Columbia Basin Collaborative

Recommended Actions for I/RG Review

April 14, 2023

Contents

Habitat Work Group

Recommendation: Implement NOAA Five-Year Review

Background:

Achieving, or making substantial progress toward, the CBC rebuilding goals for salmon and steelhead will require continued – and expanded – efforts to protect and restore habitat, implemented as part of a comprehensive suite of actions addressing multiple threats. This conclusion has been reached in virtually every analysis of actions needed for recovery and rebuilding of Columbia Basin salmon and steelhead stocks.

To restore habitat effectively and efficiently, the actions implemented need to be those with the greatest potential to benefit the stocks they target. Many efforts have been made throughout the basin to identify these actions, particularly for listed stocks. For example, ESA recovery plans are complete for all listed salmon and steelhead stocks in the basin and are supplemented by many finer scale tributary and watershed assessments and other analyses that help target the actions that will provide the greatest benefit. Recently, NOAA Fisheries completed 5-year reviews for all listed salmon and steelhead, as required by the ESA. These 5-year reviews identify priority actions, including habitat actions, for implementation in the near term and represent a synthesis of our current understanding of what actions will be most effective.

This recommendation focuses on implementing the habitat actions identified in the 5-year reviews as an important step in moving toward the CBP goals. Importantly, while implementing this recommendation would move us toward the CBP goals, still more restoration would be needed to achieve the CBP mid-range goals. The 5-year reviews contain a mix of site-specific and general habitat actions. **Below we summarize the general recommendations, while the more specific recommendations can be found in the 5-year review documents.** For non-listed stocks, we recommend implementing the general actions described below and developing specific priority actions comparable to those identified in the 5-year reviews.

Recovery plans and other documents also contain extensive information about which species will benefit from which actions, timeframes in which those benefits will accrue, priority stream reaches for restoration, and costs of implementation. Some recovery plans and other analyses have also evaluated potential fish benefits from habitat restoration, and tools such as life-cycle models continue to be developed to inform our understanding of benefits of habitat restoration to fish population abundance, productivity, spatial structure, and diversity.

Summary of Action:

Support, implement, and enhance the recommendations from the NMFS 5-year reviews. This also means fully fund and implement specific habitat related actions identified in 2022 5-year status reviews. While specific actions are identified in the 5-year review text, the general actions include:

A. Implement habitat improvement actions consistent with best practices for watershed restoration and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions that integrate a landscape perspective into decision making.

B. Prioritize habitat restoration that improves population resiliency to the impacts of climate change. Actions to restore and protect riparian vegetation, cold water refuges, streamflow, and floodplain connectivity can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to certain aspects of climate change.
C. Implement habitat restoration at a spatial scale sufficient to produce measurable changes in fish abundance at a watershed scale (e.g., Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat need to be restored to see a 25 percent increase in salmon smolt production). Most watersheds have not yet reached that level of floodplain and habitat restoration. In addition to contributing to increased fish abundance, restoring hydrologic reconnection projects are expected to provide greater opportunities for life history expression, thus contributing to increased population diversity.
D. Improve floodplain management practices and restore floodplains, including reconnecting stream channels or mainstem habitats with their floodplains. Protect the best. To the extent practicable, protect and enhance existing healthy floodplains, stream corridors and water storage from long-term development impacts. Actions might include purchasing lands, enacting land easements, and working with local, city and county governments.
E. Consider process-based methods (such as stage-0 restoration techniques and low-tech process-based actions that promote beaver recolonization) to facilitate widespread floodplain restoration across larger areas, increasing capacity and productivity of aquatic habitats.
F. For non-listed stocks develop a set of specific habitat priority actions that are comparable to those identified in a 5-year status review; also implement the above general actions.

Existing or New Program:

A network of “programs” that fund or implement habitat restoration actions exists throughout the Columbia Basin. Programs exist at various scales. Some, such as the Pacific Coastal Salmon Recovery Fund are coastwide; others, such as the Northwest Power and Conservation Council’s Fish and Wildlife Program, are basinwide; still others cover a portion of the basin (e.g., the Columbia River System Tributary Habitat Program, which covers the interior Columbia Basin.) Other programs are statewide or regional. Item #4, below, enumerates more of the entities involved in implementing habitat restoration actions in the basin.

While this action could be implemented through these existing programs to some extent, full implementation would require scaling up funding for on-the-ground actions as well as building capacity in the programs involved in all aspects of implementation. For example, not all local implementation groups have fully developed frameworks for prioritizing actions. Additionally, implementation could be enhanced and targeted by adjusting existing program (e.g., by targeting funding opportunities specifically to implementation of actions identified in the most recent ESA 5-year reviews).

Benefit Provided by Action:

Decreased Tributary and Estuary Habitat impacts by expanding or increasing habitat opportunities, capacity and function. This should result in increased smolt survival, productivity, and life history diversity of the targeted stock, if other All-H impacts are also addressed. These actions will also increase climate resiliency of the targeted stock by expanding habitat accessibility and diversity.

Stocks Benefited by the Action:

Habitat actions will be developed and implemented to target specific stocks. The magnitude of the benefit will depend on other All-H impacts to the targeted stock and the scale at which an action is implemented. It is assumed that larger, landscape scale protection and restoration actions that address primary limiting habitat factors will provide greater benefits than smaller, site-scale actions. Lifecycle modeling of targeted populations and stocks will provide more specific estimates of expected response to habitat action implementation. The goal is to benefit all stocks eventually.

Data Supporting Benefits:

It is well established in the restoration ecology literature that reconnecting floodplain, tidal and stream corridor habitat can lead to increased salmonid abundance, productivity, and diversity. The use of low-tech, process-based methods are known to result in positive habitat and salmonid outcomes: two examples of these approaches can be found in the Asotin and Bridge Creek Intensively Monitored Watershed studies. References are available.

Implementing Entities:

The collective salmon restoration community, typically state (e.g., IDFG, ODFW, WDFW), tribal, federal, local, NGO entities involved in implementing habitat restoration. The entities with responsibility or authorities that effect fish survival in tributary habitat or have a link to habitat project implementation include:

Entity Type	Entity	General Responsibility, Role, or Management Authority
Federal	NMFS	Administer ESA programs for listed anadromous fish
	USFWS	Administer ESA programs for listed resident fish
	USFS	Manage federally-owned lands; generally in headwaters
	BLM	Manage federally-owned lands; generally located downstream of USFS lands
	BOR	Manage water storage projects and fish passage and habitat mitigation projects
	USACE	Construct/maintain/manage flood risk prjects; flooplain permitting
	NRCS	Manage land conservatio nprograms and implement projects
	EPA	Manage and grant funding for land/water quality improvement
State	Fish Managers	Floodplain project review and permitting and watershed project implemenation
	Water Resource Managers	Manage and appropriate instream flow and groundwater
	Land Resource Managers	Manage state-owned lands
	Highway Departments	Manage road transportation networks in floodplains near and over streams
Tribal	Indian Tribes	Manage reservation lands and implement projects on and off reservation
Local	Counties	Administer land use and zoning laws
	Cities	Mange lands within city limits
	Recovery Boards/Watershed C	Facilitate stakeholder support and implement watershed projects
	Conservation Districts	Facilitate land conservatoin programs and implement projects
	Land Trusts/Conservation Partr	Implement watershed projects
	Non-Profits	Implement watershed projects
Mitigation Programs	NPCC	Adopt Columbia Basin F&W Program and conduct project science reviews
	BPA	Fund F&W mitigation projects thorugh Columbia Basin F&W Program
	State	Fund watershed projects
Private	Individual Landowners	Manage private owned lands
	Corporate Landowners	Manage private owned lands
	Railroads	Manage rail transportation networks in floodplains near and over streams

Time Needed to Implement:

15-20-plus years. While implementation of a single restoration project such as dike or dam breaching can be almost immediate (not accounting for planning time), cumulative actions necessary to achieve a modest restoration goal of at least 20% of floodplain and in-channel habitat within the Columbia Basin would take considerably longer.

Time Needed to Benefit Fish Populations:

10-20 years. Fish population response to habitat restoration is uncertain and can be influenced by many factors including but not limited to scale and type of restoration, degree of initial impairment, survival impacts during other life stages (e.g., ocean survival, hydrosystem survival, geology/storage capacity, climate, and genetic/life history diversity of the fish stocks. At a minimum, multiple (2) generations after action is completed would be required for benefits to be realized. However, most floodplain restoration actions will require sufficient time for riparian vegetation recovery to provide shade and other ecological processes (e.g., forage for beavers, channel forcing, organic matter input, food source for terrestrial bugs). This could be anywhere from 10-20 years for initial benefits and considerably longer for benefits such as large wood input.

Estimated Cost:

The 2023 Washington State of Salmon in Watersheds Report stated Rebuilding healthy, harvestable salmon populations requires funding to address all threats to salmon. Voluntary and regulatory programs to protect existing habitat, hatchery and harvest management and reform, fish population monitoring, and predator control are all important to achieve salmon recovery goals, and they are all expensive. A 2011 study pegged the statewide cost of implementing only habitat-related elements identified in regional salmon recovery plans for 2010-2019 at $4.7 billion in 2011 dollars. To date, only $1.6 billion has been invested, meaning that recovery has fallen further behind. As construction costs increase and habitat continues to be lost to development, increased investment will be needed.

In many cases, recovery plans identified the estimated costs to implement actions to achieve recovery targets. These costs would need to be updated and adjusted for inflation, and likely don't account for healthy and harvestable goals, but give an educated accounting for estimated costs. A recent rule of thumb for restoring floodplains in tributary rivers is approx. $1mn per mile (this is for restoration, not acquisition). Restoration costs could be lower for smaller streams. Cost of acquisition varies by location.

Uncertainties:

There are uncertainties related to benefits to habitat, fish, and length of time it will take. There are also uncertainties related to the best way to sequence habitat restoration and achieve optimal spatial distribution of restored areas. Additionally, for habitat related efforts to be successful in maximizing their impacts, out-of-basin and non-habitat impacts much be managed in coordination.

Associated Regulatory Processes or Policies:

Cultural and Endangered Species Act consultation and acquiring federal, state, and locally required permits for habitat restoration is time consuming and complex.

In general, habitat restoration project sponsors would likely follow this general permitting path:

1a. Determine the Lead Agency for Cultural Consultation to initiate consultation – this is not a permit, rather a process.

1b. Determine if your project is NEPA or SEPA exempt via the Joint Aquatic Resource Permit Application and proceed as necessary.

2. If federal funding is used in the project, determine if there is a permit programmatic in place for ESA Compliance Consultation and proceed through the consultation process

3. Proceed with permitting requirements depending on the project actions, these typically include ACOE 404 dredge fill permit, DOE 401 Water Quality Certification Permit, WDFW for hydraulic project application permit or equivalent for other states, other state specific permits such as a construction stormwater permit, water right or drilling permit, forest practices application, state aquatic lands use authorization, and locally required permits such as a Shoreline Permit, Floodplain Development Permit, or Critical Area Ordinance.

Potential Challenges:

Many potential challenges exist to implementing habitat restoration actions at the scale needed to fully implement the 5-year review recommendations. The Habitat Work Group and IR/G may want to consider developing specific recommendations to address some of these challenges. These include:

- Landowner engagement: Most opportunities for floodplain restoration are on private lands. Developing projects of a scale large enough to effect meaningful change in habitat function often means working with multiple landowners.
- Existing infrastructure: Existing infrastructure such as roads, railroads, and other human development in floodplains can complicate the design and effectiveness of restoration projects. Where moving existing infrastructure is an option, it is often extremely costly.
- Funding
- Regulatory and permitting constraints: The need for multiple permits to be obtained before projects can proceed adds substantial time and cost to the process of getting projects implemented. For example, current FEMA regulations prohibit actions that raise flood height, which presents a challenge for restoration of incised channels, where increasing flood height is one of the primary restoration goals.
- Ongoing development: To successfully achieve net gains in habitat capacity and productivity will require a combination of restoration and protection of existing habitats. Despite restoration efforts, ongoing development may result in an overall loss of habitat function. Additional monitoring is needed to understand overall trends in habitat conditions, and additional policy and regulatory interventions may be needed to ensure adequate protection of existing habitat.
- Institutional capacity: In addition to having a need for adequate funding, there is a need for entities involved in developing, designing, permitting, and implementing projects to have the knowledge and capacity to develop projects that are (a) consistent with best available science and (b) of sufficient scope and scale. Addressing this challenge involves not only having adequate funding and staffing but also adequate dissemination of best practices, adequate frameworks for identifying and prioritizing projects that will provide the greatest benefits,

building relationships with landowners, knowledge transfer, technical support, and even construction capacity.

Successful implementation of this recommendation will depend on developing strategies to address these challenges.

Adaptive Management:

For an adaptive management (AM) to be effective and long lasting, a restoration program must have strong scientific underpinnings, be relevant to the restoration community and be feasible to implement (Murray & Marmorek 2003; Schreiber et al. 2004). Similarly, the National Academies of Sciences, Engineering, and Medicine (2016), who noted, “Based on experience of other large restoration programs, AM requires a strong commitment to a dedicated organizational structure that supports planning, identifies and prioritizes key uncertainties, learns by analysis and synthesis of monitoring data, and makes adjustments to restoration projects based on new information in a timely fashion.” These principles of adaptive management have been implemented since the early 2000’s in the Columbia River estuary (Ebberts, et.al., 2018, Thom et al. 2008). Based on lessons learned and successes realized here, and from other restoration programs, we propose key adaptive management elements to support implementation of strategies recommended in NMFS’s 5-year reviews. These are summarily described below:

Key elements of adaptive management are:

- **Establish a common goal** within the restoration community. A common goal, open dialog, and long-term commitment among stakeholders and restoration managers are key to institutionalizing an adaptive management (AM) process for ecosystem restoration that is effective and long-lasting.
- **Embrace science.** Adhere to scientific principles of data acquisition, analysis, and interpretation; Formulate hypotheses to frame and motivate research, monitoring, and evaluation.
- **Learn from each other.** Share data and information including accomplishments, learnings from other projects, and upcoming activities.
- **Commit and be a determined implementer.** Commitment is fostered by having people in critical roles within each agency and organization.
- **Consistently implement a governance and decision-making structure** by using existing / established organizational processes to make the restoration program a biologically effective, cost-efficient, transparent, and long-lasting program. This governance structure will include key steps / phases: **implementing restoration, monitoring, learning (and adjusting)** (see Figure 3 from Ebberts et.al., 2018).

Figure 3. CEERP's AM process.

These **three phases are summarily characterized** as:

- **Restoration.** Managers make decisions about which projects to advance to design and construction
- **Monitoring.** Routine monitoring (systematic collection and reduction of data) and focused action effectiveness research (to investigate and test hypotheses) and uncertainties research (to fill data / information gaps). Additionally, monitoring might include development of predictive models and analysis.
- **Learning.** Learnings are informed through synthesis and evaluation of monitoring (and research).

These learnings then inform the next iteration of restoration strategies and objectives, and decisions on site prioritization and selection, project design and construction, and anticipated biological benefits.

Appendix I:

The following list are the recommended habitat actions over the near term that would achieve population viability as reviewed by NOAA Fisheries. These actions are taken directly from the NOAA Fisheries 2022 5-Year Reviews for Columbia Basin ESUs/DPSs. The list is not meant to be a prioritization list, but a comprehensive list of individual actions that are aligned with achieving the CBC Habitat Work Group's recommendation. The list is comprised of implementation actions that each listed ESU/DPS can implement in the Basin in the near term to benefit stocks across the Basin.

Please note: some Upper Willamette stocks are not included in this list because the reviews aren't available yet.

Excerpts from NOAA Fisheries: Endangered Species Act 5-Year Reviews

as of July 2022

2022 5-Year Review: Summary & Evaluation of Upper Columbia River Spring-run Chinook Salmon and Upper Columbia River Steelhead

North Cascades MPG: Wenatchee River Salmon and Steelhead Populations

Recommended Future Recovery Actions Over the Next 5 Years Toward Achieving Population Viability –

- The greatest opportunities to advance recovery of UCR spring-run Chinook salmon and UCR Steelhead in the Wenatchee subbasin through tributary habitat restoration include:
- Implement habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.).
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging, and migration) on Federal lands in the Little Wenatchee, Nason, Chiwawa, Icicle, Peshastin, and Mission watersheds.
- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes to increase juvenile rearing habitat.
- Address the importance of cold water refugia to salmon and steelhead by providing access to cold water tributaries, enhancing cold water habitat, and restoring natural hydrographs.
- Continue developing a life-cycle model for spring-run Chinook salmon and steelhead to help predict how habitat restoration, hatchery operations, predation, and hydropower management contribute to species recovery.

North Cascades MPG: Entiat River Salmon and Steelhead Populations

Recommended Future Recovery Actions Over the Next 5 Years Toward Achieving Population Viability -

- The greatest opportunities to advance recovery of UCR spring-run Chinook salmon and UCR Steelhead in the Entiat subbasin through tributary habitat restoration include:
- Implement habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.).
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging, and migration) on Federal lands in the Upper Entiat and Mad River watersheds.
- Continue developing a life-cycle model for spring-run Chinook salmon and steelhead to help predict how habitat restoration, hatchery operations, predation, and hydropower management contribute to species recovery.
- Gain a better understanding of the spring-run Chinook salmon and summer-run Chinook salmon interactions including spawning bed imposition and juvenile competition.

North Cascades MPG: Methow River Salmon and Steelhead Populations

Recommended Future Recovery Actions Over the Next 5 Years Toward Achieving Population Viability

- The greatest opportunities to advance recovery of UCR spring-run Chinook salmon and UCR steelhead in the Methow subbasin through tributary habitat restoration include:
- Implement habitat restoration actions that address anthropogenic features limiting natural riverine processes (e.g., removal or modification of levees, roads, culverts, irrigation infrastructure, bank stabilization, etc.).

- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging, and migration) through significant reductions of the road system network on Federal lands focusing in the Chewuch and Twisp River watersheds.
- Restore fish passage in Eightmile Creek and Twenty-mile Creek, tributaries to the Chewuch River.
- Continue developing a life-cycle model for spring-run Chinook salmon and steelhead to help predict how habitat restoration, hatchery operations, predation, and hydropower management contribute to species recovery.

North Cascades MPG: Okanogan River Steelhead Populations

Recommended Future Recovery Actions over the Next 5 Years Toward Achieving Population Viability –

The greatest opportunities to advance recovery of UCR steelhead in the Okanogan subbasin through tributary habitat restoration include:

- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes to increase juvenile rearing habitat through implementation of habitat restoration actions.
- Restore access to anadromous salmon and steelhead habitat in the Similkameen River above Enloe Dam.
- Address the importance of cold water refugia to steelhead by providing access to cold water tributaries, enhancing cold water habitat, and restoring natural hydrographs.
- Finalize and implement a long-term agreement between U.S. Bureau of Reclamation, OID, and CCT to maintain perennial stream flow in the lower 4.3 miles of Salmon Creek.
- Increase storage capacity in the Salmon Creek sub-watershed by expanding Salmon Lake storage. This increase in storage would provide more flow in Salmon Creek and provide additional management flexibility for fish flows and irrigators.
- Address issues relating to the fish screen, diversion structure, and fishway in Salmon Creek.
- Reduce road and stream interactions to restore aquatic habitat function, in-stream flow and sediment regimes, water quality, and biological functions (spawning, rearing, foraging and migration) through significant reductions of the road system network on Tribal, Washington State Department of Natural Resources, and Bureau of Land Management (BLM) lands focusing on the Omak, Loup, and Antoine Creek subwatersheds.
- Address the effects of past large fires throughout the Okanogan River Basin to reduce fine sediment inputs, protect against flash flooding and landslides, enhance complexity, reduce incision, and restore floodplain structure and function.
- Continue to implement and improve the CCT's Okanogan Basin Monitoring and Evaluation Program (OBMEP) that provides ongoing and long-term habitat status and trend monitoring and the associated modeling and reporting tools.

Conclusion for habitat listing factor:

Continued large-scale watershed and stream habitat restoration remains a key component of recovering this UCR spring-run Chinook salmon and UCR steelhead. Important considerations for tributary habitat restoration over the next 5 years include:

- Prioritize projects that improve habitat resiliency to climate change. Actions to restore riparian vegetation, streamflow, and floodplain connectivity and to re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, and thereby improve population resilience to certain effects of climate change (Beechie et al. 2013).
- Support and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions and integrate a landscape perspective into decision making.
- Implement habitat restoration at a watershed scale. Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat in a watershed need to be restored to see a 25 percent increase in salmon smolt production. Most watersheds occupied by this species have not yet reached that level of floodplain and habitat restoration.
- Reconnect stream channels with their floodplains. Reintroducing beaver (Pollock et al. 2017) and low-tech process-based methods (Wheaton et al. 2019) will facilitate widespread, low-cost floodplain restoration across larger areas, increasing the productivity of freshwater habitat for Chinook salmon and steelhead.
- Implement habitat improvement actions consistent with best practices for watershed restoration (see, e.g., Beechie et al. 2010; Hillman et al. 2015; Appendix A of NMFS 2020b).

2022 5-Year Review: Summary & Evaluation of Middle Columbia River Steelhead

Cascades Eastern Slope Tributaries MPG

Recommended Future Recovery Actions Over the Next Five Years Toward Achieving Population Viability

- Protect the highest quality habitats and apply best management practices to conserve ecological processes that support population viability and primary life history strategies (all populations).
- Implement recovery actions to measurably increase summer streamflow, decrease summer water temperatures, and increase spatiotemporal habitat connectivity and resiliency (Crooked River, Deschutes River Eastside, Deschutes River Westside, Fifteenmile Creek, and Rock Creek populations). Potential actions include: riparian buffer protection, riparian vegetation planting, water conservation actions and agreements, beaver habitat protection and restoration, floodplain-channel reconnection through process-based methods (NMFS 2009; ODFW 2010, 2012, 2019b; Macnab and Springston. 2019; Nelson 2019; EPA 2021).
- Provide upstream passage at the Tenold, Underhill, and Lyda Diversion Dams on Fifteenmile Creek, and at the Highway 197 culvert on Fivemile Creek (ODFW 2019a) (Fifteenmile Creek population).
- Continue to support and implement the Fifteenmile Action Plan for Stream Temperature (FAST) to improve streamflows and water temperatures (Fifteenmile Creek population). • Protect and enhance identified primary coldwater refuge areas between Bonneville and McNary dams in the Columbia River (EPA 2021).
- Protect and enhance identified primary coldwater refuge areas between Bonneville and McNary dams in the Columbia River (EPA 2021).

