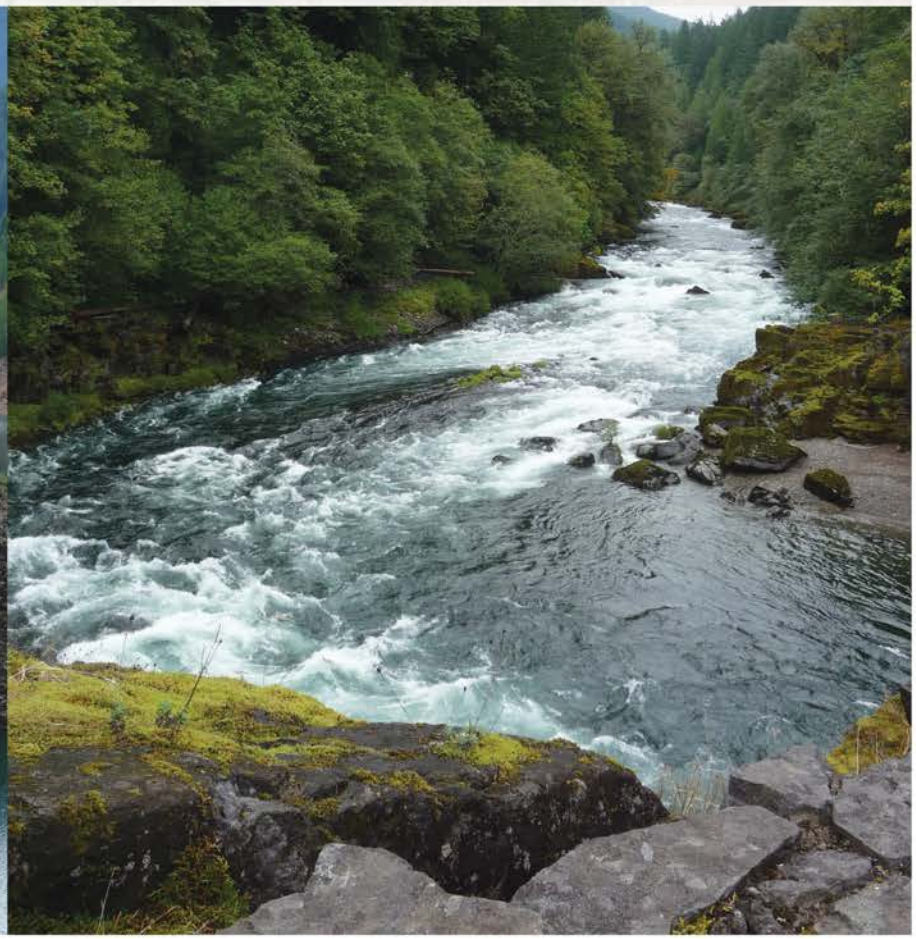
Independent Scientific Review Panel

Review of the U.S. Army Corps of Engineers' draft Research, Monitoring and Evaluation Plan and Proposals for the Willamette Valley Project



Independent Scientific Review Panel
ISRP 2011-26 | December 2011

Cover design by Melissa Shavlik, Northwest Power and Conservation Council
Photos: Erik Merrill

Independent Scientific Review Panel

for the Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204
www.nwcouncil.org/fw/isrp

ISRP Members

J. Richard Alldredge, Ph.D., Emeritus Professor of Statistics at Washington State University.

Robert Bilby, Ph.D., Ecologist at Weyerhaeuser Company.

Peter A. Bisson, Ph.D., Senior Scientist at the Olympia (Washington) Forestry Sciences Laboratory of the U.S. Forest Service's Pacific Northwest Research Station.

Charles Henny, Ph.D., Emeritus Research Scientist at the U.S. Geological Survey in Corvallis, Oregon, an expert in wildlife and environmental toxicology.

Colin Levings, Ph.D., Emeritus Research Scientist and Past Section Head Marine Environment and Habitat Science Division, Department of Fisheries and Oceans, Canada.

Eric J. Loudenslager, Ph.D., Hatchery Manager and Adjunct Professor of Fisheries Biology, Humboldt State University, California, an expert in genetics and fish culture.

Katherine Myers, Ph.D., Retired Principal Research Scientist, Investigator of the High Seas Salmon Research Program at the School of Aquatic and Fishery Sciences, University of Washington.

Thomas P. Poe, M.S., Consulting Fisheries Scientist, an expert in behavioral ecology of fishes, formerly with the U.S. Geological Survey.

Greg Ruggerone, Ph.D., Fisheries Scientist for Natural Resources Consultants.

Dennis Scarnecchia, Ph. D., Professor of Fish and Wildlife Resources, University of Idaho, an expert in large river fisheries population dynamics, and salmon, trout, char, and paddlefish.

Bruce Ward, Fisheries Scientist, formerly with the Ministry of Environment, Aquatic Ecosystem Science Section, University of British Columbia, Vancouver, B.C., Canada.

Peer Review Group

Robert J. Naiman, Ph.D., Professor of Aquatic and Fishery Sciences, University of Washington

Staff

Erik Merrill, J.D., Manager, Independent Scientific Review Program, Northwest Power and Conservation Council.

ISRP Review of the U.S. Army Corps of Engineers' draft Research, Monitoring and Evaluation Plan and Proposals for the Willamette Valley Project

ISRP Review of the U.S. Army Corps of Engineers' draft Research, Monitoring and Evaluation Plan and Proposals for the Willamette Valley Project

Executive Summary

At the request of the U.S. Army Corps of Engineers and the Northwest Power and Conservation Council, the Independent Science Review Panel (ISRP) reviewed the Corps' draft Research, Monitoring, and Evaluation Plan and Fiscal Year 2012 concept papers and proposals for the Corps' Willamette Valley Project. The Plan, concept papers, and proposals represent an ambitious effort to plan and implement studies of juvenile and adult fish passage, flows, water quality, hatchery management, and habitat restoration.

In past reviews of projects in the Columbia River mainstem implemented through the Corps' Columbia River Fish Mitigation Program, the ISRP recommended that a research plan be developed to guide efforts. The draft Research, Monitoring and Evaluation Plan for the Willamette Valley Project represents a significant step in providing this useful guidance framework. The Plan contained much useful information including substantial content on hatchery research, monitoring, and evaluation. The Plan identifies many critical uncertainties, but there are still some gaps in coverage. To improve on the next draft of the Plan, the ISRP recommends several deficiencies be addressed including prioritization of proposed monitoring and research activities, more consideration of carrying capacity of tributaries, a landscape approach, impacts of hatchery stocks on wild fish, and incorporation of a management decision framework.

The ISRP reviewed 18 proposals to implement the Plan finding that 2 proposals met scientific review criteria, 9 met criteria with some qualifications, and 7 did not meet criteria. Many of the 7 that did not meet criteria could be improved by revising, and in some cases rethinking, the proposal to add additional details on rationale and methods. Although most of the 18 proposals addressed important issues, it was unclear why these particular projects were selected for implementation whereas other projects identified in the Plan were not.

Background

On November 1, 2011, the U.S. Army Corps of Engineers (Corps) and the Northwest Power and Conservation Council (Council) asked the ISRP to review ongoing efforts to support implementation of the National Marine Fisheries Service's 2008 Biological Opinion on effects of the Corps Willamette Valley Project's thirteen dams and reservoirs (Attachment 1). This Research, Monitoring and Evaluation (RME) Program for the Willamette Valley Project is implemented through the Corps' Columbia River Fisheries Mitigation (CRFM) Program. ISRP review of projects under this program was directed in the 1998 U.S. Congress Senate-House conference report for the fiscal year 1999 Energy and Water Development Appropriations Bill. The ISRP's review responsibilities are also incorporated in the Council's 2009 Fish and Wildlife Program.

The ISRP was specifically asked to conduct a formal scientific review of three documents and 18 scientific study proposals. The documents include:

- Comprehensive Plan For Research, Monitoring and Evaluation of the Willamette Valley Project, October 2011 draft (herein RME Plan)
- Willamette Mitigation Hatchery Program Research, Monitoring and Evaluation Plan (included as Appendix C in the Comprehensive Research Plan)
- Willamette Hatchery Mitigation Program Three-Year Monitoring and Evaluation Plan (included as Appendix D in the Comprehensive Research Plan)
- Fiscal Year 2012 Research Proposals - packet of proposals submitted to address high priority research needs identified through the annual planning process for Fiscal Year 2012.

The RME Plan is intended to: a) provide an overall approach to identify, schedule, and set priorities for Corps-funded studies needed to implement NMFS Biological Opinion measures for juvenile and adult fish passage, flows, water quality, hatchery management, and habitat restoration; b) ensure Corps-funded RME is efficient and implemented as an overall program, e.g., there are no redundant or conflicting studies and full advantage is taken of complementary work; c) identify critical uncertainties for each major Willamette subbasin affected by the Willamette Valley Project; d) use RME results to inform future studies and management decisions concerning alternatives to meet Biological Opinion measures; and e) evaluate the effectiveness of actions implemented to meet Biological Opinion measures.

To help guide the ISRP review, the Corps and the Willamette Action Team for Ecosystem Restoration (WATER) RME Team provided a set of detailed questions (Attachment 2). The ISRP's review below answers these questions but re-organizes them by subject matter for coherency and to limit redundancy.

The ISRP's report begins with a review of the RME Plan, including the appendices. This Plan review is followed by a review of FY 2012 research concept papers. The report concludes with ISRP recommendations and comments on each of the 18 proposals submitted for review. The ISRP reviewed each proposal using its standard criteria, that the project is based on sound science principles; benefits fish and wildlife; has clearly defined objectives and outcomes; and has provisions for monitoring and evaluation of results. To complete this and the earlier review, we followed our standard review process

for Columbia River Fish and Wildlife Program proposals. At least three reviewers independently evaluated each proposal and provided comments, which were synthesized into a consensus recommendation that was then reviewed by the full ISRP.

The ISRP's review was greatly aided by a site tour with representatives from the Corps, NOAA Fisheries, Bonneville Power Administration, and Council staff that occurred October 3-5, 2011 (Attachment 3). The tour included a briefing that provided a comprehensive orientation of the Willamette Valley Project and site tours to the North Santiam, McKenzie, and Middle Fork subbasins. The ISRP appreciates the effort of the agency researchers and representatives in giving a successful and informative tour.

ISRP Comments on the Willamette Research, Monitoring, and Evaluation Plan

Overall Impressions of the Plan

> *Corps' Question 1: Does the Comprehensive Research, Monitoring, and Evaluation Plan (RME Plan) contain an effective and sufficient strategic framework to support implementation of the NMFS 2008 Biological Opinion's Reasonable and Prudent Alternative (RPA)?*

The RME Plan represents a significant effort to develop a comprehensive plan upfront to guide the RME effort. The RME Plan addresses some key uncertainties effectively, but a number of areas could be improved in a future draft of the plan. Specifically, the ISRP could not determine the extent to which the uncertainties identified in the plan were based on analysis and interpretation of studies conducted to date. The significance of the various uncertainties could have been better appreciated if more context was provided with an overview of the current status of salmon and steelhead populations in the Willamette and current water quality and habitat conditions. This type of analysis is required to help prioritize the key uncertainties. The Plan and concept papers provided for the ISRP review are not adequate for prioritizing uncertainties. Some uncertainties are clearly more important to fish recovery than others and should be investigated first. Documentation should be provided to specify clear priorities and show that the projects proposed for 2012 implementation are aligned with these priorities. In addition, it was difficult to associate uncertainties in the plan with the suite of projects currently being considered for implementation. To rectify this problem, the plan should associate specific study questions with specific proposals. A table with a list of all questions and monitoring activities should be compiled to identify the proposal that would address each key question.

From the ISRP's Willamette site visit, it appears that the various agencies and conservation groups are working well together on this Plan. However, this cooperation and collaboration was not always apparent in the FY 2012 proposals.

Appendices C and D provide some useful information on the hatchery program RME, and the uncertainties identified are prioritized, although the organization of these sections was cumbersome, impairing their usefulness. In addition, the hatcheries in the system have been in operation for some time, and data relevant to some of these uncertainties should be available. The Appendices should include some of this information to provide context for the hatchery RME effort.

In addition to these issues, the ISRP also identified several other items in the Plan that deserve attention. These concerns include:

1. The Plan appears to lack elements focused on improving the understanding of habitat-based productivity and capacities for the key tributaries. What is the existing carrying capacity of the individual tributary systems, and the Willamette River, for additional fish?

2. Each dam or situation is treated as a unique stand-alone issue. While there are aspects associated with each individual project that must be treated as unique, considerable efficiency could be gained if studies were structured to identify general strategies that could be applied with a reasonable chance of success across multiple projects. Furthermore, comparisons of similar types of projects across watersheds could lead to improved strategies, e.g., pre-spawn mortality in relation to trap and haul operations. This issue was not comprehensively addressed in the Plan. Further, the Plan and proposals could benefit from adopting a riverscape/landscape approach to restoration (e.g., Fausch et al. 2002, ISAB 2011-4).

3. No matter how much restoration is being done in association with the Corps' dams, the migratory fish still need to move from those sites to the ocean and back. Unfortunately, the Willamette River and the surrounding lands continue to undergo substantial alterations (and these may even be accelerating) from population pressures and climate change. That said, a substantial effort, as part of the Willamette BiOp should be directed toward predicting future environmental conditions in the river. It is likely that river conditions will continue to deteriorate into the future, especially in areas of high human population growth. As a result, certain locations in the Willamette system may become survival bottlenecks, limiting the effectiveness of restoration measures implemented to address problems created by the dams. For this reason, restoration planning, and associated RME efforts, need to be integrated across the entire Willamette subbasin.

   The ISRP understands that the Action Agencies (the Corps, Bonneville Power Administration, and Bureau of Reclamation), in collaboration with the Services (National Marine Fisheries Service [NMFS] and U.S. Fish and Wildlife Service [USFWS]), will develop and carry out a comprehensive habitat restoration program to address limiting habitat factors for ESA-listed fish populations during the term of Willamette Project Biological Opinions (BiOp). The ISRP has already reviewed a programmatic habitat restoration proposal to identify and implement restoration projects (ISRP 2010-29) in the Willamette. In 2012, the ISRP expects to review an updated monitoring plan for the project and a progress report on restoration results. The habitat restoration program continues to be in development, and participants include developers of the Willamette Basin Alternative Futures program and the Willamette Subbasin Plan. These efforts consider the issues the ISRP identifies above. However, the RME Plan for the Willamette Valley Project does not adequately describe how the efforts at the dams and reservoirs are integrally linked to the habitat restoration efforts throughout the basin, and a revised Plan should clearly describe this linkage.

4. If the existing salmon and steelhead are mostly from hatchery stock, what are the impacts on the remaining wild fish that are the subject of the Willamette BiOp? In general, see ISRP 2011-25 and ISRP 2005-15.

5. Given that biotic communities and environmental conditions in the rivers are undergoing rapid transformations, will restoration actions be compatible with the novel/hybrid communities and

ecosystems that are emerging, as well as the natural life history types of native species that are remaining? How are non-native species' changes anticipated to affect results? Responses to these questions are fundamental to successful restoration. See the ISAB's Non-Native Species Impacts Report (ISAB 2008-4), Food Web Report (ISAB 2011-1), and Landscape-Scale Restoration Report (ISAB 2011-4).

6. A plan/strategy of this scale cannot be successful without widespread and deep public involvement. The public and their local leaders need to understand and support the proposed strategy – and this must be an ongoing process. Unfortunately, the plan does not address this basic issue. To be successful, public engagement should be a prominent component of the strategy (ISAB 2011-4).

7. The Plan should include a structured decision management framework (ISRP 2011-25). This framework should be capable of evaluating the entire suite of factors impacting Willamette Chinook salmon and steelhead, including aquatic system dynamics, estuary and ocean effects, and harvest, hatchery, habitat, and hydro management procedures (e.g., Irwin et al. 2011). For example, a recent food web based macroecological model of fish abundance by McGarvey and Johnston (2011) was used to predict fish abundance and incorporated information on trophic conditions. In addition, tools such as SLAM (mentioned in Chapter 3 of the RME Plan), the All-H Analyzer (AHA), and Shiraz could be used as the basis for a decision support tool. More integration of these tools in the Plan could provide a consistent method of evaluating possible management options and also enhance prioritization of uncertainties. This type of system also can facilitate public involvement in the recovery effort, as a series of workshops could be held to present and discuss possible restoration options and what the options would mean in terms of Chinook and steelhead population response (e.g., Mapstone et al. 2008; Peterman 2004).

Adult Fish

Adult Fish Trap and Haul Protocols and Facilities

> *Corps' Question 1.a.i. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for: adult fish trap and haul protocols and facilities?*

The critical uncertainties associated with trapping and transportation of adult fish are partially captured in the RME Plan. Clearly, the high levels of pre-spawn mortality in fish transported above Willamette Valley Project dams must be reduced to take advantage of the spawning and rearing habitat available above dams. The Plan includes some of the potential factors contributing to pre-spawn mortality but fails to include some others (see discussion below on pre-spawn mortality). The tagging studies planned for winter steelhead and Chinook will provide some information on the environmental conditions to which the fish are exposed between Willamette Falls and collection at the Willamette Valley Project dams and conditions the fish experience after release above the dams. In addition, these studies will assess some alternative protocols for handling the fish that may enhance survival after release. However, there appears to be no effort to investigate the exposure of migrating fish to toxic chemicals during migration. In addition, the interaction between wild and hatchery fish on the spawning grounds was not fully addressed. The Plan indicates that hatchery origin fish will be transported above the dams

and released until enough natural-origin fish return can be captured. The possible depression in breeding success frequently occurring in populations where hatchery fish spawn with wild fish coupled with the high rates of pre-spawn mortality could significantly impair recovery. Also, there was no indication that quantitative measures of stress levels of the fish would be examined. Collection of blood samples for stress hormone analysis could be a useful tool for examining the cumulative impact of multiple stress factors on the migrating fish.

Pre-spawn Mortality

Corps' Question 2.a.

i. *Should investigation into causes and solutions for adult Chinook pre-spawn mortality be completed, given 1) the state of knowledge regarding Chinook pre-spawn mortality in the Willamette and 2) the schedule for implementing specific RPA measures for fish passage, flows, water quality, adult passage, effects of hatchery management on wild fish, and habitat restoration?*

ii. *If yes for question 2.a.i., are the critical questions and study types listed in Section 2.4 appropriate (i.e. will investigation of those critical questions following the general study types presented in Section 2.4 efficiently and effectively identify causes and solutions for pre-spawn mortality)?*

iii. *Should pre-spawn mortality investigations and analysis focus on determining the specific project effects, or widespread environmental effects common to all populations, in order to help determine what can be affected by management actions and what cannot?*

Clearly, the high levels of pre-spawn mortality in fish transported above Willamette Valley Project dams must be reduced to take advantage of the spawning and rearing habitat available above dams. Without a reduction in pre-spawning mortality, it is unlikely that a population above the dams would be sustainable given additional survival issues when passing through or around the reservoirs, migrating downriver, rearing in the ocean, and negotiating fisheries. Thus, recovery success appears to depend, in part, on reducing pre-spawn mortality. The Plan should incorporate a literature review on pre-spawning mortality and mortality of adults during transportation. This review should be used to identify hypotheses to be tested as a means to reduce pre-spawn mortality. Investigations and analysis of pre-spawn mortality should focus on both determining specific project effects as well as widespread environmental effects common to all populations. Examination of pre-spawn mortality at multiple locations may be a powerful tool for determining what is causing pre-spawn mortality. The ISRP encourages an investigation that encompasses multiple projects/watersheds, identifying conditions in those watersheds in relation to pre-spawn mortality levels. Collectively, these studies will help determine what can be affected by management actions and what cannot.

The critical questions and study types listed in Section 2.4 appear to be appropriate but incomplete. The Plan focuses on reducing pre-spawn mortality by improving trapping and handling conditions and evaluating whether date of transport, location of release, and treatment with antibiotics will reduce pre-spawn mortality. As noted earlier, several potential contributing factors are not included in the Plan, including exposure to toxics during migration. Stress and pathogens also can exacerbate pre-spawn mortality, and reduction of pre-spawn mortality caused by stress may be difficult depending on the source of the stress (see Farrell et al. 2000). One ISRP member spent three years trying to reduce stress related mortality (measured via cortisol and lactic acid, and visually) in maturing Chinook and coho

captured off the Oregon coast. Nearly all salmon died within one week of capture while being held in a variety of ways and locations. The fish were quickly inflamed with bacterial infection and died very quickly. The "best" approach to reduce mortality was to confine individual fish in "hatchery tubes" but mortality was still high. Oddly, stress-related mortality was not prevalent in maturing Chinook and coho captured and held in Puget Sound and Alaska. However, the contribution that stress may make to pre-spawn mortality rates indicates that measurement of this factor may be critical to identifying the causes of pre-spawn mortality.

Re-establishing Wild Populations above Dams

> *Corps' Question 1.a.ii. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for: … re-establishing wild populations above dams (initially using hatchery origin fish where necessary)?*

There are four critical uncertainties related to population re-establishment that were described in section 2.4 (p. 2-19 – 2-27): 1) rebuilding naturalized runs in appropriate habitat; 2) reproductive success of hatchery-origin spawners either released or returning to natural environment; 3) interactions of hatchery and naturally produced fish; and 4) development of trap and haul programs. There are research questions for each area of uncertainty.

Our evaluation of this topic considers three questions: 1) are there additional critical uncertainties when re-establishing wild populations above dams; 2) are the research questions appropriate; and 3) are the study designs sufficient to address the research questions and critical uncertainties?

One critical uncertainty missing is identification of the population structure of salmonids desired by the reintroduction effort. The early sections of the plan seem deficient in providing a clear description of the ESU, Major Population Group, and Independent Population organization of the UWR spring Chinook. Explanation is given in appendix C, the hatchery research plan, but not in the Plan itself. It is not clear that the data on genetic/population structure are sufficient to achieve a consensus among managers/stakeholders regarding the elements that need to be included in a recovery and restoration plan. From a reintroduction point of view, the question is how many subpopulations are going to be developed? What is the rationale and justification for that decision? What hatchery and natural populations are going to be developed into the reintroduction populations? How closely related are the hatchery stocks to the natural stocks? Where are the reintroduced populations going to be located?

