November 16, 2017

Response to Public Comments Received Regarding the Proposed ESA Recovery Plan for Snake River Fall Chinook Salmon

Prepared by National Marine Fisheries Service
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Introduction

The Endangered Species Act (ESA) Recovery Plan for Snake River Fall Chinook Salmon (*Oncorhynchus tshawytscha*) is the product of a multi-year effort involving coordination with federal, state, tribal, private, and non-governmental entities. We, the National Marine Fisheries Service (NMFS), developed this recovery plan by drawing on the best available scientific information, including technical documents prepared by the Interior Columbia Technical Recovery Team (ICTRT) and technical experts from NMFS, the U.S. Fish and Wildlife Service, the states of Washington, Oregon, and Idaho, the Nez Perce Tribe, and others. The Plan applies the best available science to identify limiting factors and threats affecting the species; objective and measurable delisting criteria; site-specific management actions; and time and cost estimates to achieve recovery. The Plan also identifies where scientific uncertainties exist, and explains the importance of a collaborative, adaptive management approach among federal, tribal, state, local, private, and nongovernmental partners to implement the actions identified in the Plan and achieve recovery.

We released the Proposed Recovery Plan (Proposed Plan) for public review and comment on November 2, 2015 (80 FR 67386). We received approximately 20 submissions of comments on the Proposed Plan from state, tribal, private, and non-governmental entities as well as interested individuals.

We reviewed all comments for substantive issues or new information, considered all comments in preparing the final Recovery Plan (Plan), and have addressed the comments below. For readers' convenience, we have organized comments by major issue categories, addressed similar comments with common responses where possible, and edited comments for brevity and clarity. Comments related to minor corrections and clarifications and detailed editorial comments are not summarized here but were considered and incorporated into the Plan as appropriate.

Salmon are important to the people, culture, economy, and ecosystems of the Pacific Northwest, and we recognize that public participation is essential to the task of protecting this precious natural resource. This recovery plan is the product of much work by numerous individuals and entities, and we similarly welcome the participation of all interested parties as we work collaboratively to implement it.

We adopt the recovery plan with the incorporated revisions as the final Plan; the ESA Recovery Plan for Snake River Fall Chinook salmon is available at the following website: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_fall_chinook_recovery_plan.html.

Response to Comments

We have responded to comments in these categories, presented in alphabetical order:

1. Adaptive management
2. Best available science
3. Breaching of lower Snake River dams
4. Climate change
5. Cost and time estimates
6. Delisting of Snake River fall Chinook salmon ESU
7. Density dependence
8. Duration of Plan
9. ESA recovery scenarios
    - Scenario A
    - Scenario B
    - Scenario C ("Placeholder Scenario" in Proposed Plan)
    - Suggestions to include additional scenarios
10. Habitat
    - General
    - Tributary habitat
    - Mainstem habitat
    - Estuary habitat
11. Harvest
12. Hatcheries
13. Hydropower
    - Limiting factors
    - Transportation
    - Actions
14. Implementation
15. Life-cycle modeling
16. Non-native fish species
17. Predation, competition, and disease
18. Prey availability
19. Prioritization of limiting factors
20. Recovery goals
    - General
    - Broad sense recovery goals
    - ESA delisting goals and objectives
        - Biological viability criteria and metrics
        - Threats criteria
21. Recovery strategy
22. Research, monitoring, and evaluation
23. Sufficiency of management actions
24. Toxins
25. Tribal consultation
26. Viability (current status) assessment
    - General
    - Viability curves
    - Abundance and productivity
    - Spatial structure and diversity
27. Water quality

1. Adaptive Management

Comment: The adaptive management framework in the recovery plan should prioritize the implementation of site-specific actions based on the best available science to assure the recovery of the ESU. The adaptive management should be iterative through action implementation, strategic monitoring and evaluation, and assessment of new information and updating of actions.

Response: We agree. An adaptive management framework, described in Chapter 6 of the Plan, is central to the Plan's recovery strategy. We have made revisions in Chapter 6 to clarify the central role of the adaptive management framework in implementation.

2. Best Available Science

Comment: The Plan's conclusion that the extant Lower Snake River fall Chinook salmon population is currently viable, and not highly viable, and that therefore it does not meet delisting criteria, is not supported by the best available science. Specifically, the assessment of current ESU status does not include a comprehensive, quantitative viability analysis that includes all likely factors affecting extinction risk acting simultaneously. (This commenter included a number of specific points related to the assertion regarding best available science and the viability assessment – these are included among the comments below under "Viability (Current Status) Assessment.")

Response: We disagree. The viability (current status) assessment incorporated into the Plan (see Plan, Chapter 4 and Appendix A; NWFSC 2015; NMFS 2016a) describes the current status of the Snake River fall Chinook salmon ESU based on the best available science. The specific points raised by the commenter are addressed below, under "Viability (Current Status) Assessment." At this time, it is not technically feasible to conduct a comprehensive, quantitative viability analysis that includes all likely factors affecting extinction risk acting simultaneously.

3. Breaching of Lower Snake River Dams

Comments: Breaching the four lower Snake River dams (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) is supported by best available science and is needed to recover Snake River fall Chinook salmon.

Response: We disagree that breaching the lower Snake River dams is necessary to achieve ESA recovery of Snake River fall Chinook salmon. The ESU has improved significantly in abundance and productivity since the ESA listing in 1992, and NMFS now considers the extant Lower Snake River fall Chinook salmon population viable. While the ESU is not yet meeting the ESA recovery goal, objectives, and delisting criteria, these improvements are very encouraging. At this time we see a feasible path to ESA recovery that would rely on the extant population and its existing habitat while still maintaining current levels of hatchery production (see Section 3.2.1 in the Plan). In part because there are uncertainties related to this scenario, the Plan also includes additional potential scenarios that would achieve ESA recovery (see Plan, Section 3.2.1), but these additional potential scenarios do not involve breaching the lower Snake River dams.

Dam breaching is a complex issue, and there is a range of views regarding its biological benefits to salmon, its economic consequences, and its other environmental effects. The U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration (co-lead agencies) are preparing the Columbia River System Operations Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) to address the operation, maintenance, and configuration of the 14 projects that are operated as a coordinated water management system and that are the focus of the Federal Columbia River Power System (FCRPS) biological opinion, including the four lower Snake River dams. The co-lead agencies will evaluate a range of alternatives, including a no-action alternative (current system operations and configuration). Other alternative actions will also be developed, and will likely include an array of alternatives for different system operations and additional structural modifications to existing projects to improve fish passage, including breaching one or more dams. Alternatives will include those within the co-lead agencies' current authorities, as well as certain actions that are not within the agencies' authorities, based on the court's observations about alternatives that could be considered and on comments received during the scoping process. The final Plan has been updated to reflect the ongoing NEPA analysis (see Plan, Sections 2.8.1 and 6.2.1.2). It has also been updated to discuss potential benefits of dam breaching to Snake River fall Chinook salmon, based on the results of previous evaluations (see Plan, Section 6.2.1.2).

Specific issues raised by commenters who supported dam breaching to recover Snake River fall Chinook salmon are discussed below:

- **Comment:** The lower Snake River dams inundated Snake River fall Chinook salmon spawning habitat, and that habitat must be restored to recover the ESU.

  Response: Commenters are correct that Lower Granite and Little Goose Dams inundated a substantial amount of historical fall Chinook salmon spawning habitat. While restoring some or all of that habitat would likely be beneficial, we disagree that additional spawning habitat is necessary for recovery. Considering the current viable status of the extant population ─ and the fact that the available habitat is large (containing five major spawning areas), productive, diverse, and broadly distributed ─ our view is that Snake River fall Chinook salmon can achieve ESA recovery without breaching of the lower Snake River dams. Therefore, the final recovery plan includes recovery scenarios that would not require dam breaching.

- **Comment:** A high percentage of juveniles migrating downriver do not survive the dams and reservoirs, and the Juvenile Fish Transportation Program does not work to mitigate the harmful effects of dams on fish migrating downstream.

  Response: While higher juvenile survival rates would be beneficial, we disagree that the recent survival rates of subyearling Chinook salmon smolts are limiting the productivity of Snake River fall Chinook salmon to the point that recovery is not possible. Subyearling fall Chinook salmon survival rates have been substantially improved by structural modifications and operational changes at the dams. Configurations and operations at the dams are designed to achieve the 2008 FCRPS biological opinion passage performance standards of 93 percent survival at each project for subyearling migrating juvenile fish. Survival studies show that with few exceptions, the fish passage improvement measures implemented under the biological opinion are performing as expected and are either achieving or are very close to achieving the juvenile passage survival objectives (USACE et al. 2017) (see Plan, Sections 2.8.1 and 5.2.4). Regarding the issue of juvenile transportation, managers continually evaluate the value of transportation as a strategy to improve juvenile survival. The final Plan has been updated with the results of several recently completed studies on this issue (see Plan, Sections 2.8.1.2 and 5.2.4). Managers will use these results (McCann et al. 2016; Smith et al. 2017) to inform future management decisions.

- **Comment:** Fish ladders impede adult fish migrating upriver (through thermal effects and increased adult fallback) and cause reservoirs to stratify.

  Response: We disagree. Adult fishways may exhibit temperature stratification (i.e., the upper sections are warmer than the lower sections), but they do not cause reservoirs to stratify. Lower Granite Reservoir, and to a lesser extent Little Goose and Lower Monumental Reservoirs, stratify because cool water released from Dworshak Dam meets, and sinks beneath, the warmer water from the Snake River (and Salmon and Grand Ronde Rivers). The lower Columbia River dams also do not exhibit substantial stratification in the reservoirs, though localized shallow-water areas can be much warmer than the reservoir. Regarding adult fallback, the commenters cited a study (Keefer et al. 2006) that evaluated the effects of transport on spring/summer Chinook salmon and steelhead, not fall Chinook salmon. Fall Chinook salmon do not seem to be as affected by transport as other species, most likely because they are able to imprint for longer periods of time on the mainstem Snake River and its major tributaries before migrating downstream to the collector sites (compared to yearling Chinook). Substantial delays are not considered to be an important limiting factor for adult fall Chinook salmon at this time. However, gametes of the earliest adult migrants, which are exposed to the highest temperatures, can be compromised.

- **Comment:** Dams affect fish behavior and physiology in the migration corridor by altering water temperature, dissolved gas concentrations, and other physiochemical conditions.

  Response: We agree that dams have an array of effects on water temperature, dissolved gas, and other physiochemical conditions. The Plan contains an extensive discussion of limiting factors resulting from hydropower facilities on both the Snake and Columbia River mainstems (see Plan, Section 5.2), and of actions that have been taken to address those limiting factors and that have contributed to improvements in the status of Snake River fall Chinook salmon (see Plan, Section 2.8.1). It also discusses potential additional actions that may be needed to achieve recovery (see Plan, Section 6.2.1.2), as well as research, monitoring, and evaluation needed to further evaluate these effects (see Plan, Chapter 7). We disagree with the commenters that breaching of the lower Snake River dams is needed to adequately address those effects for reasons outlined in our general response above regarding dam breaching.

- **Comment:** Construction of the lower Snake River dams caused the precipitous decline in Snake River fall Chinook salmon that led to their listing under the Endangered Species Act.

  Response: We agree that hydropower facilities were a significant factor for decline of the Snake River fall Chinook salmon ESU, particularly in the Middle Snake River, where hydropower facilities, including the Hells Canyon Complex, led to the extirpation of one of two historical populations in the ESU. However, as cited in NMFS status reviews and listing decisions (57 FR 14653; 70 FR 37160; Waples et al. 1991; Busby 1999; Good et al. 2005; Ford et al. 2011; NWFSC 2015; NMFS 2011, 2016b), the decline was due to multiple factors including loss of primary spawning and rearing areas upstream of Hells Canyon Dam; the effects of lower Snake and Columbia River hydropower and water storage projects associated with the FCRPS; the increase in non-local hatchery contribution to adult escapement; and the relatively high aggregate harvest impacts by ocean and in-river fisheries. Moreover, as also described in the Plan (see Plan, Section 2.8.1), the many actions undertaken since listing to address hydropower and other impacts have contributed to the substantial improvement in status of Snake River fall Chinook salmon.

- **Comment:** It is not possible to recover a wild population that is not dependent on hatchery production without breaching the dams.

  Response: We disagree. To achieve recovery goals, the Snake River fall Chinook salmon ESU must be self-sustaining in the wild. Artificial propagation may be used to benefit threatened and endangered species, and a self-sustaining population may include artificially propagated fish, but a self-sustaining population must not be dependent upon artificial propagation measures to achieve its viable characteristics. Thus, to achieve ESA recovery, threats due to the hydropower system, hatcheries, and any other factors must have been addressed in the aggregate to the point that the species has met ESA delisting goals, objectives, and criteria, and delisting is not likely to result in declines in the species status. Our evaluation indicates that it is likely that Snake River fall Chinook salmon can be recovered without dam breaching and while maintaining current hatchery production (see Plan, Section 3.2.1). However, because there are uncertainties, the Plan also makes clear the need to preserve options for other potential recovery scenarios (see Plan, Sections 3.2.1 and 6.1).

- **Comment:** Science that supports dam breaching includes the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (USACE 1999) and Budy 2001 (in which NMFS determined that for Snake River fall Chinook salmon, dam breaching by itself would likely lead to recovery).

Response: The Corps previously evaluated breaching the four lower Snake River dams in the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (USACE 2002). In 2010, the Corps also prepared the Lower Snake River Fish Passage Improvement Study: Dam Breaching Update Plan of Study (USACE 2010), which describes the process for initiating an evaluation of dam breaching in the event salmon populations significantly declined. In Budy 2001, the author summarized several large-scale analyses related to Columbia Basin salmon and steelhead. Since breaching of a dam at the scale of the Snake River has not yet occurred, many of the effects considered in those evaluations are estimates or preliminary assessments. Further, the previous assessments do not take into account the most current information on the status of Snake River fall Chinook salmon and new life-cycle modeling tools in development. As noted above, we expect that alternatives considered in the EIS currently in development by the FCRPS action agencies (and scheduled to be completed in 2021) will include an array of alternatives for different system operations and additional structural modifications to existing projects to improve fish passage, including breaching one or more dams. We have added discussion of this EIS process to the final Plan (see Plan, Sections 2.8.1 and 6.2.1.2), along with discussion of what the general benefits of dam breaching to Snake River fall Chinook salmon might be, based on previous evaluations (see Plan, Section 6.2.1.2).

Comment: Breaching the four lower Snake River dams will benefit endangered Southern Resident Killer Whales by providing prey for the whales.

Response: NMFS' Recovery Plan for Southern Resident Killer Whales (NMFS 2008a) identified three primary threats to Southern Resident killer whales: (1) availability of prey, especially salmon; (2) pollution and chemical contaminants; and (3) vessel traffic and noise. Our understanding of the availability of prey, especially the extent to which Southern Residents rely on salmon from the Columbia and Snake River systems, continues to evolve. Southern Resident killer whales spend much of the summer in the inland waters of the Salish Sea, where they prey primarily on adult Chinook salmon returning to the Fraser River in Canada. We know less about their late summer and fall diet, but data indicate that it includes Coho salmon in late summer and Puget Sound Chinook and chum salmon in the fall. During summer forays to the outer coast the whales may also consume salmon from other stocks, including Columbia River stocks. In winter, some of the whales spend more time on the outer coast, traveling as far north as northern British Columbia (and occasionally Southeast Alaska) and as far south as Monterey Bay in California. Preliminary analysis of fecal and prey samples indicate that Chinook salmon remain an important part of their winter diet. Available information indicates that whales consume Chinook from many different stocks up and down the coast, including but not limited to fish from the Columbia and Snake Rivers. Recent satellite tracking shows us that the whales often spend time in late winter and early spring between the mouth of the Columbia and Grays Harbor, Washington, when spring Chinook salmon would be returning. Other high-use areas also exist off of Washington's Olympic Peninsula and Northern California. The relative importance of Columbia and Snake River salmon compared to stocks from other major West Coast rivers such as the Fraser, Klamath, and Sacramento remains the focus of ongoing research. The collective recovery of West Coast salmon and their habitat, including stocks closest to the killer whales' summer range in Puget Sound, will be important to the recovery of the whales; but salmon recovery efforts on a single river are unlikely to bring about recovery of Southern Resident killer whales on their own.

NMFS assessed the operation of the four lower Snake River dams and their effects on listed salmon and steelhead in our 2008 FCRPS biological opinion (NMFS 2008b). In 2014, our supplemental biological opinion re-examined the issues, including consequences for Southern Resident killer whales (NMFS 2014). Both opinions concurred with the FCRPS action agencies' determination that the proposed action was not likely to adversely affect Southern Resident killer whales. The biological opinions concluded that hatchery production of salmon and steelhead in the Columbia and Snake systems more than offset any losses of salmon from the killer whale prey base caused by the dams. NMFS' Recovery Plan for Southern Resident Killer Whales (NMFS 2008a) did not address potential benefits of dam breaching or identify dam breaching as a needed recovery action. Recovery of Southern Resident killer whales remains a high priority for NMFS.

4. Climate Change

Comment: While the recovery plan recognizes that climate change is a threat to the recovery of Snake River fall Chinook salmon, the management strategies and actions in the Plan seem inadequate to address it. Potential effects of climate change should be carefully evaluated in the recovery plan, as they substantially and negatively interact with current stressors throughout the life cycle. Although it is not clear how fall Chinook salmon will respond to these combined stressors, it is very likely that climate change will exacerbate the negative effects of current limiting factors. Actions should be added to the Plan related to temperature monitoring in mainstem and tributaries to determine trends; determining a temperature threshold for spawning and rearing areas; monitoring pH and/or pCO2 throughout the mainstem and tributaries; and implementing structural and engineering operational changes in hydropower systems to prevent drastic changes in temperatures.

Response: We agree that climate change is a threat to Snake River fall Chinook salmon and that its effects, and interactions of those effects with current limiting factors, are complex and uncertain. It is not possible to predict at this time with precision what those effects will be. Life-cycle models for Snake River fall Chinook salmon are in development. We anticipate that these models will allow us to better discern the biological response of fall Chinook salmon to climate change, whether it be in terms of altered run timing or increased genetic tolerance of high water temperature, as well to better understand how climate change interacts with other stressors. The research, monitoring, and evaluation (RM&E) plan (see Plan, Chapter 7 and Appendix B) contains comprehensive monitoring questions related to the effects of climate change (see, e.g., Chapter 7 and Appendix B, Monitoring Objectives 4, 5, and 8). This RM&E plan will be updated over time as appropriate.

5. Cost and Time Estimates

Comments: Several commenters stated that the recovery plan did not meet ESA requirements for estimates of the time required and cost to implement recovery actions. These commenters focused primarily on the management actions in Section 6.3.2, Strategies and Actions for the Extirpated Middle Snake River Population. In their view, the Plan needed to include a "comprehensive and defensible" cost analysis for the mitigation measures that would be necessary to implement Scenario A. They also commented that statements of times required to achieve Scenario A are either absent or too vague to be useful.

Response: We disagree. The ESA requires recovery plans to include estimates of the time required and the costs to implement recovery actions. Consistent with NMFS West Coast Region guidance on cost estimates for recovery plans, our approach to estimating costs of recovery actions in this Plan was to provide cost estimates only for actions that would not occur but for the recovery plan. We do not include cost estimates for baseline actions (i.e., actions that are already in existence or that would occur regardless of the recovery plan). This includes actions mandated by laws, regulations, and/or policy directives other than an ESA recovery plan or any other action that would occur irrespective of the recovery plan. No cost estimates are provided for baseline actions because they do not represent new costs that are a result of a recovery plan. As described in the Plan, multiple entities have implemented significant programs that have benefitted Snake River fall Chinook salmon since the ESU was listed in 1992 and that have contributed to current high abundance levels. These programs are all part of the baseline costs. In addition, we anticipate that passage and reintroduction efforts above the Hells Canyon Complex would be carried out eventually as part of a relicensing agreement with the Federal Energy Regulatory Commission (FERC), pursuant to the Federal Power Act. Therefore, we consider these costs baseline costs. In addition, we do not provide cost estimates for actions where it is not practicable to do so because information is not sufficient at this time to support a cost estimate. These costs will be developed during implementation when sufficient information is available (see Plan, Section 9.2).

With regard to the time required to achieve Scenario A, we have clarified in the final Plan that, due to the time required to restore habitat, develop and install fish passage, and accomplish reintroduction with appropriate hatchery stock, it would take many decades to achieve Scenario A. It is not possible at this time to be more precise.

6. Delist the Snake River Fall Chinook Salmon ESU

Comments: Several commenters maintained that NMFS should conclude that the five listing factors in ESA Section 4(a)(1) have been satisfied, that delisting of the ESU is warranted at this time, and that the Plan is unnecessary. These commenters also noted that this determination should include "appropriately" analyzing the ESU to include hatchery fish.

Response: We disagree. On May 26, 2016, NMFS published in the *Federal Register* a notice of our 12-month finding on a petition to delist the Snake River fall run Chinook salmon ESU (81 FR 13434). This notice also announced the availability of our most recent 5-year status reviews, prepared pursuant to ESA section 4(c)(2)(A). Based on the best scientific and commercial data available, we determined that delisting the Snake River fall run Chinook salmon ESU is not warranted at this time (NWFSC 2015, NMFS 2016b).

The 12-month finding included detailed discussion of specific points raised by some of the commenters, including (1) how we consider hatchery fish in listing decisions and in assessing extinction risk status and (2) why, based on the best available scientific information, including our recent 5-year review of the status of the Snake River fall Chinook salmon ESU, we determined that, although recent improvements in the species' status are encouraging, the ESU continues to merit threatened status under the ESA.