John Day River MPG

Recommended Future Actions Over the Next Five Years Toward Achieving Population Viability –

- Decrease summer stream temperatures and increase summer baseflow connectivity and complexity in the John Day River watershed (all populations). Achieve these through a combination of riparian protection (e.g., fencing to manage grazing and browsing impacts), process-based restoration of floodplain-riparian habitats, and, where practical, water leasing or purchase agreements (McHugh et al. 2017; Middle Fork Intensively Monitored Watershed Working Group 2017; Weber et al. 2017; Macfarlane et al. 2018, 2019; Wathen et al. 2018; ODFW 2019b citing MacFarlane et al. 2017; Silverman et al. 2019; EPA 2021).
- Further reduce the effects of grazing in the Middle Fork John Day, roads, and water withdrawal for irrigation (including the removal of legacy structures in the floodplain) on Federal lands, to improve floodplain and riparian function, and channel structure.
- Improve fish passage and irrigation screening in areas affecting the Lower Mainstem and Upper Mainstem John Day River populations (ODFW 2019b).
- Protect and enhance Columbia River habitat in identified cold water refuge areas between Bonneville and McNary Dams (WDFW 2019; ODFW 2020; EPA 2021).

Yakima River MPG

Recommended Future Actions Over the Next Five Years Toward Achieving Population Viability –

- Increase April and May river flows from Roza Dam to the mouth of the Yakima River (all populations).
- Modify Prosser Dam to prevent steelhead entrainment into the Prosser Canal (all populations).
- Modify Roza Dam to ensure that all steelhead smolts are passed through surface spill (Upper Yakima population).
- Monitor effectiveness of the interim smolt passage project at Sunnyside Dam and determine how to proceed with a permanent modification (Upper Yakima and Naches populations).
- Complete the Cle Elum Dam fish passage project and establish steelhead spawning above Cle Elum Reservoir (Upper Yakima population).
- Remove all or part of the Bateman Island causeway to allow improved steelhead passage (all populations).
- Develop a strategic plan and prioritization of levee setback projects along the Yakima River to improve floodplain function (all populations).
- Protect riparian areas from grazing and improve instream flows through water conservation projects and water acquisition in Cowiche, Ahtanum, and Swauk Creeks, and Teanaway Basin streams (Upper Yakima and Naches populations).

Walla Walla and Umatilla Rivers MPG

Recommended Future Actions Over the Next Five Years Toward Achieving Population Viability –

- Continue flow and passage improvements in the Umatilla (Bureau of Reclamation), Walla Walla and Touchet Rivers, especially at Bennington Dam, the Mill Creek channel, and at Nursery Bridge.

- Construct a new Bennington Dam fish ladder.
- Complete the Walla Walla Integrated Flow Enhancement Study, which should include selecting an alternative and implementation.
- Provide passage: (1) and evaluate reintroduction feasibility over McKay Dam, a high priority passage action identified by the State of Oregon (Umatilla population); and (2) up Mill Creek, a tributary to the Walla Walla River to achieve abundance, productivity, and spatial structure goals for summer-run steelhead (Walla Walla population).
- Implement the Walla Walla Water 2050 Strategic Plan, including implementing levee setback projects up- and downstream of Milton Freewater (Walla Walla population).
- Work with Federal land managers and stakeholders to develop alternative routes to access private land on the South Fork Walla Walla River to ensure functional stream and riparian habitat for the Walla Walla population.
- Protect and enhance Columbia River coldwater refuge areas between Bonneville and McNary Dams (EPA 2021).

2022 5-Year Review: Summary & Evaluation of Snake River Basin Steelhead

Lower Snake River MPG

Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability –

The greatest opportunities toward achieving population viability and advancing recovery of SRB steelhead in the Lower Snake River MPG include:

- Tucannon River population. Improve and increase summer and winter juvenile rearing habitat, especially in high potential reaches of the Tucannon River and Pataha Creek, by restoring riparian areas, reducing temperatures and substrate embeddedness, and increasing recruitment of large wood (SRSRB 2011).
- Tucannon River population. Enhance overwinter rearing habitat for Tucannon River juvenile steelhead, increase rearing habitat complexity, and reconnect the river to its floodplain (SRSRB 2011; CCD 2021).
- Tucannon River population. Address the Tucannon Tumalum and Hixon culverts and Cottonwood Creek culvert passage barriers in the next 5 years (SRSRB 2020).

Grande Ronde River MPG

Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability -

The greatest opportunities toward achieving population viability and advancing recovery of SRB steelhead in the Grand Ronde MPG are to:

- Upper Grande Ronde and Wallowa River populations. Continue support and development of the Atlas planning framework for the Upper Grande Ronde and the Wallowa basin to guide and prioritize habitat restoration actions (Tetra Tech, Inc. 2017).
- All non-wilderness populations. Complete restoration actions that reduce summer stream temperatures and mitigate for climate change. These projects include: protecting instream flows through lease and acquisition, increasing hyporheic exchange and floodplain storage, reestablishing robust native riparian vegetation, and implementing Stage 0 floodplain

restoration techniques where appropriate (Justice et al. 2017; Powers, Helstab and Niezgoda 2018; Wondzell, Diabat and Haggerty 2019). Continue funding projects through the Columbia Basin Watershed Transactions Program.

- All non-wilderness populations. Reconnect streams to their floodplains and increase habitat complexity by creating sustainable beaver habitat that supports beaver populations (e.g., beaver dam analogs, ponds, riparian vegetation), enhances fish habitat, and mitigates climate change (Pollock et al. 2017; Dwire, Mellmann-Brown and Gurrieri 2018). Continue to increase habitat complexity, reconnect floodplains, and improve riparian conditions, particularly in the Upper Grande Ronde River and Wallowa River population areas.

Imnaha River MPG

Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability –

NMFS' recovery plan (NMFS 2017c) recommends the following habitat actions for the Imnaha MPG:

- Continue to support and develop the Atlas planning framework for the Imnaha population to guide and prioritize habitat restoration actions (Tetra Tech, Inc. 2017).
- Focus restoration actions in Big Sheep Creek, Little Sheep Creek, and the Imnaha River below Freezeout Creek to improve riparian conditions, help moderate summer temperatures, and reduce fine sediment.
- Restore tributary habitat conditions, especially for steelhead spawners and juvenile rearing.
- Maintain current wilderness protection to protect and conserve pristine tributary habitat.

Clearwater River MPG

Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability –

NMFS' recovery plan (NMFS 2017a) recommends the following habitat actions, for each population, over the next 5 years to achieve Clearwater MPG viability:

- Lower Mainstem Clearwater River population. Establish site-specific habitat restoration priorities using information the watershed plans developed from geomorphic stream assessments (also throughout the Clearwater basin) and updated information from fish population inventories in high priority watersheds. Habitat activities should be designed to preserve, restore, or rehabilitate natural habitat-forming processes (i.e., flood frequency and magnitude, sediment supply, and LWD recruitment).
- Selway River and Lochsa River populations. Prioritize habitat restoration projects to reduce road sediment and passage barriers in tributaries to the lower Selway River.
- Lolo Creek population. Eliminate migration barriers and chronic sediment sources from roads, and restore riparian conditions, large wood, and floodplain connectivity in the geographic areas of concern listed above to increase productivity and smolt production in the Lolo Creek population. Continue to support and develop the Atlas planning frameworks for the Lolo Creek and South Fork Clearwater River populations.
- South Fork Clearwater River population. Protect existing high-quality habitats, improve riparian conditions, eliminate chronic sediment and restore channel and floodplain function in historic mining sites by removing unnecessary bank stabilization structures. Support studies of juvenile rearing and migration to inform restoration of rearing habitat.

Salmon River MPG

Recommended Future Actions Over the Next 5 years Toward Achieving Population Viability -

- All populations. Continue to conduct appropriate road maintenance, road obliteration, road relocation, and road resurfacing; improve riparian conditions in disturbed areas; eliminate passage barriers; and restore floodplains.
- South Fork Salmon and Secesh populations. Improve water quality by reclaiming abandoned mine sites, such as the Cinnabar mine (NPT 2020a). Improve planning for potential climate change effects by continuing to monitor stream temperature and validate fish distribution in modeled cold water refugia (Payette National Forest 2020).
- Lower Middle Fork Salmon River population. In Big Creek, reduce and prevent sediment delivery to streams by rehabilitating abandoned mine sites and roads, such as the Dewey Mine and associated roads in the Thunder Mountain Mining District. Reduce impacts of water diversions for domestic, irrigation, stockwater, and hydropower purposes on instream flows in upper Big Creek by administering special use permits for water diversions on National Forest lands (Payette National Forest 2020) (Big Creek).
- Lemhi River, Pahsimeroi River, and Salmon River Upper Mainstem populations. Increase winter juvenile rearing habitat by increasing floodplain connectivity and complex habitat structure, reducing width-to-depth ratios, increasing low- to zero velocity pool habitat with cover, providing side channel habitat, and reducing fine sediment delivery to streams (Biomark ABS et al. 2019). As appropriate, replicate similar actions in other populations as new information identifies similar problems or is based on inference from data-rich populations. Complete Multiple Reach Assessment reports for the Upper Lemhi River basin, Lower Lemhi River basin, Lower Pahsimeroi River basin, and Upper Salmon River basin above Redfish Lake Creek to determine where habitat restoration would be most effective at increasing population viability (Biomark ABS et al. 2019).
- East Fork Salmon, Lemhi, Pahsimeroi, and Upper Mainstem Salmon River populations. Reconnect tributaries to the mainstem Salmon River from the North Fork Salmon River to Valley Creek. This action will increase available spawning and rearing habitat in tributaries, provide temperature refugia for juveniles, and lower summer water temperatures for juvenile rearing in the mainstem Salmon River (NMFS 2017a; IDFG 2021).
- Increase instream flow through: (1) expanding and continuing the Idaho Water Transactions Program; (2) securing permanent water transactions for the lower Lemhi minimum flow needs, and continuing filling needs with shorter-term agreements until permanent agreements can be established; (3) seeking additional water transaction agreements throughout the MPG; and (4) limiting new water rights in the MPG. For aging fish screen infrastructure at water diversions, ensure ongoing funding sources to complete routine maintenance and necessary upgrades. Fund new fish screens when new habitat is opened up through tributary reconnection projects.
- Lemhi River population. In the lower mainstem Lemhi River (downstream of Hayden Creek), increase habitat complexity by increasing the sinuosity of the single-thread main channel while creating areas of island braiding with complex instream structure, hydraulic variability, and low-velocity areas with cover.
- Lemhi River population. In the upper mainstem Lemhi River, increase habitat complexity by creating multi-threaded channels, narrow width-to-depth ratios, stable banks, and willow-

dominated riparian areas. Maintain and improve instream flow and tributary stream connections to the mainstem Lemhi River (Biomark ABS et al. 2019).

- For the Pahsimeroi River population. Maintain and improve instream flow. Increase habitat quantity by adding more channels within groundwater-influenced reaches that provide high-quality, complex habitat, including split flows, side channels, spring channels, and alcoves. Increase stream length by increasing sinuosity, which also increases hyporheic flow. Establish a robust, riparian community along the banks and floodplain, increasing shade, improving bank structure and habitat, and providing a buffer from upland and floodplain sediment sources (Biomark ABS et el. 2019).
- Upper Mainstem Salmon River population. Increase habitat complexity by creating or enhancing multi-threaded channels and increasing floodplain connection (Biomark ABS et al. 2019). Maintain and improve instream flow and tributary stream connections to the mainstem Upper Salmon River, particularly upstream of the Alturas Lake Creek confluence (Biomark ABS et al. 2019).
- Panther Creek population. Remove fish passage barriers at road-stream crossings, add large wood to streams, encourage beaver recolonization to restore floodplain connectivity, screen water diversions, and continue low-tech process-based stream habitat restoration efforts. Re-evaluate the role of the Panther Creek population in the MPG recovery scenario in the recovery plan, considering the natural spawning that has occurred in this population since 2005 (Conley and Denny 2019).

Conclusion for Habitat Listing Factor:

- Continued large-scale watershed and stream habitat restoration remains a key component of recovering this DPS, as described in the 2017 recovery plan (NMFS 2017a). Important considerations for tributary habitat restoration over the next 5 years include:
- Prioritize projects that improve habitat complexity and resiliency to climate change. Actions to restore channel complexity, passage, riparian vegetation, streamflow, and floodplain connectivity and re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to certain effects of climate change (Beechie et al. 2013).
- Prioritize projects that restore habitat where age classes of rearing juveniles are missing. Support geomorphic assessments and juvenile steelhead studies in the Clearwater basin to inform restoration plans that address missing age classes of rearing juveniles.
- Connect tributaries to mainstem migration corridors. Temperature refugia from tributaries is vital to successful migration and survival (Keefer et al. 2018; EPA 2021).
- Support and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions and integrate a landscape perspective into decision making. Successful examples in the DPS include the Grande Ronde, Lolo Creek, and South Fork Clearwater Atlas process and the Integrated Rehabilitation Assessment in the Upper Salmon River (Tetra Tech Inc. 2017; Biomark ABS et al. 2019; White et al. 2021). White et al. (2021) suggest that these efforts would benefit from gaining broader public support and formalizing an adaptive management strategy.
- Implement habitat restoration at a watershed scale. Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat need to be restored to gain a

25 percent increase in salmon smolt production. Most watersheds occupied by this species have not yet reached that level of floodplain and habitat restoration.

- Reconnect stream channels with their floodplains. The reintroduction of beaver (Pollock et al. 2017) and use of low-tech process-based methods (Wheaton et al., eds. 2019) will facilitate widespread, low-cost floodplain restoration across the DPS, including in higher elevation spawning and rearing areas, to increase the productivity of freshwater habitat for steelhead.
- Ensure that habitat improvement actions are implemented consistent with best practices for watershed restoration (see, e.g., Beechie et al. 2010; Hillman et al. 2016; and Appendix A of NMFS 2020a).

2022 5-Year Review: Summary & Evaluation of Snake River Spring/Summer Chinook Salmon

Lower Snake River MPG

Recommended Future Actions over the Next 5 Years toward Achieving Population Viability –

The greatest opportunities toward achieving population viability and advancing recovery of SR spring/summer Chinook salmon in the Lower Snake River are to:

- Improve and increase summer and winter juvenile rearing habitat, especially in high potential reaches of the Tucannon River and Pataha Creek, by restoring riparian areas, reducing temperatures and substrate embeddedness, and increasing recruitment of large wood (NMFS 2017a).
- Enhance overwinter rearing habitat for juvenile Chinook salmon in the Tucannon River population. Identify the specific reaches in the lower Tucannon River occupied by juvenile Chinook salmon in winter; then increase habitat complexity and reconnect the river to its floodplain in those reaches. Restore floodplain function through the reintroduction of beavers (Pollock et al. 2017), low-tech process-based methods (Wheaton et al., eds, 2019), or Stage 0 floodplain restoration techniques where appropriate (Powers et al. 2018). Address the Tucannon Tumalum culverts and the Cottonwood Creek passage barriers.

Grande Ronde River/Imnaha River MPG

Recommended Future Actions over the Next 5 Years toward Achieving Population Viability –

The greatest opportunities toward achieving population viability and advancing recovery of SR spring/summer Chinook salmon in the MPG are to:

- Continue support and development for the Atlas planning framework for the Upper Grande Ronde and Wallowa River basins to guide and prioritize habitat restoration actions (Tetra Tech, Inc., 2017; White et al. 2021). This planning framework benefits the Upper Grande Ronde, Catherine Creek, Wallowa/Lostine, Big Sheep, and Imnaha populations.
- Complete restoration actions that reduce summer stream temperatures and mitigate for climate change, including protecting instream flows through lease and acquisition, increasing hyporheic exchange and floodplain storage, reestablishing robust native riparian vegetation, and restoring floodplain function (Justice et al. 2017; Wondzell et al. 2019). Restore floodplain function through reintroduction of beavers (Pollock et al. 2017), low-tech process-based methods (Wheaton et al., eds, 2019), or Stage 0 floodplain restoration techniques where appropriate (Powers et al. 2018). These actions would benefit all of the non-wilderness populations.

- Reduce juvenile mortality during outmigration from overwintering habitats to the mainstem Snake River, especially in lower Catherine Creek and the Grande Ronde River mainstem from Catherine Creek downstream to the Wallowa River.
- Improve quantity and quality of winter rearing habitats, especially key overwintering areas in the Grande Ronde Valley. These efforts will benefit the Upper Grande Ronde and Catherine Creek populations.
- Improve summer instream flows through water lease, acquisition, and conservation—particularly for the Wallowa/Lostine, Catherine Creek, and Upper Grande Ronde populations. For the Wallowa/Lostine population, focus on increasing summer flows in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and the upper reaches of the Wallowa River. For the Catherine Creek population, improve summer flows in the lower Catherine Creek. Continue funding projects through the Columbia Basin Watershed Transactions Program. Restore instream flow in Hurricane Creek, Bear Creek and in the Wallowa River between Wallowa Lake and Enterprise.
- Address passage barriers in all non-wilderness populations.

South Fork Salmon River MPG

Recommended Future Actions over the Next 5 Years toward Achieving Population Viability –

The greatest opportunities toward achieving population viability and advancing recovery of SR spring/summer Chinook salmon in the South Fork Salmon River MPG are to:

- Reduce and prevent sediment delivery. Continue road decommissioning in the South Fork Salmon and Little Salmon populations, where the high density of roads still delivers sediment to streams. Continue appropriate road maintenance, road obliteration, road relocation, and road resurfacing in all populations in the MPG.
- Improve riparian function in selected areas. The mainstem rivers and many of the major tributaries in all populations in this MPG have roads or other human-made disturbances located within the riparian zone, and riparian function has been reduced.
- Remove or replace fish passage barriers that block access to high quality SR spring/summer Chinook salmon habitat. Anthropogenic barriers still exist in all populations in the MPG. • Improve water quality. Reclaim abandoned mine sites, such as the Cinnabar mine site in the East Fork South Fork population, to prevent pollutants (mercury, arsenic) from entering streams.
- Improve water quality. Reclaim abandoned mine sites, such as the Cinnabar mine site in the East Fork South Fork population, to prevent pollutants (mercury, arsenic) from entering streams
- Plan for climate change. Improve planning for potential climate change effects by continuing to monitor stream temperature and validate fish distribution in modeled cold water refugia (Payette National Forest 2020).

Middle Fork Salmon River MPG

Recommended Future Actions over the Next 5 Years toward Achieving Population Viability –

The primary future habitat action in this MPG toward achieving population viability and advancing recovery is maintaining the current wilderness protection and Forest Service management of land and streams in the Middle Fork Salmon River. Future opportunities to address small, localized areas of degraded tributary habitat include:

- Reduce and prevent sediment delivery to streams by rehabilitating abandoned mine sites and roads, such as the Dewey Mine and associated roads in the Thunder Mountain Mining District (Big Creek population).
- Improve riparian and floodplain health and function by encouraging and reestablishing beaver activity (all populations) (Pollock et al. 2017).
- Reduce impacts of water diversions for domestic, irrigation, stockwater, and hydropower purposes on instream flows in upper Big Creek by administering special use permits for water diversions on National Forest lands (Big Creek population) (Payette National Forest 2020). Apply water acquired for habitat restoration projects to mainstem Salmon River instream flow water rights.

Upper Salmon River MPG

Recommended Future Actions over the Next 5 Years toward Achieving Population Viability -

The greatest opportunities toward achieving population viability and advancing the recovery of Snake River spring/summer Chinook salmon in the Upper Salmon River MPG are to:

- Increase winter juvenile rearing habitat by increasing floodplain connectivity and complex habitat structure, reducing width-to-depth ratios, increasing low- to zerovelocity pool habitat with cover, providing side channel habitat, and reducing fine sediment delivery to streams – across the MPG and particularly in the Lemhi River, Pahsimeroi River, and Salmon River Upper Mainstem populations (Biomark ABS et al. 2019). As appropriate, replicate similar actions in other populations as new information identifies similar problems or based on inference from data-rich populations. Use reintroduction of beavers (Pollock et al. 2017) or low-tech process-based methods (Wheaton et al., eds, 2019) to restore floodplain function and connectivity.
- Complete Multiple Reach Assessment reports for the Upper Lemhi River basin, Lower Lemhi River basin, Lower Pahsimeroi River basin, and Upper Salmon River basin above Redfish Lake Creek to determine where habitat restoration would be most effective at increasing population viability (Biomark ABS et al. 2019).
- Increase instream flow by: (1) expanding and continuing the Idaho Water Transactions Program; (2) securing permanent water transactions for the lower Lemhi minimum flow needs, and continuing filling needs with shorter-term agreements until permanent agreements can be established; (3) seeking additional water transaction agreements for all SR spring/summer Chinook salmon populations throughout the MPG; and (4) limiting new water rights in the MPG. For aging fish screen infrastructure at water diversions, ensure ongoing funding sources continue to complete routine maintenance and necessary upgrades. Fund new fish screens when new habitat is opened up through tributary reconnection projects.
- In the lower mainstem Lemhi River (downstream of Hayden Creek), increase habitat complexity by increasing the sinuosity of the single-thread main channel while creating areas of island braiding with complex instream structure, hydraulic variability, and lowvelocity areas with cover (Lemhi River population).

- In the upper mainstem Lemhi River, increase habitat complexity by creating multithreaded channels, narrow width-to-depth ratios, stable banks, and willow-dominated riparian areas. Maintain and improve instream flow and tributary stream connections to the mainstem Lemhi River (Biomark ABS et al. 2019) (Lemhi River population).
- For the Pahsimeroi River population, maintain and improve instream flow.
- For the Pahsimeroi River population, increase habitat quantity by adding more channels within groundwater-influenced reaches that provide high-quality, complex habitat, including split flows, side channels, spring channels, and alcoves. Increase stream length by increasing sinuosity, which also increases hyporheic flow.
- For the Pahsimeroi River population, establish a robust, riparian community along the banks and floodplain, increasing shade, improving bank structure and habitat, and providing a buffer from upland and floodplain sediment sources.
- For the Pahsimeroi River population, reduce fine sediment (systemic throughout the Pahsimeroi River basin) by increasing bank stability and decreasing surface water runoff (Biomark ABS et al. 2019).
- For the Upper Mainstem Salmon River population, increase habitat complexity by creating or enhancing multi-threaded channels and increasing floodplain connection.
- For the Upper Mainstem Salmon River population, maintain and improve instream flow and tributary stream connections to the mainstem Upper Salmon River, particularly upstream of the Alturas Lake Creek confluence (Biomark ABS et al. 2019).
- For the Panther Creek population, remove fish passage barriers at road stream crossings, add large wood to streams, encourage beaver recolonization to restore floodplain connectivity, screen water diversions, and continue low-tech process-based stream habitat restoration efforts.
- For the Panther Creek population, re-evaluate the role of the Panther Creek population in the MPG recovery scenario in the Recovery Plan, considering the natural spawning that has occurred in this population since 2005 (Conley and Denny 2019).
- For the East Fork Salmon River population, maintain existing water quality and quantity and restore floodplain/riparian processes, primarily on private lands subject to historical land conversion from floodplain to agriculture.
- For the Salmon River Lower Mainstem population, restore perennial tributary connections with the Salmon River, provide thermal refugia for migrating and rearing fish, and maintain or restore floodplain connectivity and riparian processes. Reconnect tributaries to the mainstem East Fork Salmon, Lemhi, and Pahsimeroi Rivers and to the mainstem Salmon River from the North Fork Salmon River to Valley Creek.
- Improve the quantity and quality of winter rearing habitats, especially key overwintering areas in the Upper Mainstem Salmon River and the Salmon River Lower Mainstem.
- Conduct additional evaluations to identify the potential causes for low juvenile Chinook salmon survival in the mainstem Salmon River overwintering/migration corridor. Improved survival outside natal rearing areas may benefit all the MPG's populations.