Rebuilding of naturalized runs in appropriate habitat

Question 1 is the central question in this section of the RME Plan (2.4.4, page 2-22): "Will trap and hauled adults result in naturally reproducing populations of spring Chinook salmon in historic habitat?" Questions 2 and 3 (what are adult and juvenile survival rates) are subordinate issues in answering question 1.

The approach to addressing reintroduction is outlined in Study Type A1. The first task proposed is to identify causes of pre-spawning mortality (that can be as large as 95%). The strategy seems to be an evaluation of how season and environmental condition exposure prior to reaching a dam is correlated

with pre-spawning mortality post trap and haul. This effort is required to understand the magnitude of pre-spawn mortality, but the monitoring will be observational, not experimental, so causation is unlikely to be resolved. As noted above, the Plan should conduct a comprehensive literature search on pre-spawn mortality of salmon and approaches to reduce this mortality among transported fish and use this information to develop specific hypothesis that could be tested using an experimental design. The experimental design should incorporate the plan to re-introduce Chinook salmon above several dams and compare pre-spawn mortality and potential explanatory factors across watersheds.

The Plan assumes that transport of hatchery stocks above the dams would stop after a specific number of years ("to be determined") with continued transport of only natural-origin fish thereafter. Although planners might like to specify time to recovery in years, a key metric for successful recovery of salmon is life-cycle productivity. In order to reduce transport of hatchery versus natural origin fish, the program should target a return per spawner (R/S) of naturally-spawned fish that consistently exceeds replacement (R/S > 1). If the Plan anticipates incidental harvest of these fish, then the target R/S for recovery should be well above replacement.

The Plan mentions the use of life-cycle models to evaluate life-cycle fitness in Chapters 2 and 3. This type of approach could be used to provide important information and implementation targets when developing the Plan. For example, considerable data are available on smolt-to-adult survival of Willamette spring Chinook. Given these data, and appropriate adjustments for data based on hatchery releases, the Plan could estimate life-stage survival rates necessary for achieving an R/S of 1 or more. For example, if pre-spawn mortality is 50%, what survival rate is needed from fry to juveniles below the dams in order to achieve an R/S of 1 or more? Alternatively, if pre-spawn mortality is reduced to 10%, what survival rate is needed from fry to juveniles below the dams in order to achieve an R/S of 1 or more? Relatively simple analyses such as these can inform the Plan on life-stage survival rates needed to achieve recovery goals and can help frame specific questions to be addressed in monitoring programs. This approach and comparisons with observed survival rates could also be used to inform adaptive management decisions.

The explanation of Study Type A1 states that "evaluating production levels above each Willamette Valley Project dam under various population re-establishment strategies is supported by Study types J1 and J3." There is no explanation of what various re-establishment strategies might be. The cross referencing to study types J1 and J3 is cumbersome. The final paragraph suggests considering re-introduction using life stages other than adults, but the narrative is not specific enough for evaluation.

It is unlikely that sufficient opportunities for replication and tandem re-introduction exist to evaluate multiple strategies simultaneously. As noted above, the requirements for success using adults need to be identified (e.g., R/S > 1 or >> 1) and clear benchmarks established for initiating alternative life-stage re-introduction efforts. The project managers would benefit from review of the Snake River sockeye salmon re-introduction efforts that have attempted to use eggs, parr, smolts, and adults.

Reproductive success of hatchery-origin spawners either released or returning to the natural environment

The statement that understanding differences in reproductive success between hatchery- and natural-origin fish is important in designing and executing re-introduction efforts above Willamette Valley Project dams is reasonable. The three questions raised in this report section are important in regard to

hatchery management and escapement and straying of hatchery-origin individuals below Willamette Valley Project dams. But, they do not seem to specifically address differences in reproductive success above Willamette Valley Project dams. The key question for fish transported above dams is: what is the difference in reproductive success between hatchery and natural origin spawners, and how might the difference be explained by intrinsic characteristics of the hatchery fish or by environmental characteristics of the habitat in which they spawn? For example, do hatchery and natural fish that are trapped and hauled migrate to the same river reaches? Are differences in reproductive success explained by spawning location or spawning time? Do hatchery fish suffer from higher pre-spawning mortality? If the hatchery fish perform poorly, or interbreeding with natural fish yields progeny with reduced performance, then use of hatchery fish as a restoration strategy can be revisited. None of the elements of study type A2 or A3 appear to directly address the research questions. Comments on specific research questions in the plan follow below.

1. Can increasing the percentage of naturally produced spring Chinook salmon in the broodstock (pNOB) reduce the negative effects of naturally spawning hatchery fish?

First it is necessary to define and parameterize "negative effects of naturally spawning hatchery fish." Is there a definition, and what is the size of the effect? Then design an experimental study to evaluate whether the effect is reduced by adding natural adults into a hatchery program. This will require comparing fish stocks from hatchery lineages with and without addition of natural parents. Is this feasible in the Willamette tributaries and hatchery programs given the limited number of natural origin Chinook? An example where similar effort is underway is the Yakima spring Chinook program at Cle-Elum. The Yakama tribe is maintaining a supplementation lineage that is exclusively natural fish and a hatchery lineage that is maintained using hatchery-origin adults. A contrast of these two lines is used to establish a domestication estimate. Using coho salmon in Minter Creek, Washington, NOAA Fisheries (Mike Ford) is examining "re-naturalization" by eliminating hatchery progeny from a natural population that has been dominated by hatchery fish for 50 some years. These models may provide the data needed for management decisions in the Willamette, or they may provide outlines for designing experimental approaches within the Willamette.

2. Can managing the number and location of spring Chinook salmon hatchery origin spawners increase the viability of the natural population?

This is essentially the question the ISRP believes is being addressed at the Minter Creek coho salmon investigation mentioned above. None of the studies outlined in Study Type A2 or A3 are sufficient to resolve the uncertainty. Regarding the re-introduction of Chinook above dams, it seems a key strategy would be to transport as many natural origin fish as possible given the adult return rates and the desire to minimize impacts on natural origin spawners returning to areas below the dams. Goals are needed for total numbers of fish to be transported each year, including the ratio of natural to hatchery origin fish based on abundances of available natural origin and hatchery spawners. Additionally, if the population grows, then an estimate is needed for the capacity of the upstream watershed to support spawners, e.g., escapement goal.

3. Can the number of naturally spawning hatchery summer steelhead be minimized to reduce negative effects to winter steelhead viability?

The RME Plan does not explain how the questions and evaluations in Study Type A3 address the potential impact of hatchery summer steelhead on winter steelhead viability. No specific studies or concept papers were linked to this study in the Plan. The narrative cites Kostow and Zhou (2006), which demonstrates an effect of summer steelhead on winter steelhead. In Oregon, analysis of reduced releases of coho salmon (Buhle et al. 2009) and summer steelhead (Kostow and Zhou 2006) point the way toward the experiment and the methods of analysis. The ancillary data collections in Study Type A3 are unlikely to provide for an evaluation of this question. What is needed is a watershed or two that are currently stocked with summer steelhead, where stocking would be halted and a response in winter steelhead could be measured.

Interactions of hatchery and naturally produced fish

The Plan does not clarify how this uncertainty is different from question 3 for steelhead above – it is potentially broader, question 3 above is a component of this uncertainty. The plan states that ecological interactions between hatchery and natural fish are critical areas of uncertainty, but they do not state why. The effect of the interaction should be framed in terms of the consequences for VSP parameters. Then a methodology for assessing the magnitude of the deleterious effects needs to be developed. The six questions posed for this uncertainty have the potential to contribute to explaining causation, but are unlikely to yield insight into the magnitude of effect. Considerable thought is needed to devise an experimental or observational study that can yield a meaningful evaluation. No specific studies or concept papers were linked to this study in the Plan. Furthermore, Concept Paper JPL-5 seems to be the study that might address some of these questions, but there was no mention of hatchery versus natural origin evaluation in the objectives.

Hatchery Effects on Wild Fish

> *Corps' Question 1.a.vi. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for: … managing hatchery effects on wild fish*?

Please see the ISRP response to question 1.a.ii: re-establishing wild populations above dams (initially using hatchery origin fish where necessary) for issues related to managing hatchery effects on wild fish. A few additional comments are provided here.

The Plan lists a number of key questions related to critical uncertainties involving reproductive success of hatchery origin spawners and ecological interactions between hatchery and natural origin fish. We expected to see proposals designed to address each of these key questions, but the following key questions did not seem to be directly addressed by the FY 2012 "hatchery uncertainty" proposals:

1. Can increasing the percentage of naturally produced spring Chinook salmon in the broodstock (pNOB) reduce the negative effects of naturally spawning hatchery fish?
2. Can the number of naturally spawning hatchery summer steelhead be minimized to reduce negative effects to winter steelhead viability?

3. Do hatchery fish prey on naturally produced fish?
4. Do hatchery and naturally produced juveniles/smolts utilize the same habitats in river? Do they show the same life history traits?
5. Do naturally produced fish change their habitat-use patterns after hatchery fish are released (are they displaced from habitats)?
6. Do hatchery juveniles compete with naturally produced juveniles for food?

Some of these questions are important, but they may not be feasible given the limited availability of natural origin salmon. For example, the effect of natural origin fish in the brood stock on the success of those hatchery fish that survive and return to spawn in streams is important but it requires an experimental design in which pNOB can be manipulated.

Additional key uncertainties related to hatcheries could have been listed. For example, to what extent does the presence of hatchery fish increase harvest related mortality of natural origin salmonids? This question is important because the targeted life cycle productivity (R/S) should consider the likely harvest rate on natural origin fish, including catch and release mortality.

When reviewing the Willamette Hatchery Mitigation Program (Appendix C and D) it was difficult to assess the extent to which all of the listed research, monitoring, and evaluation is occurring now or will be implemented in the near future. It was clear from these documents that the plan is for an integrated hatchery population of spring Chinook. Many of the proposed benchmarks compared hatchery fish with natural fish metrics, yet no values were provided for natural fish apparently because data do not exist for the natural origin fish (e.g., Table 6.6 in appendix C). In general, there seemed to be relatively little detailed information in the Plan or appendices on population characteristics of natural origin juvenile and adult salmonids in the basin, e.g., juvenile life history types, size at age, rearing habitats, and residence time in habitats.

One of the proposals (AP-8) implied that it would meet the overarching objective to "rear and release high quality hatchery fish to minimize impacts on naturally produced fish and promote conservation and recovery of listed species" by rearing and releasing hatchery spring Chinook salmon that mimic size and behavior of naturally produced yearling migrants. However, the proposal included no information on the size and timing of natural origin yearlings and no mechanism for determining whether this proposed strategy would achieve the objective of minimizing impacts on natural origin fish. The proposal did not include any monitoring of natural salmon in the watershed below dams, and it did not reference any efforts that might provide this information. The Plan did mention Study Type J5, which involves habitat use, abundance, and survival of salmonids below the dams, but this study type did not specifically address hatchery/wild salmon interactions. Finally, in contrast to the assumption of the proposal's objective, it is likely that mimicking size and timing of natural smolts would increase the likelihood of adverse interactions between hatchery and natural origin salmon if it is even possible to successfully mimic natural smolts. Therefore, the plan should consider the tradeoffs between attempting to produce hatchery salmon that are more similar to natural salmon versus producing hatchery salmon that minimize ecological interactions with wild salmon. It appears to the ISRP that producing hatchery juveniles that are more similar to natural juveniles for the purpose of improving the survival rates of hatchery fish and for reducing the potential deleterious genetic effects when hatchery and natural salmon interbreed are not clearly stated as objectives. These topics need to reflect potential detrimental consequences from increased competition and direct predation.

In one of the FY 2012 proposals (AP-6 spring Chinook genetic diversity), microsatellite allele frequencies in hatchery and wild fish were going to be used to infer whether hatchery management was preserving life-history variation. That is, if the hatchery stocks contained the variation extant in the wild fish and allele frequencies were similar, then the implication is that genetic attributes responsible for life-history variation were being preserved. This argument is not supported by empirical or theoretical justification. Allele frequency variation could be used to evaluate genetic drift, inbreeding, effective population size, and such. But important selection could be taking place at loci not being tracked by the neutral loci.

Similarly, within the Columbia River Basin, it is the practice to monitor juvenile outmigration timing and adult run migration timing and compare hatchery and wild within a system. This provides an interesting data set and might contribute to explaining a portion of the observations on success or failure of management efforts. It is very difficult to interpret genetically. The implication is that if juvenile and adult migration timing, age of migration, and such are similar between the hatchery and wild component then everything is fine. This might not be the case. What is needed is an evaluation of trends through time in wild fish from a population not exposed to interbreeding with hatchery fish compared to a population that is interbreeding. The hatchery and wild components of a mixed population might be different owing only to hatchery rearing experience – and no genetic differences exist because it is a single equilibrium population. The hatchery and wild components of a mixed population might be the same because it is a population in genetic equilibrium, but different from a population not exposed to hatchery influence. That comparison would be the revealing one, informing the managers that genetic alteration is taking place in the wild component of the mixed population. Finally, trends through time are often used to evaluate programs, with the implication that if trends do not vary much everything is fine. Again, this may not be the case. In the face of altered environmental conditions (hydrograph, geographic spawning locations, etc.) and altered future environment from climate change, the populations may change. The goal of the management should be to preserve to the greatest extent genetic variation in the extant populations so they can evolve. Management actions with regard to hatcheries and other elements need to function in concert with natural selection, not in opposition to it. The hatchery should not be selecting spawning dates based on historical natural spawning dates if climate change is causing the natural population to shift. Designing monitoring schemes to pick up the signals from the natural population so they can be incorporated into hatchery operations are absent from the plan.

Downstream Passage of Juvenile Fish

> *Corps' Question 1.a.iii. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for: …downstream fish passage around or through reservoirs and dams.*

Most of the uncertainties related to downstream passage of juvenile Chinook and steelhead were included in the RME Plan, but the manner in which they were presented in the Plan lacked appropriate focus on the most critical issues. The most critical information that needs to be collected to address management decisions about juvenile fish passage of Willamette Valley Project reservoirs and dams is survival of the fish. The fish can exhibit any of three basic rearing behaviors: 1) rear above the reservoir, 2) rear in the reservoir, and 3) rear below the reservoir. Understanding how survival compares among these three rearing options will provide the information required to judge whether or not capture of fish at the head of the reservoir and transport downstream would provide a significant survival advantage.

Estimation of survival rates of fish utilizing different rearing strategies is one of the issues identified in the Plan, and there are proposed studies to examine this question. However, the Plan, concept papers, and proposals did not adequately address some of the methodological issues that are likely to be encountered in making these estimates (see discussion below). Smolt-to-adult survival rates (SARs) for the three rearing types also should be compared, as lower survival for one of the pathways during freshwater rearing could be compensated if these fish survive to adult at a higher rate. This may well be the case if reservoir-reared fish are considerably larger than river-reared fish at the time of emigration. Addressing many of the other uncertainties related to downstream passage, like predation rates in the reservoirs, may not be required if there is no appreciable difference in survival rates among the three rearing types or if reservoir-reared fish actually enjoy higher survival rates. The recent ISAB Food Web Report (2011-1) provides a thorough review of the issue of the effects of predation on juvenile salmon and steelhead and could provide useful information for developing some initial appreciation for the likely impact of this process in the Willamette. The Plan should make clear that there are several questions of overriding importance related to downstream passage of juvenile salmon and steelhead that need to be addressed first. A better understanding of survival will provide a much clearer indication of the other issues that need to be addressed.

As noted earlier, the Plan would have benefited from a more comprehensive review of information currently available about salmon and steelhead in the Willamette system. The Plan noted, "Historically, a wide-diversity of UWR Chinook life-history types was common, with many using the lower tributaries and mainstem for rearing (Mattson 1962)." The Plan does not provide any details on this issue. For example, what were the life history types? How many of them are still evident? What prospects are there for the hatchery-produced fish to mimic them? Are the habitats that supported these life history types still capable of supporting them? Some understanding of the range of life-history types that existed in the Willamette and the habitats they used may help to prioritize the types of studies that will be required to improve survival to smolting. It would be useful to compare the Mattson (1962) data with the Rich (1920) data mentioned in Bottom et al. (2005) to get a possible perspective on estuary habitats (e.g., lower Willamette River).

> *Corps' Question 1.c. Juvenile downstream passage: Are the study approaches in the Plan and in the FY 2012 proposal packet appropriate for evaluating survival and life history diversity of juvenile Chinook and steelhead under two general proposed passage alternatives: 1) entering reservoirs with collection and/or passage at the dam(s); or 2) collection at or near the head of a reservoir with transport to below dam(s)?*

This question is directly addressed in the one-page concept papers. Project JPL 6 is intended to compare survival of juvenile fish transported around the reservoirs and dams with fish that enter the reservoirs and are either collected in the forebay or pass through the dams. There are a number of technical challenges associated with this investigation, including tagging very small fish, recapturing sufficient numbers of tagged fish to estimate survival, and collection efficiency by size and age class. Actual detail on study approaches for addressing this issue is not provided in the Plan, the concept papers, or the proposal packet. Precise life-stage monitoring and separation of survivals from freshwater and ocean life stages will be critical to identifying the management actions most likely to contribute to recovery. Collection of these data is of considerable significance to the re-introduction of Chinook and steelhead above the Willamette Valley Project projects. Efforts to thoroughly understand life-stage specific survival rates should be given higher priority than they appear to receive in the documents being reviewed.

Corps' Question 2.b. Juvenile survival and migration below Willamette Project dams –

i. *Should investigation into timing of use and survival of juveniles in Willamette tributaries below dams, and/or in the mainstem Willamette be completed, given 1) the state of knowledge regarding Chinook use and survival in the Willamette Basin below dams, and 2) the schedule for implementing specific RPA measures for fish passage, flows, water quality, adult passage, hatchery management, and habitat restoration?*
ii. *If yes for 2.b.i., are the critical questions and study types listed in Section 2.1 appropriate (i.e. will investigation of those critical questions following the general study types presented in Section 2.1 efficiently and effectively identify timing of use, survival rates and associated limiting factors)?*
iii. *How important is considering life history diversity, survival and use (including migration timing) of the lower mainstem Willamette, Lower Columbia River, and Columbia River estuary by Willamette juvenile Chinook and steelhead when planning and implementing improvements for Chinook and steelhead at the Willamette Project dams? What coordination opportunities do you see, given ongoing work in the Lower Columbia and estuary?*

Investigation into migration timing, habitat use, and survival of juvenile salmon and steelhead in Willamette tributaries below dams, and in the mainstem Willamette should be completed in cooperation with agencies or research organizations also working on salmon recovery in this subbasin. Studies on juvenile salmonids in the Willamette system should be coordinated across the subbasin. Data at one location should be collected, analyzed, and interpreted in a manner compatible with procedures being applied in other projects on juvenile salmon and steelhead. Studies on the lower mainstem Willamette, Lower Columbia River, the Columbia River estuary, and the ocean for Willamette juvenile Chinook and steelhead cannot, and should not, be separated from planning and implementing improvements for Chinook and steelhead at the Willamette Project dams. The fact that these fish migrate make this an integrated system and, therefore, it needs to be restored and managed as such. For this reason, Study Type J5 (Habitat Use, and Reach Abundance and Survival of Upper Willamette River [UWR] Juvenile Chinook and Steelhead below Willamette Valley Project Dams) probably should be started before the others. But Study Type J5 should evaluate hatchery and natural origin fish separately and investigate interactions as noted in the plan. If habitat conditions and fish survival in the lower river are poor, then restoration efforts should be concentrated there before addressing habitat issues closer to the Willamette Valley Project dams. As all fish must pass through the lower Willamette River on their way to and from the ocean, a survival bottleneck in this location could greatly reduce the effectiveness of any measures implemented upstream.

It is encouraging to see that the importance of the estuary to juvenile Chinook, and possibly steelhead, is recognized for the Willamette, especially as the lower reaches of this river are tidal and clearly part of what practitioners consider the upper estuary. The ISRP believes that there would be considerable value in better coordination with Lower Columbia River Estuary groups to further understand how juvenile salmonids from the Willamette River use this area and to gauge juvenile survival through the estuary. The performance of Willamette River fish at the transition from fresh to salt water is of special concern since the Willamette Basin has the highest human population density and some of the highest pollution levels recorded in juvenile salmonids (see comments below).

The proponents state they will collaborate with other projects to "estimate the number of released fish surviving to the estuary through mark-recapture methods (e.g., acoustic tags)" but details were not

provided on other researchers or studies. In Plan section *6.2.4.7 Spatial/Temporal Scale* the proponents mention that a study design on this topic is not available yet. Therefore the estuary component of the project, at this stage, is a plan to develop a plan.

Opportunities exist for collaboration with numerous, ongoing Columbia River estuary studies. Due to the large number of tags required to get a reliable survival estimate and the difficulty of capturing juvenile fish in the estuary, these studies must be conducted collaboratively. Coordination with NOAA researchers locating marked fish in the trawl samples in the estuary would clearly provide valuable information on Willamette fish. Joint Pacific Northwest National Laboratory (PNNL), Corps, and NMFS studies of acoustic-tagged fish were conducted earlier (e.g., McComas et al. 2008), but it is not clear if this work is continuing. If it is, there may be an opportunity to add tagged fish from the Willamette. There may also be opportunities for joint sampling with researchers working on habitat restoration in a number of locations, such as Grays River. The Willamette fish could enter a number of lower river tributaries, and a comprehensive study design is required to ensure sampling effort is sufficient to provide a clear indication of the distribution of Willamette origin fish in the estuary. Collaboration should also be sought with researchers working on food-web ecology in the estuary (e.g., LCREP) because energy flow, predation, and other aspects of trophic dynamics are all important, although frequently overlooked, components of habitat. A project being conducted under the Lower Columbia River and Columbia River Estuary Ecosystem Monitoring and Data Management program (200300700; "Application of the emerging Columbia River Estuary Ecosystem Classification system") in the Columbia River reaches between river km 140 and river km 200 is also relevant. Habitat use by juvenile Chinook is being investigated, and some of these fish might originate from the Willamette basin.