Commenters' views that the Snake River fall Chinook salmon ESU should be delisted were based in large measure on the prevalence of hatchery-produced fish and the commenters' view that we erred in emphasizing the naturally spawned component of the ESU in our viability assessments. Again, we disagree and conclude that, consistent with our Hatchery Listing Policy and the Ninth Circuit Court of Appeals ruling in *Trout Unlimited* v. *Lohn,* hatchery fish should be evaluated in the context of their contributions to the conservation of the naturally spawned population.

The Interior Columbia Technical Recovery Team viability criteria (ICTRT 2007) and the potential recovery scenarios in the final Recovery Plan, along with their corresponding delisting criteria (see Plan, Section 3.2), provide guides for evaluating the conditions that must be met for the delisting of Snake River fall-run Chinook to be warranted. All the biological viability criteria and proposed recovery scenarios conclude that the extant Lower Snake River population must be highly viable. The Northwest Fisheries Science Center (NWFSC 2015) concluded that the Lower Snake River population is currently viable, but is less than highly viable (see Plan, Chapter 4). In other words, the current risk level of the Snake River fall-run Chinook ESU does not meet the status described in the Technical Recovery Team report (ICTRT 2007) and the recovery plan as necessary for the recovery of the ESU (see Plan, Chapters 3 and 4).

Additionally, based on our evaluation of the five ESA section 4(a)(1) factors, we concluded that historical habitat loss, continued degradation and modification of habitat, and the inadequacy of regulatory mechanisms continue to pose threats to, and limit the recovery potential of, the Snake River fall-run Chinook ESU (81 FR 13434, NMFS 2016b). Disease, predation, and overutilization do not pose major threats to the ESU at this time. We also found that the high levels of uncertainty associated with projecting the effects of other natural or man-made factors affecting the continued existence of the ESU represent a threat to the persistence and recovery potential of the Snake River fall-run Chinook ESU (81 FR 13434, NMFS 2016b). This latter uncertainty, particularly that conferred by the prevalence and broad distribution of hatchery-origin fish across all major spawning areas, needs to be addressed if we are to be able to assess the viability of the extant Lower Snake River population with sufficient certainty. Based on our review of the species' viability, the five section 4(a)(1) factors, and efforts being made to protect the species, we have concluded that the Snake River fall Chinook ESU is likely to become an endangered species throughout all or a significant portion of its range in the foreseeable future. There is no new information currently available that would alter this determination.

7. Density Dependence

Comment: The fact that density-dependent habitat effects are influencing production, or that high proportions of hatchery-origin spawners may be influencing natural production rates provides further rationale for recolonization above Hells Canyon.

Response: Some evaluations of the productivity of the extant Lower Snake River fall Chinook salmon population indicate a strong density-dependent component, and efforts are underway to develop a multistage life-cycle modeling assessment of Snake River fall Chinook salmon natural production that should reduce uncertainties regarding productivity and density-dependent life-stage capacities in future assessments. This information will inform adaptive management of the recovery strategies for the Snake River fall Chinook ESU; however, we believe that the relatively high levels of natural returns relative to the ICTRT-recommended minimum abundance requirements indicate that current life-stage capacities are sufficient to support ESA recovery.

8. Duration of Plan

Comment: The proposed duration of the plan is too long considering the uncertainties regarding success of the proposed actions, potential changes in limiting factors, and additional information that is likely to be available in 10 to 15 years. In addition, the Plan should be more aligned in duration with major management processes in the Columbia Basin, such as *U.S. v. Oregon*.

Response: We disagree. ESA Section 4(f)(1) requires us to develop site-specific management actions needed to achieve delisting objectives and to estimate the time and cost to recovery, to the maximum extent practicable. One purpose of the recovery plan is to lay out a roadmap for achieving the Plan's goals. We believe that the Plan provides an appropriate long-term framework within which management actions can be implemented adaptively. As noted in Chapter 6, the Plan is based on an adaptive management approach. Chapter 8 of the Plan describes the implementation framework for the Plan and notes the importance of coordinating implementation with ongoing management processes. It also notes that as part of implementation, 5-year implementation schedules will be developed that identify with greater specificity the actions to implement over 5-year timeframes. Further, there are provisions for updating the Plan as needed (see Plan, Section 8.4). These mechanisms for implementing the Plan in close coordination with ongoing management processes and for updating the Plan will accommodate changes needed to better align the Plan with ongoing regional processes such as the FCRPS biological opinions, *U.S v. Oregon*, and the Pacific Salmon Treaty.

9. ESA Recovery Scenarios

We received many detailed comments related to the recovery scenarios in the Proposed Plan (see Chapter 3). These comments are summarized below by scenario. We also received a number of comments asking that we identify a "preferred" scenario. We have clarified in the final Plan that at this time, we see Scenario C (which was called a "Placeholder Scenario" in the Proposed Plan) as the most likely and most timely pathway to delisting. We have also clarified in the final Plan, however, that all of the scenarios have attendant and significant tradeoffs and uncertainties and that, therefore, at this time it is also important to preserve the opportunity to pursue any of these scenarios.

Scenario A – Two Populations (one highly viable, one viable)

Comments: We received comments opposing Scenario A and requesting that it be removed from the Plan. These comments were generally based on the costs of achieving the scenario, the time to achieve it, and questions related to its feasibility. Conversely, we also received comments supporting Scenario A and advocating that it should be the preferred scenario. Comments on Scenario A are briefly summarized below:

General Objections to Scenario A

- Scenario A expresses a broad sense goal that is beyond the scope of the ESA recovery plan.
- The final Plan should focus on recovering the extant population as a more direct and plausible approach to achieve ESA recovery.
- Scenario A should be removed because studies conducted under the FERC relicensing process have found it to be uneconomical and biologically and physically impossible.
- If this scenario were implemented, there would be enormous costs and impacts to water resources and economic activities. Prospects for success of Scenario A under any reasonable and foreseeable future set of circumstances are dismal. Scenario A must be removed from the recovery plan. The other scenarios show more promise.

Specific Objections to Scenario A

- Juvenile passage:
    - Establishing a second population above Hells Canyon would require high passage survival and high collection efficiencies of downstream migrants. There is currently no successful model for passing juvenile fall Chinook salmon through a reservoir system like Brownlee. The length and large reservoir volume, the thermal characteristics, and the heavy debris loads associated with the inflowing Snake River thwarted earlier passage efforts and these challenges remain. Research and development of passage systems could cost hundreds of millions of dollars. Designing effective juvenile passage may not be possible without causing substantial direct and delayed mortality to the migrant fish.

- Habitat quality above Hells Canyon:
    - A very significant proportion of the Middle Snake River watershed does not currently have habitat that is capable of supporting a self-sustaining fall Chinook salmon population. Much of the mainstem habitat is significantly altered by the Hells Canyon Complex, by other dams and reservoirs, and by land uses. Water quality issues including altered (high) thermal regimes, high nutrient levels, and

low dissolved oxygen pose significant risks to survival. Sediment deposition and other alterations of geomorphic processes pose risks to incubation and emergence in spawning areas and depress food production in reservoirs and free-flowing reaches. Altered instream flows decrease habitat suitability in many reaches, and increase survival risk for early rearing and out-migration.
    - The ability to restore these habitats is questionable. Even if the practices that continue to contribute to these conditions could be sufficiently addressed, recovery would be decades away. Cost of such habitat restoration would be significant.
    - The recovery plan should recognize the challenges of the degraded habitat conditions above the dam.

- Stock for reintroduction:
    - Research will be needed on the feasibility of using the existing population of Snake River fall Chinook salmon for reintroduction above Hells Canyon. If use of the existing population is not feasible, a feasible alternative would need to be found.

- Adaptation:
    - There is evidence that Snake River fall Chinook salmon have adapted to being displaced into the existing habitat below Hells Canyon Dam. The altered thermal regime in the Lower Snake River created by construction of the Hells Canyon Complex created a habitat that now favors production of Age-0 fall Chinook salmon where it did not historically. These fish are continuing to adapt to the unique collection of spawning and rearing habitat conditions prevalent today, which are very different from conditions under which previous populations evolved.

- Cost analysis:
    - See above, under “Cost and Time Estimates.”

- Altered fish community:
    - Highly abundant populations of non-native fish, including smallmouth bass, largemouth bass, crappie, channel catfish, and flathead catfish, now dominate the fish community in the Middle Snake River, and there is evidence that these populations are expanding. During the period when fall Chinook salmon would undergo emergence, water temperatures would be favorable for increased foraging activity by these predators. These levels of predation would be a cause for concern.

- Risks to the extant population: Efforts to reestablish a population upstream of Hells Canyon are likely to reduce the viability of Snake River fall Chinook salmon through an increase in operation-related mortality, exposure to other risks, and through indirect genetic risks.
    - Analyses suggest that conditions under which adding an upstream spawning area would reduce the risk of extirpation are narrow, and that success would require a significant amount of new spawning habitat, continued access to current spawning habitat, and high round-trip survival for salmon using the new habitat.
    - To sustain any adult returns, an upstream population would need to increase reliance on hatchery supplementation for many decades. Because adult hatchery returns would pass through the extant population downstream of Hells Canyon Dam, a fair percentage of these hatchery fish would not be collected at Hells Canyon Dam and would subsequently contribute to the natural production below the dam. This outcome would have adverse effects on the recovery metric of reducing hatchery influence on the extant natural population. Similarly, some component of adult returns that originate from the downstream population could inadvertently be passed to the upstream population. A high level of straying will prevent local adaptation and phenotypic divergence, and thus not enhance genetic diversity of the ESU.
    - If a second population could be established, it inherently would be exposed to shared environmental risks. The likelihood that spawners using the upstream habitats would experience fewer or different stochastic events is low.

- Historical ESU Structure:
    - The two historical populations may not have functioned as a single ESU historically. The Lower Snake River population may have interacted more with fall Chinook salmon spawning areas in the Columbia River than with the Middle Snake River population, based on the large geographical separation between the Lower Snake River and the Middle Snake River core production areas and the reliance of the Middle Snake River on the discharge from the Eastern Snake River Plain Aquifer, which allowed very early emigration of juveniles. Based on these differences, it is possible that the Middle Snake River was in fact a separate ESU from the Lower Snake River.

Support for Scenario A

Other commenters supported Scenario A and asked that NMFS designate it as the preferred recovery scenario, based generally on the view that recovering the extirpated population was necessary to achieve the recovery of the ESU, had the potential to further reduce risk to the ESU, was consistent with tribal policy, and could inform the Hells Canyon Complex relicensing process that is currently underway. For example:

- We support recovery goals and scenarios that aim to recover the Snake River fall Chinook ESU to demonstrable, self-sustaining levels and include restoration of passage and populations above Hells Canyon Dam to provide an extinction-risk buffer, greater resilience, and improve viability.
- A comprehensive proposal should be developed to establish passage and a productive and diverse second population above Hells Canyon Complex to facilitate recovery. All actions tailored to promote the recovery of the fall Chinook population below the Hells Canyon complex would facilitate the reintroduction of the species above the complex. A larger population above Hells Canyon Dam would increase geographic distribution and abundance, productivity, and diversity to the ESU, and provide greater resilience to fluctuating conditions.
- Strongly support Scenario A as the preferred scenario in the final recovery plan.
- This recovery plan is occurring concurrently with the Hells Canyon Complex relicensing, making an alternative for passage and restoration of a second Snake River population more feasible than at any time in the past several decades. This next such opportunity will likely be many decades in the future. The recovery plan will be critical for informing the Hells Canyon Complex relicensing process.
- The Shoshone-Bannock Tribes stress the importance of initiating efforts to restore the Snake River system to a natural condition. The tribes' Snake River Policy provides specific direction to NMFS to restore the extirpated run of fish in the Snake River and to help restore the ecological functions to the riverine ecosystem. The Tribes request that NMFS manage Snake River fall Chinook salmon consistent with the tribal goal of restoring the Snake River to a more functional river system. The Tribes should be considered an integral and qualified manager to carry out any implementation work to help make the opportunity of fall Chinook salmon recovery above the Hells Canyon Complex a reality.
- The Hells Canyon Complex Fisheries Resource Group (HCC FRG), a group of affected tribes, state, and federal fish and wildlife agencies, has developed a draft outline of a fisheries restoration plan for passage and reintroduction of anadromous fish above the Hells Canyon Complex dams and reservoirs. While the FRG has not yet achieved complete consensus among the parties, the fisheries restoration plan contains three main goals for a phased approach for reestablishing anadromous fish, including fall Chinook, upstream of these dams. We suggest that this draft plan be included in an appendix of the final recovery plan or as a separate reference document, as it will help inform the necessary future steps of Scenario A.
- Following the ICTRT recommendation that "initial effort be placed on recovery for the extant population, concurrently with scoping efforts for re-introduction" above the Hells Canyon Complex, we would like the plan to more directly address what efforts will be made during the recovery of the Lower Mainstem Snake River population to concurrently effect reintroduction above the Hells Canyon Complex.

- There have been vast improvements in fish passage technology for juvenile and adult salmon since the Idaho Power Company initially evaluated fish passage technology in the early 1960s. Exploring and assessing these new passage technologies is consistent with Scenario A.
- More work is warranted to explore what source population(s) should be used in reintroduction efforts.

Response: After considering all comments on Scenario A (as well as comments on the other recovery scenarios) and commenters' requests that NMFS identify a "preferred" recovery scenario, we have determined that it is appropriate to retain Scenario A as one of three potential recovery scenarios in the Plan. Commenters are correct that there are multiple uncertainties regarding the feasibility of, and time needed for, restoring a viable population above the Hells Canyon Complex of dams, and they have identified many of those specific uncertainties and challenges (e.g., fish passage, habitat restoration, appropriate stock for reintroduction, strategies for dealing with hatchery fish, effects on the extant population, etc.). We have added additional text to the Plan highlighting these uncertainties, their complexity, and the time that might be required to resolve the uncertainties and implement actions (see Plan, Section 3.2.1; also see Plan, Section 9.1). During Plan implementation, these specific issues raised by commenters will be addressed within the context of the ongoing Hells Canyon Project Federal Power Act relicensing process.

As the Plan notes, all of the potential recovery scenarios in the Plan have associated, and significant, uncertainties. In the final Plan, we have added text identifying the crucial uncertainties associated with each scenario and noting that they would need to be explored before implementing, or as part of implementing, some of the associated actions (see Plan, Section 3.2.1). There is no requirement that the Plan conclusively resolve these uncertainties before it is finalized. Further, there is no requirement that the Plan do a NEPA-like analysis or a cost-benefit analysis of the proposed recovery actions and scenarios.

Precisely because of the uncertainties associated with each scenario, the final Plan also highlights the importance of preserving them all as potential scenarios at this time. As we learn more, we may able to narrow the uncertainties and provide more certainty that one of the scenarios will provide a successful path to ESA recovery. We have clarified in the final Plan that in our view the most direct and likely path to recovery at this time is Scenario C (see Plan, Sections 3.2.1 and 6.1). Given the significant uncertainties and trade-offs in all the scenarios, however, we also determined that it is important to retain Scenario A as a potential recovery scenario. It is important to preserve a path to reestablishing a population above the Hells Canyon Complex in case the other scenarios prove infeasible or unsuccessful.

Further, we also continue to support reintroduction above the Hells Canyon Complex as a broad sense recovery goal that is responsive to our tribal treaty and trust responsibilities, and that could further reduce overall risk to the ESU (see Plan, Sections 3.1.2, 3.2.1, and 6.1).

We agree that interested tribes will be important partners in implementation of the recovery plan in general and, as appropriate, in implementation of actions related to restoring natural production of Snake River fall Chinook salmon about the Hells Canyon Complex. Finally, as noted in the comments above, the Hells Canyon Fisheries Resource Group, representing affected tribes, states, and federal fish and wildlife agencies, has developed initial phases of a draft outline of a fisheries restoration plan for passage and reintroduction of anadromous fish above the Hells Canyon Complex dams and reservoirs. As noted in the Plan, this considerable effort shows the commitment of the parties to forge a pathway forward to restore anadromous fish passage and eventually provide fisheries above the Hells Canyon Complex. While the Fisheries Resource Group has not yet achieved complete consensus among the parties, the fisheries restoration plan contains three main goals for a phased approach for reestablishing anadromous fish, including fall Chinook salmon, upstream of these dams. This plan is a useful reference as it could inform future steps to reestablish passage and sustainable fish runs above the Hells Canyon Complex, which is pertinent to Scenario A and to the broad-sense goal of reestablishing natural production above the Hells Canyon Complex.

Scenario B – Single Population (highly viable, measured in the aggregate)

Comments: Comments on Scenario B were generally supportive. A recurring theme was support for the idea that under Scenario B, recovery could likely be achieved faster than under Scenario A. Other comments addressed details of how Scenario B would be implemented. Comments are summarized below:

- With some additional modifications, it is more likely that recovery goals can be met within a significantly shorter time frame under Scenario B, and with less cost and with significantly less risk to the ESU, than pursuing Scenario A. However, under Scenario B, production of hatchery fish would need to be reduced.
- We support developing recovery criteria centered on the extant population and the continued actions that have enhanced production from the diverse spawning areas available for fall Chinook salmon today. Recovery should be based on the habitat and population templates that are available today and not on historical habitats that arguably have been irreversibly altered. Thermal regimes are different than they were historically, and the yearling life history is becoming more successful, principally because of thermal regime changes. The spawning areas available today are diverse and unique and will allow for evolution of traits contributing to a viable population.
- This Plan notes that hatchery fish have been critical to the re-building of the Snake River fall Chinook salmon ESU, that natural-origin fish are now spawning in areas of the Snake and Clearwater Rivers where they have access, and that current hatchery releases also occur in those same areas. The Plan also notes that reductions in hatchery production would be needed under Scenario B, but there is no guidance provided as to what reductions might look like, how they would be decided, and for which reaches and release locations.
- The Plan states that Scenario B could conceivably be achieved in a shorter time frame than Scenario A, but that it would require reductions in current levels of hatchery

releases. How likely is it that hatchery-origin fish can be excluded from Scenario B spawning areas when their proportions are not even known at present?

- Scenario B requires natural and hatchery fish to be intensively monitored and managed separately. Achieving Scenario B would require the ability to visibly discern a hatchery-origin fish from a natural-origin fish. This is not feasible given current marking/tagging schemes, which visibly mark (adipose clip) approximately 50 percent of production. The recovery plan should explicitly call for both increases in external marking and changes in release sites to achieve the recovery viability criteria associated with this scenario.
- Idaho Power Company supports continuing the actions that have contributed to the significant progress toward recovery that has occurred since the listing of Snake River fall Chinook salmon. These actions include Idaho Power's fall Chinook salmon flow program, which provides stable flows during the spawning period and a minimum flow during the incubation period that protects redds from being dewatered. It also includes the Idaho Power Entrapment Management Plan, which implements operational protocols at Hells Canyon Dam that minimize the potential impacts to SRFC juveniles rearing in near shore habitats that become entrapped in pools as a result of operating the Hells Canyon Complex.

Response: We agree with the commenters that under Scenario B, it is likely that recovery could be achieved in a shorter time frame and with less financial cost than under Scenario A. Commenters are also correct that under this scenario, hatchery production would need to be significantly reduced, and current mitigation goals would not be met.

Commenters also note that the Plan does not include details of how Scenario B would be implemented, in terms of reductions in numbers of hatchery fish produced, release locations, tagging/marking requirements, etc. Under Scenario B, existing levels of hatchery production would need to be substantially reduced so that we could determine the underlying productivity of the population and be confident that productivity could be maintained in the long-term. Proportions of hatchery-origin spawners in the aggregate Lower Snake River fall Chinook salmon population would need to be low enough that NMFS could evaluate productivity of the natural-origin fish and determine with high confidence that the population was meeting criteria for high viability. We would also need confidence that the population was responding to natural selective forces and not to hatchery selection (see Plan, Section 3.2.1). Details of implementing such a scenario would need to be developed jointly with co-managers and in coordination with existing forums.

As we have clarified in the final Plan, at this time, we see Scenario C as the most likely and timely path to ESA recovery (see Plan, Section 3.2.1). NMFS is working with co-managers to develop a plan for implementation of Scenario C. Thus, for the short-term, implementation planning efforts will focus on Scenario C, while we also continue to explore options of re-establishing natural production above the Hells Canyon Dam complex in the event the single-population scenarios do not prove feasible for ESA recovery, and to support broad-sense goals in the event that we achieve ESA recovery with the extant population (see Plan, Sections 3.1.2, 3.2.1, and 6.1).

Finally, NMFS is extremely appreciative and supportive of Idaho Power Company's implementation of, and continuing commitment to implement, the flow actions that have contributed to significant improvements in the status of the extant Lower Snake River fall Chinook salmon population.

Scenario C – Single Population (highly viable, with Natural Production Emphasis Areas) (called "Placeholder Scenario" in Proposed Plan)

Comments: Comments on the Placeholder Scenario (called Scenario C in the final Plan) were also supportive for the most part, but noted the need to develop additional detail on how the scenario would be implemented. Several commenters requested the NMFS designate this scenario as the "preferred" recovery scenario. For example:

General Support for Scenario C

- We request that NMFS select as the appropriate recovery scenario the Placeholder Scenario.
- The Placeholder Scenario needs to be fleshed out and considered in more detail. We ask that NMFS give serious considerations to our recommendations and incorporate them into the Placeholder Scenario. If this is done, we would enthusiastically endorse implementation of that scenario.
- We encourage NMFS to develop the scenario focusing only on the extant population and including a Natural Production Emphasis Area (NPEA) in the Snake River from the confluence of the Salmon River upstream to Hells Canyon Dam. This scenario would likely lead to recovery and delisting in a much shorter timeframe than Scenario A.
- To hasten the achievement of recovery for the ESU, we recommend modifications to the Placeholder Scenario, which will, in our opinion, render it the better of the scenarios for achieving recovery of the ESU.
- With a comprehensive fleshing out of the Placeholder Scenario, we believe it is more likely that recovery goals can be met within a significantly shorter time frame, with less cost and with significantly less risk to the ESU, than pursuing Scenario A.
- The NPEA scenario that NMFS describes as a placeholder in the draft plan should be refined to include potential actions that would enable delisting under this scenario.