Conclusion for Habitat Listing Factor

Continued large-scale watershed and stream habitat restoration remains a key component of recovering this ESU, as described in the 2017 Snake River recovery plan (NMFS 2017a). Important considerations for tributary habitat restoration over the next 5 years include:

- Prioritize projects that improve habitat resiliency to climate change. Actions to restore riparian vegetation, stream flow, and floodplain connectivity and re-aggrade incised stream channels can ameliorate temperature increases, base flow decreases, and peak flow increases, thereby improving population resilience to certain effects of climate change (Beechie et al. 2013).
- Support and enhance local- to basin-scale frameworks to guide and prioritize habitat restoration actions and integrate a landscape perspective into decision making. Successful examples in the ESU include the Grande Ronde Atlas process and the Integrated Rehabilitation Assessment in the Upper Salmon River (Tetra Tech Inc. 2017; Biomark ABS et al. 2019; White et al. 2021). White et al. (2021) suggest that these efforts would benefit from gaining broader public support and formalizing an adaptive management strategy.
- Implement habitat restoration at a watershed scale. Roni et al. (2010) found that, for a watershed, at least 20 percent of floodplain and in-channel habitat need to be restored to see a 25 percent increase in salmon smolt production. Most watersheds occupied by this species have not yet reached that level of floodplain and habitat restoration.
  Reconnect stream channels with their floodplains. Reintroducing beaver (Pollock et al. 2017) and applying low-tech process-based methods (Wheaton et al., eds., 2019) will facilitate widespread, low-cost floodplain restoration across the ESU, increasing the productivity of freshwater habitat for Chinook salmon.
- Ensure that habitat improvement actions are implemented consistent with best practices for watershed restoration (see, e.g., Beechie et al. 2010; Hillman et al. 2016; Appendix A of NMFS 2020a).

2022 5-Year Review: Summary & Evaluation of Snake River Sockeye Salmon

Recommended Future Habitat Actions Over the Next 5 Years Toward Achieving Population Viability -

For habitat, the greatest opportunities to advance recovery of SR sockeye salmon are:

- Measurably reduce water temperatures in mainstem migratory habitats during adult sockeye salmon migration timing and establish cold-water refugia along the entire migratory corridor (EPA 2003; Crozier et al. 2020; NMFS 2020b). Co-managers should develop and implement plans addressing multiple spatial scales, from headwater habitats through the mainstem migration corridor (see NMFS 2016b for specifics) to moderate modeled increases in summer water temperature and low flows influenced by projected changes in climate.
- Increase Federal, state, local governments, and private organizations' efforts to improve water quantity and water quality in sockeye salmon migratory reaches. Efforts should address appropriate regulatory controls, land management practices, and hydropower operations (NMFS 2016b).
- Investigate causal factors for poor juvenile smolt survival in the Upper Salmon River basin (i.e., natal lakes downstream through Deadwater Slough) and initiate actions to improve survival.
- Continue fertilizing and monitoring natal lakes to maximize carrying capacity and growth of naturally produced sockeye salmon, which exhibit higher SARs than hatchery releases and provide greater opportunity for adaptive selection to cope with a changing environment.

- Continue to protect, and where possible restore, natural ecological processes, including free passage, in natal lakes and their inlet and outlet streams. Restoring passage at the Sawtooth Fish Hatchery weir and water intake structure should be pursued in the next 5 years. The entire migration corridor has been impaired by various forms of development. Where project sponsors determine measurable benefits can be attained, they are encouraged to implement riparian and floodplain restoration along the entire migration corridor, particularly where States or the EPA have identified existing impairments (IDEQ 2018; EPA 2020).
- Monitor in-river survival of returning adults in concert with current and projected environmental conditions (i.e., temperature) and continue to initiate adult transport at CRS facilities as necessary to maximize fish survival through migration corridors (NMFS 2016b). Evaluate and implement adult trap/haul downstream of McNary Dam if possible to account for higher mortality downstream of that point and maximize adult conversion to the Sawtooth Valley in potentially catastrophic years.
- Identify appropriate funding levels necessary to maintain an effective fish screening program throughout the species' mainstem migration corridor, and prioritize screening maintenance and/or replacement to provide the greatest protection for SR sockeye salmon as well as considering each screening location in context of other anadromous ESA-listed fish present at the site.

2022 5-Year Review: Summary & Evaluation of <u>Snake River Fall-Run Chinook Salmon</u>

Recommended Habitat Actions Over the Next 5 Years Toward Achieving Population Viability -

- Continue implementing the following ongoing actions, described above in more detail, which are considered to have contributed to the improved status of the ESU.
    - Implementation of Idaho Power Company's SR fall-run Chinook salmon spawning program to enhance and maintain suitable spawning and incubation conditions, including recent voluntary actions to improve the quality of water exiting the Hells Canyon Complex.
    - Implementation of the Columbia River System biological opinions, including hydrosystem operations such as cool-water releases from Dworshak Dam; summer flow augmentation and summer spill at multiple projects; operations at fish ladder cooling stations at Lower Granite and Little Goose Dams to address adult passage delays caused by warm surface waters entering the fish ladders; flexible spring spill and evaluation of its effects; juvenile fish transportation program as outlined in the 2020 biological opinion; and operation of the PIT-tag detector in the removable spillway weir at Lower Granite Dam and use of the data obtained to inform critical uncertainties. In addition, continue use of regional coordination to address and adaptively manage any new issues associated with the implementation of Columbia River System operations.
    - Implementation of Lower Snake River Programmatic Sediment Management Plan (PSMP) measures to reduce impacts of reservoir and river channel dredging and disposal on SR fall-run Chinook salmon.
    - Completion and implementation of TMDLs and tributary habitat improvement actions (primarily to benefit SR spring/summer Chinook salmon and steelhead but with ancillary benefits to SR fall-run Chinook salmon).

    - Efforts to restore an early-spawning fall Chinook salmon component in the Clearwater River.
- Convene a group to provide coordination for additional validation and development of the SR fall-run Chinook salmon life-cycle model so that it can be used to assess potential response of SR fall-run Chinook salmon to alternative management strategies and actions under alternative climate scenarios, and to determine the best opportunities for closing the gap between the species' current status and its ESA recovery objectives.

As noted above, a life-cycle model has been developed by the USGS in coordination with the NWFSC (Tiffan and Perry 2020). NMFS used the model to assess the effect of proposed hydropower system operations, continuing hatchery production, and recent, seasonally variable increases in sea lion predation in the lower Columbia River from the mouth to Bonneville Dam as part of its analysis for the 2020 CRS biological opinion (NMFS 2020). The model has not yet been used for the full scope of analyses envisioned in the recovery plan. Additional validation and development of the model will allow an expanded range of uses that may inform recovery actions.

- Protect and continue to study the benefits of CWRs, as outlined in the Columbia River Cold Water Refuge Plan, discussed above (EPA 2021). The CWR plan recommends implementation of actions in existing programs, plans, and regulations that would help to improve fish habitat and reduce river temperatures to help maintain CWRs in light of predicted tributary warming due to climate change. To address identified uncertainties, the Plan recommends future studies to track fish use of CWRs, to assess the benefits of CWR use, and to assess density effects and the carrying capacity of CWRs.

2022 5-Year Review: Summary & Evaluation of Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, Lower Columbia River Coho Salmon, Lower Columbia River Steelhead.

For all populations and all MPGs that comprise the four listed species in the Lower Columbia River – CR chum salmon, LCR Chinook salmon, LCR steelhead, and LCR coho salmon recommended future recovery actions over the next five years include:

- Conduct systematic review and analysis of high priority Lower Columbia River mainstem and tributary area habitat needs, identified in NMFS 2013a, and compare needs to what has been accomplished.
- Conduct monitoring to evaluate ship wake stranding frequency and locations where stranding occurs and assess factors contributing to wake stranding such as location, topography, vessel speed, et cetera, to determine best practices to reduce wake stranding mortality.
- Promote riparian plantings of native canopy tree cover species opportunistically in all watersheds.
- Coordinate with EPA in an evaluation of Washington State Water Quality Standards, reflecting Oregon and Idaho consultation outcomes.
- Increase the number of habitat projects that target fall Chinook salmon spawning (Big Creek, Elochoman/Skamokawa, Clatskanie River, Mill/Abernathy/Germany Creek, Toutle River, and Hood River).
- Apply results from the Lower Columbia Intensively Monitored Watershed study of Mill, Abernathy, and Germany creeks – a Before After Control Impact Design study which assessed how

restoration influenced salmon and steelhead abundance (WDFW 2012) – to future restoration efforts targeting coho salmon, to improve habitat restoration methods across all MPGs and promote abundance of this species.

For populations within the below listed MPGs, we recommend the following recovery actions over the next five years:

Coast MPGs

- Increase the number of projects that reduce sediment load in spawning habitat for Grays/Chinook River chum, 5-Year Review: Lower Columbia River National Marine Fisheries Service 104
- Implement projects that increase the amount of side channel/pool rearing habitat for Grays/Chinook River coho.
- Promote projects that reduce flashy stream conditions to improve spawning habitat for Grays/Chinook River chum, Grays/Chinook River fall Chinook salmon, and Grays/Chinook River coho.
- Implement projects to increase summer and winter rearing habitat complexity for Mill/Abernathy/Germany Creek coho.
- Implement additional habitat improvement projects in the Elochoman River and Abernathy, Mill, and Germany creeks, and their tributaries to augment spawning (chum) and rearing (coho) habitat.

Cascade MPGs

- Reestablish and improve passage on multiple rivers to benefit multiple populations from the Cascade MPGs, such as the North Fork Lewis River (NF Lewis River spring Chinook, NF Lewis River winter steelhead, NF Lewis River coho), and Cowlitz River (Upper Cowlitz River spring Chinook, Upper Cowlitz River fall Chinook, Upper Cowlitz River coho, Upper Cowlitz River winter steelhead).
- Identify and implement spawning habitat projects to expand spatial distribution of chum into the Cascade MPG, with priority on the Lewis and Washougal rivers, (Washington Primary populations) and the Cowlitz and Kalama rivers (contributing populations).
- Work with county and city jurisdictions to protect watershed hydrology from long-term development impacts (floodplain development and groundwater withdrawals). Focus these efforts on high growth rate watersheds along the I-5 and I-205 corridors, including the East Fork Lewis River, North Fork Lewis River, Coweeman River, Kalama River, Washougal River, Salmon Creek, and Lower Cowlitz tributaries.

Gorge MPGs

- Continue to work with partners on programs protecting instream and floodplain habitats in key chum spawning areas, such as Duncan Creek and Hamilton Creek, (e.g., evaluate if large wood debris mitigates excess winter stream flows that degrade spawning for Upper Gorge chum).
- Continue to work with partners to identify suitable chum spawning habitat streams and reaches to emplace habitat creation or enhancement projects in order to expand spatial distribution into the gorge strata.

- Improve understanding of key factors limiting recovery by evaluating summer-run Gorge steelhead losses between Bonneville Dam and Shipherd Falls.
- Implement the EPA 2021 Columbia River Cold Water Refuges Plan, for example in Woodard Creek, to benefit Upper Gorge (Wind River and White Salmon rivers) LCR fall Chinook salmon, Lower Gorge (Woodard Creek) winter steelhead, Upper Gorge (Wind River) steelhead, and Wind River summer steelhead.
- Implement habitat projects to mitigate excess winter flow to improve spawning habitat for Lower Gorge chum and Upper Gorge chum.
- Increase channel complexity to improve juvenile rearing habitat for Wind River summer steelhead.
- Pacific salmon and steelhead recovery partners are encouraged to develop and implement a long-term management strategy to reduce pinniped predation on Pacific salmon and steelhead in the Columbia River basin by removing, reducing, and-or minimizing the use of manmade haul outs used by pinnipeds in select areas (e.g., river mouths/migratory pinch points).
- Pacific salmon and steelhead recovery partners are encouraged to expand, develop, and implement monitoring efforts in the Columbia River basin, to identify pinniped predation interactions in select areas (e.g., river mouths/migratory pinch points) and quantitatively assess predation impacts by pinnipeds on Pacific salmon and steelhead stocks.

Appendix II:

The following is a list of salmon habitat restoration projects throughout the Basin. It is meant to highlight the state, MPG region, watershed, and stock and align with implementers and funders who are managing the project. This list could be used to assess gaps in funding or as a tool to uplift the need for funding.

This is a first draft of the this list that will be further developed by the CBC Habitat Work Group. This is not an exhaustive list of the all the habitat restoration projects in the Basin.

ID	State	Stock	MPG	Watershed/ River/Creek	Salmon Habitat Coordination Entities	Federal Funding Programs
1	OR	U Will R Spring Chinook	Willamette	Clackamas	Clackamas River Watershed Council (OR)	
2	OR	U Will R Spring Chinook	Willamette	Molalla	Molalla River Watershed Council (OR)	
3	OR	U Will R Spring Chinook	Willamette	Santiam NF	North Santiam River Watershed Council (OR)	
4	OR	U Will R Spring Chinook	Willamette	Santiam SF	South Santiam River Watershed Council (OR)	
5	OR	U Will R Spring Chinook	Willamette	Calapooia	Calapooia Watershed Council (OR)	
6	OR	U Will R Spring Chinook	Willamette	McKenzie	McKenzie River Watershed Council (OR)	
7	OR	U Will R Spring Chinook	Willamette	Willamette Middle Fork		

8	OR	U Will R Winter Steelhead	Upper Willamette	Molalla	Molalla River Watershed Council (OR)	
9	OR	U Will R Winter Steelhead	Upper Willamette	Santiam NF	North Santiam River Watershed Council (OR)	
10	OR	U Will R Winter Steelhead	Upper Willamette	Santiam SF	South Santiam River Watershed Council (OR)	
11	OR	U Will R Winter Steelhead	Upper Willamette	Calapooia	Calapooia Watershed Council (OR)	
12	WA	L Col R Spring Chinook	Cascade	Cowlitz Upper	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
13	WA	L Col R Spring Chinook	Cascade	Cispus	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
14	WA	L Col R Spring Chinook	Cascade	Tilton		
15	WA	L Col R Spring Chinook	Cascade	Toutle	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
16	WA	L Col R Spring Chinook	Cascade	Kalama	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
17	WA	L Col R Spring Chinook	Cascade	Lewis NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
18	OR	L Col R Spring Chinook	Cascade	Sandy	Sandy River Watershed Council (OR)	
19	WA	L Col R Spring Chinook	Gorge	White Salmon	Klickitat Lead Entity; Columbia River Inter-Tribal Fish Commission	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
20	OR	L Col R Spring Chinook	Gorge	Hood	Hood River Watershed Council (OR)	
21	WA	L Col R Fall (tule) Chinook	Coast Fall	Grays/Chinoo k	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
22	WA	L Col R Fall (tule) Chinook	Coast Fall	Elochoman/S kamokawa		
23	OR	L Col R Fall (tule) Chinook	Coast Fall	Mill/Abernath y/Germany	Lower Columbia Watershed Council (OR)	
24	OR	L Col R Fall (tule) Chinook	Coast Fall	Youngs Bay		
25	OR	L Col R Fall (tule) Chinook	Coast Fall	Big Creek		
26	WA	L Col R Fall (tule) Chinook	Coast Fall	Clatskanie	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
27	OR	L Col R Fall (tule) Chinook	Coast Fall	Scapoose	Scapoose River Watershed Council (OR)	

28	WA	L Col R Fall (tule) Chinook	Cascade Fall	Cowlitz Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
29	WA	L Col R Fall (tule) Chinook	Cascade Fall	Cowlitz Upper	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
30	WA	L Col R Fall (tule) Chinook	Cascade Fall	Toutle	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
31	OR	L Col R Fall (tule) Chinook	Cascade Fall	Coweeman		
32	WA	L Col R Fall (tule) Chinook	Cascade Fall	Kalama	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
33	WA	L Col R Fall (tule) Chinook	Cascade Fall	Lewis	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
34	ID	L Col R Fall (tule) Chinook	Cascade Fall	Salmon		
35	WA	L Col R Fall (tule) Chinook	Cascade Fall	Washougal		
36	OR	L Col R Fall (tule) Chinook	Cascade Fall	Clackamas	Clackamas River Watershed Council (OR)	
37	OR	L Col R Fall (tule) Chinook	Cascade Fall	Sandy	Sandy River Watershed Council (OR)	
38	WA, OR	L Col R Fall (tule) Chinook	Gorge Fall	Gorge Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
39	WA, OR	L Col R Fall (tule) Chinook	Gorge Fall	Gorge Upper		
40	WA	L Col R Fall (tule) Chinook	Gorge Fall	White Salmon	Klickitat Lead Entity; Columbia River Inter-Tribal Fish Commission	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
41	OR	L Col R Fall (tule) Chinook	Gorge Fall	Hood	Hood River Watershed Council (OR)	
42	WA	L Col R Late Fall (bright) Chinook	Late Fall	Lewis NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
43	OR	L Col R Late Fall (bright) Chinook	Late Fall	Sandy	Sandy River Watershed Council (OR)	
44	OR	L Col R Fall (bright) Chinook	Brights	Youngs		
45	WA	L Col R Fall (bright) Chinook	Brights	Clatskanie	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
46	WA	L Col R Coho	Coast	Grays	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
47	WA	L Col R Coho	Coast	Elochoman/Skamania		

48	OR	L Col R Coho	Coast	Mill/Abernath y/Germany	Lower Columbia Watershed Council (OR)	
49	OR	L Col R Coho	Coast	Youngs		
50	OR	L Col R Coho	Coast	Big Creek		
51	WA	L Col R Coho	Coast	Clatskanie	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
52	OR	L Col R Coho	Coast	Scapoose	Scapoose River Watershed Council (OR)	
53	WA	L Col R Coho	Cascade	Cowlitz Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
54	OR	L Col R Coho	Cascade	Coweeman		
55	WA	L Col R Coho	Cascade	Toutle SF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
56	WA	L Col R Coho	Cascade	Toutle NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
57	WA	L Col R Coho	Cascade	Cowlitz Upper	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
58	WA	L Col R Coho	Cascade	Cispus	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
59	WA	L Col R Coho	Cascade	Tilton		
60	WA	L Col R Coho	Cascade	Kalama	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
61	WA	L Col R Coho	Cascade	Lewis NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
62	WA	L Col R Coho	Cascade	Lewis EF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
63	ID	L Col R Coho	Cascade	Salmon		
64	WA	L Col R Coho	Cascade	Washougal		
65	OR	L Col R Coho	Cascade	Sandy	Sandy River Watershed Council (OR)	
66	OR	L Col R Coho	Cascade	Clackamas	Clackamas River Watershed Council (OR)	
67	WA, OR	L Col R Coho	Gorge	Gorge Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
68	WA, OR	L Col R Coho	Gorge	Gorge Upper		
69	OR	L Col R Coho	Gorge	Hood	Hood River Watershed Council (OR)	
70	OR	L Col R Coho	Other	Willamette		

71	WA	Col R Chum	Coast	Grays	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
72	WA	Col R Chum	Coast	Elochoman/Skamania		
73	OR	Col R Chum	Coast	Mill/Abernathy/Germany	Lower Columbia Watershed Council (OR)	
74	OR	Col R Chum	Coast	Youngs		
75	OR	Col R Chum	Coast	Big Creek		
76	WA	Col R Chum	Coast	Clatskanie	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
77	OR	Col R Chum	Coast	Scapoose	Scapoose River Watershed Council (OR)	
78	WA	Col R Chum	Cascade	Cowlitz	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
79	WA	Col R Chum	Cascade	Kalama	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
80	WA	Col R Chum	Cascade	Lewis	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
81	ID	Col R Chum	Cascade	Salmon		
82	WA	Col R Chum	Cascade	Washougal/I205		
83	OR	Col R Chum	Cascade	Clackamas	Clackamas River Watershed Council (OR)	
84	OR	Col R Chum	Cascade	Sandy	Sandy River Watershed Council (OR)	
85	WA, OR	Col R Chum	Gorge	Gorge Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
86	WA, OR	Col R Chum	Gorge	Gorge Upper		
87	WA	SW WA Winter Steelhead	SW WA Winter Steelhead	Grays/Chinook	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
88	WA	SW WA Winter Steelhead	SW WA Winter Steelhead	Elochoman/Skamokawa		
89	WA	SW WA Winter Steelhead	SW WA Winter Steelhead	Mill/Abernathy/Germany	Lower Columbia Watershed Council (OR)	
90	OR	SW WA Winter Steelhead	SW WA Winter Steelhead	Youngs Bay		
91	OR	SW WA Winter Steelhead	SW WA Winter Steelhead	Big Creek		
92	WA	SW WA Winter Steelhead	SW WA Winter Steelhead	Clatskanie	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program

93	OR	SW WA Winter Steelhead	SW WA Winter Steelhead	Scapoose	Scapoose River Watershed Council (OR)	
94	WA	L Col R Winter Steelhead	Cascade Winter	Cowlitz Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
95	WA	L Col R Winter Steelhead	Cascade Winter	Cowlitz Upper	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
96	WA	L Col R Winter Steelhead	Cascade Winter	Cispus	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
97	WA	L Col R Winter Steelhead	Cascade Winter	Tilton		
98	WA	L Col R Winter Steelhead	Cascade Winter	Toutle SF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
99	WA	L Col R Winter Steelhead	Cascade Winter	Toutle NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
100	OR	L Col R Winter Steelhead	Cascade Winter	Coweeman		
101	WA	L Col R Winter Steelhead	Cascade Winter	Kalama	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
102	WA	L Col R Winter Steelhead	Cascade Winter	Lewis NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
103	WA	L Col R Winter Steelhead	Cascade Winter	Lewis EF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
104	ID	L Col R Winter Steelhead	Cascade Winter	Salmon		
105	OR	L Col R Winter Steelhead	Cascade Winter	Clackamas	Clackamas River Watershed Council (OR)	
106	OR	L Col R Winter Steelhead	Cascade Winter	Sandy	Sandy River Watershed Council (OR)	
107	WA	L Col R Winter Steelhead	Cascade Winter	Washougal		
108	WA, OR	L Col R Winter Steelhead	Gorge Winter	Gorge Lower	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
109	WA, OR	L Col R Winter Steelhead	Gorge Winter	Gorge Upper		
110	OR	L Col R Winter Steelhead	Gorge Winter	Hood	Hood River Watershed Council (OR)	
111	WA	L Col R Summer Steelhead	Cascade Summer	Kalama	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
112	WA	L Col R Summer Steelhead	Cascade Summer	Lewis NF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program