In addition to the lower mainstem Willamette, Lower Columbia River, and Columbia River estuary, the ISRP recommends that consideration of ocean life history diversity, survival, and use (including migration timing) of ocean habitats, is important when planning and implementing improvements for passage of Chinook and steelhead at the Willamette Project dams. In particular, knowledge of variability in smolt-to-adult survival rates (SARs) is necessary to evaluate whether planned actions taken at Willamette Project Dams are effective. It is generally well accepted that SARs of salmon and steelhead are strongly influenced by early ocean conditions, although responses may differ between species (e.g., Burla et al. 2010). Furthermore, plans to develop hatchery stocks that mimic wild fish only during the freshwater life-history phase might be unsuccessful. Reduction in genetic and life-history diversity (e.g., age, size, growth rates, and timing of ocean entrance) by replacement of diverse wild populations with a few hatchery stocks has likely already reduced resilience of Willamette River salmon to changing ocean conditions. Age and size at ocean entrance, growth rate, and timing of ocean entrance with respect to early ocean conditions (e.g., river plume structure, sea surface temperature, and predator-prey abundance) are well-known factors influencing early ocean distribution, migration patterns, and survival of salmon and steelhead (e.g., Claiborne et al. 2011 and many others). In addition, tagging experiments have shown the Willamette River spring Chinook (yearlings) migrate rapidly northward to waters off British Columbia, southeastern Alaska, and beyond (e.g., Tucker et al. 2011 and others), while Columbia River steelhead migrate to international waters of the Gulf of Alaska during their first summer at sea (e.g., Burgner et al. 1992). At these and subsequent distant-water ocean life-history stages, ocean conditions will further influence survival, as well as size-at-age, size and age at maturity, and timing of adult returns to the river (e.g., Wells et al. 2007).

The ISRP encourages coordination with the three ongoing Bonneville Power Administration-funded projects investigating ocean survival, life history diversity, and use of the Columbia River plume and

more distant-water ocean habitats: Ocean Survival of Salmonids (#1998-014-00), Canada-USA Shelf Salmon Survival (2003-009-00), and Coastal Ocean Acoustic Salmon Tracking (COAST) 2003-114-00. In addition, coordination with the work of other state, federal, and international agencies and organizations, e.g., Alaska Department of Fish and Game, NMFS Alaska Fisheries Science Center, Pacific Salmon Commission, North Pacific Anadromous Fish Commission, and others, conducting ocean research, monitoring, and evaluation of salmon and steelhead would be a beneficial and cost effective approach.

Flow, Habitat and Water Quality

> *Corps' Question 1.a.iv. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for: …temperature and TDG conditions below dams?*

The Plan indicates that these issues will be addressed by coupling models with field data collection. This approach has been used previously in the investigation of the effects of dam water releases of temperature and dissolved gases. It seems that the CE-QUAL-W2 (Cole and Wells 2001) and the Hydrologic Engineering Center Reservoir System Simulation (HEC-ResSim) work quite well for these parameters. Additional studies should not be required other than to validate or monitor results at each dam. In general, existing literature and models can resolve the uncertainties identified in the Plan relative to temperature and dissolved gases. Physiological responses to temperature and gases are reasonably well understood for these species. The Plan elements linking changes in temperature and dissolved gases to fish population performance are more tenuous, in part due to the fact that many other factors influence the fish (as noted in the Plan). This problem is common to many of the Plan uncertainties as the process of linking site-level responses by the fish to responses at the distinct population segment or evolutionary significant unit (DPS or ESU) scale is not fully developed (see discussion below). If additional work on the effects of dam releases on water temperature or dissolved gases is required, use of the available literature and models to structure the questions as testable hypotheses would be the most efficient approach.

One key issue related to flow level below the dams was not included in the Plan. The Willamette Valley has a large human population with considerable discharge of waste into the Willamette River from waste water treatment plants (WWTP). WWTP discharges contain many contaminants that recent research has shown to be toxic to many aquatic organisms. Juvenile salmon from the Upper Willamette River contained high PBDE (flame retardant) concentrations when compared to salmon from other locations in the Columbia Basin (Sloan et al. 2010, see citation in ISAB Food Web report p. 125). PBDE concentrations in Osprey eggs (a species that only eats fish), including data from the Willamette River were high and seemed related to river flow and WWTP discharge volume "a dilution effect" (Henny et al. 2011). There is little or no understanding of the potential effects of these chemicals on juvenile salmon survival. Flow of the river is critical for dilution of discharges from WWTP, but this issue does not seem to be addressed in the Plan. Perhaps add under 2.3.1 or 2.5.2: Relationship between discharges from Corps dams and downstream dilution of discharges from WWTPs. Improved understanding of the extent to which juvenile and adult salmon use habitats in close proximity to WWTP discharges also would provide some indication of the possible severity and distribution of this issue.

Corps' Question 1.a.v. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for: … flow management below dams for fish and aquatic habitat?

The uncertainties associated with this question are closely related to water quality uncertainties; both questions are attempting to relate flow level to habitat quality for Chinook and winter steelhead. The development and application of a PHABSIM model to assess the effect of changing flow rates on suitable habitat availability should provide some useful information. However, the effect of flow on habitat is a complex issue as it involves not only water but also sediment, nutrients, temperature, and other environmental components. Certain habitats that may fall outside the preferred depth and flow velocity ranges could be important if these sites provide refuge from stressful conditions. For example, shallow areas where groundwater enters a channel may not exhibit ideal velocity and depth but may be used by the fish during warm periods. During winter, access to floodplain habitats may be important, although the standard PHABSIM model may not capture these off-channel habitats. A survey of selected reaches known to be heavily used by juvenile salmon and/or steelhead during periods considered to be particularly stressful during freshwater rearing could provide an indication of the location of these refuge sites and enable an evaluation of how access to or use of these locations could be affected by changes in river level. Further, extreme flows – both high and low – shape and re-shape habitat over longer temporal scales. Unfortunately, these very important aspects are overlooked in most in-stream flow analyses. While the Plan partially addresses some in-stream flow issues, it is much too narrowly focused on flow velocity and water depth as the sole descriptors of habitat quality rather than providing an analysis of the dynamic nature of flows and how they relate to the longer term sustainability of salmon and the ecological system. Important topics that appear to be overlooked include habitat classification and dynamics, sediment characteristics and regimes, understanding habitat potential to produce fish, seasonal and annual carrying capacity, characterization of food sources and availability, occurrence of toxic materials, and other aspects related to maintaining and sustaining salmon within a larger integrated and well-functioning system.

The Plan also appears to view habitat issues at a local scale, primarily in proximity to dams. However, salmon and steelhead utilize much of the drainage network in the Willamette subbasin and their habitat needs change over time. Therefore, issues related to operation of the Willamette Valley Project on habitat should be evaluated at the scale of the entire basin or "riverscape" (e.g., Fausch et al. 2002, ISAB 2011-1, ISAB 2011-4). Studies should focus not only on the effects of a management action at sites closest to the site where this action occurs but also evaluate the response to this action at other locations in the basin. The effect of river flow on the dilution of WWTP discharges discussed above is an example where a decision about release volumes from Willamette Valley Project dams can have an impact on habitat quality at considerable distance from the site where this action occurs. Broadening the perspective of flow impacts on both water quality and physical habitat can most effectively be accomplished by integrating and coordinating the set of RME projects examining these issues, ensuring that results from a study at one site can be applied to data being collected at other locations. It may well be that investigation of water quality and habitat uncertainties are well integrated, but the RME Plan does not reflect close coordination.

Additional Study Types

Council Question 1.d. Are there other study types that should be included that better answer critical questions in a timely manner to improve fish passage, flows, water quality, hatchery effects on wild fish, and habitat restoration (e.g. for evaluating growth, survival and migration of salmon entering reservoirs as fry)?

A number of other study types are needed, some of which are described in responses to previous questions. In general, the priority study needs relate to establishing habitat-specific carrying capacities; providing a more comprehensive approach to understanding and managing "in-stream" flow needs; establishing better connections with the human community; and working to ensure that downstream conditions – now and into the future – are suitable for migrating fishes. Overall, the suite of studies and monitoring efforts should be sufficiently integrated to provide a riverscape/landscape approach to recovering the ESA species and their habitats (Fausch et al. 2002, ISAB 2011-1, ISAB 2011-4). A riverscape/landscape approach provides many benefits, including more effective use of limited dollars to achieve recovery goals.

A key re-introduction issue is enabling juvenile salmonids to rear and pass through the reservoirs and dams with as little mortality as possible. The Plan and proposals will evaluate survival of Chinook captured and transported around the reservoirs and dams versus survival of those allowed to pass through the reservoirs and dams. Another approach that should be considered is to drawn down the reservoir during late winter and early spring (before significant recreational use) so that juveniles can be flushed out of the reservoir. Reservoirs are typically maintained at low levels during winter for flood control, but this approach may require additional draw down in order to encourage emigration. This effort could be associated with study JPL-9. Potential adverse side effects of drawdown should be evaluated such as downstream water quality and sedimentation; export of non-native fishes and sport fishes to downstream areas; and the ability of salmon prey to recover in the reservoir and support rearing salmonids during spring, summer, and fall. Significant reservoir drawdown would likely reduce the predator population in the reservoirs and could improve survival of salmon while rearing there and while attempting to pass through the dams. This approach may reduce or eliminate the need to construct expensive collection devices to route salmonids through or around dams.

Adaptive Management

Corps' Question 1.b. Does the effectiveness monitoring framework provide for a clear adaptive management decision path?

The adaptive management process described in the Plan is not comprehensive enough to be truly effective. The process could be much improved by applying an approach as described by Walters (1986). The process as described in the Plan lacks a description of how public involvement will be encouraged and provides no indication of the manner in which data and project results will be archived. Retention of information can be important to support management decisions that may be required well in the future, long after a project or activity has been completed. The process for communicating project results to decision makers also is not fully developed in the Plan. One option that has been effective in other programs is annual research meetings. To be most effective, these meetings should be open to the public, researchers, and managers. Other decision makers should be encouraged to participate.

The number of teams that have been convened to guide implementation of the Plan may hinder effective transfer of research results. The logistics of finding enough qualified people, holding the meetings, exchanging information in a time-sensitive environment can be daunting. The makeup of some of the teams also is unclear. Are decision makers, administrators, managers, as well as technical personnel included on any of these teams? If not, then the process is not fully integrated and an opportunity for effective transfer of technical information is being overlooked. Is there a way to reduce the number of teams or otherwise simplify the process by which the Plan is managed? It was apparent from our review of the FY 2012 research proposals that some of the investigators were not fully aware of other proposed projects or the proposals did not reflect this awareness.

Evaluation at Multiple Spatial Scales

> *Corps' Question1.e. Does the Plan identify the appropriate metrics and approaches for evaluating the effectiveness of actions at different scales (e.g., the specific project, population, and ESU/DPS levels) in order to determine if the RPA is effectively addressed?*

Many of the uncertainties identified in the Plan are focused on one or several of the Willamette Valley Project sites, especially the work evaluating downstream passage of juveniles, water quality, and habitat. The studies on adult upstream migration and pre-spawn mortality of Chinook are more broad-based in that they will attempt to examine the behavior and fate of the fish from Willamette falls until spawning. However, the manner in which the results from these various projects will be integrated to provide an indication of progress against viable salmonid population (VSP) goals or other ESA standards was not completely described. The development of effective large scale conservation and restoration programs must involve broad-scale evaluations of the relative benefits associated with different actions (ISAB 2003-2).

Chapter 3 of the Plan suggests that scaling results from site-level investigations to larger spatial scales will be accomplished through the application of models. These models will be parameterized using available data or expert opinion. The proposed modeling approaches rely heavily, if not exclusively on HEC-ResSim and CE-QUAL-W2. While these may be useful tools for some applications, they should be coupled with other models that are more appropriate for linking habitat to biological responses. Population models often enable the projection of life-stage-specific survival or production capacity in response to habitat characteristics that may vary with landscape context and restoration action. Linking habitat to life history characteristics remains a fundamental challenge for effective restoration. Management for wide-ranging species occurs over vast areas, such as whole watersheds and regions that contain multiple habitats. Therefore, scaling results from site- to landscape-scale requires multiple quantitative and qualitative models.

Modeling fish–habitat relationships is not a new endeavor. For salmon in particular, a rich literature exists dating back at least 30 years which describes how changes in the quantity and quality of habitat affect the survival of specific life stages (e.g., Tappel and Bjorn 1983, Chapman 1988). Some studies model the influence of in-stream habitat attributes on the survival of salmon at specific life stages (e.g., McHugh et al. 2004), and some do so across the entire life cycle thereby demonstrating the importance of various habitat changes on overall population dynamics (e.g., Greene and Beechie 2004, Sharma et al. 2005). Additionally, changes in land use by humans continue to affect salmon through their indirect

effects on habitat forming processes. Predicting the impacts of current and future alterations to salmon habitat requires a holistic modeling perspective that captures not only the expected future population size but also relevant information on stock productivity, spatial structure, and the diversity of life-history types (Lichatowich et al. 1995). Further, it is increasingly recognized that many stream fishes require the mosaic of habitat types throughout a riverine landscape to complete their life cycles as well as the diverse array of food sources produced by those habitats (ISAB 2003-2, 2011-1, 2011-4; Wipfli and Baxter 2011).

There is considerable experience with the use of models in other areas of the Columbia Basin that could be used to help guide development of a process to assess program effectiveness in the Willamette. Several of these models recently have been evaluated to determine whether their predictions are accurate. Models such as Ecosystem Diagnosis and Treatment (EDT) have been widely applied in developing subbasin plans and are continuing to play significant roles in establishing restoration priorities. As well, in-depth sensitivity analysis of EDT and other models has been conducted to quantify which model output are most or least certain (Steel et al. 2009, McElhany et al. 2010). Further, the Columbia Habitat Monitoring program (CHaMP, project 2011-006-00) and the Integrated Status and Effectiveness Monitoring Program (ISEMP, project 2003-017-00) are relying heavily on habitat data to calibrate fish-habitat models for evaluating restoration effectiveness.[1]

Program Structure, Timeframe, and Effectiveness

> *Corps' Question 1.f. Does the Plan identify a sufficient framework for testing whether implementation of a related suite of RPA measures for: 1) adult fish passage/reintroduction actually leads to greater spawning success (metric to be identified) over current conditions, 2) juvenile fish passage lead to greater overall migration survival?*

The answer to this question is discussed in other sections and summarized here. The Plan includes studies to evaluate spawning success of transported adult salmon and survival of their progeny via reservoir/dam passage or transportation around the dams. However, it is unclear whether the proposed changes during adult capture and transport might be sufficient to significantly reduce pre-spawning mortality (e.g., date of transport, location of release, treatment with antibiotics, more frequent sampling). Likewise, for comparison of transported versus in-reservoir juvenile survival, we note that detection rates of PIT-tagged fish at Willamette Falls is very low, suggesting that additional sampling of PIT-tagged salmon may be needed to detect differences in survival (see proposal review). Life-cycle modeling was discussed in the Plan, and this approach could be coupled with existing smolt-to-adult survival rates to evaluate what survival rate is needed during the adult to smolt stage to produce a self-sustaining population above dams. More than one year of investigation is needed for survival studies.

The need for evaluating VSP metrics of natural origin salmon was identified in the Plan, but the level of detail and duration of monitoring activities to collect VSP data was unclear. The overall success of RPA measures can be measured in part by collecting data to estimate R/S of the re-introduced population above dams and ensuring that it exceeds replacement (R/S > 1) on a consistent basis. If the productivity (R/S) of the re-introduced population is less than one, on average, then the population will not be viable and it will require continued intervention such as stocking with hatchery salmon. This type of an

[1] See http://www.nwcouncil.org/library/isrp/isrp2011-10.pdf

approach to evaluating the overall effectiveness of RPA measures could have been discussed in more detail in the Plan. Life cycle productivity exceeding replacement (1) is required in order to potentially achieve other VSP goals involving abundance, diversity, and spatial structure of the population.

> *Corps' Question 1.g. Is the framework and metrics described in the plan useful for programs in addition to implementation of NMFS' RPA (e.g. UWR Chinook and Steelhead Recovery Plan)?*

The projects planned for the Willamette are focused on meeting the requirements of the NMFS RPAs. Nonetheless, if demographic information sufficient to track VSP parameters over time is collected, it would be of use to other programs being implemented in the Willamette Subbasin. The part of the Plan that addressed the collection of these data is not complete enough to determine if the protocols to be used are sufficiently rigorous to ensure the appropriate data are collected to evaluate VSP parameters. There are four VSP parameters – abundance, productivity, diversity, spatial structure. Not all four are mentioned in the VSP metric column in Table 2-4 on page 2-26, which indicates the VSP parameters that will be measured. There are some other parameters included in this table with less than apparent relevance for assessing progress against VSP parameters. For example, it is not clear how pHOS is a measure of diversity and how this metric is related to transportation dates and locations. The process by which VSP parameters will be tracked could be presented in a much cleaner and more explicit fashion. In addition to using the VSP persistence scale approach developed by McElhany et al. (2000) and briefly mentioned in Chapter 3, basic stock-specific population statistics, including adult abundance by age and gender, adult return per spawner, and smolts per spawner should be monitored annually. Metrics should be kept separate for hatchery and natural origin fish.

> *Corps' Question 2. Given 1) the state of knowledge of the problem and potential solutions, 2) the experience/feasibility of available techniques for completing scientific studies under local Willamette Project conditions, and 3) RPA completion deadlines for specific actions: Are the sequence and timeframes for each study type in the Plan's subbasin schedules (Chapter 5) appropriate for addressing critical information needs associated with implementing the subbasin specific RPA measures listed in the Plan?*

Based on the Plan, the RPA timelines appear to be very tight with implementation of actions to occur within several years. Unfortunately, it may take multiple years to collect sufficient data to resolve many of the important uncertainties. Reasonable corrective actions cannot be implemented until understanding of these uncertainties has improved. For example, pre-spawn mortality of Chinook salmon varies considerably from year to year. As a result, multiple years of data are likely to be required before causes of pre-spawn mortality can be identified. Implementing actions to address pre-spawn mortality before the studies examining this problem have progressed sufficiently pose the risk of being both costly and ineffective. Timelines for RPA implementation should consider the length of time required to develop some understanding of the uncertainties associated with that RPA.

The re-introduction of salmon above the projects is reasonably straightforward, and the field and laboratory technology to evaluate success could be implemented in short order. Looking at table 5-4, the studies for developing hatchery rearing strategies for wild type fish and evaluating methods to reduce straying and increase harvest need more development to actually address the important uncertainties. The hatchery section of the North Santiam (page 5-5) identifies very specific management actions like stopping the recycling summer steelhead (catching them at the dam or hatchery and then trucking them back downstream for release for recreational angling) and moving 30,000 smolts from

release in the North Santiam to the South Santiam. It is not clear how these actions are going to be evaluated in terms of their effect on winter steelhead or natural spring Chinook VSP parameters.

ISRP Comments on the FY 2012 Concept Papers

> *Corps' Question on Concept papers*: *Do the FY12 concept papers contain the necessary objectives, and are the objectives stated clearly and accurately, to support development of proposals to address critical subbasin information needs in FY12, considering the implementation order of NMFS RPA, 2011 Recovery Plan priorities, and data gaps and schedules presented in Chapter 5 of the Plan?*

The concept papers are useful in that they bring some added structure to the discussion of uncertainties that was the focus of the Plan. As with the Plan, however, there is no indication of priority associated with the various study concepts. Such a prioritization would greatly aid in scheduling the implementation of projects. Many of the concept papers were not included in the FY 2012 proposals that were reviewed by the ISRP. The concept papers did not include life-cycle modeling efforts (studies I1, I2). The concept papers were brief (one-page) and therefore lacked detail. Comments on concept paper objectives are briefly noted below.

- Objectives for JPL-5 need to incorporate identification and evaluation of hatchery versus natural origin fishes. The objectives should also include evaluation of interactions between hatchery versus natural origin fishes, which was listed in the Plan as a critical uncertainty. Portable and/or fixed PIT tag detectors should be considered for interrogating the numerous PIT-tagged fish that will be released upstream.

- JPF-5 should consider evaluation of fish use and rearing habitat capacity in tributaries and the mainstem Willamette downstream of the targeted reach areas, which are tributaries immediately below the dams.

- Objectives for JPL-9 might include using reservoir drawdown to flush juvenile salmonids through the dams.

- Objectives for IFW-1 seem to overlap with those of JPL-5. This is fine as long as the effort is not duplicated.

- Objectives in IFW-2 do not seem to include a fish component, which should be a key part of evaluating whether proposed ramping rates strand salmonids.

- APH-1 and APH-2. These studies might consider evaluating stress (cortisol measurements) of transported fish since a key goal is to reduce pre-spawning mortality. Also, have contaminants encountered during upstream migration affected pre-spawning mortality?

- APH-4. Lower survival of female Chinook can be related to greater age at maturation and lower survival associated with older age. Objectives should include age determination for each gender, including precocious males.

- APH-13. Objectives could include an evaluation of spawning habitat quality. Does available habitat appear to be adequate to support spawning?

- APH-14. It is not clear how the GRTS survey approach will lead to reduced ecological and genetic effects of hatchery fish on natural fish, as stated in objectives 1 and 2. Objectives 3 and 4 are appropriate (monitor numbers of hatchery and natural origin spawners).

- APH-14. The objectives should include testing the presumed hypothesis that reducing densities in the hatchery increases fish size and survival, rather than simply monitoring the fish.

- APH-16. It would be good if this investigation of disease could include analysis of disease among fish transported and released above dams to identify the extent to which disease (and stress) is a factor in pre-spawning mortality.

- SIP-1. The objectives of this study could be more specific, e.g., numbers and timing of adult steelhead (winter run, summer run, hatchery/natural) in mainstem and tributaries, etc.

- Technology Development 1. This study might consider further evaluation of PIT tag shedding and tag-related mortality given recent findings in other areas of the Columbia Basin.

- Technology Development 3. This study might consider marking and releasing different sizes and species of fish at various reservoir elevations when evaluating the collection system for reservoirs. In other words, an experimental approach should be used to evaluate the device.

ISRP Comments and Recommendations on Proposals

This ISRP review section includes specific recommendations and comments on each of the 18 proposals submitted to the ISRP for review. The proposal comments are organized in the order received in the proposal packets from the Corps. The ISRP's recommendations terminology is essentially the same as used for the ISRP's reviews of projects to implement the Northwest Power and Conservation Council's Columbia River Fish and Wildlife Program.