Specific Comments on Scenario C

- This scenario requires hatchery- and natural-origin fish to be managed independently, thus requiring changes in current hatchery marking schemes and release sites; these needs should be identified.
- The Plan states that the inability to recover carcasses because of conditions in mainstem spawning reaches prevents direct estimation of area-specific hatchery and natural proportions. Unless this issue can be solved, the NPEA option does not seem feasible.
- Based on recent redd survey information, a large number of females were passed above Lower Granite Dam, but a similar number of redds was not found. Possible explanations

are that (1) all spawning areas cannot be accurately surveyed; (2) all spawning areas are not being surveyed; (3) there is a lot of redd superimposition occurring that cannot be documented; (4) there is significant pre-spawning mortality (which could be different between hatchery- and natural-origin fish); or (5) a combination of all these factors. Furthermore, not all potential spawning areas receive equal redd survey effort. This introduces uncertainty into the calculations of fractions of natural- and hatchery-origin fish on the spawning grounds and how this information will be used.

- The Plan emphasizes the area above the Salmon River confluence as a natural production emphasis area. The lower Salmon River should be included.
- Acceptable levels of hatchery-origin fish in all NPEAs should be explicitly stated.
- Given the uncertainty in the potential outcome of such a scenario, it may be prudent to phase the development of the NPEA by first reducing a component of the hatchery releases to the new location.
- If an NPEA was being managed concurrent with reintroduction efforts above Hells Canyon, adult returns intended for transport above Hells Canyon could escape capture and spawn in the NPEA, reducing its effectiveness.
- Is it feasible to achieve an NPEA in any of the major spawning areas (MaSA’s) besides an eventual, controlled reintroduction above Hells Canyon? Are efforts in place to assess pHOS and pNOB in lower Snake River mainstem spawning areas so as to evaluate the likelihood of an NPEA being successful in these areas?
- The Proposed Plan states that “to fully inform managers of the status of the population relative to spatially explicit delisting criteria, it will be necessary to estimate the spatial distribution of natural-origin spawners using an approach that accounts for the spatial distribution of hatchery-origin spawners. Appendix B identifies two approaches that could be used to estimate the annual number of natural-origin adults that escaped to the individual spawning areas.” We have concerns about how or if this can be accomplished.
- The placeholder scenario contains little information regarding how it would be implemented. The scenario should include abundance and productivity goals, as well as other details, for public review and comment; otherwise the recovery planning process probably does not meet the requirements of NEPA. The Plan does not specify how and when the public would get to review and provide input on the details of the NPEA scenario.
- For the NPEA scenario to work in the time frame suggested in the Plan, the various co-managers would need to change hatchery release locations very soon (before the next *U.S. v. Oregon* Agreement). Otherwise the time frame to recovery will be a lot longer.

Objection to Scenario C

- The Plan states that the ESU’s unique characteristics may allow recovery with just the extant Lower Mainstem Snake River Population. This statement is not substantiated by the information provided elsewhere in Plan and appears inconsistent with accepted

> conservation biology. We are concerned with the application of the NPEA scenario in relation to other Pacific Salmon ESU/DPSs, and its divergence from accepted conservation biology and VSP recovery principles. A secondary concern of the NPEA scenario is its potential to undermine Oregon’s component of harvest mitigation.

Response: The single population scenario with Natural Production Emphasis Areas (NPEAs) was identified as a “placeholder” scenario in the Proposed Plan. After considering all the comments, along with monitoring information that became available in the summer of 2017 and that informed questions related to the feasibility of this scenario, we have clarified in the final Plan that at this time we consider this scenario the most likely and most timely path to ESA recovery (see Plan, Section 3.2.1). We have also designated it “Scenario C” rather than a “placeholder” scenario.

As the final Plan also notes, all of the potential recovery scenarios presented in the Plan have associated, and significant, uncertainties. In the final Plan, we have identified the main uncertainties associated with each scenario, as well as a path to resolving those uncertainties. The Plan identifies site-specific management actions for implementing each scenario to the maximum extent practicable, as required by the ESA. Further, there is no requirement that the Plan do a NEPA-like analysis or a cost-benefit analysis of the proposed recovery actions and scenarios. The Plan itself has a categorical exclusion to NEPA requirements. Individual recovery actions that are subject to NEPA will need to comply with NEPA as appropriate as part of the implementation process.

While we consider Scenario C the most likely path to recovery at this time, the final Plan also notes that because of the uncertainties associated with each scenario, it is important to preserve all of them as potential scenarios at this time (see Plan, Sections 3.2.1 and 6.1). As we learn more, we may able to narrow the uncertainties and provide more certainty that one of the potential scenarios will provide a successful path to ESA recovery. We have clarified in the Plan that, in our view, the most direct and likely path to recovery at this time is Scenario C. Given the significant uncertainties and trade-offs in all the scenarios, however, we also determined that it is important to retain Scenarios A and B. It is important to preserve a path to reestablishing a population above the Hells Canyon Complex in case the other scenarios prove infeasible or unsuccessful. We also continue to support reintroduction above the Hells Canyon Complex as a broad sense recovery goal that is responsive to our tribal treaty and trust responsibilities, and that could further reduce overall risk to the ESU.

Efforts have been underway since the NPEA concept was developed to evaluate the feasibility of the NPEA scenario for the Lower Snake River population, including consideration of monitoring information that became available in 2017. As the final Plan notes (see Plan, Section 3.2.1), at this time, we believe the approach is feasible. If implemented, the NPEA approach will be carefully evaluated to determine its success. If the approach is unsuccessful, the Plan identifies the option to pursue additional scenarios. Should the NPEA approach not succeed, we will also continue to support efforts to develop additional alternative scenarios.

NMFS is currently working with co-managers to develop an implementation approach for Scenario C. Commenters raised some of the many questions and details related to implementation of this scenario that will need to be worked through in order to implement it. It is also possible that implementation may be phased in an adaptive management approach that will allow for evaluating initial efforts before undertaking full-scale relocation of hatchery release sites. Thus, for the short term, Scenario C is likely to dominate implementation planning, while we also continue to explore options for re-establishing natural production above the Hells Canyon Complex in the event the second population is needed for ESA recovery (and to promote the broad-sense goal of re-establishing significant natural production above the Hells Canyon Complex in the event we reach ESA recovery with the extant population).

It is not practicable to respond here in detail here to all the implementation questions raised above, because the specific issues and questions raised by commenters are more appropriately addressed collaboratively by co-managers (who have the expertise and access to the most recent information) as they work through the details of implementation. We agree that there are remaining uncertainties about how to estimate natural-hatchery composition in different areas. We will continue to work with our partners throughout the process of developing and implementing an NPEA scenario to discuss, manage, and resolve these uncertainties, and to ensure prioritization of RM&E needs and informed adaptive management.

Finally, we disagree with the comment that the basis for achieving recovery with the extant population is not substantiated in the Plan or supported by conservation biology. The Plan notes that the Snake River fall Chinook salmon ESU uniquely consisted historically of only one MPG, and that this would put the ESU at inherently greater extinction risk than other salmon species with several MPGs (ICTRT 2007). Further, the Plan notes, an ESU with a single historical MPG and a single remaining population would be at greater extinction risk than other salmon species with one MPG and more than one extant population. We also note that these were key considerations for potential Snake River fall Chinook salmon viability scenarios. The Plan and the ICTRT also acknowledged that, as with most ESUs, there is more than one potential scenario for achieving viability, and "different scenarios of ESU recovery may reflect alternative combinations of viable populations and specific policy choices regarding acceptable levels of risk." The Plan has identified several potential recovery scenarios (including both single-population and two-population scenarios). The Plan recognizes that the aggregate size, complexity, and diversity potential of the habitats supporting natural fall Chinook salmon production in the Lower Snake River population provide opportunities to meet objectives for minimizing exposure to localized catastrophic loss and providing for diversity expression that would not be available for many other populations (see Plan, Chapter 3). These specific circumstances create an opportunity to consider single-population recovery options. The single-population scenarios specifically recognize the increased long-term risk to the ESU as a result of having only one population by requiring a higher degree of confidence that the population has achieved highly viable status than is required under the two-population scenario.

Regarding concerns about the potential for the NPEA scenario to affect Oregon's component of harvest mitigation, we expect that discussions about the NPEA scenario will take place in coordination with the *U.S. v. Oregon* and other established harvest management forums. This provides an opportunity, as part of the process of exploring options for creating an NPEA, to assess the impacts of potential changes to hatchery releases on hatchery returns and their contributions to fisheries.

Suggestions to Include Additional Scenarios

Comment: We strongly encourage the inclusion of two additional scenarios that involve restoration of lower Snake River high potential spawning habitat that is currently inundated by Little Goose and Lower Granite reservoirs by removing the lower Snake River dams. One scenario should include both lower Snake River dam removal and fish passage at the Hells Canyon Complex; the other should include lower Snake River dam removal and continued improvement in status of the existing Snake River fall chinook population.

Response: While the Plan notes that it is possible that additional scenarios could be developed that would meet the ESA recovery goal and objectives (see Plan, Chapter 3), we disagree that at this time it is appropriate to explicitly incorporate scenarios that involve removal or breaching of the lower Snake River dams (see response above, under “Breaching of Lower Snake River Dams”). The improvements in status of the ESU since listing, combined with the fact that at this time Scenario C presents a feasible path to recovery, do not warrant a need to identify additional scenarios at this time.

10. Habitat

General

Comment: The recovery plan must address limiting factors related to (1) spawning and juvenile rearing; (2) juvenile migration; (3) areas for growth and development; and (4) adult migration. Suitable habitat for spawning and rearing is particularly limiting. Where suitable habitat does exist, management strategies must be in place to protect it.

Response: We agree and think that the Plan adequately addresses these limiting factors. The recovery plan contains extensive discussion of limiting factors related to habitats for spawning, juvenile rearing, and migration (mainstem, reservoir, and estuary), and adult migration (see Plan, Chapter 5). It also contains strategies and site-specific management actions, as well as RM&E actions, related to habitat (see Plan, Chapters 6 and 7). In addition, as Snake River fall Chinook salmon life-cycle models are developed and applied (see Plan, Chapter 6), they will help inform questions related to capacity and productivity of habitat.

Comment: For the reintroduction and recovery of the fall Chinook salmon population above the Hells Canyon Complex, spawning habitat and water quality must improve considerably. The recovery plan will need to address altered thermal regimes, excessive nutrients, anoxic and hypoxic conditions, altered water flow, restoration of inundated habitat, excessive sedimentation, entrapment of sediments, and erosion. Moreover, the recovery plan should consider dam removal as an alternative to improving habitat.

Response: We agree with the comments related to habitat above the Hells Canyon Complex, and the Plan is consistent with those comments. The Plan notes that habitats above the Hells Canyon Complex are currently too degraded to support significant natural anadromous fish production, and that improving the habitats to a point that they would support significant natural production is a crucial element of reestablishing natural production above the Hells Canyon Complex (see, Plan, e.g., Sections 3.1.2, 3.2.1, and 6.1.2). The comment about dam removal appears to be referring to removal of the Hells Canyon Complex, and we disagree that Hells Canyon dam removal (or breaching) should be viewed as an alternative to improving habitat. Habitat restoration above the Hells Canyon Complex is needed to support natural production above the dam regardless of whether the dams are present or not, and we have no information at this time to conclude that passage at the dam would not be sufficient to move fish into and out of the restored habitat. While one of the three potential ESA recovery scenarios included in the Plan would require reestablishing a viable population above the Hells Canyon Complex, we note in the Plan (see Plan, Section 3.2.1) that at this time we see Scenario C, which would achieve recovery with the extant population, as the most likely pathway to recovery. In any event, we continue to support reestablishing significant natural production above the Hells Canyon Complex as a broad sense recovery goal (see Plan, Sections 3.1.2, 3.2.1, and 6.1).

Comment: Major spawning areas in the lower mainstem Snake River and tributaries are affected by excessive nutrients and sedimentation. Management actions must address erosion and nutrient contamination that directly affect major spawning areas, must protect and restore riparian areas, floodplains, and stream channels, and must improve water quality.

Response: We partially agree. Snake River fall Chinook salmon spawn in the lower mainstem Snake River, primarily in the 100-mile reach of the lower Snake River downstream of Hells Canyon Dam. The upper end of the Lower Granite Reservoir is effectively the downstream limit of spawning and early rearing habitat for the ESU, although limited spawning occurs in the tailraces of the Snake River dams below Lower Granite Dam. Some fish also spawn in the lower reaches of major tributaries to the lower Snake River, including the Tucannon, Grande Ronde, Clearwater, Salmon, and Imnaha Rivers. While nutrients and sediment are not considered major limiting factors in the mainstem spawning areas, they may be limiting to some extent in the tributary spawning areas. Where we have supporting information, we have identified these limiting factors (see Plan, Section 5.2.5). The Plan also includes actions to protect and improve these habitats (see Plan, Section 6.2.1).

Tributary Habitat

Comment: Add actions regarding identifying potential spawning and rearing habitats in the lower reaches of tributaries that are currently inaccessible to fall Chinook salmon adults and restoring and protecting these areas; determining why the lower Tucannon River mainstem spawning areas are not used by natural-origin spawners; and eliminating point-source contamination.

Response: The Plan incorporates such actions (see Plan, Section 6.2.1, Management Strategy 2, Actions 2-10 and 2-23 through 2-26, and actions under Management Strategy 8).

Comment: Limiting factors for spawning and rearing in the lower Clearwater River continue to be high water temperature, increased sediments, entrapment and stranding, and excessive nutrients and pollution.

Response: The Plan identifies these as limiting factors in the Clearwater River and includes actions to maintain and improve spawning, incubation, rearing, and migration conditions by continuing ongoing actions and implementing additional actions as appropriate in the lower Snake tributaries (see Plan, Section 6.2.1, Management Strategy 2, Actions 2-10 and 2-23 through 2-26).

Comment: It is too early to conclude that the Tucannon River should be considered unoccupied. In recent years this river has been estimated to produce smolts, with some adult returns. Natural production from the Tucannon River is likely contributing to the population. The conclusion should be that the level of production and occupation in the Tucannon River is uncertain.

Response: The Plan notes that fish spawn in the Tucannon but that recent surveys indicate that nearly all natural spawners in the Tucannon are hatchery-origin returns (Milks and Oakerman 2014). The lack of natural-origin spawners in the Tucannon suggests that this major spawning area (MaSA) is not currently very productive or, alternatively, that natural-origin fish from this area stray at high rates to other MaSA's. Due to lack of evidence of natural-origin spawners, the Tucannon MaSA is not considered occupied based on the ICTRT's criteria for evaluating spatial structure as a VSP parameter (see Plan, Chapter 4). The Plan includes actions to evaluate whether habitat potential in the Tucannon River basin can be enhanced (see Plan, Section 6.2.1, Management Strategy 2, Actions 2-23 and 2-26).

Comment: The Plan ignores the thermal problems in late summer and early fall in the lower Snake River upstream of the Clearwater River, especially in very low flow, hot years such as 2015.

Response: We disagree. The Plan contains extensive discussion of temperature effects on both adults and juveniles in the lower mainstem Snake River from below Hells Canyon Dam to the Salmon River (see Plan, Section 5.2.2.1) as well as in the lower mainstem Snake River from the mouth of the Salmon River to Lower Granite Dam (see Plan, Section 5.2.3.1). In addition, Section 5.2.4.1 of the Plan discusses the 2015 events when unusually hot weather, combined with low snow pack, resulted in very high tributary and mainstem temperatures in June and July. The Plan also contains actions addressing temperature effects (see, e.g., actions 2.2, 2.3, 2.6, 2.13, and 2.19). Monitoring needs related to temperature effects in the Columbia and Snake River mainstems are also identified (see, e.g., monitoring objectives 4, 5, and 8 in Chapter 7 of the Plan).

Mainstem Habitat

Comment: Add actions regarding identifying currently inaccessible potential mainstem spawning and rearing habitats in the lower Snake River, increasing access to them, and restoring and protecting them; restoring riparian vegetation in mainstem corridors; maintaining flow that will facilitate juvenile outmigration; and eliminating point source contamination along the mainstem.

Response: Except for very limited areas in the tailraces of some lower Snake River hydropower projects, spawning habitat has been eliminated by reservoirs in the lower Snake River downstream of the confluence with the Clearwater River. Adult fall Chinook salmon have full access to these limited mainstem spawning areas. Juvenile subyearling Chinook salmon are known to rear in the reservoirs for weeks (fish from earlier migrating Snake River spawning areas) to months (primarily fish from the later migrating Clearwater spawning areas) before migrating downstream to the ocean (see Plan, Section 2.6). Subyearling fall Chinook salmon survival rates have been substantially improved by structural modifications and operational changes at the dams. Based on available information, neither current flows nor riparian vegetation conditions are substantively limiting production or survival in the lower Snake River. Current operations that manage flows and moderate summer temperatures to provide functional rearing habitat appear to be relatively effective. Toxic pollutants (from point sources or otherwise) have been identified as a limiting factor, and the Plan also identifies associated actions (see Plan, Chapter 6, Management Actions 2.20 and 2.22, and Management Strategies 8 and 10, for example). Altered food webs have been identified as an uncertainty that would benefit from future research.

Estuary Habitat

Comment: The recovery plan should address stressors in estuarine habitat, the Columbia River plume, and the ocean. Shallow-water habitat in the Columbia River estuary should be protected and restored to provide suitable habitat for yearling and subyearlings. Management actions should address cumulative impacts of dredging, diking, construction, channelization, and filling as well as pollution from industrial contamination. Loss of habitat and reduced water quality in estuarine areas is particularly important for yearlings and subyearlings because they use this habitat to transition from freshwater to saltwater environments where food availability and water chemistry changes substantially.

The Plan should include actions regarding removal of jetties, dikes, and levees that block access to off-channel habitats; restoring degraded estuarine habitat with endemic seagrass vegetation; restoring and creating access to off channel habitat; eliminating point source contamination to the estuary; and restoring vegetation in marshes and wetlands.

Response: Removal of jetties, dikes, and levees is addressed in the Plan, Management Strategy Section 6.3.1.3, Action 3-3 (“Continue to breach, lower, or relocate dikes and levees to improve connectivity to off-channel floodplain habitats”). The largest such project implemented to date is the 920-acre Columbia Stock Ranch Floodplain Reconnection, located along the Oregon shore near the City of St. Helens and acquired by the Columbia Land Trust, Bonneville Power Administration (BPA), and the U.S. Army Corps of Engineers (Corps) in 2012. The Corps and BPA are developing a restoration plan for this site that includes multiple breaches of the 33-foot levee to return 344 acres of floodplain to the river. This will jump-start lost ecological processes including the production and flux of insect prey to the mainstem where they are eaten by Snake River fall Chinook salmon on their way to the ocean. Numerous projects of this type have been implemented by private and governmental organizations over the last decades and efforts to find more opportunities are ongoing.

With regard to restoring estuarine habitat with endemic seagrass vegetation, in other coastal estuaries, subyearling salmon and their prey commonly rear in seagrass meadows, but subyearlings from the Snake River fall Chinook salmon ESU spend less than a week transiting in the 150-mile Columbia River estuary. Small numbers are caught in shallow habitat along the margins, including larger channels leading into wetland sites (Roegner and Teel 2014), but there is no evidence that this species spends weeks to months rearing in wetland habitat or in seagrass beds. In addition, freshwater outflow limits the potential for seagrass habitat to areas near the mouth of the river. Judd et al. (2009) surveyed a relatively extensive eelgrass bed (*Zostera marina*) in Baker Bay, WA, and smaller beds in Youngs Bay, OR, and at Desdemona Sands (a shoal in the mainstem channel); all these sites are located downstream of the Astoria-Megler Bridge. They transplanted eelgrass to five "suitable" sites, but only two of the experimental beds had survived when surveyed a year later, a small net gain. The limited extent of suitable habitat in the lower Columbia River and short estuarine residence time for this species reduces the value of seagrass restoration as a management strategy in this recovery plan.

Regarding identifying, restoring, and creating access to currently blocked and highly degraded, but potentially high-quality, off-channel habitats for juveniles, this is also covered in the Plan (see Plan, Section 6.2.1.3, Management Strategy 3, Action 3-3 ["Continue to breach, lower or relocate dikes and levees to improve connectivity to off-channel floodplain habitats"]).

Eliminating point source contamination from agriculture, public, industrial, and commercial sources around the Columbia River estuary is covered in the Plan as well (see Plan, Section 6.2.1.8, Management Strategy 8 ["Continue RM&E to gain a better understanding of potential negative impacts from exposure to toxic pollutants and develop actions to reduce potential effects of toxic contaminants on natural-origin Snake River fall Chinook salmon"]).

11. Harvest

Comment: Natural Snake River fall Chinook salmon are overharvested. The Plan should develop strategies to reduce harvest of natural-origin fish from this ESU. Total exploitation rates should be lower than 40 percent. Fishing should be prevented above Lower Granite Dam.