113	WA	L Col R Summer Steelhead	Cascade Summer	Lewis EF	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
114	WA	L Col R Summer Steelhead	Cascade Summer	Washougal		
115	WA	L Col R Summer Steelhead	Gorge Summer	Wind	Lower Columbia Fish Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
116	OR	L Col R Summer Steelhead	Gorge Summer	Hood	Hood River Watershed Council (OR)	
117	WA	M Col R Spring Chinook	East Cascade	Klickitat	Klickitat Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
118	OR	M Col R Spring Chinook	East Cascade	Warm Springs		
119	OR	M Col R Spring Chinook	East Cascade	Metolious	Upper Deschutes Watershed Council (OR)	
120	OR	M Col R Spring Chinook	East Cascade	Deschutes Upper	Upper Deschutes Watershed Council (OR)	
121	OR	M Col R Spring Chinook	John Day	John Day Upper Mainstem		
122	OR	M Col R Spring Chinook	John Day	John Day North Fork	North Fork John Day Watershed Council (OR)	
123	OR	M Col R Spring Chinook	John Day	John Day Middle Fork	Gilliam East John Day Watershed Council (OR); Mid-John Day/Bridge Creek Watershed Council (OR);	
124	OR	M Col R Spring Chinook	Blue Mountains	Umatilla	Umatilla Basin Watershed Council (OR)	
125	OR	M Col R Spring Chinook	Blue Mountains	Walla Walla upper	Snake River Salmon Recovery Board (WA); Walla Walla Watershed Council (OR)	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
126	WA	M Col R Spring Chinook	Blue Mountains	Walla Walla - Mill Creek	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
127	OR	M Col R Spring Chinook	Blue Mountains	Walla Walla - S Fork	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
128	WA	M Col R Spring Chinook	Blue Mountains	Touchet		
129	WA	M Col R Spring Chinook	Yakima	Yakima Upper Mainstem	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
130	WA	M Col R Spring Chinook	Yakima	Naches/American	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
131	OR	M Col R Summer/Fall Chinook	Mid-C	Deschutes	Upper Deschutes Watershed Council (OR)	

132	WA	M Col R Coho	M Col R Coho	Klickitat	Klickitat Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
133	OR	M Col R Coho	M Col R Coho	John Day	Gilliam East John Day Watershed Council (OR); Mid-John Day/Bridge Creek Watershed Council (OR);	
134	OR	M Col R Coho	M Col R Coho	Umatilla	Umatilla Basin Watershed Council (OR)	
135	WA	M Col R Coho	M Col R Coho	Walla Walla	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
136	WA	M Col R Coho	M Col R Coho	Yakima	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
137	OR	M Col Sockeye	Mid-Col	Deschutes	Upper Deschutes Watershed Council (OR)	
138	WA	M Col Sockeye	Mid-Col	Yakima	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
139	WA	M Col R Summer Steelhead	Cascade E Slope	White Salmon	Klickitat Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
140	WA	M Col R Summer Steelhead	Cascade E Slope	Klickitat	Klickitat Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
141	OR	M Col R Summer Steelhead	Cascade E Slope	Fifteenmile	Fifteenmile Watershed Council (OR)	
142	OR	M Col R Summer Steelhead	Cascade E Slope	Deschutes East	Upper Deschutes Watershed Council (OR)	
143	OR	M Col R Summer Steelhead	Cascade E Slope	Deschutes West	Upper Deschutes Watershed Council (OR)	
144	OR	M Col R Summer Steelhead	Cascade E Slope	Crooked	Crooked River Watershed Council (OR)	
145	WA	M Col R Summer Steelhead	Cascade E Slope	Rock Creek	Klickitat Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
146	OR	M Col R Summer Steelhead	John Day	John Day Lower Mainstem	Gilliam East John Day Watershed Council (OR); Mid-John Day/Bridge Creek Watershed Council (OR);	
147	OR	M Col R Summer Steelhead	John Day	John Day North Fork	North Fork John Day Watershed Council (OR)	
148	OR	M Col R Summer Steelhead	John Day	John Day Middle Fork	Gilliam East John Day Watershed Council (OR); Mid-John Day/Bridge Creek Watershed Council (OR);	
149	OR	M Col R Summer Steelhead	John Day	John Day South Fork	South Fork John Day Watershed Council (OR)	

150	OR	M Col R Summer Steelhead	John Day	John Day Upper Mainstem		
151	OR	M Col R Summer Steelhead	Umatilla - Walla Walla	Willow Creek	Umatilla Basin Watershed Council (OR); Snake River Salmon Recovery Board (WA)	
152	OR	M Col R Summer Steelhead	Umatilla - Walla Walla	Umatilla	Umatilla Basin Watershed Council (OR)	
153	WA	M Col R Summer Steelhead	Umatilla - Walla Walla	Walla Walla	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
154	WA	M Col R Summer Steelhead	Umatilla - Walla Walla	Touchet		
155	WA	M Col R Summer Steelhead	Yakima	Satus	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
156	WA	M Col R Summer Steelhead	Yakima	Toppenish	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
157	WA	M Col R Summer Steelhead	Yakima	Naches	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
158	WA	M Col R Summer Steelhead	Yakima	Yakima Upper Mainstem	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
159	WA	U Col R Spring Chinook	N Cascades	Okanogan	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
160	WA	U Col R Spring Chinook	N Cascades	Methow	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
161	WA	U Col R Spring Chinook	N Cascades	Entiat	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
162	WA	U Col R Spring Chinook	N Cascades	Wenatchee	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
163	WA	U Col R Spring Chinook	Blocked Area	Blocked Area above Grand Coulee	Upper Columbia United Tribes	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
164	WA	U Col R Summer Chinook	Cascades	Methow	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
165	WA	U Col R Summer Chinook	Cascades	Wenatchee	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
166	WA	U Col R Summer Chinook	Cascades	Entiat	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
167	WA	U Col R Summer Chinook	Cascades	Okanogan	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
168	WA	U Col R Summer Chinook	Cascades	Chelan	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program

169	WA	U Col R Summer Chinook	Cascades	Columbia Mainstem	Klickitat Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
170	WA	U Col R Summer Chinook	Yakima	Yakima	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
171	WA	U Col R Summer Chinook	Blocked Area	Blocked Area above Grand Coulee	Upper Columbia United Tribes	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
172	WA	U Col R Fall Chinook	U Col R Fall Chinook	Hanford	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
173	WA	U Col R Fall Chinook	U Col R Fall Chinook	Yakima	Yakima Basin Fish & Wildlife Recovery Board Lead Entity	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
174	WA	U Col R Fall Chinook	U Col R Fall Chinook	Columbia Mainstem PRD-CJD	Grant County PUD; Chelan County PUD; Douglas County PUD	
175	WA	U Col R Fall Chinook	U Col R Fall Chinook	Blocked Area above Grand Coulee	Upper Columbia United Tribes	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
176	WA	U Col R Coho	Upper Columbia	Wenatchee	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
177	WA	U Col R Coho	Upper Columbia	Entiat	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
178	WA	U Col R Coho	Upper Columbia	Methow	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
179	WA	U Col R Coho	Upper Columbia	Okanogan	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
180	WA	U Col R Coho	Upper Columbia	Blocked Area above Grand Coulee	Upper Columbia United Tribes	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
181	WA	U Col R Sockeye	U Col R Sockeye	Wenatchee	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
182	WA	U Col R Sockeye	U Col R Sockeye	Okanogan	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
183	WA	U Col R Sockeye	U Col R Sockeye	Blocked Area above Grand Coulee	Upper Columbia United Tribes	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
184	WA	U Col R Summer Steelhead	N Cascades	Crab	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
185	WA	U Col R Summer Steelhead	N Cascades	Entiat	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
186	WA	U Col R Summer Steelhead	N Cascades	Methow	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
187	WA	U Col R Summer Steelhead	N Cascades	Okanogan	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program

188	WA	U Col R Summer Steelhead	N Cascades	Wenatchee	Upper Columbia Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
189	WA	U Col R Summer Steelhead	Blocked Area	Blocked Area above Grand Coulee	Upper Columbia United Tribes	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
190	WA	Snake R Spring/Summer Chinook	L Snake	Tucannon	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
191	WA	Snake R Spring/Summer Chinook	L Snake	Asotin	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
192	ID	Snake R Spring/Summer Chinook	Dry Clearwater	Potlatch		
193	ID	Snake R Spring/Summer Chinook	Dry Clearwater	Lapwai/Big Canyon		
194	ID	Snake R Spring/Summer Chinook	Dry Clearwater	Lawyer		
195	ID	Snake R Spring/Summer Chinook	Dry Clearwater	Clearwater Up South Fork		
196	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Clearwater N Fork Lower Mainstem		
197	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Clearwater N Fork Upper Mainstem		
198	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Lolo		
199	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Lochsa		
200	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Meadow		
201	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Moose		
202	ID	Snake R Spring/Summer Chinook	Wet Clearwater	Selway Upper		

203	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Wenaha	Grande Ronde Model Watershed (OR)	
204	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Minam	Grande Ronde Model Watershed (OR)	
205	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Catherine Creek	Grande Ronde Model Watershed (OR)	
206	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Lookingglass	Grande Ronde Model Watershed (OR)	
207	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Lostine/Wallowa	Grande Ronde Model Watershed (OR)	
208	WA, OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Grande Ronde Up Mainstem	Grande Ronde Model Watershed (OR)	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
209	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Imnaha	Grande Ronde Model Watershed (OR)	
210	OR	Snake R Spring/Summer Chinook	Grand Ronde/Imnaha	Big Sheep		
211	WA	Snake R Spring/Summer Chinook	SF Salmon	Little Salmon		
212	ID	Snake R Spring/Summer Chinook	SF Salmon	Secesh		
213	ID	Snake R Spring/Summer Chinook	SF Salmon	Salmon SF		
214	ID	Snake R Spring/Summer Chinook	SF Salmon	Salmon East Fork South Fork		
215	ID	Snake R Spring/Summer Chinook	MF Salmon	Chamberlain		
216	OR	Snake R Spring/Summer Chinook	MF Salmon	Big Creek		

217	ID	Snake R Spring/Summer Chinook	MF Salmon	Lower Middle Fork		
218	ID	Snake R Spring/Summer Chinook	MF Salmon	Camas		
219	ID	Snake R Spring/Summer Chinook	MF Salmon	Loon		
220	ID	Snake R Spring/Summer Chinook	MF Salmon	Salmon Up Middle Fork Salmon		
221	ID	Snake R Spring/Summer Chinook	MF Salmon	Suphur		
222	ID	Snake R Spring/Summer Chinook	MF Salmon	Bear Valley		
223	ID	Snake R Spring/Summer Chinook	MF Salmon	Marsh		
224	ID	Snake R Spring/Summer Chinook	Up Salmon	Salmon NF		
225	ID	Snake R Spring/Summer Chinook	Up Salmon	Lemhi		
226	ID	Snake R Spring/Summer Chinook	Up Salmon	Salmon Mainstem Lower		
227	ID	Snake R Spring/Summer Chinook	Up Salmon	Pahsimeroi		
228	ID	Snake R Spring/Summer Chinook	Up Salmon	Salmon EF		
229	ID	Snake R Spring/Summer Chinook	Up Salmon	Yankee Fork Salmon		
230	ID	Snake R Spring/Summer Chinook	Up Salmon	Valley		

231	ID	Snake R Spring/Summer Chinook	Up Salmon	Salmon Up Mainstem		
232	ID	Snake R Spring/Summer Chinook	Up Salmon	Panther		
233	WA	Snake R Fall Chinook	Snake	Snake Lower	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
234	WA	Snake R Fall Chinook	Snake	Snake Middle		
235	WA	Snake R Coho	Snake R Coho	Tucannon	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
236	WA, OR	Snake R Coho	Snake R Coho	Grande Ronde	Grande Ronde Model Watershed (OR)	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
237	OR	Snake R Coho	Snake R Coho	Imnaha	Grande Ronde Model Watershed (OR)	
238	ID	Snake R Coho	Snake R Coho	Clearwater		
239	ID	Snake R Coho	Snake R Coho	Salmon		
240	ID	Snake R Sockeye	Stanley Basin	Redfish Lake		
241	ID	Snake R Sockeye	Stanley Basin	Alturas Lake		
242	ID	Snake R Sockeye	Stanley Basin	Hell Roaring Lake		
243	ID	Snake R Sockeye	Stanley Basin	Stanley Lake		
244	ID	Snake R Sockeye	Stanley Basin	Pettit Lake		
245	ID	Snake R Sockeye	Stanley Basin	Yellow Belly Lake		
246	ID	Snake R Sockeye	SF Salmon	Warm Lake		
247	ID	Snake R Sockeye	Payette	Payette		
248	OR	Snake R Sockeye	Wallowa	Wallowa Lake	Grande Ronde Model Watershed (OR)	
249	WA	Snake R Summer Steelhead	Lower Snake	Asotin	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
250	WA	Snake R Summer Steelhead	Lower Snake	Tucannon	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
251	ID	Snake R Summer Steelhead	Clearwater	Clearwater Mainstem Lower		
252	ID	Snake R Summer Steelhead	Clearwater	Lochsa		
253	ID	Snake R Summer Steelhead	Clearwater	Selway		

254	ID	Snake R Summer Steelhead	Clearwater	Lolo		
255	ID	Snake R Summer Steelhead	Clearwater	Clearwater North Fork		
256	ID	Snake R Summer Steelhead	Clearwater	Clearwater South Fork		
257	WA, OR	Snake R Summer Steelhead	Grande Ronde	Grande Ronde Lwr Mainstem	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
258	WA, OR	Snake R Summer Steelhead	Grande Ronde	Grande Ronde Up Mainstem	Grande Ronde Model Watershed (OR)	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program
259	OR	Snake R Summer Steelhead	Grande Ronde	Joseph Creek	Grande Ronde Model Watershed (OR)	
260	OR	Snake R Summer Steelhead	Grande Ronde	Wallowa	Grande Ronde Model Watershed (OR)	
261	OR	Snake R Summer Steelhead	Imnaha	Imnaha	Grande Ronde Model Watershed (OR)	
262	ID	Snake R Summer Steelhead	Salmon	Chamberlain		
263	ID	Snake R Summer Steelhead	Salmon	Salmon EF		
264	ID	Snake R Summer Steelhead	Salmon	Lemhi		
265	WA	Snake R Summer Steelhead	Salmon	Little Salmon		
266	ID	Snake R Summer Steelhead	Salmon	Salmon Mainstem Middle Fork Lower		
267	ID	Snake R Summer Steelhead	Salmon	Salmon Mainstem Middle Fork Upper		
268	ID	Snake R Summer Steelhead	Salmon	Salmon North Fork		
269	ID	Snake R Summer Steelhead	Salmon	Pahsimeroi		
270	ID	Snake R Summer Steelhead	Salmon	Panther		
271	ID	Snake R Summer Steelhead	Salmon	Salmon Upper Mainstem		
272	ID	Snake R Summer Steelhead	Salmon	Secesh		
273	ID	Snake R Summer Steelhead	Salmon	Salmon South Fork		

274	WA	Snake R Summer Steelhead	Other	Snake misc lower mainstem tribs	Snake River Salmon Recovery Board	NOAA Pacific Coast Salmon Recovery Fund; BPA F&W Program

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- Thus far, funding has not been sufficient to implement the actions identified in the NOAA recovery plans. More discussion is needed at the I/RG level to look at all potential sources of funding.
- The table included in the appendix of this recommendation, which identifies ongoing programs, coordination entities, and current federal funding, needs to be populated. When completed, this table will help identify where additional federal funding could be allocated.
- The set of actions included in this recommendation is a subset of the actions in the NOAA recovery plans. In the context of the CBC goals, these actions are focused on addressing the bottlenecks that are preventing endangered species delisting. This recommendation is seen as an initial step to address these bottlenecks in order to reach minimum targets for salmon abundance. Part of this recommendation calls for improvements to different grant programs to distribute available funding more efficiently to projects on the ground.
- This recommendation should not replace existing restoration efforts. The existing habitat restoration network and infrastructure in the basin are grounded in the recovery plans, so this recommendation is complementary to ongoing efforts.
- The Habitat Work Group is also considering other more systemic recommendations which will give the I/RG an opportunity to consider reforms to funding and governance processes.
- This recommendation would benefit all listed stocks, with secondary benefits to any unlisted stocks that share habitat and watersheds with listed species. The recommendations would also benefit other species and improve water quality.
- Some members of the SIWG believe this recommendation is too broad. An action that simply reiterates the need to do all the things in all the 5-year status reviews without prioritization is simply a continuation of the current ineffective strategy. Status review recommendations are already actions that have already been identified but are not being implemented because of a combination of a lack of human bandwidth, lack of funding, and lack of prioritization.

Stock Benefits Report Card:

Habitat: Recommendation on NOAA 5-Year Reviews

			Abundance			MAFAC Phase II Impact Priority								
Sub-Region	Stock	Status	Current	MAFAC Medium goal	Current as % of Medium Goal	Tributary Habitat	Estuary Habitat	Hydro (Mainstem)	Hydro (Latent)	Hydro (Blocked)	Predation	Fishery	Hatchery	Harvest
Low-C	L Col R Spring Chinook	Threatened	2,240	21,550	10%	1	3	3	3	2	3	3	2	3
Low-C	L Col R Winter Steelhead	Threatened	5,989	27,900	21%	1	2	3	3	3	3	3	3	3
Low-C	L Col R Fall (tule) Chinook	Threatened	12,329	54,100	23%	1	2	3	3	3	3	1	2	1
Low-C	L Col R Coho	Threatened	31,524	129,550	24%	1	3	3	3	3	3	3	2	3
Low-C	L Col R Summer Steelhead	Threatened	10,594	29,800	36%	2	4	4	4	2	4	4	4	4
Low-C	Col R Chum	Threatened	11,762	33,000	36%	2	2	4	4	4	4	4	4	
Low-C	SW WA Winter Steelhead	Threatened	3,252	5,850	56%	2	4	5	5	5	5	5	5	5
Low-C	L Col R Late Fall (bright) Chinook		10,800	16,700	65%									
Low-C	L Col R Fall (bright) Chinook	Threatened	11,000	11,000	100%	5	5	5	5	4	5	4	5	4
Mid-C	M Col Sockeye	Not Listed	1,036	45,000	2%	3	3	3	2	1	3	3		3
Mid-C	M Col R Spring Chinook	Not Listed	11,600	40,425	29%	2	4	4	4	4	4	4	4	4
Mid-C	M Col R Summer Steelhead	Threatened	18,155	43,850	41%	2	4	4	4	4	2	4	4	4
Mid-C	M Col R Coho	Not Listed	6,324	11,600	55%		5	4	5	5	5	4		4
Mid-C	M Col R Summer/Fall Chinook	Not Listed	11,500	13,000	88%	5	5	5	5	5	5	4	5	4
Up-C	U Col R Coho	Not Listed	392	15,000	3%									
Up-C	U Col R Summer Steelhead	Threatened	1480	31,000	5%	1	1	2	1	1	1	3	2	3
Up-C	U Col R Sockeye	Not Listed	40,850	580,000	7%	1	3	1	1	1	2	3	3	3
Up-C	U Col R Spring Chinook	Endangered	1430	19,840	7%	1	3	1	1	1	2	3	1	3
Up-C	U Col R Summer Chinook	Not Listed	16920	78,350	22%	1	2	1	1	1	3	1	2	1
Up-C	U Col R Fall Chinook	Not Listed	92,400	62,215	149%	5	5	4	5	5	5	4	5	4
Snake	Snake R Coho	Not Listed	100	26,600	0%									
Snake	Snake R Sockeye	Endangered	100	15,750	1%	3	3	1	1	1	2	3		3
Snake	Snake R Spring/Summer Chinook	Threatened	6,988	98,750	7%	1	3	1	1	2	2	3	3	3
Snake	Snake R Summer Steelhead	Threatened	28,000	75,000	37%	2	4	4	2	2	2	4	4	4
Snake	Snake R Fall Chinook	Threatened	8,360	10,780	78%	5	5	4	4	4	5	4		3
Willam	U Will R Spring Chinook	Threatened	4,278	47,850	9%	1	2	3	3	1	3	3	2	3
Willam	U Will R Winter Steelhead	Threatened	2,816	27,805	10%	1	2	3	3	3	1	3	3	3

Draft for Internal Review – 3/30/23

Stocks most benefited
Stocks receiving secondary benefit

Predation Work Group

Recommendation: Manage Double-crested Cormorants (DCCO) in the Columbia River Estuary

Problem Statement

The abundance of double-crested cormorants nesting upriver of East Sand Island in the Columbia River estuary has grown dramatically in recent years, causing concern for the recovery of imperiled salmonid runs. Most of this growth occurred during 2015–2020, coincident with implementation of a federal management plan for the nearby East Sand Island colony (ESI management plan), where 97% of double-crested cormorants within the estuary nested during 2004–2014 (pre-management period). During 2020 and 2021, however, the colony associated with the Astoria-Megler Bridge supported most breeding individuals in the estuary, although substantial numbers also occurred at a variety of other sites, mostly upriver of East Sand Island (Lawonn 2023a, 2023b). Although the intent of the ESI management plan was to reduce double-crested cormorant predation of juvenile salmon and steelhead (salmonids) listed under the federal Endangered Species Act (ESA), increases in predation associated with colonies besides East Sand Island have substantially offset the recent management-caused reduction in predation at the East Sand Island colony (Evans et al. 2022). This result is somewhat paradoxical because the abundance of double-crested cormorants in the Columbia River estuary has declined about 56% since implementation of the ESI management plan. However, per capita predation of salmonids is far higher at the upriver locations where most double-crested cormorants currently nest compared to East Sand Island. This is because salmonids make up a far larger share of the cormorant diet at upriver locations because there are fewer alternative sources of prey nearby compared with the marine zone of the estuary, where East Sand Island is located. As a result, predation by double-crested cormorants may now be equivalent to, or even substantially higher than, the pre-management period (Lawonn 2023a).

