.	–
Support system-wide monitoring program to understand effectiveness of predation management measures (cumulative predation rates over time)	Monitoring is not mitigation as defined under NEPA. Monitoring does not offset an effect.	–	–	–
Install PIT detector arrays at all project spillway weirs and other undetected passage routes as technology allows.	Monitoring and evaluating (M&E) is not mitigation as defined under NEPA. M&E does not offset an effect. ; however could be discussed as adaptive management	–	This will greatly enhance the Action Agencies ability to collect data on fish passage routes and survival and inform adaptive management through time.	–
Anadromous translocation above CJD and GCD - delete Reintroduction	More research and science needed to determine best methods for fish passage, and habitat availability to determine a successful reintroduction of fish. There are current efforts ongoing to address this problem. The alternatives being analyzed do not change fish passage for these projects from the no action - so mitigation is not needed.	–	–	[Could utilize a portion of escapement of UCR summer/fall Chinook and sockeye to the upper Columbia (above PRD) for translocation to increase production in currently inaccessible habitats above CJD and GCD to partially offset potentially reduced smolt survival due to reduced or suspended spill and reduced flow in late July and August.] from Fish team review

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Re-design spillway to mimic normal step-pool/waterfall elevations. Look at stepped spillway (MSH SRS?)	Remove. REJECT. Violates USACE's FRM authorities and dam safety concerns.	–	Interesting idea, but too complex at this point. Maybe something way down the road if our next measures don't recover. Back in the day it was thought that breaching just granite and goose would do the trick. Breach one dam instead? I don't know…Haven't we found that we get great results from changing the ogee and the weirs?	–
Truncate DWA Drawdown	Remove. In the past we have had trouble cooling the river back down after shutting off Dworshak spill. Look at old newspaper articles to see the outrage of thermal blocks (reinventing the wheel)	–	–	–
Mitigate for White Sturgeon population losses due to dam impacts	No mitigation action is identified, rather it is a comment that mitigation should be done.	–	Keep, Although Oregon recommends development of specific actions to achieve the desired outcome	–
Mitigation for operational impacts causing loss of resident fish	No mitigation action is identified, rather it is a comment that mitigation should be done.	–	Studies have shown substantial losses due to operations at GCD of up to 500k fish per year at the third powerhouse. Another study suggested draw downs below 1255 msl entrain fish resulting in a reduced fishery the following year.	–
Fish collector in/near GCD forebay, equipped with exclusionary netting, and fish transportation - return/transport mitigation fish and native species to Roosevelt	*More research and science needed to determine best methods for fish passage, and habitat availability to determine a successful reintroduction of fish. There are current efforts ongoing to address this problem. The alternatives being analyzed do not change fish passage for these projects from the no action - so mitigation is not needed.	–	Entrainment/removal of mitigation fish and native species. Increased water outflow Decreased water residence time	The exclusionary netting is in the Fish mitigation tab. The transport of fish to Lake Roosevelt would be consider reintroduction. See "Reason for deleting" column for reason for deletion.
Further Develop "Wooshh!" for multiple sized fish and volitional entry, and test efficacy of system as a means to decrease ladder passage times at dams in the extant anadromous zone and for passage above Chief Joseph and Grand Coulee dams ~~this is a technology, doesn't specify in what situation~~	*The performance of this is unteasted technology and unlear any benefits or impacts to captured fish. *More research and science needed to determine best methods for fish passage, and habitat availability to determine a successful reintroduction of fish. There are current efforts ongoing to address this problem. The alternatives being analyzed do not change fish passage for these projects from the no action - so mitigation is not needed.	–	~~Assume for reintroduction Coulee & DWA.~~ Needs consideration in the future.	[Initial investigations at PRD indicate excelerrated passage rates for "Whooshh"ed fish versus conventional ladder passage.] per fish team comments

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Restore passage to North Fork Clear Water River (aka passage at Dworshak)	deleted. The alternatives being analyzed do not change fish passage for this project from the no action - so mitigation is not needed. More research and science needed to determine best methods for fish passage, and habitat availability to determine a successful passage of fish. There are current efforts ongoing to address this problem.	Columbia River Treaty, Ecosystem-based Function, Coalition of Columbia Basin Tribes, June 2013	*Always strive to reintroduce where it is feasible. Need to be careful about genetics, NF fish were known to be the largest B's. Do their genetics still exist in a redband form above the dam? Or are they gone and it does not matter. Consider Hell's canyon complex as well. https://www.critfc.org/wp-content/uploads/2014/12/ecosystem-booklet-single-page.pdf *Oregon needs more detail about this mitigation action prior to making a technical recommendation.	–
Reporting on tributary habitat improvement actions shall provide adequate information to evaluate the tributary habitat program, including adequate inputs for future life-cycle modeling and for qualitative evaluation of the program's implementation and effectiveness.	Monitoring and evaluating (M&E) is not mitigation as defined under NEPA. M&E does not offset an effect.	–	See 2019 CRS BiOp,Term and Condition #5	–
~~Progressive Spill: to better mimic the natural hydrograph: percent spill increases as inflow increases (i.e. Snake River- 20% spill up to 40 kcfs inflow rising to 50% spill at 100 kcfs inflow...)~~	*Delete, Oregon remains open to consideration of flexibility in spill strategies so long as any alternative moved forward is robust enough to avoid jeopardy under the ESA and achieve regional recovery goals of 4-6% SARs of ESA-listed salmonids. However, this spill strategy will not achieve the desired survival benefit. *REJECT. During dry years, there'd be very little spill.	United States. The Endangered Species Act As Amended by Public Law 97-304 (the Endangered Species Act Amendments of 1982). Washington: U.S. G.P.O., 1983. Print. 2014 Columbia River Basin Fish and Wildlife Program https://www.nwcouncil.org/reports/2014-columbia-river-basin-fish-and-wildlife-program	Any ESA jeopardy analysis of the proposed action must comply with legal requirements.	–
~~Max transport no spill~~	Clarify, this could be used during times of extreme low flow late season or power emergency requiring reduced or spill cessation. Need to better clarify. Have done this 2001, 2004 and 2005 and was shown to not meet survival and recovery goals. Not a beneficial fish mitigation action. With adult stray rates associated with transport, max transport and no spill will result in diminishing adult returns to natal areas in most years. REJECT. Not a good idea for juvenile fish survival during normal flows. We did that already, pops declined and were listed. Delete. Transportation strategy needs to be implemented based on water year.	–	–	Spread the risk! Consider transport at McNary Dam if Breach? i.e spread the risk now from McNary?
~~Partial breach combined with Bypass channel to mimic natural river (including resting pools)~~	Remove. Not as cost effective as spillway crest alternative which would allow barging and full power production summer-winter.	–	Not really sure what partial breach over breach would give us when we are talking solely fish. In the power metric yeah I suppose we could still produce power.	–
WILDLIFE		–	–	–
Managing for stable reservoir elevation (promote wetlands and grow riparian vegetation on shorelines)	Delete: The native vegetation found in wetlands and riparian areas can benefit by a fluctuating water table within a target range. It is natural for there to be some fluctuation of water elevations within a range (i.e. spring freshet). It encourages cottonwood recruitment.	Jamieson, Bob-BioQuest International Consulting Ltd., Jeff Braatne-University of Idaho, 2001, Riparian Cottonwood Ecosystems and Regulated Flows in Kootenai and Yakima Sub-Basins: Volume I Kootenai River.	in both fish and wetlands	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Create a adaptive monitoring plan in areas where changes may occur. Decline or change could then determine wetland mitigation needs. Action as warrented.	An adaptive monitoring plan is not mitigation as defined under NEPA. Monitoring does not offset an effect.	–	Add. This would allow for long-term monitoring of wetland functions and values to identify continued losses of habitat caused by changes in inundation and exposure.	–
Increase monitoring for aquatic invasive species to include plankton nets, veliger plates and visual inspections of all submerged project locations (ie turbine blades, submerged traveling screens, fishways etc)	Increased monitoring is not mitigation as defined under NEPA. Monitoring does not offset an effect.	https://plan.critfc.org/2013/spirit-of-the-salmon-plan/technical-recommendations/invasive-species/ https://www.nwcouncil.org/fish-and-wildlife/topics/invasive-species https://www.westernais.org/monitoring	Well documented issues and concerns, need overall increase and participation by the action agencies on AIS Proposed under new tab "Aquatic Invasive Species"	Invasive species and their associated impacts will be a permanent concern for the basin, increased monitoring will help with early dection and rapid response to eradicate and/or control.
Organize and implement shoreline monitoring for invasive plants and animals.	Implementation of monitoring is not mitigation as defined under NEPA. Monitoring does not offset an effect.	https://plan.critfc.org/2013/spirit-of-the-salmon-plan/technical-recommendations/invasive-species/ https://www.nwcouncil.org/fish-and-wildlife/topics/invasive-species https://www.westernais.org/monitoring	Well documented issues and concerns, need overall increase and participation by the action agencies on AIS Proposed under new tab "Aquatic Invasive Species"	Similar to the need the reason for row 2, the problem is increasing and stable involvement by action agencies.
FRM	–	–	–	–
In a dry water year, establish a decision-making process for allowance of transitioning refill timing from system ICF approach versus local approach	I don't think this is a mitigation measure for FRM impacts. Project operating criteria already include operations specific to dry (and avg and wet) years. And most also take into account local flood control requirements. Specific measures in the EIS for Libby include modifications to refill for local requirements.	–	–	–
Optimize FRM – best FR projection for impact on storage reservoir	This is not an implementable mitigation measure as described. I am not sure if they mean optimize FRM operations for mitigation on FRM impacts or other impacts. Would need more information about what is being optimized.	–	–	–
Relax storage reservation diagram at 6 FRM projects	this is not a mitigation measure for FRM impacts. This would increase flood risk.	–	–	–
Remove levees*	this is not a mitigation measure for FRM impacts. This would increase flood risk.	–	–	–
Allow floodplain expansion	Not sure if this implies expansion of the flood plain or expansion into the flood plain and the location of the flood plain in mind. I will assume expansion of the flood plain so that floodwaters can flow into the flood plain. If this is for the lower Columbia it would have very little impact on flooding unless the flood plain was very large and designed to capture water under a very specific scenario, and even then it may not affect that actual peak flows.	–	Assuming this is measure is to expand floodplain storage, the CRT review looked at this measure and determined there is not enough floodplain storage to effectively reduce flood risk in the lowerr Columbia River. (per Sara Marxen)	–
change channel capacity by intentional scouring flows by changing discharge during refill	this is not a mitigation measure for FRM impacts. This would increase flood risk.	–	The sediment you scour out will end up somewhere else. Annual scour from spring freshet would clean spawning gravels. This can't be used here and there it must be system wide	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Develop a definition of "system flood" that is based on the volume forecast (Note: a refill trigger already exists)	Does not mitigate for FRM.	–	–	–
develop rules to limit flood control space shift between projects in high water years	Does not mitigate for FRM.	–	–	–
use banded operation of specific target elevation and allowance for a range of +/- 2 ft of SRD target elevation	Does not mitigate for FRM.	–	–	–
during transitions (draft/refill), situationally identify opportunities for movement of flood control space within the system	Does not mitigate for FRM.	–	–	–
Guide curve for Hungry Horse to relax draft rate in high water conditions	Does not mitigate for FRM.	–	–	–
In dry water year, establish a decision making process for reducing system flood control space requirement during spring draft (Note: local versus system trigger)	Does not mitigate for FRM. A reduction in draft would increase flood risk.	–	–	–
In dry water year, operate to local flood control requirements only rather than system requirements (Note: include refill timing and Initial Controlled Flow (ICF))	Does not mitigate for FRM.. Project operating criteria already include operations specific to dry (and avg and wet) years. And most also take into account local flood control requirements. Specific measures in the EIS for LIbby include a implementation of a local flood control draft requirement.	–	–	–
Initiate refill based on flood risk decisions/assumptions on local hydrology versus system criteria (ICF)	Does not mitigate for FRM.	–	–	–
minimize April drafting of Libby for purpose of reducing backwater effect at Bonners Ferry control point	I don't believe that April drafts are causing flooding at Bonners Ferry. Does not mitigate for FRM.	–	–	–
develop rules to limit flood control space shift between projects in high water years	Does not mitigate for FRM.	–	–	–
Blending local and system operations	Does not mitigate for FRM.	–	–	–
WATER SUPPLY		–	–	–
Aquifer recharge	Delete - not a feasible solution in the study area	–	I don't think there are any places within the study area that would benefit from aquifer recharge	–
Augment downstream flow with release of upper basin project storage	Delete - irrigation is incidental to reservoir operations; would not change operations to mitigate	–	–	–
Buy water from farmers and industry for fish	Delete - this seems like mitigation for Fish, not water supply	–	–	–
Change storage rule curves	Delete - irrigation is incidental to reservoir operations; would not change operations to mitigate	–	–	–
~~Current operations require that USBR provide M&I and Odessa subarea water through draft of Banks during juvenile migration then refill be restricted to period outside of juvenile anadromous fish migration season. This caused complicated operations and coordination this is not necessary.~~	This is not a mitigation measure for CRSO impacts to water supply.	–	Does not change the colume of water delivered, bur does change the timing of pumping	–
Increase refill probability	Delete - unclear	–	This is not clear - how would you do this? Reduce outflows? Change rule curves? Make it rain more?	–
Keep reservoirs higher (lowers pumping costs)	Delete - irrigation is incidental to reservoir operations; would not change operations to mitigate	–	–	–
More flow during irrigation season so states will permit more withdrawals	Delete - unclear	–	Unclear - increase reservoir outflows for diversion? Make it rain more?	–
Reduce flows for fish for irrigation (reduce fish flows to benefit irrigation)	Delete - irrigation is incidental to reservoir operations; would not change operations to mitigate	–	–	–
Higher and more stable headwater reservoir levels	Delete - this would be a result of the analysis, J. Johnson BOR 7May19	–	–	–
Increase water runoff storage capacity that is achieved through a highly distributed, smaller scale reservoir system	Delete - additional storage is not being included in this EIS, J. Johnson BOR 7May19	–	–	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Similarly, an accurate analysis should occur for the few irrigators taking water from the reservoir above Ice Harbor Dam looking at targeted mitigation for the dozen or so irrigators involved, not subsidizing the whole unsustainable system. The LRSD were built in the 1960s and 70s; and an agricultural industry was already in place. It is not as if irrigators won't still have a source of water between the river and groundwater that will still be present.	Evaluation is not mitigation as defined under NEPA. Evaluation does not offset an effect.	–	Impacts to all irrigators who receive water from Ice Harbor reservoir will be evaluated; targeted groups can use the information to do their own analysis, J. Johnson BOR 7May19	–
WATER QUALITY	–	–	–	–
Reconfigure stilling basins (project specific) to higher elevation/less depth for plunging flows to limit TDG	delete,likely not feasbile	–	–	–
Additional flow deflectors for TDG	already done; delete; every dam except The Dalles and Grand Coulee. The natural rocky area downstream of The Dalles that provides degassing. Refer to "Implement TDG reduction measures at Grand Coulee (flip lip)" line for rationale for not including this mitigation measure at Grand Coulee.	–	–	–
Finanical/Monitoring	Monitoring is not mitigation as defined under NEPA. Monitoring does not offset an effect.	–	Financial support for water quality monitoring of the nearshore areas to determine nutrient levels	–
Finanical/Monitoring	Education efforts is not mitigation as defined under NEPA. Education efforts does not offset an effect.	–	Financial support for education efforts to help shoreline residents reduce nutrient loading from their upland activities	–
Hyporheic and groundwater monitoring	Monitoring is not mitigation as defined under NEPA. Monitoring does not offset an effect.	–	Lake Roosevelt surface and groundwater interactions are not well understood. Dynamics may change in response to proposed operational measures.	–
Saltwater Intrusion/Lower River/Estuary	No mitigation action identified.	–	Reduce saltwater intrusion during summer and fall in connected floodplains throughout the lower river estuary ecosystem	–
Implement TDG reduction measures at Grand Coulee (flip lip)	The Studies concluded that "…the ability to reach 110 percent TDG in the river below Grand Coulee is more dependent on the TDG levels present in the reservoir than on any of the structural or operational changes studies. A 110 percent saturation level is only attainable for combined spill and power releases if the initial TDG saturation level of Franklin Delano Roosevelt Lake is at or below 105 percent…" Through the Dissolved Gas and System Configuration Team it was decided that the best way to manage TDG from the Upper Basin was to build energy dissipaters (flip buckets) at Chief Joseph Dam and manage operations between the two projects to minimize TDG in the mid and lower Columbia River below Chief Joseph Dam.	"Structural Alternatives for TDG Abatement at Grand Coulee Dam, Conceptual Design report in October 1998 Kathleen H. Frizell and Elisabeth Cohen "Structural alternatives for TDG abatement at Grand Coulee Dam" Feasibility Design Report in October 2000, Kathleen H. Frizell and Elisabeth Cohen. – A model of Grand Coulee Dam was built in Reclamations Water Resources Research Laboratory in Denver, Colorado to study structural alternatives for TDG abatement at Grand Coulee.	–	–
REC	–	–	–	–
~~More parks and boat ramps (Mitigation or w/ scope?)~~	Delete, more parks and/or boat ramps above existing levels is not likely	–	–	–
~~No extreme high/low flows for rafting~~	Delete as action seems more like a constraint or consideration but not a mitigation measure	–	–	–
NAV	–	–	–	–
~~Change spill patterns to facilitate nav~~	This is already addressed in the FOP each year and each oproject already temporarly alters spill for navigation saftey as needed.	USACE 2019 FOP	–	–
~~Limit dredging~~	Delete, limited dredging is not a mitigation measure for maintiaining navigation channel	–	–	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Dredging	This is too vague, please remove if specificity is not provided in review	–	–	–
AIR QUALITY	–	–	–	–
Identify all commitments to reduce construction emissions and incorporate these reductions into the air quality analysis to reflect additional air quality improvements that would result from adopting specific air quality measures. Prepare an inventory of all equipment prior to construction, and identify the suitability of add-on emission controls for each piece of equipment before groundbreaking. (Suitability of control devices is based on: whether there is reduced normal availability of the construction equipment due to increased downtime and/or power output, whether there may be significant damage caused to the construction equipment engine, or whether there may be a significant risk to nearby workers or the public.) ? Meet EPA diesel fuel requirement for off-road and on-highway (i.e., 15 ppm), and where appropriate use alternative fuels such as natural gas and electric. ? Develop construction traffic and parking management plan that minimizes traffic interference and maintains traffic flow. ? Identify sensitive receptors in the project area, such as children, elderly, and infirm, and specify the means by which you will minimize impacts to these populations. For example, locate construction equipment and staging zones away from sensitive receptors and fresh air intakes to buildings and air conditioners.	These are BMPs for air quality, if project assumes BMPs are part of the design/specs, then this is not mitigation.	–	–	–
CULTURAL RESOURCES	–	–	–	–
~~Enhance habitat in the tributaries and estuary~~	This may be an appropriate mitigation for wetlands/veg/wildlife, but is not appropriate for impacts to cultural resources	–	–	–
~~fish passage on the Columbia River at Grand Coulee and Chief Joseph~~	–	–	Fish passage at CJ and GC may be appropriate for ESA mitigation, not mitigation for impacts to cultural resources	–
~~Fish passage on the Snake River at Hells Canyon Complex~~	There are current efforts ongoing to address this problem. The alternatives being analyzed do not change fish passage for these projects from the no action - so mitigation is not needed.	–	Fish passage at the Hells Gate Complex is not appropriate mitigation for cultural resources, but may be appropriate for ESA mitigation	–
~~From "Public Scoping Report for the CRSO EIS": consider and mitigate impacts to treaty rights, tribal resources, treaty fishing rights, tribal way of life, tribal culture and cultural practices (e.g. ceremonial activities, religious activities, subsistence activities, and physical health) that are dependent upon healthy migratory fish runs (especially lamprey, salmon, and steelhead). In addition, impacts on the protection and mitigation of traditional fishing and hunting locations, sacred sites, historic cultural resources, and traditional cultural properties need to be mitigated.~~	This comment does not propose a specific mitigation, but impacts to fish should be addressed as impacts to ESA, not cultural resources.	–	–	–
~~Mitigate any adverse impacts to a healthy ecosystem, ecosystem function (as discussed in the Columbia River Treaty process)~~	This may be an appropriate mitigation for wetlands/veg/wildlife, but is not appropriate for impacts to cultural resources		–	–

~~Mitigate other mitigation measures~~	This comment does not propose a specific mitigation. In addition, other mitigation projects that currently occur within or because of operations of the system undergo individual NEPA review, including review of impacts to cultural resources, to include, but not limited to, review/compliance with Section 106 of the NHPA.	–	–	Some of the mitigation measures proposed would adversely affect cultural resources, such as "change channel capacity by intentional scouring flows by changing discharge during refill." Recreation requests more parks. The parks that already exist are a huge problem for cultural resources. Water Supply wants to micromanage the depth of the reservoirs; as noted, changes in water elevation impacts cultural resources. States permitted more water withdrawal may result in conversion of more shrub-steppe to farmland, which is an adverse impact to cultural resources; 220,000 acres are proposed. Changes in irrigation flows that advantage irrigators and disadvantage fish are bad for cultural resources. Extending the irrigation infrastructure to reach an undammed Snake River could impact

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
				archaeological sites. Integrating or developing renewable energy could impact all types of cultural resources. Integrating HMUs with USFWS may be unhelpful; USFWS has even more difficulty protecting cultural resources than the Corps does.
Reintroduction of anadromous species to historic habitats upstream of Chief Joseph and Grand Coulee dams, providing upstream and downstream fish passage at these projects	More research and science needed to determine best methods for fish passage, and habitat availability to determine a successful reintroduction of fish. There are current efforts ongoing to address this problem. The alternatives being analyzed do not change fish passage for these projects from the no action - so mitigation is not needed.	–	Loss of anadromous species is the loss of a cultural resource that cannot be replaced nor adequately mitigated by resident fish substitution.	–
–	–	–	–	–
POWER	–	–	–	–
Increase capacity	Deleting because it is redundant with more specific draft measures 1. adding turbines, see item 11, 12, 13 or 18 2. improving turbine efficiency, see 10 3. raising head at projects is an operational measure in some Mos	–	redundant to adding turbines, improving turbine efficiency, raise head at projects (all already on list here)	–
~~Integrate renewable energy on breached structures~~	***ODOE:** While it is likely possible to physically site other types of renewable generation (e.g., wind or solar) on top of breached dam structures, it is likely **not** the most cost-effective approach. The primary reason for this concerns the quality of the resource at the particular geographic locations where the dams are located. Cost-effective solar and wind projects tend to be sited in areas with the strongest resources (e.g., high average wind speeds or good southern exposure and strong solar irradiance). Second, the power output from the number of renewable generators that could be physically sited on the breached structures themselves would likely be significantly less than the output of the dams themselves. *Not sure what "on breached structures" means. You can't put a structure on something that is removed to the river-bed.	–	–	–

Deleted Mitigation Measure:	Reason for deleting	Citations	Notes	Additional notes
Reliability (keep loss-of-load within Council's standards) -- could include keeping reliability despite other actions that might reduce reliability such as removing dams or constraining operations -- could include keeping reliability despite climate change	This wouldn't really be a consideration. Any change to the operation of the dams within the FCRPS that negatively impacts electric reliability would be identified by the NW Power Council (and other stakeholders) and would be addressed in the same manner as any other reliability shortfall. For example, as coal plants in the region retire, the Power Council (and specifically, its Resource Adequacy Advisory Committee) evaluates how much additional capacity needs to be added to the Northwest power system to maintain overall reliability consistent with the Loss of Load Probability standard adopted by the Council. The question becomes a matter of how much it will cost the region to procure the necessary additional resources to maintain reliability.	–	–	–
Index test all units to optimize current turbine operations	This is a routine action that is expected to occur regardless of this EIS and therefore it has been removed from the mitigation toolbox.	–	This measure may help offset the impact to power generation	–

Draft Columbia River System Operations
Environmental Impact Statement

Appendix R, Mitigation, Monitoring and Adaptive Management
Part 3, Mitigation Process

Attachment D
Completed Impact Summary Spreadsheets

CHAPTER 1 - COMPLETED IMPACT SUMMARY SPREADSHEETS [4]

Water Quality – Multiple Objective 1

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby Reservoir	In-reservoir water temperatures too cold in spring/early summer	Reservoir held higher Dec - Feb for the majority of years, which may result in colder reservoir water temperatures in spring and summer. State WQS still met below LIB.	reservoir elevation	low	mitigation not possible	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	In-reservoir water temperatures could be too cold in spring/early summer in most years, butparticularly when reservoir is held high during winter months.
Kootenai River d/s of Libby	River water temperatures too cold in spring/early summer	Reservoir held higher Dec - Feb for the majority of years, which may result in colder reservoir water temperatures in spring and summer. State WQS still met below LIB.	reservoir elevation	low	mitigation not possible	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	River water temperatures too cold in spring/early summer, even with use of SWS.

[4] Note that the effects in this toolbox were preliminary and analysis was continuing to be completed in the summer of 2019

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Kootenai River d/s of Libby	River water temperatures too warm in winter	Increased outflows from Jan - March. By increasing the flows to draw the pool down aggressively, the MO1 Alternative may prevent the natural cooling of the river as it moves downstream. State WQS still met below LIB.	total outflow	low	mitigation not possible	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	River water temperatures too warm in winter, even with use of SWS.
Kootenai River d/s of Libby	High TDG	Higher winter flows would likely increase TDG > 110% in the river downstream of Libby Dam (from 8 to 35 days out of POR).	total outflow	low	Add sixth turbine to Libby powerhouse.	yes	yes	Add sixth turbine to Libby powerhouse.	CWA (TDG state water quality standard)	yes	n/a	no; level of impact is low and would occur rarely. Mitigation costs outweigh impact.	no; level of impact is low and would occur rarely. Mitigation costs outweigh impact.	n/a	TDG would still exceed state water quality standards at times.
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee Reservoir	elevated turbidity	Deeper winter draft may lead to increase shoreline erosion.	reservoir elevation/retention time	low	no mitigation proposed	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Grand Coulee Reservoir	increased mercury methlyation	Increased methylation of mercury from deeper and longer reservoir drawdowns (wetting/drying of sediments).	reservoir elevation/retention time	med	no mitigation proposed	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee Reservoir	reduced dissolved oxygen	Spokane Arm DO in low flow/high temperature conditions have a greater portion of the water column that is anoxic.	reservoir elevation/retention time	low	Install aeration or bubbler system in impacted area (near mouth of Spokane River).	yes	yes	Install aeration or bubbler system in impacted area (near mouth of Spokane River).	DO TMDL exists for Little Spokane River, but not for reservoir.	yes	n/a	no; level of impact is low and occurs in small area within reservoir; conditions may improve from efforts conducted by other. Mitigation costs outweigh impact.	no; level of impact is low and occurs in small area within reservoir; conditions may improve from efforts conducted by other. Mitigation costs outweigh impact.	n/a	n/a
Grand Coulee Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	total outflow/residence time	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Reservoir	In-reservoir water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Dworshak Tailwater	River water temperatures too high in August	Warmer water temperatures in August; affects LSR temps. State WQS still met below DWR.	change in August Dworshak outflows	high	no mitigation proposed (without changing alternative); recommend not moving forward with this measure in preferred.	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Lower Snake River Projects (LWG - IHR)	River water temperatures too high in August	Warmer water temperatures in August; 68°F LWG TW temp target exceeded.	change in August Dworshak outflows	high	no mitigation proposed (without changing alternative); recommend not moving forward with this measure in preferred.	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Lower Snake River Projects (LWG - IHR)	Increased algae growth due to high August water temperatures	Potential increased algal blooms, pH and DO (supersaturation) in August.	change in August Dworshak outflows	med	Increased harmful algae bloom monitoring at recreational areas; if algal blooms produce toxins, post recreational areas with public advisories.	yes	yes	Increased harmful algae bloom monitoring at recreational areas; if algal blooms produce toxins, post recreational areas with public advisories.	no	yes	n/a	yes; impact is seasonal and could be carried during summer months when recreational activity is high.	yes	yes; water quality and recration	algal blooms would still occur, as this mitigation measure stives to protect public, not reduce blooms.
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
none	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
none	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Water Quality – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby Reservoir	reduced in-lake biological productivity	Reservoir drawdowns and higher flushing rates.	reservoir elevation and total outflow	med	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	yes, the nutrient suplementation program currently being carried out at Dworshak Reservoir has improved overall reservoir productivity.	yes	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	ESA (bulltrout?)	yes	n/a	yes; there have been numerous studies on Hungry Horse Reservoir that link drawdowns and flushing flows to reduced in-lake productivity.	yes	yes, resident fish and water quality	resident fish populations may still struggle; nutrient additions can risk balance between in-lake nutrient levels (nitrogen and phosphorus). If these nutrients become out of balance, harmful algae (cyanotoxins) may bloom and dominate system. Monitoring and adaptive management is necessary.

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Kootenai River d/s of Libby	River water temperatures too warm in winter	Higher winter flows may impact natural cooling of river downstream of Libby Dam in early winter.	total outflow	low	no mitigation possible	n/a	n/a	no mitigation proposed	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hungry Horse Reservoir	reduced in-lake biological productivity	Reservoir drawdowns and higher flushing rates.	reservoir elevation and total outflow	med	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	yes, the nutrient suplementation program currently being carried out at Dworshak Reservoir has improved overall reservoir productivity.	yes	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	ESA (bulltrout?)	yes	n/a	yes; there have been numerous studies on Hungry Horse Reservoir that link drawdowns and flushing flows to reduced in-lake productivity.	yes	yes, resident fish and water quality	resident fish populations may still struggle; nutrient additions can risk balance between in-lake nutrient levels (nitrogen and phosphorus). If these nutrients become out of balance, harmful algae (cyanotoxins) may bloom and dominate system. Monitoring and adaptive management is necessary.
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee Reservoir	elevated turbidity	Deeper winter draft may lead to increase shoreline erosion.	reservoir elevation/retention time	low	no mitigation proposed	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Grand Coulee Reservoir	increased mercury methlyation	Increased methylation of mercury from deeper and longer reservoir drawdowns (wetting/drying of sediments).	reservoir elevation/retention time	med	no mitigation proposed	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Grand Coulee Reservoir	reduced dissolved oxygen	Spokane Arm DO in low flow/high temperature conditions have a greater portion of the water column that is anoxic.	reservoir elevation/retention time	low	Install aeration or bubbler system in impacted area (near mouth of Spokane River).	yes	yes	Install aeration or bubbler system in impacted area (near mouth of Spokane River).	DO TMDL exists for Little Spokane River, but not for reservoir.	yes	n/a	no; level of impact is low and occurs in small area within reservoir; conditions may improve from efforts conducted by other. Mitigation costs outweigh impact.	no; level of impact is low and occurs in small area within reservoir; conditions may improve from efforts conducted by other. Mitigation costs outweigh impact.	n/a	n/a
Grand Coulee Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	total outflow/residence time	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Chief Joseph Reservoir	In-reservoir water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dworshak	High TDG	Some increases in TDG below Dworshak Dam would be expected during high flow years due to increased outflow in the spring time in order to stay 10 feet below the upper rule curve (URC) (measure O2d).	total spill, TDG	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
none	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
none	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Water Quality – Multiple Objective 3

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby Reservoir	reduced in-lake biological productivity	Reservoir drawdowns and higher flushing rates.	reservoir elevation and total outflow	med	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	yes, the nutrient suplementation program currently being carried out at Dworshak Reservoir has improved overall reservoir productivity.	yes	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	ESA (bulltrout?)	yes	n/a	yes; there have been numerous studies on Hungry Horse Reservoir that link drawdowns and flushing flows to reduced in-lake productivity.	yes	yes, resident fish and water quality	resident fish populations may still struggle; nutrient additions can risk balance between in-lake nutrient levels (nitrogen and phosphorus). If these nutrients become out of balance, harmful algae (cyanotoxins) may bloom and dominate system. Monitoring and adaptive management is necessary.

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Kootenai River d/s of Libby	River water temperatures too warm in winter	Higher winter flows may impact natural cooling of river downstream of Libby Dam in early winter.	total outflow	low	no mitigation possible	n/a	n/a	no mitigation proposed	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hungry Horse Reservoir	reduced in-lake biological productivity	Reservoir drawdowns and higher flushing rates.	reservoir elevation and total outflow	med	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	yes, the nutrient suplementation program currently being carried out at Dworshak Reservoir has improved overall reservoir productivity.	yes	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	ESA (bulltrout?)	yes	n/a	yes; there have been numerous studies on Hungry Horse Reservoir that link drawdowns and flushing flows to reduced in-lake productivity.	yes	yes, resident fish and water quality	resident fish populations may still struggle; nutrient additions can risk balance between in-lake nutrient levels (nitrogen and phosphorus). If these nutrients become out of balance, harmful algae (cyanotoxins) may bloom and dominate system. Monitoring and adaptive management is necessary.

Location	Summary of Impact(s) Compared To NAA **if no impact or beneficial impact, no mitigation needed**	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	total outflow/residence time	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Reservoir	In-reservoir water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake River Projects (LWG - LMN)	Reduced dissolved oxygen/anoxia	High amounts of suspended sediemtn would be released during both years of reservoir drawdown and breach which could create very low and potentially anoxic conditions following 1st dam breach.	Total suspended sediments, sediment oxygen demand (as exist today), combined with river mechanics sediment transport modeling.	high	(1) Install aeration system in LMN to inject oxygen into water; (2) make an aerated backwater area to provide a refuge for resident fish	no, area likely too large for aeration system to work effectively, especially given that the environment will be changing quickly and aeration system is likley to be innudated/clogged with moving sediments.	no, area likely too large for aeration system to work effectively, especially given that the environment will be changing quickly and aeration system is likley to be innudated/clogged with moving sediments.	no mitigation proposed	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lower Snake River Projects (LWG - IHR)	Resuspension of contaminants and increased biological uptake	Suspension and downstream deposition of fine grained sediment that contains bioaccumulative compounds (PCBs, dioxins, pesticides, Hg, etc) will expose fish populations to new, higher levels of contaminants, with expected increases in fish tissue concentrations for at least a few years.	Sediment quality information collected over the years, combined with river mechanics sediment transport modeling.	high	Strategic removal (dredging) of any sediment "hot spots" with high contaminant levels.	yes, dredging contaminated areas first would reduce re-suspension of contaminated sediment.	yes, the Corps dredges some of these areas already.	Strategic removal (dredging) of any sediment "hot spots" with high contaminant levels.	yes, CWA	yes	n/a	yes, known contaminated sediment would be transported downstream and could be mitigated for.	yes, however costs would be high	yes, water quality, wildlife, resident fish, anadromous fish	some contaminated sediment would remain and potentially be taken up by fish and terrestrial animals.

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake River Projects (LWG - IHR)	Contaminated groundwater flows may increase pollution in LSR	Impacts to groundwater flows (several known polluted ground water sources near Lewiston); NPDES permits would likely need to be redefined (less dilution).	Total river flow/reservoir elevation	high	Groundwater control: (1) Install groundwater cutoff walls or groundwater "treatment curtains/walls" along areas of known groundwater contamination; (2) pump and treat groundwater aggressively to prevent flows from entering river; (3) Remediate known contamination areas prior to dam breach.	yes, containing or cleaning-up contaminated groundwater areas would reduce polluted inputs into lower Snake River post-breaching.	yes, these mitigation measures have been successful in other parts of the country.	Groundwater control: (1) Install groundwater cutoff walls or groundwater "treatment curtains/walls" along areas of known groundwater contamination; (2) pump and treat groundwater aggressively to prevent flows from entering river; (3) Remediate known contamination areas prior to dam breach.	yes, CWA	yes	n/a	yes, known contaminated groundwater is present and could be mitigated for.	yes, however costs would be high	yes, water quality, wildlife, resident fish, anadromous fish	if groundwater is contained rather than remediated, it would still be considered contaminated and potentially pose future risks to humans and animals.
Lower Snake River Projects (LWG - IHR)	High temperatures in summer	Water temperatures could still exceed state water quality standards during the summer months due to shallow river post-breaching.	Water temperature/total flow/reservoir elevation	med	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Lower Columbia River Projects (MCN - BON)	High TDG	Higher TDG limits as called for in MO3 would create TDG that is higher than NAA; new state water quality standards would need to be established.	total spill, TDG	low	no mitigation proposed, as MO3 measures call for higher TDG limits in lower Columbia River.	n/a	n/a	none	CWA, until new TDG waivers are established.	n/a	n/a	n/a	n/a	n/a	n/a
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
none	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

9 Water Quality – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby Reservoir	reduced in-lake biological productivity	Reservoir drawdowns and higher flushing rates.	reservoir elevation and total outflow	med	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	yes, the nutrient suplementation program currently being carried out at Dworshak Reservoir has improved overall reservoir productivity.	yes	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	ESA (bulltrout?)	yes	n/a	yes; there have been numerous studies on Hungry Horse Reservoir that link drawdowns and flushing flows to reduced in-lake productivity.	yes	yes, resident fish and water quality	resident fish populations may still struggle; nutrient additions can risk balance between in-lake nutrient levels (nitrogen and phosphorus). If these nutrients become out of balance, harmful algae (cyanotoxins) may bloom and dominate system. Monitoring and adaptive management is necessary.

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Libby Reservoir	In-reservoir water temperatures too cold in spring/early summer	Reservoir held higher Dec - Feb for the majority of years, which may result in colder reservoir water temperatures in spring and summer.	reservoir elevation	low	no mitigation possible	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Kootenai River d/s of Libby	River water temperatures too cold in spring/early summer	Reservoir held higher Dec - Feb for the majority of years, which may result in colder reservoir water temperatures in spring and summer.	reservoir elevation	low	no mitigation possible	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Kootenai River d/s of Libby	River water temperatures too warm in winter	Higher winter flows may impact natural cooling of river downstream of Libby Dam in early winter.	total outflow	low	no mitigation possible	n/a	n/a	no mitigation proposed	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Kootenai River d/s of Libby	High TDG	Some increases in TDG below Libby Dam would be expected during high flow years due to aggressive drafting of Libby Reservoir following the end-of-December draft target measure (O12).	total spill, TDG	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse Reservoir	Reduced in-lake biological productivity	Reservoir drawdowns and higher flushing rates.	reservoir elevation and total outflow	med	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	yes, the nutrient suplementation program currently being carried out at Dworshak Reservoir has improved overall reservoir productivity.	yes	Perform in-reservoir nutrient supplementation to increase primary and secondary productivity.	ESA (bulltrout?)	yes	n/a	yes; there have been numerous studies on Hungry Horse Reservoir that link drawdowns and flushing flows to reduced in-lake productivity.	yes	yes, resident fish and water quality	resident fish populations may still struggle; nutrient additions can risk balance between in-lake nutrient levels (nitrogen and phosphorus). If these nutrients become out of balance, harmful algae (cyanotoxins) may bloom and dominate system. Monitoring and adaptive management is necessary.

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Albeni Falls	Nearshore areas used for recreation may be more difficult to access due to the lower lake level, as well as from greater macrophyte and periphyton growth.	McNary Dam augmentation (O7) measure would results in slightly warmer downstream water temperatures in the summer months.	reservoir elevation, conditions under NAA	low	Implement and expand existing invasive aquatic plant removal program (e.g. Eurasian water milfoil).	yes, current removal program has been successful	yes	Implement and expand existing invasive aquatic plant removal program (e.g. Eurasian water milfoil).	no	yes	n/a	yes, current removal program has been successful	yes	yes, water quality and recreation	some invasive aquatic plants may still be present and negatively impact recreation, since impact area is so large.
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee Reservoir	elevated turbidity	Deeper winter draft may lead to increase shoreline erosion.	reservoir elevation/retention time	low	no mitigation proposed	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a
Grand Coulee Reservoir	increased mercury methlyation	Increased methylation of mercury from deeper and longer reservoir drawdowns (wetting/drying of sediments).	reservoir elevation/retention time	med	no mitigation proposed	n/a	n/a	none	no	n/a	n/a	n/a	n/a	n/a	n/a

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee Reservoir	reduced dissolved oxygen	Spokane Arm DO in low flow/high temperature conditions have a greater portion of the water column that is anoxic.	reservoir elevation/retention time	low	Install aeration or bubbler system in impacted area (near mouth of Spokane River).	yes	yes	Install aeration or bubbler system in impacted area (near mouth of Spokane River).	DO TMDL exists for Little Spokane River, but not for reservoir.	yes	n/a	no; level of impact is low and occurs in small area within reservoir; conditions may improve from efforts conducted by other. Mitigation costs outweigh impact.	no; level of impact is low and occurs in small area within reservoir; conditions may improve from efforts conducted by other. Mitigation costs outweigh impact.	n/a	n/a
Grand Coulee Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	total outflow/residence time	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Reservoir	In-reservoir water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a
Chief Joseph Tailrace	River water temperatures too high in some summers	Minor increase in spring/summer water temperatures in low water years.	upstream conditions	low	no mitigation proposed	n/a	n/a	none	CWA	n/a	n/a	n/a	n/a	n/a	n/a

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lower Snake River Projects (LWG - IHR)	High TDG	Higher TDG limits as called for in MO3 would create TDG that is higher than NAA; new state water quality standards would need to be established.	total spill, TDG	low	no mitigation proposed, as MO3 measures call for higher TDG limits in lower Columbia River.	n/a	n/a	none	CWA, until new TDG waivers are established.	n/a	n/a	n/a	n/a	n/a	n/a
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lower Columbia River Projects (MCN - BON)	High TDG	Higher TDG limits as called for in MO3 would create TDG that is higher than NAA; new state water quality standards would need to be established.	total spill, TDG	low	no mitigation proposed, as MO3 measures call for higher TDG limits in lower Columbia River.	n/a	n/a	none	CWA, until new TDG waivers are established.	n/a	n/a	n/a	n/a	n/a	n/a
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Fish (Chinook, Steelhead, and Sockeye) – Multiple Objective 1

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low) and brief explanation why**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ice Harbor	Increased frequency of high water temperatures (> 20 °C (68 °F)) that can cause migrating adult salmon to stop or delay their migration or can increase fallback at a dam.	Dworshak augmentation measure	Water temperature	high	No mitigation option (don't implement operation)	NA	NA	NA	ESA, CWA	NA	NA	seasonal (August and September)	NA	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low) and brief explanation why	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Lower Monumental	Increased number days with >2 °C differential in adult ladder that can delay adult migration	Dworshak augmentation measure	Water temperature	high	Install pumps at ladders to select cooler water. This action is a structural measure included in MO 1, MO 2, and MO 4.	This measure is estimated by Engineering to be effective in extreme hot years (25% of the time), but only if paired with a trap and haul facility/operation, which would allow fish to be transported upstream above Lower Granite. (Pumps would be required for an effective trap and haul operation). In normal years this would not be needed.	Yes. It is feasible to install, but would need to be combined with a trap and haul facility/operation. Engineering recommends Ice Harbor as a higher priority location for this operation, not Lower Monumental.	No - already included as a measure in the alternative.	ESA, CWA	NA	NA	NA	No. This action is already included in the alternatives as a structural measure.	This measure would benefit bull trout using the fish ladders	

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low) and brief explanation why	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
All projects	TDG experience from increased spill	Increased spill measures. Change to this measure (lower Spill level) would reduce or eliminate this negative impact.	TDG	medium	*implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats *increase pinniped and avian predator measures	These measures will not change TDG, but would improve conditions for existing fish migrating into and out of the system.	Yes.	Yes	ESA, CWA	No	TDG impacts cannot be mitigated without changing the alternative. Taking offsite actions would generally improve conditions for juvenile and adult fish in the river.	all years	No. There is an option for effective, onsite mitigation.	Habitat improvements would benefit resident fish (bull trout and others) and other species than anadromous fish	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low) and brief explanation why**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Granite and Little Goose	TDG experience from increased spill	Increased spill measures. Change to this measure (lower Spill level) would reduce or eliminate this negative impact.	TDG	medium	*install divider wall at LSR projects to isolate the high TDG and reduce/eliminate confounding eddies for u/s adult passage *Add ladder entrances at LWG & LGS	1)Divider walls have been studied in the past (NWW) and found not to be effective at isolating TDG. There is no effective measure available to isolate TDG, short of not implementing the spill or changing spill levels. 2) Additional ladder entrances could provide a more direct route outside of eddies created by spill, for upstream adult passage.	The walls would not isolate TDG. Additional fish ladder entrances are feasible and implementable.	Yes - ladder entrances. Divider walls are not recommended.	ESA, CWA	Yes. The construction of additional ladder entrances is an onsite mitigation measure. Construction of divider walls is not recommended.	TDG impacts cannot be mitigated without changing the alternative.	all years	Yes	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

LCOL Projects	TDG experience from increased spill	Increased spill levels. Change to this measure (lower Spill level) would reduce or eliminate this negative impact.	TDG	medium	*implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats *increase pinniped and avian predator measures	These measures will not change TDG, but would improve conditions, including resting and food sources, for existing fish migrating into and out of the system. An increase in the level of avian or pinniped predator management would help to lessen impacts to fish that are stunned or temporarily incapacitated by higher TDG levels, or adult fish that may become stalled looking for ladder entrances.	Yes	Yes	ESA, CWA	No	TDG impacts cannot be mitigated without changing the alternative. Taking offsite actions would generally improve conditions for juvenile and adult fish in the river.These measures will not change TDG, but would improve conditions, including resting and food sources, for existing fish migrating into and out of the system. An increase in the level of avian or pinniped predator management would help to lessen impacts to fish that are stunned or temporarily incapacitated by higher TDG levels, or adult fish	all years	No. There is no option for effective, onsite mitigation.	Habitat improvements would benefit resident fish and other wildlife.	TDG levels in the river would remain the same, but the number of fish affected may decrease.

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low) and brief explanation why	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
											that may become stalled looking for ladder entrances.				
LCOL Projects	TDG experience from increased spill	Increased spill levels. Change to this measure (lower Spill level) would reduce or eliminate this negative impact.	TDG	medium	*install divider wall at LCR projects to isolate the high TDG and reduce/eliminate confounding eddies for u/s adult passage *Shad removal at BON and TDA within ladders	Neither measure is effective. 1)Divider walls have been studied in the past (NWW) and found not to be effective at isolating TDG. There is no effective measure available to isolate TDG, short of not implementing the spill or changing spill levels. 2) A study at The Dalles conducted by NWP found that shad to not impact use of the fish ladders by adult salmon.	No	No mitigation recommended	ESA, CWA	NA	NA	–	Yes	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Fish (Chinook, Steelhead, and Sockeye) – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
LSR	decreased in-river survival due to increased Powerhouse encounters/increased predation and reduced spill (increased travel time)	Operational measures to increase hydropower flexibility/lifting of restrictions	survival rates: latent effects of survival for fish who move through bypasses	Med	*Add divider walls to tailrace downstream of PHs to improve egress *Behavioral guidance structures at individual dams, e.g. solid curtain in forebay (artificial shoreline), pile dikes, nets *Reduce fish handling at bypass locations, only at LSR collector prjects and MCN for transport if at all. *Increase in the level of avian and pinniped predation management	None of these actions directly and effectively address the effects of powerhouse encounters.	None of these actions directly address the effects.	Only the measure to increase the level of avian and pinniped predation management.	ESA	No.	The effects cannot be effectively and directly offset. An increase in the level of management of predators could help to limit predation on stunned or injured fish.	Yes.	Yes. Increase the level of predator management.	May be a benefit for resident fish.	–
–	Slight increase in juvenile downstream travel time by approximately 13-15 hours.	Reduction in spill to 110% TDG	juvenile fish travel times	medium	Effect cannot be mitigated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Slight increase in juvenile downstream travel time by approximately 13-15 hours.	Reduced spill levels (Spill to 110%)	juvenile fish travel times	medium	Effect cannot be mitigated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
–	Increased juvenile transportation results in increased adult migration delay from fallback and straying due to impared homing ability.	Increase transport measure	Upstream travel times/SARs. Fallback and straying is measured with PIT tagged fish	medium	Effect cannot be mitigated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Fish (Chinook, Steelhead, and Sockeye) – Multiple Objective 3

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lower Snake River Projects	Dam breaching would create high levels of turbidity/suspended sediment from Lower Granite Dam to Ice Harbor Dam during Snake Rier fall Chinook and upper Snake River sockeye migration. This could result in mortality to 20-40% of the populations.	Dam Breach	Water Quality	high	a)Construct new trap and haul operation for Snake River salmon and sturgeon b) Change dam breach timing to outside of the salmon migration window (two months later) c)Raise additional hatchery fish to offset two lost year classes prior to start of breach	Yes	Trap and Haul is feasible. Feasibility of (b) is questionable for safety reasons. Item C) may be feasible, but capacity at existing hatcheries is uncertain.	Yes	ESA	Yes	NA	Temporary result of breach, but may take years to stabilize river	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Salmon, Steelhead, and Sturgeon would be trapped and moved prior to breaching.	There would be a proportion of fish that stray and spawn elsewhere due to extreme conditions.

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake River Projects	Very low dissolved oxygen level from dam breaching would result in mortality in the Little Goose and Lower Monumental reservoirs during first phase of demolition, potentially wiping out year class of migrating Snake River fall Chinook and upper Snake RIver sockeye.	Dam Breach	Water Quality	high	a)Construct new trap and haul operation for Snake River fish b) Change dam breach timing to outside of the salmon migration window; c)Raise additional hatchery fish to offset two lost year classes prior to breach	Yes	Trap and Haul is feasible. Feasibility of (b) is questionable for safety reasons. Item C) may be feasible, but capacity at existing hatcheries is uncertain.	Yes	ESA	Yes	NA	Temporary result of breach, but may take years to stabilize river	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Salmon, Steelhead, and Sturgeon would be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted
Lower Snake River Projects	Potential island creation post-dam breaching could result in additional avian nesting habitat and increase predation pressure on migrating fish.	Dam Breach	Water Quality	low	No mitigation proposed	NA	NA	NA	ESA	NA	NA	NA	NA	NA	NA
Lower Snake River Projects	Additional days over 18° C would cause thermal stress and potential increased mortality of Snake River sockeye.	Dam Breach	Water Quality	high	No mitigation proposed - cannot be mitigated	NA	NA	NA	ESA	NA	NA	NA	NA	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Lower Snake River Projects	Decreased spawning success of Snake River spring Chinook salmon and steelhead due to perched tributaries from breaching of lower Snake River dams.	Dam Breach	Water Quality	–	Trap and haul fish during breaching; create pilot channels in tributaries likely to perch from breaching.	Yes	Yes	Yes	ESA	Yes	NA	Temporary result of breach, but may take years for river to stabilize	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Salmon, Steelhead, and Sturgeon would be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted
Lower Snake River Projects	high turbidity/sediment levels during migration resulting in 20-40% mortality	Dam Breach	Water Quality	high	*construct new trap and haul SR Sockeye above LWG at Ice Harbor. * change dam breach timing to miss salmon migrations *raise additional hatchery fish to offset two lost year classes	Yes	Yes	Yes	ESA	Yes	NA	Temporary result of breach, but may take 8 years to stabilize river	Trap and Haul - Yes Change to timing of breach - No Additional hatchery fish - Yes	Salmon, Steelhead, and Sturgeon would be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted
Lower Snake River Projects	low dissolved oxygen levels resulting in mortality in the LGS and LMO pools during first phase of deconstruction	Dam Breach	Water Quality	high	*construct new trap and haul SR Sockeye above LWG at Ice Harbor. * change dam breach timing to miss salmon migrations *raise additional hatchery fish to offset two lost year classes	Yes	Yes	Yes	ESA	Yes	NA	Temporary result of breach, but may take 8 years to stabilize river	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Salmon, Steelhead, and Sturgeon would be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lower Columbia River projects	TDG experience from increased spill	Spill to 120% TDG measure	Water Quality, TDG	medium	*implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats *increase pinniped and avian predator measures	Yes	Yes	Yes	ESA, CWA	No	TDG impacts throughout the river cannot be mitigated without changing the alternative to avoid the effect. Taking offsite actions would generally improve conditions for juvenile and adult fish in the river. Increasing management of predators would lower predation on fish stunned or injured by TDG.	All years	Yes	Habitat improvements would provide a benefit to other wildlife. Predator measure could provide benefits to resident fish.	High TDG levels would still be present in the river.

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Columbia River projects	High levels of turbidity as from the dam breaching measure could result in high levels of turbidity downstream of McNary Dam. This could result in 20-40% mortality of migraing Upper Columbia and Upper Snake River fall Chinook and sockeye	Dam Breaching	Water Quality	high	* Create MCN collection facility to allow trap and haul from MCN (to collect fall migrating fish below Snake) *Modify/improve BON collection facitlity to allow trap and haul from BON *change dam breach timing to miss Salmon Migrations *raise additional hatchery fish to offset two lost year classes	Yes	Yes	Yes	ESA, CWA	No, the trap and haul sites are downstream of the breach site.	Collection of fish downstream would keep them from entering the breach zone and keep them out of the area negatively affected by breaching.	Temporary result of breach, but may take 8 years to stabilize river	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Bull Trout and Sturgeon would also be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Lower Columbia River projects	low dissolved oxygen levels resulting in mortality in the LGS and LMO pools during first phase of deconstruction	Dam Breaching	Water Quality	high	* Create MCN collection facility to allow trap and haul from MCN *Modify/improve BON collection facitlity to allow trap and haul from BON *change dam breach timing to miss Salmon Migrations *raise additional hatchery fish to offset two lost year classes	Yes	Yes	Yes	ESA, CWA	No, the trap and haul sites are downstream of the breach site.	Collection of fish downstream would keep them from entering the breach zone and keep them out of the area negatively affected by breaching.	Temporary result of breach, but may take 8 years to stabilize river	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Bull Trout and Sturgeon would also be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted
Lower Columbia River projects	TDG experience from increased spill	Spill to 120% TDG measure	Water Quality, TDG	medium	1)install divider wall at LCR projects to isolate the high TDG and reduce/eliminate confounding eddies for u/s adult passage 2)Modify transport facility raceways to reduce TDG at McNary using steel infrastructure to degass the raceway during collection for transport.	1) Divider walls have been studied and found to not be effective for lowering TDG effects. Cost is too high to apply for confounding eddies. 2) Modification of raceways would be effective and is recommended.	Modification of raceways is feasible and implementable.	Modification of raceways carried forward for recommendation	ESA, CWA	NA	NA	Seasonal, as Spill to 120% measure is implemented	Yes. Modification of the raceways is recommended	Yes	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Columbia River projects	Decreased survival due to higher turbidity and low DO; decreased spawning success due to perched tributaries in lower Snake reach	Dam Breaching	Water Quality	High	*Trap and haul fish during implementation of breach	Yes	Yes	Yes	ESA, CWA	No, the trap and haul sites are downstream of the breach site. Construction of pilot channels prior to breaching would insure that fish had access to the tributaries, and may help to create refuges during high turbidiy and periods of low DO.	Collection of fish downstream would keep them from entering the breach zone and keep them out of the habitat area negatively affected by breaching.	Temporary result of breach, but may take 8 years to stabilize river	Trap and Haul - Yes Change Dam Breach timing - No, due to safety concerns Raise additional hatchery fish - Yes, if capacity exists	Bull Trout and Sturgeon would also be trapped and moved prior to breaching.	Water quality would be bad, but fewer fish would be impacted
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Fish (Chinook, Steelhead, and Sockeye) – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Okanogan River confluence	Dry years may see mainstem temps rise over 20C in fall, which causes confounding water temperatures and adults can't find spawning grounds.	McNary flow targets measure	water temperature, fish passage numbers	medium	no known feasible mitigation options	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake Projects	a) Increased frequency of high water temperatures (> 20° C or 68° F). This can cause migrating adult salmon to stop or delay their migration or can increase fallback at a dam would negatively impact Snake River Fall Chinook.	Change to Dworshak Spill schedule	Water Quality	High	No mitigation proposed/no mitigation possible	NA	NA	NA	Yes	NA	NA	NA	NA	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake Projects	Elevated TDG could harm upstream migrants and/or affect upstream migration of Snake River fall Chinook and Upper Snake River sockeye.	Spill to 125% TDG measure	Water Quality	High	1) Install divider wall at lower Snake River projects to isolate the high TDG and reduce/eliminate eddies that slow upsteram adult passage; 2) Add fish ladder entrances at Lower Granite and Little Goose Dams.	1)Divider walls have been studied in the past (NWW) and found not to be effective at isolating TDG. There is no effective measure available to isolate TDG, short of not implementing the spill or changing spill levels. 2) Additional ladder entrances would be effective in providing upstream passage to adult salmon and steelhead who are impacted by confounding eddies under a high spill regime.	1)Divider Walls are not feasible. 2) Additional ladder entrances are feasible.	Yes - Additional Ladder entrances only.	Yes	Yes	–	All years	Yes - Ladder Entrances	–	High TDG remains, but adult fish would have an easier upstream migration through the eddies created by high spill.
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Lower Columbia Projects	Slight increases in TDG throughout the lower Columbia River could have negative impacts on migrating Upper Columbia spring Chinook and steelhead and sockeye.	Spill to 125% TDG measure	Water Quality	High	1)Install divider wall at John Day ad McNary Dams to isoate the high TDG and reduce/eliminate confounding eddies for upstream adult fish passage; 2)implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habiatats; 3)increase pinniped and avian predation measures; 4)perfom shad removal in the fish ladders at Bonneville and the Dalles.	Neither onsite measure (1 and 4) is effective. 1)Divider walls have been studied in the past (NWW) and found not to be effective at isolating TDG. There is no effective measure available to isolate TDG, short of not implementing the spill or changing spill levels. 2) A study at The Dalles conducted by NWP found that shad to not impact use of the fish ladders by adult salmon.	Divider walls and shad removal would not have the desired effect.	The offsite measures for habitat improvement and increased avian and pinniped management are recommended.	Yes	No. The measures are offsite	TDG impacts cannot be mitigated without changing the alternative. Taking offsite actions would generally improve conditions for juvenile and adult fish in the river.	all years	No. There is no option for effective, onsite mitigation.	Habitat improvements would benefit resident fish and other wildlife.	TDG levels in the river would remain the same, but the number of fish affected may decrease.

Lower Columbia Projects	TDG experience from increased spill	Spill to 125% TDG measure	Water Quality	High	1)Implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats; 2)increase pinniped and avian predation measures; 3) perform shad removal in the fish ladders at Bonneville and the Dalles.	These measures will not change TDG, but would improve conditions, including resting and food sources, for existing fish migrating into and out of the system. An increase in the level of avian or pinniped predator management could help to minimize mortality from predation to fish that are stunned or temporarily incapacitated by higher TDG levels, or adult fish that may become stalled looking for ladder entrances. Shad removal would alleviate crowding in the fish ladders.	Yes	Yes	Yes	The habitat measures and predation management measures are offsite. The Shad removal measure is onsite.	There is no effective mitigation measure to offset the levels of TDG expected to be generated throughout the river with the spill to 125% level. However, improvements to habitat, and removal of predators and shad would benefit ESA fish as they move through the system by providing healthier conditions and food sources, and decreasing pressure from predators and competition.	All years	Yes	–	High TDG remains.
McNary	TDG experience from increased spill	Spill to 125% TDG measure	Water Quality	High	*Modify transport facility raceway at McNary to reduce TDG.	Yes	Yes	Yes	Yes - ESA fish	Onsite	Yes	Yes	Yes	Yes	High TDG in the river, but fish collected for transport at McNary

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					Use steel infrastructure in the raceway to degass during collection for transport.										would go into a lower TDG environment .
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Entire Reach	TDG experience from increased spill	Spill to 125% measure	Water Quality/TDG	High	1)implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats 2) increase pinniped and avian predator measures	These measures will not change TDG, but would improve conditions, including resting and food sources, for existing fish migrating into and out of the system. An increase in the level of avian or pinniped predator management would help to lessen impacts to fish that are stunned or temporarily incapacitated by higher TDG levels, or adult fish that may become stalled looking for ladder entrances.	Yes	Yes	Yes	No. Offsite.	There is no effective mitigation measure to offset the levels of TDG expected to be generated with the spill to 125% level. However, improvements to habitat, and removal of predators and shad would benefit ESA fish as they move through the system by providing healthier conditions and food sources, and decreasing pressure from predators and competition.	All years	Yes	–	–

22 **Fish (Resident) – Multiple Objective 1**

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
libby/kootenai	ecosystem & Burbot - the potential change in the range of spring freshet flows impacts the ecosystem and fish including burbot	–	flow	low	Construct in-channel habitats that resemble Ferry Island	Mixed results - Need data from Kootenai.	Yes - has been done in some areas.	No - see Column E - low impact for unlisted species.	–	–	–	–	–	–	–
Bonner Ferrys	Burbot - flows and temperatures affect burbot development	–	flow and temp	low	reconnect floodplain to benefit early life history for Burbot	Yes - has been attempted and worked	Yes - has been done in some areas.	No - see Column E - low impact for unlisted species.	–	–	–	–	–	–	–
Bonner Ferrys	KRWS - High winter flows continue trends of reduced riparian vegetation establishment (e.g. cottonwoods).	–	flow and temp	low	plant cottonwoods trees (1 to 2 gallon trees). (mitigate for wildlife/habitat as well)	Benefit to KRWS is unknown.	Yes - already been done. This would expand areas.	Yes	ESA- KRWS listed as endangered	Yes/This is designed to improve habitat - then improves water quatlity - improves fish survival	–	Scale not set for this mitigation	Yes	Partial	Unknown

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libby/kootenai	KRWS- decrease the number of days high flows exceed 30 kcfs at Bonners Ferry relative to the NAA. This could potentially reduce the number of spawning adults that migrate to spawning habitat upstream of Bonners Ferry.	KRWS need high flows similar to natural hydrograph to induce successful spawning - induces them to move up to adequate habitat	flow	med	Restore or improve spawning habitats near Bonners Ferry	Has been completed, but impact or effect is uncertain.	Yes - has been done in some areas.	Yes	ESA- KRWS listed as endangered	Yes - is on site and replaces in-kind losses of spawning habitat.	–	Scale not set for this mitigation	Yes	Partial	Unknown

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Hungry Horse	Bull trout - Lower elevations in summer (4'-16' lower at end of Sept) and fewer full pool results in smaller productive euphotic zone, less surface for feeding in summer, and dewaters benthic insect production; less food source (terrestrial inspects/aquatic) for bull trout	HH lake elevations affect production of phytoplanzkton, zooplankton, and invertebrates that are the base of food source for fish.	Volume of euphotic zone, percent decrease in benthic area (indexed from surface area); and surface area for summer feeding.	Med	Revegetate areas withi the top 10' of the reservoir that are adjacent to tributaries used by bull trout; combine with creation of subimpoundments (vegetate within them) in the upper reservoir bays for improved benthic production, potection from predation (varial zone issues), and to protect tributary access. Where feasible, use existing contract for debris removal to dispose of the tree material by anchoring and sinking it in strategic places in the reservoir instead of hauling it out. LIkely very low cost difference than what doing now.	Yes - studied by Reclamatiion. Recommeneded by FWP and FWS to increase bull trout habitat, increase survival of juveniles outmigrating from tribs, and provide additional area for insect production and proximity of terrestrial insects in summer.	Yes, a study has been done to determine spp and techniques that are successful. Vegetation is a natural process that is disrupted at the seed stage by reservoir operations. Plantings proposed would get vegetation past the vulnerable seed stage to establish natural vegetation closer to the water surface at most times of year and inundated for a couple of months.	Yes	Yes - Bull trout Listed as Threatened	Yes.	–	Scale with area treated. Recommend about 15 streams important to bull trout.	Yes	Yes, offsets loss of insect production. Note - same action also mitigates wildlife effects.	Can scale to fully offset food effects; likely still some tributary access and varial zone effects (predation danger minimized and area of suitable habitat increased, but stilll have more distance of varial zone to travel).

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Hungry Horse	Bull trout -Increased summer outflows (17%-21% higher) would increase zooplankton loss; zooplankton concentrated at outlets; reduced food for fish in late summer.	Increased outflows result in increased entrainment of zooplankton food resources from the reservoir.	Outflows	med	Restore operation of slide gates on temp control structure (Actual physical restoration will be done as part of HH Modernization; this measure is to use them.	Yes - used to function; water pulled from two different thermal zones and mixed to get target temp to avoid pulling from where zooplankton (and fish) are concentrated.	Yes	yes	Yes, bull trout are ESA-listed.	Yes	–	Yes	Yes	Yes, reduces entrainment of zooplankton and fish.	Depending on water temps, bull trout may still be found at deeper depths than zooplankton and still be entrainmed.

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Hungry Horse	Bull trout - in wet and average water years (Aug-Oct) for increases varial zone which increases exposure to angling/predation and difficulty entering spawning tributaries; however dry years, these effects are greater.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	med	Use native woody species to stabilize tribustary channels and provide cover (same measure as line 8). Priority for Wounded Buck, Sullivan, Wheeler, and Bunker Creeks, but this is not an exhaustive list.	Yes. Common practice and recommended by local managers, including Reclamation.	Yes - has been done before. Woody plant species proposed have been studied to determine best species and techniques for best success.	Yes	Yes - Bull trout Listed as Threatened	Yes	–	Yes, can be scaled with increased or decreased area treated.	Yes	Yes, offsets varial zone predation effects by providing cover for migrating bull trout thorugh the open varial zone.	Fish still would have further distance through the varial zone, but predation and thermal issues would be imporved.

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Hungry Horse	bull trout and spring spawners - Increased risk of access issues to tribs in Aug-Oct for bull trout and Apr-May for spring spawners.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	Med	Same action as line 8.	Yes. Success of woody species studied. Strategic placement to stabilize tributary mouths.	Yes - has been done before.	Yes - would require site specific stratey go stabilize tributary entrance into reservoir.	Yes - Bull trout Listed as Threatened	Yes	–	Can be scaled to number of tributaries affected by lower reservoir.	Yes	Yes, offsets migration impediments by stabilizing stream and providing cover.	Potentially still some delay in migration or difficulty with outmigration of juveniles.
SF and main Flathead	all fish /aquatic invertebrates. - Higher summer flows benefit food production *(benefit)* but could result in less suitable habitat due to high velocities.	Higher summer flows.	flow and temp	low	Create back-channel habitat for juvenile bull trout or otherwise create trout habitat in mainstem Flathead River	Yes - common practice	Yes	Yes	Yes, Bull trout are ESA-listed, but effect likely not biologically noticeable in mainstem Flathead River. SF Flathead River has higher effect but not critical habitat for bull trout.	Yes.	–	NA	No.	–	–
Albeni Falls	Bull trout - **no difference from the NAA** in entrainment from flows or effects from changes in water elevation	Delete	–	–	–	–	–	No	–	–	–	–	–	–	–

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Albeni Falls	cut throat and kokanee - n**o difference from the NAA** in entraiment	Delete	–	–	–	–	–	No	–	–	–	–	–	–	–
Albeni Falls	gamefish -northern pike-**no difference from NA**A in habitat availability	Delete	–	–	–	–	–	No	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CHJ -MCN	bull trout - TDG effects **Similar to NAA**	Delete	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	white sturgeon - Slightly decrease in recruitment window (June 15-July 31), 3 days instead of 8 days in 25%ile water years; 42days instead of 43days in highest water years)	–	flow	low	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	White Sturgion - **similar to NAA**; L. Roosevelt pool elevation may influence riverine reach available for sturgeon recruitment(June30 -July15).	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon-high flows are ~ 2.4% lower and WS spawning success may be reduced when compared to the NAA.	–	flow	low	–	–	–	No	–	–	–	–	–	–	–

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CHJ -MCN	**Similar flows as NAA** and would not change the risk for outmigration of supplemental fish from the project area.	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - Turbidity is not expected to change; **same as NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - **similar flows and risk of mortality in large sturgeon as NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon- slight increase in the occurance of high temperatures above MCN potentially resutling in minor increase in risk of mortality.	–	flow and temp	low	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Burbot - lower water elevation in Columbia River (March) and L. Roosevelt (winter/early spring) potentially reduce burbot habitat and stranding eggs.	–	WSE	med	–	–	–	No	–	–	–	–	–	–	–

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Canada - CHJ	burbot, kokanee, redband rainbow trout and mitigation fishery - Slighlty reduced food and increased entrainment in Dec-Mar spawning period.	–	–	low	Fish collector in/near GCD forebay, equipped with exclusionary netting, and fish transportation - return/transport mitigation fish and native species to Roosevelt	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	redband trout and kokonee - **similar to NAA**; access to trib habitat/varial zone	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	kokonee - 3'-10' deeper drops than NAA and earlier draft would put eggs/fry at higher risk of stranding/dessication.	–	WSE	low	increase spawning habitat by supplementing gravel (offsite) and/or improve spawning habitat at lower elevation (onsite)	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Mitigation fishery fish - **same as NAA**; released coincide with initiation of refill (to minimize loss).	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	Northern Pikeminnow - potentially **slight improvement from NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–

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CHJ -MCN	walleye -slight effect on juveniles with drawdown	–	WSE	low	No mitigation - Walleye are not limited in MCN pool and reducing rearing success would be a mitation measure for Salmon and Steelhead.	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	small mouth bass - slight effect on nesting with drawdown	–	WSE	low	No mitigation - SMB are not limited in MCN pool and reducing nesting success would be a mitation measure for Salmon and Steelhead.	–	–	No	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DWA	Bull trout - drafting for cooling/augmentation is begun sooner and could be as much as 6 feet lower than the NAA at the end of the bull trout migration which could limit access to spawning tribs. This could have an impact to bull trout migrating in the later half of June.	–	–	med	Channel rehab to ensure that inlet channels have passage under low water conditions.	–	–	–	–	–	–	–	–	–	–

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Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary	WS - **Similar to NAA** for recruitment (temperature and flows), slightly fewer days for spawning and recruitment	–	–	–	–	–	–	–	–	–	–	–	–	–	–
John Day	WS - spill testTDG affects on sturgeon larvae	block test spill	TDG	med	–	–	–	–	–	–	–	–	–	–	–

Fish (Resident) – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low) brief explanation of why	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
libby/kootenai	ecosystem & Burbot - the potential change in the range of spring freshet flows impacts the ecosystem and fish including burbot	–	–	low	Construct in-channel habitats that resemble Ferry Island	–	–	No	–	–	–	–	–	–	–
Bonner Ferrys	Burbot - flows and temperatures affect burbot development	–	–	low	reconnect floodplain to benefit early life history for Burbot	–	–	No	–	–	–	–	–	–	–
Bonner Ferrys	KRWS - High winter flows continue trends of reduced riparian vegetation establishment (e.g. cottonwoods).	–	–	low	plant cottonwoods trees (1 to 2 gallon trees). (mitigate for wildlife/habitat as well)	–	–	See MO1	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	Bull trout - Deeper winter drafts reduce substrate for insect production; reduces food available in spring, and reduced summer volume reduces food available.	HH lake elevations affect production of phytoplanzkton, zooplankton, and invertebrates that are the base of food source for fish.	Volume of euphotic zone, percent decrease in benthic area (indexed from surface area); and surface area for summer feeding.	Med	Revegetate areas withi the top 10' of the reservoir that are adjacent to tributaries used by bull trout; combine with creation of subimpoundments (vegetate within them) in the upper reservoir bays for improved benthic production, potection from predation (varial zone issues), and to protect tributary access. Where feasible, use existing contract for debris removal to dispose of the tree material by anchoring and sinking it in strategic places in the reservoir instead of hauling it out. LIkely very low cost difference than what doing now.	Yes - studied by Reclamatiion. Recommened by FWP and FWS to increase bull trout habitat, increase survival of juveniles outmigrating from tribs, and provide additional area for insect production and proximity of terrestrial insects in summer.	Yes, a study has been done to determine spp and techniques that are successful. Vegetation is a natural process that is disrupted at the seed stage by reservoir operations. Plantings proposed would get vegetation past the vulnerable seed stage to establish natural vegetation closer to the water surface at most times of year and inundated for a couple of months.	Yes	Yes - Bull trout Listed as Threatened	Yes.	–	Scale with area treated. Recommend about 15 streams important to bull trout.	Yes	Yes, offsets loss of insect production. Note - same action also mitigates wildlife effects.	Can scale to fully offset food effects; likely still some tributary access and varial zone effects (predation danger minimized and area of suitable habitat increased, but stilll have more distance of varial zone to travel).

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low) brief explanation of why	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse	Over 100% increase in winter outflows increases entrainment of zooplankton and fish from the reservoir.	Increased outflows in winter.	Outflows	High	See line 8; improve food production in winter insects.	Yes, will increase insect production but may reach limitations with loss of zooplankton for aquatic insectts to eat.	Yes	yes	Yes, bull trout are ESA-listed.	Yes, with nuance of increasing insect production to offset zooplankton loss.	–	Yes	Yes	–	Fish entrainment, zooplankton still entrained.
Hungry Horse	Bull trout - lower elevations in spring increases varial zone which increases exposure to angling/predation and difficulty entering spawning tributaries;	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	Low	Use native woody species plantings described in line 8 would help offset effects while improving food resources. Strategically select sites for food production that would also benefit tributary access and varial zone effects.	Yes. Common practice and recommended by local managers, including Reclamation.	Yes - has been done before. Woody plant species proposed have been studied to determine best species and techniques for best success.	Yes	Westslope Cutthroat Trout are primary species affected and are not ESA-listed, but the same mitigation would offset food web effects to bull trout, an ESA-listed species.	Yes	–	Yes, can be scaled with increased or decreased area treated.	Yes	Fish, Aquatic Invertebrates, Wildlife, Terrestrial vegetation.	Fish still would have further distance through the varial zone, but predation and thermal issues would be improved.
Hungry Horse	bull trout and spring spawners - Increased risk of access issues to tribs in Aug-Oct for bull trout and Apr-May for spring spawners.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	Med	Same action as line 8.	Yes. Success of woody species studied. Strategic placement to stabilize tributary mouths.	Yes - has been done before.	Yes - would require site specific strategy go stabilize tributary entrance into reservoir.	Yes - Bull trout Listed as Threatened	Yes	–	Can be scaled to number of tributaries affected by lower reservoir.	Yes	Yes, offsets migration impediments by stabilizing stream and providing cover.	Potentially still some delay in migration or difficulty with outmigration of juveniles.

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
SF and main Flathead	all fish /aquatic invertebrates. - Winter outflows over 100% increased over NAA. Reduces winter habitat available in mainstem Flathead River by 30%. Winter habitat is important to subyearling bull trout especially. Increase in SF Flathead River volume would also increase winter temps in mainstem Flathead River.	High winter outflows from HH.	flow and temp	High	Create back-channel habitat for juvenile bull trout or otherwise create trout habitat in mainstem Flathead River	Yes - common practice	Yes	Yes	Yes, Bull trout are ESA-listed,	Yes.	–	Yes	Yes	Fish and aquatic invertebrates.	Likely not able to completely offset velocity and temp effects.
Albeni Falls	Bull trout - n**o difference from the NAA** in effects from changes in water elevation and slight decrease in entrainment risk (*benefit)*	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Albeni Falls	cut throat and kokanee - slight decrease in entrainment risk *(benefit)*	–	–	–	–	–	–	No	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Albeni Falls	gamefish - northern pike- slight decrease in entrainment risk *(benefit)* and **no difference from NAA i**n habitat availability	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	NA	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CHJ -MCN	bull trout - TDG effects, greater potential for negative effects from TDG just below Chief Joseph dam and a reduced potential for negative impacts near McNary dam.	–	–	med	A) Reduce Spill at Chief Joseph dam during bull trout migration period. B) Put structures on GCL dam to reduce TDG, e.g. cover cap over tubes to reduce TDG. Tribal criteria is 110% TDG for hatchery.	A) yes B)	A) feasible but could change the intent of the alternative B)	No - Conferred with WQ team and there should not be increases in TDG in MO2 at CHJ	–	–	–	–	–	–	–
Canada - CHJ	White Sturgeon - **similar to NAA**; L. Roosevelt pool elevation may influence riverine reach available for sturgeon recruitment(June30-July15).	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon- effects from high flows, **no change from NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
CHJ -MCN	white sturgeon - Turbidity is not expected to change; s**ame as NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - Slightly lower flows under MO1 may increase the risk of mortality in large WS	–	–	low	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon- High temperatures under MO1 would not differ from the NAA.	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Burbot - lower water elevation in Columbia River (March) and L. Roosevelt (winter/early spring) potentially reduce burbot habitat and stranding eggs. Higher magitude of effect than MO1	–	–	med	–	–	–	Missing Mitigation - I believe this was supposed to be the habitat construction similar to Ferry Island	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Canada - CHJ	burbot, kokanee, redband rainbow trout and mitigation fishery - reduced food and increased entrainment in Dec-Mar spawning period.	–	–	low	Fish collector in/near GCD forebay, equipped with exclusionary netting, and fish transportation - return/transport mitigation fish and native species to Roosevelt	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	redband trout and kokonee - potential reduced access to trib habitat/varial zone in dry years	–	–	low	Habitat and access improvements in tribs and varial zones (structures for cover, etc.)	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	kokonee - similar to MO1, with 8.5' deeper draft in all water years.	–	–	low	increase spawning habitat by supplementing gravel (offsite) and/or improve spawning habitat at lower elevation (onsite)	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Mitigation fishery fish - **same as NAA**; released coincide with initiation of refill (to minimize loss).	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	Northern Pikeminnow - **no change from NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	walleye - **no change from NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
CHJ -MCN	small mouth bass - **no change from NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DWA	kokonee - Increase in risk of entrainment in January and early February	–	–	low	Maintain enhance nutrient restoration at DWA. This program has proven successful in maintaining higher numbers of kokanee in the reservoir and shortening the amount of time it takes the kokanee population to rebound from significant entrainment events.	–	–	No	–	–	–	–	–	–	–

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LSR	all fish - Fish would continue to pass projects in similar numbers. However, reduced survival as a higher portion of fish would pass via turbine routes instead of spill route. This passage route generally has lower survival.	–	–	low	–	–	–	No	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–		–	–	–	–	–	–	–
McNary	WS - **Similar to NAA** for recruitment (temperature and flows), more days fall below NAA in dry years.	–	–	–	–	–	–	No	–	–	–	–	–	–	–
John Day	WS -Lower spill (to 110%TDG) resulting in less risk to sturgeon larvae than NAA *(benefit).*	–	–	–	–	–	–	No	–	–	–	–	–	–	–

Fish (Resident) – Multiple Objective 3

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bonner Ferrys	KRWS - High winter flows continue trends of reduced riparian vegetation establishment (e.g. cottonwoods).	–	–	low	plant cottonwoods trees (1 to 2 gallon trees). (mitigate for wildlife/habitrat as well)	–	–	See MO1	–	–	–	–	–	–	–
Bonner Ferrys	Burbot - flows and temperatures affect burbot development	–	–	low	reconnect floodplain to benefit early life history for Burbot	–	–	No	–	–	–	–	–	–	–
libby/kootenai	ecosystem & Burbot - the potential change in the range of spring freshet flows impacts the ecosystem and fish including burbot	–	–	low	Construct in-channel habitats that resemble Ferry Island	–	–	No	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	Bull trout - Lower elevations in summer (4'-16' lower at end of Sept) and fewer full pool results in smaller productive euphotic zone, less surface for feeding in summer, and dewaters benthic insect production; less food source (terrestrial inspects/aquatic) for bull trout	HH lake elevations affect production of phytoplanzkton, zooplankton, and invertebrates that are the base of food source for fish.	Volume of euphotic zone, percent decrease in benthic area (indexed from surface area); and surface area for summer feeding.	Med	Revegetate areas withi the top 10' of the reservoir that are adjacent to tributaries used by bull trout; combine with creation of subimpoundments (vegetate within them) in the upper reservoir bays for improved benthic production, potection from predation (varial zone issues), and to protect tributary access. Where feasible, use existing contract for debris removal to dispose of the tree material by anchoring and sinking it in strategic places in the reservoir instead of hauling it out. LIkely very low cost difference than what doing now.	Yes - studied by Reclamatiion. Recommended by FWP and FWS to increase bull trout habitat, increase survival of juveniles outmigrating from tribs, and provide additional area for insect production and proximity of terrestrial insects in summer.	Yes, a study has been done to determine spp and techniques that are successful. Vegetation is a natural process that is disrupted at the seed stage by reservoir operations. Plantings proposed would get vegetation past the vulnerable seed stage to establish natural vegetation closer to the water surface at most times of year and inundated for a couple of months.	Yes	Yes - Bull trout Listed as Threatened	Yes.	–	Scale with area treated. Recommend about 15 streams important to bull trout.	Yes	Yes, offsets loss of insect production. Note - same action also mitigates wildlife effects.	Can scale to fully offset food effects; likely still some tributary access and varial zone effects (predation danger minimized and area of suitable habitat increased, but stilll have more distance of varial zone to travel).

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	Bull trout - Increased summer outflows (17%-21% higher) would increase zooplankton loss; zooplanknton concentrated at outlets; reduced food for fish in late summer.	Increased outflows result in increased entrainment of zooplankton food resources from the reservoir.	Outflows	med	Restore operation of slide gates on temp control structure (Actual physical restoration will be done as part of HH Modernization; this measure is to use them.	Yes - used to function; water pulled from two different thermal zones and mixed to get target temp to avoid pulling from where zooplankton (and fish) are concentrated.	Yes	yes	Yes, bull trout are ESA-listed.	Yes	–	Yes	Yes	Yes, reduces entrainment of zooplankton and fish.	Depending on water temps, bull trout may still be found at deeper depths than zooplankton and still be entrainmed.
Hungry Horse	Bull trout - in wet and average water years (Aug-Oct) for increases varial zone which increases exposure to angling/predation and difficulty entering spawning tributaries; however dry years, these effects are greater.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	med	Use native woody species to stabilize tributary channels and provide cover (same measure as line 8). Priority for Wounded Buck, Sullivan, Wheeler, and Bunker Creeks, but this is not an exhaustive list.	Yes. Common practice and recommended by local managers, including Reclamation.	Yes - has been done before. Woody plant species proposed have been studied to determine best species and techniques for best success.	Yes	Yes - Bull trout Listed as Threatened	Yes	–	Yes, can be scaled with increased or decreased area treated.	Yes	Yes, offsets varial zone predation effects by providing cover for migrating bull trout thorugh the open varial zone.	Fish still would have further distance through the varial zone, but predation and thermal issues would be imporved.
Hungry Horse	bull trout and spring spawners - Increased risk of access issues to tribs in Aug-Oct for bull trout and Apr-May for spring spawners.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	Med	Same action as line 8.	Yes. Success of woody species studied. Strategic placement to stabilize tributary mouths.	Yes - has been done before.	Yes - would require site specific stratey go stabilize tributary entrance into reservoir.	Yes - Bull trout Listed as Threatened	Yes	–	Can be scaled to number of tributaries affected by lower reservoir.	Yes	Yes, offsets migration impediments by stabilizing stream and providing cover.	Potentially still some delay in migration or difficulty with outmigration of juveniles.

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
SF and main Flathead	all fish /aquatic invertebrates. - Higher summer flows benefit food production *(benefit)* but could result in less suitable habitat due to high velocities.	Higher summer flows.	flow and temp	low	Create back-channel habitat for juvenile bull trout or otherwise create trout habitat in mainstem Flathead River	Yes - common practice	Yes	Yes	Yes, Bull trout are ESA-listed, but effect likely not biologically noticeeable in mainstem Flathead River. SF Flathead River has higher effect but not critical habitat for bull trout.	Yes.	–	NA	No.	–	–
Albeni Falls	Bull trout - **no difference from the NAA** in entrainment from flows or effects from changes in water elevation	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Albeni Falls	cut throat and kokanee - slight decrease in entrainment risk *(benefit)*	–	–	–	–	–	–	No	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Albeni Falls	gamefish - northern pike-**no difference from NA**A in habitat availability	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CHJ -MCN	bull trout - TDG effects Same as NAA	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	White Sturgeon - **similar to NAA**; L. Roosevelt pool elevation may influence riverine reach available for sturgeon recruitment(June30-July15).	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon- high flows are ~ 2.4% lower and WS spawning success may be reduced when compared to the NAA.	–	–	low	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - short term substantial increase in turbidity after dam breach;	–	–	–	–	–	–	No	–	–	–	–	–	–	–

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CHJ -MCN	white sturgeon - Slightly lower flows under MO1 may increase the risk of mortality in large WS	–	–	low	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - Food resources will be reduced during breach in the Snake River and from the confluence of Snake and Columbia downstream until a new equilibrium established	–	–	low	no mitigation : Sturgeon in the Columbia are not food limited and would likely avoid the area of impact until new resources had re-established.	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon- High temperatures under MO1 **would not differ from the NAA.**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Burbot - **no change from NAA** to burbot habitat.	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	burbot, kokanee, redband rainbow trout and mitigation fishery - **similar to NAA** in retention time	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	redband trout and kokonee - **similar to NAA**; access to trib habitat/varial zone	–	–	–	–	–	–	No	–	–	–	–	–	–	–

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Canada - CHJ	kokonee - improvement from NAA for eggs/fry with the exception of short-term drops could dessicate eggs and strand fry.	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Mitigation fishery fish - **same as NAA**; released coincide with initiation of refill (to minimize loss).	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	Northern Pikeminnow - depressed productivity	–	–	low	No Mitigation - NPM would likely avoid the area of impact until new resources had re-established.	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	walleye - short term losses of suitable spawning substrate on the south shore of MCN pool	–	–	low	No mitigation - Walleye are not limited and are not native	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	walleye - short term depressed zooplankton in MCN	–	–	low	No mitigation - Walleye are not limited and are not native	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	small mouth bass - slight temperature change effecting nesting at mouth of SR and Columbia	–	–	low	no mitigation - Nesting may renest if disturbed by a temperature drop.	–	–	No	–	–	–	–	–	–	–

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CHJ -MCN	small mouth bass - short term effects to flow/productivity due to dam breach	–	–	low	no mitigation - SMB in the Columbia would likely avoid the area of impact until new resources had re-established.	–	–	No	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LSR	bull trout - Short term passage issues after breaching and until new streams are established at tributary mouth; perched streams and tributaries limiting to bull trout migration. Fish come to mainstem and cannot reascend. Mainstem passage of	Drawdown leaves stream delta perched until high flows can create a new passable Channel	Stream Passage	high	pilot channel or Stream Rehab at Tucannon tributary mouth	Yes	Yes	Yes	Bull trout listed as Threatened	Yes	–	Yes	Yes	Fish	No

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LSR	bull trout / WS - Temporary reduction (2-7 years) in forage fish and invertbrate for bull trout/all species as a result of breaching Change from zooplankton to macroinvertebrates would benefit juvenile subadult bull trout	Forage fish Lost from high sediment/Low oxygen during breach.	Sediment/Oxygen Concentrations	high	Trap and Haul White Sturgeon from impacted area prior to breach. Relocation to Hells Canyon and below McNary	Yes - Brady Allen from BPA has past experience in this.	Yes	Yes	No	Yes	–	Yes	Yes	–	Still expect to lose unknown part of the WS population
LSR	bull trout / WS - Temporary reduction (2-7 years) in forage fish and invertbrate for bull trout/all species as a result of breaching Change from zooplankton to macroinvertebrates would benefit juvenile subadult bull trout	Forage fish Lost from high sediment/Low oxygen during breach.	Sediment/Oxygen Concentrations	high	Trap and Haul White Sturgeon from impacted area prior to breach. Relocation to Hells Canyon and below McNary	Yes - Brady Allen from BPA has past experience in this.	Yes	Yes	No	Yes	–	Yes	Yes	–	Still expect to lose unknown part of the WS population

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LSR	bull trout/WS - Reduced Oxygen may be lethal. However, during Aug thru Oct - limited numbers of bull trout occur in the system and short term effects to bull trout are not likely to occur. BOD would occur after initial flush of sediment. Any fish in the mainstem would likely be killed. Most bull trout leave mainstem river by July.	–	–	high	Catch and haul WS to release sites above LWG prior to Breaching - Set Lines can be efffective at capturing numbers of WS.	–	–	–	–	–	–	–	–	–	–
LSR	northern pike minnow/small mouth bass/walleye- temperature and flow changes after the breach would effect these species (all stages)	–	–	low	no mitigation - all these species are not limited in LSR and reducing success would be a benefit for Salmon and Steelhead.	–	–	No	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects		–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary	WS - More days in June with flows below 250kcfs in dry years.	–	–	low	–	–	–	No	–	–	–	–	–	–	–

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John Day	WS - Higher TDG at John Day mid-Apr thorugh June, could be at critical time for emerging larvae seeking refuge in interstitial spaces where susceptible to TDG.	–	–	med	–	–	–	None recommended	–	–	–	–	–	–	–

Fish (Resident) – Multiple Objective 3

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Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bonner Ferrys	Burbot - flows and temperatures affect burbot development	–	–	low	reconnect floodplain to benefit early life history for Burbot	–	–	No	–	–	–	–	–	–	–
libby/kootenai	ecosystem & Burbot - the potential change in the range of spring freshet flows impacts the ecosystem and fish including burbot	–	–	low	Construct in-channel habitats that resemble Ferry Island	–	–	No	–	–	–	–	–	–	–

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Hungry Horse	Bull trout - Lower elevations in summer (4'-16' lower at end of Sept) and fewer full pool results in smaller productive euphotic zone, less surface for feeding in summer, and dewaters benthic insect production; less food source (terrestrial inspects/aquatic) for bull trout	HH lake elevations affect production of phytoplanzkton, zooplankton, and invertebrates that are the base of food source for fish.	Volume of euphotic zone, percent decrease in benthic area (indexed from surface area); and surface area for summer feeding.	High	Revegetate areas withi the top 10' of the reservoir that are adjacent to tributaries used by bull trout; combine with creation of subimpoundments (vegetate within them) in the upper reservoir bays for improved benthic production, potection from predation (varial zone issues), and to protect tributary access. Where feasible, use existing contract for debris removal to dispose of the tree material by anchoring and sinking it in strategic places in the reservoir instead of hauling it out. LIkely very low cost difference than what doing now.	Yes - studied by Reclamatiion. Recommeneded by FWP and FWS to increase bull trout habitat, increase survival of juveniles outmigrating from tribs, and provide additional area for insect production and proximity of terrestrial insects in summer.	Yes, a study has been done to determine spp and techniques that are successful. Vegetation is a natural process that is disrupted at the seed stage by reservoir operations. Plantings proposed would get vegetation past the vulnerable seed stage to establish natural vegetation closer to the water surface at most times of year and inundated for a couple of months.	Yes	Yes - Bull trout Listed as Threatened	Yes.	–	Scale with area treated. Recommend about 15 streams important to bull trout. Compared to MO1 or MO3, recommend increased effort of subimpoundments in upper reservoir bays to offset lower elevation effects.	Yes	Yes, offsets loss of insect production. Note - same action also mitigates wildlife effects.	Can scale to fully offset food effects; likely still some tributary access and varial zone effects (predation danger minimized and area of suitable habitat increased, but stilll have more distance of varial zone to travel).

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Hungry Horse	Bull trout - Increased summer outflows (37% higher) would increase zooplankton loss; zooplanknton concentrated at outlets; reduced food for fish in late summer.	Increased outflows result in increased entrainment of zooplankton food resources from the reservoir.	Outflows	med	Restore operation of slide gates on temp control structure (Actual physical restoration will be done as part of HH Modernization; this measure is to use them.)	Yes - used to function; water pulled from two different thermal zones and mixed to get target temp to avoid pulling from where zooplankton (and fish) are concentrated.	Yes	yes	Yes, bull trout are ESA-listed.	Yes	–	Yes	Yes	Yes, reduces entrainment of zooplankton and fish.	Depending on water temps, bull trout may still be found at deeper depths than zooplankton and still be entrainmed.
Hungry Horse	Bull trout - in wet and average water years (Aug-Oct) for increases varial zone which increases exposure to angling/predation and difficulty entering spawning tributaries; however dry years, these effects are greater.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	med	Use native woody species to stabilize tributary channels and provide cover (same measure as line 8). Priority for Wounded Buck, Sullivan, Wheeler, and Bunker Creeks, but this is not an exhaustive list.	Yes. Common practice and recommended by local managers, including Reclamation.	Yes - has been done before. Woody plant species proposed have been studied to determine best species and techniques for best success.	Yes	Yes - Bull trout Listed as Threatened	Yes	–	Yes, can be scaled with increased or decreased area treated. Increased scale from MO1 or MO3.	Yes	Yes, offsets varial zone predation effects by providing cover for migrating bull trout thorugh the open varial zone.	Fish still would have further distance through the varial zone, but predation and thermal issues would be imporved.

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Hungry Horse	bull trout and spring spawners - Increased risk of access issues to tribs in Aug-Oct for bull trout and Apr-May for spring spawners.	Drawdowns - Low reservoir elevations at time of migration	Reservoir elevation	Med	Same action as line 8.	Yes. Success of woody species studied. Strategic placement to stabilize tributary mouths.	Yes - has been done before.	Yes - would require site specific stratey go stabilize tributary entrance into reservoir.	Yes - Bull trout Listed as Threatened	Yes	–	Can be scaled to number of tributaries affected by lower reservoir.	Yes	Yes, offsets migration impediments by stabilizing stream and providing cover.	Potentially still some delay in migration or difficulty with outmigration of juveniles.
SF and main Flathead	all fish /aquatic invertebrates. - Higher summer flows benefit area for food production *(benefit)* but flow fluctuations set back food production (offsetting the increase potential).	Steep drops in outflows and more fluctuations throughout the summer.	Aquatic insect production life cycle disruption.	Med	If possible, smooth operations to reduce wide fluctuations.	Yes	Yes. Minor adjustment to operations as modeled. (Would likely operate more smoothly than modeled anyway.)	Yes	Yes. Bull trout are ESA-listed.	Yes	–	Yes	Yes	Fish and Aquatic invertebrates.	Depends on ability to smooth operations.

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SF and main Flathead	all fish /aquatic invertebrates. - Higher summer flows benefit area for food production *(benefit)* but could result in less suitable habitat due to high velocities. Flow fluctuations set back food production (offsetting the increase potential).	Higher summer flows.	flow and temp	Med	Create back-channel habitat for juvenile bull trout or otherwise create trout habitat in mainstem Flathead River	Yes - common practice	Yes	Yes	Yes, Bull trout are ESA-listed,	Yes.	–	NA	Yes.	–	Likely.
Albeni Falls	Bull trout - **no difference from the NAA** in entrainment from flows	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Albeni Falls	cut throat and kokanee - slight decrease in entrainment risk *(benefit)*	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Albeni Falls	Bull Trout - In dry years MO4 would not reach full pool. Mean elevation in September = 2059.7 ~ 2 ft lower than NAA.	drawdowns - McNary Flow measure	WSE	low	Stream Rehab for inlet areas to improve trib acces in the varial zone. (priest river, lightning creek, etc)	Yes - dependent on	–	Yes - Would need some additional investigation to see which tribs to rehab and improve.	–	–	–	–	–	–	–

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Albeni Falls	cut throat and kokanee - **no difference from the NAA** in entraiment	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Albeni Falls	gamefish Northen Pike - On dry years Lake Pend Oreille may be as much as 2.5 feet lower June through September compared to NAA resulting a potential decrease in suitable habitat.	–	–	low	no mitigation - N. Pike are not limited	–	–	No	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CHJ -MCN	bull trout - TDG effects **Similar to NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	white sturgeon - Slightly decrease in recruitment window (June 15-July 31), 3days instead of 8days in 25%ile water years; 42days instead of 43days in highest water years)	–	–	low	–	–	–	No	–	–	–	–	–	–	–

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Canada - CHJ	White Sturgeon - **Similar in NAA** in wet and average years; dry years much lower but dry years typically have no recruitment anyway in the L. Roosevelt riverine reach (June30-July31)	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon- high flows are ~ 2.4% lower and WS spawning success may be reduced when compared to the NAA.	–	–	low	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	**Similar flows as NAA** and would not change the risk for outmigration of supplemental fish from the project area.	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - Turbidity is not expected to change; **same as NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	white sturgeon - **similar flows and risk of mortality in large sturgeon as NAA**	–	–	–	–	–	–	No	–	–	–	–	–	–	–

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CHJ -MCN	white sturgeon- slight increase in the occurance of high temperatures above MCN potentially resutling in minor increase in risk of mortality.	–	–	low	–	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Burbot - lower water elevation in Columbia River (March) and L. Roosevelt (winter/early spring) potentially reduce burbot habitat and stranding eggs. Dry years have more effect.	–	–	med	–	–	–	No	–	–	–	–	–	–	–

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Canada - CHJ	burbot, kokanee, redband rainbow trout and mitigation fishery - Slighlty reduced food and increased entrainment in Dec-Mar spawning period. Wet and Ave years similar to MO1, Dry years much higher magnitude of effect.	–	–	med	Fish collector in/near GCD forebay, equipped with exclusionary netting, and fish transportation - return/transport mitigation fish and native species to Roosevelt	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	kokonee - Wet and Ave water years similar to MO1, Dry years extensive drawdowns would further reduce habitat and strand more eggs.	–	–	low	increase spawning habitat by supplementing gravel (offsite) and/or improve spawning habitat at lower elevation (onsite)	–	–	No	–	–	–	–	–	–	–
Canada - CHJ	Mitigation fishery fish - Dry years refill is up to 6 weeks later, into June. Likely result in reduced survival of fish in pens or forced releases when entrainment susceptibility is high.	Mitigation given to local fishery then taken away by this operation - entrained by high releases.	Fish Losses/Flows	med (socio-econ)	Expancd hatchery capacity for mitigation fishery	? Sue	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
CHJ -MCN	Northern Pikeminnow - potentially slight improvement from NAA *(benefit)*	–	–	–	–	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	walleye -slight effect on juveniles with drawdown	–	–	low	No mitigation - Walleye are not limited in MCN pool and reducing rearing success would be a mitation measure for Salmon and Steelhead.	–	–	No	–	–	–	–	–	–	–
CHJ -MCN	small mouth bass - slight effect on nesting with drawdown	–	–	low	No mitigation - SMB are not limited in MCN pool and reducing nesting success would be a mitation measure for Salmon and Steelhead.	–	–	No	–	–	–	–	–	–	–
	Northern Pike	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low) brief explanation of why	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
LSR	Bull trout - Additional spill may cause delays in bull trout passage at dams in May and June when they are moving out of the system to avoid temps.	High Spill may cause delay, reduce passage, and reduce survival when bull trout cannot get back to tributaries	–	Low	improve bull trout habitat	Yes - dependent on habitat needs passage improvements on local tributaries would be the focus (culverts)	Yes - passage projects have been shown to be feasible and successful in the past	Yes	Bull trout listed as Threatened	No	Projects do not allow for on site improvments - so mitigate in tributary streams	Can be	Yes	–	–
LSR	Bull trout / white sturgeon - Bull Trout: Days over elevated TDG 110% (~10% increase over NAA 3) Higher TDG may impact additional (vs NAA) bull trout in May and June when leaving the system. WS: elevated TDG 136% TDG; ~ add 27 days compared to NAA; WQ plots show increases in exposure to high TDG from Apr through July and siginificant increases in parts of April and May when compared with the NAA.	high spill will increase TDG concentrations	Spill/TDG	med	Divider walls between spillways and turbines	Yes - would train flows so fish could find ladders better and would lower TDG on Power house side where bull trout and white sturgeon would find refuge.	Yes - Very expensive but little maintenance.	Yes	Bull trout listed as Threatened	Yes	–	May be overscaled	No	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)** brief explanation of why	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary	WS - More days in May with flows below 250kcfs in dry years.	–	–	low	–	–	–	No	–	–	–	–	–	–	–
John Day	WS - Expect detrimental effect to juvenile sturgeon with high TDG. Eggs and larvae most susceptible, but in deep eddy areas depth compensation reduces effects.	–	–	med	–	–	–	No	–	–	–	–	–	–	–

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby pool	Winter WSE higher in pool, changes spatial extent of drawdown zone could result in shift in vegetation and habitat. Drying in summer, conversion to upland habitat (summer). Affects to shoreline riparian nesting passerines/waterfowl.	December Libby Target Elevation	Drawdown of water surface elevation	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	yes, MBTA	–	–	–	–	–	–
Libby Pool	Explosure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species.	Modified Draft at Libby	–	low	Update and implement Invasive Plant Management Plan for the shoreline	yes	yes	Update and implement Invasive Plant Management Plan for the shoreline	yes, Invasive EO	yes	–	yes	yes due to comply with Invasive EO	–	–
Kootenai River including Kootenai Falls Wildlife Management Area	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	December Libby Target Elevation	Drawdown of water surface elevation	med	A) planting of native wetland and riparian vegetation (~100 acres along river) B) regrading the bank to estiblish same hydrology as the NAA	A) yes B) yes;	A) yes, B) yes, however it would require more permiting (CWA, 106, ESA) and would result more land disturbance than A) Planting mitigation	A) planting of native wetland and riparian vegetation (~100 acres along river)	EO11990 ?, CWA ?	yes	NA	yes	yes, long term medium impact to habitat inlcuding wetlands.	yes, resident fish	no remaining impact

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Kootenai National Wildlife Refuge (RM 147)	WSE and spring freshet decreases during peak of the growing season may cause conversion of habitats to a drier composition. Note: impact captured in Kootenai River habitat impact, see line above	–	Drawdown of water surface elevation	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Bonner Ferry	High winter flows continue trends of reduced riparian vegetation establishment (e.g. cottonwoods).	December Libby Target Elevation	WSE	low	no mitigation proposed, due low impact; however ~100 acres of planting mitigation (see above) would also offset this impact	–	–	–	–	–	–	–	–	–	–
Hungry Horse	Slight increase in the size of the barren zone which would increase the risk of wildlife predation, including from raptors, wolves, and mountain lions.	Hungry Horse Additional Water Supply, Sliding Scale at Libby and Hungry Horse	Drawdown of water surface elevation	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	slight decrease in the quantity, quality and distribution of wetlands along the shoreline transitions to more tolerant of dry or drought conditions., birds would be displaced from nesting and sheltering habitat in forested, scrub-shrub and/or emergent wetland habitats and would likely experience increased competition in remnant wetland habitats.	Hungry Horse Additional Water Supply, Sliding Scale at Libby and Hungry Horse	Drawdown of water surface elevation	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Albeni Falls	no change in vegetation, wildlife. **Simiilar to the NAA**	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Grand Coulee Dam study area	Collectively, these measures influence WSE in Lake Roosevelt and downstream reaches of the Columbia River, as well as outflow from Grand Coulee Dam, resulting in changes to the quantity, quality and ditribution of habitats in the study area. Changes to wildlife habitats have a corresponding effect on wildlife populations in the study area. Fluctuations in WSE in response to daily operations are similary expected to impact the quantity, quality and distribution of habitats in the study area. impact is seasonal and could result in permanent	Update System FRM Calculation; Planned Draft Rate at Grand Coulee; Grand Coulee Maintenance Operations; Winter System FRM Space; and Lake Roosevelt Additional Water Supply measures.	WSE	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Grand Coulee Dam study area	Decrease in WSE immediately upstream of the dam in Lake Roosevelt by 5-6 feet during the winter months and by 3 feet farther upstream, transition of wetlands to more upland habitats	Lake Roosevelt Additional Water Suplly	WSE	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
L. Roosevelt	Increase barren zone increases area for mountain lions to hunt and kill prey animals	Planned Draft Rate at Grand Coulee and Winter System FRM Space measures	WSE	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Columbia River below Chief Joe	Diversion of 9,600 acre-feet of water between April through October. Minimal impact (1% or less) on water surface elevations immediately downsream from the dam, and diluted further downstream. **No measurable effects to habitats or wildlife populations upstream of the dam. Negligible effects downstream of dam.**	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DWA	drawdown of reservoir increases barren zone during summer causes predation increase of small mammals	Modified Dworshak Summer Draft	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–
DWA/ Clearwater River	potential conversion of vegetation to wetter vegetation with slight increase in inundation of the pool	Modified Dworshak Summer Draft	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary	areas within McNary Wildlife Refuge could be drier in May and June causing loss of amphibian breeding areas	–	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–
John Day / The Dalles / Lake Bonneville	drawdown of water surface elevations can cause wetland habitat to convert to upland habitat	–	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
John Day, Blalock	inundation portions of the island that support avian species	Increased Forebay Range Flexibility	reducing avian habitat	med	Create avian nesting areas (~2 acres) to replace lost nesting locations	yes	Yes	Create avian nesting areas (~2 acres) outside of the Columbia Basin	Yes. Migratory Bird Treaty Act	No - offsite	Piscivorous birds are protected under the MBTA. Replacing nesting habitat within the Columbia Basin would not support the purpose of the measures. Offsite mitigation (California) has been successfully implemented in the past and would replace lost habitat in a location with less impact to ESA salmon.	yes, due to impacting MBTA species	yes due to long term medium impact and triggering MBTA	–	no remaining impacts

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Patterson Slough	could inundate wetland habitats approximately 1.5 feet vertically. Umatilla NWR would experienced an increased duration of inundation which could disrupt wetland habitats, amphibian, bird, reptiles, mammals and migratory waterfowl	Increased Forebay Range Flexibility	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–
Estuary	drawdown in spring/summer could slightly change quality of wetland habitats at Franz Lake, Pierce, and Steigerwald NWR, as well as Beacon Rock State Park	–	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–

Vegetation, Wetlands, and Wildlife – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby pool	Winter WSE higher in pool, changes spatial extent of drawdown zone could result in shift in vegetation and habitat. Drying in summer, conversion to upland habitat (summer). Affects to shoreline riparian nesting passerines/waterfowl.	December Libby Target Elevation	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Libby Pool	Explosure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species.	December Libby Target Elevation Measure	–	low	Update and implement Invasive Plant Management Plan for the shoreline	yes	yes	Update and implement existing Invasive Plant Management Plan for the shoreline	yes, Invasive EO	yes	–	yes	yes due to comply with Invasive EO	–	–
Kootenai River including Kootenai Falls Wildlife Management Area	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	December Libby Target Elevation Measure	WSE	med	A) planting of native wetland and riparian vegetation (~100 acres along river) B) regrading the bank to estiblish same hydrology as the NAA	A) yes B) yes;	A) yes, B) yes, however it would require more permiting (CWA, 106, ESA) and would result more land disturbance than A) Planting mitigation	A) planting of native wetland and riparian vegetation (~100 acres along river)	EO11990 ?, CWA ?	yes	NA	yes	yes, long term medium impact to habitat inlcuding wetlands.	yes, resident fish	no remaining impact

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Bonner Ferry	High winter flows continue trends of reduced riparian vegetation establishment (e.g. cottonwoods).	December Libby Target Elevation Measure	WSE	low	no mitigation proposed, due low impact; however ~100 acres of planting mitigation (see above) would also offset this impact	–	–	–	–	–	–	–	–	–	–
Hungry Horse	minor change in shoreline that could be more prone to invasive species	December Libby Target Elevation Measure	WSE	low	Update and implement Invasive Plant Management Plan for the shoreline	yes	yes	Update and implement Invasive Plant Management Plan for the shoreline	yes, Invasive EO	yes	NA	yes	yes	–	–
Libby and Hungry Horse	Increase barren zone increases area for mountain lions to hunt and kill prey animals	December Libby Target Elevation Measure	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
South Fork of the Flathead River	riparian vegetation change to drier habitats; exposure of mudflats, wildlife daily activities (i.e. foraging)	Ramping Rates for Safety measure	WSE	low	no mitigation proposed, due low impact.	–	–	–	–	–	–	–	–	–	–
South Fork of the Flathead River	conversion of cottonwood stands to other vegetation	December Libby Target Elevatin Measure	WSE	low	no mitigation proposed, due low impact and no regulated resource.	–	–	–	–	–	–	–	–	–	–

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Pend Oreille	Decline in wetland vegetation and decline of submerged aquatic vegetation due to increased ramping rates Decline in western grebe habitat nesting area due to drawdown	Ramping rates for Safety Measure	WSE	low	no mitigation proposed due to low impact and no regulated resource.	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lake Roosevelt	deeper drafts in Lake Rooevelt during winter months, **neglible changes to habitats d**uring growing season	Slightly Deeper Draft for Hydropower	WSE	–	–	–	–	–	–	–	–	–	–	–	–
Lake Roosevelt	fluctuating water conditions could impact quantity and quality of foraging habitat for wintering waterfowl**, neglible changes to Water Surface Elevation**	Slightly Deeper Draft for Hydropower	WSE	–	–	–	–	–	–	–	–	–	–	–	–
Lake Roosevelt	Increase barren zone increases area for mountain lions to hunt and kill prey animals	Slightly Deeper Draft for Hydropower	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Downstream of Lake Roosevelt	no effet to the quantity, quality or distributino of wildlife habitats or populations	Ramping Rates for Safety	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DWA pool	Drawdown of reservior an additional 20 feet from NAA increase barren zone	Slightly Deeper Draft for Hydropower	WSE	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Clearwater River	Dessicate amphbian eggs, alter the patterns of seed dispersal, germination of establishment of forested, scrub-shrub wetland plants like willows and cottonwoods	Ramping Rates for Safety	WSE	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Lower Snake River	changes in available fish for avian predators	increase Juenile Fish Transportation Measure	COMPASS; CSS	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
John Day, McNary, The Dalles, Bonneville	**similar to NAA conditions**	–	WSE	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Estuary	drawdown in spring/summer could slightly change quality of wetland habitats at Franz Lake, Pierce, and Steigerwald NWR, as well as Beacon Rock State Park	–	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–
John Day, McNary, The Dalles, Bonneville	changes in available fish for avian predators	increase Juenile Fish Transportation Measure	COMPASS; CSS	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–

Vegetation, Wetlands, and Wildlife – Multiple Objective 3

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby pool	Winter WSE higher in pool, changes spatial extent of drawdown zone could result in shift in vegetation and habitat. Drying in summer, conversion to upland habitat (summer). Affects to shoreline riparian nesting passerines/waterfowl.	December Libby Target Elevation	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Libby pool	Explosure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species.	December Libby Target Elevation Measure	WSE	low	Update and implement existing Invasive Plant Management Plan for the shoreline	yes	yes	Update and implement existing Invasive Plant Management Plan for the shoreline	yes Invasive EO	yes	NA	yes	yes, due to complying with invasive EO	–	–
Libby , Hungry Horse, Albeni Falls	Decline in wetland vegetation and decline of submerged aquatic vegetation due to increased ramping rates Decline in western grebe habitat nesting area due to drawdown	Ramping rates for Safety Measure	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective ?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Kootenai River including Kootenai Falls Wildlife Management Area	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	Modified Draft at Libby, Sliding Scale at Libby and Hungry Horse Measure	WSE	med	A) planting of native wetland and riparian vegetation (~100 acres along river) B) regrading the bank to estiblish same hydrology as the NAA	A) yes B) yes;	A) yes, B) yes, however it would require more permiting (CWA, 106, ESA) and would result more land disturbance than A) Planting mitigation	A) planting of native wetland and riparian vegetation (~100 acres along river)	EO11990 ?, CWA ?	yes	NA	yes	yes, long term medium impact to habitat inlcuding wetlands.	yes, resident fish	no remaining impact
Bonner Ferry	High winter flows continue trends of reduced riparian vegetation establishment (e.g. cottonwoods).	December Libby Target Elevation Measure	WSE	low	no mitigation proposed, due low impact; however ~100 acres of planting mitigation (see above) would also offset this impact	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chief Joe/Grand Coulee	**negligble effects** to habitats or wildlife populations	–	WSE	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake River	Upland mammals (Bats, small mammals, deer, bobcat), Aquatic mammals, Waterfowl; amphbians, birds	Dam Breaching	WSE	high	none. These impacts would be temporary and immediately following dam breaching. It would be anticipated that these animals would recover from effects.	–	–	–	–	–	–	–	–	–	–
Lower Snake River HMU's	Perched habitats (HMUs) with dam breach to convert to arid lands	Dam Breaching	WSE	High	Planting plan with Arid Lands Restoration to target establishment of native, arid spp	yes	yes, with a planting plan	Planting plan with Arid Lands Restoration to target establishment of native, arid spp (13,000 acres planting)	CAA, CWA (Section 402)	yes	NA	yes	yes, due to high impact and complying with regulated resources. The planting plan could also be a BMP or part of the design	–	no remaining effect
Lower Snake River Shoreline (New exposure)	Exposed sediment and exposed shoreline with dam breach (approximately 13,800 acres), includes wetland and riparian plantings	Dam Breaching	WSE	High	Planting plan with wetlands/riparian restoration (1,500 acres) to target establishment of native spp	yes	yes, with a planting plan	Planting plan with wetlands/riparian restoration (1,500 acres) to target establishment of native spp	CWA (Section 402), CAA, CWA (Section 404/401) 404(b)1 assessment.	yes	NA	yes	yes, due to high impact and complying with regulated resources. The planting plan could also be a BMP or part of the design	–	no remaining effect
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective ?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
McNary Pool (includes MWR)	Sediment Deposition (McNary Pool= 779 acres uplands, 13,639 acres open water, 97 acres forested wetlands, 58 acres emergent wetlands, 37 acres urban and mixed environs) Total is 14,610 acres	–	River Mechnaics analysis	high	a planting plan (155 acres of wetlands), possible excavation of deposited sediment (?)	yes	yes	a planting plan (155 acres of wetlands), possible excavation of deposited sediment (?)	CWA (section 404), 404(1)(b) analysis.	yes	NA	yes	yes due to high impacts and complying with regulated resources	–	–
McNary Wildlife Refuge	Sediment Deposition (McNary NWR only= 8 acres uplands, 4,748 acres open water, 23 acres forested wetlands, 12 acres urban and mixed environs)	–	River Mechnaics analysis	high	a planting plan (23 acres of the above 155 acres of wetlands), possible excavation of deposited sediment (?)	yes	yes	a planting plan (23 acres of the above 155 acres of wetlands), possible excavation of deposited sediment (?)	CWA (section 404), 404(1)(b) analysis.	yes	NA	yes	yes due to high impacts and complying with regulated resources	–	–
John Day, Blalock	inundation portions of the island that support avian species	Increased Forebay Range Flexibility	COMPASS, CSS, WSE	med	Create avian nesting areas (~2 acres) within LCR	yes	?, feasible / implementable; however concerns of avian predation on fish could result in this mitigation measure being limited or not implemented	Create avian nesting areas (~2 acres) within LCR	yes, MBTA	yes	NA	yes, due to impacting MBTA species	yes due to long term medium impact and triggering MBTA	–	no remaining impacts

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective ?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary , dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources , which ones?**	**Remaining Effects after Mitigation Implemented**
Patterson Slough	could inundate wetland habitats approximately 1.5 feet vertically. Umatilla NWR would experienced an increased duration of inundation which could disrupt wetland habitats, amphibian, bird, reptiles, mammals and migratory waterfowl	Increased Forebay Range Flexibility	WSE	low	no mitigation proposed due low impact and no regulated resources	–	–	–	–	–	–	–	–	–	–

Vegetation, Wetlands, and Wildlife – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby pool	Winter WSE higher in pool, changes spatial extent of drawdown zone could result in shift in vegetation and habitat. Drying in summer, conversion to upland habitat (summer). Affects to shoreline riparian nesting passerines/waterfowl.	December Libby Target Elevation	WSE	low	no mitigation proposed, due low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Libby Pool	Exposure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species.	December Libby Target Elevation Measure	WSE	low	Update and implement existing Invasive Plant Management Plan for the shoreline	yes.	yes.	Update and implement existing Invasive Plant Management Plan for the shoreline	yes, Invasive EO	yes	NA	Yes	Yes, comply with invasive EO	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Kootenai River including Kootenai Falls Wildlife Management Area	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	Modified Draft at Libby, Sliding Scale at Libby and Hungry Horse Measure	WSE	med	A) planting of native wetland and riparian vegetation (~100 acres along river) B) regrading the bank to establish same hydrology as the NAA	A) yes B) yes;	A) yes, B) yes, however it would require more permitting (CWA, 106, ESA) and would result more land disturbance than A) Planting mitigation	A) planting of native wetland and riparian vegetation (~100 acres along river)	EO11990 ?, CWA ?	yes	NA	yes	yes, long term medium impact to habitat including wetlands.	yes, resident fish	no remaining impact
Bonner Ferry	Lower winter flows would encourage riparian vegetation establishment (e.g. cottonwoods). **Beneficial impact/no impact**	Winter Stage for Riparian measure	WSE	–	–	–	–	–	–	–	–	–	–	–	–
Hungry Horse	**negligible impacts. Similar to the NAA**	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pend Oreille	Exposure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species.	McNary Flow Target	WSE	med	Update and implement Invasive Plant Management Plan for the shoreline	yes.	yes	Update and implement Invasive Plant Management Plan for the shoreline	invasive EO	yes	NA	yes	Yes, comply with invasive EO	–	–
Pend Oreille	Denton Slough: Change in nesting areas for waterfowl (grebes).	McNary Flow Target	WSE	med	Construct a floating boom system across Denton Slough to reduce free floating nests from entering the main part of the reservoir.	yes.	yes	Construct a floating boom system across Denton Slough to reduce free floating nests from entering the main part of the reservoir.	MBTA	yes	NA	yes	yes, due medium impact and comply MBTA	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Pend Oreille	Denton Slough: Loss of approximately 1,200 acres of vegetated wetlands due to drawdown (Denton Slough, Pack River Delta, Clark Fork Delta).	McNary Flow Target	WSE	med	Plant or restore wetland habitat (approximately 1,200 acres) to create vegetated wetlands.	yes.	yes	Plant or restore wetland habitat (approximately 1,200 acres) to create vegetated wetlands.	CWA, EO 11990	yes	NA	yes	yes due medium impact and comply with CWA and EO 11990	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. Roosevelt	Lower WSE, Potential loss of forested, scrub-shrub wetlands and gallery forests, including through lack of suitable conditions for recruitment and establishment, impacting wildlife including resident and migratory waterfowl.	Winter System FRM	WSE	Low.	no mitigation proposed due to low impact and no regulated resource		–	–	–	–	–	–	–	–	–
L. Roosevelt	Slight increase in the size of the barren zone which would increase the risk of wildlife predation, including from raptors, wolves, and mountain lions.	Hungry Horse Additional Water Supply, Sliding Scale at Libby and Hungry Horse	Drawdown of water surface elevation	low	no mitigation proposed due to low impact and no regulated resource	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective ?	Is the measure feasible/implementable ?	Mitigation Carried Forward from column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended ?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
LSR	WSE is 1ft lower in March than NAA, potential exposure of unvegetated areas could cause exposure of unvegetated barren land. Colonization of invasive speices.	McNary Target Flow	WSE	low	Update and implement Invasive Plant Management Plan for the shoreline	yes	yes	Update and implement Invasive Plant Management Plan for the shoreline	yes, Invasive EO	yes	NA	yes	yes, due to complying with invasive EO	–	–
LSR/ Clearwater River	potential conversion of vegetation to wetter vegetation (inundation of the pools above 4 inches until the end of June); potential of affecting groundnesting birds	McNary Target Flow	WSE	low	No mitigation proposed due to benefit to wetland habitat. Low effect to groundnesting birds.	–	–	–	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary, John Day, The Dalles, Bonneville	~ 0.5 to 1.5 foot lower WSE upstream of mcNary and ~ 2.3 to 4 feet lower in Lake Bonnevillle, increase in exposed mudflats, increase invasive species	McNary Target Flow	WSE	low	Update Corps' Invasive Species management plan.	yes	yes	Update Corps' Invasive Species management plan.	yes, Invasive EO	yes	NA	yes	Yes, to comply with Invasive EO	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
McNary, and Umatilla NWR	lower WSE upstream of mcNary, critial bird habitat may be impacted. Vegetation may change in composition. Exposing more island.	McNary Target Flow	WSE	med	Planting plan with wetlands/riparian vegetation (Umatilla NWR [Blalock 115 acres, Patterson Slough 180 acresl], Foundation Island 222 acres). Update existing Invasive Plant Management plan for shoreline	yes	yes	Planting plan with wetlands/riparian vegetation (Umatilla NWR [Blalock 115 acres, Patterson Slough 180 acresl], Foundation Island 222 acres. Update existing Invasive Plant Management plan for shoreline	yes, Invasive EO, MTBA	yes	NA	yes	Yes, for med impact and comply with Invasive EO and MBTA	–	–
upper portions of Region D	lower WSE, **negligible changes (similar to NAA)** in wetland habitat can have effect on amphibians, migratory songvbirds, and mammals.	–	WSE	–	–	–	–	–	–	–	–	–	–	–	–

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	None - see region-wide	NA	NA	NA	NA	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	None - see region-wide	NA	NA	NA	NA	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	None - see region-wide	NA	NA	NA	NA	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	None - see region-wide	NA	NA	NA	NA	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Per Discussions at Mitigation Workshop No mitigation is recommended for this resource.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA **if no impact or beneficial impact, no mitigation needed**	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
–	Loss of Load Probability (LOLP) increases to 11.2%. May be higher due to coal being taken offline.	–	–	–	Construct replacement energy sources to meet regional energy demand. (This would be market-driven and accomplished by others). Gas plants are cheapest replacements, but are not likely due to climate change considerations and focus on renewable energy. These replacement energy plants may be constructed by others or could be funded (partially) by BPA. This may not be implemented by co-lead agencies.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
–	Significant energy loss May - Sept due to spill, and Dworshak measure (critical water year *of 1937)*	–	–	–	Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	Significant LOLP increase in August	–	–	–	Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
–	large cost to power for structural measures	–	–	–	Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
–	winter reduction in power and flexibility	–	–	–	Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
–	December power losses	–	–	–	Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	all the above decreasing power value	–	–	–	Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA	NA	No	NA	NA	NA	NA	NA	NA
–	Increased NW wind and solar spill	–	–	–	Add export transmission facilities; Add energy storage	NA	To be implemented by others. (market-driven)	NA	No	NA	NA	NA	NA	NA	NA
–	Increased transmission congestion on certain paths - such as PDCI, MT to NW, and Hemingway-Summer Lake	–	–	–	Energy market participation; Add or modify resources (thermal, renewable, demand response, etc); Add transmission facilities (transmission lines, voltage reactors, RAS, etc)	NA	To be implemented by others. (market-driven)	NA	No	NA	NA	NA	NA	NA	NA

Power and Transmission – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Renewable energy spill associated with changes in generation	–	–	–	Add export transmission facilities; Add energy storage (battery banks; pump storage) - Not an action likely taken by BPA	NA	To be implemented by others. (market-driven)	NA	No	NA	NA	NA	No	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
–	Several power limiting measures combine to reduce average and peak generation	–	–	–	Energy market participation (BPA is looking into this for all scenarios); Add or modify resources (thermal, renewable, demand response, etc); Add transmission facilities (transmission lines, voltage reactors, RAS, etc) - creative transmission is likely mitigation for MO2.	NA	To be implemented by others. (market-driven)	NA	No	NA	NA	NA	No	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Per Discussions at Mitigation Workshop No mitigation is recommended for this resource.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Per Discussions at Mitigation Workshop No mitigation is recommended for this resource.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	LOLP increases to 13.9% because several limiting measures combine to reduce average and peak generation.	–	–	–	Replace lost power: $294.10 million/year (gas); $341.30 million/year (solar) (to achieve LOLP of NAA) to achieve 2017 reliability levels	NA	NA	No	No	NA	NA	NA	No. Actions recommended would be taken by others (market-driven)	NA	NA

–	Significant energy deficit Ap1-July of 1937, caused by several power-limiting measures cobining to reduce average generation.	–	–	–	Adjust (increase) minimum generation at Lower Columbia projects (also helps with transmission reliability) Draft GCL and maybe upstream storage projects slightly deeper by April 10 or completely eliminate the April 10 requirement. Potentially lower the April 30 elevation as well. reduce the MCN flow aug measure to be only 1 MAF phase in the water supply measures slowly as demand materialized	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA
–	within-day flexibility is significantly reduced	–	–	–	not spill or reduce spill in March, reduce summer spill to performance standard levels,	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for	NA	NA

					stop spill early or mid-August, Reduce refill probability needed to lower VDLs slightly Add flex spill Allow JDA to operate up to 266.4 ft not only in the fall but also in the winter until MIP operation starts in the spring. Criteria can be developed to draft lower as needed when the Corps determines that there is an imminent threat of flood stages downstream, similar to the criteria now in effect in the fall. implement flex spill in the spring; Allow DWR to increase discharge with power demand is unusually								potential use later.		