Response: We disagree. Harvest impact rates on natural-origin Snake River fall Chinook salmon have been reduced substantially since the ESA listing in 1992. Average total exploitation rates from 1989 to 1992 were 70 percent and from 2003-2012, they were 46 percent (see Plan, Chapter 5). Further, since ESA listing, natural-origin returns have increased substantially, as also noted in the Plan and in the most recent 5-year status review (NWFSC 2015; NMFS 2016b). At this time, we believe the existing harvest rate schedule is consistent with recovery goals for this ESU. In addition, the Plan includes actions to update harvest management plans and frameworks as needed based on new information (see Plan, Section 6.2.1.5, Management Strategy 5, Actions 5-3 through 5-5).

Comment: Fishery management plans should improve tools for estimating abundance of hatchery vs. natural-origin salmon. In addition, fishery regulations must be strictly enforced.

Response: We agree. See the Plan, Section 6.2.1.5, Management Strategy 5, Action 5-2, which calls for accurate estimates of harvest of natural-origin Snake River fall Chinook salmon in both ocean and river fisheries.

Comment: The Plan should define and appropriately use terms related to harvest (such as incidental harvest, exploitation rate, harvest rate, etc.)

Response: We agree. We have defined the terms and edited the Plan to use them consistently and appropriately.

Comment: The strategy for harvest management should consider how harvest related to the proposed John Day mitigation program might affect Snake River fall Chinook salmon.

Response: We agree. The Plan includes an action to "Ensure that potential changes to downriver fisheries in response to the John Day mitigation program do not result in harvest of natural-origin Snake River fall Chinook salmon that is inconsistent with ESA recovery objectives" (see Plan, Section 6.2.1.5, Management Strategy 5, Action 5-5).

Comment: The Plan should include actions to (1) reduce total harvest of fall Chinook salmon to 20% relative to the 1988-1993 base-period; (2) reduce fishing for fall Chinook salmon by unauthorized recreational fishers; and (3) eliminate harvest of fall Chinook salmon above Lower Granite Dam.

Response: We disagree. Regarding suggested action (1), the current management regime, which called for a reduction of 30 percent relative to the 1988-1993 base period has allowed for a substantial increase in natural-origin returns, and NMFS believes that the current harvest rate schedule is consistent with recovery goals for this ESU. In addition, the Plan includes actions to update harvest management plans and frameworks as needed based on new information (see Plan, Section 6.2.1.5, Management Strategy 5, Actions 5-3 through 5-5). Regarding suggested action (2), parties to the *U.S. v. Oregon* management agreement coordinate enforcement activities in order to minimize unauthorized fishing activity. We do not currently have information indicating that unauthorized recreational harvest is a significant problem, so it is unclear that the action is needed. In addition, Action 5-2 (see Plan, Section 6.2.1.5, Management Strategy 5) calls for accurate estimates of harvest of natural-origin Snake River fall Chinook salmon in both ocean and in-river fisheries, and additional actions identify the need to update harvest management plans and frameworks as appropriate based on new information (see Plan, Section 6.2.1.5, Management Strategy 5, Actions 5-3 through 5-5). Regarding suggested action (3), NMFS has trust obligations to various tribal entities located above Lower Granite Dam. Eliminating harvest above Lower Granite Dam would not allow us to adequately meet our trust obligations to those tribal entities. Therefore, we disagree that this action is appropriate, nor is it warranted biologically, given that harvest rates in place since listing have allowed for substantial increases in natural-origin returns.

Comment: The harvest rate schedule for Snake River fall Chinook salmon under the 2008-2017 *U.S. v. Oregon* management agreement should be reviewed. The schedule limits harvest rates based on abundance of natural-origin Chinook salmon. However, given the high proportions of hatchery-origin spawners (which boost the abundance of returning adult natural-origin fish) and uncertainties about the productivity of the natural-origin fish, the schedule may not be adequate.

Response: We believe that the current harvest rate schedule is demonstrably adequate, as it has allowed for substantial increases in natural-origin abundance to occur. We agree with the commenters that the harvest rate schedule should be revisited as appropriate in the future, and the Plan includes such actions (see Plan, Section 6.2.1.5, Management Strategy 5, Actions 5-3 and 5-4).

Comment: The Plan indicates the option of allowing additional selective, recreational harvest above Lower Granite Dam. The Plan should consider more intensive selective fishing for hatchery-origin Chinook salmon in a program designed to increase harvest, reduce the proportion of hatchery-origin spawners (pHOS), supply natural-origin broodstock, and increase the proportionate natural influence (PNI), perhaps in a new tribal fishery applying passive collection techniques (i.e., traps). If such a fishery did not achieve biological objectives, NMFS and co-managers should consider other options for removing excess hatchery-origin fish to reduce pHOS to less than 30 percent. In the short-term, managers should consider harvest of hatchery-origin Chinook salmon from fishways at Snake River dams to begin to raise PNI and promote local adaptation.

Response: NMFS is currently working with state, tribal, and federal co-managers to develop strategies for reducing pHOS and increasing PNI for Snake River fall Chinook salmon. Regarding specific suggestions made by this commenter, selective fisheries would need to be monitored so that encounters of released fish were well documented, and this approach may not be either practicable or feasible at this time. In addition, the question of where harvest impacts take place, and by what gear, is more a question of allocation and opportunity than of conservation.

Harvest policy establishes limits on overall impacts to wild populations, and harvest strategies serve as tools (e.g., selective gear types used in terminal-area fisheries) to implement the policy. Tools must ensure that impacts remain within the bounds of allowable catch defined in harvest policy. Harvest policy in the Columbia River basin is tied to both the terminal and pre-terminal areas, meaning that rates of harvest on wild fish are accounted for throughout the geographic range of Snake River salmon. Determining in what fisheries impacts to wild fish occur is one of many allocation decisions co-managers make in determining access to harvestable surpluses of fish.

Tribes make their own decisions about commercial, ceremonial and subsistence, and platform fisheries, about the gear types to use in each, and about when and where to open fisheries. Selective fishing, as described in this comment, does not generally align with cultural principles of the tribes. Once a fish is captured, the tribes view release mortality, regardless of how low, as wasteful, and therefore operate full retention fisheries. Sorting in fishways at dams may be inconsistent with tribal values and authority over tribal fishing techniques and is not necessary to achieve the recovery scenarios identified in the Plan.

12. Hatcheries

Comments: Commenters offered several suggestions for how to reduce the proportion of hatchery-origin spawners (pHOS) in the ESU, increase the proportion of natural-origin fish used in hatchery broodstock (pNOB), and improve the natural population's "proportionate natural influence" (PNI), while promoting both local adaptation and sustainable fisheries. They suggested that reprogramming of hatchery fish releases could be an important action under any of the potential recovery scenarios. Specific suggestions included:

- acclimating and releasing juvenile fish away from critical spawning habitats (and thereby reducing straying);
- releasing more fish directly from hatchery sites from which returning adults can be collected;
- establishing performance objectives for hatchery program pNOB and for PNI in the natural population, and then establishing a propagation framework that adjusts hatchery production numbers to ensure achieving performance objectives;
- ensuring that management and recovery actions promote local adaptation of the population such that it can become more productive and self-sustaining in the wild by reducing hatchery influences on the wild population;
- implementing fisheries that are selective for hatchery-origin fish above Lower Granite Dam; and
- achieving a PNI (for a species relying on a single population) of 0.67 at a minimum.

Response: NMFS is working with co-managers to explore these and other possibilities for hatchery management actions that will meet the recovery objectives identified in the Plan. At present, these discussions focus primarily on ways to implement the "Placeholder Recovery Scenario" in the Proposed Plan (called "Scenario C" in the final Plan). The Snake River fall Chinook hatchery programs are a keystone of the *U.S. v. Oregon* management process, and decisions regarding whether and how to modify these programs must be made in conjunction with state and tribal co-managers. We are making every effort to make these decisions in a manner that harmonizes ESA recovery needs with our other legislative mandates and with tribal treaty and trust responsibilities.

Comment: The proposed increased hatchery production under the John Day mitigation agreement, and the expected increased fall Chinook returns and fisheries in the Columbia River and ocean, are not adequately evaluated or considered for their potential adverse impacts on natural returns of Snake River-origin fall Chinook salmon, or for the potential of additional middle Columbia Basin hatchery production straying into the Snake River. The Plan's strategy for hatchery management should include consideration and evaluation of these potential impacts.

Response: We agree. An increase in fall Chinook salmon releases of over 10 million is currently being implemented at several sites in the middle Columbia River basin. The final recovery plan incorporates actions to address the potential impacts of these new releases on Snake River fall Chinook salmon (see Plan, Chapter 6, Management Strategy 5, Action 5-5, "Ensure that potential changes to downriver fisheries in response to the John Day mitigation program do not result in harvest of natural-origin Snake River fall Chinook salmon that is inconsistent with ESA recovery objectives," and Management Strategy 7, Action 7-6, "Ensure that adult returns from other existing and new hatchery programs (e.g., the John Day mitigation program) do not stray above acceptable levels into the Snake River," and Chapter 7, Monitoring Objective 12, "Determine the influence of hatchery programs on the viability of Lower Snake River natural-origin fall Chinook salmon").

Comments: Several commenters questioned NMFS' treatment of hatchery fish in the Snake River fall Chinook salmon ESU. In general, these commenters held that because the listed Snake River fall Chinook salmon ESU includes hatchery fish, the Plan must address the ESU as a single cohesive unit, including hatchery and non-hatchery fish. Specific points on this issue included the following:

- Because the ESU includes both hatchery and non-hatchery fish, there should be no distinction between hatchery and non-hatchery fish for purposes of determining whether the ESU has recovered.
- There is little doubt that hatchery production has benefited the recovery of the ESU.
- The suggestion that productivity declines with increasing abundance of hatchery fish is misleading. Productivity, as defined by the Plan, declines with increasing abundance regardless of the origin of the fish. Extinction risk declines with higher abundance and lower productivity.
- Higher abundance from hatchery fish reduces the impacts of predation, improves the survival rates of the ESU, and enhances productivity.
- Only naturally spawned salmon are (or will be) used as broodstock, which will prevent negative impacts from hatchery-influenced selection.

Response: We disagree. The Plan addresses the ESU as a single, comprehensive unit, and adequately and comprehensively considers hatchery fish, clearly identifies the benefits and risks of hatchery production, and lays out a strategic approach for maintaining those benefits and addressing adverse effects. Treatment of hatchery fish in the Plan is consistent with best available science, NMFS policy, and legal requirements.

Pursuant to our Hatchery Listing Policy, we base status determinations for Pacific salmon and steelhead on the status of the entire ESU, including any hatchery fish included in the ESU.[1] Consistent with section 2(b) of the ESA (16 USC 1531(b)), we apply the Hatchery Listing Policy in support of the conservation of naturally spawning salmon and the ecosystems upon which they depend (70 FR 37160).

The Hatchery Listing Policy recognizes that the presence of hatchery fish within an ESU can positively affect the overall status of the ESU, and thereby affect a listing determination by contributing to the abundance and productivity of the natural populations in the ESU, improving spatial distribution, serving as a source population for repopulating unoccupied habitat, or conserving genetic resources of depressed natural populations in the ESU. Conversely, a hatchery program managed without adequate consideration of its adverse effects can affect the status of an ESU by reducing the reproductive fitness and productivity of the ESU, or reducing the adaptive genetic diversity of the ESU.

Snake River fall Chinook salmon hatchery programs have contributed to the substantial increases in abundance and spawning escapement for the ESU. However, the large fraction of naturally spawning hatchery fish complicates assessments of the ESU's productivity. The broad distribution of naturally spawning hatchery fish has increased the ESU's spatial distribution, although the distribution of natural-origin production in the extant population is unknown due to the prevalence of naturally spawning hatchery fish. The Lyons Ferry Hatchery program has preserved genetic diversity in the past during critically low years of abundance. However, the ESU-wide use of a single hatchery broodstock may pose long-term genetic risks, impede the expression of life-history diversity, and limit adaptation to different habitat areas.

We do not interpret the ESA as requiring that we assess extinction risk based on the abundance, productivity, spatial-structure, or diversity of hatchery fish. Furthermore, failing to account for the biological distinctions between hatchery and naturally spawned salmon would be inconsistent with our obligation to base ESA listing decisions on the best scientific and commercial data available. Our Hatchery Listing Policy has been upheld by the federal courts as a reasonable interpretation of the ESA (*Trout Unlimited v. Lohn*, 599 F.3d 946 (9th Cir. 2009)). The court stated that "the ESA is primarily focused on natural populations," and that "the [plaintiff's] demand for 'equal treatment' of hatchery and naturally spawned fish during the [status] review process simply finds no grounding in the statutory text of the ESA" (Id. at 957, 960). The argument that we must treat hatchery and natural fish equally in evaluating the status of the ESU is inconsistent with our policy and with the court's decision.

Comment: The Plan's analysis of domestication is inaccurate and unsupported by the best available science. NMFS fails to acknowledge that, starting in 2016, domestication of Snake River fall Chinook salmon broodstock will no longer be a concern. Parentage Based Tagging (PBT), which began at the Nez Perce Tribal Hatchery in 2008 and at Lyons Ferry Hatchery in 2011, will effectively enable genetic identification of all untagged Snake River Hatchery returns

[1] Hatchery stocks are included in an ESU if the stock's level of genetic divergence relative to the local natural populations(s) is no more than what occurs within the ESU (70 FR 37160).

starting in 2016. Any untagged fish not found in the PBT database after that time would either be returns from out of basin strays or Snake River natural-origin fish, and the majority of these are expected to be natural origin. Considering that broodstock comes from fish captured above Lower Granite Dam, broodstock will consist only of fish that were spawned throughout the Lower Snake and Clearwater Rivers and that survived in the wild.

Response: We disagree with this comment on three points. First, PBT is a monitoring measure. While it will help us to better understand hatchery/wild dynamics, it does nothing to change those dynamics. Second, domestication does not cease to be a risk just because wild fish are used as broodstock. Third, the comment assumes that broodstock used for the hatchery programs would be 100 percent natural-origin returns, but sampling limitations at Lower Granite Dam limit the ability to achieve that level. The Plan recognizes that a more realistic, albeit ambitious, range of natural-origin contributions to hatchery broodstock would be 30 to 45 percent. Current thinking is that the risk level is a function of the proportion of those fish in the broodstock and the proportion of hatchery fish on the spawning ground, a value called proportionate natural influence (PNI). Even at the PNI level that the Hatchery Scientific Review Group feels is acceptable for a population of high conservation value (67 percent), domestication does not cease to occur; it merely stabilizes at an acceptable level. The provisions in the Plan for considering the potential benefits and risks associated with different levels of hatchery influence on natural spawning represent the best available science on the topic.

Comment: Available information, including aerial surveys, radio telemetry studies, and estimated age composition, should be incorporated into the analysis of uncertainty related to the impacts of hatchery-produced fish. The Plan acknowledges the aerial surveys but does not incorporate the results in a useful way.

Response: NMFS is working with co-managers to develop and apply better methods for evaluating relationships between hatchery and natural fish on the spawning grounds. We agree that as these approaches are developed they need to consider these uncertainties.

Comment: The effects of hatchery-influenced selection may be less in fish with subyearling life histories.

Response: It is true that nearly all the available relative reproductive success data come from studies of fish with yearling life histories. The NMFS-led Recovery Implementation Science Team (RIST 2009) also concluded that effects may be less severe in species with subyearling life histories, but cautioned that the difference may not be large. Even if fitness loss from hatchery influence is less in fish with subyearling life histories than in fish with yearling life histories, this does not mean it is negligible in subyearlings. Also, it is important to bear in mind that a considerable proportion of hatchery-produced Snake River fall Chinook salmon juveniles are released as yearlings. Moreover, yearlings occur naturally in sizable proportions.

Comments: Several comments, summarized below, related to marking of hatchery fish so that they can be identified and managed in terms of proportions of hatchery fish spawning naturally or broodstock collection:

- The Plan discusses efforts to reduce out-of-ESU hatchery strays at downstream dams. Removal of out-of-basin strays depends on their being identifiable. How is this accomplished and how effective is the method?
- External marking of hatchery-origin fish is essential for proper hatchery broodstock collection, management and measurement of pHOS, selective fisheries to reduce pHOS and increase escapement of natural-origin Chinook, and to allow for measurement of population productivity. With the current 75 percent mark rate and 70 percent pHOS, about 18 percent of spawning fall Chinook salmon are not discernible as hatchery- or natural-origin. This situation will frustrate the above management needs, and NMFS should include 100 percent marking of hatchery-origin Chinook as an action in the Plan.

Response: Currently, out-of-ESU strays that are identifiable by marking are readily and effectively screened out of broodstocks, but no large-scale screening of the run is possible at present. We assume that there will always be some level of strays, but exactly what the acceptable level should be and how it will be accomplished is a detail that will be worked out in future management and implementation of the recovery plan.

The commenters are correct that over 20 percent of current Snake River fall Chinook salmon hatchery releases are not marked or tagged, and thus not immediately identifiable as natural or hatchery origin. This means that, based on tag expansions and run reconstructions, about half of the unmarked fish at Lower Granite Dam are of hatchery origin. While 100 percent marking/tagging would facilitate hatchery/natural fish management, parentage-based tagging will enable better understanding of hatchery/natural composition post-season.

Comment: The word "supplementation" is used in many places throughout the Proposed Plan to describe hatchery production, augmentation, or artificial production. "Supplementation" has both a generic meaning (i.e., artificial production) and a specific meaning (i.e., use of hatchery production of native stock to enhance the native population in the natural environment). The term as used in the Proposed Plan causes confusion. It should be defined and used in the Plan only where appropriate, to refer to enhancing natural populations in the natural environment.

Response: We agree. The document has been revised to use the term *supplementation* only where it is appropriate (i.e., to denote the production and release of hatchery fish intended to spawn naturally to increase the abundance of the naturally spawning population).

13. Hydropower

Limiting Factors

Comments: A number of commenters suggested additions or modifications to the discussion of limiting factors and threats related to hydropower. Specific comments included the following:

- **Comment:** Hydropower systems along the Snake River and tributaries cause juvenile and adult losses affecting abundance, productivity, spatial structure, and diversity. The recovery plan should explicitly address all of these impacts and include strategies that directly address these issues, including blocked habitat, poor fish passage, alteration of flow and fish migration velocity, inundated habitat, reduction of water quality, altered thermal regime, higher predation, and loss of channel structure.

  Response: The Plan includes a full and extensive discussion of limiting factors attributable to hydropower dams and operations (see Plan, Chapter 5). The Plan also includes strategies and actions that address these limiting factors (see Plan, Chapter 6, Section 6.2.1.2). The actions are based primarily on efforts taken to date to improve juvenile and adult passage conditions and survival rates through the mainstem Columbia and Snake River dams; to improve flow conditions for spawning and migration; to address temperature issues; and to address the other factors raised by the commenters. These actions have resulted in substantial improvements to survival and increases in abundance of returning adults, and they are being managed adaptively to maintain and increase their effectiveness. Hydropower system operators also fund much of the research (including many of the papers cited by commenters as supporting evidence) conducted throughout the Columbia Basin to better understand these issues so that actions can be designed to address them. Federal, state, tribal, and power company representatives and fish managers will continue to work together in multiple technical fora on these issues.

- **Comment:** The Plan should address the extent to which the hydropower system has enhanced habitat conditions for, and distribution of, non-native species that may adversely affect fall Chinook salmon rearing and migration by reducing or altering food supplies, increasing predation, or causing other ecosystem changes.

  Response: While reservoir environments favor some species over others and have enhanced habitat conditions for certain non-native species, dams have little effect on the spread of non-native species like smallmouth bass, which are found in many free-flowing river systems throughout the Snake and John Day River basins. Current understanding of the presence of non-native species and their potential effects on the food web upon which juvenile fall Chinook salmon rely is described in the final recovery plan, and the Plan includes related strategies and actions and research and monitoring objectives and questions (see Plan, Chapter 5, Section 5.4; Chapter 6, Section 6.2.1.6, and Chapter 7).

Transportation

Comments: We received a number of comments related to the Snake River fall Chinook salmon juvenile transportation system. These comments included the following specific points:

- The Proposed Plan does not take into account negative factors associated with transportation of juveniles. Emerging data continues to find that fish transportation does not appreciably improve smolt-to-adult (SAR) survival and increases stray rates. Current survival estimates for transported juveniles are not derived from direct measures and fail to account for factors known to affect subyearling Chinook salmon (e.g., bypass impacts, latent mortality, and adult straying).

- The final Plan should note the role that summer spill has played in recent survival improvements, and explore whether additional changes in spill and/or surface passage or other FCRPS configuration/operations could further improve survival and SARs.
- The Proposed Plan does not reference the Comparative Survival Study (CSS) (McCann et al. 2016), which addresses how well transported fish survive after release.

Response: Discussions of transportation of juveniles in the final Plan have been updated to include the results of the recently completed 6-year transport study funded by the U.S. Army Corps of Engineers (Smith et al. 2017) and the results of the Comparative Survival Study of PIT-tagged salmon and steelhead (McCann et al 2016). Managers will use the results of these studies and all other available information in making future management decisions.

NMFS agrees that the installation of surface passage routes and increased summer spill (since 2005) at the three Snake River collector projects have clearly improved conditions (and survival rates) for subyearling fall Chinook salmon. There is no evidence that Snake River fall Chinook salmon are straying at significant rates compared to other, non-transported stocks. That said, recent studies indicate that transport now appears to be of little benefit until the late summer and fall. Based on these results, NMFS, in coordination with the U.S. Army Corps of Engineers and other management agencies, may consider future changes to the transport regime. Managers will continue to evaluate and use all available information to adaptively manage the transportation program for Snake River fall Chinook salmon.

Actions

We received a number of comments related to the sufficiency of the hydropower actions included in the Proposed Plan, as well as specific suggestions for additional actions. These specific comments are summarized below. (For comments on the sufficiency of actions in the Plan in general, see below under "Sufficiency of Management Actions.")