Summary of Action:

A sustained management effort using primarily non-lethal techniques could be implemented to reduce double-crested cormorant abundance on the Astoria-Megler Bridge colony and other colonies that lie upriver of East Sand Island, while minimizing double-crested cormorant dispersal to undesired areas. Five main actions would be necessary for this effort to succeed. First, double-crested cormorants would need to be deterred from nesting on the Astoria-Megler Bridge and other colony sites of management importance. Deterrence methods could include deployment of passive exclusion such as netting, bird wires, or other physical deterrents, although the use of such exclusion techniques would be limited to those that do not adversely affect the structural integrity of the Astoria-Megler Bridge or other structures used by cormorants for nesting. Along with passive exclusion, workers operating from boats or on the colonies themselves would harass, or "haze", cormorants prior to the breeding season, and continue harassment as needed through the duration of the breeding season. Harassment could involve use of water cannons, handheld lasers, pyrotechnics, predator effigies, or other techniques. Second, social attraction techniques would be used to attract cormorants displaced from the Astoria-Megler Bridge and other colonies back to East Sand Island. This action would be expected to increase the efficacy of deterrence activities and reduce the likelihood of cormorant dispersal to undesired locations. Management of bald eagle and gull disturbances could also be a component of social attraction on East

Sand Island. Third, monitoring the status of double-crested cormorants would be necessary to evaluate double-crested cormorant dispersal within the basin, as well as the effects of management on the regional population. In addition, annually monitoring predation rates at double-crested cormorant colony sites in the estuary would be necessary to ensure that management reduces predation impacts on salmonids. Fourth, adaptive management would likely be necessary to deter nesting at additional estuary colony sites because it is probable at least some individuals would disperse to undesired locations. Finally, to the extent possible, managers would evaluate whether double-crested cormorant management improved outcomes for salmonids. Such evaluation would ideally be based on changes to salmonid survival rates following management but could also be derived from a community-based modelling approach informed by research on food web dynamics in the estuary and plume. New research on food web dynamics would likely be needed for the latter modelling approach.

Existing or New Program:

This action would be part of a new program.

Benefit Provided by Action:

If successful, the action would reduce double-crested cormorant predation on most or all ESA-listed salmonids in the basin, since all outmigrants must pass through the estuary to reach the ocean. Although monitoring does not currently occur at all double-crested cormorant colonies in the estuary, available data suggest estuary-wide predation rates on various ESA-listed runs are currently at least as high as associated with East Sand Island during the pre-management period (Evans et al. 2022), when estimates of average annual predation rates at the East Sand Island colony ranged from 1.8% to 27.5% for various ESA-listed runs (Lawes et al. 2021). Lawonn et al. (2023a, 2023b) suggest that current estuary-wide predation rates could be substantially higher than during the pre-management period, perhaps by about a factor of 1.7.

Management would ideally reduce estuary-wide predation to an equivalent of no more than 5,380–5,939 breeding pairs on East Sand Island, the level envisioned by the National Marine Fisheries Service in their 2008 Biological Opinion related to hydrosystem operation. This target reflects a 4.5- to 4.9-fold reduction in double-crested cormorant predation compared to estimated predation impacts in 2021 (Lawonn 2023b).

Stocks Benefited by the Action:

Recent work suggests average annual double-crested cormorant predation rates associated with the East Sand Island colony prior to implementation of the ESI management plan (2004–2014) were about 7.4%, 7.6%, and 6.6% for Middle Columbia River, Snake River, and Upper Columbia steelhead surviving to Bonneville Dam, respectively (Roby et al. 2021). However, based on analyses in Lawonn (2023a), an estimated 17% of estuary-wide predation occurred at colonies besides East Sand Island during these years. For the purpose of this recommendation, we accounted for predation associated with these other colonies, and estimated that average annual estuary-wide predation rates during 2004–2014 were 8.9%, 9.2%, and 8.0% for Middle Columbia River, Snake River, and Upper Columbia steelhead, respectively. Reducing estuary-wide predation to the equivalent of 5,380–5,939 breeding pairs on East Sand Island would be estimated to reduce annual double-crested cormorant predation rates across the estuary to at least 3.4%, 3.5%, and 3.0% for Middle Columbia River, Snake River, and Upper Columbia River steelhead, an estimated 62% reduction in predation compared to the pre-management period, and an estimated 78% reduction in predation compared to 2021.

Although not highlighted in the Columbia Basin Partnership Task Force's phase 2 report, available information suggests double-crested cormorant predation rates on juvenile Lower Columbia River Chinook and Lower Columbia River Coho are considerably higher compared to other ESA-listed runs in the basin, with predation rates averaging about 27% and 15% on these runs, respectively, for sampled years associated with the East Sand Island colony (Roby et al. 2021). Both of these ESA-listed runs may be expected to benefit substantially from double-crested cormorant management. Based on predation rates presented in Roby et al. (2021), management may also be likely to benefit Snake River Spring Chinook, Snake River Fall Chinook, Upper Columba River Spring Chinook, Upper Willamette River Spring Chinook, Snake River Sockeye, and Lower Columbia River Steelhead.

Data Supporting Benefits:

A comprehensive analysis of estimated predation impacts following implementation of the ESI management plan is provided in Lawonn (2023a, 2023b). A recent analysis of predation rates for the double-crested cormorant colony on the Astoria-Megler Bridge is presented in Evans et al. (2022), and a synthesis of double-crested cormorant impacts on salmonids is presented in Roby et al. (2021).

Implementing Entities:

It is unknown what entities would implement this action. Current and potential colony sites are administered by a variety of local, state, and federal entities, and some potential sites may be owned by private entities. A high degree of coordination across jurisdictions would be necessary for this action to be successful. Fish and wildlife management responsibilities are also shared by multiple agencies. Parties that may be involved include:

- Bonneville Power Administration – Operates and maintains transmission towers, including those located near the confluence of the Sandy River and the mainstem Columbia River, and The Dalles Dam. These are current double-crested cormorant colony sites.
- Columbia River basin tribes and Columbia River Inter-Tribal Fish Commission representatives.
- National Marine Fisheries Service – Federal agency responsible for management of anadromous salmonids under the Endangered Species Act and the Magnuson–Stevens Fishery Conservation and Management Act.
- Oregon Department of Fish and Wildlife – State agency responsible for managing fish and wildlife.
- Oregon Department of Transportation (ODOT) - Maintains the Astoria-Megler Bridge under an agreement with the State of Washington.
- U.S. Army Corps of Engineers (USACE) - Manages East Sand Island (a double-crested cormorant colony site) and implemented the management plan, Double-crested Cormorant Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (USACE 2015).
- U.S. Coast Guard (USCG) – Regulates/advises on activities or modifications that could affect navigation near the Astoria-Megler Bridge and manages aids to navigation (e.g. buoys and channel markers) that are used for nesting by double-crested cormorants.

- U.S. Fish and Wildlife Service – USFWS responsibilities include the conservation and management of double-crested cormorants, which are included on the list of protected migratory birds under the Migratory Bird Treaty Act.
- Washington Department of Transportation – Manages Longview Bridge under an agreement with the Oregon Department of Transportation. The Longview Bridge is a current double-crested cormorant colony site.
- Washington Department of Fish and Wildlife – State agency responsible for managing fish and wildlife.

Time Needed to Implement:

Given the need for substantial funding and coordination across various governmental and tribal entities and compliance with federal and state environmental laws and regulations, it is likely that recommended actions would not begin until at least 2024 or 2025.

A redistribution of double-crested cormorants from the Astoria-Megler Bridge and other colony sites to East Sand Island will likely take at least four years. Thereafter, a reduced level of management will be necessary in perpetuity to maintain deterrence infrastructure and actively manage individuals attempting to nest at undesired locations. Monitoring will need to occur in perpetuity to guide adaptive management.

Time Needed to Benefit Fish Populations:

Benefits for salmonid populations could be realized during the first return years associated with reduced double-crested cormorant predation on outmigrating juvenile salmonids.

Estimated Cost:

The overall cost for this plan is estimated to be at least $9.5 M over four management years, with a recurring cost of up to or greater than $0.4 M annually thereafter. An estimated $2.6 M will be needed prior to and during the first year of implementation: $1 M dedicated for deterring double-crested cormorant use of the Astoria-Megler Bridge, $0.5 M for social attraction on East Sand Island, $0.3 M for a status assessment of the regional double-crested cormorant population (ideally conducted prior to plan implementation), $0.4 M for monitoring within the Columbia River basin, and $0.4 M for deterring use of other colony sites, as needed. Costs may decline in future years as double-crested cormorant fidelity to East Sand Island increases and as the efficacy of deterrence improves at the Astoria-Megler Bridge and other sites where displaced birds may attempt to relocate. Nevertheless, the estimated cost for the second through fourth year of implementation is $2.3 M annually. Because the Columbia River estuary is a highly attractive site for double-crested cormorants, monitoring and management will likely be required in perpetuity to prevent reuse of the bridge or other undesired sites for nesting. Therefore, an estimated $0.4 M will be required annually following the initial four-year management period to continue monitoring and deterrence efforts on the Astoria-Megler Bridge and other colony sites, as needed. If relocation of double-crested cormorants to East Sand Island is not successful, annual costs for monitoring and deterring cormorant use of undesired sites in the estuary could be substantially greater than $0.4 M annually. Because of substantial uncertainty inherent in the estimates above, they should be considered minimum estimates.

Uncertainties:

There are three main uncertainties related to management. First, it is unclear the extent to which predation by double-crested cormorants or other predators reduces life-cycle scale abundance of anadromous salmonids in the Columbia River basin (ISAB 2016). Losses to double-crested cormorants during the juvenile life stage might be ameliorated by improved survival later in life, especially if double-crested cormorants preferentially consume the least fit individuals (ISAB 2016).

Second, the role of predators in maintaining the structure of biological communities, even communities altered by humans, is often poorly understood (ISAB 2016). For example, depending on their colony sizes, double-crested cormorants can consume hundreds to even thousands of tons of forage fish in the Columbia River estuary annually, the vast majority of which are non-salmonids (Lawes et al 2021). Reductions in double-crested cormorant abundance could therefore substantially alter the local food web and predator community, which could result in counterintuitive and unintended consequences for juvenile salmonids, as suggested by a wide body of research related to predator-prey dynamics across a variety of taxa (Holt and Lawton 1994, Sih et al. 1998, Yodzis 2001, Bruno and O'Connor 2005, Harvey and Karieva 2005, Weise et al. 2008, Abrams 2009, Ellis-Felege et al. 2012).

Finally, the likelihood that management will substantially reduce estuary-wide double-crested cormorant predation is uncertain, at least at the estimated minimum cost of implementing this recommendation. The Independent Science Advisory Board (2016) suggests predator management is best suited to local scale and temporary conflicts (i.e. hotspots) rather than persistent conflicts that occur across a wide geographical area. This is because of the high cost and biological uncertainty related to predation management conducted at large scales. Nevertheless, this recommendation seeks to manage cormorant predation across a wide area because isolated colony-specific management would likely cause dispersal of displaced cormorants to new areas of the estuary unless prevented, which would move the predation issue rather than resolve it.

There are several examples of uncertainties related to such large-scale management:

1) Double-crested cormorants nested at 20 discrete sites in the Columbia River estuary in 2021. The cost of managing these sites could be substantially higher than estimated if the relatively less expensive passive dissuasion techniques recommended here are unsuccessful.
2) Bald eagle disturbance of the East Sand Island colony has been an important contributing factor to recent breeding failures there and may reduce the likelihood of future nesting at that location. If eagles or other factors prevent renesting at East Sand Island despite social attraction efforts, deterring use of other colony sites will be more difficult and costly because of the lack of a viable alternative breeding site for displaced individuals.
3) The focus on non-lethal management may not be as effective or cost-effective as desired, and lethal take may therefore need to be incorporated at a larger scale than anticipated.

Despite the uncertainties listed in this section, however, available information suggests substantial risk to salmonids from ESA-listed runs as a result of double-crested cormorant predation across the Columbia River estuary (Lawes et al. 2021, Roby et al. 2021, Evans et al 2022, Lawonn 2023a, 2023b). We therefore recommend carefully designed and implemented management with adequate effectiveness monitoring and adaptive management to address this risk. This recommendation is further supported by recent work by the Independent Science Advisory Board (ISAB 2021). They reviewed two studies that considered the effects of avian predation on interior Columbia Basin steelhead and concluded that the most prudent conclusion from a management perspective is that, despite the uncertainties, these predators have some level of effect on adult returns. Finally, the double-crested cormorant colony on the Astoria-Megler Bridge is causing substantial costs related to infrastructure maintenance and even human safety risks, which appear likely to be resolved with management at that site, despite uncertainties related to benefits for salmonids.

Associated Regulatory Processes or Policies:

Agencies implementing the recommended actions would have to comply with relevant federal and state environmental laws and regulations, such as the National Environmental Policy Act (NEPA), ESA, MBTA, and the Bald and Golden Eagle Protection Act. If double-crested cormorants can be managed using non-lethal techniques, environmental reviews are expected to be less complex than if lethal techniques are used.

Potential Challenges:

The high abundance of prey (juvenile salmonids, marine forage fish, and other species) in the Columbia River estuary is a major draw for double-crested cormorants and will likely continue to make the estuary an attractive nesting location. There are 11 historical nesting colonies or colony complexes in the estuary, and individuals would likely disperse among these sites if management is not appropriately coordinated. In addition, unused potential nesting habitat is present within the estuary at a variety of locations, suggesting management-related dispersal could be a persistent problem. Finally, potential colony sites are administered by a variety of local, state, federal, and private entities; coordination across jurisdictions would be necessary for this recommendation to be successful. Furthermore, given the multiple jurisdictions and agencies involved, it is currently unclear which parties would be responsible for implementation, monitoring, and adaptive management.

Adaptive Management:

We envision several reasons for adaptive management:

1) Double-crested cormorant distribution and abundance in the estuary are not responding as anticipated.
2) Estuary-wide predation rates are not responding as anticipated.
3) Ideally changes to measures of survival across the life cycle would be used to assess project success and whether a change in management actions would be necessary. However, given the degree of variability in annual marine survival, human activities, and environmental conditions, these changes would be extremely difficult, perhaps impossible, to assess empirically.

A detailed adaptive management plan that outlines roles and responsibilities of the implementing parties would need to be developed. Examples of adaptive responses include adjusting management effort at the Astoria-Megler Bridge and upriver sites in response to cormorant use, and potential management of colony disturbances at East Sand Island.

Best Management Practices (BMPs)

The working group recommends development of a formal set of best practices and guiding principles for predator management that can be used to guide future work. The following are examples of potential BMPs:

- Managers should identify clear objectives and develop evaluation criteria for avian management to measure progress toward meeting these objectives.
- Predation should be managed at the appropriate spatial scale.
- Managers should plan, coordinate, and budget for adaptive management.
- Managers should conduct effectiveness monitoring that directly measures results against management objectives.
- Potential non-lethal management options should be evaluated before implementing lethal methods, as appropriate.

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SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- Any avian predation proposal should be coordinated regionally.
- This recommended action should be prioritized in order to deliver considerable synergy as the Oregon Department of Transportation (ODOT) and Washington Department of Transportation (WDOT) undertake a public process to develop solutions to the safety and structural integrity concerns caused by the DCCO colony on the bridge. This creates an opportunity for the DOTs to fund components of this action but requires the two processes to develop on a similar timeframe. The DOT's management action on the bridge must nest within the broader context of this recommendation to maximize the likelihood of long-term sustainable success.
- The recommended action identifies key uncertainties, including the potential distribution of birds upriver, which would not be beneficial, and the presence of bald eagles on East Sand Island.
- The benefits of this action will be extensive throughout the basin since all stocks swim through the estuary, so every stock will benefit to some extent. Lower river stocks and steelhead are likely to benefit the most. Existing empirical data also suggest this action is likely to benefit reduction in predation for both Snake River and Upper Columbia Steelhead stocks.

Stock Benefits Report Card:

Predation: Recommendation for management of double-crested cormorants in the Columbia River Estuary

			Abundance			MAFAC Phase II Impact Priority								
Sub-Region	Stock	Status	Current	MAFAC Medium goal	Current as % of Medium Goal	Tributary Habitat	Estuary Habitat	Hydro (Mainstem)	Hydro (Latent)	Hydro (Blocked)	Predation	Fishery	Hatchery	Harvest
Low-C	L Col R Spring Chinook	Threatened	2,240	21,550	10%	1	3	3	3	2	3	3	2	3
Low-C	L Col R Winter Steelhead	Threatened	5,989	27,900	21%	1	2	3	3	3	3	3	3	3
Low-C	L Col R Fall (tule) Chinook	Threatened	12,329	54,100	23%	1	2	3	3	3	3	1	2	1
Low-C	L Col R Coho	Threatened	31,524	129,550	24%	1	3	3	3	3	3	3	2	3
Low-C	L Col R Summer Steelhead	Threatened	10,594	29,800	36%	2	4	4	4	2	4	4	4	4
Low-C	Col R Chum	Threatened	11,762	33,000	36%	2	2	4	4	4	4	4	4	
Low-C	SW WA Winter Steelhead	Threatened	3,252	5,850	56%	2	4	5	5	5	5	5	5	5
Low-C	L Col R Late Fall (bright) Chinook		10,800	16,700	65%									
Low-C	L Col R Fall (bright) Chinook	Threatened	11,000	11,000	100%	5	5	5	5	4	5	4	5	4
Mid-C	M Col Sockeye	Not Listed	1,036	45,000	2%	3	3	3	2	1	3	3		3
Mid-C	M Col R Spring Chinook	Not Listed	11,600	40,425	29%	2	4	4	4	4	4	4	4	4
Mid-C	M Col R Summer Steelhead	Threatened	18,155	43,850	41%	2	4	4	4	4	2	4	4	4
Mid-C	M Col R Coho	Not Listed	6,324	11,600	55%		5	4	5	5	5	4		4
Mid-C	M Col R Summer/Fall Chinook	Not Listed	11,500	13,000	88%	5	5	5	5	5	5	4	5	4
Up-C	U Col R Coho	Not Listed	392	15,000	3%									
Up-C	U Col R Summer Steelhead	Threatened	1480	31,000	5%	1	1	2	1	1	1	3	2	3
Up-C	U Col R Sockeye	Not Listed	40,850	580,000	7%	1	3	1	1	1	2	3	3	3
Up-C	U Col R Spring Chinook	Endangered	1430	19,840	7%	1	3	1	1	1	2	3	1	3
Up-C	U Col R Summer Chinook	Not Listed	16920	78,350	22%	1	2	1	1	1	3	1	2	1
Up-C	U Col R Fall Chinook	Not Listed	92,400	62,215	149%	5	5	4	5	5	5	4	5	4
Snake	Snake R Coho	Not Listed	100	26,600	0%									
Snake	Snake R Sockeye	Endangered	100	15,750	1%	3	3	1	1	1	2	3		3
Snake	Snake R Spring/Summer Chinook	Threatened	6,988	98,750	7%	1	3	1	1	2	2	3	3	3
Snake	Snake R Summer Steelhead	Threatened	28,000	75,000	37%	2	4	4	2	2	2	4	4	4
Snake	Snake R Fall Chinook	Threatened	8,360	10,780	78%	5	5	4	4	4	5	4		3
Willam	U Will R Spring Chinook	Threatened	4,278	47,850	9%	1	2	3	3	1	3	3	2	3
Willam	U Will R Winter Steelhead	Threatened	2,816	27,805	10%	1	2	3	3	3	1	3	3	3

Draft for Internal Review – 3/14/23

Stocks most benefited
Stocks receiving secondary benefit

Predation Work Group

Recommendation: Enhance and Modify the Marine Mammal Protection Act Section 120 Pinniped Removal Program

Problem Statement:

The following recommendation addresses pinniped predation on adult returning salmon and steelhead.

Steller sea lions (SSL) and California sea lions (CSL) residing at Bonneville Dam and Willamette Falls can consume between 2 and 6 adult salmon per day depending on salmon aggregation densities at the ladders, which means approximately 2,000 adult migrating chinook salmon consumed for every 10 sea lions present at each project (assuming 4 salmon per sea lion per day for a 50-day period). This translates to 2% mortality on spring run chinook salmon (assuming a run size of 100,000) for every 10 sea lions present. Mortality estimates vary depending on run size, sea lion abundances, and sea lion residency times. Direct observations at Bonneville Dam have been documented since 2002, accounting for animals in the immediate vicinity of Bonneville Dam. Salmonid mortalities have ranged from 2-6% at Bonneville in that period within the area observable at Bonneville dam, but the total impact is greater because predation is not limited to the observed area. Sea lion predation studies documented losses of Spring chinook salmon between 22% and 50% of the run in the Astoria to Bonneville reach.

The Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Idaho Department of Fish and Game (IDFG), and the Columbia River Inter-Tribal Fish Commission (CRITFC) jointly manage and implement lethal removal of SSLs and CSLs under the Marine Mammal Protection Act Section 120 Pinniped Removal Program. Section 120(f) of the program authorizes removal of sea lions from river mile 112 to river mile 292 of the Columbia River, and its tributaries to the mouth. Sea lion removals under the program have resulted in approximately 30-60% reductions of the animals present. The 120(f) permit is authorized through August 2025 and funded through June 2024. The current program has reduced pinniped predation mortality on salmon and steelhead. Stable long-term funding is essential to maintain the reduction in predation. Additional improvements and innovations may increase the effectiveness of the program.

Summary of Action:

Recommended enhancements and modifications to the existing Marine Mammal Protection Act Section 120 Pinniped Removal Program would include:

a. Extend authorization and fully fund the *status-quo* 120(f) permit scope with inflationary costs through 2035 to provide stability to the program's effectiveness.
b. Additionally provide one-time funding for new sea lion removal equipment and to replace outdated equipment.
c. Provide additional funding to increase the capacity to remove sea lions and process animals, including a program to maintain an on-call veterinarian roster for euthanasia processing, and a program to train more state and/or tribal biologists and technicians for seasonal work.
d. Additionally extend and fully fund pinniped abundance estimation and kill rate monitoring programs, e.g., USACE Bonneville monitoring.

e. Additionally pursue research and development into lethal tributary removals and the use of lethal darts.

Existing or New Program:

Existing program.

Benefit Provided by Action:

A removal of 10 sea lions per year can translate to between 1,200 and 5,100 additional adult salmon passing Bonneville Dam and Willamette Falls (based on a 60 to 90 consumption window and a range of 2 to 6 salmon per day).

Stocks Benefited by the Action:

Spring chinook and winter steelhead migrating past Willamette Falls and Bonneville Dam will benefit from the removal of CSLs and SSLs.

Data Supporting Benefits:

COE observed CSL abundance and salmon kills at Bonneville dam. See Van der Leeuw B.K. and K.S. Tidwell. 2022. Evaluation of Pinniped Predation on Adult Salmonids and Other Fish In The Bonneville Dam Tailrace, 2021. U.S. Army Corps of Engineers, Portland District, Fisheries Field Unit. Cascade Locks, OR. 42 pp.

Implementing Entities:

ODFW, WDFW, IDFG, Tribes.

Time Needed to Implement:

The *status-quo* 120(f) component is already implemented. Additional research and innovation actions can be implemented before the expiry of the 2025 120(f) permit and continue upon extension.

Time Needed to Benefit Fish Populations:

The 120(f) status-quo is on-going, and immediately benefits each run of adult chinook and steelhead upon removal of CSLs and SSLs. Additional trapping and darting capacity and innovation will benefit salmon and steelhead runs immediately upon implementation.