The ISRP uses the following terms for final recommendations:

- Meets Scientific Review Criteria
- Meets Scientific Review Criteria (Qualified)
- Meets Scientific Review Criteria - In Part
- Meets Scientific Review Criteria - In Part (Qualified)
- Does Not Meet Scientific Review Criteria

Response Loop Note. ISRP reviews of Fish and Wildlife Program proposals include a response loop in which the ISRP requests additional information from a project proponent to address any deficiencies or unclear items. The project proponent is generally given three to four weeks to address the ISRP's concerns in a formal written response often including a revised proposal. The ISRP bases a final recommendation on the response. Many of the Willamette BiOp proposals below that received a "does not meet scientific review criteria" recommendation had deficiencies that might be addressed in a response. That is, they simply lacked important information to conduct a full review on the scientific merits. A response loop is not, however, built into the Corps' review process and the ISRP is participating in another major review this winter. Consequently, the ISRP did not request responses. If the Corps' wants certain proponents to respond and resubmit revised proposals to address ISRP concerns, the ISRP can certainly entertain such a request. However, the ISRP intends that its review comments include enough constructive suggestions that the Corps can work with any high priority projects to remedy deficiencies without immediate ISRP review.

The full definition for ISRP recommendation categories are:

1. Meets Scientific Review Criteria is assigned to a proposal that substantially meets each of the ISRP criteria. Each proposal does not have to contain tasks that independently meet each of the criteria but can be an integral part of a program that provides the necessary elements. For example, a habitat restoration project may use data from a separate monitoring and evaluation project to measure results as long as such proposals clearly demonstrate this integration. Unless otherwise indicated, a "Meets Scientific Criteria" recommendation is not an indication of the ISRP's view on the priority of the proposal, nor an endorsement to fund the proposal, but rather reflects its scientific merit and compatibility with Program goals.

2. Meets Scientific Review Criteria - In Part is assigned to a proposal that includes some work that substantially meets each of the ISRP criteria and some work that does not. The ISRP specifies which elements do not meet the review criteria and recommends that initiating work be delayed until certain technical issues are properly addressed. Examples are proposals that include objectives that are not scientifically supported, for instance, a proposal for both background assessment work and concurrent

on-the-ground implementation that cannot be justified before results of the assessment are known, or proposals that include use of unsound methods to meet a particular objective. “In Part” is also used for proposals that are justified for a portion of the years proposed for funding, but would benefit from an interim review within those years, for example, a proof of concept research project for which methods need to be tested at a pilot scale before full implementation. Required changes to a proposal will be determined by the Council and Bonneville Power Administration (BPA) – or for reimbursable program projects, the Corps or USFWS – in consultation with the project proponents in the final project selection process.

(Qualified) is assigned to recommendations in the two categories above for which additional clarifications and adjustments to methods and objectives by the sponsor are needed to fully justify the entire proposal. The ISRP expects that needed changes to a proposal will be determined by the Council and BPA – or for reimbursable program projects, the Corps or USFWS – in consultation with the project sponsor in the final project selection process. The ISRP also uses “Qualified” in two other situations: (1) for proposals that are technically sound but appeared to offer marginal or very uncertain benefits to fish and wildlife and (2) when further ISRP review of a project’s final implementation plan or analysis of results is needed before the project moves to full implementation. Regardless of the Council’s or BPA’s recommendations (or for reimbursable program projects, the Corps or USFWS), the ISRP expects that, if a proposal is funded, subsequent proposals for continued funding will address the ISRP’s comments.

3. Does Not Meet Scientific Review Criteria is assigned to a proposal that is significantly deficient in one or more of the ISRP review criteria. One example is a proposal for an ongoing project that might offer benefits to fish and wildlife, but does not include provisions for monitoring and evaluation or reporting of past results. Another example is a research proposal that is technically sound but does not offer benefits to fish and wildlife because it substantially duplicates past efforts or is not sufficiently linked to management actions. In most cases, proposals that receive this recommendation lack detailed methods or adequate provisions for monitoring and evaluation, and some propose actions that have the potential for significant deleterious effects to non-target fish or wildlife. The ISRP notes that proposals in this category may address needed actions or are an integral part of a planned watershed effort, but the proposed means or approaches are not scientifically sound. In some cases, a targeted RFP may be warranted to address the needed action.

Table of Proposals with ISRP Recommendations

Proposal Title	Study Code	Proponent	Meets ISRP Review Criteria?
1. An evaluation of carcass supplementation as a tool to influence spring Chinook salmon spawner distributions	Adult Passage 5 (obj. 4)	ODFW	Yes (Qualified)
2. Effect of size and time of hatchery Chinook releases on adult returns	AP-8	ODFW	Yes (Qualified)
3. Adult Chinook salmon monitoring in the South Fork McKenzie River relative to water temperature control and upstream passage facilities at Cougar Dam	None	ODFW	No
4. Effects of reduced spring Chinook salmon rearing densities at McKenzie River Hatchery	AP-15	ODFW	No
5. Survivorship, disease resistance and genotype-phenotypic characteristics of hatchery, wild, and hatchery-wild crosses of spring Chinook salmon in the context of reintroduction	AP-9	ODFW	No
6. Disease risks associated with hatcheries in the Willamette River basin	None	OSU	No
7. Genetic Diversity of Willamette River spring Chinook salmon populations	AP-6	ODFW	Yes (Qualified)
8. Genetic stock identification and relative natural production of Willamette River steelhead	Adult Passage 3	ODFW	Yes (Qualified)
9. Behavior, distribution, and passage metrics of juvenile salmonids in Willamette Valley Project (WVP) reservoirs and passed dams: Cougar Dam.	Juvenile Fish Downstream Passage and Life History - 3 (old FP-11-03)	USGS	Yes (Qualified)
10. Behavior, distribution, and passage metrics of juvenile salmonids in Willamette Valley Project (WVP) reservoirs and passed dams: Detroit Dam.	Juvenile Fish Downstream Passage and Life History - 3 (old FP-11-03)	USGS	Yes (Qualified)
11. Genetic pedigree analysis of McKenzie River spring Chinook salmon: An evaluation of adult outplanting strategies	None	ODFW	Yes (Qualified)
12. Development of a wild fish surrogate for UWR Chinook salmon	None	ODFW, USGS	No

13. Juvenile Salmonid Outmigration Monitoring at Willamette Valley Project Reservoirs	Fish Passage	ODFW	Yes (Qualified)
14. Life-history Characteristics of Juvenile Spring Chinook Salmon Rearing in Willamette Valley Reservoirs	Fish Passage	ODFW	No
15. Comparing the Effectiveness of Head of the Reservoir Collection and Transport with Direct Reservoir and Dam Passage	TBD (Juvenile Passage 6)	ODFW	Yes (Qualified)
16. Assess Water Operational Approaches to Reduce Predation on Upper Willamette River Chinook Salmon and Steelhead and Improve Juvenile Fish Passage in Willamette Valley Project Reservoirs	Juvenile Passage 9	ODFW	No
17. Monitoring upstream migration, distribution, and pre- and post-spawn survival of adult UWR winter steelhead and summer steelhead	Study Integration and System Performance 1; FP-09-04, FP-10-03	UI, ODFW	Yes
18. Monitoring upstream migration and potential causes of prespawn mortality in adult UWR Chinook, Middle fork Basin of the Willamette River	None	UI, ODFW	Yes

1. An evaluation of carcass supplementation as a tool to influence spring Chinook salmon spawner distributions

Study Code: Adult Passage 5 (obj. 4)
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

Qualified by the need to 1) more explicitly explain the experimental design including control and treatment stream attributes; 2) indicate annual variation in spawner abundance; 3) describe sample size requirements; and 4) justify treatment prescription dosage. See the ISRP comments and questions to consider.

ISRP Comments:

Goals and Objectives

This is a brief yet succinct and novel proposal to add Chinook salmon carcasses to treatment and control tributaries to test the action's effectiveness in attracting Chinook salmon spawners to underutilized areas. However, the proposal was so brief on some subjects as to be incomplete. The overall goal was reasonable as were Objectives 1-3. Objective 4, however, was vague and confusing. Some of the proposal's deficiencies are noted below.

Methods

The following deficiencies and comments apply to the methods:

1. The objectives and methods seemed clear, but should have been supported with evidence (data) and maps from the field to indicate the abundance and distribution of redds since outplanting began in 1993, including annual variation. It is likely that variation is great in both abundance and distribution. It is also likely that under-utilized areas lacked features that attract spawners, but these features were illusive to testable procedures.
2. The experimental design appeared somewhat superficial yet is likely sound if interannual and among-tributary variation is not excessive. Furthermore, information on how treatment and control sites were chosen was lacking, as was information on the number of sites (tributaries) in each catchment. A more thorough description of the parameters that will be used to show similarity and differences among treatments and controls was also expected, including *a priori* testing procedures on these.
3. The description of the statistical methods to be employed in the analysis was superficial. Although a simple ANOVA approach is most obvious, there are other options, such as constructing multivariate models using spawner abundance as the response variable that might offer some advantages. The proposal proponents should consider a range of possible analytical approaches and these should be described in the proposal.
4. The proposal notes that both carcass presence/absence and stream habitat attributes will be included in the analysis of spawner abundance and distribution at the study sites. Insufficient detail on specific habitat attributes that will be measured (or derived from previously collected data) was provided. Given that data on spawner distribution in the absence of carcasses are available back to 1993, it would seem that development of a spawner distribution model based

solely on habitat attributes could be based on these data. Post carcass placement, a response could be evaluated by examining deviations from the pre-carcass placement relationships between habitat and spawner abundance and that observed post-treatment.

5. No rationale was provided for the decision that the treatment consist of 10 to 12 carcasses per stream. It was not clear that this would be enough carcass tissue to enable live fish to detect the scent of the carcasses – no evidence was provided. The source to be used for the salmon carcasses should be identified.

Relevance to the BiOp

Increases to abundance and distribution of Chinook salmon spawners are directly linked to the BiOp. The use of carcasses to attract more spawners remains hypothetical but testable.

Research Plan (Background and Past Results)

High mortality of pre-spawners was noted, and may be the larger concern, among other issues (e.g., passage). Issues of harassment and poaching of spawners were noted, but there was no mention of how these would be addressed, and whether they may confound the results.

A pre-assessment of sample size requirements and statistical power should be possible given past data on abundance and distribution, and is highly recommended.

The proposal noted that information on spawner distribution has been collected using radio-tagged fish, but these data were not presented in the proposal. If radio-tagged fish will continue to be released in the vicinity of the study sites, these data could be used to augment redd and spawner survey data. No mention of tagging released fish in the future was made in the proposal.

There may be several reasons why "… adult Chinook do not utilize extensive reaches of apparently suitable habitat, but instead congregate at high densities that may lead to superimposition of redds and less-than-optimal production." The design provides an opportunity for a more comprehensive investigation of mechanisms causing this; the focus on carcasses as attractive agent alone may be too narrow. Further, are there other studies from the primary and secondary literature suggesting that carcasses attract spawning adults? If not, this should be clearly stated.

Specific Comments

1. The reports by Emig and Friesen *in prep.*, Zymonas et al. *in prep.* should be made available for review.
2. There were three objectives in one part of the proposal (where only one was needed) and four in another part of the proposal (the summary) – this was confusing.
3. It was stated that similar "control" tributaries will be identified and subsequently monitored but there was no description of what that monitoring would include. This is needed.
4. How many tributaries will be used in each catchment? This is important; the actual tributaries and their physical characteristics should be in a table in the proposal.

2. Effect of size and time of hatchery Chinook releases on adult returns

Study Code: AP-8
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

Qualification is based on the need to address questions and comments described below.

ISRP Comments:

Goals and Objectives

The stated goal of this research project is to assess the potential benefits and risks of juvenile hatchery spring Chinook release strategies on performance of hatchery Chinook salmon (e.g., SARs). The proposed objectives intend to meet the overarching objective (Peven and Keefe 2010, 2011) to "rear and release high quality hatchery fish to minimize impacts on naturally produced fish and promote conservation and recovery of listed species." To meet this objective, the project plans to "(1) Rear and release hatchery spring Chinook salmon to mimic size and behavior of naturally produced yearling migrants and (2) Investigate alternative rearing and release strategies to increase the adult return rate of hatchery fish such that fewer juvenile fish need to be released in order to reach mitigation objectives."

However, the proposal did not describe the size and behavior (migration timing) of natural spring Chinook salmon to which the hatchery would mimic. Instead, the proposed releases involve late fall, early spring, and late spring releases of fish that are progressively larger over time. Section 9 (Schedule) of the proposal identifies additional objectives (evaluate the effect of size at release on migration rate, passage timing and survival at Willamette Falls), but there is no discussion of these important objectives or their methodology in the proposal.

High growth rates coupled with high ocean productivity may contribute more to high SARs than juvenile body size at release. For example, BPA-funded NOAA ocean research (#1998-014-00: Ocean Survival of Salmonids) indicates that adult returns of yearling (not subyearling) spring Chinook migrants are highly, positively correlated with otolith growth in the first ocean summer and May-June levels of insulin-like growth factor. The ISRP encourages the proponents to plan and coordinate their research with NOAA ocean researchers.

The proposal implies that it is testing size and time at release effects on adult hatchery return rates such that strategies with higher survival might be combined with lower release numbers in order to reduce hatchery release numbers while maintaining adult return numbers and harvests. It appears that this proposal only involves releases from one brood year. One year is likely insufficient to fully test the goals and objectives given that environmental conditions will change from year to year and would likely affect findings. Furthermore, the proposal should clearly state that it is not independently testing the effects of size and release timing on SARs. Smaller salmon will be typically associated with earlier release timing. At McKenzie Hatchery, the investigators noted an unusual bimodal size distribution of fish to be released in November. The reason for this bimodal pattern is apparently unknown and should be investigated because it is likely related to unique rearing conditions of the test group. The investigators apparently will use this bimodal size distribution to further test the size at release hypothesis, but the

proposal needs to clearly identify that this test will involve fish that have two unique coded-wire-tags to identify small and large fish.

SARs will be estimated for each time/size release group and hatchery (Marion Forks and McKenzie) in hope to identify strategies that produce higher survival. However, one should anticipate fish released earlier in the season will have lower survival because they are smaller and because they encounter one or several more months of mortality in the river compared with later releases. This effect should be considered when evaluating SARs. An important component of this analysis would be to assess migration rate, passage timing, growth rate, and survival from release to Willamette Falls as identified in Section 9 but not otherwise discussed in the proposal. Furthermore, one might expect fish released in November to overwinter in the river and potentially compete with native fishes, or consume salmon fry emerging in early spring.

The proposal should describe how this effort will complement Study AP-15, which will investigate the effect of rearing densities on fish condition and SARs.

Methods

Coded wire tagged fish will be recovered in fisheries, at hatcheries, and during spawner surveys to track survival of individual releases. Return rates of Marion Hatchery fish released at two different sizes and at two different times will be compared. Releasing Marion Hatchery fish at a third intermediate size and at a third intermediate time would be useful if the SAR rates do not respond in a linear manner to size and timing but rather increase with size or timing to a point, then decrease. That is, a curvilinear response in SARs could not be detected if only two levels of treatments are used. Releases from McKenzie Hatchery will occur at three time periods (November, February, March) and may serve this purpose.

The bimodal growth pattern and larger mean size of McKenzie Chinook to be released in November suggests these fish experienced a different rearing environment compared with other release groups. Researchers should investigate why this is happening because this may influence survival of these fish after release compared with other releases.

The proposal did not clearly justify whether the sample size of 30 fish for monitoring length and weight was adequate for both unimodal and bimodal distributions. Using haphazard sampling of juvenile fish in the ponds could result in a biased sample because, for example, smaller less fit fish may be more prone to capture.

The investigators conducted analysis to determine numbers of fish to receive coded wire tags (CWTs). It was unclear if the bimodal size groups will receive two unique tags so survival from each mode can be estimated. The assumed difference in survival rates used in the sample size determination was not discussed. The proposal should mention that CWT recoveries will be expanded by considering the sampling rate, as is normally done by the PSMFC. Will 100% of fish returning to the hatchery be sampled for CWT? Given the need to improve precision, it would be worthwhile to sample all fish. Additionally, given that each release group is reared in a unique raceway, it might be worthwhile to mark every fish in each release group with a unique mark so that they can be recovered as adults at the hatchery. For example, a unique otolith thermal mark might be considered for each release group.

It appears that the investigation will rely on releases from only one brood year. This is likely insufficient to fully test the objectives and the results might change in response to the environment.

Methods to evaluate migration rate, passage timing, and survival from release to Willamette Falls were not described, but it was mentioned in Section 9. Size of fish sampled at Willamette Falls should be estimated in addition to the metrics noted above.

Given the high rate of mini-jacks produced in some spring Chinook hatcheries (up to 50% of males), it would be worthwhile to conduct assays to evaluate the percentage of mini-jacks just before release. Mini-jacks have the potential to compete with native fishes for a longer time plus they can influence SARs.

Use of logistic regression, that is a logit model, could allow a more complete analysis of factors influencing tag recovery than the proposed contingency table analysis.

Relevance to the BiOp

It is not clear that the proposed project will "experimentally release hatchery juveniles from Marion Forks Hatchery at a size and time more similar to natural origin fish" or that it will address the recommendation 41: "Every hatchery should monitor the spatial and temporal distribution of juvenile fish released from the program" as stated in the proposal. The proposed study did not identify the time and size of natural salmon that it might mimic. The proposed study did not provide methodology to monitor spatial and temporal distribution of juveniles released from the hatchery. Perhaps this effort is covered by other investigators. If so, those projects should be referenced and discussed in detail. It is important to the overall project goal to evaluate which release group has the greatest potential to interact with native fishes, including natural spring Chinook salmon.

Research Plan (Background and Past Results)

Pre-release size distributions of fish scheduled for the three release dates are presented for the McKenzie Hatchery. Please note the text in Figure 1 does not contain the November 2011 release (presumably the last Feb 2012 label is a typo).

No information was presented on past results, such as SARs from previous releases from the two hatcheries and how release times and sizes from previous years compared with the proposed release and sizes. To what extent can information from previous releases inform this investigation? Likewise, what do studies from other watersheds in the Columbia Basin tell us about the influence of time and size at release? Apparently these proposals were suppose to be brief, ~10 pages, but referencing other projects and a quick summary would be beneficial and may shed light on the proposed study design.

3. Adult Chinook salmon monitoring in the South Fork McKenzie River relative to water temperature control and upstream passage facilities at Cougar Dam

Study Code: None
Proponents: ODFW

ISRP Recommendation: Does not meet scientific review criteria

ISRP Comments:

Goals and Objectives

The goals of this project are to characterize spawning by Chinook salmon in the South Fork McKenzie River while considering the influences of upstream fish passage and hatchery out-planting, and to facilitate fish passage operations at Cougar Dam. The objectives are to (1) provide information on spawning distribution, abundance, and hatchery versus wild origin of adult Chinook salmon; and (2) collect biological data on fish captured in the upstream passage facility and assist in its operation. The investigators note that project data would be used to evaluate the status of Chinook and the influences of temperature control at Cougar Dam, upstream passage, and hatchery out-planting. This effort largely provides data that would be analyzed by other projects. However, it is not always clear who would be responsible for analyzing and reporting scientific findings (i.e., what was learned), beyond a simple annual report summarizing what was done.

The investigators should state whether this is a one-year project (budget is only one year) or if they anticipate it will continue each year, as it should.

The stated goal to characterize spawning by Chinook in the South Fork McKenzie is clear. The aspects of the goal relating to "considering the influences of upstream fish passage and hatchery out-planting" are not as clear. For example, the goals and objectives of the proposed project could have been expanded and described within a more scientific, investigative framework. That is, what are the specific questions and hypotheses that the investigation will address regarding 1) modified temperature below Cougar Dam, 2) adult transport upstream, and 3) effect of hatchery out-planting? How can the proposed data collection be optimally designed to help answer these questions and provide information that may be useful not only on the South Fork McKenzie but also in other systems? As the proposal is written, the reviewers were unable to determine whether the most important questions and hypotheses would be addressed because data analysis and interpretation did not seem to be part of this investigation, nor were the scientists ultimately responsible for analysis and interpretation identified.

Methods

The methods are mostly standard approaches as described. The rationale for the methods is very brief, as is an assessment of the expected reliability of the methods for the chosen applications. For example, how reliable have the spawning surveys been and how likely are they to be in detecting changes in conditions or status? Such evaluations have been done in the Columbia River Basin, and they should be referenced and used in assessing the potential effectiveness of the proposed methods, even if the methods themselves are "standard." The following statement did not provide enough content for

reviewer evaluation of the analysis methodology, “These data will be constituent to detailed analyses in conjunction with data from other concurrent and future projects.” (Section 4, Method of Analysis).

Specific protocols of surveys should be briefly but clearly described. It was unclear whether surveys would be conducted by foot or raft, and how many people would conduct the surveys. Redds should be flagged in addition to recording GPS location so that they are not counted twice. Given other studies involving these fish, we highly recommend that the survey crew carry a CWT wand and collect snouts from CWT fish so that hatchery treatment groups can be identified. Otoliths should be aged and consideration given to investigating otolith microchemistry. When sampling adults at the passage facility, scales should be collected from the preferred area and aged because this will help determination of why so many male versus female salmon returned in 2011. Gender of the fish should be recorded at the passage facility and from carcasses on the spawning grounds. Carcasses should be examined to determine whether the fish successfully spawned. The investigators recognize that some hatchery fish receive bad adipose fin clips; the hatchery should determine the percentage of juvenile release groups receiving poor fin clips that might be considered unclipped. Perhaps the proponents have a protocol that specifically addresses each of these points, but it was not clear that this was the case.

Relevance to the BiOp

The proponents relate some tasks to the BiOp and state that the project partially addresses elements of some RPAs. The activities themselves, if conducted in a sound scientific manner, seem relevant to the BiOp.

Research Plan (Background and Past Results)

The background section provides useful context for the project. More information concerning surveys downstream of Cougar Dam since 2001 and upstream of Cougar Reservoir since 2005 should have been included to indicate how changes in Cougar Dam operations relate to changes in redd and carcass counts. With regard to the overarching Objective 3, what is the plan for passing natural versus hatchery Chinook to the upstream spawning areas? Do the investigators have a pre-determined ratio based on the number of natural and hatchery Chinook that return, or do they pass every fish that is collected?

There is no discussion of subsequent years of investigation. Who is responsible for maintaining the data and will an annual report be produced that addresses key scientific findings and progress rather than simply describing data collection? Although the investigators state, “The proposed work is not an experimental study,” the proposal would be greatly improved if the proponents developed key questions or hypotheses and described how the investigation would address these questions. If others are designated to address these scientific questions, their activities should be explicitly described or identified. As proposed, it appears that data collection would occur without much thought as to synthesis and evaluation of key questions.