Comment: The Plan incorporates hydropower actions from the 2008 FCRPS biological opinion reasonable and prudent alternative and actions being implemented as part of the relicensing of the Hells Canyon Complex by FERC, pursuant to the Federal Power Act. These actions are insufficient hydropower actions for recovery of the ESU.

Response: Given the improvements in the status of Snake River fall Chinook salmon since ESA listing, and the comprehensive and adaptive nature of the hydropower actions included in the Plan, we disagree that the actions in the Plan are insufficient. The Plan includes a full and extensive discussion of limiting factors attributable to hydropower dams and operations (see Plan, Chapter 5, Section 5.2). The Plan also includes strategies and actions that address these limiting factors (see Plan, Chapter 6, Section 6.2.1.2). The hydropower actions are based primarily on efforts taken to date to improve juvenile and adult passage conditions and survival rates through the mainstem Columbia and Snake River dams; to improve flow conditions for spawning (fall/winter) and migration (spring); to address summer temperature issues; and to address other hydropower effects. These actions have contributed to the substantial improvements in abundance and productivity of Snake River fall Chinook salmon since the ESA listing, and the actions are being managed adaptively to maintain and increase their effectiveness. The Plan also identifies potential additional hydropower actions, along with key uncertainties related to these actions and their effects on Snake River fall Chinook salmon. In addition, it highlights the importance of research to better understand the mechanisms that have contributed to improved status of the ESU so that any additional actions can be targeted effectively. As noted above, the FCRPS action agencies are also in the process of preparing an EIS pursuant to NEPA that will analyze the effects of alternatives for operating the hydropower system, including different system operations and additional structural modifications to existing projects to improve fish passage. The EIS is expected to be complete in 2021, and NMFS expects that the analysis of alternatives evaluated in the EIS will further inform management for the Snake River fall Chinook salmon ESU. The final Plan has been updated to reflect the ongoing NEPA analysis (see Plan, Chapter 2, Section 2.8.1). Federal, state, tribal, and power company representatives and fish managers will continue to work together in multiple technical fora to understand and address hydropower effects.

Comment: NMFS should convene collaborative work sessions to review hydropower impacts to Snake River fall Chinook salmon, develop recovery actions adequate to address those impacts, and conduct the analysis necessary to ensure the proposed actions are sufficient. At least three hydropower strategies will be needed: (1) modify and operate Snake River projects to provide mainstem Snake River adult holding and spawning habitats sufficient to provide the spawning capacity needed for recovery; (2) modify and operate Snake River projects to provide mainstem Snake River pre-smolt rearing habitats and dispersal among mainstem habitats to provide sufficient early juvenile rearing capacity for recovery; and (3) modify and operate the FCRPS hydropower system to assure smolt-to-adult survivals (SARs), measured from and returning to Lower Granite Dam, are sufficient to achieve and sustain recovery.

Response: NMFS' view is that these strategies are already being adequately addressed through the actions identified in the Plan (both the ongoing actions and the potential additional actions) and as evidenced by the recent performance of the fish. The recovery plan has laid out an adaptive management framework (see Plan, Section 6.1.3) and a collaborative implementation framework (see Plan, Section 8.1) that should provide opportunities to evaluate the need for and efficacy of additional management actions needed for recovery.

Comments: The Plan should incorporate additional actions related to hydropower effects in the lower mainstem Snake River (below the Hells Canyon Complex), including consideration of dam removal, improved fish passage, and maintenance of flows during migration.

Response: We disagree with the need to incorporate actions related to dam removal or breaching at this time (see comments above, under "Breaching of Lower Snake River Dams"). Regarding the other actions suggested by commenters for the lower Snake River mainstem, as also noted previously, numerous actions implemented by multiple entities, including multiple actions related to effects of hydropower dams and operations, have contributed to the significant increases in abundance and productivity that this species has experienced since the ESA listing in 1992. These actions include cool-water releases from an upstream storage project (Dworshak Dam), structural and operational modifications to mainstem Snake and Columbia River hydropower projects, and fall/winter flow management of the Hells Canyon Complex to enhance Snake River fall Chinook spawning and incubation habitat. We agree that these actions need to continue unless or until new information demonstrates that changes are warranted to maintain or continue to improve the species status, and that dam operators and managers should evaluate opportunities to modify actions to further improve survival rates and to provide safe and effective passage.

Comment: The Plan should incorporate additional actions related to hydropower effects in the middle mainstem Snake River (above Hells Canyon Dam), including evaluating removal of the Hells Canyon Complex, passage feasibility studies, habitat restoration planning above Hells Canyon Complex, reintroduction feasibility studies, and water quality monitoring in potential spawning and rearing areas to determine temporal trends.

Response: Most of the issues raised by this commenter have been identified, and many have been addressed, in the Hells Canyon Complex relicensing application and FERC's 2007 final Environmental Impact Statement. We agree that feasibility studies related to passage, habitat restoration, and reintroduction should proceed and would need to be completed in order to determine what approaches would most likely support efficient and effective upstream and downstream passage as well as functioning and adequately productive habitats in the middle mainstem Snake River. The final recovery plan identifies these as actions. It also describes the substantial challenges that would need to be overcome to reestablish a second, viable population above the Hells Canyon Complex of dams (see Plan, e.g., Chapter 3, Section 3.1.2). While one of the three potential ESA recovery scenarios included in the Plan would require reestablishing a viable population above the Hells Canyon Complex, we note in the Plan (see Section 3.2.1) that at this time we see Scenario C, which would achieve recovery with the extant population, as the most likely pathway to recovery. In any event, we continue to support reestablishing significant natural production above the Hells Canyon Complex as a broad-sense recovery goal (see Plan, Sections 3.1.2, 3.2.1, and 6.1). At this time, NMFS disagrees that there is a need to evaluate removal or breaching of the Hells Canyon Complex.

Comment: Flow effects of the hydropower system need to be adequately managed to support spawning, rearing, and juvenile and adult migration to achieve high viability. Actions must also address altered temperature regimes that have created warmer than historical temperatures in rearing areas. Effects of dams on sedimentation dynamics (i.e., retaining sediments that reduce turbidity and thereby increase the probability of predation and competition) should also be addressed.

Response: Many operations have been developed and continue to be implemented to protect spawning and rearing fall Chinook salmon. These actions, which are incorporated into the recovery plan, include the Idaho Power Company's fall Chinook spawning flow program, ongoing evaluations of stranding and entrapment pools, and proposals to improve dissolved oxygen and reduce total dissolved gas as part of the Hells Canyon Complex relicensing application. They also include the use of Dworshak Dam by the U.S. Army Corps of Engineers to release cool water during the summer months to provide adequate adult passage and juvenile rearing conditions in the lower Snake River. Releases from the Hells Canyon Complex ensure that Fall Chinook salmon redds in mainstem Snake River habitat are not being dewatered. The RM&E plan for Snake River fall Chinook salmon (see the Plan, Chapter 7 and Appendix B) identifies the need for monitoring to allow assessment of potential climate change impacts. Effects of dams on sedimentation dynamics are also fully described in the Plan (see, e.g., Sections 5.2.2.1, 5.2.2.3, and 5.2.4.3). Reduced turbidity during the spring and summer migration period due to the mainstem dams has been acknowledged in both the Hells Canyon Project relicensing process and in the FCRPS section 7 consultation processes. While increased turbidity could be considered as a means of reducing predation, potential unanticipated consequences to the food web that presently supports rearing fall Chinook would also need to be considered.

Comment: The Proposed Plan does not adequately describe actions that could achieve favorable water temperatures in the basin or the targets that must be achieved to restore water quality suitable for fall Chinook salmon. A more comprehensive analysis on the effects of federally authorized uses on water temperature in the basin should be incorporated in the final recovery plan.

Response: The Plan includes an extensive discussion of effects of temperature on both adult and juvenile fall Chinook salmon, including altered temperature regimes as a result of the hydropower system and possible temperature effects of climate change (see, e.g., Section 5.2.2.1, 5.2.31., and 5.2.7). The Plan also includes actions and monitoring needs regarding temperature (see, e.g., Chapter 6, actions 2.2, 2.3, 2.6, 2.13, and 2.19, and Chapter 7, monitoring objectives 4, 5, and 8). We conclude that while the temperature regime for Snake River fall Chinook salmon has been altered by the hydropower system, more information is needed to assess the effect of the current temperature regime on the abundance and productivity of fall Chinook salmon. While the temperatures are not always optimum, and while some Upper Hells Canyon reach spawners may be negatively affected, existing studies specific to Snake River fall Chinook salmon do not point to temperature as a significant limiting factor. Recent high abundance of naturally produced Snake River fall Chinook salmon spawning in the area also suggests that this is not currently one of the more significant limiting factors for the ESU. We also note that Snake River temperatures are projected to increase in the future due to global climate change. It is uncertain how, or to what extent, these changes will affect Snake River fall Chinook salmon or to what extent these fish might compensate behaviorally (e.g., later adult migration timing or earlier juvenile migration timing). This underscores the importance of continuing monitoring to detect changes and assess their effects on Snake River fall Chinook salmon.

The Environmental Protection Agency (EPA) and the states are responsible for developing water quality standards for temperature. EPA has completed ESA section 7 consultation on state water quality standards for temperature in Oregon (NMFS 2015). As part of implementing the biological opinion on Oregon standards, EPA is identifying the locations of cold-water refugia and actions to protect and restore the refugia and improve the survival of fish using them (see

Plan, Chapter 6, action 2.19). On August 10, 2017, EPA sent a letter to the states of Washington, Oregon, and Idaho regarding a 2000 Memorandum of Agreement (MOA) between EPA and those states that describes mutual commitments for development of a total maximum daily load for temperature pollution in the Columbia and Lower Snake Rivers. EPA requested that the states and EPA convene to discuss possible amendments to the existing MOA to facilitate development of the TMDL going forward. Actions to address temperature as a result of these and other processes could potentially improve temperature conditions for adult fall Chinook salmon or their gametes and could potentially contribute to offsetting future climate change impacts. However, based on our current understanding of temperature effects on Snake River fall Chinook salmon, it is not clear that a comprehensive temperature analysis is needed to address recovery needs for Snake River fall Chinook salmon at this time.

14. Implementation

Comment: Will the Columbia Basin Partnership be connected with or inform implementation?

Response: The Columbia Basin Partnership (CBP) Task Force, a task force organized under NMFS' Marine Fisheries Advisory Committee (MAFAC), will be making recommendations to MAFAC on common goals and helping to define a shared path to long-term salmon recovery. The CBP Task Force will recommend a shared vision for Columbia Basin salmon and quantitative goals to meet conservation needs and provide harvest opportunities. While the focus of the Partnership is on integrating existing goals and on broad-sense goals that go beyond ESA recovery, it is possible that the CBP Task Force could enhance the recovery plan by identifying efficiencies and building more support for implementation.

Comment: We encourage NMFS to secure the necessary capacity to fulfill the role of providing coordination, facilitation, and administrative support for the Science Team and the Policy Group.

Response: We agree that these are important functions, and we will support them to the extent practicable. We will also strive to coordinate meetings at times and locations in conjunction with other relevant meetings to conserve staff resources, and save travel time and expenses whenever possible.

Comment: We recommend that NMFS convene a technical, co-manager workgroup to finalize and prioritize the recovery scenarios and management and RM&E actions, prior to issuing the final Plan.

Response: We agree that prioritization of management and RM&E actions is crucial to successful implementation of recovery plans and to achieving recovery. However, because prioritization is an iterative process that must be informed by adaptive management, we consider it part of implementation rather than part of plan development. Similarly, evaluation of which recovery scenario is most feasible from both policy and technical perspectives will be ongoing throughout implementation, although we have noted in the final Plan that at this time the scenario with Natural Production Emphasis Areas (Scenario C) appears to be the most likely pathway to recovery. NMFS has suggested two new implementation groups specific to Snake

River fall Chinook salmon. These groups, which are described in Chapter 8 of the Plan, would play communication and coordination roles during these future implementation tasks. We envision these groups (the Snake River Fall Chinook Salmon Science Team and the Snake River Fall Chinook Salmon Policy Group) as having broad membership and providing input into prioritization and implementation of the management and RM&E actions in this Plan.

Comment: The new coordinating groups recommended in the Proposed Recovery Plan (the Snake River Fall Chinook Salmon Science Team and the Snake River Fall Chinook Salmon Policy Group) need to have active membership and participation by the Upper Snake River Tribes Foundation member tribes as this recovery plan is implemented.

Response: NMFS is committed to meeting our tribal treaty and trust responsibilities, and we welcome the participation of the Upper Snake River Tribes and other interested tribes in the implementation process.

15. Life-cycle Modeling

Comment: Life-cycle models are a valuable tool to develop, evaluate, and prioritize potential research, monitoring, and evaluation and recovery actions. A comprehensive life-cycle model could identify recovery criteria for a selected scenario prior to recovery action implementation. Such a model should take into account all components of the life cycle and include all life-history strategies; a less prevalent contemporary life-history strategy may have a greater recovery benefit.

Response: We agree that life-cycle models are an important tool for Snake River fall Chinook salmon recovery. The recovery strategy calls for developing these models – and, in fact, a multi-stage life-cycle model is currently in development for Snake River fall Chinook salmon that will improve our understanding of the combined and relative effects of actions addressing different threats across the life cycle (see Plan, Section 6.1). An initial version of this state/space Bayesian model is under review by the Independent Scientific Advisory Board (ISAB). The initial version includes juvenile and adult life stages as well as both major life-history patterns (subyearling and yearling) of Snake River fall Chinook salmon. Including subarea production relationships is targeted for the next iteration of the model. This model will provide a valuable framework for systematically assessing the potential response of Snake River fall Chinook salmon to alternative management strategies and actions under alternative climate scenarios. This information will inform decisions about the most effective management strategies and direct future RM&E priorities to improve future decision making. The information will also be used to assess the status of the ESU as a whole, and interactions between different spawning areas.

16. Non-native Fish Species

Comment: The presence of nonindigenous fish species poses one of the greatest threats to the persistence of healthy native fish populations. Most listings cite non-native fishes as the cause of endangerment, typically involving changes in the food web, increases in predation and competition, and infection by non-native pathogens or parasites.

Response: We have updated the section of the Plan dealing with predation (see Plan, Section 5.4.1) based on a literature review of the most recent literature on predation by birds, marine mammals, and fish (including non-native fish species). The Plan also includes recovery strategies and actions (see Plan, Section 6.2.1.6) addressing this source of predation, along with related monitoring objectives.

17. Predation, Competition, and Disease

Comment: The following additional actions related to predation, competition, and disease should be added to the Plan:

a. Improve fishing regulations for non-native fish predators such as pikeminnow, smallmouth bass, channel catfish and walleye.
b. Determine whether hatchery-origin salmon is outcompeting natural-origin fish for resources such as food and refuge.
c. Reduce potential stress and physical injuries that lead to diseases of fall Chinook salmon by implementing operational changes in hydropower systems, fish ladders, fish passages, holding ponds, fish transports, etc.

Response: Regarding suggested action "a," both Oregon and Washington have removed size and bag limits for walleye, smallmouth bass, and channel catfish in their sport fishing regulations, and there have never been size or bag limits for (native) pikeminnow. Regarding suggested action "b," the Plan includes RM&E actions related to the influence of hatchery programs on natural-origin Snake River fall Chinook salmon (see Plan, Chapter 7, Monitoring Objective 12: "Determine the influence of hatchery programs on the viability of Lower Snake River natural-origin fall Chinook salmon"). Regarding suggested action "c," substantial improvements have been made in hydropower system operations that benefit juvenile and adult migrants in the Snake and Columbia Rivers (see Plan, Chapter 2, Section 2.8.1, and Chapter 5, Section 5.2), and we expect that these actions will continue.

Comment: There are a lot of important steps that we can take to aid the salmon that do not involve wasting tax dollars to scapegoat and kill sea lions for consuming some fish out of the Columbia River below Bonneville Dam. The impacts on ESA-listed wild salmon from dams, habitat loss, harvest, non-native fish & plants, hatchery fish, warm water, drought, unscreened culverts & water diversions, deforestation, and toxic pollutants have greater effects and should be addressed.

Response: We have updated the section of the Plan dealing with predation, competition, and disease based on a review of current literature on predation by birds, marine mammals, and fish (see Chapter 5, Section 5.4). As the Plan notes, marine mammals prey on winter and spring migrating adult salmon and steelhead in the lower Columbia River and as they attempt to pass over Bonneville Dam; Snake River fall Chinook salmon for the most part are not migrating when California sea lions are most abundant, and are therefore less affected by that species than spring Chinook salmon or steelhead. They are, however, vulnerable to Steller sea lions in the tailrace of Bonneville Dam during August through October. We do not have information at this time to indicate that predation by marine mammals is a significant limiting factor for Snake River fall Chinook salmon, although the Plan does incorporate monitoring actions related to this issue. Impacts of marine mammal predation on Columbia and Snake River spring Chinook salmon and steelhead are addressed in the recovery plan for those species. We agree that the other factors mentioned in the comment affect Snake River fall Chinook salmon and the Plan addresses these limiting factors with site-specific management actions and RM&E actions.

18. Prey Availability

Comment: Prey availability that directly affects growth and survival is an important limiting factor for juvenile salmon across the Snake River basin and tributaries. Growth rate of natural-origin fall Chinook salmon continues to decline in Lower Granite Reservoir because of changes in prey availability and competition for food resources with hatchery-origin salmon and non-native species. Thus, competition for food availability, especially of juveniles with other species, non-native species, and with hatchery-origin salmonids should be fully addressed in the recovery plan.

Response: The issue of prey availability as a limiting factor for naturally produced fall Chinook salmon is described in the Plan (see Chapter 5, Section 5.4.2) and identified as a research need (see Plan, Chapter 7 and Appendix B).

19. Prioritization of Limiting Factors

Comment: Chapter 5 appears to provide a comprehensive suite of factors and threats limiting the viability of Snake River fall Chinook salmon. Given the causal factors for the ESU's ESA listing, one can reasonably assume that the primary threats for Snake River fall Chinook are: (1) the mainstem Columbia River and Snake River hydropower system including the Hells Canyon Complex and (2) hatcheries. Chapter 5 should clarify that the hatchery programs were established to mitigate for harvest opportunities lost as a result of the hydropower system. All other threats and limiting factors (e.g., harvest, predation/competition, disease, toxics, tributary habitat) should be classified as secondary or tertiary priorities.

Response: We have not explicitly ranked or prioritized limiting factors and threats in this Plan. Each species faces a unique set of threats across its life cycle, and it is also possible that the relative importance of threats will change over time. It is not necessary to reduce each threat to some specified level of impact but rather for the impact of threats in the aggregate to have been addressed to the point that delisting is not likely to result in declines in the species status (see Plan, Sections 3.2.3 and 3.3). Furthermore, as noted in the Plan, a key element of the recovery strategy is to gain a better understanding of the driving factors for the recent improvements in abundance and productivity, and to evaluate other critical uncertainties regarding the status of the Lower Snake River population and the combined and relative effects of limiting factors and threats (see Plan, Section 6.1). These steps will help to refine the recovery strategy for the ESU in a way that will be more effective than prioritizing limiting factors and threats at this stage would have been.

20. Recovery Goals

We received general comments on the goals in the Plan, as well as comments related specifically to the broad sense goals incorporated into the Plan and the ESA recovery goals, objectives, scenarios, and biological viability and threats criteria in the Plan.

General

Comment: It is unclear what NMFS' recovery goals are for Snake River fall Chinook salmon, as the information presented is contradictory. For example, several of the broad-sense recovery goals refer to existing programs whose primary purposes are mitigation for hydropower system impacts.

Response: We have edited Chapter 3 of the Plan to clarify distinctions between broad sense recovery goals and the ESA recovery goals, objectives, and criteria, as well as the relationships between them. We have also edited Chapter 3 to clarify the relationships between ESA recovery goals, objectives, scenarios, and biological viability and threats criteria. Finally, we added additional detail to the discussion of scenarios to highlight tradeoffs and uncertainties among them and to explain which scenario we think is most likely to lead to recovery in the fastest time frame, based on our current understanding (see Plan, Section 3.2.1).

Broad Sense Recovery Goals

Comments: Several commenters did not support the inclusion of broad sense goals into the recovery plan. The specific concerns raised in these comments were generally that the broad sense goals exceed the requirements of the ESA. In one case the commenters stated that the Plan "seeks to have the recovery plan and those affected by it…bear the added burden of these additional social and cultural objectives." Some of these commenters requested that NMFS remove all references to broad sense goals from the Plan. Others stated that broad sense goals should be identified in their appropriate forums and pursued under different mandates, including those associated with the federal government's tribal trust responsibility.

A commenter raised questions regarding broad sense goals and NMFS' tribal treaty and trust obligations. This commenter's view was that NMFS was using the recovery plan to add additional obligations on entities that do not have treaty and trust obligations to the tribes. Other commenters asked for clarification regarding broad sense recovery goals, including the relationship between broad sense recovery goals and ESA delisting goals, between broad sense goals and hatchery mitigation goals, and between broad sense goals and artificial propagation. On this last issue, the commenters saw a tension between the broad sense goals and artificial propagation, stating that because the draft plan considers hatchery fish to be a threat, there is an inherent inconsistency with broad sense goals, which have specific targets for hatchery production. These commenters requested that "the bias against hatchery fish be eliminated."

Response: We have edited Chapter 3 of the Plan to clarify distinctions between the broad sense recovery goals identified in the Plan and the ESA recovery goals, objectives, and criteria, and the relationship between the two. However, we disagree with the comments requesting that broad sense goals be removed from the Plan and the comments that viewed a tension between broad sense goals and artificial propagation.