Estimated Cost:

$3.25M total operational budget per year, plus a $800K one-time equipment cost. The status-quo removal budget for the 120(f) program is approximately $2M per year for ODFW, WDFW, IDFG, and CRITFC operational costs. It is recommended that this budget be extended through 2035. Additional annual budgets are:

1. Research and development to increase capacity to remove and process animals - $250K
2. Effectiveness monitoring of pinniped abundance and kill rates (USACE) - $500K
3. Adaptive management research and analysis - $250K
4. Research and development in the use of darts and lethal removal from tributaries - $250K

Uncertainties:
Biological uncertainties exist regarding sea lion abundance trends and upstream migration rates, as well as the resulting predation mortality rates. Uncertainties also exist in capture and removal effectiveness rates.

Associated Regulatory Processes or Policies:
Marine Mammal Protection Act section 120(f).

Potential Challenges:
Trapping and euthanizing animals has many logistical problems and sea lions periodically change their haul out behavior which necessitates changes in trapping methods. Darting and retrieving animals may provide new challenges for managers to consider. Legal authorization only allows remove with trap or dart capture followed by chemical euthanasia.

Adaptive Management:
Continued monitoring and/or abundance estimation of predator and prey abundances, and of prey kills will provide evidence of the effectiveness of the program.

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- This program has been successful, but the funding is still inconsistent. Consistent funding and the ability to continue to build on progress is important from the states' perspective.
- Available data indicate that sea lions in this vicinity are responsible for 25-50% of mortality for spring and summer Chinook. Removing the sea lions at these locations would have a significant benefit for adult returns.
- All the stocks travel through the Columbia River in the spring when California and Steller sea lions are present, so this action would benefit all stocks. Spring and summer Chinook are likely to benefit the most.
- Additionally, because this predation occurs on adult fish rather than juveniles, the predation benefits are likely additive rather than compensatory.

Stock Benefits Report Card:

Predation: Recommendation to enhance and modify the Marine Mammal Protection Act Section 120 Pinniped Removal Program

			Abundance			MAFAC Phase II Impact Priority								
Sub-Region	Stock	Status	Current	MAFAC Medium goal	Current as % of Medium Goal	Tributary Habitat	Estuary Habitat	Hydro (Mainstem)	Hydro (Latent)	Hydro (Blocked)	Predation	Fishery	Hatchery	Harvest
Low-C	L Col R Spring Chinook	Threatened	2,240	21,550	10%	1	3	3	3	2	3	3	2	3
Low-C	L Col R Winter Steelhead	Threatened	5,989	27,900	21%	1	2	3	3	3	3	3	3	3
Low-C	L Col R Fall (tule) Chinook	Threatened	12,329	54,100	23%	1	2	3	3	3	3	1	2	1
Low-C	L Col R Coho	Threatened	31,524	129,550	24%	1	3	3	3	3	3	3	2	3
Low-C	L Col R Summer Steelhead	Threatened	10,594	29,800	36%	2	4	4	4	2	4	4	4	4
Low-C	Col R Chum	Threatened	11,762	33,000	36%	2	2	4	4	4	4	4	4	
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Draft for Internal Review – 3/14/23

Stocks most benefited
Stocks receiving secondary benefit

Predation Work Group

Recommendation: Develop and initiate testing of a comprehensive piscine predator monitoring and evaluation program (PPMEP) for the Columbia River Basin

Problem Statement:

Currently, there is no coordinated, large-scale program to investigate and quantify the overall predatory impact of piscine predators (e.g., Northern Pikeminnow, Smallmouth Bass, Walleye) to juvenile salmonid stocks in the lower and mid-Columbia River Basin. Without more complete estimates of piscine predation rates to salmonid stocks and data to track potential predator compensatory responses, it is difficult to recommend meaningful predator management actions and virtually impossible to measure the effect of any implemented management actions. Furthermore, sustained piscine predation information is needed to track long-term changes to the ecological system and to better inform management decisions involving natural and anthropogenic processes (e.g., climate change). This action item recommends the Region support the process needed to design an improved PPMEP that can be used to provide actionable information for future piscine predation management. The scope of this action item and associated budget are limited to the PPMEP project design process and does not include any PPMEP implementation. It is intended that this action item be the first in a series of action items eventually culminating in a functional PPMEP used to guide management decisions to improve the status of salmonid stocks.

Numerous studies have already been implemented to estimate piscine predation to juvenile salmonids (e.g., Beamesderfer et al. 1996, Tiffan et al. 2020, Northern Pikeminnow Management Program 2021, WDFW in prep.) and while they have improved our understanding of the predator/prey dynamics in the lower and mid-Columbia River Basin, the findings are difficult to compare to each other as the methods employed were often different. Furthermore, none of the previous studies have received the support needed to be expanded into a lower and mid-Columbia Basin PPMEP. Previous studies have estimated the effects of piscine predation to salmonids but there remain several key data gaps:

- Unbiased estimates of predator abundance
- Identification of salmonid prey including stock and hatchery- versus natural-origin
- Spatial and temporal trends of salmonid predation
- A general lack of understanding about the seasonal and interannual variability in native and non-native predator/prey population dynamics

In order to implement and measure the impact of future piscine predator management actions, a scientifically robust and spatiotemporally broad monitoring program is needed in the lower and mid-Columbia River Basin that would address these data gaps. The PPMEP stemming from this action item would be spatially modular incorporating slight study modifications due to the physical and biological differences in the various sub-areas of the lower and mid-Columbia River Basin. However, the focus would be to collect biological metrics that would be comparable over space and time, relative to the predator and prey species present in each sub-area. This action item is designed to leverage the numerous pre-existing study designs with the technical knowledge of staff at various agencies, tribes, and NGO's to design an improved PPMEP with monitoring and analytical tools to address the listed data gaps. This action item establishes the framework for that design process (action item 'a' in Section 3) and recommends pilot projects needed to inform the design of a lower and mid-Columbia River Basin PPMEP (action sub-items '1 – 4' in Section 3).

The product from this action item would be a study design to provide a lower and mid-Columbia River Basin data stream that address critical questions regarding the effects of piscine predation on the viability (e.g., life stage specific survival rates) of salmonid stocks. The design process for this action item is structured to incorporate the collaborative approach of the CBC by including technical expertise from an array of state, federal, tribal, NGO, and academic entities. This approach will culminate in a study design for monitoring and evaluation of piscine predation that will be relevant to the unique conditions of the lower and mid-Columbia River Basin.

Summary of Action:

The following components action items are required to inform the design of a lower and mid-Columbia River Basin PPMEP:

1. Design a modular PPMEP study to generate unbiased estimates of predator abundance and the consumption rates of juvenile salmonids. These metrics can be used to inform adaptive management of the lower and mid-Columbia River Basin (**PPMEP Study Design**).
    - 1.1. Assess the effectiveness and bias of sampling gear types for selected piscine predators (**Gear Effectiveness**).
    - 1.2. Develop GIS layers classifying river habitat (e.g., bank, near shore, off-shore) at the required spatial scales to inform predator abundance models (**GIS Habitat**).
    - 1.3. Evaluate methods to improve prey information from predator digestive tract contents beyond species (e.g., stock, origin, ESU or population) (**Diet Analyses**).
    - 1.4. Assess information about new or expanding non-native piscine predator species Adaptively manage the PPMEP study design to incorporate information to achieve unbiased predator abundance estimates (**Additional Non-native Predators**).

Existing or New Program:

The **PPMEP Study Design** action item will incorporate technical staff identified by the Columbia Basin Collaborative Piscine Predation Work Group who will utilize pre-existing studies to design a PPMEP for the lower and mid-Columbia River Basin, including field and analytical components (e.g., Beamesderfer et al. 1996, Friesen and Ward 1999, Counihan 2011, Tiffan et al. 2020, Murdoch pers. comm.). The four action sub-items (**Gear Effectiveness, GIS Habitat, Diet Analyses, Additional Non-native Predators**) could be integrated into existing programs or study designs (e.g., Northern Pikeminnow Management Program, WDFW GRTS study). There are a number of state, federal, regional, tribal, and academic groups that are currently conducting work related to these action items. These existing efforts could collaborate and partner with the proposed action sub-items for effective and efficient PPMEP implementation, in a future action item.

Benefit Provided by Action:

PPMEP Study Design:

Designing a scientifically robust, lower and mid-Columbia River Basin PPMEP is the missing tool to effectively assess the benefit of future management actions and prioritize impacts among all sources of piscine predation mortality. Developing a modular study design to generate unbiased piscine predator abundance estimates and analytical tools to compare estimates across space and time will reduce the inherent uncertainty in the responses of predator populations to management actions and climate change. Without a PPMEP, there will be significant data gaps and uncertainty related to any future management action, further complicating the utility of actionable information to resource managers. The occurrence of piscine predation on juvenile salmonids is certain, but inaccurate estimates of predation lead to questions about the efficacy or necessity of piscine predation control measures among resource managers and stakeholders. Long-term monitoring studies conducted under the recommended adaptive management framework should provide actionable management information while maintaining the flexibility to incorporate additional monitoring approaches to account for the expected (but unknown) dynamics of the Columbia River Basin.

Gear Effectiveness, GIS Habitat, Diet Analyses, Additional Non-native Predators:

The four additional action sub-items could be addressed concurrently with and to help inform the PPMEP design process. These action sub items are Gear Effectiveness, GIS Habitat, Diet Analyses, and Additional Non-native Predators. Addressing each of these four areas would provide critical information needed to ensure the PPMEP is utilizing effective and efficient sampling gear, has appropriate habitat data to inform statistical models, provides taxonomically resolved predator diet composition data, and can integrate sampling for additional non-native piscine predators.

Stocks Benefited by the Action:

Presumably, the survival of individuals from all stocks is negatively impacted by piscine predation (i.e., another data gap). However, because information about piscine predator impacts to out-migrating juvenile salmonids are data limited, the size at migration may serve as a relative measure. Hence, subyearling Chinook may benefit the greatest and steelhead the least, while Spring Chinook, Coho and Sockeye are intermediate.

Data Supporting Benefits:

Studies assessing piscine predator/prey dynamics have been conducted in the Columbia River Basin for over 40 years. Below is a list of relevant studies that will be used to help inform a lower and mid-Columbia River Basin PPMEP though this list is not exhaustive:

Beamesderfer, R.C., Ward, D.L. and Nigro, A.A., 1996. Evaluation of the biological basis for a predator control program on northern squawfish (Ptychocheilus oregonensis) in the Columbia and Snake rivers. Canadian Journal of Fisheries and aquatic sciences, 53(12), pp.2898-2908.

Counihan, T.D., Hardiman, J.M., Burgess, D.S. and Simmons, K.E., Assessing Native and Introduced Fish Predation on Migrating Juvenile Salmon in Priest Rapids and Wanapum Reservoirs, Columbia River, Washington, 2009–11.

Friesen, T.A. and Ward, D.L., 1999. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. North American Journal of Fisheries Management, 19(2), pp.406-420.

McLellan, H. J., S. Wolvert, A. O. Silver, K. T. Thurman, C.D. Lee, and T. Parsons. 2019. Lake Roosevelt Northern Pike Suppression and Monitoring, 2018 Annual Report. Bonneville Power Administration Project # 1994-043-00 and 2017-004-00.

NPMP 2022

Poe, T.P. and Rieman, B.E. eds., 1988. Predation by resident fish on juvenile salmonids in John Day reservoir, 1983-1986. US Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife.

Tiffan, K.F., Erhardt, J.M., Hemingway, R.J., Bickford, B.K. and Rhodes, T.N., 2020. Impact of smallmouth bass predation on subyearling fall Chinook salmon over a broad river continuum. Environmental biology of fishes, 103, pp.1231-1246.

Waltz, G. T., K. J. Rybacki, C. M. Barr, A. L. Carpenter, K. R. Anderson, E. B. Lamb, and P. E. Chambliss. 2022. Report C–System-wide predator control program: fisheries and biological evaluation. Oregon Department of Fish and Wildlife, Project Number 1990-077-00. 2021 Annual Report to the Bonneville Power Administration, Portland, Oregon.

Willis, C.F., Ward, D.L. and Nigro, A.A., 1993. Development of a Systemwide Program: Stepwise Implementation of a Predation Index, Predator Control Fisheries, and Evaluation Plan in the Columbia River Basin. 1992 Annual Report. BPA Project, (90-077).

Implementing Entities:

Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), the Yakima Nation (YN), and the Confederated Tribes of the Colville Reservation (CTCR). Other fisheries resource agencies may also choose to participate.

Time Needed to Implement:

PPMEP design efforts could be initiated within a couple of months after funding. CBC Piscine Predation Work Group members have the professional contacts needed to staff a PPMEP design panel as well as the technical capacity to lead the design of a lower and mid-Columbia River Basin PPMEP (resumes available on request). Action sub-items 1.1 – 1.4, could be integrated with ongoing projects affiliated with ODFW (NPMP), WDFW, YN, and CTCR. While much work is conducted during the juvenile salmonid outmigration (April – July), other components could be implemented at any time of the year (e.g., Gear Effectiveness).

PPMEP could be designed in 1-2 years. Some of the action sub-items would be conducted concurrently with the PPMEP design process because the PPMEP design process can be initiated while the sub-action items are being completed. These sub-action items would also take 1-2 years to complete.

Time Needed to Benefit Fish Populations:

Unlike other sources of predation (avian and pinniped), piscine predation has not been adequately quantified. Relative to other sources of predation, the magnitude of predation by species is unknown. This critical data gap precludes prioritization of management actions due to uncertainty in the effectiveness of any action.

Estimated Cost:

Existing programs could serve as a cost share (e.g., WDFW ~ $282k; NPMP ~$4.2M), but funding to design a PPMEP, including all sub-action items, is likely to require an additional $500,000-$1,100,000 which does not include implementing PPMEP in the lower and mid-Columbia River Basin.

Uncertainties:

Many of the uncertainties as related to the PPMEP can be addressed through adaptive management of the monitoring program that results from the design process. Given the lack of previous work in the Columbia River Basin for many of the components, the precision of estimates is unknown at this time. As the PPMEP is fully implemented and our understanding of the predator-prey interactions increases, the type and effectiveness of management actions is also uncertain. Compensatory response to Northern Pikeminnow (NPM) reductions may have been occurring over the last 30 years. The responses of Northern Pikeminnow or other piscine predators to further management actions will require better information than we have gathered to date.

Associated Regulatory Processes or Policies:

Permits to collect NPM, Smallmouth Bass, Walleye, and potentially incidental take of other species (e.g., salmonids) including ESA coverage for all salmonid populations.

Potential Challenges:

Engagement with the recreational angler and guide community will be important and challenging. Providing unbiased scientific information as related to the predator risk will be critical for resource managers to take any recommended control measures.

Effective PPMEP study design will need to be scalable, potentially incorporating pilot studies in sub-areas of the lower and mid-Columbia River Basin, as well as modular such that the core study design is relevant across this large spatial scale. There will likely be many challenges to develop a relevant and effective PPMEP study design for all sub-areas of the lower and mid-Columbia River Basin. Some of these challenges are expected from previous research while there are potentially numerous others that will be identified through the design process. However, the modular and scalable nature of the PPMEP will be a strength as it progresses from the design to testing and eventually implementation phases (which would be conducted in subsequent action items) as the inherent challenges can be addressed at each stage of the process.

Adaptive Management:

Initially, adaptive management will occur as data gaps are filled. As additional information is collected on piscine predation, monitoring (spatial or temporal) and analyses to evaluate the performance of management actions can be adjusted. The response of predator populations to future management actions and climate change is also of great importance. Reducing overall mortality related to the community of piscine predators, not simply a single species, is the primary objective. Hence, the PPMEP can respond with management actions consistent with responses observed by predator populations.

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- There are many data gaps in predator-prey dynamics in the basin. This recommendation is intended to look systematically at piscine predation in the basin and use data collection and analytical tools to monitor and understand the effectiveness of piscine predator management actions that will be proposed in the future.
- This recommendation will allow managers to better evaluate future actions and understand which predation actions provide the greatest return on investment.
- This proposal does not replace but rather expands on the experience and struggles of the existing northern pikeminnow management program's ability to fully track complex piscine predator-prey dynamics among the predator community that is funded through Bonneville Power Administration mitigation.
- This recommendation would help prioritize habitat restoration efforts by showing where predators limit conservation benefits.
- Understanding when predation events occur could help inform hydropower system management and there is overlap with the natural origin run timing recommendation developed by the Hydropower Work Group.
- There are also implications for hatcheries, since piscine predators consume hatchery as well as wild fish.
- The benefits of this recommended action will depend on the specific geographic range and actions that are ultimately applied and implemented. This proposal is to develop that detailed project study design plan. The intention is for the study design to be modular and scalable, allowing for portability to different parts of the basin, including currently blocked areas. Over the long-term and depending on specific follow-on predation suppression actions, this has the potential to benefit all stocks. The framework would monitor predation baselines, assess suppression action effectiveness, and inform predation related adaptive management into the future.

Stock Benefits Report Card:

Benefit depends on the geographic range that is chosen for implementation.

Predation Work Group

Recommendation: Develop and fund a robust Columbia River Northern Pike and invasive nonnative fishes monitoring project

Problem Statement

Invasive non-native fishes compromise salmonid species in the Columbia River watershed through predation, competition for food, interbreeding, disease transmission, food web disruption, and physical habitat alteration. These fish pose direct threats to salmonid restoration efforts and compromise millions of public dollars spent to protect and conserve salmonids in the Columbia River watershed. Specifically, Northern Pike *Esox lucius* (Pike) have become established in the blocked area of the Columbia River. Pike have been documented to have profound predatory impacts on native fish species assemblages when they became established in waters within the Columbia Basin. The WDFW and Tribal comanagers have taken extreme measures to suppress these expanding populations with the goal of preventing or at least slowing the progression of these fish into the anadromous portion of the Columbia Basin. The establishment of Pike within the anadromous portion of the basin would be detrimental to the recovery of ESA listed salmon and steelhead stocks, affect salmon and steelhead-based economies and would continue to degrade fishery resources that are culturally significant to Native American Tribes connected to the Columbia Basin and Washington coastal fisheries.

Other non-native invasive fish such as Fathead Minnow *Pimephales promelas*, Brook Stickleback *Culaea insonstans*, Black bullheads *Ameiurus melas*, Yellow Bullheads *A. natalis*, Brown Bullheads *A. nebulosus*, Tadpole Madtom *Noturus gyrinus*, Common Carp *Cyprinus carpio*, Tench *Tinca tinca*, Western Mosquitofish *Gambusia affinis* and American Shad *Alosa sapidissima* are present in Washington State, primarily in the lower sections of the Columbia and Snake rivers. Their predatory impacts to native salmonids are unknown. Their populations will likely spread into new waterbodies as no suppression or monitoring is currently occurring on these species.

Predatory impacts to salmonids in the Columbia River watershed by non-native game fish such as Yellow Perch *Perca flavescens*, Pumpkinseed *Lepomis gibbosus*, Bluegill *Lepomis macrochirus*, Largemouth Bass *Micropterus salmoides*, White Crappie *Pomoxis annularis*, Black Crappie *Pomoxis nigromacultus*, Brook Trout *Salvelinus fontinalis*, Lake Whitefish *Coregonus clupeaformis*, Brown Trout *Salmo trutta* and, Channel Catfish *Ictalurus punctatus* likely occur at varying levels throughout the watershed; however, no specific monitoring programs exist that include these species.

Summary of Action:

Develop and fund a robust Columbia River Northern Pike and invasive non-native fishes monitoring project that leverages current suppression, monitoring, and research activities with new projects to fill data gaps:

1. Determine which water bodies are contributing to the increased abundance of Northern Pike or other invasive non-native fishes in the Columbia Basin.
2. Implement wide scale eDNA monitoring in key lakes, reservoirs, tributaries, tributary mouths and the mainstem Columbia River for the presence of Northern Pike and other key invasive non-native fishes.

3. Explore and implement actions to reduce or stop Northern Pike or other invasive non-native fishes from immigrating into anadromous waterbodies.
    a. Suppression actions include physical removal, weirs, fences, grates or electric fences.
    b. Design and implement watershed wide eradication efforts if applicable.
    c. Adjust fishing regulations to allow the public to assist with harvesting fish at key locations to reduce the abundance of Northern Pike or other invasive non-native fishes in the Columbia Basin.
    d. Engage in public outreach to inform the public of the problem, the planned solutions with a link to how it will help their local communities.
        i. Removal actions will increase salmon fishing opportunities which have positive economic impacts to local communities.
        ii. Removal actions will increase salmon abundance in the watershed which have positive impacts to the environment through marine derived nutrients.
        iii. Removal actions will support an increase in salmon abundance which could assist with Orca Recovery.
        iv. Removal actions will also assist with restoring culturally significant resident fish, salmon and steelhead fisheries within the entire Columbia Basin.
4. Develop Northern Pike Rapid Response plans for each “section” of the Columbia River.
    a. The WDFW is currently developing a Statewide Northern Pike Rapid Response Plan that will be finalized by the fall of 2023. This is a high-level plan with the goal of developing watershed specific plans.
    b. Plans have been developed for all of the mainstem reservoirs upstream of Priest Rapids Dam (Four Peaks Environmental 2022; McLellan et al. 2018).
    c. Funds should be made available to the WDFW (or other designated agency) to develop Northern Pike Rapid Response Plans for the Columbia Basin Irrigation District and each mainstem Columbia River Project area below Priest Rapids Dam.
5. Continue to fund Northern Pike Suppression projects in the upper Columbia River watershed beyond 2025 (the current end of most funding plans).

Existing or New Program:

New Programs. However, each area may have resources that can be leveraged to achieve the monitoring and suppression actions.

Benefit Provided by Action:

Basin wide reduction of Northern Pike and invasive non-native fishes will increase overall salmonid abundance.

Stocks Benefited by the Action:

Native resident fish communities and anadromous stocks (specifically Upper Columbia River (UCR) spring and summer/fall Chinook and UCR steelhead, Sockeye and Coho) will benefit from the removal of non-native predators by reducing predation, competition for food, interbreeding, disease transmission, food web disruption, and physical habitat alterations.

The specific magnitude of the benefit is unknown at this time as regional studies need to be conducted to determine which non-native species are causing harm and to what extent.

Data Supporting Benefits:

WDFW has data on a few irrigation drains in mid-Columbia River that currently support the movement of non-native invasive and non-native game fish into the Columbia River. However, more data on locations and species of concern is required before actions can be implemented.

Implementing Entities:

Federal, state, tribal, local utilities and other resource stewards.

Time Needed to Implement:

Pike and invasive non-native fish suppression and monitoring should occur throughout the year.

1. Determine fish communities and waterbodies of concern – ongoing as Northern Pike or other invasive non-native fishes increase in abundance or colonize portions of the basin - 1-10 years
2. Implement Northern Pike eDNA – year 1
3. Explore and implement actions to reduce abundance and distribution of Northern Pike or other invasive non-native fishes – Years 2-10 (and beyond)
4. Adjust fishing regulations – years 2-10 and beyond
5. Engage in public outreach – years 1-10
6. Develop Northern Pike Rapid Response Plans – 1-5 years
7. Support ongoing Northern Pike Suppression actions in the upper Columbia River – 1-10 years.