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
					high, e.g. during heat waves in August.										
–	Loss of voltage support provided by the Lower Snake Project	–	–	–	Adjust minimum generation at Lower Columbia projects	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA
–	Increased transmission congestion on certain paths - such as Hemingway-Summer Lake caused by several power-limiting measures, which combine to reduce average and peak generation.	–	–	–	Increase transmission paths going north- south (highest priority), strategically locating power generation.	NA	NA	No	No	NA	NA	NA	No. Recommended action is outside of scope and would be accomplished under a separate NEPA action. Removed from mitigation recommendation and archived for potential use later.	NA	NA

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Power and Transmission – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Considerations for establishment of riparian vegetation below Libby Dam limit power generation flexibility	Operational measure to establish riparian vegetation below Libby Dam	Survival rate of previous plantings	Med.	Plant larger diameter cottonwoods below Libby dam to aid in their establishment	Use of larger diameter stock to aid establishment is warranted, given the site conditions. However, this is a consideration in the implmentation of this measure, not an action that would offset an impact of this measure. As such, it is not recommended as a mitigation action.	Yes	No. This would be a consideration for implementation of the measure. Removed from mitigation recommendation and archived to inform implementation of this measure if warranted.	No	Yes	NA	NA	No. This would be a consideration for implementation of the measure. Removed from mitigation recommendation and archived to inform implementation of this measure if warranted.	Yes. This action would also provide benefits for fish and wildlife.	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	See below	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Per Discussions at Mitigation Workshop No mitigation is recommended for this resource.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increased transmission congestion on certain paths - such as Hemingway-Summer Lake caused by several power-limiting measures, which combine to reduce average and peak generation.	–	–	–	Increase transmission paths going north- south (highest priority), strategically locating power generation.	NA	NA	No	No	NA	NA	NA	No. Recommended action is outside of scope and would be accomplished under a separate NEPA action. Removed from mitigation recommendation and archived for potential use later.	NA	NA

–	Within-day flexibility is significantly reduced caused by drawdown to MOP on Lower Columbia projects, combined with spill to 125% beginning in March (not enough water in the system)	–	–	–	reduce summer spill to performance standard levels, stop spill early or mid-August, Allow forebay operations above the MOP/MIP restriction on occasion, such as when power prices hit a certain trigger level or for a certain number of days per month to increase power flexibility when it is most needed. This would help with flexibility, reliability, and generally help power. Allow JDA to operate up to 266.4 ft not only in the fall but also in the winter until MIP operation starts in the spring. Criteria can be developed to draft lower	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
					as needed when the Corps determines that there is an imminent threat of flood stages downstream, similar to the criteria now in effect in the fall. Stop spill when the temperature is high (when power demand is particularly high). This would help with flexibility, reliability, and generally help power.										

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	Measures that reduce operating ranges, increase spill, operate at MOP result in loss of flexibility in hydropower generation; would aid wind/solar integration	–	–	–	–	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA
–	August has very large generation loss and loss-of-load probability caused by the McNary Flow Augmentation measure	–	–	–	Draft upstream projects deeper in August to increase flows; end spill earlier in dry years	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	Large impacts to power for structural measures	–	–	–	Remove fish screens to lower O&M costs (b/c most fish are going through spillway) Alternatively, remove fish screens during Nov-Dec since adults will be going through winter spill	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
–	Winter reduction in power generation and flexibility caused by rain-induced flooding measure	–	–	–	Modify the measure that protects against rain-induced flooding. Allow Grand Coulee to be slightly higher when there is no low-elevation snow, but draft Grand Coulee more if low-elevation is falling. Presumably this would involve some sort of adaptive management	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA
–	December power generation losses caused by Libby End - of -December Measure	–	–	–	Allow Libby to draft deeper in December, at least during cold snaps	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	Potential reduction of voltage support from the lower Columbia Project caused by decreased generation at the Lower Columbia projects (spill).	–	–	–	Adjust minimum generation at Lower Columbia and Snake River projects	NA	NA	No	No	NA	NA	NA	No. Recommended action is a change to the alternative. Removed from mitigation recommendation and archived for potential use later.	NA	NA
–	Increased transmission congestion on certain paths - such as Hemingway-Summer Lake caused by several power-limiting measures, which combine to reduce average and peak generation.	–	–	–	Increase transmission paths going north- south (highest priority), strategically locating power generation.	NA	NA	No	No	NA	NA	NA	No. Recommended action is outside of scope and would be accomplished under a separate NEPA action. Removed from mitigation recommendation and archived for potential use later.	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
–	Several power-limiting measures combine to reduce average and peak generation, resulting in LOLP increases to 29.6%	–	–	–	build $420.50 million/year (gas); or $511.0 million/year (solar) (to achieve LOLP of NAA)	NA	NA	No	No	NA	NA	NA	No. Recommended action is outside of scope and would be accomplished under a separate NEPA action. Removed from mitigation recommendation and archived for potential use later.	NA	NA

Air Quality and Greenhouse Gases – Multiple Objective 1

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby/Lake Koocanusa	Potential for short term windblown fugitive dust (PM) emissions that cause negative human health effects	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Med due to potential for human health effects	1)Seeding dry sediment areas with vegetation if severe. 2)Prohibiting vehicle traffic on dry sediment. 3)Wind barriers if necessary. 4) BMPs during construction.	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee/Lake Roosevelt	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Dworshak	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
McNary Area - Replacement Power Resources	Air pollutant and GHG emissions from natural gas replacement power generation *(only under the least cost power portfolio)*	Natural gas power generation replaces changes in hydropower generation increasing GHG emissions and air pollutants	Changes in GHG emissions from power generation; air pollutants described qualitatively and proportionally relative to change from No Action	Low	Carbon capture and storage technology and/or ensuring stringent emissions controls and best available technology. Offsetting emissions through planting of vegetation or other offsetting sequestration methods (e.g., credits)	–	–	No	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Multiple	Air pollutant and GHG emissions from power resource construction	The construction and interconnection of new power resources generates air pollutants and GHG emissions from construction activities at various locations across the Pacific Northwest	Qualitative discussion about need for replacement power and magnitude of generation requiring replacement	Low	Watering construction roads. BMPs for construction operations. Additional fuel and construction practices as directed by EPA Clean Construction guidance	–	–	No. Will be implemented as a BMP	–	–	–	–	–	–	–

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Air Quality and Greenhouse Gases – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby/Lake Koocanusa	Potential for short term windblown fugitive dust (PM) emissions that cause negative human health effects	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Med due to potential for human health effects	if multiple measures, please number them. 1)Seeding dry sediment areas with vegetation if severe. 2)Prohibiting vehicle traffic on dry sediment. 3)Wind barriers if necessary. 4) BMPs during construction.	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee/Lake Roosevelt	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	–	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Dworshak	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	–	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
McNary Area - Replacement Power Resources	Air pollutant and GHG emissions from natural gas replacement power generation *(only under the least cost power portfolio)*	Natural gas power generation replaces changes in hydropower generation increasing GHG emissions and air pollutants	Changes in GHG emissions from power generation; air pollutants described qualitatively and proportionally relative to change from No Action	–	Carbon capture and storage technology and/or ensuring stringent emissions controls and best available technology. Offsetting emissions through planting of vegetation or other offsetting sequestration methods (e.g., credits)	–	–	No	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Multiple	Air pollutant and GHG emissions from power resource construction	The construction and interconnection of new power resources generates air pollutants and GHG emissions from construction activities at various locations across the Pacific Northwest	Qualitative discussion about need for replacement power and magnitude of generation requiring replacement	–	Watering construction roads. BMPs for construction operations. Additional fuel and construction practices as directed by EPA Clean Construction guidance	–	–	No. Will be implemented as a BMP	–	–	–	–	–	–	–

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby/Lake Koocanusa	Potential for short term windblown fugitive dust (PM) emissions that cause negative human health effects	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Med due to potential for human health effects	if multiple measures, please number them. 1)Seeding dry sediment areas with vegetation if severe. 2)Prohibiting vehicle traffic on dry sediment. 3)Wind barriers if necessary. 4) BMPs during construction.	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulate d resource (CWA, ESA, 106)**	**Is the mitigatio n action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigatio n**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary , dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemente d**
Hungry Horse	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee/Lake Roosevelt	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lower Snake Projects	Fugitive dust from construction activities (on road and non-road)	Dam Breaching and other Construction	Area of exposed shoreline	Low	No known effective mitigation actions	–	–	NA	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulate d resource (CWA, ESA, 106)**	**Is the mitigatio n action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigatio n**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary , dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemente d**
Lower Snake Projects	GHG and air pollutant emissions from construction vehicles	Dam Breaching and other Construction	Scale of Demolition/Constructio n	Low	No known effective mitigation actions	–	–	NA	–	–	–	–	–	–	–
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary Area - Replacemen t Power Resources	Air pollutant and GHG emissions from natural gas replacemen t power generation *(only under the least cost power portfolio)*	Natural gas power generation replaces changes in hydropower generation increasing GHG emissions and air pollutants	Changes in GHG emissions from power generation; air pollutants described qualitatively and proportionally relative to change from No Action	–	Carbon capture and storage technology and/or ensuring stringent emissions controls and best available technology. Offsetting emissions through planting of vegetation or other offsetting sequestratio n methods (e.g., credits)	–	–	No	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Multiple	Air pollutant and GHG emissions from power resource construction	The construction and interconnection of new power resources generates air pollutants and GHG emissions from construction activities at various locations across the Pacific Northwest	Qualitative discussion about need for replacement power and magnitude of generation requiring replacement	–	Watering construction roads. BMPs for construction operations. Additional fuel and construction practices as directed by EPA Clean Construction guidance	–	–	Implement as BMP	–	–	–	–	–	–	–

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Libby/Lake Koocanusa	Potential for short term windblown fugitive dust (PM) emissions that cause negative human health effects	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	Low	1)Seeding dry sediment areas with vegetation if severe. 2)Prohibiting vehicle traffic on dry sediment. 3)Wind barriers if necessary. 4) BMPs during construction.	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	–	See above	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Grand Coulee/Lake Roosevelt	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	–	See above	1) No, as flucutation will inundate new plantings 2) Yes 3)Uncertain 4)Yes	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Dworshak	Fugitive windblown dust from exposed river sediment	Additional drawdown relative to No Action risks potential fugitive dust emissions from exposed sediment	Feet of reservoir elevation change relative to No Action; potential associated effects on PM emissions qualitative	–	See above	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down. Implement as construction BMP 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Yes	1) No, as flucutation will inundate new plantings 2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 3)No, wind barriers efficacy are uncertain 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Clean Air Act	Yes	NA	Seasonal and Temporary	2) Yes, prohibiting vehicle traffic on shorelines will help keep dust and erosion down 4)Yes, but BMPs are implemented anyway, so don't need to call them out as mitigation	Prohibiting vehicular traffic will also protect wildlife and wildlife habitat	Seasonal and temporary episodes of blowing dust
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
McNary Area - Replacement Power Resources	Air pollutant and GHG emissions from natural gas replacement power generation *(only under the least cost power portfolio)*	Natural gas power generation replaces changes in hydropower generation increasing GHG emissions and air pollutants	Changes in GHG emissions from power generation; air pollutants described qualitatively and proportionally relative to change from No Action	–	Carbon capture and storage technology and/or ensuring stringent emissions controls and best available technology. Offsetting emissions through planting of vegetation or other offsetting sequestration methods (e.g., credits)	No	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Multiple	Air pollutant and GHG emissions from power resource construction	The construction and interconnection of new power resources generates air pollutants and GHG emissions from construction activities at various locations across the Pacific Northwest	Qualitative discussion about need for replacement power and magnitude of generation requiring replacement	–	Watering construction roads. BMPs for construction operations. Additional fuel and construction practices as directed by EPA Clean Construction guidance	Implement as BMP	–	–	–	–	–	–	–	–	–

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66 Navigation and Transportation – Multiple Objective 1

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee	Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	Operational measures that draft Grand Coulee deeper	Reservoir Levels	High	Extend the ramp at the Gifford-Inchelium Ferry so that it's available at lower water elevations.	Yes	Yes	Yes	No	Yes	NA	Temporary but severe effect	Yes	NA	None
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LSR Projects	Negligible effects on navigation operating costs	NA	NA	Low	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
LCOL Projects	Negligible effects on navigation operating costs	NA	NA	Low	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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69 **Navigation and Transportation – Multiple Objective 2**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee	Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	Operational measures that draft Grand Coulee deeper	Reservoir Levels	High	Extend the ramp at the Gifford-Inchelium Ferry so that it's available at lower water elevations.	Yes	Yes	Yes	No	Yes	NA	Temporary but severe effect	Yes	NA	None
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LSR Projects	Negligible effects on navigation operating costs	NA	NA	Low	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
LCOL Projects	Negligible effects on navigation operating costs	NA	NA	Low	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

72 **Navigation and Transportation – Multiple Objective 3**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee	Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	Operational measures that draft Grand Coulee deeper	Reservoir Levels	High	Extend the ramp at the Gifford-Inchelium Ferry so that it's available at lower water elevations.	Yes	Yes	Yes	No	Yes	NA	Temporary but severe effect	Yes	NA	None
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
LSR Projects	Carbon emission increase with increased movement on road and rail with LSR navigation channel no longer operational	Dam Breaching	air quality	Low	None proposed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LSR Projects	Potential increased traffic on road and/or rail lines impacting congestion and/or capacity of system to move goods after breaching eliminates barge navigation on the LSR	Dam Breaching	Traffic volumes on roads	Low	None proposed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LSR Projects	Potential congestion or capacity issues at road and/or rail shipping facilities after breaching eliminates barge traffic on the LSR	Dam Breaching	Traffic volumes on rail	Low	None proposed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
LCOL projects	Commercial navigation eliminated at four LSR projects potentially causing additional storage and/or movement at Lower Columbia port facilities	Dam Breaching	shipping volume from LSR	NA	None - market driven	–	–	–	–	–	–	–	–	–	–
LCOL projects	Potential sediment issues above McNary dam - Lake Wallula and confluence of Snake and Columba (note unclear if this is Region C or extends in to Region D)	Dam Breaching	volume of sediment	medium - several commercial berths/ports may become inaccessible	Dredge channel and around impacted facilities and/or relocate impacts port and dock facilities to alternate, unaffected location, or expand existing port facilities	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
LCOL projects	Potential increased traffic on road and/or rail lines impacting congestion and/or capacity of system to move goods	Dam Breaching	Traffic volumes on roads	Low	None - market driven	–	–	–	–	–	–	–	–	–	–
LCOL projects	Potential congestion or capacity issues at road and/or rail shipping facilities	Dam Breaching	Traffic volumes on rail	Low	None - market driven	–	–	–	–	–	–	–	–	–	–
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Navigation and Transportation – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee	Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	Operational measures that draft Grand Coulee deeper	Reservoir Levels	High	Extend the ramp at the Gifford-Inchelium Ferry so that it's available at lower water elevations.	Yes	Yes	Yes	No	Yes	NA	Temporary but severe effect	Yes	NA	None
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Neglible effects on navigation operating costs	NA	NA	NA	NA	NA	NA	None	NA	NA	No	NA	NA	NA	NA
Lower Monumental, Little Goose	Increased shoaling in nav channel	High Spill combined with tailrace conditions	Sediment movement	med	Installation of Coffer cells to dissipate energy	Yes	Yes	Yes	No	Yes	NA	Yes - impact is all years	Yes	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary, John Day	Increased shoaling in nav channel	High Spill combined with tailrace conditions	Sediment movement	med	Installation of Coffer cells to dissipate energy	Yes	Yes	Yes	No	Yes	NA	Yes - impact is all years	Yes	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Recreation – Multiple Objective 1

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible - No mitigation recommended	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible - No mitigation recommended	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible - No mitigation recommended	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible - No mitigation recommended	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Recreation – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Dworshak	Reduced access to the Dworshak State Park Boat Ramp (up to 108 days) from mid-Jan - May. Impacting access for hunters and fishermen at a heavily used boat ramp. Most lost usage is outside of the recreation season, but changes in WSE take the ramp out of service in the month of April (30 days), during turkey hunting season and a time when the reservoir is open for the start of bass fishing season. Because of the steep	Operational measures for increased power flexibility	Visitor days	med (loss of access at mid-reservoir, in prime hunting areas)	Extension of the Dworshak State Park Boat ramp by approximately 26 feet.	Yes	Yes	Yes	No	Yes	NA	Yes. The impact is seasonal, but this boat ramp provides access to mid-reservoir hunting areas, and is one of most efficient ways to access.	Yes	NA	NA

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
	terrain and limited road network, this ramp is important for recreation access.														
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible - No mitigation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ice Harbor/McNary	Sedimentation of boat ramp at Hood Park (below Ice Harbor Pool). Drop in pool elevations may require that boat ramp is extended	Dam Breaching	Accessibility of river for recreation	med	Dredge after breach, probably annually over 5-10 years until river stabilizes, and extend the Hood Park boat ramp.	Yes	Yes	Yes	No	Yes	NA	Temporary over 6-10 years until river stabilizes.	Yes	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
McNary	Sedimentation in the McNary Pool caused by breaching would negatively impact access to the McNaryYacht Club, a leased area in the McNary Pool.	Dam Breaching	Accessibility of river for recreation	High	Dredge approach and marina at McNary Yacht Club to maintain access. It is estimated this may need to be done annually (of varying scales) until the sediment load in the Snake River stabilizes.	Yes	Yes	Yes	No	Yes	NA	Likely within the first 5 years after completion of breaching. Will require monitoring to understand scale of the action.	Yes	NA	NA
McNary	Sedimentation in the McNary Pool caused by breaching would negatively impact access to the Walla Walla Yacht Club, a leased area in the McNary Pool.	Dam Breaching	Accessibility of river for recreation	High	Dredge approach and marina at the Walla Walla Yacht Club to maintain access. It is estimated this may need to be done annually (of varying scales) until the sediment load in the Snake River stabilizes.	Yes	Yes	Yes	No	Yes	NA	Likely within the first 5 years after completion of breaching. Will require monitoring to understand scale of the action.	Yes	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Ice Harbor	Breaching the LSR Dams would convert that area from lake recreation to river recreation. WSE drop approximately 95 feet.	Dam Breaching	Accessibility of river for recreation	High	Extend the boat ramp at Charbonneau Park approx. 95 feet to facilitate water access to the river from the existing park	Yes	TBD - engineering awaiting additional terrain data to determine feasibility	Yes	No	Yes	NA	All years after breaching	Yes	NA	NA
Ice Harbor	Breaching the LSR Dams would convert that area from lake recreation to river recreation. WSE drop approximately 70 feet.	Dam Breaching	Accessibility of river for recreation	High	Extend the boat ramp at Charbonneau Park approx. 70 feet to facilitate water access to the river from the existing park	Yes	Yes	Yes	No	Yes	NA	All years after breaching	Yes	NA	NA
Little Goose	Breaching the LSR Dams would convert that area from lake recreation to river recreation. WSE drop in elevation impacts recreational access.	Dam Breaching	Accessibility of river for recreation	High	Extend the boat ramp at Boyer Park approx. 20 feet to facilitate water access to the river from the existing park	Yes	Yes	Yes	No	Yes	NA	All years after breaching	Yes	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Monumental	Breaching the LSR Dams would convert that area from lake recreation to river recreation. WSE drop in elevation impacts recreational access.	Dam Breaching	Accessibility of river for recreation	High	Extend the boat ramp at Lyon's Ferry Park approx. 65 feet to facilitate water access to the river from the existing park	Yes	Yes	Yes	No	Yes	NA	All years after breaching	Yes	NA	NA
Lower Granite	Breaching the LSR Dams would convert that area from lake recreation to river recreation. WSE drop in elevation impacts recreational access.	Dam Breaching	Accessibility of river for recreation	High	Extend the boat ramp at Swallow's Park 25'	Yes	Yes	Yes	No	Yes	NA	All years after breaching	Yes	NA	NA
Lower Granite	Breaching the LSR Dams would convert that area from lake recreation to river recreation. WSE drop in elevation impacts recreational access.	Dam Breaching	Accesibility of river for recreation	High	Extend the Greenbelt Ramp near Lewiston, ID 30 '	Yes	Yes	Yes	No	Yes	NA	All years after breaching	Yes	NA	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary	Sedimentation of boat ramps on McNary project at Hat Rock State Park, Sacajawea State Park, and Warehouse Beach (Corps boat launches)	Dam Breaching	Accesibility of facilities	med	dredge after breach, probably annually over 5-10 years until river stabilizes	Yes	Yes	Yes	No	Yes	NA	Temporary over 6-10 years until river stabilizes.	Yes	NA	NA
McNary	Sedimentation of Walla Walla Yacht Club Marina, and McNary Yacht Club Marina (private marinas)	Dam Breaching	Accesibility of facilities	med-high	dredge after breach, probably annually over 5-10 years until river stabilizes	Yes	Yes	Yes	No	Yes	NA	Temporary over 6-10 years until river stabilizes.	Yes	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Recreation – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N)	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Negligible - no mitigation	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee Lake Roosevelt	lower water levels reduce accessibility at 11 boat ramps for 7-19 days per year.	Operational measures - McNary Flow Aug.	Accessibility of boat ramps	Low	Extend boat ramps	Yes	Yes	No - impact is less than 10 days/year	No	Yes	NA	Seasonal, with worst impacts in January, February, and May.	No - scale of impact and timing does not warrant	NA	Boat ramp will remain inaccessible during period described.

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N)**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Grand Coulee Lake Roosevelt	Lower water levels reduce accessibility at 6 (Evans, Hawk Creek, Marcus Island, Napolean Bridge, North Gorge) boat ramps for 55-63 days per year.	Operational measures - McNary Flow Aug.	Accessibility of boat ramps	Low	Extend boat ramps	Yes	Yes	No - impact is less than 10 days/year	No	Yes	NA	Seasonal, with greatest impacts in May, June, and August.	Yes	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Visual – Multiple Objective 1

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Visual – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Visual – Multiple Objective 3

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Dam Breaching	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Visual – Multiple Objective 4

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Temporary construction activities at projects	Structural measures - Construction	Visual	Med	None	NA	NA	NA	NA	NA	NA	Temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

98 **Noise – Multiple Objective 1**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Noise – Multiple Objective 2

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

100 **Noise – Multiple Objective 3**

Location	**Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures – Dam Breaching	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

101 **Noise – Multiple Objective 4**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	Increase in noise from temporary construction activities at projects	Structural Measures - Construction	Noise - decibels	low	None	NA	NA	NA	NA	NA	NA	temporary	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

102 **Cultural Resources – Multiple Objective 1**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hungry Horse	Reservoir fluctuation leads to exposure of archaeological resources increase by 17%, leading to increased erosion, recreational impacts, possible looting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	Amplitude of reservoir elevation changes (from max to min) icreases by 10%, leading to increased erosion, recreational impacts, possible looting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee	Exposure of archaeological resources increase by 10%, leading to increase by 10%, leading to increased erosion, recreational impacts, and possible looting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Grand Coulee	Frequency of reservoir elevatinal changes increases by 32% relative to the NAA, increasing the rate at which erosion occurs.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Dworshak	High draft rate events increase from an average of 2 times a year to above 4 times a year, leading to increased potential for slumping and other kinds of mass wasting	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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105 **Cultural Resources – Multiple Objective 2**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hungry Horse	Reservoir fluctuation result in exposure of archaeological resources increased by 6%, leading to increased erosion, recreational impacts, and possible looting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse	Reservoir fluctuation results in amplitude of reservoir elevation changes (from max to min) increase by 13%, leading to increased erosion.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse	High draft rate events increase from an average of 1 time every 2 years to once a year, leading to increased potential for slumping and other kinds of mass wasting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Libby	High draft rate events increase from an average of 0.7 times a year to abouve 1.3 times a year, leading to increased potential for slumping and other kinds of mass wasting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Libby	Reservoir fluctuation results in increase in exposure of archaeological resources by 8%, leading to increased erosion, recreational impacts, and possible looting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Hungry Horse	High draft rate events increase from an average of 1 time every 2 years to once a year, leading to increased potential for slumping and other kinds of mass wasting.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Creative mitigation measures to address tribal interests and concerns, to be implemented under existing FCRPS program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand Coulee	Reservoir fluctuations result in exposrure of archaeological resources increase by 13%	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Grand Coulee	Frequency of reservoir elevational changes increase by 26% relative to NAA, increasing the rate at which erosion occurs.	Operational Measures	Exposure of shoreline/erosion	varies by site	continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Grand Coulee	Frequency of reservoir elevational changes increase by 26% relative to NAA, increasing the rate at which erosion occurs.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Creative mitigation measures to address tribal interests and concerns, to be implemented under existing FCRPS program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Dworshak	Reservoir fluctuations result in exposure of archaeological resources increase by 13%.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Dworshak	Amplitude of reservoir elevation changes (from max to min) increase by 28%, leading to increased erosion.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation proposed. Use existing FCRPS program for continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Dworshak	Amplitude of reservoir elevation changes (from max to min) increase by 28%, leading to increased erosion.	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Creative mitigation measures to address tribal interests and concerns, to be implemented under existing FCRPS program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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107 **Cultural Resources – Multiple Objective 3**

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hungry Horse	Hungry Horse - Exposure of archaeological resources increased by 18%	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Hungry Horse	Hungry Horse - Amplitude of reservoir elevation changes (from max to min) increases by 11%, leading to increased erosion	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective ?**	**Is the measure feasible/implementable ?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended ?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Libby	Libby - Exposure of archaeological resources increased by 8%	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Libby	Libby - High draft rate events increase from an average of 0.7 times a year to above 1.2 times a year, leading to increased potential for slumping and other kinds of mass wasting	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Continued archaeological monitoring; periodic monitoring of landslides and other unstable landforms; develop/continue site protective capping or stabilization program; data recovery under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Hungry Horse	Hungry Horse - Amplitude of reservoir elevation changes (from max to min) increases by 11%, leading to increased erosion	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Creative mitigation measures to address tribal interests and concerns (language programs, etc.) under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Grand Coulee	Grand Coulee - High draft rate events increase from an average of 5.8 times a year to above 6.3 times a year, leading to increased potential for slumping and other kinds of mass wasting	Operational Measures	Exposure of shoreline/erosion	varies by site	continued archaeological monitoring; periodic monitoring of landslides and other unstable landforms; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Grand Coulee	Grand Coulee - High draft rate events increase from an average of 5.8 times a year to above 6.3 times a year, leading to increased potential for slumping and other kinds of mass wasting	Operational Measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Creative mitigation measures to address tribal interests and concerns (language programs, etc.) under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
–	–	–	–	–	–	–	–	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
–	–	–	–	–	–	–	–	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	–	–	–	–	–	–	–
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lower Snake Projects	Lower Snake Projects - Draw down rate of 2 ft. per day leads to slumping and mass wasting of post-reservoir sediments on archaeological sites	Dam Breach measures	Exposure of shoreline/erosion	varies by site	Monitor drawdown zones and newly exposed banks for cultural resources. - Implementation BMP	NA	NA	No. This action is a cultural resources BMP proposed during the implementation phase. No new mitigation.	Section 106 of NHPA, possible NAGPRA	NA	NA	NA	NA	Cultural Only	NA

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
Lower Snake Projects	Lower Snake Projects - Invasive weeds take over exposed soils leading to the development of a post-reservoir plant community that does not resemble pre-reservoir conditions. This would diminish the integrity of exposed traditional cultural properties	Dam Breach measures	Exposure of shoreline	varies by site	Restoration of native plants (using plant list developed with Payos Kuus Cuukwe group) within the newly exposed area on LSR.	Yes	Yes	Yes	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. Implementation of native plantings will prevent other issues such as noxious weed establishment.	Yes	Cultural and Wildlife Effects	NA
Lower Snake Projects	Existing plants fail to propogate over areas exposed by removal of reservoir due to lack of water. The lack of plant cover leads to accelerated erosion of archaeological resources	Dam Breach measures	Exposure of shoreline/erosion	varies by site	Targeted irrigation and replanting with native species in newly exposed areas.	Yes	Yes	Yes. Irrigation for 3 years will be essential in successful establishment of newly planted vegetation.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. Implementation of native plantings will prevent other issues such as noxious weed establishment.	Yes	Cultural and Wildlife Effects	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Lower Snake Projects	Lower Snake Projects - Exposure of archaeological sites due to removal of reservoir waters leads to increased looting	Dam Breach measures	Exposure of shoreline/erosion	varies by site	Increase law enforcement patrols; develop agreements with local law enforcement; public outreach campaign to deter looting; signage; develop site protective capping program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	–	–	Cultural Only	NA
Lower Snake Projects	Lower Snake Projects - Exposure of sandy areas along rivers leads to increase vehicle traffic on the former bed of the reservoir, which leads to rutting and damage to exposed sites	Dam Breach measures	Exposure of shoreline/erosion	varies by site	Increase law enforcement patrols; develop agreements with local law enforcement; public outreach campaign to deter off-road vehicle traffic; signage; creation of vehicle barriers along access routes; develop site protective capping program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	–	–	Cultural Only	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective ?	Is the measure feasible/implementable ?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended ?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Lower Snake Projects	Lower Snake Projects - Draw down rate of 2 ft. per day leads to slumping and mass wasting or deposition of post-reservoir sediments on traditional cultural properties	Dam Breach measures	Exposure of shoreline/erosion	varies by site	No new mitigation. Creative mitigation measures to address tribal interests and concerns (language programs, etc.) under existing FCRPS mitigation program.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Lower Snake Projects	Lower Snake Projects - Draw down rate of 2 ft. per day leads to slumping and mass wasting or deposition of post-reservoir sediments on traditional cultural properties	Dam Breach measures	Exposure of shoreline/erosion	varies by site	Stabilization of traditional cultural properties (revegetating, capping, erosion control, maintain site/intact site)	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	Cultural Only	NA
Lower Snake Projects	breaching leads to the dismantling of historic structures (eligible)	Dam Breach measures	Historic Properties criteria and requirements	varies by site	HABS-HARE documentation; public outreach campaign to deter looting; signage; data recovery (museum curation of "pieces"), security fencing to prevent access	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes	Yes	Cultural (interpretation of sites). The Fencing is a security/life safety measure to keep the public out of the dam structures post-breaching.	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNary	Release of accumlated sediment from Lower Snake River dam breaching overwhelms some wetlands, and affects distribution of plant communities that are critical to some traditional cultural properties (such as tule).	Dam Breach measures	Sediment accumulation	varies by site	Develop tule habitat at alternate sites; language program to perpetuate cultural knowledge of tule; interpretative signage;	Yes	Yes	Yes	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This mitigation action proposes to reestablish tule communities at sites impacted by sedimentation from Dam Breaching.	Yes	Cultural and Wildlife Effects	NA
Not Region Specific	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
General - LSR	Drawdown of reservoirs will expose at least 360 known culutral resources sites, possibly more, making them susceptible to damage and looting.	Dam Breach Measures	Exposure of shoreline	High	Develop dedicated mitigation program to address exposure of known cultural sites under drawdown conditions, as suggested in 2002 Lower Snake Feasibility Study. This would be a separate program from the existing cultural mitigation program for the FCRPS.	Yes	Yes	Yes	Section 106 of NHPA, possible NAGPRA	Yes	NA	Yes. This mitigation action proposes to reestablish tule communities at sites impacted by sedimentation from Dam Breaching.	Yes	Cultural and Wildlife Effects	NA

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Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Region A: Libby, Hungry Horse, Albeni Falls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hungry Horse	Hungry Horse - Exposure of archaeological resources increased by 23%, leading to increased erosion, recreational impacts, and possible looting	Operational Measures	Exposure of shoreline/erosion	med	continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Hungry Horse	Hungry Horse - Amplitude of reservoir elevation changes (from max to min) increases by 10%, leading to increased erosion	Operational Measures	Exposure of shoreline/erosion	med	continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Hungry Horse	Hungry Horse - Frequency of reservoir elevational changes increases by 8% relative to the NAA, increasing the rate at which erosion occurs	Operational Measures	Exposure of shoreline/erosion	med	continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Albeni Falls	Albeni Falls - Exposure of archaeological resources increased by 7%, leading to increased erosion, recreational impacts, and possible looting	Operational Measures	Exposure of shoreline/erosion	med	continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Libby	Libby - Frequency of reservoir elevational changes increases by 9% relative to the NAA, increasing the rate at which erosion occurs	Operational Measures	Exposure of shoreline/erosion	med	continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Hungry Horse	Hungry Horse - Amplitude of reservoir elevation changes (from max to min) increases by 10%, leading to increased erosion	Operational Measures	Exposure of shoreline/erosion	med	Creative mitigation measures to address tribal interests and concerns under existing programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Region B: Grand Coulee, Chief Joseph	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee	Grand Coulee - Exposure of archaeological resources increased by 47%, leading to increased erosion, recreational impacts, and possible looting	Operational Measures	Exposure of shoreline/erosion	med	increased continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery using existing mitigation programs	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Grand Coulee	Grand Coulee - Frequency of reservoir elevational changes increases by 24% relative to the NAA, increasing the rate at which erosion occurs	Operational Measures	Exposure of shoreline/erosion	med	increased continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery using existing mitigation programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee	Grand Coulee - Amplitude of reservoir elevation changes (from max to min) increases by 9%, leading to increased erosion (still within the normal operating range)	Operational Measures	Exposure of shoreline/erosion	med	increased continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery using existing mitigation programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Grand Coulee	Grand Coulee - High draft rate events increase from an average of 5.8 times a year to above 6.3 times a year, leading to increased potential for slumping and other kinds of mass wasting	Operational Measures	Exposure of shoreline/erosion	med	increase continued archaeological monitoring; drone monitoring; satellite monitoring; develop/continue site protective capping or stabilization program; data recovery using existing mitigation programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA

Location	Summary of Impact(s) Compared To NAA if no impact or beneficial impact, no mitigation needed	Cause of Impact (indicate the measure or group of measures from this alternative)	Indicator/Metric used to describe impact	Severity of impact (high, med, low)	Proposed Mitigation Measures	Is the measure likely to be effective?	Is the measure feasible/implementable?	Mitigation Carried Forward (Y/N) from Column F	Does impact effect a regulated resource (CWA, ESA, 106)	Is the mitigation action in-kind and on site?	If no in-kind and onsite, then document logic for proposing the off site mitigation	Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years	Is this mitigation action recommended?	Note if this mitigation action offsets impacts for multiple resources, which ones?	Remaining Effects after Mitigation Implemented
Grand Coulee	Grand Coulee - Frequency of reservoir elevational changes increases by 24% relative to the NAA, increasing the rate at which erosion occurs	Operational Measures	Exposure of shoreline/erosion	med	Creative mitigation measures to address tribal interests and concerns. (creative mitigation = language programs, interpretive materials, etc) under existing mitigation programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Grand Coulee	Grand Coulee - High draft rate events increase from an average of 5.8 times a year to above 6.3 times a year, leading to increased potential for slumping and other kinds of mass wasting	Operational Measures	Exposure of shoreline/erosion	med	Creative mitigation measures to address tribal interests and concerns under existing mitigation programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
Region C: Dworshak, 4 Lower Snake Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Region D: 4 Lower Columbia Projects	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Location	**Summary of Impact(s) Compared To NAA** **if no impact or beneficial impact, no mitigation needed**	**Cause of Impact (indicate the measure or group of measures from this alternative)**	**Indicator/Metric used to describe impact**	**Severity of impact (high, med, low)**	**Proposed Mitigation Measures**	**Is the measure likely to be effective?**	**Is the measure feasible/implementable?**	**Mitigation Carried Forward (Y/N) from Column F**	**Does impact effect a regulated resource (CWA, ESA, 106)**	**Is the mitigation action in-kind and on site?**	**If no in-kind and onsite, then document logic for proposing the off site mitigation**	**Is the mitigation scaled to the level of impact? Including: seasonal, temporary, dry-year only, all years**	**Is this mitigation action recommended?**	**Note if this mitigation action offsets impacts for multiple resources, which ones?**	**Remaining Effects after Mitigation Implemented**
John Day	John Day - Exposure of archaeological resources increased by 23%	Operational Measures	Exposure of shoreline/erosion	med	Continued archaeological monitoring; drone monitoring; satellite monitoring; law enforcement patrols; public education regarding not digging in archaeological sites; signage; develop/continue site protective capping or stabilization program; data recovery under existing mitigation programs.	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA
John Day	John Day - Exposure of archaeological resources increased by 23%	Operational Measures	Exposure of shoreline/erosion	med	Creative mitigation measures to address tribal interests and concerns under existing mitigation programs	Yes	Yes	Yes. Mitigation is implentation of existing FCRPS cultural program/PA. May require increase in existing mitigation program budgets.	Sec. 106, NAGPRA	Yes	NA	Yes. This will be implemented on a case-by-case basis using an existing program.	No new mitigation is proposed. Use existing program to address impacts.	NA	NA

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Draft Columbia River System Operations
Environmental Impact Statement

Appendix R, Mitigation, Monitoring and Adaptive Management

Part 3, Mitigation Process

Annex E

- **Proposed Mitigation Summary Tables for Each Multiple Objective Alternative**

CHAPTER 1 - PROPOSED MITIGATION SUMMARY FOR MULTIPLE OBJECTIVE 1 [5]

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization only	Proposed to move forward or rationale for removal
Water Quality	On the Lower Snake River Increased harmful algae bloom monitoring at recreational areas; if algal blooms produce toxins, post public advisories at recreational areas with to protect the public	Increased algae growth due to high August water temperatures in the Lower Snake River Projects	Best Management Practices/Update Plans	Yes, as Avoidance/Minimization
Vegetation, Wildlife, & Wetlands	Implement Invasive Plant Management Plan for the shoreline at Libby	Exposure of mudflats and barren lands caused by drawdown during the summer months could result in establishment of non-native, invasive plant species.	Best Management Practices/Update Plans	Yes, as Avoidance/Minimization
Vegetation, Wildlife, & Wetlands	On Kootenai River downstream of Libby: Plant native wetland and riparian vegetation (~100 acres along river)	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Impacts would occur seasonally, and would result in permanent effect habitat	–	Yes, as Mitigation

[5] Note that the effects in this table are draft

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization only	Proposed to move forward or rationale for removal
Vegetation, Wildlife, and Wetlands	Create up to 2 acres of avian nesting habitat outside of the Columbia River Basin	Inundation of nesting habitat from measure intended to fluctuate reservoir levels to reduce avian nesting habitat	–	Not carried forward the reservoir levels for this alternative are within the normal operating range. This operating range associated with John Day has been mitigated for with the creation of Umatilla National Wildlife Refuge in compliance with Fish and Wildlife Coordination Act Report for John Day construction and operations. In addition, the existing mitigation sites for both the estuary and inland tern management projects have capacity for additional birds.
Anadromous Fish	Add additional fish ladder entrances at Little Goose to provide additional ladder entry location for adult salmon and steelhead during high spill conditions	Increased spill levels cause turbulence and eddies below the dams. Direct offset to the eddies due to the spill. Onsite mitigation	–	Replaced with "Temporary extension of performance standard spill levels in coordination with the Regional Forum to assist fish migration."

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization only	Proposed to move forward or rationale for removal
Anadromous Fish	Increase level of avian predator management on the LSR and LCOL, and pinniped predator management on the LCOL projects.	This is an onsite/offsite measure to minimize impacts to fish that may be negatively impacted by TDG levels in the river.	–	Not included in the mitigation chapter because the existing programs are part of the NAA and all MOs. The existing avian predator management programs will be carried forward. In addition, Predation Disruption Operation measure would address this impact. For pinniped management program, the existing program would continue with potential for extending the timeframe.
Anadromous Fish	Implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats	This is offsite mitigation recommended to offset impacts from TDG of spill. Habitat actions would improve the health of fish, making them better able to overcome negative conditions in the river.	–	Not carried forward - this alternative would result in an overall reduction in impacts to anadromous fish. In addition, this mitigation would not directly offset the impact.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization only	Proposed to move forward or rationale for removal
Resident Fish - ESA Kootenai River White Sturgeon	Plant 1-2 gallon cottonwoods at Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region.	The flow regime at Libby has made establishment of riparian vegetation challenging. High flows have made it difficult to sustain young stands of cottonwoods.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization only	Proposed to move forward or rationale for removal
Resident Fish – ESA Bull Trout	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Wounded Buck, Sullivan and Wheeler and Bunker Creeks,) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir.	Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation.	–	Yes, as Mitigation
Resident Fish - Burbot, Kokanee, & Redband Rainbow Trout	Region B: Changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. Determine post-operations where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	–	Yes

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization only	Proposed to move forward or rationale for removal
Navigation & Transportation	Extend the ramp at the Inchelium-Gifford- Ferry on Lake Roosevelt so that it's available at lower water elevations.	Inchelium- Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	–	Yes, as Mitigation

Proposed Mitigation Summary for Multiple Objective 2 [6]

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Water Quality	Perform in-reservoir nutrient supplementation at Libby and Hungry Horse to increase primary and secondary productivity	Reduced in-lake biological productivity caused by reservoir drawdowns and higher flushing rates.	–	Yes. Continue implementation of nutrient supplementation at Libby, and add a nutrient supplementation program at Hungry Horse.
Vegetation, Wildlife, & Wetlands	Update, and/or prepare and implement invasive species management plans	Decreased in quality and quantity of wetland habitat at Libby and Hungry Horse caused by lower water elevations from implementation of the December Libby Target Elevation measure. This could result in the establishment and spread of invasive plant species.	Best Management Practices/Update Plans	Yes
Vegetation, Wildlife, & Wetlands	On Kootenai River downstream of Libby: planting of native wetland and riparian vegetation (~100 acres along river)	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	–	Yes, as Mitigation

[6] Note that the effects in this table are draft

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Anadromous Fish	Increase level of avian predator management on the LSR and LCOL, and pinniped predator management on the LCOL projects.	This measure is recommended to offset the anticipated increase in powerhouse encounter rate for anadromous fish.	–	The existing avian predator management programs will be carried forward. In addition, Predation Disruption Operation measure would address this impact. For pinniped management program, the existing program would continue with potential for extending the timeframe.
Resident Fish – ESA Kootenai River White Sturgeon (Libby)	Plant 1-2 gallon cottonwoods at Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region.	The flow regime at Libby has made establishment or riparian vegetation challenging. High flows have made it difficult to sustain young stands of cottonwoods.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish – ESA Bull Trout (Hungry Horse)	Plant the top 10’ of the varial zone in areas adjacent to tributaries used by Bull Trout at Hungry Horse. Use vegetation that will withstand reservoir fluctuations and provide food sources for ESA Bull Trout. Construct sub-impoundment berms in the upper reservoir for establishment of vegetation, plantings, install large woody debris, and grading to provide access to tributaries used by Bull Trout (up to 15 Tributaries) at Hungry Horse	Deeper winter drafts (100% increase in winter outflows) reduce substrate for winter insect production, which reduces food availability in spring. Reduced summer water volume reduces food availability for Bull Trout	–	–

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish – ESA Bull Trout	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Wounded Buck, Sullivan and Wheeler and Bunker Creeks,) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir.	Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation.	–	Yes
Resident Fish – ESA Bull Trout (Hungry Horse)	Create back channel habitat for juvenile Bull Trout on the Flathead River	Winter outflows increase over 100% over NAA, which reduces winter habitat available in the mainstem Flathead River by 30%. Winter habitat is important to sub yearling bull trout especially. Increase in SF Flathead River volume would also increase winter temps in mainstem Flathead River.	–	–

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish - Burbot, Kokanee, & Redband Rainbow Trout	Region B: Changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. Determine post-operations where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	–	Yes
Navigation & Transportation	Extend the ramp at the Inchelium-Gifford- Ferry so that it's available at lower water elevations.	Inchelium-Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	–	Yes, as mitigation
Recreation	Extend the boat ramp at Dworshak State Park (Freeman Creek) to make it accessible in April, when it is used by turkey hunters and bass fishermen	Changes in water levels would make this boat ramp inaccessible for 30 days in the month of April, the start of turkey hunting season and early bass fishing season. Because of the steep terrain and limited road access at Dworshak, this boat ramp is heavily used by recreators, especially hunters and fishermen, outside of the traditional recreation season.	–	Yes, as Mitigation

Proposed Mitigation Summary for Multiple Objective 3 [7]

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Water Quality	Perform in-reservoir nutrient supplementation at Libby and Hungry Horse to increase primary and secondary productivity.	Reduced in-lake biological productivity caused by reservoir drawdowns and higher flushing rates.	–	–
Water Quality	Strategic removal (dredging) of any sediment "hot spots" with high contaminant levels in Lower Snake River prior to breaching	Suspension and downstream deposition of fine grained sediment that contains bioaccumulative compounds (PCBs, dioxins, pesticides, Hg, etc.) will expose fish populations to new, higher levels of contaminants, with expected increases in fish tissue concentrations for at least a few years.	–	The co-lead agencies do not have authority to implement this mitigation measure. It would need to be implemented by others.

[7] Note that the effects in this table are draft

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Water Quality	Prior to breaching implement groundwater control near Lewiston, ID (1) Install groundwater cutoff walls or groundwater "treatment curtains/walls" along areas of known groundwater contamination; (2) pump and treat groundwater aggressively to prevent flows from entering river; (3) Remediate known contamination areas prior to dam breach.	Impacts to groundwater flows (from several known polluted ground water sources near Lewiston); NPDES permits would likely need to be redefined (less dilution). Containing or cleaning-up contaminated groundwater areas would reduce polluted inputs into lower Snake River post-breaching.	–	This mitigation measure would need to be implemented by others.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Water Quality	Install bubble curtain fixtures for DO supplementation.	Impacts from low DO to aquatic species creates dead zones, mobilizing these pockets or creating new ones will likely have major impacts to aquatics. Bubble curtains provide for DO.	–	Replaced with: "The co-leads would conduct these studies to investigate more accurately the impacts of water quality and specifically, dissolved oxygen to aquatic organisms and fish. The co-lead agencies would coordinate with state and Federal resource agencies to determine the best way to minimize any impacts to water quality. Some potential options could include aeration, dilution from upstream sources (e.g., the North Fork Clearwater River), or chemical treatment (e.g., peroxide dosing)."
Vegetation, Wildlife, and Wetlands	Update and implement existing Invasive Plant Management Plan for the shoreline at Libby	At Libby: Exposure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species.	Best Management Practices/Update Plans	Yes, as Avoidance/Minimization

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Vegetation, Wildlife, and Wetlands	A) planting of native wetland and riparian vegetation (~100 acres along river) on the Kootenai River	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	–	Yes, as Mitigation
Vegetation, Wildlife, and Wetlands	Planting plan and implementation of arid lands restoration to target establishment of native, arid spp (13,000 acres planting) on the lower Snake River, post-breaching	Perched habitats (HMUs) with dam breach to convert to arid lands	–	Yes, as Mitigation
Vegetation, Wildlife, and Wetlands	Planting plan and implementation of wetlands/riparian restoration (1,500 acres) to target establishment of native species on the lower Snake River post-breaching	Exposed sediment and exposed shoreline with dam breach (approximately 13,800 acres), includes wetland and riparian plantings	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Vegetation, Wildlife, and Wetlands	Develop a planting plan (155 acres of wetlands) for areas downstream of Ice Harbor. This plan may include possible excavation of deposited sediment from dam breaching.	Sediment Deposition (McNary Pool= 779 acres uplands, 13,639 acres open water, 97 acres forested wetlands, 58 acres emergent wetlands, 37 acres urban and mixed environs) Total is 14,610 acres.	–	Yes, as Mitigation
Vegetation, Wildlife, and Wetlands	Create avian nesting areas (~2 acres) outside of the Columbia River Basin	inundation of portions of the island that support avian species	–	Not carried forward the reservoir levels for this alternative are within the normal operating range. This operating range associated with John Day has been mitigated for with the creation of Umatilla National Wildlife Refuge in compliance with Fish and Wildlife Coordination Act Report for John Day construction and operations. In addition, the existing mitigation sites for both the estuary and inland tern management projects have capacity for additional birds.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Anadromous Fish	Construct new trap and haul operation for Snake River fish (Chinook Salmon, Sockeye, Steelhead) at McNary to allow removal of Chinook salmon, sockeye, and steelhead prior to breaching.	Dam breaching would create high levels of turbidity/suspended sediment from Lower Granite Dam to Ice Harbor Dam during Snake River fall Chinook and upper Snake River sockeye migration. This could result in mortality to 20-40% of the populations. Very low dissolved oxygen level from dam breaching would result in mortality in the Little Goose and Lower Monumental reservoirs during first phase of demolition, potentially wiping out year class of migrating Snake River fall Chinook and upper Snake River sockeye.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Anadromous Fish	Raise additional hatchery fish to offset two lost year classes prior to start of breach on the lower Snake River*	Dam breaching would create high levels of turbidity/suspended sediment from Lower Granite Dam to Ice Harbor Dam during Snake River fall Chinook and upper Snake River sockeye migration. This could result in mortality to 20-40% of the populations. Very low dissolved oxygen level from dam breaching would result in mortality in the Little Goose and Lower Monumental reservoirs during first phase of demolition, potentially wiping out year class of migrating Snake River fall Chinook and upper Snake River sockeye.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Anadromous Fish	Create MCN collection facility to allow trap and haul from MCN (to collect fall migrating fish below the Snake) Modify/improve Bonneville collection facility to allow trap and haul from Bonneville	Dam breaching would create high levels of turbidity/suspended sediment from Lower Granite Dam to Ice Harbor Dam during Snake River fall Chinook and upper Snake River sockeye migration. This could result in mortality to 20-40% of the populations. Very low dissolved oxygen level from dam breaching would result in mortality in the Little Goose and Lower Monumental reservoirs during first phase of demolition, potentially wiping out year class of migrating Snake River fall Chinook and upper Snake River sockeye.	–	Redundant with the McNary measure above.
Anadromous Fish	Modify the McNary Raceway using stainless steel infrastructure to degas the water in the raceway during collection for transport.	Water in the raceway is expected to have high TDG. Degassing in the raceway would allow fish to be transported in water with lower TDG than what is in the river.	–	–

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish - ESA Kootenai River White Sturgeon	Plant 1-2 gallon cottonwoods at Bonners Ferry to improve habitat and floodplain connectivity, which would benefit ESA-Listed Kootenai River White Sturgeon (KWRS) by providing a food source. This would complement ongoing habitat actions already being taken in the region.	The flow regime at Libby has made establishment or riparian vegetation challenging. High flows have made it difficult to sustain young stands of cottonwoods.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish – ESA Bull Trout (Hungry Horse)	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Sullivan, Bunker, Wounded Buck, and Wheeler Creeks, to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir.	Lower elevations in summer (4'-16' lower at end of Sept) and fewer days of full pool results in smaller productive euphotic zone, less surface for feeding in summer, and dewaters benthic insect production; less food source (terrestrial inspects/aquatic) for bull trout	–	Yes, as Mitigation
Resident Fish – ESA Bull Trout (LSR)	Modify channel (pilot channel) at mouth of the Tucannon River (tributary to Snake) to allow Bull Trout passage after reservoir levels drop from breaching.	Breaching will result in reservoir drawdown which would leave the river delta perched until high flows can create a new passable channel for Bull Trout.	–	Yes, as Mitigation

Resource	**Proposed Mitigation Action**	**Impact Offset**	**Avoidance / Minimization**	**Proposed to move forward or rationale for removal**
Resident Fish – White Sturgeon	On the Snake River, trap and haul White Sturgeon from impacted area(s) prior to breach. Relocate to Hells Canyon and below McNary	Dam breaching would create high levels of turbidity/suspended sediment from Lower Granite Dam to Ice Harbor Dam on the Snake River. Very low dissolved oxygen level from dam breaching would result in mortality in the Snake River for sturgeon and the forage fish they feed on. Although sturgeon are not ESA-listed, they are important to regional tribes and sport fishers.	–	Yes, as Mitigation
Resident Fish – ESA Bull Trout	Construct passage improvements in the Tributaries, to include replacement of culverts.	Additional spill may cause delays in bull trout passage at dams in May and June when they are moving out of the system to avoid warming water temps.	–	Not carried forward - not sufficient information about known impacts to develop mitigation measure

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish - Burbot, Kokanee, & Redband Rainbow Trout	Region B: Changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. Determine post-operations where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	–	Yes
Engineering/Infrastructure	Armor up to 25 bridge piers to protect from erosion caused by higher velocity water caused by breaching	Breaching the LSR dams will result in higher water velocities, increasing scour around bridge piers	–	Yes, as Mitigation
Engineering/Infrastructure	More than 80 miles of railroad and highway embankments would need to be armored to protect from erosion	Breaching the LSR dams will result in higher water velocities in the river, increasing erosion and higher flows through drainage structures/culverts.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Engineering/Infrastructure	Repair roads and railroad beds along the LSR after drawdown is completed	It is expected that repairs to roads and rail beds would be needed as a result of settlement and slope failures of embankments after breaching.	–	Yes
Navigation & Transportation	Dredge channel and around impacted facilities and/or relocate impacts port and dock facilities to alternate, unaffected location, or expand existing port facilities on the McNary Reservoir below Ice Harbor	Potential sedimentation issues above McNary near confluence of Snake/Columbia. Potential impacts to ports and/or docks following breach for 2-7 years and possibly beyond	–	–
Navigation & Transportation	Extend the ramp at the Inchelium -Gifford Ferry so that it's available at lower water elevations.	Inchelium -Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	–	Yes

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Cultural Resources	Prepare and implement a new programmatic agreement to avoid, minimize, and mitigate impacts to over 360 known cultural sites that would be exposed or accessible after drawdown. Actions covered within the PA could include law enforcement patrols, vegetation and reseeding, and archaeological monitoring.	Drawdown of the reservoirs will expose known cultural resources sites.	–	Yes, as Mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Cultural Resources	Implement the Historic American Building Survey and Historic American Engineering Record programs to document historic places, infrastructure, and landscape features. At the dams install security fencing and signs, and implement a public outreach campaign to document and excavate exposed sites.	Drawdown of the reservoirs may expose known historic structures. Breaching the dams would impact the historic integrity of the dams.	–	Yes
Real Estate	Construct cattle watering corridors to avoid damage from cattle to terrestrial and spawning habitat along the river. Install wells and pumps for flow into stock watering tanks. Install fencing to control cattle access.	Breaching would affect access to the river for cattle watering operations. Original land use agreements allowed cattle ranchers access to the reservoir for water for their cattle. Modifications to honor these agreements would need to be made under the drawdown condition.	–	–

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Real Estate	Following breach, replace gas lines that cross the Snake River near Lyons Ferry	Higher water velocities would create scour conditions that could damage existing pipes	–	This measure would be coordinated prior to implementation
Engineering	Modify/replace the large scale irrigation pumping plants in the 13 mile reach of the Snake River upstream of Ice Harbor. (Supply 680 cfs) Replace the existing large scale plants with one large pumping and distribution system	Drawdown would leave existing irrigation pumping plants without access to the river, creating a high impact for existing irrigators.	–	Not carried forwarded - these are private water supply facilities and any modification due to changed conditions would be implemented by owners.
Engineering	Evaluate impacts to existing wells. Exact impacts are uncertain, but it is expected that existing wells in the shallow aquifer would need to be deepened and have new pumps installed.	Drawdown of the reservoirs will impact existing wells within 1 mile of the Snake River.	–	Not carried forwarded - Wells are private water supply infrastructure. Co-leads do not have authority to modify.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Engineering	Install auxiliary water intakes in deep water to supply the existing Potlatch corporation well in Lewiston, ID	The lower water surface elevation caused by reservoir drawdown will not allow existing Potlatch water intake to function properly during low flow periods.	–	Not carried forwarded - Private infrastructure. Modifications to be implemented by others.
Engineering	Relocate Potlatch Corp. effluent diffuser to a deeper reach of the river downstream from current location	The lower water surface elevation caused by reservoir drawdown will not allow the existing wastewater effluent diffusers to function.	–	Not carried forwarded - Private infrastructure. Modifications to be implemented by others.
Recreation	Dredge sediment from McNary Yacht Club to maintain access	Sediment deposition in McNary Pool from breaching the LSR dams will prevent access to the McNary Yacht Club, a leased recreation area.	–	Not carried forward – upon completion of the recreation analysis, impact was not realized.
Recreation	Dredge sediment from Walla Walla Yacht Club to maintain access.	Sediment deposition in McNary Pool from breaching the LSR dams will prevent access to the McNary Yacht Club, a leased recreation area.	–	Not carried forward - upon completion of the recreation analysis, this impact would be short term and would resolved itself in the long term, so no long term impact

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Recreation	Extend the boat ramp at Charbonneau Park, on the Ice Harbor project near the Tri Cities, WA, approximately 95 feet to facilitate access to the river from the existing park.	Breaching would convert area from lake recreation to river recreation, necessitating extension of the boat ramps to provide access to the river.	–	Not carried forwarded - Lands would be deauthorized if breaching implemented.
Recreation	Extend the boat ramp at Fishhook Park, on the Ice Harbor Project near the Tri Cities, WA, approximately 70 feet to facilitate access to the river from the existing park.	Breaching would convert area from lake recreation to river recreation, necessitating extension of the boat ramps to provide access to the river.	–	Not carried forwarded - Lands would be deauthorized if breaching implemented.
Recreation	Relocate boat ramp at Boyer Park on Little Goose project to provide river access (approx. 20’ ramp)	Breaching would convert area from lake recreation to river recreation, necessitating extension of the boat ramps to provide access to the river.	–	Not carried forwarded - Lands would be deauthorized if breaching implemented.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Recreation	Relocate boat ramp at Lyons Ferry Park to provide river access on the Lower Monumental project. This would require construction of a boat ramp approximately 65' in length.	Breaching would convert area from lake recreation to river recreation, necessitating extension of the boat ramps to provide access to the river.	–	Not carried forwarded - Lands would be deauthorized if breaching implemented.
Recreation	Extend the existing four lane boat ramp at Swallow's Park, on the Lower Granite project near Clarkston, WA (annual visitation 268k) to provide access to the river.	Breaching would convert area from lake recreation to river recreation, necessitating extension of the boat ramps to provide access to the river.	–	Not carried forwarded - Lands would be deauthorized if breaching implemented.
Recreation	Extend the existing 2-lane Greenbelt Ramp on the Lower Granite project near Lewiston, ID to provide access to the river.	Breaching would convert area from lake recreation to river recreation, necessitating extension of the boat ramps to provide access to the river.	–	Not carried forwarded - Lands would be deauthorized if breaching implemented.

9 Proposed Mitigation Summary for Multiple Objective 4 [8]

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Water Quality	Perform in-reservoir nutrient supplementation at Libby and Hungry Horse to increase primary and secondary productivity.	Reduced in-lake biological productivity caused by reservoir drawdowns and higher flushing rates.	–	Yes. Continue implementation of nutrient supplementation at Libby, and add a nutrient supplementation program at Hungry Horse.
Vegetation, Wildlife, and Wetlands	At all projects, implement and expand existing Invasive Plant Management Plans including the invasive aquatic plant removal program (e.g. Eurasian water milfoil) at Albeni Falls	Exposure of mudflats and barren lands during the summer months could result in establishment of non-native, invasive plant species. ~ 0.5 to 1.5 foot lower WSE upstream of McNary and ~ 2.3 to 4 feet lower in Lake Bonneville, increase in exposed mudflats, increase invasive species With regards to invasive aquatic plants, nearshore areas used for recreation may be more difficult to access due to the lower lake level, as well as from greater invasive macrophyte and periphyton growth.	Best Management Practices/Update Plans	Yes, as Avoidance and Minimization

[8] Note that the effects in this table are draft

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Vegetation, Wildlife, & Wetlands	planting of native wetland and riparian vegetation (~100 acres along river)	Conversion of wetland to upland habitat in May through summer (off-channel habitat). Impacts on wildlife phenology and fecundity (inverts, amphibian eggs, flycatchers, bats). Occurs seasonal and would result in permanent effect habitat	–	Would use existing programs at Lake Pend Oreille to address impacts.
Vegetation, Wildlife, & Wetlands	Construct a floating boom system across Denton Slough on Lake Pend Oreille to reduce free floating nests from entering the main part of the reservoir.	Denton Slough: Change in nesting areas for waterfowl (grebes) as a result of the drafts to support McNary Flow target measure.	–	–
Vegetation, Wildlife, & Wetlands	Plant or restore wetland habitat (approximately 1,200 acres) to create vegetated wetlands on Lake Pend Oreille	Denton Slough: Loss of approximately 1,200 acres of vegetated wetlands due to drawdown (Denton Slough, Pack River Delta, Clark Fork Delta) at Lake Pend Oreille	–	Would use existing programs at Albeni Falls and Lake Pend Oreille to address effects.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Vegetation, Wildlife, & Wetlands	Planting plan with wetlands/riparian vegetation (Umatilla NWR [Blalock 115 acres, Patterson Slough 180 acres], Foundation Island 222 acres) on Lower Columbia Update existing Invasive Plant Management plan for shoreline.	Lower WSE upstream of McNary, critical bird habitat may be impacted. Vegetation may change in composition. Deeper drafts may expose more island.	Best Management Practices/Update Plans	Not carried forward – At Umatilla NWR, the reservoir levels for this alternative are within the normal operating range. This operating range associated with John Day has been mitigated for with the creation of Umatilla National Wildlife Refuge in compliance with Fish and Wildlife Coordination Act Report for John Day construction and operations. In addition, the existing mitigation sites for both the estuary and inland tern management projects have capacity for additional birds. In addition, at Foundation Island, the level of impact offset is not commiserate with the cost.
Anadromous Fish	Add fish ladder entrances at Little Goose Dams to help migrating Chinook avoid confounding eddies.	Elevated TDG could harm upstream migrants and/or affect upstream migration of Snake River fall Chinook and Upper Snake River sockeye due to eddies created by High Spill conditions.	–	Replaced with "Temporary extension of performance standard spill levels in coordination with the Regional Forum to assist fish migration."

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Anadromous Fish	Increase level of avian predator management on the LSR and LCOL, and pinniped predator management on the LCOL projects.	This is an onsite/offsite measure to minimize impacts to fish that may be negatively impacted by TDG levels in the river	–	The existing avian predator management programs will be carried forward. In addition, Predation Disruption Operation measure would address this impact. For pinniped management program, the existing program would continue with potential for extending the timeframe.
Anadromous Fish	Implement mainstem habitat improvement projects to increase food sources and reconnect back-channel habitats	This is offsite mitigation recommended to offset impacts from TDG of spill. Habitat actions would improve the health of fish, making them better able to overcome negative conditions in the river.	–	Not carried forward - this alternative would result in an overall reduction in impacts to anadromous fish. In addition, this mitigation would not directly offset the impact.
Anadromous Fish	Modify the McNary Raceway using stainless steel infrastructure to degas the water in the raceway during collection for transport	Water in the raceway is expected to have high TDG. Degassing in the raceway would allow fish to be transported in water with lower TDG than what is in the river.	–	Yes.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish - Burbot, Kokanee, & Redband Rainbow Trout	Region B: Changes in elevation would leave current habitat dewatered and expose new potential areas appropriate for developing additional gravel spawning habitat.	Develop additional spawning habitat at Lake Roosevelt to minimize impacts to resident fish. Determine post-operations where to site spawning habitat augmentation at Lake Roosevelt for burbot, kokanee, and redband rainbow trout to inform where mitigation is needed. Place appropriate gravel (spawning habitat) at locations up to 100 acres along reservoir and tributaries.	–	Yes
Resident Fish – ESA Bull Trout	On the lower Snake: improve tributary passage by replacing culverts on the Tucannon and Asotin Creek.	High spill levels may cause delays in bull trout passage at dams in May and June when they are moving out of the system to avoid temps.	–	–
Resident Fish – ESA Bull Trout	Operate slide gates at Hungry Horse to provide optimum water temperatures. Use of the slide gates (after the Hungry Horse Modernization is complete) would reduce entrainment of food sources for Bull Trout.	Increased summer outflows in MO 4 would increase the entrainment of zooplankton, phytoplankton, and invertebrates used as food sources for Bull Trout. Use of the slide gates to mix to the desired water temperature would eliminate this issue. This impact is the most severe for MO 4, with high effect in wet and average years and extreme effect in dry years	Within operations of NAA	This operation is described in the No Action Alternative, and is not considered a mitigation action.

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Resident Fish – ESA Bull Trout	On the Hungry Horse Reservoir install structural components like woody debris, and plant vegetation at the tributaries (Sullivan and Wheeler Creeks, possibly more) to stabilize the channels, increase cover for migrating fish, and improve the varial zone to minimize impacts of reservoir fluctuation where the tributaries enter the reservoir	Drawdowns cause low water elevations at time of Bull Trout migration, which could make it difficult to enter spawning tributaries and make Bull Trout more susceptible to angling/predation.	–	Yes, as Mitigation
Navigation & Transportation	Extend the ramp at the Inchelium -Gifford Ferry so that it's available at lower water elevations.	Inchelium –Gifford Ferry (transportation for Tribal community of Inchelium) will go out of service for longer durations and isolate community members	–	Yes, as Mitigation
Navigation & Transportation	Installation of Coffer cells to dissipate energy at Lower Monumental, Little Goose, McNary, and John Day	High Spill combined with tailrace conditions would result in Increased shoaling in the navigation channel	Monitoring would inform the need to install coffer cells.	Yes, as Avoidance and Minimization, and mitigation

Resource	Proposed Mitigation Action	Impact Offset	Avoidance / Minimization	Proposed to move forward or rationale for removal
Recreation	Extend the public and private boat ramps in Lake Pend Oreille so that it's available at lower water elevations.	Increase draft at Lake Pend Oreille for the McNary flow measure would drop elevations 1-3ft during the period of drafting.	–	This effect is identified, but effects to non-federal docks would need to be addressed by others.

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Public Scoping Report for the Columbia River System Operations Environmental Impact Statement

October 2017

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October 2017

U.S. Army Corps of Engineers
Northwestern Division
Portland, Oregon

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

Bonneville Power Administration
Portland, Oregon

ACRONYMS AND ABBREVIATIONS

BPA	Bonneville Power Administration
CO2	Carbon Dioxide
CRSO	Columbia River System Operations
EIS	Environmental Impact Statement
ESA	Endangered Species Act
GHG	Greenhouse Gas
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
ROD	Record of Decision
TDG	Total dissolved gas

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1.0 INTRODUCTION

This public scoping report was prepared by the U.S. Army Corps of Engineers (Corps), the U.S. Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (BPA), collectively referred to as the "co-lead agencies." This report provides a summary of the public scoping comments received during the scoping period for the Columbia River System Operations (CRSO) Environmental Impact Statement (EIS). This report includes a description of the communications and outreach to solicit public participation on the scope of the CRSO EIS and a summary of the comments received by topic area.

2.0 BACKGROUND - COLUMBIA RIVER SYSTEM

The co-lead agencies are preparing a comprehensive EIS under the National Environmental Policy Act (NEPA) for the coordinated water management functions for the operation, maintenance, and configuration of the 14 federal multiple purpose dams and related facilities ("projects") within the interior Columbia River Basin in Idaho, Montana, Oregon, and Washington (Figure 1). The Corps was authorized by Congress to construct, operate and maintain twelve of these projects for flood control, power generation, navigation, fish and wildlife conservation, recreation, water quality, and municipal and industrial water supply, though not every project is authorized for every one of these purposes. These projects include Libby, Albeni Falls, Dworshak, Chief Joseph, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville. Reclamation was authorized to construct, operate, and maintain two projects for purposes of flood control, power generation, navigation, and irrigation. The Reclamation projects include Hungry Horse and Grand Coulee. BPA is responsible for marketing and transmitting the power generated by these projects. Together, the co-lead agencies are responsible for managing the Columbia River System (System) for these various purposes.

In the 1990s, the co-lead agencies analyzed the socioeconomic and environmental effects of operating the System in the System Operation Review (SOR) EIS and issued respective Records of Decision (RODs) in 1997 that adopted a system operation strategy, which included operations for Endangered Species Act (ESA) listed fish while fulfilling all other authorized purposes required by Congress. Since the completion of the SOR EIS, the co-lead agencies have operated the System consistent with the analyses in the SOR EIS, while adopting some changes to System operations under subsequent ESA consultations and additional NEPA documents.

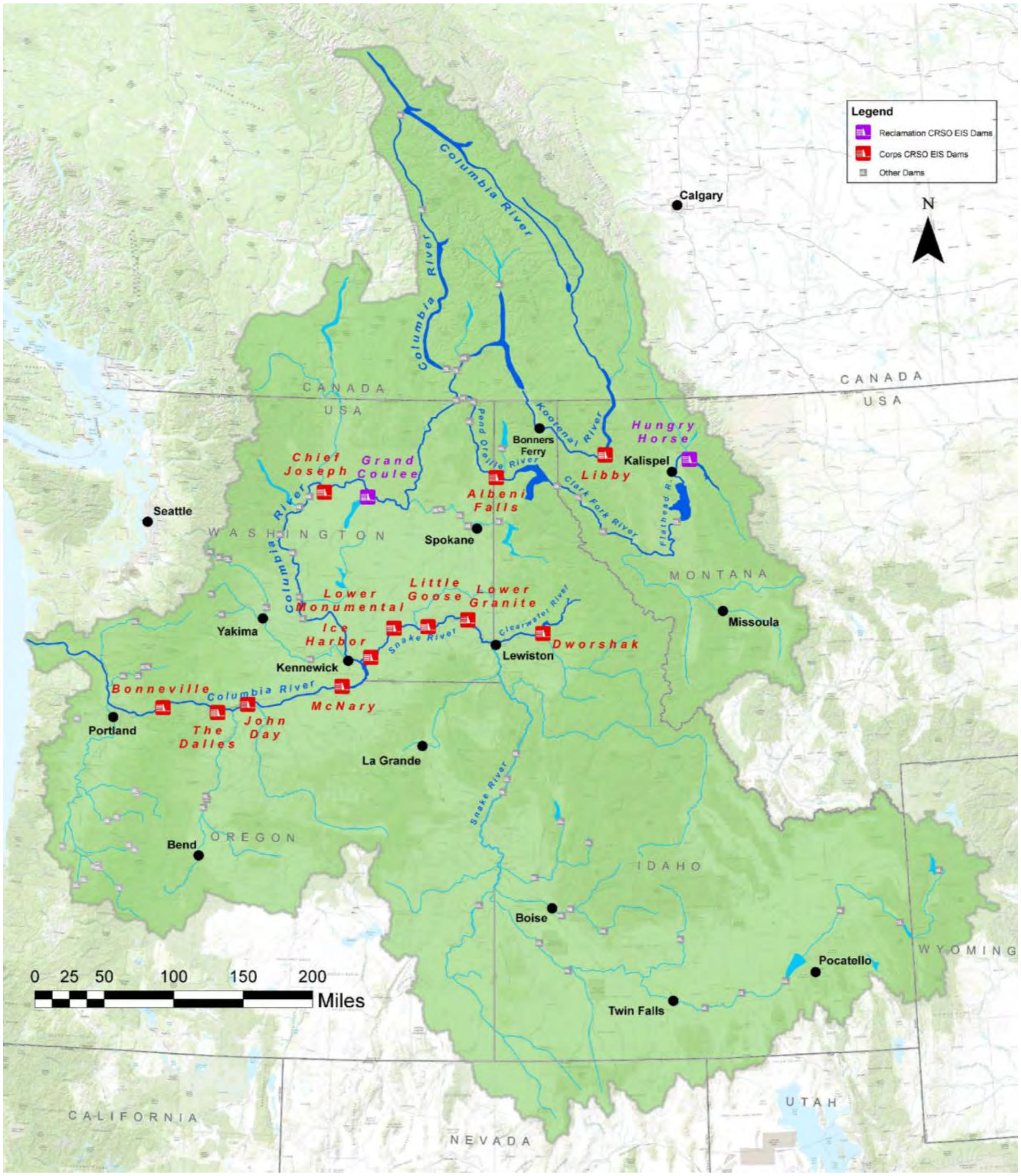

Figure 1. System Overview Map

2.1 Draft Purpose and Need Statement

DRAFT PURPOSE AND NEED FOR ACTION

The Corps, Reclamation, and BPA are co-leads in preparing this Environmental Impact Statement under NEPA on the coordinated water management functions for the operation, maintenance, and configuration ("management") of the 14 multiple-purpose federal dam and reservoir projects that comprise the Columbia River System (System). The U.S. Congress authorized the Corps and Reclamation to construct, operate and maintain the System projects to meet multiple specified purposes, including flood control (also referred to as flood risk management), navigation, hydropower production, irrigation, fish and wildlife conservation, recreation, municipal and industrial water supply, and water quality, though not every project is authorized for every one of these purposes. BPA is authorized to market and transmit the power generated by these coordinated System operations.

The on-going action that requires evaluation under NEPA is the long-term coordinated management of the System projects for the multiple purposes identified above. An underlying need to which the co-lead agencies are responding is reviewing and updating the management of the System, including evaluating measures to avoid, offset, or minimize impacts to resources affected by the management of the System in the context of new information and changed conditions in the Columbia River Basin. In addition, the co-lead agencies are responding to the Opinion and Order issued by the U.S. District Court for the District of Oregon[1] such that this EIS will evaluate how to insure that the prospective management of the System is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat, including evaluating mitigation measures to address impacts to listed species. The EIS will evaluate actions within the co-lead agencies' current authorities, as well as certain actions that are not within the co-lead agencies' authorities, based on the District Court's observations about alternatives that could be considered and comments received during the scoping process. The EIS will also allow the co-lead agencies and the region to evaluate the costs, benefits and tradeoffs of various alternatives as part of reviewing and updating the management of the System.

The co-lead agencies will use the information garnered through this process to inform future decisions and allow for a flexible approach to meeting multiple responsibilities including resource, legal, and institutional purposes.

Resource Purposes:

- Provide for a reliable level of flood risk by managing the System to afford safeguards for public safety, infrastructure, and property
- Provide an adequate, efficient, economical and reliable power supply that supports the integrated Columbia River Power system
- Provide water supply for irrigation, municipal, and industrial uses
- Provide for waterway transportation capability
- Provide for the conservation of fish and wildlife resources, including threatened, endangered, and sensitive species
- Consider and plan for climate change impacts on resources and on the management of the System

[1] *NWF v. NMFS*, 184 F.Supp. 3d 861 (D. Or. 2016).

- Provide opportunities for recreation at System lakes and reservoirs
- Protect and preserve cultural resources

Legal and Institutional Purposes:

- Act within the authorities granted to the agencies under existing statutes; and when applicable, identify where new statutory authority may be needed
- Comply with environmental laws and regulations and all other applicable federal statutory and regulatory requirements, including those specifically addressing the System such as requirements under the Northwest Power Act "to adequately protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, affected by such projects or facilities in a manner that provides equitable treatment for such fish and wildlife with the other purposes for which such system and facilities are managed and operated." 16 U.S.C.A. § 839b(11)(A)
- Protect Native American treaty rights and trust obligations for natural and cultural resources
- Continue to utilize a collaborative Regional Forum framework to allow for flexibility and adaptive management of the System
- Ensure project Water Control Manuals adequately reflect the management of the System

3.0 SCHEDULE TO RECORD OF DECISION

The Draft Environmental Impact Statement (DEIS) will be prepared taking into consideration all public scoping comments received.[2] According to the schedule ordered by the U.S. District Court for the District of Oregon (Court), the co-lead agencies will publish the DEIS by March 2020 for public review and comment and will hold public meetings to solicit comments on the DEIS. Public comments received on the DEIS will be considered and responses provided in the Final Environmental Impact Statement (FEIS). The FEIS will be published in March 2021 and the RODs will be signed on or before September 24, 2021.

4.0 DESCRIPTION OF THE FEDERAL ACTION

The federal action for this EIS is the coordinated water management functions for the long-term operations, maintenance and configuration (management) of the fourteen federal dam and reservoir projects that comprise the System for the purposes of flood risk management, navigation, hydropower, irrigation, fish and wildlife conservation, recreation, water quality, and municipal and industrial water supply in a manner that is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of

[2] The co-lead agencies are not required under NEPA to address or reflect all of the submitted comments in the analyses in the DEIS. For instance, issues or alternatives addressing issues outside the scope of the EIS or which are not feasible may not be addressed in the DEIS.

designated critical habitat, including mitigation measures to address impacts to ESA-listed species, and in compliance with other statutory and regulatory responsiblilties.

5.0 PUBLIC SCOPING PROCESS

The co-lead agencies implemented a robust public scoping process intended to provide ample opportunity for the public to understand how the System currently operates and identify issues of concern to be addressed in the EIS. The co-lead agencies invited the public to provide assistance to help define the issues, concerns, and the scope of alternatives to be addressed. The Notice of Intent to prepare the CRSO EIS provided a a summary of the intent of the EIS, established a schedule of public meetings, and provided points of contact for each of the co-lead agencies.

6.0 PUBLIC NOTIFICATIONS

A variety of notifications were used to announce the open houses/public scoping meetings and public comment period, including publishing the Notice of Intent in the *Federal Register* to prepare the EIS, sending a public scoping letter to interested parties, issuing news releases, and updating the CRSO website (see Section 7.2).

7.0 FEDERAL REGISTER NOTICES AND PUBLIC SCOPING LETTER

The Notice of Intent to prepare the EIS was published in the *Federal Register* on September 30, 2016 (81 FR 67382). The comment period was scheduled to end on January 17, 2017 and a schedule was announced for 15 public meetings and two webinars. Also on September 30, 2016, a public scoping letter was sent to interested parties. On November 4, 2016, the co-lead agencies issued a *Federal Register* notice that an additional public meeting would be held in Pasco, Washington (81 FR 76962). On January 3, 2017, the comment period was extended to February 7, 2017 (82 FR 137). Copies of the Notices of Intent are in Appendix A. A copy of the public scoping letter is in Appendix B.

7.1 News Articles and Newspaper Advertisements

The co-lead agencies issued a series of press releases intended to keep the public informed about the EIS public scoping process. The press releases were also provided on the CRSO website (See Section 7.2). Copies of the press releases and the published articles about the CRSO EIS public scoping process are in Appendix C.

Each public meeting was announced in at least two local newspapers, with ads running two to three times beginning approximately two weeks prior to the meeting. Three ads were placed in the Boise area newspaper for the Boise meeting. Copies of the newspaper advertisements and a complete list of the newspapers and ad run dates are in Appendix D.

7.2 Website

A public website was established at the time the Notice of Intent was published to communicate and share information about the CRSO EIS: www.crso.info. The website announced public scoping meeting dates, times, and locations in addition to providing all the information shared during the public scoping meetings (e.g. overview video and posters). The public could also use the comment submission link on the website to submit comments during the public comment period. News releases, documents, and upcoming public meeting information were available to the public through the website.

7.3 Public Scoping Meetings

The 16 open house-style public meetings were held across the region to allow the public to ask questions in person, and contribute their comments and ideas on what should be included in the EIS. Two webinars were held on December 13, 2016 to provide the same opportunity for those unable to participate at one of the in-person locations. The meeting in Pasco was added after the first Notice of Intent at the request of several public entities and the meeting was noticed through the *Federal Register* on November 21, 2016 and through public outreach. The Astoria meeting was originally scheduled for December 8th and was cancelled due to inclement weather and was rescheduled for December 15th, but adverse weather conditions again required its the cancellation. It was rescheduled again and held on January 9th, 2017.

An interdisciplinary team from the Corps, Reclamation, and BPA attended all public scoping meetings to provide subject matter expertise in the areas of NEPA process, cultural resources, Columbia River System operations, flood risk management, hydropower, irrigation, river navigation, fish and wildlife conservation, recreation, climate change, water quality, and endangered species. Each of the 14 projects also had available a project-specific expert to discuss features and operations of a specific dam or reservoir complex.

The specific dates and times of the public meetings are contained in Table 1 below and the locations throughout the Pacific Northwest are shown in Figure 2 also below.

The meetings were held in an informal open house format, with 35 poster stations staffed by technical experts from the co-lead agencies. The style of meeting was chosen to provide attendees an opportunity to comment after reviewing information about the System and how it is currently operated, as well as on the NEPA process that will lead to the development of the DEIS, ask questions, and have informal one-on-one discussions with various subject-matter experts. A total of 2,318 people signed in at the 16 public scoping meetings. The agencies intended this style of meeting to help generate informed scoping comments. Two webinars were also held to cover the same information available at the open house, with subject matter experts in attendance to address comments provided through the webinar. The co-lead agencies held the webinars for interested members of the public that could not attend the open houses in person. All materials from the open house were available on the CRSO website so that participants could review in their own time.

Upon arrival at an open house meeting, attendees were invited to sign in and then view a short orientation video. The video introduced most of the poster topics, and explained the methods to provide comments. Following the video, attendees were invited to visit the poster stations to discuss the subjects and ask questions of the technical subject matter experts staffing the boards. A handout was provided with a short description of each station (Appendix E). Attendees were also invited to submit public scoping comments at the meeting in a number of ways including: 1) verbally through a court reporter, 2) online at a computer station, or 3) in hard copy form. Attendees were also advised that they could review all the materials, including the video, online and submit comments via either email, online using a prepared webform, or in hard copy mailed to a post office box established specificially for the purpose of collecting scoping comments for this project. All meeting materials and all comments submitted during the scoping period can be viewed online at www.crso.info. Copies of the posterboards are included in Appendix F.

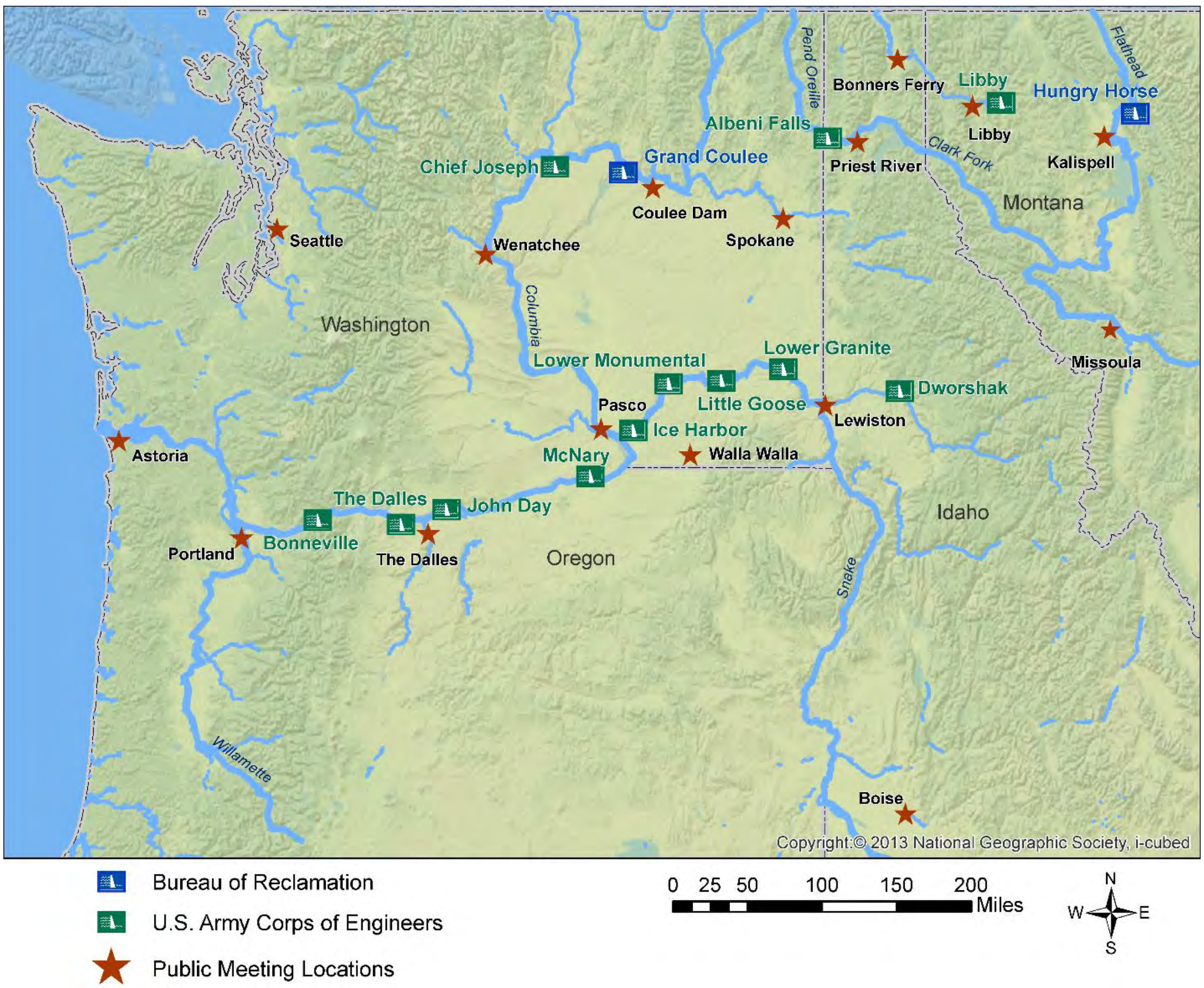

Figure 2. Map of public scoping meeting locations

Table 1. Public scoping meeting dates and locations

Date	Time	Location	Address	Attendees[3]
Monday, October 24	4 p m. to 7 p.m.	Wenatchee Community Center	504 S. Chelan Ave., Wenatchee, WA	63
Tuesday, October 25	4 p m. to 7 p.m.	The Town of Coulee Dam, City Hall	300 Lincoln Ave., Coulee Dam, WA	15
Wednesday, October 26	4 p m. to 7 p.m.	Priest River Community Center	5399 Hwy 2, Priest River, ID	36
Thursday, October 27	4 p m. to 7 p.m.	Kootenai River Inn Casino & Spa	7169 Plaza St., Bonners Ferry, ID	29
Tuesday, November 1	4 p m. to 7 p.m.	Red Lion Hotel Kalispell	20 North Main St., Kalispell, MT	56
Wednesday, November 2	4 p.m. to 7 p.m.	City of Libby City Hall	952 E. Spruce St., Libby, MT	14
Thursday, November 3	4 p m. to 7 p.m.	Hilton Garden Inn Missoula	3720 N. Reserve St., Missoula, MT	116
Monday, November 14	4 p m. to 7 p.m.	The Historic Davenport Hotel	10 South Post Street, Spokane, WA	265
Wednesday, November 16	4 p m. to 7 p.m.	Red Lion Hotel Lewiston, Seaport Room	621 21st St., Lewiston, ID	315
Thursday, November 17	4 p m. to 7 p.m.	Courtyard Walla Walla, The Blues Room	550 West Rose St., Walla Walla, WA	123
Monday, November 21	4 p m. to 7 p.m.	Holiday Inn Express & Suites	4525 Convention Place, Pasco, WA	305
Tuesday, November 29	4 p m. to 7 p.m.	The Grove Hotel	245 S. Capital Blvd., Boise, ID	229
Thursday, December 1	4 p m. to 7 p.m.	Town Hall, Great Room	1119 8th Ave., Seattle, WA	313
Tuesday, December 6	4 p m. to 7 p.m.	The Columbia Gorge Discovery Center, River Gallery Room	5000 Discovery Drive, The Dalles, OR	100
Wednesday, December 7	4 p m. to 7 p.m.	Oregon Convention Center	777 NE Martin Luther King Jr. Blvd., Portland, OR	271
Monday, January 9	4 p m. to 7 p.m.	The Loft at the Red Building	20 Basin St., Astoria, OR	57

[3] Number of attendees based on counts from sign-in sheets.

Photo 1 - Public scoping meeting in Spokane, Washington on November 14, 2016

7.4 Webinars

Two webinars were held on December 13, 2016 at 10:00 a.m. and at 3:00 p.m. Pacific Time for an hour and a half each, to accommodate individuals who were not able to attend one of the public meetings in person. The online webinars were staffed by subject matter experts who presented the same visual material provided during the open house public meetings. Through the webinars, the public was able to submit questions and comments.

8.0 COMMENTS

The co-lead agencies received 412,016 comment submittals during the scoping period. The comment submittals were provided by members of the public, tribes, local and state governmental agencies, non-governmental organizations, and other stakeholders. In early February, the co-lead agencies developed a methodology for reviewing and sorting the large number of comments received, with the intent of providing consistency across the three agencies and capturing each unique comment provided within the submittals. The methodology followed several steps. First, comments within each letter were characterized as either a study objective, proposed methodology, recommendation for the scope of analysis, or a comment about a particular resource. The comments determined to be a resource concern were further categorized based on the resource referenced in the comment, such as Fisheries Management, Non-hydropower Energy, or Transportation, among others. Then, comments were further sorted into categories (such as structural measures) and subcategories (for example, items related to fish passage).

After sorting and categorizing, the comments were compiled into spreadsheets, grouped by comment summary category and resource, and distributed to the broader co-lead agency team for use and consideration in the initial development of draft alternatives and the scope of analysis. This input is being considered by the co-lead agency alternatives development teams in formulating measures for potential analysis and inclusion in the draft array of alternatives developed for the DEIS. Additionally, resources that may be significantly affected or were identified through the scoping process as resources of public concern will also be considered for inclusion in the DEIS for purposes of analysis and evaluation. Proposed methodologies and sources of data identified in scoping comments are currently being investigated for potential use in the analyses underpinning the DEIS.

Unique content submittals were identified if there were no duplicates of that specific submittal. Submittals were considered a form letter if two or more identical submittals were received. Form letters that had additional, unique content were identified and this content was processed for identification and sorting by topic area. Each comment submittal (unique, form letter, and form letter and added content) was reviewed and specific comments identified and sorted by topic area.

The following subsections provide a summary of all submittals received and comments identified by topic or resource area(s) for the purposes of this report.[4] In some cases, several topic areas were mentioned within a single sentence or statement (i.e., “The EIS should evaluate climate change, dam removal, and impacts to salmon.”), and the intent of the comment was assigned to a broader topic area that captured complex interactions or combinations of resource concerns (Scope of Analysis). Many of the topic areas are closely related with regard to the types of comments that were received. Identification and assignment of comments to a topic area for this report was made using best assumptions of the author’s overall intent. As a result, some of the themes within a topic area may be repeated within another topic area, but from a different perspective in order to accurately capture and summarize the intent.

[4] These subsections are not intended as a comprehensive list of all comments received, but rather a summary of these comments. While a specific comment may not be listed, it will be considered in the CRSO EIS process. The comments summarized here do not reflect the co-lead agencies’ agreement with the content or accuracy of the comment.

8.1 NEPA Process

The co-lead agencies received a variety of comments addressing NEPA process topics, such as schedule, coordination with local governments, and other NEPA projects, and the way in which the NEPA process is conducted. Summarized comments included the following:

- The co-lead agencies should have developed the purpose and need prior to requesting scoping input from the public, and that purpose and need statement should comply with minimum legal standards under Section 7 of the ESA.
- The EIS process currently underway is expensive and unnecessary. The 2002 EIS concluded that the lower Snake River dams should be breached, and that action should be taken now without further study through an emergency response action by the Corps.
- The co-lead agencies should involve local government as cooperating agencies in the development of the EIS. Concurrent NEPA efforts on hatcheries/harvest and ongoing Canadian efforts should be combined.
- The co-lead agencies should shorten the five-year timeline for the EIS and take action immediately to protect salmon.
- The three co-lead Agencies have a vested interest in the process and cannot conduct an unbiased NEPA process, despite five court decisions that found that the BiOps failed to meet the standards of the ESA.
- The co-lead agencies should involve independent technical review in the EIS process to assure accuracy and transparency.
- The co-lead agencies should provide novel or new solutions that better preserve and protect environmental resources.

8.2 Public Scoping Involvement

This summary of comments reflect feedback on the public scoping meeting format, requests for additional public scoping meetings, requests for additional information, and suggestions for how public comments should be collected and used to develop the EIS. Other general comment summaries for Public Scoping Involvement include:

- General support was expressed for the effort made to hold the public scoping meetings. All comments received should be made available on the project website. Moving forward, the co-lead agencies should conduct outreach among interested parties and schools, and should communicate regularly with the public during development of the EIS. The EIS should be written using plain language and the sources used should be available electronically to the public.
- The co-lead agencies should have conducted an open hearing where members of the public could address the attendees. It would have been helpful to advertise the meetings as an "Open House," not a public meeting.
- A longer comment period was requested.

- The co-lead agencies should have provided notice further in advance of the public meeting and should have provided formal notification to affected parties, such as local homeowners, farmers, and ranchers.
- The co-lead agencies did not include enough meetings in communities where fisheries are affected, such as the Pacific Northwest coast, California, and Alaska.
- Additional meetings were requested in the Tri-Cities area, in Idaho including the Clearwater River Basin and the Salmon River Basin, the entire Snake River Basin including northwest Oregon, and in Montana.
- The information provided by the co-lead agencies did not provide an adequate depth of information on some topics. Background information and access to experts was requested as well as specific information on barging, irrigation, reservoir temperatures, comparison of fish counts to target counts, and mitigation.

8.3 Alternatives

Comments summarized in this section are primarily focused on requests to consider alternative actions to be analyzed or considered in the EIS. Other general comment summaries for alternatives include:

- The EIS should analyze resource specific impacts and mitigation actions for each developed alternative.
- The EIS should consider the need for congressional approval for funding of analyses if alternatives are developed that change authorized dam uses.
- The EIS should consider changes in any adaptive management or mitigation plans for each alternative.
- The EIS needs to cover a range of reasonable alternatives for long-term operations, and provide comprehensive analyses of impacts for each alternative on economic, environmental, public, and energy resources.
- General recommendations for breaching one or more dams.
- Requests for the removal or breaching of one or more of the Snake River dams due to multiple resource concerns, such as salmon migration and survival, economic opportunities for tourism, general environmental considerations, disagreement with river transportation and irrigation needs, and minimal energy output.
- General recommendation to leave all dams in place because dam removal is not a reasonable alternative and would require congressional action, dams and fish can coexist, that dam removal does not guarantee salmon recovery, and that the hydropower, irrigation, transportation, recreation, and flood control benefits the dams provide far outweigh the cost and/or risk of removing any dams.
- The EIS alternatives should consider an “All-H” approach, including measures on hydropower, habitat, harvest, and hatcheries.

- The EIS alternatives should consider fish passage and reintroduction of salmon above various dams such as Grand Coulee and Chief Joseph.
- The EIS should consider an alternaive considering modifications to flood risk management levels.
- The EIS should consider a “dry-water year” strategy alternative.

8.4 Scope of Analysis for the EIS

Comments summarized on this topic are directed at general topics or combinations of resource areas that should be considered in developing the EIS. Other general comment summaries for Scope of Analysis include:

- The EIS should use a balanced approach and include a number of ecological, biological, environmental, economic, power, public interest, and hydrological interest areas that need to be assessed individually, in combination, and cumulatively.
- The EIS should identify the win-win alternative and evaluate habitat, hydrology, hatcheries and harvest actions.
- The EIS should analyze impacts that are larger than dam breaching from a regional perspective, to include additional water storage acreage or other water management capabilities.
- The multipurpose properties and authorized uses of the dams, and consideration of these uses related to river management and dam operations, should be included in the EIS.
- The EIS should discuss reconsideration of Columbia River Fish Accord (Fish Accord) actions, and should address their funding, effectiveness, and future needs.
- The EIS should address the funding for salmon mitigation plans, the effectiveness of mitigation plans, and a requirement for more comprehensive mitigation.
- The co-lead agencies should rely on the 2002 EIS for breaching (not configuration and operational changes) the four lower Snake River dams, and not include this alternative in the EIS. There is enough information already from past studies and analyses to expedite EIS development and make changes to CRSO. A new EIS is not necessary and any changes to the CRSO can be made now.
- The analysis for the EIS should include a review of scenarios that consider a range of operation and configuration changes for Snake River dams, including breaching, spill, flow augmentation, passage improvements, and other dam modifications to improve salmon recovery.
- The co-lead agencies should be transparent and provide novel or new solutions that better preserve and protect environmental resources.
- Dams outside of the named 14 federal projects should be included in the EIS for impacts and analyses, and the EIS should include the effects that changes at the 14 federal projects have on other regional dams and related resources.