As the Plan states, the goal of ESA recovery plans is for listed species to reach the point at which they no longer need the protection of the Endangered Species Act and thus can be delisted. NMFS' salmon and steelhead recovery plans have also typically discussed state, tribal, and local desires to address salmon recovery interests that go beyond ESA delisting to include social, economic, and ecological values. The plans are explicit that these "broad sense goals" are not required for ESA delisting but instead would achieve even lower risk levels for naturally produced salmon and steelhead across their native range. The broad sense goals would provide social, cultural, and economic benefits including harvest opportunities that are sustainable over the long term, enhanced ecosystem function, and salmon recovery that respects local customs and benefits local communities and economies.

In the case of the Snake River fall Chinook salmon recovery plan, NMFS included broad sense goals related to the vision statements developed by subbasin planners, to mitigation for production lost due to hydropower development in the Columbia and Snake Rivers, and to the reintroduction of Snake River fall Chinook salmon above the Hells Canyon Complex. NMFS is supportive of broad sense recovery goals. As stated in the Plan (see Chapter 3), we believe that achieving viability of natural populations and delisting is consistent with broader goals to reach a stable, long-term condition in which fall Chinook salmon are thriving and harvestable. Upon delisting, NMFS will work with co-managers and local stakeholders, using our non-ESA authorities, to pursue broad sense recovery goals while continuing to maintain robust natural populations. In some situations, it is also appropriate to consider broad sense goals in designing ESA recovery strategies and scenarios. For instance, in this Plan, NMFS has identified a recovery scenario that is compatible with tribal treaty and trust obligations regarding harvest and with maintaining hatchery production at levels consistent with current mitigation goals (i.e., Scenario C – see Chapter 3).

The broad sense goals are not developed in the ESA recovery planning forum. They are developed in appropriate local or other forums and identified in the recovery plan. The broad sense goals do not impose an additional burden beyond ESA delisting.

For discussion of issues related to hatchery fish and the commenters' view that the plan has a "bias against hatchery fish," see above, under "Hatcheries."

ESA Delisting Goals and Objectives

Comment: The Plan misstates the role that the Plan will play in a delisting decision. For example, the Plan states that "in order for the [Snake River fall Chinook] salmon to be delisted, the ESA recovery objectives ... should be met." This statement suggests that the Plan, and the criteria set forth in the Plan, are binding on NMFS with respect to any delisting decision. This is not the case. It is well established that recovery plans are not binding on agencies' delisting decisions. *Friends of Blackwater v. Salazar*, 691 F.3d 428, 432-434 (D.C. Cir. 2012); see also *Fund for Animals v. Rice*, 85 F.3d 535, 547 (11th Cir. 1996). As the D.C. Circuit Court stated in

Friends of Blackwater v. Salazar: “A [recovery] plan is a statement of intention, not a contract. If the plan is overtaken by events, then there is no need to change the plan; it may simply be irrelevant.” In short, the Plan should clearly explain the role that it will play in the recovery and eventual delisting of the species. At a minimum, the Plan should specify that it is not binding on NMFS with respect to any decision to delist the Snake River fall Chinook salmon ESU.

Response: NMFS agrees with the opinion in *Friends of Blackwater v. Salazar*, where the court stated that “a recovery plan, even if not binding . . . provides ‘objective, measurable criteria’ by which to evaluate the Service’s progress toward its goal of conserving the species.” 691 F.3d at 434. The Plan does not state that the criteria “must be met” to achieve delisting. The *Friends of Blackwater* opinion does not suggest that NMFS could not delist a species based on the attainment of recovery criteria. NMFS intends to use the delisting criteria to evaluate progress toward conserving the species, consistent with the requirements of ESA section 4. We have refined Chapter 3 of the Plan to clarify the ESA recovery goals, objectives, scenarios, and biological viability and threats criteria.

Comment: The ESA sets forth five factors that NMFS must take into account when deciding whether to delist a species. 16 U.S.C. § 1533(a)(1); see also 50 CFR § 424.11(d)). The determination of whether to delist a species must be based on any one or a combination of these five factors: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) any other natural or manmade factors affecting the species' existence. Any delisting decision must be based on these factors, and these factors only. Any other criteria set forth in a recovery plan are advisory only. The Plan is not clear with respect to the relationship between the five statutory factors and the other criteria set forth in the Plan. See *Friends of Blackwater v. Salazar*, 691 F.3d at 432-434; *Fund for Animals v. Babbitt*, 903 F.Supp. at 111-113.

Response: NMFS believes that the Plan complies with the requirements of ESA section 4(f), in that it includes “objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of [section 4(f)], that the species be removed from the list.” 16 U.S.C. 1533(f)(1). We have added language to the Plan clarifying the relationship between the biological viability criteria, which help us determine whether the threats have been addressed to the point where the species is no longer threatened with extinction, and the threats criteria, which describe the conditions under which the five listing factors can be considered to be addressed or mitigated, and under which adequate conservation measures are in place to protect the species.

Comment: The goal of the Plan, as stated in Chapter 3, is problematic for the following reasons:

- Differences between the terms "self-sustaining" and "viable" are ignored. The term "self-sustaining" excludes human intervention, whereas the term "viable" does not. These terms are used interchangeably throughout the Plan. Because the ESU by definition includes hatchery fish, the term "self- sustaining" is not appropriate to use in the Plan.

- A "viable population" in the Plan is defined as one that has a "negligible extinction risk" over a "100-year time frame," making "extinction risk" the clear metric to be used in determining whether the goal (viable population) has been achieved. Yet, in developing recovery objectives, NMFS largely ignored "extinction risk," and instead chose to focus on several biological factors – abundance, productivity, spatial structure, diversity, and threats – without regard to the presence of the hatchery component of the ESU. Moreover, in estimating the "extinction risk" for the ESU, NMFS only considered the first two factors – abundance and productivity. Spatial structure, diversity, and threats were not included in the calculations and therefore did not influence the metric.
- It is not appropriate to marginalize the role of artificial propagation in maintaining the viability of the ESU. The Plan does not acknowledge any positive effects of hatchery-origin fish on extinction risk. The unscientific prejudice is against artificial propagation.

Response: We disagree. ESA section 4(f) requires a recovery plan to contain objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of section 4(f), that the species be removed from the list. 16 U.S.C. 1533(f)(1). NMFS believes that the Plan complies with that requirement. In our recovery plans for salmon and steelhead, we identify biological and threats criteria for delisting. These criteria reflect the recovery goal and objectives stated in Chapter 3 of the Plan. NMFS intends to use the recovery criteria to evaluate progress toward conserving the species, consistent with the requirements of ESA section 4. NMFS interprets the ESA as requiring that a species be self-sustaining (i.e., not dependent *at the ESU level* on artificial propagation), in order for it to be considered recovered under the ESA. Self-sustaining does not mean that there must be no hatchery influence; it means that we must be confident that the ESU would persist into the future with a negligible risk of extinction without inputs of hatchery-origin spawners. In our view, an ESU cannot be viable without also meeting the definition of self-sustaining. Artificial propagation may be used to benefit threatened and endangered species, and a self-sustaining population or ESU may include artificially propagated fish, but must not be dependent upon artificial propagation to achieve its viable characteristics. Artificial propagation may contribute to recovery, but is not a substitute for addressing the underlying factors (threats) causing or contributing to a species' decline. A self-sustaining, viable population or ESU must demonstrate high enough natural productivity and capacity to withstand year-to-year fluctuations in environmental conditions, it must have sufficient spatial structure and life-history diversity to avoid extinction due to potential short term catastrophic events, and artificial production must be at low enough levels that future adaptation is predominated by natural selection.

The recovery objectives and biological and threats criteria incorporated into the Plan are consistent with the ESA recovery goal and with the way NMFS evaluates extinction risk of Pacific salmon ESUs using the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. The risk of extinction of an ESU depends upon the abundance, productivity, spatial structure, and diversity of the naturally spawned populations comprising it. We evaluate these VSP factors by evaluating the probability that the population exceeds a given risk category: "very low" risk corresponds to less than a 1 percent risk of extinction over a 100-year period; "low" risk corresponds a 1 to 5 percent risk of extinction over a 100-year period; "moderate" risk corresponds to a greater than 5 to 25 percent risk of extinction over a 100-year period; and "high" risk corresponds to a greater than 25 percent risk of extinction over a 100-year period (ICTRT 2007). The extinction risk status of the individual populations within an ESU depends upon the populations' abundance, productivity, spatial structure, and diversity. Abundance and productivity need to be sufficient to provide for population-level persistence in the face of year-to-year variations in environmental conditions. Spatial structure of populations should provide for resilience to the potential impact of catastrophic events. Diversity should provide for patterns of phenotypic, genotypic, and life-history diversity that sustain natural production across a range of conditions, allowing for adaptation to changing environmental conditions. When evaluating ESU status, we evaluate the five ESA listing factors, relative to the threats criteria incorporated into recovery plans.

Finally, the Plan, including the approach to assessing ESU extinction risk relative to the delisting criteria and the recovery strategy and actions, is consistent with our hatchery listing policy and acknowledges the positive effects that hatchery fish can have, as well as the risks they pose to natural fish. As the Plan states, hatchery production of salmon can affect all four VSP parameters and be a source of both benefits and risks to natural-origin salmonid populations. Most simply put, hatcheries can benefit small populations but can become a risk to productivity and diversity in larger populations, in some cases becoming limiting factors.

Comment: The draft plan fails to recognize that the only relevant metric for ESA delisting is extinction risk. The potential recovery scenarios do not relate to extinction risk, nor are the recovery objectives adequately tied to extinction risk. NMFS should (1) eliminate references to "self-sustaining" populations, (2) revise the recovery goal to reference only "negligible risk of extinction over a 100-year time frame," (3) designate "risk of extinction" as the sole metric by which all recovery objectives are measured, and (4) revise the recovery objectives to include clear "risk of extinction" benchmarks. Extinction risk of the ESU should be assessed with a modified, comprehensive, VSP-like analysis.

Response: We disagree. ESA section 4(f) requires NMFS to include in recovery plans, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of [section 4(f)], that the species be removed from the list. 16 U.S.C. 1533(f)(1). NMFS believes that the Plan complies with that requirement. The ESA recovery objectives in the Plan define general characteristics relative to abundance and productivity, spatial structure, diversity, and threats to the species that are consistent with the ESA recovery goal. The ESA recovery, or delisting, criteria are the "objective, measurable criteria" (ESA section 4(f)) that NMFS will use to evaluate species status and determine whether the species should be removed from the list of threatened and endangered species. NMFS uses biological viability criteria, which describe population or demographic parameters, to help evaluate progress in ameliorating the threats, which relate to the five listing factors in ESA section 4(a)(1). NMFS intends to use the delisting criteria to evaluate progress toward conserving the species, consistent with the requirements of ESA section 4.

NMFS developed potential criteria and metrics for measuring viability characteristics relative to each of the potential recovery scenarios. These criteria were developed by NMFS regional and science center staff with input from co-managers. They are consistent with the ESA recovery objectives in Section 3.1.1 and with the ICTRT's recommendations and guidelines, summarized in Section 2.5; they also reflect policy choices that are consistent with the ICTRT's recommendations and guidelines. The potential metrics are based on best available information but illustrate example metrics and not absolute standards. Over time, they may evolve as RM&E results emerge and as our scientific understanding improves. For the Middle Snake River population in Scenario A, for example, the *criteria* are that the Middle Snake River population would have a combination of natural-origin abundance and productivity that exhibits a 50 percent probability of exceeding the viability curve for viable status. There are related criteria for spatial structure and diversity. The *metrics* correspond to the criteria and provide example values for abundance and productivity that would correspond to a point relative to a viability curve that would be consistent with the *criterion*.

We assess the extinction risk of Pacific salmon ESUs using the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. The risk of extinction of an ESU depends upon the abundance, productivity, geographic distribution, and diversity of the naturally spawned populations comprising it. McElhany et al. 2000 concluded that measures of these four parameters are "reasonable predictors of extinction risk (viability)." We evaluate these VSP factors by evaluating the probability that the population exceeds a given risk category: "very low" risk corresponds to less than a 1 percent risk of extinction over a 100-year period; "low" risk corresponds a 1 to 5 percent risk of extinction over a 100-year period; "moderate" risk corresponds to a greater than 5 to 25 percent risk of extinction over a 100-year period; and "high" risk corresponds to a greater than 25 percent risk of extinction over a 100-year period (ICTRT 2007). The viability of the individual populations within an ESU depends upon the populations' abundance, productivity, spatial structure, and diversity. Abundance and productivity need to be sufficient to provide for population-level persistence in the face of year-to-year variations in environmental conditions. Spatial structure of populations should provide for resilience to the potential impact of catastrophic events. Diversity should provide for patterns of phenotypic, genotypic, and life-history diversity that sustains natural production across a range of conditions, allowing for adaptation to changing environmental conditions. When evaluating ESU status, we also evaluate the status of the five ESA listing factors, relative to the threats criteria incorporated into recovery plans.

For discussion related to the term "self-sustaining," see the above comment and response.

Biological Viability Criteria and Metrics

Comment: The criteria given for an ESU to be considered highly viable is "a combination of natural-origin abundance and productivity with a 50 percent probability of exceeding the viability curve for a 1 percent risk of extinction over 100 years." It is unclear what "exceeding a curve" means – falling to the right and above? This implies that having a high probability of exceeding the 1 percent risk curve implies viability. In fact, this criterion, as stated, has a zero likelihood of being met – how often will the probability of exceeding any curve be exactly 50 percent? Such a criterion is difficult to interpret without a clearer presentation of how the variability that produced distribution of risks was generated. It is unclear why two probability statements are needed, rather than incorporating this variability into the risk metric.

Response: Exceeding a viability curve means demonstrating a combination of abundance and intrinsic productivity that falls on or above that curve.

Comment: The recovery document proposes that 10-year geometric mean spawner abundance and 20-year geometric productivity be used to assess recovery. The time dimension of the productivity metric seems somewhat arbitrary. Perhaps the approach could be extended to provide general guidance across species.

Response: Delisting criteria and our assessment of species status are based on the best available scientific information and incorporate the most current understanding of the ESU and the threats it faces. NMFS is required to assess species status at least every five years, and will consider this comment in future status assessments. As the ICTRT described, the choice of a 10-year geometric mean for abundance and a geometric mean of low-to-moderate productivities over the most recent 20 years represents a balance between trying to capture current population characteristics and recognizing that there are large scale environmental fluctuations that can dramatically influence annual estimates. We are exploring alternative analytical approaches to estimating these important population parameters. In addition, as this recovery plan is implemented, new information will likely become available that improves our understanding of the status of populations and ESUs and of threats, their impacts, and the extent to which they have been ameliorated. If appropriate, NMFS will review and revise delisting criteria in the future based on new information.

Comment: Use of the Hanford Reach data to produce Figure 3-1 and associated ICTRT VSP criteria raises questions. The underlying data for natural-origin spawners in the Lower Mainstem Snake are not provided and it is unclear whether male as well as female spawners are included, how natural-origin spawners are identified, and what modeling approaches were used to produce the VSP curves and proposed criteria. In general, how can we infer VSP criteria for new spawning areas with different carrying capacities and possibly different productivities? In addition, relying on the large Lower Snake population seems contrary to the goal of identifying productivity at low abundances.

Response: The Snake River fall Chinook salmon viability curves were actually generated using only the Snake River fall Chinook salmon data series. Earlier analyses did include data from the Hanford Reach. The statement regarding use of Hanford Reach data in the caption to Figure 3-1 in the Proposed Plan (now shown in Figure 2-9 and Figure 4-6 in the final Plan) was an error and has been corrected.

Comment: Abundance and productivity requirements for delisting are described as “and” conditions, even though the TRT nomogram suggests a trade-off exists, so this is an inconsistency. It is not reasonable to expect population growth in perpetuity, and levels of acceptable productivity should be lower when abundances are fluctuating around an equilibrium and when trends are less uncertain.

Response: This is the primary reason the ICTRT productivity metric is defined as the expected productivity from parent-spawner escapements at low-to-moderate abundance relative to the minimum abundance threshold for a given population. It is intended as a measure of the resilience of a population to being driven below desired average levels by environmental fluctuations. The Plan recognizes the related problem identified in this comment: that it may not be possible to use the simple ICTRT metric for intrinsic productivity if spawner abundances over 20 years are consistently higher than a population's minimum abundance threshold. The Plan identifies alternative approaches for estimating or confirming productivities in that circumstance.

Comment: It is unclear why a recovered state for Snake River fall Chinook salmon would require a dominant subyearling life-history pattern to be stable or increasing. Given the altered habitat of today's template relative to pre-development, a different mix of life-histories should be anticipated. Embracing and managing toward an increase in a yearling life history is consistent with the philosophy of understanding that ecological systems are dynamic and that the best approach to conservation does not fight against the ability of species to evolve in response to changing habitats, rather than attempting to enshrine maladapted species in a non-existent past.

Response: We have modified the wording of this criterion slightly. The ICTRT noted the need to recognize adaptations but also noted that if the adaptations were to human-induced changes, and if a new life-history type totally dominated, then there might be cause for concern. At a minimum, major life-history patterns that were there historically need to be represented. Since the subyearling life-history type was the dominant pattern in the ESU historically, the ICTRT's approach would assign low risk for life-history diversity if it is stable or increasing.

Comment: The final Plan should include explicit expression of the Minimum Abundance Threshold (MAT) (3,000 adult spawners) defined by the ICTRT in the abundance/productivity recovery criteria. The MAT is a key component to assessing viability and is included in viability curves as shown in Figure 3-1 of the draft plan.[2] All viability scenarios should include a minimum abundance threshold of 3,000 adult natural-origin spawners as one of the viability criteria.

Response: We agree that the ICTRT minimum abundance threshold of 3,000 natural-origin spawners is a key element of the viability criteria for the Lower Snake River population. The higher observed minimum abundance requirements associated with the single-population recovery scenarios are the direct result of requiring a high or very high level of certainty of exceeding 3,000 spawners. For example, the standard error (lognormal) associated with the recent 10-year geometric mean number of spawners was 0.19, which means the observed estimate would need to be greater than approximately 4,250 to result in an 80 percent chance of exceeding 3,000.

[2] Note that the Snake River fall Chinook salmon viability curves, shown in Figure 3-1 in the Proposed Plan, are shown in the final Plan as Figures 2-9 and 4-6.

Comment: A hatchery program operated to achieve a 67 percent proportion of natural influence is not achievable under current trapping constraints for the hatchery programs. A very large proportion of the adult returns would need to be handled to achieve such a constraint and still maintain age-specific broodstock targets at Lower Granite Dam.

Response: As noted in the Plan, achieving the overall viability objectives with the single extant population requires either a major overall reduction in hatchery fish on the spawning grounds above Lower Granite Dam (Scenario B) or a substantial reduction in hatchery proportions in one or more Natural Production Emphasis Areas (Scenario C).

Comment: The population metrics with a recommended 10-year geometric mean abundance goal of more than 4,200 natural origin spawners should have more discussion or explanation of why the MAT or minimum abundance goal is not higher (such as 5,000-6,000). These higher goals would be consistent with numerous population conservation papers that recommend more than 5,000 naturally reproducing adults (and some recommend 10,000 or more) to maintain abundance, demographic characteristics, and genetic diversity for long-term sustainability. The higher number would also be conservative to account for uncertainties regarding the success of proposed actions, changes in ocean conditions, climate change, and the ability to monitor the population response over time with a high degree of accuracy. A higher natural abundance goal would also help reduce the high pHOS levels that are identified as a risk to the population.

Response: The ICTRT minimum abundance recommendations were based on the summary provided in McElhany et al. 2000 and further reviews of the general conservation literature (ICTRT 2003 and 2007). McElhany et al. 2000 noted that, given the approximate 4-year life cycle of salmon, "a breeding population of approximately 417 (based on the methods of Franklin 1980 and Soule 1980) to 4,170 (based on the methods of Lande 1995) is necessary." The ICTRT-recommended minimum threshold for Snake River fall Chinook salmon is in the higher end of this range.

Threats Criteria

Comment: We received a number of detailed comments regarding the wording of specific components of the threats criteria.

Response: We considered these comments and made changes in the text of the Plan as we deemed appropriate. In addition, we adjusted several of the habitat-related threats criteria to be more specific to Snake River fall Chinook salmon.

21. Recovery Strategy

Comment: The final Plan should describe a clear and strategic plan and set of actions that would move the ESU to viability and delisting. The draft plan relies heavily on modeling and evaluation recommendations that are not likely to lead to improved status of the ESU.

Response: The Snake River fall Chinook salmon ESU is unique in that the status of the ESU has improved markedly since the ESU was listed in 1992. NMFS attributes these improvements to actions that have improved survival through the hydropower system, reduced harvest in ocean and mainstem fisheries, lowered predations rates, and increased natural production in remaining habitats through hatchery supplementation, including many actions that have been implemented through ESA Section 7 requirements. Precisely because of the contribution of these actions in improving the status of the ESU, NMFS has called for those actions to continue into the future to maintain the progress made to date.

In addition, because at this time there are critical questions regarding the productivity of the natural population and the primary drivers of the recent increases in abundance and productivity, it is not possible at this time to identify with certainty exactly what additional actions are needed.

We have clarified and focused the recovery strategy in the final Plan, noting that it is centered on (a) maintaining recent improvements; (b) using life-cycle modeling, research, and monitoring to confirm the factors driving recent increases in abundance and improve our understanding of the combined and relative effects of limiting factors and recovery actions; and (c) using that improved understanding to identify the most beneficial additional actions. This approach is especially important for this ESU precisely because of the extent to which it has improved in status and because of the nature of the remaining questions about its status and what is needed to meet the ESA recovery goal and objectives. Research, modeling, and monitoring information is needed to help us better target actions with the most potential to further improve the status of the ESU (see Plan, Section 6.1).