Time Needed to Benefit Fish Populations:

Fish populations will immediately begin to benefit from actions that reduce the abundance and distribution of Northern Pike and/or invasive non-native fishes.

Estimated Cost:

1. Determine fish communities and waterbodies of concern - $500,000
2. Implement Northern Pike eDNA - $100,000 per year for 10 years.
3. Explore and implement actions to reduce non-native fish - $500,000- $1 million per project per year.
4. Adjust fishing regulations – minimal cost covered by state management agencies.
5. Engage in public outreach - $100,000 per year
6. Develop Northern Pike Rapid Response Plans - $50,000 per plan
7. Support ongoing Northern Pike Suppression actions in the upper Columbia River - $250,000 per agency per year to supplement funding received from other sources.

Uncertainties:
Active suppression will affect non-target fish populations. The impacts are unknown but can be monitored and mitigated (adaptive management) for each specific location and action taken.

Important to engage the public to avoid the spread of misinformation.

Associated Regulatory Processes or Policies:
State fishery management agencies develop and implement fishing regulations.

All suppression activities in areas occupied by ESA-listed salmonids will need to be reviewed and approved by NOAA.

Potential Challenges:
Ensuring enough funding is available to hire staff and to implement projects.

Adaptive Management:
Fish species present and actions taken in each "section" or watershed will be different. Regional experts will need to adaptively manage each action to fit their specific watershed.

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- This proposal focuses on developing a systematic approach for minimizing the risk of introduction and spread as well as planning for suppression and eradication as non-native invasive species enter the system, including an early warning system in place and the ability to detect predators as they arrive and respond to those invasions.
- This recommendation builds upon individual efforts to develop rapid response plans within the basin and would complement ongoing efforts and coordination such as the Northwest Pike Regional Forum.
- Since northern pike is the primary invasive fish species of focus right now, the upper Columbia stocks are likely to benefit the most in the near term. As northern pike move downstream, there will be benefits for other stocks as well.
- There are ties between this recommendation and reintroduction efforts. For example, this effort would benefit fish being reintroduced above Grand Coulee Dam. Future reintroduction efforts can utilize the baseline information that is established to inform decisions.

Stock Benefits Report Card:

Predation: Recommendation for Northern Pike and invasive non-native fishes monitoring project

			Abundance			MAFAC Phase II Impact Priority								
Sub-Region	Stock	Status	Current	MAFAC Medium goal	Current as % of Medium Goal	Tributary Habitat	Estuary Habitat	Hydro (Mainstem)	Hydro (Latent)	Hydro (Blocked)	Predation	Fishery	Hatchery	Harvest
Low-C	L Col R Spring Chinook	Threatened	2,240	21,550	10%	1	3	3	3	2	3	3	2	3
Low-C	L Col R Winter Steelhead	Threatened	5,989	27,900	21%	1	2	3	3	3	3	3	3	3
Low-C	L Col R Fall (tule) Chinook	Threatened	12,329	54,100	23%	1	2	3	3	3	3	1	2	1
Low-C	L Col R Coho	Threatened	31,524	129,550	24%	1	3	3	3	3	3	3	2	3
Low-C	L Col R Summer Steelhead	Threatened	10,594	29,800	36%	2	4	4	4	2	4	4	4	4
Low-C	Col R Chum	Threatened	11,762	33,000	36%	2	2	4	4	4	4	4	4	
Low-C	SW WA Winter Steelhead	Threatened	3,252	5,850	56%	2	4	5	5	5	5	5	5	5
Low-C	L Col R Late Fall (bright) Chinook		10,800	16,700	65%									
Low-C	L Col R Fall (bright) Chinook	Threatened	11,000	11,000	100%	5	5	5	5	4	5	4	5	4
Mid-C	M Col Sockeye	Not Listed	1,036	45,000	2%	3	3	3	2	1	3	3		3
Mid-C	M Col R Spring Chinook	Not Listed	11,600	40,425	29%	2	4	4	4	4	4	4	4	4
Mid-C	M Col R Summer Steelhead	Threatened	18,155	43,850	41%	2	4	4	4	4	2	4	4	4
Mid-C	M Col R Coho	Not Listed	6,324	11,600	55%		5	4	5	5	5	4		4
Mid-C	M Col R Summer/Fall Chinook	Not Listed	11,500	13,000	88%	5	5	5	5	5	5	4	5	4
Up-C	U Col R Coho	Not Listed	392	15,000	3%									
Up-C	U Col R Summer Steelhead	Threatened	1480	31,000	5%	1	1	2	1	1	1	3	2	3
Up-C	U Col R Sockeye	Not Listed	40,850	580,000	7%	1	3	1	1	1	2	3	3	3
Up-C	U Col R Spring Chinook	Endangered	1430	19,840	7%	1	3	1	1	1	2	3	1	3
Up-C	U Col R Summer Chinook	Not Listed	16920	78,350	22%	1	2	1	1	1	3	1	2	1
Up-C	U Col R Fall Chinook	Not Listed	92,400	62,215	149%	5	5	4	5	5	5	4	5	4
Snake	Snake R Coho	Not Listed	100	26,600	0%									
Snake	Snake R Sockeye	Endangered	100	15,750	1%	3	3	1	1	1	2	3		3
Snake	Snake R Spring/Summer Chinook	Threatened	6,988	98,750	7%	1	3	1	1	2	2	3	3	3
Snake	Snake R Summer Steelhead	Threatened	28,000	75,000	37%	2	4	4	2	2	2	4	4	4
Snake	Snake R Fall Chinook	Threatened	8,360	10,780	78%	5	5	4	4	4	5	4		3
Willam	U Will R Spring Chinook	Threatened	4,278	47,850	9%	1	2	3	3	1	3	3	2	3
Willam	U Will R Winter Steelhead	Threatened	2,816	27,805	10%	1	2	3	3	3	1	3	3	3

Draft for Internal Review – 3/30/23

Stocks most benefited
Stocks receiving secondary benefit

Hydropower/Blocked Areas Work Group

Recommendation: Fully fund the Phase 2 Implementation Plan (P2IP)

Summary of Action:

Fully fund the Upper Columbia United Tribes (UCUT) and their project partners to implement the Phase 2 Implementation Plan to evaluate the feasibility and strategies for fish passage at five hydroelectric dams on the upper Columbia and Spokane rivers and reintroduce anadromous fish to historically occupied habitats. This includes (1) providing juvenile hatchery fish from appropriate donor stocks from existing and/or local interim fish production facilities; (2) performing juvenile and adult behavior and survival studies; (3) developing, operating, and maintaining a trap-and-haul operation at Chief Joseph Dam; (4) programmatic research, monitoring, and evaluation; (5) depending on outcomes from experimental releases above; design, install, test, operate, and maintain upstream and downstream interim fish passage facilities at up to five hydroelectric dams (Chief Joseph, Grand Coulee, Little Falls, Long Lake, and Nine Mile dams). In addition to fully funding the P2IP, the below policy recommendations are necessary to advance Phase 2 in an efficient manner:

a. *Policy Recommendation:* Expedite the supply of hatchery fish to support the P2IP through expansion of existing facilities and development of new fish production facilities. This will require adequate funding and efficient regulatory processes.
b. *Policy Recommendation*: Provide access to appropriate donor stocks, including Chief Joseph Hatchery, so that both the facilities and fish stocks may be used for fish passage and reintroduction activities.
c. *Policy Recommendation*: Authorize and fund the U.S. Army Corps of Engineers and Bureau of Reclamation to research, develop, and maintain fish passage facilities at Chief Joseph and Grand Coulee dams and to utilize funds from both public and private sources for such activities and facilities.
d. *Policy Recommendation: E*xpedite the development of fish passage facilities essential to the reintroduction effort by means of adequate funding and alleviation of regulatory burdens.

The IRG alongside tribal, federal, and state partners should be tasked with identifying the most appropriate funding mechanism or mechanisms to support completion of the P2IP.

Existing or New Program:

New program. The Phase 2 Implementation Plan is following recommendations that go back as far as 2003 (NPCC Program and subbasin plans) and approaches described by Columbia Basin Tribes and Indigenous Nations (CBTFN 2015) as well as the Northwest Power and Conservation Council (NPCC 2014). Some tribal, state and federal funding has been made available and work has begun with ceremonial and pilot experimental releases and planning efforts. Although described within existing guiding documents the fish passage and reintroduction effort does not receive dedicated funding and should thus be considered a new program.

Benefit Provided by Action:

Completion of the P2IP will provide fish passage at five hydroelectric dams, reconnecting extant stocks with more than 1,000 miles of historically occupied habitats in the United States portion of the blocked area, begin to establish naturally reproducing populations in these habitats, and establish new fish production programs in the region. All of these aspects will contribute to increasing abundances of Chinook and sockeye salmon in the Columbia Basin and begin to meet goals described by the Columbia Basin Partnership Task Force. Most importantly to the UCUTs, reconnecting the people with the fish will be a restoration of culture and identity that was stripped from them nearly a century ago.

Phase 2 is an experimental phase evaluating the feasibility of fish passage and reintroduction. For the suite of studies proposed in the plan, upper Columbia summer Chinook and sockeye are the donor stocks of choice as they are not listed under the Endangered Species Act, extant populations are abundant and readily available.

Table 1. Chinook salmon spawning and rearing habitat (river miles) made accessible in the U.S. portion of the blocked area by providing upstream passage at individual hydroelectric dams.

Upstream Passage Project	Chinook Salmon (Spring & Summer/Fall) Spawning Habitat Opened		
	Tributary (mi)	**Large River (mi)**	**Total Habitat (mi)**
Chief Joseph Dam	0	17	*17*
Grand Coulee Dam	141	36	*177*
Little Falls Dam	2	0	*2*
Long Lake Dam	80	0	*80*
Nine Mile Dam	132	10	*142*
Total:	**355**	**63**	***418***

Table 2. Modeled chinook salmon spawner capacities within habitats made accessible as upstream fish passage is provided.

Upstream Passage Project	Estimated Spawner Capacities (NOR)	
	Low Estimate	**High Estimate**
Chief Joseph Dam	600	20,000
Grand Coulee Dam	8,102	35,560
Little Falls Dam		
Long Lake Dam	7,698	10,078
Nine Mile Dam		
Total:	**16,400**	**65,638**

Additional spawning habitat in Canada would be accessible as upstream passage at Grand Coulee dam is completed. Canadian tributary and mainstem habitats are not reflected in the tables above.

Fish passage and reintroduction will provide a number of ancillary benefits to the Basin.

- **Increased harvest.** Artificial and natural production associated with the program will be available for harvest both in marine and Columbia Basin fisheries.
- **Increased capacity of the Basin.** Opening blocked habitats will increase the spawning, rearing and migratory habitats available to anadromous fish, thereby increasing capacity and productivity of the Basin.
- **Climate change resiliency.** Access to habitat in higher elevation and higher latitudes will provide resiliency to climate change.

Stocks Benefited by the Action:

Upper Columbia Summer Chinook and Sockeye are the species targeted for feasibility testing in the P2IP. The magnitude of benefit during the implementation of the P2IP will depend on the survival at the hydro projects, the level of hatchery production and the productivity of natural spawners. The P2IP calls for fairly modest hatchery production (<200,000 per species) combined with the trap and transport of surplus hatchery fish and returning natural-origin fish. The larger magnitude of benefits are going to occur in Phase 3 of reintroduction, but implementing the P2IP is a necessary step to get to Phase 3 where implementation could be at a scale to allow for the attainment of CBP population goals.

Data Supporting Benefits:

Previous works performed by the UCUT are presented in their Phase 1 Report and Phase 2 Implementation Plan. Primary components of Phase 1 include a (1) reintroduction risk and donor stock assessment; (2) six assessments evaluating tributary, mainstem, and reservoir habitats; (3) reviews of fish passage technologies at high head dams; (4) life cycle modeling of several management scenarios. The work was reviewed by federal and state agencies, Columbia Basin Tribes, and the Independent Scientific Advisory Board. Similarly, the same entities have reviewed the P2IP.

Implementing Entities:

The UCUT, their partners, and subcontractors. Although the UCUT have been and will continue to lead the reintroduction effort, strong coordination with agencies and Basin Tribes will be necessary. The UCUT team has worked closely with WDFW, USGS and PNNL in the development of Phase 2 workplans and early implementation of ceremonial and experimental releases. Currently, the Upper Columbia Blocked Areas Anadromous Fish Working Group is the primary coordinating body for the reintroduction effort and is an opportunity for continued coordination throughout Phase 2. Members include: Coeur d'Alene Tribe, Confederated Tribes of the Colville Reservation, Kalispel Tribe of Indians, Kootenai Tribe of Idaho, Spokane Tribe of Indians, Confederated Tribes of the Umatilla Indian Reservation, Confederated Salish and Kootenai Tribes, Fort McDermitt Paiute and Shoshone Tribes, Nez Perce Tribe, Yakama Nation, Army Corps of Engineers, Bonneville Power Administration, Bureau of Indian Affairs, Bureau of Reclamation, U.S. Fish And Wildlife Service, U.S. Geological Survey, National Marine Fisheries Service, National Park Service, State of Idaho, State of Oregon, and the State of Washington.

Time Needed to Implement:

The P2IP laid out a schedule of 21 years to complete the survival studies and upstream and downstream interim fish passage facilities at all five hydroelectric dams. However, the stepwise approach described within the plan begins to provide fish passage to and from productive habitats in

year 6. The UCUTs also believe that, given adequate resources and commitment from the dam owners and operators, the P2IP could be completed more quickly.

Time Needed to Benefit Fish Populations:

1-6 years. Small but important ecological benefits will begin with the first releases in year one, but larger population scale benefits will take several years due to the life-cycle of salmon. The initial cultural releases have shown that Chinook will find and utilize spawning habitat and generate natural offspring in the first year they are provided access to the habitat.

Estimated Cost:

$300 million (perhaps more with inflation and adaptive management).

Uncertainties:

There is no uncertainty regarding our ability to implement studies, develop interim fish passage facilities, and evaluate the feasibility of reintroduction. There is some uncertainty regarding how successful the program will be in terms of generating adult salmon returns (or how much effort it will take to achieve success). However; we already know that if we provide access to habitat in the blocked area, summer Chinook will spawn and produce offspring. We also know that juvenile hatchery fish with PIT and acoustic tags will survive outmigration to the ocean and return as adults. There is uncertainty regarding the rate at which they will survive and return and how much that survival will vary from year to year. **Therefore, there is uncertainty regarding the magnitude of effort it will take to achieve various levels of a successful reintroduction program.**

Associated Regulatory Processes or Policies:

The list of regulatory process and policies associated with P2IP actions is long and complex. The BAAFWG has already worked on this and should be consulted for a more in-depth review of regulatory processes associated with specific activities. Primary regulatory processes/policies include:

- Tribal Trust Responsibilities to Federally Recognized Tribes
- Northwest Power Act
- Endangered Species Act
- NEPA/NHPA
- Fish and Wildlife Coordination Act
- Clean Water Act
- US v OR
- Many others

Importantly, the P2IP states that efforts will not introduce ESA-listed species into the blocked area or require major operational changes to the hydrosystem such as power production, flood control or irrigation.

The fish production and harvest management actions that are affected by this UCUT P2IP effort will be closely coordinated with, and managed through, the existing US v OR process to ensure it does not adversely impact the law of this case or any relevant provisions of a management agreement that may be in place. [*Note: This portion of the recommendation will need review and refinement from policy/legal staff to ensure it can be supported by all stakeholders*.]

Potential Challenges:

- Consistent source of donor stocks
  - Depending on the donor stock and hatchery facilities used, the hatchery production may need to be coordinated with and in some cases approved by other processes such as US v Or and the Mid-Columbia relicensing forums. This can present a challenge because not all UCUT tribes have direct representation in those forums. However, the UCUT tribes and their project partners have already successfully utilized hatchery fish and facilities with ties to both US v Or and the Mid-Columbia PUD relicensing forums, so we know this is not an insurmountable obstacle to successful implementation.
  - The initial hatchery production requirements of the P2IP are relatively low compared to existing mitigation programs in the basin and the potential future hatchery production that may be needed to meet the medium goals of the CBPTF. Efforts should be made to find ways to generate additional fish to support the P2IP, rather than shifting existing production to the new release areas. However, in the near-term when funding and facility expansion and development has not yet occurred, it will likely be necessary to get the program started by utilizing existing hatchery production. This is not meant to supersede or undermine any existing programs, agreements or entities that do not wish to support such an effort.

- Adequate (new) funding for projects
  - It is important that the funding strategy for this project (and all others recommended by the CBC) does not undermine the restoration or recovery of stocks in other areas.

- Engineering solutions at high head dams

Adaptive Management:

The P2IP outlines extensive adaptive management throughout its implementation. In general, each study will be evaluated and used to guide the next step in the program. The plan calls for technical and policy groups to evaluate the information and make decisions about how to use that information for proceeding with subsequent studies and actions, pivoting to a different approach, or selecting a different objective. Decision-making flow charts are included to help guide the decision-making process and identify potential next steps.

Additional Comments:

Efforts to reintroduce and rebuild stocks above Chief Joseph and Grand Coulee Dam need to take care not to instill even further constraints on downriver fisheries. As reintroduction efforts proceed, and fish from the blocked area contribute to downstream fisheries, communication and coordination should occur with existing harvest forums such as US v Or and PFMC.

Supporting reintroduction of unlisted stocks in the Upper Columbia blocked area is not, by default an endorsement to undermine ESA recovery in the extant areas, current or proposed mitigation programs, nor downstream fisheries. Co-authors of the P2IP made great efforts to address concerns regarding existing recovery and restoration programs, associated funding, hatchery management, and harvest within their plan. They went so far as to include an objective to perform the P2P under current hydrosystem operations, particularly with respect to flood risk management, power generation, and irrigation. Given the magnitude of benefits and interests within the FCRPS, these concerns are understandable. Aside from providing assurances that reintroduction will be an additive benefit to the Basin, it is not clear how these concerns can be further ameliorated.

One of the principles of the CBP was to achieve improvements across all stocks, to reach the medium abundance goals on a timeline and to achieve those goals in areas including the blocked area of the UCR. The CBP had the vision to not make these things mutually exclusive, the point is to achieve all of the goals, not to forsake one for the other. The region and the fish populations need new funding and new paradigms to realize the goals established by the CBP, simply re-shuffling the same deck of cards will not result in success.

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- This action has cross-cutting implications related to hydropower, hatcheries, and habitat.
- This action could impact predation since northern pike are present above the blocked areas. If this predator species were to enter the system downstream of the dams, this would have negative impacts on salmon. The Phase 2 Implementation Plan (P2IP) discusses this issue noting that providing downstream fish passage would likely enable the interception of non-native piscivorous fish. Therefore, this action could also serve as a mechanism to prevent northern pike from going downstream.
- An additional potential benefit of this action is that when access for anadromous fish is improved, resident fish can reestablish anadromy, which could benefit Upper Columbia steelhead.
- The benefits provided by this recommendation also depend on efforts to improve conditions for salmon in the lower Columbia. The I/RG should consider this as they prioritize the implementation of various recommended actions.

Stock Benefits Report Card:

Blocked Areas: Recommendation to fund the Upper Columbia United Tribes Phase 2 Implementation Plan

			Abundance			MAFAC Phase II Impact Priority								
Sub-Region	Stock	Status	Current	MAFAC Medium goal	Current as % of Medium Goal	Tributary Habitat	Estuary Habitat	Hydro (Mainstem)	Hydro (Latent)	Hydro (Blocked)	Predation	Fishery	Hatchery	Harvest
Low-C	L Col R Spring Chinook	Threatened	2,240	21,550	10%	1	3	3	3	2	3	3	2	3
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Mid-C	M Col Sockeye	Not Listed	1,036	45,000	2%	3	3	3	2	1	3	3		3
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Up-C	U Col R Spring Chinook	Endangered	1430	19,840	7%	1	3	1	1	1	2	3	1	3
Up-C	U Col R Summer Chinook	Not Listed	16920	78,350	22%	1	2	1	1	1	3	1	2	1
Up-C	U Col R Fall Chinook	Not Listed	92,400	62,215	149%	5	5	4	5	5	5	4	5	4
Snake	Snake R Coho	Not Listed	100	26,600	0%									
Snake	Snake R Sockeye	Endangered	100	15,750	1%	3	3	1	1	1	2	3		3
Snake	Snake R Spring/Summer Chinook	Threatened	6,988	98,750	7%	1	3	1	1	2	2	3	3	3
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Snake	Snake R Fall Chinook	Threatened	8,360	10,780	78%	5	5	4	4	4	5	4		3
Willam	U Will R Spring Chinook	Threatened	4,278	47,850	9%	1	2	3	3	1	3	3	2	3
Willam	U Will R Winter Steelhead	Threatened	2,816	27,805	10%	1	2	3	3	3	1	3	3	3

Draft for Internal Review – 3/30/23

Stocks most benefited
Stocks receiving secondary benefit

Hydropower/Blocked Areas Work Group

Recommendation: Assess run timing and entry timing of natural origin juvenile salmon and steelhead

Summary of Action:

Assess run timing and entry timing of natural origin juvenile salmon and steelhead from natal tributaries into the Columbia River to provide information that can be used in adaptive management of spill and/or bypass operations to ensure safe passage routes for early migrants. Data could be collected through smolts traps, PIT tag detection (barges or other) or in some cases mainstem bypasses and traps or other methods.

Existing or New Program:

Varies. Some tributaries and populations are beginning to collect this information, and others are not. In many cases existing monitoring methods (bypass operation, PIT detection, juvenile trapping, etc.) do not begin early enough in the migratory season to understand the scope and magnitude of fish use and migration before April. Beginning in 2018, the juvenile bypass system at one or two lower Snake River dams has begun operating as early as March 1 to assess the extent to which juvenile salmon and steelhead are migrating in the lower Snake River prior to the defined spring spill season. This information is not sufficient to assess individual populations and does not assess when juveniles are entering the Snake River from their natal tributaries. The data gap in the upper Columbia may be greater. To date, other than decades-old fyke net studies at Wells Dam, there has been no early sampling at mainstem mid-Columbia River dams, yet smolt trap data from the Wenatchee and Entiat may indicate a sizable proportion (up to 60%; ISAB 2018-01 of the ESA listed natural origin spring Chinook are entering the Columbia River prior to the start of spill.

This recommendation assumes that adequate numbers of Juveniles are PIT tagged for species or populations.

Citation: Independent Scientific Advisory Board (ISAB). 2018. Review of Spring Chinook Salmon in the Upper Columbia. ISAB 2018-01 February 9, 2018.

Benefit Provided by Action:

These data would inform whether spill and other means of passing juvenile fish begins early enough to provide the same migratory benefits to both wild and hatchery fish. Natural origin spring chinook appear to migrate earlier out of their natal tributaries than their hatchery counterparts. In the upper Columbia potentially up to 50% of the natural origin spring chinook have migrated into the mainstem reservoirs prior to the start of spring spill (based on smolt trap data in the lower reaches of tributaries). In some cases, spring chinook may enter the Columbia and rear in a reservoir for a time prior to migration, but the behavior, passage timing, and survival of these fish is largely not known. Typical bypass operation and associated monitoring do not begin early enough to understand this component of the natural origin spring chinook migration.