4. Effects of reduced spring Chinook salmon rearing densities at McKenzie River Hatchery

Study Code: AP-15
Proponents: ODFW

ISRP Recommendation: Does not meet scientific review criteria

A basis in sound science was lacking. The proposed actions were not adequately described nor scientifically defended based on a thorough literature review and results of past research in this and related contexts. Although benefits of the proposed activities were possible, objectives and outcomes were not clearly defined. Provisions for monitoring and evaluating the ultimate outcome of improved smolt-to-adult survivals and returns were not included.

ISRP Comments:

Goals and Objectives

The rational of this study is that by reducing rearing densities of pre-smolts in the hatchery to one-half of historical levels, the smaller number of smolts will have the benefits of improved condition and higher overall smolt-to-adult survival of spring Chinook salmon, such that *higher overall returns* will result.

The scientific basin for this approach needs to be carefully and thoroughly defended. Such a defense may be possible. However, a review of literature for this project is minimal. More background should have been provided on 1) the specific effects expected from lowering the density of salmon reared and 2)how these effects typically translate into higher survival (and, importantly, *how much higher* survival). This proposed approach must have been practiced at various hatcheries beyond the Columbia Basin, and several relevant reports probably exist. The proposal should also describe how this effort will complement Study AP-8 that will assess the effects of size and release timing on SARs and life history characteristics. The authors also need to consider the relationship between SARs and early ocean growth and survival.

The rationale for describing the maximization process for adult returns is not clearly described. In the proposal, the authors state that "because hatchery production is particularly efficient from the egg to smolt life history stages, resulting in very high release numbers, additional mortality in later life history stages is compensated for, and adults routinely return in high numbers (Coronado and Hilborn 1998). This inverse relationship is non-linear and the inflection point of that curve is the theoretical maximum for efficiency from the perspective of maximizing return rates of adults. This inflection point may be below current rearing densities at MRH." It was unclear if the authors meant maximizing return rate or maximizing returns (even though the rate was somewhat lower with more releases). This section could be written much more clearly. It can also be quantified quite simply with a graphical model depicting how much higher of a return rate would be needed for a higher overall return based on the proposed rearing strategy. This simple approach would be useful for assessing prospects for success.
The objectives are further described to "quantify survival, growth rate, and condition between fish reared at standard and 0.5 standard densities from 'ponding' to time-of-release…" No groundwork has been laid in the proposal for exactly what is meant by fish "condition." Is it traditional fish condition or something coming out of the proposed truss analysis?

Methods

Methods are modifications of standard hatchery practice and statistical procedures, and are acceptable. Evidence of consideration of sample size requirements was provided, but no past data or indication of the numbers of returns that might be examined was provided, and needs to be.

The authors state that they "intend to describe differences in survival to size-at-release, phenotypic differences such as fin morphology, condition, physiological state, and survival to adult return reared at standard and at 0.5 standard densities." However, they have not adequately described the exact response variables that they intend to measure, what those variables indicate, and what their hypotheses are regarding these relationships. For example, a given ratio of two truss measurements might be higher of lower and correlated with some other metric of fish condition of survival. One of the most obvious limitations of rearing fish in high densities is the erosion of fins, yet typical truss analysis for fish emphasizes body shape differences rather than fins. Also, there is a need to address physiological state in the methods; it is identified in the goals and objectives. Methods to assess physiological state must be described.

The methods for assessing fish condition are unclear. The proposal should describe whether methods include traditional fish condition factors or relative weights W_r or other metrics. Although the truss analysis may be of interest, it is not described how the specific truss measurements translate into fish condition or general fish well being. The authors state that "these computer generated measurements provide very precise information with which to compare mean size and shape of juvenile fish from different groups." What sizes and shapes? And what are the hypotheses as to what the sizes and shapes mean? That is, what are the specific hypotheses linking the truss measurements to fish condition and improved smolt quality? Are there references to support the hypotheses?

Relevance to the BiOp

The goal of increased returns is directly applicable to the BiOp.

Research Plan (Background and Past Results)

The research plan for this work lacks sufficient detail for a clear assessment of whether the goals and objectives can be met. Hypotheses–based activities are badly in need of identification to clarify the research plan.

5. Survivorship, disease resistance and genotype-phenotypic characteristics of hatchery, wild, and hatchery-wild crosses of spring Chinook salmon in the context of reintroduction

Study Code: AP-9
Proponents: ODFW

ISRP Recommendation: Does not meet scientific review criteria.

In general, the questions the proposal intends to address are of interest, especially the disease resistance issue, in the context of Chinook reintroductions. There is merit in trying to understand survivorship in the basin based on hatchery and wild parentage. However, the proposed goals, objectives, methods, and background information were not sufficiently well reasoned or developed to establish that the project is based on sound science or would produce any benefit to fish and wildlife. A new, reworked proposal is encouraged.

ISRP Comments:

Goals and Objectives

The basic premise of the project's goal – to assess the potential for developing hatchery Chinook salmon stocks that produce juvenile similar to "wild type", and (therefore) most appropriate for future reintroduction to their historic habitat – needs to be more clearly explained. The notion that hatchery programs could be developed that produce juveniles more similar to "wild type" is one research topic. The notion that one stock might be better for reintroduction than another is a second independent research topic. The experiments will probably only indirectly address either question. Certainly, the time frame and extent of the current proposal does not explicitly address differences in colonization capability of different sources of salmon.

The objective(s) – rear and release hatchery spring Chinook that mimic size and behavior of naturally produced yearling migrants, and reduce genetic effects of hatchery fish spawning with naturally produced fish – are also independent issues. The proposal does not address ecological risks associated with potential increase in interaction when hatchery and natural fish are more similar in life-history attributes.

The proponents could have done a more thorough job of addressing the life history implications of determining whether HxH, HxW, or WxW origin Chinook are suitable for reintroduction efforts. In a subbasin the size of the Willamette River, it is likely that there are a number of Chinook life history variations (time in fresh water, rearing locations in the subbasin, specific habitat preferences) that could result in differing exposure to pathogens. For example, the disease organism selected for the laboratory challenge (*Aeromonas salmonicida*, which causes furunculosis) exhibits increasing virulence with increasing temperatures. If juvenile and pre-smolt Chinook possessing multiple life history options in different parts of the Willamette River system spend time in habitat with higher temperatures, the risk of developing furunculosis may increase. Whether artificial propagation and rearing maintains the life-history diversity exhibited by wild fish is not well known. It would be helpful if this research addressed the question of the suitability of a "generic" donor stock in the context of pathogen exposure and life

history diversity, including whether hatchery rearing will result in reduced life history variation that may place the fish at greater risk.

Methods

Section III.B lists project-specific objectives, which are really methodological tasks that are listed again in expanded form as tasks for project-specific objectives. A methods section that followed the same order as these project-specific objectives and tasks would have been easier for reviewers to evaluate.

The first paragraph of the methods section briefly describes sampling of juvenile fish during rearing at the hatchery. The hatchery metrics should be reconsidered, and based on life-cycle stanzas, not months. See ISAB 2000-4 and ISRP 2008-7 for hatchery performance metrics. Pre-spawning mortality, fertilization rate, hatch, survival, and growth to a specific underyearling age (120 days), and survival and length/weight at smolting are appropriate. Monthly survival and size metrics are not going to add much information. The proposed visual method for evaluating smoltification seems prone to observation error and needs further justification. In addition, the proponents should address potential experimental problems and risks that might be associated with the proposed sampling methods for example, stress, mortality, and immunosuppression associated with handling and use of MS-222 solution.

Specific hypotheses proposed to be tested, were described in the literature review section III A.2: (1) "test for differences in survivorship (SARs), sex ratio, age at maturation, date of return, straying rates, disease resistance and other phenotypic traits (size, condition, etc.) among cross groups" (HxH, HxW and WxW), and (2) test the hypothesis that survivorship of hatchery and wild crosses can be explained by within group variability of immune defense, as a function of individual major histocompatibility complex (MHC) genotypes, than by hatchery/wild parentage. The connection between MHC and the pathogen challenge does not seem to be adequately explained. Why was this topic selected for investigation?

For disease challenge experiments, justification for selection of the pathogen *A. salmonicida,* as compared to other pathogens that might have been selected, would have been useful. For example, would it be possible to also use a pathogen that thrives in cooler water, for example, *Myxobolus*, *Ceratomyxa*, or *Parvicapsula*? Proponents did not mention that *A. salmonicida* is one of five pathogens selected for evaluation by Oregon State University's (OSU) proposal, "Disease risks associated with hatcheries in the Willamette River basin." The OSU proposal states: "There are no examples that the viability of wild fish populations has been affected by this pathogen, but high mortalities may occur in culture facilities." Did the proponents purposely select a pathogen known to affect only hatchery fish? Proponents do not mention any coordination or collaboration between the two proposed studies.

The source of broodstock for proposed experiments (collected at a new trap on the North Santiam, Upper Bennett) is mentioned only in the project summary. Further justification beyond the ability to collect adequate numbers of hatchery and wild fish for the experimental crosses, and background information on the hatchery and wild broodstocks to be used for the proposed experiments, would have been useful.

Visible fish size and morphological data collected from adult broodstock prior to spawning will be used to generate experimental crosses, as stated by the proponents, "perhaps reflecting more natural mate selection processes, for evaluation of possible effects on juvenile performance." Will data on parental genotypes also be collected? For example, an evaluation of whether wild broodstock to be used for the

WxW and HxW crosses are F1 offspring of hatchery spawners and whether MHC genotypes differ between H and W broodstock would be useful before proceeding with the proposed release experiments of progeny.

In the project summary, the proponents mention that spawning protocols will be the same as those used in 2010, but these protocols are not described in the methods section. Otoliths will be examined to confirm hatchery/wild origin of spawners, but proponents need to describe the specific procedure used to distinguish wild from hatchery fish using otoliths.

Some background information on the Marion Forks Hatchery rearing and release site would have been useful, for example, background information on water quality, past outbreaks of disease, disease treatment protocols in the hatchery, and such. How might selection of this site versus another rearing site affect the outcome of experiments? Will the experimental results be representative of other potential sites? What are the "similar" environmental conditions in the hatchery that fish will be exposed to; how will these similar conditions be achieved; how might these rearing conditions affect experimental outcomes?

It is not clear (page 13, 6. Numbers and species and sources) whether the current mating scheme is going to use the same design as used in 2010. In any case, why are the only crossbred individuals the offspring of female hatchery by wild male matings? Should there not be a reciprocal – wild female x hatchery male? It is also not clear whether CWT codes are per family or genotype class (HxH, HxW, WxW). Evaluations completed with steelhead at the Forks Hatchery in Washington and in the Hood River demonstrate substantial variance in production by family – even in the hatchery. If the fish cannot be kept separate until large enough to CWT, then fin clips and parentage analysis should be anticipated to measure family effects.

The proponents discuss limitations in the use of CWTs to estimate SARS. Have they considered using other, more precise tagging methods that could identify all individuals in the experimental groups, e.g., parentage-based genetic tagging? How will CWT codes be structured to identify crosses? What are the "standard CWT Quality Assurance/Quality Control procedures for determining tag loss rates (citation)? How will tag loss after release be accounted for in the experimental results? Will selective fishing for hatchery versus wild fish prior to recovery affect experimental outcomes?

More information is needed on CWT recovery methods. The description states "fisheries, spawning ground surveys, and at hatcheries" but further details are not given on the location, sampling frequency, and assumptions that will be used to translate these recoveries into SARs. What evidence exists that enough tag recoveries will be obtained to calculate survivorship with reasonable accuracy?

The list of key personnel identifies NOAA collaborators. It would be useful to have those individuals assist with the statistical design of the breeding (Jeff Hard, NOAA Montlake) and post release behavior and life-history evaluations (Barry Berijikian, NOAA Manchester).

Relevance to the BiOp

The project summary states that the proposed work directly addresses RPA 6.2.1, 6.2.2, and 6.2.4 without further explanation. In section III. A. 1, the proponents repeat the text of RPA 6.2.4, without further explanation, and relevance of the project to RPA 6.2.1 and 6.2.2 is not mentioned.

This section of the proposal would be improved by including a description of coordination with other related projects.

Research Plan (Background and Past Results)

Information in the proposal indicates that this study was initiated in 2010, however, a summary of this work and relevant results to date were not provided, except for Table 1 (in the methods section), showing a statistical analysis of fork lengths of cross types. The literature review for this project was minimal, especially considering the amount of relevant research being conducted in the Columbia River Basin, as well as in other regions.

Knudsen et al. (2006) is misinterpreted. The proposal states: "traits were demonstrated to differ between spring Chinook progeny from wild and hatchery origin parents, even when raised in a common hatchery environment." Knudsen evaluated life-history (trait) differences between natural fish (the "wild" stocks they used had little to no prior hatchery intervention) and hatchery fish reared using protocols intended to minimize differences between the two. The hatchery fish were generated using wild parents. Knudsen repeatedly emphasized that the differences could be due to both genetic and environmental causes and the design could not be used to distinguish them. The point of the Knudsen paper was that even with the best of efforts they were unable to mimic traits in the natural fish. This point seems to be ignored in the development of this proposal. The literature cited is insufficient in summarizing the progress (or lack of) in developing alternative rearing strategies, and evaluating conventional versus alternatives (acclimation, NATURES, etc). Efforts to use NATURES rearing in the Yakima and Clearwater with spring Chinook have not yielded demonstrable improvement in post release survival (see ISRP 2011-25).

The statement on "informed crosses" is entirely out of place. Either they are, or they are not, and this should be developed in the methods section, not the literature cited.

The literature review also fails to summarize the efforts to reintroduce coho and Chinook throughout the Columbia River Basin in the context of selecting appropriate donor stocks.

6. Disease risks associated with hatcheries in the Willamette River basin

Study Code: None
Proponents: OSU

ISRP Recommendation: Does not meet scientific review criteria

The proposed goals, objectives, methods, and background information were not sufficiently well reasoned or developed to establish the need for this project or whether the project is based on sound science or would produce any benefit to fish and wildlife. Central to the ISRP's recommendation is the complete lack of background information on the current status of disease monitoring, outbreaks, and treatment of hatchery influent or effluent in Willamette River Basin hatcheries or how the project may meet needs related to the 2008 BiOp, regional action plans, and any ongoing disease monitoring programs.

ISRP Comments:

Goals and Objectives

The project's goal is "to investigate disease risks associated with hatcheries in the Willamette River basin by testing for the presence of fish pathogens above, below and in culture facilities." Furthermore, the "Impacts" section of the proposal emphasizes: "The goal of this study is to develop a qualitative risk assessment for the transmission of pathogens from wild to hatchery fish and from hatcheries to wild fish." The study is generally designed to inform hatchery operations by determining if disease risks support the use of water disinfection on hatchery influent or effluent. While the ISRP agrees that determining (and monitoring for) potential disease risks associated with hatcheries is an important goal, the proponents failed to establish how the project's goal and objectives meet specific needs identified in the BiOp or other local/regional action plans. There is no information about whether some disease monitoring programs are already in place (USFWS, USGS, or ODFW), and if so how this study will coordinate or fill in a void in these programs.

The proponents list five objectives. Objectives 1-4 are really methodological tasks, while Objective 5 seems to be the primary objective, i.e., to inform "decisions on the impacts of hatcheries on health of naturally reproducing fish and the potential importance of treating hatchery water supplies and effluents." The proposal would have been improved by linking objectives to specific study elements and methods.

Methods

The descriptions of methods were insufficient to establish that the study is based on sound science. There is a lack of clarity on whether a qualitative (as stated by the proponents) or a quantitative approach will be used. For example, in the Impacts section, the proponents state "If pathogen levels present in fish or water samples below hatcheries is higher than levels above hatcheries this indicates the hatchery may serve as a point source of amplification. However, if pathogen levels in fish and water above the hatcheries are high and a disease outbreak occurs in the facility this indicates transmission from wild and naturally reproducing populations. Because the proponents plan to assess risk based on pathogen levels in water or fish, they need to describe/define or give examples of how a high versus low level of pathogens will be quantified (e.g., numbers of organisms per mL or L).

In the Approach subsection the proponents seem to indicate that this is a pilot study - "In the first project year, two hatcheries will be selected for pilot studies to develop water sampling methods and sentinel fish exposure strategies." However, further along in the Methods section some specific sample sizes and designs are given, suggesting that this is more than a pilot study, but no clarification was provided.

Since this is to be a qualitative study, apparently no statistical analysis of results is planned. Therefore, sample sizes seem rather arbitrary and need further justification by comparison with other successfully published studies of this type. For the wild fish survey proponents expect that a sample size of 60 fish is sufficient (with 95% confidence) to find one infected fish if the minimum assumed pathogen prevalence level of infection equals or exceeds 5%. How does this compare with what has been found in other published studies of these pathogens?

Justification for the study sites selected was not provided. Roaring River rainbow trout and Willamette Hatchery spring Chinook salmon will be used as sentinel stocks. It's not clear why these particular stocks were selected, and whether results for these stocks would be representative of other stocks in the Willamette Basin. For example, why is a rainbow trout stock rather than steelhead stock proposed for use as a sentinel stock?

The proposal would be improved by providing more detailed information on sampling, diagnostic, and risk assessment protocols. For example, the proponents state that pathogen detection protocols will follow standard methods described in the American Fisheries Society Fish Health Section Blue Book (2007). Similarly, proponents state that water sampling protocols will follow those developed for monitoring the myxozoan parasite, *Ceratomyxa shasta* (Hallett and Bartholomew 2006), with modifications for the pathogens of interest. The proposal would be improved if succinct summaries of the protocols from these publications had been provided.

The proposed wild salmon survey depends on collection of samples by ODFW and Corps personnel not directly supported by the project. The proponents have not provided a solid alternative sampling plan in the event that sufficient samples are not obtained.

Additional justification of methods would have been useful for the sentinel fish exposures, for example, how do they know that five-day exposures are sufficient? Fish will be held 10-m above and below hatchery intakes and outputs. There is no information on how environmental conditions (water flow, temperature, pollutants, etc.) might affect the outcome of these experiments.

The first year of the project involves pilot studies. The proposal schedule states that these would begin in April 2011, and since this time is well past it is not clear whether the schedule has been revised or pilot studies have already begun.

No plan is provided on exactly how the qualitative risk assessment resulting from this project will be used by hatchery managers. For example, will the project develop a specific adaptive management process to reduce disease impacts?

Relevance to the BiOp

The proponents do not explain the relevance of this project to the BiOp.

Research Plan (Background and Past Results)

The proposal does not include "Background and Past Result" sections. The "Problem Statement" section contains only a few references to other studies, and a "Review of Pathogens" section reviews criteria for selection of the five pathogens to be evaluated in this study. This is a new study, but the proponents need to provide much more extensive information regarding previous pathogen outbreaks and past research, monitoring, and evaluation of pathogen problems and treatments of water supplies and effluents in Willamette Basin hatcheries, using the scientific literature and technical reports. Lacking such information, the proponents failed to establish the need for this project.

One of the selected pathogens, *Aeromonas salmonacida,* is also being proposed for investigation by the Oregon Department of Fish and Wildlife (proposal AP-9, "Survivorship, disease resistance and genotype-phenotypic characteristics of hatchery, wild, and hatchery-wild crosses of spring Chinook salmon in the context of reintroduction.") The proponents do not mention any coordination or collaboration between the two proposed studies.

7. Genetic Diversity of Willamette River spring Chinook salmon populations

Study Code: AP-6
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

Qualifications include a requirement to provide a description of the gene-linked molecular markers and how allele frequency variation at these genes will be analyzed; a presentation of the methods for estimating effective population size and demonstration that the rotational sampling design is sufficient to provide data for the effective population size estimation; a consideration of measuring gene flow from the hatchery to the natural population; and further development of the approach to evaluating the risk to natural population status from interbreeding with hatchery salmon. These issues can be addressed in annual reports and future proposals.

ISRP Comments:

Goals and Objectives

The overall goal "to provide estimates of population genetic diversity for natural and hatchery origin populations of Upper Willamette River spring Chinook" is reasonable. The goal statement indicates the information is necessary to meet performance standards in a Hatchery and Genetic Management Plan (HGMP). Without inspection of the HGMP, it is not possible to fully understand how this data will be used in hatchery/natural population management. The information will undoubtedly be useful in some form.

Methods

Project Summary section II.c. (methodology). The general outline for collecting tissue samples, genotyping fish, and analysis is appropriate. The genes that have been selected for analysis include a suite of GAPS microsatellites and a suite of gene-linked molecular markers. There is no published description of the gene-linked markers or how they should be analyzed, and the proposal doesn't address these issues. Additional information to justify and explain using the gene-linked markers should be provided in annual reports and future proposals. The sampling scheme is very general – "collect fin tissue from natural and hatchery salmon at hatcheries, fish collection facilities, and spawning grounds." A summary of the distribution of spring Chinook in the Willamette River subbasin and evidence that coverage of the major populations is adequate needs to be established during contracting.

Project Description section III and Final Statistical Design document. Until the initial survey of genetic diversity is completed, and there is a better understanding of the level of genetic distance between

hatchery and wild populations, and between wild populations, the ability to make inferences using the rotational sampling design or the sample size of 100 individuals per class (hatchery, wild, location) is limited. Contingencies for review of the sample approach should be developed. The proponents will estimate effective population size using methods of Waples (1990). These methods should be elaborated briefly with specific reference to the rotational sampling scheme to provide enough information to conclude that the approach is sound. Is the estimate of effective population size based on allele frequency change across a generation or is it by linkage disequilibrium within a single sample? If the estimate is by change in allele frequencies from one generation to another, how is the overlapping of generations accommodated, and will the rotational design re-sample populations at the correct interval? Some effort (simulation modeling?) may be required to confirm that the rotational design will provide robust estimates of the essential parameters of interest. A discussion of sampling needed to evaluate the parameters of interest should be included in the next annual report and future proposals. If genetic distance is very small and the sampling scheme is determined to be inadequate following the initial screening, a review of experimental alternatives is needed for a future proposal.

Relevance to the BiOp

Adequate explanation. The project fulfills several RPAs in the BiOp.