- The EIS should consider impacts to specific dams from any operational or configuration changes across the CRSO.
- The EIS should compare Snake River dam breaching with examples of successful dam breaching, such as on the Elwha River, in order to assess impacts and realize the potential benefit to environmental resources such as salmon.
- The EIS should include information on coordination required with other local, state, and federal agencies, and compliance with their regulations and requirements.
- The EIS should incorporate the history and status of the Biological Opinion, how it affects current operations, and how coordination between the EIS and the Biological Opinion will proceed in assessing the alternatives and mitigation actions that will be required.
- The EIS should examine how System operation changes will affect Hungry Horse, Albeni Falls, Chief Joseph, Grand Coulee, and Libby Dams as flow conditions needed for fish survival and resources are different from dams downriver on the Columbia.
- The EIS should consider the river system as a whole—with basinwide water volume depending on rainfall, temperature, watershed soils, and riparian areas—and should consider how the river ecosystem will respond in the future if those watershed attributes do not follow historical patterns.

8.5 Impact Analysis Methodologies

This summary of comments identifies recommended specific approaches, methodologies or models for assessing impacts to specific resources in the context of analyzing alternatives. Other general comment summaries for Impact Analysis Methodologies include:

- The EIS should consider a variety of appropriate models to assess the effects of different alternatives on different resources.
- The co-lead agencies should use cold water refugia information being developed by the Environmental Protection Agency for assessing alternatives that enhance salmon recovery.
- The EIS should assess and integrate ecosystem services in determining impacts from each alternative.
- The EIS should use a plan for analyzing and testing hypotheses estimates and survival studies in assessing the impact of alternatives for salmon recovery.
- Predictive analyses or generation of new study information should be used in the EIS rather than a dependence on historic information.

8.6 Hydrology and Hydraulics

This summary of comments reflects concerns about changes in hydrologic conditions, flow and spill, reservoir drawdown, and sedimentation under current and future climate conditions. Other general comment summaries for Hydrology and Hydraulics include:

- The EIS should consider the historical, current, and projected environmental conditions in the Columbia River watershed to determine the historical and predicted extent of glacial water storage loss and implications of the loss for System operations, and should model what changes can be expected in the Columbia River watershed hydrologic regime.
- The EIS should model various flow and spill scenarios for System operation and configuration alternatives (including a natural flow pattern), to assess impacts of seasonal flow, and changes in reservoir elevation at the reach-level and ecosystem-level (i.e., water supply, groundwater levels, flood control, flow augmentation for fish).
- This EIS should include the impacts of drawdowns or dam removal on water quality from runoff, on aquifer recharge, on the elevation changes of the affected rivers, and on riverine and structural erosion.
- This EIS should take into consideration scientific literature regarding sediment transport as it pertains to dam removal and dam operations.
- The EIS should describe the role of hydrosystem operations and alternative reservoir operations on distribution, transport, and cycling of toxic pollutants, contaminated sediments, contaminat mobility, and contaminant bioavailability.

8.7 Climate Change

This summary of comments expresses concern that climate change be taken into account in the EIS with respect to how a changing environment would affect the System, and with respect to how the factors that contribute to climate change (e.g. greenhouse gas (GHG) emissions) would change with each alternative. Other general comment summaries for Climate Change include:

- The EIS should include information on the regional climate change forecast and incorporate a range of climate change scenarios when evaluating impacts of alternatives on water quantity and quality (particularly temperature in streams and reservoirs), salmonid survival and recovery, hydropower production, and groundwater recharge. Increasing temperatures, reduced snowpack, altered amount and timing of runoff, drought, and low water conditions were of particular concern.
- The EIS should address how climate change could affect current salmon recovery mitigation actions (e.g. habitat improvements in tributaries and the estuary).
- The EIS should address the GHG emissions associated with each alternative in the context of contributing to or mitigating for climate change.
- The EIS should address the feasibility of various alternatives to mitigate for climate change (e.g. operational changes to balance water storage and flow augmentation for water quality; configuration changes to minimize GHG emissions).
- The analysis of alternatives with respect to climate change scenarios should include community public health impacts.

8.8 Water Quality

This summary ofcomments addresses water quality concerns to be considered in the analysis of current and proposed changes to operations or System configuration—temperature, total dissolved gas (TDG), suspended sediment, and pollutants. Other general comment summaries for Water Quality include:

8.8.1 General and Alternatives Considerations

- The EIS should consider how municipal, industrial, and stormwater discharges affect water quality, and how improving discharge practices could improve water quality.
- The analysis of alternatives should consider how current permit holders (e.g. municipal, industrial, and stormwater dischargers) would be affected by changes in water quality characteristics.
- The analysis of alternatives should consider impacts on groundwater quality resulting from fluctuating water levels.
- The EIS should consider the effects of livestock grazing and the resultant habitat degradation on water quality and should consider retiring grazing permits as a mitigation action under the alternatives.
- When evaluating operational alternatives, the EIS should examine water quality issues affecting the upper Columbia River and tributaries where mining contaminants are a concern, as well as assess fish and wildlife health and recovery efforts.
- The EIS should consider management practices (e.g. improved spill prevention and response planning) related to use of oil and lubricants for dam operation and maintenance.

8.8.2 Temperature, Total Dissolved Gas, and Sediment

- The EIS should include a description of the water temperature and TDG regimes under current operations; it should describe the relationship between System operations and temperature and TDG levels and the current water quality standards for temperature and TDG. It should also describe the effectiveness of mitigation to address water temperature and TDG issues.
- The analysis of alternative System operations, modifications, and mitigating actions should assess temperature and TDG against limits relevant to salmon recovery and at locations relevant to salmon recovery.
- The EIS should develop a water temperature model for the Columbia and Snake Rivers (from the base of Hells Canyon Dam to the confluence of the Snake with the Columbia) to estimate water temperatures.
- The EIS should address the impacts of water temperature and lack of flow on juvenile and adult salmonid health, survival, and spawning success if water temperatures exceed their optimal range.
- The EIS should consider the historic (pre-dam) water temperatures in the river system.

- The EIS should consider future temperature regimes associated with earlier runoff and lower flows expected with climate change.
- The EIS should consider temperature and related fish loss data from other large river systems.
- In the analysis of a dam breach or removal alternative, the EIS should address sediment characteristics, present sediment transport and deposition modeling data, and provide an assessment of the ecological impacts of siltation, suspended sediment, and sediment release to aquatic and ESA-listed species downstream. Turbidity and water clarity effects on outmigrating smolts and returning adult salmon should be analyzed in the EIS.

8.8.3 Other Pollutants

- In its description of the affected environment, the EIS should describe the distribution of toxic pollutants in river sediment and water, their effects on fish, and their effects on human health (both directly and via fish consumption). Pollutants from upstream mining and smelting operations, the Hanford site, and agricultural runoff were stated as issues that should be analyzed; polychlorinated biphenyls, flame retardants, and pharmaceutical chemicals were also mentioned.
- The EIS should describe the role of hydrosystem operations and alternative reservoir operations on distribution, transport, and cycling of toxic pollutants, contaminated sediments, contaminat mobility, and contaminant bioavailability.
- In the analysis of alternatives, the EIS should address nutrient levels in the river and reservoirs and their associated impacts (e.g. eutrophication) on aquatic habitat, anadromous fish, and resident fish. Comments were also received that nutrient cycling and supply of nutrients to the ocean should be analyzed in the EIS.

8.9 Water Supply and Irrigation

This summary of comments concerns water availability and supply for municipal, industrial, and agricultural uses, currently and under future changes in the river system. Most of the comments were related to irrigation—the importance of the System for supplying irrigation water and alternatives for supplying irrigation water under a dam breaching alternative. Other general comment summaries for Water Supply and Irrigation include:

- The EIS should consider local watershed management plans in its assessment of water availability and supply.
- The analysis of alternatives should describe where the water is being diverted for municipal, industrial, and agricultural uses, and the impact of alternative operations or configurations on the availability of water for those uses, as well as for drought seasons and fire control.
- The EIS should describe current water sources for irrigation, irrigation practices, and levels of water use for irrigation throughout the watershed and particularly in the lower Snake River. The description should address the water- and power-efficiency of the various types of irrigation systems.

- The analysis should include impacts of diversions and irrigation drawdowns on water supply for ecosystem, recreation, and tourism activities.
- The analysis should address changes in hydrological conditions related to climate change, such as changes in glacial storage and changes in precipitation and runoff patterns, and their impact on water supply in the river system.
- The EIS should consider alternatives involving construction of new water storage reservoirs and/or smaller distributed reservoirs for both irrigation and climate change mitigation purposes.
- The analysis of alternatives needs to address groundwater supply (recharge and availability); including in the Odessa and Grand Ronde aquifers.

8.10 Air Quality

This summary ofcomments is directed at regional and global air quality impacts of alternative System configurations, primarily CO_2 and other GHG emissions from power generation and transportation, but they also include comments regarding regulated pollutants. Other general comment summaries for Air Quality include:

- The EIS should compare the emissions of all regulated air pollutants, CO_2, and other GHGs from any proposed alternative sources of power generation, if needed to replace lost hydroelectric power generation. The EIS should clearly articulate assumptions about how and from where power would be sourced in the absence of hydropower production.
- The analysis of alternatives should compare the emissions of all regulated air pollutants, CO_2, and other GHGs from rail or semi-trucks to that of barge transportation.
- The analysis of alternatives needs to consider the impacts of fugitive dust and toxic emissions from any demolition, drawdown, construction, and maintenance activities. The analysis should incorporate mitigation strategies to minimize fugitive dust and toxic emissions.
- The EIS should address the impacts of methane and other GHG emissions from the reservoirs.

8.11 Anadromous and Resident Fish – General

This summary of comments isdirected at requests and suggestions to address the status of anadromous and resident fish populations in the EIS and for consideration of how fish populations in general are affected by different activities and other actions throughout the Columbia River System. Other general comment summaries for Anadromous and Resident Fish include:

8.11.1 Consideration of Habitat, Harvest, Hatchery, and Hydropower Impacts

- The impacts of hatchery fish on wild fish should be analyzed in the EIS.
- The EIS should address if and how hatchery production of fish is needed to help fish populations recover.

- The EIS should analyze if sport, commercial, and tribal fishing have a negative effect on fish populations.
- Climate change may affect fish habitat quality in the future and should be assessed in the EIS.
- Fish habitat degradation impacts should be studied and quantified in the EIS.
- The EIS should fully assess fish mortality from dams.
- The EIS needs to describe effective habitat and hatchery programs to mitigate hydropower impacts to fish.

8.11.2 Positive Fish Survival Efforts

- The EIS should describe all of the fish restoration efforts and how they have improved fish survival.
- Habitat mitigation is working and salmon populations are recovering.
- Monies spent for improving fish migration are working and survival percentages for salmon are going up.

8.11.3 Fish Declines from Impacts Other than Hydropower

- The EIS should analyze how ocean conditions affect the current status of anadromous fish population abundances.
- The impacts of vessel traffic should be considered in assessing the current status of salmon and other fish species' decline.
- The EIS should describe what is known regarding the prevalence of diseases in salmon and how that has contributed to their population levels.

8.11.4 Predatory Fish Species

- The EIS should examine the impacts on salmon populations from native and non-native predatory fish species, such as walleye, smallmouth bass, Northern pikeminnow, and channel catfish, and should consider measures to control these populations of predatory fish.
- The EIS should consider how reintroduction of Pacific lamprey in the Columbia and Snake Rivers will affect populations of salmon through potential predation.
- The EIS should consider how changing environmental conditions, such as habitat, water temperature, and dam removal, may affect native and non-native predatory fish species, and what the subsequent impacts to salmon populations may be.

8.11.5 General Salmon (Anadromous Fish) Considerations

- The EIS should describe the importance of salmon to the environment of the Pacific Northwest and how salmon contribute to key ecosystem services.

- The EIS should consider how the recovery of Snake River sockeye salmon will be accomplished.
- General sentiment that salmon should be recovered and protected.
- ESA status of protected salmonids should be revisited due to population changes and allowable harvest.
- The EIS should consider fish passage and reintroduction of salmon above various dams such as Grand Coulee and Chief Joseph.

8.11.6 Resident Fish and Fish Other Than Salmon Considerations

- The EIS should provide an overview of status and impacts to Pacific lamprey populations historically and under current and future operation scenarios.
- The EIS should provide an overview of bull trout status and impacts to bull trout populations historically and under current and future operation scenarios.
- The EIS should evaluate and assess all impacts to sturgeon species from historic and current operations and future System changes that may affect specific populations of sturgeon such as Kootenai River white sturgeon.
- The EIS should evaluate and assess all impacts to resident fish species such as burbot, native kokanee, and native rainbow trout and native redband trout populations.

8.12 Threatened and Endangered Fish Species – Dam Configuration & Operation

These comments are specifically directed at the relationship between ESA-listed fish species such as salmon, bull trout, and white sturgeon and dam configuration and/or operations. Other general comment summaries for Threatened and Endangered Fish Species – Dam Configuration and Operation include:

8.12.1 Effects of Dam Operations on Salmon and Resident Fish Species

- Removal of dams will not help salmon recovery, and the EIS should provide an analysis to support this.
- The co-lead agencies are relying on past studies and information that may not provide a correct interpretation of fish survival through the hydropower System, and are misrepresenting the impacts of dams on juvenile fish survival.
- The EIS should specifically analyze the impact of Snake River dam operations on salmon.
- The EIS should consider impacts of dam operations on other fish species such as bull trout and Kootenai River white sturgeon.

8.12.2 Improvements to Dam Operations and Alternatives for Salmon and Resident Fish Species Survival

- The EIS should include information on how specific dam improvements for operations, such as spill scenarios for migration of juvenile salmon and fish ladders for returning adults, have improved salmon population abundances.
- The EIS should consider impacts of reservoir and temperature operations for ESA-listed resident fish.
- General comments remarking that both dams and fish are needed.
- The EIS should consider improvements to specific dams to optimize salmon habitat, migration, and abundance at those locations.
- The EIS should assess the minimum operating pool for dams and optimize habitat conditions for salmon survival.
- The EIS should specifically analyze different spill scenarios and the impact of spill operations on salmon.
- The EIS should specifically analyze the effectiveness of fish transport and the long-term benefits to juvenile salmon survival and returning adults.

8.12.3 Effects of Dam Configuration on Salmon and Resident Fish Species

- The EIS should describe how implementation of fish passage technologies and structures have helped improve salmon recovery, and what additional changes or configurations could be used to optimize salmon survival.
- The EIS does not need to consider dam breaching as salmon populations are recovering.
- The EIS should consider modernization efforts at specific dams and the subsequent configuration changes needed to optimize fish survival.
- An analysis of how dam breaching could negatively affect salmon habitat and water quality should be included in the EIS.
- The EIS should consider new fish passage facilities at specific dams.
- Investments in dam technologies to promote salmon passage or optimize salmon recovery should continue.
- The EIS should consider additional dam technologies, studies, or analyses for how salmon and other ESA-listed fish can increase in abundance and survival related to hydropower operations.
- The EIS should analyze the need for new turbine technologies and turbine replacement programs for salmon survival.
- The EIS should analyze the effectiveness and need for fish ladders at dams to improve salmon migration.

8.12.4 Dam Removal or Other Configuration Alternatives Needed for Salmon and Resident Fish Species Recovery

- The EIS should analyze the benefits to salmon survival and abundance from breaching one or more dams, including the Snake River dams.
- The EIS should consider alternative salmon passage technologies or engineered solutions to allow free migration for juveniles and adults returning to spawn to enhance species recovery.
- The EIS should consider how dam removal may provide opportunity to consider delisting salmon populations.
- The EIS should describe the importance of salmon and salmon recovery equally with the need for hydropower structures and consider how structures can be modified or removed to support fish populations.
- The EIS should consider and examine the relationship between recovery of salmon populations, economics, and energy needs in an alternative to breach one or more of the Snake River dams.
- The EIS should consider the success of ongoing mitigation efforts to improve fish passage and survival, and should analyze engineering improvements, spill modifications, hatcheries, and habitat restoration efforts rather than removing any dams.
- Many general comments requesting the Snake River dams be breached for the sake of restoring salmon and providing abundant salmon as prey for Orca.
- Some comments stating that the EIS should consider modernization efforts at specific dams and the subsequent configuration changes needed to optimize fish survival.
- The EIS should consider and examine the relationship between recovery of salmon populations, economics, and energy needs in an alternative to breach one or more of the Snake River dams.

8.13 Wetlands and Vegetation

This summary of comments voices concern for impacts and recovery of wetland habitats and riparian or native vegetated areas. Other general comment summaries for Wetlands and Vegetation include:

- The EIS should include impacts on wetlands and vegetation or loss of riparian and wetland habitats from current or planned operations.
- The EIS should consider how vegetation and riparian areas will be restored from shoreline erosion or from operation or breaching impacts.

8.14 Wildlife

This summary of comments covers a range of predation and population concerns for species other than fish. Other general comment summaries for Wildlife include:

8.14.1 Predation Control

- The EIS should analyze the effectiveness of salmon predation control programs and efforts.

8.14.2 General Predator Assumptions

- The EIS should not focus on the level of salmon predation by avian or pinniped species because they are not a major contributor to salmon decline.
- The EIS should include impacts to predator species populations from culling or predator control efforts.

8.14.3 General Predation of Salmon

- The EIS should analyze all predatory impacts to salmon populations, especially from invasive predator species.
- The EIS should consider the effects of predation on salmon, and include control of predation of salmon as a contributor to salmon recovery.

8.14.4 Pinniped Predation

- The EIS should discuss the effectiveness of efforts to control salmon predation by pinnipeds.
- Protections for pinniped species under the Marine Mammal Protection Act should be reviewed for current applicability given increases in pinniped populations.

8.14.5 Avian Predation

- The EIS should evaluate the effectiveness of programs and efforts directed at limiting salmon predation by avian species.
- The EIS should assess the contribution of different avian species to salmon predation, and assess how predation can be controlled or minimized.

8.14.6 Impacts to Orca

- The EIS should include the effects to Orca when assessing impacts to salmon populations.
- The Snake River dams should be breached to restore salmon populations that will increase overall prey abundance for Orca.
- The 2002 Lower Snake River Juvenile Salmon Migration Feasibility EIS should be used now to breach the Snake River dams and allow salmon to recover in time to feed Orca and prevent the Puget Sound pods from further decline.
- The EIS should consider impacts to Orca from other sources such as exposure to toxic substances and pollutants and vessel strike and not just from any changes in salmon predation.

8.14.7 Wildlife Affected by Salmon Abundance

- The EIS should consider how changes to salmon populations affects populations of different predator species.

8.14.8 General Impacts to Wildlife and their Habitats

- The EIS needs to take an ecosystem approach and consider impacts to all wildlife and their habitats when assessing the various alternatives.

8.14.9 Impacts to Invertebrate Species

- The EIS should consider impacts to mussels and their habitat as well as zooplankton for each alternative, and their relationship to support the food chain and other ecosystem functions.

8.15 Invasive and Nuisance Species

This summary ofcomments mentioned concerns about the impact of invasive or nuisance plant and animal species that may become further established, or voiced concerns over how these species will be controlled. Other general comment summaries for Invasive and Nuisance Species include:

- The EIS should consider how changes in System operations will affect or control invasive or nuisance plant and animal species.
- The EIS should address what measures will be used to identify and control the spread of invasive mussels, such as the zebra and quagga mussels.
- The EIS should address what measures will be used to identify and control the spread of invasive plant species, such as Eurasian milfoil, hydrilla, and flowering rush.

8.16 Cultural, Historic, and Tribal Interests and Resources

This summary of comments is directed at the impact of dam removal, current operations, and future operations on cultural and historic resources in general, and on tribal interests and resources of concern. Comments are also directed at the National Historic Preservation Act (NHPA) Section 106 compliance process as it relates to the protection of cultural resources important to tribes. Some comments describe recommendations for how and when the co-lead agencies need to engage, consult with, and involve tribes in the EIS process. Other general comment summaries for Cultural, Historic, and Tribal Interests and Resources include:

- When analyzing the breach alternative, the EIS should consider the value of recovering currently inundated archaeological and sacred sites such that these resources can be made accessible to tribes, scientists, and the public for research, educational, and cultural perpertuation purposes.
- In consultation with tribes, the co-lead agencies should conduct NEPA and NHPA Section 106 analysis of historic and current adverse impacts that dams (i.e., infrastructure, erosion, operations, and mitigation activities) have on tribal treaty rights and tribal resources

of concern as well as identify correlating mitigation for these impacts. Specificially, the co-lead agencies' EIS should address impacts to tribal treaty fishing rights, tribal way of life, tribal culture, and cultural practices (e.g., ceremonial activities, religious activities, subsistence activities, and physical health) that are dependent upon healthy migratory fish runs (especially Pacific lamprey, salmon, and steelhead). In addition, impacts on the protection and mitigation of traditional fishing and hunting locations (i.e., Celilo Falls), sacred sites, historic cultural resources, and traditional cultural properties should be addressed in the EIS.

- The EIS should analyze how breaching of the lower Snake River dams will benefit tribal treaty fishing rights, tribal resources, tribal way of life, tribal culture, and cultural practices, which are dependent upon healthy migratory fish runs (especially salmon and lamprey).
- The EIS should analyze impacts to cultural resources in a holistic manner by incorporating local and traditional knowledge to address impacts to archaeological sites, historic sites, traditional cultural properties, traditional foods, human health, cultural landscapes, cultural traditions, and other values associated with healthy ecosystems.
- The co-lead agencies should develop a cohesive, holistic, and integrated approach to tribal consultation such that cultural resources can be managed in a holistic and meaningful manner.
- The co-lead agencies should work with tribes to honor the Fish Accord partnership and work to protect and recover salmon and steelhead and associated habitat.
- The co-lead agencies should place emphasis on ecosystem function as developed through the Columbia River Treaty process in their analysis of alternatives.
- The EIS should analyze ongoing tribal fish mitigation activities (e.g., efforts to improve fish passage (Pacific lamprey and salmon) at current projects, enhance habitat in the tributaries and estuary, and reduce the adverse impact of predation on juvenile and adult salmonids by pinnipeds, other fish, and avian predators, as well as fish reintroduction efforts.
- The EIS should consider creative mitigation measures to address tribal interests and concerns (e.g., cultural resources and wildlife resource mitigation, diabetes prevention and other health protection improvements, language preservation, resource access, improved and protected fishery harvest opportunities, land and water acquisition, creation of employment opportunities, and educational opportunities).
- The EIS should include an assessment of how alternatives may impact current tribal economic and cultural adaptations and dependence upon current dam operations such as fish hatcheries and subsistence hunting and other associated economic and cultural benefits of current operations.
- The EIS should analyze Grand Coulee Dam operational alternatives on the erosion, deposition, changes in availability of metals to the aquatic ecosystem, and the effects on the ecosystem of contaminated sediment in the upper Columbia River between the U.S.–Canadian border and Grand Coulee Dam.

- The EIS should analyze and mitigate operational and infrastructure impacts to watershed ecosystems and associated habitat within the context of impacts on traditional cultural properties and sacred sites in consultation with tribes such that mitigation can be accomplished in a manner consistent with federal treaty rights and trust obligations to Indian tribes.
- Upper Columbia tribal interests regarding reintroduction of salmon and other fish species, socioeconomic impacts, and water quality should be addressed in the EIS.

8.16.1 Tribal Involvement

- The co-lead agencies should make every effort to involve the tribes and address tribal concerns and perspectives on resources important to them (such as treaty rights) and consider giving more weight to these concerns in the EIS process.
- The co-lead agencies should consider using tribal media outlets such as tribal newspapers and hosting meetings on reservations in order to have more comprehensive outreach to tribal members such that they are provided with an adequate opportunity to participate in the process and become more involved.
- Tribes would like to participate as Cooperative Agencies in the EIS, providing input/analysis into several resource areas, but also expect the co-lead agencies to recognize that their treaty rights, and trust and government-to-government consultation obligations are distinct from and not altered by such participation.
- The co-lead agencies should consider using the Fish Accord agreements as a model for cooperating agency agreements.
- Tribes request early formal policy-level government-to-government level consultation with tribes, during scoping and prior to any Agency decisions regarding alternatives.
- Tribes request the co-lead agencies to develop clear and realistic work schedules and establish technical working group meetings with tribes for various resource areas analyzed by the EIS (e.g., cultural resources, water quality, etc.).

8.16.2 National Historic Preservation Act Compliance

- The co-lead agencies should consult with tribes as required under NHPA, and incorporate tribal perspectives on impacts to and protection of cultural resources important to tribes. Specifically, these resources include those that meet the broad definition of cultural resources as defined by NEPA, traditional cultural properties, historic properties of religious and cultural significance, First Food locations, archaeological sites, and a holistic view of cultural resources as an integrated landscape of both natural and cultural resources.
- As part of the NHPA Section 106 compliance process, the co-lead agencies should seek tribal concurrence on the definition of area of potential effect and seek tribal input and participation on comprehensive cultural resources inventories, evaluations, mitigations, and treatments such that adverse effects to tribal cultural resources can be adequately resolved in culturally sensitive ways.

- The EIS should incorporate other cultural resources compliance requirements and social impact assessment methodologies into their analysis and should consider engaging tribal experts, as well as archaeologists and anthropologists, to assist in a holistic analysis.
- The Agencies should reconsider their NHPA Section 106 approach in consultation with tribes with regard to the applicability of the existing programmatic agreement to the proposed action.

8.17 Flood Risk Management

Comments summarized on flood risk management concerned the flood control benefits provided by the dams in general, whether or not the four lower Snake River dams provide any flood control; flood risk specifically at Lewiston, Idaho; reservoir operations in Montana; and changes in flood risk management that would need to be considered under alternative System configurations. Other general comment summaries for Flood Risk Management include:

- The scope of the EIS needs to include how reservoirs would be managed for flood control under various operational or configuration alternatives. The analysis should consider a suite of “dry year” operations in which upper Columbia reservoirs are managed to increase spring and early summer flows to benefit migrating juvenile fish; several comments suggested a change in the control point for triggering “dry year” operations from The Dalles to be able to adjust for water supply in upstream reservoirs. The analysis should also consider climate change models and future changes in runoff patterns, flow regimes, reservoir storage, and instream flows for fish.
- The EIS needs to clearly state its assumptions regarding the flood risk management requirements of the Columbia River Treaty, potential renegotiation of the treaty, and to consider the impacts of the changes in flood risk management scheduled to take effect in 2024 under the treaty. Comments expressed concern that when flood storage is no longer assured in Canada, the need to draw down more volume in U.S. reservoirs more often would adversely affect ecosystem function for both anadromous and resident fish.
- The agencies’ NEPA process should include a watershed-wide programmatic review of flood protection, infrastructure capacity and capability, floodplain management, levees, and reservoir operations. The analysis should include alternative flood risk management regimes such as less reliance on reservoirs.
- In its analysis of alternatives, the EIS needs to describe the change in flood risk to affected communities and the impacts of flooding on those communities, especially communities on the mainstem such as the Tri-Cities, The Dalles, Portland, and Vancouver, as well as communities downstream of Hungry Horse and Libby dams in Montana. Potential impacts include loss of life, property damage, road washouts, maintenance of flood control structures, loss of agricultural land, potential for relocation, flood insurance, and potential need for disaster relief funding.
- In its analysis of alternatives, the EIS needs to describe the change in flood risk specifically to Lewiston, Idaho, where there is significant sediment accumulation. The cost of managing both flood risk (e.g. raising or maintaining levees) and sediment at Lewiston should also be considered in the analysis.

- In its analysis of a lower Snake River dam breaching alternative, the EIS should consider the degree of flood control provided by those dams compared with the flood protection provided by a restored flood plain.
- The analysis of flood risk management on the upper Columbia should consider the relationship between BPA property acquisition, Hungry Horse Reservoir operations, Flathead Lake levels, and Flathead River flows, and the effects of changes to that system on adjacent property owners and nearby communities.

8.18 Power Generation/Energy

Comments summarized for power and energy include power generation, power capacities, energy alternatives and energy integration, the cost of production, the Columbia River Treaty with Canada, and impact analyses. Comments also expressed general support for hydropower. Other general comment summaries for Power Generation/Energy include:

- The EIS should analyze the significance of the contribution of the four lower Snake River dams to the regional power supply, particularly the inability of the dams to provide power at peak load due to low water flows, and whether the benefits of the hydropower exceed the cost to maintain the dams.
- The EIS should consider energy alternatives such as demand side management, conservation, and solar, wind, natural gas, geothermal, and nuclear generation. The analysis of energy alternatives should include the cost of replacement, the cost of production, reliability of supply, carbon dioxide emissions, and the potential for anadramous fish restoration.
- The alternatives analysis should include feasibility studies for energy alternatives that would evaluate whether those alternative energy sources are capable of supplying the necessary baseload energy.
- The EIS should consider integration of renewable energy, such as wind and solar, with continued operation of the hydropower dams.
- The EIS should address alternatives under which the hydropower system is expanded to include more dams.
- The evaluation of the continued operation of hydropower in the EIS should consider the use of pumped storage for load leveling and the benefits of additional pumped storage should be considered.
- When considering alternatives that retain the dams, the EIS should include the stability of hydropower supply and the multiple regional benefits, including regional navigation, carbon-free electricity, irrigation, and jobs.
- The analysis in the EIS should include a detailed forecast of future power supply and demand, power purchase contracts, and changes in the transmission network.
- The alternatives in the EIS should be coordinated with the ongoing Columbia River Treaty negotiations, and the EIS analysis scenarios should consider potential changes in river operation resulting from future treaty modifications.

8.19 Power Transmission

This summary ofcomments primarily expressed concern about the power transmission system reliability, as well as the cost and timeframe for potential upgrades or new transmission related to replacement power generation should any dams be removed. Other general comment summaries for Power Transmission include:

- The EIS should include an analysis of impacts on the power transmission system and the cost of any needed changes to the transmission system associated with each hydro system alternative.
- In its analysis of transmission system impacts, the EIS should include an accurate description of the current transmission system including recent upgrades.
- The EIS should suggest replacement power options when analyzing the breaching or removal of one or more of the Snake River dams.

8.20 River Navigation

Comments summarizing the river navigation system ranged from stressing its local and global economic importance to the cost of maintaining it, alternatives for replacing it, and the impacts of changes to the CRSO related to river navigation. The majority of comments called for considering the impacts of rail and trucking alternatives to barge transportation, under any dam breaching or drawdown scenarios. Some comments stated that barge transportation could be replaced by truck and rail, and that the navigation system was costly to maintain. Other comments stated that the low carbon footprint and socioeconomic benefits of the current river navigation system and the expense of replacing it were too great to consider drastic changes to it. Other general comment summaries for River Navigation include:

8.20.1 River Navigation System General Considerations

- The EIS needs to consider that transportation is an authorized use of the river system, thus the alternatives must include analysis of appropriate navigation channel configuration for barge transportation.
- The EIS needs to accurately characterize the current level and type of navigation activity throughout the System as a whole, particularly the lower Snake River portion in relation to the rest of the System, and including commercial and recreational activity upstream in Idaho and Montana. Some comments emphasized that an evaluation of commercial navigation on the lower Snake River should be limited to freight through the locks (e.g. reaches upstream of Ice Harbor Dam).
- The EIS should accurately characterize the past trends, current level, and projected future use of the river navigation system for commercial shipping compared with other modes of transportation. Comments concerned the volume, dollar value, number of trips, and frequency of trips for various commodities shipped. Some comments were specific about the analysis methodology that should be used (e.g. address the economic value of freight transport using ton-miles of freight vs. just tons).

- Analysis of alternatives maintaining a river navigation channel should investigate potential beneficial uses for dredged material as well as disposal options with fewer environmental impacts.

8.20.2 Scope of Analysis for Alternative Columbia River System Operations or Configurations for River Navigation

This summary of comments pertains to the analysis of alternatives to barge transportation for alternatives calling for dam breaching or significant reservoir drawdowns.

- The analysis of alternatives should compare the efficiency and price stability of barge transport relative to that of other modes of shipping wheat, forest products, and other agricultural commodities to national and international markets. The analysis should also consider the impact on competitiveness of U.S. products in the global economy.
- The analysis of alternatives should compare the emissions of CO_2 and other GHGs and air pollutants from barge transport relative to that of replacement modes of transportation for an equivalent volume and tonnage.
- The analysis of alternatives should consider the scope, capital cost, and maintenance cost of adequate truck and rail infrastructure to serve Idaho, Montana, eastern Washington, and eastern Oregon farms. The analysis should include the amount of fossil fuel required, the cost of fuel per ton of goods moved, and availability of qualified labor related to these modes of transportation.
- The analysis should consider the public safety and traffic congestion issues associated with a large number of additional semi-trucks on roads and highways as well as increased freight rail use.
- The analysis should consider the number of jobs both directly and indirectly related to river navigation system.
- The analysis should consider impacts on transportation infrastructure affected by reservoir drawdowns (e.g., shoreline structures, roads, bridges, railways).
- Analysis of any alternative calling for breaching the four lower Snake River dams should consider the loss of recreational navigation on the Snake River and the socioeconomic impacts of lower Snake River dam breaching on Lewis Clark Valley communities, including the number of industries, recreational opportunities, and associated beneficial tax revenues.

8.20.3 Costs/Subsidies of River Navigation

- The analysis of alternatives should include the cost of operating and maintaining the navigation system relative to the payments from users. Many commenters felt the lower Snake River dams in particular were not cost-effective, that barge transportation on this section of the river navigation system principally benefits wheat growers (a single industry/small group), and that barge transportation could easily be replaced by (or was already being replaced by) rail transport.

- The analysis of alternatives should describe the level of investment needed to maintain shipping, particularly crops for export markets, and the socioeconomic impact on the communities that would become the hubs for truck and rail transportation, if dams are breached or removed.
- The EIS should consider the "lost opportunity cost of a free-flowing river" in its analysis of alternatives.

8.21 Transportation

This summary of comments concerns transportation other than the river navigation system. Other general comment summaries for Transportation include:

- In its analysis of alternatives, the EIS should evaluate the impacts of System operational or configuration changes on the existing transportation infrastructure, (e.g. where breaching or drawdown might affect adjacent roads, bridges, railways, and recreational boating facilities).
- The analysis of transportation infrastructure impacts should include the cost and socioeconomic impacts (e.g. traffic disruption, reduced visitation) of repairing any damage and protection from future damage.

8.22 Recreation

This summary of comments concerns impacts to recreational activities along the river system. Other general comment summaries for Recreation include:

- The EIS should consider the negative impacts dam breaching would have on recreation including effects to individuals that regularly partake in recreational activities on and along the river such as camping, boating, and fishing; businesses that offer recreational and tourism activities; and athletic organizations such as the Washington State University rowing team.
- The EIS should consider the positive impacts dam breaching would have on recreation including introducing new recreational activities to the area, such as whitewater rafting.
- The EIS should include analysis of existing recreational opportunities and their areas for improvements, potential recreational opportunities, and the economic impact of recreation and tourism on surrounding communities.

8.23 Socioeconomics and Environmental Justice

Comments summarized on Socioeconomics and Environmental Justice are directed at both the positive and negative impacts of the proposed action to tourism, recreation, fisheries, hydropower generation and flood control, industry, the tribes, transportation, and agriculture. Other general comment summaries for Socioeconomics and Environmental Justice include:

8.23.1 Scope of Socioeconomic Analysis and Alternatives

- The EIS should include a thorough analysis of the direct and indirect economic impact of the current System. This analysis should include identification and valuation of all businesses dependent on the System across multiple industries. This analysis should also compare the current costs of operating the dams to the benefits they provide.
- The EIS should include a thorough analysis of the direct and indirect economic impact of a free-flowing river system. This analysis should include forecasted impacts on all relevant industries and dam removal costs and details concerning the cost recovery.
- The EIS should include socioeconomic analyses that are consistent across each alternative and the current System. These analyses should not only include quantitative measures but also qualitative measures. The degree of uncertainty and risk in the analysis should also be included.
- The EIS needs to address the direct and indirect employment changes that would result from each alternative. This analysis needs to include the industries where jobs would be lost as well as industries where new jobs would arise due to each alternative.
- The EIS should address the costs of replacing baseload electric generation should the dams be removed. This analysis should also include the effect this would have to rate payers and their standard of living.
- The EIS should discuss what would happen with the land that was obtained by the Corps in the event of the dams being removed.
- Economic analysis included in the EIS should include adequate economic forecasting of each alternative's costs and benefits. Examples of figures that should be included are the dams operations and maintenance cost trends over recent years and revenue from electric production and cargo ton-miles transportation trends.
- The EIS should thoroughly discuss and address the socioeconomic considerations for water concerns including, but not limited to, water rights consideration, access to drinking water, access to irrigation for agriculture, and access to adequate water supply to support firefighting activities.
- The EIS should thoroughly analyze the rising operations and maintenance costs of the lower Snake River dams in question. These costs should also include forecasts of expected major maintenance of aging infrastructure.

8.23.2 Economic Effects of Dam Breaching

- The EIS should specifically include the impacts that dam breaching would have to the agricultural industry due to the potential unavailability of irrigation. Included in these impacts should be the direct job loss in the agricultural industry and also the associated indirect losses. The EIS should also consider the industries that rely on the agricultural industries, such as food processing.
- The EIS needs to recognize the recreation and tourism industry's impact on surrounding areas and the reliance these industries have on the current river system. A detailed analysis of jobs lost and the indirect impact of declines in these industries needs to be included.

- The complete impact of the benefits of the existing navigation of the Columbia and Snake Rivers should be included in the EIS. These benefits come from many industries including agriculture, recreation, tourism, and transportation. The use of the current river system in these industries and the economic impact they have on surrounding communities should be completely captured in the EIS.
- The EIS should analyze all industries' sensitivity to increased electricity prices and the ability of local businesses to remain a cost competitive member of their respective industry if electricity prices were to increase due to breaching.
- The EIS should discuss potential road and other infrastructure upgrades that could be needed if dams were breached. If these upgrades were needed, what are the impacts to surrounding industries (e.g. discussion about how the logging industry would be impacted by roads needing repair should be included).
- The EIS should consider the cost of dam removal, replacing irrigation and transportation infrastructure, and flood protection/mitigation as reason enough to not remove any dams.
- The EIS should analyze and consider the effect of dam breaching on the agricultural industry. This should include topics such as a decrease in production and subsequently jobs, increased wheat transportation costs, and the cost of food locally.
- The EIS should consider the effect of dam breaching on waterfront properties and the personal financial impacts those changes have on homeowners. The drop in the housing market that would result from a loss of local jobs and increased living expenses should also be considered.
- The EIS should include discussion and analysis of increased economic activity in the tourism, recreation, commercial fishing, and rail activities that would result from breaching the dams as well as the indirect impacts of these increases.
- Inclusion of qualitative benefits in addition to quantitative benefits resulting from breaching the dams, such as communities reconnecting with the waterfront, must be a part of the EIS.

8.23.3 Impacts to Businesses and Communities

- The EIS should consider that low cost hydropower provided by the dams have allowed jobs in industries such as wood, chemical companies, and aluminum manufacturing to remain.
- The EIS needs to consider the benefit of the cargo that can be transported via barge on the river because of the dams as well as the positive impact the dams have in the commerce, shipping, irrigation, flood control, and recreation industries.
- The EIS should consider the negative impacts of increased electricity costs on residents and the effect those cost increases have on the standard of living.
- The EIS should analyze and consider the effect of dam breaching on the agricultural industry. This should include topics such as a decrease in production and subsequently jobs, increased wheat transportation costs, and the cost of food locally.
- The EIS should recognize the loss in direct and indirect jobs from the recreation and tourism industry that currently exist due to the dams as well as the impact of loss of recreation on

quality of life. Also, the EIS should consider the sunk cost to residents with propeller watercraft that will no longer be usable.

- The EIS needs to report the loss of property tax income to schools and local governments resulting from mitigation land purchases.
- The EIS should consider the effect of dam breaching on waterfront properties and the personal financial impacts those changes have on homeowners. The drop in the housing market that would result from a loss of local jobs and increased living expenses should also be considered.
- The EIS should include analysis of the decline in the commercial fishing industry that took place as the hydroelectric System was developed. This should include the findings from the Lower Snake River Juvenile Salmon Migration Feasibility Study Anadromous Fish Economic Analysis.
- The EIS should include the impact on the existing commercial fishing that breaching may result in. This analysis should include both positive impacts and any negative impacts to downstream fishing operations. This should also include the indirect impacts of the potential changes in the industry.

8.23.4 Power System

- The EIS should address the fish and wildlife mitigation funding that will be affected by dam breaching and the subsequent loss of revenue from the dams. The EIS should also discuss the potential of a reclamation fund that each federal hydropower facility contributes to being used for mitigation efforts.
- The EIS should address the impact of mitigation efforts on ratepayers, including an analysis of the portion of electric rates paid that are directed toward mitigation efforts.
- The EIS should include a comprehensive analysis of the costs and benefits of hydropower generation at the four lower Snake River dams; this analysis should address both the value of the power produced and the cost of replacement power should the dams be breached. The analysis should also address integration of renewables, particularly wind power, impacts on electric rates, and the carbon emissions of existing vs. replacement power sources.
- If hydropower production is reduced by configuration or operational changes to the CRS, the EIS should consider improving the infrastructure and financial structure (fees, taxes) for transitioning to wind and solar power.
- The EIS should consider additional revenue sources that could be generated by the CRS and the impact the revenue would have on local economies.
- The EIS should consider the affordable, carbon-free, and firming power (for integration of wind and solar energy) benefits of hydropower as reason enough to not remove any dams.

8.23.5 Environmental Justice

- In accordance with E.O. 12898, the EIS should address environmental justice. The EIS should include a thorough analysis to identify any disproportionately high and adverse health or environmental effects any action or lack thereof would have on minority populations, low-income populations, and Native American tribes.

8.24 General Perspectives on the CRSO EIS Process

This summary of comments includes the expressed opposition to the EIS or NEPA process and the express support for the EIS or NEPA process. Those opposing primarily question its necessity, the cost to taxpayers and ratepayers, and the commitment of the agencies to complete the process. Those supporting this effort reinforced the work by the co-lead agencies. Other comments in this category expressed support for the CRSO and its continued operation in general..

9.0 CONCLUSION

The co-lead agencies engaged in a robust scoping process including public meetings, public notifications, and scoping comment solicitation and received tremendous public participation in the scope and scale of comments to guide the development of the scope of analysis for the CRSO EIS. This includes public comments on the scope of EIS, ideas for alternatives, methods of evalautions, and resource concerns expressed by public, state and federal agencies, and tribes. The co-lead agencies are using these comments to develop the EIS and focus on those issues expressed through public scoping as important in the analysis.

10.0 REFERENCES

59 FR 7629. February 16, 1994. “Executive Order 12898 of February 11, 1994, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.” *Federal Register*, Office of the President.

81 FR 67382. September 30, 2016. “Notice of Intent to Prepare the Columbia River System Operations Environmental Impact Statement.” *Federal Register,* U.S. Army Corps of Engineers, Bonneville Power Administration, and Bureau of Reclamation.

81 FR 76962. November 4, 2016. “Notice of Additional Scoping Meeting for the Columbia River System Operations Environmental Impact Statement.” *Federal Register,* Bureau of Reclamation.

82 FR 137. January 3, 2017. “Notice to Extend the Public Comment Period for the Notice of Intent to Prepare the Columbia River System Operations Environmental Impact Statement.” *Federal Register,* Bureau of Reclamation.

Endangered Species Act of 1973. Public Law 100-478, as amended, 16 U.S.C. § 1531 *et seq*.

Marine Mammal Protection Act of 1972. 86 Stat. 1027, as amended, 16 U.S.C. § 1361 *et seq*.

National Environmental Policy Act of 1969 (NEPA). Public Law 91-190, as amended, 42 U.S.C. § 4321 *et seq*.

National Historic Preservation Act of 1966 (NHPA). Public Law 89-665, as amended, 54 U.S.C. § 300101 *et seq*.

Pacific Northwest Electric Power Planning and Conservation Act. Public Law 96-501, S. 885, as amended, 16 U.S.C. § 839 *et seq*.

Appendix A

Federal Register Notices

Three Notices of Intent regarding the preparation of the Columbia River System Operations environmental impact statement were published in the *Federal Register*. The original, dated September 30, 2016 (81 FR 67382; Figure A.1), announced the comment period ending date as January 17, 2017, and published a schedule for public meetings and webinars. On November 4, 2016, the Action Agencies issued a *Federal Register* notice that an additional public meeting would be held in Pasco, Washington (81 FR 76962; Figure A.2). On January 3, 2017, the comment period was extended to February 7, 2017 (82 FR 137; Figure A.3).

Figure A.1. September 30, 2016 *Federal Register* Notice (81 FR 67382)

Alternative 2 would not store San Juan-Chama Project water in Elephant Butte Reservoir. Alternative 3 would not include the carryover accounting provision. Alternative 4 would not include the diversion ratio adjustment. Alternative 5 is the No Action Alternative and it would eliminate both the carryover accounting and diversion ratio adjustment from Rio Grande Project allocation and accounting procedures.

The FEIS analyzes the effect of these five alternatives on (1) water resources (total storage, Elephant Butte Reservoir elevations, allocation, releases, net diversion, farm surface water deliveries, farm groundwater deliveries, groundwater elevations, and water quality); (2) biological resources (vegetation communities including wetlands, wildlife, aquatic species, and special status species and critical habitat); (3) cultural resources (historic properties, Indian sacred sites, and resources of tribal concern); and (4) socioeconomic resources (Indian trust assets, recreation, hydropower, regional economic impacts and economic benefits, and environmental justice).

On January 15, 2014, a Notice of Intent was published in the **Federal Register** (79 FR 2691) inviting public scoping comments on the proposed action of continuing to implement the Operating Agreement through 2050. A Notice of Availability was published in the **Federal Register** on March 18, 2016 (81 FR 14886), and the public was invited to provide comments on the Draft EIS during an 83-day comment period ending on June 8, 2016.

Public Disclosure

Before including your address, phone number, email address, or other personal identifying information in your comment, please be advised that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Dated: September 7, 2016.

Brent Rhees,

Regional Director, Upper Colorado Region.

[FR Doc. 2016–23525 Filed 9–29–16; 8:45 am]

BILLING CODE 4332–90–P

DEPARTMENT OF DEFENSE

Department of the Army, U.S. Army Corps of Engineers

DEPARTMENT OF ENERGY

Bonneville Power Administration

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[RR01041000, 16XR0680G3, RX.16786921.2000100]

Notice of Intent To Prepare the Columbia River System Operations Environmental Impact Statement

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DoD; Bonneville Power Administration, Energy; Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare an environmental impact statement.

SUMMARY: In accordance with the National Environmental Policy Act, the U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (BPA) (Action Agencies) intend to prepare an environmental impact statement (EIS) on the system operation and maintenance of fourteen Federal multiple purpose dams and related facilities located throughout the Columbia River basin. The Action Agencies will use this EIS process to assess and update their approach for long-term system operations and configuration through the analysis of alternatives and evaluation of potential effects to the human and natural environments, including effects to socio-economics and species listed under the Endangered Species Act (ESA). The Action Agencies will serve as joint lead agencies in developing the EIS.

DATES: Written comments for the Action Agencies' consideration are due to the addresses below no later than January 17, 2017. Comments may also be made at public meetings. Information on the public meetings is provided under the **SUPPLEMENTARY INFORMATION** section of this notice.

ADDRESSES: Written comments, requests to be placed on the project mailing list, and requests for information may be mailed by letter to U.S. Army Corps of Engineers Northwestern Division Attn: CRSO EIS, P.O. Box 2870, Portland, OR 97208–2870; or online at *comment@crso.info*. All comment letters will be available via the project Web site at *www.crso.info*. All personally identifiable information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Call the toll-free telephone 1–(800) 290–5033 or email *info@crso.info*. Additional information can be found at the project Web site: *www.crso.info*.

SUPPLEMENTARY INFORMATION:

Background

The fourteen Federal multiple purpose dams and related facilities are operated as a coordinated system within the interior Columbia River basin in Idaho, Montana, Oregon, and Washington. A map identifying the locations of these dams can be found on the project Web site at *www.crso.info*. The Corps was authorized by Congress to construct, operate and maintain twelve of these projects for flood control, power generation, navigation, fish and wildlife, recreation, and municipal and industrial water supply purposes. The Corps' projects that will be addressed in this EIS include Libby, Albeni Falls, Dworshak, Chief Joseph, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville. Reclamation was authorized to construct, operate, and maintain two projects for purposes of flood control, power generation, navigation, and irrigation. The Reclamation projects that will be addressed in this EIS include Hungry Horse and Grand Coulee. BPA is responsible for marketing and transmitting the power generated by these dams. Together, these Action Agencies are responsible for managing the system for these various purposes.

In the 1990s, the Action Agencies analyzed the socio-economic and environmental effects of operating the system in the Columbia River System Operation Review (SOR) EIS and issued respective Records of Decision in 1997 that adopted a system operation strategy, which included operations supporting ESA-listed fish while fulfilling all other congressionally-authorized purposes. Since the completion of the SOR EIS, the Action Agencies have operated the system consistent with the analyses in the SOR EIS, while some changes to system operations have been adopted under subsequent ESA consultations and project-specific National Environmental Policy Act documents.

Proposal for New EIS

The proposed Columbia River System Operations EIS will assess and update the approach for long-term system operations and configuration. In addition to evaluating a range of alternatives, the EIS will consider the direct, indirect, and cumulative impacts of these alternatives on affected resources, including geology, soils, water quality and quantity, air quality, fish and wildlife (*e.g.*, ESA-listed species and their designated critical habitat), floodplains, wetlands, climate, cultural resources, tribal resources, social and economic resources, and other resources that are identified during the scoping process. The impacts to the resources will be addressed in light of anticipated climate change impacts, such as warmer water temperatures, diminished snow-pack, and altered flows. The Action Agencies will evaluate a range of alternatives in the EIS, including a no-action alternative (current system operations and configuration). Other alternatives will be developed through the scoping period based on public input and Action Agency expertise, and will likely include an array of alternatives for different system operations and additional structural modifications to existing projects to improve fish passage including breaching one or more dams.

The EIS will also identify measures to avoid, offset or minimize impacts to resources affected by system operations and configuration, where feasible. For instance, non-operational mitigation measures to address impacts to the fish resources, such as habitat actions in the tributaries and estuary, avian predation management actions, and conservation and safety net hatcheries, may be proposed.

Additionally, the Action Agencies will comply with all applicable statutory and regulatory requirements in evaluating the proposed action, such as the ESA, Clean Water Act, Section 106 of the National Historic Preservation Act (NHPA), and Executive Orders, including E.O. 12898 *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*.

Request for Comments

The Action Agencies are issuing this notice to: (1) Advise other Federal and state agencies, tribes, and the public of their plan to analyze effects related to system operations and configuration; (2) obtain suggestions and information that may inform the scope of issues and range of alternatives to evaluate in the EIS; and (3) provide notice and request public input on potential effects on historic properties from system operations and configuration in accordance with Section 106 of the NHPA (36 Code of Federal Regulations 800.2(d)(3)).

The Action Agencies are inviting interested parties to provide specific comments no later than January 17, 2017, on issues the agencies should evaluate related to the Columbia River System Operations EIS. All comments and materials received, including names and addresses, will become part of the administrative record and may be released to the public.

Public Meetings

The Action Agencies will hold 15 public scoping meetings during the fall and winter of 2016 to invite the public to comment on the scope of the EIS. The 15 public meetings will be held on:

- Monday, October 24, 2016, 4 p.m. to 7 p.m., Wenatchee Community Center, 504 S. Chelan Ave., Wenatchee, Washington.
- Tuesday, October 25, 2016, 4 p.m. to 7 p.m., The Town of Coulee Dam, City Hall, 300 Lincoln Ave., Coulee Dam, Washington.
- Wednesday, October 26, 2016, 4 p.m. to 7 p.m., Priest River Community Center, 5399 Highway 2, Priest River, Idaho.
- Thursday, October 27, 2016, 4 p.m. to 7 p.m., Kootenai River Inn Casino & Spa, 7169 Plaza St., Bonners Ferry, Idaho.
- Tuesday, November 1, 2016, 4 p.m. to 7 p.m., Red Lion Hotel Kalispell, 20 North Main St., Kalispell, Montana.
- Wednesday, November 2, 2016, 4 p.m. to 7 p.m., City of Libby City Hall, 952 E. Spruce St., Libby, Montana.
- Thursday, November 3, 2016, 4 p.m. to 7 p.m., Hilton Garden Inn Missoula, 3720 N. Reserve St., Missoula, Montana.
- Monday, November 14, 2016, 4 p.m. to 7 p.m., The Historic Davenport Hotel, 10 South Post Street, Spokane, Washington.
- Wednesday, November 16, 2016, 4 p.m. to 7 p.m., Red Lion Hotel Lewiston, Seaport Room, 621 21st St., Lewiston, Idaho.
- Thursday, November 17, 2016, 4 p.m. to 7 p.m., Courtyard Walla Walla, The Blues Room, 550 West Rose St., Walla Walla, Washington.
- Tuesday, November 29, 2016, 4 p.m. to 7 p.m., The Grove Hotel, 245 S. Capitol Blvd., Boise, Idaho.
- Thursday, December 1, 2016, 4 p.m. to 7 p.m., Town Hall, Great Room, 1119 8th Ave., Seattle, Washington.
- Tuesday, December 6, 2016, 4 p.m. to 7 p.m., The Columbia Gorge Discovery Center, River Gallery Room, 5000 Discovery Drive, The Dalles, Oregon.
- Wednesday, December 7, 2016, 4 p.m. to 7 p.m., Oregon Convention Center, 777 NE Martin Luther King Jr. Blvd., Portland, Oregon.
- Thursday, December 8, 2016, 4 p.m. to 7 p.m., The Loft at the Red Building, 20 Basin St., Astoria, Oregon.
- Tuesday, December 13, 2016, 10 a.m. to 11:30 a.m., and 3 p.m. to 4:30 p.m., PST, webinar. For those that cannot participate in person, an online webinar will be provided to interested parties. The webinar will cover the material discussed in the in-person public scoping meetings. Detailed instructions on how to participate in the webinar may be found on the project Web site at *www.crso.info*. To submit written comments, please follow the instructions in the **ADDRESSES** section of this notice.

The Action Agencies will consider requests for an extension of time for public comment and additional opportunities for public involvement if requests are received in writing by December 1, 2016. Requests for additional time to comment and opportunities for public involvement should be sent to the address listed in the **ADDRESSES** section of this notice. Requests should include an explanation of the specific purposes served by the requested extension, and should explain how the extension could benefit the National Environmental Policy Act process and analysis. Announcements for any such further opportunities for public involvement, if appropriate given the court-ordered schedule for this EIS, will be published in the **Federal Register** and by news releases to the media, newsletter mailings, and posting on the project Web site.

The draft EIS is scheduled to be published by March 2020 for public review and comment, and after it is published, the Action Agencies will hold public comment meetings. The Action Agencies will consider public comments received on the draft EIS and provide responses in the final EIS.

Scott A. Spellmon,

Brigadier General, US Army, Division Commander.

Elliot E. Mainzer,

Administrator, Bonneville Power Administration.

Lorri J. Lee,

Regional Director—Pacific Northwest Region, Bureau of Reclamation.

[FR Doc. 2016–23346 Filed 9–29–16; 8:45 am]

BILLING CODE 4332–90–P

Figure A.2. November 4, 2016 *Federal Register* Notice (81 FR 76962)

the terms and conditions of an approved permit and any other applicable provision under these regulations.

The NPS consulted with traditionally associated American Indian tribes and groups, State Historic Preservation Officers, United States Fish and Wildlife Service, United States Environmental Protection Agency, state oil and gas regulatory commissions, and the state of Alaska.

The ROD includes a summary of the purpose and need for action, synopses of alternatives considered and analyzed in detail, a description of the selected alternative, including measures that are included in the rule to minimize environmental harm, the basis for the decision, a description of the environmentally preferable alternative, and findings on impairment of park resources. The ROD is not the final agency action for those elements of the EIS that require promulgation of regulations to be effective. Promulgation of such regulations will constitute the final agency action for such elements, and will be published in a separate **Federal Register** document.

Dated: October 23, 2016.

Jonathan B. Jarvis,

Director, National Park Service.

[FR Doc. 2016–26492 Filed 11–3–16; 8:45 am]

BILLING CODE 4312–52–P

DEPARTMENT OF THE INTERIOR

Bureau of Ocean Energy Management

[MMAA104000]

Notice on Outer Continental Shelf Oil and Gas Lease Sales

AGENCY: Bureau of Ocean Energy Management (BOEM), Interior.

ACTION: List of Restricted Joint Bidders.

SUMMARY: Pursuant to the joint bidding provisions of 30 CFR 556.511—556.515, the Director of the Bureau of Ocean Energy Management is publishing a List of Restricted Joint Bidders. Each entity within one of the following groups is restricted from bidding with any entity in any of the other following groups at Outer Continental Shelf oil and gas lease sales to be held during the bidding period November 1, 2016, through April 30, 2017. This List of Restricted Joint Bidders will cover the period November 1, 2016, through April 30, 2017, and replace the prior list published on May 17, 2016, which covered the period of May 1, 2016, through October 31, 2016.

Group I BP

America Production Company
BP Exploration & Production Inc.
BP Exploration (Alaska) Inc.

Group II Chevron Corporation

Chevron U.S.A. Inc.
Chevron Midcontinent, L.P.
Unocal Corporation
Union Oil Company of California
Pure Partners, L.P.

Group III

Eni Petroleum Co. Inc.
Eni Petroleum US LLC
Eni Oil US LLC
Eni Marketing Inc.
Eni BB Petroleum Inc.
Eni US Operating Co. Inc.
Eni BB Pipeline LLC

Group IV

Exxon Mobil Corporation
ExxonMobil Exploration Company

Group V

Petroleo Brasileiro S.A.
Petrobras America Inc.

Group VI

Shell Oil Company
Shell Offshore Inc.
SWEPI LP
Shell Frontier Oil & Gas Inc.
SOI Finance Inc.
Shell Gulf of Mexico Inc.

Group VII

Statoil ASA
Statoil Gulf of Mexico LLC
Statoil USA E&P Inc.
Statoil Gulf Properties Inc.

Group VIII

Total E&P USA, Inc.

Abigail Ross Hopper,

Director, Bureau of Ocean Energy Management.

[FR Doc. 2016–26737 Filed 11–3–16; 8:45 am]

BILLING CODE 4310–MR–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[RR01041000, 17XR0680G3, RX.16786921.2000100]

Notice of Additional Scoping Meeting for the Columbia River System Operations Environmental Impact Statement

AGENCIES: Bureau of Reclamation, Interior.

ACTION: Notice.

SUMMARY: The Bureau of Reclamation, along with the U.S. Army Corps of Engineers and the Bonneville Power Administration as joint lead agencies, are adding one public scoping meeting to invite the public to comment on the scope of the Columbia River System Operations Environmental Impact Statement.

DATES: The additional scoping meeting will be held on Monday, November 21, 2016, 4 p.m. to 7 p.m., in Pasco, Washington.

ADDRESSES: The meeting will be held at the Holiday Inn Express & Suites Pasco-Tri Cities, 4525 Convention Place, Pasco, Washington 99301.

FOR FURTHER INFORMATION CONTACT: Call the toll-free telephone 1–(800) 290–5033 or email *info@crso.info*. Additional information can be found at the project Web site: *www.crso.info*.

SUPPLEMENTARY INFORMATION: One scoping meeting is being added to the schedule. All other scoping meetings for the Columbia River System Operations Environmental Impact Statement were previously announced in a notice that was published in the **Federal Register** on September 30, 2016 (81 FR 67382). As the project evolves, there may be additional scoping meetings. All additional scoping meetings for this project will be announced on the project Web site at *www.crso.info*.

Dated: October 26, 2016.

Lorri J. Lee,

Regional Director—Pacific Northwest Region, Bureau of Reclamation.

[FR Doc. 2016–26740 Filed 11–3–16; 8:45 am]

BILLING CODE 4332–90–P

INTERNATIONAL TRADE COMMISSION

Notice of Receipt of Complaint; Solicitation of Comments Relating to the Public Interest

AGENCY: U.S. International Trade Commission.

ACTION: Notice.

SUMMARY: Notice is hereby given that the U.S. International Trade Commission has received a complaint entitled *Certain UV Curable Coatings for Optical Fibers, Coated Optical Fibers, and Products Containing Same, DN 3181;* the Commission is soliciting comments on any public interest issues raised by the complaint or complainant's filing under the Commission's Rules of Practice and Procedure.

FOR FURTHER INFORMATION CONTACT: Lisa R. Barton, Secretary to the Commission, U.S. International Trade Commission, 500 E Street SW., Washington, DC 20436, telephone (202) 205–2000. The public version of the complaint can be

Figure A.3. January 3, 2017 *Federal Register* Notice (82 FR 137)

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[RR01041000, 17XR0680G3, RX.16786921.2000100]

Notice To Extend the Public Comment Period for the Notice of Intent To Prepare the Columbia River System Operations Environmental Impact Statement

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of extension.

SUMMARY: The U.S. Army Corps of Engineers, Bonneville Power Administration, and Bureau of Reclamation (Action Agencies) are extending the public comment period for the Notice of Intent (NOI) to Prepare the Columbia River System Operations Environmental Impact Statement (EIS) to Tuesday February 7, 2017. The NOI and Notice of Public Meetings was published in the **Federal Register** on Friday, September 30, 2016. The public comment period for the NOI was originally scheduled to end on Tuesday, January 17, 2017.

DATES: Comments on the NOI will be accepted until close of business on Tuesday February 7, 2017.

ADDRESSES: Written comments, requests to be placed on the project mailing list, and requests for information may be mailed by letter to U.S. Army Corps of Engineers Northwestern Division Attn: CRSO EIS, P.O. Box 2870, Portland, OR 97208–2870; or online at *comment@crso.info*. All comment letters will be available via the project Web site at *www.crso.info*. All personally identifiable information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Call the toll-free telephone 1-(800) 290–5033, or email *info@crso.info*. Additional information can be found at the project Web site: *www.crso.info*.

SUPPLEMENTARY INFORMATION: In response to requests for an extension, the Action Agencies are extending the close of the public comment period for the NOI to Prepare the Columbia River System Operations Environmental Impact Statement to Tuesday February 7, 2017.

Public Disclosure

Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Dated: December 6, 2016.

Lorri J. Lee,

Regional Director—Pacific Northwest Region, Bureau of Reclamation.

[FR Doc. 2016–31621 Filed 12–30–16; 8:45 am]

BILLING CODE 4332–90–P

INTERNATIONAL TRADE COMMISSION

[Investigation No. 731–TA–410 (Fourth Review)]

Light-Walled Rectangular Pipe and Tube From Taiwan Institution of a Five-Year Review

AGENCY: United States International Trade Commission.

ACTION: Notice.

SUMMARY: The Commission hereby gives notice that it has instituted a review pursuant to the Tariff Act of 1930 ("the Act"), as amended, to determine whether revocation of the antidumping duty order on light-walled rectangular pipe and tube from Taiwan would be likely to lead to continuation or recurrence of material injury. Pursuant to the Act, interested parties are requested to respond to this notice by submitting the information specified below to the Commission.

DATES: Effective January 3, 2017. To be assured of consideration, the deadline for responses is February 2, 2017. Comments on the adequacy of responses may be filed with the Commission by March 17, 2017.

FOR FURTHER INFORMATION CONTACT: Mary Messer (202–205–3193), Office of Investigations, U.S. International Trade Commission, 500 E Street SW., Washington, DC 20436. Hearing-impaired persons can obtain information on this matter by contacting the Commission's TDD terminal on 202–205–1810. Persons with mobility impairments who will need special assistance in gaining access to the Commission should contact the Office of the Secretary at 202–205–2000. General information concerning the Commission may also be obtained by accessing its internet server (*https://www.usitc.gov*). The public record for this proceeding may be viewed on the Commission's electronic docket (EDIS) at *https://edis.usitc.gov*.

SUPPLEMENTARY INFORMATION:

Background.—On March 27, 1989, the Department of Commerce issued an antidumping duty order on imports of light-walled rectangular pipe and tube from Taiwan (54 FR 12467). Following first five-year reviews by Commerce and the Commission, effective August 22, 2000, Commerce issued a continuation of the antidumping duty order on imports of light-walled rectangular pipe and tube from Taiwan (65 FR 50955). Following second five-year reviews by Commerce and the Commission, effective August 9, 2006, Commerce issued a continuation of the antidumping duty order on imports of light-walled welded rectangular carbon steel tubing from Taiwan (71 FR 45521). Following the third five-year reviews by Commerce and the Commission, effective February 2, 2012, Commerce issued a continuation of the antidumping duty order on imports of light-walled welded rectangular carbon steel tubing from Taiwan (77 FR 5240). The Commission is now conducting a fourth review pursuant to section 751(c) of the Act, as amended (19 U.S.C. 1675(c)), to determine whether revocation of the order would be likely to lead to continuation or recurrence of material injury to the domestic industry within a reasonably foreseeable time. Provisions concerning the conduct of this proceeding may be found in the Commission's Rules of Practice and Procedure at 19 CFR parts 201, subparts A and B and 19 CFR part 207, subparts A and F. The Commission will assess the adequacy of interested party responses to this notice of institution to determine whether to conduct a full review or an expedited review. The Commission's determination in any expedited review will be based on the facts available, which may include information provided in response to this notice.

Definitions.—The following definitions apply to this review:

(1) *Subject Merchandise* is the class or kind of merchandise that is within the scope of the five-year review, as defined by the Department of Commerce.

(2) The *Subject Country* in this review is Taiwan.

(3) The *Domestic Like Product* is the domestically produced product or products which are like, or in the absence of like, most similar in characteristics and uses with, the *Subject Merchandise*. In its original investigation determination, its full first and second five-year review determinations, and its expedited third

Appendix B

Scoping Letter

The scoping letter provided by the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and the Bonneville Power Administration requesting information for the preparation of an environmental impact statement for Columbia River System operations is provided on the following three pages.

COLUMBIA RIVER SYSTEM OPERATIONS

Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION
DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION
DEPARTMENT OF ENERGY

IN REPLY REFER TO: CRSO-EIS

30 SEP 2016

TO WHOM IT MAY CONCERN:

The U.S. Army Corps of Engineers (Corps), Northwestern Division, Bonneville Power Administration (BPA) and Bureau of Reclamation (Reclamation) (collectively, the Agencies), are serving as co-leads in preparation of an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) on Columbia River System operations and configurations for 14 federal projects in the interior Columbia basin. The Agencies are requesting your assistance in gathering information that will help define the issues, concerns, and the scope of alternatives to be addressed in the EIS. Information will be gathered from interested parties during the scoping period beginning September 30, 2016 and ending January 17, 2016.

The EIS will evaluate and update the Agencies' approach for long-term system operations and configuration through the analysis of different alternatives to current operations and maintenance; including changes to flood risk management, navigation, hydropower, irrigation, fish and wildlife conservation, recreation and municipal and industrial water supply. The Agencies will also analyze potential effects on species, including those listed under the Endangered Species Act, cultural resources, tribal resources, and other social and natural resources. This EIS will be used to select a preferred alternative, which will be adopted by the Agencies in order to operate and maintain the Columbia River System.

The EIS evaluation area under consideration includes 14 federal multiple purpose dams and related facilities, operated as a coordinated system in Idaho, Montana, Oregon, and Washington. Congress authorized the Corps to construct, operate, and maintain 12 of these projects for flood risk management, navigation, power generation, fish and wildlife conservation, recreation, and municipal and industrial water supply purposes. The Corps' projects that will be addressed in this EIS include Libby, Albeni Falls, Dworshak, Chief Joseph, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville. Congress authorized Reclamation to construct, operate, and maintain two of these projects for purposes of irrigation, flood risk management, power generation, and navigation. Reclamation projects include Hungry Horse and Grand Coulee. BPA is responsible for marketing and transmitting the power generated by these dams. Together, the Agencies are responsible for managing the system for all of these various purposes.

During the preparation of the EIS, the Agencies will be identifying potential alternatives that best meet our responsibilities for providing for authorized purposes while minimizing or eliminating environmental impacts and meeting all federal statutory and regulatory requirements. The Agencies plan to identify a preferred alternative in the draft EIS. The Agencies will evaluate a range of alternatives in the EIS, including a no-action alternative (current system operations and configuration). Other alternatives will be developed through the scoping period based on public input and the Agencies' expertise, and will likely include an array of alternatives for different system operations and additional structural modifications to existing projects to improve fish passage, including breaching one or more dams.

The EIS will also identify measures to avoid, offset, or minimize impacts to resources affected by system operations and configuration, where feasible. For instance, non-operational mitigation measures to address impacts to the fish resources, such as habitat actions in the tributaries and estuary, avian predation management actions, and conservation and safety net hatcheries, may be proposed.

The Agencies welcome your comments, suggestions and information that may inform the scope of issues, potential effects, and range of alternatives that should be evaluated in the EIS. Letters of comment or inquiry can be submitted to comment@crso.info, or addressed to U.S. Army Corps of Engineers, Northwestern Division, Attn: CRSO EIS, P.O. Box 2870, Portland, Ore. 97208-2870. Comments may also be submitted at public scoping meetings to be conducted by the Agencies as follows:

Week of October 24th

- Monday, October 24, 4 p.m. to 7 p.m., Wenatchee Community Center, 504 S. Chelan Ave., Wenatchee, WA.
- Tuesday, October 25, 4 p.m. to 7 p.m., The Town of Coulee Dam, City Hall, 300 Lincoln Ave., Coulee Dam, WA.
- Wednesday, October 26, 4 p.m. to 7 p.m., Priest River Community Center, 5399 Hwy 2, Priest River, ID.
- Thursday, October 27, 4 p.m. to 7 p.m., Kootenai River Inn Casino & Spa, 7169 Plaza St., Bonners Ferry, ID.

Week of October 30th

- Tuesday, November 1, 4 p.m. to 7 p.m., Red Lion Hotel Kalispell, 20 North Main St., Kalispell, MT.
- Wednesday, November 2, 4 p.m. to 7 p.m., City of Libby City Hall, 952 E. Spruce St., Libby, MT.
- Thursday, November 3, 4 p.m. to 7 p.m., Hilton Garden Inn Missoula, 3720 N. Reserve St., Missoula, MT.

Week of November 14th

- Monday, November 14, 4 p.m. to 7 p.m., The Historic Davenport Hotel, 10 South Post Street, Spokane, WA.
- Wednesday, November 16, 4 p.m. to 7 p.m., Red Lion Hotel Lewiston, Seaport Room, 621 21st St., Lewiston, ID.
- Thursday, November 17, 4 p.m. to 7 p.m., Courtyard Walla Walla, The Blues Room, 550 West Rose St., Walla Walla, WA.

Week of November 28th

- Tuesday, November 29, 4 p.m. to 7 p.m., The Grove Hotel, 245 S. Capital Blvd., Boise, ID.
- Thursday, December 1, 4 p.m. to 7 p.m., Town Hall, Great Room, 1119 8th Ave., Seattle, WA.

Week of December 5th

- Tuesday, December 6, 4 p.m. to 7 p.m., The Columbia Gorge Discovery Center, River Gallery Room, 5000 Discovery Drive, The Dalles, OR.
- Wednesday, December 7, 4 p.m. to 7 p.m., Oregon Convention Center, 777 NE Martin Luther King Jr. Blvd., Portland, OR.
- Thursday, December 8, 4 p.m. to 7 p.m., The Loft at the Red Building, 20 Basin St., Astoria, OR.

Week of December 12th

- Tuesday, December 13, 2016, 10 a.m. to 11:30 a.m., and 3 p.m. to 4:30 p.m., PST, webinar. For those that cannot participate in person, an online webinar will be provided to interested parties. The webinar will cover the material discussed in the in-person public scoping meetings. Detailed instructions on how to participate in the webinar may be found on the project website at www.crso.info.

All comments need to be submitted by January 17, 2017. Should you need additional information, do not hesitate to contact www.crso.info or call: 1-800-290-5033. Thank you for your participation. We look forward to working with you on this important effort.

On behalf of the Action Agencies,
Sincerely,

David J. Ponganis, SES
Director, Programs

Appendix C

News Releases and Other Publications

Columbia River System Operations press releases were issued during the project scoping period and copies of each are presented on the ensuing pages of this appendix. The press release titles and issue dates are listed in Table C.1. In addition, various local and regional news articles, editorials, news programs, and letters to the editor were published concerning the scoping action (Table C.2).

Table C.1. Press Releases Issued by the Action Agencies During Scoping

Federal Agencies Begin Scoping Process for Columbia River System Operations EIS	9/30/2016
Federal Agencies to Hold Nine More Scoping Meetings for Columbia River System Operations EIS	11/09/2016
Federal Agencies to Host Two Webinars December 13 for Columbia River System Operations EIS	12/01/2016
Federal Agencies Postpone Astoria Public Scoping Meeting for Columbia River System Operations EIS	12/12/2016
Federal Agencies Postpone Astoria Public Scoping Meeting for Columbia River System Operations EIS	12/15/2016
Scoping Comment Period Extended for Columbia River System Operations EIS	12/23/2016
Update on Columbia River System Operations EIS Scoping Comments	3/31/2017

Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

NEWS RELEASE

Contact
Amy Gaskill, U.S. Army Corps of Engineers, (503) 808-3710
Kelly Bridges, Bureau of Reclamation, (208) 378-5020
David Wilson, Bonneville Power Administration, (503) 230-5607

For Release: September 30, 2016

Federal agencies begin scoping process for Columbia River System Operations EIS

PORTLAND, Oregon – The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration have announced their intent to prepare an environmental impact statement (EIS) on the Columbia River System operations and configurations for 14 federal projects in the interior Columbia Basin.

In this Columbia River System Operations EIS, the three agencies will present a reasonable range of alternatives for long-term system operations and evaluate the potential environmental and socioeconomic impacts on flood risk management, irrigation, power generation, navigation, fish and wildlife, cultural resources and recreation.

Beginning today, and concluding Jan. 17, 2017, the agencies are seeking comments through a public scoping period that provides anyone who is interested an opportunity to help the agencies identify issues and concerns that could be analyzed in the EIS. As part of the comment period, the agencies will host public scoping meetings throughout the Northwest at the following locations:

Oct. 24 Wenatchee Community Center 504 S. Chelan Ave. Wenatchee, Wash. 4-7 p.m.	Oct. 25 Coulee Dam City Hall 300 Lincoln Ave. Coulee Dam, Wash. 4-7 p.m.	Oct. 26 Priest River Community Center 5399 Highway 2 Priest River, Idaho 4-7 p.m.
Oct. 27 Kootenai River Inn Casino and Spa 7169 Plaza St. Bonners Ferry, Idaho 4-7 p.m.	Nov. 1 Red Lion Hotel Kalispell 20 North Main St. Kalispell, Mont. 4-7 p.m.	Nov. 2 City of Libby, City Hall Ponderosa Room 952 E. Spruce St. Libby, Mont. 4-7 p.m.

Nov. 3 Hilton Garden Inn Missoula 3720 N. Reserve St. Missoula, Mont. 4-7 p.m.	Nov. 14 The Historic Davenport Hotel 10 South Post St. Spokane, Wash. 4-7 p.m.	Nov. 16 Red Lion Lewiston Seaport Room 621 21st St. Lewiston, Idaho 4-7 p.m.
Nov. 17 Courtyard Walla Walla The Blues Room 550 West Rose Street Walla Walla, Wash. 4-7 p.m.	Nov. 29 The Grove Hotel 245 S. Capitol Blvd. Boise, Idaho 4-7 p.m.	Dec. 1 Town Hall Great Room 1119 8th Ave. Seattle, Wash. 4-7 p.m.
Dec. 6 The Columbia Gorge Discovery Center River Gallery Room 5000 Discovery Drive The Dalles, Ore. 4-7 p.m.	Dec. 7 Oregon Convention Center 777 NE Martin Luther King Jr. Blvd. Portland, Ore. 4-7 p.m.	Dec. 8 The Loft at the Red Building 20 Basin St. Astoria, Ore. 4-7 p.m.

Additionally, two webinars will be held Dec. 13, 2016, at 10-11:30 a.m. and 3-4:30 p.m. PST. Information and links to the webinar will be provided on the project website.

For more information about the Columbia River System Operations EIS, please visit www.crso.info. Information is also available by calling 800-290-5033, though official comments are not accepted over the phone. Written comments may be submitted at any of the public meetings or mailed to U.S. Army Corps of Engineers, Attn: CRSO EIS, P.O. Box 2870, Portland, Oregon 97208-2870. Emailed comments should be sent to comment@crso.info.

When submitting comments, please be aware that your entire comment including your name, address and email will become part of the public record.

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Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

NEWS RELEASE

Contact
Amy Gaskill, U.S. Army Corps of Engineers, (503) 808-3710
Kelly Bridges, Bureau of Reclamation, (208) 378-5020
David Wilson, Bonneville Power Administration, (503) 230-5607

For Release: Nov. 9, 2016

Federal Agencies to hold nine more scoping meetings for Columbia River System Operations EIS

PORTLAND, Oregon – About 300 people attended one of seven scoping meetings regarding the operation of 14 federal hydropower projects in the Columbia Basin. Nine more meetings and two webinars will be convened before the public comment period closes January 17, 2017, on the Columbia River System Operations (CRSO) Environmental Impact Statement (EIS).

Hosted by the U.S. Army Corps of Engineers (Corps), the Bureau of Reclamation (Reclamation) and the Bonneville Power Administration (BPA), the open-house style meetings include more than a dozen learning stations, staffed by agency subject matter experts. The public comment period began on Sept. 30, 2016. Together the Corps, Reclamation, and BPA are using the scoping meetings to solicit public input on CRSO impacts such as flood risk management, irrigation, power generation, navigation, fish and wildlife, cultural resources, recreation and socioeconomic interests.

The agencies will accept comments until January 17, 2017, after which they will analyze the comments and develop a reasonable range of alternatives for long-term system operations. The range of alternatives will be further analyzed in the EIS draft that is expected to be completed by 2020 with a final due in 2021.

To date, the agencies have hosted scoping meetings at Wenatchee and Coulee Dam, Washington; Priest River and Bonners Ferry, Idaho and Kalispell, Libby and Missoula, Montana. A meeting in Pasco, Washington was added to the schedule.

Nov. 14 The Historic Davenport Hotel 10 South Post St. Spokane, Wash. 4-7 p.m.	Nov. 16 Red Lion Lewiston Seaport Room 621 21st St. Lewiston, Idaho 4-7 p.m.	Nov. 17 Courtyard Walla Walla The Blues Room 550 West Rose Street Walla Walla, Wash. 4-7 p.m.

Nov. 21 Holiday Inn Express Vineyard Ballroom 4525 Convention Place Pasco, Wash. 4-7 p.m.	Nov. 29 The Grove Hotel 245 S. Capitol Blvd. Boise, Idaho 4-7 p.m.	Dec. 1 Town Hall Great Room 1119 8th Ave. Seattle, Wash. 4-7 p.m.
Dec. 6 The Columbia Gorge Discovery Center River Gallery Room 5000 Discovery Drive The Dalles, Ore. 4-7 p.m.	Dec. 7 Oregon Convention Center 777 NE Martin Luther King Jr. Blvd. Portland, Ore. 4-7 p.m.	Dec. 8 The Loft at the Red Building 20 Basin St. Astoria, Ore. 4-7 p.m.

Two webinars, December 13, 2016 from 10-11:30 a.m. and 3-4:30 p.m. PDT are being hosted for those who are unable to attend one of the 16 meetings. Information and links to the webinars will be provided on the project website (www.crso.info).

For more information about the CRSO EIS, please visit www.crso.info. Information is also available by calling 800-290-5033. Although official comments are not accepted over the phone, written comments may be submitted at any of the public meetings or mailed to U.S. Army Corps of Engineers, Attn: CRSO EIS, P.O. Box 2870, Portland, Oregon 97208-2870. Emailed comments should be sent to comment@crso.info.

When submitting comments please be aware that your entire comment including your name, address and email will become part of the public record.

###

Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

NEWS RELEASE

Contact:
Amy Gaskill, U.S. Army Corps of Engineers, 503-808-3710
Kelly Bridges, Bureau of Reclamation, 208-378-5020
David Wilson, Bonneville Power Administration, 503-230-5607

For Release: December 1, 2016

Federal Agencies to Host Two Webinars December 13 for Columbia River System Operations EIS

PORTLAND, Oregon – The U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration will host two public scoping webinars December 13 from 10 to 11:30 a.m. and 3 to 4:30 p.m. PST on the operation of 14 federal hydropower projects in the Columbia River Basin.

These electronic meetings are being hosted for those who are unable to attend one of the 16 face-to-face meetings scheduled across the Pacific Northwest from October 24 through December 8. A presentation on current system operations will be provided with a question and answer session following. Once the webinar has concluded, participants can then submit comments in one of three ways as discussed below.

Comments will be accepted through January 17, 2017, and can be submitted through the online comment form, via email at comment@crso.info, or mailed to U.S. Army Corps of Engineers, Attn: CRSO EIS, P.O. Box 2870, Portland, Oregon 97208-2870.

The call-in information for the morning webinar is as follows:
The conference begins at 10:00 AM Pacific Time on December 13, 2016; you may join 10 minutes prior.
Step 1: http://ems7.intellor.com/login/708750
Step 2: Enter Web Access ID hand578dhtkv
Step 3: Instructions for connecting to conference audio will then be presented on your computer.

You will be connected to the webinar with the AT&T Connect Web Participant Application; there is no software download or installation required.
If you are unable to connect to the conference by computer, you may listen by telephone only at 1-877-369-5243.
If you need technical assistance, please call the AT&T Help Desk at 1-888-796-6118 or 1-847-562-7015.

The call-in information for the afternoon webinar is as follows:
The conference begins at 3:00 PM Pacific Time on December 13, 2016; you may join 10 minutes prior.

Step 1: http://ems7.intellor.com/login/708737
Step 2: Enter Web Access ID hand578dhtkv
Step 3: Instructions for connecting to conference audio will then be presented on your computer.

You will be connected to the webinar with the AT&T Connect Web Participant Application; there is no software download or installation required.
If you are unable to connect to the conference by computer, you may listen by telephone only at 1-877-369-5243.
If you need technical assistance, please call the AT&T Help Desk at 1-888-796-6118 or 1-847-562-7015.

For more information about the Columbia River System Operations EIS, please visit www.crso.info or call 1-800-290-5033. Comments will not be accepted over the phone.

When submitting comments, please be aware that your entire comment, including your name, address, and email will become part of the public record.

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Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

MEDIA ADVISORY — Dec. 15, 2016

Federal agencies postpone Astoria public scoping meeting for Columbia River System Operations EIS

Who: U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration

What: The Dec. 8 Astoria Public Scoping meeting for Columbia River System Operations EIS was postponed due to anticipated inclement weather. The new date and time are listed below.

When and Where:

December 15
4 p.m. to 7 p.m.
The Loft at the Red Building
20 Basin St.
Astoria, Oregon

Instructions: For more information on this change please contact one of three media representatives: Amy Gaskill, U.S. Army Corps of Engineers, 503-808-3710; David Walsh, Bureau of Reclamation, 208-378-5020; or David Wilson, Bonneville Power Administration, 503-230-5607.

Background: As part of the CRSO environmental review, the three federal agencies are holding 16 public scoping meetings in the fall of 2016. Two webinars will also be held Tuesday, December 13 from 10 to 11:30 a.m. and 3 to 4:30 p.m. PST. The CRSO public scoping process ends, Jan. 17, 2017.

To learn more about the public scoping process, how to submit public comments and the preparation of the Columbia River System Operations EIS, please visit www.crso.info.

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Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

MEDIA ADVISORY — Dec. 15, 2016

Federal agencies postpone Astoria public scoping meeting for Columbia River System Operations EIS

Who: U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration

What: The Dec. 15 Astoria Public Scoping meeting for Columbia River System Operations EIS is postponed due to inclement weather. A new date and time has not been set but will likely be after Jan. 6, 2017.

Instructions: For more information on this change please contact one of three media representatives: Amy Gaskill, U.S. Army Corps of Engineers, 503-808-3710; David Walsh, Bureau of Reclamation, 208-378-5020; or David Wilson, Bonneville Power Administration, 503-230-5607.

Background: As part of the CRSO environmental review, the three federal agencies have held 15 public scoping meetings and two webinars in the fall of 2016. The CRSO public scoping process ends, Jan. 17 2017.

To learn more about the public scoping process, how to submit public comments and the preparation of the Columbia River System Operations EIS, please visit www.crso.info.

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Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

Amy Gaskill, U.S. Army Corps of Engineers, (503) 808-3710
David Walsh, Bureau of Reclamation, (208) 378-5020
David Wilson, Bonneville Power Administration, (503) 230-5607

For Release: 23 December 2016

Scoping Comment Period Extended for Columbia River System Operations EIS

PORTLAND, Oregon – The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration are extending the public scoping comment period for the Columbia River System Operations Environmental Impact Statement (EIS) by 3 weeks.

The previous comment period deadline was Jan. 17, 2017, and will now be extended to Feb. 7, 2017.

"Scoping comments from the public are a vital part of the EIS process, "said U.S. Army Corps of Engineers Northwestern Division Commander Major General Scott A. Spellmon. "We want to be sure the public has a chance to weigh in on the alternatives and impacts to be studied," he said.

Since Oct. 24, the three Action Agencies have held 15 public scoping meetings and two webinars across the Pacific Northwest. During this period the public and stakeholders were able to gather information and provide comment on the Columbia River System Operations and configurations for 14 federal projects in the interior Columbia Basin.

Comments collected during the scoping meetings, either in person, online or by mail will help inform a range of alternatives and impacts to resources for evaluation in the EIS. The agencies are committed to considering all regional perspectives and to running an open and transparent public process. To that end, the action agencies will continue to provide opportunities for meaningful engagement and dialogue with the region after the scoping comment period closes. A draft EIS will be completed and available for public review no later than spring 2020.

For more information about the Columbia River System Operations EIS, please visit www.crso.info. Written comments may be submitted by mail Attn: CRSO EIS, P.O. Box 2870, Portland, Oregon 97208-2870. Emailed comments should be sent to comment@crso.info. Information is also available by calling 800-290-5033, though official comments are not accepted over the phone.

When submitting comments, please be aware that your entire comment including your name, address and email will become part of the public record.

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Environmental Impact Statement P.O. Box 2870, Portland, OR 97208-2870 1-800-290-5033

U.S. ARMY CORPS OF ENGINEERS DEPARTMENT OF THE ARMY | BUREAU OF RECLAMATION DEPARTMENT OF THE INTERIOR | BONNEVILLE POWER ADMINISTRATION DEPARTMENT OF ENERGY

NEWS RELEASE For Release: March 31, 2017

Contact:
Amy Gaskill, U.S. Army Corps of Engineers, 503-808-3710
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David Wilson, Bonneville Power Administration, 503-230-5607

Update on Columbia River System Operations EIS Scoping Comments

More than 2,300 people attended a series of public meetings and webinars provided by the U.S. Army Corps of Engineers, Bonneville Power Administration, and the Bureau of Reclamation (Action Agencies) regarding the environmental impact statement (EIS) the Action Agencies are developing for the operations and maintenance of the Columbia River System (CRSO EIS).

The meetings were held throughout the Pacific Northwest from Oct 24, 2016 through Jan 9, 2017. The CRSO includes 14 federal dams and their related facilities located in the interior Columbia and Snake River Basins that are operated in a coordinated manner for multiple purposes.

During the four month public comment period, the Action Agencies urged members of the public to provide input on the scope of issues, potential effects, and range of alternatives to evaluate in the draft EIS. Together, the Action Agencies received 393,352 comments.

Some topics the public suggested for study include:

- Dam breaching
- Dam construction
- Operational changes
- Transportation analysis
- Recreational opportunities
- Replace hydropower generation with other sources of energy generation
- Increase hydropower generation
- Fish passage (non-structural)
- Fish management actions

The Action Agencies are producing the CRSO EIS to fulfill our National Environmental Policy Act responsibilities. Once completed, the CRSO EIS will describe the impacts associated with the long-term future operation and configuration of the Columbia River System projects.

To ensure stakeholders and other members of the public are kept informed during the CRSO EIS process, the Action Agencies plan to provide periodic updates through newsletters, fact sheets and dynamic content to the www.crso.info website. A draft CRSO EIS is expected by early 2020. The final EIS is expected in 2021.

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Table C.2. Publications Concerning CRSO Scoping

Date	Affiliation	Title	Link
1/26/2017	King-5	Snake River dams examined after decades of lawsuits	http://www.king5.com/tech/science/environment/snake-river-dams-examined-after-decades-of-lawsuits/393726964
1/19/2017	Pullman Daily News	Dams: To keep or to breach?	http://dnews.com/local/dams-to-keep-or-to-breach/article_e901fb00-5681-5389-a4ec-98381f6e33db.html
1/17/2017	The Daily News	Removing dams could affect Cowlitz industries, electric rates	http://tdn.com/news/local/removing-dams-could-affect-cowlitz-industry-electric-rates/article_6347b242-b7df-5233-8b13-ac42fd8be9b6.html
1/12/2017	Tri-City Herald	Letter: Lower four Snake River Dams are not the problem	http://www.tri-cityherald.com/opinion/letters-to-the-editor/article125972084.html
1/9/2017	The Guardian	Dams be damned, let the world's rivers flow again	https://www.theguardian.com/global-development-professionals-network/2017/jan/09/dams-building-let-rivers-flow
1/2/2017	Bend Bulletin	Historical sites enter debate over dams	http://www.bendbulletin.com/localstate/4947753-151/historical-sites-enter-debate-over-dams
12/30/2016	Tri-City Herald	Letter: Breaching Snake River dams would cause incalculable harm	http://www.tri-cityherald.com/opinion/letters-to-the-editor/article123610824.html
12/25/2016	Tri-City Herald	Letter: Snake Dams have decimated salmon productivity	http://www.tri-cityherald.com/opinion/letters-to-the-editor/article122813404.html
12/22/2016	Coeur d'Alene/ Post Falls Press	Keep our Snake River Dams	http://www.cdapress.com/archive/article-7248453e-7350-5a61-9c66-2dada69bf3ee.html
12/7/2016	Idaho Statesman	Lower Snake River farmers seek federal ruling to allow Idaho salmon to go extinct	http://www.idahostatesman.com/news/local/news-columns-blogs/letters-from-the-west/article119599948.html
12/7/2016	Sequim Gazette	Brunell: Removing Snake Dams is unwise	http://www.sequimgazette.com/opinion/brunell-removing-snake-river-dams-is-unwise/
12/6/2016	PRNE News Wire	Groups urge Trump Administration to protect lower Snake River dams in	http://www.prnewswire.com/news-releases/groups-urge-trump-administration-to-protect-lower-snake-river-dams-in-washington-state-300373609.html?wb48617274=E2AF4723

Date	Affiliation	Title	Link
		Washington State	
12/5/2016	Oregonian	Portland meeting on future of Snake River dams expected to draw big crowd	http://www.oregonlive.com/environment/index.ssf/2016/12/portland_meeting_on_future_of.html
11/29/2016	Forbes	Will removing large dams on the Snake River help salmon?	http://www.forbes.com/forbes/welcome/?toURL=http://www.forbes.com/sites/jamesconca/2016/11/29/will-removing-large-dams-on-the-snake-river-help-salmon/&refURL=&referrer=
11/27/2016	Tri-City Herald	Guest column: Breaching dams won't help Orcas	http://www.tri-cityherald.com/opinion/opn-columns-blogs/article117168133.html
11/25/2016	Idaho Statesman	Chris Carlson Commentary: Here's my idea for breaching the dams; what's yours?	http://lmtribune.com/opinion/here-s-my-idea-for-breaching-the-dams-what-s/article_59438323-310e-5054-84cd-46652e6d27b4.html
11/23/2016	Tri-City Herald	Letter: Snake River dams are vital part of state's economy	http://www.tri-cityherald.com/opinion/letters-to-the-editor/article116478368.html
11/19/2016	myfoxtricities.com	Public meeting to discuss Snake River dams	http://www.myfoxtricities.com/public-meeting-held-to-discuss-the-situation-involving-snake-river-dams/ No long available
11/21/2016	Tri-City Herald	People passionate about saving Snake River dams	http://www.tri-cityherald.com/news/local/article116355413.html
11/21/2016	OPB Radio	Courtney Flatt: Why the northwest is debating dams on the Snake River (again)	http://www.opb.org/news/article/future-of-the-snake-river-dams/
11/21/2016	Defenders of Wildlife	Public Hearing on orcas, salmon and Seattle	http://www.defenders.org/event/public-hearing-orcas-salmon-seattle No longer available
11/21/2016	KEPR TV	River OPS Meeting	http://mms.tveyes.com/Transcript.asp?StationID=4360&DateTime=11%2F21%2F2016+6%3A05%3A33+PM&Term=Bonneville+Power&PlayClip=TRUE No longer available.
11/20/2016	Tri-City Herald	Our Voice: Snake River dams in peril, so speak up	http://www.tri-cityherald.com/opinion/editorials/article116010548.html
11/20/2016	Seattle Times	Irrigators ask Trump for 'God Squad' as Snake River dam breaching floated	http://www.seattletimes.com/seattle-news/environment/irrigators-ask-trump-for-god-squad-as-snake-river-dam-breaching-floated/

Date	Affiliation	Title	Link
11/19/2016	Capital Press	Breaching Snake River dams would 'devastate' wheat industry, growers say	http://www.capitalpress.com/Idaho/20161120/breaching-snake-river-dams-would-devastate-wheat-industry-growers-say
11/18/2016	The Columbia Basin Bulletin	Hundreds turn out for Lewiston federal scoping meeting regarding draft EIS for Snake River Dams	http://www.cbbulletin.com/437988.aspx
11/17/2016	Spokesman Review	Big crowd turns out in Spokane to talk about lower Snake River dams	http://www.spokesman.com/stories/2016/nov/14/big-crowd-turns-out-in-spokane-to-talk-about-lower/#/0
11/17/2016	Spokesman Review	Snake River dams meetings raise flood of interest	http://www.spokesman.com/blogs/outdoors/2016/nov/17/snake-river-dams-meetings-raise-flood-interest/
11/16/2016	KPQ Radio	Dams on the Snake River?	http://kpq.com/dams-snake-river/
11/16/2016	Idaho Statesman	Dam Removal is poised for a breakthrough	http://www.idahostatesman.com/opinion/readers-opinion/article114829658.html
11/15/2016	East Oregonian,	Region depends on Columbia-Snake River system	http://www.eastoregonian.com/eo/columnists/20161115/region-depends-on-columbia-snake-river-system
11/15/2016	East Oregonian	Meeting to weigh in on Columbia River system	http://www.eastoregonian.com/eo/local-news/20161115/meeting-to-weigh-in-on-columbia-river-system
11/15/2016	OPB Radio	Conservation groups ask for changes to Snake River Dams Hearings	http://www.opb.org/news/article/conservation-groups-ask-for-changes-to-snake-river-dams-hearings/
11/15/2016	Public News Service	lower Snake River Dams, Nez Perce Treaty Rights at Issue	https://www.nmtribune.com/lower-snake-river-dams-nez-perce-treaty-rights-at-issue/. No longer available
11/15/2016	KXLY TV	Removing Snake Dams	http://mms.tveyes.com/Transcript.asp?StationID=3560&DateTime=11%2F14%2F2016+6%3A50%3A10+PM&Term=Bonneville+Power&PlayClip=TRUE. No longer available
11/15/2016	KPVI TV	Meeting on Snake River Dam Removal	http://mms.tveyes.com/Transcript.asp?StationID=5225&DateTime=11%2F15%2F2016+6%3A39%3A15+AM&Term=Bonneville+Power&PlayClip=TRUE. No longer available
11/13/2016	Spokesman Review	Columbia, Snake dams topic of public meetings	http://www.spokesman.com/stories/2016/nov/13/columbia-snake-dams-topic-of-public-meetings/

Date	Affiliation	Title	Link
11/12/2016	Tri-City Herald	Under pressure, Corps adds dam meeting in Tri-Cities	http://www.tri-cityherald.com/news/local/article114468843.html
11/9/2016	Spokesman Review	Snake River dams vs salmon hearing in Spokane on Monday	http://www.spokesman.com/blogs/outdoors/2016/nov/09/snake-river-dams-vs-salmon-hearing-spokane-monday/
11/6/2016	Idaho Statesman	Judge's order revives movement to remove dams	http://www.idahostatesman.com/news/state/idaho/article112912313.html. No longer available.
11/3/2016	National Resources Defense Council	Without salmon, we lose our killer whales	https://www.nrdc.org/experts/giulia-cs-good-stefani/without-salmon-we-lose-our-killer-whales
11/2/2016	Peninsula Daily News	PAT NEAL: Dam removal a whale of an issue -	http://www.peninsuladailynews.com/opinion/pat-neal-dam-removal-a-whale-of-an-issue/
11/2/2016	Chiwulff.com	Throw your two cents in on the Snake River Dams	http://chiwulff.com/2016/11/02/throw-your-two-cents-in-on-the-snake-river-dams/
11/2/2016	Priest River Times	Feds come to town to gather input	http://www.priestrivertimes.com/article/20161102/ARTICLE/161109997
11/2/2016	Kpax.com	Dam hearings come to Western Montana	http://www.kpax.com/story/33594221/dam-hearings-come-to-western-montana
11/1/2016	AgInfo net	Public meetings to discuss scope of Columbia River System	http://aginfo.net/index.cfm/report/id/Farm-and-Ranch-Report-35543
10/31/2016	Flathead Beacon	Federal agencies examining Columbia River Dam operations	http://flatheadbeacon.com/2016/10/31/federal-agencies-examining-columbia-river-dam-operations/
10/28/2016	Christian Science Monitor and AP	Puget Sound orcas: Would removing dams save the whales?	http://www.csmonitor.com/Environment/2016/1029/Puget-Sound-orcas-Would-removing-dams-save-the-whales
10/28/2016	Tribal Tribune	Federal agencies to host scoping meetings	http://www.tribaltribune.com/news/article_9f8a0e74-9d1e-11e6-81ca-3366e8fd7b0b.html
10/27/2016	Spokesman Review	Feds release recovery plan for Snake River chinook and steelhead	http://www.spokesman.com/stories/2016/oct/27/feds-release-recovery-plan-for-snake-river-chinook/

Date	Affiliation	Title	Link
10/27/2016	Char-Koosta News	Agencies preparing environmental impact statement	http://www.charkoosta.com/2016/2016_10_27/EIS.html
10/26/2016	Natural Resource Report	Ag Action Call over Columbia Basin plan	http://naturalresourcereport.com/2016/10/ag-action-call-over-columbia-basin-plan/
10/25/2016	Capital Press	Ag voices must be heard on Columbia River System, group says	http://www.capitalpress.com/Water/20161025/ag-voices-must-be-heard-on-columbia-river-system-group-says
10/25/2016	Wenatchee World	Feds begin meeting tour on salmon-protection plans	http://www.wenatcheeworld.com/news/2016/oct/25/feds8217-salmon-outreach-long-on-content-short-on-context/
10/24/2016	Spokesman Review	Pressure mounts on lower Snake dams as fish runs sag	http://www.spokesman.com/stories/2016/oct/24/pressure-mounts-on-lower-snake-dams-as-fish-runs-s/
10/24/2016	Spokesman Review	Lower Snake River Dams have a long history of controversy	http://www.spokesman.com/stories/2016/oct/24/lower-snake-river-dams-have-a-long-history-of-cont/
10/22/2016	Spokesman Review	Nancy Hirsh: We can restore salmon and have carbon-free energy	http://www.spokesman.com/stories/2016/oct/22/we-can-restore-salmon-and-have-carbon-free-energy/
10/21/2016	OPB	Taking down Snake River Dams: It's back on the table	http://www.opb.org/news/article/taking-down-snake-river-dams-on-table/
10/19/2016	Priest River Times	River OPS meeting set	http://www.priestrivertimes.com/article/20161019/ARTICLE/161019947
10/19/2016	The Star	A federal review of the entire river will be worth watching	http://www.grandcoulee.com/story/2016/10/19/opinion/a-federal-review-of-the-entire-river-will-be-worth-watching/7971.html
10/17/2016	Seattle Times	Environmental effects of Columbia, Snake River Dams scrutinized	http://www.seattletimes.com/seattle-news/environment/environmental-effects-of-columbia-snake-river-dams-scrutinized/
10/12/2016	Forbes	Global warming versus salmon: Dam if You Do, Dam if You Don't	http://www.forbes.com/sites/jamesconca/2016/10/12/global-warming-versus-salmon-dam-if-you-do-dam-if-you-dont/#2a63ed8b614e

Date	Affiliation	Title	Link
10/7/2016	Columbia Basin Bulletin	Agencies seek public scoping comments for EIS related to new basin salmon/steelhead recovery plan	http://www.cbbulletin.com/437702.aspx
10/4/2016	The Idaho Statesman	Will federal agencies' review of Columbia, Snake dams lead to removal?	http://www.idahostatesman.com/news/local/news-columns-blogs/letters-from-the-west/article105835657.html
10/03/2016	newsdata.com	Analysis: How might the Columbia's hydro system be altered to strengthen fish rebuilding?	http://www.newsdata.com/fishletter/362/2story.html
10/03/2016	Greenwire.com	Ruling prompts debate on dam removal - Staff	No link, full article in "summary" section
10/2/2016	The Register Guard	A federal judge is forcing discussion of a radical step to save endangered salmon: taking out four dams on the lower Snake River -- Becky Kramer	http://projects.registerguard.com/apf/ore/wa-salmon-habitat-restoration/. No longer available
10/2/2016	Bonner County Daily Bee	Updated EIS sought for Columbia River dams	http://www.bonnercountydailybee.com/local_news/20161002/updated_eis_sought_for_columbia_river_dams
10/01/2016	Lewiston Tribune	Feds Taking Comments on Plan for Snake-Columbia Dams: Planned environmental statement expected to take five years to complete	http://lmtribune.com/northwest/feds-taking-comments-on-plan-for-snake-columbia-dams/article_ad452e2b-7935-5bcc-af01-b9ddf0ea072a.html
9/30/2016	Earthjustice	Feds announce hearings for public to weigh in on lower Snake River dam removal	http://earthjustice.org/news/press/2016/feds-announce-hearings-for-public-to-weigh-in-on-lower-snake-river-dam-removal

Date	Affiliation	Title	Link
9/30/2016	Idaho Rivers United	Unfolding comment period give Idahoans a voice for salmon	http://www.idahorivers.org/newsroom/2016/9/30/upcoming-hearings-will-give-idahoans-a-voice-for-salmon
9/30/2016	Spokesman Review	Feds asking public to weigh in on breaching Snake River Dams	http://www.spokesman.com/stories/2016/sep/30/should-lower-snake-river-dams-be-breached/

Appendix D

Newspaper Advertisements

The U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and the Bonneville Power Administration issued a series of advertisements in local newspapers to announce public meetings regarding the preparation of an environmental impact statement for Columbia River system operations, which are presented on the following pages.

Wenatchee Public Meeting
October 24, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Wenatchee World	Sunday, Tuesday, Friday	10/11/16 (T)	10/16/16 (Su)	10/18/16 (T)
Cashmere Valley Record	Wednesday	10/12/16 (W)	10/19/16 (W)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Monday, October 24, 2016
4 p.m. to 7 p.m.
Wenatchee Community Center
504 S. Chelan Avenue
Wenatchee, Washington

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*

Information is also available by calling 800-290-5033.

Coulee Dam Public Meeting
October 25, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date
Coulee City News Standard	Wednesday	10/12/16 (W)	10/19/16 (W)
The Star	Wednesday	10/12/16 (W)	10/19/16 (W)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Tuesday, October 25, 2016
4 p.m. to 7 p.m.
The Town of Coulee Dam, City Hall
300 Lincoln Avenue
Coulee Dam, Washington

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*

Information is also available by calling 800-290-5033.

Priest River Public Meeting
October 26, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date
Priest River Times	Wednesday	10/12/16 (W)	10/19/16(W)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Wednesday, October 26, 2016
4 p.m. to 7 p.m.
Priest River Community Center
5399 Hwy 2
Priest River, Idaho

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*

Information is also available by calling 800-290-5033.

Bonners Ferry Public Meeting
October 27, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Bonner County Daily Bee	Daily	10/13/16 (Th)	10/20/16 (Th)	10/22/16 (Su)
Bonners Ferry Herald	Thursday	10/13/16 (Th)	10/20/16 (Th)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Thursday, October 27, 2016
4 p.m. to 7 p.m.
Kootenai River Inn Casino & Spa
7169 Plaza Street
Bonners Ferry, Idaho

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*

Information is also available by calling 800-290-5033.