In addition, we have also clarified that a key component of the recovery strategy for the extant population, in addition to continuing the ongoing actions that have contributed to improvements in the ESU's status, is the additional actions identified in Section 6.2.1.7 for hatchery management. These actions will inform key questions about the species productivity and diversity.

Comment: The recovery strategy for Snake River fall Chinook salmon should aim to rebuild the ESU to a level that, besides being self-sustaining and maintaining sustainable tribal fisheries, provides the needed ecological services that salmon spawning bring to rivers, watersheds, and adjacent ecosystems in terms rich marine nutrients and food supply for other species. The potential benefits to ecosystem function above the Hells Canyon Complex would be large, because the presence of anadromous fish, and the marine derived nutrient subsidy they provided literally shaped the landscape of the Snake River basin.

Response: While ecological services are not explicitly incorporated as a recovery goal, the ESA recovery goal to conserve the ecosystems upon which Snake River fall Chinook salmon depend implicitly includes such ecological services. These types of benefits of salmon would also be enhanced by achieving the broad sense goals that the Plan incorporates and supports.

22. Research, Monitoring, and Evaluation

Comment: Appendix B appears to provide a comprehensive summary of the current RM&E efforts and gaps for Snake River fall Chinook salmon. As presented, however, it appears that each of the RM&E objectives is equally important in terms of implementation. The RM&E plan should include prioritization information for each monitoring objective and an associated timeframe for implementing each monitoring question to ensure a strategic RM&E approach for (1) assessing the ESU's viability, (2) evaluating the status and trends of primary threats, and (3) addressing the most critical data uncertainties and monitoring gaps.

Response: We agree that prioritization of RM&E efforts will be of primary importance, particularly for Snake River fall Chinook salmon, where RM&E is crucial to identifying and designing implementation strategies for additional actions needed to achieve recovery. This prioritization should take place as part of implementing the recovery plan.

Comment: We received a number of specific comments related to Monitoring Objective 1 ("Assess status and trends in abundance and productivity of natural- and hatchery-origin fall Chinook salmon within the Lower Mainstem Snake River population"); Monitoring Objective 2 ("Assess the status of the spatial structure of the Lower Mainstem Snake River fall Chinook salmon population based on current and historically used habitat"); Monitoring Objective 10 ("Determine the effects of disease, predation, prey base, competition, non-native species, and other ecological interactions on the viability of Snake River fall Chinook salmon"); Monitoring Objective 12 ("Determine the influence of hatchery supplementation programs on the viability of the natural population of Snake River fall Chinook salmon"); Monitoring Objective 13 ("Develop life-cycle models to identify and assess potential factors that could limit the viability of Snake River fall Chinook salmon, including effects under current climate change projection scenarios"); and Monitoring Objective 15 ("Determine the feasibility of restoring passage and reintroduction of fall Chinook salmon populations in habitats upstream of the Hells Canyon Complex").

Response: We appreciate these comments. We have considered them and made edits in the text as appropriate. Details related to some of the comments are also addressed below under specific topics and will be considered in Plan implementation as well.

23. Sufficiency of Management Actions

Comments: Some commenters disagreed with NMFS' determination that the Plan identifies actions sufficient to achieve ESA recovery of the Snake River fall Chinook salmon ESU. Specifically, these comments included the view that the Plan relies too heavily on the continuation of ongoing actions (including those whose primary purposes are to meet ESA section 7 requirements to avoid jeopardy), supplemented by modeling and analysis, rather than on a set of clearly identified and additional actions that would improve life-cycle survival and lead to recovery.

Response: We disagree. The Snake River fall Chinook salmon ESU is unique in that the status of the ESU has improved markedly since the ESU was listed in 1992. NMFS attributes these improvements to the combined effects of actions that have improved survival through the hydropower system, reduced harvest in ocean and mainstem fisheries, lowered predations rates, and increased natural production in remaining habitats through hatchery supplementation. Many of these actions have been implemented though ESA section 7. Precisely because of the contribution of these actions to improving the status of the ESU, NMFS has called for them to continue into the future to maintain the progress made to date.

Further, as also noted in the Plan, the recovery strategy for Snake River fall Chinook salmon is threefold. First, we aim to maintain recent improvements in the species' status through ongoing implementation of actions that have contributed to those improvements. Second, we will continue RM&E to confirm the driving factors for the recent improvements in abundance and productivity, and to evaluate other critical uncertainties regarding the status of the Lower Snake River population and the combined and relative effects of limiting factors and threats. Third, through an adaptive management framework, we will use the information gained through RM&E to identify and implement additional actions needed to address the limiting factors and threats to the species and achieve recovery. Gaining an improved understanding of the driving factors for the population's improved status is especially important for Snake River fall Chinook salmon precisely because the ESU has improved so markedly in status and because there are questions related to both the ESU's current biological status (i.e., to the productivity of the natural fish) and the additional actions that will be most effective in continuing to improve the status. We have edited the Plan to clarify the recovery strategy and the questions remaining about status and potential additional actions.

Comment: The Plan should note that a number of recent actions implemented by the stakeholders have improved the status of the ESU.

Response: We agree. The Plan acknowledges the contributions of actions implemented by stakeholders. See, for example, discussion of the Idaho Power Company's programs to provide suitable spawning and incubation conditions and discussion of actions to improve estuarine rearing habitat, restore riparian areas; manage predation; improve abundance through hatchery supplementation; and reduce harvest impacts (see Plan, Chapter 2). In several places in the Plan we have added more detail on these actions, and the Plan repeatedly states that these actions have contributed to recent improvements in Snake River fall Chinook salmon status.

Comment: The Proposed Plan ignores the need for a host of management actions that would be necessary to make habitat in the Middle Snake watershed capable of supporting a viable, self-sustaining fall Chinook salmon population.

Response: We disagree. The Plan identifies limiting factors in the Middle Snake River and points to the feasibility studies and assessments underway as part of the Hells Canyon Project relicensing proceedings. Until more assessments are completed, it is not possible to identify specifically what actions need to be carried out.

24. Toxins

Comments: Federal support for toxic reduction is needed for the Columbia River. The recovery plan management strategies and actions must address chemical contamination, including ways to increase our understanding of effects of pollution in juveniles and adults.

Response: We agree that reduction of toxic pollutants will contribute to recovery of Snake River fall Chinook salmon (see Plan, Chapter 6, Management Strategy 8, actions 8-1 through 8-4, and Chapter 7, Monitoring Objective 14).

25. Tribal Consultation

Comment: Tribal input is a necessary part of the recovery planning process, helping managers effectively consider tribal rights and issues prior to implementing a decision. Without effective consultation, the tribes often bear the burden of conservation activities or the adverse impacts from federal decisions to defer a restoration action, such as the decision to defer requiring fish passage at the Hells Canyon Complex. The tribes input during this process is aimed at ensuring tribal rights and interests are adequately represented in the final decision and to advocate for a common-sense approach to restoring a second population of Snake River Fall Chinook above the Hells Canyon Complex.

Response: NMFS is committed to meeting our federal treaty and trust responsibilities to the tribes. We believe that our partnership with the Pacific Northwest tribes is critically important to the region's future success in recovery of listed Pacific salmon.

26. Viability (Current Status) Assessment

We received a number of comments on the viability assessment (i.e., current status assessment) of the Snake River fall Chinook salmon ESU. We have summarized these below by general topic:

General

Comments: General comments related to the Snake River fall Chinook viability assessment included the following:

- The viability assessment is not based on best available science.
- The Plan fails to take into account relevant scientific information and includes analytical errors.
- The viability assessment in the Plan does not reflect current conditions in terms of changes in survival that might have resulted from recent actions to improve spawning, rearing, and migration.
- The Plan's analysis of threats is incomplete – effects of landslides, toxic spills, dewatering streams, predation, and introduction of lethal disease on extinction risk need to be added to the quantitative viability assessment.
- Request an estimation of long-term extinction risk for the ESU instead of using viability curves.
- Viability assessment should incorporate predation mortality.
- The status assessment ratings for abundance/productivity and spatial structure/diversity should include qualitative ratings of uncertainty.

- Oak Ridge National Lab (ORNL) has used statistical population viability analysis (PVA) methods to establish abundance and productivity metrics that suggest the extant population is viable with risk < 0.02 over 100 years.
- Appendix A requires substantial revision to improve content clarity and specificity regarding the analysis and resulting viability determination.

Response: The viability assessment incorporated into the Plan (see Plan, Chapter 4 and Appendix A; NWFSC 2015; NMFS 2016b) is based on best available science, is a reasonable depiction of the ESU's current status, and is consistent with the approach used for status assessments throughout the NMFS West Coast Region. The ICTRT's methods for evaluating population extinction risk status, which were used in the assessment incorporated into the Plan, were reviewed by the Independent Scientific Advisory Board in 2007 (ISAB 2007).

Regarding the incorporation of relevant information, commenters specifically requested that the Plan incorporate two documents that they stated "illustrate the flaws in the Plan's analysis of exploitation rates and address the concerns in the Plan relating to domestication": (1) the Pacific Salmon Commission Joint Chinook Technical Committee (CTC) 2015 and 2014 Exploitation Rate Analysis and Model Calibration and (2) Adaptive Snake River Broodstock Management (Milks and Arnsberg 2013).

The exploitation rates that NMFS reviewed as part of the viability assessment (and that are being incorporated into the multi-stage life-cycle model that is in development) use the estimated ocean exploitation rates from the CTC analyses reported on in the referenced document, and NMFS CTC members were consulted regarding the estimates.

Regarding the recommendation to consider the information in Milks and Arnsberg (2013) on natural contributions to broodstock, the basic information in that report was available from other sources referenced in the plan (e.g., Milks & Oakerman 2014), and the information was considered in the viability assessment. However, the commenters incorrectly interpret Milks and Arnsberg (2013) to indicate a very high proportion of natural-origin fish in the broodstock used for the Lyons Ferry and Nez Perce hatchery programs. Milks and Arnsberg (2013) was not a detailed review of natural contribution rates to the broodstock but rather was targeted on evaluating progress on one important aspect of broodstocking for the program: the elimination of out-of-basin stocks inadvertently collected from the run at large. As noted in the Plan, that problem was identified as a major concern in the 1990s (see Plan, Section 2.8.8). Milks and Arnsberg (2013) noted that co-managers had been striving to increase the relative contribution of natural-origin returns in recent years but did not include the estimates of natural-origin contribution rates available in other reports cited in the recovery plan. Unmarked fish taken at the Lower Granite Dam trap have been included in Snake River hatchery broodstocks since 2003. Those unmarked fish include a substantial proportion of unmarked returns from the Snake River hatchery program, natural-origin fish, and, likely, a small number of out-of-basin strays. Young et al. (2017) explicitly described recent-year natural-origin brood-year proportions derived from run reconstruction and the results of the first year of full implementation of parental based tagging (PBT). Since 2010, run reconstruction methods indicate that natural-origin broodstock proportions have averaged about 25 percent, varying from 15 to 30 percent. The single-year PBT estimate available for 2016 was 37 percent. This information is routinely discussed at the Snake River Fall Chinook Program Review Symposia and NMFS staff attend these symposia and work regularly with many of the presenters.

Changes in survival that might have resulted from recent actions are not incorporated into the estimates of abundance and productivity because doing so is not practicable with the tools and/or data currently available. In some cases, changes resulting from recent actions would not be reflected yet in adult returns. In the future, we expect that the life-cycle models currently in development will be utilized in status assessments, and these models will make it more practicable to project the benefits of actions more recently implemented.

The Plan contains a comprehensive assessment of limiting factors and threats (see Plan, Chapter 5). It is not technically feasible or practicable to quantify and incorporate all these factors into a single quantitative assessment of extinction risk. The life-cycle models currently in development for Snake River fall Chinook salmon will make this more practicable, and will improve our understanding of the relative and combined effects of limiting factors and threats, as well as of the driving factors that have contributed to recent improvements in species abundance and productivity. Regarding predation, the final Plan does include an updated discussion of effects of predation by birds, fish, and marine mammals on Snake River fall Chinook salmon throughout their life cycle (see Plan, Section 5.4). Estimates of the level of certainty with respect to abundance/productivity are incorporated into the evaluation of status relative to viability curves (see Plan, Chapter 4). Regarding certainty of ratings for spatial structure and diversity, we appreciate this comment and will consider ways to incorporate consideration of uncertainty in future status reviews.

The status information in the recovery plan is based on the best available information, including NMFS' 2016 5-year ESA status review and information provided through the public comment process. Regarding the PVA developed by ORNL, NMFS completes a review of the status of all listed ESUs at least once every five years. At the time of those reviews, we request from the public any information that would be relevant to those reviews and consider it in the reviews. The PVA mentioned was not submitted during our 2015 status review. At the time of the next Snake River fall Chinook status review, we will consider all relevant information submitted as part of that review.

Appendix A has been edited for clarity. We also refer readers to NWFSC 2015. Appendix A was developed while the NMFS 2015 5-year status review was underway so that we could incorporate the most up-to-date information on status into this recovery plan. Appendix A is consistent with, but contains detail not included in, the final 2015 status review (NWFSC 2015).

Viability Curves

Comments: The Plan should include updated viability curves. The ICTRT (2007) stated that the viability curves were to be updated every five years. No such updates are mentioned in the Plan. One commenter was also concerned that, as noted in Appendix A of the Plan, the magnitude of inter-annual variation may be greater now than in the past, and this change in inter-annual variation would not be reflected in the ICTRT 2007 viability curves.

Response: In response to this comment, the NWFSC developed preliminary updates of the viability curves and applied the ICTRT's approach to determining where population status is relative to the curves. This additional analysis captured changes in annual variation. Based on these updated viability curves, the determination of the ESU's current status as viable would not change. We expect that in future status reviews, the viability curves will be generated with or supplemented by results from life-cycle models currently in development.

Comment: No consideration was given to hatchery fish or to the effects of spatial structure, diversity, and threats to the ESU in the creation of viability curves.

Response: As a point of clarification, the basic intent of viability curves is to determine whether a population is demonstrating characteristics that indicate that it could be self-sustaining without hatchery inputs. When calculating current abundance and productivity status relative to a viability curve, any hatchery fish on the spawning grounds are counted as spawners. In simple terms, viability curves are based on an analysis of production of natural returns from total (hatchery- + natural-origin) spawners. Thus, the offspring of hatchery-origin spawners are included in estimates of population productivity. In other words, for estimating productivity, hatchery spawners are treated just like natural-origin fish. Other effects of hatchery fish and of spatial structure and diversity are not incorporated into the viability curves or into an overall quantitative analysis because current analytical techniques and data do not support such an approach. Instead, as noted above, those factors are evaluated separately and integrated into the overall risk rating for the population using a matrix. For criteria regarding treatment of hatchery fish specifically, see ICTRT 2007. This approach is consistent with the approaches used by other TRTs.

Comment: Request NMFS perform separate stock-recruit analysis – one for hatchery fish and one for natural-origin fish – to either estimate viability curves or to estimate current long-term extinction risk.

Response: As described in the Plan, we base assessment of population and ESU status on the concepts presented in McElhany et al. 2000 and, in the case of Snake River fall Chinook salmon, on additional analyses and recommendations from the ICTRT (ICTRT 2007). A fundamental component of our approach is that the hatchery component of a population cannot be considered demographically independent if the fish are intermingled when spawning, as is the case with Snake River fall Chinook salmon. The approach used in this recovery plan is consistent with all TRTs in the Northwest and with McElhany et al. 2000. This approach has been upheld by the Federal courts as a reasonable interpretation of the ESA (*Trout Unlimited v. Lohn*, 599 F.3d 946 (9th Cir. 2009)). The approach suggested by the commenters would not be consistent with the ICTRT's approach, with the approaches of other TRTs, or with McElhany et al. 2000.

Comment: Snake River fall Chinook viability curve was generated based on data from salmon in the Hanford Reach of the Columbia River, and not the Snake River. NMFS should explain why this approach is appropriate.

Response: The Snake River fall Chinook salmon viability curves are not based on Hanford Reach data. The caption on Figure 3-1 in the Proposed Plan was in error and has been corrected (note that this figure appears as Figure 4-6 in the final Plan). The viability curve is fit to Snake River fall Chinook salmon abundance and age-composition data. Hanford Reach data were used at one point to evaluate effects of variability, but that approach is no longer used.

Comment: We received a number of comments related to the derivation of the viability curves (Figure 3-1 in Proposed Plan; shown as Figures 2-9 and 4-6 in final Plan). These comments are summarized below:

- **Comment:** Points for spawner-recruit relationships plotted in the viability curve are not related to the current 10-year geometric mean of abundance (6,418). Rather, they are related to estimates of carrying capacity, which are included in Table 4-3 (page 113, column labeled "Equil"). Points for spawner-recruit relationships should not have been plotted; instead they should have been used to produce new viability curves.

  Response: We disagree. The equilibrium points from spawner-recruit relationships are demonstrating the same aspect of population performance as the 10-year geo-mean. The ICTRT developed extensive guidance on assessing population abundance and productivity, and the viability curves and comparison of current population data to those curves are consistent with that guidance, which was reviewed by the ISAB (ISAB 2007). See ICTRT 2007, Appendix A, for a more detailed description of viability curves and how the ICTRT recommended comparing population status to the curves. The status assessment in the Plan is consistent with the ICTRT’s approach, is robust, and accounts for various aspects of uncertainty in estimating population status relative to abundance and productivity. The ICTRT described ways to modify a stock recruitment fit that would account for variability, and make a stock recruitment fit directly comparable to viability curves. They also developed a simple method for assessing abundance and productivity extinction risk that is more suited for low escapements, and that could be used if not adapting stock recruitment curves per their guidance. The status assessment incorporated into the Plan (and into the NMFS 2016 5-year status reviews) included estimates of status relative to abundance and productivity that were derived using that simple set of recommendations. The status assessment also provides estimates based on fitting modified stock recruitment curves, following the ICTRT’s guidance, and discusses how these related to the simple approach. The assessment also includes an interim analysis to show what expected equilibrium abundance and productivity would be if using stock recruitment curves, and notes that a Bayesian approach is in development but not yet complete. The recent 10-year geometric mean natural-origin spawner abundance used in the simple ICTRT method for characterizing current status directly corresponds to the equilibrium spawner abundance estimate derived from fitting the stock-recruit relationships using the methods described in the assessment. When expressed as steepness, the estimated (return-per-spawner) productivity at a parent-spawner level of 20 percent of the predicted equilibrium escapement, the fitted values from those stock-recruit analyses directly correspond to the intrinsic productivity values derived using the simple ICTRT methodology.

- **Comment:** The point for the 2014 estimate of population status in the graph (Figure 3-1 in Proposed Plan, changed to Figure 4-6 in final Plan) is based on the 20-year geometric mean of spawner-to-spawner ratios from 1991-2010. This is not appropriate because it was not the metric for productivity used to develop the viability curves in the graph.

  Response: This comment is incorrect. The viability curves were generated using representative levels of variability in return rates. The methods outlined by the ICTRT (2007) for estimating current natural abundance and productivity were applied. The assessments of current abundance and productivity using the simple ICTRT methodology followed the guidelines and examples provided by the ICTRT (2007). The ICTRT called for estimating current intrinsic productivity as the expected return-per-spawner at low-to-moderate escapements over a recent 20-year period. Using the simple hockey-stick return-per-spawner approach provided by the ICTRT, that estimate is obtained by taking the geometric mean of brood year return-per-spawner estimates from parent escapements less than 75 percent of the minimum abundance threshold over the most recent 20-year series. Most Snake River fall Chinook salmon return as age 3, 4, and 5-year old's. The year 2010 was the last brood year with a full complement of returns (years 2013-2014) to calculate a return-per-spawner estimate at the time the assessments included in this plan were done. Abundance in viability curves is assumed to be the equilibrium natural-origin abundance in a stock recruitment function and, under the simple ICTRT hockey-stick model approach, is defined as the most recent 10-year geometric mean of natural-origin spawner abundance. See Appendix A of ICTRT 2007, pp. A2-A3, for a more detailed description of the derivation and use of viability curves.

- **Comment:** The caption references "1 % and 5%" viability curves, whereas the figure itself includes "1 % and 25%" viability curves. This inconsistency should be reconciled.

  Response: We have added the Snake River fall Chinook salmon viability curves as Figure 2-9 in the final Plan. Figure 2-9 shows the 1 percent viability line. Figure 3-1 in the Proposed Plan (now Figure 4-6 in the final Plan) is intended to emphasize that the current status of the extant Snake River fall Chinook salmon population is higher than a 1 percent risk of extinction.

Abundance and Productivity

Comment: The Plan's definition of productivity is improper. The Plan appears to contemplate several different definitions for the term, including the following:

- The average number of surviving offspring per parent at very low population size.

- The geometric mean of spawner-to-spawner returns from low-to-moderate escapements over the past 20 years (ICTRT simple method).
- "Steepness"--geometric mean of spawner-to-spawner return when spawning abundance is 20% of equilibrium abundance.
- The geometric mean (median) of the R/S ratio in a spawner-recruit relationship when S is effectively 0.

The fourth definition is the most similar to the standard definition used in fisheries science – the expected value (mean) of the R/S ratio when S is effectively 0 in an adult-to-adult spawner-recruit relationship that includes harvest. However, NMFS never uses this definition in its analysis and did not explain why in the Plan. Instead, NMFS uses the other three definitions, which tend to overestimate extinction risks by underestimating actual intrinsic productivity. Use of spawner-to-spawner relationships to estimate intrinsic productivity instead of adult-to-spawner relationships compounds this overestimation. Use of different spawner-recruit models to build viability curves (hockey-stick model (2007)) and to estimate intrinsic productivity (Beverton and Holt (2015)) also has an effect on subsequent estimates of extinction risk. NMFS should take these different approaches into account and expressly address any unaccounted for biases.