Research Plan (Background and Past Results Literature Review)

The connection of the work to hatchery/natural population integration for conservation is brief but adequate. More information should be provided on past genetic analysis of Willamette spring Chinook – the agencies must have microsatellite data on these populations. None is cited. The treatment of the main theme needs further development: "Genetic monitoring of hatchery and wild salmon populations can be used to measure divergence through time, providing an estimate of risk posed by a hatchery population to its associated wild population, under various stray rate scenarios." Although two citations are provided for this approach, it is not clear that the project design is actually sufficient for the task. Part of this project is geared to measure integration of natural salmon into the hatchery populations, but it is not clear that the design will also measure the reverse – gene flow from the hatchery population to the natural population. Further, it is not clear that "stray rate" will be able to be estimated from the data, or how "risk" will be assessed.

On page 8, in section 8, Expected Results and Applicability, the proposal states: "Peven and Keefe (2011) recommend that annual monitoring and comparison of hatchery and wild microsatellite genotypes should be used as a benchmark for monitoring hatchery '*broodstock to ensure that naturally produced life history characteristics are maintained.'"* This framework for evaluating the maintenance of genes for natural life history traits in the hatchery population is probably insufficient for the interpretations desired. Monitoring microsatellites potentially will permit characterizing genetic change from hatchery management owing to genetic drift but probably not selective differences. Perhaps the gene-linked markers can help, but they would only "mark" a few chromosome regions. Whole genomic analysis might provide the bridge. Preservation of neutral genetic variation (microsatellite alleles) does not measure or ensure that life-history characteristics are maintained. More fundamentally, the management requirement is to ensure the adaptability and fitness of the natural population. The theoretical framework is that if migration from the hatchery to the wild is larger than the selection differentials between the hatchery and wild for different phenotypes for an adaptive trait, the wild population will lose natural spawning fitness. Measuring allele frequencies provides an opportunity to

measure the gene flow but does not estimate the selection differentials. Consequently, the interpretation of the outcome from the analysis is ultimately ambiguous. The ODFW 2010 citation is not in the literature list.

8. Genetic stock identification and relative natural production of Willamette River steelhead

Study Code: Adult Passage 3
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

The basic approach to the work is appropriate. However, future proposals and annual reports need to address:

1. The level of natural production of summer steelhead smolts that can be detected by the sampling design;
2. Natural summer steelhead production that might be occurring outside of the tributaries sampled;
3. How the analysis is conducted in the absence of "pure" representative individuals of winter and summer steelhead;
4. A timeline for conducting the investigation and plan for archiving the data, and;
5. Consideration of ecological interactions between summer and winter steelhead smolts.

ISRP Comments:

Goals and Objectives

The stated objectives – identify Willamette River subbasins that support summer steelhead reproduction; determine the proportion of summer steelhead smolts with each subbasin; compare proportions of summer steelhead smolts among subbasins; and analyze smolts for evidence of winter and summer steelhead introgression – are reasonable and should be amendable to resolution with sufficient samples and genetic markers.

The second paragraph in the objectives section on page 5 of the proposal is confusing and seems contradictory to the first paragraph in the objectives and material elsewhere in the proposal. The paragraph states that an original objective included the development of quantitative estimates of introgression between summer and winter steelhead, and then states these estimates were not made because "pure fish" were unavailable. It is not clear to the ISRP how the objective being discussed in this paragraph is different from objective 4*: utilize existing software to further explore the genotype data from 2009-2012 for evident of introgression (using STRUCTURE…)* on page 5. The proponents state that this objective was not pursued because representative samples of pure summer and winter lineages were not available. The proponents go on to state that reporting-group probabilities in preliminary work are indicative of negligible levels of introgression.

What is not clear is why representative samples used to establish the winter and summer assignments could not serve as the "pure" samples for introgression analysis. Further, if the reference data are insufficient for the analysis, how can statements be made about negligible introgression, or even statements on the small proportions of adults and smolts assigned to summer steelhead.

Methods

The methods section (page 5 and 6) is too brief for thorough evaluation. The proposal states that 50 smolts (per subbasin) from multiple locations (within each subbasin) will be collected. There is no mention of the total number of smolts to be collected and analyzed. If individuals are being collected from the North and South Santiam and McKenzie with lesser numbers collected in the Molalla and Calapooia rivers, it seems as though the collection may be less than 200 individuals. With current laboratory through-put many more samples should be analyzed. The stated sample of 50 individuals per subbasin seems too small. For a site, or for a tributary, that number might be justifiable, but not for an entire subbasin.

The statistical model and graph on page 6 does not relate well to the questions posed by the research effort. One question might be is there evidence of natural production of summer steelhead, with a definition that evidence means 1% or 5% of the smolts are from summer steelhead natural spawning. The statistical problem under that case is then figuring out how large a sample is needed to have a specified probability of detecting some small proportion in the sample. The example graph is for a comparison of two subbasins with different levels of summer steelhead production. The graph indicates that if a subbasin has 0.30 proportion of summer steelhead, with a sample of 50 from each, a difference with another subbasin will only be confirmed if the production in the second subbasin is under 0.10. This does not seem very powerful. Under any circumstance, the robustness of the analysis is not related to the precision needed for management decisions. How big a difference between subbasins needs to be detected? Why do the managers even care about differences among subbasins? Are not the real concerns 1) evidence of reproduction, 2) the level of production above some threshold 5-, 10-, 20% etc, and, 3) is there introgression?

It is not clear that the sampling design is adequate and whether increases in sampling of individuals and genes would lead to improved precision of the important estimates.

It is also not clear why the sampled subbasins focus on Willamette Dams. The ISRP realizes the motivation for the BiOp and RPA actions are driven by the development of dams and reservoirs, but the listed status of winter steelhead carry over to other tributaries. If summer steelhead spawn in tributaries without dams, their progeny may be impacting winter steelhead produced in the dammed larger metapopulation core locations.

Relevance to the BiOp

In general, the relevance to the BiOp is adequate. It is not clear how and when project results will be used to meet BiOp priorities, however. A few sentences on the timeline and mechanisms would be welcome.

Research Plan (Background and Past Results)

The background section and past results is too brief to fully understand the status of the studies. There is one statement on differentiation of winter and summer steelhead detected by Van Doornick and Teel. Since these proposals are extremely brief, we are not clear how much depth is expected, but the preliminary analysis is discussed in such limited perspective that not much can be said other than that they did the work. It cannot be used to justify the scale and design of the work for the current phase. The proposal does not indicate whether they hope this is the end of the summer/winter steelhead genetic analysis or just the beginning.

1. It would be useful to see a timeline for the completion of this project, including the final report.
2. It is not clear how data will be archived for assess in the future by others. Considerable effort has gone into this project and the basic data have potential long term value.
3. A list of professional publications from the project would have been helpful for the evaluation.

This project is focused on reproduction and introgression as a consequence of the annual release of non-native summer steelhead smolts to provide recreational angling when they return from the ocean as adults. A more significant threat to winter steelhead may be ecological interactions with the released hatchery smolts or ecological interactions with naturally produced summer steelhead smolts (Kostow and Zhou, 2006). Management strategies to address this uncertainty need to be developed.

9. Behavior, distribution, and passage metrics of juvenile salmonids in Willamette Valley Project (WVP) reservoirs and passed dams: Cougar Dam.

Study Code: Juvenile Fish Downstream Passage and Life History - 3 (old FP-11-03)
Proponents: USGS

ISRP Recommendation: Meets scientific review criteria (qualified)
ISRP Comments:

Goals and Objectives

The overall goal of the study is to provide data about movements of hatchery-origin juvenile Chinook near passage routes at Cougar Dam to inform decisions about future downstream passage studies. The objectives are to collect information on seasonal and diel distribution, behavior, and movements of juvenile salmonids. This proposal is an extension of a 2011 project with some fairly minor changes. This project acknowledges that for fish passage, knowledge of water velocities required for attraction and passage is critical. The proposed interaction with WATER and the Corps is an important aspect of the proposal, i.e., to design specific water velocities that can be enacted and evaluated.

The proponents propose to focus this study on conditions required for attracting fish to get close enough to a passage route that they will enter it. A previous study suggests that fish are already successfully guided to a location near enough to a route of passage that they can detect a passage route to be attracted to it. The authors state that “Results in Beeman et al. (2011) suggest that guidance to the cul-de-sac area at Cougar reservoir commonly occurs.” It is not clarified what the presumed causes of that guidance are. Is this information specifically known? Although this may seem like a minor point, if it is known what factors lead to the natural attraction, the attraction can perhaps be easily enhanced to

improve passage. If the factors are not clearly known, the past observed attraction may not persist as conditions change interannually and a more exploratory evaluation may be necessary. Furthermore, Beeman et al. (2011) indicate that fish tend to move repeatedly back and forth between reservoir headwaters and the dam. This movement pattern suggests that the process of attraction and passage is substantially impeded. Much remains to be learned about optimizing attraction under different reservoir operational conditions. Inasmuch as a review of resumes of investigators suggests that they have extensive experience with similar passage studies, the lack of specific hypotheses targeted for investigation seems surprising. The study would benefit from some specific hypotheses to guide the study, so that it not just one of many fairly routine studies proposing to tag fish and see what they do. This is a significant qualification of the recommendation.

The proposed plan to release about 80 tagged fish every two weeks in the spring and the fall does not justify the adequacy of this amount of tagging. It would be worthwhile to briefly approximate the numbers of tagged fish that are likely to be located within the reservoir and the numbers needed for making meaningful inferences. That is, does past field evidence suggest that a high fraction or all of the tagged fish will be repeatedly detected in reservoir until they pass? This may be obvious to the proponents, but some sense of detectability in-reservoir would help reviewers.

Methods

The fish to be used in the study are to come from a proposed project, "Development of a wild fish surrogate for UWR Chinook salmon," currently being reviewed. It is not clear what strategy will be used if this project to supply fish is not implemented, but such a strategy should be identified.

The proponents propose to model water velocities near the temperature control tower to allow estimating rates of attraction under differing water velocity conditions. This methodology should allow the design of an experiment to evaluate and compare rates of attraction, as well as spatial and temporal locations, of fish under various conditions to better inform future downstream passage solutions. Consideration of sample sizes and the number and type of treatments should be completed prior to project implementation to enhance the likelihood of project success. The fact that some of the data collected constitutes recurring events complicates sample size determination but does not reduce its importance. Formal statistical comparisons of results for differing water velocity conditions should be included as part of project reporting.

Although the proponents have data from 2011 that indicates similarity among many measures of movement and passage of hatchery and wild fish, more information should be provided before this critical assumption is accepted. The consequences of planning passage solutions based on hatchery fish behavior are potentially important if there are fundamental differences between hatchery and wild fish.

Relevance to the BiOp

The relevance to the BiOp is clearly articulated. The BiOp requires evaluation of feasibility of installing new juvenile collection and bypass facilities at Cougar Dam. This project is part of evaluating the feasibility of such a project.

Research Plan (Background and Past Results)

This study is an extension of similar study in 2011, i.e., it is based on yearling-size juvenile Chinook monitored with acoustic telemetry system. But in addition, it is proposed to use fluid dynamics model outputs to design operations with specific known water velocities near the temperature control tower and estimate rates of attraction and rate of subsequent passage during those conditions. It would seem that the rate of attraction is the most important piece of information. Some additional information from 2011 has been added in a revision that seems useful in planning the next stage of the project. This project is fact-finding to learn operations that attract fish for passage. We agree with the ODFW comments that the "focus of the study should be to determine flow requirements for design of future surface flow bypass facilities located near temp control tower. Need experimental design to test full range of surface flows (feasible within project constraints) that will provide an understanding of the effectiveness of various surface flow regimes." It appears that the fluid dynamics model mentioned above helps to address the issue, but it would be useful for additional clarification on exactly how the model is structured and will function in addressing unknowns.

Overall, the research plan implements many of the actions necessary to eventually come to an understanding of factors associated with passage. For example, in Objective 1, it will probably be feasible to collect meaningful data regarding collection of "seasonal and diel distribution of juvenile salmonids in the forebay-near dam area." The methodology is essentially a telemetry study. In the proposal, however, it would be beneficial if the proponents would have presented the methods in the context of what factors they see up front as affecting this observed distribution, including a literature review (if any exists) of environmental factors as they vary inter-annually and as they vary with operational decisions. If, for example, factors such as water depth, water clarity, temperature, food supply, or other factors affect their distribution, the conditions could vary with year and with natural variation or with different operations by year. Without some sense of what environmental factors or operational decisions, or their interaction, might be causing or at least influencing the observed fish distribution, the data needed to understand the variations in the distribution might not be measured. For that reason, some hypotheses and a bit of hypothesis testing would make the study look more like an investigation and not strictly a fairly routine data collection effort. As a minimum, it would be useful for the proposal to outline some of the environmental factors that are currently being measured for this or other work, and that can easily be measured under this proposal, that might prove useful in interpreting the results. The point is, if one distribution occurs every year, that is a problem, but if they see different ones each year, what are the reasons for it? How can operations be adjusted to deal with the differences? Perhaps specific environmental conditions could be used to create a more predictable distribution of fish and improve guidance, attraction, and passage.

10. Behavior, distribution, and passage metrics of juvenile salmonids in Willamette Valley Project (WVP) reservoirs and passed dams: Detroit Dam.

Study Code: Juvenile Fish Downstream Passage and Life History - 3 (old FP-11-03)
Proponents: USGS

ISRP Recommendation: Meets scientific review criteria (qualified)

ISRP Comments:

Goals and Objectives

The goal of the project is to provide data on juvenile Chinook salmon movements in the reservoir and dam passage to help inform decisions about future downstream solutions. Steelhead are also included.

This Detroit Dam project is very similar to the Cougar Dam project but is not quite as far along in terms of fish movement information from the reservoir. In addition, there is another dam (Big Cliff) a short distance below Detroit that poses some questions about where juvenile fish should be released (above or below the second dam, Big Cliff). However, the ISRP notes that essentially all of the comments made for the proposed Cougar Dam passage project, except for issues related to the tower, apply to this project and comments made there should be addressed for this project as well. The same major qualification regarding the lack of meaningful hypotheses is also relevant. Given the experience of the proponents in such studies, it would seem that such hypotheses could be developed.

Methods

This proposal discusses including steelhead in the investigation but does not effectively justify the adequacy of using 200 fish in terms of answers to specific questions.

This proposal also mentions the use of a robotic boat for collecting water velocity information as an alternative to estimating water velocities using a computational fluid dynamics model. Could the robotic boat be used beneficially at Cougar Dam as well?

Relevance to the BiOp

The Relevance to the BiOp is made clear: In consultation with Willamette River Basin Flood control Project (RPA 2.12.3), Action Agencies will investigate the feasibility of improving downstream fish passage from another high Dam (Detroit). If feasible, they will construct and operate downstream passage facilities.

Research Plan (Background and Past Results)

Experiments should be designed to examine the influence that water velocities due to varying flow conditions have on seasonal and diel distribution, behavior, and movements of juvenile salmonids. Are there any hypotheses that the proponents might test? The same request is made for the development of hypotheses to focus and guide the effort.

Justification of the adequacy of selected sample sizes should be provided before data collection begins.

In this proposal, there is some additional effort with a robotic sampler to get velocity and bathymetric data. Is this because it is already available for the Cougar Dam study but not for this location? In both studies (Detroit and Cougar), there will be a need for considerable physicochemical data to assess the significance of distribution patterns observed with the telemetry.

The issue of possibly releasing fish in front of Big Cliff Dam, rather than below Big Cliff Dam, could stand to be clarified. Why would someone want to force the downstream migrants past another dam immediately below Detroit Dam? Would it not be better to release the juveniles an extra mile or two below Big Cliff so they will not have to encounter problems with passage?

11. Genetic pedigree analysis of McKenzie River spring Chinook salmon: An evaluation of adult outplanting strategies

Study Code: None
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

The proponents need to provide additional discussion and details in the research plan and methods in annual reports and future proposals in response to comments/questions below.

ISRP Comments:

Goals and Objectives

The goal and objectives of this project address important questions about the reproductive success and total lifetime fitness of hatchery versus natural origin spring Chinook transported above Cougar Dam reservoir. Three transportation scenarios will be addressed apparently for both hatchery and natural salmon: date of adult transport, location of release, and treatment with antibiotics.

The project goals and objectives are clearly stated and reasonable for evaluating the release of adult Chinook above Cougar Dam on the South Fork McKenzie River. Results from this investigation should provide a better understanding of the variance in reproductive success among females and males transported above the dam and outplanted to provide natural production.

Methods

The primary method – parentage analysis using DNA microsatellite markers – is appropriate for the problem. In general the methods are well established in salmon production evaluations. However, the sampling scheme is not adequately justified. The first issue is the adequacy of adult sampling at the Cougar Dam trap. Method item 3 states that tissues will be taken from all unmarked adult spring Chinook trapped at the dam. It is not clear how many fish this may be or how many fish arrive in the vicinity of the dam but are not trapped. Inferences regarding lifetime fitness will require assumptions regarding the trap sample being representative of the production from spawning by outplanted adults. Relative production of fish from different origins, dates of release, handling protocols, and so forth can

be evaluated if the trap sample is representative. However, without information on straying and contributions to fisheries, the absolute lifetime production will not be known.

Some salmon are likely to receive a poor adipose fin clip at the hatchery; therefore, some fraction of unmarked salmon is hatchery origin. Furthermore, Chinook salmon spawn adjacent to the trap at Cougar Dam, and progeny from these spawners will likely enter the trap as unmarked adults along with fish originating from parents above Cougar Dam. It is likely that the project will be able to identify and exclude these adults from the analysis. It is not clear that enough of the population of adults at the dam is being sampled to evaluate the lifetime fitness of fish assigned to different treatments. Also, progeny from transported adults may spawn downstream of the Cougar Dam trap.

The sample numbers for returning adults seem small (20 jacks, 100 4 yo, 300 5 yo) based on the production of 1000 outplanted adults. This would equate to only 0.42 adults per spawner. Especially since some of these fish will apparently be natural production from other portions of the McKenzie River, these numbers should be better explained.

The proposal does acknowledge that all juveniles caught in a screw trap will be sampled and that, if a sample of 2000 is not sufficient for comparisons, additional fish will be genotyped. It is not clear what portion of the juvenile population is intercepted in the screw trap. Additional modeling of potential bias in the relative production should be considered.

The total lifetime fitness analysis depends on a return per spawner of approximately 0.3 to 0.5 (Table 1). Is this assumed R/S reasonable given the low R/S of spring Chinook spawning below dams in the Willamette Basin and the fact that pre-spawn mortality of transported adults is high and juvenile mortality is likely high when passing through the reservoir (e.g., typical smolt-to-adult survival is reportedly only 0.1%, as reported in other proposals)? If survival is lower than anticipated, will sample sizes be sufficient to address the effects of transportation (time, release location, antibiotic treatment) in addition to fish origin (hatchery, natural, crosses)?

When sampling adults at the trap, length, presence of CWT and PIT tag, and scale should be collected in addition to gender and fin clip marks.

Relevance to the BiOp

The proposal provides sufficient explanation of relationship to the 2008 Willamette BiOp and upper Willamette River spring Chinook status reviews. Important topics are being addressed by this project.

Research Plan (Background and Past Results)

The explanation of the history of outplanting spring Chinook above Cougar Dam on the South Fork McKenzie River is useful and adequately covered. The evaluation that can be accomplished should contribute data for future spring Chinook status evaluation and ongoing designs of reintroduction programs above blocked areas (or concluding they are not worth the effort). The most recent proposal (cooperative agreement – research work order #71) does not provide a summary of accomplishments from the first year of activities. The more detailed proposal for FY 2011 provides only numbers of fish collected. Once genotyping data are available, effort to ensure the sufficiency of the statistical components of the project is needed.

Preliminary findings from recent data collections should have been reported in the proposal, including pedigree analyses involving fry and smolts. Have problems with these analyses been identified, or is the initial analysis proceeding as anticipated? Why did the 2007 brood-year fry become missing (Table 1)?

Are there other investigations, such as juvenile collection and transport around the reservoir or hatchery releases above the dam that may confound the analyses?

Pre-spawn mortality is apparently high among transported Chinook in this watershed. Will fry sampling be sufficient to distinguish whether relative reproductive success of a particular treatment is owing to prespawning mortality versus treatment effects on spawning performance of the surviving individuals? It seems pre-spawn mortality may have the potential to overwhelm the findings if sample size is not sufficient.

12. Development of a wild fish surrogate for UWR Chinook salmon

Study Code: None
Proponents: ODFW, USGS

ISRP Recommendation: Does not meet scientific review criteria

Conceptually, the goal to raise hatchery fish as surrogates for wild fish by raising them to match size and developmental stage for use as test fish merits consideration. This is because too often hatchery fish that are very different from the wild stock (i.e., in size, age, and behavioral characteristics) are used to simulate wild fish in experimental tests. However, in its current state, the proposal does not contain sufficient information for the ISRP to adequately evaluate the proposed project.

ISRP Comments:

Goals and Objectives

The project goal is to provide a hatchery surrogate UWR Chinook salmon (and perhaps later UWR steelhead) that emulates performance of wild fish for Willamette Valley BiOp projects. There are 5 objectives. Objectives 1, 3, and 4 are mostly focused on developing a plan. The objectives need to clearly indicate what is specifically proposed.

The proponents state that there are “many field studies related to fish passage” and the BiOp that will require UWR spring Chinook surrogates. However, among the passage proposals currently under review, we could find only one project proposing to use OSU-produced surrogates, i.e., “Behavior, distribution, and passage metrics of juvenile salmonids in Willamette Valley Project (WVP) reservoirs and passed dams: Cougar Dam.” The proponents need to demonstrate that there are in fact a large number of projects that need hatchery surrogates that emulate wild fish.

A very important objective that seems to be missing is a pre-release evaluation of the potential risks to wild UWR Chinook salmon juveniles from releases of hatchery surrogates that emulate wild phenotypes (competition, disease risks, and so forth).

Methods

This section is incomplete. The proponents do not include any detailed methods for raising these fish, but only provide a general discussion of what may be done once the plans/procedures are developed.

The proponents of the Cougar Dam passage project proposal (referred to in the previous section) state that JSATS tags to be used in their study require fish with a minimum fork length of 95 mm, and sample sizes/time of release for tagging are 500 fish released in spring 2012 and 500 fish released in fall 2012. In this case, the relatively large body size needed for JSATS tags seems to preclude emulation of wild/natural phenotypes, which include both subyearling and yearling migrants (Schroeder et al. 2007). For example, Schroeder et al. (2007) reported mean sizes of UWR subyearling migrants captured by beach seine in 2002-2007 that exceeded the minimum fork length of 95 mm in only one year (83.3 mm in 2002, 85.2 in 2003, 84.4 in 2004, 83.6 in 2005, 95.9 in 2006 89.0 in 2007; Table 29; Schroeder et al. 2007). At a minimum, however, proponents could explain for this specific case the steps needed to produce fish of this specific phenotype/release times that might emulate wild UWR Chinook salmon (morphologically, physiologically, and behaviorally).