Kalispell Public Meeting
November 1, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Daily Inter Lake	Daily	10/18/16 (Tu)	10/25/16 (Tu)	10/30/16 (Su)
Flathead Beacon	Wednesdays	10/19/16 (W)	10/26/16 (W)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Tuesday, November 1, 2016
4 p.m. to 7 p.m.
Red Lion Hotel Kalispell
20 North Main Street
Kalispell, Montana

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Libby Public Meeting
November 2, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date
The Montanian	Wednesday	10/19/16 (W)	10/26/16 (W)
Western News	Tuesdays, Fridays	10/18/16 (Tu)	10/25/16 (Tu)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Wednesday, November 2, 2016
4 p.m. to 7 p.m.
City of Libby City Hall
952 E. Spruce Street
Libby, Montana

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Missoula Public Meeting
November 3, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Missoula Independent	Thursday	10/20/16 (Th)	10/27/16 (Th)	
The Missoulian	Daily	10/20/16 (Th)	10/27/16 (Th)	10/30/16 (Su)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Thursday, November 3, 2016
4 p.m. to 7 p.m.
Hilton Garden Inn Missoula
3720 N. Reserve Street
Missoula, Montana

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Spokane Public Meeting
November 14, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Cheney Free Press	Thursday	11/3/16 (Th)	11/10/16 (Th)	
Spokesman-Review	Daily	10/31/16 (M)	11/7/16 (M)	11/13/16 (Su)
Spokane Valley News Herald	Friday	11/4/16 (F)	11/11/16 (F)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Monday, November 14, 2016
4 p.m. to 7 p.m.
The Historic Davenport Hotel
10 South Post Street
Spokane, Washington

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Lewiston Public Meeting
November 16, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Lewiston Morning Tribune	Daily	11/2/16 (W)	11/9/16 (W)	11/13/16 (Su)
Moscow Pullman Daily	Monday - Saturday	11/2/16 (W)	11/9/16 (W)	11/12/16 (Sa)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Wednesday, November 16, 2016
4 p.m. to 7 p.m.
Red Lion Hotel Lewiston, Seaport Room
621 21st Street
Lewiston, Idaho

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Walla Walla Public Meeting
November 17, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Tri-City Herald	Daily	11/3/16 (Th)	11/10/16 (Th)	11/13/16 (Su)
Waitsburg Times	Thursday	11/3/16 (Th)	11/10/16 (Th)	
Walla Walla Union-Bulletin	Daily	11/3/16 (Th)	11/10/16 (Th)	11/13/16 (Su)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Thursday, November 17, 2016
4 p.m. to 7 p.m.
Courtyard Walla Walla, The Blues Room
550 West Rose Street
Walla Walla, Washington

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Pasco Public Meeting
November 21, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Hermiston Herald	Wednesday	11/9/16 (W)	11/16/16 (W)	
Tri-City Herald	Daily	11/16/16 (W)	11/18/16 (F)	11/20/16 (Su)
Walla Walla Union Bulletin	Daily	11/18/16 (F)	11/20/16 (Su)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Monday, November 21, 2016
4 p.m. to 7 p.m.
Holiday Inn Express & Suites
4525 Convention Place
Pasco, Washington

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Boise Public Meeting
November 29, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Boise Idaho Statesman	Daily	11/15/16 (Tu)	11/22/16 (Tu)	11/27/16 (Su)

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Tuesday, November 29, 2016
4 p.m. to 7 p.m.
The Grove Hotel
245 S. Capital Blvd.
Boise, Idaho

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Seattle Public Meeting
December 1, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Bellevue Reporter	Friday	11/18/16 (F)		
Seattle Times	Daily	11/17/16 (Th)	11/24/16 (Th)	11/27/16 (Su)
Seattle Weekly	Wednesday	11/16/16 (W)	11/23/16 (W)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

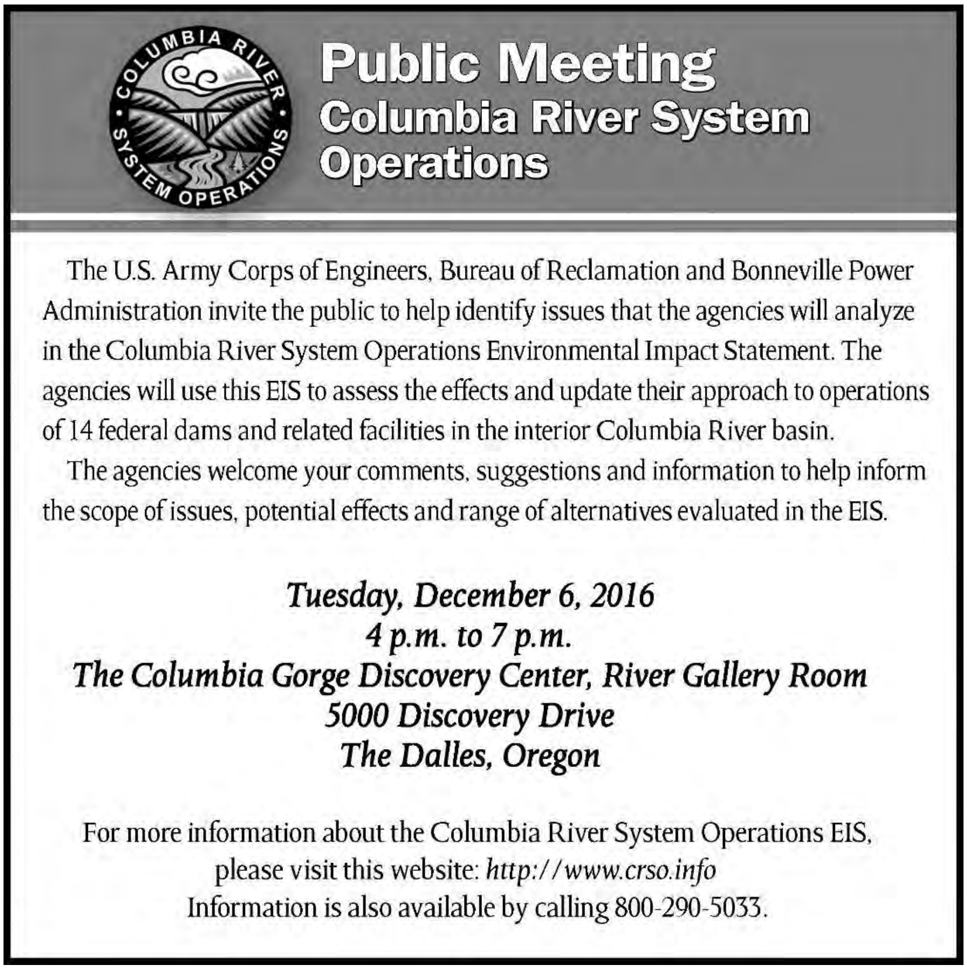
The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Thursday, December 1, 2016
4 p.m. to 7 p.m.
Town Hall, Great Room
1119 8th Avenue
Seattle, Washington

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

The Dalles Public Meeting
December 6, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date
The Dalles Chronicle	Sunday, Tuesday - Friday	11/22/2016 (Tu)	11/29/2016 (Tu)
Hood River News	Wednesday and Saturday	11/23/2016 (W)	11/30/2016 (W)



Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Tuesday, December 6, 2016
4 p.m. to 7 p.m.
The Columbia Gorge Discovery Center, River Gallery Room
5000 Discovery Drive
The Dalles, Oregon

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Portland Public Meeting
December 7, 2016

Newspaper	Publication Cycle	1st Run Date	2nd Run Date	3rd Run Date
Portland Oregonian	Sunday, Wednesday, Friday, Saturday	11/23/2016 (W)	11/30/2016 (W)	
Portland Tribune	Tuesdays, Thursdays	11/22/2016 (Tu)	11/24/2016 (Th)	11/29/2016 (Tu)
Beaverton Valley Times/Tigard Times/Lake Oswego Review/West Linn Review	Thursdays	11/24/2016 (Th)	12/1/16 (Th)	
Hood River News	Wednesday and Saturday	11/23/16 (W)	11/30/2016 (W)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

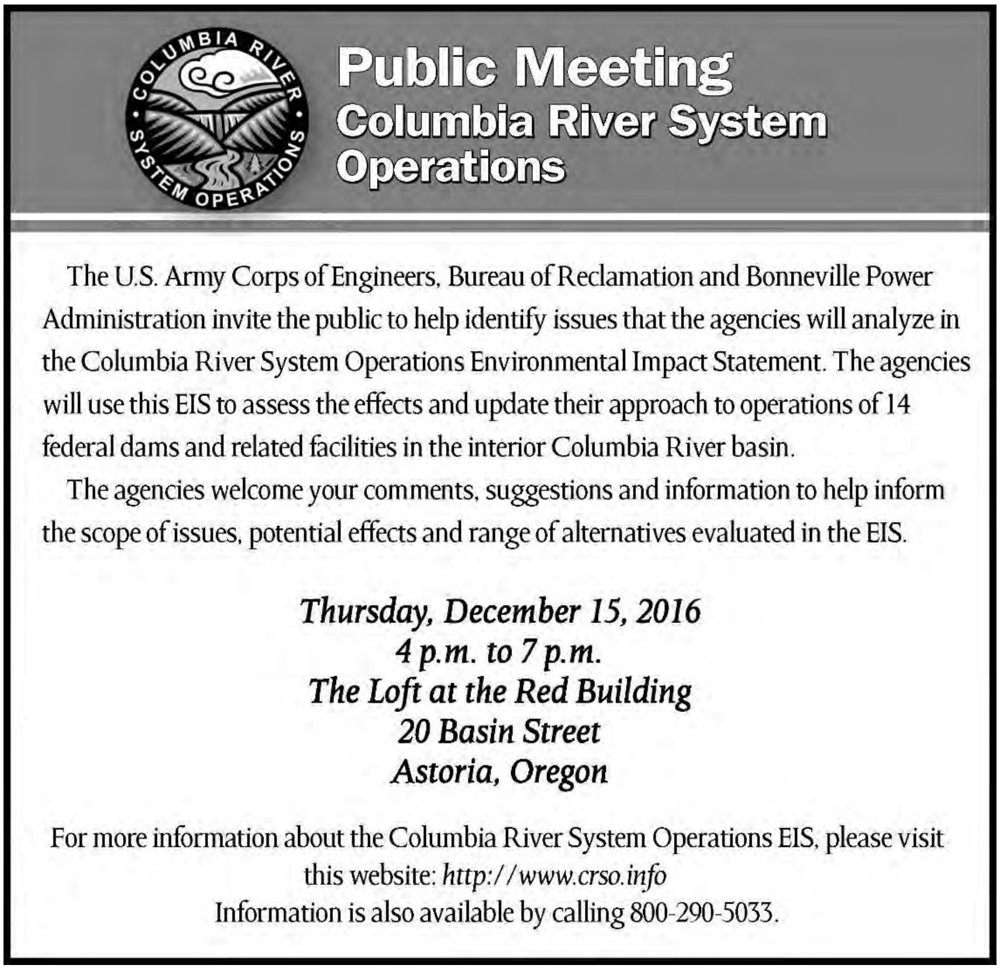
The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Wednesday, December 7, 2016
4 p.m. to 7 p.m.
Oregon Convention Center
777 NE Martin Luther King Jr. Blvd.
Portland, Oregon

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Astoria Public Meeting
December 15, 2016 (Cancelled due to weather)

Newspaper	Publication Cycle	1st Run Date	2nd Run Date
Daily Astorian	Monday–Friday	11/24/16 (Th)	12/1/16 (Th)
Warrenton Columbia Press	Friday	11/25/16 (F)	12/2/16 (F)



Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Thursday, December 15, 2016
4 p.m. to 7 p.m.
The Loft at the Red Building
20 Basin Street
Astoria, Oregon

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Astoria Public Meeting
January 9, 2017

Newspaper	Publication Cycle	1st Run Date	2nd Run Date
Daily Astorian	Monday–Friday	12/30/2016 (F)	1/6/2017 (F)
Warrenton Columbia Press	Friday	1/6/2017 (F)	

Public Meeting
Columbia River System Operations

The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration invite the public to help identify issues that the agencies will analyze in the Columbia River System Operations Environmental Impact Statement. The agencies will use this EIS to assess the effects and update their approach to operations of 14 federal dams and related facilities in the interior Columbia River basin.

The agencies welcome your comments, suggestions and information to help inform the scope of issues, potential effects and range of alternatives evaluated in the EIS.

Monday, January 9, 2017
4 p.m. to 7 p.m.
The Loft at the Red Building
20 Basin Street
Astoria, Oregon

For more information about the Columbia River System Operations EIS, please visit this website: *http://www.crso.info*
Information is also available by calling 800-290-5033.

Appendix E

Scoping Meeting Handout

Public meetings were held to provide information on how the co-leads currently manage the Columbia River system, to allow the public to engage in dialog with subject matter experts from the agencies, and to communicate how the public could contribute their comments and ideas on what should be included in the environmental impact statement. An open house guide was distributed to attendees at each scoping meeting, providing information and guidance as to the scoping process and procedures, as well as the topics to be included in the environmental impact statement. A copy of the guide is provided on the following two pages.

Open House Guide

Today's meeting is to provide you with detailed information on the process we are undertaking, the current system operations, and how the system is used to meet multiple purposes. It is important because we want to make sure you have the information you need to share your ideas on what we should consider in the environmental impact statement (EIS). The EIS will evaluate and update the Agencies' (U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration) approach to long-term system operations and dam configuration through a thorough analysis of alternatives to current practices.

Please stop by and watch the video, then visit with the subject matter experts we have brought along. They are prepared to provide you more information on the following topics:

NEPA
Public participation in the development of an EIS is required by the National Environmental Policy Act (NEPA). The public is encouraged to comment and provide feedback on the potential impacts of Columbia River System Operations (CRSO) operations and configurations.

Cultural Resources
The Agencies seek input regarding steps to avoid, minimize, or mitigate adverse effects that would result from changes in system operations as required under the National Historic Preservation Act.

System Overview
The Columbia River Basin is a large and complex system that supports regional and tribal economies, wildlife, flood risk management, hydropower, navigation, irrigation, recreation, water quality, and fish migration.

Flood Risk Management
Flooding associated with natural weather events in the past had severe consequences. The CRSO provides for flood control through storage and release operations at dams and reservoirs.

Hydropower
The CRSO provides hydropower energy, and is a flexible and sustainable energy resource that provides energy to meet continuous and peak demand needs.

Irrigation
The Bureau of Reclamation delivers irrigation water to the Columbia Basin Project and other smaller projects. This irrigation water supports crops such as grapes, hops, fruit trees, potatoes, sweet corn, onions, and alfalfa.

Navigation
The Columbia River System supports both commercial and recreational vessel navigation. Recreational boaters can enjoy the entire river system, and commercial goods can be transported between the Pacific Ocean and inland ports in Washington and Idaho.

Fish and Wildlife Conservation
The Agencies implement fish and wildlife conservation, protection, and mitigation activities in compliance with the Endangered Species Act, Clean Water Act, and the Northwest Power Act.

Recreation
Residents in the Northwest enjoy many recreational opportunities associated with Federal project reservoirs and lands throughout the Columbia River Basin.

Climate Change
The Columbia River Basin will continue to have fluctuations in temperature and snowpack, which require adaptation to these changing conditions in the future.

Water Quality
Water quality is important for the health of aquatic species that reside in Columbia River Basin waters. The Agencies operate the Columbia River Basin dams to manage temperatures and total dissolved gas, and monitor other water quality parameters such as nutrients and dissolved oxygen.

Endangered Species Act Listed Fish and Lamprey Information
Partnerships among government and tribal entities, non-governmental and private organizations are critical to restoring healthy salmon runs and securing the economic and cultural benefits they provide.

CRSO Projects
Authorized purposes for CRSO dams include flood control, navigation, hydropower, irrigation, recreation, and support fish & wildlife.

The U.S. Army Corps of Engineers, Northwestern Division, Bureau of Reclamation, and Bonneville Power Administration (collectively, the Agencies) are the co-leads in preparation of an EIS under NEPA on CRSO operations and configurations for 14 Federal projects in the interior Columbia Basin. The Agencies request your assistance in gathering information that will help define the issues, concerns, and the scope of alternatives addressed in the EIS. Information will be gathered from interested parties during the scoping period beginning September 30, 2016, and ending January 17, 2017.

The Agencies welcome your comments, suggestions, and information that may inform the scope of issues, potential effects, and range of alternatives evaluated in the EIS. Comments may also be submitted at public scoping meetings at the Comment station.

Comments or inquiries can also be submitted:

By online comment submission: http://www.crso.info

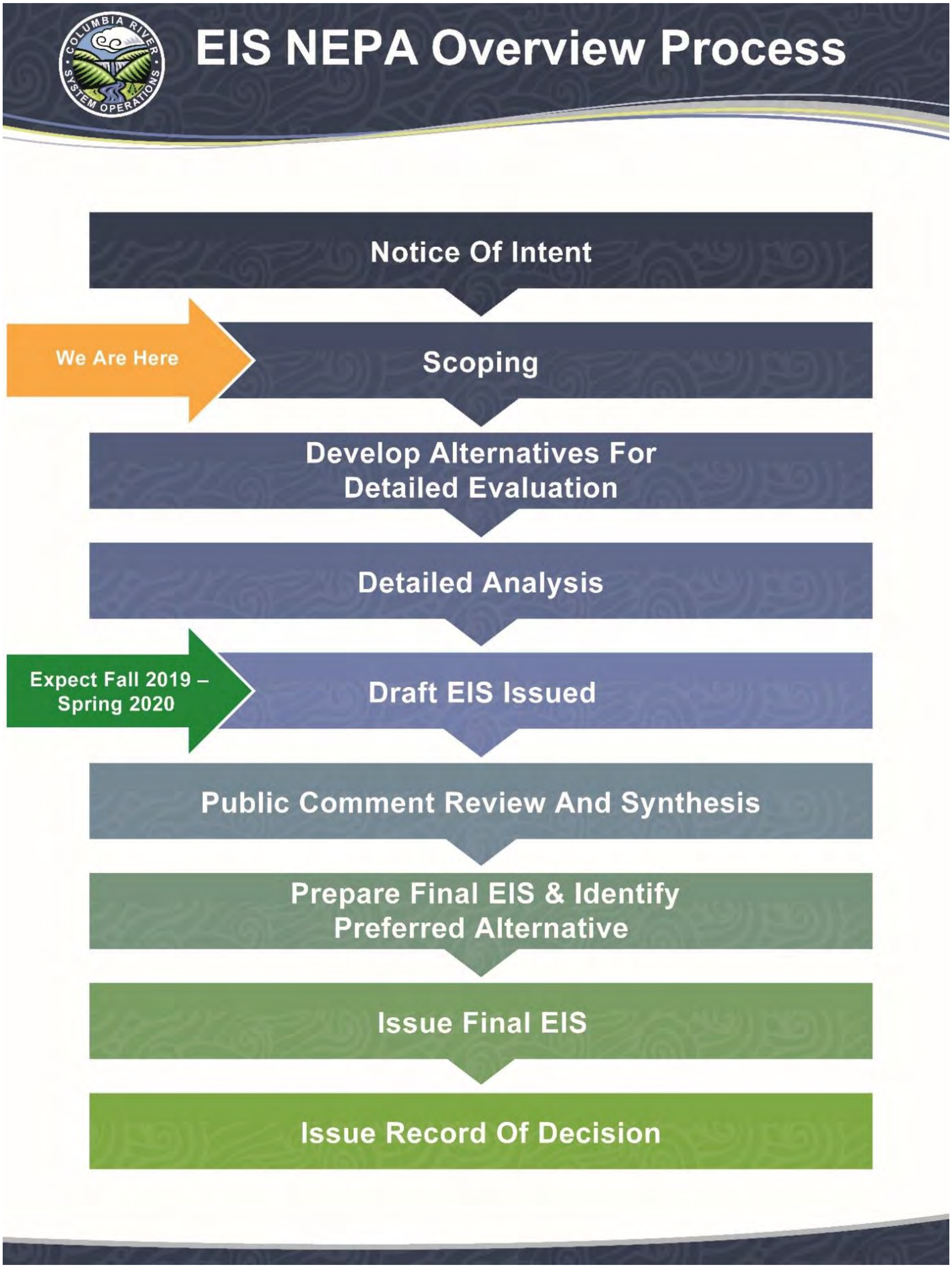
By email to comment@crso.info

By mail addressed to:
U.S. Army Corps of Engineers, Northwestern Division,
Attn: CRSO EIS, P.O. Box 2870, Portland, OR 97208-2870.

Appendix F

Scoping Meeting Posters

Public scoping meetings were held by the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and the Bonneville Power Administration, providing information to the public as to the National Environmental Policy Act process and how to contribute comments and ideas concerning the environmental impact statement. At each meeting, poster stations were created, allowing the attendees an opportunity to review information and discuss topics regarding environmental impact statement development. Poster topics included an overview of the National Environmental Policy Act and environmental impact statement process, a map and overview of the Columbia River system, National Historic Preservation Act Section 106 information, a brief history of flood risk management and current flood risks, hydropower, irrigation, navigation, fish and wildlife, recreation, climate change, water quality, and the dams included in the Columbia River System. Copies of each posterboard are provided in the ensuing pages.


EIS NEPA Overview Process
Notice Of Intent
We Are Here
Scoping
Develop Alternatives For Detailed Evaluation
Detailed Analysis
Expect Fall 2019 – Spring 2020
Draft EIS Issued
Public Comment Review And Synthesis
Prepare Final EIS & Identify Preferred Alternative
Issue Final EIS
Issue Record Of Decision

National Environmental Policy Act

The National Environmental Policy Act (NEPA):

Enacted as law in 1970, NEPA establishes a national environmental policy and provides a process for implementing the goals of the law which are protecting, maintaining, and enhancing the environment.

Encourages harmony between people and the environment;

Promotes efforts to prevent or eliminate unnecessary environmental change;

Requires Federal agencies to:

(1) consider potential environmental consequences prior to making a decision to proceed and,
(2) provide opportunities for public involvement in the decision-making process.

NEPA and You - *Your Involvement is Important*

We need your input

Your comments:

- Help shape the direction and analysis of the impacts
- Ensure your concerns are part of the public record and are shared with decision makers who benefit from your knowledge
- Should present reasonable alternatives or components to the project with a rational basis for consideration of the alternative or component
- Should consider potential impacts to you such as your property, your community and local infrastructure, services, economy, etc.
- Should identify resource issues and/or alternatives to the project or its components while providing a rational basis for consideration of issues or alternatives identified.

1. Need for action identified and proposal developed.
2. Are environmental effects likely to be significant?
3. If YES, prepare Environmental Impact Statement.
4. Publish Notice of Intent.
5. Conduct public scoping. PUBLIC INVOLVEMENT — WE ARE HERE
6. Draft Environmental Impact Statement.
7. Public review and comment of Draft EIS. PUBLIC INVOLVEMENT
8. Final Environmental Impact Statement.
9. Public availability of Final EIS.
10. Record of Decision.

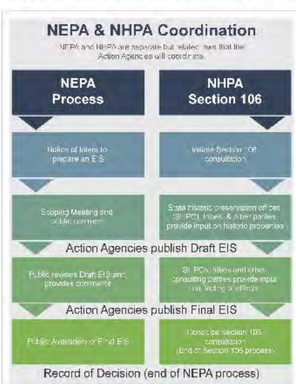
NEPA

Section 106 of the National Historic Preservation Act (NHPA)

Your Comments are Invited

NHPA requires Federal agencies to take into account the effects of their actions on historic properties. As a part of this process, the agencies must "seek and consider the views of the public." The Action Agencies are using the CRSO EIS scoping meetings to solicit public comment about historic properties. Your comments are an important part of this process.

Public comments about the steps taken to identify and evaluate historic properties will help the Action Agencies make an informed decision. We also invite comments about the steps that might be taken to avoid, minimize, or mitigate adverse effects that would result from changes in system operations.



Cultural Resources Program

The Action Agencies manage historic properties at 14 Federal dams and reservoirs in the Columbia River basin. ***More than 4000 cultural resources have already been identified.*** *The cultural resources and historic properties are managed for the benefit and enjoyment of the American people while also fulfilling important missions to the public, including providing hydroelectric energy, flood control management, management of endangered species and habitat, and recreation.*

What are "Cultural Resources" and "Historic Properties?"

Cultural resources are objects or places of human activity, occupation, or use that are assigned a value by social or cultural groups.

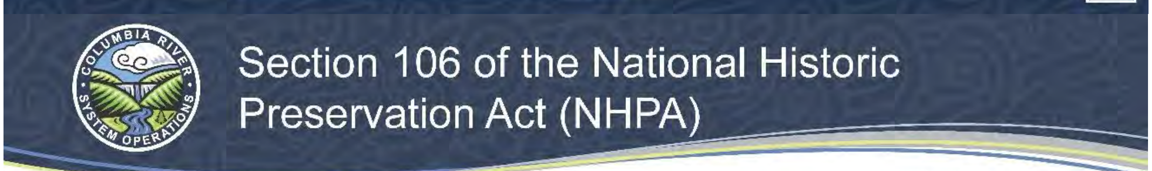
Historic properties are a legally defined subset of cultural resources, and refers specifically to cultural resources that have been determined to be eligible for inclusion on the National Register of Historic Places.

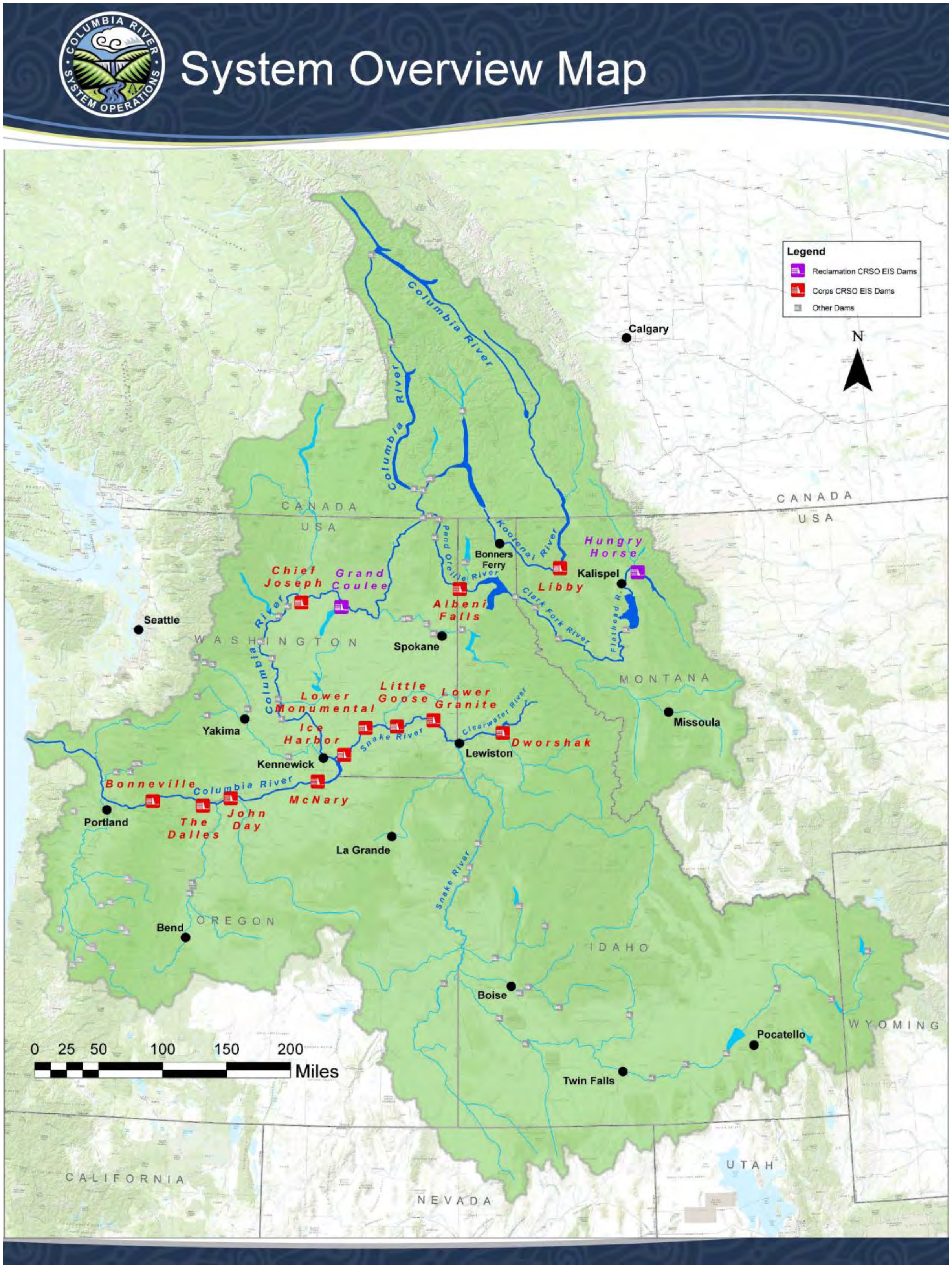
This knoll in central Idaho marks the origin place of the Nez Perce Tribe and is an example of a traditional cultural property.

Pre-contact archaeological sites are frequent throughout the Columbia River basin, as Native Americans focused much of their lives on salmon and other resources.

The historical significance of Bonneville Dam has been recognized by the Secretary of the Interior who made this structure a National Historic Landmark in 1987.

Sometimes, it is not feasible to address adverse effects where they occur. The Action Agencies supported restoration of this historic building as a form of off site mitigation.




System Overview Map
COLUMBIA RIVER SYSTEM OPERATIONS
Legend
Reclamation CRSO EIS Dams
Corps CRSO EIS Dams
Other Dams
N
Calgary
Columbia River
Kootenai River
Pend Oreille River
Clark Fork River
Flathead R.
Snake River
Clearwater River
CANADA
USA
Hungry Horse
Libby
Kalispel
Bonners Ferry
Chief Joseph
Grand Coulee
Albeni Falls
Seattle
WASHINGTON
Spokane
MONTANA
Missoula
Lower Monumental
Little Goose
Lower Granite
Ice Harbor
Dworshak
Yakima
Kennewick
Lewiston
Bonneville
McNary
The Dalles
John Day
Portland
La Grande
OREGON
Bend
IDAHO
Boise
Pocatello
Twin Falls
WYOMING
0 25 50 100 150 200
Miles
CALIFORNIA
NEVADA
UTAH

System Operations Overview

Managing a Complex System

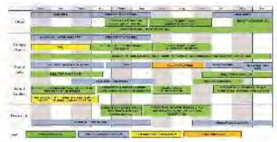
Managing a Complex System

The Columbia River Basin is a large and complex system with variable stream flows and weather patterns. The economic vitality of the region and its tribes, communities, industries, and fish and wildlife species, all depend on the system's ability to provide for multiple uses, including flood risk management, hydropower, navigation, irrigation, recreation, water quality, and fish and wildlife.

Project Authorizations

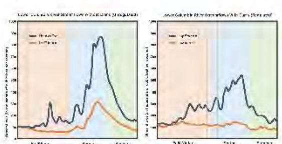
The federal Columbia River Basin projects (dams, reservoirs, and other associated facilities) are operated to meet many authorized purposes. These multiple uses must be considered and balanced in operational decisions. Actions that benefit one use or resource can have the opposite effect on others.

The people of the Northwest use the Columbia River in many ways. The water projects make up a multiple-use system.

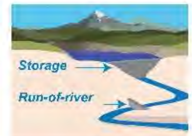


How do dams change river flows?

The Columbia River Basin experiences a wide range in runoff from year to year, from floods to droughts. Each water year poses different challenges for operators. Without the dams in place, the spring months would experience very high flows from melting snow while fall, winter, and summer flows would be low. The dams store water in the spring, reducing potential flooding from damaging river levels downstream. Once reservoirs fill in the summer, some storage projects are drafted (water is released) to augment naturally low summer flows in the lower river. This is done to improve river conditions for migrating fish. In the fall and winter, reservoirs water levels are lowered in preparation for flood risk management operations to capture the spring runoff. This also provides more water in the rivers and generates power and helps meet winter demand for electricity.



Storage vs. Run-of-River

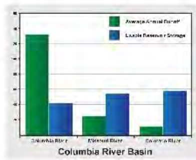


Storage projects hold water in reservoirs and reshape the river's flow patterns to meet a variety of authorized project purposes. Water from rain and snowmelt is stored until it is needed. This water is later released through turbines to generate electricity, to meet irrigation needs and provide flows for fish migration. Storage helps regulate flows, reducing potentially damaging floods downstream, while providing valuable water during dry periods.

Run-of-river projects have limited storage. They allow water to pass the dam at about the same rate it enters the reservoir. They provide power generation and may give sufficient water depth over rapids and other obstacles to permit barge navigation through navigation locks and reservoirs.

Where is the storage?

The Columbia River Basin storage projects primarily lie higher in the basin near the mountains where they can strategically catch snowmelt to help provide flood-damage reduction downstream.



The Columbia River Basin storage projects can only store about 30 percent of the annual runoff. For this reason, reservoirs can be used to change the timing of flows within the year, but cannot store enough water to change a dry year into a wet year.

Managing the System by Season

Streamflow without dams (unregulated) | Streamflow with dams (regulated)

Fall and Winter Operations
(Roughly October to mid-March)

Spring Operations
(Roughly mid-March to mid-June)

Summer Operations
(Roughly mid-June to September)

Fall and Winter Operations

In the fall and winter months, storage projects in the Columbia River Basin are preparing for the following spring's runoff (snowmelt and rain). Storage projects are operated to reduce flooding downstream. As snow accumulates in the mountains, reservoirs are lowered (drawn down) to be able to catch high flows in the spring.

In the fall and winter, river flows are flowing at low, base-flow levels. Little is known at this time of year about how much snow will fall throughout the winter and how much water will be coming down the river in the upcoming spring. Winter storms may also bring rises in the river during this season.

In the fall and winter the system is operated to prepare reservoirs for the upcoming spring runoff. During this time operators also must provide a safe navigation corridor, generate power, and protect wildlife habitat and cultural resources.

September – December:
Operate the system to meet downstream flow needs in support of salmon spawning in the Vernita Bar/Hanford Reach and downstream of Bonneville Dam.

November – December:
Provide water conditions for chum, fall chinook and kokanee spawning.

November – December:
Meet winter flood risk management requirements at storage projects.

January – March:
Draft the system for flood risk management and provide river levels to support incubation of chum below Bonneville Dam and fall chinook below Priest Rapids Dam. The amount of draft depends on the water supply forecast. Storage reservoirs are targeted to be as full as possible while meeting flood risk management needs by April 10, in time for fish passage season.

September – March:
Libby and Hungry Horse are operated to provide minimum flow for bull trout.

Spring Operations

Water supply forecasts provide context to the type of runoff anticipated in the spring and they inform the space required for flood risk management (FRM) operations. Runoff can occur earlier in lower elevation basins, because of earlier snowmelt and low elevation rains. Once runoff begins, the storage projects reduce outflow and begin refilling the reservoirs. The Agencies balance FRM requirements and refill by attempting to operate no lower than the FRM elevation as of April 10th.

The system is operated in the spring primarily to manage spring runoff for flood risk management, store water for irrigation use later in the season, and provide conditions to aid juvenile and adult fish migration. During this time operators also must provide a safe navigation corridor, generate power, and protect wildlife habitat and cultural resources.

March-May:
Operate McNary Dam to improve waterfowl nesting conditions.

April-June:
Storage projects begin refilling with the goal to be full in summer.

April-June:
Beginning in April, projects on the lower Columbia and lower Snake rivers release water through the spillway for juvenile fish passage. Spill levels are monitored continuously and adjusted as necessary throughout the spring and summer to manage total dissolved gas (TDG) in the rivers.

April-June:
Storage projects are operated to target spring flow objectives at Lower Granite, McNary and Priest Rapids dams for the benefit of salmon and steelhead. Seasonal flow objectives are developed in-season through coordination with regional salmon managers to shape available water to provide flows that maximize benefits to both juvenile and adult fish during this time.

April-June:
Lower Snake River projects are operated in the spring at minimum operating pool (MOP) to aid juvenile fish passage and provide safe navigation. John Day Dam is operated to minimum irrigation pool (MIP) to aid juvenile fish passage, provide safe navigation and meet irrigation pumping needs.

May-June:
Libby Dam is operated to provide a pulse of water to encourage spawning of Kootenai River white sturgeon downstream of the dam.

April-June:
Libby and Hungry Horse are operated to provide minimum flow for bull trout.

Summer Operations

Storage reservoirs will reach their highest elevation in the summer months, often reaching full pool. Valuable water stored during the spring is then released to augment flows for fish in the lower Columbia and lower Snake rivers. Flows also provide water for irrigation, recreation, and to produce power.

By summer, the peak flows from spring runoff transition to lower summer flows. Projects fill and release water to supplement the lower base-flow period.

In the summer months the system is operated to balance additional flow for augmentation downstream to aid juvenile and adult fish migration, provide water for irrigation use, and generate power. During this time operators also must provide a safe navigation corridor, support recreation interests, and protect wildlife habitat and cultural resources.

June-August:
Projects on the lower Columbia and lower Snake rivers continue to release water through the spillway for juvenile fish passage. Spill levels are monitored continuously and adjusted as necessary throughout the spring and summer to manage TDG in the rivers.

June-August:
Storage projects are operated to target summer flow objectives at Lower Granite and McNary dams for the benefit of salmon and steelhead.

July– August/September:
Lower Snake River projects continue operating at minimum operating pool (MOP) to aid juvenile fish passage and provide safe navigation. John Day Dam remains at the minimum irrigation pool (MIP) to aid juvenile fish passage, provide safe navigation and meet irrigation pumping needs.

July-August:
Key storage reservoirs are lowered in July-August (Libby and Hungry Horse are drafted into September) to provide flows downstream for salmon and steelhead. Libby and Hungry Horse drafts are limited to benefit resident fish that enter the reservoirs.

July-September:
Dworshak Dam is operated to provide cool water to help maintain river temperature in the Lower Granite Dam tailrace below 68° F for the benefit of salmon and steelhead.

July-September:
Libby and Hungry Horse are operated to provide minimum flow for bull trout.

May-September:
Hungry Horse is operated to release warmer water to match water temperatures in the mainstem Flathead River.

HYDROPOWER
Water that flows through turbines generates electricity to power homes and businesses in the Pacific Northwest and beyond year round. System operations generally prioritize flood risk management and environmental responsibilities, and any remaining flexibility to manage water flow is used to shape power production to meet the daily and seasonal demand for electricity. In emergency situations, however, operations to keep the lights on are prioritized to protect human health and safety as well as the safety and reliability of the power grid. The Columbia River Treaty with Canada and the Pacific Northwest Coordination Agreement are used to coordinate power operations among the many Canadian, U.S. federal and nonfederal dams in the Columbia River Basin.

RECREATION
Projects provide lake and river recreational opportunities. The Agencies operate projects with sensitivity to widespread public use and attempt to balance operations in consideration of public safety. Important considerations include providing flows that are neither too high nor too low for safe boating. Another goal is to have water levels high enough for boat ramps to be operational.

IRRIGATION
Storage reservoirs typically fill by early summer by capturing snowmelt runoff. In spring and early summer, runoff is higher than irrigation demand but in July and August, when natural flows have diminished, irrigation demand is highest. To supplement irrigation demand during times of low flow, water is stored in the reservoirs during high runoff and released from storage when streamflow runoff is lower. Storage projects help provide a reliable irrigation water supply which allows for the production of a range of crops.

NAVIGATION
The Corps maintains a congressionally authorized navigation channel from the Pacific Ocean to Lewiston, Idaho and operates navigation locks for commercial and recreational traffic at eight projects. These operations require water levels above minimum levels in affected reservoirs. The four lower Columbia run-of-river projects and the four lower Snake dams operate together to allow river transport of products. Additionally, the lock system enables barge transport of juvenile salmon from below Lower Granite to below Bonneville Dam.

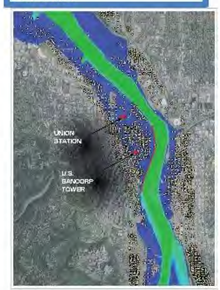
MUNICIPAL AND INDUSTRIAL WATER SUPPLY
Municipal and industrial (M&I) is typically defined to mean water used in the operations of municipal or domestic water systems and for uses in industrial processes. Industrial processes can include thermal power generation and mining operations. Municipal uses include household, commercial and public supplies. Like irrigation, M&I demand is typically higher during July and August as household and public supplies often include watering lawns. To supplement M&I during times of low flow, water is stored in the reservoir during high runoff and released when streamflow runoff is lower. Storage projects help provide a reliable M&I water supply for both personal use and industrial processes.

CULTURAL RESOURCES
Projects are operated to limit impacts and exposure to cultural resource sites.

A Brief History of Columbia River Basin Flood Risk Management

1900 | 1925 | 1950 | 1975 | Present

1894 Flood Downtown Portland



Engineers use computer models to understand potential consequences of flooding. On this map, each circle represents a building in downtown Portland; the blue area depicts where flooding would occur if 1894 happened today.

1948 Columbia River Flood

After 1948, the President directed the U.S. Army Corps of Engineers to include flood control in all future Columbia River Basin planning studies.

Vanport, Oregon in 1948

The 1948 flood destroyed Vanport, Oregon, a city of 20,000-30,000 people. About 50-60 people were killed.

Trail, B.C. in 1948

The flood damaged homes, farms, and levees from British Columbia all the way to Astoria, Oregon.

1950 Flood Control Act

1950 Flood Control Act (House Document 531):

- Addressed new levees and improvements to existing levees
- Added to and modified previous system reservoir design
- Authorized several projects to provide 20.55 Maf* of useable flood control storage (including Libby Dam)

* Maf = million acre feet

1962 Flood Control Act

1962 Flood Control Act (House Document. 403):

- Re-examined projects after studies found that multiple reservoirs authorized by 1950 FCA were impracticable or undesirable
- Authorized 14.9 Maf of useable flood control storage (down from 20.55 Maf, including Dworshak Dam)
- Only two large storage projects authorized by either the 1950 or the 1962 Flood Control Acts were actually constructed: Libby and Dworshak Dams (providing 7 Maf of storage out of the original 14.9 Maf).

Present

Columbia River Basin Flood Risk Management Storage

- All Columbia River dams operating for system flood risk management are authorized for multiple purposes.
- A total of 40 Maf of storage space is available in the Columbia River Basin for flood risk management operations. About half of this storage is located in Canada.

Flood Risk Management in the Columbia River Basin

Managing the System with Forecast-Informed Operations

Flood storage dams in the Columbia River Basin system generally draft in the winter (i.e. empty out water to leave "space") and refill in the spring and early summer. Reservoirs aren't drafted to empty every year but only as much as operators predict is needed to capture spring snowmelt and rain that can cause flooding. Operators also want to ensure that reservoirs are full come summer so that water is available for other things such as recreation, irrigation, and fish.

In order to make sure dams are drafted enough but not too much, engineers create predictions of the volume of water that will run off. These predictions, called seasonal volume forecasts, are created using information such as the amount of snow on the ground upstream of a dam. The most difficult thing to predict, however, is how quickly snow will melt and how much additional rain will fall over the spring and early summer. This is one reason why managing flood risk is challenging. Reducing the drafted flood risk space too much may lead to flooding. If the drafted flood risk space increases too much, reservoirs might not fill by summer.

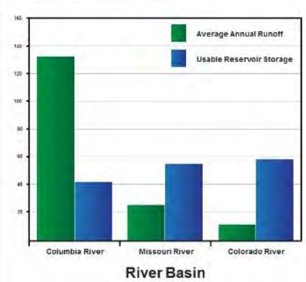
Flood Risk Management Generic Operation

Local and System Flood Risk Management

Flood storage dams can only store inflow into the dam; they cannot capture rain or snowmelt downstream of the dams.

An Overview of the Reservoir Storage Space in the System

Only 1/3 of the average annual flow can be stored in the basins' reservoirs. This means that in the event of a flood, the flood risk management storage in the basin can only REDUCE the peak. It CANNOT ELIMINATE the risk of flooding.

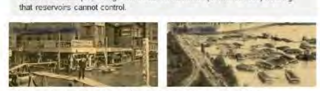


Snowmelt and Rain: A Complicated System

With a larger runoff forecast (more snow), the dams will draft more.

With a smaller runoff forecast (less snow), a dam will draft less, but it still needs space to store spring rainfall.

In years with lots of snow and/or rain, flooding CANNOT BE PREVENTED! After a reservoir reaches its spring draft, the physical risk is set, meaning that there is only so much water the reservoir can capture; the rest is up to mother nature. For example, a huge rainstorm could cause (or has caused) flooding that reservoirs cannot control.

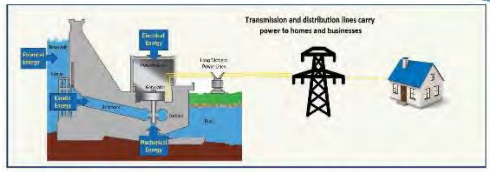


The property and life safety consequences of flooding are severe, whether it's from rain or snowmelt.

Hydropower

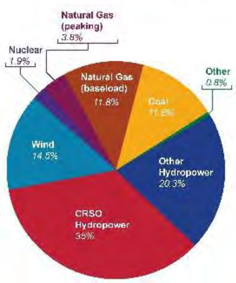
Dams convert potential energy of stored water into electricity.

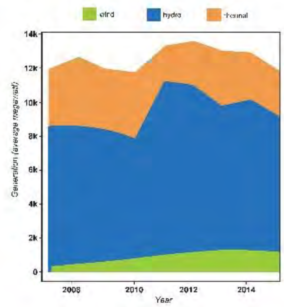
- Water moving through a turbine drives a generator that converts kinetic energy into electrical energy.
- Hydroelectric generation is determined by snowpack and rainfall, and varies from year to year. Seasonal variation in generation occurs due to the timing of snowmelt and rainfall.
- Storage projects allow some water to be stored for later use.



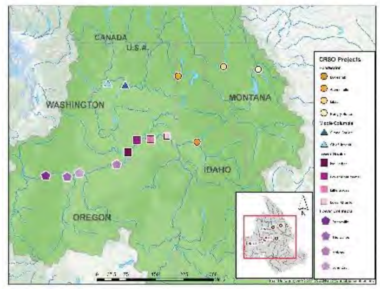
Power from the dams is delivered to local and regional utilities via the transmission system. Local utilities then distribute the power to homes and businesses via distribution lines.

Pacific Northwest Generating Capacity





Hydropower provides the bulk of generating capacity in the region. The Columbia River System Operations (CRSO) alone constitute about 35% of total regional capacity.



Almost all of the CRSO generation is produced by 14 dams located in the Columbia River Basin. Because generation may not occur near homes or businesses, transmission lines carry power generated at the CRSO dams to population centers.

In total, these 14 dams generate enough electricity to power about 7 million homes.

Irrigation

Columbia River System Irrigation

Federal Irrigation

The Bureau of Reclamation delivers water to the three irrigation districts that make up the Columbia Basin Project (CBP), with a combined 720,000 acres of land. The CBP diverts water from the Columbia River at Grand Coulee Dam through a series of pumps to Banks Lake. From there, a network of canals deliver water to farms that produce a variety of crops including potatoes, sweet corn, and onions, as well as specialty crops like grapes, hops, fruit trees and alfalfa. The annual value of CBP crops alone is estimated at $870 million. In addition to the CBP three other Federal project pump directly from the Columbia River to supply water for irrigation to the Bureau of Reclamation's Chief Joseph Dam Project, Umatilla Project Phase I and II, and The Dalles Project.

Authorization

The Columbia Basin Project Act of 1943, based on extensive studies known as the Columbia Basin Joint Investigations, authorized construction of the Columbia Basin Project, which consists of 330 miles of major distribution canals, lakes and reservoirs, and about 2,000 miles of laterals.

Chief Joseph Dam Project, not to be confused with the Corps' Chief Joseph Dam, was incrementally authorized by Congress in the following public laws: 89-557 (September 7, 1966); Public Law 83-540 (July 27, 1954); 85-393 (May 5, 1958); and 88-599 (September 18, 1964).

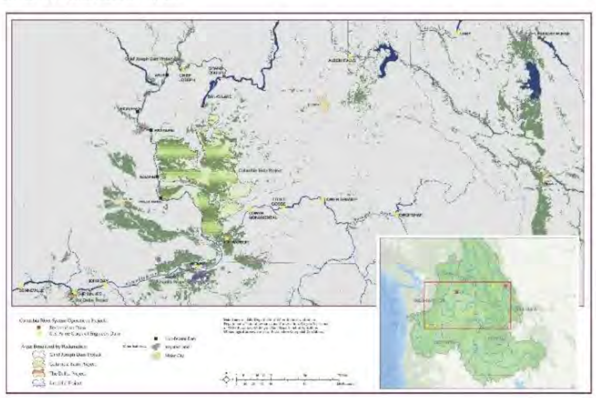
The pumping portion of the Umatilla water exchange facilities were authorized by the Act of October 28, 1988, for the purposes of mitigating losses to anadromous fishery resources and continuing water service to the irrigation districts.

Congress authorized The Dalles Project, not to be confused with the Corps' The Dalles Dam, in Public Law 86-745 dated September 13, 1960.

Private or Non-Federal Irrigation

In addition to these federal irrigation projects, private irrigation projects pump from several Corps reservoirs on the lower Snake and Columbia rivers. The Corps does not operate any of the 12 projects in the Columbia River System for irrigation. However, the projects are operated in such a way as to maintain a pool for other purposes that allow the opportunity for private irrigators and local municipalities to withdraw water from reservoirs or the rivers.

CRSO OPERATIONS FOR FEDERAL IRRIGATION PROJECT	
Columbia Basin Project	720,000
CRSO IMPACTS FEDERAL IRRIGATION PROJECT OPERATIONS	
Chief Joseph Dam Project	13,700
Umatilla Project	24,300
The Dalles Project	5,500
Total Area Benefited by Federal Projects	763,500 Acres



Navigation

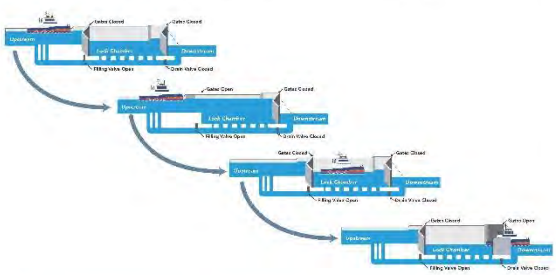
Navigation on the Columbia River System is both commercial and recreational. Commercial goods can be transported by water on federally maintained channels from the Pacific Ocean though the mouth of the Columbia River to the Tri-Cities area on the Columbia River and to Lewiston, Idaho, on the Snake River. Recreation boaters enjoy the entire river system.

Management for Navigation

Ships and barges need minimum water depths to navigate year round. Operations and maintenance for navigation are different above and below Bonneville Dam.

In the Columbia River below Bonneville Dam, the depth of the navigation channel is maintained by regular maintenance dredging.

Above Bonneville Dam and in the Snake River, the inland waterways require maintaining a 14-foot minimum water depth in the channel and at the locks to accommodate the Columbia River tugs, barges, log rafts, and recreations craft.



Construction of the locks at Federal dams has improved navigation on the Columbia and Snake rivers.

Navigation on the Columbia and Snake rivers was improved in two segments.

The first segment is the 106-mile-long open river channel used by deep-draft ships from the Pacific Ocean to the Portland/Vancouver area.

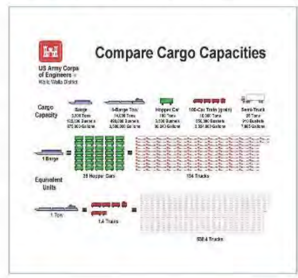
The second segment is a barge channel that extends 359 miles from Vancouver, WA to the Tri-Cities area on the Columbia River and to Lewiston, ID, on the Snake River.

Navigation upstream of Bonneville Dam is made possible by a series of locks and reservoirs at eight Federal dams.

Commercial Navigation

Greater than half of the commercial navigation on the Columbia–Snake River System is exports. However, it is also an important transportation route for goods moving to the interior, such as fuel to the Tri-Cities area and up to Lewiston, ID.
Some of the top exports are wheat, oilseeds (soybean, flaxseed and others), lumber, and corn. The top imports include iron and steel products, manufactured equipment, and building material like sand, gravel, stone, building cement and concrete.

An average of 57 million tons of commodities were transported in 2010–2014, which would have required transport by over 2 million semi-trucks. Of that, approximately 36.6 million tons were exported to foreign destinations (64%).



Fish and Wildlife

For decades, the Agencies have implemented fish and wildlife conservation, protection, and mitigation activities throughout the Columbia River Basin utilizing various authorities:

Project Authorities include fish and wildlife conservation as a project purpose.

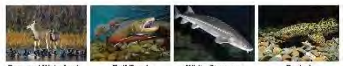
The ***Northwest Power Act*** requires hydropower operators to provide for fish and wildlife protection, mitigation, and enhancement activities in a manner that provides equitable treatment with the other purposes.

Fish and wildlife activities in response to ***the Endangered Species Act***, and ***the Clean Water Act***; and for cultural resources protection under the ***National Historic Preservation Act***.

Federal government ***treaty and trust*** responsibilities to Columbia Basin tribes also support fish and wildlife mitigation and enhancement.

System Operations Affect Many Fish and Wildlife Species in the Basin

- Anadromous (ocean going) fish like salmon, steelhead, and lamprey
- Resident (non ocean-going) fish like bull trout, burbot, and Kootenai River white sturgeon
- Wildlife species affected by inundation from reservoirs, such as mule deer, waterfowl, song-birds, and elk



Deer and Waterfowl | Bull Trout | White Sturgeon | Burbot

Pacific Lamprey | Streaked Horned Lark | Salmon | Elk

Operations and other actions to benefit fish and wildlife are science-based, relying on biological monitoring to adaptively manage and prioritize actions.

Dam and Reservoir Actions
- Operational Actions
  - Flow augmentation
  - Spill, transport, ramping rates
- Configuration Actions
  - Adult and juvenile passage
  - Water quality features

Predation
- Birds, sea lions, fish

Habitat
- Tributary
- Estuary

Hatchery Management and Reform
- Ongoing hatchery management plans
- Additional hatcheries and modification of structures

Dam Operations and Configuration Improvements for Anadromous Fish Species

Juvenile Salmon Passage
- Surface passage systems
- Turbine intake screened bypass system improvements
- Turbine improvements
- Juvenile fish passage spill
- Juvenile fish collected in screened bypass systems are transported via barge or truck from the uppermost three dams on the Snake River to below Bonneville Dam

Adult Fish Passage
- Fish ladders at all eight lower Snake and lower Columbia River dams provide upstream passage
- Ladder temperature improvements at Lower Granite and Little Goose dams
- Lamprey passage improvements

Flow Augmentation and Temperature Control
- Water stored in reservoirs at Grand Coulee, Libby, Hungry Horse, and Dworshak is released in summer to augment naturally low summer flows
- Cool water stored in Dworshak Reservoir is released during the summer to moderate temperature in the lower Snake River.

Fish and Wildlife

Operations for Resident Fish Species

Operations for ESA-listed resident fish species
- Kootenai River White Sturgeon
  - Flow pulse and outflow temperature management during spring at Libby Dam to support spawning and egg incubation
- Bull Trout
  - Minimum flow requirements and flow fluctuation restrictions at Libby and Hungry Horse dams
  - Pre-drafting storage projects when high flows anticipated to avoid high total dissolved gas

Operations for non-listed resident fish species
- Kokanee
  - Minimum reservoir elevation for Grand Coulee Dam in Fall to improve access to tributaries for spawning and support zooplankton production (an important food source for kokanee)
  - Stable lake elevation during fall at Albeni Falls to support spawning
  - Minimize spill during spring at Dworshak to keep kokanee in the reservoir
- Burbot
  - Flow temperature management during winter at Libby Dam to aid upstream migration to spawning areas in the Kootenai River

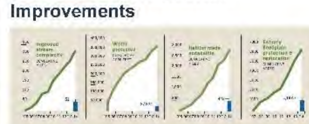
Predation on Anadromous Fish in the Columbia River Basin

Fish Predators
- Northern pikeminnow predation on juvenile salmon has been reduced by about 40 percent since 1990

Avian Predators
- Actions are underway in the estuary to reduce Caspian tern and double-crested cormorant predation on juvenile salmon
- Actions are underway inland to reduce Caspian tern predation on juvenile salmon
- Hazing occurs at dams to discourage gull and other avian predation on juvenile salmon as they pass the dams

Pinnipeds (Sea lions)
- Pinniped predation on returning adult salmon has increased sharply in recent years below Bonneville Dam to the mouth of the Columbia River
- The U.S. Army Corps of Engineers enumerates pinnipeds immediately below Bonneville Dam and installs barriers each year to prevent the sea lions from entering fish ladders at the dam
- The Tribes actively haze pinnipeds below Bonneville Dam to discourage predation on adult salmon
- NOAA and the states of Oregon and Washington are actively managing and removing sea lions from the tailrace of Bonneville Dam

Fish and Wildlife Habitat Improvements



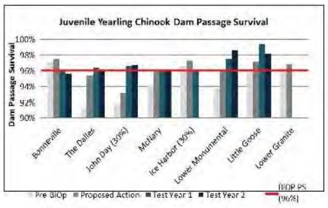
Actions in the tributaries from 2007 to 2015:
- Protected over 373,000 acre feet of water which is roughly 186,500 Olympic swimming pools of water
- Opened access to over 3,300 miles of fish habitat, which is about equal to 1.2 times the distance from Los Angeles to New York City
- Restored 400 miles of stream habitat complexity, which is the equivalent of restoring a stream channel that followed I-84 from Portland to Boise

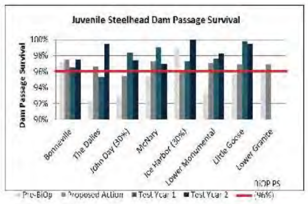
Actions in the estuary from 2007 to 2015:
- Protected or restored over 7,700 acres of floodplain = 12.1 square miles
- Restored or enhanced over 42 miles of estuarine tidal channels

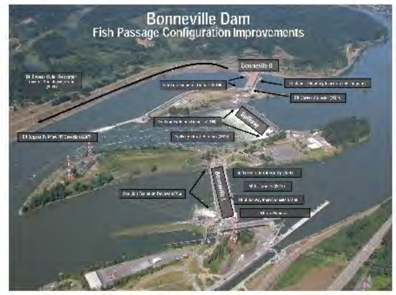
Fish and wildlife
- About a million acres of land have been put under conservation easement for fish and wildlife

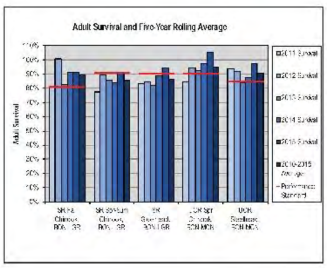
Fish and Wildlife

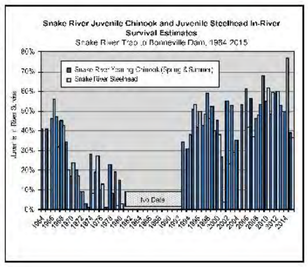
Fish Survival and Travel Time through the Hydrosystem











Recreation

- The Federal project reservoirs and lands along the Columbia and Snake rivers provide opportunities for many water and land based activities.
- Public waterbodies used for boating, swimming, fishing, water-skiing and windsurfing are directly dependent upon the availability of public access to launch points and shorelines.
- Public waterbodies also provide an "aesthetic complement" to many land-based recreation activities such as camping, trail riding, hiking, wildlife viewing and nature photography.

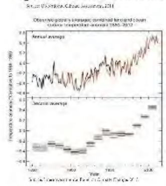
Northwest residents enjoy recreational opportunities at projects throughout the Columbia River Basin. Recreation was not specifically identified as a major project use when most of the dams were authorized, but was recognized as an important public resource during later legislation. A diverse range of recreational opportunities and facilities are located on and near our reservoirs.

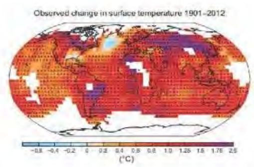
- Federal projects have high visitation at the dams and fish ladders, camping facilities, beaches and boat ramps.
- While recreation occurs throughout the year, the highest visitor numbers are seen during the summer and early fall. Seasonal variations in water levels can have local impacts on the type of recreational opportunities available as well as the quality of the recreational experience. For instance, while low water levels may limit boat launching, variations in downstream river flows that aid in fish mitigation often benefit local fishing.
- The U.S. Corps of Engineers and Bureau of Reclamation cooperate with other Federal and non-federal governmental agencies to enhance and maintain recreational opportunities. These partnerships provide a local presence and ensure that recreational facilities are well maintained and remain open to the public.

Climate Change in the Pacific Northwest

Global Climate Change:

- The Earth is warming
  - Global annual average temperature has increased 1.5°F since 1880 (through 2012)
  - 2001-2015, every year was warmer than 1990s average
- Warming is not spread evenly throughout planet
- Human-induced climate change is projected to continue and accelerate as global emissions increase





Global Emissions Scenarios:

Carbon emissions drive climate change. The more fossil fuels burned, the higher the emissions and global temperatures.

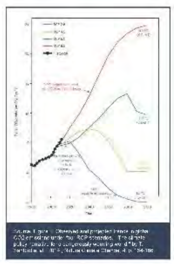
Representative Concentration Pathways (RCP) developed by Intergovernmental Panel on Climate Change (IPCC):

RCP8.5* - Currently surpassing this rate "Business as usual", rising

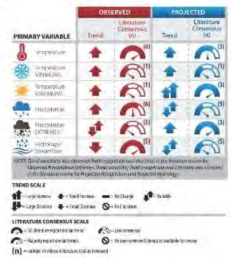
RCP6.0 - Peak at ~2080, stabilization after 2100

RCP4.5* - Peak at ~2050, stabilization after 2100

RCP2.6 - Presently no technology to make feasible near-term peak, decline to net negative emissions

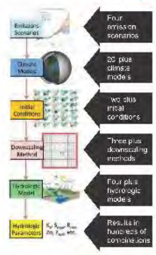


What does Climate Change mean here in the PNW?



Modeling Climate Change in the PNW:

Steps of Modeling Process

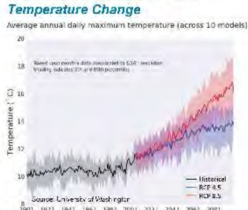


- Federal agencies have been monitoring, studying climate change for over a decade
- Converting data from the global to the local level requires many steps
- Each step has multiple methods
- There is no correct combination
- BPA, Reclamation and the Corps are working with University of Washington/Oregon State University on creating new datasets for the PNW
- In 2017 there will be 172 new climate change streamflow datasets
- Reservoir operation modeling is being completed to look at potential effects of climate change in the region

Climate Change Effects

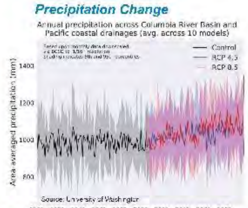
Temperature and Precipitation Trends for Columbia River Basin

Temperature Change



- Temperature increase depends on future emissions
- Warmer temperatures means less snow

Precipitation Change

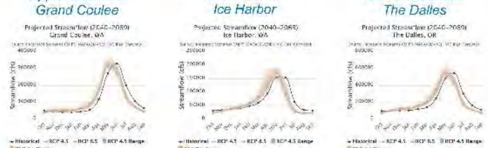


- Precipitation trend is not as clear
- More precipitation in the winter, less in the summer

Federal agencies asked the University of Washington to use the Global Climate Modeling information to give projections of temperature and precipitation for the Columbia River Basin

Streamflow Projections – Without Dam Regulation

Upper Columbia Grand Coulee | *Snake River Ice Harbor* | *Lower Columbia The Dalles*



Expected Flow Changes through Mid-Century (not including dam regulation):
- Higher winter flows, mostly in southern half of the basin
- No significant change in Canadian winter flows
- Higher spring flows, but more uncertainty on individual flow peaks
- Earlier spring runoff peak
- Lower summer flows
- Large year-to-year swings in annual volumes will likely continue

Changes in Snowpack: Nature's Reservoirs

Projected change in April 1st snow water equivalent
RCP 8.5 2040-2069 vs 1971-2000

Data Source: Hydrology: VIC, Multi-Model Mean

- The Columbia River Basin has historically been a snowmelt river system
- Measuring basin snow provides information for forecasting runoff
- Warmer winter temperature means less snow in the mountains
- Rain events in spring and winter are expected to increase
- Ecosystem and hydrology will change in response

Our Future with Climate Change

- Snow will continue in the mountains, but there will be less
- Snowpack, which is a key "natural reservoir" will tend to:
  - shrink, more in US, less in Canada
  - be more variable from year-to-year
  - harder to predict water volumes
- More winter precipitation will fall as rain
- The Columbia River Basin will continue to be dry in the summer and become even drier
- Temperatures will be warmer year round, with more warming east of the Cascades than near the coast
- More runoff in the winter
- Less runoff in the summer
- Meeting all reservoir operations will be more difficult
- Federal agencies are studying future adaptation options

Water Quality - Temperature

Introduction

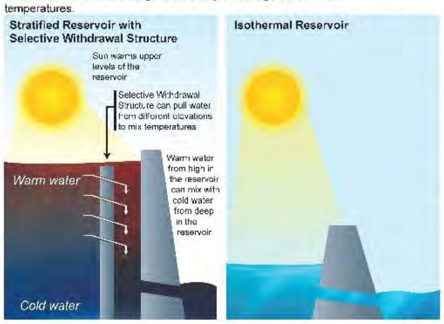
Water quality is important for the health of aquatic species, including ESA-listed fish. The Agencies operate the Columbia River Basin dams to manage total dissolved gas (TDG) and temperatures in the rivers. The Agencies also monitor other water quality parameters such as nutrients, potassium, pH, conductivity, dissolved oxygen, and others.

Which Reservoirs Can Help Manage Temperatures?

Some reservoirs stratify (warm water stays on top, while cold water sinks to the bottom). Water from these reservoirs can sometimes be used to help manage temperature conditions for aquatic species downstream. Depending on the time of year, warmer or cooler water can be released to help manage downstream temperatures.

Other reservoirs are isothermal (temperature is nearly the same from top to bottom). These reservoirs cannot be used for temperature management downstream.

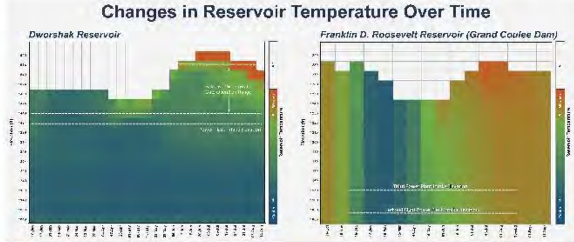
Some reservoirs are stratified in the summer and isothermal in the fall and winter, which can limit the Agencies' ability to manage downstream temperatures.



WQ Operations Map

Libby and Hungry Horse dams in Montana, and Dworshak Dam in Idaho all have reservoirs that stratify and have selective withdrawal structures to release warmer or cooler water for downstream temperature management. Temperature influences are strongest immediately downstream of the dam but lessen as this water travels farther downstream.

Changes in Reservoir Temperature Over Time



Dworshak Reservoir stratifies in the summer with warm and cool water accessible through the dam's selective withdrawal gates. Dworshak is used in the summer months to help cool temperatures on the lower Snake River.

In an average year, the Columbia River flow at Grand Coulee Dam is enough to fill the project approximately eight times. With the high volume of water that flows through the reservoir, the pool weakly stratifies. Grand Coulee Dam has two elevations from which to draw water into three power plants. At these elevations the temperatures are very similar throughout the year. In early summer the outflows from Grand Coulee Dam are typically cooler than the inflows to the reservoir near the border with Canada.

Water Quality - Total Dissolved Gas

Total Dissolved Gas (TDG) Overview

The U.S. Army Corps of Engineers implements a water quality program to manage TDG associated with spill operations at the lower Columbia and lower Snake River dams from April through August, consistent with the National Marine Fisheries Service's Biological Opinion to increase survival of ESA-listed juvenile salmon and steelhead as they pass the dams on their downstream migration to the ocean.

The Corps adjusts the amount of spill in real-time operations based on multiple spill guidance documents, reports, and computer models in order to attempt to maintain TDG within state TDG water quality standards.

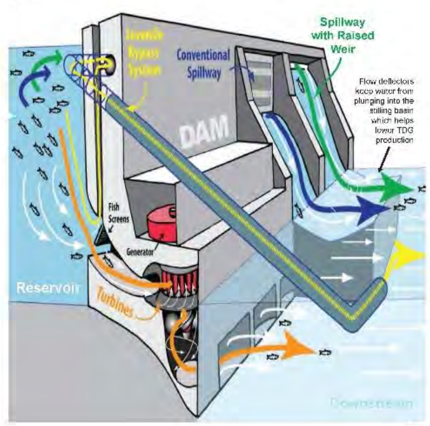
What is TDG?

TDG is a measure of air dissolved into water. When water plunges into a pool, it takes air bubbles with it. The high pressure causes the bubbles to dissolve into the water and the water becomes supersaturated with gases, primarily nitrogen.

High spill levels at the dams can increase TDG in the water below the dam because as water flows over the spillway, air becomes trapped by the spill flow. When fish and other aquatic species are exposed to elevated TDG, the excess gas can build up in their bloodstream and tissues, causing a condition called gas bubble trauma, with symptoms ranging from minor injuries to death depending on the TDG concentration.

Why do Dams Spill?

High levels of spill and associated TDG supersaturation often happen in the spring when melting snowpack creates high river flows and/or flooding. Water that cannot be stored in the reservoir behind a dam or passed through turbines to generate electricity is sent over the spillway or through an outlet. From April through August, the Agencies also spill water to help juvenile salmon migrate downstream to the ocean. Sometimes spill also occurs because maintenance forces operators to send water over a spillway, or through another outlet. So while spill is most common in the spring time, it can happen during other seasons as well.



Salmon and Steelhead in the Columbia River Basin

Restoring healthy salmon runs is a regional challenge

Partnerships among government and tribal entities, non-governmental and private organizations are critical to restoring healthy salmon runs and securing the economic and cultural benefits they provide.

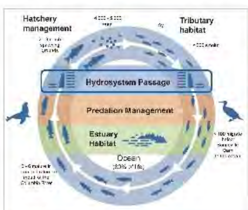
The life cycle of salmon and steelhead make them vulnerable to human and environmental impacts, and their recovery a complex issue.

Columbia and Snake River salmon and steelhead were listed for protection under the Endangered Species Act in the 1990s as a result of steep declines in the numbers of adult fish returning to spawn.

This regional challenge requires regional solutions

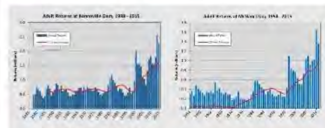
The lifecycle of salmon and steelhead requires the fish to rely on different environments as they grow and mature. Each stage of their lifecycle comes with its own survival challenges.

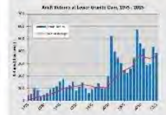
Salmon and steelhead have been impacted by more than a century of human and environmental impacts including:



- Dams and water diversions
- Fishing
- Hatchery practices
- Habitat degradation
- Mining
- Ocean conditions
- Predation
- Water quality

Fish ladder counts help tell part of the salmon story





About this graph: The total count includes listed and non-listed salmon, natural-origin and hatchery-origin fish, and adults and approximately 120,000 jacks (young males that mature and return to spawning grounds earlier than others in their age class). Currently, hatchery fish comprise approximately 80% of the returning adults.

Major dams along the Columbia and Snake River systems have fish counting stations to monitor adult salmon and steelhead migrations. The combination of natural-origin and hatchery-origin adult fish returning from the ocean is higher than in the 1990s and since dam counts first began.

Several factors contribute to these improvements in abundance, including:

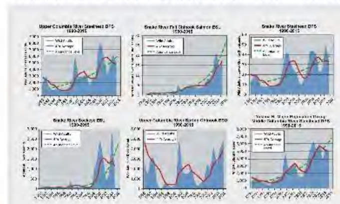
- Fish passage improvements
- Fish travel time improvements
- Habitat enhancement
- Harvest management
- Hatchery actions
- Ocean conditions
- Predation management actions

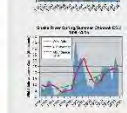
How are salmon and steelhead in the Columbia River Basin doing?

In the Pacific Northwest, the status of salmon and steelhead is evaluated by measuring several factors, including abundance (the number of adult fish that return each year to spawn).

In 2016, NOAA Fisheries completed a five-year status review of all ESA-listed West Coast salmon and steelhead – including the 13 stocks of the Columbia River Basin – and found that no changes in ESA listing status are warranted.

The following graphs show abundance levels from 1990-2015 for the seven natural-origin salmon and steelhead stocks that spawn above Bonneville Dam





About the graphs: These graphs represent natural-origin fish only and do not include listed hatchery fish (with the exception of the Snake River Sockeye stock, which is sustained through a captive broodstock program). Fish populations tend to vary widely from year to year due to changing conditions. In these graphs the annual data is in blue, and a four-year average is plotted in red to smooth out some of that annual variability. In six of the seven populations, a statistically-significant increasing trend in abundance is illustrated in green.

Lamprey, Kootenai River White Sturgeon and Bull Trout in the Columbia River Basin

Pacific Lamprey

Pacific lamprey belong to a group of eel-like fishes and are a significant cultural and subsistence resource for tribal communities. Lamprey begin their life in fresh water, migrate to the ocean and return to fresh water to spawn. Each stage of their lifecycle comes with its own survival challenges. Since lamprey larvae spend years buried in the soft sediment of stream beds, they are especially susceptible to physical disturbance, dewatering events and contamination. Pacific lamprey populations have declined throughout their west coast range, including in the Columbia River Basin. They are considered a Species of Concern.

*Daytime counts at Bonneville and Lower Granite dam are useful as an index only. Many lamprey pass these dams at night and through other unknown passage routes

Impacts:

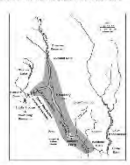
- Habitat degradation
- Ocean conditions
- Passage barriers
- Predation
- Reduced flows
- Water quality

Conservation actions:

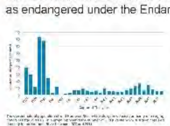
- Genetics monitoring
- Passage improvements
- Propagation research
- Tagging studies
- Translocation

Kootenai River white sturgeon

Kootenai River white sturgeon have been genetically isolated from other white sturgeon in the Columbia River system for approximately 10,000 years by the natural impassable barrier of Bonnington Falls in British Columbia, Canada. These long-lived fish live in a 167 river mile stretch of the Kootenai River from Kootenai Falls, Montana — located 31 river miles below Libby Dam — downstream to Kootenay Lake in British Columbia. Approximately 45 percent of their range is located in British Columbia.



They live to approximately 100 years, with females in the Kootenai River reaching reproductive maturity in their late twenties to early thirties. The wild Kootenai River white sturgeon population is comprised mainly of older adults, and significant larval recruitment has not occurred since the 1970s. In 1994, the fish was listed as endangered under the Endangered Species Act.



The wild population of Kootenai River white sturgeon is in decline due to an aging population and low juvenile survival. Although the specific causes of low juvenile survival remain unclear, years of research suggest that most mortality occurs between egg and larval stages. The hatchery program continues to be crucial for the longevity of the species.

Impacts:

- Altered Hydrograph
- Altered Thermograph
- Habitat degradation
- Reduced nutrients and river productivity

Conservation actions:

- Conservation Aquaculture
- Flow augmentation and water temperature management at Libby Dam
- Habitat restoration
- Harvest restriction

Bull trout

Bull trout are members of the salmonid family (Salmonidae) which include salmon, trout, grayling, whitefish and char. Bull trout exhibit both resident and migratory life cycles. Compared to other salmonids, bull trout have more specific temperature requirements. They occur in cold water streams, and are rarely found in waters where temperatures exceed 15.0 to 17.8°C (59 to 64°F). Once found in about 60 percent of the Columbia River Basin, today bull trout occur in less than half of their historic range. Bull Trout were listed as threatened under the Endangered Species Act in 1998.

Impacts:

- Competition with and predation by non-native fish
- Habitat degradation
- Migration barriers
- Overfishing and poaching
- Water temperatures
- Water quality

Conservation actions:

- Controlling non-native fish populations
- Habitat improvements
- Harvest reductions or prohibitions
- Instream flow enhancement
- Land use modifications
- Passage improvements
- Silt and erosion reduction
- Temperature improvements
- Water quality improvements

Bonneville Dam and Lake Bonneville

Quick Facts
- Stream: Columbia River (RM 146.1)
- Location: Cascade Locks, OR
- Owner: U.S. Army Corps of Engineers, Portland District
- Authorized Purposes: Hydropower, Navigation (1935 Rivers and Harbors Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality
- Type of Project: Run-of-river

Dam
- Completed: 1938; 1981 (powerhouse 2)
- Height: 171 ft
- Length: 2,477 ft
- Features: 2 powerhouses, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 71.5–76.5 ft msl
- Spillway Capacity (max): 1,600,000 cfs

Powerhouse
- Generation Capacity:
  Powerhouse 1 = 518 MW, 10 Units
  Powerhouse 2 = 532 MW, 8 Units
- Hydraulic Capacity:
  Powerhouse 1 = 136,000 cfs
  Powerhouse 2 = 152,000 cfs

Bonneville Dam was authorized by Congress for power and navigation in the 1935 Rivers and Harbors Act. The first powerhouse, spillway, and navigation lock were completed in 1938, and the second powerhouse in 1981. The lock was expanded in 1993.

Bonneville Lock and Dam was placed on the National Register of Historic Places in 1986 and declared a National Historic Landmark in 1987.

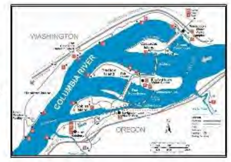
Hydropower
Bonneville Dam has 18 turbine units and a total generating capacity of over 1,200 megawatts - enough to power 900,000 homes.

Bonneville Dam, Lake Bonneville, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, and Water Quality.

Navigation
The Bonneville navigation lock was rebuilt in 1993 to accommodate larger tows. Bonneville is the first of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID. About 10 million tons of cargo pass through the Bonneville lock annually.

Water Quality
Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation
Recreation opportunities are provided at two visitor areas, a fish hatchery, and several trail systems, parks, and designated recreation areas. Popular activities include boating, fishing, windsurfing, kiteboarding, hiking, wildlife viewing, camping, and more.



Fish & Wildlife
Multiple fish ladders provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, sturgeon, shad, and others. Passage routes operated for downstream-migrating fish are the corner collector, spillway, juvenile bypass system, and sluiceway.

The Bonneville Hatchery on Tanner Creek—one of the oldest hatcheries in Oregon—is funded by the Corps and operated by the Oregon Dept of Fish & Wildlife to mitigate for the loss of spawning habitat that occurred when the reservoir was created.

Surrounding lands are managed to provide 200 acres for waterfowl and non-game species habitat, and 682 acres for wildlife habitat at Steigerwald Lake near Camas, WA.

The Dalles Dam and Lake Celilo

Quick Facts
- Stream: Columbia River (RM 192)
- Location: The Dalles, OR
- Owner: U.S. Army Corps of Engineers, Portland District
- Authorized Purposes: Hydropower, Navigation (1950 Flood Control Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Run-of-river

Dam
- Completed: 1957
- Height: 185 ft
- Length: 2,640 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 157–160 ft msl
- Spillway Capacity (max): 2,290,000 cfs

Powerhouse
- Generation Capacity: 1,780 MW, 22 Units
- Hydraulic Capacity: 375,000 cfs

The Dalles Lock and Dam was authorized by Congress for power and navigation in the 1950 Flood Control Act. The project was constructed between 1952 and 1957 near the city of The Dalles, OR, 192 miles upstream of the Pacific Ocean. Lake Celilo extends upstream of the dam for 24 miles to John Day Dam.

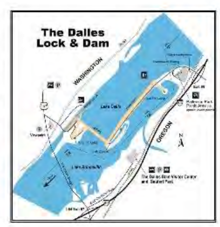
Hydropower
The Dalles Dam has 22 turbine units and a total generating capacity of 2,080 megawatts.

The Dalles Dam, Lake Celilo, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

Navigation
The Dalles Dam navigation lock is the second of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID.
The Dalles lock passes up to 10 million tons of cargo annually.

Water Quality
Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation
Popular recreational activities at The Dalles Dam and Lake Celilo include boating, fishing, windsurfing, kiteboarding, hiking, wildlife viewing, geocaching, camping, and more. There are several Corps-managed and state parks along the shoreline of Lake Celilo.



Fish & Wildlife
The Dalles Dam has two fish ladders—one on each shore—to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, sturgeon, shad, and others. Passage routes operated for downstream-migrating fish are the spillway and sluiceway.

John Day Dam and Lake Umatilla

Quick Facts
- Stream: Columbia River (RM 215.6)
- Location: Rufus, OR
- Owner: U.S. Army Corps of Engineers, Portland District
- Authorized Purposes: Hydropower, Navigation, Flood Control (1950 Flood Control Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Storage
- Authorized Flood Storage: 535,000 acre-ft

Dam
- Completed: 1972
- Height: 281 ft
- Length: 5,543 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: Jul-Sep = 265–268 ft msl Nov-Jun = 260–265 ft msl
- Spillway Capacity (max): 1,560,000 cfs

Powerhouse
- Generation Capacity: 2,160 MW, 16 Units
- Hydraulic Capacity: 322,000 cfs

John Day Lock and Dam was authorized by Congress for power, navigation, and flood control in the 1950 Flood Control Act and amended in 1957. The project was completed in 1971 near the city of Rufus, OR, 215 miles upstream of the Pacific Ocean. Lake Umatilla extends upstream of the dam for 110 miles to McNary Dam.

Hydropower
John Day Dam has 16 turbine units and a total generating capacity of 2,480 megawatts.

John Day Dam, Lake Umatilla, and associated facilities are operated for Hydropower, Navigation, Flood Risk Management, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

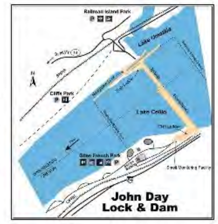
Navigation
John Day Dam navigation lock is the third of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID.

Annually, about 10 million tons of commercial cargo pass through the John Day lock.

Flood Risk Management
John Day Dam was originally authorized for 2 million acre-feet of flood control storage; however, due to concerns from local and downstream interests, the authorization was amended to 500,000 acre-feet in 1957.

Water Quality
Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation
Popular recreational activities at John Day Dam and Lake Umatilla include boating, fishing, windsurfing, kiteboarding, hiking, wildlife viewing, camping, and more. There are several state parks and Corps recreation areas along the shoreline of Lake Umatilla.



Fish & Wildlife
John Day Dam has two fish ladders—one on each shore—to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, sturgeon, shad, and others. Passage routes operated for downstream-migrating fish are the spillway, two spillway weirs, and a juvenile bypass system.

McNary Dam and Lake Wallula

Quick Facts
- Stream: Columbia River (RM 292)
- Location: Umatilla, OR
- Owner: U.S. Army Corps of Engineers, Walla Walla District
- Authorized Purposes: Hydropower, Navigation (1945 Rivers and Harbors Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Run-of-River

Dam
- Completed: 1957
- Height: 183 ft
- Length: 7,365 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 337–340 ft msl
- Spillway Capacity (max): 2,200,000 cfs

Powerhouse
- Generation Capacity: 980 MW, 14 Units
- Hydraulic Capacity: 232,000 cfs

McNary Lock and Dam was authorized by Congress for power and navigation in the 1945 Rivers and Harbors Act. Construction began in 1947, and all turbine units were operational in 1957. Lake Wallula extends upstream of the dam for 64 miles to Hanford and has over 242 miles of shoreline.

Hydropower
McNary Dam has 14 turbine units and a total project capacity of 980 megawatts, enough to power about 686,000 homes. The Corps and BPA are collaborating to modernize the turbines to improve power and hydraulic capacity and incorporate the latest fish-friendly design.

McNary Dam, Lake Wallula, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

Navigation
McNary Dam navigation lock is the fourth of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID. In 2015, more than five million tons of cargo passed through the McNary lock.

Water Quality
Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation
Nearly 17,000 acres of public lands surrounding Lake Wallula are utilized for recreation, wildlife habitat, and water-connected industry. Currently, there are about 2,400 acres leased to state or local park agencies, 17 public boat launch facilities, and 8 commercial boat club facilities.

Fish & Wildlife
McNary Dam has two fish ladders—one on each shore—to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, sturgeon, shad, and others. Passage routes operated for downstream-migrating fish are the spillway, two spillway weirs, and a juvenile bypass system.

The McNary National Wildlife Refuge is owned and managed by the U.S. Fish & Wildlife Service as part of the larger Mid-Columbia River Refuge Complex.

Chief Joseph Dam and Rufus Woods Lake

Quick Facts
- Stream: Columbia River (RM 545)
- Location: Bridgeport, WA
- Owner: U.S. Army Corps of Engineers, Seattle District
- Authorized Purposes: Hydropower, Irrigation (1945 Rivers and Harbors Act)
- Other Purposes: Recreation, Water Quality
- Type of Project: Run-of-river

Dam
- Completed: 1955 (Units 1-8); 1958 (Units 9-16); 1979 (Units 17-27)
- Features: powerhouse, spillway
- Height: 236 ft
- Length: 5,962 ft
- Forebay Elevation Normal Operating Range: 950–956 ft msl
- Spillway Capacity (max): 1,200,000 cfs

Powerhouse
- Generation Capacity: 2,069 MW, 27 Units
- Hydraulic Capacity: 219,000 cfs

Chief Joseph Dam was originally authorized as Foster Creek Dam in the River and Harbor Act of 1946 for power and irrigation. The project was renamed Chief Joseph Dam in the River and Harbor Act of 1948. Construction began in 1949, and the first eight generating units were brought online in 1955. Eight more units were completed in 1958, then eleven more in 1979, to total 27 units.

The construction of Chief Joseph Dam on the Columbia River created Rufus Woods Lake, which extends upstream for a distance of 51 miles.

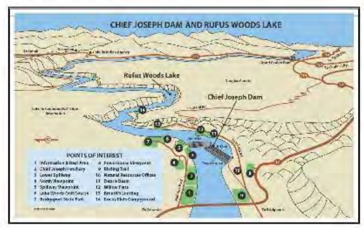
Chief Joseph Dam, Rufus Woods Lake, and associated facilities are operated for Hydropower, Irrigation, Recreation, and Water Quality.

Hydropower
Chief Joseph Dam is the 2nd largest hydropower-producing dam in the U.S. and is the largest Corps-operated hydropower dam. The powerhouse is over a third of a mile long and holds 27 house-sized turbines with a total generating capacity of over 2,000 megawatts, enough to power the entire Seattle metropolitan area. Chief Joseph Dam produces approximately $450 million worth of electricity every year.

Water Quality
Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. The Chief Joseph Dam spillway was fitted with flow deflectors in 2008 that act to reduce total dissolved gas levels downstream of the project when water is passed over the spillway.

Recreation
Recreational opportunities in and around Rufus Woods Lake include boating, swimming, hunting, fishing, hiking, picnicking, and camping. There are two campgrounds near Chief Joseph Dam–Marina Park in Bridgeport and Bridgeport State Park on the north shore of the lake.

Rufus Woods Lake is a favorite spot for anglers from all over the region. Walleye, rainbow trout, and triploid trout are the major game fish caught in the lake.



Grand Coulee Dam

Grand Coulee Dam
Grand Coulee Dam includes three major hydroelectric power generating plants (named Third, Left, and Right) and a pump generating plant. The facilities provide power generation, irrigation, flood risk management, stream flow regulation for fish migration. Additional incidental benefits include providing flows for navigation, and recreation. Grand Coulee Dam is the main feature of the Columbia Basin Project.

Authorization
Authorized under the National Industrial Recovery Act and later by the Rivers and Harbors Act. Right and Left Power Plants were constructed between 1933 and 1941. The Third Power Plant was added in the 1970s.

Irrigation
The Columbia Basin Project Act of 1943 authorized construction of the Columbia Basin Project, which consists of 330 miles of major distribution canals, lakes and reservoirs, and about 2,000 miles of laterals that currently irrigate approximately 720,000 acres of land.

Power Production
Power production facilities at Grand Coulee Dam are among the largest in the world; the total generating capacity is rated at 7,015 megawatts. Average yearly power production is 21 billion kWh with power distributed to Washington, Oregon, Idaho, Montana, California, Wyoming, Colorado, New Mexico, Nevada, Utah and Arizona. In addition, Canada receives power under the Columbia River Treaty. Grand Coulee Dam is operated as part of a coodinated federal system of hydroelectric facilities, which provides 75% of the entire power supply of the Pacific Northwest.

Flood Risk Management
From January through June, the reservoir level is adjusted for flood risk management. Grand Coulee Dam, the largest Federal storage reservoir on the Columbia River system, works with other storage projects in the system to provide flood risk management for the lower Columbia River including Portland, OR and Vancouver, WA areas.

Economic Value
The economic value of the Columbia Basin Project includes irrigated crops, hydropower production, and the prevention of flood damages.

Fish Hatcheries
Grand Coulee Dam funds a complex of three hatcheries (Leavenworth, Winthrop and Entiat), collectively known as the Leavenworth Complex, to mitigate for the loss of anadromous fish above the dam. Over 2 million spring Chinook and summer steelhead are raised annually.

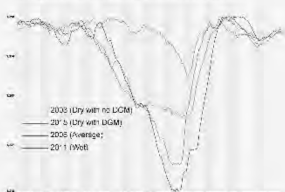
Recreation
Grand Coulee Dam creates Franklin D. Roosevelt (FDR) Lake. The lake stretches 151 miles with about 500 miles of shoreline. A portion of the lake area has been designated a National Recreation Area and is administered by the National Park Service.

Water Operations at Grand Coulee Dam
Grand Coulee Dam operations are closely coordinated to benefit a wide range of needs including hydropower, flood risk management, recreation, and operations to benefit resident and anadromous fish.

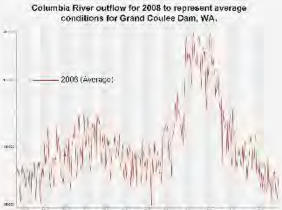
Maintenance Activities
Annual maintenance on dam outlet works, spill structures, power plants, etc. is necessary for continued operations. Periodically extraordinary maintenance activities are necessary to safely operate the project. Examples include power plant modernization (such as the ongoing efforts in the Third, Left and Right Power Plants), drum gate maintenance overhaul, and maintenance and upgrades to the John W. Keys III Pump Generating Plant.

Quick Facts about Grand Coulee Dam
- Original Construction: Right and Left Power Plants 1933 – 1941, Third Power Plant added 1967 to 1974
- Dam Type: Concrete Gravity
- Dam Height: 550 feet
- Crest Length: 5223 feet
- River: Columbia River
- Active Capacity: 5,349,560 acre-feet (total capacity of 9,715,346 acre-feet)
- Spillway (type/capacity all at pool elevation 1290 feet):
  - 11 drum gates /1,000,000;
  - 40 outlet works/ 265,000 cubic feet per second (cfs)
- Three Power Plants: Total Generating Capacity 7015 MW
  - The Left and Right Power Plants - 18 units (6,000 cfs each),
  - Third Power Plant - 6 units (3@ 25,000 cubic foot per second (cfs) each and 3@ 30,000 cfs each),
  - John W. Keys III Pump Generating Plant - 6 pump/generators (2 @ 1605 cfs each, and 4@ 1,700 each), and 6 pumps (1,600 cfs each)

Pool Elevation for selected water years to represent wet, average, and dry conditions for Grand Coulee Dam, WA.



Columbia River outflow for 2008 to represent average conditions for Grand Coulee Dam, WA.



General operational purposes by season.

Albeni Falls Dam and Lake Pend Oreille

Quick Facts

- Stream: Pend Oreille River (RM 90.1)
- Location: Bonner County, ID
- Owner: U.S. Army Corps of Engineers, Seattle District
- Authorized Purposes: Flood Control, Hydropower (1950 Flood Control Act)
- Other Purposes: Recreation, Fish & Wildlife, Water Quality
- Type of Project: Storage
- Authorized Flood Storage: 600,000 acre-ft

Dam

- Completed: 1955
- Height: 90 ft
- Length: 1,080 ft
- Features: powerhouse, spillway, log chute (currently inactive)
- Forebay Elevation Normal Operating Range: 2,051–2,062.5 ft msl
- Spillway Capacity (at full pool): 106,000 cfs

Powerhouse

- Generation Capacity: 42 MW, 3 Units
- Hydraulic Capacity: 33,000 cfs

Albeni Falls Dam was authorized by Congress in the 1950 Flood Control Act, and construction was completed in 1955.

The dam is located at the site of natural waterfalls that impounded Lake Pend Oreille. On completion, the 90-foot-tall dam increased the storage of Lake Pend Oreille and reduced upstream and downstream flood risks. The dam is made up of a powerhouse with three generating turbine units and a spillway.

Hydropower

Albeni Falls Dam has three turbine units and a total generating capacity of 42 megawatts–enough to power roughly 15,000 homes.

Albeni Falls Dam, Lake Pend Oreille, and associated facilities are operated for Flood Risk Management, Hydropower, Recreation, Fish & Wildlife, and Water Quality.

Flood Risk Management

Prior to construction of the dam, flow was restricted through the natural waterfalls, which caused flooding upstream along Lake Pend Oreille during years of high spring runoff. The construction of the dam expanded the channel and increased capacity to pass water downstream through the spillway, reducing upstream flood risk.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species.

Recreation

Recreational opportunities are abundant at scenic Lake Pend Oreille, including camping, fishing, boating, hiking, picnicking, and more. Operation of Albeni Falls Dam benefits recreation at Lake Pend Oreille by maintaining a steady lake level during the summer months at the peak of recreation on the lake.

Fish & Wildlife

Albeni Falls Dam does not have fish passage facilities; however, the project is operated in a manner to mitigate for losses to the kokanee population that have occurred since the dam was constructed. Kokanee are an important food source for bull trout–a threatened species under the Endangered Species Act–and measures to protect the kokanee in Lake Pend Oreille may also serve the recovery efforts for bull trout.

Other fish species found in Lake Pend Oreille include Kamloops trout, whitefish, cutthroat and brown trout, mackinaw or lake trout, large and smallmouth bass, crappie, pumpkinseed sunfish, northern pike, walleye, perch, bullhead catfish, and others.

Libby Dam and Lake Koocanusa

Quick Facts

- Stream: Kootenai River (RM 221.9)
- Location: Libby, MT
- Owner: U.S. Army Corps of Engineers, Seattle District
- Authorized Purposes: Flood Control, Hydropower (1950 Flood Control Act)
- Other Purposes: Recreation, Fish & Wildlife, Water Quality
- Type of Project: Storage
- Authorized Flood Storage: 4,980,000 acre-ft

Dam

- Completed: 1973
- Features: powerhouse, spillway
- Height: 432 ft
- Length: 2,887 ft
- Forebay Elevation Normal Operating Range: 2,287–2,459 ft msl
- Spillway Capacity (at full pool): 150,000 cfs

Powerhouse

- Generation Capacity: 525 MW, 5 Units
- Hydraulic Capacity: 24,100 cfs

Libby Dam was authorized by Congress in the 1950 Flood Control Act for hydropower and flood protection, and construction was completed in 1973. The dam is located on the Kootenai River, 17 miles upstream of Libby, MT.

The reservoir behind the dam, Lake Koocanusa, extends 90 miles upstream into British Columbia, Canada.

Libby Dam is the fourth dam constructed under the Columbia River Treaty between the U.S. and Canada. The other three treaty projects are located in Canada.

Libby Dam, Lake Koocanusa, and associated facilities are operated for Flood Risk Management, Hydropower, Recreation, Fish & Wildlife, and Water Quality.

Flood Risk Management

Libby operations for flood risk management are based on a variable flow operating criteria. Lake Koocanusa has nearly five million acre-feet of storage space available for local and regional flood control.

Hydropower

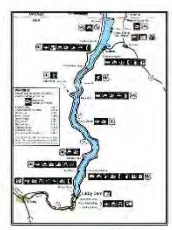
Libby Dam has 5 turbine units and a total generating capacity of 525 megawatts–enough to power roughly 400,000 homes.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species.

Recreation

There are nine Corps-managed public recreation areas and visitor facilities at Libby Dam and Lake Koocanusa that provide opportunities for a variety of activities, including fishing, camping, hiking, boating, and dam tours. The U.S. Forest Service manages additional recreation sites along the shores of Lake Koocanusa.



Fish & Wildlife

The Kootenai River, downstream of Libby Dam, is home to two fish species listed for protection under the Endangered Species Act – bull trout (threatened) and white sturgeon (endangered). Libby Dam is operated to provide adequate flows during critical periods for protection of these species.

Lake Koocanusa is home to a variety of sport fish, including rainbow trout, west slope cutthroat, brook trout, kokaneee salmon, burbot, whitefish, Kamloops trout, and others.

Hungry Horse Dam

Hungry Horse Dam

The Hungry Horse Dam project includes the dam, reservoir, powerplant, and switchyard. At the time of its completion the dam was the third largest dam, and the second highest concrete dam, in the world. The project plays an important role for meeting the power needs in the Pacific Northwest and flood risk management. It also contributes to other uses includting irrigation and navigation.

Flood Risk Management Operations

From January through June, the reservoir level is adjusted for flood risk management space requirements. The amount of reservoir draft or space is dependent on inflow forecasts. The objective of the flood risk management season is to provide enough space in the reservoir for system flood risk management operations in the lower Columbia River, and also to provide local flood protection in the mainstem Flathead River near Columbia Falls, Montana.

Operations for Fish

Hungry Horse Dam is operated to augment flows in the spring,from April to June, to aid spring anadromous fish migrating in the lower Columbia River. From July through September, the project is operated to balance reservoir storage to meet local and downstream fish needs. The reservoir is drafted to supplement flows for juvenile anadromous fish migration in the lower Columbia River, but timing and limit of the draft are also intended to benefit resident fish. Flows from the reservoir are maintained year round to preserve fish habitat in the river below the dam.

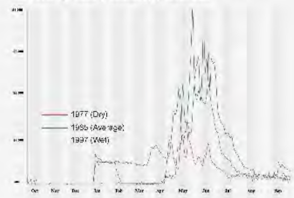
Maintenance Activities

Annual maintenance on dam outlet works, spill structures, power plants, etc. is necessary for continued operations. Periodically, extraordinary maintenance activities are necessary to safely operate the project. An example of extraordinary maintenance at Hungry Horse Dam is the modernization of the power plant.

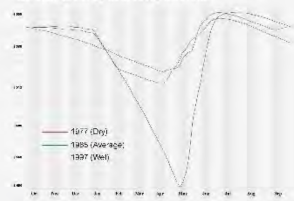
Quick Facts

- Original Construction: 1948 to 1953
- Dam Type: Concrete Arch
- Dam Height: 564 feet
- Crest Length: 2,115 feet
- River: South Fork (SF) of Flathead River
- Active Capacity: 3,467,179 acre-feet at pool elevation 3560 feet
- Spillway (type/capacity all at pool elevation 3565 feet): Gated Morning Glory Spillway /50,000 cubic feet per second (cfs); hollow-jet valves / 14,000 cfs
- Power Plant: Four 107MW generators, with combined hydraulic capacity of 12,000 cfs (transmission limited to 9,000 cfs) at pool elevation 3560 feet.

Modeled SF Flathead River flows near Columbia Falls, MT for wet, average, and dry water supply conditions.



Modeled reservoir pool elevations for Hungry Horse Dam, for wet, average, and dry water supply conditions.



General operational purposes by season.

Ice Harbor Dam and Lake Sacajawea

Quick Facts

- Stream: Snake River (RM 9.7)
- Location: Pasco, WA
- Owner: U.S. Army Corps of Engineers, Walla Walla District
- Authorized Purposes: Hydropower, Navigation (1945 Rivers and Harbors Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Run-of-River

Dam

- Completed: 1962
- Height: 141 ft
- Length: 2,822 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 437–440 ft msl
- Spillway Capacity (max): 850,000 cfs

Powerhouse

- Generation Capacity: 603 MW, 6 Units
- Hydraulic Capacity: 106,000 cfs

Ice Harbor Lock and Dam was the first of four dams constructed as part of the Lower Snake River Project, authorized in the Rivers and Harbors Act of 1945. Construction began in 1956, and three turbine units were operational in 1961. Three more turbine units were installed and operational in 1976.

Lake Sacajawea extends 32 miles upstream to Lower Monumental Dam.

Hydropower

Ice Harbor Dam has three 90-megawatt turbines and three 111-megawatt turbines, for a total of 603 megawatts. The first of two new advanced technology, "fish-friendly" turbines is scheduled to be operational in 2017.

Ice Harbor Dam, Lake Sacajawea, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

Navigation

Ice Harbor Dam navigation lock is the fifth of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID. In 2015, more than 2.3 million tons of cargo passed through the Ice Harbor lock.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation

Popular recreation activities around Ice Harbor Dam and Lake Sacajawea include fishing, swimming, picnicking, boating, hunting, hiking, and camping. There are 3,517 acres of public lands around Lake Sacajawea utilized for public recreation, wildlife habitat, wildlife mitigation, and water-connected industry.

Currently, there are seven public boat launch facilities and a marina at Charbonneau Park.

Fish & Wildlife

Ice Harbor Dam has two fish ladders—one on each shore—to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, shad, and others. Passage routes operated for downstream-migrating fish are the spillway, a spillway weir, and a juvenile bypass system.

Lower Monumental Dam and Lake West

Quick Facts
- Stream: Snake River (RM 41.6)
- Location: Kahlotus, WA
- Owner: U.S. Army Corps of Engineers, Walla Walla District
- Authorized Purposes: Hydropower, Navigation (1945 Rivers and Harbors Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Run-of-River

Dam
- Completed: 1970
- Height: 152 ft
- Length: 3,791 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 537–540 ft msl
- Spillway Capacity (max): 850,000 cfs

Powerhouse
- Generation Capacity: 810 MW, 6 Units
- Hydraulic Capacity: 130,000 cfs

Lower Monumental Lock and Dam was the second of four dams constructed as part of the Lower Snake River Project, authorized in the Rivers and Harbors Act of 1945. Construction began in 1961, and three turbine units were operational in 1970. Three more units were operational in 1978.

Lake Herbert G. West extends upstream of the dam for 28 miles to Little Goose Dam.

Hydropower

Lower Monumental Dam has six 135-megawatt turbines, for a total generating capacity of 810 megawatts.

Lower Monumental Dam, Lake West, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

Navigation

Lower Monumental Dam navigation lock is the sixth of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID. In 2015, more than 2 million tons of cargo passed through the Lower Monumental lock.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation

Popular recreation activities around Lower Monumental Dam and Lake West include fishing, swimming, picnicking, boating, hunting, hiking, and camping. There are more than 7,000 acres surrounding Lake West utilized for public recreation, wildlife habitat, wildlife mitigation, and water-connected industry.

Currently, there are 7 day-use areas, 5 campgrounds, 5 boat launch facilities, and 1 designated swimming beach. Lake West is known for the scenic confluence of the Snake and Palouse rivers, the historic Mullan Road and Lyons Ferry crossing, and the Joso Railroad Bridge.

Fish & Wildlife

Lower Monumental Dam has two fish ladders—one on each shore—to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, shad, and others. Passage routes operated for downstream-migrating fish are the spillway, a spillway weir, and a juvenile bypass system.

In 2015, about 1.2 million juvenile salmon and steelhead were collected in the bypass system—of those, 98,000 were returned to the river and over 1 million were transported downstream by barge or truck and released below Bonneville Dam.

Lower Granite Dam and Lake Lower Granite

Quick Facts
- Stream: Snake River (RM 107.5)
- Location: Pomeroy, WA
- Owner: U.S. Army Corps of Engineers, Walla Walla District
- Authorized Purposes: Hydropower, Navigation (1945 Rivers and Harbors Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Run-of-River

Dam
- Completed: 1975
- Height: 151 ft
- Length: 3,200 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 733–738 ft msl
- Spillway Capacity (max): 850,000 cfs

Powerhouse
- Generation Capacity: 810 MW, 6 Units
- Hydraulic Capacity: 130,000 cfs

Lower Granite Lock and Dam was the fourth of four dams constructed as part of the Lower Snake River Project, authorized in the Rivers and Harbors Act of 1945. Construction began in 1965 and three turbine units were operational in 1975. Three more turbine units were installed and operational in 1979.

Lake Lower Granite extends from the dam upstream for 40 miles to Lewiston, ID. The Corps constructed roughly 8 miles of levees around Lewiston, ID, to help protect lives and property from potentially destructive high water conditions.

Hydropower

Lower Granite Dam has six 135-megawatt turbines, for a total generating capacity of 810 MW.

Lower Granite Dam, Lower Granite Lake, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

Navigation

Lower Granite Dam navigation lock is the last of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID. In 2015, more than 1.1 million tons of commercial commodities passed through the Lower Granite lock.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

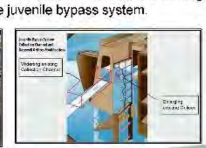
Recreation

Popular recreation activities around Lower Granite Dam and Lake include fishing, swimming, picnicking, boating, hunting, and camping. There are several day-use areas, campsites, parks, habitat management units, boat launch facilities, and marinas.

Fish & Wildlife

Lower Granite Dam has one fish ladder with entrances on both shores to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, shad, and others. Passage routes operated for downstream-migrating fish are the spillway, a spillway weir, and a juvenile bypass system. In 2015, about 2.7 million juvenile salmon and steelhead were collected in the bypass system—of those, roughly 1.5 million were transported downstream by barge or truck and released below Bonneville Dam.

Recent improvements to Lower Granite fish facilities include installation of pumps to draw cooler water from deep in the forebay to cool the adult ladder in the hot summer months, and an ongoing overhaul and upgrade of the juvenile bypass system.



Little Goose Dam and Lake Bryan

Quick Facts
- Stream: Snake River (RM 70.3)
- Location: Dayton, WA
- Owner: U.S. Army Corps of Engineers, Walla Walla District
- Authorized Purposes: Hydropower, Navigation (1945 Rivers and Harbors Act)
- Other Purposes: Fish & Wildlife, Recreation, Water Quality, Irrigation
- Type of Project: Run-of-River

Dam
- Completed: 1970
- Height: 149 ft
- Length: 2,655 ft
- Features: powerhouse, spillway, navigation lock, fish passage facilities
- Forebay Elevation Normal Operating Range: 633–638 ft msl
- Spillway Capacity (max): 850,000 cfs

Powerhouse
- Generation Capacity: 810 MW, 6 Units
- Hydraulic Capacity: 130,000 cfs

Little Goose Lock and Dam was the third of four dams constructed as part of the Lower Snake River Project, authorized in the Rivers and Harbors Act of 1945. Construction began in 1963, and three turbine units were operational in 1970. Three more turbine units were operational in 1978.

Lake Bryan extends from the dam upstream for 37 miles to Lower Granite Dam.

Hydropower

Little Goose Dam has six 135-megawatt turbine units and a total generating capacity of 810 MW.

Little Goose Dam, Lake Bryan, and associated facilities are operated for Hydropower, Navigation, Fish & Wildlife, Recreation, Water Quality, and Irrigation.

Navigation

Little Goose Dam navigation lock is the seventh of eight locks encountered in the Columbia-Snake Inland Waterway, a 465-mile river highway that allows barge transport of commodities between the Pacific Ocean and Lewiston, ID. In 2015, more than 1.9 million tons of cargo passed through the Little Goose lock.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species. During spill for juvenile fish passage at the four Lower Columbia and four Lower Snake River projects, the Corps implements a Water Quality Program to manage total dissolved gas.

Recreation

Popular recreation activities around Little Goose Dam and Lake Bryan include fishing, swimming, picnicking, boating, hunting, and camping. Currently, there are 7 day-use areas, 5 campgrounds, 5 boat launch facilities, and 2 swimming beaches.

Fish & Wildlife

Little Goose Dam has one fish ladder with entrances on both shores to provide a passage route for upstream-migrating fish, including adult salmon and steelhead, lamprey, shad, and others. Passage routes operated for downstream-migrating fish are the spillway, a spillway weir, and a juvenile bypass system.

In 2015, nearly 2.2 million juvenile salmon and steelhead were collected in the bypass system—of those, 480,000 were returned to the river and over 1.8 million were transported downstream by barge or truck and released below Bonneville Dam.

Dworshak Dam and Dworshak Reservoir

Quick Facts
- Stream: North Fork Clearwater River (RM 1.9)
- Location: Ahsahka, ID
- Owner: U.S. Army Corps of Engineers, Walla Walla District
- Authorized Purposes: Flood Control, Hydropower (1962 Flood Control Act)
- Other Purposes: Recreation, Fish & Wildlife, Water Quality
- Type of Project: Storage
- Authorized Flood Storage: 2,015,800 acre-ft

Dam
- Completed: 1972 (flood control); 1973 (power)
- Features: powerhouse, spillway, fish hatchery
- Height: 717 ft
- Length: 3,287 ft
- Forebay Elevation Normal Operating Range: 1,445–1,600 ft msl
- Spillway Capacity (max): 180,000 cfs

Powerhouse
- Generation Capacity: 400 MW, 3 Units
- Hydraulic Capacity: 10,500 cfs

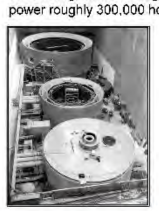
Originally authorized as Bruces Eddy Dam in the 1962 Flood Control Act, the name was changed to Dworshak Dam in 1963. Construction began in 1966, and the project started operating for flood control in 1972. The three turbine units began generating power in 1973.

Dworshak Dam is the third tallest dam in the U.S. The reservoir extends upstream for roughly 54 miles into the Clearwater National Forest in the Bitterroot Mountains.

Dworshak Dam, Dworshak Reservoir, and associated facilities are operated for Flood Risk Management, Hydropower, Recreation, Fish & Wildlife, and Water Quality.

Hydropower

Dworshak Dam has one 220-megawatt turbine unit that is the largest hydroelectric generator in the Corps' inventory. The other two units are 90-megawatt, for a total project generating capacity of 400 megawatts–enough to power roughly 300,000 homes.



Flood Risk Management

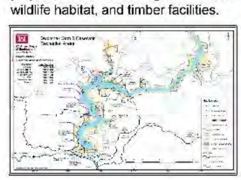
Dworshak Reservoir has over 2 million acre-feet of storage space for local and regional flood control.

Water Quality

Water quality is monitored and managed consistent with Clean Water Act and state standards for the health of aquatic species.

Recreation

Popular recreation activities at Dworshak Dam and Reservoir include boating, swimming, fishing, hunting, camping, picnicking, geocaching, and hiking. There are roughly 30,000 acres of project lands surrounding the reservoir used for public recreation, wildlife habitat, and timber facilities.



Fish & Wildlife

The height of Dworshak Dam made it infeasible to install fish ladders for upstream fish passage. Instead, the Corps constructed the Dworshak National Fish Hatchery just below the dam in 1969. The U.S. Fish & Wildlife Service operates the hatchery and raises Clearwater River "b-run" steelhead, spring Chinook, coho, and rainbow trout.

Dworshak is operated to benefit salmon and steelhead in the Snake River by releasing cool water from the reservoir during the warm summer months. Water is drawn from various depths in the reservoir to adjust the temperature, which typically ranges from 46°–48°F.

Wildlife mitigation lands are managed to offset habitat losses that occurred when the reservoir filled. About 7,000 acres are managed specifically for habitat for the Rocky Mountain elk.

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Draft Columbia River System Operations Environmental Impact Statement

Appendix T
Comments and Responses

(Pending Final Environment Impact Statement)

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Columbia River System Operations
Environmental Impact Statement

Appendix U
Fish and Wildlife Coordination Report on the Columbia River System Operations

Note: The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The Agency has made every effort to ensure that the information in *Appendix U: Fish and Wildlife Coordination Report on the Columbia River System Operations* is accessible. However, if readers have any issues accessing the information in this appendix, please contact the *U.S. Army Corps of Engineers* at (800) 290-5033 or info@crso.info so additional accommodations may be provided.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE 11th Avenue
Portland, Oregon 97232-4181

In Reply Refer to:
FWS/IR09/IR12

JAN 1 4 2020

Jesse Granet, Program Manager, Columbia River System Operations EIS
U.S. Army Corps of Engineers, Northwestern Division
P.O. Box 2870
Portland, Oregon 97208-2870

Dear Mr. Granet:

In accordance with the Scope of Work from May 2018, the U.S. Fish and Wildlife Service (Service) has completed a draft of the Fish and Wildlife Coordination Act 2(b) Report (FWCAR) for the CRSO Project. The Service understands that the draft FWCAR will be released in February 2020 for public comment as an appendix to the draft Columbia River System Operations (CRSO) Environmental Impact Statement (EIS).

This draft FWCAR is the culmination of work from across Service programs and the geographic region, and it documents the Service's analysis and conclusions of how the five CRSO EIS alternatives (the No Action Alternative and Multi-objective alternatives 1 through 4) would impact fish and wildlife species and their habitats. The draft FWCAR also includes conservation recommendations that would benefit species impacted by dam modifications and operations included in CRSO EIS alternatives. Both the analysis and conservation recommendations described in the draft Report were informed by input from experts across the Columbia River Basin.

We will work with you to address comments and finalize this report before the Final EIS is released in June 2020.

We appreciate the opportunity to conduct this important work for you and provide information for the selection of your preferred alternative in the forthcoming Final EIS. If you have any questions regarding the enclosed draft Report, please contact our CRSO FWCA Coordinator, Lee Corum (telephone: 360-753-5835; email: Lee_Corum@fws.gov).

Sincerely,

Mary M Abrams

Acting Regional Director

Enclosure

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DRAFT Fish and Wildlife Coordination Report

on the

Columbia River System Operations

Prepared for:
U.S. Army Corps of Engineers – Portland District
Bonneville Power Administration
Bureau of Reclamation

Prepared by:
U.S. Fish and Wildlife Service
Columbia – Pacific Northwest Region

January 2020

ACRONYMS AND ABBREVIATIONS

AEP	annual exceedance probability
Basin	Columbia River Basin
BCC	Bird of Conservation Concern
BMC	Bird of Management Concern
BO	Biological Opinion
Bonneville	Bonneville Power Administration
Corps	U.S. Army Corps of Engineers
CRS	Columbia River System
CRSO	Columbia River System Operations
DEIS	draft Environmental Impact Statement
EIS	Environmental Impact Statement
ESA	Endangered Species Act
EVT	existing vegetation type
FCRPS	Federal Columbia River Power System
Feasibility Study	Juvenile Salmon Migration Feasibility Study
final EIS	Environmental Impact Statement
FRM	Flood Risk Management
FWCA	Fish and Wildlife Coordination Act
FWCAR or report	Fish and Wildlife Coordination Act Report
GIS	geographic information system
H&H	Hydrology and Hydraulics
HMU	Habitat Management Unit
LANDFIRE	Landscape Fire and Resource Management Planning Tools database
MBTA	Migratory Bird Treaty Act
MIP	Minimum Irrigation Pool
MO alternative or MOs	Multiple Objective alternative
MO1	Multiple Objective 1
MO2	Multiple Objective 2
MO3	Multiple Objective 3
MO4	Multiple Objective 4
MOP	Minimum Operating Pool
NAA	No Action Alternative
NEPA	National Environmental Policy Act
NLCD	National Land Cover Data
NMFS	National Marine Fisheries Service
NWHI	Northwest Habitat Institute
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
Reclamation	Bureau of Reclamation
Rkm	river kilometers

RM	river mile
SOW	Scope of Work
System Operation Review	Columbia River System Operation Review
TDG	Total Dissolved Gas
U.S.	United States
EPA	U.S. Environmental Protection Agency
Service	U.S. Fish and Wildlife Service
WPA	Waterfowl Protection Area
WMA	Wildlife Management Area

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (Corps) and U.S. Bureau of Reclamation (Reclamation) operate the 14 Federal projects that comprise the Columbia River System Operations (CRSO), to serve authorized project purposes including power generation, water supply, flood risk management (FRM), irrigation, navigation, and recreation. Bonneville Power Administration (Bonneville) markets and transmits the electricity generated by the projects, and, collectively, the three agencies (co-lead agencies) are responsible for operating and maintaining the CRSO.