Response: We disagree. There are many different definitions of productivity, and it is important to understand which definition is most appropriate for any given context. Productivity is defined in the ICTRT viability criteria as the expected replacement rate at low-to-moderate abundance relative to a population's minimum abundance threshold. This is a key measure of the potential resilience of a natural population to annual environmentally driven fluctuations in survival. The ICTRT document, which was reviewed by ISAB, explains why TRT viability analyses are based on geometric mean productivity at low-to-moderate abundances. The ISAB noted that "the proposed criteria are based on a well-reasoned and well-supported set of scientific principles and are laid out in a relatively transparent fashion with clear guidelines and examples for their application. . . . The ICTRT encourages the use of multiple approaches (models) as independent lines of evidence to address uncertainties and evaluate risks because there is no single best, unbiased, or universally accepted predictor. The viability criteria appear to be developed independent of specific ESU designation and criteria,…which permits more general application beyond the focus of the specific case examined by the ICTRT. In cases where ESUs have a single MPG, criteria are more stringent in recognition of the special risks in these situations. All of these are very positive features" (ISAB 2007). See ICTRT 2007, Appendix A, for more information on viability curves and their use.

In developing an approach for assessing relative extinction risk, the ICTRT used an approach based on viability curves developed using the simplest possible set of estimates that captured the importance of resilience at low to moderate spawner abundances. As the commenters have noted, the ICTRT generated viability curves using a hockey-stick method. A hockey-stick production relationship assumes a constant return-per-spawner until the point where capacity limits production. The slope of the line up to the point where capacity limits production is by definition the return-per-spawner at low-to-moderate abundance. Under the hockey-stick production relationship, the productivity at the lowest possible number of spawners is exactly the same as the productivity at the inflection point, or the point where capacity limits production. The ICTRT noted that estimates of productivity generated using, say a Beverton-Holt function, can be directly compared to a hockey-stick generated viability curve, if productivity is expressed as “steepness.” Steepness is commonly used in fisheries analyses and is defined as the productivity expected at 20 percent of equilibrium spawner abundance. A Beverton-Holt stock recruitment fit informs about the capacity that a population is moving toward and the maximum return-per-spawner at very low abundance (i.e., 2 fish).

Comment: Estimated values for “a” and “α” in Table 4-3 do represent intrinsic productivity in simulations with a stochastic spawner-recruit model that has lognormal variance σ^2 and an autogressive process with a one brood-year lag. However, the stand-alone estimate of intrinsic productivity is its expected value – in this case $\alpha\exp[\sigma^2/2/(1-\rho^2)]$ where ρ is the first-order autocorrelation coefficient. This expected value is consistent with the first definition of intrinsic productivity given above – the average number of surviving offspring per parent at very low population size. The stand-alone, expected value of intrinsic productivity – $\alpha\exp[\sigma^2/2/(1-\rho^2)$ – should represent "productivity" in tables and figures in the Plan. In addition, values for parameters “a” and “α” do not represent intrinsic productivity unless the Pacific Decadal Oscillation time series has been scaled to zero. The Plan should be revised to include information on this issue.

Response: This comment relates to the same issue raised in comments above. The commenter’s concern seems to be that NMFS’ status assessment may overestimate extinction risk by underestimating actual intrinsic productivity. We disagree. There are many different definitions of productivity, and it is important to understand which definition is most appropriate for any given context. Productivity is defined in the ICTRT viability criteria as the expected replacement rate at low-to-moderate abundance relative to a population’s minimum abundance threshold. This is a key measure of the potential resilience of a natural population to annual environmentally driven fluctuations in survival. The ICTRT document, which was reviewed by ISAB (ISAB 2007), explains why ICTRT viability analyses are based on geometric mean productivity at low-to-moderate abundances. See ICTRT 2007, Appendix A, for more information on viability curves and their use.

Comment: There are errors in Figure 4-5. With respect to the top graph in the figure, the spawner-recruit model is not explicitly given, but is implied to be the Beverton-Holt model based on spawners-to-spawners. The bootstrap samples appear to be centered on the estimated "steepness" parameter of 1.77 and the estimated equilibrium abundance (carrying capacity) of 3,387. Use of either statistic is inconsistent with the viability curves. The ICTRT (2007) did not use "steepness" as a measure of productivity. In fact, contrary to the implication on page 111 of the Proposed Plan, "steepness" is not mentioned in ICTRT 2007. Rather, the y-axis on viability curves represents current abundance, not the equilibrium population size.

Response: This comment relates to the same issue raised in comments above. The commenter’s concern seems to be that NMFS’ status assessment may overestimate extinction risk by underestimating actual intrinsic productivity. We disagree. There are many different definitions of productivity, and it is important to understand which definition is most appropriate for any given context. Productivity is defined in the ICTRT viability criteria as the expected replacement rate at low-to-moderate abundance relative to a population's minimum abundance threshold (ICTRT 2007). This is a key measure of the potential resilience of a natural population to annual environmentally driven fluctuations in survival. The ICTRT viability criteria (2007), which were reviewed by the Independent Scientific Advisory Board, explain why TRT viability analyses are based on geometric mean productivity at low-to-moderate abundances. See ICTRT 2007, Appendix A, for more information on viability curves and their use.

Comment: Additional details need to be provided for Figure 4-1 and other related figures and tables (Figures 4-2 and 4-9 and Table 4-2).[3] Figure 4-1 should be revised to include confidence intervals for the estimated "wild" escapement, particularly because this statistic was estimated with sampling. Also, lines and geometric means were smoothed without any explanation as to the reason for the smoothing or the method/extent of the smoothing.

Response: The standard error in the geometric mean (as noted in the text) is 0.19. See the methods section in NWFSC 2015 for additional discussion of methods and confidence intervals around the recent geometric mean.

Comment: There are errors in Figure 4-2. The caption and the y-axis label are inconsistent. Also, the negative deviations in Figure 4-2 do not match the smoothed red line in Figure 4-1. Note that the smoothed number of "wild" spawners in 2014 is greater than the comparative number in 2010 in Figure 4-2, yet the negative value for the 2010 brood year in Figure 4-2 indicates otherwise.

Response: Figure 4-2 and Figure 4-1 start from same dataset but are not directly comparable in the manner that the commenters suggest. This is not an analytical error. See Figure 4-4 and associated text for an explanation of the relationship between parent escapement and productivity.

Comment: The legend for Figure 4-3 is incorrect. Contrary to what is indicated, both lines on the graph correspond to total exploitation rates, which is the combined effect of ocean and in-river fishing. The blue line was calculated from releases of yearling smolts from the Lyons Ferry Hatchery and the red from sub yearling (fingerling) releases from the same hatchery. The specific errors can be detected by comparing Figure 2.49 and Table 2.1 from the Chinook Technical Committee (2015) with Figure 4-3 in the Plan. Since subyearling releases and returns have become more prevalent, the combined estimated total exploitation rates for Snake River fall Chinook salmon have recently stabilized. They are no longer 50 percent, but are closer to 30 percent. In addition, the total exploitation rates in Table 5-2 were incorrectly calculated, with double representation of in-river exploitation in the Columbia River.

[3] Note that Figure 4-9 in the Proposed Plan is shown as Figure 4-10 in the final Plan.

Response: The commenter is incorrect about the data represented by the two lines in Figure 4-3. Both lines represent estimates from the Chinook Technical Committee analyses. The line labeled “total” is the combined exploitation rate resulting from both ocean and in-river harvests. The second line represents ocean impacts only and is expressed in the same units. The difference between the two estimates therefore represents the portion of total exploitation rate resulting from in-river harvest.

The commenter is incorrect that the two lines represent yearlings and subyearlings. All harvest rate estimates for Snake River fall Chinook salmon are derived from Lyons Ferry hatchery subyearling tags. These fish are used as an indicator of impacts on wild Snake River fall Chinook salmon. The Chinook Technical Committee also reports relative harvest rates on tagged Lyons Ferry Hatchery yearling releases. These fish have a more southerly ocean distribution than the subyearlings, and it would not be practicable to try to develop an index of the two.
Also, note that we replaced Table 5-2 in the Proposed Plan with Figure 5-9 in the final Plan because the latter was a better display of allocation of total exploitation among fisheries. We realize that Figure 5-9 does not express the exploitation rate, just the distribution among fisheries. The level of exploitation is reflected in Figure 4-3.

Comment: There are errors in Figure 4-4. The definitions of the axes in the caption are inconsistent with the axis labels. This inconsistency should be reconciled.

Response: Commenter is correct. We have corrected the caption for this figure.

Comment: Appendix A indicates that only fish 4 years and older were counted as spawners (and recruits). Referring to the June 2015 NOAA dataset “SR Fall CH 77 12” and “SR Fall CH 90 12” spreadsheets, the column D header says “Total Spawners” and Column O header says “Total Adult Spawners 4-6.” These two columns contain identical numbers even though 2- and 3-year-old fish constitute up to 70 percent of the spawners. Computation of log (R/S) operate directly on these numbers without removing 2- and 3-year-old fish. Thus, the text in the manuscript or the text in the spreadsheet seems to be wrong.

Response: Commenters are correct that there was an inconsistency. The text has been corrected. For fall Chinook salmon, the dominant life-history pattern is subyearling. We used adult returns as estimated based on Lower Granite Dam counts as the basis for our analysis. In Lower Granite Dam counts, adults are defined as fish greater than 53 centimeters fork length. (The text inadvertently reflected the approach for used for Snake River spring/summer Chinook salmon).

Comment: The Proposed Plan states that “the geometric mean natural abundance for the most recent 10 years of annual spawner escapement estimates (2004-2014) is 6,418, with a standard error of 0.19.” This geometric-mean abundance value is inconsistent with values reported in other recent NMFS sources. For example, the data set that NMFS used in the 2014 FCRPS biological opinion and litigation in June 2015 gives a recent 10-year geometric mean of 4,576 adult fish. How was the standard error of 0.19 computed? Perhaps this is the standard error for recruits per spawner. The dataset used for the Lower Mainstem Snake River Chinook salmon population viability assessment was not provided in Appendix A of the Proposed Plan; this deficiency should be rectified in the final Plan.

Response: We will clarify the units for expressing natural-origin abundance standard errors in the Plan. The ICTRT assumed that variation in annual abundance would be log-normal in nature. The standard error of 0.19 is expressed in terms of natural log abundance. The variability around the point estimate of geometric mean abundance is displayed in the graphic representation of current status vs. the viability curve for 1 percent risk. Given the log normal assumption, the standard errors and the confidence limits are normally distributed on a log scale, but asymmetrical when translated to an arithmetic scale. The estimated log-normal standard error of 0.19 translates into multipliers of 0.83 and 1.21. The point estimate minus one standard error would therefore be 0.83 x 6,418 = 5,307. One standard error above the point estimate would be 1.21 x 6,418 = 7,761. The 10-year geometric mean of 6,418 adult spawners represents the most current 10-year data series available at time the status assessment was conducted for the 5-year review. Earlier analyses (e.g., those used in the 2014 FCRPS biological opinion and 2015 FCRPS litigation) were based on earlier data sets. Abundance and productivity data used in the status assessment are available on the Northwest Fisheries Science Center website at https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:1.

Comment: While recently improved, efforts at run reconstruction are still plagued with uncertainty since the estimates include unmarked hatchery fish that are visibly indistinguishable from natural-origin fish. Parental-based tagging (PBT) techniques will be used to validate the run reconstruction estimates beginning in 2016. Until such validation is available, references to run reconstruction estimates need to acknowledge the uncertainty of those values.

Response: High levels of year-to-year uncertainty are common among salmonid data series. This is why the ICTRT recommended estimating current status based on multiyear geometric-mean averages of abundance and productivity (ICTRT 2007). The run reconstruction estimates we use are the most recent available from the recently formed Run Reconstruction Group, which includes state and tribal co-managers. We are very supportive of the application of PBT, but full returns of PBT fish were not available until the 2016 return year (so were not available for this status review). However, a comparison of the run reconstruction estimates for 2016 with the new PBT assessment showed that estimates made using both methods were very close. Further, in the multi-stage life-cycle modeling effort currently underway we are working to include indices that could adjust for annual variations in factors influencing ocean survival, which could be contributing to the high variability in annual returns.

Comment: Appendix A states that the uncertainty buffering requirement was not met and “as a result, the Lower Mainstem Snake River fall Chinook salmon population is rated at Moderate Risk for abundance and productivity.” However, other sections of the Plan and Appendix A state that population is rated Low Risk for abundance and productivity and that the overall status rating is Viable.

Response: The statement that the population is at moderate risk for abundance and productivity was an error and has been corrected to indicate low risk.

Comment: The abundance and productivity data in the Proposed Plan (abundance = 6,418 and productivity = 1.5) puts this population just above the viability curve for a 1 percent extinction risk. The abundances and productivities from the June 2015 NOAA dataset (abundance = 4,576 and productivity = 0.95) would put the population below the 25 percent extinction probability curve. These differences are not trivial.

Response: The alternative estimates of abundance and productivity generated by the commenter from the June 2015 data set are not consistent with the ICTRT (2007) methods for calculating those parameters for comparison to a return-per-spawner based viability curve. The estimates in the recovery plan were generated following the ICTRT (2007) guidance. Current natural-origin abundance is expressed as the most recent 10-year geometric mean of spawners, and intrinsic productivity is calculated as the geometric mean of brood-year return-per-spawner estimates for only those parent escapements in the past 20 years that were below 75 percent of the minimum abundance threshold. The objective in calculating productivity is to measure resilience – i.e., the ability of the population to respond sufficiently after it is driven below average levels by annual variations in environmental influences (e.g., annual ocean survivals). The recovery plan identifies the problem with using the simple ICTRT return-per-spawner alternative when most spawning escapements in a recent series are above the minimum threshold. Methods for expressing intrinsic productivity from alternative estimation procedures are discussed in the Plan.

Spatial Structure and Diversity:

Comment: The determination of "low risk" for spatial extent or range may be incorrect. Appendix A classifies the distribution as "linear," which appears to mean that it is classified as Population Group A (see Table 1 on page 16 of ICTRT [2007] for definitions of categories). However, the metrics for "trellis" configuration were used to determine risk for spatial extent or range. If the metrics for a "linear" population had been applied, then a determination of "moderate risk" would follow.

Response: The detailed description of current spawning distribution in Appendix A clearly corresponds to the "trellis" classification as described by the ICTRT (2007). The reference to a linear pattern in mainstem spawning sites was not intended to represent the overall spatial structure of the Lower Snake River fall Chinook salmon population. The fact that there were multiple major spawning areas in both the mainstem Snake and in large tributaries results in that classification.

Comment: The hydropower system was rated as a "low risk" for unnatural selection on adults migrating upstream. Several publications are relevant here and warrant inclusion in this determination: Caudill et al. 2007, Keefer et al. 2008, and McCann et al. 2015.

Response: The assignment of a "low risk" rating for selectivity for Snake River fall Chinook salmon followed the quantitative guidelines provided by the ICTRT (2007). The three papers cited in the comment all deal with influences of factors on the average upstream survival of returning adults. One of the papers (Keefer et al. 2008) reports results only for spring- and summer-run Chinook salmon and has no direct information on Snake River fall Chinook salmon adult migration survivals. The studies cited in the comment are useful for gaining an understanding of juvenile and adult migration stages. However, given the study designs (in particular, the sample sizes) these studies provide no additional quantitative information on selectivity – e.g., differential impacts on particular components of returning adults for Snake River fall Chinook salmon.

Comment: The determination of "low risk" for major life-history strategies is not supported by the information presented in Appendix A. The only data presented are in a graph that shows a decreasing trend in the proportion of natural-origin juveniles that overwinter (Figure A-11 in the Proposed Plan; Figure A-12 in the final Plan). This proportion has steadily decreased from about 0.81 to 0.16 over the past eleven years. Appendix A states that this change probably does not have a genetic basis but is rather a result of phenotypic plasticity. The argument provided in Appendix A is not compelling. Table 11 in ICTRT (2007) provides risk ratings for major life-history strategies. A "moderate risk" exists if there is significant (meaningful) change in the pattern of variation. Figure A-11 in Appendix A of the Proposed Plan (Figure A-12 in the Final Plan) indicates a significant change since 2004.

Response: The rating of "low risk" for major life-history strategies does reflect current information on contributions of the two major pathways of ocean-entry timing present in the population as well as the guidance provided by the ICTRT on how to consider adaptations. The guidance on interpreting major life-history pattern risks by the ICTRT (2007) clearly recognizes the need to consider both positive adaptations to current conditions and preservation of predominant historical patterns in assessing current risk.

Comment: The determination of "low risk" for phenotypic variation is subjective. Connor et al. 2014 is referenced with respect to many phenotypic characteristics, but Connor et al. 2014 is not specified in the literature cited section of Appendix A. Thus, we have no basis for evaluating the risk determination made in Appendix A. However, the declining overwintering pattern suggests that the risk category for phenotypic variation is probably "moderate."

Response: Connor et al. 2014 is cited in the general literature section for the recovery plan and has been added to the literature cited section of Appendix A. Connor et al. 2014 does not carry out the analysis of phenotypic variation, but documents estimated contribution rates of yearling and subyearling migration types to recent year returns, thereby extending the available data series. The NMFS status assessment (NWFSC 2015) reviews those updates against the guidelines provided by the ICTRT (2007). Treatment of the patterns in overwintering versus subyearling migration in adult returns was discussed in response to other comments (see above). Treatment of those two life-history forms is consistent with the ICTRT guidance on assessing current major life-history forms (ICTRT 2007), as well as with treatment in previous 5-year status reviews (see, for example, Ford et al. 2011).

Comment: There is a lack of genetics data on this ESU. The genetics study of Snake River fall Chinook salmon cited in the recovery plan was conducted in the 1990s (Marshall et al. 2000). It seems like an updated study is warranted before making long-term decisions about recovery. While informative, the Marshall study primarily examined genetic variation in fall Chinook salmon sampled from the Lyons Ferry Hatchery and the distinctness of fall run fish from spring run fish, it did not test whether there was any structuring between the five MaSA's outlined in the recovery plan. This issue should be examined given the ESU's current listing as a single management unit. It is not sufficient to assume that there is no structure. Finally, there needs to be an assessment that examines historically dominant patterns of diversity at the genetic level. If this type of assessment is not feasible at this time, we should locate historical samples and compare those to diversity in the extant population to help guide conservation efforts.

Response: All three recovery scenarios in the Plan call for actions to promote natural patterns of within-population diversity. The ICTRT concluded it would be difficult, if not impossible, to reconstruct historical genetic patterns for populations like the Lower Snake River fall Chinook salmon population. The information in the recovery plan reflects the findings in the 2012 Biological Opinion on Snake River Fall Chinook Salmon Hatchery Programs (NMFS 2012). That review concluded that widespread releases and returns of hatchery fish from a common broodstock (the Snake River Egg Bank Program) likely has resulted in a more homogenized population. The focus of the recovery strategies in the final Plan is on implementing actions to promote the expression of within-population diversity.

27. Water Quality

Comment: The recovery plan should address water quality such as temperature, dissolved oxygen, and turbidity, which are limiting factors during early and late life stages for fall Chinook salmon. Early life-history stages, such as egg incubation and emergence time of the Snake River fall Chinook salmon, are substantially influenced by water temperature. In fact, water temperature is so important during early life stages that fall Chinook salmon exhibit at least two alternative juvenile life-history types depending on whether spawning and rearing areas are relatively colder or warmer. Currently, the mainstem Snake below Hells Canyon Dam to the mouth of the Salmon River may be more productive than the rest of the spawning grounds because warmer water is released from the Hells Canyon Complex.

Response: The Plan comprehensively addresses the issue of water quality. It includes an extensive discussion of water quality, including the impacts of hydropower and land uses on water quality, and the effects of these impacts on juvenile and adult Snake River fall Chinook salmon in the middle mainstem Snake River, lower mainstem Snake River, Columbia River mainstem, lower Snake River tributaries, and the Columbia River estuary (see Plan, Section 5.2). This discussion is based on most of the same sources the commenters cite in their comments, as well as on more recent literature (e.g., Connor 2013; Connor et al. 2016). The treatment of temperature is extensive and includes the known and potential effects of temperature (including potential effects as a result of climate change) on Snake River fall Chinook spawning aggregates.

Comment: The following actions related to water quality should be added to the Plan:

a. Coordinate with state agencies, local universities, and NGOs to monitor major pollutants throughout the mainstem, tributaries, and the Columbia River estuary.
b. Identify potential new point sources of contamination that are unknown and that could be substantially affecting water quality upstream above the Hells Canyon Complex.
c. Enforce current regulations to eliminate/reduce point source contaminations.

Response: We believe that the intent of these actions is adequately addressed in the Plan. See, for example, Chapter 7, Monitoring Objective 4 ("Assess the status and trend of current and historically used adult holding, spawning, and juvenile rearing mainstem and tributary habitats used by the Lower Snake River fall Chinook salmon population"); Monitoring Objective 5 ("Determine the effects of habitat limiting factors and associated management efforts in the major and minor spawning and rearing areas on the Lower Snake River fall Chinook salmon population"); and Monitoring Objective 14 ("Determine the influence of toxic contaminants on the viability of Snake River fall Chinook salmon") and associated monitoring questions. Also see Chapter 6, Section 6.2.1, Management Strategy 8 ("Continue RM&E to gain a better understanding of potential negative impacts from exposure to toxic pollutants and develop actions to reduce potential effects of toxic contaminants on natural-origin Snake River fall Chinook salmon") and its associated actions – for example, Action 8-3: Implement National Pollution Discharge Elimination System permit programs to address point source pollution.

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