Relevance to the BiOp

No specific relevance (i.e. RPAs or other requirements) to the BiOp is identified in the proposal, other than a brief mention that "The lack of availability of wild spring Chinook requires researchers to use hatchery fish for many field studies related to fish passage and the implementation of the Willamette Valley Project BiOp."

Research Plan (Background and Past Results)

The proponents state they did not have enough time to do a literature review or data review which is necessary for a complete proposal. It is evident that this proposal is incomplete. This proposal is written in a short format much like a pre-proposal (~ four pages). There are a number of studies that could be cited, including Connor and Tiffan (2009) for Snake River fall Chinook, which have used the procedure of raising hatchery fish as surrogates for wild fish.

13. Juvenile Salmonid Outmigration Monitoring at Willamette Valley Project Reservoirs

Study Code: Fish Passage
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

Qualifications are that the proponents consider providing some additional discussion and details in their research plan and methods in response to comments/questions below.

ISRP Comments:

Goals and Objectives

The goals are clearly stated, i.e., to provide information on movement of juvenile Chinook salmon into and out of Willamette Valley reservoirs. Specific objectives are to monitor timing and size of juveniles entering and exiting the reservoirs and to assess the injury rates and injury types as related to fish size and route.

It is not clear if the objective involving development of monitoring infrastructure below dams could be used for monitoring route of passage through dams, an objective that was deleted from the revised USGS acoustic tagging projects at Cougar and Detroit dams due to infeasibility.

Methods

Statistical justification of required sample size should also consider samples sizes required to evaluate fish injury and disease after exiting the reservoirs and the characterization of the influence of flow on passage with specified confidence. An important question is will there be a sufficient number of observations of naturally produced fish to successfully evaluate the data collected? Statistical comparisons, such as confidence intervals, should be presented to characterize the uncertainty in estimated fish size, abundance, injury rates, and so forth. Also, what use will be made of data from hatchery fish?

The proponents state that their effort could provide naturally produced fish for the USGS acoustic tagging efforts, but those revised projects propose to use only hatchery origin fish.

Additional questions and comments:

1. To what extent might lack of access to trapping sites compromise the study?
2. What lengths are used to classify fry, parr, and smolt?
3. In what way were methods modified from Suring et al. (2009)?
4. The study should record basic environmental data such as water temperature, river flow if available or river height, precipitation, water clarity, etc.
5. Clipping the caudal fin of ~40-50 mm fry will be difficult and could impair their survival. Marking fish with dye such as Bismarck brown should be considered for the mark/recapture trap

efficiency tests. However, dye marking can fade after a few days. The objectives state that different marking techniques would be evaluated, yet only fin clipping was described.

6. Investigators might add fungus to the injury list. Will these observations be made under a dissecting scope or by eye while holding the fish in a small aquarium?
7. An ODFW proposal by Johnson and Friesen plans to release 50,000 65 mm Chinook (PIT tag only) and 50,000 40 mm Chinook (unmarked) above Lookout Point reservoir. All released fish are hatchery origin. How will these unmarked hatchery fish be identified and considered in this evaluation when calculating abundance and migration timing? The larger release group will have PIT tags, so a detector could be used to identify those fish. Will a detector be available?
8. The screw trap would be sampled once per day. Investigators should consider sampling twice per day during the peak migration period so that it can be determined whether most fish emigrate during day versus night.
9. Why are fish not sampled below Dexter Dam?
10. If there are multiple years of study, will there be an attempt to compare fish entering and exiting the reservoir that are from the same brood year?
11. The objectives state that survey information will be compiled. How will this be done? Will a database be developed? Is there a common location in the basin where these databases would reside?

Relevance to the BiOp

This proposed study specifically responds to BiOp RPAs 4.8, 4.9, 4.10, 4.12, and 9.3, and generally to 4.1, 4.13, and 9.2.

Research Plan (Background and Past Results)

The investigators should mention how this effort integrates with other juvenile (and adult) studies in each watershed, including studies by the USGS and OSU (parentage study). Only the USGS acoustic study was noted. Is there some duplication of effort, or are the investigators collaborating? As written, the reviewer is left wondering who will assess some obvious questions such as juveniles produced per transported spawner, ratio of juveniles exiting the reservoir versus those entering the reservoir, and change in size over time. Will the activities of other studies compromise this study, or will this study compromise other studies?

14. Life-history Characteristics of Juvenile Spring Chinook Salmon Rearing in Willamette Valley Reservoirs

Study Code: Fish Passage
Proponents: ODFW

ISRP Recommendation: Does not meet scientific review criteria

The scientific description basis of the study was incomplete. Benefits to fish and wildlife were unclear since there was no clear connection to possible management actions or decisions. Objectives and outcomes were not clearly defined, and provisions for monitoring and evaluating the ultimate outcome to recruitment were not included.

The proponents plan to primarily conduct their research at Lookout Reservoir. The RME Plan should provide the context, and the proposal should describe how the proposed activities relate to the Plan.

ISRP Comments:

Goals and Objectives

The stated goal is "to characterize the life-history of juvenile spring Chinook salmon rearing in Cougar, Lookout Point, and Detroit reservoirs" particularly as related to dam passage. The proposed project has three objectives: (1) determine distribution, dispersion, and habitat use of spring Chinook fry and parr in reservoirs; (2) assess relative risks and benefits between reservoir rearing and stream rearing by evaluating growth rates and vulnerability to fish predation; and (3) investigate temporal changes in physiological indicators of smoltification in reservoir and natural stream-rearing fish. A cleaner definition of goals, objectives, strategies, and tactics would have assisted the review.

The objectives are incomplete in terms of developing a comprehensive understanding of the relative impact of the reservoirs on the success of juvenile Chinook in the Willamette Valley. However, we understand that this is part of a larger RME Plan, and that there is a stated need to evaluate life history information to eventually address dam passage improvements, though the connection seems tenuous and confusing. The objectives and goals are vague and undefined in relation to outcomes and potential management decisions and actions. Clarification of these decisions and actions is required. The objective that would be most relevant to recovery of the fish would be an understanding of the relative survival of reservoir-rearing versus stream-rearing juvenile Chinook, both from fry-to-smolt and smolt-to-adult life stages. The project as proposed may provide some information that helps address this objective. Certainly, understanding relative growth rates in the two habitat types (reservoir and stream) provides some indication of possible post-smolting survival (i.e., larger smolts often survive at a higher rate than smaller ones). But the objectives relating to fish distribution in the reservoirs and fish predation may not provide information that directly informs relative survival rates. The predation study simply provides an estimate of the magnitude of this mortality factor in one reservoir. The significance of fish predation on juvenile Chinook cannot be meaningfully interpreted unless total survival rate of the reservoir-rearing fish is measured. Even if a complete understanding of mortality processes impacting reservoir fish was developed, appreciating the management implications of this information would require an assessment of the rates of mortality for stream-rearing fish, which was not provided.

Other projects propose to release numerous unmarked hatchery fish into Lookout Point reservoir (e.g., an ODFW proposal by Johnson and Friesen plans to release 50,000 65 mm Chinook [PIT tag only] and 50,000 40 mm Chinook [unmarked] above Lookout Point reservoir). How will these unmarked hatchery fish be identified and considered in this evaluation? Is this project coordinated with other projects in the watershed?

Methods

There were several areas where methods may be improved, and while some appeared to be mostly consistent with the objectives of examining fish rearing in streams versus reservoirs (e.g., growth and diet), others did not (ATPase activity and predation studies). Our concerns and questions are listed here:

1. It was not clear how many fish will be PIT-tagged in the reservoir. It would seem that a large sample of fish would require tagging if recaptured fish are to be used to determine migration patterns and growth rates. Exploration of the sample size requirements would assist.
2. Results of gill ATPase measurements of fish collected at Cougar Reservoir may not be transferable to other reservoirs. Would it be possible to collect a smaller number of samples at reservoirs other than Cougar to provide a preliminary indication of the generality of the results being obtained at Cougar?
3. Comparison of juvenile Chinook salmon growth rates will be compared between reservoir-rearing and stream-rearing populations by capturing and measuring the size of fish in late August. However, fish will be captured using different methods in the stream and reservoir. If there is any size-bias in either of the capture methods, the comparisons of body size may be incorrect. Some evaluation of size-bias of the capture methods should be attempted to address this problem. Another option would be to base the growth rate comparisons on changes in body size over the summer in tagged fish which are recaptured. This method would require marking stream-rearing fish as well as reservoir fish.
4. Methods are needed to distinguish hatchery and wild fish. Are all hatchery fish marked (see note above indicating many unmarked hatchery releases)? Examination of differences in life-history characteristics of hatchery and wild fish which use the reservoirs seems critical towards interpreting the results.
5. Better scientific methods may be required for some aspects and should be explored, including the use of hydroacoustic surveys to determine distribution and dispersion, which appear as key information needs.
6. How the information comparisons of growth and ATPase between reservoirs and streams might be used is also unclear.
7. Provisions were not adequately described for monitoring and evaluating the ultimate result, i.e., effects to overall recruitment, if differences exist and are measureable.
8. The project describes mainly observational data collection and no experimental manipulation or hypothesis testing. An experimental management approach could prove more fruitful, including size-stratified marking (tagging), as well as spatial and temporal comparisons of survivals of smolts.

Relevance to the BiOp

See comments above on the objectives. Clearly understanding how these reservoirs impact juvenile Chinook salmon is important to achieving recovery for spring Chinook populations in the Willamette

Valley. However, the set of studies proposed here will only provide a partial answer to this question. Studies should be focused on developing an understanding of the survival rate and size of smolts produced by reservoir-rearing and stream rearing fish and the subsequent survival of smolts from each of these habitats to adult. The relationship of some of the proposed study elements to this overarching objective is not clear.

Research Plan (Background and Past Results)

The background information to be collected may provide some context for the importance of understanding the effect of reservoirs on juvenile Chinook, especially related to smolting. Nonetheless, the information really does not provide a rationale for all the project objectives. Several examples are provided where improvements are suggested:

1. Little information is provided regarding the significance of migration patterns in the reservoir for subsequent juvenile Chinook performance.
2. Differences in ATPase activity seem obvious (those that migrate will have higher levels than those that do not). How does this inform management?
3. A more thorough treatment of what is known about predation in reservoirs on juvenile Chinook also could have been included.
4. A conceptual model of the interaction factors potentially affecting reservoir-rearing and stream-rearing Chinook would be a useful addition to this section and would help to place the project objectives in a broader context.
5. Inclusion of a full life history model and *a priori* exploration of the potential differences of stream versus reservoir rearing by Chinook juveniles, by examining potential impacts to recruitment, including effects of size and age differences on adult return time, age, size, and fecundity, and other life history characteristics, would assist development of an experimental plan to assess these differences and would assist informing the data requirements of the project.

The background information that might be provided by this project is not meant to be a comprehensive life history study but rather a study to fill some gaps in life-history information that would complement other ongoing and proposed studies. More specific details of exactly how the proposed life-history studies will complement these other projects would help. A review of the draft 2011 Comprehensive Plan for Research, Monitoring, and Evaluation of the Willamette Valley Project indicates that this proposed project includes elements of several studies proposed in the plan to address key uncertainties, for example, 1) J1 Timing, Abundance, and Size Distribution of Natural-Origin Juvenile Chinook and Steelhead Emigrants Above and Below WVP Dams; 2) J2 Reservoir Use by Juvenile Chinook and Steelhead under Current and Alternative Operations at WVP Dams; and, particularly, (3) J5 Habitat Use, and Reach Abundance and Survival of UWR Juvenile Chinook and Steelhead below WVP Dams. The proponents should be encouraged to develop a revised proposal that indicates the relationship of their objectives to the Comprehensive RME Plan.

15. Comparing the Effectiveness of Head of the Reservoir Collection and Transport with Direct Reservoir and Dam Passage

Study Code: TBD (Juvenile Passage 6)
Proponents: ODFW

ISRP Recommendation: Meets scientific review criteria (qualified)

Qualifications are that the proponents provide some additional discussion and details in Sections II and III of their proposal in response to ISRP comments/questions below, specifically on methods.

ISRP Comments:

Goals and Objectives

The effectiveness of head of reservoir collection and transport from the head of reservoir collection point to a release site below Dexter Dam are not actually being done. This indicates that the title is somewhat misleading and should be changed, unless this is a multi-step research project. If so, then a timeline showing a phased approach or plans for studying the efficacy of head of reservoir collection should be provided or referred to.

The second goal – to evaluate the effectiveness of direct passage through Willamette Project dams and the three objectives related to this goal – is adequate. The authors could be more explicit in the goals statement that this study is phase one of two phases.

Methods

The methods described for this study are generally adequate, but the ISRP has several comments and questions and recommendations below for the proponents to consider.

1. The authors need to be more specific about release points below Dexter Dam and above Lookout Point Reservoir and provide a rationale for selecting release points.

2. "The downstream movements of PIT tagged fish (groups J65A and J65B) will be passively recorded; data will be then obtained from the PIT Tag Information System (http://www.ptagis.org/) which reports detections of PIT tags at numerous interrogation sites, including the Sullivan Power Plant at Willamette Falls." As PIT tag detection rates at the interrogation site at Willamette Falls are known to be low, have the proponents considered placing an in-river PIT tag detection array in the lower Middle Fork prior to confluence with the mainstem Willamette? Additionally, can PIT tag detectors be installed at Dexter Dam or Lookout Point Dam? Given the very low detection rate at Willamette Falls (2-6%), additional tag detection facilities would be worthwhile. Additional detection sites would facilitate survival and migration rate analyses.

3. The authors should discuss the fact that the fish used in the study are hatchery fish and passage behavior and survival of wild fish may differ significantly. Furthermore, slowing the growth of the hatchery fish to meet the 40 mm release goal in May could cause many fish from this release group to hold over in the reservoir or lower river and migrate during the following year. Or, are

these fish produced by late spawning Chinook? Will movements and survival of these yearlings be monitored? Do natural 40 mm fry also enter the reservoir in May (in other watersheds 40 mm Chinook typically occur much earlier in the season)?

4. What is the accuracy of the parentage analysis? Can natural Chinook produced by spawners below Dexter Dam be miss-classified and added to one of the study groups? Alternatively, is it possible for some of the study fish to not be associated with the appropriate group? If so, what is the potential for error?

5. Will fish released below Dexter Dam be held there for a while so they can acclimate to the site? Some studies indicate that acclimation is important to survival and straying (Clarke 2010). Will returning adults be sampled downstream of Dexter Dam so that fish that do not swim into the adult ladder at Dexter could be detected? This may be particularly important for the below Dexter Dam release group. Undetected straying of the Dexter release group could bias the survival estimates of this group and potentially suggest (incorrectly) less mortality for passage through the reservoir.

6. We appreciate the presentation of the power analysis to examine adequacy of release numbers. However, the analysis indicates that the proposed release sample size along with "typical" survival (0.1%) for Willamette Chinook is barely sufficient to detect a statistical difference when returns from one group is 50% lower than the other. What does the power analysis indicate when survival is below average? How many more juveniles should be released? Is it possible to increase numbers of fish in the release groups?

7. Is one year of releases sufficient to address the goal?

Relevance to the BiOp

This proposed study specifically responds to BiOp RPAs 4.10, 4.11, and 4.12, and generally to 4.9.

Research Plan (Background and Past Results)

"All juvenile spring Chinook used in this study will be released on (or near) the same date in May 2012, generally reflecting the timing of outmigration by naturally produced Chinook in the Middle Fork Willamette." A reference is needed to document prior knowledge of outmigration timing.

The investigators should be aware of recent and older studies showing the effects of PIT tag loss and tag-related mortality on overall survival estimates (see ISRP 2011-25).

The literature review indicated that transported juvenile salmon tend to have higher stray rates when they return as adults. How will additional straying by the transported fish be evaluated in this study? Can adults be detected at locations below Dexter Dam? Will field crews sample for PIT-tagged Chinook in downstream areas? Collaboration with other studies could be worthwhile.

This proposal only considers transport versus in-reservoir migration. Has the idea of late winter/early spring drawdown of the reservoir been considered as a means to flush juveniles out the reservoir? This

might be an alternative to consider if collection of fish at the head of reservoirs (or at dams) is not efficient.

16. Assess Water Operational Approaches to Reduce Predation on Upper Willamette River Chinook Salmon and Steelhead and Improve Juvenile Fish Passage in Willamette Valley Project Reservoirs

Study Code: Juvenile Passage 9
Proponents: ODFW

ISRP Recommendation: Does not meet scientific review criteria

ISRP Comments:

The basic goal of this proposed project is to produce a white paper to assess the status and significance of predation on juvenile salmonids in the Willamette basin and determine what, if any, operational changes of Willamette Valley Project Dams are necessary and feasible to reduce predation. The paper will also assess how operational changes would affect the outmigration of juvenile salmonids. This project is basically a literature review using standard procedures to locate information of interest. The title should be changed to reflect that this is a review project.

This proposed project responds to RPA 4.10 "…if juvenile fish are exposed to heavy predation while in the reservoir, then efforts would need to be directed at either head-of-reservoir collection, reducing predators or predator habitat, or reservoir operations that would encourage juvenile fish to quickly migrate downstream." However, it would need to be more comprehensive to have better relevance to the BiOp. As it stands, it is only a first step.

A literature review and the examination of operational possibilities to reduce predation is a necessary part of scientific proposal preparation, and not an end in itself. Further, it does not adequately address the stated objective of examining the "status and significance" of predation on juvenile salmonids at existing dams – this requires field work, and that is not proposed here. The proposers appear to have a good grasp of available information and data, and most likely already know some of the priority research issues to be pursued.

17. Monitoring upstream migration, distribution, and pre- and post-spawn survival of adult UWR winter steelhead and summer steelhead

Study Code: Study Integration and System Performance 1; FP-09-04, FP-10-03
Proponents: UI, ODFW

ISRP Recommendation: Meets scientific review criteria

ISRP Comments:

The proposal should look at contaminate loads in the fish.

Goals and Objectives

This proposal describes an interesting investigation, and apparently a much needed one. There are quite a few objectives for one study, causing some concern about the feasibility of accomplishing them all successfully. The proponents might consider focusing on only those objectives most critical to meeting recovery goals. However, the objectives are completely described and, if all could be achieved, these objectives will provide information that may be important to the recovery of winter steelhead. The one objective that doesn't relate as clearly to recovery goals is objective 5, which is optional. Objective 5 will examine the fate of summer steelhead collected at Dexter Dam and released downstream to provide additional angling opportunity. The proposal indicates that native winter steelhead in the Willamette system typically are found in tributaries lower in the system than the Middle Fork. Therefore, an improved understanding of the fate of the summer steelhead released at Dexter Dam may not provide much information regarding interactions between introduced summer-run fish and the native winter run steelhead. Understanding the effect of introduced summer steelhead (i.e., Skamania stock) and hatchery winter steelhead (i.e., Big Creek stock) on native winter steelhead would seem far more important to recovery efforts for winter steelhead. Would it be possible to conduct the assessment planned for Dexter Dam in one of the tributaries more heavily utilized by native winter steelhead?

The proposal also notes that the final set of objectives may change somewhat (or change in emphasis) due to a final decision from the Corps regarding the stocks on which they want the study to focus. The proposal indicates that adult steelhead from summer and winter run fish will be collected at Willamette Falls and tagged. This tagging design would enable all project objectives to be addressed except Objective 5 (Dexter Dam tagging). It is not clear how the Dexter Dam tagging would contribute to a better understanding of the factors impacting native winter-run steelhead. However, tagging fish at Dexter Dam will not provide any indication of these interactions. The project proponents indicate that the project focus may shift to a comparison of hatchery versus native winter steelhead or late versus early run winter run fish. It would seem that either of these later alternatives would preclude an assessment of interactions between summer run and winter run fish. Given the relatively large size of the summer run, it would seem that understanding their effect on native winter run fish would be a priority objective.

Methods

The tagging and telemetry methods are generally well suited to project objectives and are thoroughly described. There were, however, a number of elements of the proposal that would have benefitted from

additional clarification. The section describing statistical analysis of the data was notably incomplete. The proposal states, "The proposed sample size should provide quantitative estimates of passage times, fate, distribution into tributaries, and relative estimates of population composition and timing." No indication of the sample size required to achieve these objectives is provided. Is the sample size large enough to be statistically valid? The minimum sample size should be established *a priori*. In addition, the analytical techniques to be applied were not described. The authors indicate that sample size will dictate statistical analysis methods. However, a minimum sample size and an analytical technique appropriate for those data should have been associated with each objective. In addition, the proposal needs to describe how data will be stored and archived for use by others. The information gathered from this project is a resource for all to use.

Some of the sampling methodology also requires some clarification. On page 10 the proposal indicates that "We propose to sample 100-200 adults of each run …" whereas, in other places, the proponents seem to indicate that the total number of fish sampled from all runs is ~200. Objectives 3c and 4g plan to use "PIT tag data from the double-tagged (radiotelemetry and PIT tag) sample plus data from up to an additional 200-300 steelhead of each run…" Depending on the size of individual runs, this could mean capturing (handling) and tagging nearly all the fish. Does this present a problem in terms of potential stress on these listed populations? Finally page 11 notes "Complementary analyses of scales and/or otoliths could efficiently be incorporated to ongoing Chinook salmon life history studies by UI (Caudill and Kennedy)." The ongoing study is not adequately described in the proposal. What are the objectives of the scale/otolith analyses? What incremental benefit will analysis of scales and otoliths collected in the proposed study provide to the ongoing study? Additional justification for this aspect of the proposal is required.

The project timeline also appears to be overly ambitious. It seems unlikely that the project could commence in early 2012. It may be necessary to delay the start for 6-8 months, thereby giving enough time to prepare everything for 2013 start. The project timeline also does not provide time for analysis and writing. Finally, the specific responsibilities of each researcher are not described in the proposal.

Relevance to the BiOp

Understanding the migration behavior and spawning distribution of native winter run steelhead in the Willamette and their interaction with introduced, summer run fish is very relevant to the recovery of Willamette steelhead.

Research Plan (Background and Past Results)

The background and past results are described, but, as noted above, the ongoing UI study on Chinook life history was not described. As the life history study and the proposed work are closely related, additional detail on the life history study would have been appropriate.