Operation of the CRSO has negatively impacted important ecological and physical processes (e.g., water flow, nutrient cycling, and natural disturbance) that maintain critical habitat structure and function to support ecologically, socioeconomically, and culturally valuable fish and wildlife resources throughout the Columbia River Basin (Basin). Impacts on fish and wildlife resources listed as threatened or endangered under the Endangered Species Act (ESA) have been documented in past Biological Opinions (BOs) (NMFS 1995, 2008, 2019; USFWS 2000) and Fish and Wildlife Coordination Act Reports (FWCARs or reports) (USFWS 1995, 1999) written by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).

Since the CRSO has been in operation, the co-lead agencies have implemented conservation measures to protect, mitigate, and enhance fish and wildlife resources affected by project operations. However, the CRSO will continue to negatively impact fish and wildlife resources in the Basin, even with ongoing conservation measures in place.

This FWCAR focuses exclusively on identifying additional impacts on fish and wildlife resources from both current operations and the five alternatives identified in the co-lead agencies' scoping process for the Draft Environmental Impact Statement (DEIS) for the CRSO. The alternatives considered in this analysis include the No Action Alternative or NAA (i.e., current operations) and four Multiple Objective (MO) alternatives or MOs (see "CRSO DEIS Alternatives").

In development of this FWCAR, the Service coordinated among its programs and with stakeholders and collected relevant data to analyze impacts of current operations and potential changes in operations of the CRSO Federal projects. This FWCAR includes the Service's evaluation of the potential positive and negative impacts of the alternatives on the overall health of landscapes (rivers, lakes and reservoirs, riparian, wetlands, and uplands) in the study area (see "Study Area and Basin Extent" and Appendix B). In this analysis, the Service used indicators of ecological and physical processes (Table 4) that support habitats, subhabitats, and fish and wildlife resources (Appendix F and G). This report includes summary tables (Tables 15, 16, 17, and 18) of the projected trends of overall health of landscapes at key sites under all alternative scenarios and a narrative that describes the impacts of structural and operational measures associated with each alternative (see "Impacts on Fish and Wildlife Resources" and Appendix G).

The Service concludes that each of the alternatives will continue to negatively impact the overall health of landscapes, to one degree or another. Thus, each of the alternatives has some negative impacts on fish and wildlife resources that depend on these landscapes. For example, the Service identified primarily decreasing trends in the overall health of river, lakes and reservoirs, riparian, and wetlands landscapes in the study area under the NAA. Most key sites characterized by certain landscapes are likely to experience further decreasing trends in overall health under MO1 and MO2, except for an unimpounded river reach in the Lower Snake River (the Clearwater River). While no alternative is wholly beneficial to fish and wildlife resources, measures associated with MO3 and MO4 could either slow decreasing trends in overall health compared to the NAA or even reverse decreasing trends in overall health at some key sites.

To enhance the resiliency of ecological and physical processes, habitats, subhabitats, and fish and wildlife resources negatively impacted by the CRSO, the Service recommends co-lead agencies implement additional conservation measures that are likely to result in increasing trends in the overall health of landscapes (Appendix G).

The Service shares a prioritized list of measureable conservation recommendations intended to provide guidance and assistance to the co-lead agencies in identifying actions to mitigate, avoid, or minimize negative impacts of the alternatives. Many of these conservation recommendations were proposed as components of the five alternatives presented by the co-lead agencies. The Service grouped the conservation recommendations into six major categories, followed by a number of specific actions, in this FWCAR (see "Conservation Recommendations"):

- restore or mimic critical components of natural hydrological systems, such as establishing functional flow regimes;
- increase habitat connectivity and improve fish passage, such as reconnecting floodplains and removing barriers;
- maintain functionality of National Wildlife Refuges (NWRs) affected by CRSO operations, such as ensuring sustainability of current NWR management operations;
- maintain or enhance habitat complexity and heterogeneity, such as supporting delta-forming processes;
- reduce the spread of invasive species, and prevent future invasions, such as coordinating with interagency invasive species teams; and,
- support long-term monitoring and adaptive management approaches to future management, such as improving coordination between biologists and engineers working together on dam operations.

Reducing negative impacts on specific processes and habitats, which characterize various landscapes, effectively reduces associated impacts on fish and wildlife resources that live in and depend on those landscapes.

PURPOSE, SCOPE, AND AUTHORITIES

PURPOSE

The Corps – Portland District, Reclamation, and Bonneville (co-lead agencies) have prepared a DEIS for the CRSO in accordance with the National Environmental Policy Act (NEPA). The CRSO includes the coordinated water management functions for the operations, maintenance, and configurations for, or management of, 14 Federal dam and reservoir projects located in the Basin.

This document is the Service's 2(b) FWCAR for the CRSO and fulfills the Service's shared responsibilities under the Fish and Wildlife Coordination Act (FWCA) of March 10, 1931, as amended (16 U.S.C. §§ 661-667e). With this report, the Service communicates the potential impacts of the proposed alternatives on trust fish and wildlife resources, highlighting the value of these resources and their significance to stakeholders (e.g., Federal and state agencies, local entities, tribes, and the public) in the Basin. The Service also provides conservation recommendations for the co-lead agencies to consider in developing the final Environmental Impact Statement (EIS) for the CRSO. The purpose of providing these conservation recommendations is to minimize further loss of, or damage to, fish and wildlife resources in the Basin, and to support future management and restoration of those resources (Smalley and Mueller 2004, p. I-28).

SCOPE

Between 2017 and 2018, the Service developed a Scope of Work (SOW), outlining key responsibilities and coordination strategies, and a budget request with the co-lead agencies in support of completing this report (USFWS and USACOE 2018, pp. 1, 6). The SOW clarifies the geographic scope of the Service's analysis, which includes the Basin, the mainstem Columbia River, major Columbia River tributaries, and portions of their tributaries affected by dam modifications and operations identified in the DEIS as of March 2018, including an approximate 0.5 mile (0.8 km) terrestrial habitat buffer along the river and tributary banks.

This FWCAR does not address other operationally related areas and projects such as those associated with irrigation systems, power delivery, and habitat restoration and mitigation (USFWS and USACOE 2018, p. 8). The "Study Area and Basin Extent" section and Appendix B further define areas covered and excluded by this analysis.

On April 25, 2018, the Corps, acting on behalf of the co-lead agencies, signed the final SOW (USFWS and USACOE 2018, p. 1). Appendix A (Table A1) includes a timeline that illustrates key milestones in the Service's engagement among its programs, and with stakeholders and the co-lead agencies for FWCAR development.

CRSO DEIS Alternatives

In accordance with NEPA, the co-lead agencies developed five alternatives for the operations, maintenance, and configuration of the 14 Columbia River System (CRS) projects to meet authorized project purposes and to balance competing demands for water (USACOE et al. In prep.). The Service considered these alternatives in their analysis.

The co-lead agencies defined eight objectives to guide alternatives development. The final set of alternatives included the No Action Alternative (NAA) and four action Multiple Objective alternatives or MOs. The NAA describes ongoing CRSO operations under current conditions, and the MOs describe modifications to one or more aspects of CRSO operations.

The MOs include structural and operational measures that address future delivery of additional water for irrigation, municipal, and industrial purposes and increased water management flexibility to react to unanticipated changes in river flow and allow for refill of storage reservoirs. The MOs also include measures that address a range of spill levels for juvenile salmon, varying levels of hydropower production, and differing actions to support the needs of resident fishes (e.g., native trout, suckers) and migratory fishes.

Alternatives are summarized here and described in more detail in the CRSO DEIS (USACOE et al. In prep.).

No Action Alternative

The NAA includes current operations and maintenance of the 14 Federal projects that comprise the CRSO. Continued operation of the projects on the Columbia and Snake Rivers would require further development and improvement of existing and future structural and operational features, many of which are intended to protect fish and wildlife resources. Under the NAA, the co-lead agencies would continue to operate the CRSO for multiple authorized purposes including FRM, power generation, water supply, irrigation, navigation, and recreation.

Multiple Objective Alternative 1

Multiple Objective Alternative 1 (MO1) is intended to benefit ESA-listed Pacific salmon and ESA-listed resident fishes. MO1 proposes implementation of a juvenile fish passage spill operation ("Block Spill" test), which includes alternating spill at the Lower Snake and Lower Columbia River projects. MO1 also includes changes to water-management, power generation, irrigation, and navigation.

Multiple Objective Alternative 2

Multiple Objective Alternative 2 (MO2) relaxes some of the restrictions on operating ranges and ramping rates to evaluate the potential to increase hydropower production and operational flexibility at various projects to respond to changes in power demand and renewable power generation. MO2 includes an expanded juvenile fish transportation operation system and reduced spill operations with a target of 110 percent total dissolved gas (TDG), the lowest end of the range of juvenile fish passage spill operations.

Multiple Objective Alternative 3

The co-lead agencies developed Multiple Objective Alternative 3 (MO3) to evaluate dam breaching on the Lower Snake River as part of the NEPA analysis. MO3 would breach the earthen portions of the four Lower Snake River dams (Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam). MO3 limits juvenile fish passage spill operations to no more than 120 percent TDG at the four Lower Columbia River projects: Bonneville Dam, The Dalles Dam, John Day Dam, and McNary Dam.

Multiple Objective Alternative 4

The co-lead agencies developed Multiple Objective Alternative 4 (MO4) to evaluate a combination of proposed changes that could be implemented within existing authorities. MO4 would benefit migratory fishes and includes proposed changes to water-management, hydropower production, and water supply. MO4 would also limit juvenile fish passage spill operations to no more than 125 percent TDG.

Draft Preferred Alternative

The co-lead agencies will be selecting a Draft Preferred Alternative for the CRSO DEIS (USACOE et al. In prep.). The Service evaluated the impacts on fish and wildlife resources based on conditions of the NAA and structural and operational measures of the four MOs, and, through this FWCAR, provides conservation recommendations for each of the MOs. The Service did not evaluate the co-lead agencies' Draft Preferred Alternative in this report because it was not available during the period of analysis.

AUTHORITIES

Fish and Wildlife Coordination Act

The FWCA authorizes the Secretaries of the Departments of Interior and Commerce to provide assistance to Federal and state agencies to protect fish and wildlife resources, assess possible damage to wildlife resources associated with the implementation of Federal water resource development projects like the CRSO, and define protective and enhancement means and measures for those resources.

The FWCA recognizes the importance of fish and wildlife resources and their value and significance to stakeholders. The FWCA requires that fish and wildlife conservation be given equal consideration with other water resource development project and program elements through early coordination, joint planning efforts, data exchange, interagency cooperation, and the development of specific measures and project alternatives for fish and wildlife conservation and rehabilitation (Smalley and Mueller 2004, pp. 14-17).

Additionally, the FWCA authorizes the Secretary of the Interior to provide assistance to, and cooperate with, Federal agencies and other groups in developing, preserving, rearing, and stocking of fish and wildlife and to protect their habitat in the course of Federal activities, such as the modification of a body of water, natural river, or such activities proposed in the CRSO DEIS.

During any given project period, the FWCA authorizes the Service to make other investigations of fish and wildlife resources, including lands and waters, and to accept contributions of funds and donations of land to meet FWCA purposes.

To ensure fish and wildlife resources receive equal consideration, the FWCA requires the co-lead agencies to coordinate with the Service, NMFS, and other groups or cooperating agencies regarding the potential impacts of the proposed project and associated actions on fish and wildlife resources (NMFS and USFWS 2018, pp. 1-6). For this report, early coordination and interagency cooperation resulted in data-sharing and -collection, collaborative analysis, report production and review, and the Service's development of conservation recommendations. The results of this coordination are not binding. However, the co-lead agencies proposing the action should consider input received during the FWCA coordination process and incorporate conservation recommendations from the FWCAR in their project designs and plans (Smalley and Mueller 2004, p. 160).

The Service anticipates the co-lead agencies will initiate and complete various consultations, restoration projects, and mitigation projects to address the CRSO and its impacts. Mitigation projects will depend on local opportunities and other factors, and those designed for one suite of habitats or species may lead to negative impacts on others. Potential conflicts and tradeoffs are not foreseeable or considered in this analysis, however the Service will count on future opportunities through NEPA to review and provide comments on specific project proposals and their various components (e.g., alternatives, impacts) as they are issued in the future.

Congressional Authority

The U.S. Congress provides the authority for the Corps and Reclamation to construct, operate, and maintain the 14 Federal CRSO projects to meet multiple purposes (Table 1). Purposes include flood control (i.e., FRM), power generation, water supply, irrigation, navigation, and recreation. Not every project is authorized for all of these purposes.

Bonneville has the authority to market and transmit the power generated by these coordinated operations (USACOE n.d.). The co-lead agencies are responsible for managing and operating the CRSO for multiple purposes while meeting their statutory and regulatory obligations.

Table 1. Federal agencies and projects in the CRSO

Federal Agency	Federal Projects
Corps	Albeni Falls Dam Bonneville Dam Chief Joseph Dam The Dalles Dam Dworshak Dam Ice Harbor Dam John Day Dam Libby Dam Little Goose Dam Lower Granite Dam Lower Monumental Dam McNary Dam
Reclamation	Grand Coulee Dam Hungry Horse Dam

The co-lead agencies are reviewing and updating the long-term, coordinated management of the Federal projects, including evaluating measures associated with various project alternatives to avoid, offset, or minimize potential negative impacts on resources significant to various stakeholders or user groups. The DEIS enables the co-lead agencies to collaboratively evaluate the costs, benefits, and tradeoffs of various measures and alternatives as part of reviewing and updating the management of the Federal projects and the CRSO (USACOE 2017).

COOPERATING AGENCIES AND TRIBES

Early in the NEPA process, the co-lead agencies requested cooperation from Federal, state, tribes, and local agencies that either have jurisdiction by law or special expertise on relevant environmental issues to participate in DEIS development (40 CFR § 1501.6). The co-lead agencies and several of the designated cooperating agencies and tribes collaborated with the Service in this reporting effort (Table 2). Other agencies, tribes and non-governmental partners contributed to this report, but were not cooperating agencies (see "Coordination and Information-Sharing").

Table 2. Cooperating agencies and tribes that contributed to the FWCAR

General Affiliation	Specific Tribes and Agencies
Tribes	Confederated Tribes of the Grand Ronde Community of Oregon Cowlitz Indian Tribe Kootenai Tribe of Idaho Yakama Nation
State Agencies	Montana Department of Fish, Wildlife, and Parks Montana Department of Natural Resources and Conservation Oregon Department of Fish and Wildlife Washington State Department of Ecology Washington Department of Fish and Wildlife

RELEVANT PRIOR FWCA REPORTS IN THE BASIN

The Service has previously developed FWCARs, planning aid letters, and general memos in response to Federal agency-led water resource development activities and their potential impacts on fish and wildlife resources in the Basin. Prior FWCAR reporting efforts, described below, identify the Federal Columbia River Power System (FCRPS) as the coordinated operation of 14 specific Federal projects in the Basin. However, these projects represent only a subset of the 31 total Federal projects that actually comprise the FCRPS (NPCC 2011, para. 3). The name change (from FCRPS to CRSO in reference to the 14 CRS projects) is meant to eliminate past confusion. The term FCRPS is used in this section ("Relevant Prior FWCA Reports in the Basin") because it was also used in past FWCARs, however, outside of this section, the Service used the term CRSO rather than FCRPS.

Past FWCARs for FCRPS can be assigned to two time periods: pre-dam construction and post-dam construction. When the Federal Basin hydropower projects or dams were first designed and constructed, FWCARs, letters, and memos focused on project (dams and associated infrastructure) construction and operations. In those documents, the baseline conditions used to analyze changes in the environment as a result of the proposed action did not include the impacts of dams, as the dams were not yet constructed. The Service's FWCARs of that time included the only description of the environmental impacts of the FCRPS projects prior to their construction.

Congress did not enact NEPA until 1969 and did not fully implement it until the mid-1970s. Construction of the last Federal Basin project, Lower Granite Dam, was finalized in 1975, so the design and construction of the FCRPS was not subject to NEPA. Until the 1990s, the Service issued FWCARs with narrow scopes for individual project structural improvements and operational changes. Few FWCARs addressed the system, yet two are notable as a result of their broader scope and more detailed analyses: the Columbia River System Operation Review (System Operation Review) and another related to fish passage in the Lower Snake River (USFWS 1995, 1999).

1995 FWCAR FOR SYSTEM OPERATION REVIEW

The Service's 1995 System Operation Review FWCAR for the Corps evaluates resources for the FCRPS. Through a comprehensive evaluation of the FCRPS, this review made recommendations to promote recovery of Pacific salmon newly listed under the ESA. The 1995 FWCAR was comprehensive and also unique in that it marked an early approach to integrate fish and wildlife mitigation, enhancement, recovery, and restoration with the existing FCRPS and the proposed action. At the time, the Service was confident that addressing these issues in a holistic ecosystem context, rather than on a project-by-project basis, would be more biologically appropriate and effective.

The Service's 1995 FWCAR presented a broad ecosystem planning and management approach for evaluating and addressing operational and biological impacts of the proposed action (USFWS 1995, p. 15). Rather than recommend specific actions for implementation, the Service declared that mitigation, enhancement, recovery, and restoration strategies included in the preferred alternative would require adaptive implementation (UFWS 1995, p. 24). This approach included identification, design, implementation, and evaluation of restoration strategies, and would have generated proposed modifications based on information obtained during the FWCA evaluation phase. This report did not suggest project-specific measures or actions for the Federal action agencies to implement; rather, it recommended a process for identifying potential measures, implementing those measures as agency budgets allow, and evaluating their efficacy over time.

1999 FWCAR FOR IMPROVED FISH PASSAGE IN THE LOWER SNAKE RIVER

In the proposed Lower Snake River fish passage improvements, the Corps – Walla Walla District analyzed an alternative for breaching the four Lower Snake River dams: Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam. Federal listing of several stocks of Pacific salmon in the mid-1990s due to overharvest, habitat loss and degradation, construction of dams and reservoirs prompted the NMFS to issue two BOs on FCRPS operations (NMFS 1995, 2000). The BOs outlined measures to avoid jeopardizing the continued existence of ESA-listed species affected by FCRPS operations. As a result, the Corps implemented a study of alternatives known as the Lower Snake River Juvenile Salmon Migration Feasibility Study (Feasibility Study) to analyze the impacts of Lower Snake River dams and reservoirs as barriers to migratory fishes (USACOE 1992a, p. ES-2).

The Feasibility Study evaluated the technical, environmental, and economic feasibility of structural alternatives that would increase survival and improve the prospects for recovery of Pacific salmon in the Snake River and allow them to pass through the four Lower Snake River dams. The study was conducted in two phases. Phase I, completed in mid-1995, included a preliminary assessment of multiple concepts such as drawdown of reservoirs, upstream collection and transport of juvenile salmon, additional reservoir storage, and more alternatives for improving conditions for fish migration. Phase II, completed in 1996, included an evaluation of the feasibility of reservoir drawdown to spillway crest elevations and below, and other improvements to existing fish passage facilities. Based on the Phase I and Phase II reports, the 1999 Environmental Impact Statement (EIS) developed four alternatives (USACOE 1992b, pp. 3-2-3-22).

The Federal Record of Decision reflected the Corps' decision to implement the Major System Improvements (Adaptive Migration) Alternative. Over the next 10 to 15 years, the Corps and Reclamation implemented many of the measures outlined in the EIS, however the agencies did not request that the Service revisit its analysis with new or different information.

STUDY AREA AND BASIN EXTENT

The study area includes the Basin, and its tributaries and infrastructure affected by the CRSO. Thus, the study area is comprised of the mainstem Columbia River, the Lower Snake River (beginning approximately 9 miles (14 km) below its confluence with the Salmon River, to the Snake River's confluence with the Columbia River), and all portions of tributaries affected by regular flow management, including terrestrial and aquatic habitats within an approximate 0.5 mile (0.8 km) buffer (USFWS and USACOE 2018, p. 8).

The Basin covers approximately 258,000 square miles (668,217 km^2) and includes major portions of Washington, Oregon, Idaho, the western part of Montana; minor portions of Nevada, Utah, and Wyoming; and the southeastern part of British Columbia (Figure 1). The Columbia River, the fourth largest river in amount of discharge (i.e., 265 kcfs [7,503 m^3s^{-1}]) in North America, delivers more water to the Pacific Ocean than any other river in North or South America (Bloodworth and White 2008, p. 98; Kammerer 2005). It is approximately 1,270 miles (2,044 km) long and flows through the Rocky and Cascade Mountain ranges.

Where the Columbia River meets the Pacific Ocean, saltwater intrusion extends approximately 23 miles (37 km) upstream. Tidal impacts extend up to Bonneville Dam, 146 river miles (RM) (235 river kilometers [Rkm]) inland (Hadley, H., in litt. 2019). Stream flow in the Basin typically begins to rise in April, reaching a peak during May or early June, and about 60 percent of the natural runoff occurs May through July. Regarding infrastructure, the Basin includes over 400 dams, of which 133 dams produce hydropower as their primary or secondary purpose. Other dams are primarily related to irrigation, fish hatcheries, or other purposes (Hadley, H., in litt. 2019).

Ecologically, the Basin includes diverse habitats, affected by several mountain-influenced precipitation patterns, differences in elevation, aspect, soils, and underlying geology and resulting hydrology. The Cascade Range separates the Pacific Ocean coast from the interior of the Basin, dividing the maritime climate to the west from the interior land east of the crest, leaving the interior Basin with a continental climate of cold winters and warm, dry summers (Hadley, H., in litt. 2019). Variability in geology, soils, and climate results in a diverse array of upland, wetland, aquatic, and riparian (i.e., relating to transitional land adjacent to bodies water such as rivers or streams) habitats.

The Columbia River has many tributaries, and four are of particular focus in the proposed CRSO action: Snake River, Clearwater River, Kootenai River, and Pend Oreille River. Appendix B includes a detailed description about the focal tributaries and how the Service further defined the study area for the FWCAR.

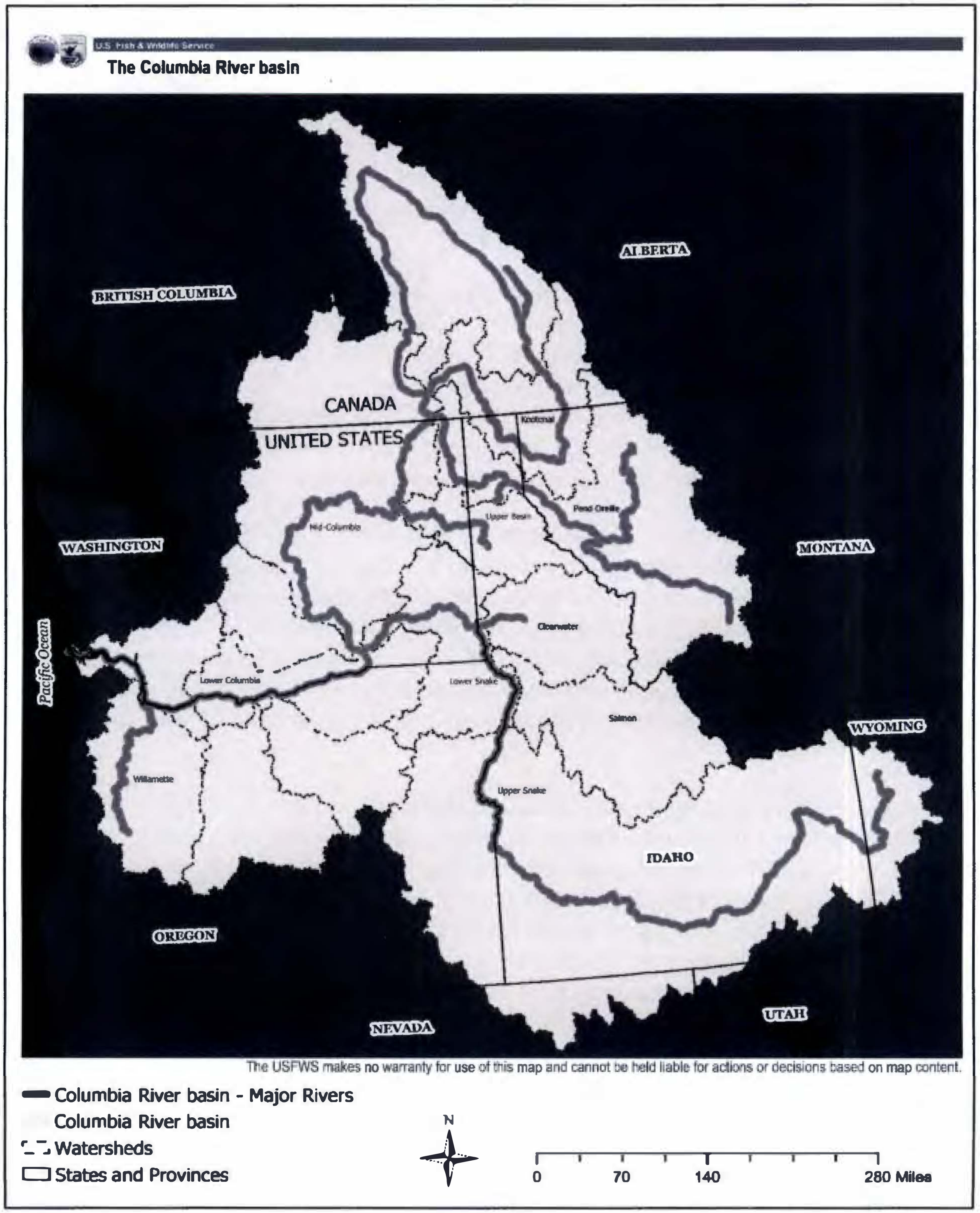

Figure 1. The Columbia River Basin

METHODS

This FWCAR analyzed and described impacts of the co-lead agencies' proposed changes to modifications, operations, and configurations of CRSO Federal projects on fish and wildlife resources. The Service coordinated with other Federal and state agencies, local entities, and tribes to define trust fish and wildlife resources to consider in the analysis of impacts (see "Impacts on Fish and Wildlife Resources" and Appendix G).

For this analysis, the Service identified key ecological and physical processes that support Basin landscape structure and function. Based on those structures and functions, the Service identified fish and wildlife resources that depend on certain habitats and subhabitats in the study area. Finally, the Service organized the data and analysis by subbasins in the study area (Table 3 and Figure 2).

Table 3. Subbasins identified by the Service and associated Federal projects in the study area

Subbasin	Description	Federal Projects
Lower Columbia River	Pacific Ocean to the confluence with the Snake River	Bonneville Dam The Dalles Dam John Day Dam McNary Dam
Mid-Columbia River	Confluence of the Snake River to the Canadian border	Chief Joseph Dam Grand Coulee Dam
Upper Basin	Pend Oreille, Kootenai, and Clark Fork Rivers and Reservoirs	Albeni Falls Dam Libby Dam Hungry Horse Dam
Lower Snake River	Confluence of the Columbia River to Dworshak Reservoir	Ice Harbor Dam Lower Monumental Dam Little Goose Dam Lower Granite Dam Dworshak Dam

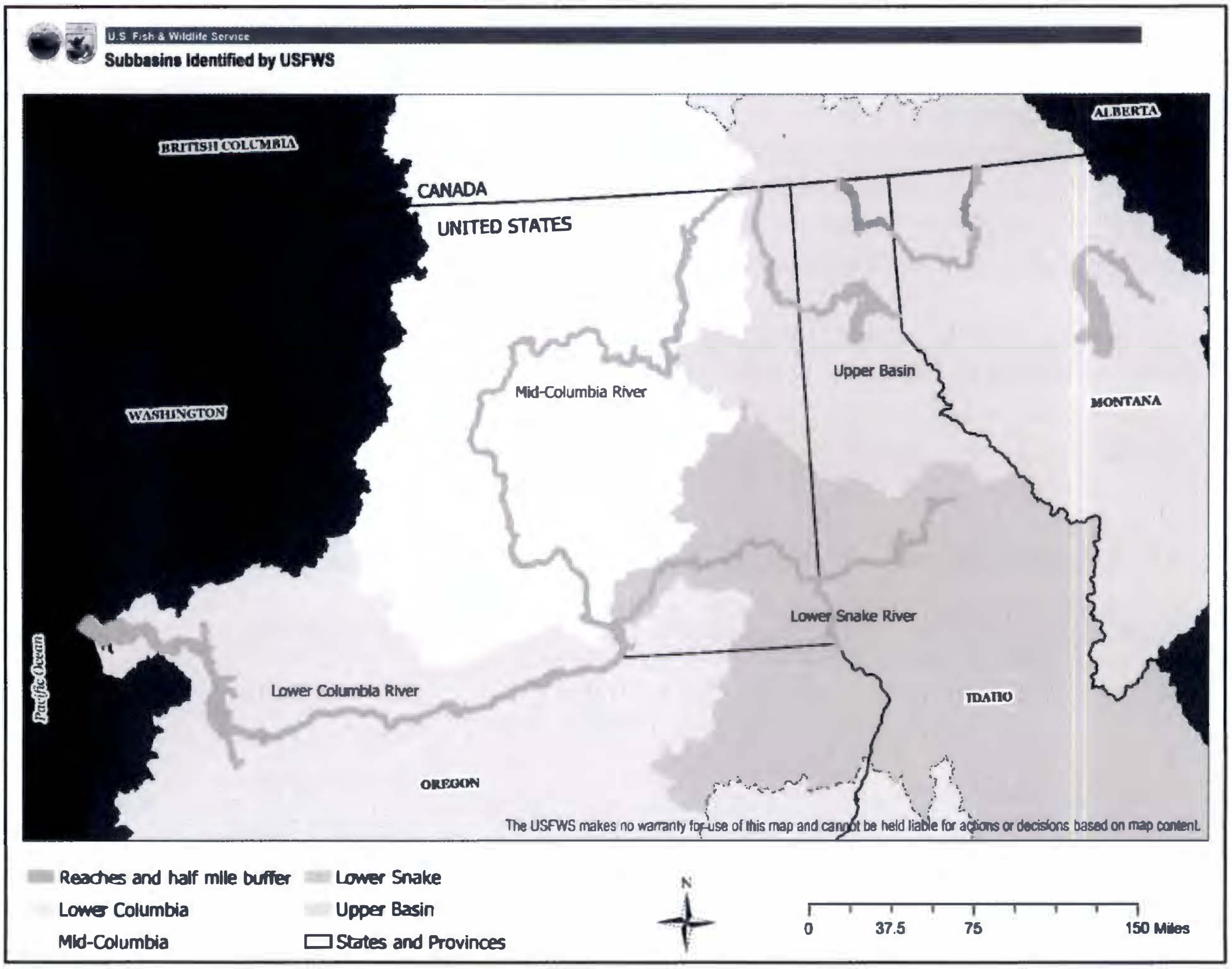

Figure 2. Subbasins identified by the Service for the FWCAR analysis

ECOLOGICAL AND PHYSICAL PROCESSES

The Service identified ecological and physical processes critical to support functional Basin landscapes and persistent fish and wildlife resources under current conditions. The Service also developed general indicators of processes (Table 4). For example, high ecosystem function may be a good indicator of diverse plant growth and successful animal reproduction in a specific location. For the FWCAR analysis, the Service considered the indicators in Table 4 to determine how changes in dam operations may affect ecological and physical processes and fish and wildlife resources that depend on them.

Table 4. Ecological and physical processes and indicators identified by the Service for the FWCAR analysis

Ecological and Physical Processes	Indicators
Channelization Channel avulsion Natural disturbance Channel migration Water flow	Connectivity
Disturbance Nutrient cycling Plant and animal interactions (e.g., growth)	Ecosystem function
Channel avulsion Disturbance Forest succession Sediment bar formation Nutrient cycling Plant and animal reproduction Recruitment and transport of large wood[1/] Sediment dynamics (e.g., sediment transport) Soil formation	Habitat complexity and diversity Species diversity
Erosion (i.e., scouring)	Landforms (e.g., natural bluffs)
Natural disturbance Nutrient cycling Pollination Seasonal flooding	Native vegetation (e.g., grasslands)
Bioturbation (e.g., spawning or burrowing) Erosion (e.g., bank sloughing) Fire occurrence (i.e., frequency, intensity) Flooding Sediment dynamics (e.g., deposition) Channel migration	Natural disturbance
Precipitation Soil formation	Natural flood regime

Ecological and Physical Processes	Indicators
Storing water (e.g., floodwater) Water flow	
Natural disturbance (e.g., storms) Precipitation Storing water (e.g., floodwater) Water flow (e.g., base flow, subsurface flow)	Pre-dam hydrograph
Erosion Sediment filtration Surface water inundation	Terrain (e.g., streambanks, shorelines)
Climate variability patterns Cooling/warming of water Mixing of fresh and ocean waters Sediment dynamics (e.g., deposition) Storing/biodegrading pollutants Stratification	Water quality (in this report, total dissolved gas [TDG])
Evaporation Flooding Groundwater discharge Precipitation Water flow (e.g., subsurface flow) Water storage Water uptake (e.g., adsorption by plants)	Water quantity

[1/]Instead of "large woody debris," this report uses "large wood" to imply dead but mostly intact fallen trees large enough to influence ecological and physical processes (e.g., channel avulsion or sudden channel formation by erosion)

LANDSCAPES

To address the diverse range of ecological communities in the study area and their values to fish and wildlife resources, the Service identified landscapes that could be impacted by the ecological and physical processes changed under the proposed CRSO actions (see "Resources" and Appendix F).

Using the U.S. Environmental Protection Agency (EPA) Level 3 and 4 Ecoregions in the study area, the Service selected a preliminary list of four broad aquatic and terrestrial landscapes potentially affected by the CRSO proposed action: lakes/reservoirs/rivers, riparian, wetlands, and uplands (EPA 2017). These landscapes helped refine the evaluation species, habitats, subhabitats, and key sites selected for this analysis (USFWS and USACOE 2018, p. 9). The uplands landscape comprises a relatively small proportion of the study area, and, thus, the Service analyzed impacts on this landscape generally, without identifying key sites or locations as with other landscapes (see "Quantitative Key Site and Location Selection").

A given landscape may contain features similar to those that also characterize other landscapes, however this analysis limits discussion of those features as part of only one, rather than more than one, landscape. For instance, the Service analyzed riparian habitats separately from wetland and upland habitats to the extent possible. In general, this analysis focused on relatively undeveloped lands, rather than human-populated or -developed subhabitats (i.e., residential, commercial, and industrial areas and associated infrastructure), as the undeveloped lands are more likely to support fish and wildlife resources.

EVALUATION SPECIES

For the FWCAR, the Service evaluated trust fish and wildlife resources, including: migratory birds; migratory fishes (e.g., multiple species of fish such as Pacific lamprey [*Entosphenus tridentatus*] and white sturgeon [*Acipenser transmontanus*]) and interjurisdictional fishes; species with socioeconomic value, including consumptive and non-consumptive human uses such as fishing, hunting, and birdwatching; environmentally sensitive species; species performing a key ecological role; species affected by Federal water resource development; and species that represent groups of species using a common environmental resource (Smalley and Mueller 2004, p. III-18).

In identifying the evaluation species, the Service reviewed documents including State Wildlife Action Plans, Priority Habitats and Species of Washington, and State Species of Concern. A preliminary list of approximately 100 evaluation species were evaluated and then prioritized using the following criteria:

- **Indicators of ecological change**. For example, the "rivers/lakes/reservoirs" landscape includes the Pacific lamprey, an indicator of water quantity (i.e., timing and total yield of water originating from a watershed) as well as water quality and tributary substrates (Clemens et al. 2017, p. 7).
- **Likelihood to be negatively or positively impacted** by changes in processes affected by proposed alternatives, including dam operations and maintenance.
- **Representative of identified subbasins and landscapes in the Basin**. To understand the impacts of the CRSO basin-wide, within each landscape, the Service selected representative species that inhabit landscapes occurring across four subbasins in the study area. The four subbasins selected were: Lower Columbia River, Mid-Columbia River, Upper Basin, and the Lower Snake River (Table 3 and Figure 2).

- **Not listed as threatened or endangered under the ESA**. Impacts on ESA-listed fishes (bull trout [*Salvelinus confluentus*], Kootenai white sturgeon [*A. transmontanus*], and 12 stocks of Columbia River Basin salmon and steelhead), wildlife, and plant species will be addressed in consultations under section 7(a)(2) of the ESA and, thus, are outside the agreed upon scope of this FWCAR. Species that have state listing status (e.g., endangered, threatened, candidate, of concern) and do not have Federal threatened or endangered status were prioritized (NMFS 2019, pp. 5-6). Analyzing potential impacts on these species would likely be mutually beneficial to the Service and state agency partners in strengthening collaborative conservation efforts.
- **Of interest to multiple states and tribes**. Selected species (e.g., Pacific lamprey) that multiple states (Idaho, Montana, Oregon, and Washington), tribes, and other stakeholders across geopolitical boundaries have identified as a priority in their respective management plans were also prioritized.

Service experts, the co-lead agencies, and other state, local, tribal, and private partners participated in a review of the prioritized species list. Based on their reviews, the Service developed an initial list of landscapes and evaluation species (Table 5). This initial, focused list of evaluation species was approved in the SOW (USFWS and USACOE 2018, p. 9).

Table 5. Focused list of landscapes and evaluation species in the approved SOW

Landscapes	Evaluation Species
Rivers/Lakes/Reservoirs	Clark's grebe (*Aechmophorus clarkii*) Columbia River redband trout (*Oncorhynchus mykiss gairdnerii*) Pacific lamprey (*Entosphenus tridentatus*) Shortface lanx (*Fisherola nuttalli*) Trumpeter swan (*Cygnus buccinator*) Westslope cutthroat trout (*Onchorhynchus clarkii lewisi*)
Riparian	Townsend's big-eared bat (*Corynorhinus townsendii australis*) Ute-ladies'-tresses (*Spiranthes diluvialis*) Western bumblebee (*Bombus occidentalis*) Yellow-billed cuckoo (*Coccyzus americanus*)
Wetlands	Northern leopard frog (*Lithobates pipiens*) Western pond turtle (*Actinemys marmorata*) Western toad (*Anaxyrus boreas*)
Uplands	Ferruginous hawk (*Buteo regalis*) Washington ground squirrel (*Urocitellus washingtoni*)

Landscapes	Evaluation Species
	White bluffs bladderpod (*Physaria douglasii* spp. *tuplashensis*)

Source: USFWS and USACOE 2018, p. 9

RELATING AND REFINING LANDSCAPES AND SPECIES

Following the SOW approval, the Service refined and expanded the focused list based on key evaluation elements:

- the proposed action and alternatives and their potential impacts on the study area and fish and wildlife resources;
- important ecological and physical processes (biological, chemical, physical), habitats, and subhabitats, and ecological features that occur in or characterize the study area; and,
- potential evaluation species that could serve as indicators of ecological change given the suite of potential CRSO impacts.

The Service created an interim list of five landscape groupings (rivers, lakes and reservoirs, riparian, wetlands, and uplands) and 78 species. Six of the 78 species had been included in the initial, focused list (Table 5). Next, the Service ranked potential evaluation species from this interim list according to the indicator of ecological change criterion.

The Service's refinement considered unique ecological links among the proposed CRSO action and alternatives, ecological and physical processes, landscapes and habitats, and species life history stages and ecological niches. This refinement of the landscapes and evaluation species lists reflected the following changes:

- **Reconsideration of landscapes**. Separation of "lakes and reservoirs" and "rivers" landscapes based on a discussion of the unique biological, chemical, and physical processes, habitats and subhabitats, and ecological features that differentiate rivers from lakes and lake-like environments such as reservoirs. For this FWCAR, the Service discussed impacts on Pacific lamprey primarily in association with the rivers landscape rather than the lakes and reservoirs landscape due to their strong dependence on riverine subhabitats in the study area.
- **Confirmation of evaluation species.** Pacific lamprey and Clark's grebe (*Aechmophorus clarkii*) were confirmed as evaluation species from the focused list.
- **Substitution of evaluation species.** Twelve species were substituted as evaluation species because they were considered to be better indicators of potential changes in landscapes throughout the study area. For instance, the black cottonwood (*Populus trichocarpa*) substituted for the Ute-ladies'-tresses orchid (*Spiranthes diluvialis*) because

of its prevalence throughout riparian habitats and subhabitats in the Basin and likelihood to be affected by CRSO impacts.

- **Addition of two evaluation species**. The American bittern (*Botaurus lentiginosus* and the Western grebe (*A. occidentalis*) were added as evaluation species.
- **Elimination of two evaluation species**. The White Bluffs bladderpod (*Physaria douglasii* spp. *tuplashensis*) and Townsend's big eared bat (*Corynorhinus townsendii australis*) were eliminated as evaluation species based on their limited geographic range in particular subhabitats of the study area.

Table 6 shows the resulting refined list, which received support from, and approval by, Service experts and other state, local, tribal, and private partners. See the "Resources" section and Appendix F for more detailed information about landscapes, habitats and subhabitats, and their relationships to ecological and physical processes. Appendix F also includes descriptions of the final evaluation species the Service selected for, and analyzed in, the FWCAR.

Table 6. Refined list of landscapes and final evaluation species analyzed in the FWCAR

Landscapes	Evaluation Species
Rivers	Pacific lamprey (*Entosphenus tridentatus*) Western pearlshell (*Margaritifera falcata*) White sturgeon (*Acipenser transmonatus*)
Lakes and Reservoirs	Clark's grebe (*Aechmophorus clarkii*) Western grebe (*Aechmophorus occidentalis*) Dunlin (*Calidris alpina*) Floaters (*Anodonta* spp.)
Riparian	Black cottonwood (*Populus trichocarpa*) Viceroy butterfly (*Limenitis archippus*) Yellow warbler (*Setophaga petechia*)
Wetlands	American bittern (*Botaurus lentiginosus*) Mallard (*Anas platyrhynchos*) Western painted turtle (*Chrysemys picta*)
Wetlands	Woodhouse's toad (*Bufo woodhousii*)
Uplands	Long-billed curlew (*Numenius americanus*) Sage thrasher (*Oreoscoptes montanus*)

Other Guilds, Communities, and Species

The Service also identified additional species, guilds, and communities to highlight particular impacts of some of the proposed alternatives—impacts that could not be illustrated through analysis of the evaluation species. For example, the Service identified the Columbia yellowcress (*Rorippa columbiae*) in the wetlands landscape because it is uniquely reliant on specific wetland subhabitats (e.g., emergent wetlands). Similarly, the Service highlighted Bullock's oriole (*Icterus bullockii*) and willow flycatcher (*Empidonax traillii*), along with the yellow warbler (*Setophaga petechia*), representing a large and diverse guild of riparian songbirds and serving as indicators of potential impacts on other wildlife (e.g., terrestrial invertebrates, amphibians, reptiles, and mammals) that use riparian habitat (Croonquist and Brooks 1991, pp. 708-709). In these ways, additional species, guilds, and communities illustrated different scales of potential impacts of the proposed alternatives.

COORDINATION AND INFORMATION-SHARING

Workshops

The FWCA requires the Service to consult and coordinate with other groups, including the co-lead agencies, cooperating agencies, and Federal and state agencies, local entities, and tribes to augment its understanding of the potential impacts of the proposed alternatives on fish and wildlife resources. This coordination enhances the information available for analysis and yields a more complete understanding of the ecological, socioeconomic, and cultural values of these resources, and their potential risk as a result of proposed changes to the CRSO. Due to the size and scope of this action, the diversity of values held among stakeholders in the Basin, and the many fish and wildlife resources at risk, it was imperative that the Service effectively coordinate with participating stakeholder groups. This maximized capturing various perspectives and insights the Service's research and analyses for the FWCAR. To enhance coordination and gather input, the Service planned and hosted a series of multi-stakeholder technical workshops in the summer of 2019.

The Service designed and facilitated five workshops in May and June, 2019. Each workshop focused discussions on either a landscape (e.g., riparian, wetlands, lakes and reservoirs, or rivers) or a subbasin (e.g., Upper Basin) (Table 7). Each workshop was held in a different location in the Basin to allow for convenient travel and easy participation among stakeholders. The Service facilitated the first three workshops and a consulting firm, DS Consulting, located in Portland, Oregon, facilitated the last two workshops.

Table 7. The Service's workshop focus topics, dates, and locations

Workshop Focus	Dates	Location
Wetlands	May 20-21	Mid-Columbia River NWR Complex Office in Burbank, Washington
Upper Basin[1/]	May 28-29	Montana Department of Fish, Wildlife, and Parks Office in Kalispell, Montana
Riparian	June 5-6	Mid-Columbia River NWR Complex Office in Burbank, Washington
Rivers	June 24-25	Columbia River Fish and Wildlife Conservation Office in Vancouver, Washington
Lakes and Reservoirs	June 25-26	Columbia River Fish and Wildlife Conservation Office in Vancouver, Washington

[1/]Uplands habitats and subhabitats in the Basin likely to be affected by the CRSO were discussed as part of the Upper Basin Workshop

Appendix C includes the Service's outreach and communications associated with these workshops. More than 110 stakeholders from 21 organizations participated in at least one or more of these workshops (Table 8).

Table 8. Stakeholders represented at the Service's workshops

General Stakeholder Group	Affiliation within General Stakeholder Group
Federal Agencies and Programs	Bureau of Reclamation U.S. Amy Corps of Engineers U.S. Fish and Wildlife Service U.S. Forest Service
State Agencies	Montana Department of Natural Resources and Conservation Montana Department of Fish, Wildlife, and Parks Oregon Department of Fish and Wildlife Washington State Department of Ecology Washington Department of Fish and Wildlife
Tribes	Confederated Tribes of Grand Ronde Cowlitz Indian Tribe Kalispel Tribe of Indians

General Stakeholder Group	Affiliation within General Stakeholder Group
	Kootenai Tribe of Idaho Yakama Nation
Private Entities	Inter-Fluve Meadow Run Environmental LLC
Academic Institutions	Eastern Washington University Oregon State University Southern Illinois University – Edwardsville University of Idaho University of Lethbridge

During each workshop, the Service provided an overview of the CRSO and the FWCA, detailed the FWCAR approach, and defined the purpose and goals for the workshop. Workshop discussions centered on four to five questions designed to encourage stakeholders to share specific information on the following:

- ecological and physical processes that maintain resource health and potential impacts of changes to existing conditions;
- the status of significant resources;
- key sites and locations defined by ecological and physical processes that either do, or could, support resources; and,
- measurable and achievable actions to conserve, protect, and enhance the identified resources.

Each workshop provided an opportunity for participating stakeholders to learn about the CRSO proposed action and alternatives and contribute to or add technical information related to the previously identified key ecological and physical processes, landscapes, and evaluation species. The Service requested stakeholders identify and describe fish and wildlife resources and habitats, or specific locations or sites with special value to them and their agencies; discuss how changes to existing conditions could potentially impact these resources; and suggest measures to conserve, protect, and enhance ecological and physical processes, habitats, and species. The Service also asked for information (e.g., data, reports from past surveys or studies, white papers, gray literature, species population assessments, expert knowledge) to fill knowledge gaps. Appendix D includes the Service's workshop agendas and questions.

Data and Modeling

The Service used data from different sources including modeling efforts led by the co-lead agencies, existing databases, primary literature, technical experts who participated in the above-described workshops, draft and final Service (e.g., consultations) and Corps reports (e.g., Biological Assessments) and gray papers, and maps and aerial photographs. The Service performed a series of quantitative and qualitative assessments using available data to examine and measure the potential impacts of the CSRO on fish and wildlife resources in the Basin. Appendix E includes the primary data sources the Service used in these assessments for the FWCAR.

QUANTITATIVE KEY SITE AND LOCATION SELECTION

The Service worked with stakeholder participants during various workshops to identify key sites or locations in the study area with specific characteristics, based on the following criteria:

- best representative of ecological and physical processes and functional habitats;
- actively managed or protected to maintain fish and wildlife resource value; and,
- greatest contribution to native species conservation (e.g. important migratory bird areas, well-connected corridors, reservoirs with water management operations that benefit important species).

Other locations (e.g., Blalock Island complex) were identified from follow-up discussions with Service experts and through communications with cooperating agencies and workshop participants regarding specific fish and wildlife resources (e.g., Caspian tern [*Hydroprogne caspia*]).

As part of the analysis of impacts, key sites and locations were evaluated by subbasin (Table 3 and Figure 2) and landscape. Because there is little uplands landscape in the 0.5 mile (0.8 km) buffer in comparison to the other landscapes, the Service analyzed impacts on the uplands landscape generally and did not identify key sites or locations associated with this landscape.

Key sites associated with the remaining four landscapes (rivers, lakes and reservoirs, riparian, and wetlands) are summarized in Table 9, shown in Figure 3, and discussed in more detail in the "Resources" and "Impacts on Fish and Wildlife Resources" sections and appendices G and H.

Table 9. Key sites and locations identified by the Service, organized by landscape and subbasin

Landscape	Subbasin	Key Sites
Rivers	Lower Columbia River	1. Columbia River Estuary 2. Mouth of the Deschutes River 3. John Day Reservoir or Pool (Lake Umatilla)
	Mid-Columbia River	4. Hanford Reach 5. Reach 21, above Grand Coulee Pool (Lake Roosevelt)
	Upper Basin	6. Kootenai River 7. Pend Oreille River
	Lower Snake River	8. Clearwater River 9. Lower Monumental Reservoir or Pool (Lake Herbert G. West)
Lakes and Reservoirs	Lower Columbia River	10. John Day River Confluence 11. Blalock Island Complex 12. Umatilla River Confluence
	Mid-Columbia River	13. Lake Roosevelt
	Upper Basin	14. Lake Pend Oreille 15. Lake Koocanusa
	Lower Snake River	16. Dworshak Reservoir
Riparian	Lower Columbia River	17. Julia Butler Hansen National Wildlife Refuge 18. Sandy River Delta 19. Umatilla National Wildlife Refuge
	Mid-Columbia River	20. Okanogan River Confluence 21. Threemile Creek to Six Mile Creek confluences 22. Little Sheep Creek Confluence
	Upper Basin	23. Stillwater River Confluence 24. Clark Fork Delta at Lake Pend Oreille 25. Yaak River and Star Creek confluences

Landscape	Subbasin	Key Sites
	Lower Snake River	26. Catholic Creek Confluence 27. Tucannon River Confluence 28. Big Flat Recreation Area
Wetlands	Lower Columbia River	29. Reed Island 30. Steigerwald Lake and Sauvie Island Wildlife Area 31. Sandy River Delta
	Mid-Columbia River	32. Hanford Reach 33. Wells Wildlife Area 34. Lower Crab Creek 35. McNary National Wildlife Refuge
	Upper Basin	36. Everett Island 37. Kootenai National Wildlife Refuge 38. Pack River Delta
	Lower Snake River	39. Silcott Island 40. Snake River Delta 41. Palouse River Delta

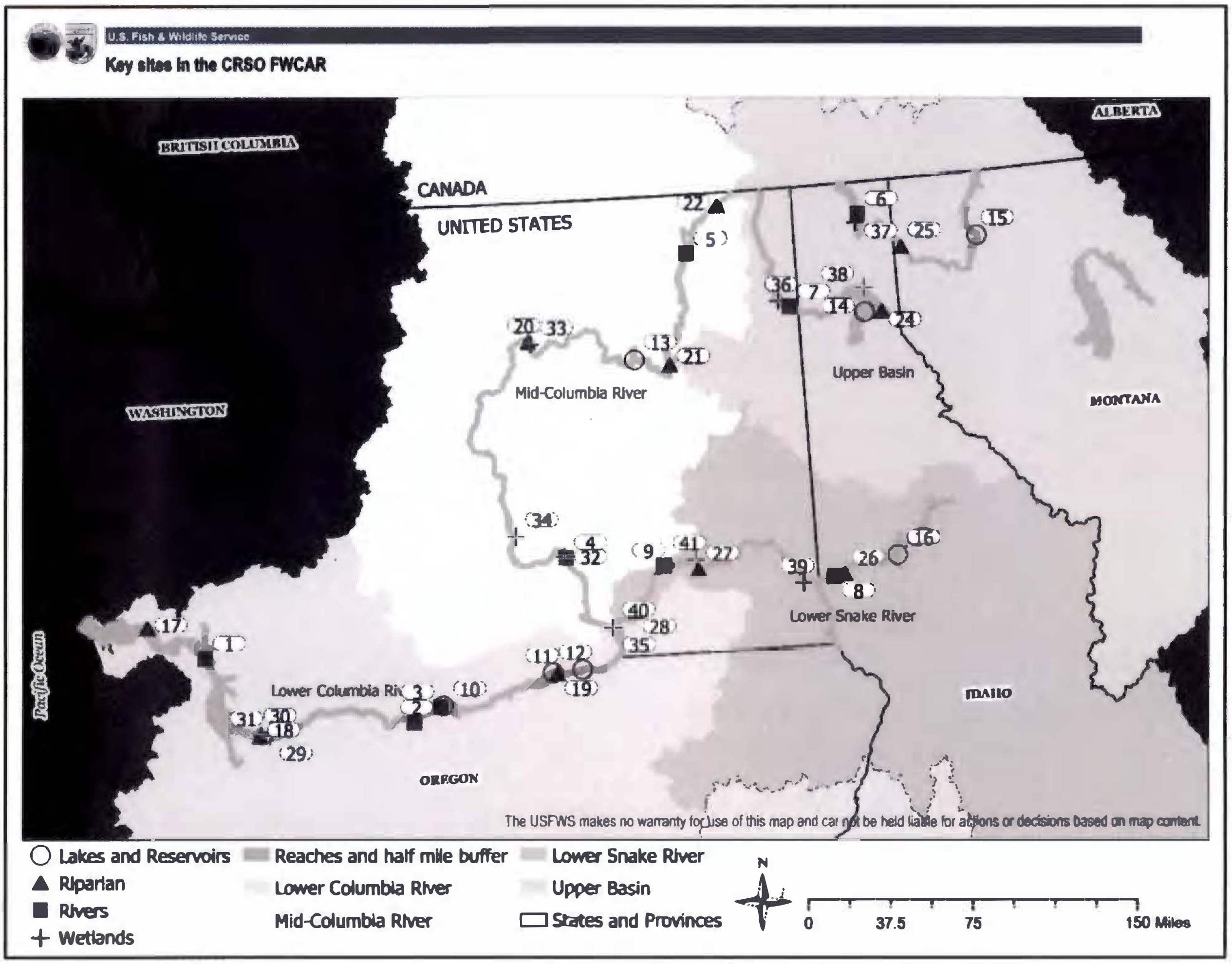

Figure 3. Key sites and locations analyzed in the FWCAR

RESOURCES

Evaluation species (Table 6), according to their close association with these processes and habitats, will be affected by proposed CRSO changes outlined in the "CRSO DEIS Alternatives" section, and they are representative of other species that are also reliant on those habitats. Additional guilds, communities, and species were considered and are described within relevant landscapes.

The Service selected a list of aquatic and terrestrial landscapes, divided into habitats and subhabitats, in the study area that are likely to be affected by the CRSO proposed changes (Table 10). A more detailed description of each landscape and its habitats and subhabitats is included in Appendix F.

Table 10. Landscapes, habitats, and subhabitats identified by the Service in the study area

Landscape	Habitats
Rivers	River – including banks and shorelines, floodplains, side channels, transition areas, tributary mouths, and unimpounded reach subhabitats Estuary Nearshore Marine Environment Barren Lands Islands
Lakes and Reservoirs	Natural Lakes Reservoirs Barren Lands Islands
Riparian	Emergent Scrub-Shrub Forest Islands
Wetlands	Palustrine – including forest, scrub-shrub, and subhabitats Lacustrine Emergent Barren Lands Islands River Deltas
Uplands	Forest Uplands – coniferous, deciduous, and mixed subhabitats Arid Uplands – agriculture, grasslands, and shrub-steppe subhabitats

RIVERS

This landscape includes river, estuary, and nearshore marine environments, which are often characterized by streams and tributaries, edges of rivers and sloughs, and temporary impoundments. For this report, common river subhabitats in the Basin include river banks and shorelines, side channels, transition areas, and unimpounded reaches (Appendix F).

Within the regulated CRSO, river subhabitats are representative of the historic free-flowing riverine environment, of which only remnants exist in the study area. These subhabitats maintain ecological and physical processes and hydrologic function that the reservoir environment cannot provide, and they support various life history stages of aquatic species. Appendix F includes more details on river resources in the study area.

Trends in River Landscape and Habitat Quality

Historical and recent trends in populations of biologically, socioeconomically, and culturally important aquatic species in the riverine environment throughout the Basin (e.g., Pacific lamprey, white sturgeon, freshwater mussels) have mirrored the declining trends of Pacific salmon fisheries (Nedeau et al. 2009, p. 34). In general, the factors that pose the greatest threats to many of these species come from a loss of access to, or quality of, habitat and important ecological and physical processes. These habitats and processes continue to be negatively impacted by water diversion projects for irrigation, power generation, and water supply, particularly throughout Idaho, Oregon, and Washington in the Pacific Northwest (Nedeau et al. 2009, p. 34).

The presence of the Federal projects and other dams and barriers have significantly altered the riverine environment in the Basin and all of its inhabitants, especially those species that use rivers for migratory purposes (e.g., Pacific lamprey, salmon, trout, and white sturgeon). The few remaining free-flowing and unimpounded reaches maintain important hydrologic processes that allow for habitat complexity, increased ecosystem function, and improved water quantity and quality standards required to support healthy fish and aquatic species populations at various life history stages (Beamesderfer and Anders 2013, p. 57; Ward et al. 2001, pp. 318-321; Williams et al. 2006, p. 642;).

Evaluation Species

Evaluation species associated with the rivers landscape include Pacific lamprey, western pearlshell mussel (*Margaritifera falcata*), and white sturgeon. For detailed descriptions of these species, see Appendix F.

Key Sites and Locations

Within the Basin, the Clearwater River in Idaho; Flathead River in Montana; Grand Ronde River, John Day River, and the Sandy River in Oregon; and Klickitat River in Washington are part of the National Wild and Scenic Rivers System (NWSRS 2018).

Key sites and locations, identified by the Service and characterized by river habitats and subhabitats throughout the study area, are listed in Table 11. The impacts of the proposed alternatives on the river landscape and evaluation species at these key sites are described in the "Impacts on Fish and Wildlife Resources" section and Appendix G.

Table 11. Key sites characterized by the rivers landscape, organized by subbasin

Subbasin	Key Sites
Lower Columbia River	Columbia River Estuary Mouth of the Deschutes River John Day Reservoir or Pool (Lake Umatilla)
Mid-Columbia River	Hanford Reach Reach 21, above Grand Coulee Pool (Lake Roosevelt)
Upper Basin	Kootenai River Pend Oreille River
Lower Snake River	Clearwater River Lower Monumental Reservoir or Pool (Lake Herbert G. West)

LAKES AND RESERVOIRS

Lakes are naturally occurring low points in the landscape that contain lentic water, predominantly in the form of year-round, open water habitat. Groundwater or surface water may constitute the inflow, outflow, or both. In contrast to rivers and tributaries, natural lakes and reservoirs store more water and usually have less flow. Reservoirs are man-made impoundments rather than natural lakes. Appendix F includes more details on lakes and reservoir resources in the study area.

Trends in Lake and Reservoir Landscape and Habitat Quality

Prior to the construction of Federal and non-Federal hydropower projects, the Columbia and Snake Rivers were free-flowing. They consisted of intact and productive mainstem and side channel subhabitats in tributaries and naturally occurring lakes. The river subhabitats in the Lower Snake River, for instance, included ecological features such as gravel bars, islands, runs, pools with backwaters, side channels, and sloughs, which increased overall habitat complexity and ecosystem function.

Currently, due to dam construction and related infrastructure, and continuing CRSO project operations and maintenance, river habitats have degraded and reduced aquatic (e.g., migratory fishes) and terrestrial species populations. Though some natural lakes (e.g., Flathead Lake, Lake Pend Oreille) and their habitats have remained functionally intact, most lake-like habitat exists today as storage reservoirs behind dams. One of the most prominent changes observed in river habitat throughout the Basin over time has been the inundation of river habitat and conversion to run-of-river reservoirs.

Evaluation Species

Evaluation species associated with the lakes and reservoirs landscape include Clark's and Western grebes, dunlin (*Calidris alpina*), and floaters (*Anodonta* spp.). For detailed descriptions of these species, see Appendix F.

Key Sites and Locations

Key sites and locations characterized by lakes and reservoir habitats are listed in Table 12. The impacts of the proposed alternatives on the lakes and reservoir landscape and evaluation species at these key sites are described in the "Impacts on Fish and Wildlife Resources" section and Appendix G.

Table 12. Key sites characterized by the lakes and reservoirs landscape, organized by subbasin

Subbasin	Key Sites
Lower Columbia River	John Day River Confluence Blalock Island Complex Umatilla River Confluence
Mid-Columbia River	Lake Roosevelt
Upper Basin	Lake Pend Oreille Lake Koocanusa
Lower Snake River	Dworshak Reservoir

RIPARIAN

Riparian areas are transition zones between aquatic and upland habitat along rivers, streams, and other watercourses, and are typically characterized by frequent disturbances from flooding, erosion, and deposition, which create a mosaic of plant community ages and seral stages (Bentrup 2008, p. 110; Brinson et al. 1981, p. 23; Gregory et al. 1991, p. 540; USFWS 1999, pp. M4-10, M4-12, 2019a, p. 5).

In riparian areas, groundwater flows at shallower depths and the frequency of flooding is greater than in adjacent terrestrial environments or uplands. Riparian habitats have distinctly different vegetation, exhibiting more vigorous or robust growth forms, than other habitats in the study area (USFWS 2019a, p. 6).

Riparian habitat in the Basin is often a mosaic of wet to moderately wet areas), depending on topography and soil characteristics that reflect sediment deposition patterns and subsurface water depth. Riparian areas may have forests, areas of low woody vegetation, sand and gravel bars, wet meadows, flood-scoured areas, perennial and intermittent secondary channels or side channels, and other stream-related habitats and vegetation (Fischer et al. 2001, pp. 1-2). For this report and analysis, the Service divided the riparian landscape into three habitats (emergent, scrub-shrub, and forest) (USFWS 2019a, pp. 7-8). Appendix F includes more details on riparian resources in the study area.

Trends in Riparian Landscape and Habitat Quality

Currently, riparian areas comprise important habitat for fish and wildlife resources. While riparian habitat makes up less than 1 percent of the land area in the western states, it hosts more species of breeding birds than any other habitat, as well as 75 percent of all terrestrial species, and also serves as an important habitat for most amphibians, fish, and other aquatic organisms (Fischer et al. 2001, p. 4). Aside from bird species that depend on riparian habitat, both riparian-obligate mammals (e.g., moose, beavers, otters, mice, muskrats, and mink) and other upland mammals (e.g., woodland caribou, elk, deer, wolves, grizzly bears, and mountain lions) also depend on riparian habitat to complete critical life history stages (BOR 2016, p. 4-15; Hauer et al. 2016, pp. 6-7).

Riparian habitats serve as a continuous corridor and provide dense cover and rich food resources, thus are critically important for breeding, feeding, dispersal, and migration of wildlife species. These corridors help connect otherwise isolated habitats and reduce genetic isolation and extirpation of sub-populations (Everest and Reeves 2007, p. ix).

In the Basin, hydropower development has significantly changed, either directly or indirectly, the timing, magnitude, and pattern of water levels, water velocities, sedimentation, and the ecological and physical processes that support the structure and function of riparian habitats (Hough-Snee et al. 2015, p. 1151). Loss or degradation of these ecological and physical processes have resulted in conversion of riparian forest habitat to upland habitat, which reduces structural diversity and heterogeneity (Macfarlane et al. 2016, p. 448). This homogenized landscape limits the number and type of ecological and physical processes, subhabitats, and niches that can support fish and wildlife resources (Fierke and Kauffman 2005, p. 150).

The adoption of "environmental" or "functional" flow regimes has proven to be effective in increasing cottonwood and willow recruitment and conserving endangered species without major negative impacts on hydropower production (Rood et al. 2005, pp. 193, 196-198). Functional flow regimes are those that mimic the most important aspects of the pre-dam hydrograph, which are responsible for driving the processes that ultimately function to maintain and regenerate riparian vegetation. During high water years, higher water volumes are released during the spring freshet, followed by an appropriate rate of recession (no more than 1 inch (2.5 cm) per day), and this pattern mimics the episodic flow conditions that would naturally lead to cottonwood and willow recruitment a couple of times a decade.

These functional flows include a minimum of the important aspects of a natural flow regime to support ecological and physical processes (Foster and Rood 2017, p. 1088; Foster et al. 2018, p. 921; Rood and Mahoney 2000, p. 109; Rood et al. 1998, p. 557; Rood et al. 2003, p. 647). Similarly, "variable discharge" (VARQ FC) functional flow regimes adopted in 2003 at Libby Dam in Montana to benefit the Kootenai River white sturgeon have also resulted in anecdotal evidence of increased cottonwood recruitment (Burke et al. 2009, p. S235; USACOE 2006, pp. S-3-S-9; USFWS 2019b).

Evaluation Species

Evaluation species associated with the riparian landscape include black cottonwood, viceroy butterfly (*Limenitis archippus*), and yellow warbler. Other important guilds include cottonwood-willow communities and riparian songbirds. For detailed descriptions of these species and guilds, see Appendix F.

Key Sites and Locations

Key sites and locations, identified by the Service and characterized by riparian habitats throughout the study area, are listed in Table 13. The impacts of proposed alternatives on the riparian landscape and evaluation species at these key sites are described in the "Impacts on Fish and Wildlife Resources" section and Appendix G.

Table 13. Key sites characterized by the riparian landscape, organized by subbasin

Subbasin	Key Site
Lower Columbia River	Julia Butler Hansen National Wildlife Refuge Sandy River Delta Umatilla National Wildlife Refuge
Mid-Columbia River	Okanogan River Confluence Threemile Creek to Six Mile Creek confluences Little Sheep Creek Confluence
Upper Basin	Stillwater River Confluence Clark Fork Delta at Lake Pend Oreille Yaak River and Star Creek confluences
Lower Snake River	Catholic Creek Confluence Tucannon River Confluence Big Flat Recreation Area

WETLANDS

Wetlands are typically "inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (40 CFR § 232.2). Water saturation (i.e., hydrology) influences soil development and determines the plant and animal communities living in and on the soil. Prolonged presence of water creates anaerobic conditions that favor the growth of specially adapted plants and promote the development of wetland areas (e.g., river deltas and wetland subhabitats on islands).

The Service relied primarily on the National Wetland Inventory (NWI) and the U.S. Department of Agriculture and U.S. Department of Interior Landscape Fire and Resource Management Planning Tools database (LANDFIRE) to identify and classify wetland habitats in the Basin for this analysis. The resulting wetland habitats are either naturally occurring or managed as palustrine, lacustrine, and emergent or estuary (i.e., tidal) wetlands (Cowardin et al. 1979, pp. 3-5). Appendix F includes more details on wetland resources in the study area.

Trends in Wetland Landscape and Habitat Quality

Wetlands habitat and the ecological and physical processes that support their structure and function are critical in maintaining the health and status of a diversity of fish and wildlife resources throughout the Basin. Though a significant number of well-distributed water areas and wetlands exist in the study area, many of them have been lost due to water impoundment behind dams (USFWS 2019c). Specific to the Basin, a study from 1990 concluded that 56 percent, 31 percent, and 38 percent of wetlands were lost during the 1780s and 1980s in Idaho, Washington, and Oregon, respectively (Dahl 1990, p. 12).

As previously stated, wetland habitat habitats have since been created in the Basin, for example, as part of the Service's NWR System (e.g., McNary NWR). While these refuges support many valuable fish and wildlife resources (e.g., waterfowl), current resources may differ from those naturally supported, historically. In some cases, Federal projects in the study area create abnormal or more frequent fluctuations in water surface elevation that do not coincide with the optimum spring and summer conditions necessary for proper functioning and creation of new wetland habitats. However, projects may create slower-moving water conditions in general, which can support wetland habitats in discrete areas within the Basin.

Evaluation Species

Evaluation species associated with the wetlands landscape include American bittern, mallard (*Anas platyrhynchos*), western painted turtle (*Chrysemys picta*), and Woodhouse's toad (*Bufo woodhousii*). Other species of interest include Columbia yellowcress and sora (*Porzana carolina*). For detailed descriptions of these species, see Appendix F.

Key Sites and Locations

The Service identified key sites characterized by wetland habitats and subhabitats in the study area (Table 14). Based on feedback from stakeholder participants in the Service's Wetlands Workshop (see "Workshops"), key site selection focused on island and river delta habitats with distinct wetland subhabitats. These areas are heavily used by birds, amphibians, and reptiles for foraging and rearing (USFWS 2019c). The impacts of proposed alternatives on the wetlands landscape and evaluation species at these key island and river delta sites are described in the "Impacts on Fish and Wildlife Resources" section and Appendix G.

Table 14. Key island and river delta sites characterized by the wetlands landscape, organized by subbasin

Subbasin	Wetland Habitats (Islands and River Deltas)	Key Island and River Delta Sites
Lower Columbia River	Islands	Reed Island
	River Deltas	Steigerwald Lake National Wildlife Refuge and Sauvie Island Wildlife Area Sandy River Delta
Mid-Columbia River	Islands	Hanford Reach Wells Wildlife Area
	River Deltas	Lower Crab Creek McNary National Wildlife Refuge
Upper Basin	Islands	Everett Island Kootenai National Wildlife Refuge
	River Deltas	Pack River Delta
Lower Snake River	Islands	Silcott Island
	River Deltas	Snake River Delta Palouse River Delta

UPLANDS

In general, upland habitats are located outside waterbodies (i.e., lakes, reservoirs, and rivers) and include areas that are not prone to inundation long enough for their soils to have anaerobic characteristics (i.e., wetlands). Flooding or high water tables do not greatly influence the function of upland habitats. Through this analysis, the Service identified two broad uplands habitats, forested and arid uplands. Subhabitats within forested and arid uplands in the study area are described in Appendix F.

Trends in Upland Landscape and Habitat Quality

In the Basin, native habitat conversion has disconnected and deteriorated habitats (USDA et al. 1997, p. 99). Loss of grass and shrub cover coupled with the loss of structural diversity have resulted in reduced plant and insect forage, nesting habitat, and cover for many sagebrush bird species, resulting in population declines (Knick and Rotenberry 1995, p. 1069). Additionally, juniper woodlands expansion into grassland and sagebrush habitats has negatively impacted birds such as rock wren (*Salpinctes obsoletus*) and chipping sparrow (*Spizella passerina*) (Mac et al. 1998, pp. 437-964).

In the Basin, loss of native grasslands and reduction in grassland cover is the result of livestock grazing, the spread of non-native species (e.g., cheatgrass and cowbirds), and fire frequency and intensity changes. These losses have, in turn, resulted in reduced available plant and insect forage, nesting habitat, and cover for a variety of species (e.g., Columbian sharp-tailed grouse [*Tympanuchus phasianellus columbianus*], sandpiper [*Scolopacidae* spp.], and sagebrush sparrow [*Artemisiospiza nevadensis*]) (Mac et al. 1998, pp. 437-964).

Sagebrush (*Artemisia tridentata*) and bunchgrass cover types in the Basin have experienced greater losses than any other habitats and will likely continue to decline with the impacts of present land uses, including increased fire frequency, livestock overgrazing, herbicide spraying, plowing, seeding, and conversion of land for agriculture (Saab and Groves 1992, p. 11; Saab and Rich 1997, p. 14; Bock et al. 1993, p. 304; Knick and Rotenberry 1995, p. 1069). In Washington alone, roughly 60 percent of the historical, native shrub-steppe habitat has been converted for other uses (Dobler et al. 1996, p. 10).

Changes in the structure, abundance, and distribution of shrub-steppe have also led to declines in species such as the greater sage-grouse (*Centrocercus urophasianus*), Brewer's Sparrow (*S. breweri*), and sagebrush sparrows (Martin and Carlson 1998; Rotenberry et al. 1999; Schroeder et al. 1999).

Evaluation Species

Evaluation species associated with the uplands landscape include long-billed curlew (*Numenius americanus*) and sage thrasher (*Oreoscoptes montanus*). For detailed descriptions of these species and guilds, see Appendix F.

Key Sites and Locations

Though the uplands landscape comprises a relatively small proportion of the study area, upland habitats generally occur within, and adjacent to, the 0.5 mile (0.8 km) buffer. Thus, the impacts of proposed alternatives on the uplands landscape and evaluation species are generally described throughout the study area (see "Impacts on Fish and Wildlife Resources" section and Appendix G).

OTHER HABITATS

Three landscapes (rivers, lakes and reservoirs, and wetlands) share other habitats identified as important to consider in this evaluation: barren lands, islands, and river deltas. As a product of dam presence, reservoir drawdown, and water release timing and magnitude, any of which may change as a result of the proposed CRSO DEIS alternatives, these habitats and the fish and wildlife resources that rely on them are considered in this analysis.

Barren Lands

Barren lands (i.e., drawdown zones) are so frequently inundated as to preclude vegetation growth. This may include reservoir drawdown zones and the shorelines surrounding rivers, lakes, reservoirs, and estuaries. When reservoirs are filled with water, through inflow from precipitation or dam operations, the barren zone is not visible. In some areas, reservoir drawdowns will expose bare slopes, while, in other areas, fluctuations in water level may expose mudflats or islands. Low lake levels expose previously inundated land (NPS 2015). For instance, near the mouth of the Columbia River, the estuary includes extensive mudflats, numerous islands and bars, tidal marshes, and tidal swamps.

Islands

In the Basin, islands may be located in rivers, lakes, reservoirs, and estuaries. Thus, islands do not fit appropriately in consideration of any single landscape. In some cases where there are slopes, the shorelines are abrupt and, in other cases, shorelines may be less abrupt and, thus, are likely to provide for a variety of habitats such as mudflats and even emergent or estuary riparian habitats. For instance, McNary NWR contains islands situated near the east bank of the Columbia River near the confluence with the Snake River, and these islands are inhabited by nesting colonies of Caspian terns, double-crested cormorants (*Phalacrocorax auritus*), white pelicans (*Pelecanus erythrorhynchos*), and waterfowl (USFWS 2018a).

The Blalock Island complex, one of the key sites related to the lakes and reservoirs landscape, is a cluster of islands protected by the Service and located between Boardman and Irrigon, Oregon (i.e., RM 274 [Rkm 441] to RM 276 [Rkm 444]). The Blalock Island complex supports several wildlife guilds in the John Day Pool. For example, the Blalock Island complex supports multiple waterbird breeding colonies, including Caspian terns, Forster's terns (*Sterna forsteri*), California gulls (*Larus californicus*), ring-billed gulls (*L. delawarensis*), great blue herons (*Ardea herodias*), great egrets (*A. alba*), and black-crowned night-herons (*Nycticorax nycticorax*) (Collis et al. 2019, p. 32). The complex also provides sanctuary habitat for wintering waterfowl; staging, roosting, and foraging habitat for migratory and wintering waterfowl and shorebirds; breeding habitat for pollinators; and rare wet meadow habitat found in few other places in the Basin (Dunwiddie 2018, pp. 1-2; Healy, F., in litt. 2019).

Other examples of islands in the study area include large islands in the Lower Columbia River that are associated with Lewis and Clark and Julia Butler Hansen NWRs. The Corps has historically and continues to place dredge material on some of these islands, maintaining open, sandy habitats for species such as streaked horned larks (*Eremophila alpestris strigata*) (USACOE et al. 2018, pp. 119-135; USFWS n.d., p. 3).

River Deltas

River deltas occur at confluences, where a river may join the ocean (i.e., estuary), lake, reservoir, or other river. They are created as a result of sediment deposition, in which sediment is carried by a river and deposited as it enters slower-moving water. Various types of river deltas (e.g., fan-deltas) exist in the study area (e.g., Sandy River Delta in the Lower Columbia River) (Liangqing and Galloway 1991, pp. 388, 391-392). River deltas represent important wetland habitat that supports diverse and ecologically high-functioning ecosystems.

IMPACTS ON FISH AND WILDLIFE RESOURCES

The Service's analysis of impacts for the FWCAR focused on ecological and physical processes and their indicators (Table 4) that characterize the structure and function of habitats and key sites representative of the five landscapes and sixteen evaluation species (Table 6). Additional guilds, communities, species, and key sites were identified based on whether they were most likely to experience significant ecological change under all proposed CRSO alternatives (see"Methods").

The Service analyzed impacts of structural and operational measures of the NAA and each MO, including ecological costs to, and benefits for, fish and wildlife resources.

The analysis is organized first by landscape and then by MO. The following subsections present table summaries of the impacts of proposed alternatives on each landscape, characterized by specific ecological and physical processes and indicators, habitats, evaluation species, and key sites—where relevant. For a detailed description of these findings, see Appendix G.

SUMMARY OF LANDSCAPE FINDINGS

The Service analyzed impacts of the proposed CRSO alternatives on the overall health of the rivers landscape. Tables 15, 16, 17, and 18 include a qualitative summary of the rivers, lakes and reservoirs, riparian, and wetlands landscape findings and shows the trend of overall health of this landscape at key sites under the NAA as well as the projected change in the long-term trend (i.e., more than 5 years) resulting from each MO.

For key sites where change in overall health is projected to occur, the Service used varying shades (light, medium, and dark) of color (orange and blue) to indicate whether or not the projected impacts are projected to be generally negative or positive (respectively) for the rivers landscape in the study area. The intensity of the shading indicates the severity of the change, either positive or negative (light = least extreme, medium = average, dark = most extreme).

A detailed description of the impacts of proposed alternatives on the different landscapes is included in Appendix G. Unlike the summaries of other landscape findings in this report, the summary of wetlands landscape findings includes a focused analysis of impacts on key island and river delta sites located in various subbasins in the study area.

The Service also analyzed impacts on critical indicators of ecological and physical processes that support the uplands landscape, habitats and subhabitats, and evaluation species. Overall, impacts on the uplands landscape in the study area were found to be insubstantial, since there is little to no uplands landscape in the 0.5 mile (0.8 km) buffer. Thus, the Service did not identify any key sites or develop a summary table similar to Tables 15, 16, 17, and 18 to illustrate the projected impacts of the CRSO. Instead, a detailed description of the impacts of proposed alternatives on the wetlands landscape is included in Appendix G.

Table 15. Summary of projected trends of overall health of the rivers landscape under all CRSO alternatives, organized by subbasin

Subbasin	Key Site	NAA Trend	MO1 Trend	MO2 Trend	MO3 Trend	MO4 Trend
Lower Columbia River	Columbia River Estuary	Decreasing	No change	No change	No change	Faster rate of decrease
	Mouth of the Deschutes River	Decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease	Increasing
	John Day Reservoir or Pool (Lake Umatilla)	Decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease	Increasing
Mid-Columbia River	Hanford Reach	Decreasing	No change	No change	Increasing	No change
	Reach 21, above Grand Coulee Pool (Lake Roosevelt)	Decreasing	Faster rate of decrease	No change	Faster rate of decrease	Faster rate of decrease
Upper Basin	Kootenai River	Decreasing	Faster rate of decrease	No change	Faster rate of decrease	Faster rate of decrease
	Pend Oreille River	Decreasing	No change	No change	No change	No change
Lower Snake River	Clearwater River	Decreasing	Increasing	Increasing	Increasing	Faster rate of decrease
	Lower Monumental Pool (Lake Herbert G. West)	Decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of increase compared to MO4	Increasing

Table 16. Summary of projected trends of overall health of the lakes and reservoirs landscape under all CRSO alternatives, organized by subbasin

Subbasin	Key Site	NAA Trend	MO1 Trend	MO2 Trend	MO3 Trend	MO4 Trend
Lower Columbia River	John Day River Confluence	Decreasing	Faster rate of decrease	Fastest rate of decrease	Faster rate of decrease compared to MO1	No change
	Blalock Island Complex	Decreasing	Faster rate of decrease	Fastest rate of decrease	Faster rate of decrease compared to MO1	No change
	Umatilla River Confluence	Decreasing	Faster rate of decrease	Fastest rate of decrease	Faster rate of decrease compared to MO1	No change
Mid-Columbia River	Lake Roosevelt	Decreasing	Faster rate of decrease	Fastest rate of decrease	Faster rate of decrease compared to MO1 and MO4	Faster rate of decrease
Upper Basin	Lake Pend Oreille	Decreasing	Faster rate of decrease	Fastest rate of decrease	Faster rate of decrease compared to MO1 and MO4	Faster rate of decrease
	Lake Koocanusa	Decreasing	No change	Faster rate of decrease compared to MO3	Faster rate of decrease	No change
Lower Snake River	Dworshak Reservoir	Decreasing	Faster rate of decrease	Fastest rate of decrease	Faster rate of decrease compared to MO1 and MO4	Faster rate of decrease

Table 17. Summary of projected trends of overall health of the riparian landscape under all CRSO alternatives, organized by subbasin

Subbasin	Key Site	NAA Trend	MO1 Trend[1/]	MO2 Trend[1/]	MO3 Trend[1/]	MO4 Trend[1/]
Lower Columbia River	Julia Butler Hansen National Wildlife Refuge	Decreasing	No change	No change	No change	No change
	Sandy River Delta	Slowly increasing	Decreasing *	Decreasing *	Decreasing *	Decreasing *
	Umatilla National Wildlife Refuge	Decreasing	Fastest rate of decrease	No change	Faster rate of decrease compared to MO4	Faster rate of decrease *
Mid-Columbia River	Okanogan River Confluence	Decreasing	No change	No change	No change	No change
	Threemile Creek to Six Mile Creek confluences	Decreasing	No change	No change	No change	Faster rate of decrease *
	Little Sheep Creek Confluence	Decreasing	No change	No change	No change	Faster rate of decrease *
Upper Basin	Stillwater River Confluence	Decreasing	No change	Faster rate of decrease	No change	No change
	Clark Fork Delta at Lake Pend Oreille	Decreasing	No change	Faster rate of decrease	No change	Faster rate of decrease compared to MO2

Subbasin	Key Site	NAA Trend	MO1 Trend[1/]	MO2 Trend[1/]	MO3 Trend[1/]	MO4 Trend[1/]
	Yaak River and Star Creek confluences	Slowly increasing	Decreasing	Fastest rate of decrease	Faster rate of decrease compared to MO1	Faster rate of increase
Lower Snake River	Catholic Creek Confluence	Decreasing	No change	Faster rate of decrease	No change	No change
	Tucannon River Confluence	Decreasing	No change	No change	Increasing	Faster rate of decrease
	Big Flat Recreation Area	Slowly increasing	No change	No change	Faster rate of increase	No change

[1/]An asterisk is used in Table 17 to mark opportunities for the co-lead agencies to potentially reverse negative impacts of the MOs through improved management of the potential drawdown of water surface elevation (see "Conservation Recommendations").

Table 18. Summary of projected trends of overall health of the wetlands landscape under all CRSO alternatives, organized by subbasin

Subbasin	Key Site	NAA Trend	MO1 Trend	MO2 Trend	MO3 Trend[1/]	MO4 Trend
Lower Columbia River	Reed Island	Decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease
	Steigerwald Lake National Wildlife Refuge and Sauvie Island Wildlife Area	Slowly decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease
	Sandy River Delta	Decreasing	Faster rate of decrease compared to MO2, MO3, and MO4	Faster rate of decrease	Faster rate of decrease	Faster rate of decrease
Mid-Columbia River	Hanford Reach	Slowly decreasing	Faster rate of decrease	Faster rate of decrease compared to MO1	No change	No change
	Wells Wildlife Area	Slowly decreasing	No change	No change	No change	No change
	Lower Crab Creek	Decreasing	No change	No change	No change	No change
	McNary National Wildlife Refuge	Slowly decreasing	No change	No change	No change	Faster rate of decrease
Upper Basin	Everett Island	Decreasing	Faster rate of decrease	Faster rate of decrease	Slower rate of decrease	Slower rate of decrease

Subbasin	Key Site	NAA Trend	MO1 Trend	MO2 Trend	MO3 Trend[1/]	MO4 Trend
	Kootenai National Wildlife Refuge	Slowly decreasing	Faster rate of decrease compared to MO2	Faster rate of decrease	Slower rate of decrease	Increasing
	Pack River Delta	Decreasing	No change	Faster rate of decrease	Slower rate of decrease	Faster rate of decrease compared to MO2
Lower Snake River	Silcott Island	Decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of increase compared to MO4 *	Increasing
	Snake River Delta	Decreasing	Faster rate of decrease	Faster rate of decrease	Increasing	Faster rate of decrease
	Palouse River Delta	Decreasing	Faster rate of decrease	Faster rate of decrease	Faster rate of increasing compared to MO4 *	Increasing

[1/]An asterisk is used in Table 18 to mark opportunities for the co-lead agencies to potentially enhance positive impacts (e.g., increasing trends) of MO3 through the control of invasive species, planting of native vegetation in the spring and fall, and long-term monitoring

CONSERVATION RECOMMENDATIONS

The Basin supports well-documented and widely recognized ecological, socioeconomic, and cultural values, and it is home to diverse habitats, and unique ecological and physical processes and habitats that enable fish, wildlife, and plant species to thrive. The Basin provides an estimated $189.9 billion in ecosystem service benefits (i.e., contributions to human health and well-being) annually, with $11 billion accruing directly from rivers (Flores et al., 2017, p. 42).

Since the mid-1930s, the construction of dams and associated infrastructure as part of the CRSO has compromised the biological integrity of the Basin and led to the degradation of important ecological, physical, and chemical processes and habitats on which fish and wildlife resources depend. The Service acknowledges the multiple authorized purposes of the Federal dams and reservoirs. However, the Service's analysis found that proposed changes in dam configurations including operations and maintenance of the 14 Federal projects that comprise the CRSO will overall negatively impact fish, wildlife, and plants in the Basin along with the natural capital they offer.

Over the past year, the Service engaged with partners in the Basin through region-wide, multi-program workshops and meetings to develop specific, measurable, time-oriented conservation recommendations for the co-lead agencies to protect fish and wildlife resources associated with the proposed action. The conservation recommendations address the impacts of one or more of the proposed MOs and their measures presented in the CRSO DEIS, and they also represent the values and interests of multiple partners.

The Service recommends a mitigation hierarchy that seeks to first avoid, and then minimize impacts before mitigating with off-site actions, such as habitat restoration. This does not mean that off-site mitigation be excluded from consideration. Rather, the Service believes avoiding and minimizing impacts have a higher probability of success. The following conservation recommendations are ordered within this hierarchy, where possible. Conservation recommendations are grouped into six categories, each defined by a goal statement that illustrates the Service priority to support diverse ecological and physical processes, resilient habitats, and sustainable fish and wildlife resources.

The Service offers the following conservation recommendations, grouped by conservation goal to benefit species affected by the CRSO and support more coordinated, systemic, and flexible management and conservation of Basin-dependent fish and wildlife resources.

RESTORE OR MIMIC CRITICAL COMPONENTS OF NATURAL HYDROLOGICAL REGIMES

The integrity of free-flowing water systems depends largely on natural dynamics, among which the hydrological regime is centrally important (Poff et al. 1997, pp. 768-769). Natural hydrological regimes include varying environmental components (e.g., flows) characterized by seasonal timing, frequency, magnitude and other factors which drive ecosystem productivity.

The historically free-flowing Columbia and Snake Rivers are now fragmented by dams and associated infrastructure that significantly alter the natural hydrological regimes that once characterized these water systems and supported fish and wildlife resources.

In light of the many ecological benefits of maintaining natural variability in river flows in the Basin, the Service seeks to minimize impacts associated with dam operations and reduce reservoir fluctuations, decrease ramping rates, minimize daily and seasonal flow fluctuations, and establish a hydrograph that mimics what occurred prior to the influence of dams. The Service recognizes that restoring critical components of natural hydrological regimes may not be possible every year, given the variable water supply and timing of annual runoff. Thus, the Service offers conservation recommendations that could be implemented when environmental conditions are favorable. To identify favorable conditions, the Service encourages the co-lead agencies to work with the Service, other Federal and state agencies, tribes, and other partners collectively to understand when, where, how, and under what conditions a pre-dam hydrograph and natural flood regime could be implemented. The following conservation recommendations aim to avoid or minimize impacts and, thus, are the Service's highest priorities:

- Raise and maintain John Day Reservoir elevations between 264.5 ft and 266.5 ft during April and May. All habitat for colonial nesting waterbirds (e.g., Caspian tern) will be inundated during typical peak nest initiation times, potentially resulting in waterbird relocation to other breeding colony sites during peak juvenile salmonid outmigration.
- Operate at the lowest reservoir levels feasible from June to September, which would potentially allow for late successful colonial nesting waterbird productivity, after most of the ESA-listed juvenile salmonids have outmigrated.
- Establish a functional flow regime by managing river flows to mimic the pre-dam hydrograph in the following ways:
    - Allow seasonally appropriate high water events once or twice per decade (i.e., to achieve natural conditions suitable for successful riparian seedling establishment);
    - During high flow years, drawdown and ramping rates should be no more than 1 inch per day, which will promote the growth and survival of newly established riparian seedlings; and,
    - Monitor riparian vegetation recruitment and respond to years of high cottonwood and willow recruitment. This could be accomplished by limiting winter water levels to not exceed the previous peak-flow water level associated with high riparian recruitment for at least two winters following the year of high riparian recruitment.
- Constrain ramping rates at all projects to avoid large stage fluctuations, especially in

June during cottonwood and willow seed dispersal and recruitment.

- Decrease ramping rates below Libby to 1 inch (2.5 cm) per hour per stage increase or decrease to mimic the natural water recession rate.
- Minimize stage drop of 2.6 ft (79 cm) in Lake Pend Oreille to smaller increments from June through September of dry years to maintain native vegetation.
- Operate downstream projects to maintain natural water surface elevation and avoid rapid fluctuations in Lake Pend Oreille and Flathead Lake.
- Support continuation of Montana operations at Libby Dam (i.e., VarQ discharge and spring pulse) that establish functional flows for white sturgeon and riparian vegetation (MFWP et al. 2017, pp. 12-14).
- Invest in energy storage infrastructure and technology to minimize flow fluctuations in response to short-term changes in power demand. If pump storage is implemented, ensure stored water does not negatively affect the natural hydrology of river or natural lake environments.
- Work with partners to maintain or establish functional flow regimes on tributary streams wherever possible to contribute natural sediment that nourishes floodplains and backwater deltas. Where applicable, ensure water surface elevation of reservoir pools are below the elevation of tributary mouths during the fall in order to capitalize on weather events that remove accumulated sediments through scour thereby providing fish passage at tributary mouths.
- When restoring pre-dam hydrologic regimes is not feasible, mimic natural hydrology to provide flushing flows, channel maintenance flows, and sediment transport annually or biannually. Develop and implement flow and temperature recommendations to meet this objective in addition to other objectives (e.g., juvenile fish downstream migration), including: minimizing hourly and daily flow fluctuations; considering the timing and frequency of peaks; and providing recommendations across all water year types (e.g., deficit, normal, and abundant). Consider the approach taken on large river systems elsewhere in the western U.S. (e.g., Green River below Flaming Gorge Reservoir, Colorado River below Lake Powell).
- Regardless of MO, for the Sandy River Delta and associated riparian habitat during implementation of the first summer stage decline, time water surface elevation drops to coincide with normal peak flow recession (i.e., in early to mid-June following natural peak flood timing). The rate of recession should be gradual (i.e., no more than 1 inch [2.5 cm] per day) to help promote the establishment of native riparian vegetation instead of invasive species on exposed shoreline.
- Similarly, in the case of MO4, plan the timing and rate of drawdown to mimic natural peak flow recession for Umatilla NWR, Threemile Creek to Sixmile Creek confluences, Little Sheep Creek Confluence, and other riparian habitat in the vicinity (refer to the

previous conservation recommendation).

INCREASE HABITAT CONNECTIVITY AND IMPROVE FISH PASSAGE

In both terrestrial and aquatic environments, habitat connectivity is important for maintaining biodiversity and enabling fish and wildlife resources access to different habitats through all life history stages. In the last century, habitat connectivity has decreased in the Basin. Dam construction and proposed changes to continuing operations of the Federal projects either have fragmented, or threaten to further fragment intact and functional habitats. As a result, fish, wildlife, and plant populations are more susceptible to population isolation and changes that affect ecological structure and function. Migratory fishes (e.g., Pacific lamprey and white sturgeon) are likely to remain blocked or lose access to necessary spawning and rearing habitat. Changes to the current configuration and operation of Federal projects in the Basin present opportunities to increase habitat connectivity.

The Service's conservation recommendations to increase habitat connectivity and improve fish passage seek to minimize impacts associated with dam operations. These impacts are expected to continue as long as the CRSO projects remain. Minimizing these impacts, consistent with these conservation recommendations, will begin to address impacts associated with future operations:

- To the maximum extent practicable, reconnect rivers and tributaries to their floodplains, side channels, and associated wetlands, including barrier removal, breach, or setbacks.
- Improve connectivity between the riparian habitat along mainstems and in tributaries. Maintain or improve existing riparian vegetation or establish new vegetation through functional flows or planting.
- To the maximum extent practicable, set back or remove structures such as levees, dikes, riprap, and bank stabilization measures that constrain lateral movement of rivers, and reconnect rivers and tributaries to floodplains, associated wetlands, side channels, and oxbows to rivers and side channels.
- Where appropriate, consider removing structures like dikes and revetments and purchasing floodplain properties to reconnect floodplain and side channel habitat in the Columbia River estuary, thus creating and expanding shallow water habitat.
- Decrease current, and prevent additional, water withdrawals from the Columbia and Snake Rivers to build long-term resiliency in the system to benefit migratory and resident fishes.
- Remove obsolete dams, barriers, and other infrastructure to improve habitat connectivity. Prioritize these actions according to potential ecological benefit, in locations such as tributaries with habitat that supports cold-water aquatic species (e.g., Columbia River redband trout [*Oncorhynchus mykiss gairdneriii*] and Westslope

cutthroat trout [*O. clarki lewisi*]).

- Revise the Section 408 process (authorized in the River and Harbors Appropriation Act of 1899 [33 U.S.C. § 14]) to allow more efficient and less expensive levee set-back and removal projects to increase habitat connectivity with floodplains and side channels. Currently, few projects are completed because of the cost and time spent per project and serious consequences (e.g., fines per project) if coordination with the Corps does not occur. Investigate and implement, if feasible, a revised, programmatic approach for the co-lead agencies to undertake in future projects.
- Improve, build, or modify Pacific lamprey passage structures at all projects in the Lower Columbia and Snake Rivers. Evaluate passage structure efficacy and make improvements, if necessary.
- Install and maintain bird wire arrays at all dam tailraces and consider additional non-lethal control methods.
- To better inform future analyses of impacts in dam operation changes in the Basin on migratory fishes, conduct studies on native aquatic species survival including white sturgeon and other non-ESA-listed aquatic species throughout all life history stages and passage routes. Focus on collecting information about migration timing, duration of migration, movements and reversals, use of habitat during migratory periods, and overall connectivity and how these variables contribute to overall survival and fitness.
- Create and implement effective reintroduction plans for native aquatic species above projects with little to no access or connectivity. For instance, assist migration of white sturgeon to enhance adult population levels, as white sturgeon populations upstream of Bonneville Dam are small and have limited recruitment. Additionally, consider reintroducing Western pearlshell mussel and other aquatic invertebrates in appropriate river, lake, and reservoir landscapes, since they are limited in their own abilities to recolonize areas from which they have been extirpated.
- In regard to MO2, if the co-lead agencies modify operations for salmonid passage, they should also consider developing and carrying out restoration projects that restore access to disconnected side channels and wetlands created by reductions in water surface elevation. They should also maintain the functionality of wildlife corridors that connect wetlands to uplands and are important for reptiles and amphibians such as Western pond turtle and Woodhouse's toad, respectively.
- In regard to MO3, if the co-lead agencies breach the four lower Snake River dams, then the greatest ecological benefits for evaluation species and other migratory mainstem, migratory corridor, and localized, non-migratory species may be realized. These benefits would, in many cases, be dependent on implementation of associated restoration projects.

MAINTAIN FUNCTIONALITY OF NATIONAL WILDLIFE REFUGES AFFECTED BY CRSO OPERATIONS

The Service's NWR System is a network of lands and waters that maintains ecological processes and habitat features to support fish, wildlife, and plants. NWRs are protected areas that allow for the conservation, management, and restoration of fish and wildlife resources to ensure environmental health and public enjoyment. The study area has several NWRs: Lewis and Clark NWR, Julia Butler Hansen NWR, Ridgefield NWR, Steigerwald Lake NWR, Umatilla NWR, and Kootenai NWR. The Service also manages Waterfowl Production Areas (WPAs) (e.g., Flathead Lake WPA) under Wetland Management Districts. Further changes to the current CRSO configuration will likely impact the structure and function of some NWRs and other lands. The following recommendations support NWR functionality despite changing conditions from the CRSO proposed action:

- Ensure sustainability of current management operations on NWRs as needed to meet system mission, goals, and refuge purposes (i.e., 601 FW 1) including, but not limited to, conservation and protection of migratory birds and the "Big Six" fish- and wildlife-dependent public uses (e.g., hunting, fishing, wildlife observation, photography, interpretation, and environmental education).
- Support the Service in monitoring impacts on habitat, natural resources, and fish- and wildlife-dependent recreational opportunities on NWRs and mitigate impacts that constrain the ability of those lands to meet their individual mission, goals, and purposes; of particular consideration should be those impacts that compromise migratory bird use or the "Big Six" public uses of NWR lands.
- Minimize impacts of operations to existing infrastructure that maintains critical refuge system habitats. As necessary, add, replace, and modify infrastructure to ensure its long-term functionality. Infrastructure changes could include, but are not limited to, the installation of pump sites and fish screens as needed to enable NWRs to function and meet establishment purposes.
- Maintain existing waterbird (e.g., waterfowl and shorebirds) use areas and, through restoration and conservation projects or activities, enhance habitat diversity for waterfowl use, specifically, throughout all life history stages (e.g., migrating, wintering, and breeding stages).
- Support the Service in protecting and replacing any existing waterbird areas lost or rendered dysfunctional due to potential impacts associated with operational change such as sedimentation, flooding, and the invasion and establishment of non-native species.
- Support the Service in providing additional open water migratory bird sanctuaries in the

Columbia River adjacent to existing refuge system habitats to mitigate for loss of open water habitat as a result of sedimentation. To be effective, new sanctuary habitat should mimic existing habitats and include particular landscape features (e.g., moist soil, shoreline and shallow water habitats for shorebirds, and open water habitat of various depths with submerged aquatic vegetation) to adequately support migratory birds.

- Support the Service's monitoring and management of invasive species on NWRs as needed to maintain the structure and function of various habitats.
- Acquire water rights to protect the ability of NWRs to meet establishment purposes and, especially, keep intact the structure and function of certain areas on refuge lands that support migratory birds.
- Maintain NWR infrastructure (e.g., water control structures, ditches, and pumping stations) to deliver and distribute water that sustains functional wetlands, like those at Kootenai NWR. Provide sufficient resources to design and implement infrastructure modifications, as necessary to meet refuge objectives depending on the alternative that is eventually implemented.

MAINTAIN OR ENHANCE HABITAT COMPLEXITY AND HETEROGENEITY

Habitat complexity and habitat heterogeneity greatly influence the function of ecological communities. Ecological communities with high habitat complexity and heterogeneity often contain greater species richness and abundance, and thus, increase the chance of species survival through all life- history stages. In the Basin, the presence of dams and associated infrastructure in and along mainstems, tributaries, riparian zones, and wetlands has reduced habitat complexity and led to homogenization of habitats, thereby decreasing overall ecological function (Hauer et al. 2016, p. 1; Macfarlane et al. 2016, p. 455; Moyle and Mount 2007, pp. 5711-5712; Poff et al. 2007, p. 5732; Utzig and Schmidt 2011, pp. i, 33; Williams et al. 2006, p. 646). Further changes to the current configuration of Federal projects in the Basin may pose additional threats to remaining complex and diverse habitats.

The following recommendations are intended to maintain or enhance habitat complexity and heterogeneity throughout the Basin. Some recommendations are intended to compensate for impacts on habitat that can neither be avoided nor minimized. These recommendations could be implemented offsite, without a direct connection to the CRSO. The Service recommends that these off-site recommendations be implemented after actions intended to avoid and minimize have been fully considered.

- Maintain, enhance, and restore habitat complexity and heterogeneity and implement identified measures to increase habitat complexity and heterogeneity. Design and implement actions that increase large wood in the system and maintain vital ecological processes such as sediment transport and tributary delta formation.
- Evaluate potential for improvements in habitat functionality at a landscape scale and

prioritize conservation and restoration projects at sites likely to be responsive to project actions and activities aimed at making such improvements.

- Provide sufficient resources and support to acquire or enhance lost or diminished habitats, landscape features, and niches to maintain habitat mosaics that support waterbirds, wetland, and riparian species.
- Acquire, maintain, and support maintenance of emergent wetland vegetation, shallow water habitat, meadows, and moist foraging areas for waterbirds and shorebirds, frogs, and painted turtles that inhabit the Lower Columbia River and Snake River.
- Protect mudflats for migratory shorebirds, including foraging and roosting habitat. Avoid changes in water levels that reduce mudflats downstream near the Columbia River Estuary and Julia Butler Hansen NWR.
- Restore channel complexity in mainstems, tributaries, and side channels of rivers and implement identified measures to increase side channel complexity. Additional restoration activities should include the removal of structures like dikes and riprap to soften banks and shorelines, thereby improving connectivity and habitat complexity.
- Reintroduce beaver in areas where beaver were either historically located or can be properly supported to enhance habitat complexity in aquatic and semi-aquatic environments. Cooperate with and support beaver reintroduction efforts, such as those piloted by state agencies in the Basin.
- Work with partners to exclude livestock from riparian areas wherever possible, especially in years following high riparian vegetation recruitment. Other than non-functional flow regimes, livestock grazing is the most immediate threat to riparian habitat, so exclusion is essential to retain riparian restoration progress made by establishing functional flows.
- Promote and fund stream restoration and address operational inefficiencies in irrigation, municipal use, and voluntary water actions to minimize negative impacts associated with water withdrawal from rivers and tributaries.
- Support monitoring of cottonwood and seedling mortality and implement the Winter Stage for Riparian operational measure at Libby Dam and Hungry Horse Dam and as needed at other dams if cottonwood seedling mortality is observed due to rising winter ice (USACOE et al. In prep.).
- Create and maintain cold-water refugia (i.e., areas in water bodies that are persistently cooler than other areas) as follows (EPA 2019, pp. 2-4):
    - Review and consider recommendations developed by the EPA in their Columbia River Coldwater Refugia Plan (EPA 2019, pp. 158-162);
    - Identify existing cold-water refugia in the study area and propose and implement restoration actions such as installing riparian shading to reduce solar heating,

restoring stream flows to increase resiliency of tributary subhabitats, and exploring opportunities to coordinate with partners to release cooler water from upstream dams;

    - Protect cold-water refugia where there is an emergence of groundwater; and,
    - Opportunistically purchase instream water rights in cold water tributaries to restore late-summer instream flows.

- Restore sediment dynamics in prioritized river reaches (e.g., through gravel augmentation or the installation of large wood to better retain sediment).
- Manage flows and reservoir elevations and use other appropriate management techniques to create or mimic natural sediment transport and depositional regimes. Support fish passage and alleviate issues at tributary deltas where increased sedimentation impedes habitat development and reduces or eliminates connectivity.
- Conserve colonial nesting waterbird populations in historical numbers within historical range, and supplement breeding habitat (i.e., at a 2:1 ratio) in the event colonies are displaced or destroyed.
- Reduce the likelihood of land bridge exposure to islands in preservation of waterbird nesting habitat to reduce predation and disturbance during nesting seasons.
- Install signage and develop and enforce regulations (e.g., no wake zones and closures) to protect essential waterbird breeding and nesting habitat.
- Develop and implement restoration projects at the Pack River Delta that aim to minimize wave action created by recreational boating on Lake Pend Oreille.
- Continue Kootenai River and Lake Kootenay nutrient- enhancement efforts.
- Post-implementation of barrier removal or breaching measures:
    - Evaluate changes in abundance and diversity of native aquatic invertebrates in wetland habitats post-implementation of breaching measures. Determine and implement restoration activities that preserve remaining and promote natural establishment of wetland habitats and associated aquatic invertebrate abundance and diversity.
    - Promote establishment and survival of native riparian vegetation:
        - Adopt functional flow regimes at Dworshak Dam. Work with partners to establish functional flows at other upstream dams.
        - Time the initial stage decrease (i.e., following barrier removal or breaching) to coincide with natural peak flow recession. This would promote the establishment of native riparian vegetation for which seed dispersal and normal springtime peak flows occur contemporaneously in an unregulated system.

        - Maintain, and potentially increase, invasive species prevention and control efforts to prevent the invasion and establishment of non-native species in newly exposed shorelines during the first few years until riparian species have established.
        - Support Operational Loss Mitigation Plan activities to protect and restore riparian habitat on the Flathead River (Bergeron et al. 2018).
    - Plant native wetland vegetation, which establishes quickly in response to new sediment deposition in the McNary Reservoir.
    - If reestablishment of functional flow regimes is not feasible, apply native seeds or plantings and support non-native species management in newly exposed persistent terrestrial habitats (e.g., uplands, wetlands, and riparian habitat).
- In regard to MO3 and MO4, restore wetland habitat on recently exposed islands resulting from breaching the four Lower Snake River dams or when land is exposed as a result of reservoir drawdown.

REDUCE THE SPREAD OF INVASIVE SPECIES, AND PREVENT FUTURE INVASIONS

Invasive species are non-native animal and plant species that pose harm to native fish and wildlife resources. Invaders often thrive in new environments as they have few, if any, natural predators but plenty of resources, allowing them to outcompete native species. Invaders can also introduce new pathogens (which are also invasive species) to ecosystems. Similar to what has occurred in other systems (i.e., the Laurentian Great Lakes), non-native species like northern pike (*Esox lucius*) in Lake Roosevelt above Grand Coulee Dam, and reed canary grass (*Phalaris arundinacea*) in the Basin have invaded reservoir and wetland environments, preying upon or outcompeting native species. Proposed changes to the configuration and operations of the Federal projects, especially Grand Coulee, and their features (e.g., turbines) may contribute to the spread of invasive species and exacerbate future invasions.

The Service recognizes CRSO operations are not solely responsible for introducing invasive species to the Basin, and those operations are not likely to lead to future introductions. However, because of the Federal dam operations and project reservoirs, there is the potential to spread invasive species throughout the basin. If left unaddressed, then invasive species can lead to additional environmental impacts, economic impacts, and higher costs for prevention of their establishment and control. In the interest of controlling invasive species, reducing their spread, and preventing future invasions, the Service offers the following recommendations:

- Reduce the impacts of non-native fish in the study area, and support northern pike removal program efforts.
- Provide support and resources for additional boat cleaning stations to prevent invasion and establishment of non-native species (e.g., aquatic invertebrates and plants).

- Support research to determine potential impacts, including directly or indirectly influencing predation of native species, of American shad (*Alosa sapidissima*) in the Lower Columbia and Snake Rivers to understand their potential impact on native aquatic species.
- Coordinate with, and implement prioritized actions identified by, interagency invasive species teams. The Aquatic Invasive Species Network and the Western Regional Panel can provide direction in regard to aquatic invasive species. Each state in the study area (i.e., Idaho, Montana, Oregon, and Washington) has an invasive species council that can also provide direction on focused actions to eradicate and reduce the spread of invasive species.

SUPPORT LONG-TERM MONITORING AND ADAPTIVE APPROACHES TO FUTURE MANAGEMENT

In the Basin, maintaining ecological processes, restoring habitat, and preserving fish, wildlife, and plants are essential to the future sustainability of our biologically, socioeconomically, and culturally valuable natural resources. Predicting how water resource and infrastructure development or changing conditions such as climate change will impact the environment is exceedingly difficult. In the face of such uncertainty, Federal, state, tribal, academic, and private partners should inform and support science-based policy decisions that advocate for more research, long-term monitoring and evaluation, and adaptive approaches to managing fish and wildlife resources. To maintain ecosystem resiliency in the face of uncertainty and future threats, the Service offers the following recommendations:

- Monitor water quality (temperature, TDG, pH) to ensure that operations do not result in significant, long-term changes to standards or benchmarks that are environmental cues for successful growth and reproduction of migratory and resident fishes and other aquatic and semi-aquatic species.
- Monitor Caspian tern breeding colony abundance at the inland Basin system-level (i.e., the Columbia River Plateau Region). This should include monitoring colony abundance at Goose Island and other islands in the Potholes Reservoir, Crescent Island, the ten "at-risk" islands identified in the Inland Avian Predation Management Plan, and the unnamed islands in Lenore Lake (USACOE 2014a, pp. 28-29).
- Provide support and resources for monitoring the John Day and McNary Dam operations impacts on Umatilla NWR and priority public uses identified in the Comprehensive Conservation Plan (USFWS 2007, p. B-2). These monitoring data can inform future adaptive management at this site.
- Monitor occupancy of riparian birds in restored riparian habitats as measures of efficacy of restoration efforts.
- Monitor and catalog wetland and riparian vegetation at reference locations following

manipulation of water surface elevation. This monitoring should include various losses and gains in terms of wetland habitat. Monitor long-term plant and animal responses to drawdown to increase understanding of physical changes to habitats and fish and wildlife resources.