Stocks Benefited by the Action:

All early migrating salmon and steelhead stocks throughout the Columbia Basin, including Upper Columbia, Mid-Columbia, and Snake River stocks would benefit if mainstem dam operations are not aligned with actual migration timing. Magnitude of benefit may be population or MPG-specific and will not be understood until data is collected.

Data Supporting Benefits:

In the Upper Columbia this data gap is supported by information learned from smolts traps in the lower Wenatchee and Entiat Rivers. In the Snake River this data gap is supported, at least in part, by the early bypass operations which have begun at one-to two projects per year. Other populations likely exhibit similar behaviors (Umatilla, Yakima, Klickitat, etc.). In addition, climate change projections (especially increasing winter temperatures) support the idea that many ocean type salmon and steelhead populations might respond to climate change by migrating earlier in the year. Earlier monitoring, both in the lower reaches of tributaries and at key mainstem projects, would ensure that operations designed to protect juvenile migrants retain their effectiveness.

Implementing Entities:

State and Tribal Agencies (tributaries) and federal and non-federal dam operators (key mainstem Snake and Columbia River dams) and fishery co-managers (tributary traps and detection sites).

Time Needed to Implement:

Minimal data can be collected immediately. Acting upon the data can also be implemented quickly but may require use of adaptive management or modification of existing agreements or requirements.

Time Needed to Benefit Fish Populations:

Immediately: if it is determined that spill and other bypass measures should start earlier to ensure that earlier migrating natural origin fish are provided adequate spill and bypass operations.

Estimated Cost:

Variable based on method of data collection and pre-existing monitoring programs. Where existing sampling infrastructure exists, costs may be minimal to collect the information. Cost of implementing responsive operations would be variable and depend upon the specific project starting spring spill operations at an earlier date.

Uncertainties:

The behavior of juvenile salmon and steelhead after entering the mainstem Snake and Columbia Rivers (do they continue migrating, rear for extended periods before continuing to migrate, etc.). The ability (and willingness) of dam operators to implement early bypass and data collection. Costs may be incurred to obtain data values of zero; but this should not be a deterrent to learning.

Associated Regulatory Processes or Policies:

To collect data where fish sampling permits currently exist there may be no new regulatory processes. In areas where new sampling infrastructure are needed, new state and federal permits may be required.

Potential Challenges:

Data collection and sampling may require improved facilities, earlier staffing and training, and other challenges. Data collected may have implications for system-wide water management, power production, predator management (avian, native, and non-native fish, and pinnipeds), resident recreational fisheries management, (and navigation?) which will present challenges to adaptive management.

Adaptive Management:

Data informing when fish are entering the Columbia and Snake rivers could be used to adaptively manage when spill and bypass operations start each season if a relationship between mainstem entry and passage at key mainstem projects could be established.

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- While this recommendation is focused on juvenile salmon, there is also substantial impact on adults (particularly for steelhead) due to issues related to overshoot and fallback. The Hydropower work group may develop a separate recommendation on this topic; the I/RG could weigh in on how to best package these recommendations.
- While the title of this recommendation is focused on determining run timing, the information gathered through this action would be broader. This recommendation could be viewed more as an expansion of an existing monitoring program rather than a new program. PIT tagging fish and expanding monitoring capabilities will allow managers and stakeholders to learn more about various aspects of salmonid migration and behavior.
- This recommendation integrates with predation since fish are exposed to more predation the longer time they spend in reservoirs. Information collected through this action could be used to prevent some predation.
- Prioritizing stocks might be appropriate for this recommended action. This prioritization could focus on the most imperiled stocks and those stocks that benefit less from spill due to their run timing.

Stock Benefits Report Card:

Hydropower: Recommendation for assessment of run timing and entry timing of natural origin juveniles

			Abundance			MAFAC Phase II Impact Priority								
Sub-Region	Stock	Status	Current	MAFAC Medium goal	Current as % of Medium Goal	Tributary Habitat	Estuary Habitat	Hydro (Mainstem)	Hydro (Latent)	Hydro (Blocked)	Predation	Fishery	Hatchery	Harvest
Low-C	L Col R Spring Chinook	Threatened	2,240	21,550	10%	1	3	3	3	2	3	3	2	3
Low-C	L Col R Winter Steelhead	Threatened	5,989	27,900	21%	1	2	3	3	3	3	3	3	3
Low-C	L Col R Fall (tule) Chinook	Threatened	12,329	54,100	23%	1	2	3	3	3	3	1	2	1
Low-C	L Col R Coho	Threatened	31,524	129,550	24%	1	3	3	3	3	3	3	2	3
Low-C	L Col R Summer Steelhead	Threatened	10,594	29,800	36%	2	4	4	4	2	4	4	4	4
Low-C	Col R Chum	Threatened	11,762	33,000	36%	2	2	4	4	4	4	4	4	
Low-C	SW WA Winter Steelhead	Threatened	3,252	5,850	56%	2	4	5	5	5	5	5	5	5
Low-C	L Col R Late Fall (bright) Chinook		10,800	16,700	65%									
Low-C	L Col R Fall (bright) Chinook	Threatened	11,000	11,000	100%	5	5	5	5	4	5	4	5	4
Mid-C	M Col Sockeye	Not Listed	1,036	45,000	2%	3	3	3	2	1	3	3		3
Mid-C	M Col R Spring Chinook	Not Listed	11,600	40,425	29%	2	4	4	4	4	4	4	4	4
Mid-C	M Col R Summer Steelhead	Threatened	18,155	43,850	41%	2	4	4	4	4	2	4	4	4
Mid-C	M Col R Coho	Not Listed	6,324	11,600	55%		5	4	5	5	5	4		4
Mid-C	M Col R Summer/Fall Chinook	Not Listed	11,500	13,000	88%	5	5	5	5	5	5	4	5	4
Up-C	U Col R Coho	Not Listed	392	15,000	3%									
Up-C	U Col R Summer Steelhead	Threatened	1480	31,000	5%	1	1	2	1	1	1	3	2	3
Up-C	U Col R Sockeye	Not Listed	40,850	580,000	7%	1	3	1	1	1	2	3	3	3
Up-C	U Col R Spring Chinook	Endangered	1430	19,840	7%	1	3	1	1	1	2	3	1	3
Up-C	U Col R Summer Chinook	Not Listed	16920	78,350	22%	1	2	1	1	1	3	1	2	1
Up-C	U Col R Fall Chinook	Not Listed	92,400	62,215	149%	5	5	4	5	5	5	4	5	4
Snake	Snake R Coho	Not Listed	100	26,600	0%									
Snake	Snake R Sockeye	Endangered	100	15,750	1%	3	3	1	1	1	2	3		3
Snake	Snake R Spring/Summer Chinook	Threatened	6,988	98,750	7%	1	3	1	1	2	2	3	3	3
Snake	Snake R Summer Steelhead	Threatened	28,000	75,000	37%	2	4	4	2	2	2	4	4	4
Snake	Snake R Fall Chinook	Threatened	8,360	10,780	78%	5	5	4	4	4	5	4		3
Willam	U Will R Spring Chinook	Threatened	4,278	47,850	9%	1	2	3	3	1	3	3	2	3
Willam	U Will R Winter Steelhead	Threatened	2,816	27,805	10%	1	2	3	3	3	1	3	3	3

Draft for Internal Review – 3/30/23

Stocks most benefited
Stocks receiving secondary benefit

Hydropower/Blocked Areas Work Group

Draft Concept: Develop an outreach strategy to advance the recommendations from the CBC

***Please note:** This draft concept was introduced by the work group but has not been developed into a full recommended action. The work group is seeking direction from the I/RG on whether to continue pursuing this concept and prepare a full recommendation for I/RG consideration.*

Summary of Action:

Develop an outreach strategy to advance the recommendations from the CBC. Outreach should include meeting with stakeholders (electricity, flood control, irrigators, navigation, work group participants, owners of the barriers) to understand what people would like to see with salmon, educate people, and understand impacts to stakeholders. Through this process, the effort will build support for operational changes in the hydropower system and other recovery actions.

Although this topic is coming from the Hydropower Work Group, stakeholder engagement will be vital for any process in the basin across salmon recovery efforts.

- An outreach strategy should be developed by professionals with outreach expertise and needs more details on schedule, funding, agendas, etc.
- Outreach efforts should be tailored to address the unique concerns of different regions.
- The outreach effort should be done with a holistic view of salmon and should be able to clarify how hydropower with other impacts are effecting salmon.
- The outreach will differ from the past outreach efforts because it will not be tied to a BiOp process, but rather tied to the recommendation concepts for proposed actions.

Existing or New Program:

1. Building on the Columbia Basin Partnership; bringing the recommendations to a broader group of stakeholders
    a. Education of Stakeholders on Salmon Recovery Recommendations
    b. Education by Stakeholders on Impacts to Stakeholder Groups (SCEE considerations)
    c. Listening Session for Stakeholders
    d. Representatives from impacted stakeholders in the same room
    e. This effort would be separate from outreach done in BiOp lawsuits
2. Facilitated Conversations
    a. Formal and informal conversations (e.g. several day meeting to allow for dinner chats, side conversations, etc)
    b. Possible site visits

Benefit Provided by Action:

- Common understanding of tradeoffs
- Understanding of potential alternatives

- Understand and clarify mitigation needs for stakeholders upfront before implementation of CBC recommended actions

Stocks Benefited by the Action:

- All

Data Supporting Benefits:

- Klamath River Example
- Yakama Basin Integrated Plan

Implementing Entities:

a. States and Tribal leads (all relevant state and tribal agencies represented)
b. FACA concerns if led by Federal agencies
    i. Bureau of Reclamation
    ii. U.S. Army Corps of Engineers
    iii. Bonneville Power Administration
    iv. NOAA Fisheries

Time Needed to Implement:

- Ongoing
- Initial Engagement early 2023
- In-person meetings in late spring/early summer
- Community meetings in fall

Time Needed to Benefit Fish Populations:

- Ongoing

Estimated Cost:

- TBA

Uncertainties:

- CRS Biop litigation may impact implementation of stakeholder engagement
- Instability of political landscape

Associated Regulatory Processes or Policies:

- FACA may impact State admin processes/polices
- Implementation of some recommendations/mitigation actions will likely require Congressional Authorization
- Treaties, CWA, ESA

Potential Challenges:

- Instability of political landscape

Adaptive Management:

- Interaction within and among stakeholder groups should improve decision making.

- Improved outcomes.

SIWG Narrative Feedback & Stock Benefits Report Card:

SIWG Feedback:

- This recommendation is focused on community involvement, education, and building relationships with stakeholders that extend beyond the members of the CBC. There is a need to carry forward the outreach and relationship-building components of the Columbia Basin Partnership and the CBC to work towards implementation of recommendations.
- The I/RG will need to consider where the resources for this effort would come from.
- This recommendation is cross-cutting across all the threat categories because it would create a forum for interacting and communicating with the public on all these topics.
- One way to help achieve this could be leveraging CBC representatives of specific stakeholder groups to lead communication and outreach efforts to those communities.

Stock Benefits Report Card:

Benefit is not necessarily stock specific.

Science Integration Work Group

Recommendation Concept: Study carrying capacity of the Columbia River

Please note: *This draft concept was introduced by the work group but has not been developed into a full recommended action. The work group is seeking direction from the I/RG on whether to continue pursuing this concept and prepare a full recommendation for I/RG consideration.*

Background:

When species near or exceed their carrying capacity, they can experience density dependent factors that negatively impact their growth and survival. Widespread habitat degradation and the annual release of large numbers of hatchery-reared fish into rearing areas used by wild fish create the potential for density dependent effects on salmonid production within the Columbia River (CR). In natural systems, populations may buffer against density dependence via life history diversity and utilizing the available habitat at different times (i.e., staggered entry timing). However, this strategy becomes complicated and is likely not as effective in highly altered systems such as the CR. Additionally, there is also significant hatchery production with releases into the CR over a relatively short period. This practice introduces the added potential for competition between hatchery and wild fish. For example, Bottom et al. 2021 compared nearshore habitat use between hatchery and natural production Chinook salmon within a CR estuary nearshore environment and found that although abundance was generally higher for natural production fish at the locations studied, pulse releases of large groups of hatchery origin fish caused them to dominate numerically at some sites episodically after release. This was particularly prevalent during the spring/summer, when they also observed the successive release of hatchery fish served to ensure their continuous presence at all sites. Notably, the biomass of the hatchery origin fish was often equal to or greater than natural origin fish due to their large size. However, the duration and natural of the hatchery-wild interactions in the CR are still poorly understood and the authors were not able to measure/evaluate the potential effects of the overlap in habitat observed. Though others have noted hatchery fish may have a competitive advantage due to their large size compared to wild counterparts (Einum & Flemming 2001).

For Pacific Salmon, density dependence within the CR is most likely to occur at juvenile life stages in part because multiple populations often rely on a common critical habitat with limited prey resources. Due to the migratory nature of salmonids, constraints to carrying capacity can be experienced at multiple spatial scales and within a variety of habitat types. For example, density dependence can occur within tributaries, within the Columbia and Snake River mainstem, confluences, and reservoirs, and within the Columbia River estuary. Additionally, within each of these habitat types, carrying capacity may differ nearshore compared to within the channel. In another CR estuary study, Weitkamp et al. (2022) demonstrated overlapping habitat and resource use for hatchery and natural production salmon and steelhead juvenile outmigrants using the main channel, however, there was no evidence over the study period that resources were limited for either group.

Summary of Action:

This recommendation is aimed at outlining a strategy for establishing the carrying capacity of the CRB for supporting robust salmon and steelhead stocks using metrics such as fish abundance, density, growth and survival by life stage and habitat type. Understanding seasonal and geographic patterns in prey availability and in the carrying capacity of critical habitats throughout the CR is essential to ensure that habitat is adequate for supporting wild populations and that hatchery releases are of appropriate size and timing such that they do not negatively impact the survival and growth of either group. Furthermore, carrying capacity is cross-cutting in that it touches many of the factors implicated in the decline of salmon and steelhead (e.g., habitat, hatcheries, hydrosystem, harvest, and predation). Having baseline information about carrying capacity and associated bottlenecks for ESA listed species will allow us to better prioritize funding for research, restoration, and other management actions. We recognize that the geographic and temporal scope of the CR is vast therefore, we recommend a stepwise approach towards this evaluation, starting with collection of existing data, and followed by focal case studies or pilot projects that can either be scaled up where appropriate or the results extrapolated to other, similar sites (See et al. 2021). We also recommend starting with a focus on listed species that have high CBP Phase II priority impact scores (i.e., 1 or 2) for tributary or estuarine habitat and for hatchery influence. These would include UCR steelhead and spring/summer Chinook salmon, LCR coho, fall Chinook tules, spring Chinook, and winter steelhead, UWR spring Chinook and steelhead, and SR spring/summer Chinook salmon.

Phase 1 Actions:

1. **Establish carrying capacity and potential bottlenecks for juvenile salmon and steelhead within estuary and tributary habitats.** Collect information about growth, diet, and environmental data beginning with the stocks listed above (by habitat type). Information about diet and associated growth rates can be used in bioenergetics modeling to determine the consumption rates and energy requirements of juvenile salmon and steelhead for the periods they are present within a given habitat type. This information can then be combined with information about each habitat type, including nutrient and prey availability, water quality, and geographic scope for periods when fish are present and used to determine juvenile rearing capacity and to identify where density dependent effects might be occurring. We recommend starting with existing data and then conducting test or pilot projects as needed to inform such analyses. These pilot projects will focus on, critical growth periods and habitats where significant growth is occurring and that can also be tied to size-selective mortality. By doing so investigations can focus on habitats and periods that most strongly influence freshwater and early marine survival. Given the scale of the Columbia Basin, information needed to assess the carrying capacity would ideally be available via a central, spatially explicit database with standard formatting. This would serve to consolidate all available data and information about the species in question, facilitate collaboration among groups, and highlight knowledge gaps. For example, See et al. (2021) used Quantile Random Forest models to estimate carrying capacity for salmon parr in several interior CR streams during the summer months based on long-term data sets detailing fish abundance and density, and a suite of habitat characteristics.

2. **Conduct targeted studies to examine density dependent growth in areas identified as potential bottlenecks during the exercise above.** Juvenile growth and size selective mortality can act as indicators of density dependence, with slow growth periods coupled with size selective mortality often indicating periods of prey supply limitations or competition. Growth can be assessed during existing sampling using

data from tags (i.e., PIT tags) and/or by analyzing growth patterns on otoliths and scales. Otoliths and scales sampled from both juveniles and adults throughout their life cycle can also be used to evaluate whether size selective mortality is occurring (Norrie et al. 2022). Size selective mortality often occurs due to competition for limited prey resources resulting in increased mortality or risk of predation for specific size classes of fish.

3. **Establish carrying capacity and potential bottlenecks at the redd/fry stages beginning with the stocks listed above**. Taking a similar approach as described for assessing juvenile carrying capacity, assess whether spatial distribution and redd density in tributaries result in density dependence at the fry stage, thus limiting overall smolt recruitment.

4. **Conduct targeted studies to confirm density dependence at the redd/fry stages in areas identified as potential bottlenecks during the exercise above**. It has long been recognized that the highest rates of mortality in wild salmonid populations typically occur at the fry stage. Density dependence has been observed at the fry stage and linked to high mortality in Atlantic Salmon and Brown Trout, before fry are able to disperse from redd locations (Einum et al. 2008, Finstad et al. 2013). Similarly, an ongoing study in the Skagit River suggests that density dependence is common at the fry stage for steelhead and can occur at low abundance when redd clustering occurs (Nick Chambers personal communication). This same phenomenon is likely to occur with other species of Pacific Salmon with extended freshwater rearing (i.e. Chinook and Coho), but has not been study yet. Nor has it been assessed in the Columbia Basin.

Phase 2:

1. **For habitats where carrying capacity has been exceeded, conduct hatchery release time studies for maximizing growth and survival of both hatchery and wild salmonids.** Life history diversity for traits such as entry times into common habitats can buffer density dependent effects and environmental variability via portfolio effects (Greene et al. 2010), stabilizing the overall survival for juveniles and returning adult salmonids. Additionally, entry timing and density dependence can impact habitat selection, with implications for growth and survival. A pilot study assessing alternative release strategies in Puget Sound showed that late released (September) Fall Chinook had 30% higher smolt to adult survival and the fish were significantly older at return than the typical May release group. An October release group of Spring Chinook on the Lewis River in the Lower Columbia has yielded similar results, with improved survival compared to typical yearling program released in the spring. We propose that information on hatchery release times as related to growth and survival be collected and reviewed for selected stocks (described above) in an attempt to identify potential for CB hatcheries to identify opportunities to alter their release strategies. We further recommend release timing studies be conducted where appropriate to evaluate the effectiveness of such approaches towards minimizing density dependent impacts on wild fish while maintaining robust hatchery returns. A number of hatcheries throughout the Salish Sea are currently evaluating alternative release strategies (coordinated by Long Live the Kings), their approaches could be utilized to inform study design and as regional comparison of results.

2. **Conduct studies to investigate how hatchery produced fish impact wild fish growth and survival through methods other than competition for nutrients and displacement from refugia**. For example, through aggregation of predators and through transfer of parasites or other pathogens from hatchery to wild fish (Nickelson 2003). A recent study in Puget Sound showed a relationship between hatchery Coho smolt releases and the survival of wild steelhead smolts, due to shared habitat use between the two species being linked to attracting Coho predators to prey on cohabitating wild steelhead (Malick et al. 2022). Following termination of hatchery supplementation in the Salmon River, Jones et al. 2018 attributed an increase in natural origin coho to a variety of factors, including 1) a rapid expansion in the spawner timing window for natural origin fish, 2) an end to displacement/mortality of wild juveniles by hatchery fish, 3) an end in high predation due to predators being drawn to large hatchery release groups, and 4) an end to density dependent interactions such as disease transmission from hatchery to wild fish, competition, and direct predation on natural origin early life stages.

3. **Use life cycle modelling to evaluate how all of the above acting in concert impacts SARs**. Based on the above studies, evaluate if food/space limitations and/or negative impacts from the presence of hatchery fish concurrent with natural production fish is likely to result in lower SARs for a given ESU or population of concern.

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Science Integration Work Group

Recommendation Concept: Develop a Structured Decision-Making (SDM) Framework

Please note: *This draft concept was introduced by the work group but has not been developed into a full recommended action. The work group is seeking direction from the I/RG on whether to continue pursuing this concept and prepare a full recommendation for I/RG consideration.*

Background:

Despite a roughly $20 billion investment in salmon and steelhead recovery in the Columbia River basin since (year x), most salmon and steelhead populations have failed to recover and, in some cases, have continued to decline. One reason for this failure is that recovery efforts have not been well integrated across the various sectors/factors that affect survival such as habitat, hatcheries, fishing, predation, and dam operations. These factors do not impact salmon and steelhead independently; rather, they are interrelated such that change in one factor can increase or negate the impact of a change in another factor. For example, habitat improvements that increase the rearing capacity for juvenile salmon have not been coupled with higher escapement goals to ensure that enough adult fish return to fully seed the habitat and realize the full benefits of habitat restoration. The harm of failing to consider coordinated actions across limiting factors was called out in a recent report (Bilby et al. 2022), which summarized the findings from 20 years of monitoring in "intensively monitored watersheds" throughout the Northwest, as well as in the Hatchery Scientific Review Group's report to Congress in 2015. The Columbia Basin Partnership stated in its Phase 2 Report: "integrating and aligning salmon management decisions, strategies and actions is critical to maximize effectiveness, meet treaty rights and trust responsibilities, ensure strategic use of funds, and increase transparency." (p.19).

Summary of Action:

The CBC Science Integration Working Group proposes two actions to coordinate and sequence actions across limiting factors to increase the effectiveness of our collective salmon recovery efforts and obtain a much better return on investment of our salmon recovery dollars.

1. Develop a structured decision-making (SDM) framework for the CBC and its work groups to use to make integrated, multi-factor salmon recovery planning a reality. The SDM framework would provide a science-based, transparent approach and tools for identifying actions across limiting factors that could be sequenced and bundled to achieve major gains in abundance, productivity, diversity, and fish distribution and fully realize the benefits of past and future habitat actions throughout the basin.
2. Share the framework, tools and associated restoration recommendations with management, funding, and regulatory agencies to foster integrated, multi-factor actions. This would enhance managers' abilities to develop and implement integrated, multi-factor strategies and actions needed to recover salmon and steelhead. This could include integrated work groups that have representation from each threat category to ensure that H-integration is built into recovery and management actions, and that funding agencies consider funding suites of actions (e.g., habitat

and hatchery management) as part of more cohesive projects. The SDM framework we call for in the previous action could be used by the integrated agency work groups.

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