18. Monitoring upstream migration and potential causes of prespawn mortality in adult UWR Chinook, Middle fork Basin of the Willamette River

Study Code: None
Proponents: UI, ODFW

ISRP Recommendation: Meets scientific review criteria

ISRP Comments:

Goals and Objectives

Given the high rates of pre-spawn mortality of Chinook salmon in the Willamette River system, a better understanding of the factors contributing to early death of the fish could make an important contribution to recovery. The list of specific objectives given in the proposal address some of the key uncertainties related to this issue and are focused on providing information that can be used to modify management approaches. A thorough discussion of the current state on knowledge about pre-spawn mortality and a review of the results that have been obtained to date from this study are used as a basis for the development of these objectives.

Methods

Methods are generally described completely and are appropriate for the project objectives. There were a few elements of the methods that would have benefitted from more complete description, however. An experiment to assess the use by salmon of cool, hypolimnetic water in reservoirs was briefly mentioned, but no details are provided about this aspect of the project. How many fish have been involved in this study to date? The proposal mentions that this aspect of the project will be expanded but does not elaborate on what this expansion will involve. Will more fish be tagged and released into the Fall Creek Reservoir? Will the releases be expanded to other reservoirs? More detail should be provided here. The discussion about Objective 1g was incomplete. More detail about the watershed/habitat characteristics that will be included in the analysis and how this information will be obtained is required. For example, land use is noted as one of the watershed characteristics that will be included. Is the assumption that land use will adequately reflect channel habitat conditions (i.e., channels on agricultural lands all exhibit essentially the same conditions)? Or will actual information on channel conditions be collected? Actual information on the channel conditions that are considered to be most important for adult salmon would provide a much more accurate picture of conditions being experienced by the fish. Aspects of water quality, other than temperature, are only superficially addressed in the proposal. Contaminants have been identified as a primary cause of pre-spawn mortality of coho salmon in the Puget Sound region. The fact that the Willamette River is heavily influenced by urban and agricultural land use, both of which can produce heavy contaminant loads, raises the possibility that this factor may be playing a role in pre-spawn mortality of Chinook. Available data on water quality of the Willamette system, coupled with supplemental sampling of those sites that are used most heavily by the fish (based on the radio-tag data) would provide an indication of the chemical environment to which the fish are exposed. Comparison of contaminant levels in fish that successfully spawned and those that died prior to spawning also could help indicate the significance of this factor in pre-spawn mortality. The data to be used to address Objective 2b also would benefit from a more complete discussion. The proposal indicates that existing water temperature data will be used to

identify the suitability of potential adult salmon release sites. The proposal also indicates that a temperature logger will be deployed in NFMF and Fall Creek to augment existing information. But no indication is given of the amount of water temperature data available on which to base these recommendations. Some review of data availability would have provided an indication of the feasibility of achieving this objective. Despite these quibbles, however, the methods were very appropriate and adequately described. The statistical methods also were well covered, and the inclusion of a decision-support tool to aid in weighing management options is an effective way to help ensure the application of project results.

Relevance to the BiOp

The project is highly relevant to the recovery of spring Chinook in the Willamette system. Given the high rates of pre-spawn mortality at some sites and in some years, addressing this problem could make a significant contribution to the recovery of spring Chinook in this system.

Research Plan (Background and Past Results)

The proponents provide abundant detail on how they will proceed with regard to each objective. This is a well-crafted proposal that will provide important insights into the causes of pre-spawn mortality.

Attachment 1. Review Request Letter from the U.S. Army Corps of Engineers to the ISRP

[Header modified from original letter]

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, PORTLAND DISTRICT PO BOX 2946
PORTLAND OR 97208-2946

NOV 0 1 2011

Planning, Programs and Project Management Division

Erik Merrill
Manager, Independent Scientific Review Program
Northwest Power and Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204

Dear Mr. Merrill,

As part of our ongoing efforts to support implementation of the National Marine Fisheries Service's 2008 Biological Opinion on effects of the Corps Willamette Project, we are requesting a formal scientific review of three documents and several scientific study proposals by the Independent Science Review Panel. The documents include:

- Comprehensive Plan For Research, Monitoring and Evaluation of the Willamette Valley Project
- Willamette Mitigation Hatchery Program Research, Monitoring and Evaluation Plan (included as Appendix C in the Comprehensive Research Plan)
- Willamette Hatchery Mitigation Program Three-Year Monitoring and Evaluation Plan (included as Appendix D in the Comprehensive Research Plan)
- Fiscal Year 2012 Research Proposals -packet of proposals submitted to address high priority research needs identified through our annually planning process for Fiscal Year 2012.

The Comprehensive Plan is concurrently in review by the Willamette Action Team for Ecosystem Restoration (WATER) Research, Monitoring and Evaluation Team until November 18th. Other materials have already been reviewed by WATER.

We are working with WATER to refine the list of questions to help focus the Panel's review and identify areas for which we are seeking the Panel's input. We will transmit this list of questions by the week of November 6th.

We would appreciate receiving comments back by December 9th, 201 1, so that we can consider incorporating any recommendations from your Panel into our Fiscal Year 2012 research plans.

The time you and the Panel took by joining us on a field tour to become familiar with the Willamette Project was greatly appreciated, and we look forward to receiving your written comments. Should you have any questions as you proceed with your review, please contact Rich Piaskowski of my staff at (503) 808-4775, or at richard.m.piaskowski@usace.anny.mH.

Sincerely, [Signed by Joyce Casey, Chief, Environmental Resources Branch]

Attachment 2. Questions for ISRP review of the Willamette Comprehensive RM&E Program (11/14/11)

Comprehensive RM&E Plan

1. Does the Comprehensive RM&E Plan (Plan) contain an effective and sufficient strategic framework to support implementation of the NMFS 2008 Biological Opinion RPA?

   Specifically:

   a. Does the Plan identify the appropriate critical questions and study approaches supporting identification, design and implementation of actions to address specific RPA measures for:
      i. adult fish trap and haul protocols and facilities;
      ii. re-establishing wild populations above dams (initially using hatchery origin fish where necessary);
      iii. downstream fish passage around or through reservoirs and dams;
      iv. temperature and TDG conditions below dams,
      v. flow management below dams for fish and aquatic habitat;
      vi. managing hatchery effects on wild fish?
   b. Does the effectiveness monitoring framework provide for a clear adaptive management decision path?
   c. Juvenile downstream passage: Are the study approaches in the Plan and in the FY12 proposal packet appropriate for evaluating survival and life history diversity of juvenile Chinook and steelhead under two general proposed passage alternatives: 1) entering reservoirs with collection and/or passage at the dam(s); or 2) collection at or near the head of a reservoir with transport to below dam(s)?
   d. Are there other study types that should be included that better answer critical questions in a timely manner to improve fish passage, flows, water quality, hatchery effects on wild fish, and habitat restoration (e.g. for evaluating growth, survival and migration of salmon entering reservoirs as fry)?
   e. Does the Plan identify the appropriate metrics and approaches for evaluating the effectiveness of actions at different scales (e.g. the specific project, population, and ESU/DPS levels) in order to determine if the RPA is effectively addressed?
   f. Does the Plan identify a sufficient framework for testing whether implementation of a related suite of RPA measures for: 1) adult fish passage/reintroduction actually leads to greater spawning success (metric to be identified) over current conditions, 2) juvenile fish passage lead to greater overall migration survival?
   g. Is the framework and metrics described in the plan useful for programs in addition to implementation of NMFS' RPA (e.g. UWR Chinook and Steelhead Recovery Plan)?

2. Given 1) the state of knowledge of the problem and potential solutions, 2) the experience/feasibility of available techniques for completing scientific studies under local Willamette Project conditions, and 3) RPA completion deadlines for specific actions: Are the sequence and timeframes for each study type in the Plan's subbasin schedules (Chapter 5) appropriate for addressing critical information needs associated with implementing the subbasin specific RPA measures listed in the Plan?

Including:

a. Pre-spawn mortality –
    i. Should investigation into causes and solutions for adult Chinook pre-spawn mortality (PSM) be completed, given 1) the state of knowledge regarding Chinook PSM in the Willamette and 2) the schedule for implementing specific RPA measures for fish passage, flows, water quality, adult passage, effects of hatchery management on wild fish, and habitat restoration?
    ii. If yes for question 2.a.i., are the critical questions and study types listed in Section 2.4 appropriate (i.e. will investigation of those critical questions following the general study types presented in Section 2.4 efficiently and effectively identify causes and solutions for PSM)?
    iii. Should PSM investigations and analysis focus on determining the specific project effects, or widespread environmental effects common to all populations, in order to help determine what can be affected by management actions and what cannot?
b. Juvenile survival and migration below Willamette Project dams –
    i. Should investigation into timing of use and survival of juveniles in Willamette tributaries below dams, and/or in the mainstem Willamette be completed, given 1) the state of knowledge regarding Chinook use and survival in the Willamette Basin below dams, and 2) the schedule for implementing specific RPA measures for fish passage, flows, water quality, adult passage, hatchery management, and habitat restoration?
    ii. If yes for 2.b.i., are the critical questions and study types listed in Section 2.1 appropriate (i.e. will investigation of those critical questions following the general study types presented in Section 2.1 efficiently and effectively identify timing of use, survival rates and associated limiting factors)?
    iii. How important is considering life history diversity, survival and use (including migration timing) of the lower mainstem Willamette, Lower Columbia River, and Columbia River estuary by Willamette juvenile Chinook and steelhead when planning and implementing improvements for Chinook and steelhead at the Willamette Project dams? What coordination opportunities do you see, given ongoing work in the Lower Columbia and estuary?

FY12 Concept Papers and FY12 Research Proposal Packet

1. *Concept papers*: Do the FY12 concept papers contain the necessary objectives, and are the objectives stated clearly and accurately, to support development of proposals to address critical subbasin information needs in FY12, considering the implementation order of NMFS RPA, 2011 Recovery Plan priorities, and data gaps and schedules presented in Chapter 5 of the Plan?

2. *Proposals*: Does the FY12 research proposal packet include the necessary studies to address critical subbasin information needs in FY12, considering the implementation order of NMFS RPA, Recovery Plan priorities, and data gaps and schedules presented in Chapter 5 of the Plan?

3. Are the FY12 research proposal study approaches and designs appropriate to efficiently and effectively address the objectives as stated in the proposals?

Attachment 3. Agenda for Orientation Tour of the Willamette Project

October 3-5, 2011

Monday, October 3rd – North Santiam Subbasin

8:45 am Meet in Portland at the Hilton on Broadway between Salmon and Taylor.
9:00 am Vanpool departs Portland.
10:00 am Arrive in Salem for orientation meeting at the Cherry Ave Training Center
11:30 am Depart for Detroit Dam
12:30 pm Arrive at Detroit Dam. Tour area features and Willamette Project facilities:

- Minto adult collection stopover (if time permits)
- Detroit dam and reservoir
- North Santiam upstream of reservoir
- Marion Forks Hatchery

4:00 pm Depart for Corvallis
6:00 pm Arrive at Holiday Inn Express (781 NE 2nd ST), Corvallis

Tuesday, October 4th – McKenzie Subbasin

8:00 am Depart Holiday Inn. Pick-up sack lunches.
10:00 am Arrive at Leaburg Dam. Tour area features and Willamette Project facilities:

- McKenzie River
- Cougar Dam and adult collection facility
- Cougar temperature control tour
- Cougar Reservoir
- South Fork McKenzie

2:30 pm Depart for Green Island habitat restoration site
4:00 pm Arrive at Green Island habitat restoration site
5:00 pm Depart for La Quinta Inn and Suites (155 Day Island Road), Eugene
5:30 pm Arrive at La Quinta Inn and Suites

Wednesday, October 5th –Middle Fork Subbasin

8:00 am Depart La Quinta Inn and Suites - Eugene
8:30 am Arrive at Dexter Dam. Tour area features and Willamette Project facilities:

- Dexter Dam and adult collection facility
- Lookout Point dam and reservoir
- North Fork of the Middle Fork Willamette
- Willamette Hatchery
- Fall Creek and/or Hills Creek dams – as time allows

Grab snacks and lunch in Oakridge
2:00 pm Depart for Portland
5:00 pm Arrive at Hilton in Portland on Broadway between Salmon and Taylor

References

Bottom, D. L., and 7 others. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. United States Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-68:246. (B2, C7, D7).

Buhle, E. R., K. K. Holsman, M. D. Scheuerell, and A. Albaugh. 2009. Using an unplanned experiment to evaluate the effects of hatcheries and environmental variation on threatened populations of wild salmon. Biological Conservation 142:2449-2455.

Burgner, R.L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (Oncorhynchus mykiss) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51. 92 p.

Burla, M., A.M. Baptista, E. Casillas, J.G. Williams, and D.M. Marsh. 2010. The influence of the Columbia River plume on the survival of steelhead (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*): a numerical exploration. Canadian Journal of Fisheries and Aquatic Sciences. Volume 67, Number 10, 1 October 2010, pp. 1671-1684(14).

Chapman, D.W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Trans. Am. Fish. Soc. 117:1–21.

Claiborne, A.M., J.P. Fisher, S.A. Hayes, and R.L. Emmett. 2011. Size at release, size-selective mortality, and age of maturity of Willamette River Hatchery yearling Chinook salmon. Trans. Am. Fish. Soc., 140:1135-1144.

Clarke, L. and four co-authors. 2010. Post-release performance of acclimated and directly released hatchery summer steelhead into Oregon tributaries of the Snake River. N. Am. J. Fish. Manage. 30:1098-1109.

Cole, T. and Wells, S.A. 2001. CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.1. Report EL-2001-USA. Engineering and Research Development Center, Waterways Experiment Station, Vicksburg, MS.

Connor, W.P., and K.F. Tiffan. 2009. Research, monitoring, and evaluation of emerging issues and measures to recover Snake River fall Chinook salmon ESU. 2007 Annual Progress Report to the Bonneville Power Administration, Portland, OR. Project No. 1991-029-00.

Farrell, A.P., P. Gallaugher, C. Clarke, N. DeLury, H. Kreiberg, W. Parkhouse, and R. Routledge. 2000. Physiological status of coho salmon (Oncorhynchus kisutch) captured in commercial nonretention fisheries. Can. J. Fish. Aquat. Sci. 57: 1668–1678.

Fausch, K. D., C. E. Torgersen, C. V. Baxter, and H. W. Li. 2002. Landscapes to riverscapes: bridging the gap between research and conservation of stream fishes. BioScience 52:483-498.

Greene, C.M., and T.J. Beechie. 2004. Consequences of potential density-dependent mechanisms on recovery of ocean-type Chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish. Aquat. Sci. 61:590–602.

Henny, C.J., R.A. Grove, J.L. Kaiser, B.L. Johnson, C.V. Furl, R.J. Letcher. 2011. Wastewater dilution index partially explains observed polybrominated diphenyl flame retardant concentrations in osprey eggs from Columbia River Basin, 2008-2009. Ecotoxicology 20:682-697.

Irwin, B.J., M.J. Wilberg, M.L. Jones, and J.R. Bruce. 2011. Applying structured decision making to recreational fisheries management. Fisheries 36(3):113-122.

ISAB (Independent Scientific Advisory Board). 2000-4. Recommendations for the Design of Hatchery Monitoring Programs and the Organization of Data Systems. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon. www.nwcouncil.org/library/isab/isab2000-4.htm

ISAB. 2001-1. Model Synthesis Report. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon. www.nwcouncil.org/library/report.asp?d=312

ISAB. 2003-2. Review of Strategies for Recovering Tributary Habitat. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon. www.nwcouncil.org/library/report.asp?d=370

ISAB. 2008-4. Non-native species impacts on native salmonids in the Columbia River Basin. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon.www.nwcouncil.org/library/isab/isab2008-4.htm

ISAB. 2011-1. Columbia River Food-Webs: Developing a Broader Scientific Foundation for Fish and Wildlife Restoration. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon. www.nwcouncil.org/library/isab/2011-1/

ISAB. 2011-4. Using a Comprehensive Landscape Approach for More Effective Conservation and Restoration. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon. www.nwcouncil.org/library/report.asp?d=640

ISRP/ISAB (Independent Scientific Review Panel and Independent Scientific Advisory Board). 2005-15. Monitoring and Evaluation of Supplementation Projects. Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon. www.nwcouncil.org/library/report.asp?d=417

ISRP. 2008-7. Metrics Review: Review of Project Reporting Metrics for the Columbia River Basin Fish & Wildlife Program. Northwest Power and Conservation Council, Portland, Oregon. www.nwcouncil.org/library/isrp/isrp2008-7.htm

ISRP. 2010-29. Final Review of Willamette Bi-Op Habitat Restoration (2009-012-00). Northwest Power and Conservation Council, Portland, Oregon. www.nwcouncil.org/library/report.asp?d=4

ISRP. 2011-25. Retrospective Report 2011. Northwest Power and Conservation Council, Portland, Oregon. www.nwcouncil.org/library/report.asp?d=647

Kostow, K. E. and S. Zhou. 2006. The effect of an introduced summer steelhead hatchery stock on the productivity of a wild winter steelhead population. Transactions of the American Fisheries Society 135:825-841.

Lichatowich, J.A., Mobrand, L.E., Lestelle, L.C., and Vogel, T.S. 1995. An approach to the diagnosis and treatment of depleted Pacific salmon populations in Pacific Northwest watersheds. Fisheries 20:10–18.

Mapstone, B.D. , L.R. Little, A.E. Punt, C.R. Davies, A.D.M. Smith, F. Pantuse, A.D. McDonald, A.J. Williams, and A. Jones. 2008. Management strategy evaluation for line fishing in the Great Barrier Reef: Balancing conservation and multi-sector fishery objectives. Fisheries Research:315-329

Mattson, C.R. 1962. Early life history of Willamette River spring Chinook salmon. Oregon Fish Commission, Portland, Oregon.

McComas,R. L., G. A. McMichael, J. A. Vucelick, et al. 2008. "A Study to Estimate Salmonid Survival through the Columbia River Estuary using Acoustic Tags, 2006." Report by Fish Ecology Division, Northwest Fisheries Science Center and Pacific Northwest National Laboratory (PNNL). Portland, OR: US Army Corps of Engineers and Seattle, WA: NOAA, National Marine Fisheries Service. http://www.nwfsc.noaa.gov/assets/26/6914_05082009_161212_Acoustic-Tag-2006-Accessible.pdf.

McElhany P, Ruckelshaus MH, Ford MJ, Wainwright TC, Bjorkstedt EP. 2000. Viable salmonid populations and the recovery of evolutionary significant units. National Oceanic and Atmospheric Administration, United States Department of Commerce. Report no. NMFS-NWFSC-42. (25 July 2011; www.nwfsc.noaa.gov/assets/25/5561_06162004_143739_tm42.pdf)

McElhany, P., Steel, E.A., Avery, K., Yoder, N., Busack, C., and Thompson, B. 2010. Dealing with uncertainty in ecosystem models: lessons from a complex salmon model. Ecological Applications 20:465-482.

McGarvey, D.J., and J.M. Johnston. 2011. A Simple Method to Predict Regional Fish Abundance: An Example in the McKenzie River Basin, Oregon. Fisheries. American Fisheries Society, Bethesda, MD, 36(11):534-546

McHugh, P., Budy, P., and Schaller, H. 2004. A model-based assessment of the potential response of Snake River spring–summer Chinook salmon to habitat improvements. Trans. Am. Fish. Soc. 133: 622–638.

Peterman, R.M. 2004. Possible solutions to some challenges facing fisheries scientists and managers. ICES Journal of Marine Science 61:1331-1343.

Rich, W. H. 1920. Early history and seaward migration of Chinook salmon in the Columbia and Sacramento Rivers. Bulletin of the United States Bureau of Fisheries 37. 73 pp.

Scheuerell, M. D., R. Hilborn, M. H. Ruckelshaus, K. K. Bartz, K. M. Lagueux, A. D. Haas, K. Rawson. 2006. The Shiraz model: a tool for incorporating fish-habitat relationships in conservation planning. Canadian Journal of Fisheries and Aquatic 63:1596-1607.

Schroeder, R.K., K.R. Kenaston, and L.K. McLaughlin. 2007. Spring Chinook in the Willamette and Sandy Basins. Annual Progress Report, Fish.

Sharma, R., Cooper, A.B., and Hilborn, R. 2005. A quantitative framework for the analysis of habitat and hatchery practices on Pacific salmon. Ecol. Model. 181:231–250.

Sloan, C. A., and 7 others. 2010. Polybrominated diphenyl ethers in outmigrant juvenile Chinook salmon from the lower Columbia River and estuary and Puget Sound, Washington. Archives of Environmental Contamination and Toxicology 58:403-414, doi 10.1007/s00244-009-9391-y.

Steel, E.A., Fullerton, A., Caras, Y., Sheer, M., Olson, P., Jensen, D., Burke, J., Maher, M., and McElhany, P. 2008. A spatially explicit decision support system for watershed-scale management of salmon. Ecology and Society 13 (2 (50)): [online] URL: www.ecologyandsociety.org/vol13/iss12/art50/.

Steel, E.A., P. McElhany, N.J. Yoder, M.D. Purser, K. Malone, B.E. Thompsen, K.A. Avery, D. Jensen, G. Blair, C. Busack, M.D. Bowen, J. Hubble, T. Kantz, L. Mobrand. 2009. Making the best use of modeled data: Multiple approaches to sensitivity analysis. Fisheries 34 (July): 330-339.

Tappel, P.D., and Bjorn, T.C. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. N. Am. J. Fish. Manag. 3:123–135.

Tucker, S., M. Trudel, D.W. Welch, J.F.T. Morris, J.R. Candy, C. Wallace, and T.D. Beacham. 2011. Life-history and seasonal stock-specific ocean migration of juvenile Chinook salmon. Trans. Am. Fish. Soc. 140:1101-1119.

Walters, C.J. 1986. Adaptive management of renewable resources. MacMillan, NY. 374p.

Wells, B. K., C. B. Grimes, and J. B. Waldvogel. 2007. Quantifying the effects of wind, upwelling, curl, turbulence, and sea surface temperature on growth and maturation of a California Chinook salmon (*Oncorhynchus tshawytscha*) population. Fisheries Oceanography 16:363–382.

Wipfli, M.S. and C.V. Baxter. 2011. Linking ecosystems, food webs, and fish production: Subsidies in salmonid watersheds. Fisheries 35:373-387.