- Develop education and outreach materials to illustrate and explain the mutual ecological and socioeconomic benefits associated with overland flow. Share these materials with various entities or stakeholders (e.g., landowners) to help inform them about potential positive impacts (e.g., more fertile soil) resulting from more dynamic flows and changes in water elevation.
- Coordinate with Xerces Society, state fish and wildlife agencies, land trusts, and citizen science initiatives to monitor native terrestrial invertebrates (i.e., distribution, habitat, life-history needs) and implement restoration and conservation actions or activities in locations where they may be affected by proposed changes in dam operations.
- Work with the Service's Pacific Lamprey Conservation Initiative to implement restoration and conservation actions that address the impacts of the Lower Columbia and Snake Rivers operations. Additionally, work with the initiative to support new and ongoing field studies aimed to fill gaps in existing information and knowledge about Pacific lamprey biological and life-history requirements.
- In proposing future restoration activities in the mainstem Columbia and Snake Rivers, use the Service's, Bureau of Land Management's, and U.S. Forest Service's joint Best Management Practices to minimize impacts on Pacific lamprey.
- Monitor and evaluate operational impacts on species other than anadromous salmonids and ESA-listed fishes. Establish an interagency fish and wildlife adaptive management group, or task and support existing interagency forums to consider the impacts of hydropower operations on all species. Provide support and resources to facilitate the interagency groups' or forums' conservation efforts.
- Improve coordination efforts between biologists and engineers working together on short-term (i.e., daily) dam operations to identify flexibility in operations and, in turn, capitalize on opportunities to restore and conserve habitat that yields environmental benefits to fish and wildlife resources.
- Consider climate change impacts on fish and wildlife resources and develop a climate change adaptive management plan to ensure conservation of fish and wildlife resources and their habitat.
- In regard to MO3 (measures S1, S2, O1, and O2), monitor native aquatic invertebrates affected by hydropower operations and coordinate with the Pacific Northwest Native Freshwater Mussel workgroup to identify restoration and conservation actions for mitigation purposes.

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APPENDIX A. TIMELINE

The timeline (Table A1) in this appendix highlights key milestone activities in the Service's engagement in CRSO FWCAR development from spring 2017 through summer 2020.

Table A1. Service activities related to CRSO FWCAR development

Date of Activity	Activity Description
2017	
October 17	The Service committed to develop a SOW, including budget request, for the Corps to potentially develop a FWCAR for the CRSO
2018	
March 21	The Service sought input on landscapes and evaluation species from Service Program staff and the co-lead agencies for the FWCAR
April 23	The Corps formally requested a FWCAR for the CRSO and asked the Service to finalize the SOW for the project
April 25	The Service delivered the SOW to the Corps
May 15	The Service and the Corps approved the SOW
August 8	The Service and the co-lead agencies jointly held a CRSO Kick-Off Meeting in Portland, Oregon
September 25	The Service considered landscapes and an initial, focused evaluation species list
October 3	Service staff participated in a half-day FWCA training webinar
October 25	Secretaries of the Interior, Commerce, and Energy, and the Assistant Secretary of the Army for Civil Works received a Presidential Memorandum, "Promoting the Reliable Supply and Delivery of Water in the West" (207 FR 53961 [October 25, 2018]), directing the co-lead agencies to develop a schedule to complete the CRSO final EIS, BO, and FWCAR in 2020
November 2	The Service refined the landscapes and evaluation species list
December 22	U.S. Department of the Interior Federal agencies, including the Service, shut down due to a lapse of appropriated funds, and work paused for 21 working days
2019	
January 25	The partial Federal Government shutdown ends, and work resumed

Date of Activity	Activity Description
February 25	Based on the Presidential Memorandum (207 FR 53961), the Corps revised the schedule for the following deliverables and deadlines: • CRSO DEIS due February 2020; • final EIS due June 2020; • associated BOs due June 2020; • final FWCAR due June 2020; and, • the Record of Decision in September 2020.
May 20 to 22	The Service hosted the "Wetlands" workshop in Burbank, Washington
May 28 to 29	The Service hosted the "Upper Basin" workshop and "Uplands" discussion in Kalispell, Montana
June 5 to 7	The Service hosted the "Riparian" workshop in Burbank, Washington
June 24 to 26	The Service hosted both the "Rivers" and "Lakes and Reservoirs" workshops in Vancouver, Washington
August	Service staff analyzed the CRSO alternatives
September 9	Service finalized conservation recommendations and mitigation strategies
September 30	The Service's Regional Leadership was briefed on FWCAR status and upcoming review opportunities
October 1	The Service began internal review of the FWCAR
October 9	The Service submitted a Planning Aid Letter to the Corps including the Service's draft conservation recommendations from the FWCAR
2020	
January 14	The Service delivered the FWCAR to co-lead agencies

APPENDIX B. CRSO STUDY AREA, FURTHER DEFINED

This appendix includes additional information the Service used to further define the study area for the FWCAR.

FOCAL TRIBUTARIES

The Snake, Clearwater, Kootenai, and Pend Oreille rivers represent the focal tributaries in the proposed CRSO action.

Snake River

At approximately 1,040 miles (1,674 km) long, the Snake River is the largest tributary of the Columbia River (Kammerer 2005). The Snake River drainage basin comprises 41 percent of the entire Basin and includes parts of all seven Basin-intersected states. The Snake River has an average annual discharge of 57 kcfs (1,614 m^3s^{-1}) or 21 percent of the Columbia River's discharge. The study area and, thus, this analysis include only the lower portion of the Snake River affected by CRSO operations (i.e., beginning approximately 9 miles (14 km) below its confluence with the Salmon River, to the Snake River's confluence with the Columbia River).

Clearwater River

The Clearwater River in north-central Idaho flows west along the Idaho-Montana border and joins the Snake River at Lewiston, which marks the head of navigation on the Snake River. The Dworshak Reservoir (created by Dworshak Dam on the North Fork of the Clearwater River) is the only major lake on the Clearwater system. The Clearwater River is the largest tributary of the Snake River, and its average annual discharge is approximately 15 kcfs (425 m^3s^{-1}).

Kootenai River

The Kootenay or Kootenai River basin contains approximately 16,180 square miles (41,906 km^2) of southeastern British Columbia, northern Idaho, and western Montana. The Kootenai River originates just north of Kootenay National Park and flows 485 miles (781 km) through Montana and Idaho, back into Canada, and finally into Kootenay Lake (Kootenai and Montana FWP 2004, p. 5; Kootenai River Network, Inc. n.d., p. 1). The topography of the Kootenai River basin is dominated by steep mountainous country, 90 percent of which is forested or above tree-line. Rainfall is relatively plentiful throughout this basin, making it the second largest tributary of the Columbia River in terms of run-off volume (27.6 kcfs [782 m^3s^{-1}]), though it is only the third largest in terms of drainage area. Only the Snake River contributes more volume, and it does so from a much larger watershed area (Knudson 1994, p. 6).

Pend Oreille River and Tributaries

The Pend Oreille River, which drains portions of northeastern Washington, northern Idaho, and southeastern British Columbia, is approximately 130 miles (209 km) long and, below Box Canyon Dam, has a discharge averaging approximately 26 kcfs (736 m^3s^{-1}) (USGS 2019a). Lake Pend Oreille is the largest and deepest natural lake in Idaho (Idaho DEQ 2001, p. 1). The Clark Fork River, Flathead River, Flathead Lake, Blackfoot River, Bitterroot River, Lake Pend Oreille, and Pend Oreille River are among the main bodies of water in the basin (MTDEQ et al. 2007, p. 16). The Pend Oreille River drains an area of almost 26,000 square miles (67,340 km^2), mostly through the Clark Fork River and its tributaries in western Montana, including a portion of the Flathead River in southeastern British Columbia (BC Hydro 2006, p. 7; MTDEQ et al. 2007, p. 3). The total area of the Pend Oreille basin is just under 10 percent of the entire 258,000-square mile (668,217 km^2) Basin.

Clark Fork River

The Clark Fork River or the Clark Fork of the Columbia River, drains most of Montana's west slope, and flows approximately 300 miles (483 km) from the headwaters, a few miles northwest of Butte, Montana to Lake Pend Oreille in North Idaho (MTDEQ et al. 2007, pp. 16, 20). Over the last 22 years, the discharge of the Clark Fork River below Cabinet Gorge Dam has averaged over 20 kcfs (566 m^3s^{-1}), draining over 22,000 square miles (56,980 km^2) (USGS 2019b).

Flathead River

The Flathead River begins in the Canadian Rockies and flows 158 miles (254 km) into the Clark Fork River near Paradise, Montana. All headwater forks are either entirely (e.g., Middle and North Fork) or in part (e.g., South Fork located above Hungry Horse Dam) designated as National Wild and Scenic Rivers (Public Law 90-542 § 1[b]; 16 U.S.C. § 1274 [1968]; Flathead Watershed Sourcebook 2016). Below Hungry Horse Dam, the Flathead River flows into the broad alluvial Flathead Valley (Smith et al. 2000, p. 41). The Flathead River has an average discharge of just under 12 kcfs (340 m^3s^{-1}) and contributes over half of the Clark Fork River's flow (Confederated Salish and Kootenai Tribes and Montana FWP 2004, pp. 5-6).

COLUMBIA RIVER SYSTEM OF FEDERAL PROJECTS

The study area includes the 14 Federal dams or projects managed as part of a single, larger system of operations, the CRSO (Table B1 and Figure B1) (USFWS and USACOE 2018, pp. 1, 8).

Table B1. Columbia River System and notable tributaries in which operating agencies coordinate and manage CRSO Federal projects

River System and Tributaries	Operating Agency	Federal Project
Columbia River mainstem	Corps	Bonneville Dam

River System and Tributaries	Operating Agency	Federal Project
		The Dalles Dam John Day Dam McNary Dam Chief Joseph Dam
Columbia River mainstem	Reclamation	Grand Coulee Dam
Snake River	Corps	Ice Harbor Dam Lower Monumental Dam Little Goose Dam Lower Granite Dam
Clearwater River	Corps	Dworshak Dam
Kootenai River	Corps	Libby Dam
Pend Oreille River	Corps	Albeni Falls
Flathead River	Reclamation	Hungry Horse Dam

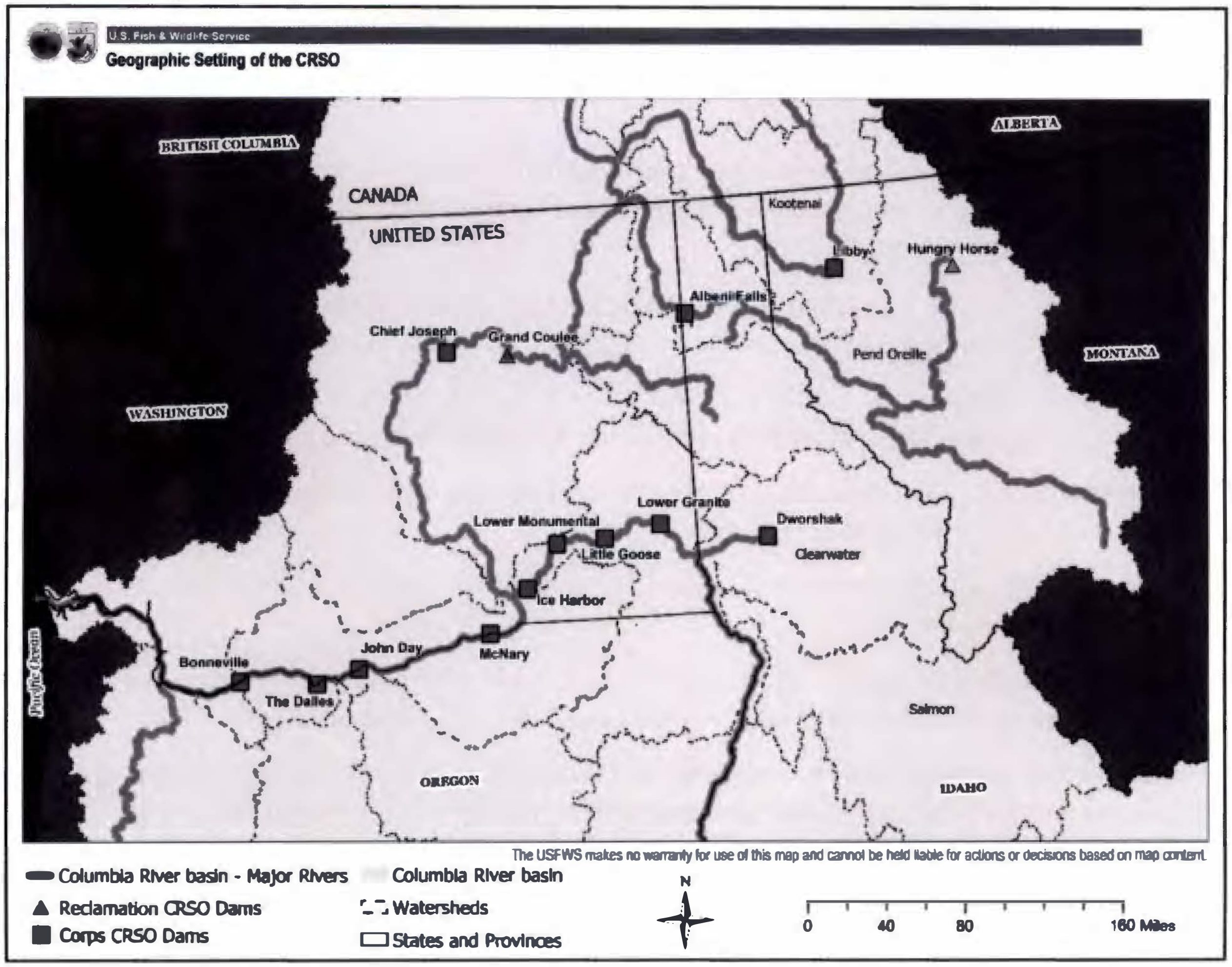

Figure B1. Geographic setting of the CRSO (USACOE n.d.)

The co-lead agencies coordinate operation of these 14 Federal projects with Canada reservoir projects pursuant to the Columbia River Treaty and several nonfederal, private and public utility district dams (Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids) throughout the Basin (BPA et al. 2001, pp. 18-19; Columbia River Basin Treaty 1961).

The Service's analysis of the potential impacts of the CRSO and its alternatives on fish and wildlife resources includes the operational response to the removal of water for seven Federal irrigation projects: Columbia Basin Project, The Dalles, Chief Joseph, Umatilla, Yakima, Crooked River, and the Deschutes Projects. Certain areas and operations related to these projects are excluded (see "Excluded Areas" in this appendix) in this analysis.

RIVER SEGMENTS (OR REACHES)

The study area also includes the extent of the projected upstream inundation in the mainstem Columbia River and tributaries, as well as downstream impacts of modified flows from the 14

Federal projects to the point where such flow modification no longer has measurable impacts (USFWS and USACOE 2018, p. 8). Within that scope, the Service's analysis of the impacts of CRSO Federal project proposed alternatives was confined by regional boundaries:

- the mainstem Columbia River, from the uppermost extent of river affected by Lake Roosevelt, down to and including the Columbia River estuary and plume (i.e., nearshore ocean adjacent to the mouth);
- the Snake River, beginning approximately 9 miles (14 km) below its confluence with the Salmon River, to the Snake River's confluence with the Columbia River;
- Dworshak Reservoir and the North Fork Clearwater River downstream of Dworshak, flowing into the Clearwater River to its confluence with the Lower Snake River;
- Libby Reservoir (i.e., Lake Koocanusa) and the Kootenai River downstream of Libby Dam to its confluence with the Columbia River;
- Lake Pend Oreille and the Pend Oreille River, including Albeni Falls Dam, to its confluence with the Columbia River;
- Hungry Horse Reservoir and the South Fork Flathead River, downstream of Hungry Horse Dam to the confluence with the mainstem Flathead River and Flathead Lake;
- stream reaches and land areas permanently or seasonally inundated (i.e., as determined by 200-year water level events) by currently permitted and legal operations of the CRSO Federal projects; and,
- landscapes, habitats, and sites within a 0.5 mile (0.8 km) distance (i.e., buffer) of the above listed areas.

The study area includes distinct river segments or reaches that range from the reservoirs upstream of Federal dams, such as Hungry Horse Reservoir above Hungry Horse Dam on the South Fork of the Flathead River, to downstream of Bonneville Dam as far as the nearshore marine environment beyond the mouth of the Columbia River (i.e., within one half mile of the terminus of the banks) (Table B2 and Figure B2). Table B2 lists these reaches in order from the Pacific Ocean to headwater stream segments.

Table B2. River reaches included in the FWCAR analysis

Rivers and Focal Tributaries	Number related to Figure B2	Reach Name	From River Mile	To River Mile	Length (miles [km])	Area (acres [km²])[1/]
Columbia River	0	Ocean to Quinn Island	-0.5	30	79 [127]	144,441 [382]

Rivers and Focal Tributaries	Number related to Figure B2	Reach Name	From River Mile	To River Mile	Length (miles [km])	Area (acres [km²])1/
	1	Quinn Island to Bonneville Dam	30	146	429 [690]	348,935 [90]
	2	Bonneville Dam to The Dalles Dam	146	191	103 [166]	55,805 [280]
	3	The Dalles Dam to John Day Dam	191	217	54 [87]	27,884 [165]
	4	John Day Dam to McNary Dam	217	291	188 [303]	121,892 [80]
	5	McNary Dam to Priest Rapids Dam	291	397 (Columbia River) and 9 (Snake River)	255 [410]	146,463 [593]
Snake River	6	Ice Harbor Dam to Lower Monumental Dam	9	41	64 [103]	29,508 [119]
	7	Lower Monumental Dam to Little Goose Dam	41	69	68 [109]	28,653 [116]
	8	Little Goose Dam to Lower Granite Dam	69	106	79 [127]	35,495 [144]
	9	Upstream of Lower Granite Dam to Dworshak Dam	107	178 (Snake River), 7 (Grand Ronde River), 45 (Clearwater River)	238 [383]	94,506 [382]

Rivers and Focal Tributaries	Number related to Figure B2	Reach Name	From River Mile	To River Mile	Length (miles [km])	Area (acres [km²])[1/]
Columbia River	15	Priest Rapids Dam to Wanapum Dam	397	415	43 [69]	22,321 [90]
	32	Upstream of Dworshak Dam	1 (North Fork Clearwater River)	55 (North Fork Clearwater River)	55 [89]	69,192 [280]
	16	Wanapum Dam to Rock Island Dam	415	454	80 [129]	40,718 [165]
	17	Rock Island Dam to Rocky Reach Dam	454	475	47 [76]	19,706 [80]
	18	Rocky Reach Dam to Wells Dam	475	515	88 [142]	37,316 [151]
	19	Wells Dam to Chief Joseph Dam	515	546	58 [93]	29,367 [119]
	20	Chief Joseph Dam to Grand Coulee Dam	546	597	107 [172]	42,603 172]
	21	Grand Coulee Dam to U.S. – Canada Border	597	748	153 [246]	199,793 [809]
Pend Oreille River	22	Boundary Dam to Box Canyon Dam	16 (Pend Oreille River)	33 (Pend Oreille River)	37 [60]	13,437 [54]
	23	Box Canyon Dam to Albeni Falls Dam	33	89	119 [192]	66,915 [271]

Rivers and Focal Tributaries	Number related to Figure B2	Reach Name	From River Mile	To River Mile	Length (miles [km])	Area (acres [km²])[1/]
	24	Albeni Falls to Cabinet Gorge Dam	89	156, 2 (Pack River) and 15 (Clark Fork River)	189 [304]	172,539 [698]
Flathead River	28	Southern end of Flathead Lake to Hungry Horse Dam	79 (Flathead River)	156 (Flathead River, 6 (Stillwater River), 11 (Whitefish River), and 5 (South Fork Flathead River)	172 [277]	244,639 [990]
	30	Upstream of Hungry Horse Dam	5 (South Fork Flathead River)	41 (South Fork Flathead River)	37 [60]	57,571 [233]
Kootenai River	29	U.S. – Canada Border to Libby Dam	104 (Kootenai River)	220 (Kootenai River)	246 [346]	102,100 [413]
	31	Upstream of Libby Dam	220 (Kootenai River)	220 (Kootenai River)	48 [77]	67,058 [271]

[1/]The acres and km² listed are rounded to the nearest whole number

Source: USGS n.d.

0.5 MILE (0.8 KM) BUFFER

The Service designated a 0.5 mile (0.8 km) buffer around the mainstem Columbia and Snake Rivers as an outer boundary to constrain the analysis (Figure B2). To define the buffer, the Service referenced the 200-year Annual Exceedance Probability (AEP) layer from the NAA and reviewed the co-lead agencies' Hydrology and Hydraulics (H&H) model outputs (Appendix G) (Hadley, H., in litt. 2019).

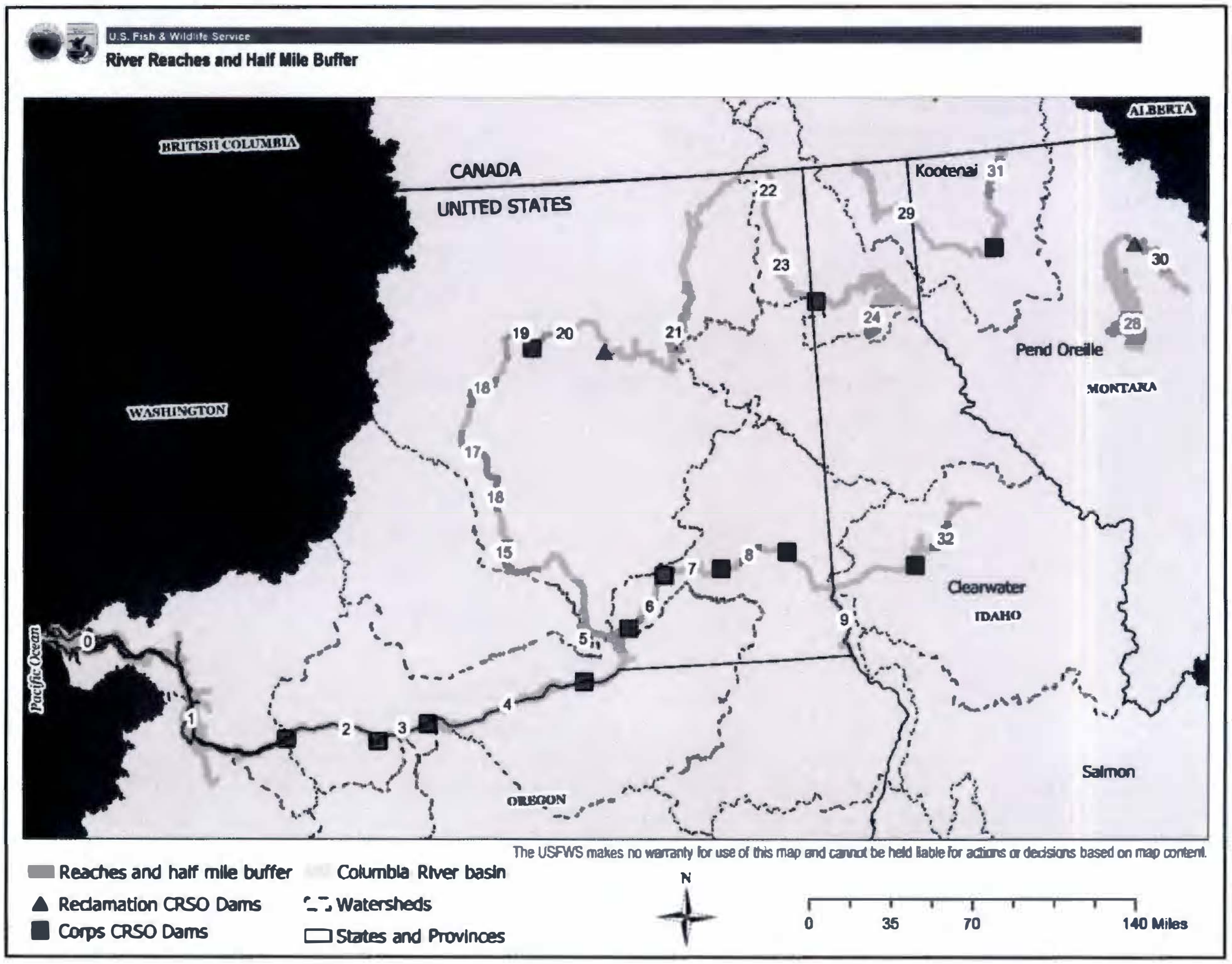

Figure B2. River reaches included in the FWCAR analysis and 0.5 mile (0.8 km) buffer

EXCLUDED AREAS

The study area does not include reaches located in Canada or upper portions of the Basin watersheds beyond the 0.5 mile (0.8 km) buffer. While the study area includes reaches influenced by dams operated by nonfederal entities (e.g., Wanapum Dam, Rock Island Dam), this report analyzes impacts of changes in configuration, maintenance, and operations of only those Federal projects that comprise the CRSO. The Service excluded lands associated with the transmission of electricity and irrigation on private lands from this analysis because they are outside the scope of the project.

APPENDIX C. SERVICE OUTREACH AND COMMUNICATIONS

The following documents represent the Service's outreach to stakeholders. Outreach materials included briefing memos and e-mails to Service programs' leadership, staff from other fish and wildlife resource agencies, tribes, private groups, and academic institutions.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

February 22, 2019

To: R1 ES Project Leaders, Columbia Basin
Project Leader, Montana Field Office, R-6

From: State upervisor, Washington Fish and Wildlife Office
Lacey, Washington

Subject: Opportunities for Input on USFWS Analysis of Federal Dam Effects

Background

The co-lead agencies of the Corp: of Engineers (Corps), Bonneville Power Administration (BPA), and Bureau of Reclamation (BOR) are preparing and Environmental Impact Statement (EIS) on the operations of fourteen large federal dams in the Columbia Basin (Columbia Basin stem Operations or CRSO). The Corps has pro ided funding to the USFWS to produce a Fish and Wildlife Coordination Act Report (FWCAR) that will be an appendix to the Environmental Impact Statement for CRSO.

Mission

The mission of the CRSO FWCAR is to:

"Promote conservation of ecological proce ses and diverse ecological communities affected by dam modifications and operation in the Columbia River basin by providing technical assistance and recommendations to the co-lead agencie ."

A main objective of the FWCAR is to document the effects of dam operations on landscapes or aspects of landscapes that will not receive as much attention through ESA con ultation. To that end, the USFW team has identified five priority landscapes to analyze: Arid Uplands, Riparian, Wetlands, Rivers, and Lakes/Reservoirs.

Focusing the analysis

Given the number of ecological processes, communities, and species that could be affected by the dams, the USFWS narrowed the focus of their analysis by selecting specie to illustrate the effects of changing dam operations. Specie were selected through two phases. In the first phase, SFWS staff from the Washington Fish and Wildlife Office identified pecies that:

- were likely to be impacted,
- were good indicators of ecological change,
- represented the different parts of the basin, and
- occupy multiple states.

The first phase also prioritized pecies with special status under state law, but are not listed under the Endangered pecies Act since the effects of dam operation to E A-listed species will be analyzed through con ultation with SFWS and OAA. The co-lead agencies and Washington Department of Fish and Wildlife provided feedback on the list.

To prepare the FWCAR, the USFWS assembled a team from different programs across the region led by the USFWS office in Lacey, Washington. After the USFWS CRSO FWCAR team was assembled, the team revisited the list during a second phase of identifying illustrative species.

During the second phase USFWS staff across four programs edited the initial species list focusing on whether other species would be better indicators of ecological change while retaining the previous criteria. The second phase of selecting species resulted in the following list:

Priority Landscapes and Focal Species for the USFWS CRSO FWCAR

Priority Landscape	Focal Species
Arid Uplands	Long-billed curlew
	Sage thrasher
Riparian	Black cottonwood
	Viceroy butterfly
	Yellow warbler
Wetlands	American bittern
	Mallard
	Western painted turtle
	Woodhouse's toad
Rivers	Western pearlshell mussel
	White sturgeon
Rivers / Lakes/Reservoirs	Pacific lamprey
Lakes/Reservoirs	Clark's/Western grebe
	Dunlin
	Floaters

While the team's analysis of dam operations will focus on those sixteen species, they will welcome information about other species that will help explain the effects of dam operations on ecosystems.

Input from others

The USFWS CRSO FWCAR team will gather input from other stakeholders through a series of workshops in the spring and summer of 2019. The workshops will provide opportunities for state fish and wildlife agencies, tribes, and other organizations to contribute their expertise to the USFWS CRSO FWCAR. The workshops will cover the status of landscapes and species, how dam operations will affect them, and recommendations to increase conservation of species and their habitats.

We will appreciate input from professionals with knowledge about the species we have selected or other species that can help illustrate how dam operations affect the landscape. There will be one workshop on each of our priority landscapes, and each workshop will be one or two days. Workshop locations to be determined.

The USFWS will also accept comment letters as input for the FWCAR.

For more information, contact the USFWS CRSO FWCAR Coordinator Lee Corum at Lee_Corum@fws.gov or (360) 753-5835

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

Memorandum April 9, 2019

To: Columbia Basin ES Project Leaders (Idaho, Montana, and Oregon)

From: State Supervisor, Washington Fish and Wildlife Office
Lacey, Washington

Subject: Workshops for Technical Input on the Columbia River System Operations Fish & Wildlife Coordination Act Report

The USFWS Columbia River System Operations Fish and Wildlife Coordination Act Report (CRSO FWCAR) team (herein referred to as "the team") is ready to reach out to stakeholders and begin inviting experts to workshops. Please coordinate with the USFWS CRSO FWCAR Coordinator about what role, if any, you would like to have in introducing the project to your partners and asking for their participation in the workshops. Feel free to share this memo with your partners.

Background

The co-lead agencies of the Corps of Engineers (Corps), Bonneville Power Administration, and Bureau of Reclamation are preparing an Environmental Impact Statement (EIS) on the operations of fourteen large federal dams in the Columbia Basin. The Corps has provided funding to the USFWS to produce a formal 2(b) FWCAR that will be included as an appendix to the CRSO EIS. We will deliver the final FWCAR to the co-lead agencies before the final CRSO EIS is published in June 2020.

The mission of the USFWS CRSO FWCAR is to:
"Promote conservation of ecological processes and diverse ecological communities affected by dam modifications and operations in the Columbia River basin by providing technical assistance and recommendations to the co-lead agencies."

Related to that mission, a main objective of the FWCAR is to document the effects of dam operations on landscapes defined by ecological processes and communities that will not be prioritized through Endangered Species Act (ESA) Section 7 consultation. Consultation under the ESA will thoroughly analyze effects to ESA-listed species and their habitats, but dam operations may affect ecological processes and communities not linked to an ESA-listed species. The team has identified five broad priority landscapes within the Columbia River basin to analyze: Arid Uplands, Riparian, Wetlands, Rivers, and Lakes/Reservoirs to structure the FWCAR.

Workshops for technical input

We are soliciting input from stakeholders about the status of ecological processes, communities, and landscapes as well as how dam operations affect priority landscapes and associated communities. The team will gather input for their analysis and FWCAR from stakeholders through a series of workshops in May and June of 2019. The workshops will provide opportunities for stakeholders to share their diverse perspectives as they contribute technical information to the USFWS description of processes, landscapes, communities, species, and habitat statuses that will contribute to the USFWS analyses of dam modification/operation alternatives. Information from stakeholders could include, but is not limited to, reports from surveys or studies, white papers, gray literature, species population assessments or expert knowledge about ecological processes, species and their habitats, communities, and landscapes.

During the workshops, it would be helpful to the team for stakeholders to:

1. Identify and describe resources/areas that have special importance to stakeholders
2. Offer information to fill information gaps identified during the workshops
3. Suggest measures to conserve, protect, and enhance ecological processes, communities, and landscapes

We expect that stakeholders with technical knowledge about the status of ecological processes, communities, and landscapes, and existing impacts of dam operations could include, but is not limited to, representatives from:

- Federal agencies
- State natural resource agencies/departments
- Tribal natural resource agencies/departments
- Utility districts and local government (cities/counties)
- Non-government organizations
- Academia

There are five workshops scheduled for the team to receive input from stakeholders. Each workshop focuses on a different priority landscape or geographic area, we welcome stakeholders to attend any workshops that they can contribute to.

Workshop Focus	Dates	Location
Wetlands	May 20-21, 2019	Mid-Columbia River NWR Complex Office, Burbank, WA
Upper Basin	May 28-29, 2019	To be determined
Riparian	June 5-6, 2019	Mid-Columbia River NWR Complex Office, Burbank, WA
Rivers	June 24-25, 2019	Columbia River Fish and Wildlife Conservation Office, Vancouver, WA
Lakes/Reservoirs	June 25-26, 2019	Columbia River Fish and Wildlife Conservation Office, Vancouver, WA

The one- to two-day workshops provide an efficient method for the team to receive and discuss information from stakeholders. The team will also accept comment letters as input for the FWCAR.

For more information please contact the USFWS CRSO FWCAR Coordinator: Lee Corum at (360) 753-5835 or by email at Lee_Corum@fws.gov.

APPENDIX D. SERVICE WORKSHOP AGENDAS

The following documents are the workshop agendas. For each workshop, there were four or five questions designed to encourage stakeholders to share information about fish and wildlife resources in the Basin.

USFWS CRSO FWCA Workshop – Wetlands

May 20 – 21, 2019
Mid-Columbia River National Wildlife Refuge Complex Office
Burbank, Washington

Workshop Goals

- Identify significant resources (e.g., processes, landscapes, habitat components, and species) in specific areas within the study area that are of special value to workshop participants
- Discuss how modifications to existing conditions related to water quality and quantity could potentially impact significant resources
- Compile a list of potential actions to conserve, protect, and enhance significant resources
- Obtain valuable data (e.g., from white papers, grey literature, technical reports, survey assessments) to fill existing information gaps

AGENDA

Monday, May 20, 2019

Introduction to the USFWS CRSO FWCA		
1:00 pm	**Welcome and introductions**	Lee Corum
1:30 pm	**Introduction to the Columbia River System Operations (CRSO)** National Environmental Policy Act (NEPA) context General scope of proposed action and alternatives USFWS CRSO mission Team structure and organization Geographic scope	Lee Corum Michael Carlson
2:00 pm	**Overview of the Fish and Wildlife Coordination Act (FWCA)** Purpose and goals FWCA versus the Endangered Species Act Unique qualities and strengths of the FWCA Deliverables	Molly Good
2:15 pm	**Approach to USFWS CRSO FWCA Report** Priority landscapes Evaluation species	Molly Good
2:30 pm	**Workshops** Purpose and goals Exercises and questions Expectations for workshop participants	Lee Corum
2:50 pm	**BREAK**	

	Orientation to Wetlands	
3:00 pm	**"What we know so far..."** Characterization of priority landscape Significant resources Use of landscape and habitat components Critical processes or features	Robert Haltner

	Exercise I	
3:30 pm	**"What is it, and what's its status?"** Large group discussion: *Given the study area, comment on significant resources (e.g., processes, landscapes, habitat components, and species) of special value to you and their current statuses and trends (e.g., specific location, population [increasing, stable, decreasing], niches).*	Lee Corum
4:30 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn for the day**	

Tuesday, May 21, 2019

	Exercise I, Continued	
9:00 am	**Discussion, continued**	Lee Corum

	Exercise II	
9:30 am	**"What is critical, how will it change, and what are the impacts?** Small group discussion: *What processes (e.g., erosion) and landscape or habitat components (e.g., native wetland vegetation) are most critical to the health and well-being of the significant resources you identified? And, why?*	Lee Corum
11:00 am	**Report out**	Lee Corum
12:00 pm	**LUNCH**	
1:00 pm	**Discussion, continued** Small group discussion: *How would modifications to existing conditions (e.g., water elevation or depth) in the study area alter processes and landscape or habitat components you just identified? Be specific.* Small group discussion: *List the impacts of these potential alterations in processes and landscape or habitat components on significant resources.*	Lee Corum Lee Corum
2:00 pm	**Report out**	Lee Corum
2:50 pm	**BREAK**	

Exercise III		
3:00 pm	**"If we could save it all..."** Small group discussion: *In light of your previous answers, list TEN measurable and achievable actions to conserve, protect, and enhance the significant resources you identified.*	Lee Corum
4:00 pm	**Report out**	Lee Corum
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn the workshop**	

USFWS CRSO FWCA Workshop – Upper Basin

May 29, 2019
Montana Fish, Wildlife, and Parks Office
Kalispell, Montana

Workshop Goals

- Identify significant resources (e.g., processes, landscapes, habitat components, and species) in specific areas within the study area that are of special value to workshop participants
- Discuss how modifications to existing conditions related to water quality and quantity could potentially impact significant resources
- Compile a list of potential actions to conserve, protect, and enhance significant resources
- Obtain valuable data (e.g., from white papers, grey literature, technical reports, survey assessments) to fill existing information gaps

AGENDA

Wednesday, May 29, 2019

Introduction to the USFWS CRSO FWCA		
9:00 am	**Welcome and introductions**	Lee Corum
9:10 am	**Introduction to the Columbia River Systems Operation (CRSO)** National Environmental Policy Act (NEPA) context General scope of proposed action, alternatives, and operations USFWS CRSO mission Team structure and organization Workshop goals and expectations	Lee Corum Mark Bagdovitz Lee Corum
9:40am	**Fish and Wildlife Coordination Act (FWCA)** Purpose and goals Approach to USFWS CRSO FWCA Report	Molly Good
9:50 am	**Geographic Scope** Study area Orientation to the Upper Basin	Michael Carlson Erin Kuttel

Exercise I		
10:00 am	**"Where do we prioritize?** <u>Discussion:</u> *Given the study area, please identify high priority sites and explain why they are of interest or value to your agency.*	Lee Corum
10:50 am	**BREAK**	

Exercise II		
11:00 am	**"What must we maintain?"** Discussion: *In these high priority sites, what are the unique processes, landscape features, or time periods (e.g., growing season) necessary to maintain existing conditions that support significant resources?*	Lee Corum
12:00 pm	**LUNCH**	

Exercise III		
1:00 pm	**"How could it all change?"** Discussion: *Considering how current dam operations occur, how will changes involving higher or lower water flows affect these high priority sites?*	Lee Corum
2:30 pm	**BREAK**	

Exercise IV		
4:00 pm	**"What can we do?"** Discussion: *In light of your previous answers, please identify TEN measureable and achievable actions to conserve, protect, and enhance the sites you identified and significant resources you discussed.*	Lee Corum
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn the workshop**	

USFWS CRSO FWCA Workshop – Riparian

June 5 – 6, 2019
Mid-Columbia River National Wildlife Refuge Complex Office
Burbank, Washington

Workshop Goals

- Identify significant resources (e.g., processes, landscapes, habitat components, and species) in specific areas within the study area that are of special value to workshop participants
- Discuss how modifications to existing conditions related to water quality and quantity could potentially impact significant resources
- Compile a list of potential actions to conserve, protect, and enhance significant resources
- Obtain valuable data (e.g., from white papers, grey literature, technical reports, survey assessments) to fill existing information gaps

AGENDA

Wednesday, June 5, 2019

Introduction to the USFWS CRSO FWCA		
1:00 pm	**Welcome and introductions**	Lee Corum
1:10 pm	**Introduction to the Columbia River Systems Operation (CRSO)** National Environmental Policy Act (NEPA) context General scope of proposed action, alternatives, and operations USFWS CRSO mission Team structure and organization Workshop goals and expectations	Lee Corum Mark Bagdovitz Lee Corum
2:00 pm	**Fish and Wildlife Coordination Act (FWCA)** Purpose and goals Approach to USFWS CRSO FWCA Report	Molly Good
2:15 pm	**Geographic Scope** Study area	Michael Carlson
2:30 pm	**BREAK**	

Orientation to Riparian		
2:45 pm	**"What WE know so far…"** Characterization of priority landscape Significant resources Use of landscape and habitat components Critical processes or features	Gabrielle Robinson

Exercise I		
3:00 pm	**"What is riparian, to YOU?"** Discussion: *Given your knowledge of riparian landscape structure and function, please identify different classes or types of riparian habitat likely to exist within the study area.*	Lee Corum

Exercise II		
3:30 pm	**"Where do we prioritize?** Discussion: *Given your previous response, please identify high priority sites with riparian habitat in the study area, and explain why they are of interest or value to your agency.*	Lee Corum
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn for the day**	

Thursday, June 6, 2019

Exercise III		
9:00 am	**Summary of morning session and next steps**	Lee Corum
9:10 am	**"What must we maintain?"** Discussion: *In these high priority sites, what are the unique processes, landscape features, or time periods (e.g., growing season) necessary to maintain existing conditions that support significant resources?*	Lee Corum
10:20 am	**BREAK**	

Exercise IV		
10:30 am	**"How could it all change?"** Discussion: *Considering how current dam operations occur, how will changes involving higher or lower water flows affect these high priority sites?*	Lee Corum
12:00 pm	**LUNCH**	
1:00 pm	**Discussion, continued**	Lee Corum
3:20 pm	**BREAK**	

Exercise V		
3:30 pm	**"What can we do?"** Discussion: *In light of your previous answers, please identify TEN measureable and achievable actions to conserve, protect, and enhance the sites you identified and significant resources you discussed.*	Lee Corum
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn the workshop**	

USFWS CRSO FWCA Workshop – Rivers

June 24 – 25, 2019
Columbia River Fish and Wildlife Conservation Office
Vancouver, WA

Workshop Goals

- Identify significant resources (e.g., processes, landscapes, habitat components, and species) in specific areas within the study area that are of special value to workshop participants
- Discuss how modifications to existing conditions related to water quality and quantity could potentially impact significant resources
- Compile a list of potential actions to conserve, protect, and enhance significant resources
- Obtain valuable data (e.g., from white papers, grey literature, technical reports, survey assessments) to fill existing information gaps

AGENDA

Monday, June 24, 2019

Introduction to the USFWS CRSO FWCA		
9:00 am	**Welcome and introductions**	Lee Corum
9:10 am	**Introduction to the Columbia River Systems Operation (CRSO)** National Environmental Policy Act (NEPA) context General scope of proposed action, alternatives, and operations USFWS CRSO mission Team structure and organization Workshop goals and expectations	Lee Corum Mark Bagdovitz Lee Corum
10:00 am	**Fish and Wildlife Coordination Act (FWCA)** Purpose and goals Approach to USFWS CRSO FWCA Report	Molly Good
10:15 am	**Geographic Scope** Study area Rivers versus lakes/reservoirs	Michael Carlson
10:30 am	**BREAK**	

Orientation to Rivers		
10:45 am	**"What WE know so far..."** Characterization of priority landscape Significant resources Use of landscape and habitat components Critical processes or features	Mike Hudson

Exercise I		
11:00 am	**"What are rivers, to YOU?"** Discussion: *Given your knowledge of riverine landscape structure and function, please identify different classes or types of riverine habitat likely to exist within the study area.*	Facilitator
12:00 pm	**LUNCH**	

Exercise II		
1:00 pm	**"Where do we prioritize?** Discussion: *Given your previous response, please identify high priority sites with riverine habitat in the study area, and explain why they are of interest or value to your agency.*	Facilitator

Exercise III		
2:00 pm	**"What must we maintain?"** Discussion: *In these high priority sites, what are the unique processes, landscape features, or time periods (e.g., growing season) necessary to maintain existing conditions that support significant resources?*	Facilitator
3:00 pm	**BREAK**	

Exercise IV		
3:10 pm	**"How could it all change?"** Discussion: *Considering how current dam operations occur, how will changes involving higher or lower water flows affect these high priority sites?*	Facilitator
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn for the day**	

Tuesday, June 25, 2019

Exercise IV, continued		
9:00 am	**Summary of prior sessions and next steps**	Facilitator
9:10 am	**Discussion, continued**	Facilitator

Exercise V		
10:20 am	**BREAK**	
10:30 am	**"What can we do?"** Discussion: *In light of your previous answers, please identify TEN measureable and achievable actions to conserve, protect, and enhance the sites you identified and significant resources you discussed.*	Facilitator

USFWS CRSO FWCA Workshop – Lakes/Reservoirs

June 25 – 26, 2019
Columbia River Fish and Wildlife Conservation Office
Vancouver, WA

Workshop Goals

- Identify significant resources (e.g., processes, landscapes, habitat components, and species) in specific areas within the study area that are of special value to workshop participants
- Discuss how modifications to existing conditions related to water quality and quantity could potentially impact significant resources
- Compile a list of potential actions to conserve, protect, and enhance significant resources
- Obtain valuable data (e.g., from white papers, grey literature, technical reports, survey assessments) to fill existing information gaps

AGENDA

Tuesday, June 25, 2019

	Introduction to the USFWS CRSO FWCA	
1:00 pm	**Welcome and introductions**	Lee Corum
1:10 pm	**Introduction to the Columbia River Systems Operation (CRSO)** National Environmental Policy Act (NEPA) context General scope of proposed action, alternatives, and operations USFWS CRSO mission Team structure and organization Workshop goals and expectations	Lee Corum Mark Bagdovitz Lee Corum
2:00 pm	**Fish and Wildlife Coordination Act (FWCA)** Purpose and goals Approach to USFWS CRSO FWCA Report	Molly Good
2:15 pm	**Geographic Scope** Study area Lakes/reservoirs versus rivers	Michael Carlson
2:30 pm	**BREAK**	

	Orientation to Lakes/Reservoirs	
2:45 pm	**"What WE know so far..."** Characterization of priority landscape Significant resources Use of landscape and habitat components Critical processes or features	Katie Powell

Exercise I		
3:00 pm	**"What are lakes/reservoirs, to YOU?"** Discussion: *Given your knowledge of lake/reservoir landscape structure and function, please identify different classes or types of lake/reservoir habitat likely to exist within the study area.*	Facilitator

Exercise II		
3:30 pm	**"Where do we prioritize?** Discussion: *Given your previous response, please identify high priority sites with lake/reservoir habitat in the study area, and explain why they are of interest or value to your agency.*	Facilitator
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn for the day**	

Wednesday, June 26, 2019

Exercise III		
9:00 am	**Summary of morning session and next steps**	Lee Corum
9:10 am	**"What must we maintain?"** Discussion: *In these high priority sites, what are the unique processes, landscape features, or time periods (e.g., growing season) necessary to maintain existing conditions that support significant resources?*	Facilitator
10:20 am	**BREAK**	

Exercise IV		
10:30 am	**"How could it all change?"** Discussion: *Considering how current dam operations occur, how will changes involving higher or lower water flows affect these high priority sites?*	Facilitator
12:00 pm	**LUNCH**	
1:00 pm	**Discussion, continued**	Facilitator
3:20 pm	**BREAK**	

Exercise V		
3:30 pm	**"What can we do?"** Discussion: *In light of your previous answers, please identify TEN measureable and achievable actions to conserve, protect, and enhance the sites you identified and significant resources you discussed.*	Facilitator
4:50 pm	**Announcements**	Lee Corum
5:00 pm	**Adjourn the workshop**	

APPENDIX E. DATA SOURCES

The following data sources were used by the Service to conduct quantitative and qualitative assessments of the suite of potential CRSO impacts on fish and wildlife resources.

WATER HYDROLOGY AND HYDRAULICS (H&H) MODELS

The Service referred to outputs from the co-lead agencies H&H modeling efforts. The Service focused on reviewing summary hydrographs for each alternative (see "CRSO DEIS Alternatives") to compare discharge over time at various locations, in identified reaches, in the study area.

The Service relied on the co-lead agencies' to conduct H&H modeling analyses and share results. Service staff and modelers communicated regularly through conference calls and webinars to acquire and better understand modeling outputs. The co-lead agencies provided outputs from their H&H model, which is a combination of two hydro regulation models, Hydro Simulation Program (HYDSIM) and the Reservoir System Simulation (HEC-ResSim). The Service converted the outputs and associated AEP to GIS (geographic information system) format to better visualize summary hydrographs for each alternative for multiple AEPs. Each modeling spreadsheet included information specific to each of the CRSO dams, each dam reservoir and dam outflow, and a small number of intermediate points between dams. Each spreadsheet also had summary information displayed in chart format. Summary categories are defined in this list:

- **Peak discharge frequency analysis, performed for each of three time-windows**: annual (October 1 to September 30), spring (April 1 to July 31), and winter (November 1 to March 31). This is the probability of maximum daily mean discharge exceedance within each time window, based on 5,000 simulated years. That is, for any given value of discharge in the model output list or summary chart, the corresponding probability is the chance that, in any given year, the maximum daily discharge for that time window will equal or exceed this given discharge.
- **Discharge duration analysis, performed for time windows representing each calendar month and for the entire year**. In this, the word "duration" means average proportion of time during which a given discharge is exceeded.
- **Frequency of floods or droughts, number of floods above a threshold flow or water level, by month**. This is the number of 7-day low flow events above and below a threshold flow or water level, by month. For "threshold," one could use the 75th percentile for maximum or peak flows and the 25th percentile for low flow events.
- **Duration of floods or droughts**, mean duration (i.e., total days between beginning and end) of flow events, by month and for the year (annual). This is defined as high flow events (flood conditions) above a threshold and 7-day low flow events (i.e., drought conditions) below a threshold.
- **Rate of change of flow or water level**, mean difference between daily values of flow or

water level during the rising water leading up to a peak flow and mean difference between daily values of flow or water level during the receding water after a peak flow. This mean could be an average of all the flood events above a threshold value of flow or water level, such as the 75th percentile. Mean differences between high and low flow or water levels during 3-day periods could also be due to changes in spill or power generation during otherwise stable hydrological conditions.

GEOGRAPHIC INFORMATION SYSTEMS (GIS) DATA

The Service also used GIS data related to vegetative cover, landscapes and habitats, and species occurrences throughout the study area. The Service collected and mapped GIS data from readily accessible natural resources databases and coordinated with the co-lead agencies to request additional GIS data, as needed.

Vegetation Type and Cover

The Service characterized and classified various habitats and subhabitats throughout the study area using data primarily from NWI and LANDFIRE (Cowardin et al. 1979, pp. 4-5; LANDFIRE 2016; USFWS 2019a, p. 8, 2019d).

The Service used the 0.5 mile (0.8 km) buffer to combine NWI and LANDFIRE data set. The Service used the NWI data as a base layer and, for areas not covered by the NWI, the Service added LANDFIRE data to illustrate wetland and riparian habitats. The Service also conducted qualitative assessments of habitats at specific sites in the study area to focus this analysis on the impacts of proposed alternatives.

For areas outside of the NWI data and within a 0.5 mile (0.8 km) buffer, the Service used LANDFIRE data. Other GIS data sets were considered for this analysis, such as the Northwest Habitat Institute (NWHI) and National Land Cover Data (NLCD) (MRLC n.d.). The scale and resolution of these datasets were either coarser (NLCD has 30-meter [98-ft] resolution) or more generally characterized (NWHI habitat categories were considered to generalized for this analysis). For all data sources, mapped features may have changed since the date of the layers and are, at best, an approximation of habitats present in the study area and described in this analysis.

National Wetlands Inventory

The NWI is a useful tool for determining the location, type, and size of wetlands and deep-water habitats (Cowardin et al. 1979, p. 4). NWI is prepared from analysis of high-altitude imagery based on vegetation, visible hydrology, and geography. In 2006, the NWI added the riparian data layer for mapping purposes based on the development of a new system for mapping riparian areas. The Service described a new system and updated the document in 2009 and 2019 (USFWS 2019a, pp. 7-8). Beyond the system level, the codes become more detailed and specialized for each habitat.

Landscape Fire and Resource Management Planning Tools (LANDFIRE) Database

LANDFIRE was originally developed to support wildland fire management. LANDFIRE uses predictive landscape models from field satellite imagery, biophysical gradient layers, reference data, and classification and regression trees to create existing vegetation type (EVT) layers. The LANDFIRE vegetation layers describe the vegetation type, canopy cover, and height and catalogs these differences into detailed habitat categories. The EVT data layer also corresponds to the terrestrial ecological systems classification created by NatureServe (n.d.). Additional descriptions of the data, including the data themselves, plus descriptions of EVT are available (LANDFIRE 2016).

Species Occurrence Data

Species occurrence GIS data is a foundation of the FWCAR analysis and was gathered through many sources. The co-lead and cooperating agencies and tribes supplied much of the data used by the Service through the coordination process, as previously described. Additionally, the Service documented critical information from technical experts and other participants during the workshop period. Much of the species occurrence data originated from state Natural Heritage Programs or surrogate data sets, such as the Washington Department of Fish and Wildlife's Priority Habitats and Species and Wildlife Survey Data Management system. Other data sources the Service used came from the Butterflies and Moths of North America citizen science project, the Cornell Lab of Ornithology Birds of North America online database, Forest Inventory Analysis data from U.S. Department of Agriculture Forest Service, and the Xerces Society for Invertebrate Conservation (Lotts and Naberhaus 2017; Rodewald 2015; USFS 2019; Xerces Society 2019).

The Service also referred to species occurrence data from eBird, which is managed by the Cornell Lab of Ornithology. eBird is a community science-driven tool that collects, stores, and manages millions of bird records collected by birders worldwide (Sullivan et al. 2009). While there is bias in the collected and compiled data toward observation locations that are easily accessible and frequently visited, models have been developed that correct for that bias and have since described habitat associations, densities and abundances, and population trends for many species since the mid-2000s (Johnston et al. 2019, pp. 1-2).

APPENDIX F. DETAILED DESCRIPTION OF LANDSCAPES AND THEIR EVALUATION SPECIES AND STATUSES

This appendix includes detailed descriptions, organized by landscape, of the evaluation species the Service selected for the FWCAR.

RIVERS

Landscape, Habitats, and Subhabitats

This landscape includes river, estuary, and nearshore marine environments, which are often characterized by streams and tributaries, edges of rivers and sloughs, and temporary impoundments. For this report, common river subhabitats in the Basin include river banks and shorelines, side channels, transition areas, and unimpounded reaches (Table F1).

Within the regulated CRSO, river subhabitats are representative of the historic free-flowing riverine environment, of which only remnants exist in the study area. These subhabitats maintain ecological and physical processes and hydrologic function that the reservoir environment cannot provide, and they support various life history stages of aquatic species.

Table F1. The rivers landscape, characterized by its habitats and subhabitats in the study area

Habitats	Subhabitats	Description
River	Mainstem	Primary downstream segment of a river
	Banks and Shorelines	Terrain along the bed of a river or the perimeter of reservoirs, where water meets land
	Floodplain	Area adjacent to stream channel, formed by periodic inundation and deposition of suspended sediment
	Side Channels	Off-channel areas characterized by flowing water with identifiable upstream and downstream connections to the main channel; often define the boundaries of islands
	Transition Areas (e.g., tailwater-to-reservoir)	Areas defined by flowing water that are variable in size due to dam operations; specific to run-of-river reservoirs, areas between the outflow of a dam and the pool formed by the next dam downstream
	Tributary	A stream that flows into a larger stream, mainstem, or lake

Habitats	Subhabitats	Description
	Tributary Mouths (i.e., confluence zones)	Confluence where a stream flows into a larger body of water, often characterized by a delta where deposition of sediment from a smaller incoming stream occurs
	Unimpounded Reaches	Free-flowing stretch of river not affected by downstream dams
Estuary		Transition zones of river and marine environments that are often brackish
Nearshore Marine Environment		Waters outside the mouth of the river (e.g., Columbia River) that are still influenced by riverine processes and dynamics

Rivers

In rivers, water flows at a relatively rapid rate compared to water in lentic (i.e., still or slower-moving) environments such as ponds, lakes, and reservoirs. The velocity of a river depends on many factors including channel shape, gradient, volume of discharge, and friction with riverbed (Ames 2018). Flow regimes, landscape geology, and longitudinal slope are other important variables, and they operate dynamically at both the watershed and reach-scale (Imhof et al. 1996, pp. 313-315).

Free-flowing river reaches represent portions of the river not influenced by the Federal project operations. Due to the extensive system of dams in the Basin, remaining free-flowing reaches are critically important for native fish and wildlife resources. Notable free-flowing reaches in the study area include the Columbia River downstream of Bonneville Dam, the Hanford Reach downstream of Priest Rapids Dam, the Pend Oreille River between Albeni Falls Dam and Box Canyon Reservoir, the Flathead River downstream of Hungry Horse Dam, the Clearwater River, and the Kootenai River between Libby Dam and Bonners Ferry, Idaho.

Even free-flowing reaches experience altered hydrology from project operations, and these alterations can affect floodplain connectivity, river morphology, and sediment transport capacity (Hadley, H., in litt. 2019).

The eight major Federal reservoirs on the Lower Columbia River and the Lower Snake River are part of the "rivers landscape" because these projects operate as run-of-river. Thus, although impounded, there is flow through the reservoirs that varies in velocity depending on operations and location in the reservoir.

Related structures, such as canals and sloughs, are not part of this analysis.

Estuaries

Estuaries are transition zones that separate one or more rivers from the nearshore marine environment. These areas are tidally influenced and are often brackish, slower-moving water. The Service's analysis of impacts on estuary habitat is limited to the Lower Columbia River below the confluence with the Cowlitz River. This area provides for an abundance of waterfowl in the winter and some breeding waterfowl populations (e.g., mallard and Canada geese [*Branta* Canadensis]) in the summer. Water levels in the Columbia River are influenced by tides upstream to Bonneville Dam.

Nearshore Marine

The nearshore marine environment includes waters beyond the mouth of the river, yet are still influenced by the river, and features ranging from submerged high-relief rocky reefs to broad expanses of intertidal mudflats, soft sandy and muddy bottoms, and broad expanses of sandy beaches interspersed with rocky headlands (Oregon Conservation Strategy 2016a). Environmental conditions in adjacent estuarine, terrestrial, and freshwater habitats greatly influence the nearshore ocean ecology.

Evaluation Species

Pacific Lamprey (E. tridentatus)

Pacific lamprey are a Service trust species and are important to Federal, state, and tribal partners. Though Pacific lamprey are not currently listed under the ESA, the Service has implemented conservation actions under a conservation agreement to achieve long-term persistence of Pacific lamprey and support traditional tribal cultural use of Pacific lamprey throughout their historic range in the Basin and beyond (USFWS 2012, p. 1).

Pacific lamprey are anadromous (i.e., migrate to the ocean as juveniles and return to freshwater as adults to spawn) and they are native to the Pacific Coast of North America and northern Asia, including the Basin. In the study area, Pacific lamprey use different parts of river habitat and some estuary and nearshore marine environment habitat to complete all life history stages (i.e., recently summarized in Clemens et al. 2010, pp. 582-585 and Kostow 2002, p. 8). For instance, larval and juvenile lamprey migrate downstream from natal tributaries, through the estuary, and out to the nearshore marine environment of the Pacific Ocean to feed and mature. Additionally, adult Pacific lamprey use river habitat, including side channel subhabitat, as important migratory corridors when they leave the nearshore marine environment and return to tributaries in which they spawn.

Generally, Pacific lamprey ammocoetes (i.e., larval stage of the lamprey) remain in tributaries and undergo metamorphosis from 4 through 7 years (Close et al. 2002, p. 20). Ammocoetes are known to use slow depositional areas along stream banks and burrow into fine sediments mixed with organic matter and detritus during important rearing periods (Graham and Brun 2005, p. 11; Lee et al. 1980, p. 34; Pletcher 1963, p. 54; Torgerson and Close 2004, p. 622). Ammocoetes have been observed residing in sediments up to 16 m deep in the mainstem Columbia and Willamette Rivers (Jolley et al. 2010, p. 20; Jolley et al. 2011, p. 12). When ammocoetes transform to macrophthalmia (i.e., anadromous juvenile lamprey), they move from slower-moving waters with fine substrate to faster-moving waters with a moderate current and silt covered gravel. From there, after they are fully transformed, Pacific lamprey move into even faster-moving river waters with moderate to strong current and gravel or boulder substrate (Beamish 1980, p. 1914; Potter 1980, p. 1650; Richards and Beamish 1981, p. 74).

Historically, the only real measure of adult lamprey abundance in the Basin was based on visual counts at the fishways at dams (Moser and Close 2003, p. 116). As a result, Pacific lamprey have been observed throughout the Basin, from the mouth of the Columbia River upstream to the headwaters of the mainstem Columbia River in Canada, to Shoshone Falls in the Snake River, and in the tributaries of each of these rivers (USFWS 1999, p. M5-20; Ward et al. 2012, p. 352). Currently, Pacific lamprey populations are located in most major tributaries and some smaller tributaries in the Columbia River up to Chief Joseph Dam and, in the Snake River, up to Hells Canyon Dam (Luzier et al. 2011, pp. 118, 136, 154, 172).

Pacific lamprey, like listed salmonids, face considerable threats in the Basin (e.g., reduced access to high quality habitat, degradation of spawning and rearing areas, loss of emigrating juvenile lamprey to turbine entrainment, predation by non-native predators, pollution) (Moser and Close 2003, p. 116). Continued operations and maintenance, and changes in overall configuration of the Federal dams as part of the CRSO will likely negatively impact the river landscape that supports the Pacific lamprey and all of its life history stages. This reflects various threats including: barriers to effective passage, dewatering and stream flow management, channel maintenance activities, and predation (Close et al. 1995, pp. 4, 8, 18; Dauble et al. 2006, p. 170; Devine Tarbell and Associates 2006, p. 16; King et al. 2008, p. 29; Luzier et al. 2011, pp. 22, 24, 117, 137; Moser et al. 2002, p. 51; Moursund et al. 2001, p. 4.1; Moyle 2002, p. 97).

Western Pearlshell Mussel (M. falcata)

Western pearlshell mussel prefer clear, cold water and are able to complete all of their life history stages throughout the study area (Jepsen et al. 2012, p. 7). They are normally located at depths between 1.5 feet and 5 feet (between 0.5 and 1.5 m), and they tend to congregate in aquatic habitats with specific substrate type such as gravel and boulders, with some sand, silt, and clay (Stone et al. 2004, p. 341). Like other freshwater mussels, western pearlshell require river habitats with slower-moving water and low shear stress (Howard and Cuffey 2003, p. 73; Stone et al. 2004; p. 341; Vannote and Minshall 1982, p. 4104;). They can inhabit headwater streams but are more commonly found in larger rivers (Nedeau et al. 2009, p. 33).

Freshwater mussels, including western pearlshell, require certain host fishes to reproduce and disperse. The majority of documented and potential host fishes for this mussel include salmon and trout (e.g., Chinook salmon [*Oncorhynchus tshawytscha*], Coho salmon [*O. kisutch*], kokanee [*O. nerka*], the migratory form of rainbow trout or steelhead [*O. mykiss*], Columbia River redband trout, cutthroat trout [*O. clarkia*], bull trout, and other fishes (e.g., three-spined stickleback [*Gasterosteus aculeatus*]) (Frest and Johannes 1997, p. 127; Nedeau et al. 2009, p. 33). Thus, any potential adverse impacts on habitats and processes that support these host fishes also affect the western pearlshell. The average lifespan for the western pearlshell mussel is approximately 60 or 70 years, with some individuals living more than 100 years, making this one of the longest-lived animal species (Nedeau et al. 2009, p. 33).

Historically, western pearlshell mussels were distributed in the Basin from the mouth upstream to the headwaters in the Columbia and Snake Rivers, and in the tributaries of each of these rivers (Jepsen et al. 2012, p. 7). Western pearlshell mussels have since become extirpated throughout much of the mainstem Columbia and Snake Rivers in Oregon and Washington (Nedeau et al. 2009, p. 35). Currently, they occupy river habitats in low numbers in the Hanford Reach of the Columbia River and the Hells Canyon Reach of the Snake River (Helmstetler and Cowles 2008, p. 212; Montana Field Guide 2019). Their distribution has been further constrained by continued dam operations and maintenance and poor water quality as a result of activities implemented for conservation of other aquatic species. Western pearlshell mussel is not listed under the ESA, however it is monitored by the Pacific Northwest Freshwater Mussel Workgroup, of which the Service and state and tribal partners are members.

White Sturgeon (A. transmontanus)

White sturgeon is a large river species that once thrived throughout the study area (Figure F1) (USFWS 1999, p. M4-8). The most robust population is found downstream of Bonneville Dam, where the Lower Columbia River, estuary, and nearshore marine environment habitats provide critical resources for juvenile and adult white sturgeon that are unavailable elsewhere in the Basin (Beamesderfer and Anders 2013, p. 57).

In the Basin, white sturgeon generally spawn in the spring when water temperatures are between 10 °C and 18 °C (50 °F and 64 °F), and there is high turbidity (Hanson et al. 1992, p. 14; Parsley et al. 1993, p. 220; Perrin et al. 2003, p. 154). These sturgeon are broadcast spawners and release eggs and milt into the river over gravel, cobble, and boulder substrate for fertilization (Parsley et al. 1993, pp. 223-224). Average spawning depths can exceed 19 feet and water velocities near the bottom of the water column average approximately 4.6 ft per sec (1.4 m per sec) (Parsley et al. 1993, p. 220).

Changes in the operations and maintenance of the Federal projects as part of the CRSO have impacted, and will likely continue to impact, both juvenile and adult life stages of white sturgeon. The CRSO operations reduce or eliminate connectivity among populations and decrease or eliminate essential habitats and processes necessary to support all life history stages of the white sturgeon (Beamesderfer and Anders 2013, pp. 76-77).

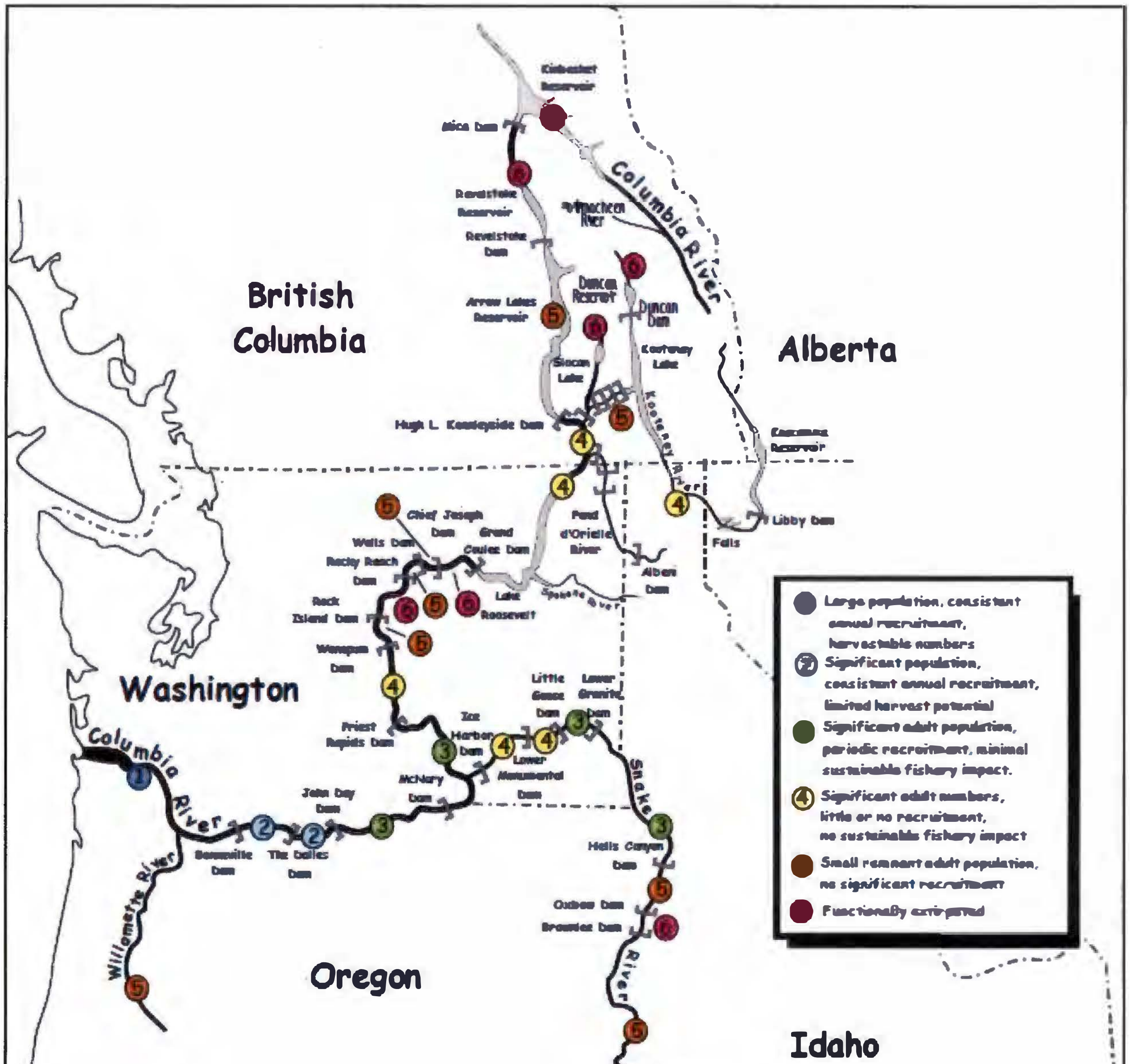

Figure F1. Distribution of white sturgeon subpopulations in the Columbia and Snake Rivers
Source: Beamesderfer and Anders 2013, p. 58

LAKES AND RESERVOIRS

Landscape and Habitats

Lakes are naturally occurring low points in the landscape that contain lentic water, predominantly in the form of year-round, open water habitat. Groundwater or surface water may constitute the inflow, outflow, or both. In contrast to rivers and tributaries, natural lakes and reservoirs store more water and usually have less flow. Reservoirs are man-made impoundments rather than natural lakes.

Natural Lakes

There are two prominent natural lakes in the study area. Lake Pend Oreille in northern Idaho and Flathead Lake in northwest Montana. While both are large and deep, they have been subject to changing water levels and impacts (e.g., bank erosion) as a result of operations and maintenance of the hydropower projects that regulate their outflow. For example, Albeni Falls Dam is a CRSO Federal project that controls the outflow of Lake Pend Oreille. The outlet of Flathead Lake is regulated by the Confederated Salish and Kootenai Tribes' Seli'š Ksanka Qlispe' Dam, but this non-Federal project is outside the scope of this report.

Reservoirs

Reservoirs, man-made impoundments, rather than natural lakes, are prevalent in the Basin. Typically, reservoirs store large volumes of water, have large operating ranges (hydraulic heads) and long water retention (hydraulic residence) times in comparison to rivers. However, reservoirs are formed as a result of the damming of a river and conversion of lotic (i.e., fast-moving) waterbodies. Reservoirs may also flood and convert to lentic waterbodies if they were once adjacent to the river. In some cases, reservoirs have flooded natural lakes (e.g., Lake Pend Oreille) that were once a part of the mainstem river system. Reservoirs tend to have a larger catchment to surface area ratio and, thus, reservoirs tend to have greater retention of runoff and snowmelt than natural lakes. In the Basin, reservoir water surface elevation levels and flow depend on inflow and dam operations, and water temperatures are influenced by factors including depth of water that is released from dams.

Dams create reservoirs, and the size and shape of the reservoir can vary considerably, depending on inflow and project operations. Thus, there may be overlap in habitats and features of rivers, natural lakes, and reservoirs in this analysis. Table F2 includes the natural lakes and reservoirs natural landscape considered in this analysis.

Table F2. The lakes and reservoirs landscape, characterized by its habitats in the study area

Habitats	Description
Natural Lakes	Large areas filled with freshwater, usually localized in a basin, surrounded by land and separated from other water (e.g., rivers);
Reservoirs	Artificial or man-made freshwater lakes that store and supply water for naturally occurring waterbodies (e.g., rivers and lakes)

As part of the CRSO, there are two types of reservoirs in this system: storage (Table F3) and run-of-river reservoirs (Table F4) (BPA et al. 2001, pp. 9-13). Storage reservoirs hold water and reshape river flow to meet project purposes including local and system-wide FRM, power generation, irrigation, navigation, and recreation.

Table F3. Major Federal storage reservoirs in the Basin

Storage Reservoirs	Federal Project
Lake Roosevelt	Grand Coulee Dam
Lake Pend Oreille	Albeni Falls Dam
Lake Koocanusa	Libby Dam
Hungry Horse Reservoir	Hungry Horse Dam
Dworshak Reservoir	Dworshak Dam

Table F4. Major Federal run-of-river reservoirs in the Basin

Run-of-River Reservoirs	Federal Project
Lake Bonneville	Bonneville Dam
Lake Celilo	The Dalles Dam
John Day Reservoir or Pool (Lake Umatilla)	John Day Dam
Lake Wallula	McNary Dam
Rufus Woods Lake	Chief Joseph Dam
Lake Sacajawea	Ice Harbor Dam
Lower Monumental Reservoir or Pool (Lake Herbert G. West)	Lower Monumental Dam
Lake Bryan	Little Goose Dam
Lower Granite Lake	Lower Granite Dam

Run-of-river reservoirs have relatively limited storage capacity and allow water to pass dams at approximately the same rate as inflow. Most run-of-river reservoirs, and those storage reservoirs with limited storage ability that function as run-of-river reservoirs (e.g., John Day Reservoir or Pool [Lake Umatilla]), are not addressed as part of this landscape. Rather, they are addressed part of the rivers landscape.

Rivers, lakes, and reservoirs share some characteristics. At low water levels, extensive areas may be exposed that are underwater at higher water levels. Islands and exposed barren lands share similar issues within the Basin system as a result of the CRSO, and are considered separate from the water bodies in which they occur (see "Other Habitats").

Evaluation Species

Clark's Grebe (A. clarkia) and Western Grebe (A. occidentalis)

Clark's and Western grebes (grebes) are protected under the Migratory Bird Treaty Act (MBTA), a statute enforced by the Service (16 U.S.C. §§ 703-712 [1918]). Under this authority, it is "illegal to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid Federal permit". In particular, the Western grebe (i.e., non-breeding individuals) is also a focal species of the Service as a Bird of Conservation Concern (BCC). As part of the BCC list, the Western grebe represents one of the Service's highest conservation priorities regarding migratory and non-migratory bird species (USFWS 2015a).

Clark's grebe and western grebes were historically considered the same species, though they exhibit subtle differences (LaPorte et al. 2013). Both species are ubiquitous throughout the Basin, however Western grebes are more frequently detected and found in higher numbers compared to Clark's grebes (LaPorte et al. 2013; Sauer et al. 2017). Grebes are almost exclusively dependent upon water for their life history stages. Grebes construct floating nests on emergent and submergent vegetation located in nearshore of natural lakes or lake-like habitats (i.e., reservoirs) or near the water's surface. Grebes also use the open water to forage for, and consume, a variety of fish, which comprise 80 percent of their diet, along with other aquatic species (Riensche et al. 2009, pp. 8-9).

Grebe nesting occurs from April through July, and its success is critically dependent upon the availability of stable water, with a depth of roughly 12 inches (30 cm), in lake and reservoirs habitats with persistent emergent vegetation (Feerer and Garrett 1977, p. 87). Fluctuations in water surface elevation, especially during the nesting season, isolate individuals from their nests and young (La Porte et al. 2013).

In the Basin, the grebe nesting season coincides with the boating and water recreation season and, as a result, disturbance due to sound, wave action, and increased crowds poses threats to the survival and reproduction success of grebes that inhabit the same areas. This disturbance could, and often does, result in the destruction of fragile-floating nest colonies, general disruptions during breeding periods when the birds are flightless and resting on the water, and mortality among new chicks (Ivey and Herziger 2006, p. 22). Grebes may still be at high risk, due to disturbance, in post-breeding areas where they come together in large groups, often with young that are too little to escape on their own successfully (LaPorte et al. 2013).

Systematic surveys of grebe breeding and reproductive success have not been conducted in the Basin, but the available data suggest potential declines in both species (WDFW 2013, pp. 189-190). Data from the U.S. Geological Survey's North American Breeding Bird Survey data suggest declines in the numbers of grebes in Washington, although declines are not statistically reliable due to limited sample sizes (Sauer et al. 2017). However, trends in grebe population abundance in

Oregon and the western North American survey area, which have larger sample sizes, also show sizable declines and recent stability in population abundance since about 1990 as a result of pesticides, habitat destruction, and human disturbance (Sauer et al. 2017; WDFW 2013, p. 191).

Dunlin (C. alpina)

Dunlin are protected under the MBTA, and they are a Service focal species as a Bird of Management Concern (BMC). In contrast to grebes and other birds, dunlin are tundra-breeding shorebirds and typically nest in or along bays, estuaries, and coastlines. During the nonbreeding season in winter months, dunlin are the most widespread of the North American shorebirds, and they are abundant in most coastal areas. In other seasons, they prefer mudflats, but can also be observed on sandy beaches and coastal grasslands (Warnock and Gill 1996).

Dunlin flocks are often impressive in number as they display coordinated aerial maneuvers to escape predation by small falcons such as kestrels (*Falco sparverius*) and merlins (*F. columbarius*). When foraging, which they do on their own, they rummage through exposed mud or in shallow water, either picking food from the water's surface or probing in the mud. On their breeding grounds, dunlin primarily feast on insects and insect larvae and, in coastal habitats, they eat small crustaceans, marine worms, mollusks, and small fish. In both environments, dunlin are limited in forage hours, dependent significantly on tidal fluctuation.

Though dunlin are commonly observed shorebirds throughout the study area, their abundance has declined in the Pacific Northwest throughout recent decades (Andres et al. 2012, pp. 187-188, 189-190; Warnock and Gill 1996). The total population that migrates and winters in this area is estimated to be approximately 550,000 individuals (Andres et al. 2012, p. 187). There has been little habitat destruction or disturbance on their breeding grounds, but various activities (e.g., recreation, navigation, infrastructure and associated changes in water levels) continue to threaten dunlin's migratory habitat or overwintering areas in the study area (i.e., mudflats, sandy beaches, rocky shores) and breeding areas that are outside of the study area (i.e., wet tundra, low ridges). No reliable information about dunlin population abundance or trends exists within their range or this study area. However, dunlin remain key indicators for assessing the health of and status of natural lake and some river habitats (i.e., estuary and nearshore marine environment) in the Pacific Northwest (Warnock and Gill 1996).

Floaters (Anodonta spp.)

Floaters are freshwater mussels and habitat generalists, yet grow best in stable, nutrient-rich water bodies such as lakes and reservoirs (Nedeau et al. 2009, p. 19-22). Of all freshwater mussels located throughout the study area, *Anodonta* spp. are most tolerant of lower oxygen, lentic or lake-like conditions and, thus, are most commonly located in natural lakes, reservoirs, and in downstream, low-gradient reaches of rivers in depositional habitats. Floaters are short-lived, fast growing mussels that rely on hosts to complete their life history stages. While some freshwater mussels use or require a specific host fishes, floaters are not highly host-specific, meaning they can likely use native fish like Westslope cutthroat trout, sculpin, or stickleback as necessary hosts (Nedeau et al. 2009, p. 22).

In western North America, floaters are widely distributed from southern California to Canada. Most species are located west of the Continental Divide: winged floater (*Anodonta nuttalliana*), Oregon floater (*A. oregonensis*), Yukon floater (*A. beringiana*), California floater (*A. californiensis*), and the western floater (*A. kennerlyi*). All of these floaters, except for the Yukon floater, exist throughout the study area (Nedeau et al. 2009, pp. 17, 23-28). Other freshwater mussels, like the western pearlshell and the Western ridged mussel (*Gonidea angulate*) also occur in the study area (Nedeau et al. 2009, pp. 33, 38). Most species are not located in high elevation waters in the Cascades or Rockies and, thus, are more commonly found in watersheds at lower elevations (Nedeau et al. 2009, p. 20).

In general, floaters have declined in abundance, and continue to decline, in many parts of western North America. Floater populations have become extirpated from many historic sites, especially in Arizona, California, Oregon, Utah, and Washington (Nedeau et al. 2009, pp. 23-25). In the study area, the main threats to floater reproduction and survival include changes in water level, water diversion for irrigation, water supply, and power generation (Nedeau et al. 2009, p. 22). Though floaters can tolerate reservoir-like conditions, many reservoirs experience severe annual, and often daily, monthly, or even hourly, water level fluctuations that impact freshwater mussel abundance in several areas. For example, a 1992 study of a quick drawdown of the Lower Granite Reservoir, revealed one mass floater mortality event, which included California and western floaters and Western ridged mussels (Nedeau et al. 2009, p. 23).

Reservoir drawdowns like the one that occurred in 1992 can lead to dry periods, which expose freshwater mussels to barren lands, causing them to dry out or desiccate and overheat. During these dry periods, floaters and other aquatic resources can become extremely susceptible to predators like raccoons, muskrats, and other scavengers. Additionally, due to their thin and fragile shells, floaters are vulnerable to damage resulting from erosion and pollution (Nedeau et al. 2009, p. 21).

Other Guilds and Communities

Colonial Nesting Waterbirds

The lakes and reservoirs landscape supports many waterbird species including terns, gulls, herons, egrets, and cormorants throughout the study area.

The Pacific Flyway (i.e., major flyway for migratory birds) breeding population of Caspian tern, for example, has shown a decline in the numbers of breeding pairs, from approximately 18,872 breeding pairs in 2009 to a minimum census estimate of 10,580 breeding pairs in 2018 (Peterson et al. 2017a, p. 8; Peck-Richardson et al. 2019, p. 1). Two management plans have been implemented to reduce the predation on ESA-listed juvenile salmonids by reducing available nesting habitat and therefore the size of breeding colonies of Caspian terns in the Columbia River Estuary and in the Columbia Plateau Region (USACOE 2014a; 2015). In addition, the second largest Caspian tern colony site will likely have all nesting habitat removed in 2020 due to human health and safety concerns (Lawrence, M., in litt. 2019). An additional 1,100 breeding pairs will be searching and competing for limited nesting locations throughout the Pacific Flyway. This would reduce the size of the Pacific Flyway breeding population if they do not relocate.

The latest version of the Caspian tern population model was developed to predict population trajectories under multiple scenarios of varying management and environmental breeding conditions (Suzuki et al. 2018, p. 1). The model population trajectories indicate resiliency of the Pacific Flyway population of Caspian terns under most of the analyzed management scenarios, including the scenario that reduced the available nesting habitat in the Columbia River Plateau Region (Suzuki et al. 2018, p. 5). Long-term population declines were predicted with the management scenario of reductions in nesting habitat in the Columbia River Estuary and the Columbia Plateau Region, coupled with the less favorable environmental conditions for breeding in the Columbia River Estuary persisting into the future.

Less favorable breeding conditions have been observed in recent years. The scenarios that reflected less favorable environmental conditions for nesting Caspian terns in the Columbia River Estuary alone predicted a stable population trend, however they were not analyzed in concert with reducing the available nesting habitat in the Columbia Plateau Region or with reduced nesting habitat in the Salish Sea (Suzuki et al. 2018, p. 4).

An average of 422 breeding pairs of Caspian terns (average peak number) have been recorded on the Blalock Island complex since implementation of the Inland Avian Predation Plan at Crescent Island began (Collis et al. 2019, pp. 32-35). There was an increase in colony size at the Blalock Island complex after implementation of tern management actions at Crescent Island. The 2018 peak colony size was 313 breeding pairs (Collis et al. 2019, p. 34).

RIPARIAN

Landscape, Habitats, and Subhabitats

Riparian areas are transition zones between aquatic and upland habitat along rivers, streams, and other watercourses, and are typically characterized by frequent disturbances from flooding, erosion, and deposition, which create a mosaic of plant community ages and seral stages (Bentrup 2008, p. 110; Brinson et al. 1981, p. 23; Gregory et al. 1991, p. 540; USFWS 2019a, p. 5).

In riparian areas, groundwater flows at shallower depths and the frequency of flooding is greater than in adjacent terrestrial environments or uplands. Riparian habitats have distinctively different vegetation, exhibiting more vigorous or robust growth forms, than other habitats in the study area (USFWS 2019a, p. 6).

Riparian habitat in the Basin is often a mosaic of wet to moderately wet areas), depending on topography and soil characteristics that reflect sediment deposition patterns and subsurface water depth. Riparian areas may have forests, areas of low woody vegetation, sand and gravel bars, wet meadows, flood-scoured areas, perennial and intermittent secondary channels or side channels, and other stream-related habitats and vegetation (Fischer et al. 2001, pp. 1-2). For this report and analysis, the Service divided the riparian landscape into three habitats (emergent, scrub-shrub, and forest) (Table F5) (USFWS 2019a, pp. 7-8).

Table F5. The riparian landscape, characterized by its habitats and subhabitats in the study area

Habitats	Description
Emergent	Zones with erect, rooted herbaceous vegetation present during most of the spring and summer (approximately March through September)
Scrub-Shrub	Zones with more than 30 percent canopy cover of woody riparian vegetation (e.g., tree saplings and shrubs) less than 20 ft (6 m)tall
Forest	Zones with more than 30 percent canopy cover of woody riparian vegetation greater than 20 ft (6 m) tall

Descriptions of other habitats within riparian zones (e.g., wetland subhabitats) are included in the other landscape descriptions in this report.

Evaluation Species

Black Cottonwood (P. trichocarpa)

The black cottonwood is a keystone species in riparian zones, and it is common along the mainstem Columbia River and its tributaries (Figure F2) (Fierke and Kauffman 2005, p. 150). It is often the only large tree found in the more arid portions of the study area.

Black cottonwoods are phreatophytes (i.e., trees that rely on water from the riparian water table rather than from precipitation) and, thus, are dependent upon a connection to a constant source of water (Mahoney and Rood 1993, p. 228). Forming a major component of the canopy of riparian gallery (i.e., corridor) forests east of the Cascades, and in wetter portions of the floodplain west of the Cascades, the black cottonwood provides shade, leaf litter, soil rooting matrix, and large wood associated with riparian and river interactions. It also serves as foraging and nesting habitat and cover for numerous bird species, many of which use the cotton from the trees' fruiting bodies in constructing their nests. Insects also feed on their leaves (DeBell 1990, pp. 570-573).

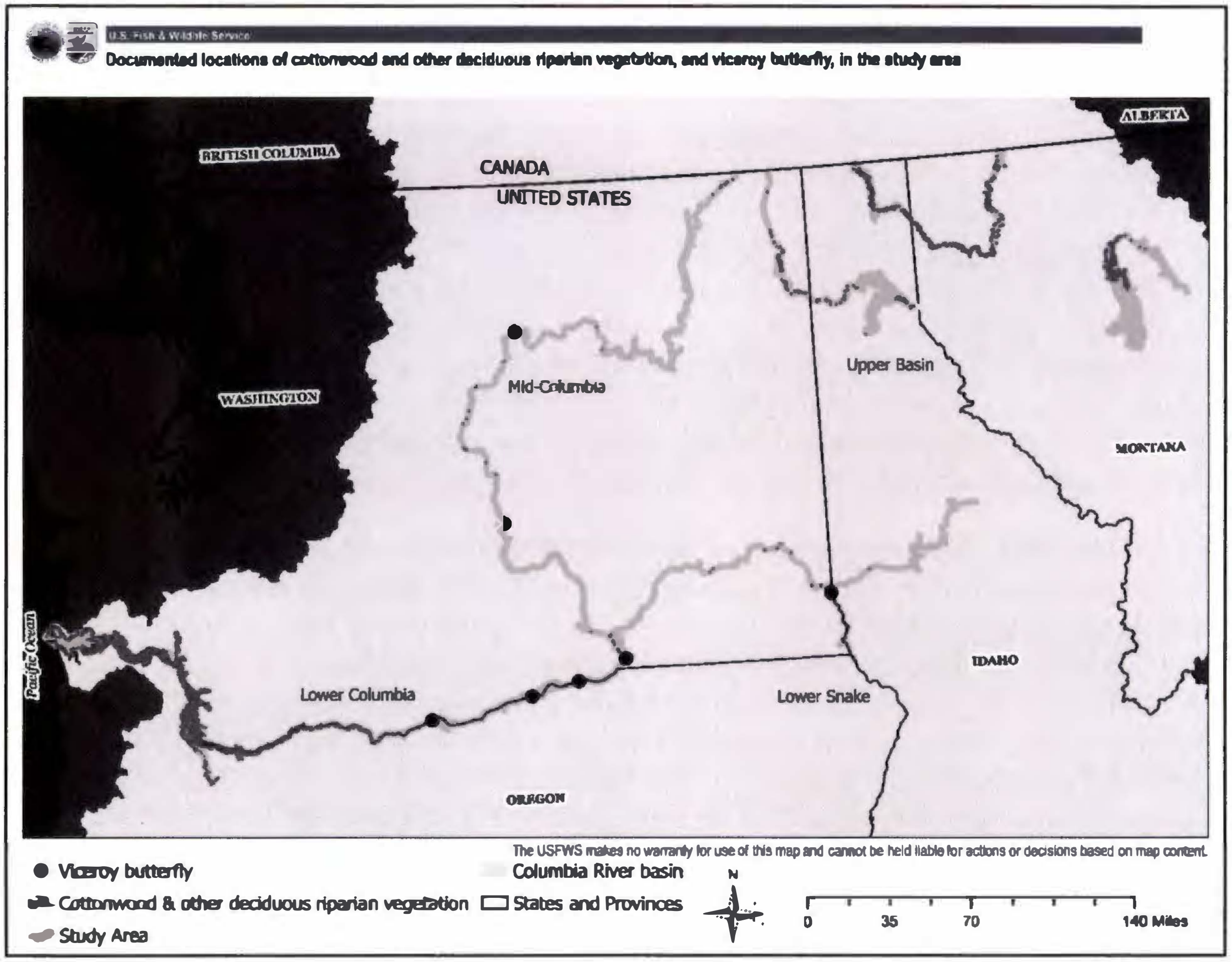

Figure F2. Documented presence of black cottonwoods, other deciduous riparian vegetation, and viceroy butterflies in the study area

Black cottonwood regeneration is dependent upon a natural hydrologic pattern; cottonwoods have evolved to release seeds following a peak flow (flood), which historically occurred in early June. Peak flows scour river banks creating barren, moist habitat for cottonwoods. Wind and water disperse seeds, which are then deposited along recently-exposed, moist shorelines as flood waters slowly begin to recede. To successfully establish, seeds must sprout while the soil is moist and at the proper elevation above base water level, and then the post-flood water level recession rate must not exceed the elongation rate of the seedling roots, so seedlings can be sufficiently irrigated. For newly-established seedlings to survive and grow, they must not be exposed to excessive scour and deposition during the first few years of life, as well as long-term inundation during the spring and summer. Conditions for successful cottonwood regeneration in natural, uncompromised system, occur approximately once every five to ten years (Mahoney and Rood 1998, pp. 635-642).

Historically, common riparian vegetation such as black cottonwood was widespread along the Columbia River and its tributaries, especially in alluvial (i.e., river-deposited) valley segments. However, after installation of the Federal dams in the Basin, a sharp decline in cottonwood recruitment was observed at many tributaries of the Columbia River as well as along other rivers throughout the Pacific Northwest, including the Kootenai River; Snake River; Yakima River; Willamette River; Waterton River; and the St. Mary's River due to altered hydrologic regimes (Benjankar et al. 2012, p. 88; Braatne et al. 2007a, p. 247; Burke et al. 2009, p. S224; Dykaar and Wigington 2000, p. 101; Fierke and Kauffman 2005, p. 149; Foster and Rood 2017, p. 1088; Hauer and Lorang 2004, p. 394). Currently, as a result of continuing CRSO Federal project operations, black cottonwood are negatively affected by related impacts associated with alterations in hydrologic regimes including permanent inundation of formerly productive substrate and disruption of flood-mediated processes, which deprive cottonwood seedlings of moisture and render some habitats unsuitable for black cottonwood growth and survival.

As riparian-obligates, black cottonwoods are indicators of riparian health, and the loss of these specialized components from the riparian forest often indicates habitat degradation, which has many anthropogenic causes (Braatne et al. 1996, p. 76; Macfarlane et al. 2016, p. 448). Cottonwood-dominated forests, especially later-seral mixed riparian forests, have greater biomass and structural diversity than forests dominated by later-successional tree species (Fierke and Kauffman 2005, pp. 160-161). When natural flooding and river meandering is inhibited, the flood-adapted pioneer component of a riparian forest (e.g., cottonwood, willow species) is lost and may be replaced by later-successional riparian species, resulting in a long-term net loss of habitat and landscape biomass and diversity (Fierke and Kauffmann 2005, p. 160; Johnson et al. 1976, p. 81). In addition, riparian-obligate vegetation interacts with stream flow and, thus, contributes more to diversifying streambed morphology, which, in turn, benefits the overall aquatic ecosystem (Castro and Thorne 2019, p. 319).

Viceroy Butterfly (L. archippus)

The viceroy butterfly is a riparian-obligate, considered to be an ecological indicator species of riparian forest health and ecosystem function (Nelson 2003, p. 203). Due to its association with cottonwood and willow trees, upon which viceroy butterfly larvae feed, overwinter, and complete metamorphosis, this species may be found in the study area where cottonwoods or willows are found; in moist areas most often along the edge of water (Figure F2).

The viceroy butterfly ranges from the Northwest Territories in Canada south to central Mexico, and from the eastern slopes of the Cascades and Sierra Nevada Ranges east throughout the rest of the U.S. (Lotts and Naberhaus 2017). Viceroy butterflies need trees and shrubs of the willow family (cottonwoods, willows, and poplars) as host plants for their larvae (Nelson and Anderson 1994, p. 142). Female viceroys lay their eggs from May through September on the tips of leaves and plants of cottonwoods, willows, and poplars (Sourakov 2009). In riparian habitats, viceroys rely on subsurface water flows to provide humidity and a high water table for food plant nectar production, and periodic flooding to create bare and moist substrate for puddling (i.e., extracting amino acids and essential minerals from mud and other damp sediments) (Nelson 2003, p. 210).

Adult viceroys are diurnal, and early generations will feed on a variety of food items such as carrion, dung, and decaying fungi early in the season when flowers are not yet available. Later generations will nectar on flowers, favoring composite flowers including milkweed (*Asclepias* spp.), thistle (*Cirsium* spp.), aster (*Symphyotrichum* spp.), goldenrod (*Solidago* spp.), shepherd's-needle (*Scandix pectin-veneris*), and others (Lotts and Naberhaus 2017). Viceroy butterflies are unlikely to travel outside of mesic areas, but they can travel distances along riparian corridors, suggesting that riparian habitat access and connectivity is important for dispersal and locating potential mates (Nelson 2003, p. 210). Viceroy butterflies do not migrate and, instead, use riparian habitats year-round during larval and adult stages, the winter period of dormancy (diapause), and the adult flight period.

There is very little information in the peer-reviewed literature regarding the status of viceroy butterflies in the study area. As part of this analysis, the Service found little data on the occupancy and abundance of viceroy butterflies in the study area. However, one citizen science resource included reports of verified observations of viceroy butterflies throughout the Pacific Northwest as follows: 20 in Idaho, 48 in Montana, 13 in Oregon, and 24 in Washington from unknown dates prior to 2004 to as recently as June 2014 (Idaho), July 2017 (Montana), July 2018 (Oregon), and September 2018 (Washington) (Lotts and Naberhaus 2017). Other, historical observations from unknown dates prior to 2004 are located in various counties in Idaho, Montana, Oregon, and Washington.

Yellow Warbler (S. petechia)

Protected under the MBTA, the yellow warbler is a neotropical migrant with one of the widest distributions of any North American warbler, breeding coast-to-coast across northern states, Canada and Alaska, and across the southwest. Non-migratory yellow warbler populations occur in Mexico, the West Indies, and South America. With few exceptions, across their range, they show an affinity for cottonwood, willow, and other riparian shrub associations for feeding, breeding, and during migration (Humple and Burnett 2010, pp. 355-356; Lowther et al. 1999; Rich 2002, pp. 1130-1134).

Yellow warblers breed across the entirety of the study area. Because of their strong association with riparian habitats, particularly sub-canopy and tall shrub foliage, yellow warblers are also focal species as part of the conservation strategies for landbirds in the lowlands and valleys of western Oregon and Washington and in the Columbia Plateau of eastern Oregon and Washington (Altman 2000, pp. v, 19, 32, 91; Altman and Holmes 2000, pp. v, 14, 26, 73-75). Yellow warblers feed on insects and other arthropods anywhere within the canopy, but most commonly between 16 ft and 33 ft (4 m and 11 m) from the ground (Lowther et al. 1999). Yellow warblers begin breeding in May and June and, within they study area, they breed most often in wet, deciduous thickets dominated by willow. Yellow warblers build small cup nests typically between 6 ft and10 ft (ranging from 0 ft to 50 ft [0 m to 16 m]) from the ground in willows or other small shrubs or trees in riparian landscapes (Lowther et al. 1999).

Yellow warblers are closely associated with willows throughout the breeding season and also, typically, during migration (Lowther et al. 1999). Studies show that the presence of willow shrubs and certain stream characteristics conducive to willow growth are the best predictors of yellow warbler presence (Strusis-Timmer 2009, p. 31).During the breeding season, yellow warblers have been observed in every river reach of the study area, though there are fewer observation reports from river reaches with less riparian vegetation (eBird Basic Dataset, Version: EBD_relMar-2019). Yellow warblers have experienced significant regional population declines, largely associated with the loss or degradation of riparian habitat (Lowther et al. 1999). For instance, survey data from 1966 through 2015 shows a negative trend in population abundance for the yellow warbler in various regions including the Great Basin, Northern Pacific Rainforest, and Northern Rockies; and state-wide, including Idaho, Montana, Oregon, and Washington (Ballard et al. 2003, p. 742; Sauer et al. 2017).

Other Guilds and Communities

Cottonwood-Willow Communities

There has been less focus on willows (*Salix* spp.) relative to cottonwoods in documenting the impacts of altered hydrologic flow regimes and decline of riparian habitats throughout the study area. However willows are in the same family (Salicaceae) as cottonwoods and share similar characteristics (e.g., regeneration) and flood-tolerant adaptations (e.g., adventitious roots, rapid root growth following germination, dispersal of seeds largely by water) that allow them to thrive in riparian habitats (Torrez 2014, pp. 18-21). Willows are even more sensitive than cottonwoods to a rapid decline in the water table following germination; specifically, while cottonwoods can tolerate a stream stage decrease of about 1.0 inch (2.5 cm) per day, willows can only tolerate a decline of about 1 cm per day. In general, a gradual decline in the water table following seed germination promotes the growth and survival of seedlings in both genera when compared to a rapidly declining or stagnant water table (Amlin and Rood 2002, pp. 338, 345).

As such, negative impacts on willows caused by altered hydrologic flow regimes, flood control, development projects, and irrigation practices are similar to those on black cottonwoods, and such factors have caused declines in willow populations in riparian habitat throughout the study area (Wissmar et al. 1994, pp. 17, 28). Field studies have demonstrated that, in general, altered streamflow has resulted in decreased abundance of willow (Caskey et al. 2015, pp. 592-593). For example, one study in the Basin documented that (unregulated) river reaches upstream of dams on the Snake River, and river reaches with unrestricted flow on the undammed Salmon River, had higher willow abundance than (regulated) river reaches downstream of dams on the Snake River (Rood et al. 2011, pp. 31, 37-38).

Invasive species such as reed canary grass and Russian olive (*Elaeagnus angustifolia*) have spread throughout much of the riparian habitat throughout the Basin, greatly reducing the habitat complexity, species diversity, ecosystem function, and utility to wildlife, of the riparian corridor (Shafroth et al. 2010, p. vii). Under natural flow conditions, native riparian species such as cottonwood and willow will often survive and often may outcompete invasive species, due to their specialized adaptation to elements of life on the floodplain that prevent most other species from surviving there (Shafroth et al. 2010, p. 121-122). However, with the elimination or alteration of many important elements of the natural hydrologic flow regime on regulated systems, native species lose the competitive edge, and conditions may favor invasive species. For example, heavily moderated flows and persistent elevated summer stage associated with river regulation favor reed canary grass that now dominates much shoreline habitat where native cottonwood and willow once existed (Braatne et al. 2007a, p. 254).

Over the last century, riparian habitat, namely cottonwood and willow communities, has been in rapid decline due largely to anthropogenic factors like changes in hydrology, cattle grazing, and the introduction of invasive plant species (Braatne et al. 1996, pp. 74-76; Obedzinski et al. 2001, p. 169). "By disrupting the fluvial geomorphic regime – the principal organization force creating and maintaining floodplain and riverine habitats – we pose a major, perhaps the single most important impediment to riparian forest regeneration" (Dykaar and Wigington 2000, p. 101). Cottonwoods and willows are major components of the canopy and understory, respectively, of structurally-complex riparian forests. As such, the loss of cottonwood and willow communities is one of the key factors contributing to the homogenization and loss of complexity in riparian habitat, upon which riparian bird and insect diversity directly depend (Caskey et al. 2015, p. 586; Hinojosa-Huerta et al. 2008, p. 74; Nelson 2003, p. 210).

Riparian Songbirds

An estimated 95 percent of all riparian habitats in the western U.S. has been severely degraded in the last century. While riparian habitats represent only 1 percent of western landscapes, they support the richest diversity of birds compared to other habitats (Ohmart 1994, p. 273). The reduction in quantity and quality of riparian habitats, and the subsequent decline of many bird species, has been well-documented (DeSante and George 1994, p. 173; Hunter et al. 1987, p. 10; Ohmart 1994, p. 273). A recent large-scale comprehensive data analysis published in *Science* reports that North America has lost about 30 percent (or nearly three billion) birds from 1970 through 2019 (Rosenberg et al. 2019, p. 120). Notably, the destruction or degradation of riparian habitats is cited as the leading cause of bird population declines in western North America in the last century (DeSante and George 1994, p. 185). The loss or degradation of cottonwood-willow riparian habitat has led to the subsequent decline and local extirpation of many riparian songbirds including the yellow-billed cuckoo (*Coccyzus americanus*), willow flycatcher, vermilion flycatcher (*Pyrocephalus rubinus*), and Bell's vireo (*Vireo bellii*) (Hunter et al. 1987, p. 12). While these riparian songbirds are all protected under the MBTA, the yellow-billed cuckoo and willow flycatcher have an additional Federal listing status as a threatened species and BCC, respectively.

A complex and heterogeneous riparian habitat supports greater species diversity and abundance, especially of birds (Skagen et al. 2005, p. 526). Riparian birds rely on the flow-related geomorphic processes responsible for establishing new willow and cottonwood stands, and avian species richness and diversity increases with increasing structural complexity of riparian vegetation (Scott et al. 2003, p. 284). Additionally, yellow warbler density as well as that of several other species (e.g., American goldfinch [*Spinus tristis*] and yellow-breasted chat [*Icteria virens*]) was found to be greater in cottonwood-shrub habitat than in stands of cottonwood alone, illustrating the importance of structurally diverse, mixed cottonwood-willow habitat with ample understory to yellow warblers and other riparian breeding birds (Scott et al. 2003, pp. 290-291) (Figure F3). For example, a study of avian species richness along the South Fork of the Snake River in Idaho documented that the best predictors of avian species richness were natural and structurally complex landscapes, large cottonwood patches, and proximity to other cottonwood patches (Saab 1999, p. 135).

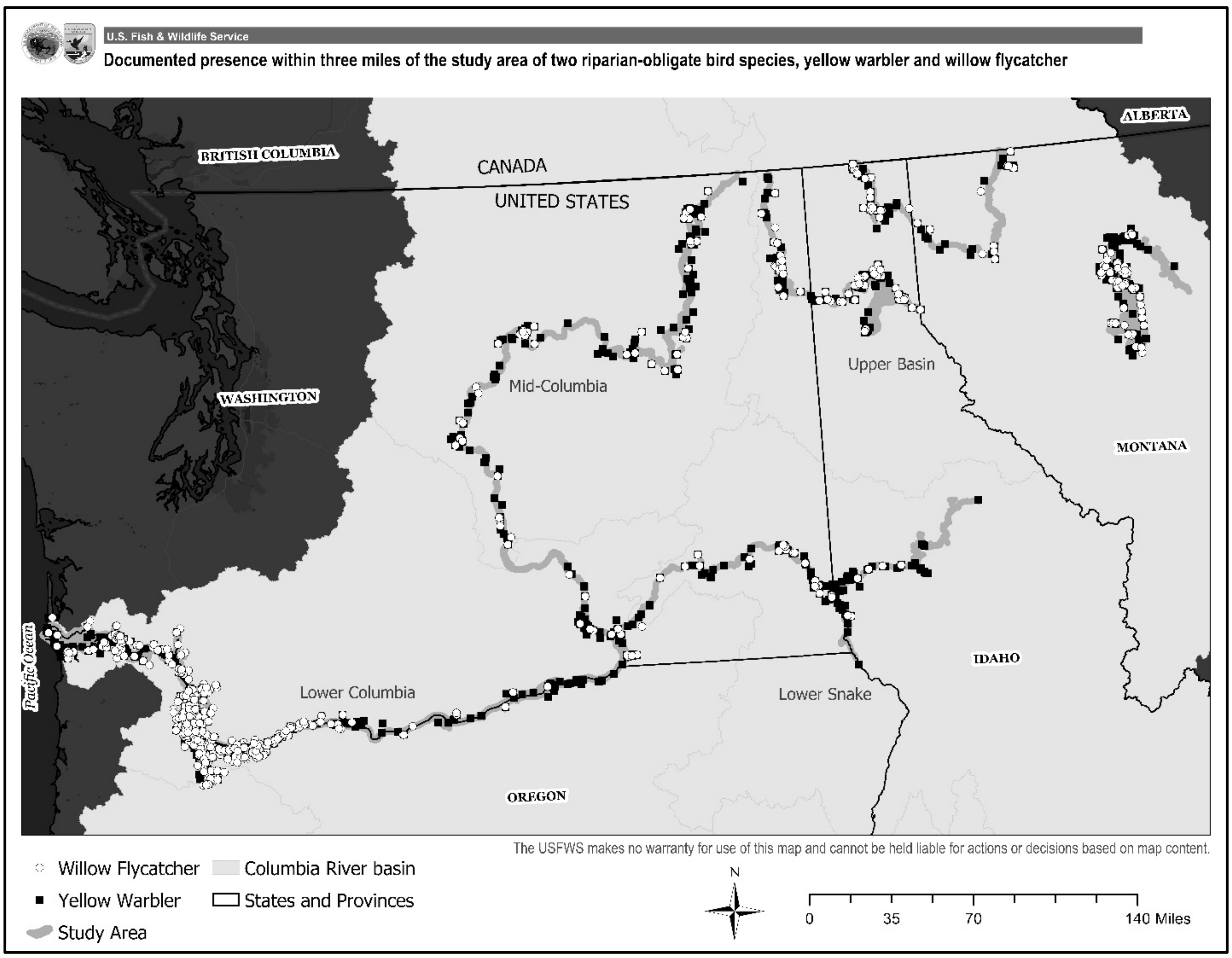

Figure F3. Documented presence of yellow warbler and willow flycatcher within 0.8 miles (5 km) of the study area

Avian diversity and abundance show a positive response to the restoration of willow and cottonwood habitat. For example, after the construction of large dams on the Colorado River, studies showed that the floodplain was deprived of the natural flood regime for nearly 50 years, which resulted in the loss of willow and cottonwood habitat and the local extirpation of at least 9 bird species. However, in the last 25 years, larger-volume releases from some of the dams, operated to simulate natural base flows and pulse floods, has led to some regrowth of willow and cottonwood, and several formerly-extirpated bird species reestablished in the regenerated forest (Hinojosa-Huerta et al. 2008, pp. 75, 80-81).

WETLANDS

Landscape, Habitats, and Subhabitats

Wetlands are typically "inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (40 CFR § 232.2). Water saturation (i.e., hydrology) influences soil development and determines the plant and animal communities living in and on the soil. Prolonged presence of water creates anaerobic conditions that favor the growth of specially adapted plants and promote the development of wetland areas (e.g., river deltas and wetland subhabitats on islands).

The Service relied primarily on the National Wetland Inventory (NWI) and the U.S. Department of Agriculture and U.S. Department of Interior Landscape Fire and Resource Management Planning Tools database (LANDFIRE) to identify and classify wetland habitats in the Basin for this analysis. The resulting wetland habitats are either naturally occurring or managed as palustrine, lacustrine, and emergent or estuary (i.e., tidal) wetlands (Table F6) (Cowardin et al. 1979, pp. 3-5). The Service also evaluated wetlands based on connectivity to adjacent waterbodies such as rivers, lakes, and reservoirs, and other habitats such as islands:

- directly connected wetlands are frequently, if not always, in association with water (e.g., riverine systems);
- indirectly connected wetlands may maintain connections with water at higher water levels but may lose those connections at low water levels; and,
- disconnected wetlands have no direct connection to water and are influenced primarily by snowmelt, runoff, and groundwater.

Table F6. The wetlands landscape, characterized by its habitats and subhabitats in the study area

Habitats	Subhabitats	Description

Palustrine	Forest	Wetlands that are dominated by woody plants at least 20 ft (6 m) in height
	Scrub-shrub	Wetlands that are dominated by woody plants less than 20 ft (6 m) in height; shrubs may include true shrubs, young trees that have not yet reached 20 ft (6 m) in height, and woody plants that are stunted because of adverse environmental conditions
	Emergent	Wetlands shoreward of river channels, on river floodplains, estuaries, natural lakes, reservoirs, slopes, or in isolated catchments; usually characterized by erect, rooted, herbaceous plants and perennials
	Other	Wetlands associated with other palustrine categories including aquatic bed, rock bottom, unconsolidated bottom, and unconsolidated shore
Lacustrine		Wetlands along natural lakes and reservoirs in the littoral zone and characterized by depth of water
Emergent		Nutrient-rich wetlands that occur in shallow water with groundwater input or in areas subjected to flooding

Palustrine Wetlands

Of the main wetland habitats found in the Basin, palustrine wetlands include all non-tidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, as well as vegetated wetlands more traditionally known as marshes, swamps, bogs, fens, prairies, and ponds. Palustrine wetlands may be shoreward of lakes, river channels, or estuaries, on river floodplains, in isolated catchments, or on slopes. They may also occur as islands in lakes and rivers. In all seasons, forested and scrub-shrub wetland subhabitats, even more than other palustrine subhabitats, provide important feeding, sheltering, and breeding or nesting habitat for many fish and wildlife resources in the Basin.

Lacustrine Wetlands

Lacustrine wetland habitats include non-tidal and tidal freshwater wetlands that are associated with an intermittently to permanently flooded lake or reservoir while estuarine wetland habitats are present in low-wave-energy environments where there is a mix of seawater and freshwater (Brophy et al. 2019, p. 3; Lane and Taylor 1996, p. 393). Areas with deep, permanent water can also be classified as lacustrine wetlands, but, for the purposes of this report, the Service classified those areas as either lakes, reservoirs, or rivers.

Emergent Wetlands

Emergent wetlands are found throughout the study area except for in marine systems like the Pacific Ocean. Like marshes and wet meadows, emergent wetlands include a number of areas subject to extended periods of flooding. Due to significant groundwater contributions, emergent wetlands are fairly nutrient-rich and are home to diverse communities of erect, rooted, herbaceous plants, usually perennials. In areas with relatively stable climate conditions, vegetation in emergent wetlands is present for most of the spring and summer (Cowardin et al. 1979, pp. 19-20).

Though wetlands occur naturally in the Basin, the NWR System and state-owned Wildlife Management Areas (WMAs) employ several management strategies to maintain and enhance wetland function in specific locations to the extent possible for wetland-obligate species. For example, some Service refuges and WMAs manage wetlands by pumping water in and out to control water levels and vegetation. The Service may also disk, burn, and actively manage wetlands in other ways. On McNary NWR on the east bank of the Columbia River, for instance, existing operations lead to seasonally flooding of wetland habitats, which are important for birds and, particularly, waterfowl by stimulating the growth of forage resources for these birds (USFWS 2014).

Evaluation Species

American Bittern (B. lentiginosus)

American bittern is protected under the MBTA. American bittern is a marshbird with a breeding range that includes the study area as well as much of the northern continental U.S. This species has been observed to frequent the Flathead River in Montana, Lake Pend Oreille and the Pend Oreille River in Idaho and Washington, the Snake River near Lewiston, Washington, the Columbia River near Kennewick, Washington, and the Columbia River at Umatilla NWR, Paterson, Oregon. In the study area, the greatest number of American bittern observations occur in wetland habitats below Bonneville Dam in the Lower Columbia River, at Steigerwald Lake NWR in Washougal, Washington, and Ridgefield NWR in Ridgefield, Washington.

Typically, bittern habitat is dominated by tall emergent or aquatic bed vegetation with a high degree of cover-water interspersion, which includes wetland fringes, shorelines, bogs, swamps, wet meadows, but rarely tidal marshes. Within the Basin, American bittern primarily rely on scrub-shrub (i.e., palustrine wetland habitat) that provide an adequate prey base including insects, crayfish, amphibians, small fish, and small mammals.

American bittern also rely on the vegetation found in emergent wetland habitat for nesting. American bitterns build their nests on platforms of emergent vegetation surrounded by water (Gibbs and Melvin 1992, p. 52). They are solitary birds that prefer relatively large wetland habitats (i.e., that cover 7 ac [3 ha] or more) to strategically build nests that are obstructed from view by the tall vegetation (Brown and Dinsmore 1986, p. 394; Hanowski and Niemi 1986, pp. 19-20). American bittern use rush (*Juncus* spp.), sedge (*Carex* spp.), bulrush (*Schoenoplectus* spp.), prairie cordgrass (*Spartina pectinata*), tall mannagrass (*Glyceria grandis*), bur-reed (*Sparganium eurycarpum*), or cattail (*Typha* spp.) for nesting (Dechant et al. 1999, pp. 7-11). Generally, they build their nests from April through August on floating platforms in shallow water where they are vulnerable to major pool fluctuations. Individuals may continue to forage in emergent wetlands until September or October when they begin to migrate to coastal areas that stay above freezing for overwintering (Lor 2007, p. 19; Lowther et al. 2009). American bitterns overwinter in a variety of wetland habitats characterized by flooded willow and salt marshes along the west coast, extending south to Mexico and along the southern U.S. border.

From the late 1960s through 1990, American bittern populations were in decline due to overall wetland habitat loss and the establishment of non-native species in marshlands (Cooper and Beauchesne 2003, pp. ii, 1). However, according to data from the North American Breeding Bird Survey, their populations may now be stable, barring further wetland habitat loss (Sauer et al. 2013, p. 14). The study area encompasses the edge of both the breeding and overwintering ranges for American bittern and, thus, represents habitats and subhabitats that are of value to the overall life history and range of the species.

Mallard (A. platyrhynchos)

The mallard is protected under the MBTA, and the western mallard population is part of the Service's BMC list. As part of the BMC list, mallards, like other bird species on the list, poses special management challenges due to many factors (e.g., too few, too many, conflict with human interests) (USFWS 2015b). Mallards also have public value as they are the most sought-after and harvested duck in North America (Petrie et al. n.d.).

The mallard is the largest of the dabbling ducks and the most abundant duck species in North America, and it is found in all four of the North American migratory flyways (USFWS 2018b). Mallards remain in the Columbia River and its tributaries year-round, and they make particular use of various habitats for overwintering and breeding. Mallards prefer slower-moving waters for foraging and they are generalist foragers, eating a variety of foods including aquatic insects, worms, crayfish, seeds, aquatic vegetation, and cereal crops.

Within the Basin, mallards primarily use the slower-moving waters found in wetlands for foraging. Around March or April, breeding pairs congregate in smaller wetlands and seem to prefer ephemeral, seasonal, and semi-permanent ponds and marshes. From April through June, they typically build their nests on dry land close to water and, occasionally, on floating platforms of vegetation (Barnes 2017). Mallard populations have responded positively to changes in the amount of wetland habitat, associated vegetation, and to changes in water levels and sedimentation (Krapu et al. 1997, p. 743).

Western Painted Turtle (C. picta)

The western painted turtle has a limited range in the Pacific Northwest, including British Columbia, Oregon, and Washington. A significant portion (i.e., the entire western-most) of the range of the species is located in the study area. Western painted turtles prefer wetland habitats with stagnant or slower-moving waters, muddy substrate, and submerged woody material. In the study area, they inhabit marshes, ponds, sloughs, and streams (Gervais et al. 2009, p. 5). Western painted turtles feed on plants and small animals such as aquatic insects, fish, crustaceans, and some carrion. Mating occurs after hibernation, in the spring, when water temperatures are still cool. Females carry the fertilized eggs until June or July, after which they move to land, where they dig a hole in soft, sandy soil and lay their eggs. Hatchlings emerge by August, however, many hatchlings will overwinter in the nest and emerge the following spring. Wetland habitat diversity or heterogeneity is important for Western painted turtles and other wetland species as they forage among aquatic vegetation, bask on logs, and nest in soft soil on land.

There are few studies on the historical and current population status of Western painted turtles in the study area. However, this species will likely respond negatively to changes in wetland habitat amount, as well as associated vegetation and woody material, water level elevation, and changes in sedimentation, flow regimes, and habitat fragmentation in a given area.

Woodhouse's Toad (B. woodhousii)

Woodhouse's toad is a medium-sized true toad of the family *Bufonidae*, and it is found in many western-central states in the U.S. The toad's range extends from Mexico to Montana, but the species occupies only a few small areas within the Basin. In the study area, Woodhouse's toad occurs in a small area of the Columbia Plateau Ecoregion along the Snake River, and also along the Columbia River between Priest Rapids Dam and John Day Dam (Leonard et al. 1993, p. 114; WDFW 2019). They inhabit areas in the stretch of the Columbia River from Richland to Roosevelt in Washington.

Woodhouse's toads are semi-aquatic, as they live most of their life on land but move to lowland areas with shallow, standing water where egg laying and fertilization occurs (Jones et al. 2005, pp. 166-169). During breeding season, which typically occurs from March through June, Woodhouse's toads rely on shallow standing water in emergent wetlands (e.g., ponds, sloughs, ditches, marshes) for breeding. Outside the breeding season, Woodhouse's toads are most often located in river valleys in grassland and shrub-steppe habitats. They are sensitive to hydrological fluctuations in spring and early summer, such as changes in wetland availability, lack of seasonal inundation, water-level elevation, and habitat fragmentation (Sullivan 1989, p. 60; WDFW 2015, p. 21).

There is not enough available survey information to determine population trends in the study area, however, the only known populations of Woodhouse's toad in the Pacific Northwest occur in the study area (Jones et al. 2005, p. 169).

Other Species

Columbia Yellowcress (R. columbiae)

Columbia yellowcress, a low growing perennial herb in the mustard family, is threatened in Washington State. Columbia yellowcress thrives in wetland habitats that are inundated for part of the year, experience seasonal fluctuations in water surface elevation, have wet soil well into the spring and summers, and support other vegetation types. Population abundance varies from year to year, with hydrologic conditions as a main driver of this variation. The plant grows and reproduces in late summer and early fall, when water levels are lowest (WNHP 2003, p. 1-1).

The population of Columbia yellowcress located in the Hanford Reach, administered by the Central Washington NWR Complex represents one of 11 populations of the species (Stenvall, C., in litt. 2019a). This population occurs throughout the Hanford Reach of the Columbia River, the Lower Columbia River, couth-central Oregon, and the Modoc Plateau in northeastern California. Based on results from field studies in 1982 and 1994, the Hanford Reach population of Columbia yellowcress is considered the most vigorous population of the species (Evans et al. 2003, pp. 47-48).

Sora (P. carolina)

The sora is protected under the MBTA and is a BMC. The Sora is a marshbird that inhabits emergent wetlands (e.g., marshes) across North America. Despite its abundance, it is easily observed because it is often hidden in dense marshy growth or wet meadows. It forages by picking items from the surface of the ground, water, or plants, and will periodically probe with its bill in the mud or among vegetation. Although the Sora appears to be a weak flier over wetland habitats, it regularly migrates long distances, as many travel to South America for the winter. During some seasons, it feeds exclusively on seeds, including those of smartweeds, sedges, grasses, and other wetland plants. Sora also consumes a variety of insects, snails, and other aquatic invertebrates (Melvin and Gibbs 2012).

Courtship displays by both members of a pair involve ceremonial preening and sometimes bowing, facing toward and then away from each other. Nesting sites are often located in dense marsh vegetation, especially cattails, sedges, and bulrushes. Nests are composed of well-built cups of dead cattails, grasses, other plants, lined with finer material, placed a few inches above water. The nests often have vegetation arched over top, and sometimes have a ramp or runway of plant material leading to the nest (Melvin and Gibbs 2012).

According to the North American Breeding Bird Survey, sora populations are declining in the Northern Pacific Rainforest Bird Conservation Region (BCR) and increasing in the Great Basin and Northern Rockies BCRs (Sauer et al. 2017). Sora breeds, and stops over on migration and during winter, in portions of the study area.

Sora depends on diverse stands of both fine-leaved and robust emergent plants including sedges, bulrushes, and especially cattails, as well as moist-soil annuals around the periphery of wetland habitats. This species is particularly sensitive to manipulations in water surface elevation, which reduce habitat quality in wetlands.

UPLANDS

Landscape, Habitats, and Subhabitats

In general, upland habitats are located outside waterbodies (i.e., lakes, reservoirs, and rivers) and include areas that are not prone to inundation long enough for their soils to have anaerobic characteristics (i.e., wetlands). Flooding or high water tables do not greatly influence the function of upland habitats. Through this analysis, the Service identified two broad uplands habitats, forested and arid uplands. Subhabitats within forested and arid uplands in the study area are described in Table F7.

Table F7. The uplands landscape, characterized by its habitats and subhabitats in the study area

Habitats	Subhabitats	Description
Forest Uplands	Conifer	Lands with more than 70 percent coniferous trees
	Deciduous	Lands with more than 70 percent deciduous trees
	Mixed	Lands that include a mix of coniferous and deciduous trees
Arid Uplands	Agriculture	Croplands, pastures, orchards, vineyards, poplar plantations, and associated buildings
	Grasslands	Lands that are too dry to support shrubs, where the primary vegetation is grass
	Shrub-Steppe	Lands with limited moisture, where the primary vegetation are shrubs

Forest Uplands

Forested uplands generally support more than ten percent tree canopy cover and are categorized by plant species and structural features. This analysis is based on broad groupings of forest habitat, characterized by dominant vegetation: conifers, deciduous, and mixed. Conifer forests including western larch (*Larix occidentalis*) are found in the study area along the Hungry Horse Reservoir in the Flathead National Forest in western Montana. Deciduous forest (i.e., oak woodland), is found on both the east and west side of the Cascade Mountain Range (Cascades) and in dry portions of the Ridgefield NWR in Washington (USFWS 2018c). Mixed stands, such as those comprised of Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), bigleaf maple (*Acer macrophyllum*), and red alder (*Alnus rubra*) are often located along the Lower Columbia River, west of the Cascade Crest and in portions of the Columbia Gorge.

Arid Uplands

In this analysis, arid uplands include human-influenced subhabitats such as agricultural lands, native grasslands, and shrub-steppe. Agriculture is a common land-use practice on private as well as publicly-owned lands throughout arid uplands in the Basin. Agricultural crops include irrigated orchards and vineyards as well as corn, wheat, and some other crops grown under cooperative agreements.

Arid uplands in the Basin include dry slopes and plateaus with well-drained soils that support native grasslands, dominated by drought-resistant perennial bunchgrasses (e.g., bluebunch wheatgrass and Idaho fescue [*Festuca idahoensis*]) and forbs. Grasslands have similar features to those of prairies and meadows (i.e., mesic areas that typically occupy depressions), and they share some prairie-associated animals (e.g., pygmy rabbit [*Brachylagus idahoensis*]) and plant species. These native grasslands are maintained by periodic disturbances including fire, wind, salt spray, and soil upheaval (i.e., burrowing) by rodents (Oregon Conservation Strategy 2016b).

In the Basin, shrub-steppe is a natural, treeless subhabitat of arid uplands that receives little rain and supports perennial shrubs (e.g., big sagebrush [*Artemesia tridentatae*]), steppe bunchgrasses, and forbs (e.g., common marrow [*Achillea millefolium*]) (Dobler et al. 1996, pp. 12, 29-30). Shrub-steppe thrives in various soil types often found on basalt bedrock sites. Within the shrub-steppe subhabitat, there may be other features such as meadows, bluffs, cliffs, talus caves, sand dunes, and saline soils (i.e., areas of low precipitation where mineral salts have accumulated on the soil surface). Ecological processes in the shrub-steppe subhabitat include frequent droughts and fire events and, thus, diverse species inhabitants have developed adaptations (i.e., extensive root systems and good seedling vigor) to summer drought conditions and low annual precipitation (WNPS 2019).

Evaluation Species

Long-Billed Curlew (N. americanus)

Long-billed curlews are protected under the MBTA, and the species is a BCC and BMC.

Considered the largest shorebird in North America, long-billed curlew once occurred in large numbers throughout most of the prairie areas of the U.S. and southern Canada. This species inhabits areas with sparse, short grasses including bunchgrass and mixed grass prairies, and will also use agricultural fields, if they are managed, and cheatgrass for breeding and nesting habitat (Stocking et al. 2010, p. 6). After long-billed curlews leave the nest, they may move to areas with taller and denser grass. In Idaho, researchers observed long-billed curlews inhabiting unusually tall, dense grassland areas resulting from high spring rainfall and foraging in freshly plowed fields or wet pastures rather than grass (Jenni et al. 1982, p. 64). During the nonbreeding season, from June through mid-March, long-billed curlew habitat preferences range from firm mud substrate of high-tidal areas to soft mud, sand, or low-tidal areas (Engilis et al. 1998, p. 334; Gerstenberg 1979, p. 33).

Long-billed curlew populations have experienced significant declines during the last 150 years. Overharvest in migration areas and overall loss of breeding habitat, in particular, are considered the main reasons for the species decline (Duggar and Duggar 2002). Further loss of grassland habitats is thought to be the greatest threat to population stability and, thus, long-billed curlews are now restricted to scattered populations. Though no comprehensive population abundance survey exists, the total population is estimated to be approximately 140,000 (approximately 90 percent certainty, potentially ranging from 98,000 to 198,000 individuals) (Andres et al. 2012, p. 183).

Sage Thrasher (O. montanus)

Sage thrashers are protected under the MBTA, and this species is a BCC and BMC.

Found primarily in shrub-dominated valleys and plains of the western U.S., it is a sagebrush obligate, and is thus dependent on large patches of sagebrush steppe habitat for successful breeding. Sage thrashers primarily feed on insects on the ground and nest in big sagebrush and three-tip sagebrush (*A. tripartita*), but will occasionally nest elsewhere such as in low sagebrush (*A. arbuscula*), black greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnus* spp.), bitterbrush (*Purshia tridentata*), horsebrush *(Tetradymia* spp.), and juniper (*Juniperus* spp.) (Alcorn 1988, p. 288; Bent 1948, pp. 427-434; Castrale 1982, p. 946; Gilman 1907, p. 43; Linsdale 1938, p. 106; Reynolds et al. 1999). Some nests are located on the ground at the base of the plant species while others may be placed up to 12 inches (30 cm) off the ground, but typically just below the densest vegetation in the vertical profile of the shrub (Castrale 1982 pp. 948-951; Rich 1980, pp. 363-365).

Sage thrasher populations have experienced an estimated declining trend of 1.2 percent per year for 40 years across the west with some local extirpations as a result of land conversion (Sauer et al. 2017). Where native sagebrush has been eliminated and replaced with non-native crested wheatgrass (*Agropyron cristatum*) and other species, the sage thrasher has also been eliminated (Reynolds and Trost 1980, p. 122). Conversion of native shrub-steppe habitat to agriculture lands has resulted in a 50 percent loss of shrub-steppe breeding habitat for birds and other species and has fragmented other formerly contiguous shrub-steppe dominated subhabitats (Reynolds et al. 1999).

APPENDIX G. DETAILED DESCRIPTION OF LANDSCAPE FINDINGS

This appendix includes bulleted summaries followed by detailed descriptions of the impacts of the proposed alternatives. These descriptions are organized first by landscape and then by MO.

RIVERS

NAA

NAA Summary of Rivers Landscape Findings

- Current operations and maintenance of the CRSO Federal projects would continue to negatively affect overall habitat complexity, water quantity, water quality, and connectivity.
- Current operations and maintenance would likely decrease and, at best, maintain the abundance of accessible bank and run-of-river reservoir shoreline, floodplain, side channel, transition area, tributary mouth, and unimpounded reach subhabitats throughout the study area.

NAA Impacts on Indicators of Ecological and Physical Processes

<u>Water Quantity and Quality</u>

In the Basin, water quantity is largely dependent on the size of the annual snowpack and runoff. Storage reservoirs can only hold approximately 40 percent of the average annual runoff. Current operations fill and drawdown various amounts of water out of storage reservoirs, and, in all but the highest water years, flows largely attenuate through run-of-river projects in the Lower Columbia River, Mid-Columbia River, and the Lower Snake River.

Under the NAA, the 14 CRSO Federal projects greatly influence the river landscape downstream of each project (Nilson and Berggren 2000, p. 783; Ward and Stanford 1983, pp. 29-30). The current presence, operations, and maintenance of these projects pose major threats to indicators of ecological and physical processes like water quantity and water quality (e.g., temperature, TDG, turbidity) in mainstem and tributary subhabitats the ecosystem function of remaining unimpounded river reaches (Stanford and Ward 2001, p. 308).

For example, due to the presence of the hydropower system, temperature regimes are inconsistent in comparison to natural seasonal regimes throughout the Basin. In the Upper Basin, the current operation of storage reservoirs, which contain varying amounts of water at different times during the year, result in fluctuations in water temperature, which negatively affect aquatic species (e.g., freshwater mussels, white sturgeon) that rely on environmental cues like temperature to complete critical life-history stages (Ward 2002, p. 58). The amount of water within, and distributed through, storage reservoirs at various times of the year negatively impacts the river landscape related to historic flows and timing of peak flows (Figure G1) (Volkman 1997, p. 31).

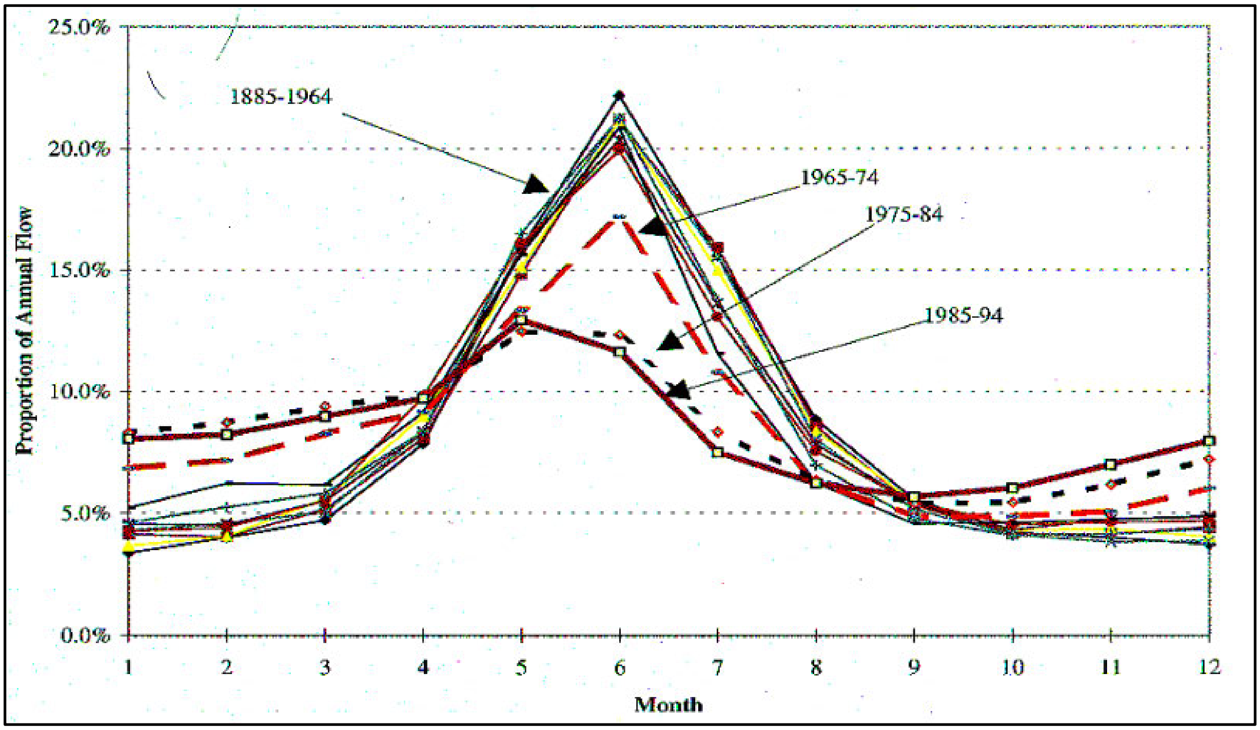

Figure G1. Historic magnitude of flows and peak flows at The Dalles Dam
Source: Volkman 1997, p. 31

These changes are shown by the co-lead agencies' H&H modeling efforts specific to four CRSO projects and adjacent river habitat: McNary Dam and Chief Joseph Dam, and the river habitat between the dams; Libby Dam and the Kootenai River in the Upper Basin, and Dworshak Dam, and the Lower Snake River habitat below the dam (Figure G2). Changes in water quantity and quality and physical processes like sediment deposition and channel avulsion at these Federal projects in the Upper Basin are likely to have cascading effects on storage reservoirs, downstream of the reservoirs, and throughout each successive run-of-river project in the Lower Snake and Lower Columbia rivers.

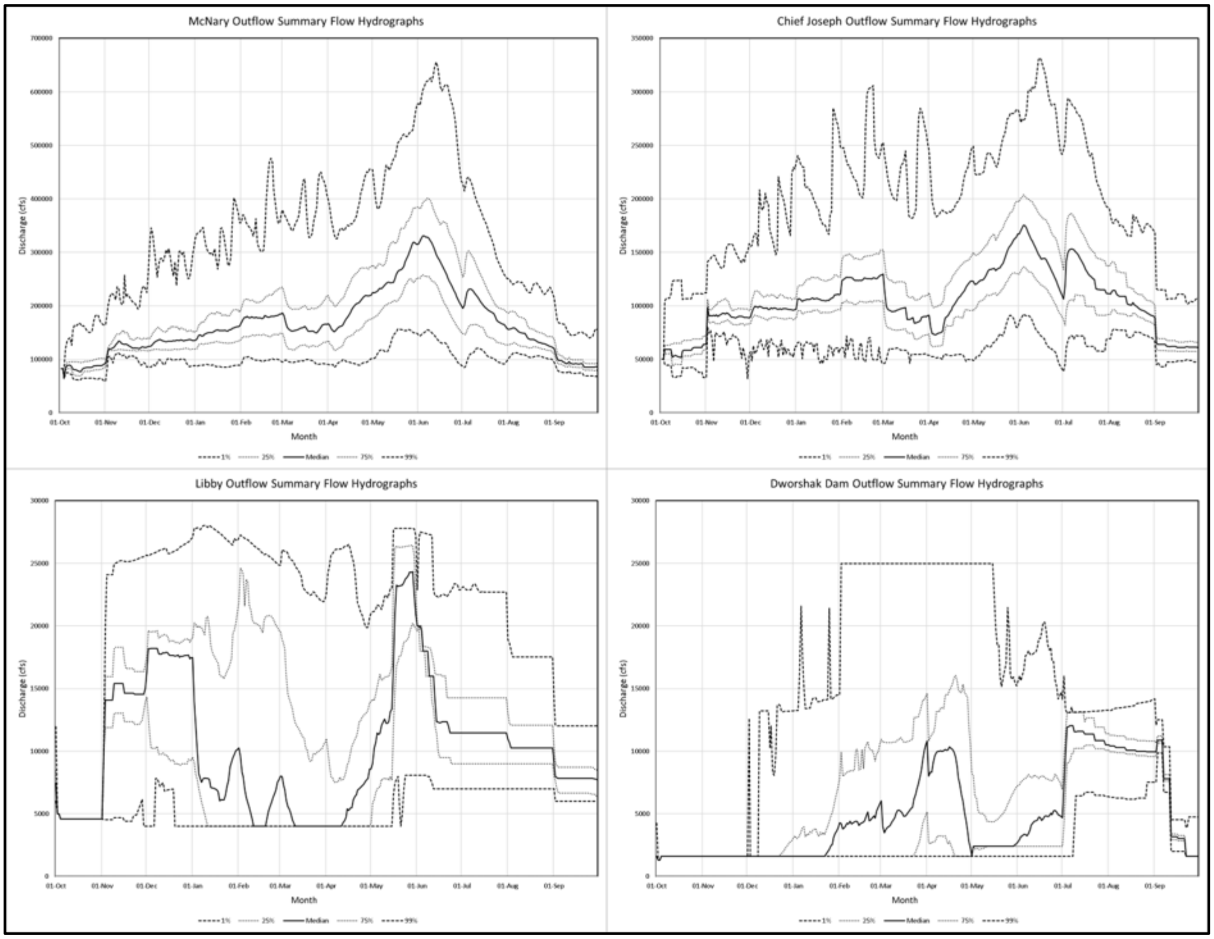

Figure G2. Summary hydrographs for McNary Dam, Chief Joseph Dam, Libby Dam, and Dworshak Dam

<u>Connectivity</u>

Alteration of the pre-dam hydrograph has reduced opportunities to reconnect historical floodplain and side channel subhabitats, which have been further exacerbated by the presence of levees and tide gates, primarily in the Lower Columbia River. Loss of these historical connections has resulted, over time, in decreased access to productive, structurally complex habitats that offer essential resources to support aquatic and semi-aquatic species' life-history stages, and no surrogate resources exist in the remaining system (BPA and USACOE 2013, p. 9).

As a result of the hydropower system, estimates show a loss of 25 percent of the historical floodplain and side channel subhabitats basinwide, negatively impacting ecological and physical processes (e.g., sediment transport) (Bond et al. 2018, pp. 1212, 1219). Under the NAA, operations and maintenance of the Federal projects would likely continue to negatively impact ecological and physical processes, preventing restoration of historical processes that serve an important role in maintaining habitat connectivity (Dauble et al. 2003, p. 641).

Habitat Complexity

In general, structurally complex river subhabitats include pools, riffles, and runs that support a variety of aquatic and semi-aquatic species. Throughout the study area, CRSO operations have largely altered the structure and function, and reduced the complexity, of rivers, tributaries, and streams apart from the few existing unimpounded river reaches including: the Columbia River Estuary below Bonneville Dam; the Hanford Reach below Priest Rapids Dam; the Pend Oreille River below Albeni Falls Dam; the Kootenai River below Libby Dam; the Flathead River below Hungry Horse Dam; and the Clearwater River, a tributary of the Snake River. Under the NAA, river habitats throughout the Basin, including the remaining free-flowing reaches, are influenced by current operations at upstream dams. Approximately 13 percent of river habitats in the Columbia River and 58 percent of river habitats in the Snake River upstream of Hells Canyon Dam remains (Dauble et al. 2003, p. 641). Elsewhere, mainstem, tributaries, and streams are characterized by the pools created behind dams and throughout transition areas, such as the tailwater-to-reservoir transition area below Federal projects.

NAA Impacts on Habitats and Subhabitats

Banks and Shorelines

In this analysis, banks and shoreline subhabitat occurs along run-of-river reservoirs, and it supports the growth of aquatic vegetation and recruitment of large wood, which provides food and shelter for aquatic and semi-aquatic species, respectively. Fluctuating reservoir levels and shoreline armoring do not provide the stability or appropriate substrate for these areas to establish. Operations under the NAA would likely continue to negatively impact these areas in the run-of-river reservoirs at key sites such as the John Day Reservoir in the Lower Columbia River and the Lower Monumental Reservoir or Pool (Lake Herbert G. West) in the Lower Snake River.

Floodplains

Floodplains are particularly important throughout the study area especially in the Columbia River Estuary, within and adjacent to reservoirs, and in unimpounded reaches. Floodplains provide critical food resources and protective cover for aquatic and semi-aquatic species during various life history stages (BPA and USACOE 2013, p. 9). In the Basin, there has been an estimated loss of approximately 70 percent of historical floodplain subhabitat in the Columbia River estuary, in particular, due to conversion to agriculture and urban development protected by dikes (Marcoe and Pilson 2013, p. 1). Many of these dikes include tide gates that restrict exchange between the floodplain and river.

Floodplain subhabitat that historically existed in the study area has been inundated and lost under reservoir pools (e.g., John Day Reservoir and Lower Monumental Reservoir) situated behind dams and modified by unseasonal flows (i.e., more or less water than would normally flow in the natural river) from managed releases associated with current dam operations. To mitigate for the Federal projects, certain sites are protected throughout the Basin, and are managed to maintain remaining floodplain habitat structure and function. Examples include several NWRs (e.g., Julia Butler Hansen NWR in the Lower Columbia River, Umatilla NWR in the Mid-Columbia River, Kootenai NWR in the Upper Columbia River, and Big Flat Habitat Management Unit in the Lower Snake River).

Floodplain subhabitat still exists in unimpounded river reaches in the study area such as: the Hanford Reach, Reach 21, above Grand Coulee Pool or Lake Roosevelt (Table B2); the Kootenai River below Libby Dam; the Pend Oreille River below Albeni Falls Dam; and the Clearwater River below Dworshak Dam). However, due to regulation of the river, there have been declines in the availability of floodplain subhabitat in these unimpounded reaches, and they will likely continue at the same or faster rate under the NAA (Stanford 2000, p. 172).

Side Channels

Side channel subhabitat is largely absent in impounded river reaches. While ecological and physical processes that create and maintain side channels may be present in unimpounded reaches, river regulation upstream can still negatively impact flow and sediment transport, which are critical in side channel establishment. Thus, current CRSO operations limit the productivity of this river subhabitat in providing critical support for fish and wildlife resources. These conditions are expected to continue under the NAA.

Transition Areas

Transition areas like tailwater-to-reservoir transition areas located at the head of the reservoirs such as the John Day Reservoir and the Lower Monumental Reservoir. These areas have qualities similar to those of natural river habitat and, in the CRSO, occur just below the tailrace and extend to the head of the next downstream reservoirs. In transition areas, changes in water quantity influence flow and water depth through discharge at dams, and fluctuations in water quality depend on the timing and magnitude of dam releases at spillways. The regulated nature and limited longitudinal distance of these areas do not often provide ample opportunity for ecological and physical processes to occur. Operations under the NAA would likely continue to dynamically impact these areas, depending on the water year.

Tributary Mouths

Tributary mouths provide thermal refugia and serve as important subhabitats for sediment input and accumulation. However, many tributary mouths in the Basin have been negatively impacted by ongoing operations especially in the Deschutes, John Day, Umatilla, Walla Walla, and Snake rivers. Fluctuating run-of-river reservoir levels do not provide the stability for delta formation and beneficial river subhabitats (e.g., floodplain, shorelines) to establish. Operations under the NAA would likely continue to negatively impact tributary mouths, resulting in decreased habitat complexity and loss of connectivity and access.

Unimpounded Reaches

The NAA along with existing management agreements (e.g., 1988 Vernita Bar Agreement, replaced by the 2004 Hanford Reach Fall Chinook Protection Program) have provided some stability in unimpounded river reaches, which has led to improved water quality and better functioning of physical processes, resulting in habitat that supports many aquatic species (USFWS 2019e). Under the NAA, unimpounded river reaches would continue to provide the most benefit to aquatic and semi-aquatic species in the Basin.

NAA Impacts on Evaluation Species

White Sturgeon and Other Mainstem Migratory Fishes

White sturgeon, along with northern pikeminnow (*Ptychocheilus oregonensis*) and several species of suckers (*Catostomus* spp.), are mainstem migratory fishes. White sturgeon spawn in the spring when water temperature is between 10 ºC and 18 ºC (50 °F and 64 °F) and water turbidity is high (Hanson et al. 1992, p. 14; Parsley et al. 1993, p. 220; Perrin et al. 2003, p. 154). In the Columbia River downstream of Bonneville Dam and in Hanford Reach, juvenile white sturgeon have been observed migrating upstream in the fall and downstream in the spring (Haynes et al. 1978, pp. 279-280; Parsley et al. 2008, p. 1007). While white sturgeon are migratory, they do not rely as critically upon the maintenance of specific migratory corridors in comparison to species like Pacific lamprey and coastal cutthroat trout (*O. clarkii clarkii*).

White sturgeon once thrived throughout the Basin. Currently, the most abundant white sturgeon population is found downstream of Bonneville Dam, where the Lower Columbia River, the estuary, and the marine environment provide habitat components unavailable elsewhere in the study area (Beamesderfer and Anders 2013, p. 59). The operation and maintenance of the CRSO under the NAA would continue to negatively impact juvenile and adult white sturgeon, in addition to other aquatic migratory fishes, reduce or eliminate connectivity among populations, and lead to reductions in quality of habitat necessary to support various life-history stages of fish (Beamesderfer and Anders, pp. 76-77).

Pacific Lamprey and Other Migratory Corridor Species

Pacific lamprey, like other species that use migratory corridors, rely on specific routes for travel to other river habitats to complete certain life history stages. For instance, at various life history stages, Pacific lamprey may use differing habitats like the nearshore marine habitat for feeding, slow moving, depositional shoreline subhabitat along reservoir and stream banks for cover, swift river habitat for migration, and, eventually, upstream tributaries and streams for spawning and rearing.

Historically, Pacific lamprey were distributed in the Basin from the mouth of the Columbia River upstream to the headwaters, to Shoshone Falls in the Snake River, and in the tributaries of each of these rivers (Ward et al. 2012, p. 352). Currently, populations can be found in most major tributaries and some smaller tributaries in the Columbia River up to Chief Joseph Dam and in the Snake River up to Hells Canyon Dam (Luzier et al. 2011, pp. 118, 136, 154, 172). Under the NAA, continued operations and maintenance of the CRSO would continue to pose threats to maintaining habitat connectivity and habitat complexity that enables Pacific lamprey to fulfill all life history stages in the Basin.

Western Pearlshell Mussel and Other Non-Migratory Species

Freshwater mussels and other non-migratory species have preferences regarding substrate type (boulders and gravel substrate, with some sand, silt, and clay), turbidity, and water temperature (clear, cold water) and, thus, inhabit various river habitats at different times of the year (Howard and Cuffey 2003, p. 73; Stone et al. 2004, p. 341; Vannote and Minshall 1982, p. 4104).

Historically, freshwater mussels such as Western pearlshell were distributed in the Basin from the mouth of the Columbia River Estuary upstream to the headwaters in the Snake and Columbia Rivers, and in the tributaries of each of these rivers to these extents (Jepsen et al. 2012, p. 7). Currently, Western pearlshell have been observed in low numbers in the Hanford Reach of the Columbia River and Hells Canyon Reach of the Snake River (Helmstetler and Cowles 2008, p. 212). Other aquatic non-migratory species would likely experience adverse impacts from continued operations and maintenance of the CRSO due primarily to changes in water quality as a result of higher water temperatures, channel avulsion, and increased sedimentation.

MO1

MO1 Summary of Rivers Landscape Findings

- Structural and operational measures of MO1 may benefit mainstem migratory fishes such as white sturgeon and migratory corridor species such as Pacific lamprey, particularly in the Lower Snake River. However, the implementation of some operational measures associated with MO1 may negatively impact these species.
- Structural and operational measures of MO1 intended to benefit Pacific lamprey would have positive impacts on lamprey survival during spawning, rearing, and migratory stages.

MO1 Impacts on Indicators of Ecological and Physical Processes

Compared to the NAA, operational measures of MO1 (e.g., Lake Roosevelt Additional Water Supply, Hungry Horse Additional Water Supply) would negatively impact water quantity, especially in the Upper Basin, resulting in higher winter flows out of Libby Dam. The Chief Joseph Dam Project Additional Water Supply measure, which includes provisions to supply an additional 9,600 ac-ft (1,185 ha-m) of irrigation water, would lead to higher flows in the Kootenai River. Other operational measures, including the Modified Dworshak Summer Draft operational measure, would result in further alterations of the hydrograph on the Clearwater River and water temperature regime downstream of the confluence of the North Fork River with the Clearwater

River. The modified draft at Dworshak Dam is intended to benefit migratory fishes by providing additional cool water to the Lower Snake River in July and August, and in September.

Unique to MO1, the proposed Block Spill Test (base + 120/115 percent) operational measure exceeds state water quality standards for TDG below the four Lower Columbia River Dams and four Lower Snake River Dams (ODEQ and WSDE 2002, pp. 11-12). However, this proposed spill is not different than the NAA. This measure would also negatively impact water quality in transition area subhabitat such as those found at the head of key sites like the John Day Reservoir and the Lower Monumental Reservoir, which may affect habitat complexity and connectivity for mainstem and migratory corridor species that use these areas for extended time periods. These operational measures of MO1 represent changes from current operations, but they still, if implemented, neither represent nor support historic conditions, prior to the dams, of the river landscape.

MO1 Impacts on Evaluation Species

White Sturgeon and Other Mainstem Migratory Fishes

Under MO1, structural and operational measures intended to benefit anadromous salmonids may benefit other mainstem migratory fishes like white sturgeon. The Modify Bonneville Ladder Serpentine Weir structural measure, for instance, would benefit white sturgeon by improving the functioning of the weir for juveniles.

Operational measures including Predator Disruption Operations and Increased Forebay Range Flexibility (both at John Day Dam and the four Lower Snake River dams) would likely reduce the abundance of transition areas in river habitat at key sites like the John Day Reservoir and the Lower Monumental Reservoir.

Pacific Lamprey and Other Migratory Corridor Species

The following structural measures regarding fish passage outlined in MO1 would improve passage for adult Pacific lamprey at the four Lower Columbia River dams and four Lower Snake River dams: Lamprey Passage Structures, Turbine Strainer Lamprey Exclusion, Bypass Screen Modifications for Lamprey, and Lamprey Passage Ladder Modifications. These measures include the expansion and modifications of Lamprey Passage Structures and modification of turbine intake screens.

However, impacts to Pacific lamprey will remain including the low conversion rates of adult Pacific lamprey passing Bonneville Dam and the level of mortality of juvenile lamprey that encounter the turbine intake screens, which were designed to protect juvenile salmon. These structural measures attempt to address these issues and, thus, the Service encourages the co-lead agencies to implement these improvements under whatever alternative is ultimately selected.

Operational measures associated with MO1 (Increased Forebay Range Flexibility) would result in increased reservoir water surface elevation levels at John Day Dam, followed by increased forebay operating range flexibility, which may negatively impact juvenile Pacific lamprey along banks and reservoir shorelines. Out-migrating juvenile Pacific lamprey burrow in sediments along banks and shoreline river subhabitat, which may become inundated and subsequently exposed due to changes to operations proposed under MO1.

Western Pearlshell Mussel and Other Non-Migratory Species

Proposed structural and operational measures under MO1 are not intended to benefit localized, non-migratory species like the Western pearlshell mussel. However, those species that use transition areas at key sites like the John Day Reservoir and the Lower Monumental Reservoir could be negatively impacted by operational measures as those described to impact mainstem migratory fishes.

MO2

MO2 Summary of Rivers Landscape Findings

- Structural measures of MO2 would benefit Pacific lamprey, however operational measures that enable operation at full pool and provide no restrictions on ramping rates (i.e., rate of change of water flow, measured in m per sec per hr) could negatively affect this species.

MO2 Impacts on Indicators of Ecological and Physical Processes

Proposed operational measures under MO2 (Slightly Deeper Draft for Hydropower) would result in higher flows out of Dworshak Dam, likely increasing spring flows in the Clearwater and Lower Snake rivers and resulting in lower water temperatures. These conditions, compared to those under the NAA, may be more representative of those under a pre-dam hydrograph, and, thus, could benefit river evaluation species. However, proposed operational measures under MO2 (in comparison to those under the NAA, MO3, and MO4) that allow for full reservoir operating range at the four Lower Snake River dams (Winter System FRM Space) and reduce ramping rate limitations (Ramping Rates for Safety) may negatively impact both bank and reservoir shoreline and transition area subhabitats in John Day Reservoir and Lower Monumental Reservoir.

MO2 Impacts on Evaluation Species

White Sturgeon and Other Mainstem Migratory Fishes

The implementation of structural measures associated with MO2 would include diverting fish away from turbines at John Day Dam, McNary Dam, and Ice Harbor Dam (Additional Powerhouse Surface Passage); upgrading spillway weirs at John Day Dam, McNary Dam, Ice Harbor Dam, Lower Monumental Dam, and Little Goose Dam (Upgrade to Adjustable Spillway Weirs); installing pumping systems for fish ladders at Ice Harbor Dam and Lower Monumental Dam (Lower Snake Ladder Pumps); and installing fish friendly turbines at John Day Dam (Improved Fish Passage Turbines). As proposed, these measures may benefit anadromous salmonids. It is unclear, however, whether or not the proposed structural measures would benefit other mainstem migratory fishes because they have not been assessed for evaluation species that inhabit the Columbia River such as white sturgeon.

The MO2 operational measure intended to limit fish passage spill associated with TDG at 110 percent (Spill to 110 percent TDG) provides the most limited TDG under any of the MO scenarios, and does not exceed state water quality standards for TDG (ODEQ and WSDE 2002, pp. 11-12). If the co-lead agencies select MO2, then this spill level would not likely provide any benefits to mainstem migratory fishes (e.g., white sturgeon) that inhabit riverine environments below the four Lower Columbia River dams (e.g., the John Day Reservoir or the four Lower Snake River dams.

Operating the Lower Snake River dams at full pool (Full Range Reservoir Operations) could limit the tailrace-to-pool transition area subhabitat such as the transition area at the head of the Lower Monumental Reservoir. Removing restrictions on ramping rates may lead to reductions in habitat quantity and quality throughout the river landscape in the study area.

Pacific Lamprey and Other Migratory Corridor Species

Under MO2, the implementation of fish passage improvements for juvenile Pacific salmon at the four Lower Columbia River dams and the four lower Snake River dams would also likely benefit Pacific lamprey. Likewise, the measures in MO2 associated with modifying the John Day Dam (Improved Fish Passage Turbines, Additional Powerhouse Surface Passage, and Upgrade to Adjustable Spillway Weirs) would likely yield additional benefits to migratory fishes like Pacific lamprey. However, it is unclear to what degree those benefits would be realized for Pacific lamprey and other migratory corridor fishes apart from anadromous salmonids. Ceasing or delaying the installation of fish screens at John Day Dam and McNary Dam would benefit juvenile Pacific lamprey that are migrating downstream. Juvenile Pacific lamprey are often impinged on screens intended to protect juvenile Pacific salmon from Federal project turbines. Impingement mortality on these screens is often 100 percent. The Service recommends the co-lead agencies exercise some flexibility in the timing of screen installation to optimize the conservation benefits for species beyond just Pacific salmon (Moser and Russon 2009, p. 2; Moser et al. 2014, pp. 106, 113).

Operating the Lower Snake River dams at full pool (Full Range Reservoir Operations) could limit the tailrace-to-reservoir transition area, and no restrictions on ramping rates at the four lower Columbia River dams and the four lower Snake River dams (Ramping Rates for Safety) may reduce the stability of these subhabitats. Increases in the flexibility of elevation operating range could lead to decreases in the abundance of transition areas upstream, and no restrictions on ramping rates could lead to rapid fluctuations in the size of these habitats, thus reducing stability. Further, juvenile Pacific lamprey burrow in sediments along banks and reservoir shorelines, which may be inundated and subsequently exposed due to proposed changes to ramping rates as part of MO2, threatening their survival.

Western Pearlshell Mussel and Other Non-Migratory Species

Proposed structural and operational measures under MO2 are not intended to benefit localized, non-migratory species like the Western pearlshell mussel. However, those species that utilize transition areas (e.g., suckers, sculpin) could be negatively impacted by operational measures as those described to impact mainstem migratory and migratory corridor species.

MO3

MO3 Summary of Rivers Landscape Findings

- The greatest ecological benefits for evaluation species and other mainstem migratory, migratory corridor, and localized, non-migratory species may be realized from breaching the earthen portions of the four Lower Snake River dams.
- While structural measures in MO3 would benefit Pacific lamprey, some of the operational measures in MO3 could negatively impact this species and other migratory corridor species due to a lack of ramping rate restrictions.

MO3 Impacts on Indicators of Ecological and Physical Processes

In comparison to the other alternatives, proposed structural measures (Breach Snake Embankments, Lower Snake Infrastructure Drawdown) and operational measures (Drawdown Operating Procedures, Drawdown Contingency Plans) associated with MO3 provide the potential for the greatest ecological improvements in the study area. In particular, dam breaching would likely improve water quality, connectivity to existing unimpounded river reaches (e.g., Hanford Reach, Clearwater River), habitat complexity, floodplain and side channel creation and maintenance, and tributary mouths throughout the study area.

Similar to MO1, and in contrast to NAA and MO2, the implementation of operational measures in MO3 (Modified Draft at Libby, December Libby Target Elevation) would provide higher flows out of Libby Dam, leading to higher winter flows in the Kootenai River. Under MO3, in contrast to NAA and MO4, negative impacts on river ecological and physical processes could be realized at the four Lower Columbia River dams as a result of proposed operational measures that affect pool levels (John Day Full Pool), reduced restrictions on ramping rates (Ramping Rates for Safety), and increased TDG below projects (Spring Spill to 120 percent TDG). This could negatively impact key sites like the mouth of the Deschutes River and John Day Reservoir. However, the overall ecological benefits from dam breaching measures appear to surpass the potential negative impacts of other measures.

MO3 Impacts on Evaluation Species

<u>White Sturgeon and Other Mainstem Migratory Fishes</u>

The dam breaching structural and operational measures associated with MO3 have the greatest potential to positively impact mainstem migratory fishes, including Pacific lamprey and white sturgeon. Breaching the earthen portions of the four Lower Snake River dams would provide access to more habitat that can support several mainstem migratory fishes.

Proposed operational spring spill at the four Lower Columbia River dams (Spring Spill to 120 percent TDG) exceeds state water quality standards for TDG (ODEQ and WSDE 2002, pp. 11-12). This is not likely to negatively impact mainstem migratory fishes like white sturgeon that use these areas to complete multiple life history stages such as spawning and juvenile rearing.

Structural measures associated with MO3 include diverting fish away from turbines at John Day, McNary, and Ice Harbor Dams (Additional Powerhouse Surface Passage); upgrading spillway weirs at John Day, McNary, Ice Harbor, Lower Monumental, and Lower Granite Dams (Upgrade to Adjustable Spillway Weirs); and installing fish friendly turbines at John Day Dam (Improved Fish Passage Turbines). However, it is unclear whether these proposed structural measures would benefit mainstem migratory fishes because they have not been assessed for evaluation species that inhabit the Columbia River (e.g., white sturgeon).

<u>Pacific Lamprey and Other Migratory Corridor Species</u>

MO3 would lead to significant benefits for migratory corridor species. There are numerous resident and migratory species in the Lower Snake River that are negatively affected by current operations. Breaching the earthen portions of the four Lower Snake River dams would benefit these species, and the river landscape overall, by increasing connectivity between river habitats that support various ecological and physical processes and life history stages.

Proposed operational spring spill at the four lower Columbia River dams (Spring Spill to 120 percent TDG) exceeds state water quality standards for TDG. This would not likely negatively impact Pacific lamprey and other migratory corridor species in places such as the head of the John Day Reservoir (ODEQ and WSDE 2002, pp. 11-12).

Under MO3, the operational measure proposing to not restrict ramping rates (Ramping Rates for Safety) at the four Lower Columbia River dams may negatively impact transition areas and bank and reservoir shoreline subhabitats (i.e., at sites like the John Day Reservoir). Proposed changes as a result of structural measures (e.g., expanding and thereby improving Lamprey Passage Structures at the four Lower Columbia River dams) would likely benefit Pacific lamprey. Similar to MO2, the implementation of measures associated with MO3 would provide greater benefits to Pacific lamprey than those associated with MO1.

<u>Western Pearlshell Mussel and Other Non-Migratory Species</u>

The structural and operational dam breaching measures of MO3 may benefit the Western pearlshell and other freshwater mussels, over time. However, in the short-term, the release of accumulated sediment behind the four dams will negatively impact any fish and wildlife species that cannot relocate to alternative sites (such as the mussels). This effect will be particularly acute in the Lower Snake River and the McNary Reservoir (i.e., Lake Wallula). While there will likely be negative impacts on freshwater mussel habitat and other non-migratory species associated with the release of accumulated sediment, these impacts will also be short-term given the sediment transport capacity of the Lower Snake River (Grant and Lewis 2015, p. 34).

In the long-term, breaching the earthen portions of the four Lower Snake River dams would likely lead to the reestablishment of natural hydrologic processes (e.g., deposition and sediment transport). This return to natural hydrology would in turn promote island habitat and side channel subhabitat formation, which support various life history stages of aquatic species.

MO4

MO4 Summary of Rivers Landscape Findings

- Structural and operational measures of MO4 are likely to benefit evaluation species and other mainstem migratory, migratory corridor, and localized or non-migratory species, but likely not to the extent of the MO3 benefits.
- Operating at the Minimum Operating Pool would maximize the abundance and size of transition areas throughout mainstem subhabitats within the study area and would improve upstream and downstream migration for migratory evaluation species like Pacific lamprey, white sturgeon, and other migratory fishes.
- MO4 includes an operational measure that proposes the highest spill percentage among all alternatives. This may have particularly negative impacts on water quality standards critical for white sturgeon growth and survival.

MO4 Impacts on Indicators of Ecological and Physical Processes

In comparison to the NAA and MO2, the implementation of proposed operational measures under MO4 (Modified Draft at Libby, December Libby Target Elevation) would result in higher winter flows out of Libby Dam, which translate to higher flows in the Kootenai River during that time. While this measure may provide more downstream water delivery flexibility, it may not represent the historic environmental conditions in this reach.

Operational measures of MO4 proposed (Spill to 125 percent TDG) in the Lower Columbia and Lower Snake rivers would result in the highest TDG levels among alternatives below Federal projects, potentially negatively impacting connectivity and critical transition area subhabitat (i.e., at key sites like the John Day Reservoir and the Lower Monumental Reservoir). However, in comparison to all other alternatives, operational measures of MO4 that provide minimum flows out of McNary Dam (McNary Flow Target) and establish reservoir levels at Minimum Operating Pool (MOP) (Drawdown to MOP) may decrease the overall temperature profile below McNary Dam. This results from peak flows through the descending limb of the hydrograph, thus improving water quality and supporting the formation and maintenance of bank and reservoir shoreline, transition (e.g., John Day Reservoir), and tributary mouth (e.g., mouth of the Deschutes River) subhabitat in the Lower Columbia River.

MO4 Impacts on Evaluation Species

White Sturgeon and Other Mainstem Migratory Fishes

The implementation of structural measures associated with MO4 include diverting fish away from turbines at the John Day, McNary, and four Lower Snake River dams (Additional Powerhouse Surface Passage) and improving the Lower Granite Dam adult trap bypass (Lower Granite Trap Modifications). The MO4 would also add spillway weir notch gates at John Day, McNary, and the four lower Snake River dams (Spillway Weir Notch Inserts); pumping systems for fish ladders at Ice Harbor and Lower Monumental Dams (Lower Snake Ladder Pumps); and fish friendly turbines at the John Day Dam (Improved Fish Passage Turbines). These measures are intended to primarily benefit migratory corridor species like anadromous salmonids, but, due to similar life history stage requirements, may also benefit mainstem migratory fishes like white sturgeon.

Proposed high spill during the spring emigration (Spill to 125 percent TDG) as part of MO4 exceeds state water quality standards for TDG and may negatively impact mainstem migratory fishes (e.g., white sturgeon) at key sites like the head of the John Day and Lower Monumental Reservoirs more than MO3 (ODEQ and WSDE 2002, pp. 11-12).

Operating the four lower Columbia River dams and the four Lower Snake River dams at MOP (Drawdown to MOP) would maximize the tailrace-to-reservoir transition area subhabitat at key sites like the John Day Reservoir and the Lower Monumental Reservoir. This would, increase the complexity of the river landscape and support mainstem migratory fishes (e.g., white sturgeon), migratory corridor species (e.g., Pacific lamprey), and non-migratory species (e.g., Western pearlshell mussel).

The measure to maintain 220 kcfs (6,230 m^3s^{-1}) flows (an increase in downstream flow) at McNary Dam (McNary Flow Target) may benefit mainstem migratory fishes in the Lower Columbia River, especially in low water years. For example, in 2015, from May 1 through July 31, 2015, the average outflow at McNary Dam was 164 kcfs (4,644 m3s1) (ranging from 111 kcfs to 220 kcfs [3,143 to 6,230 m^3s^{-1}]). Higher flows in low-water years may lead to improved ecological conditions below Federal projects in the Lower Columbia River that benefit multiple life history stages of mainstem migratory and migratory corridor species.

Pacific Lamprey and Other Migratory Corridor Species

Proposed modifications as part of MO4 (e.g., modification of cooling water strainer to exclude Pacific lamprey at the four Lower Columbia River and four Lower Snake River dams) would likely yield benefits for aquatic species like Pacific lamprey. Structural modifications (Improved Fish Passage Turbines, Bypass Screen Modifications for Lamprey, and Lamprey Passage Ladder Modifications) at the four Lower Columbia River dams would likely benefit Pacific lamprey. These include expanding or improving lamprey passage structures at Bonneville, The Dalles Dam, and John Day Dam; modifying cooling water strainer to exclude Pacific lamprey; modifying turbine intake screens at McNary Dam; and, modifying ladders for lamprey passage at the four lower Columbia River dams and the four lower Snake River dams. As in MO2 and MO3, the implementation of measures associated with MO4 would provide greater benefits to Pacific lamprey than MO1.

Operating the four lower Columbia River dams and the four Lower Snake River dams at MOP would maximize the tailrace-to-reservoir transition area subhabitat (e.g., at key sites like the head of the John Day Reservoir and the Lower Monumental Reservoir). This would increase the complexity of the rivers landscape and support of migratory corridor species (e.g., Pacific lamprey).

Western Pearlshell Mussel and Other Non-Migratory Species

Operating the four lower Columbia River dams and the four lower Snake River dams at MOP will maximize the tailrace-to-reservoir transition area (e.g., at key sites like the head of the John Day Reservoir and the Lower Monumental Reservoir), thereby increasing the structural complexity and resiliency of the river landscape.

LAKES AND RESERVOIRS

NAA

NAA Summary of Lakes and Reservoir Landscape Findings

- Structural and operational measures proposed under the NAA would continue to negatively affect the current hydrograph by reducing water quantity in unimpounded river reaches during high flows, reducing peak discharges, and by storing water for use later in the year.

NAA Impacts on Indicators of Ecological and Physical Processes and Subhabitats

Water Quantity

In the Basin, water quantity is largely dependent on the size of the annual snowpack and runoff. The storage reservoirs hold water during the spring runoff for power generation, water supply, and to reduce flood risk downstream. Operations under the NAA fill and drawdown various amounts of water from the storage reservoirs in the Lower Columbia River, Mid-Columbia River, and the Lower Snake River.

Under the NAA, the 14 Federal dams and associated reservoirs have greatly influenced the river landscape downstream of each project (Nilson and Berggren 2000, p. 783; Ward and Stanford 1983, pp. 29-30). Changes in operations and maintenance of these dams can significantly change the water quantity in the reservoirs located in the Basin (Stanford and Ward 2001, p. 308).

Habitat Complexity, Species Diversity, and Ecosystem Function

Due to the lack of diverse vegetation and natural substrate, storage reservoirs in the Columbia and Snake Rivers are not as morphologically or ecologically diverse as the natural lake or river habitats in place prior to dam construction (USFWS 1999, p. M4-1). There are potential negative cascading effects due to frequent changes in water levels in these lakes and reservoirs from system operations. Under the NAA, these effects include the loss of riparian vegetation and modification of shoreline structure and species composition, which could result in significant regional declines in, and even the extirpation of, wildlife species (McAllister et al. 2001, pp. 15-39).

Barren Lands and Islands

The abundance of barren land (i.e., drawdown zones) and shorelines surrounding reservoirs and islands within reservoirs depends on the water surface elevation of reservoirs in the Basin. Under the NAA, drawdowns and refills would continue to negatively impact fish and wildlife resources. For example, when reservoirs are full, the barren zone is unavailable to shorebirds, such as dunlin, that might benefit from exposed habitats for foraging. Similarly, islands are more exposed during times of low water surface elevation. Increased exposure can lead to the creation of land bridges, which may open new travel corridors for terrestrial predators or, potentially, invasive species. Increased predation and spread of non-native species could result in negative impacts on colonial nesting birds such as Caspian terns and double-crested cormorants. Conversely, if water levels are higher (i.e., decreased exposure), islands may become inundated and thus, unable to provide nesting habitat and other habitat for fish and wildlife resources.

NAA Impacts on Key Sites

Continuing operations of the CRSO Federal projects under the NAA will sustain current trends and impacts on the hydrology and ecology of the study area. The operations that drive those trends and the ecological consequences for key sites identified in the Basin are discussed here.

Lower Columbia River: John Day River Confluence, Blalock Island Complex, and Umatilla River Confluence

Under the NAA, from April 10 through September 30, John Day Dam is operated to minimize water travel time for out-migrating juvenile salmon by operating the forebay within the Minimum Irrigation Pool (MIP) range (from 262.5 ft to 264.0 ft [80.0 m to 80.5 m). The MIP is the lowest pool elevation that allows for irrigation withdrawals. Irrigation withdrawals from the John Day Pool typically begin in early March and extend through mid-November. During this time of year, increased barren lands and shoreline as well as islands would be exposed in comparison to winter months.

Safety precautions prohibit sudden changes in the flow from the John Day Reservoir under current operating conditions (NAA). However, during unusual or emergency conditions, water surface elevation may be adjusted to meet other authorized project purposes such as navigation.

Operating projects within a large range (e.g., ± 2 ft [61 cm]) causes lake and reservoir habitats to either be unusable for fish and wildlife resources, even becoming a source of mortality for them. For example, when water levels are low, terrestrial wildlife may attempt to nest in the barren lands and along the shoreline. When low water levels are maintained, these habitats can be productive. However, if water levels are subsequently raised, any nests and eggs could be flooded, disturbed, or lost. These barren lands and nearshore areas can become “mortality sinks” because they appear to offer ideal conditions for nesting, but changing conditions (i.e., rising water levels) can result in lost productivity and mortality in these same areas.

Conversely, when water levels are high, aquatic species may attempt to spawn in these areas during periods of flooding. If the water levels subsequently drop, any eggs or larval fish will be lost, and those spawning attempts would ultimately fail.

Continuing to operate the John Day Reservoir to raise and lower water surface elevation on a regular basis will lead to similar impacts on fish and wildlife resources and important habitats. Conversely, maintaining a fairly stable pool elevation during important foraging, breeding, and spawning periods would minimize the impacts to both aquatic and terrestrial species.

Mid-Columbia River: Lake Roosevelt

The current operational draft rate limit for Lake Roosevelt is 1.5 ft (0.5 m) per 24 hrs. This minimizes potential bank sloughing and erosion caused by rapid reservoir drawdown. Additionally, the co-lead agencies currently manage Grand Coulee Dam, Libby Dam, Hungry Horse Dam, and Dworshak Dam to provide flow augmentation to benefit migratory fishes in the spring and summer. Spring flow augmentation generally begins in April, after the storage reservoirs have filled to the FRM targets for that year. These operations would continue under the NAA.

To provide summer flow augmentation, water from Libby Dam and Hungry Horse Dam is allocated after refill to maximum water surface elevation, usually around June 30. The summer augmentation draft benefits native migratory and resident fishes downstream of the Federal projects. This benefit would also be realized under the NAA. Beginning in July, Grand Coulee Dam is also drafted to provide summer flow augmentation to benefit juvenile Pacific salmon the Columbia River.

These drafts reduce the negative impacts on important habitats for fish and wildlife resources along the Columbia and Snake Rivers by attempting to mimic a pre-dam hydrograph. The pulse improves conditions for native species that depend on high flows in late spring and early summer (i.e., for reproduction), followed by a descending hydrograph from mid-summer to mid-fall. Flow augmentation drafts would allow many of the key sites along the Columbia River to experience conditions that benefit native species.

Upper Basin: Lake Pend Oreille and Lake Koocanusa

The co-lead agencies manage water surface elevation at Albeni Falls Dam to support kokanee, a critical food source for ESA-listed bull trout. During the spring, the co-lead agencies fill Lake Pend Oreille in accordance with existing FRM criteria. During the summer, the co-lead agencies maintain Lake Pend Oreille around an elevation of 2,062 ft (628 m) for recreational activities through Labor Day. Starting October 1, the project begins drafting to target an elevation within a 0.5 ft (15 cm) of 2,051 ft (625 m) by mid-November, prior to kokanee spawning.

Operations at Libby Dam include the release of flows to benefit ESA-listed Kootenai River white sturgeon. Sturgeon flow augmentation is typically initiated during mid- to late May and extends into mid-June. Augmentation may continue into late June or early July, depending on sturgeon spawning behavior and location, water temperature, local inflow below the Libby Project, and FRM downstream of Libby Dam. The intent of sturgeon flow augmentation is to increase lower Basin runoff from tributaries of the Kootenai River downstream of the Libby Project. The benefits associated with this augmentation would continue under the NAA.

Libby Dam is drafted in the summer to benefit resident fishes in the Kootenai River and salmonids in the Columbia River. To meet the needs of Kootenai River white sturgeon and resident trout species, current operations ensure minimum flows in the rivers downstream to support both species, and are prioritized over summer refill for recreation. Libby Dam is operated during the winter and early spring for FRM to achieve a 75 percent probability of reaching the April 10 elevation objective to provide water to increase spring flows. Grand Coulee Dam is operated during the winter and early spring for FRM to achieve 85 percent probability of reaching the April 10 elevation objective to provide water to increase spring flows. These benefits for resident fishes would continue under the NAA.

Lower Snake River: Dworshak Reservoir

In the spring, the co-lead agencies operate Dworshak Dam to maximize the probability of refilling the reservoir to support summer flow augmentation and, additionally, to provide flows needed to meet spring objectives in the Lower Snake River during the out-migration of juvenile salmon and steelhead. In the spring, Dworshak Dam releases between approximately 4 kcfs and 6 kcfs (113 m^3s^{-1} to 170 m^3s^{-1}) to help move fish from the Dworshak National Fish Hatchery and the Clearwater State Hatchery, located directly downstream, into the mainstem Clearwater River.

Flow augmentation from Dworshak Dam, which will continue under the NAA, significantly reduces water temperatures from mid-summer to early fall and increases water velocities through the Clearwater and the Lower Snake rivers. These lower temperatures and higher water velocities benefit many lakes and reservoir habitats and evaluation species (e.g., Pacific lamprey and native freshwater mussels) by creating conditions close to those historically used by these species.

NAA Impacts on Evaluation Species and Other Guilds and Communities

Clark's Grebe and Western Grebe

Wildlife species affected by rapid fluctuations in reservoir water surface elevation include Western and Clark's grebes. The maintenance of a stable water surface elevation in the persistent emergent vegetation areas around a water body during April through July is critical to grebe nesting success and to prevent isolation of individuals from their nests. Additionally, grebe nesting coincides with the boating and water-recreation season in the Basin, which can negatively impact grebes given their colonial nesting behavior, fragile-floating nest structures, and general refusal to fly during breeding (La Porte et al. 2013). Under the NAA, disturbance would continue to threaten grebe growth and survival on all but adequately protected waters.

Dunlin

Dunlin can benefit from barren lands and exposed shorelines. In the Lower Columbia River, dunlin use these areas, which include mudflats, for foraging during their spring and fall migration periods. Operations under the NAA would likely result in maintaining the current abundance of migratory habitat that is seasonally available to dunlin.

Floaters

Rapid drawdowns of storage reservoirs can be problematic for a suite of wildlife species, but especially freshwater mussels like floaters. Dry periods and reservoir drawdowns usually expose these resources and, while a few individuals may make it to deeper water, most burrow into the sediment and die if water levels do not quickly return to normal before the mussels desiccate and overheat (Gates et al. 2015, pp. 620-621; Nedeau et al. 2009, pp. 1-4). Exposed resources are also more susceptible to predation by foraging birds and mammals. Under the NAA, operations would continue to result in negative impacts on freshwater mussels and floaters, in particular.

Colonial Nesting Waterbirds

The co-lead agencies' conduct current operations and water management to reduce predation of juvenile Pacific salmon and steelhead in the Lower Columbia River by limiting habitat and colony establishment for colonial nesting waterbirds (Collis et al. 2006, pp. 5-8, 42-44). The continuation of these operations and activities under the NAA would effectively limit colonial nesting waterbird colonies in the Lower Columbia River and could negatively impact population abundance in the future.

MO1

MO1 Summary of Lakes and Reservoir Landscape Findings

- Structural and operational measures proposed under MO1 would continue to negatively affect the current hydrograph; the most significant change in comparison to the NAA would be an increase in water surface elevation, overall, and an increase in the frequency of fluctuations of the John Day Reservoir during the spring and summer.

MO1 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

MO1 would further alter the current hydrograph in some areas of the Basin, leading to the accelerated loss of habitat complexity, species diversity, and ecosystem function. MO1 includes two operational measures (Increased Forebay Range Flexibility, Predator Disruption Operations) that would change water quantity and water surface elevation of the John Day Reservoir. For instance, the Increased Forebay Range Flexibility measure would increase the reservoir elevation range and operational flexibility at John Day Dam between April and August. Under this measure, the co-lead agencies would increase water surface elevation 2 ft (61 cm) above MIP between June 1 and August 31. Additionally, the implementation of the Predator Disruption Operations measure would raise the pool elevation in the John Day Reservoir in April and May by an additional 1.5 ft (46 cm) for a total of a 2 ft (61 cm) increase in reservoir elevation.

The implementation of several other structural measures under MO1 would improve passage rates of Pacific lamprey at John Day Dam. Improving the passage rates of Pacific lamprey ensures the sustainability of this species in the Basin, thereby helping to maintain the native species diversity in this system.

MO1 Impacts on Key Sites

<u>Lower Columbia River: John Day River Confluence, Blalock Island Complex, and Umatilla River Confluence</u>

Under MO1, the Increased Forebay Range Flexibility operational measure would increase the frequency of fluctuations in water levels and an increase in water surface elevation by 0.5 ft (15 cm) in the summer months. In addition, implementation of the Predator Disruption Operations measure at John Day Dam would raise the pool elevation in the John Day Reservoir in April and May by approximately 1 ft (30 cm). This operational would also lead to an increase in water surface elevation, thereby reducing the abundance of barren lands, shorelines, and low-lying areas for evaluation species to use in and around the John Day Reservoir during the spring and summer months.

Under MO1, Umatilla NWR will experience a major loss in diversity of island habitat, primarily at the Blalock Island complex. The proposed structural and operational measures will negatively affect pool management capabilities at the refuge, thereby decreasing the resiliency of rare wet meadow plant communities that develop on the narrow edges of island habitat and support waterfowl and other species (Healy, F., in litt. 2019).

<u>Mid-Columbia River: Lake Roosevelt</u>

Collectively under MO1, the implementation of various operational measures, including the Update System FRM Calculation and Planned Draft Rate at Grand Coulee, would influence water quantity and water surface elevation, particularly in Lake Roosevelt. These measures would reduce water levels in Lake Roosevelt longer into the spring months compared to current conditions. The Winter FRM Space operational measure in MO1 would also result in a water quantity reduction in Lake Roosevelt during the winter months compared to the NAA.

Under MO1, the implementation of some measures would increase the exposure time of the barren zone around the perimeter of Lake Roosevelt as well as around islands in the winter and spring months. This could result in habitat shifts from wetland or riparian habitats to those that are more tolerant of dryer conditions.

Upper Basin: Lake Pend Oreille and Lake Koocanusa

Under MO1, no structural changes would be implemented at Albeni Falls Dam. Similarly, no changes would be made to Albeni Falls operations in most water years. The co-lead agencies' H&H modeling output shows water surface elevation in most water years consistent with the NAA, except for a few river reaches that would not impact Lake Pend Oreille. The differences in monthly water surface elevation (less than 6 inches [15 cm]) during most water years and months are within the expected range of natural variability.

Only one operational measure in MO1 (Winter System FRM Space) applies and is likely to impact Albeni Falls Dam. This measure would increase flexibility to account for winter precipitation runoff events by increasing space for water in Lake Pend Oreille. Under MO1, water quantity and natural lake water surface elevation would remain the same in Lake Pend Oreille, with the exception of lower water levels in the winter months as a result of this measure.

Under MO1, three operational measures would be implemented at Libby Dam including: Modified Draft at Libby, December Libby Target Elevation, and Sliding Scale at Libby. Implementing the Modified Draft at Libby measure would base Lake Koocanusa's refill initiation on the local forecast versus forecasts at The Dalles Dam, as specified in the NAA. This would modify operations at Libby Dam to provide additional flexibility for the co-lead agencies to respond to local conditions in the Upper Basin. This measure also would provide more flood space for local high-spring flow, and lower the risk of filling the reservoir early, which could result in the need to draw down the reservoir to create more flood space before the end of the FRM operations season.

The implementation of the December Libby Target Elevation measure would change current operations at Libby Dam from a variable draft at the end of December to a fixed draft target of elevation 2,420 ft (738 cm) to prevent over-drafting of the Lake Koocanusa in years that have less precipitation than forecasted.

The implementation of the Sliding Scale at Libby measure would increase operational flexibility at Libby Dam by using local water supply forecasts to manage operations to support local fish and wildlife resources, rather than using The Dalles Dam, as specified in the NAA. This measure establishes a new September target elevation 5 ft (1.5 m) higher, resulting in water level increases from 1 ft to 2 ft (30 cm to 61 cm), on average, in Lake Koocanusa between June and September. Under MO1, during the spring, water levels in Lake Koocanusa would drop and, during the summer, fall, and winter months, water levels would increase from water levels in current conditions.

Lower Snake River: Dworshak Reservoir

Under MO1, two operational measures (Winter System FRM Space and Modified Dworshak Summer Draft) would impact water quantity at and around Dworshak Reservoir. The Winter System FRM Space measure would increase the space, and therefore lower the water surface elevation, in Dworshak Reservoir from December through March. The Modified Dworshak Summer Draft measure would result in decreased water surface elevation in the early summer months. However, in August and early September, the draft rate would also decrease, resulting in water surface elevation increasing by as much as 10 ft (3 m) relative to current conditions. By the end of September, water surface elevation in the reservoir would be consistent with pool elevations in current conditions.

The implementation of the Modified Dworshak Summer Draft measure would reduce the quantity of water in Dworshak Reservoir during the early summer months, but augment it later in the summer.

MO1 Impacts on Evaluation Species and Other Guilds and Communities

Floaters

Operational measures associated with MO1 would likely subject floaters and Western pearlshell to more frequent water surface elevation fluctuations, which could leave these species intermittently exposed to desiccation and predation, especially by waterbirds (LaPorte et al. 2013; Nedeau et al. 2009, p. 21). Conversely, the implementation of several structural measures in MO1 would improve passage rates of Pacific lamprey at John Day Dam upstream to the John Day Reservoir and then on to upstream rivers (e.g. John Day River and Umatilla River).

In the Mid-Columbia River, the implementation of some measures associated with MO1 could increase the exposure time of the barren zone around the perimeter of Lake Roosevelt and island habitats during the winter and spring months, which could lead a transition from wetland and riparian subhabitats to those more tolerant of dryer conditions. Thus, species like floaters could be negatively impacted (Nedeau et al. 2009, p. 21).

Colonial Nesting Waterbirds

The implementation of structural and operational measures associated with MO1 would result in higher and more variable reservoir elevations in the Lower Columbia River. The Predator Disruption Operations measure in MO1 would raise and maintain John Day Reservoir water surface elevations between 263.5 ft (80 m) and 265 ft (81 m) during the months of April and May to disrupt Caspian terns from successfully nesting at the Blalock Islands complex. The increased water surface elevation caused by the Predator Disruption Operations measure would also reduce the abundance of barren lands, shorelines, and low-lying areas in and around the John Day Reservoir during the spring and summer months.

The Increased Forebay Range Flexibility measure in MO1 would increase the operating elevation range from June 1 to August 31 to MIP by 2 ft (61 cm), from 262.5 ft to 264.5 ft (80 m to 81 m). Caspian terns have historically had low productivity at the Blalock Island complex either due to nest predation by mammalian or avian predators or to high water levels and high winds in John Day Reservoir that inundated nesting areas during the incubation period (BRNW 2013, p. 23; BRNW 2014, p. 27). Inundation would be greater as a result of the Increased Forebay Range Flexibility measure during the typical incubation season compared to what occurred in recent years.

Water surface elevations at and below the 263.5 ft (80 m) reservoir level would likely provide nesting habitat for approximately 6,000 waterbirds. However, a rise in water surface elevation will inundate nests. There is a high likelihood colonial waterbirds would attempt to nest at the Blalock Island complex if the reservoir elevations drop below 263.5 ft (80 m), as they have a history of habitat use there. The greatest negative effects would occur if birds initiate nesting and subsequently reservoir elevations are increased.

The potential impacts of raising or maintaining John Day Reservoir water surface elevations between 263.5 ft and 265.0 ft (80 m and 81 m) during typical nest initiation time through the Predator Disruption Operations measure, and implementing the Increased Forebay Range Flexibility measure during typical incubation time include:

- Reduction in the regional breeding population by 3 percent if the Caspian terns do not relocate (i.e., do not nest again);
- Nest initiation followed by subsequent flooding of nests with eggs or chicks, which would decrease productivity;
- Relocation by Caspian terns to other areas in the Columbia River Plateau Region, like colony sites at Sprague Lake and Lenore Lake; and
- Relocation by Caspian terns to other sites in, or outside of, the Basin at active or historic sites and Corps-created or -enhanced sites. Although habitat was created and enhanced outside the Basin to mitigate impacts from management plans, the numbers of nesting Caspian terns have not increased at these sites over the past couple of years, even though additional nesting habitat is available (Hartman et al. 2019, p. 13; Peck-Richardson et al. 2019, p. 22; Peterson et al. 2017a, p. 22; Peterson et al. 2017b, p. 1). The sites are likely limited by other drivers like food availability, disturbance, and predation.

The impacts of the MO1 measures at John Day Reservoir on Caspian terns should be viewed from a Pacific Flyway population perspective, considering the cumulative effects of management plans and actions across the flyway that affect the population. These impacts, along with all previous and likely future impacts, will likely further reduce the Caspian tern regional breeding population

The increased water surface elevation caused by the Predator Disruption Operations measure would also reduce the abundance of barren lands, shorelines, and low-lying areas in and around the John Day Reservoir during the spring and summer months. This could lead to a reduction in quantity and quality of foraging areas available to other migratory birds, such as dunlin (Warnock and Gill 1996). Conversely, under MO1, operational measures in the Mid-Columbia River would reduce reservoir levels and increase the exposure time of barren lands and shoreline surrounding Lake Roosevelt, as well as surrounding island habitat in the winter and spring.

MO2

MO2 Summary of Lakes and Reservoir Landscape Findings

- Structural and operational measures proposed under MO2 would result in deeper drafts for hydropower, which would lead to overall temporary decreases in water surface elevation and the potential for the most frequent fluctuations in water surface elevation in both mainstem and storage reservoirs.

MO2 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

The implementation of MO2 includes two operational measures (Spill to 110 percent TDG and Contingency Reserves in Fish Spill) that would increase the amount of water moving through turbines, but would not affect water quantity or water surface elevation in the John Day Reservoir. Other operational measures associated with MO2 that may impact reservoirs in the study area include Ramping Rates for Safety and the John Day Full Pool measures. Ramping rates for safety would allow water levels in natural lake and reservoir habitats to fluctuate more often, which could negatively impact ecological and physical processes that support habitat complexity, species diversity, and ecosystem function. The John Day Full Pool operational measure would increase the water quantity in, and elevation of, the John Day Reservoir. This measure would also lead to the most frequent (hourly and daily) fluctuations in water levels compared to other measures associated with other alternatives.

MO2 includes several structural measures including: Lamprey Passage Structures, Turbine Strainer Lamprey Exclusion, Bypass Screen Modifications for Lamprey, and Lamprey Passage Ladder Modifications. Collectively, these measures would increase survival of juvenile Pacific lamprey and improve upstream passage conditions for adult Pacific lamprey, especially at John Day Dam.

MO2 Impacts on Key Sites

<u>Lower Columbia River: John Day River Confluence, Blalock Island Complex, and Umatilla River Confluence</u>

Under MO2, overall water surface elevation would increase, reducing the quantity of available barren lands, shorelines, and low-lying areas throughout the year in comparison to current conditions. However, under MO2, the Ramping Rates for Safety and the John Day Full Pool operational measures would increase the likelihood of frequent fluctuations in water levels, thereby negatively impacting subhabitats and evaluation species in the John Day Reservoir.

Similar to MO1, under MO2, Umatilla NWR will experience a major loss in diversity of island habitat, primarily at the Blalock Island complex, thereby negatively impacting rare wet meadow plant communities, waterfowl, and colonial nesting waterbirds.

Mid-Columbia River: Lake Roosevelt

Under MO2, like MO1, no structural measures would be implemented in the Mid-Columbia River. However, several operational measures proposed at Grand Coulee Dam, including Ramping Rates for Safety, Slightly Deeper Draft for Hydropower, Update System FRM Calculation, Planned Draft Rate, Grand Coulee Maintenance Operations, and Winter System FRM Space would influence water surface elevation in Lake Roosevelt, resulting in changes to the quantity and distribution of lake-like habitats in this area.

The implementation of the Update System FRM Calculation operational measure would use forecasts at The Dalles Dam to determine end-of-April draft requirements without modification at Grand Coulee Dam (every year, from January through April). Under the Planned Draft Rate and Winter System FRM Space operational measures, lower water surface levels in Lake Roosevelt are expected to persist longer into the spring months in comparison to current conditions.

The implementation of Ramping Rates for Safety and Slightly Deeper Draft for Hydropower operational measures would result in changes in draft rates to provide operational flexibility for hydropower production. The Ramping Rates for Safety measure, in particular, would enable dam operators to change flow operations within a 24-hour period to meet changes in energy demands; functionally, this measure would enable the co-lead agencies to change water surface elevation at a faster rate.

The implementation of several operational measures associated with MO2 would influence water quantity and water surface elevation in Lake Roosevelt. The Planned Draft Rate and Winter System FRM Space measures would create lower water levels in Lake Roosevelt area that are expected to persist longer into the spring months in comparison to current conditions. Under MO2, the implementation of these measures would increase the exposure time of barren lands and shorelines around the perimeter of Lake Roosevelt, as well as around islands in the winter and spring, benefitting terrestrial species that rely on these habitats.

Upper Basin: Lake Pend Oreille and Lake Koocanusa

No structural changes would be implemented at Albeni Falls Dam. However, three operational measures (Winter System FRM Space, Slightly Deeper Draft for Hydropower, and Ramping Rates for Safety) would be implemented at Albeni Falls Dam and would impact Lake Pend Oreille. These measures would alter draft and refill processes to maximize hydropower production while balancing FRM to adjust winter pool elevation targets. In average water years, winter outflows from Albeni Falls Dam in the winter months would increase substantially in comparison to current conditions.

Under MO2, water quantity and disturbance as a result of recreational activities would largely remain the same in Lake Pend Oreille, with the exception of water surface elevation, which would decrease during the winter months. Changing ramping rates and draft conditions at Albeni Falls Dam would change water surface elevation on Lake Pend Oreille, leading to increased desiccation of submerged aquatic vegetation and emergent wetland plants.

Under MO2, several operational measures would be implemented at Libby Dam including: Ramping Rates for Safety, Slightly Deeper Draft for Hydropower, Sliding Scale at Libby, Modified Draft at Libby, and December Libby Target Elevation. The implementation of the Ramping Rates for Safety and Slightly Deeper Draft for Hydropower measures would result in changes in draft rates from current conditions. The Ramping Rates for Safety measure would allow the co-lead agencies to change flow operations and allow for water surface elevation to fluctuate at a faster rate. The Slightly Deeper Draft for Hydropower measure would relax restrictions on seasonal pool water surface elevation at the Federal storage projects to allow for deeper drafts. These operational measures, compared to those associated with the NAA and MO1, would lead to a significant increase in the frequency of fluctuations in water levels in Lake Koocanusa.

The implementation of the Sliding Scale at Libby operational measure would increase operational flexibility at Libby Dam by using local water supply forecasts to manage operations to balance local fish and wildlife priorities and downstream flows, rather than using those associated with The Dalles Dam, as specified in the NAA. This measure would also establish a new September target elevation 5 ft (1.5 m) higher, resulting in an increase in water surface levels from 1 ft to 2 ft (30 cm to 61 cm), on average, in Lake Koocanusa between June and September. Under MO2, the implementation of the Modified Draft at Libby and December Libby Target Elevation operational measures would result in similar effects to those of MO1.

Under MO2, water quantity and natural lake elevation in Lake Koocanusa would be lower for the majority of the year in the winter and spring months, in comparison to current conditions. During the summer months, water quantity would be slightly higher and likely more variable based on energy demands.

<u>Lower Snake River: Dworshak Reservoir</u>

As a result of the implementation of the Ramping Rates for Safety, Slightly Deeper Draft for Hydropower, and Winter System FRM Space operational measures associated with MO2, the co-lead agencies would draft Dworshak Reservoir would be drafted deeper that under current conditions. Under MO2, pool elevations would decrease by approximately 2.5 ft to 3 ft (76 cm to 91 cm) during the winter, spring, and summer months.

MO2 Impacts on Evaluation Species and Other Guilds and Communities

Clark's and Western Grebes

MO2 would increase the abundance of barren lands around Lake Roosevelt, which would lead to transformations in associated plant and animal communities. Changes in water surface elevation on Lake Pend Oreille would alter the availability of vegetation and suitable nesting habitat for Clark's and Western grebes and other nesting waterbirds. If water levels drop rapidly or become lower than those in current conditions, nests could dislodge and break apart, which would likely result in egg and juvenile mortality (USFWS 2019f). Rapid fluctuations in ramping rates would expose nests to increased risk of predation and additional disturbance (i.e., by boat traffic and recreation) (LaPorte et al. 2013). Measures in MO2 that increase the frequency of water surface level fluctuations in Lake Koocanusa would also negatively impact grebes and floaters that reside there (LaPorte 2013; Nedeau et al. 2009, pp. 1-4).

Dunlin

The implementation of the John Day Full Pool operational measure also has the potential to reduce the quantity, quality, and distribution of barren land habitat in the John Day Reservoir, likely impacting the amount of foraging areas available to migrating birds such as dunlin (Warnock and Gill 1996).

Floaters

Higher reservoir levels are expected in the Upper Basin during the summer in MO2, which would benefit resident fishes like kokanee and cutthroat trout, floaters, and other freshwater mussels (Nedeau et al. 2009, p. 21). Lower reservoir levels would be expected as a result of MO2 in the Dworshak Reservoir, negatively impacting resident, cold-water fishes like cutthroat trout. Variable water elevations would be detrimental to many species such as nesting birds, migratory fishes, and freshwater mussels.

Colonial Nesting Waterbirds

In the John Day Reservoir, measures under MO2 would likely decrease the availability of prey that support a variety of wildlife populations at higher trophic levels (e.g., Caspian terns, double-crested cormorants, gulls). The Service expects certain avian species that depend on juvenile Pacific salmon as prey to transition to other food resources or relocate to other sites or locations where access to prey resources is greater. MO2 includes measures that increase the range of reservoir elevations in the John Day Reservoir. The impacts of these measures would be similar to the impacts of the Predator Disruption Operations and Increased Forebay Range Flexibility measures on Caspian terns discussed as part of MO1.

MO3

MO3 Summary of Lakes and Reservoir Landscape Findings

- Structural and operational measures proposed under MO3 would, over time, restore portions of the Lower Snake River to near-natural aquatic conditions, thereby providing benefits to various habitats and aquatic evaluation species that inhabit these waters; however, these benefits would not be observed in storage reservoirs throughout the study area.
- As a result of some structural and operational measures, apart from the four dam breaching measures, other natural lake and reservoir habitats in the Basin and their inhabitants may be more negatively impacted than in current conditions.

MO3 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

MO3 proposes breaching the earthen portions of the four dams on the Lower Snake River. This measure, although beneficial to almost all ecological and physical processes and habitats identified in this report (and analyzed as part of other landscapes in the "Impacts on Fish and Wildlife Resources" section and this appendix) would neither impact the Federal storage reservoirs in the Basin nor increase the flood risk anywhere in the Basin.

The implementation of other measures associated with MO3 are specific to hydropower production and, collectively, would change draft rates and increase water surface elevation of the storage reservoirs in the Lower and Mid-Columbia River. Proposed operational measures that change draft rates from those in current conditions would also change the quantity of barren land and island habitat, leading to potentially positive (e.g., for dunlin) and negative (e.g., for freshwater mussels) impacts on fish and wildlife resources in the study area.

MO3 also includes several structural measures that would improve passage rates of juvenile and adult Pacific lamprey.

MO3 Impacts on Key Sites

<u>Lower Columbia River: John Day River Confluence, Blalock Island Complex, and Umatilla River Confluence</u>

Under MO3, the implementation of the John Day Full Pool operational measure would reduce the Minimum Irrigation Pool +1.5 ft (46 cm) restriction. This would likely raise the pool elevation in the John Day Reservoir during the entire year. This measure would increase the amount of water in the John Day Reservoir and, thus, reduce the abundance of barren land and island habitat at these key sites. The implementation of this measure, in comparison to other alternatives, would allow for the greatest change in water levels (hourly and daily) in the John Day Reservoir. Higher water levels in reservoirs, especially during the spring and summer months, could benefit freshwater mussels (Nedeau et al. 2019, p. 21). These benefits may be negated by operational measures that could result in more frequent fluctuations in water levels, thereby stranding freshwater mussels and other invertebrates (USFWS 2019f).

Similar to MO1 and MO2, Umatilla NWR will experience a major loss in diversity of island habitat, primarily at the Blalock Island complex under MO3.

Mid-Columbia River: Lake Roosevelt

The implementation of operational measures under MO3 would influence water quantity and water surface elevation in Lake Roosevelt. The Planned Draft Rate operational measure would create lower water levels in Lake Roosevelt that persist longer into the spring months in comparison to current conditions.

Changes proposed by the Ramping Rates for Safety operational measure could result in more rapid water surface elevation changes in reservoirs throughout the study area, which could affect the abundance of barren land and shoreline habitat.

Upper Basin: Lake Pend Oreille and Lake Koocanusa

Under MO3, like MO1 and MO2, no structural changes would be implemented at Albeni Falls Dam. Output from the co-lead agencies' H&H modeling show water surface elevation in most water years would remain consistent with the NAA, except for a few river reaches that would not impact Lake Pend Oreille.

Only one operational measure (Ramping Rates for Safety) in MO3 would apply to Albeni Falls Dam and, thus, have an impact on Lake Pend Oreille. This measure would enable the co-lead agencies to change flow operations within a 24-hour period to meet changes in energy demands. All impacts on water quantity, disturbance as a result of recreational activities, and water surface elevation would be similar to those of MO1.

Under MO3, the Sliding Scale at Libby, December Libby Target Elevation, and Modified Draft at Libby operational measures would all be implemented at Libby Dam. The implementation of these measures would result in similar impacts as those of MO1 and MO2.

Lower Snake River: Dworshak Reservoir

Under MO3, pool elevations at Dworshak Reservoir would decrease by approximately 2.5 ft to 3 ft (76 cm to 91 cm) during the winter, spring, and summer seasons in comparison to current conditions.

MO3 Impacts on Evaluation Species and Other Guilds and Communities

Floaters

Higher storage reservoir water surface elevation during spring and summer months would likely benefit freshwater mussels such as floaters and the Western pearlshell mussel (Nedeau et al. 2009, p. 21). Maintaining a higher water surface elevation would likely result in less migratory foraging habitat for dunlin, however. Regardless, western pearlshell, floaters, and other native freshwater mussels will likely be subject to rapid fluctuations in water surface levels, which can leave them intermittently exposed to desiccation and predation (LaPorte et al. 2013; Nedeau et al. 2009, p. 21).

Colonial Nesting Waterbirds

MO3 includes structural and operational measures that increase the range of reservoir elevation in the John Day Reservoir. The impacts of these measures would be similar to the impacts of the Predatory Disruption Operations and Increased Forebay Range Flexibility measures on Caspian terns discussed as part of MO1.

MO4

MO4 Summary of Lakes and Reservoir Landscape Findings

- Structural and operational measures proposed under MO4 would lead to lower pool water surface elevation in storage reservoirs in the Lower Columbia River during the spring and summer months.

MO4 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

Under MO4, reservoir water surface elevation throughout the Lower Columbia River would likely be at least 1.5 ft (46 cm) lower (operating to MOP) than in current conditions. Proposed operational measures such as Spill for Adult Steelhead, Spill to 125 percent TDG, Drawdown to MOP, and Above 1 percent Turbine Operations are intended to enhance survival of migratory fishes. The implementation of the Drawdown to MOP operational measure, for instance, would likely have short-term negative impacts on natural lake and reservoir habitats, but long-term positive impacts for these habitats as a result of decreased pool water surface elevation in the John Day Reservoir between April and July (in all years) and between March and August in dry years.

MO4 Impacts on Key Sites

Lower Columbia River: John Day River Confluence, Blalock Island Complex, and Umatilla River Confluence

Under MO4, the water surface elevation in the John Day Reservoir would be approximately 1.5 ft (46 cm) lower than current conditions during April and July (in all years) and March and August in dry years. Portions of the shoreline regularly inundated in current conditions would be exposed during spring and summer under MO4. As a result, open water could transition to mudflats or barren lands (Warnock 1996).

Under MO4, lowered water levels in the John Day Reservoir will reduce irrigation capacity for the NWR operations. Irrigation inputs for refuge operations at this location are through wells or pump stations both of which are dependent on appropriate pool levels (Healy, F., in litt. 2019).

Mid-Columbia River: Lake Roosevelt

Impacts of the implementation of measures proposed at Grand Coulee Dam under MO4 would be similar to those of MO1. Additionally, impacts on water quantity and reservoir elevations associated with MO4 would not be noticeably different from those of the NAA and MO1.

Upper Basin: Lake Pend Oreille and Lake Koocanusa

Under MO4, like the other MOs, no structural changes would be implemented at Albeni Falls Dam, and no changes would be made to project operations in most water years. Output from the co-lead agencies' H&H modeling show water surface elevation in most water years remains consistent with current conditions, except for a few river reaches that would not impact Lake Pend Oreille.

Like MO3, only one operational measure in MO4 (Winter System FRM Space) applies to Albeni Falls Dam and, thus, would have an impact on Lake Pend Oreille. This measure would increase the flexibility to account for winter precipitation run-off events by increasing space in Lake Pend Oreille. All impacts on water quantity, disturbance as a result of recreational activities, and water surface elevation would be similar to those of MO1 and MO3.

MO4 includes three operational modifications at Libby Dam: Modified Draft at Libby, December Libby Target Elevation, and Sliding Scale modifications. In the spring and early summer, water levels would drop 2.5 ft (76 cm) below average to account for deeper draft, as a result of implementing the Modified Draft at Libby measure. The December Libby Target Elevation measure proposes a new draft target that would increase winter water levels in Lake Koocanusa, peaking in January when the pool elevation would be 7 ft (2 m) higher than in current conditions.

Similar to other MOs, MO4 includes the implementation of the Sliding Scale at Libby operational measure, which would increase operational flexibility at Libby Dam through the use of local water supply forecasts rather than The Dalles Dam forecasts as in current practices.

Lower Snake River: Dworshak Reservoir

Only one operational measure (Winter System FRM Space) would influence water quantity in the Dworshak Reservoir under MO4. This measure would lower the water surface elevation in the Dworshak Reservoir from December through March to provide space for winter precipitation run-off events.

MO4 Impacts on Evaluation Species and Other Species

MO4 proposes to operate the John Day Dam at MOP rather than MIP. Operating the John Day Dam at MOP would provide the most natural conditions for key sites, which would benefit evaluation species at these sites (USFWS 2019f).

Potential impacts on Clark's and Western grebes would be the same as those under MO1. Structural and operational measures that increase the abundance of barren land in and around Lake Roosevelt would affect plant and wildlife communities both positively and negatively. MO4 includes modifications that would reduce water surface elevation and expose certain sites during spring and summer. In the short-term, key sites with open water could transition to mudflats or barren land habitats. These areas could attract and support more wading waterbirds like dunlin, especially during migratory periods (Warnock 1996). However such a transition could also lead to the loss of important ecological and physical processes that support freshwater mussels and other invertebrates (Nedeau et al. 2009, p. 21).

RIPARIAN

NAA

NAA Summary of Riparian Landscape Findings

- With the continued lack of functional flows throughout most of the study area, native riparian-obligate species will continue to decline and be replaced by later-successional communities and, eventually, uplands landscapes, thereby decreasing habitat complexity and species diversity throughout the region.
- The suppression of cottonwood and willow regeneration has led to a significant loss in structural complexity of riparian forests. As old relict stands of cottonwoods reach the end of their lifespan without new generations to take their place, river corridors may lose this keystone riparian species that supports a disproportionate quantity and diversity of wildlife.

NAA Impacts on Indicators of Ecological and Physical Processes and Subhabitats

Pre-Dam Hydrograph and Natural Flood Regime

A pre-dam hydrograph in the Basin included rising stage in the spring associated with snow melt, followed by peak flows in early June and a gradual recession to base flow by September, and lowest flows during the winter months (Figure G3). The general shape of a pre-dam hydrograph does not vary significantly in an unregulated system, but it may show higher or lower extremes during wet or dry years. The timing associated with peak floods and return to base flow for the pre-dam hydrograph may vary slightly given geographic location, but hydrographs for rivers across western North America, from Alberta to New Mexico, have similar patterns and nearly the exact same timing (Mahoney and Rood 1998, p. 636).

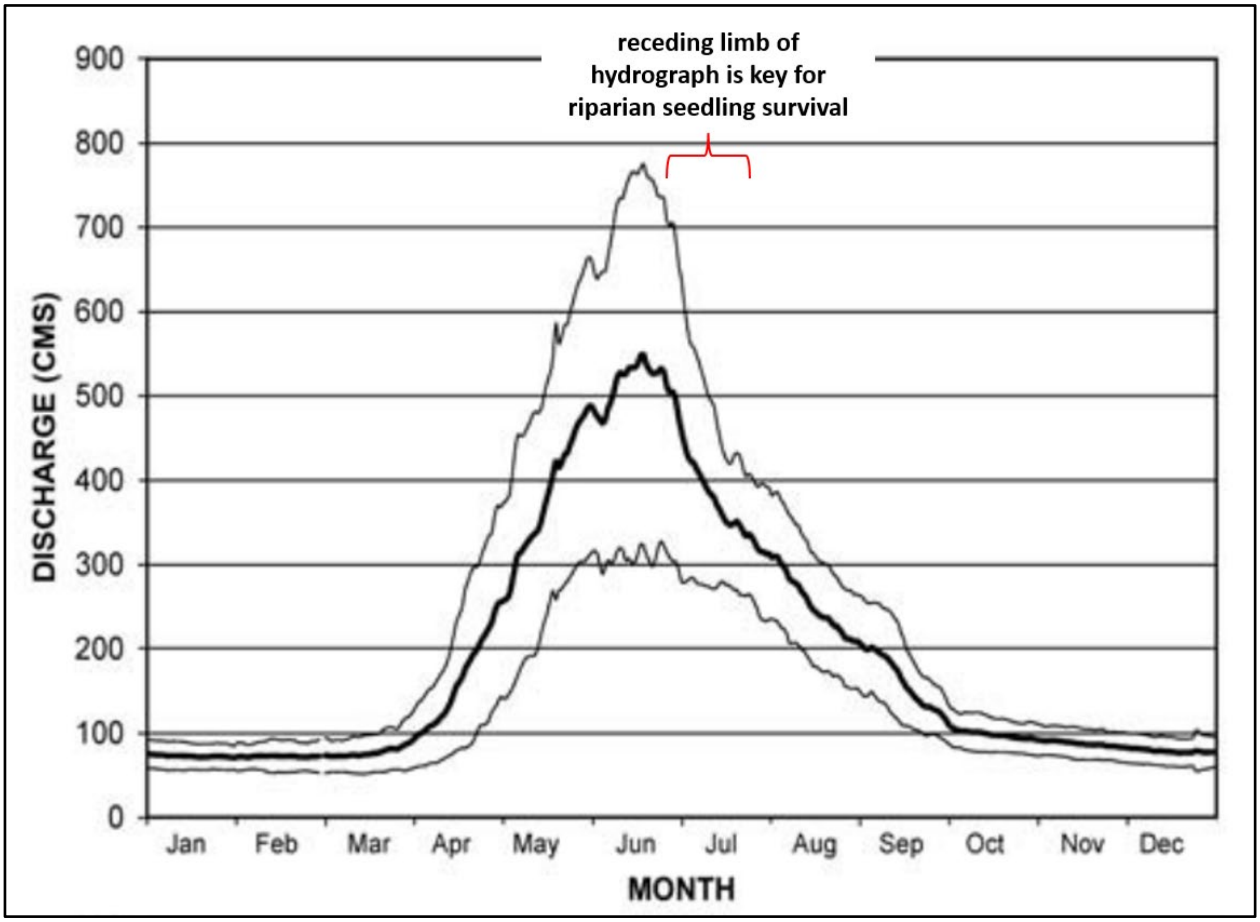

Figure G3. A typical hydrograph of the Upper Snake River (±1 standard deviation) during the pre-dam period of record, from 1911 to 1956
Source: Adapted from Hauer and Lorang 2004, p. 31

<u>Native Riparian Vegetation</u>

The pre-dam hydrograph governs nearly every aspect of the riparian ecosystem, including streambed morphology, sediment and nutrient cycling and deposition, and it helps fulfill essential life-history requirements for riparian vegetation and wildlife (Poff et al. 1997, p. 769). Cottonwood and willow, keystone species in riparian habitats throughout the Basin, are specially adapted to the pre-dam hydrograph and natural flood regimes, as they must survive and outcompete flood-intolerant species along the shoreline and on the floodplain. Annual seed dispersal of cottonwoods and willow is timed to coincide with peak flood events, allowing wind and water to transport seeds to the flood-created, newly exposed, moist and barren shoreline habitat, as flood waters recede. Cottonwood and willow seeds are released in large numbers, but are only viable for up to a few weeks. Seeds germinate on the newly exposed habitat, and the roots of the newly established seedlings must elongate at a rate that keeps them in contact with the receding water table, which is typically less than 1.0 inch (2.5 cm) per day (Mahoney and Rood 1998, pp. 634-638).

Due to the close correlation of the life history of riparian keystone plant species with the pre-dam hydrograph, disruption from river regulation can greatly impede the survival and regeneration of these species, and thus other wildlife species that depend on them. Regulated rivers like the Columbia and Snake Rivers and their tributaries have moderated hydrographs, with greatly attenuated peak flow events, which can inhibit cottonwood and willow regeneration by disrupting ecological and physical processes that create habitat for germination of these species (Mahoney and Rood 1998, pp. 634-635). Peak flow events may also occur at different times on a regulated river, perhaps several weeks earlier or later than normal, which also inhibits cottonwood and willow regeneration and benefits invasive species. For example, when peak flows occur one month later than average peak flows, in early July instead of early June, they coincide with seed maturation and dispersal of non-native reed canary grass, (Waggy 2010; Rood, S., pers. comm. 2019). Additionally, ramping rates on regulated rivers affect how quickly water levels increase and drop downstream of dams. Even if a regulated river does experience a peak flood at the appropriate timing, ramping rates draw water down at a rate that is faster than the rate at which new cottonwood and willow seedling roots can elongate to survive, also preventing regeneration of cottonwood and willow forests (Mahoney and Rood 1993, p. 231). These conditions and their impacts would continue under the NAA.

Regeneration of riparian forests depends not only on establishment of new seedlings dictated by elements of the normal river hydrograph, but also on seedling and adult survival. Established cottonwood and willow plants can suffer from drought stress or prolonged inundation when management causes the river stage to rise above or fall below levels that are typical for that particular season for extended periods of time (Braatne et al. 2007a, p. 262). Additionally, unnaturally high or frequently fluctuating winter stages can displace newly established seedlings, when ice rising with the river stage brings associated seedlings with it, plucking them from the ground (USFWS 2019b).

The suppression of cottonwood and willow regeneration has led to a widespread loss in structural complexity of riparian forests, as well as to a loss of diversity that accompanies the invasion and establishment of non-native plant species (Braatne et al. 2007a, p. 263; Kleindl et al. 2015, p. 1366; Macfarlane et al. 2016, p. 454). Such loss of structural complexity of riparian habitat may have contributed to the extirpation of species such as the yellow-billed cuckoo, once common in the study area, and the decline of other riparian bird species in the study area (Hughes 2015; Ohmart 1994, pp. 276-277; Scott et al. 2003, p. 284; Skagen et al. 2005, p. 526). Most of the remaining patches of riparian-obligate vegetation in the study area are comprised of old cottonwood trees forming the canopy, with sparse native understory, which would typically support a large proportion of the nesting bird species (Braatne et al 2007b, pp. 254-256; Ohmart 1994, pp. 274-275). Much of the riparian corridor in the study area is now devoid of cottonwood, while other areas still support relict populations of aging trees with limited long-term viability (Braatne et al. 2007a, p. 247; Dykaar and Wigington 200, p. 92) (Figure G4). This reduction in the riparian community would continue and perhaps be exacerbated (as extant trees age and slow reproduction) under the NAA.

Figure G4. Example of relict cottonwoods along the Mid-Columbia River subbasin near Chelan, Washington
Source: Stewart Rood, University of Lethbridge

<u>Habitat Complexity, Ecosystem Function, and Connectivity</u>

Riparian communities are extremely diverse and also naturally scarce in the study area and, as a result, the loss of riparian habitat has disproportionate impacts on the diversity and abundance of semi-aquatic and terrestrial species that depend on it for part, or all aspects, of their life history stage requirements (Brinson et al. 1981, pp. iv, 87). Thus, habitat complexity and ecosystem function decrease when riparian habitat and subhabitats are lost or converted to more common upland forest, grassland, sagebrush subhabitats through the loss of river function (Fierke and Kauffman 2005, p. 160). Decreases in habitat complexity and function reduce the diversity and abundance of wildlife the region can support (Naiman et al. 1998, p. 289). Habitat connectivity may also be greatly reduced with the loss of even small tracts of riparian habitat, as these remnant riparian corridors function as important migratory and dispersal routes for many species of wildlife (Hauer et al. 2016, p. 9). There are cascading impacts of an altered hydrograph and the lack of normal flood regimes, starting with the loss of native riparian vegetation and the alteration of structure and species composition of shorelines, which can result in significant regional declines and even extirpation of wildlife species under the NAA conditions (Hauer et al. 2016, p. 9; Hunter et al. 1987, p. 12).

NAA Impacts on Key Sites

<u>Lower Columbia River: Julia Butler Hansen NWR, Sandy River Delta, Umatilla NWR</u>

Julia Butler Hansen NWR has a relatively large area of undeveloped shorelines. Precipitation helps replenish the water table in this region and, as a result, riparian habitat has maintained resiliency during changes in river water surface elevation caused by dam operations (Rood, S., pers. comm. 2019). However, the altered hydrograph at this site limits the regeneration of new cottonwood-willow habitat. Thus, while more riparian habitat survives here than at other sites in the Basin, what remains is degraded and in decline (Christy and Putera 1993, pp. 21, 27). This trend will continue under the NAA.

The majority of the Sandy River Delta is protected from development under either Federal or state jurisdiction, and therefore has a relatively large area of undeveloped shoreline with relatively healthy wetland and riparian habitat. Additionally, this site has been the focus of ongoing habitat restoration efforts since the late 1990s, including planting of cottonwood seedlings, and removing non-native reed canary grass and Himalayan blackberry (*Rubus armeniacus*) (Kelly and Dobson 2001, p. 1). Although the riparian habitat on the Columbia River portion of this site is affected, and will continue to be affected under the NAA, precipitation helps recharge the water table, so that drought-induced mortality due to abnormal river flows is less of a threat to existing cottonwoods and willows (Christy and Putera 1993, p. 13; Rood, S., pers. comm. 2019).

The Sandy River Delta is also one of the few sites in the Pacific Northwest where sightings of vagrant yellow-billed cuckoos have been observed in recent years, though there are no known populations or breeding occurring throughout this part of the species' former range (eBird Basic Dataset, Version: EBD_relMar-2019). Although this site is relatively protected from development and supports some of the largest stands of cottonwood and willow in the Lower Columbia River, abnormal Columbia River flows inhibit natural riparian regeneration and, thus, the understory is highly degraded (Christy and Putera 1993, pp. 13, 21; Kelly and Dobson 2001, p. 1). Unlike most other sites in the Basin where cottonwoods remain, the large relict patches of cottonwood at this site now exist alongside younger cohorts that have been planted since 1997. Though structural diversity is degraded at this site, and what little understory remains is comprised mostly of invasive blackberry, invasive plant removal has been one of the restoration strategies (Dobson 2009, p. 16; Kelly and Dobson 2001, p. 1). Overall, riparian habitat at this site has declined from historical conditions, but it could increase slightly even under the NAA in overall health in the future due to restoration efforts (Christy and Putera 1993, p. 27; Kelly and Dobson 2001, p. 1).

Umatilla NWR is located approximately 8 RM to 15 RM (13 Rkm to 24 Rkm) downstream from the McNary Federal project, and was established for the protection of migratory birds. While this refuge is managed mostly for waterfowl, it is also critical in supporting other bird species including neotropical migrants, as well as other riparian-dependent plants and wildlife. Because this site is protected as a NWR, its undeveloped shorelines have great potential to maintain riparian vegetation, and therefore increase habitat diversity and ecosystem connectivity. The hydrograph here is highly regulated, inhibiting natural flood regimes that promote riparian recruitment. Despite being an important stronghold of riparian habitat in the region, the quantity and quality of riparian habitat here will continue to decline under NAA operations as existing stands of cottonwood mature with little regeneration.

Mid-Columbia River: Okanogan River Confluence, Threemile Creek to Six Mile Creek confluences, and the Little Sheep Creek Confluence

The Okanogan River tributary confluence and river delta is located in a part of the Basin where much of the shoreline is either steeply banked, armored, or otherwise developed. These conditions, along with the heavily moderated hydrograph, leave little opportunity for regeneration of riparian species (Figure G5). Thus this tributary confluence supports dynamic processes that do not occur in much of the rest of this region, including both sediment deposition and erosion (USFWS 2019b). Riparian habitat exists along some of the river shoreline as well as on the Cassimer Bar, Washburn Island, and Wells Wildlife Area, but non-native Russian olive and cheatgrass have been encroaching on the riparian zone (USFWS 2019b). Although degradation of riparian habitat at this site will likely continue without change to current management practices, it functions as an important oasis of habitat connectivity and diversity and related ecological and physical processes that are lacking throughout most of this subbasin.

Figure G5. The Okanogan river delta
Source: Stewart Rood, University of Lethbridge

The Threemile Creek to Sixmile Creek confluences are located approximately 50 RM (80 Rkm) upstream from the Grand Coulee Dam, and the Little Sheep Creek confluence is located approximately 140 RM (225 Rkm) upstream from the Grand Coulee Dam near the Canadian border. Threemile Creek to Sixmile Creek confluences, the Little Sheep Creek confluence, and surrounding area represent reaches of the Mid-Columbia River in Lake Roosevelt characterized by several small tributary confluences, which contribute flow and sediment to the mainstem, and relatively undeveloped shoreline (Yarnell et al. 2015, p. 965). Aerial imagery shows that much of the exposed shoreline not inundated by Lake Roosevelt currently supports mostly upland vegetation. There are some shallower-sloped shorelines and sandy bars in both of these confluences, which appear to support some riparian vegetation and could support more given a more natural flow regime, but they would likely continue to be converted to upland vegetation under NAA conditions.

The summary hydrograph for the Threemile Creek Confluence shows the lowest water surface elevation occurring from February through May, and a higher water surface elevation in July throughout the rest of the year. The summary hydrograph for the Little Sheep Creek area shows low flows from February through April and attenuated peak flows occurring in July. Neither of these hydrographs promote regeneration of native riparian species, and this status quo would continue under NAA conditions. In the absence of substantial flooding, stable conifer climax communities develop in place of riparian species (Gucker 2012).

Upper Basin: Stillwater River Confluence, Clark Fork Delta at Lake Pend Oreille (Derr Island, Panhandle Wildlife Management Area [WMA]), Yaak River and Star Creek confluences

The Stillwater River confluence is located approximately 20 RM (32 Rkm) downstream of the confluence of the South Fork Flathead and Flathead Rivers, and 25 RM (40 Rkm) downstream of the Hungry Horse Dam. Because Hungry Horse Dam impacts only one tributary (South Fork Flathead) of the three that flow into the main stem Flathead River (North, Middle, and South Fork of the Flathead River), impacts of Hungry Horse Dam on the mainstem Flathead River are somewhat diluted now and would likely be diluted under NAA conditions. The largest impacts are typically confined to the reach above the confluence of the South Fork Flathead, while impacts below the confluence are diluted and typically most pronounced during low flows from mid- to late summer (Rood, S. pers. comm. 2019; USFWS 2019g). However, the reach of the Flathead River above Flathead Lake has experienced a reduction in potential inundation (flooding) of 27 percent and 32 percent for the 100-year 50-year floodplain, respectively, which results in a 35 percent loss of ecological function in the 50-year floodplain (Bergeron and Wood 2018, pp. 2, 78). This loss in ecological function would continue under the NAA.

Riparian habitat at the Stillwater River confluence, though degraded, is more plentiful than many other parts of the Basin, and the inflow of the Stillwater River brings unique sediment and flow dynamics to this reach. Even though it is clear from aerial imagery that many portions of the riparian corridor in this subbasin have transitioned to upland conifer forest, the Stillwater confluence maintains wide meanders, sandy exposed shoreline, and fairly undeveloped bars and islands making it an ideal location for restoration of riparian vegetation.

The confluences of several small tributaries, as well as the inflow delta created where the main channel enters the reservoir, makes the Clark Fork Delta a complex system of side channels, islands, and a matrix of riparian forest and wetland habitats and subhabitats (USFWS 2019b). As with most tributary confluences, added flow, sediment dynamics, and nutrient input provided from the Johnson and Lightning Creek tributaries benefit the mainstem Clark Fork River at this site. In addition, there is an artificial inflow pattern here, where the river enters the reservoir, which mimics a natural delta (USFWS 2019b). These factors increase the ecological value of the area. However, as in most other areas of the Basin, riparian habitat is in decline in complexity, quantity, and quality due to the loss of a functional flow regime and the subsequent spread of invasive species, and this trend would continue under NAA conditions (Jankovsky-Jones 1999, p. 69; Kauffmann 1988, p. 49).

The Yaak River Confluence is located approximately 45 RM (72 Rkm) downstream from Libby Dam on the Kootenai River. Here and elsewhere, riparian habitat has declined in quantity and quality due in part to dam operations, and this decline would continue under the NAA (Burke et al. 2009, p. S224). Functional flows may be implemented at dams to mimic the most important aspects of the pre-dam hydrograph and benefit riparian habitat and wildlife that evolved with important elements of the pre-dam hydrograph (Rood et al. 2005, p. 193). Since functional flows were implemented at, Libby Dam, cottonwood and willow recruitment has been increasing. The quantification of this trend has not yet been published, but it has been observed by multiple experts in the field (Burke et al. 2009, p. S235; USFWS 2019b). This trend would continue under NAA conditions.

Despite new recruitment of cottonwood and willow with the newly adopted functional flow regime, abnormally high winter water surface elevation cause mortality of newly established cottonwood and willow seedlings. Under a natural flow regime, water levels peak in the late spring due to snowmelt, followed by a gradual recession back to base flow by September, with the lowest flows in winter. Even when peak flows are mimicked by releases at Libby Dam, promoting downstream cottonwood and willow recruitment, various manipulations of the flows for power generation can cause water levels to rise in the winter, thereby displacing young trees that have not yet grown large enough to withstand the force of the rising water and ice. This phenomenon has been observed on the Kootenai River, where successful cottonwood and willow recruitment has been partially offset by the inability of newly-established seedlings to survive the following winter (Merz et al. 2013, p. 126; USFWS 2019g). There has been an overall loss of riparian habitat on the Kootenai River since the CRSO dams were installed, and this trend would continue under the NAA. Unlike in other parts of the Basin, there has also been a very recent increase in cottonwood and willow recruitment on the Kootenai River due to functional flows.

<u>Lower Snake River: Catholic Creek Confluence downriver to Hog Island, Tucannon River Confluence, Big Flat Recreation Area</u>

Undeveloped shoreline with some riparian vegetation characterize the confluence of Catholic Creek, in addition to several other islands in the main channel. Similarly, downstream at the Lapwai Creek confluence near Spalding, Idaho, there is a riparian stringer (i.e., narrow strip) that meets the mainstem at the Nez Perce National Historical Park, where additional undeveloped shoreline habitat exists. Downstream, several islands including Hog Island support some riparian vegetation, and could present opportunities for recruitment of riparian vegetation if flow conditions are appropriate. Steep canyon walls, manmade infrastructure, and shoreline armoring limit already-scarce riparian vegetation in this subbasin. Key sites have maintained undeveloped, shallow-sloped shoreline present opportunities for riparian recruitment unavailable elsewhere in the subbasin. Narrow bands of riparian habitat, even if degraded, provide critical wildlife habitat in the form of migratory corridors and stopover sites, offering unique foraging and rearing opportunities in areas with limited resources. However, as with other regulated reaches throughout the Basin, dam operations on the Snake River inhibit recruitment of riparian-obligate vegetation (Rood et al. 2010, p. 102). This trend would continue under NAA conditions.

The narrow riparian strip along the Tucannon River provides some of the only riparian or large woody vegetation in the area, which is evident from aerial imagery. Although the extent of riparian vegetation is confined here, due to current conditions (e.g., steep canyon walls) and anthropogenic development (e.g., Highway 261 infrastructure), existing habitat is important for maintaining habitat diversity and connectivity. As in other parts of the Basin where flows are highly regulated, riparian quality here is degraded and its regeneration would be limited under the NAA.

Big Flat Recreation Area is a Habitat Management Unit (HMU) constructed and maintained by the Corps as mitigation for dam construction on the Lower Snake River. As a result, this site is heavily managed using irrigation to promote growth of native riparian plants (cottonwood and willow). Approximately 90% of this site is dominated by invasive Russian olive, although removal efforts are underway (Valente et al. 2019, pp. 1, 3-4). These irrigated plots of woody vegetation exist among a larger proportion of uplands landscape that dominates the subbasin and, thus, they represent some of the only forested and scrub-shrub habitat in the Lower Snake River. Assuming that invasive removal and irrigation continues at this site as proposed in the NAA, the quality of riparian habitat here could slowly increase in the future.

When the Lower Snake River dams were constructed, historical shorelines that once supported riparian vegetation were inundated, leaving uplands landscape along the river's edge in most areas (USACOE 2014b, p. 19). In addition, most shorelines of the Lower Snake River are now either armored or otherwise developed, and flow moderation and flood attenuation further reduce the opportunity for riparian vegetation survival and regeneration. This constraint would continue under NAA conditions.

Remaining fragments of riparian habitat in and along the Lower Snake River are important to plant and wildlife diversity and habitat connectivity. The Big Flat Recreation Area represents one of these remaining fragments. This site is currently managed with irrigation for riparian plants, and experimental removal of invasive Russian olive (Valente et al. 2019, pp. 1-18). For this analysis, the Service assumes all current management practices at this site would continue under all the alternatives.

NAA Impacts on Evaluation Species and Other Guilds and Communities

Under natural conditions on unregulated rivers, uplands species are prevented from encroaching on the riparian corridor due to periodic flooding and the high water table, while riparian species are prevented from moving into the uplands due to the lack of available soil moisture. In most arid environments, the transition between uplands and riparian landscapes is less than 3 ft (1 m) (Ohmart 1994, p. 273). Riparian forests succeed to upland subhabitats due to the altered hydrograph. Where undeveloped shoreline remains in the study area, much of the riparian corridor has been converted to uplands vegetation due to the lack of ecological and physical processes that form and maintain riparian communities (Macfarlane et al. 2016, p. 9). This conversion would continue under NAA conditions.

<u>Cottonwood and Willow</u>

Cottonwood and willow historically occurred along most of the Basin in the study area (Bergeron et al. 2018, p. 13; Braatne et al. 2007b, p. 271; Christy and Putera 1993, p. 21; Naiman et al. 1998, pp. 305-306; Polzin and Rood, 2000, p. 221; Wissmar 2004, p. 378). While gallery forests are far less extensive in river canyons where the river banks rise steeply in elevation, transitioning abruptly to uplands vegetation like conifer forest or shrub-steppe, narrow riparian stringers that occur in these confined reaches are important for maintaining habitat diversity and connectivity (USFWS 2019b).

The lack of gallery forests in portions of the Basin today does not necessarily indicate that none were present historically. There is evidence that riparian forest once occurred even in more upland subhabitats of the Basin. For example, historical records in the semi-arid regions of eastern Oregon show that cottonwood and willow occurred along most streamlines including Columbia River tributaries such as the Deschutes, John Day, and Crooked Rivers, throughout the 1800s (McAllister 2008, p. 420). Historical accounts document cottonwood galleries 0.25 miles (400 m) wide on the John Day River, where only a few relict cottonwoods now stand (Wissmar et al. 1994, p. 17).

Today, gallery forests with cottonwoods exist in other arid regions such as in the southwest, and they are remnant in upland subhabitats in the study area (e.g., Lower Snake River) (Asplund and Gooch 1998, p. 21; USACOE 2014b, p. 19). While it is possible that some locations in the Basin, including some reaches of the Lower Snake River, may not have ever supported gallery forests, it is reasonable to assume willow and other riparian species would have occurred at least in narrow stringers. For example, historical accounts from the 1800s show willow was the most dominant streamside species in the large John Day/Clarno Uplands Ecoregion (McAllister 2008, p. 418).

Though river regulation negatively impacts riparian habitat, it is not the only cause of decline in riparian forests. Riparian habitat would have already been altered and degraded, or lost completely in certain locations, by the time the dams were built in the mid-1900s. Deforestation, grazing, mining, overharvesting, draining of wetlands, channel manipulation for navigation, water diversion, irrigation and flood control, among other factors, have been at play during the 200 years since European settlement (Christy and Putera 1993, p. 5; Wissmar et al. 1994, p. 1). In particular, livestock grazing tends to be concentrated in riparian areas, with 80 percent of vegetation removed by livestock occurring in riparian corridors (Roath and Krueger 1982, p. 101). In addition to river regulation, livestock grazing has been documented in some areas as the most imminent threat to remaining riparian habitat (Ohmart 1994, p. 278). This source of decline in riparian vegetation would continue under the NAA.

<u>Viceroy Butterfly</u>

There was very limited data available to determine the presence of viceroy butterfly and other pollinators in the study area. Using a national database and expert-validated citizen science submissions to Moths and Butterflies of North America, the Service found few records, only seven of which fell in the study area: four in the Lower Columbia River between the John Day and Ice

Harbor projects including one at Umatilla NWR; one on reach 16 at RM 419 (Rkm 674) on the Mid-Columbia River near Vantage, Washington; one at the Okanogan River confluence in the Mid-Columbia River; and one on the Lower Snake River just south of the Clearwater River confluence (Lotts and Naberhaus 2017). There were no records of viceroy available from the Upper Basin. However, the Service assumes that viceroys could be present anywhere in the study area east of the Cascade Range where cottonwood and willow (i.e., the larval host plants) occur, and where adequately moist soils required for puddling are present during the summer (i.e., their flight period). Loss of host plant and moist soils historically produced through annual flooding is likely threatening viceroy butterfly populations, and this trend would likely continue under NAA conditions (Nelson 2003, p. 210).

Yellow Warbler and Riparian Songbirds

Riparian birds represent what is the largest and most diverse guild of wildlife species that depend on riparian habitat (Croonquist and Brooks 1991, p. 708). Destruction of riparian habitat is the major cause of decline for the largest proportion of landbirds in western North America (DeSante and George 1994, p. 177). This decline would continue under the NAA. To identify whether the yellow warbler and other focal riparian birds were likely breeding at certain locations or sites in the recent past, the Service filtered eBird observations by location (within 3 miles [5 km] of the study area) and by date (between June 1 and July 31 or the height of the breeding season from 2010 to 2018) (Table G1).

Table G1. Documented presence of riparian birds at various locations in the study area

Key Sites	Yellow Warbler	Willow Flycatcher	Bullock's Oriole
Julia Butler Hansen NWR	X	X	X
Sandy River Delta	X	X	X
Umatilla NWR	X	X	X
Okanogan River Confluence	X	X	X
Threemile to Sixmile Creek confluences			
Little Sheep Creek Confluence	X		
Stillwater River Confluence	X	X	X
Clark Fork Delta/Derr Island	X	X	X
Yaak River Confluence	X		

MO1

MO1 Summary of Riparian Landscape Findings

- While riparian habitat at most of the sites analyzed would not undergo significant change under MO1 in comparison to the NAA, there would be minor to moderate loss of riparian habitat on the Lower Columbia River and in the Upper Basin on the Kootenai River.
- Because the Lower Columbia River and Kootenai River support some of the least degraded riparian habitat in the project area, negative impacts on these areas would be disproportionately felt, and should be avoided to the extent possible.

MO1 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

MO1 will further the alteration of the hydrograph and flood regimes in some areas of the Basin, which will lead to the accelerated degradation and loss of native riparian vegetation. The degradation and loss of native riparian vegetation will alter the structure and vegetative species composition of riparian habitats, and ultimately reduce habitat complexity, connectivity, and ecosystem function. The most ecologically significant changes to the hydrograph will be slightly decreased peak and summer flows in lower regions of the Lower Columbia River such as the Sandy River Delta site; extreme prolonged shoreline inundation throughout the spring and summer in the upper portions of the Lower Columbia River; and decreased peak flows paired with increased winter stages in the Kootenai River of the Upper Basin.

MO1 Impacts on Key Sites

<u>Lower Columbia River: Julia Butler Hansen NWR, Sandy River Delta, Umatilla NWR</u>

Julia Butler Hansen NWR is located approximately at RM 35 (Rkm 56). Water surface elevation downstream of RM 105 (Rkm 169) under MO1 are expected to decrease less than 3 inches (8 cm) during the spring and summer months, which is considered within the current range of variability. Thus, there should be no significant impact to riparian habitat at this site under MO1.

The Predator Disruption Operations and Increased Forebay Range Flexibility operational measures under MO1 causing water surface elevation changes at the Sandy River Delta to increase approximately 3 inches (8 cm) during the winter and decrease approximately 5 inches (13 cm) or less during the spring and summer. Under MO1, winter water surface elevation should have little impact to riparian vegetation, but lower spring and summer water levels may result in a reduction in riparian habitat through lost contact with the lowered water table during the spring and summer. The drop in water surface elevation would also expose a small amount of riparian shoreline immediately adjacent to the water. This newly exposed shoreline could foster new riparian growth if exposure occurred during the right time of year (spring) and was followed by a gradual recession rate (1 inch [2.5 cm] per day or less) to allow root elongation to maintain contact with the water table. However, newly exposed shoreline could also be colonized by invasive plants. Most likely, given the altered hydrograph at this site, and, without proper implementation of the change, there would be a small net loss of riparian habitat under MO1 in comparison to NAA.

The Predator Disruption Operations and the Increased Forebay Range Flexibility operational measures proposed under MO1 causing the prolonged inundation (of approximately 1.5 vertical ft [46 cm) of riparian shoreline at Umatilla NWR during April through August, which would likely lead to loss of riparian vegetation in the inundation zone. There would be a net loss of riparian habitat in MO1 in comparison to NAA, thereby reducing habitat complexity and ecosystem function at the refuge, and further limiting habitat connectivity and migration corridors available to wildlife in the region.

Mid-Columbia River: Okanogan River Confluence, Threemile Creek to Six Mile Creek confluences, and the Little Sheep Creek Confluence

As a result of the Chief Joseph Dam Project Additional Water Supply operational measure under MO1, water surface elevation immediately below the Chief Joseph project is expected to decrease by 1 percent or less. This amount of change is expected to be within the current range of variability. The Okanogan River confluence is located approximately 6 RM (10 Rkm) downstream of Chief Joseph Dam, and, thus, impacts on riparian habitat under MO1 are not expected to differ significantly from those of the NAA.

Water surface elevation in the river reaches upstream of the Grand Coulee Dam would be between 3 ft and 6 ft (1 m and 2 m) lower throughout the winter and into early spring (December through March) due to the following MO1 operational measures: Lake Roosevelt Additional Water Supply, Planned Draft Rate at Grand Coulee, and Winter System FRM Space. However, water surface elevation would likely return to the level maintained currently, beginning in March and throughout the rest of the spring and summer. Because the drop in water surface elevation occurs outside the spring and summer, it is not expected to negatively impact riparian vegetation. Thus, impacts on riparian habitat under MO1 are not expected to differ significantly from those of the NAA at Threemile Creek to Sixmile Creek confluences.

The impacts described above would likely be even more diluted at the Little Sheep Confluence due to its greater distance upstream from the Grand Coulee Dam. Thus, under MO1, impacts on riparian habitat at this site are not expected to differ significantly from the NAA.

Upper Basin: Stillwater River Confluence, Clark Fork Delta at Lake Pend Oreille (Derr Island, Panhandle Wildlife Management Area [WMA]), Yaak River and Star Creek confluences

The Sliding Scale at Libby and Hungry Horse operational measures under MO1 would increase water surface elevation on the South Fork Flathead River by a few inches or less in August and September, but this change is within the current range of variability. While a slight increase in water surface elevation during August and September could benefit riparian vegetation, the increase is minimal and not expected to change the quantity and quality of riparian habitat on the South Fork Flathead. Reaches downstream of the confluence with the Flathead River would experience even further diluted impacts. Thus, the impacts of MO1 to riparian habitat are consistent with those of the NAA at the Stillwater River confluence.

Water surface elevation in reaches below Albeni Falls Dam may decrease by a few inches in high water years in November, which should have no impact on riparian habitat at the Clark Fork Delta at Lake Pend Oreille. Reaches above Albeni Falls, including the Clark Fork Delta, are not expected to change under the MO1 relative to the NAA.

The Modified Draft at Libby and December Libby Target Elevation operational measures under MO1 would decrease water surface elevation at the Yaak River Confluence in April and May, and during peak flows in June, but would increase water surface elevation in February and March. Water surface elevation may drop by 1 ft (30 cm) or more in December and increase by the same amount in February and March. Large winter fluctuations in water surface elevation could lead to increased mortality of newly established cottonwood and willow seedlings, as rising ice uproots them. The decrease in flows in April and May could cause drought stress or mortality in existing cottonwood and willow no longer able to access the lowered water level, and reduction in peak flows in June would hinder recruitment of new cottonwood and willow. Decreased water levels in the spring could also disrupt life cycles of aquatic emergent insects, an important base component of the riparian food web, which may affect fitness and fecundity of wildlife (i.e., riparian birds). Changes under MO1 will have negative impacts on riparian habitat at the Yaak River Confluence in comparison to the NAA.

<u>Lower Snake River: Catholic Creek Confluence downriver to Hog Island, Tucannon River Confluence, Big Flat Recreation Area</u>

The Modified Dworshak Summer Draft operational measure under MO1 would create a slight increase in habitat inundation downstream of Dworshak Dam on the Clearwater River during June and July. This increase in water surface elevation is considered within the current range of variability. The impacts downstream of the Clearwater confluence with the Snake River are expected to be even more diluted, and, thus, impacts on riparian habitat under MO1 at the Catholic Creek and Tucannon River Confluences, and at the Big Flat Recreation Area, are not expected to differ significantly from those under the NAA.

MO1 Impacts on Evaluation Species and Other Guilds and Communities

While most of the sites analyzed will not undergo significant changes under MO1 relative to the NAA, the additional loss of riparian habitat at three sites (Sandy River Delta, Umatilla NWR, and Yaak River Confluence) will lead to further loss of species diversity and continued declines in abundance of riparian plants and wildlife at a higher rate than under current conditions.

The Sandy River Delta would likely experience a small net loss of riparian habitat due to the lower (5-inch [15-cm] decrease) summer stage. This loss could potentially be mitigated and possibly result in an increase in riparian habitat if executed in a way that promotes the colonization of the newly exposed riparian shoreline with native riparian species instead of invasive species (Rood, S., pers. comm. 2019). This would require the timing of the initial drawdown to align with germination of native cottonwood and willow (June). Additionally, the drawdown would need to occur at a rate not to exceed 1.0 inch (2.5 cm) per day, allowing for seedling root elongation. The viceroy butterfly and other pollinators may also experience short-term conservation gains due to the increase in moist soil that would be available for puddling with the additional exposed riparian shoreline. However, if these requirements are not met, the new shoreline could be colonized by invasive species. There could also be loss of some existing riparian habitat due to the decreased summer stage. All riparian species at this site could be affected if this change is implemented in a way that results in net loss of riparian habitat, with cottonwood and willow most directly impacted if lower summer stage causes drought-stress or mortality with the loss of connection of the trees' root systems to the water table. Any impacts, positive or negative, would likely be relatively minor given that only a small amount of shoreline would likely be affected under MO1. The negative impacts on riparian species at Sandy River Delta under MO1 would be slightly greater than under the NAA, and comparable to those under MO2, MO3, and MO4.

Umatilla NWR would experience a significant loss of riparian habitat, with the prolonged inundation of approximately 1.5 vertical ft (46 cm) of currently exposed habitat throughout most of the spring and summer (April through August). Prolonged inundation of riparian habitat could cause mortality in riparian vegetation such as cottonwood and willow, and eventual conversion of riparian vegetation to emergent aquatic vegetation, such as reed canary grass. Viceroy butterfly would also be impacted from the loss of exposed riparian shoreline available for puddling. Riparian habitat is already in decline at this site, and MO1 would induce a greater rate of decline than that expected under current conditions. Yellow warbler, Bullock's oriole, willow flycatcher, and viceroy butterfly have all been recently observed during the peak of breeding season at Umatilla NWR, and all of these species and others would be negatively impacted by the additional loss of riparian habitat. Umatilla NWR and surrounding riparian habitat would likely experience more loss or degradation under MO1 than under the NAA, MO2, and MO3, but not as much loss as under MO4.

Changes at the Yaak River Confluence under MO1 would generally lead to degradation of riparian habitat (e.g., cottonwood and willow) through increased (about 1 ft [30 cm]) winter stage, reduced spring stage, and reduced peak flows in June. There would likely be more degradation of riparian habitat at this site under MO1 than under the NAA or MO4, but less degradation of riparian habitat in comparison to MO2 or MO3.

MO2

MO2 Summary of Riparian Landscape Findings

- Structural and operational measures proposed under MO2 would cause the most widespread and detrimental effects on riparian habitat and species in comparison to any of the other proposed alternatives, including the NAA.

MO2 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

The implementation of structural and operational measures under MO2 will further alter the hydrograph and flood regimes in many areas of the Basin, which will lead to the accelerated degradation and loss of native riparian vegetation. The most ecologically significant changes to the hydrograph will be slightly decreased peak and summer flows in lower regions of the Lower Columbia River such as the Sandy River Delta site; decreased river stages during the early part of the spring and summer paired with increased winter stages in the Upper Basin and Lower Snake River; and increased frequency and rate of daily stage changes throughout the Basin due to ramping rates.

MO2 Impacts on Key Sites

Lower Columbia River: Julia Butler Hansen NWR, Sandy River Delta, Umatilla NWR

Julia Butler Hansen NWR is located approximately at RM 35 (Rkm 56), and changes to water surface elevation downstream of RM 105 (Rkm 169) under MO2 are expected to be minimal, and considered within the current range of current variability. There should be no significant change to riparian habitat at this site under MO2 in comparison to the NAA.

The co-lead agencies attribute water surface elevation changes at the Sandy River Delta in the Lower Columbia River to an unspecified combination of proposed operational modifications at Grand Coulee Dam and other upstream projects under MO2. As such, the impacts of MO2 to riparian habitat in this segment of the Basin appear to result from an interaction between the entire suite of structural and operational measures of this MO, and specific measures individually cannot account for the resulting change presented by the co-lead agencies' H&H modeling output. The overall impact to water surface elevation downstream of Bonneville Dam is an increase of less than 12 inches (30 cm) in November through January, and a decrease of less than 6 inches (15 cm) in the spring and summer months. Winter water surface elevation is not expected to impact riparian habitat because of its occurrence outside the spring and summer, and its occurrence in a reach of river not prone to deep freezing during the winter. Reduction in water levels of about 6 inches (15 cm) during the spring and summer would have impacts on riparian habitat at this site comparable to those of MO1. Some loss of riparian vegetation may occur due to the lowered summer water table, and newly exposed riparian shoreline would likely be colonized by invasive species unless efforts were made to time the exposure and flows properly to promote colonization of native riparian species. There is likely to be some loss of riparian habitat under MO2 in comparison to the NAA.

Under MO2, despite changes to reservoir levels at John Day Dam, water surface elevation in the John Day Reservoir, which includes Umatilla NWR, is not expected to have measurable differences from current water surface elevation. Thus, impacts on riparian habitat under MO2 should not differ significantly from those of the NAA.

Mid-Columbia River: Okanogan River Confluence, Threemile Creek to Six Mile Creek confluences, and the Little Sheep Creek Confluence

Due to the Ramping Rates for Safety and Winter System FRM Space operational measures under MO2, water surface elevation at the Okanogan River Confluence would increase slightly in December and decrease from February through September. This change is expected to be 6 inches (15 cm) or less and within the current range of variability. Thus, impacts on riparian habitat should not differ significantly under MO2 in comparison to the NAA.

Water surface elevation in the river reaches upstream of the Grand Coulee Dam would shift between 3 ft and 6 feet (1 m and 2 m) lower throughout the winter months due to the Planned Draft Rate at Grand Coulee and Slightly Deeper Draft for Hydropower operational measures under MO2. However, water surface elevation would be consistent with that of the NAA throughout the rest of the year. Because the drop in water surface elevation occurs outside of the spring and summer, it is not expected to cause negative impacts on riparian vegetation. Thus, impacts on riparian habitat under MO2 in the area of the Sixmile Creek confluence and the Little Sheep Creek confluence are not expected to differ significantly from those of the NAA

<u>Upper Basin: Stillwater River Confluence, Clark Fork Delta at Lake Pend Oreille (Derr Island, Panhandle Wildlife Management Area [WMA]), Yaak River and Star Creek confluences</u>

The Ramping Rates for Safety and Slightly Deeper Draft for Hydropower operational measures under MO2 appear to be associated with an increase in water surface elevation by 18 inches (46 cm) on the Flathead River in January and a decrease by 6 inches (15 cm) or less between March and July. These changes would have negative impacts on riparian habitat at the Stillwater River Confluence related to vegetation survival during the spring and summer and throughout the winter months. The modest decrease in water levels during the spring and summer could lead to vegetation mortality or could degrade the health of riparian vegetation by causing drought stress. Substantial increases in water levels during January would severely impact riparian vegetation, causing mortality of newly established seedlings. Proposed modifications associated with MO2 are expected to lead to declines in riparian vegetation quantity and quality at this site, preventing cottonwood and willow recruitment in the riparian zone. Thus, riparian habitat is expected to decline significantly here under MO2 in comparison to the NAA.

The Ramping Rates for Safety and Slightly Deeper Draft for Hydropower operational measures under MO2 appear to be associated with an increase in water surface elevation by 6 inches (15 cm) at the Clark Fork Delta during the winter and a decrease by 6 inches (15 cm) between March and May. Both of these changes could lead to mortality of cottonwood and willows. The increase in winter water levels would reduce survival rates of newly recruited cottonwood and willow, and the decrease in water surface elevation during the spring may result in drought stress for riparian vegetation. Additionally, a reduced spring stage could disrupt insects, a food source for riparian birds, from completing all of their life history stages. Thus, impacts of implementing MO2 would cause a greater decline in riparian habitat at the Clark Fork Delta in comparison to the NAA.

A combination of the Ramping Rates for Safety, Slightly Deeper Draft for Hydropower, Modified Draft at Libby, and December Libby Target Elevation operational measures under MO2 appear to be associated with a significant departure from the pre-dam hydrograph on the Kootenai River (Yaak River Confluence), resulting in significantly higher flows in winter and lower flows in the spring and summer. Water surface elevation would increase from 18 inches to 36 inches (46 cm to 91 cm) in the winter, and decrease by 18 inches (46 cm) during the rest of the year. Both of these changes would have detrimental impacts on riparian habitat on the Kootenai River. Higher winter water levels would cause an increase in riparian seedling mortality, and lower water levels throughout the rest of the year (spring freshet and spring and summer) would hinder cottonwood and willow recruitment and threaten the survival of existing plants.

The MO2 impacts are expected to be the most detrimental to riparian habitat, relative to current ecological conditions and the other MOs, in this portion of the Basin. This is significant because this area supports the highest quantity and quality of riparian habitat remaining in the study area.

Lower Snake River: Catholic Creek Confluence downriver to Hog Island, Tucannon River Confluence, Big Flat Recreation Area

The Ramping Rates for Safety and Winter System FRM Space operational measures under MO2 appear to be associated with an increase in water surface elevation by 12 inches (30 cm) at the Catholic Creek Confluence in January and February and a slight decrease in March, April, June, and July. The increase in water surface elevation in the winter could displace newly established cottonwood and willow seedlings. The decrease in water levels during the spring and summer, especially in hot months, could lead to drought stress or mortality and reduced recruitment of riparian vegetation. Thus, riparian vegetation at this site would decrease in quantity and quality due to changes under MO2 in comparison to the NAA.

The implementation of operations under MO2 would affect flows on the Clearwater River, but not on the Lower Snake River, so impacts on riparian habitat at the Tucannon River Confluence and Big Flat Recreation Area under MO2 are not expected to differ significantly from those of the NAA.

All sites under MO2 (and MO3) would be affected by the operational measure (Ramping Rates for Safety) that aims to lift ramping rate restrictions. In addition to the potential for increased ramping rates to strand fish and other aquatic species, increased rate and frequency of river stage fluctuations are potentially damaging to riparian habitat. Without knowing the scale of stage fluctuations it is hard to predict the impacts, as smaller-scale fluctuations would be less damaging than relatively larger-scale fluctuations. Frequent stage fluctuations would be especially harmful to riparian vegetation during the short seed dispersal window, if the constantly fluctuating water levels continuously re-suspended seeds and prevented them from depositing and establishing on suitable shoreline habitat while viable. Frequent stage fluctuations could also change soil texture over time through the removal of sand, fines, and organics, therefore impacting soil quality and functionality, and would also likely promote colonization of invasive species such as non-native reed canary grass (Burke, M., in litt. 2019). Erratic stage fluctuations that change soil composition and subsequently alter vegetation types promoted by those soils, could cause mortality of cottonwood and willow and lead to long-term loss of riparian vegetation. Thus, for impacts on key sites analyzed under MO2 (and MO3, apart from those sites affected by dam breaching measures), it should be assumed that this operational measure would have negative impacts on riparian habitat.

MO2 Impacts on Evaluation Species and Other Guilds and Communities

The impacts on riparian species at the Sandy River Delta under MO2 would be comparable to those described under MO1, as the resulting change in water surface elevation under MO1 and MO2 have approximately the same magnitude and timing. Negative impacts on riparian species at Sandy River Delta under MO2 would be slightly greater than under the NAA, and comparable to those under MO1, MO3, and MO4.

Changes in water surface elevation at the Stillwater River confluence would cause the hydrograph to deviate further from the pre-dam state, and would lead to decreases in recruitment of riparian vegetation, survival of newly established seedlings during the winter, and resiliency of existing riparian vegetation. Impacts on cottonwood and willow would be direct and immediate, and impacts on riparian birds, viceroy butterfly, and other wildlife resources that rely on this vegetation would be indirect, resulting from long-term loss or degradation of habitat. There are multiple recent records of yellow warbler, Bullock's oriole, and willow flycatcher throughout the Basin during the breeding season, and these species could experience long-term local declines due to loss of habitat used for breeding, feeding, and migrating. Riparian species near the Stillwater River Confluence in the Basin would experience negative impacts under MO2 to a greater degree than those under the NAA, MO1, MO3, or MO4.

Under MO2, impacts on riparian habitat and species at the Clark Fork Delta would be similar, but less severe, to those at the Stillwater Confluence. The change in flow regime would stray further from the pre-dam hydrograph, causing mortality of newly established cottonwood and willow seedlings due to increased winter stage. Existing riparian vegetation also may undergo drought stress due to lower water levels in the early part of the spring and summer, but the return to normal water levels by the time of the spring freshet would likely lessen the severity of impacts on riparian species here than at the Stillwater confluence area. Yellow warblers and other riparian songbirds, viceroy butterfly, and other wildlife that depend on riparian habitat could also be affected, resulting in a reduction in fitness, survival, and productivity, which could lead to regional population declines.

The Kootenai River downstream of Libby Dam, including at the Yaak River Confluence, would undergo changes under MO2 that would have detrimental impacts on riparian species. Large decreases in river stage throughout the spring and summer would modify conditions associated with peak flows that lead to cottonwood and willow establishment, and cause drought stress and mortality of existing cottonwood and willow. Large increases in winter stage would further reduce recruitment by causing displacement of any newly established seedlings. Thus riparian wildlife species would likely undergo significant habitat loss and degradation in this region under MO2, and there would likely be regional population declines of these species. Riparian species at the

Yaak River Confluence would experience greater negative impacts under MO2 than with any of the other alternatives, including the NAA.

Decreases in water surface elevation at key sites like Catholic Creek Confluence during the spring and throughout most of the spring and summer could cause prolonged drought-stress during the spring and summer for cottonwood and willow. Loss of quantity and quality of cottonwood and willow habitat could have minor short- and long-term impacts on the viceroy butterfly and riparian birds that depend on riparian habitat, which is already very limited and degraded in this part of the Basin. Even small losses to riparian habitat in this part of the Basin, where little riparian habitat remains, can threaten remaining habitat connectivity. Habitat diversity and connectivity is especially important for the dispersal of species like the viceroy butterfly, and for neotropical migrants such as yellow warbler, Bullock's oriole, and willow flycatcher that depend on quality migratory corridors to provide shelter and food resources. Negative impacts on riparian species at the Catholic Creek confluence area would be greater than those associated with the NAA or the other MOs.

The Ramping Rates for Safety operational measure under MO2 would likely have negative impacts on riparian species. The long-term loss of riparian vegetation such as cottonwood and willow as a result of the lifting of ramping rate restrictions would cause indirect negative impacts on productivity and survival of the species that require this vegetation, such as viceroy butterfly and riparian bird species. In addition, increased rate and frequency of stage fluctuations would likely disrupt the life cycles of aquatic emergent insects and other invertebrates, leading to population declines or even extirpation (Kennedy et al. 2016, p. 561). Disrupting the timing or success of insect hatches could also have significant negative implications for productivity and survival of riparian birds, many of which depend more heavily upon the high-protein insect component of their diets during the breeding season when energy expenditure is high, and high quality resources are needed for raising young. Therefore, the lifting of ramping rate restrictions is likely to have negative consequences for riparian species for all sites under MO2 and MO3.

MO3

MO3 Summary of Riparian Landscape Findings

- If steps are taken to prevent the spread of invasive species into newly exposed riparian shoreline beyond what is specified in MO3, the potential long-term ecological benefits to riparian habitat afforded by breaching the earthen portions of the four Lower Snake River dams would be greater than any short-term costs, such as loss of riparian vegetation existing on the current shorelines when water levels drop.
- If implemented properly, MO3 would bring the most ecological benefits to riparian habitat of all the other proposed Ms.

MO3 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

MO3 would further the alteration of the hydrograph and flood regimes in some areas of the Basin, which would lead to the accelerated degradation and loss of native riparian vegetation. However, in the Lower Snake River, the hydrograph would become more like the pre-dam hydrograph, and riparian shorelines would improve with a return to historical shorelines more suitable for riparian growth, which could lead to the long-term increase in quantity and quality of riparian vegetation. The increase in quantity and quality of native riparian vegetation in the Snake River portion of the Basin would improve the structure and vegetative species composition of riparian shorelines, leading to increased habitat complexity, ecosystem function, and connectivity in the Basin. Under MO3, the most ecologically significant changes to the hydrograph will be:

- moderate prolonged shoreline inundation during the spring in the upper portions of the Lower Columbia River;
- slightly decreased peak flows and summer stage in lower regions of the Lower Columbia River such as the Sandy River Delta;
- decreased peak flows and decreased river stage during the spring and summer paired with increased winter stage in the Kootenai River of the Upper Basin; and,
- increased frequency and rate of daily stage changes throughout the Basin (due to ramping rates).

MO3 Impacts on Key Sites

<u>Lower Columbia River: Julia Butler Hansen NWR, Sandy River Delta, Umatilla NWR</u>

Water surface elevation under MO3 is expected to change less than 3 inches (8 cm) downstream of RM 105 (Rkm 169), and this change is within the current range of variability. Impacts on riparian habitat at Julia Butler Hansen NWR, under MO3, will not differ significantly from those of the NAA.

The Ramping Rates for Safety and John Day Full Pool operational measures under MO3 appear to be associated with an increase in water surface elevation downstream of Bonneville Dam by less than 6 inches (15 cm) in November and December and a decrease by 6 inches (15 cm) in January and April through September. The Sandy River Delta would likely experience a loss in riparian habitat as a result of lower spring and summer stage, similar to what would occur under MO1 and MO2.

The John Day Full Pool operational measure under MO3 appears to increase water surface elevation from 6 inches to 12 inches (15 cm to 30 cm) in April and May, resulting in prolonged inundation of riparian shoreline, which could cause mortality of existing riparian vegetation in the inundation zone. Under MO3, impacts on riparian habitat at Umatilla NWR are expected to be similar, but less severe than those of MO1 (18 inches [46 cm] inundation in MO1). Under MO3, one impact may be an increased rate of decline of riparian habitat quantity and quality at Umatilla NWR, compared to the NAA.

Mid-Columbia River: Okanogan River Confluence, Threemile Creek to Six Mile Creek confluences, and the Little Sheep Creek Confluence

As a result of the Chief Joseph Dam Project Additional Water Supply operational measure under MO3 (and MO1), which diverts additional water from the river to support agricultural irrigation needs during the spring and summer, water surface elevation immediately below the dam is only expected to decrease by 1 percent or less, progressively waning downstream of the dam. This minimal amount of change is expected to be within the current range of variability. The Okanogan River confluence is located approximately 6 RM (10 Rkm) downstream of Chief Joseph Dam, and, thus, impacts on riparian habitat under MO3 are not expected to differ significantly from those of the NAA.

MO3 diverts additional water from the mainstem for agriculture, and capturing this extra water would result in an increase in water levels immediately upstream of Grand Coulee Dam by approximately 6 inches (15 cm) during the winter. Withdrawing this water would lead to a decrease in water levels by less than 12 inches (30 cm) in the early spring. Water surface elevation would return to those consistent with the NAA by May. Impacts on riparian vegetation situated immediately upstream of the dam may be minor. Nearly 50 RM (80 Rkm) upstream of Grand Coulee Dam, where Threemile and Sixmile Creek confluences are located, the impacts may be negligible or consistent with those under the NAA.

Structural and operational measures implemented under MO3 likely to impact Lake Roosevelt are only expected to have impacts immediately upstream of Grand Coulee Dam. Little Sheep Creek Confluence is located approximately 140 RM (225 Rkm) upstream of Grand Coulee Dam, and, thus, impacts on riparian habitat under MO3 are not expected to differ significantly from those of the NAA.

Upper Basin: Stillwater River Confluence, Clark Fork Delta at Lake Pend Oreille (Derr Island, Panhandle Wildlife Management Area [WMA]), Yaak River and Star Creek confluences

The Ramping Rates for Safety operational measure under MO3 is the only measure that would impact this site. The co-lead agencies claim that resulting variation in water surface elevation on the South Fork Flathead are within the current range of variability, and that variation in water surface elevation would be even more diluted downstream of the South Fork and the mainstem Flathead River confluence. Because the Stillwater River confluence is located approximately 20 RM (32 Rkm) downstream of the South Fork and mainstem Flathead River confluence, impacts on this area under MO3 are not expected to differ significantly from those of the NAA.

The Hungry Horse Additional Water Supply operational measure under MO3 is expected to have negligible impacts on Lake Pend Oreille, resulting in a lower water surface elevation (by a few inches) in the winter and spring. This change is minor, and it would occur largely outside the spring and summer. Thus, under MO3, impacts on riparian vegetation at the Clark Fork Delta should not differ significantly from those of the NAA.

The Ramping Rates for Safety, Modified Draft at Libby and December Libby Target Elevation operational measures under MO3 increase water surface elevations on the Kootenai River from 6 inches to 24 inches (15 cm to 61 cm) in November and December and decrease in water surface elevations from 6 inches to 36 inches (15 cm to 91 cm) during the rest of the year. The implementation of MO3 would lead to increased mortality of cottonwood and willow during the winter due to rising water levels plucking ice-encased seedlings from the ground, as well as mortality of plants no longer able to access the water table. Under MO3, the loss of riparian vegetation at the Yaak River Confluence would be greater than the loss experienced under MO1, but slightly less than the loss experienced under MO2.

<u>Lower Snake River: Catholic Creek Confluence downriver to Hog Island, Tucannon River Confluence, Big Flat Recreation Area</u>

The Ramping Rates for Safety operational measure under MO3 would lift non-safety-related ramping rate restrictions at Dworshak Dam, but no other operational measures would occur at Dworshak Dam to impact the Catholic Creek confluence. Besides negative impacts resulting from proposed changes in ramping rates, impacts on riparian habitat under MO3 are not expected to differ significantly from those under the NAA.

The dam breaching structural and operational measures under MO3 (Breach Snake Embankments, Lower Snake Infrastructure Drawdown, Drawdown Operating Procedures, and Drawdown Contingency Plans) may impact riparian vegetation at the mouth of the Tucannon River tributary by disconnecting the tributary from the water table when the water level drops. However, riparian vegetation in the tributary itself may persist after mainstem water levels drop due to its connection with the tributary water table. Dam breaching would newly expose shoreline of the former floodplain for new riparian vegetation to colonize. Initially, however, there may be some net loss of riparian vegetation at the mouth of the tributary. As with other sites on the Snake River, there is the potential for the establishment of non-native plants, especially without proper management during and immediately following dam breaching. Adoption of functional flows at Dworshak Dam would promote native riparian establishment over the invasion of non-native species and, coupled with targeted invasive species removal during the first few years following dam breaching, could result in a significant net gain of riparian habitat at the Tucannon River Confluence and other similar habitats in the Lower Snake River subbasin under MO3.

Breaching the four Lower Snake River dams under MO3 could have significant impacts on Big Flat Recreation Area and nearby sites. The recreation area may not change if current management practices continue, but if management ceases, it is likely that Russian olive would continue to dominate this site and, eventually, outcompete native riparian vegetation. Alternatively, if management continued at this site, in concert with invasive plant control efforts, native riparian vegetation could establish on the newly exposed shoreline, resulting in a long-term increase in riparian habitat at this site.

Additional monitoring and management actions would be necessary to ensure the suitable conditions for establishment of native riparian species during and immediately following dam breaching. The co-lead agencies should consider timing dam breaching so shorelines are exposed, coinciding with native riparian seed release and allow a gradual recession of water levels. The adoption of a functional flow regime at Dworshak Dam, at least in high-water years, would also help ensure the survival and longevity of native riparian habitat along the newly exposed shoreline. Assuming the use of available and cost-effective means to prevent the spread of invasive species, there could be a long-term increase and overall improvement in riparian habitat at this site in comparison to the NAA.

All sites under MO3 would be affected by the operational measure (Ramping Rates for Safety) that aims to lift ramping rate restrictions. Thus, for all sites (apart from those sites that would be directly impacted by the implementation of the dam breaching measures), the Service expects this particular operational measure would have negative impacts on riparian habitat as previously described.

MO3 Impacts on Evaluation Species and Other Guilds and Communities

Under MO3, the impacts on species at the Sandy River Delta would be comparable to those under MO1, as the resulting change in water surface elevation under MO3 and MO1 are of approximately the same magnitude and timing. Thus, under MO3, negative impacts on riparian species at Sandy River Delta would be slightly greater than those under the NAA, and comparable to those under MO1, MO2, and MO4.

Under MO3, impacts on riparian species at Umatilla NWR are expected to be similar but less severe than those of MO1. Prolonged inundation could cause some mortality of riparian vegetation along the riparian shoreline, which could result in a net loss of habitat for riparian species such as the yellow warbler, Bullock's oriole, willow flycatcher, and viceroy, all of which have been observed at this site during the breeding season. Inundated riparian habitat could eventually be converted to submerged or emergent aquatic vegetation such as reed canary grass. Conversion of riparian habitat to any other habitats will decrease habitat complexity, ecosystem function, and connectivity. The Lower Columbia River, east of the Cascades, is characterized by little remaining riparian habitat, most of which is degraded, and, thus, even a minor loss in riparian habitat can lead to disproportionate impacts on wildlife resources. Under MO3, negative impacts on riparian species at Umatilla NWR would be greater than those under the NAA or MO2, but not as severe as those under MO1 and MO4.

A decrease in water surface elevation at sites downstream of Libby Dam on the Kootenai River (e.g., Yaak River Confluence) during the early summer would lead to reduced establishment of new cottonwood and willow seedlings, and increased winter stage would cause mortality in newly established seedlings. In addition, a decrease in water surface elevation through the rest of the year could cause drought stress or mortality of existing cottonwood and willow. Loss of cottonwood and willow habitat would impact species that depend on this vegetation for one, or all, life history stages. These species include the viceroy butterfly, which uses only plants in the willow family as larval host plants, and riparian birds (such as the yellow warbler, Bullock's oriole, and willow flycatcher), which use cottonwood and willow habitat for feeding, nesting, raising young, and to sustain long migrations. Drops from current summer water levels could be beneficial if they occur in a way that mimics the natural flow regime and creates additional riparian shoreline suitable for the establishment of riparian vegetation. If initial drops in water surface elevation occur in early June, and are allowed to recede at a rate of no more than 1.0 inch (2.5 cm) per day for the following several weeks, then additional shoreline would be exposed at a time when new riparian vegetation would naturally establish. However, high winter water levels in the Basin could lead to displacement of newly established seedlings, negating the benefits of riparian establishment earlier in the season. Because MO3 includes large increases to water levels in winter stage, the implementation of spring stage recession would be unlikely to benefit riparian species, as increased winter stage would lead to a net decrease in riparian vegetation. Direct impacts on cottonwood and willow would have indirect impacts on riparian species such as riparian songbirds. Under MO3, impacts on riparian species in the area of the Yaak River Confluence would be slightly more negative than those of MO2 and slightly more positive than those under MO1.

Under MO3, at Lower Snake River sites like the Tucannon River Confluence and Big Flat Recreation Area, dam breaching could cause some immediate loss of existing riparian vegetation. However, most of the riparian vegetation in the Tucannon River would likely survive due to its connection with the water table. At the Big Flat Recreation Area, riparian vegetation irrigated by the Corps would also likely survive. Over time, dam breaching would also enable the shoreline to return to a condition closer to its historical state, which once supported more riparian vegetation than the current shoreline. In addition to MO3, newly exposed riparian shoreline at either of these sites could be colonized with native riparian vegetation, if managed properly, thereby further increasing the quantity and potential quality of riparian habitat compared to the NAA.

The initial loss of existing riparian vegetation at the Tucannon River Confluence and Big Flat Recreational Area sites would reduce available nesting sites, decrease the quantity of host plant substrate, and limit food resources for riparian species in the short-term. There may also be short-term decreases in survival and productivity of riparian species at these sites, which could negatively impact local populations. However, in addition to MO3, if some actions are taken to prevent the future spread and establishment of non-native plants into newly exposed riparian shoreline, native riparian vegetation will likely increase in abundance at both of these sites in the long-term, benefitting riparian species.

Under MO3, the Service projects a long-term increase in riparian vegetation, such as cottonwood and willow, in the Lower Snake River reaches, which would lead to long-term benefits to riparian species. Healthier, more complex riparian vegetation would support a more resilient ecosystem in this subbasin.

The Ramping Rates for Safety operational measure under MO3 would likely have negative impacts, as previously described, to all riparian species that inhabit various sites throughout the study area apart from those sites affected by the four structural and operational dam breaching measures.

MO4

MO4 Summary of Riparian Landscape Findings

- Structural and operational measures proposed under MO4 would lead to losses in riparian habitat quantity and quality, comparable to those under MO2, in all areas of the Basin except for on the Kootenai River, where the Lower Stage for Riparian operational measures would benefit the riparian landscape and species inhabitants.
- In comparison to the other MOs, the implementation of MO4, with the inclusion of some riparian landscape-specific management provisions primarily associated with the rate and timing of drawdown, represents the largest opportunity for improvement of riparian habitat quantity and quality.

MO4 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

The structural and operational measures proposed under MO4 would accelerate the degradation and loss of native riparian vegetation in most areas of the Basin. The greatest changes to the hydrograph would include slightly decreased peak flows and summer stage in lower regions of the Lower Columbia River, such as the Sandy River Delta site; extreme prolonged shoreline inundation throughout the spring and summer in the upper portions of the Lower Columbia River; extreme reductions in stage throughout the spring and summer in the Mid-Columbia; and prolonged inundation throughout the spring and summer on the Lower Snake River. However, lower and less erratic fluctuations in winter stage on the Kootenai River resulting from MO4 would shift the current hydrograph closer to the pre-dam hydrograph and, thus, could result in some positive impacts on riparian habitat.

MO4 Impacts on Key Sites

<u>Lower Columbia River: Julia Butler Hansen NWR, Sandy River Delta, Umatilla NWR</u>

Under MO4, changes to water surface elevation downstream of RM 105 (Rkm 169) are expected to be within the current range of variability. Thus, impacts on riparian habitat at Julia Butler Hansen NWR are not expected to differ significantly from those of the NAA.

Under MO4, the Drawdown to MOP operational measure appears to be associated with a decrease in water surface elevation at the Sandy River Delta from 2 inches to 7 inches (5 cm to 18 cm) during the spring and summer, resulting in similar impacts on riparian habitat to what would occur under MO1, MO2, and MO3. Water surface elevation would also increase from 2 inches to 4 inches (5 cm to 10 cm) during the winter, but this change should not impact riparian habitat significantly. As with MO1, MO2, and MO3, decreases in water surface elevation during the spring and summer could result in drought stress or mortality of riparian vegetation. However, newly exposed shoreline could be colonized by native riparian species, provided the initial transition to the lower water level was managed properly. If the rate and timing of drawdown is disregarded, then there would likely be a net loss of riparian habitat in comparison to current conditions, which is consistent with loss resulting from MO1, MO2, and MO3.

The Drawdown to MOP operational measure also appears to be associated with decreasing water surface elevation on river reaches between McNary Dam and Bonneville Dam. This decrease would occur between April and July in most years and between March and August in dry years. Drops in water surface elevation would begin at 6 to 18 inches above McNary Dam, and they would increase in magnitude (2.3 to 4 feet) with distance downstream to Bonneville Dam. Under MO4, the water surface elevation at Umatilla NWR would decrease by approximately 1 to 2 feet, which could lead to significant loss of riparian habitat. As with the Sandy River Delta site above, newly exposed shoreline could be colonized by native riparian species if the initial transition to the lower water level was managed with appropriate timing and a subsequent gradual recession rate, resulting in an increase in riparian habitat. However, without proper management of the stage decrease there would likely be a net loss in riparian habitat under MO4 in comparison to NAA.

<u>Mid-Columbia River: Okanogan River Confluence, Threemile Creek to Six Mile Creek Confluences, and the Little Sheep Creek Confluence</u>

Due to the Lake Roosevelt Additional Water Supply and Chief Joseph Dam Project Additional Supply operational measures associated with MO4, the change in water elevation downstream of Chief Joseph Dam is expected to be within the current range of variability. Therefore, the impacts on riparian habitat at the Okanogan River confluence, resulting from MO4, are not expected to differ significantly from those of the NAA.

The Winter FRM Space and McNary Flow Target operational measures decrease in water surface elevation from 6.0 ft to 8.0 ft (1.8 m to 2.4 m) in the winter in Lake Roosevelt immediately upstream of the Grand Coulee Dam and from 2.0 ft to 8.0 ft (0.6 m to 2.4 m) in the spring and summer. The amount of stage decrease would attenuate with upstream distance from Grand Coulee Dam, resulting in a decrease in water surface elevation from only 3 ft to 4 ft (91 cm to 122 cm) in the winter and from 1 ft to 2 ft (30 cm to 61 cm) in the spring and summer in the upstream reaches near the Canadian border. A decrease in water surface elevation in the winter should be largely inconsequential for riparian habitat quantity and quality, but a decrease in water surface elevation during the spring and summer would result in the loss of riparian vegetation. If the timing of the initial drop in the water level was scheduled appropriately, and at a gradual rate during the first year of implementation, then native riparian species could colonize the newly exposed shoreline, leading to an increase in riparian vegetation quantity. However, the hydrograph for MO4 is stagnant most of the year except for a decrease in water surface elevation between February and July, and would not support the colonization of riparian species and, rather, would likely cater more toward invasive species establishment. Thus, under MO4, it is expected that there would be a greater loss of riparian habitat from the Threemile Creek to Six Mile Creek confluences in comparison to the NAA.

Under MO4, the Winter FRM Space and McNary Flow Target operational measures appear to be associated with a decrease in water surface elevation at the Little Sheep Creek confluence from 3 ft to 4 ft (91 cm to 122 cm) in the winter and from 1 ft to 2 ft (30 cm to 61 cm) in the spring and summer. The nature and mechanism of the impacts on riparian habitat would be similar to those described for Threemile Creek to Sixmile Creek confluences, but less severe. The Service expects there would be a greater loss of riparian habitat at this site in comparison to the NAA.

Upper Basin: Stillwater River Confluence, Clark Fork Delta at Lake Pend Oreille (Derr Island, Panhandle Wildlife Management Area [WMA]), Yaak River and Star Creek confluences

Water surface elevation on the South Fork of the Flathead River is expected to be slightly lower in the winter and spring, and slightly higher in the summer. However, these changes in water surface elevation on the South Fork are expected to be within the current range of variability, and changes downstream of the confluence of the South Fork and mainstem Flathead River are expected to be further diluted. The Stillwater River confluence is located approximately 20 RM (32 Rkm) downstream from the South Fork and mainstem Flathead River confluence, and therefore not expected to experience impacts as a result of MO4 that differ from those of the NAA.

Operational measures implemented at Hungry Horse Dam (e.g., Hungry Horse Additional Water Supply) are expected to have negligible impacts downstream of the South Fork and mainstem Flathead River confluence, where the Clark Fork Delta is located. The McNary Flow Target operational measure at Albeni Falls Dam appears to be associated with no change in water surface elevation in Lake Pend Oreille in most years, but with a reduction in water surface elevation at Lake Pend Oreille during dry years by up to 31 inches (78 cm) during the summer. This decrease in water surface elevation could lead to drought-induced mortality of existing riparian vegetation in dry years. Even if native riparian species were able to colonize the newly exposed soil during dry years, they would become inundated when water levels returned to the normal summer surface elevation in other years. Although, in most years, the impacts of MO4 on native riparian habitat would not differ significantly from those of the NAA, there would be a greater decline in riparian habitat quantity and quality caused by drought-induced mortality during dry years under MO4 in comparison to the NAA and MO2 (6 inch [15 cm] drop in spring water levels)

The Modified Draft at Libby and December Libby Target Elevation operational measures under MO4 appear to be associated with a decrease in water surface elevation downstream of Libby Dam (i.e., Yaak River Confluence) in November and December, increasing from January through March, decreasing in April and May, and increasing through the spring peak flows in June and through July. Under MO4, the Lower Stage for Riparian operational measure would prevent winter water levels from exceeding the previous peak flood water level in a given year. The summary hydrograph from the co-lead agencies H&H modeling output at this site shows slightly higher water levels in January and February, but much lower water levels in November and December, and overall more consistent water levels throughout the winter.

More consistent water levels throughout the winter would help prevent winter mortality of newly established cottonwood and willow by reducing the potential for fluctuating winter water levels to displace ice-encased seedlings. The increased peak flows in June followed by a recession rate similar to that of the NAA, which allows for cottonwood and willow establishment, would benefit riparian habitat by increasing the potential for new recruitment with larger peak floods. Higher water levels through the end of July would also decrease drought stress of riparian vegetation during hot, dry summers. This regime would further enhance functional flows already occurring at Libby Dam that favor cottonwood and willow recruitment, and also increase overwintering survival of newly established seedlings that would be under threat of rising winter water levels in current conditions. Riparian habitat at this site is expected to increase in quantity and quality as a result of proposed modifications under MO4 in comparison to those of the NAA.

Lower Snake River: Catholic Creek Confluence downriver to Hog Island, Tucannon River Confluence, Big Flat Recreation Area

No changes in operations at Dworshak Dam would occur under MO4. Impacts of the Drawdown to MOP operational measure at Lower Granite Dam would decrease water surface elevation by approximately 12 inches (30 cm) in March and increase water surface elevation by approximately 4 inches (10 cm) in spring and summer. However, impacts on the Lower Granite Dam pool would be reduced upstream of the Catholic Creek confluence, and the summary hydrograph for the Catholic Creek confluence is nearly identical to that of the NAA. Thus, under MO4, impacts on riparian habitat at this site would not differ significantly from those of the NAA.

Under MO4, the Drawdown to MOP operational measure at Ice Harbor Dam appears to be associated with a decrease in water surface elevation by approximately 12 inches (30 cm) in March, as well as an increase of approximately 4 inches (10 cm) through June, in reaches above Ice Harbor Dam including the Tucannon River Confluence. A decrease in water levels in March may lead to drought stress of riparian vegetation. The maintenance of higher water levels through June would overlap with normal peak flow and seed release in early June, which would inhibit the regeneration of riparian vegetation. The summary hydrograph for the NAA at the Tucannon River Confluence is abnormally shaped, as it is for MO4, but with lower lows in the early spring and higher peaks in June. Thus, impacts on the riparian landscape at the Tucannon River Confluence under the NAA and MO4 will be similar, but, under MO4, there may be some further degradation of the riparian landscape.

At the Big Flat Recreation Area, the Drawdown to MOP operational measure would lead to changes in water surface elevation similar to those described for the Tucannon River Confluence. However, the majority of riparian vegetation at Big Flat HMU is heavily managed and exists at an elevation that would not be inundated by a modest increase in water surface elevation. Riparian vegetation that is not irrigated but exists naturally adjacent to the shoreline could be negatively impacted by early summer inundation under MO4, but the majority of riparian vegetation at this site would likely remain unaffected. Overall, under MO4, the quantity and quality of riparian vegetation at this site is not expected to differ significantly from that of the NAA.

MO4 Impacts on Evaluation Species and Other Guilds and Communities

Under MO4, the impacts on species at the Sandy River Delta site would be comparable to those described under MO1, as the resulting change in water surface elevation under MO1 and MO4 are of approximately the same magnitude and timing. Thus, under MO4, negative impacts on riparian species at the Sandy River Delta site would be slightly greater than those under the NAA, and comparable to those of MO1, MO2, and MO3.

Under MO4, water surface elevation at Umatilla NWR would decrease throughout most of the spring and summer, dropping between approximately 1 ft and 2 ft (30 cm and 61 cm) in April through July in most years and March through August in dry years. The drop in water surface elevation during June would further reduce spring peak flows, inhibiting recruitment of new cottonwood and willow, and lower water levels throughout the spring and summer could result in drought stress and mortality of existing cottonwood and willow. The net loss of riparian vegetation at this site would lead to indirect impacts on riparian species such as the yellow warbler, Bullock's oriole, willow flycatcher, and viceroy butterfly. A reduction in the quantity and quality of riparian habitat could lead to reduced productivity and survival of these species at this site and others. Riparian habitat is limited in quantity and quality in this subbasin, and, thus, even minor losses can have disproportionate effects on fish and wildlife resources.

Under MO4, water surface elevation at both Threemile to Sixmile Creek confluences and Little Sheep Creek confluence would decrease in the winter and throughout the spring and summer. Cottonwood and willow vegetation unable to maintain contact with the lower water table during the spring and summer would undergo drought stress and mortality, and there would be a net loss of riparian vegetation quantity and quality, which would impact local riparian animal populations that would suffer from loss of habitat. Due to the altered hydrographs at these sites and the new shoreline to be exposed under MO4, there would likely be an increased risk of the spread and establishment of non-native species. However, appropriate flow management could negate these negative impacts and even result in benefits to riparian habitat. Without appropriate flow management, however, negative impacts on riparian species upstream of Grand Coulee Dam would be greater than those of the NAA or the other MOs.

Potential drought stress experienced by riparian vegetation combined with increased inundation through the end of June would likely further degrade riparian vegetation at the Tucannon River Confluence in comparison to current conditions. Riparian stringers such as the one at the Tucannon River Confluence are important to maintain, as they serve as dispersal and migratory corridors for riparian species. In comparison to the NAA, MO4 is the only proposed MO that would result in greater negative impacts on riparian species at the Tucannon River Confluence.

The reduction in water surface elevation at the Clark Fork Delta during dry years of up to 2.6 ft (70 cm) during the spring and summer would result in drought stress and subsequent mortality of cottonwood and willow. Under MO4, adverse impacts on riparian habitat at the Clark Fork Delta exceed those of the NAA, MO1, and MO3, and they are comparable to those of MO2.

Riparian songbirds such as yellow warbler, Bullock's oriole, and willow flycatcher and other riparian species would suffer indirectly from long-term loss of cottonwood and willow all of these aforementioned sites. During dry years, wildlife resources may also suffer directly due to desiccation of habitat. For example, the desiccation of typically moist or inundated shoreline in the middle of the summer can disrupt the life history stages of invertebrates, such as aquatic emergent insects, which feed breeding riparian birds, among other species, and help form the base of the riparian food web.

Riparian vegetation at the Yaak River Confluence would likely benefit from the impacts of MO4 for several reasons. First, winter water levels would be more consistent in general, and they would be managed to not exceed levels of the previous peak flow. Second, peak flows would be slightly higher in June, followed by a carefully managed stage recession rate that would promote the recruitment of native riparian vegetation. Third, slightly higher water levels in July would reduce drought stress for riparian vegetation during hot and dry summer periods. These factors would likely cause a modest increase in quantity and quality of riparian vegetation immediately adjacent to the shoreline, even though riparian vegetation situated deeper into the riparian corridor would be unlikely to benefit. In comparison to current conditions, MO4 is the only proposed MO under which riparian species in the area of the Yaak River Confluence would likely gain some ecological benefits.

WETLANDS

NAA

NAA Summary of Wetlands Landscape Findings

- Structural and operational measures associated with the NAA will continue to maintain the current quantity and quality of wetland vegetation, subhabitats, and species inhabitants at key sites in the study area.

NAA Impacts on Indicators of Ecological and Physical Processes and Subhabitats

<u>Habitat Complexity and Ecosystem Function</u>

Continued dam operations and water surface elevation changes will result in reduced habitat complexity and ecosystem function across the wetlands landscape in the study area, impacting the ecological and physical processes that support wetland vegetation important for evaluation species and other species. These conditions and their impacts would continue under the NAA. In some parts of the Basin, the current composition of native wetland vegetation, in particular, is low, and the implementation of structural and operational measures under the NAA would likely lead to further losses in plant and wildlife species diversity.

Pre-Dam Hydrograph and Natural Flood Regime

The wetlands landscape and subhabitats may be affected by mainstem river discharge or fluctuating water surface elevation either directly (i.e., direct connection or interactions) or indirectly via long-term impacts of water discharge patterns. The NAA will continue to sustain wetland habitats and subhabitats in their current ecological condition, and continued regulation of the hydropower system will limit pioneering of wetland habitat reestablishment in the study area (USFWS 2019c).

NAA Impacts on Key Sites

Key Island Sites

For the purposes of the FWCAR, the Service analyzed impacts of the NAA and all other MOs on key island sites in the four subbasins. These islands, and others in the study area, are characterized by wetlands landscape that is likely to be particularly sensitive to fluctuations in water surface elevation as a result of both continued and modified dam operations and maintenance.

The NAA represents the baseline ecological conditions under the current configuration of the CRSO and its operations. The NAA includes an array of structural and operational measures, along with a major off-site habitat-restoration program (i.e., at Steigerwald Lake NWR), which could affect the wetlands landscape at certain island sites. Under the NAA, the co-lead agencies will maintain wetland habitats and subhabitats in their current, but overall degraded, state at island key sites as a result of alternating periods of desiccation and inundation of wetlands, disconnected from the mainstem and river subhabitats. Future wetlands landscape-driven restoration projects may improve the complexity and ecological function of the wetlands landscape at local levels.

Key River Delta Sites

For the purposes of the FWCAR, the Service analyzed impacts of the NAA and all other MOs on key river delta sites in the four subbasins. These river deltas, and others in the study area, are characterized by wetlands landscape that is likely to be particularly sensitive to fluctuations in water surface elevation as a result of both continued and modified dam operations and maintenance (Vörösmarty et al. 2009, p. 35). These conditions and their impacts would continue under the NAA.

For example, continued fluctuations in water surface elevation under the NAA would likely lead to more frequent periodic erosion, supporting a pattern of alternating periods of desiccation and inundation of wetland habitats and subhabitats. These fluctuations will ultimately affect the expansion of the wetlands landscape and limit the foraging and nesting opportunities for wetland-obligate species (USFWS 2019c).

At the 15,000-ac (61-km^2) McNary NWR, water entrained from the CRSO has created a network of high-carbohydrate food-providing farm fields and wetland subhabitats throughout the refuge. The Burbank Slough system occupies the original Snake River channel and has evolved to a stabilized water system that produces high quality aquatic vegetation beds for staging and wintering waterfowl. The Wallula Unit encompasses the original Walla Walla River Delta and floodplain, and has transitioned to an active management area to replicate natural hydrologic regimes through moist-soil wetland impoundments (Healy, F., in litt. 2019). Over 75,000 ac (304 km^2) of riverine habitat within the jurisdiction of the McNary NWR contain native submerged aquatic vegetation beds that support a significant proportion of the wintering waterfowl in the Basin (USFWS 2007, p. 4-26).

NAA Impacts on Evaluation Species and Other Species

Species that rely on wetland habitats and subhabitats in the study area include the American bittern, Columbia yellowcress, mallard, sora, tiger salamander, Western painted turtle, Woodhouse's toad, and Western toad. In current ecological conditions, some of these species benefit more from dam operations than others. For example, mallard will continue to occupy slow moving waters within the wetlands landscape Basinwide on an annual basis, and they continue to utilize nesting areas in the uplands landscape from April to June. Reptiles and amphibians, including turtles, toads, and salamanders, will also continue to utilize the existing wetland landscape to complete various life history stages (FERC 2006, p. 241).

The implementation of structural and operational measures associated with the NAA will enable the American bittern and sora to use wetland subhabitats comprised of tall, emergent vegetation. However, regulated water surface elevation in the study area will affect population expansion and productivity of these species by continuing to reduce access between foraging and breeding areas (Stevens et al. 1997, p. 164). These conditions and their impacts would continue under the NAA.

Prior studies show that artificial flooding of wetland habitat and subhabitats for prolonged periods of time, a result of dam operations, can alter grass and sedge composition (Ward and Stanford 1979, p. 127). This artificial flooding, to varying degrees, is expected to continue with the implementation of the NAA. Columbia yellowcress, for instance, located in the Mid-Columbia River, will be impacted by hydrological changes associated with the NAA (FERC 2006, p. 273). Species populations may vary in abundance as changes in patterns of water surface elevation may impact individuals' ability to grow and reproduce seasonally (during late summer and early fall).

MO1

MO1 Summary of Wetlands Landscape Findings

- Structural and operational measures associated with MO1 will result in low to moderate impacts on wetland habitat and subhabitats, especially throughout the Lower Columbia River subbasin and the Kootenai River.

- The implementation of some measures under MO1 would lead to the temporary inundation of wetland subhabitats at some key sites and, conversely, the desiccation of wetland habitats and subhabitats at other sites, resulting in the potential for non-native species invasion.

MO1 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

The implementation of several operational measures under MO1, including those proposed for Libby Dam in northwestern Montana (e.g., Modified Draft at Libby), have the potential to negatively affect wetland habitats and subhabitats by increasing or decreasing water surface elevation more frequently and for a greater duration of time than in current conditions. These impacts would be especially evident in backwaters, which may become disconnected from the mainstem (e.g., Kootenai River). Disconnected wetlands expose species inhabitants to a higher level of desiccation, which results in less complex habitat and reduced species abundance (USFWS 2019c).

Changes in water surface elevation resulting from MO1 would also negatively impact wetland vegetation quantity and quality in comparison to NAA conditions. Higher water levels in the summer (June through September) would increase inundation at adjacent wetland habitats upstream of dams, resulting in potential loss of existing emergent vegetation or a transition in plant community structure and status (to one that is more tolerant of patterns of regular inundation). However, under MO1, the implementation of operational changes in outflows downstream of Federal projects would reduce water levels during the spring by several inches, thereby preventing regrowth of existing native vegetation and resulting in the desiccation of wetland habitats.

MO1 Impacts on Key Sites

<u>Key Island Sites</u>

Lower Columbia River: Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area

As a result of the Block Spill Test (Base + 120/115 percent) and Increased Forebay Range Flexibility operational measures, impacts on island sites in the Lower Columbia River would be evident at Reed Island, and Steigerwald Lake NWR and Sauvie Island Wildlife Area. These measures would likely result in the periodic short-term reduction of water during spring and summer, leading to desiccation of wetland habitats.

Mid-Columbia River: Hanford Reach and Wells Wildlife Area

The implementation of the Block Spill Test (Base +120/115 percent) operational measure would likely have diminished impacts in the Mid-Columbia River at identified island sites. The Hanford Reach, in particular, would be exposed to the impacts of this test due to operational changes at Grand Coulee Dam. In comparison to the NAA, water surface elevation near the Hanford Reach is expected to decrease by approximately 6 inches (15 cm) from February through September. Thus, under MO1, the Hanford Reach will likely experience short-term periods of desiccation in May and June, resulting in the potential loss critical wetland vegetation and cover that supports species' breeding and rearing areas. These impacts may also be evident, but diminished, upstream at the Wells Wildlife Area.

Upper Basin: Everett Island and Kootenai NWR

Under MO1, the impacts of some operational measures would likely be diminished during some water years at key island sites like Everett Island that are adjacent to river tributary subhabitat, which can buffer the impacts of fluctuating water levels. According to the co-lead agencies H&H modeling output, water surface elevation at most sites during most water years would likely be similar to that in current conditions. However, during the highest water years, in river reaches below Albeni Falls Dam, sites like Everett Island might experience a decrease in water surface elevation of 5 inches (13 cm) in November. Overall, changes in water surface elevation related to MO1 could result in a faster rate of decrease in wetland quality at Everett Island and other sites in comparison to the NAA.

In comparison to the NAA and other MOs, the implementation of the Modified Draft at Libby and December Libby Target Elevation operational measures in MO1would have the greatest impacts on the wetlands landscape in the Upper Basin at the Kootenai NWR. Under MO1, the water surface elevation would be lower in December and higher in February and March at the Kootenai NWR. The refuge currently manages wetland subhabitat by pumping water from the Kootenai River and Deep Creek from September through November, and dikes keep the river flows from impacting the majority of the refuge's wetlands. Higher water surface elevation during this time could lead to increased inundation at the Kootenai NWR, but likely only in some wetlands outside of existing dikes. After March, as air and water temperatures warm, proposed operational measures would result in lower flows near the Kootenai NWR. Lower flows could be detrimental to the wetlands landscape only if they are low enough to disconnect wetlands from the mainstem Kootenai River (Stenvall, C., in litt. 2019b).

Lower Snake River: Silcott Island

As a result of MO1, wetland habitats and subhabitats at Silcott Island in the Lower Snake River would also likely experience slightly more inundation, however, the impacts of erosion during this time would be buffered and would not differ from those of the NAA.

<u>Key River Delta Sites</u>

In most years, the implementation of MO1 would be expected to result in no major impacts on key river delta sites in the study area. For example, in the Pack River Delta near Lake Pend Oreille in the Upper Basin, there would be a slight rise in late summer flow, but within the current range of variability. Under MO1, changes in water surface elevation changes in mainstem river subhabitat in the study area would also likely fall within current range of variability and, thus, would have little to no impact to the wetlands landscape throughout all subbasins. Under MO1, McNary NWR would likely experience similar impacts on those of the NAA. However, in the case that McNary NWR and the affiliated Walla Walla River Delta experience significantly lower water levels under MO1, then the refuge's water management capabilities will be impaired (Healy, F., in litt. 2019; Stenvall, C., in litt. 2019a).

MO1 Impacts on Evaluation Species and Other Species

A decrease in water levels during the spring and summer in the Lower Columbia River could reduce the quantity and quality of wetland habitats, especially at NWR sites including Reed Island, Steigerwald NWR, and Sauvie Island Wildlife Area, where Service managers maintain wetlands landscape for species such as Western painted turtles.

As a result of changes in water levels proposed under MO1, species that live in and use wetland habitat and subhabitat in the study area and in the Mid-Columbia River may experience negative impacts. For example, mallard would have less open water to forage, and potential desiccation of some wetland habitats could lead to loss of breeding and rearing areas for amphibians (e.g., Woodhouse's toad) that inhabit the Hanford Reach and Wells Wildlife Area. Mallard, tiger salamander, and Western painted turtle may be less influenced by MO1 at the Lower Crab Creek site, since changes in water surface elevation resulting from operations of Grand Coulee Dam would be minor. Overall, the implementation of structural and operational measures associated with MO1 would lead to immeasurable impacts on the survival, growth, and reproduction of wetland species in the Mid-Columbia River in comparison to the NAA.

In the Upper Basin, mallard would likely benefit initially from high water surface elevation for feeding. As higher water levels persist, the composition of emergent vegetation in inundated areas will transition and, instead, support a different suite of species that are perhaps more adaptable in their food resource needs (e.g., mallard). For example, MO1, which includes operational measures that would increase the frequency and duration of fluctuations in water surface elevation, will impact species (e.g., mallard, sora, and Western toad) at Kootenai NWR. Increased water levels over longer periods of time would limit seasonal access to forage resources and reduce available besting habitat during the breeding season. Given the current dike infrastructure at Kootenai NWR, shallow backwaters at this site (i.e., at the confluence of the Kootenai River and Myrtle Creek) may become intermittently dry as water surface elevation decreases, leading to desiccation of some wetland habitat needed by amphibians (e.g., Western toad) to lay their eggs (McMenamin et al. 2008, p. 16989; Stenvall, C., in litt. 2019b).

The implementation of the operational measure (Modified Dworshak Summer Draft) at Dworshak Dam has the potential to negatively affect wetland habitats and evaluation species at Silcott Island and the Snake River and Palouse River deltas, yet the impacts diminish below the confluence of the Clearwater River. Mallards would likely benefit from the creation of more wetlands landscape with slower moving water. Under MO1, proposed changes in summer draft operations may also benefit amphibians. The Western toad, for example, breeds in pools and slower-moving waters in Idaho from early May to late June, and tadpoles are generally present from late May to early September (WDFW 2015, p. 19). Increasing the quantity and quality of wetted areas during the breeding season would support increased reproductive success and overall fecundity of this species, which is susceptible to minor changes in water quality (USFWS 2019c).

Increased reservoir water surface elevation as a result of proposed changes in MO1 may reduce water velocity at some sites and, thus, would likely lead to an increase in predation by non-native species (e.g., amphibians, birds, and fish)of amphibians in the study area (Rosen and Schwalbe 1995, p. 453). Alternatively, decreased reservoir water surface elevation could lead to the invasion and establishment of non-native plant species in drawdown zones.

MO2

MO2 Summary of Wetlands Landscape Findings

- A general pattern of higher winter flows followed by lower spring and summer flows at various island and river delta key sites in the study area may lead to conversion of wetland habitats and displacement of evaluation species.
- Proposed operations of the CRSO Federal project reservoirs MOP would result in widespread negative impacts on the wetlands landscape and evaluation species.

MO2 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

In general, MO2 includes structural and operational measures that will result in more frequent fluctuations in water levels, thereby negatively impacting the growth potential of critical wetland vegetation (USFWS 2019c). Under MO2, on average, water levels immediately downstream of Bonneville Dam would be slightly higher in the winter (November through January) and lower in the spring and summer. Although these changes appear to be minor, they would likely lead to low to moderate changes in wetland habitat complexity and ecosystem function throughout the Lower Columbia River in comparison to the NAA.

The implementation operational measures associated with MO2 (e.g., Planned Draft Rate at Grand Coulee) would likely result in deeper drafts for power generation, which would lower water surface elevation from 3 ft to 6 ft (1 m to 2 m) during the winter at Grand Coulee Dam and in Lake Roosevelt. Since these proposed changes in drafting operations would be implemented during the winter months, there would be negligible impacts on wetland habitats and subhabitats during the spring and summer. Deeper drafts could affect the pre-dam hydrograph and natural flood regimes in the Mid-Columbia River unless such drafts remain in the current range of variability.

At the Kootenai NWR on the Kootenai River, water levels under MO2 would vary between 1.5 ft and 3.0 ft (46 cm and 91 cm) higher in early winter and approximately 1.5 ft (46 cm) lower during the rest of the year. As a result of higher winter flows, the banks and shoreline of the mainstem

Kootenai River would become inundated, and any riparian vegetation (i.e., cottonwood and willow) seeds and seedlings deposited during the summer months would be carried downstream as flows recede in January. Lower spring freshets would likely reduce deposition of riparian seeds onto banks and shorelines, thereby reducing the potential for cottonwood and willow establishment. Higher water levels in the mainstem during the winter could freeze water in and around the shoreline, which would increase the likelihood of bank sloughing and erosion, degrading water quality.

Under MO2, the co-lead agencies would draft Dworshak Reservoir for power generation, and pool elevation would decrease from approximately 2.5 ft to 3 ft (76 cm to 91 cm) during the winter, spring, and summer (January to August). In this scenario, water surface elevation would be reduced at Silcott Island while it would be maintained at current levels further downstream on the Snake River and Palouse River deltas.

MO2 Impacts on Key Sites

<u>Key Island Sites</u>

Lower Columbia River: Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area

In the Lower Columbia River, operational measures associated with MO2 (Ramping Rates for Safety and John Day Full Pool) may expose the wetlands landscape on island sites to various negative impacts. On average, water levels immediately downstream of Bonneville Dam at Reed Island, Steigerwald Lake NWR, and Sauvie Island Wildlife Area would be slightly higher in the winter (November through January) and approximately 0.5 ft (15 cm) lower in the spring and summer. The reduction in water surface elevation during the spring and summer would limit water availability as it is needed to sustain critical wetland vegetation, thereby reducing the quality of wetland habitats in comparison to the NAA.

Mid-Columbia River: Hanford Reach and Wells Wildlife Area

Under MO2, the Planned Draft Rate at Grand Coulee and Slightly Deeper Draft for Hydropower operational measures would result in noticeable impacts on the wetlands landscape at island sites in the Mid-Columbia River. However, the Winter System FRM Space operational measure could influence water levels upstream of McNary Dam. The projected increase in water levels during the winter and the decrease in water levels during the spring and summer would be less than 0.5 ft (15 cm) different in comparison to those expected under the NAA. These changes, compared to those associated with the NAA and other MOs (MO3 and MO4) would likely lead to a faster rate of decrease in quality of the wetlands landscape quality in the Hanford Reach, whereas the potential impacts of these changes would likely be less impactful at the Wells Wildlife Area.

Upper Basin: Everett Island and Kootenai NWR

Proposed structural and operational measures in association with MO2 would impact wetland habitats in a variety of ways. For instance, the implementation of MO2 would cause notable changes in outflow from Libby Dam in almost every season; however, changes to wetland habitats and species inhabitants would likely be most evident during the winter, as a result of the December Libby Target Elevation operational measure.

Higher water levels in the Kootenai River and at Kootenai NWR during the winter could lead to increased bank sloughing and erosion, resulting in degraded water quality. Implementing the Ramping Rates for Safety operational measure at Hungry Horse Dam would influence flow conditions and water surface elevation, but in a less significant way, at Albeni Falls Dam. Everett Island in the Pend Oreille River and similar wetland habitats throughout the Upper Basin would also experience moderate impacts, including a reduction in abundance and distribution wildlife resources that live and use the wetlands landscape. Lastly, in comparison to the NAA, changes in ramping rates under MO2 would likely alter patterns of seed dispersal, germination and establishment, and the long-term viability of wetland vegetation at these island sites.

Lower Snake River: Silcott Island

The implementation of other operational measures in association with MO2, with impacts on wetland habitats in the Lower Snake River include: Spill to 110% TDG, Ramping Rates for Safety, Full Range Reservoir Operations, Slightly Deeper Draft for Hydropower, Full Range Turbine Operations, Contingency Reserves in Fish Spill, Winter System FRM Space, and Zero Generation Operations. At Silcott Island, in comparison to the NAA, changes in water surface elevation as projected under MO2 would likely result in a decrease of hydrologic connectivity related to wetland habitats, leading to desiccation and a transition in plant community structure and status.

<u>Key River Delta Sites</u>

Lower Columbia River: Sandy River Delta

Under MO2, average water levels immediately downstream of Bonneville Dam would be less than 1 ft (30 m) higher in the winter and approximately 0.5 ft (15 cm) lower in the spring and summer. In comparison to the NAA, wetland habitats and subhabitats at the Sandy River Delta and elsewhere (e.g., Walla Walla River Delta) would experience minor negative impacts due to fluctuating water levels, with these impacts under MO2 becoming progressively muted downstream, near the Columbia River Estuary.

Mid-Columbia River: Lower Crab Creek and McNary NWR

Wetlands at the Lower Crab Creek and other key sites in the Mid-Columbia River would also, similar to what would occur in current conditions, likely remain intact under MO2. McNary NWR, for instance, would not experience negative impacts as a result of changes in water levels or flow conditions.

Upper Basin: Pack River Delta

In the Upper Basin, various habitats most likely to be affected by fluctuating water levels under MO2 would be mudflats and barren zones, emergent and forested wetlands, scrub-shrub wetlands, and submerged aquatic beds. Implementing MO2, in comparison to the NAA, would increase exposure of these habitats to erosion from boat wakes, wind, and waves. Under MO2, these impacts would impact the Pack River Delta due to increased desiccation of submerged aquatic vegetation and emergent wetland plants, which could lead to decreased productivity and changes to plant composition in wetland habitats over time.

Lower Snake River: Snake River Delta and Palouse River Delta

The implementation of the Ramping Rates for Safety and Winter System FRM Space operational measures associated with increased hydropower production would be most likely to have the greatest adverse impacts on the wetlands landscape in the Lower Snake River. Alternatively, wetland habitats that characterize the Snake River Delta will remain intact, as changes in water surface elevation would be less significant downstream towards the confluence of the Snake River.

MO2 Impacts on Evaluation Species and Other Species

Under MO2, in the Lower Columbia River, a 1-ft (30-cm) rise in water surface elevation in the winter and a 0.5 ft (15 cm) decrease in the spring and summer may threaten the survival of American bittern, and Western painted turtle local populations, especially at Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area. Other species at the Sandy River Delta site, for instance, may not be affected by structural and operational measures associated with MO2.

Under MO2, in the Mid-Columbia River, both an increase in water surface elevation during the winter and a decrease in water surface elevation during spring and summer would be less than 0.5 ft (15 cm) in comparison to that under the NAA. These changes would be most evident in terms of impacts observed at the wetlands landscape at the Hanford Reach, downstream of Priest Rapids Dam. While proposed changes in water surface elevation as a result of the implementation of MO2 may be within the current range of variability, mallard and Woodhouse's toad may be displaced from existing narrow segments of wetland habitats due to decreased water availability in the spring and summer. Additionally, off-channel wetlands connected to the Columbia River may become disconnected, negatively influencing the ability of amphibians to successfully rear their young (USFWS 2019c).

In the Upper Basin, proposed changes in ramping rates and draft conditions at Albeni Falls Dam would change water surface elevation on Lake Pend Oreille and the Pend Oreille River, downstream of the dam. While proposed operational measures at Libby Dam would result in higher winter flows and lower spring flows, the current trend of degrading wetland vegetation and habitat conversion would likely continue (Kootenai 2009, p. 2-64). While mallard foraging opportunities might be more readily available as a result of higher winter flows, sora nesting and

Western toad rearing could be negatively impacted. Changes in water surface elevation on Lake Pend Oreille, particularly at the Pack River Delta, would further alter the availability and quality of critical wetland vegetation and suitable nesting habitat for the American bittern, mallard, and sora.

Under MO2, American bittern, mallard, and Western toad would experience noticeable impacts at Silcott Island in the Lower Snake River. In response to changes in water surface elevation at this key site, wetland evaluation species may relocate to areas with more suitable foraging habitat. Impacts on other species at the Snake River and Palouse River deltas would be minor.

In the study area, proposed changes to operations of the CRSO Federal project reservoirs above MOP would likely negatively impact wetland vegetation growth and survival by increasing opportunities for invasion and establishment of non-native species and predators (Rosen and Schwalbe 1995, p. 453).

MO3

MO3 Summary of Uplands Landscape Findings

- Structural and operational measures related to breaching of the earthen portions of the four dams on the Lower Snake River will lead to negative short-term and positive long-term impacts on ecological and physical processes that support the structure and function of the wetlands landscape.
- Under MO3, discrete wetland habitats and subhabitats could become desiccated, resulting in negative impacts on some evaluation species. However, if wetland restoration activities in addition toMO3 are implemented and monitored long-term, then wetland habitat quality may increase.

MO3 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

Under MO3, changes in water levels and patterns of inundation and seasonal drying have the potential to drown out wetland vegetation, but this impact may not be noticeable in the Lower Columbia and Mid-Columbia river subbasins. The two structural and two operational dam breaching measures associated with MO3, if implemented, would restore a portion of the Lower Snake River to a free-flowing state and, thus, over time, more closely resemble a pre-dam hydrograph and more natural flood regime (Grill et al. 2019, p. 215).

The implementation of the dam breaching measures could result, in deposition of sediment at the Snake River Confluence in the McNary Pool. This deposition, over time, would likely support the reestablishment of wetland habitats and subhabitats downstream of the confluence. However, breaching the earthen portions of the four Lower Snake River dams would likely reduce habitat complexity and ecosystem function in the short-term.

The implementation of structural and operational measures under MO3 would change the composition, quantity, and quality of wetland vegetation in the study area, especially in the Lower Snake River. Reservoir drawdown would likely threaten existing wetland habitats, now perched higher in the tributaries, with extended periods of drying. Non-native vegetation could spread and establish in drawdown zones if active habitat restoration does not occur.

MO3 Impacts on Key Sites

<u>Key Island Sites</u>

Lower Columbia River: Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area

Structural measures associated with MO3, if implemented, would be unlikely to noticeably affect wetland habitats negatively throughout the Lower Columbia River. Key sites might experience the impacts of minor changes in water surface elevation under MO3, similar to those described in the other MOs. These changes would be most evident in the Columbia River Gorge, downstream of Bonneville Dam.

Lower water levels in the Lower Columbia River in the spring and summer would limit the quantity and quality of wetland vegetation at managed wetlands (e.g., Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area). In comparison to the NAA, those wetland habitats with less water availability will lose more wetland vegetation during the spring and summer due to desiccation under MO3.

Mid-Columbia River: Hanford Reach and Wells Wildlife Area

MO3 includes five operational measures (Ramping Rates for Safety, Update FRM Calculation, Planned Draft Rate at Grand Coulee Dam, Grand Coulee Maintenance Operations, and Lake Roosevelt Additional Water Supply) that propose changes in operations likely to result in impacts on wetland habitats in the Mid-Columbia River. These changes would result in operations similar to those under the NAA rather than those under MO1 or MO4, and they would likely lead to a decrease by 1 ft (30 cm) in water surface elevation from April to October. Collectively, the Service does not anticipate the aforementioned measures to result in measurable impacts on existing conditions at the Hanford Reach and Wells Wildlife Area, among others.

Upper Basin: Everett Island and Kootenai NWR

Under MO3, operational measures including Ramping Rates for Safety, Sliding Scale at Libby and Hungry Horse, Modified Draft at Libby, December Libby Target Elevation, and the Hungry Horse Additional Water Supply would likely influence the wetlands landscape throughout the Upper Basin.

Outflows near Everett Island and Kootenai NWR would likely increase by 10 to 35 percent in early winter (November and December) and decrease by 5 to 40 percent during the rest of the year. As a result, water surface elevation on the Pend Oreille and Kootenai rivers would be between 0.5 ft to 2.0 ft (15 cm to 61 cm) higher in the early winter and between 0.5 ft to 3.0 ft (15 cm to 91 cm) lower during the rest of the year, in comparison to those conditions under the NAA.

High winter flows would likely inundate river banks at Everett Island and Kootenai NWR and redistribute seeds from existing wetland habitats and subhabitats. Higher water levels in the winter would also lead to increasing bank sloughing and erosion, which would potentially degrade water quality. Lower spring flows would likely reduce the moisture content of wetland soils, thereby reducing the suitability of shorelines in the spring and summer for successful seed deposition and wetland plant establishment.

Lower Snake River: Silcott Island

The structural and operational dam breaching measures associated with MO3, if implemented, have the potential to result in widespread, long-term positive impacts on the wetlands landscape in the Lower Snake River, especially at island sites. Under MO3, water surface elevation would drop from approximately 95 ft to 110 ft (29 m to 34 m) exposing approximately 13,800 ac (56 km^2) of substrate (mostly sand and silt) along the banks of the Lower Snake River. According to the co-lead agencies H&H modeling output and GIS modeling, the wetlands landscape would decrease significantly in quality, and the availability of other landscapes would increase in comparison to those conditions under the NAA. Beyond MO3, wetland vegetation could be reestablished as a result of focused restoration efforts and long-term monitoring.

However, the Service projects that wetland subhabitat could be reestablished as a result of focused restoration efforts and long-term monitoring.

Because most emergent wetland subhabitats are linked to hydrologic regimes associated with the Snake River in this subbasin, transitioning from a reservoir system to river system with lower water elevation would impact long-term wetland habitat quantity, quality, and distribution throughout the 140-mile (64-km) section of river.

Where wetlands already occur in the NAA, these habitats could transition to uplands habitats. Beyond MO3, with the assistance of habitat restoration efforts and related activities, over time, new wetland habitats and subhabitats could establish, especially at Silcott Island.

<u>Key River Delta Sites</u>

Lower Columbia River: Sandy River Delta

Under MO3, wetland habitat will likely be maintained at the Sandy River Delta in the Lower Columbia River, providing high quality habitat for the benefit of local plants and wildlife. Patterns of flooding or inundation and erosion, and the resulting impacts of these ecological and physical processes on wetland habitats and subhabitats would not substantively change from those in current conditions.

Mid-Columbia River: Lower Crab Creek and McNary NWR

Structural and operational measures under MO3, if implemented, would produce negligible impacts in downstream flows through the Mid-Columbia River. Wetland habitats at Lower Crab Creek, for instance, would likely remain intact.

The four structural and operational dam breaching measures associated with MO3, however, would result in an extreme amount of sedimentation at McNary NWR. Native soils that existed prior to the dam and flooding will experience further sediment deposition. In the short-term, many of the submerged aquatic vegetation beds that occur at this key site will be lost or degraded due to the sedimentation or conversion to more riverine (i.e., lotic) subhabitats. At McNary NWR, existing infrastructure for wetland management and cooperative farming will be severely compromised (Healy, F., in litt. 2019). In the long-term, focused restoration efforts and long-term monitoring beyond, or in conjunction with, MO3 could assist in reestablishing wetland vegetation and increasing the quality of wetland habitats throughout the Basin.

Upper Basin: Pack River Delta

In the Upper Basin, the implementation of the Hungry Horse Additional Water Supply operational measure would reduce flows on the Flathead, Clark Fork, and Pend Oreille rivers by 90 kcfs (2,549 m^3s^{-1}) in the winter and spring; however, this measure would have negligible impacts on water surface elevation in Lake Pend Oreille and river reaches downstream of the Albeni Falls Dam. Despite these changes, the Hungry Horse Additional Water Supply measure would not influence the quantity, quality, and distribution of wetland vegetation adjacent to the reservoir or river landscapes

Lower Snake River: Snake River Delta and Palouse River Delta

In the Lower Snake River, in the short-term, wetland habitats would decrease in quantity and quality at river delta sites due to changes in water surface elevation resulting from reservoir drawdown. However, in the long-term, structural and operational measures associated with dam breaching would create additional areas for wetland reestablishment.

Deep sediment deposits adjacent to the mainstem post-dam breaching would be more suitable for wetland reestablishment than the rocky, shallow soils that current characterize the shorelines.

At the Palouse River Delta, a major drop in water surface elevation would lead to increased sediment accumulation in the mainstem (i.e., Snake River). Over time, as ecological and physical processes begin to be restored, erosion and nutrient transport would support the development of more wetland habitats and subhabitats distributed throughout the Lower Snake River (Cushing 1993, p. iii; Keeler 2015, p. 15).

MO3 Impacts on Evaluation Species and Other Species

Wetland evaluation species that inhabit areas within the Lower Columbia River would experience diminished impacts as a result of MO3. For instance, a decrease in water surface elevation during the spring and summer could reduce the quantity and quality of wetland habitats, especially at key sites like Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area, where managers maintain the wetlands landscape to support many species (e.g., Western pond turtle).

On average, at the Sandy River Delta, near RM 123 (Rkm 198), the change in water surface elevation is expected to be less than 3 inches (8 cm) and, thus, within the current range of variability. Regardless, this minor change could affect wildlife resource (i.e., mallards, Western painted turtles) use of wetland habitats and subhabitats at this river delta site. Under MO3, there may be seasonal occurrences during which this average reduction in water surface elevation is exceeded. These instances, if prolonged, would result in limited feeding and reproduction opportunities for wetland species.

Evaluation species that inhabit wetlands in the Upper Basin would also be exposed to negative impacts resulting from the implementation of MO3. For example, lower spring and summer flows on the Kootenai River could lead to lower water levels in off-channel sloughs and backwaters from May to late June, drying out amphibian (i.e., Western toad) eggs. Lower water surface elevation is likely to be detrimental to the breeding success of birds such as the American bittern, mallard, and sora, depending on when and where they breed during the year. Further, changes to the frequency of wetting and drying cycles in wetland habitats at various sites would affect the availability and quality of wetland plants used for nest construction.

In the short-term, MO3 would negatively affect wetland reptiles and amphibians during and immediately following the implementation of the dam breaching measures and reservoir drawdown. Reptiles are generally more mobile than amphibians and, thus, are less dependent on the accessibility to aquatic landscapes, with the exception of turtles. A permanent reduction in water surface elevation and loss of riparian and wetlands landscape could isolate amphibian populations and lead to the desiccation of eggs. Past studies showed that amphibian eggs exposed to desiccation for approximately one day are no longer viable (McMenamin et al. 2008, p. 16989). Thus, amphibian populations could experience population-level declines following a widespread, generational loss of eggs along some stretches of the river. Over time, however, wetlands evaluation species could increase in abundance as shallow water habitats and wetland subhabitats reestablish. In the long-term, contiguous wetland habitats would improve habitat connectivity to support dispersal of, and movement for, reptiles and amphibians.

Under MO3, in the long-term, the abundance of wetland habitats on island sites in the Lower Snake River would increase and, thus, support more and diverse wildlife resources. For instance, approximately 50 islands in this subbasin, each greater than 5 ac (2 ha), provided support for nesting habitat for Canada geese before they were inundated behind the Lower Snake River dams (Martin et al. 1985, p. D-3). Wintering mallard would likely experience disturbance during dam breaching, causing individuals to potentially relocate. In the short-term, degraded water quality and sediment transport processes would limit aquatic prey resources and foraging success for waterfowl dependent on aquatic invertebrates and fish both during and immediately following dam breaching and reservoir drawdown. The drawdown, however, may expose and lead to greater access of new food resources (e.g., benthic invertebrates) for native species (EAS 2014, p. 2). In regard to wetland vegetation, there would be a transition from submerged aquatic plants (e.g., pondweeds and waterweeds) in slower-moving reservoirs to those that characterize higher-velocity riverine systems.

Similar to those structural and operational measures associated with other MOs, the measures associated with MO3 include changes that lower water surface elevation in the Lower Snake River following potential dam breaching, which would affect the abundance of benthic organisms and could enable the invasion and establishment of non-native species in the resulting drawdown zones (Chen et al. 2016, p. 1; Cushing 1993, p. 27).

MO4

MO4 Summary of Uplands Landscape Findings

- Some structural and operational measures proposed under MO4 could lead to positive impacts on the expansion and sustainability of the wetlands landscape, especially in the Upper Columbia River (e.g., Kootenai River) and Lower Snake River.
- Proposed operations of the CRSO Federal project reservoirs at MOP could hinder efforts to increase wetland habitat complexity and ecosystem function, especially in the Lower Columbia River where significant decreases in water surface elevation are projected to occur below McNary Dam.

MO4 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

The implementation of the Drawdown to MOP operational measure in MO4 would effectively lower the water surface elevation at Bonneville Dam, John Day Dam, The Dalles Dam, and McNary Dam between April and July, and between March and August in dry years. Under MO4, MOP operations, specific to the NAA, would continue at these Federal projects. Pool elevations would be between approximately 0.5 ft and 1.5 ft (15 cm and 46 cm) lower upstream of McNary Dam, and the change in pool elevation would increase progressively downstream until a potential decrease (between approximately 2.3 ft and 4 ft [70 cm and 122 cm] lower in comparison to the NAA) in the Bonneville Reservoir.

Under MO4, the Columbia River Estuary below Bonneville Dam would experience minor changes in water surface elevation in average years and wet years, similar to those described in MO1. In very dry years (80 to 99 percent AEP) the spring freshet in May and June could increase water surface elevation from 0.5 ft to 1.5 ft (15 cm to 46 cm), in comparison to the NAA. However, in most years, the Service expects changes in water surface elevation, with an increase in winter water levels by approximately from 2 inches to 4 inches (5 cm to 10 cm) and a decrease in water levels during the spring and summer from approximately 2 inches to 7 inches (5 cm to 18 cm), to result in negative impacts on the wetlands landscape. However, these impacts would be slightly less negative further downstream of Bonneville Dam, toward the Columbia River Estuary.

Changes in water surface elevation would result in negative impacts on wetland habitats and subhabitats in the study area. In the Upper Basin, for example, changes in water levels during the spring and summer have the potential to alternately inundate and desiccate narrow bands of emergent vegetation in wetland habitats, which could negatively influence the abundance and distribution of aquatic and semi-aquatic species near the Kootenai NWR. However, these changes would likely be offset in part by the implementation of the Winter Stage for Riparian and McNary Flow Augmentation operational measures. These measures, in particular, would likely benefit, and could even reverse the trend of widespread losses in, riparian and wetland vegetation along the Kootenai River (Kootenai 2009, p. 2-6). Changes in the hydrograph and flood regime based on this measure would likely yield long-term benefits to the wetlands landscape throughout the Upper Basin.

The implementation of the Drawdown to MOP operational measure in MO4, if implemented, would lead to major changes in operations at Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam such that pool elevation would be drawn down so that it would be, on average, approximately 4 inches (10 cm) above the pool elevation under the NAA. Due to aggressive drafting before raising the water surface elevation for the summer months, reservoir pool elevation at all sites in the Lower Snake River would decrease by approximately 1 foot in late March than what is proposed under the NAA, thereby promoting a more pre-dam hydrograph and natural flood regime.

MO4 Impacts on Key Sites

<u>Key Island Sites</u>

Lower Columbia River: Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area

Under MO4, the implementation of the Drawdown to MOP operational measure would lower water surface elevation at reservoir pools associated with Bonneville Dam, The Dalles Dam, John Day Dam, and McNary Dam between April and July and, in dry years, between March and August. For example, at Bonneville Dam, water surface elevation would be between approximately 2.3 ft and 4.0 ft (70 cm to 122 cm) lower than that in current conditions. As a result of this measure, wetland subhabitats at key island sites in the Lower Columbia River could dry out, negatively impacting wetland vegetation that support evaluation species.

Mid-Columbia River: Hanford Reach and Wells Wildlife Area

While structural and operational measures associated with MO4 may influence operations of Grand Coulee Dam and Chief Joseph Dam, they are not expected to result in measurable differences in outflow or water surface elevation in comparison to the NAA.

Upper Basin: Everett Island and Kootenai NWR

Implementing the McNary Flow Target operational measure, however, would lead to an increase in water surface elevation on the Pend Oreille River downstream of Albeni Falls Dam during the spring summer in average and low water years. This change in water surface elevation would likely inundate a small portion of wetland habitat at Everett Island, however the impacts may be muted since this site is further downstream of Albeni Falls Dam. Under MO4, at Libby Dam, changes in water surface elevation during the spring and summer have the potential to alternately inundate and desiccate narrow bands of emergent vegetation, which could negatively influence evaluation species. Outside of the spring and summer, these changes, and the resulting impacts, would be less severe.

Lower Snake River: Silcott Island

Due to aggressive drafting, the water surface elevation at all key sites the Lower Snake River would decrease by approximately 1 ft (30 cm) in late March in comparison to the NAA. According to the co-lead agencies H&H modeling output, however, wetland habitats and subhabitats would remain wet for longer periods of time, especially during the spring and summer, in comparison to the NAA, MO1, and MO2. As a result, the quantity and quality of nesting habitat for ground-nesting birds, like waterfowl, which breed along well-concealed streambanks or on islands with wetland habitat (e.g., Silcott Island), may decrease.

<u>Key River Delta Sites</u>

Lower Columbia River: Sandy River Delta

The implementation of structural and operational measures associated with MO4 is not expected to impact protected lands or upland habitats behind levies downstream of Bonneville Dam. However lower river levels in the spring and summer could reduce the quantity and quality of wetland habitats at the Sandy River Delta and other similar wetland habitats throughout the Lower Columbia River.

Mid-Columbia River: Lower Crab Creek and McNary NWR

While operational measures associated with MO4, if implemented, would influence operations of the Grand Coulee Dam and Chief Joseph Dam, they are not expected to result in outflow or changes in water surface elevation that are measurably different from those of the NAA. Consequently, the implementation of related measures would have negligible impacts on water availability and, thus, wetland habitats (e.g., at Lower Crab Creek) or wildlife resources in the Mid-Columbia River subbasin.

Under MO4, the implementation of the Drawdown to MOP operational measure would lower water surface elevation at reservoir pools associated with McNary Dam between April and July and, in dry years, between March and August. For example, upstream of McNary Dam, water surface elevation would decrease from 0.5 ft to 1.5 ft (15 cm to 46 cm) than that in current conditions. As a result of this measure, wetland subhabitats at key river delta sites such as McNary NWR and the affiliated Walla Walla River Delta will experience lower water levels during critical time periods, which will impair the refuge's ability to manage water to irrigate moist soil wetlands and cooperatively farmed fields and support breeding waterfowl (Stenvall, C., in litt. 2019a). At the refuge, MO4 (similar to MO1) will promote the introduction and establishment of non-native species and compromise wildlife-dependent recreation opportunities (Healy, F., in litt. 2019).

Upper Basin: Pack River Delta

Wetland habitats and subhabitats at Pack River Delta in the Upper Basin would likely be negatively impacted by the implementation of operational measures associated with MO4. This site has a complex alluvial fan, and it is characterized by adjacent wetland habitats, both connected and disconnected from the mainstem Pack River. Under MO4, in dry years, the Pack River Delta would experience a summer stage drop in water surface elevation of approximately 2.6 ft (79 cm). In comparison to the projected drops associated with the other MOs, this projected drop is most extreme.

Lower Snake River: Snake River Delta and Palouse River Delta

Under MO4, pool water surface elevation would likely be higher along the Lower Snake River during the spring and summer months, and there may be a slight increase in the quantity and quality wetland habitats and off-channel pools along the shorelines at the Snake River and Palouse River delta sites. Under MO4, the Service projects a faster increase in quality or overall health of the wetlands landscape at the Palouse River Delta in comparison to the NAA, MO1, and MO2.

MO4 Impacts on Evaluation Species and Other Species

Under MO4, the implementation of the Drawdown to MOP operational measure would result in negative impacts on American bittern, mallard, and Western painted turtle. This measure, if implemented, would result in the overall reduction in water surface elevation at Reed Island and Steigerwald Lake NWR and Sauvie Island Wildlife Area, and Sandy River Delta, thereby impacting the survival, growth, and reproduction of wetland evaluation species. These negative impacts will be more pronounced upstream at the McNary NWR.

Evaluation species that inhabit wetland habitats and subhabitats in the Mid-Columbia River would likely retain their current population status.

In the Upper Basin, a decrease in water surface elevation of 2.6 ft (79 cm) during dry years would affect many wetland species, decreasing their ability to forage and reproduce, especially at the Pack River Delta site. At the Kootenai NWR however, changes in operations (due to the Winter Stage for Riparian and McNary Flow Augmentation operational measures) and the resulting periodic inundation of narrow bands of wetlands would potentially benefit the mallard, sora, and Western toad in the long-term.

American bittern, mallard, and Western toad that inhabit key sites in the Lower Snake River may all benefit from the modest increase in water surface elevation in the spring and summer, proposed under MO4. However, in the short-term, the initial increase in water surface elevation could disrupt foraging, breading, and rearing activities of various evaluation species (USFWS 2019c).

Under MO4, depending on the location in the study area, reductions in water surface elevation in Federal project reservoirs to MOP would likely reduce the abundance of available shallow-water habitat that often supports non-native aquatic predators like Northern pike. However, other wetland subhabitats, where a slight increase in water surface elevation is likely to occur, may promote establishment of non-native piscivorous (i.e., fish-eating) fish.

UPLANDS

NAA

NAA Summary of Uplands Landscape Findings

- Structural and operational measures associated with the NAA will not have measurable impacts on native grassland and sagebrush subhabitats and uplands evaluation species.
- In the future under the NAA, native grasslands and sagebrush subhabitats will continue to be impacted by other land use management and policy decisions.

NAA Impacts on Indicators of Ecological and Physical Processes and Subhabitats

<u>Grassland and Sagebrush Subhabitats</u>

Though native grassland and sagebrush subhabitats characterize areas surrounding the Mid-Columbia River and Lower Snake River, no significant changes to grasslands and sagebrush in the study area are expected as a result of the NAA. Much of the uplands landscape in the Basin is physically and functionally separate from the mainstem Columbia and Snake Rivers and, thus, unlikely to be impacted due to continued dam operations and maintenance.

<u>Natural Bluff Landforms</u>

Though natural bluff landforms occur throughout the uplands landscape in the Columbia and Snake River valleys, no significant changes to natural bluffs are expected in current conditions, within the scope of this analysis. Though current dam operations and maintenance do not directly affect natural bluffs that are high above fluctuating river water levels, other actions facilitated by the presence of dams may have negative impacts on natural bluff landforms. In particular, natural bluffs and other uplands landforms may be impacted by irregular groundwater levels and perched groundwater that seeps out at the face of bluffs. The NAA will maintain irregular groundwater levels and will not alleviate perched soil moisture resulting from irrigation that can destabilize bluff faces. Thus, the NAA will sustain the risk of losing natural bluff landforms to sloughing.

NAA Impacts on Evaluation Species

<u>Long-Billed Curlew</u>

The structural and operational measures associated with the NAA are not expected to impact long-billed curlew or uplands species with similar ecological niches or habitat needs. Apart from existing threats to long-billed curlew (e.g., increasing fire frequency), no further loss of long-billed curlew, as a result of continued dam operations and maintenance, is expected.

<u>Sage Thrasher</u>

Sage thrasher are not expected to change in abundance as a result of continued dam operations and maintenance. Sage thrashers require intact expanses of sagebrush for breeding and nesting habitat. No proposed modifications associated with the NAA will result in further loss or degradation of sagebrush habitat, upon which this species and others depend.

MO1

MO1 Summary of Uplands Landscape Findings Under MO1

- Structural and operational measures associated with MO1 will not have measurable impacts on native grassland and sagebrush subhabitats and uplands evaluation species.
- In the Basin, the uplands landscape is physically separated from the mainstem Columbia and Snake Rivers by slope, other landscapes, and development, which prevents fluctuations in water levels from impacting this landscape.

MO2

MO2 Summary of Uplands Landscape Findings

- Structural and operational measures associated with MO2 will not have measurable impacts on native grassland and sagebrush subhabitats and uplands evaluation species.

MO3

MO3 Summary of Uplands Landscape Findings Under MO3

- Structural and operational measures associated dam breaching as part of MO3 have the potential to impact the uplands landscape by creating areas with more newly exposed soil, during times when the water surface elevation is low.

- Without active uplands restoration and management following potential dam breaching, the quantity and quality of uplands landscape adjacent to the Lower Snake River would be compromised.

MO3 Impacts on Indicators of Ecological and Physical Processes and Subhabitats

The dam breaching structural and operational measures specific to MO3 may impact uplands landscape and evaluation species in the Basin. The proposed removal of the earthen portions of the four dams on the Lower Snake River will result in flushes of water being released at various times, which will result in inundation of land. These rapid flushes of water, depending on the timing, magnitude, and duration, have the potential to temporarily flood existing uplands vegetation.

These measures may also lead to long-term impacts on soil exposure, as once impounded water, held at artificial levels above dams, transitions to flowing water. Under MO3, lower water surface elevation could create areas in the Basin that are devoid of uplands vegetation and promote the establishment of non-native species.

In March 1992, drawdown tests were conducted at Lower Granite and Little Goose reservoirs to observe the physical impacts of substantial drawdown or lowering of the reservoirs. According to the tests, the reservoirs were drawn down (Lower Granite by 37 ft [11 m] below MOP and Little Goose by 15 ft [5 m] below MOP) for one month. Aside from testing physical impacts of the drawdowns, the Corps conducted several studies to determine biological impacts. One study analyzed the drawdowns and their impacts on fish resources and vegetation, concluding that the drawdowns led to significant changes in overall fish survival (i.e., stranding, blocked passage) and vegetation community structure (i.e., reductions in plant diversity). Conditions of low pool elevation upstream of Lower Granite Dam and Little Goose Dam led to changes in substrate that supported the growth of some pioneering grass species and non-native vegetation (e.g., cheatgrass) (Dauble and Geist 1992, p. 1.1).

Thus, if uplands landscape restoration activities beyond those specified in MO3, including invasive plant management, follow dam breaching and uplands vegetation is reestablished, then wildlife resources may be better supported throughout the study area.

MO4

Summary of Uplands Landscape Findings Under MO4

- Structural and operational measures associated with MO4 will not have measurable impacts on native grassland and sagebrush subhabitats and uplands evaluation species.
- In the Basin, the uplands landscape is physically separated from the mainstem Columbia and Snake Rivers by slope, other landscapes, and development, which prevents fluctuations in water levels from impacting this landscape.